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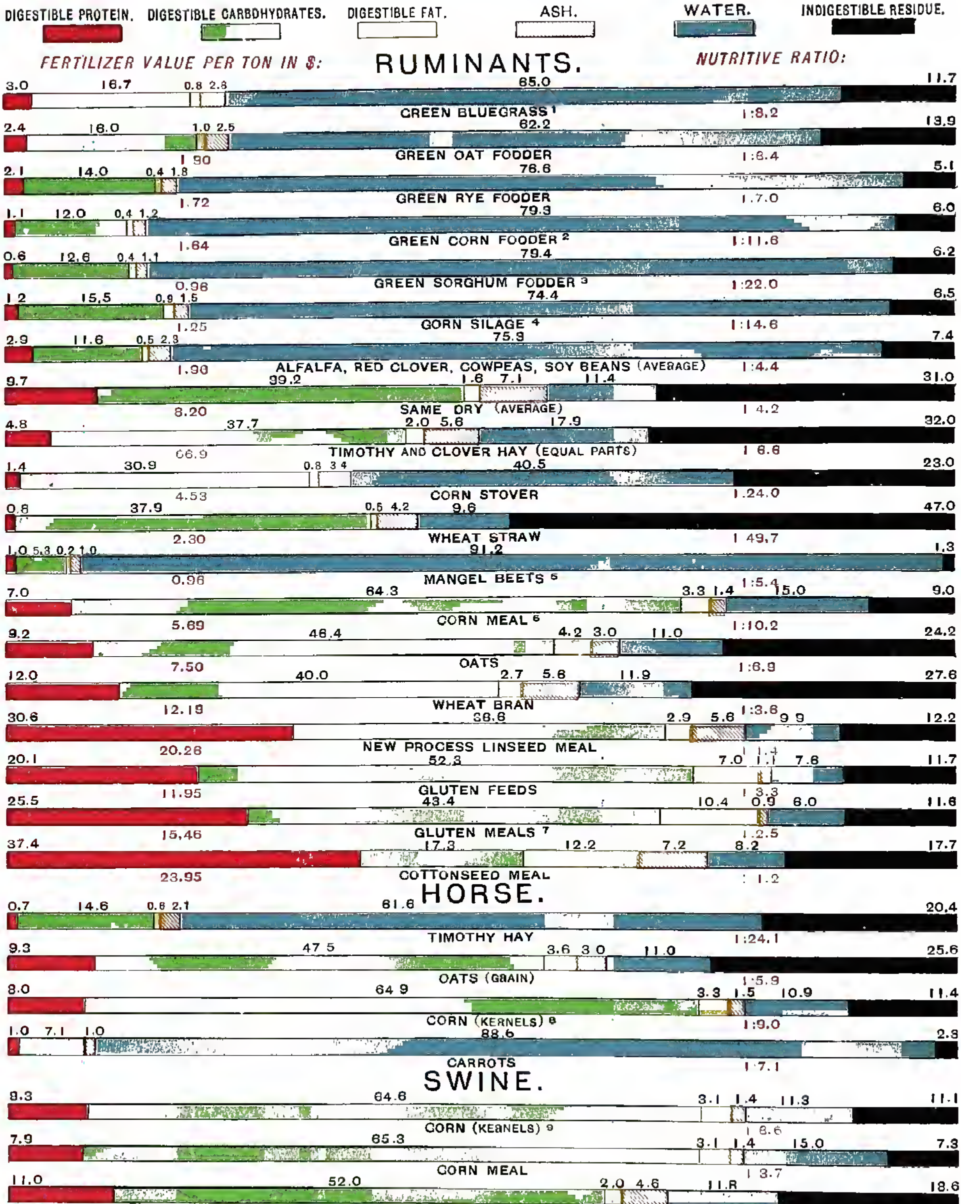
FEEDING CHART.



FEEDING CHART—Notes: 1, 6, 7 Myrick's *Key to Profitable Feeding*. 2 Composition, average of all varieties; digestion coefficient, dent corn. 3 Composition, Henry's tables. 4 Average dent and flint. 5 Massachusetts Experiment Station, 1896. 8 Average of all varieties. 9 Flint corn, digestion coefficients for dent being unavailable. 10 Digestion coefficient for *fat* assumed from results with ruminants. Except as noted, Chart is based on Jordan's figures. It will be observed that the nutritive ratio varies according to digestive power of animal. (Prepared by Willis MacGerald.)

PRACTICAL FARMING

AND

GARDENING

BY

JOSEPH J. EDGERTON, Soil Fertility, Crops
ARTHUR T. ERWIN, Gardening, Trucking
LEVI R. TAFT, Fruits, Forestry
E. S. G. TITUS, Injurious Insects, Plant Diseases
HERBERT W. MUMFORD, Animal Husbandry
L. H. KERRICK, Beef Making
JOHN P STEVENSON, Feeding Native Steers for Beef
DAVID RANKIN, Feeding Range Steers for Beef
R. A. CRAIG, Diseases of Farm Animals
F W. WOLL, Silos and Silage
P. H. JACOBS, Making Poultry Pay

EDITED BY

WILLIS MacGERALD

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Introductory Note

THE LITERATURE OF FARMING

"There are three classes of farmers," says Dean Davenport, of the Illinois State College of Agriculture; "one class studies, experiments, originates; another class emulates the success of the originator, imitates his methods, and in time learns to go to first sources for information; a third has little faith in 'book-learning,' and, misunderstanding success, will neither imitate nor learn. The whole tendency of modern times is to make farming so difficult a calling—so to raise the standard of competition—that the third class will be crowded to the wall and be forced into the poorest lands.'

It is for the class that puts brains into the management of soil and plants and animals that this volume has been published. The several articles have been prepared with a single view to giving a brief, but sufficiently comprehensive, introduction to modern agricultural practice. This composite of the sciences which we call farming is not to be dished up in a single volume; but in a single volume it is quite possible to tell the man who wants to read on any given farm topic, where he may find the book he wants. It is possible, further, to give so clear an insight into the essentials of farming under modern conditions as will simplify and illuminate all future reading, and to add thereto such handbook matter and useful information as every farmer needs, and finds it difficult to obtain at the moment it is needed.

In the preparation of the classified bibliographies, the several specialist contributors have been absolutely uninfluenced by so much as the suggestion of commercial considerations. They have treated each book, as regards omission or inclusion, solely on its merits, as those merits appeared to them. In connection with the book-lists it should be observed that those publications of the United States Department of Agriculture to which no price is attached may be had free of charge on application to the Secretary of Agriculture, Washington, D. C.; those to which a price is attached may be ordered from the Superintendent of Documents, Union Building, Washington, D. C., making remittances by postal money order or registered letter—never in stamps. From the Secretary, also, may be obtained lists to date of the free and priced publications, together with the monthly list of new publications, which is mailed regularly on request.

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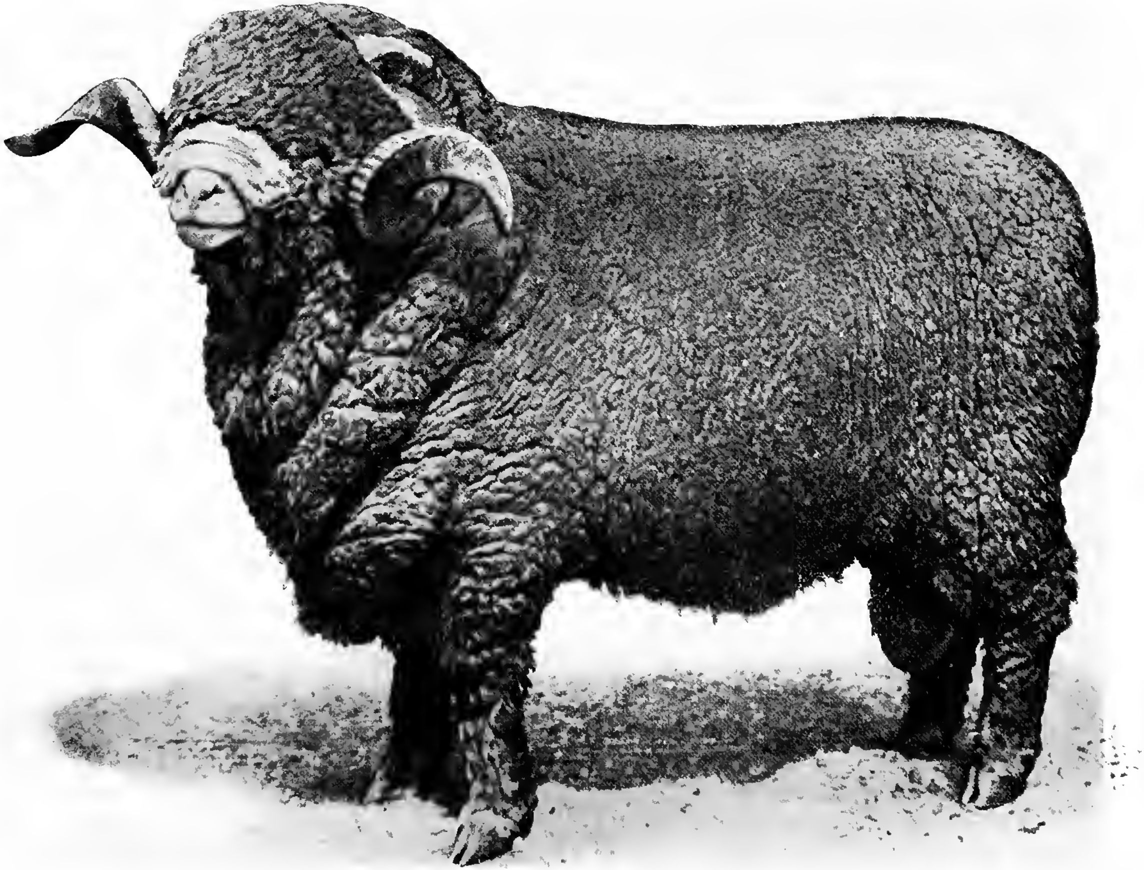

FIG. 1. Typical Rambouillet ram, winner of first prize and champion prize, Paris Exposition of 1900; at thirty months weighed 139 kilograms (306 pounds); bred by M. Victor Gilbert, Wideville (near Crespières) Seine-et-Oise, France. M. Gilbert was the son of the famous Victor Gilbert, for many years director of the French Government at Rambouillet, near Paris, who contributed more to the development of this breed than any other breeder in the world, unless it be the late Baron von Hofmeyer. (From a photograph furnished by *The American Sheep Breeder.*)

PRACTICAL FARMING AND GARDENING

Modern Ideas in Soil Treatment and Tillage

By Joseph J. Edgerton, B. S. A.
Instructor in Agricultural Physics, Iowa College of Agriculture

FUNDAMENTAL NOTIONS

Modern farming, from the very nature of the case, represents no radical departure from the best agricultural practice of earlier days. The advance that has been made is chiefly along the lines of a more thorough understanding of the principles underlying successful method; of the systemization of agricultural research and harmonizing of results; and of the formulation of a body of flexible rules, more or less easily adaptable to the solution of individual difficulties. We can not get away from the necessity for experimentation; for the science is intricate, and the conditions under which its laws operate are ever varying. But instead of being dependent upon his own experiments, as formerly, the farmer is now able, through the accumulation of recorded data of experiments systematically conducted, to profit by the experience of others. In many cases reference to this fund of accumulated experience will enable the present-day farmer to project his operations on a sure foundation, where otherwise he would be compelled to grope his way in the dark and with a great deal of uncertainty as to the final outcome.

In the modern view, the soil is a laboratory, in which plant food is elaborated, and in which, under favoring conditions, the physical and chemical processes of organic growth are carried on. The soil had its origin in the rock masses of the earth's surface, from which it was broken down into its present form by the action of rain, snow, wind, changes of temperature, erosion by rivers and glaciers, the growth and decomposition of vegetation, the burrowing of various forms of animal life, and other similar agencies. Thus it will be seen that the bulk of the soil is decomposed rock, the additional material being organic matter—dead plant or animal tissue, returned to the earth that nourished it, and more or less completely

FIG. 2. Photograph of total root of one hill of corn, showing depth to which this plant penetrates the soil in its search for moisture and food. (Prof. F. H. King: *Physics of Agriculture.*)

broken down into its chemical constituents. This organic matter, called *humus,* is one of the most important factors to be considered in the study of soil manipulation.

Source of Plant Food — Plants, like animals, require both food and water for their sustenance. The water is obtained through the roots. Of the food materials, the carbon and a large part of the oxygen (which together constitute a large percentage of the dry matter of all plants) are, under the influence of sunlight, taken in through the leaves in the form of carbon dioxide,[1] while the *ash* or mineral portion (composed essentially of nitrogen, phosphorus, potassium, calcium, sulphur, iron, magnesium, and possibly sodium and chlorine[2]) is taken up by the roots from the soil. These mineral constituents, with the exception of nitrogen,[3] are rendered available to the roots of the plants by the

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1 This gas exists in the air as a resultant product of animal respiration and decomposition, and of combustion generally.

2 There are other mineral elements found in the ash of plants, some of which, such as silica, are present in large quantities. Their presence, however, is only incidental, owing to their presence in the soil water. They are not essential to the welfare of the plant.

3 This element, owing to its great importance, and the need of a thorough knowledge of its source and the means by which it may be increased, as well as the conditions under which it is lost, will receive especial attention in another place.

gradual decomposition of the rock materials, and their subsequent solution in the soil waters.

Thus physical and chemical action in the soil are constantly transforming *potential* into *available* plant food, and the soil water is transporting the salts thus prepared to the root hairs of the plant. This food-laden water is passed from cell to cell of the plant by what is called *osmotic pressure*,[1] and the excess of water over what is required for purposes of growth finally is transpired from the leaves of the plant, leaving the salts behind to enter into the combination of organized tissue.

This brings us to the consideration of the subject of

SOIL FERTILITY

Determining Factors — Soil fertility is dependent upon natural conditions and upon soil management, and may be defined as *the ability of a soil to produce in response to a given amount of assistance rendered it in the form of cultivation.* This term is too commonly used as referring only to the amount of the mineral elements a soil may contain in a soluble form. But in reality the quantity of salts or mineral plant food a soil may contain is only one of several factors that determine its fertility. In fact, it is a factor of rather secondary importance, because the most plentiful supply of plant food will fail to produce a crop in the absence of sufficient moisture to convey it to and through the plant.

The quantity of soluble salts a soil contains is, nevertheless, of vital importance. While but a very small percentage of the total plant is made up of these elements, this little is just as necessary to the life of the plant as though it comprised the whole. The absence from the soil of any one of these elements will insure as complete a failure of plant growth as though they were all absent. If you plant seeds in a soil from which one of these essential elements, as potash, has been removed, there will be but a very feeble growth of two or three leaves to a plant, and this growth will be accomplished by the aid of the little of this element that nature has stored in the seed for the purpose of securing its germination and start in life. Some of these elements need to be present in much larger quantities than others. Iron, for example, is just as essential for the life of the plant as is any other element, but only a comparatively small percentage is necessary.

In order for a soil to be fertile, it is necessary not only that these elements all be present in a soluble form, but that the quantity be many times greater than the immediate needs of the crop. This is owing to the fact that (a) the root hairs in

[1] *Osmosis* is the term applied to the diffusion of liquids through porous membranes.

penetrating the soil come into contact with a very, very small part of it; that (b) the capillary moisture is frequently so low that but a small portion of these salts is taken up thereby and moved into contact with the plant roots; and that (c) the feeding period of the plant covers but a comparatively short space of time.

It has been found by analyzing plants at various stages of development that, of the total mineral plant food taken up by a crop (wheat being used as an example), 75 per cent of it is taken up during the first fifty days of the plant's life (or, in the case of wheat, by the time it has reached the height of eighteen inches). Considering these facts, it will be readily understood that not only must these materials be present in great abundance, but they must also be in readiness for plant use as early in the season as possible. This early availability will depend, especially as regards the nitrogen portion, upon the amount of moisture, air, vegetable matter, and heat there is in the soil.

Alkali Spots — A soil may be unproductive, on the other hand, from containing too large a quantity of some of these essential salts. Thus are produced what are termed alkali lands, or alkali spots. Through the presence of an excess of these alkali salts the vegetation is corroded and killed. Such soils are referred to as alkali soils, and occur mostly in sections having natural or artificial irrigation. Small alkali patches occur more or less frequently in semi-humid regions where there is a seepage of water from higher lands. The soluble salts in these higher lands, being carried down by the seepage water and left behind upon its evaporation, accumulate to an extent that is injurious to vegetation.

Remedy for Alkali Spots — There are two forms of alkali — the carbonate or "black alkali" and the sulphate or "white alkali." The latter may be present in much larger quantities than the former without producing injurious results.

If the soil is unproductive from too much black alkali, it may often be corrected in part by the application of gypsum or land plaster, to convert the carbonate into a sulphate. In irrigated sections it is well to examine the water used, and, if it is found to contain considerable quantities of carbonate salts, to use land plaster in the irrigation ditches to correct the condition of these salts before reaching the fields.

In semi-humid climates these spots may often be temporarily remedied by scraping off the immediate surface after a long-continued drought, when the long-continued evaporation will have concentrated the greater portion of the excess of salts in the surface three or four inches of soil. Where the trouble is mild a good application of a coarse barnyard manure well worked into the soil will often afford temporary relief. The permanent remedy, however, is underdrainage.

NITROGEN OF THE SOIL

Outside of the elements of plant food contained in water, the nitrogen of the soil is the only constituent supplied to the plants through their roots, the source of which does not lie in the rock fragments, and the supply of which can not be increased by improving the facilities for decomposition.

Source — Its source is the free nitrogen of the air, and the quantity in the soil may be increased naturally only by drawing upon this bounteous supply.

How Obtained — Our ordinary farm crops can not use this nitrogen in its free form, but certain microscopical forms of life that grow upon the roots of leguminous plants (such as clover, lucerne [alfalfa], peas, beans, etc.), forming nodules thereon, have the power of taking this free nitrogen and converting it into organic nitrogen. In the subsequent decomposition of this organic matter the increased supply is made available for the use of succeeding crops. The amount of nitrogen that may be added to the soil by the growing of a single crop of some legume is often relatively very large. When the effect upon future crops or the commercial value of nitrogen as a fertilizer is considered, this collateral benefit derived from a leguminous crop is often greater than the food value of the crop itself.[1]

Except in soils well supplied with nitrogen, in the form ordinarily available, the leguminous plants will not thrive in the absence of these organisms. But if the organisms are present this family of plants will thrive luxuriantly even on soils containing little nitrogen. It follows that, while these organisms are parasitic in their nature, they are in reality a benefit to the host on which they grow. This relation of plants to each other, the growing together for mutual benefit, each obtaining support from the other, is called *symbiosis*. Some soils upon which clover ordinarily refuses to thrive, after being inoculated with these germs by the addition of a sprinkling of soil from an old clover field, will produce clover of the finest kind.

Forms of Soil Nitrogen — Nitrogen exists in the soil in several distinct forms, representing the various stages of transition from the free nitrogen of the air to that form available for farm crops. It may be present :

---

[1] Crimson clover, when from 5 to 6 inches high, has been found to contain nitrogen to the value of $21.94 per acre; from 12 to 14 inches high, to the value of $34.64 per acre; in bloom, $37.06 per acre; fully matured, to the value of $43.36 per acre. (Report of the Superintendent of Institutes for Ontario, Can., 1900.)

(a) As free nitrogen of the soil air, which is seized upon and made fast by the forms of microscopic life previously described.

(b) As organic or albuminoid nitrogen, the product of these nitrogen-fixing germs, and likewise present in all undecomposed vegetable and animal tissue. This is the only form of soil nitrogen that is not soluble in water, and hence readily leached out and lost from the soil.

(c) As ammonia, nitrous acid, and nitric acid. These are transition stages in the development of the nitrate or available form from the organic or albuminoid form.

(d) As nitrates of lime, magnesia, potash, and soda. This is the form in which nitrogen is used by most farm crops, the nitrates being formed by the union of nitric acid with one of the bases—lime, magnesia, potash, etc.—found in the soil.

Nitrification—The process of developing nitrates from the decayed and broken-down albuminoids is termed *nitrification*, and involves four distinct stages: (a) The ammonia stage, in which certain organisms, under the proper conditions of temperature, moisture, and air, feed upon the organic or albuminoid nitrogen, throwing off ammonia as a waste product. This is a highly volatile product, which, under improper soil conditions, may escape from the soil and pass off into the air as gas.[1] But under the proper conditions the ammonia is absorbed by the soil and the soil water, and is retained for the use of another class of germs which in the (b) nitrous-acid stage use it in their life processes, throwing off nitrous acid as a waste product. Still another class of germs[2] take up this nitrous acid and oxidize it into (c) nitric acid, which attacks the bases that are held in the soil by weaker acids, displacing them and forming (d) the various nitrate salts. These nitrates are formed only under favorable conditions of temperature, moisture, and air; and, on the other hand, when once formed, they may, under subsequent unfavorable conditions, be changed back into

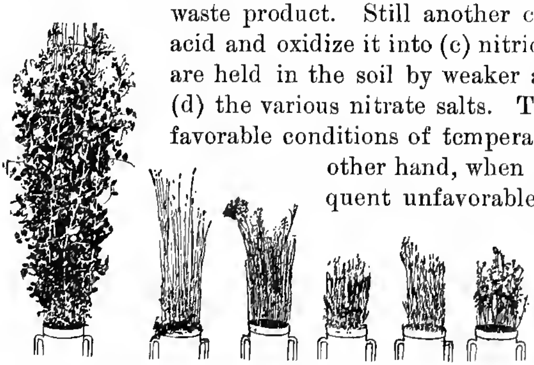

FIG. 3. Drawing from photograph showing comparative growth of peas, rye, flax, oats, wheat, and buckwheat in soil fertile in all elements of plant food except nitrogen, the peas thriving in virtue of the presence of nitrogen-fixing bacteria on their roots. (Prof. F. H. King: *Physics of Agriculture*. After P. Wagner.)

[1] The pungent odor arising from a rapidly-fermenting manure heap is produced by ammonia that is being formed and is escaping to the air.

[2] These are called "nitre germs" or "mother of petre." Some idea of the amount of these nitrate salts that may be developed under proper conditions may be obtained from a consideration of the fact that formerly the nitrate of potash for the manufacture of gunpowder was obtained from the soil. Thereby was developed what was termed "nitre farming," in which the soil was manipulated to get the most rapid nitrification possible.

forms unavailable to crops, or even be lost from the soil. This brings us to the consideration of another process, called :

Denitrification — This process, as the name implies, is exactly the opposite of nitrification. The soil is full of micro-organisms that require oxygen for their existence, and their ability to extract it is such that, if the soil becomes so filled with water as to exclude the air, they will take away that which is combined in the nitrates, either partially or wholly deoxidizing them. In the latter case the nitrogen is set free and may escape entirely from the soil.

Soils Lacking in Nitrogen — A soil that has little nitrogen in the available form will give indication of the fact in the yellow, slender, unhealthy condition of the leaves of the vegetation growing upon it.

To the other elements of plant food obtained from the soil, and the best means of maintaining or increasing their quantity, reference will be made under the head of "Vegetable Matter as a Factor of Fertility."

SOIL WATER AS AN ELEMENT OF FERTILITY

It has been seen that water is the vehicle whereby food, in solution, is conveyed to the root hairs and distributed throughout the plants, besides entering largely into the vegetable structure.[1] It is therefore as essential an element of fertility as is the mineral plant food. Many soils containing a very high percentage of soluble plant food are a barren waste because of lack of moisture, and it follows, by the same token, that any addition of commercial fertilizers to soils deficient in plant food will prove ineffectual unless conditions of moisture are right.

The great semi-desert regions of our western plains, as well as most, if not all, similar regions the world over, show the presence, upon chemical analysis, of a large percentage of soluble plant food, and numerous

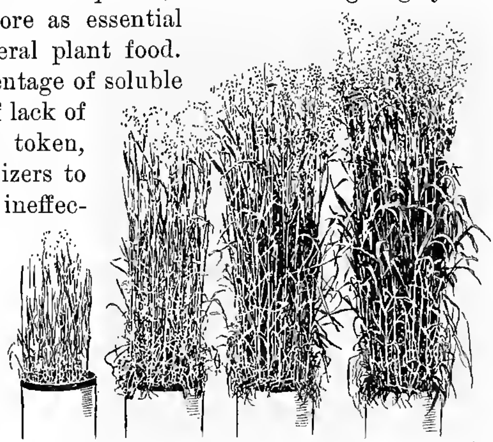

FIG. 4. Drawing from photograph showing oats growing under conditions identical with those illustrated in Fig. 3, except that the several pots received 1, 2, and 3 grams, respectively, of Chile saltpetre. Comparison shows the immense importance to such plants of nitric nitrogen. (Prof. F. H. King: *Physics of Agriculture*. After P. Wagner.)

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[1] Water comprises from 61 to 91 per cent of the total weight of all green crops, the amount varying with the kind of crop and stage of development.

experiments have demonstrated that all that is necessary to make these waste places fruitful is simply to supply the needed moisture.

But water, on the other hand, must not be too abundant. It must not fill all the pores of the soil so as to exclude the air, or the land will be rendered unproductive while this condition exists. Plants that will thrive in water will not thrive in a soil saturated with water, because in the water culture the water is free to move, and, the constant change bringing different parts constantly to the surface and into contact with the air, a certain amount of this air is absorbed, replacing any that may have been taken out by the roots; whereas, in a soil saturated with water there is not this opportunity for the air to enter.

Water in soils is of three kinds — *hygroscopic*, *capillary*, and *free*.

The hygroscopic water is present in the form of a film around each soil grain. Pressure will not expel it. Only heat above the boiling point of water will drive it off.

Capillary water is the outer film around the soil grain, more or less closely filling the interstices, less firmly held than is the inner hygroscopic film by the molecular attraction of the soil, and capable of motion in any direction under stress of capillary attraction.

Free water is that which lies outside the range of control of the molecular attraction of the soil grains, and moves under the influence of gravity. This water practically excludes oxygen from the soil it occupies. Its surface is called the "water table." The capillary water is the only form of soil moisture that to any extent can be made use of by the plants.

Water Required by Crops — The amount of water required in the process of plant building is very large, the various farm crops requiring to be transpired through their leaves from 300 to 600 tons of water for each ton of dry matter produced.

According to Prof. F. H. King, the results of 138 trials with various farm crops show that, to grow an average acre, the product of which was 5.987 tons of dry matter, required 23.165 inches of water. The crop requiring the most was oats, the average yield of this crop being 8.89 tons; and water required, 39.53 inches.

Capacity of Soils for Capillary Water — The amount of capillary water that may be retained in a given quantity of soil will depend upon the fineness of the soil particles, the amount of vegetable matter present,[1] the general physical

[1] The effect of vegetable matter upon the capillary capacity of soils will be referred to more fully under the head of "Vegetable Matter as a Factor of Fertility."

condition, the distance above the water table, and the frequency and amount of rainfall. Prof. F. H. King has found that under field conditions, and with the surface only eleven inches above the water table, soils would contain capillary water as follows:

Clay loam	32.2 per cent.
Clay	23.8 to 24.5 per cent.
Clay and sand	22 6 per cent.
Fine sand	17.5 per cent.

This, when averaged and reduced to inches, is equal to 21.24 inches of water distributed through the first five feet of soil.[1]

Water not all Available to Crops — Of this capillary water only from 50 to 75 per cent can be extracted by the crops for their use, owing to the fact that the roots, while thoroughly permeating the soil, actually come in contact with only a very small part of it; and to the additional fact that, when the water movement through the plant for the translocation of materials falls below a certain rate, growth ceases to take place. Long before this point is reached, growth becomes very slow and imperfect. It frequently happens, in the absence of a properly distributed rainfall, that this condition is reached just as the crop is ready to form the seed or grain. The result is an average and sometimes large growth of foliage, but little grain.

Time of Greatest Need — By far the largest portion of the water used by a crop is required from the time of blossoming to maturity. This period frequently coincides with one of very limited rainfall.

IRRIGATION

It follows from what has been said that the artificial application of moisture may often, even in humid climates, be very beneficial to crops, and the farmer of a humid climate, who is so situated that he can at comparatively small expense maintain a storage supply of water for such use in time of need, will find this a very profitable investment. In fact, the returns should be greater in proportion to the amount invested than in arid countries, where all the water must be supplied in this way. A little additional water applied just at the right time may be productive of large results, even in average years.[2]

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1 A 5-foot column of the same soil would contain less, because the water table would be much farther away from part of it than in the above case.

2 Prof. F. H. King reports the following result of an experiment conducted with a variety of flint corn: On the irrigated soil, 14.5 tons of dry matter were produced; while on the same kind of soil, growing the same kind of corn, not irrigated, but otherwise receiving the same treatment, there were produced only 4 tons of dry matter per acre.

In an experiment conducted by the writer during a year when the distribution of the rainfall was better than the average, an application of water equal to 5 per cent of moisture in the first four feet of soil resulted in increasing the yield of corn from 68 to 91.5 bushels per acre.

The quantity of water required to irrigate a tract of land is seemingly very large. To cover one acre of land one inch deep will require 3,630 cubic feet of water; and to carry this depth of water onto 100 acres, in 50 hours, would require a stream one square foot in cross-section, and flowing at the rate of two feet per second.

TILLAGE TO CONSERVE MOISTURE

Since the annual rainfall for a given locality, while fairly constant, is irregular and uncertain as regards its distribution throughout the season, and since irrigation is not generally practicable, it becomes necessary to conserve the soil moisture and to make the available supply of capillary water as large as possible. These ends are accomplished by such means as proper tillage, underdrainage, and increasing the supply of humus.

Deep plowing and subsoiling on heavy, close-textured clay soils may loosen them up and increase their water-holding capacity. This practice is especially applicable in climates where the frost does not penetrate to loosen up the subsoil. Frequent stirring of the surface soil cuts off the capillary connection with the deeper soil water, and thus prevents its coming to the surface and being evaporated, besides checking the growth of weeds that would absorb moisture needed by the crop. This frequent stirring to check evaporation is necessary for the reason that when the surface is allowed to stand for a short time the capillary connection with the lower ground becomes reëstablished. In case of a rain this reëstablishment takes place very quickly; so, to retain the largest possible amount of a given rainfall, it is necessary to thoroughly stir the surface soil as soon after the rain as it can be done without puddling.[1] Tools used for this purpose should be such as will stir all the surface and pulverize it as thoroughly as possible.

The Harrow — If the surface soil has been previously made very loose, or if it is somewhat rough as left by the plow, harrowing, thoroughly done, may develop a very good mulch. If, however, the surface has become somewhat firm, as after a heavy rain, the harrow may increase the loss by evaporation by simply cutting small furrows and increasing the amount of surface exposed.

The Disk — The disk-harrow or cultivator, as well as the surface cultivators

[1] Very fine-grained soils have a tendency, owing to the close contact of their particles, to contract upon themselves at all times. When they become very wet this tendency is increased. If stirred at the proper stage, as the excess of moisture is leaving, this tendency is readily overcome. If, however, this cultivation is done before a sufficient amount of water has been removed, all parts of the soil subjected to the pressure of the horses' feet and the tools used will be compressed still more, excluding the air and reducing the capillary capacity of the soil. These portions, when dry, form hard clods, and this cementing action in soils is termed puddling.

with blades running horizontally under the surface, form an excellent mulch. The surface is practically all moved and deposited in a different place and in a finely pulverized condition, thus cutting off the capillary connection very completely.

Effectiveness of the Soil Mulch — Professor King found that a 3-inch soil mulch, as against no mulch, conserved from evaporation during a period of 100 days on a black marsh soil 2.928 inches of water; on sandy loam, 3.009 inches; and on virgin clay loam, 13.458 inches.

Depth of Mulch — The same investigator found that during a 100-day period a 3-inch mulch conserved 0.181 inches more water than a 2-inch mulch, and the 2-inch mulch conserved 0.11 inches more than a 1-inch mulch when stirred in the same manner twice a week.

Frequency of Cultivation — Professor King also found that a 3-inch mulch, when stirred twice a week, conserved 0.323 inches more water than when stirred once a week, and that stirring once a week conserved 0.586 inches more than stirring only once in two weeks.

The necessity for frequent cultivation will depend, however, upon the condition of the weather and the character of the soil. Dry weather immediately following the stirring makes the mulch more effective and more lasting.

On a close-grained soil, as clay, the particles tend to draw together and reëstablish capillary connection much more quickly than on a coarser, looser soil, or a soil well supplied with vegetable matter. Hence, the former will require more frequent stirring than the latter in order to maintain an equally good condition of mulch.

Plowing — The time and manner of plowing may affect the quantity of moisture available for a given crop. Ground plowed late in the fall and left in the rough will catch and hold the snows and rains, and will contain a larger amount of moisture the next spring than similar soil left unplowed. On land that is to be put into a fall crop, moisture will be conserved for the starting of that crop by plowing as early as possible after the spring crop has been removed, to save what would otherwise be evaporated through the growth of weeds and other vegetation. Spring plowing, for the greatest saving of moisture, should be done as early as the soil is in fit condition. When the frost leaves the ground, capillary connection between the lower soil and the surface is very complete, and the warm, dry winds that are apt to occur at this time of year frequently cause a rapid evaporation of moisture. At this season a loss of 28.2 tons of water per acre per day for seven consecutive days has been observed. For the same reason, land that has been plowed in the fall should be gone over with the disk-harrow or other effective tool as early in the spring as the condition of the soil will permit, for the purpose of developing a mulch. In the same way, also, evaporation may be checked on unplowed land, where there is more of it than can be plowed in good season.

For the conservation of moisture, plowing at any time of year except late in the fall should be followed immediately by thorough harrowing. Ground freshly plowed, unless very mellow, will allow the air to circulate more or less freely throughout the greater portion of its depth. Such a condition, owing to the large amount of surface exposed, affords an opportunity for very rapid evaporation, and if allowed to go uncorrected, in a dry time, may so reduce the water content of the plowed portion that seeds can not germinate. The writer knows of one instance where there was no rain from the time of plowing in the spring until late in the summer, and land that was plowed and left for some time without harrowing became so dry that the corn, when planted, did not germinate until the autumn rains; while other tracts in the same locality which were not allowed to lie over night, or even during the noon hour, without harrowing, and were kept well cultivated afterward, were by this difference in treatment enabled to produce a fair crop of corn.

The Roller—This implement is used mainly for the purpose of firming the plowed soil, to bring the particles into closer contact. Through this reëstablishment of capillary connection with the deeper soil, the water may be drawn up from the lower levels into the seed-bed, to aid in the germination of the seeds and starting the young plants. When the roller is used it should be followed by some implement that will stir the immediate surface into a dry dust mulch, in order to prevent this water, when drawn up, from reaching the surface and escaping by evaporation.

Level culture will conserve the moisture better than ridged cultivation, there being less surface exposed for evaporation. There is quite a prevalent notion that ridged cultivation will increase the yield of potatoes, but experiments do not bear it out. Late ridging, after the potatoes are set on, may be of some benefit in protecting the tubers from the sun.

UNDERDRAINING TO CONSERVE MOISTURE

The lowering of the water table by underdrainage, on lands where it remains a considerable portion of the time nearer to the surface than four feet, will increase the amount of water available to plants in two ways:

(a) By increasing the supply of capillary water.
(b) By permitting a greater root development.

(a) **Capillary Supply**—The removal of the free water from a soil removes, to a great extent, the tendency of fine-grained soils to contract into a puddled condition, also allowing the various aggregations of particles to become broken up and separated, and the soil to become more free and open generally. In this way the amount of capillary water that a cubic foot of the soil will retain is greatly increased. This more open condition of soil allows a free passage of water through it in all directions, and enables a much larger proportion of a dashing rain to enter it instead of running off the surface. It also enables the surface to more quickly get in readiness for cultivation after a rain, so that a mulch may be developed, to prevent that which is taken in from being lost by evaporation.

(b) **Root Development** — The root systems of farm crops do not, as many suppose, confine themselves to the few inches of soil at the surface, unless compelled to do so by a saturated soil or other impassable barrier. There are few of our farm crops but will penetrate to a depth of four feet if the soil is in proper condition.

Where the soil is free and open to a good depth there will be a much larger and better developed root system, with corresponding increase of capacity for absorbing and carrying moisture to the plant. This last is a most important factor, as it frequently happens, where the water table stands high during the early part of the season, that there is so small a development of roots that, when the plant reaches the stage of most rapid development and most rapid transpiration of moisture, the roots will not be able to take in water fast enough to supply the needs of growth, even with a comparative abundance of water present in the soil.[1]

FIG. 5. Photograph showing root development of oats. (Prof. F. H. King: *Physics of Agriculture*.)

[1] It is due to this fact that crops thrive and develop so much better in a dry summer if preceded by a moderately dry spring than when preceded by a wet one.

HUMUS AS A CONSERVER OF MOISTURE

The supply of humus,[1] as a factor in controlling the capillary supply of moisture, can not be too highly valued. Its presence (a) produces a more porous condition of soil, (b) prevents the soil particles from drawing together in a puddled condition, (c) increases the actual capillary capacity, and (d) tends to prevent the solidifying of the surface, thus serving to check evaporation in the absence of cultivation, and making necessary less cultivation to maintain a good mulch.

AIR AS AN ELEMENT OF FERTILITY

As we have seen, air is necessary in the soil to supply oxygen for the development of the nitrogenous plant food, and in its absence, though only temporary, this plant food, once developed, may be reduced into an unavailable form, or even lost from the soil.

Air is also needed for the processes of decomposition and other chemical action that develop the various forms of plant food. Without air in the soil, the seeds of farm crops will not germinate. If after germination the air be excluded, they will cease to grow, will get yellow and sickly, and, if this condition continues long enough, will die. A soil may also be too open and admit of a greater circulation of air than is best. A very coarse, gravelly soil; land into which a large amount of coarse manure has been plowed; or a piece of poorly plowed land left without any further treatment, may in this way be subject to a loss of moisture by internal evaporation.

The supply of air in the soil may be modified by (a) tillage, (b) kind of vegetation grown, (c) underdrainage, and (d) the addition of vegetable matter.

(a) **Ventilation by Tillage**—Almost all the different processes of tillage produce a change of air at the time, and also affect the movement of soil air for some time to come. Plowing a hard, compact soil breaks it up and admits a freer entrance and circulation of air, whereas, the plowing in of vegetable matter on soils that are too loose and open will result in a beneficial restraint upon this movement.

Subsoiling will increase the air movement in the deeper soil.

Harrowing may check the entrance and escape of air on fresh-plowed land where ventilation is excessive, or facilitate the aëration of lands that have lain without stirring until a crust has formed over the surface. Disking and stirring with the various forms of cultivators give more thorough aëration to the seed-bed.

Rolling, by closing up the pores to some extent, usually results in a lessened

[1] The influence of humus on moisture will be discussed more in detail under the head of "Vegetable Matter as a Factor of Fertility," page 23.

amount of air movement in the soil, and, on soils that are too open, will be beneficial for this purpose.

(b) **Ventilation by Vegetation** — The growth of any kind of vegetation, by drawing the moisture out of the soil, tends to draw air in to take its place. The decomposition of the roots of deep-feeding plants leaves openings that admit of a greater aëration of the deeper soil.

(c) **Ventilation by Underdrainage** — Underdrainage modifies the amount of air in the soil: (1) By removing the free water that would otherwise exclude the air. (2) By loosening up the soil and giving greater freedom of movement. (3) The water in passing from the soil into the drain will tend to draw the air into the soil to fill the space it has occupied.

(d) **Ventilation by Addition of Humus** — Vegetable matter, added to the soil in the form of barnyard manure, stubble, weeds, sod, and other green crops, plowed under, will have the effect of making a close, heavy soil more open, and of binding together those that are too thoroughly aërated.

TEMPERATURE AS AFFECTING FERTILITY

A proper soil temperature is an indispensable factor of a high degree of fertility. No matter how perfect the other conditions, if the temperature is too low germination and growth will not take place. Corn, for example, requires a soil temperature of 60° to 65° Fahr. during a portion of the day, for satisfactory germination. If the soil is so cold as to allow only slow and feeble germination the crop can never make the growth and development that it would under the same after-conditions, but with a good, vigorous start.

A certain degree of warmth is required also for the various chemical changes incident to the decomposition and development of plant food. This is especially true of the nitrogenous plant food. The nitrifying germs do not thrive below a temperature of 55° Fahr., and do not attain their most rapid growth and elaboration of nitrates until the soil temperature gets well up toward 100° Fahr.

The temperature of the soil also affects the rate of plant-feeding. As we have seen,[1] the water and plant food of the soil are supplied to the plant by osmotic pressure, and this, as well as the capillary movement of the soil water, is to a marked degree affected by the temperature. If the soil temperature falls below a certain point, this action may become so feeble as to allow the plants to wilt when there is an abundance of water present in the soil.

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[1] See page 7, footnote.

Poor Stands of Grain are often caused, not by poor seed, as supposed, but because the seed was placed in a soil too cold for germination. The above consideration, coupled with the facts that the soil temperatures, under average field conditions, between latitudes 40° and 45°, will not average above 45° Fahr. for the month of April, or 58° Fahr. for the month of May, and that plants require the bulk of their nitrogenous food during the early stages of growth,[1] emphasizes very strongly the need of increasing the temperature of the soil, especially early in the spring.

Conditions Affecting Soil Temperature — These conditions are as follows: (a) Color of soil, (b) topography of surface, (c) smoothness and compactness of surface, (d) tilth, (e) wetness of soil, (f) rate of evaporation, and (g) amount of vegetable matter being decomposed therein.

(a) Color of Soil — A dark-colored surface will absorb and pass on to the deeper soil more heat from the sun than will a light-colored one, the difference ranging from 1° to 3° Fahr.[2]

(b) Topography — A south slope will receive the sun's rays more nearly vertically than will a level field; hence a given cross-section of heat rays will be spread over less surface of soil than on a level surface, or one sloping away from the sun. Professor King found that a stiff red clay soil, sloping 18° to the south, had a temperature of 70.3°, 68.1°, and 66.4° Fahr. for the first, second, and third feet in depth, as compared with 67.2°, 65.4°, and 63.6° for the same kind of soil and the corresponding depths on a level surface.

(c) Smoothness and Compactness — A rough, uneven surface, owing to the greater amount of surface exposed, will radiate back into the atmosphere a larger portion of the heat received than will an even surface. If the roughness is due to a cloddy condition this loss is aggravated, since the poor connection between the clods and the underlying soil prevents the heat being conducted downward. A firm, compact soil will conduct the heat into the deeper soil much more readily than one that is very loose and open.

(d) Tillage — It follows from what has just been said that thorough cultivation, especially if deep, hinders the conduction of heat to the deeper soil. But while the total amount of heat stored in the soil may be lessened on this account, the temperature of the cultivated portion is very much increased by this concentration. This is one of the chief advantages to be gained by a thorough and early

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[1] See page 9, footnote.

[2] A light-colored soil may be made materially darker by the addition of vegetable matter.

preparation of the seed-bed. Tillage also favors a more rapid decomposition of the organic matter in the soil, which action produces heat. Thorough preparation further increases the temperature of the seed-bed by removing any excess of moisture that may exist, and by checking evaporation from the surface.

(e) Wetness of the Soil — A wet soil is colder than a similar soil when dry, for two reasons: (1) The various chemical changes which produce heat are taking place less rapidly. (2) It requires a greater amount of heat to raise the temperature of a pound of wet soil through any given number of degrees than to effect an equal increase of temperature in the same weight of dry soil. The specific heat of water is much greater than that of soils. To raise the temperature of water a given number of degrees requires nearly ten times as much heat as for sand, weights being equal in both cases. The matter of removing all excess of moisture is therefore very important, from this standpoint. For the same reason the manner of removing should be by underdrainage rather than by evaporation.

(f) Evaporation — This process has a marked cooling effect upon the soil, as much heat being required to evaporate a pound of water from the surface of the soil as would raise through several degrees the temperature of a cubic foot of average soil. Professor King records a difference in temperature, in favor of drained as against undrained soil, as great as 12.5° Fahr. on a cloudy day, and states that the difference is due mainly to difference in rate of evaporation.

(g) Effect of Vegetable Matter — The decay of vegetable matter in the soil increases its temperature (1) by making it darker colored, so that more of the sun's heat will be absorbed, (2) by lessening evaporation of water trom the surface, and (3) by reason of heat produced in the process of decomposition.[1]

MECHANICAL STRUCTURE AND ITS RELATION TO FERTILITY

The size of the soil particles, and their mechanical relation to one another, is not the least of the factors that determine the value of a soil for the production of crops. Soil grains vary in size from the coarse grains of sand down to particles so fine that they can be seen only by the aid of a powerful microscope. The smaller the particles, the larger the amount of soil-grain surface in a cubic foot of soil. A soil with particles of a given average size contains practically ten times as much surface as one whose particles are ten times as large. The amount of surface, other things being equal, determines the rate of solution of the mineral plant food.

[1] Everyone is familiar with the generation of heat in the fermenting manure heap, and with the use of manure to develop heat in hotbeds. The same result follows proportionally upon the decomposition of all organic matter everywhere.

The amount of surface also affects the amount of moisture that may be held in the form of a film around the soil grains. The amount of surface also is a measure of the amount of feeding ground allotted to the plant roots growing in the soil. A column of soil one foot square and four feet in depth (to which depth the roots of most of our farm crops penetrate), whose particles have an average diameter of .01 of an inch, would expose a surface of .34 of an acre, while one whose particles averaged .001 of an inch would have a soil-grain surface area of 3.4 acres. The size of the soil particles very materially affects the amount of pore space in a soil, as well as the size of the pores. The larger the particles, the larger the pores, but the smaller the aggregate amount of pore space;[1] and a greatly lessened proportion of this space will consist of pores small enough to hold water, or to draw it from the deeper soil by capillary attraction.

It follows from the foregoing that, generally speaking, the finer the soil the more capillary water it will retain, and the greater will be its power to draw water from supplies deep down in the earth. It is possible, however, for both water movement and water capacity to be lessened by an extreme fineness of soil grains. In the case of an extremely fine clay soil the particles may be so drawn together by their attraction for each other, rendering the interspaces extremely fine, as to permit only a comparatively small amount of water to enter these various aggregations. An extremely fine-grained soil, with its consequent fine pore spaces, is unfavorable to thorough aëration; neither does it allow the roots proper freedom in penetrating and exploring the feeding ground. Any tendency toward a puddled condition in these soils is apt to affect the uniformity of development of the root systems, and in the case of tuberous crops, as potatoes, or root crops, such as sugar beets, may materially affect the condition and quality of the crop.

How Certain Physical Defects may be Remedied — (a) Tillage when the soil is in proper condition will break up the contracted condition and increase the aëration and capillary capacity of the surface portion of very fine soils.

(b) Freezing expands these soils, forcing the particles apart. Its beneficial effects on a stiff clay soil can hardly be estimated, especially if not counteracted by heavy rains after the frost goes out. The thoroughness with which the frost does this work can not be duplicated by the use of any tool or combination of tools.

(c) Underdrainage, to prevent the free water remaining in the soil, is a great factor in preventing its contraction.

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[1] The amount of pore space in a cubic foot of soil that is unoccupied, or occupied only by air or water, varies from a little more than one-third in the case of a fine gravel to over one-half in some of the finest clay soils.

(d) The growth of grasses whose roots will thoroughly fill the upper soil, and of the legumes, whose larger roots penetrate the deeper soil, is an important aid in loosening up and expanding these soils. The decaying roots and other vegetable matter, if sufficient in quantity, will effectually prevent their contraction into a puddled condition, will render them constantly more loose and open, will make them much more easily cultivated, and, in fact, will improve them in every way. Decaying vegetable matter also tends to bind together those soils that are too coarse and whose pores are too large, increasing their water-holding capacity and decreasing evaporation therefrom.

FIG. 6. Photograph showing root development of medium red clover. (Prof. F. H. King: *Physics of Agriculture.*)

VEGETABLE MATTER AS A FACTOR OF FERTILITY

Lands continuously cultivated gradually diminish in productive capacity. The growth of any kind of vegetation, as we have seen, takes up a certain amount of various mineral elements from the soil. The discovery of this fact, and of the additional one that these several substances are necessary elements of plant food, naturally led to the conclusion that the loss in productive capacity must be due to the diminished supply of mineral plant food, and that any successful effort to maintain or increase the fertility of a soil must lie in the direction of replacing these elements by artificial means.[1]

The table[2] on the following page shows how much of each of the three elements most readily lost from the soil is removed therefrom in the production of various crops.

1 In some of the States more than $6,000,000 is expended annually for commercial fertilizers in an effort to increase the productiveness of the land.

2 Adapted from publications of the United States Department of Agriculture.

FERTILIZING CONSTITUENTS REMOVED FROM SOIL BY GIVEN QUANTITIES OF CERTAIN CROPS

KIND OF CROP.	Weight of Material.	Nitrogen.	Potash.	Phosphoric Acid.
	Pounds.	Pounds.	Pounds.	Pounds.
Alfalfa, dry	2,000	44.00	34.00	10.60
" green	2,000	14.40	11.20	2.60
Barley, grain only	2,000	35.00	12.00	15.00
Beans, kernels only	2,000	80.00	24.00	24.00
Beets, red, roots only	2,000	4.80	8.80	1.80
" yellow fodder, roots only	2,000	3.80	9.20	1.80
" sugar (whole plant, to produce one ton roots)	2,500 to 3,060	4.60 to 12.00	5.54 to 17.20	1.47 to 4.74
Buckwheat, dry hay	2,000	16.70	48.40	12.20
" green, in blossom	2,000	10.20	8.60	2.20
Cabbage	2,000	7.60	8.60	2.20
Carrots	2,000	3.20	10 20	0.20
Clover, Alsike dry	2,000	46 60	40.20	14.00
" " green	2,000	8.80	4.00	2.20
" crimson, dry	2,000	40.00	25.00	7.60
" " green	2,000	8.60	9.80	2.60
" red, dry	2,000	42.00	40.00	10 00
" " green	2,000	10.60	9 20	2.60
" white, dry	2,000	50.00	30.00	14.00
" " green	2,000	11.20	4 80	4.00
Corn, field (kernels and cobs)	2,000	28.20	9.40	11.40
" fodder, dry (with ears)	2,000	36.00	18.00	11.00
" sweet (whole plant, to produce one ton husked ears)	5,260	15.20	17.80	5.80
Cotton (to produce 100 lbs. lint)	947	20.71	13.06	8.17
Cow-pea, dry, whole plant	2,000	39.00	29.40	10.60
" green	2,000	5.40	6.20	2.00
Flax (to produce 100 lbs. fiber)	687	12.37	7.29	6.76
Hemp (to produce 100 lbs. clean fiber)	598	6.27	10.13	3.32
Hops, leaves and stems	2,000	15 00	17.60	8.00
Kentucky blue grass	2,000	23.80	31.40	8.00
Lettuce leaves	2,000	4 60	7.40	1.40
Millet, dry	2,000	25.60	34.00	10.00
" green	2,000	12.20	8.20	3.80
Oats, hay, in bloom	2,000	24.00	50.80	13.40
" green fodder	2,000	9.80	7.60	2.60
" grain only	2,000	40.00	12.00	16.00
Onions	2,000	4.00	3.50	2.50
Parsnips	2,000	4.40	12.40	3.80
Peas, dry, in bloom	2,000	66.00	34.00	10.20
" green	2,000	10.00	11.20	3.60
" seed only	2,000	80.00	20.00	16.00
Potatoes, Irish, tubers	2,000	4.20	5.80	1.40
" sweet, roots	2,000	4.80	7.40	1.60
Pumpkins, whole fruit	2,000	2.20	1.80	3.20
Rice, unhulled grain only	2,000	26 80	5.60	9.40
Rye, grain only	2,000	35.00	11.00	16.00
Sugar cane, leaves and tops removed	2,000	3.40	2.17	1.48
Timothy hay	2,000	25.20	30.60	9.20
Tobacco (to produce one ton leaf)	2,600 to 3,000	44 to 120.10	70 to 170	11.8 to 20.4
Tomatoes, fruit	2,000	3.20	5.40	1.00
Turnips, roots	2,000	3.60	7.80	2.00
Wheat, winter (to produce one ton grain)	5,000	51.11	28.88	22.22

It is the gravest error, however, as has been previously pointed out, to consider that the fertility of a soil depends upon its supply of mineral plant food ; neither is it any more correct to consider the supply of soluble mineral plant food in any soil as a definite amount, like so much horse feed in a barrel, to be drawn upon until exhausted, with no power in the barrel to renew the supply. As has been shown, all soils have their origin in the rock masses of the earth, and what has been developed from a given material may continue to be developed therefrom under like conditions; under improved conditions the rate of its development may be accelerated. If there were no means of replacing these elements from the foundation soil, the estimates that have so commonly been made as to the number of years a given soil might be expected to produce a certain crop, based upon the amount of plant food in the soil as shown by chemical analysis, and the quantity taken up by an average growth of this crop, would be entirely erroneous.

This method of calculation takes no account of leaching, which in humid or semi-humid climates is very great, there being leached out of an average soil by the percolating waters from five to seven pounds of plant food for every pound taken up by the crop.

It is also a decided error to refer to the sale of so many pounds of plant food, contained in grain, as the only, or even the greatest, evil resulting from the continued production of grain crops and their sale from the land. Even if the whole crop were returned to the soil, there would be replaced only 15 to 20 per cent of the mineral plant food that has been given up by the soil during the production of that crop.

As the rock fragments are decomposed and dissolved, a part is taken up by the plants, and, as we see, a much larger part is carried away by the percolating waters to the sea, to be again laid down, to go through the process of rock formation, and perhaps at some future day to repeat the process now going on.

It may still be asked, what causes the reduction in fertility, if not the reduction of the amount of soluble plant food?

The answer is, a lessening of that element in the soil which not only affects, but very largely controls, all the factors of fertility heretofore discussed, namely, *humus*.

Effect of Humus on Mineral Plant Food—The supply of vegetable matter in the soil not only improves the mechanical condition thereof as regards the decay of the rock fragments, but the heat generated by its decomposition and the humic acid supplied therefrom are among the most potent agents in rendering soluble the mineral plant food.

The following experiment is given to show the effect of vegetable matter in decomposing and rendering soluble the inert mineral matters of the soil. It also illustrates the loss of this soluble plant food from a soil, aside from what is taken up by the crop, as the soil was kept bare. Two boxes were filled with soil identically the same, except that to one was added 20 per cent of its weight in cow manure. These boxes were treated exactly alike for twelve months, the soil receiving an occasional stirring. At the end of this period an analysis showed an increase of 30 per cent in the soluble plant food of the soil to which manure was added, after making allowance for what was contained in the manure, while that which received no manure showed a loss in soluble plant food of 4.36 per cent.

According to a series of experiments that have been carried on for a number of years at the Minnesota Experiment Station, continuous grain-cropping where (a) no manure was applied resulted in the reduction of the humus content of the soil at the rate of 1,500 to 1,800 pounds an acre per annum. But where (b) a rotation was practiced that had clover for one of its factors, and had the second-growth clover plowed under as green manure, there was at the end of the first complete rotation not only no decrease, but a very decided increase, in the amount of humus in the soil. The amount of soluble plant food was very greatly reduced in the first case, while in the latter there was a decided increase. This, too, in spite of the fact that the rotation lands had in consequence thereof produced larger crops which had consequently removed more plant food from the soil. The increase in yield was five bushels of wheat and twenty bushels of corn to the acre.

The more abundant the vegetable matter in the soil, the more rapid will be its oxidation and reduction. It is found also that the amount of soluble plant food is reduced much more rapidly than is the humus content, the change in this latter showing itself very quickly in its effect upon the mechanical condition of a soil, and consequently upon the decomposition of its particles.

Professor Snyder has done quite extensive work in the way of collecting and analyzing soils that have been cropped in various ways; also of soils that have not been cropped at all. He finds that a native prairie soil contains about twice as much vegetable matter, and three to five times as much of the more important elements of plant food in a soluble form, as adjacent soils that have been continuously cropped with grain for fifteen or twenty years, while many farms that have been under cultivation for much longer periods, but which have been allowed to produce an occasional crop of timothy and clover (receiving now and then a dressing of manure), remain in a condition almost equal to that of the native soils. One particular instance may be cited. Of two adjoining farms, both under cultivation for thirty-five years, and originally alike, one has received frequent dressings of manure, has produced wheat, corn, oats and timothy, and clover in rotation, and shows no apparent decline in fertility. The other has grown grain continuously without receiving any manure or vegetable matter in any form. During the first few years heavy crops were raised, but during the past few years the yields have been very low, especially in dry years. It is estimated that the producing power of this piece of land has been reduced 68 per cent. A neighboring farm that has been under cultivation for forty-two years, and has received a systematic rotation, with a dressing of manure, every five years, at the rate of ten tons per acre, is in even better condition than the one first mentioned.

Effect of Humus on Moisture of Soils—It has been found that a native prairie soil will retain about 20 per cent more moisture than one that has been continuously grain-cropped for fifteen or twenty years.

Some samples of soil taken in 1899, to a depth of four and one-half feet, showed the following relation to each other in percentage of moisture and total volatile matter. The samples were taken on the same day on land that was almost level, being taken from adjoining plots, which had produced the same kind of a crop, and had had the same kind of cultivation and treatment throughout the season. The results are averages for the four and one-half feet in depth.

SAMPLE.	Vegetable Matter Per Cent.	Moisture Per Cent.
No. 1	2.37	11.93
No. 2	4.5	21.7

A soil will not yield all its water to plants. In a good average soil, plants can not reduce the moisture below 6 or 7 per cent. So that soil No. 2 contained at the time of sampling less than twice as much vegetable matter and more than two and one-half times as much available moisture as No. 1. In experiments to determine the effects of manure upon evaporation it has been found that a good application of well-rotted manure, well worked into the soil, will reduce the evaporation to the extent of one ton of water per acre per day.

To show the effect upon the moisture capacity of a soil produced by an extreme amount of vegetable matter, the following example is given: This sample was taken on a piece of permanent pasture land and to a depth of four feet. The percentage of vegetable matter present was 34.66, and the moisture content was 63.13 per cent.

During the extreme drought of 1901 the moisture was so conserved on a plat very rich in vegetable matter, as to result in a yield of over eighty bushels of corn to the acre; while a plat a few rods distant, on practically the same level and

FIG. 7. Photograph of corn, showing moisture-conserving effect of vegetable matter in the soil during a dry season. (Edgerton.)

receiving the same cultivation, but poor in humus, produced less than twenty bushels per acre. (Figs. 7 and 8.)

The loss of vegetable matter produces a decided effect upon the soil in another way especially noticeable in wet seasons or after heavy rains. As the vegetable skeleton is decomposed the soil particles are allowed to come together more closely and form greater obstruction to the passage of the excess of water through them, so that even if well underdrained a much longer time is required for the surface to get in proper condition for cultivation, and for the soil to receive a new supply of air for the use of roots and the various germs. The writer has known this difference in vegetable content to mean, on the one hand, the almost continual exclusion of air from the soil, with no opportunity for cultivation; and, on the other hand, fairly good aëration, a fair opportunity for cultivation, and a good healthy growth of crop. (Figs. 9 and 10.)

FIG. 8. Photograph of corn grown on soil having the same elevation and located only a few rods from that which produced corn shown in Fig. 7, but which, by reason of long cultivation, contained a very small amount of vegetable matter. (Edgerton.)

Effect on Aëration—In soils that are at all compact the problem of improving the aëration is a very important one, and for this purpose no treatment or manipulation can be applied that will duplicate the effect produced by the presence of decaying vegetable matter. Tillage will open up the surface portion but can not extend to the deeper soil. After the soil is stirred, in the absence of a good supporting vegetable skeleton, it tends to settle and draw together again, gradually cutting off the air movement. In very fine soils a heavy rain, soon after the stirring takes place, may cause almost an entire suspension of air movement. The presence of a good supply of vegetable matter will maintain a constant open condition on any well-drained soil under almost any conditions of rainfall. The growth and decomposition of somewhat fleshy roots, as of clover and alfalfa, open up passageways for the air into the deeper soil. On soils that are too coarse and open, vegetable matter, by increasing the amount of water held and binding the particles together, also by partially filling some of the larger interspaces, tends to hold in check the excessive air movement of such soils and thus to lessen internal evaporation.

Influence on Soil Temperature—As we have observed, the temperature of a soil is a very important factor. Vegetable matter affects temperature (a) by making the soil darker in color, and enabling it to absorb more of the sun's heat; (b) by lessening evaporation, which is a cooling process; (c) by enabling the soil to get rid of its surplus water by percolation, so that the same amount of heat will raise the temperature of the soil to a higher degree; (d) by its decomposition, and by furnishing conditions more favorable for the action of the countless germs in the soil, and for the more rapid decomposition of the mineral matters. Almost all of these processes of decomposition generate more or less heat.

Methods of Increasing the Humus Content of Soils—As previously stated, the production of a cultivated crop on an average soil will result in the loss from that soil of from 1,500 to 1,800 pounds of humus per acre, which in some manner must be replaced if the fertility of the soil is to be maintained. There are three ways in which this may be done: (a) By the application of manure, (b) by proper rotation of crops, and (c) by a combination of the first two.

(a) Application of Manure—From what has been said it is but a logical deduction that the sale of the roughage from the farm, or the burning of the straw, is far worse for the fertility of that farm than is the sale of the grain portion of the crop, inasmuch as the greater portion of the vegetable fiber of a crop is contained in the fodder portion. If lands are to produce grain or other cultivated crops continuously, and to be maintained solely by the application of manure, they will require a dressing of at least fifteen tons of well-rotted manure every five years, or as may sometimes give better results, a dressing of three tons each year. This should be thoroughly worked into the soil.

The time of application should be governed by the crop that is to follow. Moreover, unless manure is plowed in soon after being drawn, the condition and topography of the surface will have a great deal of influence upon the loss that may occur. Manure spread and allowed to lie for some time on a stiff clay, with an unplowed surface, especially if rolling, or on rolling ground when frozen, may be subjected to heavy loss by the action of rains leaching through it and carrying portions of it away in the surface drainage.

(b) PROPER ROTATION — This means not only that various crops shall be grown, but that the variation shall be such as to allow the ground to be covered a portion of the time with crops, perennial in their nature, that do not require cultivation, so that they may be left to occupy the ground long enough for their roots to thoroughly ramify the soil. It has been clearly demonstrated that such a system may result, not only in maintaining the supply of vegetable matter in a soil, but in increasing it, while at the same time, larger crops are being produced.

FIG. 9. Photograph showing how underdrainage may be rendered ineffective during a wet season by lack of humus in the soil. (Edgerton.)

As regards the crops adapted for this purpose: Some of the leguminous plants should be used in the rotation, as they will not only increase the supply of nitrogen, but, their roots being large and penetrating deeply, they will open up and add humus to the deeper soil. Some of the grasses that develop a good sod, as timothy, blue grass, or orchard grass, should also have an occasional place in the system, as their roots permeate all parts of the soil most completely and greatly improve its mechanical condition, especially as regards the upper portion, or that which forms the seed-bed.

(c) COMBINING ROTATION WITH APPLICATIONS OF MANURE — A combination of the two methods just described is much better than either one alone.

The application of manure can not well be made to reach the subsoil with its physical effects, and, on the other hand, the soil may be improved much more rapidly by the addition of manure than by rotation alone. Also, if so desired, a larger percentage of grain crops may enter into the rotation without injury to the land, if the rotation is supplemented with an occasional dressing of manure.

MIXED FARMING

The surest way to improve the fertility of a piece of land, or even to maintain it, is to employ such a mixture of stock and grain-growing that practically all the grain and roughage that is raised on the farm will be consumed thereon. If no stock is kept, the only incentive for rotation is the improvement of the soil, and consequently it is too apt to be neglected. If there is a considerable amount of stock the growing of grasses and clover has for its additional purpose the supplying of pasture and hay for the animals. In the latter case, also, the manure, a large part of which is sure to be lacking in exclusive grain-growing, is a consideration of value.

The kind of stock used is of minor importance so long as it is such a class or combination of classes as to utilize the "roughness" for either food or bedding. It is very much better to have the straw worked into manure by utilizing it for bedding than to let it rot in the stack.

Bedding should be used freely enough with all animals to absorb all the liquid, as there is often more plant food voided in the urine than in the solid excrement. Furthermore, the liquid portion of the excrement is in such condition as to be very readily transformed into available plant food and thus to give quick returns for its application.

There is a difference, however, in the concentration and mechanical division of the excrement from the different classes of animals which renders the immediate effects of their application decidedly different. For example: The application of one ton of sheep manure will produce much greater immediate results than the same amount of the manure of cattle, the difference in concentration making it somewhat richer (it has a considerably less percentage

FIG. 10. Photograph of corn growing on the same level and only 100 feet from that shown in Fig. 9, on land having the same underdrainage, but with a larger quantity of vegetable matter in the soil. (Edgerton.)

of water), and the difference in mechanical division making its content of plant food more readily available and so increasing its immediate effect upon the soil.

Commercial vs. Natural Fertilizers — The term "commercial fertilizers," as used here, is intended to apply in its entirety only to those fertilizers made by grinding up various kinds of rock material that contain a high percentage of one or more of the essential elements of plant food. Those having an animal or vegetable origin (like tankage from slaughter-houses, the guanos, etc.) have a value, as heretofore explained, aside from the actual plant food contained.

Owing to the multiplicity of causes that usually combine to produce a given effect in the agricultural world, it very commonly happens that first conclusions as to the cause of a given result cover but a small portion of the actual field.

It was but natural, in the present case, that inasmuch as the percentage of soluble plant food in a soil decreases as the yield of crops decreases, the soil's content of soluble plant food should at first have been considered the sole controlling factor in crop production. The logical procedure from such a basis would be an attempt to maintain or increase the productiveness of the soil by adding to it some material containing these essential elements in large quantity. Hence, there has grown up an immense industry, based on this theory, and more or less patronized by all the older sections of the country. Most of the Eastern States spend annually millions of dollars in an effort to increase the productiveness of their soils by this method. That some benefit is often derived from such application there is no doubt, and in favorable seasons and under certain conditions the effect may even be very marked. The outcome, however, is very uncertain, owing to the fact that such an application, as a rule, affects only the one factor of fertility, namely, the supply of mineral plant food. The moisture capacity, temperature, aëration, etc., are unaffected thereby. It follows that very often this application produces no increase in yield, and the total crop is sometimes worth no more than has been expended on commercial fertilizers for its production.

The mineral plant food contained in these fertilizers is only partially soluble, and those who have been using them for years have discovered that by mixing them with manure and maintaining proper conditions for fermentation these materials will be rendered much more soluble. It is only reasonable to suppose that a similar action would produce a similar effect when applied to the same materials already in the soil. This we have seen to be the actual result as evidenced by experiment.

Therefore, when we remember that the soil contains an abundance of these necessary mineral elements, in one form or another, and that the conditions necessary for their rapid transformation into available form are also the conditions most favoring the other factors of fertility, we can only conclude that millions of dollars are annually being wasted. In fact, money spent in this way is very often worse than wasted, because if the proper methods were pursued, the farmer would not only save that expense but enjoy a much larger yield of crop and an improved condition of soil for years to come. When a man buys such fertilizer he is spending money for a commodity which he already possesses in greater abundance than he can ever hope to utilize.

In short, it is poor business policy to buy what you can grow or develop yourself without any expense, especially when by so doing you are increasing your gross returns and permanently improving the condition of your lands in other ways.

An extensive series of experiments with the various commercial fertilizers and barnyard manure conducted by the Michigan Agricultural College furnishes a good illustration.[1] This report covers nine separate sets of experiments, conducted, one at the college and one in each of eight different counties.

The crops used were corn, potatoes, beans, and sugar beets. A statement of the condition of the lands used is lacking in most of the cases, but those described are spoken of as having been severely and injuriously cropped. These results do not show much benefit to have been derived by the use of commercial fertilizers over no fertilizers at all, whereas, the increase in yields of plots fertilized with manure over those fertilized with commercial fertilizer was very marked, and in some cases almost double. This, too, in the face of the fact that in some cases, at least, the manure was applied in a coarse and unrotted condition, a procedure that would not, by any means, give the best possible results for that year.

Many similar cases might be given, but this example is sufficient to show the immediate effects produced by manure, and it very frequently happens, in the application of manure, especially if it is not well rotted before being applied, that much greater benefits will be derived therefrom in the second and third years after application than in the first, and the effect may continue to be noticed for years.

An idea of the immediate benefits that may be derived from the growing of leguminous crops upon the land may be obtained from the following examples:

Prof. J. F. Duggar reports an experiment in which the plowing under of a crop of cow-pea vines, after the peas had been harvested, gave an increase in yield of 250 per cent of wheat, 300 per cent of oats, and an increase in seed-cotton worth

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1 Bulletin 181, Michigan Agricultural Experiment Station.

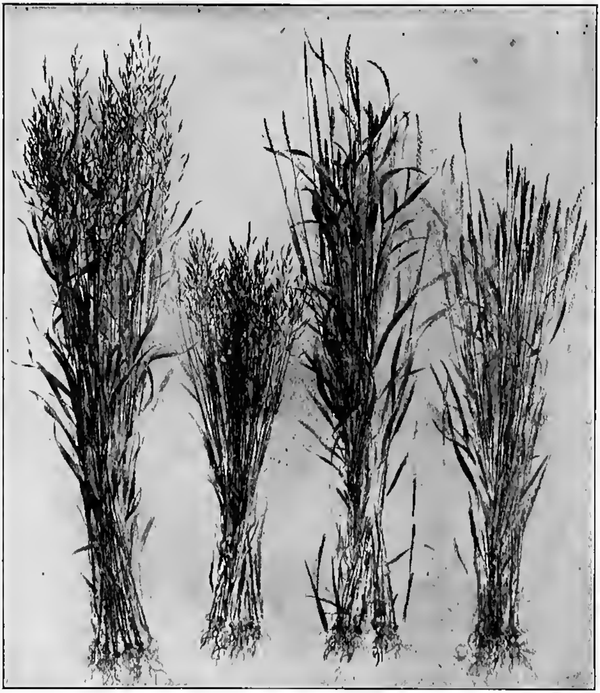

FIG. 11. Photograph showing beneficial effects upon the soil of growing leguminous crops, alfalfa being used in this experiment. The two larger samples of oats and wheat were grown upon alfalfa land, the two smaller ones upon land that had been continuously in some grain or cultivated crop. (Prof. B. C. Buffum, Bulletin 44, Wyoming Experiment Station.)

(at 6¾c.) \$16.50 to \$17.40 to the acre. In an experiment at the Wyoming Station, a tract of land of uniform condition and quality was divided, and one-half seeded to and allowed to remain in alfalfa for five years. The other half produced each year a crop of grain or potatoes. At the end of the five years the whole plot was plowed, prepared, and each half planted to the same crop. The increase in yield from the alfalfa land over that from the land that had been continuously cropped with cultivated crops, when figured at the local market prices, was equal to \$16 per acre. This was figuring the crop from the two sections to be of equal quality, whereas, as a matter of fact, there was considerable difference in quality in favor of the alfalfa land. Where plants are enabled to go right along with a normal and vigorous development they can elaborate and store up in their seeds a larger amount of material, and plumper, heavier seed will result than where the plants are less thrifty, or where their development is cut off by a sudden shortage in moisture supply or other cause. In the above case oats from the alfalfa land weighed forty-three pounds to the bushel.[1]

[1] The legal weight of oats in the various States ranges between 26 pounds (Maryland) and 36 pounds (Oregon and Idaho).

SOIL AMENDMENTS

There may occur, either from improper treatment or from unfavorable natural conditions, soil conditions that may be greatly ameliorated by the application of certain mineral ingredients as corrective agents. As we have seen, lands that have become unproductive through too great an accumulation of carbonate salts (black alkali) may be greatly improved by an application of gypsum to change these salts into the sulphate (white alkali) form, which is less injurious. Close, heavy soils, or even lighter soils, under improper conditions may become sour. In such cases an application of lime will be found of great value. From twenty to seventy-five bushels may be applied, according to the severity of the case. A direct application of lime is sometimes injurious to certain crops, so that the safer plan will be to make any such applications the fall before the land is to be put into crop. Lime may also perform a very valuable service in improving the texture of very fine heavy clays, by flocculating[1] the minute particles and thus rendering such soils more free and open for the entrance of air, the movement of moisture, and the penetration of roots.

UNDERDRAINAGE

WHAT TILE DRAINAGE DOES

In what has gone before, many of the various soil amendments effected by proper drainage have been indicated in their connection. We may now summarize these benefits:

It has been shown that air (the most important components of which are nitrogen, oxygen, and a small proportion of carbon dioxide) must be present in the soil, being essential to the germination of seeds, to the growth of plants, to the activities of the nitrifying bacteria, to the life of the parasites of the legumens, and to the chemical changes that set free mineral plant food in the soil. Free water excludes air, and the mischief, as has been seen, does not end with the simple cessation of the processes mentioned; for the denitrifying bacteria, deprived by excess of water of the oxygen they require, extract the needful element from the nitrates, so locking up or even setting free available nitrogen.

Underdrainage Aërates the Soil — (a) By improving soil texture, or making possible such improvement, so as to admit air to spaces formerly occupied by free water; (b) by admitting plants to a deeper growth and providing livable

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1 This term refers to the gathering together of the fine particles into groups or clusters, and has the effect of making the soil somewhat coarser.

conditions for earthworms and burrowing animals, all of which aid in ventilation; (c) by permitting the flocculation of the clay subsoil and by lessening its tendency to contract upon itself; (d) by the agency of the lines of tile themselves, into which soil air is forced by barometric high pressure or expansion due to rising temperature, and from which the plant roots derive fresh air when barometric low pressure or fall in temperature produces a partial vacuum in the soil.

Effect on Soil Moisture — We have also observed that plants can not properly develop without an adequate supply of capillary moisture. In the underdrained field the reservoir of capillary water has been increased; surface washing and leaching are both reduced, owing to the greater capacity of this reservoir to handle the rainfall; a heavier rainfall may be received without making the surface soil too wet for proper cultivation. By no means of least importance is the fact that the larger root development, that is stimulated by underdrainage, enables the plant to absorb a given amount of water with a much less percentage of moisture present in the soil.

Fig. 12. Photograph showing shallow rooting of corn in undrained soil. (Prof. F. H. King: *Physics of Agriculture.*)

Effect on Soil Temperature — A warm soil, as we have learned, is also of the greatest importance. Underdrainage aids greatly in the production of a warmer condition of soil: (a) By removing the surplus moisture by percolation instead of evaporation; (b) by decreasing the amount of surplus water in the soil, and thus enabling a given amount of heat to warm a larger amount of soil; (c) by enabling the soil in the early spring to absorb a larger proportion of the warm rains (such rainfall containing a very large amount of latent heat); and (d) by improving the conditions for decomposition and various chemical actions which produce heat.

Effect on Alkali Lands — It has also been pointed out that an excess of salts (forming alkali lands) may be fatal to the growth of vegetation. Underdrainage is the only practical, permanent remedy for such conditions.

WHEN DRAINAGE IS BENEFICIAL

The kind of lands that need underdraining are: (a) Flat lands with basins, or where surface drainage is very poor; (b) comparatively flat lands, if of large area, that receive the surface drainage from higher ground; (c) low-lying lands that are kept too wet by the natural underground seepage from the surrounding higher lands; (d) flat lands, of considerable extent, having fair surface drainage but underlaid near the surface with thick beds of close, impervious clay; (e) hillsides where there is an outcropping of water-bearing strata; (f) lands that are subject to inundation, especially if of a somewhat fine texture, or if surface drainage is not first class; (g) lands requiring excessive irrigation for special crops, as rice; and (h) alkali lands.

All lands in which the surface of the free water remains for any considerable length of time nearer the surface of the ground than three feet will be benefited by underdrainage. This may be determined by digging a hole with a spade or post auger, in which the water will stand on a level with that in the surrounding soil.

HOW TO DRAIN LAND

Location of Ditches — The getting of a proper outlet is of course the first consideration in locating a tile drain. The outlet should be as free and unobstructed as possible; any obstruction at the mouth will tend to fill up the drain farther back, for the water is carrying more or less sediment almost all the time, and if the flow is checked the sediment will be deposited. It must be so located that there will be a continuous rise in the line of tile from this point to the source, else there will be a stoppage from the same cause.

In draining level land that is not affected by seepage from higher lands the drain should in a general way follow the lower land. The exceptions occur where there is so little difference in altitude between the outlet and some of the lower portions of the field to be drained that the tile can not be placed far enough below the surface in the lower portion to insure its remaining undisturbed; or where, to reach some low point in the field at a given altitude, it becomes necessary to cut across and shorten the distance of the main line as much as possible.

Wet sloughs or draws that have a fair slope of surface are usually wet because of seepage water from the higher ground on either side, and will be dry ground if this is cut off. So, in a wide draw, the best plan is to run a line of tile up either side to catch this water as it comes from the higher ground. Where the draw is narrow, one line up the center will usually answer every purpose.

In draining any piece of land the conditions should be carefully studied, and the actual source of the water that is causing the trouble should be determined. Level lands that are wet because of seepage from higher ground will usually be more thoroughly dried by running one line of tile along the outcrop (several feet, it may be, above the main body of wet land), to catch this water as it comes out and prevent it getting into the other soil, than by a whole network of underdrains distributed through the level land to remove the water after it once gets in. The same principle applies to boggy hillsides and all lands made wet from the outcrop of a water-bearing stratum.[1] The mistake has very frequently been made, in attempting to drain such places, of putting the tile on the lower side to catch the water after it has passed through the other soil and has done more or less damage, instead of on the upper side, to catch it before it gets into the adjoining territory.

In determining the location of a system of tile drains on level land a level should be used, as the eye, measuring as it does by comparison with surrounding objects, can not be depended upon to tell which are the lowest and highest points.

Depth of Drain — Except where the outlet is such as to necessitate a shallower ditch in order to maintain a proper fall, tile should always be placed four feet below the surface, and for the following reasons:

(a) To obtain, as we have seen, a large reservoir for capillary water and a larger field for root development.

(b) To enable a given line of tile to drain a larger area.[2]

(c) To enable the excess of water to get away more quickly after a heavy rain. It is a mistaken idea that a shallow-laid tile will carry off the surplus water more quickly after a rain than a deeper one. Aside from the fact that the deeper-laid tile develops a larger reservoir, into which this surplus water can sink many hundred times as fast as it can get into any tile, the water will find its way through the soil to the deeper tile faster than to the shallower one, by reason of the steeper incline of the surface of the free water that may be developed. The water reaching

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[1] This water-bearing stratum may be a layer of sand or gravel, or any other porous substance, with a layer of clay or other less porous substance beneath.

[2] The surface of the free water does not extend from the tile on a level, but owing to the friction and the attraction of the soil particles, which hinder its flow, it recedes on an incline so that a tile 4 feet in depth will draw the water from a distance at least one-third greater than one 3 feet in depth.

the tile may also be forced into the deeper tile faster than into the shallower one, by reason of the greater pressure developed by the greater depth, or head of water.

Establishing the Grade and Cutting the Ditch—In some sections tiling consists largely in the drainage of sloughs or other lands that have a good fall all the way from source to outlet. In such districts a careful man of good judgment may do a good job without using a level; especially if he have running water for a guide. Such cases are, however, comparatively rare. The first step in establishing the grade is to determine the distance between the source and the outlet, and the difference in altitude between the outlet and the bottom of the prospective ditch at the source. The amount of this difference in altitude, divided by the number of hundred feet in length of ditch, will give the amount of fall for each hundred feet of ditch. The fall or grade should be made uniform all the way, unless the conditions are such as to bring the steeper grade at the lower end of the drain.

If the steeper grade be at the upper end of the line, sediment will be deposited in the lower portion of the drain, where the water runs less swiftly. If the topography of the area to be drained is such as to necessitate a steeper grade in the upper portion, then a silt basin should be constructed at the point where the change in grade is to be made, for the purpose of collecting the sediment brought down by the swift-running water and preventing its getting into the lower portion. This basin should extend two or three feet below the line of tile, and should be occasionally cleaned, as the sediment gathers.

A fall of two inches for every one hundred feet should be secured where possible. In the draining of flat lands this will very often be impossible, and in such cases the greatest care must be taken to have the line of tile true to a line of uniform grade. It is sometimes necessary to lay drains on such lands with a fall of less than one-half inch to the hundred feet. In such cases a little inaccuracy in the workmanship, that would leave the bottom of the ditch a half-inch too high at any point, would leave no fall for a hundred feet, would reduce the capacity of the tile, and might in time cause a complete stoppage. For the laying of drains under these conditions an experienced and careful man or crew should be secured, and even then the work should be carefully supervised and inspected. The bottom of the ditch should be scraped to an exact grade, as bringing the tile to grade by filling under loose dirt in the low places will cause the tile to get out of shape through the settling of the loose dirt. Perhaps the best method of obtaining an accurate grade to the bottom of the ditch is by means of a line stretched above and attached to stakes set every 50 or 100 feet along the line of ditch. Care must be taken that the line is parallel with the desired grade; then, that the measuring rod be set accurately at the point indicating the depth of ditch below the line, and the ditch carefully measured all the way.

The ditch should not be made wider than will just give room to work conveniently. Anything more is a waste of energy in removing the dirt and in filling the ditch. The ditch should be narrowed down with the last spading so that at the bottom it is little wider than the tile. The bottom should be left rounded by the use of a cleaning scoop of convexity similar to that of the tile, to aid in keeping the tile in its proper place. A ditch unnecessarily wide at the bottom is liable to cause the tile to be misplaced in the filling.

Laterals should enter the main at a higher level than the bottom of the main, unless the same sized tile is used for both and there is good fall. They may be brought in on top of the main, or at the side, above the bottom. Many tile makers now make connections for joining mains and laterals. If these are used the difference in altitude of lateral and main ditch should equal one-half the difference in diameter of tile used. For example, in joining a 3-inch lateral to a 5-inch main, the bottom of lateral ditch should be one inch above bottom of main.

Fig. 13. Photograph showing willow roots as taken from a tile drain which they had completely clogged. (Edgerton.)

Laying of Tile — The first thing to look to in this connection is the character of the tile. They should be smooth, strong, well shaped, and with good, well-fitting ends. A porous tile is not essential, as but little water enters the drain in this way. They should also be well and uniformly burned so as to be of uniform diameter and thickness of rim. If they are not uniform in this respect they may be sorted, putting the hard-burned ones together and at the upper end of the system, or using them for laterals, as they are smaller. The tile should be laid in perfect alignment, crowded up as tightly and made to fit as snugly as possible, to prevent sediment entering at the joints. The laying is usually done by means of a tile hook on the end of a long pole.

Filling the Ditch—After the line of tile has been carefully inspected a few inches of dirt (clay, if possible) should be carefully filled in by hand to hold the tile in place, after which the remainder of the filling may be done with horses attached to a plow by means of a long doubletree, that will enable one horse to walk on either side of the ditch.

Frequency of Drains—The distance apart that drains should be placed on level land will depend upon: (a) The character of the subsoil through which the water must pass in order to reach the tile, whether fine and close or open; (b) the depth of the tile below the surface, the deeper drain drawing water from a greater distance than the shallower one; (c) the frequency of overflow or of rains sufficiently heavy to produce percolation. It is seldom necessary to place drains nearer than 100 feet, and in open, alluvial soils, 200 feet will usually suffice if the tile is laid four feet deep. On such lands a system may be put in in such a way that other laterals may be inserted later, if those first put in are found too far apart. This will avoid the possibility of needless expense in putting in more lines than are needed.

Size of Tile—A tile should be sufficiently large to carry away the surplus water as fast as it can get to and into it. But any size greater than is necessary to do this is not only an unnecessary expense, but in many cases does not make so good a drain. The theory held by some that a large tile is less liable than a small one to become filled with sediment, is not correct. With a given amount of water passing, the larger the tile the more readily will the sediment be deposited, because the water, being spread out over a greater surface, will be more shallow and run much more slowly. After this deposition has once begun the tendency is greatly increased. A 3-inch tile is the best size for laterals or any single lines of not more than half a mile in length and having a good fall. The fall is, of course, a large factor in determining the amount of water a tile will carry. Larger sizes should be used for the main drain, varying according to the amount drained into it. An 8-inch tile, with a fall of two or more inches for every 100 feet is sufficient to carry the surplus water from 80 acres of land. The carrying capacity of a tile varies according to the square of its diameter, except for the influence of friction which is proportionately greater in the smaller sizes.

Keep Clear of Tree Roots—Any living trees should be avoided with lines of tile, or else the trees killed at once, lest they enter the tile and choke it up. Such trees as the willow, poplar, elm, and soft maple should never be left nearer than 75 feet.

Cost of Tiling—This is a question that can be determined for each case only by the conditions affecting the same. The cost of digging the ditch will depend upon the average depth, the size of the tile to be laid, the character of the soil,[1] and by the amount of fall, making a greater or less amount of care necessary in getting the line of tile true and even.

The cost of tile will also vary somewhat with different seasons and with the distance to a good tile factory. The writer has paid all the way from $9 to $13 a thousand for 3-inch tile, and from 20 to 35 cents per rod for cutting a 4-foot ditch, laying the tile and filling in sufficient dirt to hold the tile securely in place. Most modern tile are made 12 inches in length and sixteen of them will lay one rod.

ROADS AND ROAD MAKING

The condition of the roadways of any locality, whether in city or country, largely determines the value of its property. A good road is essential, not only for pleasurable driving, but also for the marketing of the various products of the farm.

In sections having very poor roads it frequently happens that the farmers are unable to take advantage of the favorable changes in the market, owing to inability to haul their crops whenever they desire.

The cost of moving farm products and supplies averages,[2] on all our country roads, twenty-five cents per ton per mile, while in the "good-roads" districts the average is only about eight cents — a difference which in the aggregate amounts to more than the entire annual expenditures of the National Government. Whereas, *one-twelfth* of the farm value of the agricultural products of the United States would be sufficient to pay for hauling *over good roads* to shipping points, the cost of hauling *over roads as they are* is equal to *one-quarter* of the farm value. The destruction of perishable products for want of access to markets, the failure to reach markets when prices are at a maximum, and the enforced idleness of men and draft animals during seasons of impassable roads, constitute a "bad-road tax" upon the industry of the nation generally and upon that of the farmer directly.

EARTH ROADS

There are various systems of road construction, but for many years to come the greater portion of the roads in many parts of the country will continue to be constructed entirely of earth, owing to the difficulty of obtaining other material. The

[1] Whether friable and easy to dig, or hard and stony; also whether or not there are sand patches that are liable to give trouble by caving.

[2] According to calculations made by the United States Department of Agriculture.

earth road, however, by the use of proper methods of construction and of maintenance afterward, may be made into a very passable road for all seasons of the year. As the construction should be the same whether an all-earth road is the end sought, or whether it is to be finished by surfacing a part or all of it with stone or gravel, the construction of the "dirt road" will be first considered.

Drainage — The first essential of a good road, regardless of the surfacing material used, is thorough surface and underdrainage, either natural or artificial. No stone surface will keep its place for any length of time if it has a soft, spongy foundation.

There should be surface drains where necessary, to carry off the surface water quickly and not allow it to stand and soak into the road.

If there is not good natural underdrainage, tile should be laid. This should have a free outlet and as much fall as possible.

In most cases one line under the center of the road will be more effective than two lines run on either side of the road, as the former gives a greater depth of drained soil where it is most needed.

Where possible, the tile should be laid four feet below the natural level of the ground, regardless of the amount of grading that has been done.

If the road passes through a springy place in such a way that the water comes in from both sides, it is usually best to put a line of tile on each side of the road

If it is on a hillside and water comes out directly under the roadbed, these lines, or branches therefrom, should be carried under the road in such a manner as to catch this seepage.

If the road passes such a place on the lower side, so that water tends to enter the roadbed only from one side, the tile should be placed on that side in such manner as to catch the water before it enters the road, instead of, as sometimes placed, on the lower side to catch it after it has passed through the road and done the mischief.

A 3-inch tile with a good fall will be large enough to carry the water for a half-mile of road, except in very wet places or where the surface drainage is not good. Where it is necessary to put in longer lines larger sizes of tile will be necessary in the lower part of the course.

Owing to the difficulty of securing outlets in many localities it may often be of mutual advantage for the road supervisors to join with the farmers and drain the road and adjacent farm lands in one system.

Establishing the Grades — The steeper grades in the road should be lessened as much as may be. The extent to which this should be carried, from an economical standpoint, will depend upon the quality of the roadbed. It will be of no special advantage to be able to haul very large loads over the main portion of the road if there are a few places over which these loads can not be drawn.

Forming the Roadbed — The roadbed should be made of medium width; 16 or 18 feet, with a strip of grass 3 feet wide on each side, making 22 to 24 feet between the surface drains, is usually satisfactory.

The surface should be graded to a proper convexity by the use of a road machine, or by other means where a road machine can not be used. The surface should have sufficient slope to carry off the water quickly, but not enough to cause washing, or to cause vehicles to slide or cut deep ruts on the lower side by reason of the weight of the load being thrown largely on that side. A road of the width mentioned should be about 6 inches higher in the center than at the margins.

The surface should be thoroughly harrowed to get it even and smooth and then well rolled with a heavy roller. This will put the surface in shape not only for convenient traveling but also for quick surface drainage, preventing the water from entering the road to soften it up.

Surfacing—In some localities where the soil is a gravelly loam, excellent roads may be maintained without the use of any other material. In most sections, however, they may be very greatly improved by surfacing with rock or gravel.

MACADAM ROADS

Where a road is required to support a large amount of heavy traffic the surfacing should be done on the macadam plan, which is as follows:

Prepare the roadbed a year in advance, if possible, to allow it to become thoroughly settled.

On each side of the portion of road that is to be surfaced, is left a shoulder of earth, of a height equal to the desired thickness of the made surface, to hold it in place.

Over the roadbed is then spread a 3 or 4-inch layer of crushed rock of as nearly uniform size as possible. This layer is thoroughly rolled and then evenly covered with enough finely crushed rock to fill the interspaces between the larger rock, into which it is worked by thorough wetting and rolling.

Then another layer is applied in like manner, making a very solid road surface, 8 or 9 inches thick.

The layer of rock should be evenly spread, so there will be no tendency to bunches and hollows. The roller used should be heavy and of sufficient diameter so that it will not push the stone in front of it in the least. The rolling should begin at the outer edges and continue toward the center, and should be repeated until the surface is thoroughly hard and smooth.

COMBINATION EARTH AND STONE ROAD

Where there is less heavy traffic a much cheaper form of construction than the all-stone road, and one that gives very good satisfaction, is that which employs stone for one-half and earth for the other. The one track is sufficient for the heavy loads, and may, in times when the dirt surface is soft, carry all the traffic.

GRAVEL ROADS

In many sections there are beds of gravel that may be used with very good results for the surfacing of roads where traffic is not heavy. The best results are obtained by screening the gravel and using the same methods in its application as in the construction of the stone road.

Crushing the gravel will very much increase its value for this work, as it is usually so rounded as not to bind nearly so well as the more angular forms. The thickness of the application may depend somewhat upon the amount of traffic.

SANDY ROADS

A sandy country sometimes presents a difficult problem in roadmaking, owing to the almost complete absence of binding properties in the sand when dry and to the readiness with which it parts with its moisture.

Sand, when containing the necessary amount of moisture to bind it together, forms a very good road, and with this principle in mind it may be readily understood that the most practical treatment of such roads will be along the line of increasing their water-holding capacity.

Clay, where it can be obtained, if applied to the surface in proper quantity, will supply this deficiency in the best and most permanent form. Straw, sawdust, and any other form of vegetable matter will increase the moisture-holding capacity of such roads, but the rapid decay of these substances renders their frequent renewal necessary.

J. J. Edgerton

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Field Crops: Their Adaptations and Economic Relations, with Specific Cultural Directions

By Joseph J. Edgerton, B. S. A.
Instructor in Agricultural Physics, Iowa College of Agriculture

In the great plan of nature everything has a place. Each class of animate objects has some office that it can fill better than can be done by any other class. It is only when these various component parts find their proper places that the forces of nature will work together harmoniously for their development. A plant, for example, the ancestors of which for countless generations have lived in arid or semi-arid regions, has become adapted to those climatic conditions and will not develop naturally in a moist climate. Accordingly, it does not follow, merely because a certain plant will produce valuable crops in one locality, that it is the best plant to grow under all conditions. What are valuable plants in some localities are weeds in others.

One of the problems of the agriculturist, therefore, is to find those plants suited to his needs that are best adapted to his conditions of climate and soil.

GRAIN CROPS

CORN[1]

Corn is native to a tropical climate, and hence is favored by a warm soil and a warm atmosphere. By cultivation and selection its range of successful growth is being extended. Where it can be successfully grown it is well calculated to form the major part of the ration for all farm animals. The color of the grain has little to do with its feeding value.

The composition of any variety of corn may be changed by selection and breeding, thus developing breeds of corn adapted to specific uses. In the North, where seasons are short, early varieties should be planted, and farther south, for early feeding, they may comprise a portion of the crop. But where the season is of

1 For notes on the selection of seed corn, see page 76.

sufficient length to allow the larger, later varieties to mature, they will usually produce much the greater yield.

About one-half the food value of the average corn crop is contained in the fodder portion, hence, leaving the fodder to stand in the field is a great waste.

The best point in a rotation at which to apply manure is just previous to the corn crop, as the application of manure just before a crop of small grain is liable to cause lodging.

Culture—If land has been fall-plowed, stir thoroughly, preferably with a disk-harrow, as early in the spring as the soil is in fit condition to conserve the moisture and warm up the seed-bed. This will give the weed seed in the seed-bed an opportunity to germinate, so that by a couple more diskings at proper intervals, the weeds may be very largely got out of the way before planting. Thus the after cultivation of the crop will be materially simplified. If the land be not fall-plowed, the plowing should, as a rule, be done as early in the spring as practicable and the surface prepared as though the crop were to be planted at once, the weeds being killed as they appear, the same as in the case of the fall plowing.

SPRING VS. FALL PLOWING—As to which is the better, spring or fall plowing, much will depend upon conditions. Much may often be gained by plowing a piece of ground early in the fall, to turn under a crop of weeds before they ripen their seed. Sod, or manure that is somewhat coarse, has more time to decompose and get in proper condition for the coming crop if turned under in the fall. Fall plowing, by exposing certain insects that have buried themselves in the soil for the winter, will often cause their destruction. On the other hand, early spring plowing, especially of heavy clay soils, properly treated, may better conserve the moisture of the deeper soil throughout the summer; will make possible the absorption of a larger portion of a dashing rain; in cases of continued, excessive rainfall will allow the excess of water to percolate away more readily; and will keep the soil more open and porous for the admission and circulation of air.

Planting should not be done too early; but it may be safely done earlier in a dry spring than a wet one, as the soil will warm up earlier.

Corn, as has been observed, is native to a tropical climate, and if put in the ground before it is thoroughly warmed up is very apt to germinate slowly and poorly. The result will be a very uneven crop, many of the plants getting a weakly start and never recovering. The writer has seen early-planted corn overtaken and passed, before the season of cultivation was over, by corn planted two weeks later, on no better soil, but where the seed-bed had been put in proper condition early in the spring.

Plant in hills from 42 to 48 inches apart and from two to three grains in a hill, according as the land is rich or poor. On new clean ground drilling may give a larger yield, but unless hoeing is to be practiced it is usually better to plant so as to cultivate in both directions.

TILLAGE—Where the soil has been put in proper condition and the weeds all killed beforehand, the harrow and weeder, used at the right time, will give all the cultivation necessary, except in wet seasons, until the corn gets a good start. The weeder may often be used to advantage to run crosswise after the first plowing. Used at the right time it may be just as effective as another plowing, and can be done a great deal faster.

On ground which, for lack of vegetable matter or for any other reason, tends to contract and become solid, deep tillage, becoming shallower toward the last, should be practiced in order to keep the soil properly loosened up and aërated. On light, loose soils, shallow tillage throughout the season is preferable, as it conserves more moisture.

The argument against root pruning by deep cultivation, except where done in excess or late in the season, is not well founded, as a little root pruning usually does no harm and may often do great good.

The cultivation of the corn crop should not cease because the corn has become too large to plow with the straddle-row cultivator. Very frequently conditions are such as to develop, after this point is reached, a crop of weeds which, if left, will absorb moisture and nutriment that should go to making corn. Or, a rain may destroy the dust mulch and establish capillary connection with the surface, causing loss of moisture by evaporation. This later cultivation is best accomplished by means of one horse attached to a garden cultivator that stirs only the surface, and that may be adjusted in width to conform to the width between the rows. For the conservation of moisture, level culture is better than ridging, as it exposes less surface for evaporation; heavy ridging may in some cases help the corn to stand against a storm, though it is doubtful if this effect is often appreciable.

KAFIR-CORN

The grain from this crop is similar in composition to dent corn, the percentage of fat being a little less and of starch a little greater. As would be expected from the foregoing, its feeding value is hardly equal to that of corn, although experiments indicate that there is no great difference. Its virtue as a grain crop lies in its ability to thrive and produce a fair yield in regions so dry that corn can not be successfully grown.

The fodder portion of this crop is somewhat superior in feeding value to corn fodder.

Culture — Preparation of seed-bed and cultivation should be the same as for corn.

SOY BEANS

Soy beans are a highly nitrogenous crop belonging to that group of plants which gather free nitrogen from the air by means of bacteria growing upon their roots (Fig. 14). The beans are a very valuable feed when ground and used in conjunction with corn or other starchy food, having an equal value for this purpose with linseed and cotton-seed meal. In experiments made at the Kansas Experiment Station the addition of soy bean meal to corn or kafir-corn effected a saving of 30 per cent in the amount of food necessary to produce 100 pounds of gain on hogs. Aside from producing a valuable crop soy beans are highly beneficial to the soil.[1]

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1 According to the Kansas Experiment Station, Bulletin 96, the yield of all crops is increased where they follow soy beans, wheat showing in large fields an increase of five bushels per acre over that grown on adjoining land that had not been in beans.

FIG. 14. Photograph showing nodules formed by nitrogen-fixing bacteria on roots of soy beans grown the second season on the same soil. Both A and B, two-thirds natural size. (Prof. H. Garman, Bulletin 98, Kentucky Agricultural Experiment Station.)

This crop also is adapted to a dry, hot climate.

Culture — Preparation of soil should be the same as for the preceding crops, the necessity for thorough preparation and for a warm seed-bed in which to plant being even more urgent in the case of soy beans. Furthermore, in order to get the best results in crop and the greatest enrichment of soil it is usually necessary, on ground where this crop has not been grown, to inoculate the soil with the root germs peculiar to this species of plant. This is effected by sowing with the seed dry soil from some field where soy beans have grown and developed tubercles.[1] If grown for the beans north of latitude 41°, a sandy loam or soil rich in vegetable matter should be selected, as on a cold soil they may not mature in time to escape injury by frost. For this same reason seed should not be used that has been grown farther south.

Sow in drills 26 to 30 inches apart and 2 to 3 inches apart in the row. Give thorough cultivation, lettiug the weeds at no time get an advantage.

Sugar beet machinery is very well adapted to the plantiug and cultivation of this crop, four rows being planted at once and two rows cultivated at once when desired.

COW-PEAS

The cow-pea is another tropical plant of the nitrogen-gathering family and, like the preceding, is rich in protein. While called a pea, it belongs properly to the bean family. It is a vigorous-growing, deep-rooted plant, especially adapted to the improvement of old and lifeless soils.[2] It is also a valuable addition to the grain ration for all classes of animals. This crop requires even longer to mature

[1] See Bulletins 96 and 100, Kansas Agricultural Experiment Station, Manhattan, Kan.; Bulletin 22, Storrs Experiment Station, Storrs, Conn.

[2] Inoculation of the soil for this crop is also of great importance where the germs that grow upon it are lacking. Professor Duggar reports an increase of 600 per cent in yield of crop as the result of such inoculation.

than the soy bean, and only the earlier varieties should be grown in the North for the production of seed. Some attempt is being made at present to develop by selection and breeding a variety better adapted to northern conditions.

Culture — The same throughout as for soy beans, except to emphasize still more strongly the importance of a warm seed-bed. Any plant to develop properly must make a continuous growth. If held in check while young, they will seldom recover; for this reason, with many of these tropical plants, time is gained by delay in the planting until the conditions are such as to produce rapid development. The cow-pea, as far north as Central Iowa, should never be planted before the 20th of June and then have the seed-bed well prepared beforehand.

FIELD PEAS

The field pea is another nitrogenous food of the family of legumens, but adapted to cooler climatic conditions. It is not injured by a light frost.

Culture — May be (a) sown early with oats and the mixture harvested and threshed together, (b) sown broadcast by themselves on good clean ground, or (c) drilled in with a grain drill; or, they may be (d) drilled farther apart and cultivated the same as soy beans and cow-peas.

If sown with oats, either the peas should be sown first and covered by plowing shallow with a stirring plow, then the oats sown and covered by thorough harrowing; or, what is better, the seed-bed should be prepared by the use of the disk and harrow, the oats and peas being then mixed together and sown with a drill. Care is necessary, too, to get varieties of peas and oats that will ripen together. If sown broadcast alone, the ground should be fairly free from weeds. The peas may be covered by plowing as when sown with oats or put in with the drill. If sown in rows and cultivated, the preparation of soil and tillage of crop may be same as for soy beans, except that the peas should be planted early in the spring, so as to mature before the weather becomes too hot.

WHEAT

Wheat, by its long cultivation and development, is adapted to a great variety of climatic conditions. It may be sown in the fall in some localities, in others only in the spring, and in some it may be sown in either fall or spring. It will survive a great amount of cold, but some varieties endure much more than others. What are spring varieties in cold climates may become winter varieties in warmer latitudes.

Wheat has been raised primarily for human food, but what is good food for man is also good food for most other animals. Wheat, as such, is capable of forming the bulk of the grain ration of any of our domestic animals, and the by-products, especially bran, are a very valuable adjunct to the corn crib.

Culture — Winter Wheat — The matter of first importance is the selection of the proper varieties. In the milder climates the basis of this selection should be the productiveness and milling qualities of the grain.[1] In colder portions of the country, however, the matter of first importance is to obtain a variety that will withstand the severity of the climate with a reasonable degree of success. The locality from which the seed is obtained, whether more or less severe in climate, will affect materially the hardiness of any variety, and a variety not entirely hardy in a given locality may be improved in that respect by continued growth and acclimatization.

For the milder climates some of the best yielding varieties at the present time are: *Poole, Mealy, Red Russian,* and *Early Ripe,* of the smooth varieties; *Nigger, Currell's Prolific, Gipsy,* and *Egyptian,* of the bearded varieties.[2]

Standard varieties for the South-Central West: *Fultz, Extra Early Red, Currell's Prolific, Hindostan, Jones's Winter Fife, American Bronze,* and *Missouri Blue Stem.*[3]

For the region from Southern Iowa north the only variety that can be unhesitatingly recommended at the present time is the *Turkey Red.* The *Budapest* is, so far as tried, standing the winters well, but has no advantages over the *Turkey Red,* being, to all appearances, the same wheat under a different name. Other varieties will come through most of the winters in good condition, but there is much more risk in sowing them.

Ground that has been in corn or potatoes, and from which the crop can be removed in time for proper fall seeding, makes a very congenial place for this crop. The best conditions, however, are afforded by having the land previously occupied by some leguminous crop, as clover, cow-peas, or soy beans. If corn or potato ground is free from weeds and other trash it may be prepared by a thorough use of the disk and harrow without resort to the stirring plow. If the ground be such as requires plowing with the stirring plow, this should be done early, if possible, to allow the trash that is turned under to decompose and the plowed portion to settle. The seed-bed should be in fine condition, but the lower portion of it and the soil immediately below should be well compacted. A loose, open condition in the lower portion of the plowed section will not permit the plant to become so well established before the cold weather and it will be much more liable to winterkill. The use of the roller, subsurface packer, disk, or a combination of these is usually necessary to put plowed land in proper condition for the seeding of winter wheat.

Seeding in the milder climates should not be done too early, as there will be more danger of trouble from the fly. For the central portion of Ohio, Indiana, Illinois, and Southern Iowa the best time is from the 10th to the 20th of September.

Seeding should be done with a drill, and in the colder sections always with a press drill.[4] Seeding should be at the rate of four to six pecks to the acre, depending upon the size of the berry, and the tendency of the variety to stool. The land should not be touched with any implement after the drilling is done. The ridges left between the drill rows hold the snow for a protection during the winter and in the spring will crumble down and fill in around the plant when the freezing and thawing weather is tending to lift it out of the ground.

SPRING WHEAT — This may follow to advantage the same kind of crops as the winter wheat,

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[1] An effort is being made to discover if there is any difference between the various varieties in withstanding the attacks of the fly. The Ohio Station, in Bulletin 118, reports as follows: So far as we have been able to learn no variety of wheat is fly-proof, but some sorts have the reputation of being less injured by the Hessian fly than others; of these the following may be mentioned: *Mealy, Mediterranean, Fulcaster,* and *Clawson.*

[2] Bulletin 118, Ohio Experiment Station, Wooster, Ohio.

[3] Bulletin 21, Missouri Experiment Station, Columbia, Mo.

[4] A drill having a wheel following each runner to press the dirt firmly over the seed.

but is a little more liable to lodge if the land is very rich. It will stand better, however, than oats. Spring wheat should not be grown where winter wheat can be grown successfully, as its later ripening renders it more subject to damage by storms, chinch bugs, and hot, blighting days at time of filling. Prepare the soil well and sow with the drill[1] as early in the spring as the ground is in proper condition for working.

MACARONI WHEAT

Macaroni wheat is a variety of wheat comparatively new to this country, but grown in large quantities in the east and south of Russia. Its principal use at present is for the manufacture of macaroni. There is a growing demand for this variety of wheat in this country, and it is especially adapted to the hot and semi-arid regions of the West and Southwest, where most cultivated grain crops are uncertain. It is also adapted, by reason of its long residence on soils of that character, to growing on soils that are somewhat alkaline. So far as it has been grown in this country it gives promise of being proof against depredations of smut and rust. In the northern sections it is a spring wheat, but in the South may be grown as a winter wheat. Reports from Kansas indicate that this grain at present is not sufficiently hardy for fall seeding so far north, but it can undoubtedly be made so by selection. Fall seeding, where it can be practiced, will give the best results. Macaroni wheat is a vigorous grower and where seeded in the fall will make an abundance of winter pasture.

Culture—The same as for other wheats, using about the same amount of seed. The grain should be thoroughly ripe before being harvested, and harvesting should not be done in damp or cloudy weather if it can be avoided.

OATS

Oats also are adapted to a wide range of climatic conditions as well as uses. Through selection and breeding there have been established varieties having a wide range in time of ripening. The later ripening varieties, where the conditions are favorable for their growth, will give a larger yield of grain than the earlier varieties, owing to the greater length of time allowed for the gathering and elaboration of food. On the other hand, for many conditions the early varieties are the more satisfactory. They do not grow so rank, hence are better adapted to rich soils. They are much less liable to be caught by storms or by hot days at filling time—circumstances that will produce a poor-quality, light-weight grain. Not growing

1 All spring crops of small grain, as well as those sown in the fall, should be sown with the drill. A fifth less seed will produce as good a stand as in broadcast seeding and the seeds are all down where they are not liable to be killed, or at least stunted, by hot, dry days soon after germination. Moreover, plants get a good, deep, vigorous hold that enables them to better withstand droughts.

so rank and ripening earlier, they are a far better nurse crop with which to start clover or grass crops than the later varieties.

Culture — The same as for spring wheat, except that oats will not stand up on quite so rich land, not being quite so stiff in the straw.

REMEDY FOR LODGING — Lodging is due, except in cases of severe storm or extreme conditions, to a lack of woody fiber in the stem, caused by undue shading by a heavy growth of foliage. By pasturing with a sufficient amount of stock to eat off the excessive growth before the seed stalks are started, or by mowing the crop just as they are starting, the tendency to lodge may be very materially lessened.

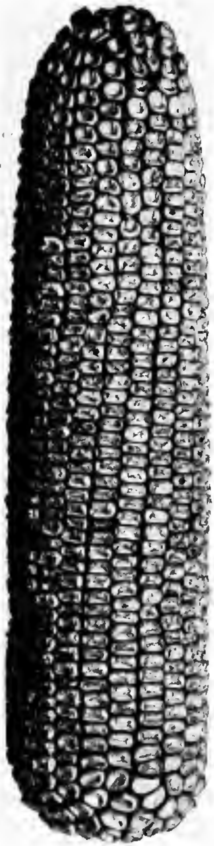

FIG. 15. Photograph showing a good type of ear, Reid Yellow Dent corn. (From an ear furnished by L. C. Brown.)

BARLEY

Barley is an excellent food, when ground, for all classes of animals, but is too hard to be properly masticated when fed whole. It is not quite so well relished as corn, and experiments indicate that its feeding value is a little less. Barley is well adapted to cool climates and to rich lands. Being shorter in the straw than oats or wheat it is less liable to lodge than either of them, and this, combined with its early ripening, makes it one of the best nurse crops we have. Considerable objection is sometimes offered to the raising of this crop on account of the beards; but with modern machinery and methods of handling this objection should have but little weight. Varieties of beardless barley are being developed, some of which give much promise for the future. The *Success* is one of the best of these, but as yet they are far outyielded by the six-rowed, bearded variety known as the *Mandscheuri*.

Culture — Prepare the soil the same as for oats (except that richer ground may be used) and sow early with the drill. Barley will stand more freezing than oats, hence may be sown earlier. It is important to sow all these small grains that are adapted to cooler latitudes as early as conditions will permit. Their nature is to ripen about a certain time of the year, regardless of the time they were sown; so that a given variety, if sown early, has a longer time in which to gather plant food than if sown late. For this reason the early-sown grain is better filled and weighs more to the bushel.

RYE

Rye is more resistant to cold and severe climatic changes than winter wheat, hence, may be grown farther north. It

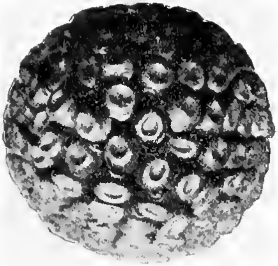

FIG. 16. Photograph showing a good type of tip end, Reid Yellow Dent corn. (From an ear furnished by L. C. Browu.)

is adapted also to places where for one reason or another the soil can not be put in proper condition for wheat. Being a more rugged plant and a coarser feeder it will get hold where the wheat plant will not. This crop, when ground, makes a valuable food for all kinds of stock, there being no other feed that will make heavier fleeces on lambs.

Culture — While it is true, as stated above, that barley will make a fair crop under conditions where wheat would fail, yet there is no other crop that will respond more freely than rye to good treatment. To get the best results the ground should be as carefully prepared as for wheat and the rye drilled in in the same manner. It may be put in later than the wheat, but if put in early will make an abundance of fall and early spring pasture and a good crop of grain besides.

EMMER[1]

Emmer is a cereal new to this country, but one that gives promise of great value to particular sections. It comes from Europe, Russia, from which country we get our best seed, raising the largest amount.[2] The great value of emmer lies in its drought-resisting qualities and its consequent adaptation to the regions of scanty and uncertain rainfall. It will thrive, however, under a very wide range of climatic conditions and is worth a trial in any section of the country. It is raised both as a winter and a spring crop. Emmer is closely related to the wheats, although the chaff adheres to the grain when threshed. It is similar in composition to oats, containing a little less fat and a little more protein. For the year 1900, at the Iowa Experiment Station, it gave a yield per acre of 2,200 pounds of grain, weighing 35 pounds to the struck bushel. The North Dakota Experiment Station reports a yield for 1900 of 63 bushels per acre. In a feeding experiment with sheep, at the Iowa station, in which were compared the feeding value of emmer, soy beans, corn, and gluten-feed and corn, all other conditions being the same, the largest gaius were made by the lot fed on emmer. The straw is shorter and stiffer than that of wheat, making it much less liable to lodge; for

FIG. 17. Photograph showing a good type of butt end, Reid Yellow Dent corn. (From an ear furnished by L. C. Brown.

1 This grain is frequently improperly called speltz.
2 See Farmers' Bulletin 139, United States Department of Agriculture.

this reason it should prove an excellent nurse crop. Emmer seems thus far to be more resistant to the attacks of rust than the more common cereals of this country. Not the least of its prospective value lies in the improvement that may be made in our wheats by crossing them with it.[1]

Culture—Same as for wheat, except that the earliness of seeding should be emphasized, and that the rate of seeding should be about the same as for oats.

FLAX

Flax is a grain rich in fat and protein, which supplies the linseed oil of commerce on the one hand, and the oil cake, or oil meal for stock feeding on the other.

Culture—Flax is a strong-feeding plant adapted to the taming of freshly-broken wild land, as it can be made to produce a fair crop where the sod is too resistant to be properly worked up for any other crop. Such lands, however, should be put in as good condition as possible, as the extra work will be more than repaid by the increased yield. A good heavy roller is a necessary part of the equipment for properly putting in flax on freshly-broken wild land. If a soil that has been under cultivation is used, it should be rich in vegetable matter and should be prepared the same as for corn.

The flax plant is very tender and seed should not be sown until all danger of frost is past. A press drill should be used in the seeding.

Flax-sick Soil—One of the necessities for a rotation of crops lies in the fact that if a given species of plant is grown continuously on the same ground the various parasitic diseases that prey upon it have an opportunity to multiply until they may destroy the crop. This is especially true of flax, and for this reason it should not be grown two years in succession on the same ground. It is the continued cropping that gives rise to what is known as "flax-sick soil."

BUCKWHEAT

Buckwheat, while used primarily for human food, is also a valuable food for stock, experiments indicating that it has a feeding value almost equal to that of wheat.

Culture—One of the chief values of this crop lies in its adaptability to the production of a crop late in the season on lands that have been too wet in the early part of the season for the starting of other crops. It may be sown as late as the middle of July in sections as far north as the center of Iowa. A good seed-bed should be prepared and the seed sown broadcast and well covered or put in with the drill.

ROOT CROPS

One of the urgent needs of winter feeding in sections of the country where animals must be fed for a long time on dry feed is for some product that will furnish

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1 See Bulletin 63, Iowa Experiment Station, Ames, Iowa.

the laxative that is obtained in summer from the grass. Too lax a condition in cold weather is not desirable, but a certain degree of it is necessary in order for the various food materials to be properly assimilated and carried through the body. This is especially true of animals from which it is desired to obtain a large flow of milk.

There is probably no other form of succulent food that will so largely aid in the translocation of food materials from the digestive tract to their proper destination as the unorganized compounds found in the various root crops. Their value for use as a regulator of the system can hardly be overestimated.

FIG. 18. Photograph showing ear with grain too irregular. (James Atkinson, Iowa State College of Agriculture.)

BEETS

Of these several varieties are used for field crops. The sugar beet, grown extensively for the manufacture of sugar, is also valuable for stock food, being better relished by hogs than the mangel varieties. Where used for the manufacture of sugar the pulp from which the juice has been expressed is a valuable food.

The varieties of mangel are better adapted, however, for exclusive stock feeding as they yield more heavily, are much more easily harvested, carry less dirt with them to the cellar, are better relished by sheep and cattle, and are about as good for hogs.

Of the mangel varieties the *Mammoth Long Red* is one of the best for light soils. It is usually the heaviest yielder and is less liable to be damaged if caught in a little freeze before being harvested, as the heavier growth of leaves affords greater protection. In some sections the *Golden Tankard* makes a better keeper, but this is not universally true.

Culture — When growing for feed select a piece of soil rich in vegetable matter or enrich well with well-rotted manure. This should be free from trash, corn stalks, etc., that will interfere with hoeing, or cause the small beets to be covered up when cultivating.

Plow thoroughly in the fall or early spring. Develop a seed-bed early and kill all the weeds as nearly as possible before planting the crop. A fine seed-bed is necessary, but it must not be too loose. If loose in the subsurface, the moisture will not be drawn up well around the seed for their germination, and if there is too much loose earth on the immediate surface, a dashing rain may bury and destroy the young plants soon after they come up.

The seed may be sown with any garden drill, or in large areas with horse drills made especially for that purpose. If the horse drill is used, care must be taken not to get the beets planted too deep, as a uniform stand is highly important. Use plenty of seed, as they must be thinned in any case. From 5 to 15 pounds of seed to the acre will be required, according to the width between the rows and the care used in planting. Much more seed should be used with the horse than with the hand drill, as the former is not so accurate in its work and more of the seed may be buried too deeply to come up.

Give thorough cultivation. If done at the right time and if the land has been well cleaned of weeds, this may be done mostly with the horse, no hand work in many cases being needed, except a hoeing with a wheel-hoe when beets first come up, and thinning after they get well started. The thinning may be done, first, with the hoe — cutting through the row, leaving bunches of two and three in a place — and afterward by going over them and hand-thinning to one in a place, having one plant every 10 inches when through.

Beets should not be harvested in the fall until there is danger of freezing weather, as it is more difficult to keep them if harvested before the warm days are past. A light freeze will do them no harm, if they remain in the ground until thawed out. When pulled, the tops should be cleanly removed and the dirt jarred off, as both affect their keeping. They should be stored in a cool place where the temperature will be as uniform as possible and where there is fair ventilation.

Culture for Sugar — Where the sugar beet is grown for sugar, care should be taken, in the first place, to obtain seed of beets that have been developed especially for that purpose. Secondly, the soil must not be overrich, especially in fresh manure, as too large and rough a growth is less productive of sugar. A smooth, clean beet of medium size gives the best quality of juice. Sugar beets will also bear being left closer together in the row than where more size is desired, 6 to 8 inches being a good width on good soils.

CARROTS

These are grown more especially for horses. They start more delicately than beets, are more difficult to harvest and do not yield so well, but horses are very fond of them, whereas they are not so fond of beets. For this purpose a large growing variety that will yield well should be selected. The *Large White Vosges* is perhaps the best variety. The *Long Yellow Orange* is a good yielder, but grows so long that it is more difficult to harvest.

Culture — The same as for beets except that they may be left nearer together in the row, 6 inches apart being a good distance.

TURNIPS

A valuable crop for early winter feeding, but will not keep so well as beets. Sheep are especially fond of them, and in the milder climates they may be fed off the ground without harvesting.

Culture — The best soil for turnips is one rich in vegetable matter. Prepare and sow in drills, thinning and cultivating the same as for beets. Or, if the ground is free from weeds, they may be sown broadcast. For winter feeding they should not be sown before the latter part of June for Central Iowa. Turnips will stand considerable freezing weather, before harvesting, without damage. They are better, however, not to be harvested while in a frozen condition. If they are caught by a freeze, leave in the ground until the frost is again out of them.

RUTABAGAS OR SWEDISH TURNIPS

The rutabaga is a hard-fleshed turnip belonging to the same family as cabbage. It is a much better keeper than the common turnip and in cool climates is a heavy yielder and a very valuable crop; but it is not adapted to the dry, hot summers of Iowa and localities farther south and southwest, developing practically no bulb in these sections.

Culture — The same as for beets.

KOHLRABI

The kohlrabi is another plant closely related to cabbage, but differing from the one just considered in that it produces the bulb entirely above ground. It is not properly a root crop, but is treated here because of its similar economic relation in the problem of stock food supply. The kohlrabi is a good keeper, is easy to raise and easy to harvest, starting much more quickly than beets or carrots. It is adapted to a much wider range of climatic conditions than the rutabaga; growing in warm as well as cool climates and being resistant to drought.

Culture — The same as for beets.

POTATOES

Culture — A good clover sod, well plowed and prepared, makes an excellent bed for the potato. The potato likes an abundance of vegetable matter, but not much of this should be in the form of freshly applied stable manure, especially if the crop is intended for market, as it tends to produce a scabby tuber. Too rich a soil is apt to cause a very rank growth of vine and few potatoes.

For an early crop, potatoes may be planted as soon as the frost is out of the ground and the soil in workable condition. For a winter crop they should be planted late enough so that the tubers will not be ready to set until the fall rains commence. They may be tended very largely with the harrow if the soil is kept sufficiently loose for the harrow to be effective. A little dragging, pruning, and burying of the tops will do them no harm. Use level culture until the tubers set on, when they should be hilled enough to protect the tubers from injury by the sun. Experiments indicate that ridging does not increase the yield.

ARTICHOKES

Artichokes are a valuable food for maintaining hogs in a healthy condition during the fall, when they are on a heavy feed of corn. They are very easily raised and the hogs do their own harvesting.

Culture—Plant moderately early on a piece of ground where it will be convenient to allow the hogs to run in the fall. If the soil is not already rich in vegetable matter, manure well. Plant and cultivate the same as potatoes. The tops, early in the season, will get large enough to shade the ground and keep down the weeds.

The tubers are usually attached to the plant by much longer stems than are potatoes, which makes them difficult to harvest, but by allowing the hogs to do the harvesting this objection is removed. By not allowing the hogs to dig them too close they will re-seed themselves and produce a crop the following year, without the necessity of any planting or cultivation.

PUMPKINS

The pumpkin has a similar economic place in the feed yard to that of the root crops. It is a valuable fall and early winter feed for cattle, sheep, and swine, and is adapted to a very wide range of climatic conditions.

Culture—Pumpkins may be grown with the corn crop, producing, where the stand is not perfect or where the corn does not grow large, a considerable amount of feed without materially affecting the yield of corn. If grown as a separate crop, the ground should be prepared the same as for corn. Plant about the same time, in hills 8 feet apart each way, putting 3 to 4 seeds in a hill. When the plants are well started, thin to one plant in a hill. Give thorough cultivation. Harvest before freezing weather and store in a cool, dry place.

SOILING CROPS

In those portions of the country that are subject, during the summer, to a period of two or more weeks' drought, in which the grasses of the pastures cease to grow, there should be planted each spring some crop of quick growth that may be cut off and fed during this period. Such a practice not only maintains a steady growth of the animals, but by saving the pastures renders them more productive. If pastures are eaten very close, they may become so thoroughly burned out at such times as to kill much of the grass, making it slow in starting

FIG. 19. Photograph showing ear too tapering. (James Atkinson, Iowa State College of Agriculture.)

up again and much less productive for a long time afterward. This killing out, making thin patches, gives the weeds their opportunity and thus makes weedy pastures.

A given amount of land may be made to carry a much larger amount of stock by being handled in this way. In fact, a much larger amount of feed can be produced per acre in this way in any locality than can be obtained by pasturing, so that as lands become higher in price resort will have to be made more and more to this method of summer feeding. Some of the crops best adapted for this use are

SORGHUM

Sorghum is one of the best crops for soiling purposes. It grows very rapidly, is ready early, yields abundantly, and above all is very much relished by all stock, owing to its sweet, pleasant taste. It is also well adapted to the semi-arid regions, being exceedingly resistant to both drought and heat.

Culture — Prepare the soil the same as for corn and sow with a grain drill at the rate of 100 pounds of seed per acre. Sorghum should not be sown until the ground is thoroughly warm, or it will be slow in starting and the weeds will get a start For Central Iowa it should not be sown before the 1st of June, and will make a good, heavy crop when sown as late as the 10th of July.

In humid or semi-humid climates, when sown in this way on land that has been well prepared, no cultivation is needed. In drier climates better results may be obtained by drilling in rows 26 to 30 inches apart and giving thorough cultivation to conserve the moisture.

Sorghum Poisoning — In the drier regions west of the Missouri River there have been occasional deaths from what appeared to be a virulent poison, when cattle have been grazed on this crop. This has prejudiced a large number of farmers against its use. So far as the writer knows no trouble of this kind is ever experienced where sorghum is cut and fed green or as dry fodder.

There is a prevalent belief that it is only the second growth of sorghum that causes this trouble, but this is not correct. Most of the reported cases have occurred in pasturing the second growth, for the reason that the first growth is seldom pastured, being cut for fodder instead.

It is not yet known what is the cause of these deaths, but present evidence indicates that they are not due to any poison in or on the plant itself. Like the corn stalk disease, it is yet to be worked out.

KAFIR-CORN

Kafir-corn also is an excellent plant for soiling and for some conditions may be preferable to sorghum. It is not as large a yielder as sorghum and usually not so well relished by stock, although a few reports indicate that there are exceptions to this rule. Being in a high degree drought-resistant, it is well suited to semi-arid regions.

Culture — The same as for sorghum.

CORN

Corn is not so well adapted for the use under consideration in the semi-arid climates as the two crops just considered, but it is equal or superior to the kafir-corn for humid and semi-humid climates, as it is just as well relished and, where moisture is plentiful, will produce a larger yield.

Culture—Corn may be sown broadcast, drilled the same as the crops just considered, or planted thickly in drills with a corn-planter having a drill attachment. In the latter case it can be given cultivation and will develop more grain. It should be planted thick enough so that the stalks will be small and soft.

RYE

The chief value of this crop for soiling purposes lies in the fact that it will furnish a supply of food earlier in the season than can be obtained from any of the spring-sown crops.

Culture—The same as for a crop of grain except that 6 pecks of seed per acre should be used.

PEAS-AND-OATS

Peas-and-oats is one of the earliest spring crops that can be sown for soiling, being ready to follow immediately after the rye. This crop may be grown as a winter crop in the South.

Culture—Sow very early on rich soil, mix the oats and peas half-and-half, and seed with the drill at the rate of 3 bushels per acre.

RAPE

Rape is especially well liked by sheep and swine, yields heavily, is very succulent and will continue to grow until freezing weather. Its great succulence gives it a tendency to produce bloat if eaten ravenously, especially while wet. It grows best in a cool, moist climate, but is quite resistant to drought.

Culture—If land is not rich, manure well and prepare thoroughly as for a root crop. Drill with a grain drill, stopping two out of every three holes, or with a horse beet drill. Seed at the rate of 5 pounds of seed per acre. Give thorough cultivation. This crop starts quickly and grows rapidly and will soon shade the ground and keep down weeds.

Another method of growing this crop for a supplementary feed is to seed with the spring varieties of small grain. In such cases seeding should not take place until the grain is well up, lest the rape get the start of the grain. As so little seed is required, this entails very little expense, and if the season is favorable a large amount of feed will be produced after the grain is cut off.

Still another plan that frequently meets with success is to sow in corn at the last cultivation. The amount of feed that the rape will make in such cases will depend largely upon the condition of the corn growth. If the corn is of good stand and rank in growth, the rape can make but little feed.

SOY BEANS

The soy bean is valuable for soiling, especially for use in conjunction with sorghum or some of the more carbonaceous foods. It is especially adapted to use on lands that need building up, as it will thrive better on this soil than many of the other crops, and at the same time will improve the soil. It is also well adapted to regions of light rainfall.

Culture — The same as for the seed crop except that a little heavier yield may be obtained by using more seed to the acre.

COW-PEAS

The cow-pea holds a similar economic place among soiling crops as the one just discussed. In many parts of the country it produces a much larger quantity of feed and in such localities is preferable to the former on that account. It is also well adapted to growing on and improving thin lands.

Culture — More seed to the acre should be used than for a seed crop; otherwise the culture may be the same; or, on good clean ground cow-peas may be sown with a grain drill and not cultivated. The same observation should be made in regard to securing the earlier, quick-growing varieties for the northern sections, and also to securing seed grown as far north as possible.

TEOSINTE

Teosinte is a new crop for the North, but, so far as tried, does not give promise of possessing any advantages over those previously mentioned for this region. It gives very large yields under favorable conditions in the South and is reported as making excellent forage. It is a native of Mexico, and is thought by some botanists to be the original of our Indian corn.

Culture — Prepare the soil the same as for corn and plant in hills the same distance apart each way; place two seeds in a hill, and cultivate the same as for corn.

FIG. 20. Photograph showing ear too open — space between rows too great. (Iowa State College of Agriculture.)

ANNUALS FOR DRY FORAGE

It not infrequently happens in many sections of the country that by reason of winterkilling on present mowing lands, or of failure to secure a proper stand on those intended as such, there is a temporary shortage in the supply of dry roughage for winter use. There are a number of annuals well adapted, when properly grown and cared for, to supplying such deficiencies. On some of the higher-priced lands it may even be economy to grow some of these crops each year and maintain a smaller amount of mowing land, as many of these will return a much larger yield per acre than can be obtained from the permanent meadows. Furthermore, by the use of some of these crops, good winter feed may be obtained in regions where, for lack of rain, the native grasses do not get large enough to mow and where our common perennial grasses will not survive the summer's drought and heat. The Experiment Station at Highmore, in the buffalo-grass region of South Dakota, reports for 1901 a yield of three tons of dry fodder per acre in the case of yellow Milo Maize and 2.9 tons per acre of Amber Cane.

CORN

The first thing that should be considered in this connection in a region where corn is grown is the utilization of the fodder portion of the corn crop.

The corn should be cut when it is sufficiently matured, so that it will not shrivel up and become loose in drying out. The grains on a majority of the ears should be well dented. Whether or not this fodder maintains the value it has when first cut, will depend upon the manner in which it is put up. This is a very important matter, even if the corn is only to stand in shock until it is thoroughly cured, as an improperly built shock may become very much damaged within a few days after cutting.

Whether the corn is cut by a machine and bound into bundles or set up loose, it is important that each bunch be set up snugly at bottom and top, and that it be set up straight, not allowed to lean to the one side or the other. No more time is required to set it up the right way than the wrong.

It should be cut close to the ground, not only to save the feed and leave less stubble in the way, but to have the ears kept up off the ground in better shape. This is especially important if the corn is to stand and be fed from the shock during the winter.

The manner of tying the shock is also of the greatest importance. The band should be placed just as near the top as possible and yet enclose all but a few of the tops. This will not only save twine, but it will be found that the shock will stand much better than if placed lower down. The band (ordinary binding twine may be used) should be drawn tight, both to exclude the rain from the shock and to keep it from getting out of shape. In order to secure the proper tightness of the band the shock must first be drawn up with a rope. This should be done in such a manner as not to twist the shock at all in the operation, as any twist given to it at this time will tend to throw it over as it settles. The best and quickest method of drawing up and tying the shocks is for two persons to perform the work together. The rope is passed around the shock, each takes an end, both draw with force as nearly equal as possible, and while one holds the two ends the other ties the band.

Shredding or Cutting — The cutting or shredding of the fodder, except for convenience of feeding, for mixing with other grain, for spring feeding, or where it is desired to get the corn separated from the stover, is not a profitable operation, as not enough more will be consumed, over what would be consumed when fed whole and in a similar manner, to pay for the extra expense.

It is much easier, however, to feed the corn fodder when in this form, and if fed in the barn, what is not eaten, if shredded or cut, is very good material for bedding. For spring feeding it is much better to have fodder cut or shredded and under cover, as it damages rapidly in the field after the warm weather comes on. It is also more difficult to get it from the field at this time and the weather conditions are not so favorable for outside feeding. If fed whole, the fodder should be fed in racks, or, during freezing weather it may be fed on a good clean, sheltered blue-grass pasture, if well scattered. If corn is to be cut and fed with all the corn on, it will produce more feed to the acre by planting somewhat thicker than for a grain crop, and the consequent lessening in the size of the ears will enable the cattle to handle them better.

SORGHUM

Sorghum makes excellent dry feed for winter use and is much relished by all classes of stock.

Culture — The same as for producing a crop for soiling purposes. Cut when the seed is in the dough stage. It may be cut with a corn binder and shocked the same as corn, or mowed and handled the same as hay. It should be cured well before being shocked, and then should stand in shock for some time before being put in stack or barn, as the stalks dry out very slowly In sections where the winters are dry and cold, it will keep in very good condition in the field for winter feeding, if put in large shocks.

Milo Maize — There are two varieties of this non-saccharine sorghum, the white and the yellow. This is a heavy yielding crop and one that is also well liked by stock. For some sections, this may be a more profitable crop than sorghum. Its culture is the same as for sorghum.

MILLET

Millet is a quick-growing plant of which there are many varieties, some of them very resistant to heat and drought. Most of them make hay that is not nearly so coarse, and is much more easily handled as such, than the crops previously considered in this connection. Some of them grow very large, *Pearl Millet* or *Pencillaria*, that is being so widely advertised by seedsmen, yielding a very large amount of hay. Little satisfactory evidence can be obtained, however, at the present time as to the character of the hay produced. The yield of most of the millets is very much less than that of the sorghums.

Culture — Sow on well-prepared soil from the middle of May to the 1st of July. In favorable seasons a crop of the earlier varieties may be obtained, as far north as Central Iowa, after a crop of barley or early oats has been harvested. Millet should be cut when seeds are well formed.

SOY BEANS

The soy bean is a very valuable hay plant, especially if there is no clover or other nitrogenous forage on hand. As has been observed, it is especially adapted to thin lands and to sections of scant rainfall.[1]

Culture — The same as for soiling purposes. Cut when first pods begin to turn.

COW-PEAS

This crop produces a hay very similar to that of the soy bean, except that the vines do not stand up so well, and it is difficult to obtain hay of as good quality.

Culture — The same as for soiling purposes. Cut when first pods begin to turn.

OTHER SOILING CROPS

Velvet Bean — In some sections of the South this plant produces a larger crop of feed and greater improvement upon the soil than the cow-pea, but it is adapted only to extreme southern conditions.

Oats and Field Peas — This crop furnishes a large quantity of excellent forage and is especially adapted to northern sections where the more tropical plants do not thrive so well. Varieties should be selected that will ripen together.

Culture — The same as when grown for soiling. Cut when the oats begin to turn.

Hairy Vetch — This is not a satisfactory hay crop when grown alone, on account of its low trailing habit, but it may be grown with some kind of small grain. It usually gives the best results when sown with winter wheat or, in the milder climates, with winter oats.

Culture — Prepare the ground the same as for winter wheat and sow at the same time as for a crop of winter wheat.

With winter wheat mix in equal parts, and with oats mix one part vetch to two parts oats. Of the former mixture sow 4 to 6 pecks per acre; of the latter 8 to 10 pecks should be used. Sow with a drill; in the North this must be a press drill.

Salt-bushes — This is a class of plants adapted to extremely dry and strongly alkaline regions, where none of the commonly cultivated crops will grow. While they are called a bush, the percentage of fiber in them is not large. While green, they are quite succulent. They are relished by all classes of animals, and, for the conditions above mentioned, are a very valuable supplement to the other feeds. As they take up a large amount of salts, their growth on alkali lands tends to correct

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[1] Prof. H. Garman, of the Kentucky Experiment Station, says of this plant: "In short, it has more good qualities than any other forage plant that has recently engaged the attention of our farmers."

that trouble. Owing to the large amount of salts taken up by them the hay made from them should not be allowed to constitute the whole of the roughage, at least until the animals become accustomed to it.

PERMANENT MEADOWS

While the permanent meadow is not so productive as many of the annual crops, yet a piece of good clean mowing ground is a source of great satisfaction to its owner. This manner of obtaining forage can not be entirely dispensed with, if the productivity of the land is to be conveniently maintained.

In order for each part of the farm to have an occasional rest from cultivated crops and a thorough filling up with grass roots, these mowing lands should not be made too permanent, and yet there may often be reason why they should stand for a considerable length of time. In such cases some care is often necessary to keep them in the most productive condition.

In some sections meadows are subject to killing by extreme cold and in others by extreme drought and heat. When this occurs the sod should be scarified with the disk or other efficient implement and more seed sown. Frequently the same kind of seed will not produce a growth in time to cut with the remainder of the crop the year that it is seeded. In such cases it will be advantageous to seed with it some small grain or other quick-growing crop to help out the yield of that year. A light dressing of manure immediately following this seeding will sometimes assist in getting a good catch. This seeding should be done very early in the spring, before the ground becomes settled by the spring rains.

In many parts of the country great difficulty is experienced in keeping the blue grass out of the meadows for any considerable length of time. This, while a very valuable pasture grass for such localities, is not a desirable grass to have mixed in the mowing land, as it ripens earlier than most other plants used for that purpose and does not grow large, thereby lessening both the yield and quality of the hay obtained. This grass can best be kept down by inducing as early and as large a growth as possible of the other grasses. To this end the meadows should not be closely pastured, the stock being kept entirely from them during the late winter and early spring. An occasional dressing of manure will also help greatly in this direction. On farms that can all be cultivated, less care need be exercised in keeping this grass out, if the meadow be turned into pasture when the blue grass comes in, that which has been in pasture plowed up, and a newly-seeded section used for mowing.

Where plants are used, for permanent meadows, that have a tendency to thicken up into a very dense sod, there is often produced what is termed a sod-bound condition. The remedy for such a condition is thorough cutting up with a disk and sowing some clover seed, in sections where clover thrives, after disking; the harrow may then be run over the ground to advantage.

Manuring is also a help in correcting a sod-bound condition. A little manure is a good thing for a meadow at any time, and, when it is not needed worse elsewhere, may be applied here to great advantage. It always should be well rotted, however. When spread on the surface there is much less opportunity for decomposition than when incorporated in the soil, and any coarse manure will be gathered up more or less with the succeeding crop of hay.

SEED MIXTURES FOR MEADOWS

Not only is there an adaptation of plants to climate as regards temperature and moisture, but there is also an adaptation to soil conditions. Where there is more than one valuable plant adapted to a given condition a larger yield can be obtained by growing them together than by growing them separately, owing to the fact that different plants will feed somewhat differently. It is, therefore, of advantage, so far as time of ripening and habit of growth will permit, to grow these plants in combination.

The following mixtures per acre[1] are given as in a general way adapted to the accompanying described conditions. The variation of conditions, however, and the manner in which one may shade off into another, make it advisable for each locality to do more or less experimenting for its own peculiar conditions.

I. For Humid and Semi-humid Climates Having More or Less Severe Winters

(a) *For Rich, Well-underdrained Soils:*	(b) *Or, for Rich, Well-underdrained Soils:*	(c) *For Thin, High Lands:*	(d) *For Wet Lands:*
Medium Red Clover 6 lbs.	Medium Red Clover 7 lbs.	Mammoth Red Clover 6 lbs.	Alsike Clover 5 lbs.
Timothy 4 lbs.	Orchard Grass 18 lbs.	Timothy 4 lbs.	Timothy 4 lbs.

In some sections half the timothy may be replaced to advantage by red-top, although this plant does not make as palatable hay as timothy.

These mixtures may be sown with either a fall or a spring nurse crop. In some localities subject to severe, hot, dry weather at the time the nurse crop is removed, better results may be obtained, in case a spring nurse crop is used, by seeding the timothy on the stubble at the close of the hot weather — say about the 1st of September.

II. For Humid and Semi-humid Climates Having Milder Winters and Hotter Summers

(a) *For Light, Sandy Soils:*	(b) *For Richer, Heavier. Well-underdrained Soils:*	(c) *Or, instead of (b):*	(d) *For Low, Wet Lands:*
Medium Red Clover 6 lbs.	Medium Red Clover 5 lbs.	Medium Red Clover 5 lbs.	Alsike Clover 4 lbs.
Tall Oat Grass 14 lbs.	Orchard Grass 15 lbs.	Orchard Grass 15 lbs.	Red Top 4 lbs.
	Rescue Grass 10 lbs.	Tall Fescue 10 lbs.	Large Water Grass 4 lbs.

As a rule, the best time to seed the foregoing mixtures, for the climates mentioned, is at the beginning of the fall rains.

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1 The quantity of seed here recommended contemplates the use of pure, clean, germinable seed and a thorough preparation of the seed-bed. If either of these conditions is lacking, more seed must be used.

III. For Semi-arid Regions

(a)

Orchard Grass	20 lbs.
Meadow Fescue	15 lbs.
Red Clover	3 lbs.

(b)

Alfalfa	20 to 30 lbs.

Seed (a) with a press drill, on thoroughly-prepared ground, well firmed in the subsurface. Sow moderately early in the spring, without any other crop, and mow the weeds to prevent smothering the first summer.[1]

Seed (b) alone, with a press drill, on soil thoroughly prepared, and with the subsurface well firmed. Alfalfa[2] should be seeded in the fall in localities having dry, hot summers. Where the summers are more moderate and the winters more severe, seeding should be done early in the spring and the weeds mown the first summer.

IV. For Arid Climates

(a)

Alfalfa	20 to 30 lbs.

(b)

Smooth Brome Grass	40 to 50 lbs.

Seed (b) on well-prepared soil, with well-firmed subsurface, early in the spring. Fall plowing is best for this purpose. Owing to the coarseness and lightness of the seed, it does not seed readily with a drill. Should be sown broadcast, and covered as well as possible with the disk and smoothing harrow. No alarm should be felt over a somewhat thin appearance of the stand at first, as it tends to thicken up very fast after the first year.

PERMANENT PASTURES

In most localities there is more or less land that is not suitable for cultivation and that must be utilized in the form of a permanent pasture. In any case it is usually desirable to have more or less land in this form. The value of such pastures will depend very largely upon getting the varieties best adapted to the conditions and upon the degree of care that is given them. They are subject to the same damaging effects of extreme climatic conditions as are the permanent meadows, and the same remedy is applicable. The sod-bound condition, especially in the blue grass regions, is even more liable to occur in pastures than in mowing lands. The method of spreading by underground runners, that is characteristic of some of the best pasture grasses, contributes largely to the development of such a condition.

The disking of such pastures, followed by a light seeding of clover and the application of manure, as in the case of mowing lands, is the best method of improving them. The native pastures may also be very greatly increased in productiveness by thoroughly cutting them up with a disk and seeding with plants adapted to the various conditions.

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1 Bulletin 62, Kansas Experiment Station.

2 Alfalfa is hardy and productive in the more moist climates, but is not recommended as a hay crop owing to the difficulty of curing it into a good quality of hay in such climates.

As in the case of mowing lands, a greater productiveness may be secured by growing a mixture of plants for pasture. The variety thus afforded also makes the product of greater value.

SEED MIXTURES FOR PASTURES

I. For Humid Climates Having Severe Winters

(*a*)

Medium Red Clover	3 lbs.
Kentucky Blue Grass[1]	8 lbs.
Orchard Grass	8 lbs.
Smooth Brome Grass	10 lbs.

(*b*)

Medium Red Clover	2 lbs.
White Clover	2 lbs.
Orchard Grass	8 lbs.
Meadow Fescue	5 lbs.
Smooth Brome Grass	8 lbs.

(*c*) *For High, Rather Thin Soils:*

Mammoth Red Clover	3 lbs.
Kentucky Blue Grass	8 lbs.
Orchard Grass	8 lbs.
Smooth Brome Grass	10 lbs.

(*d*) *For Low, Wet Lands:*

Alsike Clover	4 lbs.
Red Top	6 lbs.
Timothy	4 lbs.

All the components of Mixture (a) start very early in the spring, and the clover and brome grass will remain green and continue to grow during quite dry weather.

II. For Humid Climates Farther South

(*a*) *For Light Sandy Soils:*

Smooth Brome Grass	15 lbs.
Tall Oat Grass	15 lbs.
Hairy Vetch	15 lbs.

(*b*) *For Richer, Heavier, Well-underdrained Soils:*

Orchard Grass	10 lbs.
Tall Fescue	10 lbs.
Rescue Grass	10 lbs.
Medium Red Clover	3 lbs.
(or Hairy Vetch, 12 lbs.)	

(*c*) *For Low, Wet Lands:*

Alsike Clover	4 lbs.
Red Top	4 lbs.
Large Water Grass	4 lbs.

Mixture (a), below the snow line, will afford growing pasture for almost the entire year.

One report[2] from the South mentions orchard grass as not being relished by the stock, but as a rule they are fond of it.

All the foregoing mixtures are best sown at the beginning of the fall rains.

III. For Semi-arid Regions

Meadow Fescue	10 lbs.
Orchard Grass	12 lbs.
Smooth Brome Grass	15 lbs.
Medium Red Clover	2 lbs.
Alfalfa	6 lbs.

(a) Prepare the ground thoroughly, and seed with a press drill early in the spring for the more northerly regions, and in the fall farther south.

(b) The same mixture may also be sown advantageously on the native pastures, after first thoroughly scarifying them with a disk or other effective implement.

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[1] This grass once introduced into a locality to which it is adapted, will usually come into a pasture very quickly without seeding.

[2] Bulletin 87, Kentucky Experiment Station, Lexington, Ky.

PLANTING TABLE

NAME.	Inches Apart in Rows.	Rows or Drills, Inches Apart.	Quantity Sown Per Acre.
Alfalfa			20 to 30 lbs.
Artichokes	15	36	6 to 7 bu.
Barley	Drilled		8 pecks.
"	Broadcast		10 pecks.
Beans, field, for forage			2 bu.
" soy, for forage		26 to 30	3 to 4 pecks.
" soy, for seed		26 to 30	2 to 3 pecks.
" velvet, for forage			1 to 2 bu.
Beets, for stock	In Drills	26 to 30	5 to 15 lbs.
" for sugar	In Drills	26 to 30	5 to 15 lbs.
Buckwheat			2 to 3 pecks.
Carrots	In Drills		4 to 6 lbs.
Clover, Alsike	Alone		7 lbs.
" red	Alone		10 lbs.
Corn, field, for grain	42 to 48	42 to 48	8 lbs.
" " for forage	In Drills	30 to 36	2 to 3 pecks.
" "	Broadcast		3 to 4 pecks.
Cow-peas, for seed		26 to 30	2 to 3 pecks.
" for forage			4 to 6 pecks.
Emmer	Drilled		8 pecks.
"	Broadcast		10 pecks.
Flax	Drilled		2 to 3 pecks.
Grass, blue	Alone		30 lbs.
" brome, smooth			45 lbs.
" meadow fescue			25 lbs.
" orchard			30 lbs.
" red top			9 lbs.
" rescue			30 lbs.
" tall fescue			35 lbs.
" tall oat			35 lbs.
" timothy			6 lbs.
Kafir-corn, for grain		36 to 40	7 to 10 lbs.
" " for forage			4 to 5 pecks.
Kohlrabi			2 lbs.
Macaroni wheat, spring seeding	Drilled		4 to 6 pecks.
" " fall seeding	Drilled		4 to 5 pecks.
Millet	Drilled		4 to 5 pecks.
"	Broadcast		6 pecks.
Milo maize	Drilled		6 pecks.
" "	Broadcast		8 pecks.
Oats	Drilled		8 pecks.
"	Broadcast		10 pecks.
Peas, field			2 to 3 bu.
Peas and oats, for forage			3 bu.
Potatoes	10 to 18	30 to 36	6 to 10 bu.
Pumpkins, alone	96	96	5 lbs.
Rape			5 lbs.
Rutabagas	In Drills	28 to 30	2 lbs.
Rye, for grain	Drilled		4 pecks.
" " "	Broadcast		5 pecks.
" for forage			6 pecks.
Sorghum, for forage	Drilled		75 to 100 lbs.
"	Broadcast		100 to 125 lbs.
Turnips	In Drills	28 to 30	2 lbs.
"	Broadcast		4 lbs.
Vetch			1 bu.
Wheat	Drilled		4 to 5 pecks.
"	Broadcast		5 to 6 pecks.
" and Hairy Vetch, for forage			4 to 6 pecks.

HOME-GROWN SEEDS

Nothing is of greater importance in the production of any crop than that good seed be used to start it. While there are reasons why a man or company making seed-growing a specialty should be able to make the best progress in the development of good seeds, there are, on the other hand, very strong reasons why the farmer to a large degree should be his own seedsman.

Objections to Purchased Seed — As a rule, seedsmen are anxious to supply the purchaser with good seed, since they know that spurious seed will lose them customers. How well many of them do this depends entirely upon the intelligence, vigilance, and integrity of their employes. Much seed is grown by contract and often in a different part of the country from that in which the seed house is located. In this way the purchaser may obtain seeds not adapted to his climate.

A lack of vigilance in keeping weeds out of the growing seed crop may result in seeding the purchaser's farm with weeds that are very difficult to eradicate. The handling of a large quantity of seed requires a great deal of care to prevent injury to its germinating qualities. A little carelessness on the part of persons having this work in charge, or a lack of integrity in reporting conditions, sometimes results in the sending out of a lot of seed that is very poor in germinating qualities. The writer has purchased from prominent seedsmen seed not 5 per cent of which would grow.

Some Tests of Purchased Samples — Some of the conditions that may be met with in purchased seeds or in home-grown seeds that have not been properly cleaned or cared for, are illustrated in Figs. 21, 22, and 23.[1] In each case tube No. 1 represents a pound of seed as it was obtained on the market; No. 2 the quantity of pure seed contained in the pound; No. 3 the amount of broken seed and dirt; No. 4 the amount of spurious seed; No. 5 the total waste, and No. 6 the quantity of pure and germinable seed.

It will be observed that of the sample represented in Fig. 21, only about 60 per cent was pure seed, and that if it were clover seed purchased at, say, $5 a bushel the purchaser would in reality be paying nearly $10 a bushel for the pure seed.

In Fig. 22 is shown a sample which, while containing a larger percentage of pure seed, at the same time contains very little germinable seed. Such a sample would be of no value whatever as seed.

The sample represented in Fig. 23 shows a condition that should always obtain, and that with proper care may always be secured in the home-grown seed.

[1] From Farmers' Bulletin 111, United States Department of Agriculture.

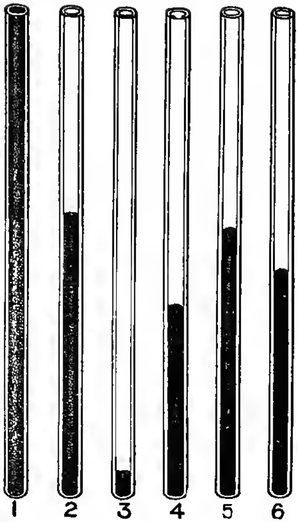

FIG. 21.

Advantages of Home Selection — The improvement of the various crops depends largely upon the care used in the growing of the crop from which seed is to be selected — whether the soil conditions and the cultivation given are such as to produce the greatest possible development, or only an imperfect crop. The man who selects his own seed has the advantage of knowing the condition of the crop from which he makes his selection.

In any field there is more or less variation in the development of different plants, due to various causes. The man who selects his own seed has an opportunity to take advantage of this and select from only the best plants, while the seed that is purchased from those who handle it in quantity is usually only an average of that grown in any one field.

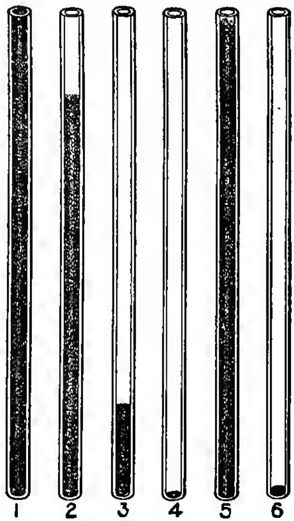

FIG. 22.

It will not, of course, be practical to select the seed for the main crop from individual plants of such crops as oats, wheat, and barley; but a small quantity of seed of these crops may be selected in this way each year from which to grow seed the following year.

One of the chief advantages in the home selection of seeds lies in the opportunity afforded by the variation due to climatic and soil conditions. In this manner crops may be made hardy, the time of ripening changed, and in other ways improved in their adaptation to local conditions.

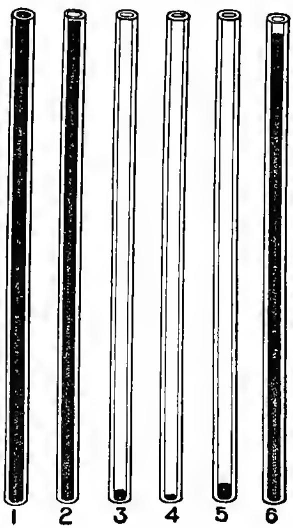

FIG. 23.

"Running Out" of Seed — There is a strong belief in many localities that seed grown in a given place for a considerable length of time tends to "run out," *i. e.*, to become less productive, and that the only way to maintain the yield is occasionally to import fresh seed. No doubt there often is a tendency to deterioration of this sort, but it is usually due to a lack of proper care in the selection of seed and to poor soil conditions.

Requisites in Seed Selection — Some of the more important observations to be made in the selection of seeds are: Yield, quality, uniformity, hardiness, time of ripening, freedom from attacks of smut and rust, and, in the case of small grain, the stiffness of the straw.

Corn — This crop requires, perhaps, as great care in the selection as any other, and merits special attention. The rapid improvement that has been made in this crop, combined with the readiness with which the different varieties cross and mix, renders it extremely subject to variation. Constant care is necessary in order to establish the desirable qualities that are brought out in these variations and to more thoroughly eradicate those not desirable.

Some of the points (see Figs. 15–20) to be observed in the selection of seed corn are:

(a) *Size and shape of ear;* ear should approach as nearly as may be a uniform diameter from end to end.

(b) *Size and quality of cob,* a medium-sized cob being much better than a large, spongy one.

(c) [1] *Depth of grain.*

(d) [1] *Shape of grains;* grains should carry their wedge shape uniformly to the end, so that the ear may present as nearly as possible a solid surface.

(e) [1] *Covering of cob;* cob should be as completely and evenly covered as possible at both ends.

(f) *Hardness of grain,* too hard and flinty a grain not being readily masticated and digested. A hard grain, also, is more liable to be a shallow one.

(g) *Grains of even, uniform size and similar shape,* to make possible uniformity of planting.

(h) *Color of grain,* purity of color indicating purity of the corn.

Care of the Seeds — After the seeds have been selected they should be thoroughly dried where they have room to be well spread, so that there will be no possible chance for any fermentation. They should not be subjected to freezing temperatures until well dried. They should be kept in a thoroughly dry place during the winter.

Preparing for Planting — No matter how great care has been taken in the handling of seeds, it is a very good practice always to test them before planting, as they sometimes lose their vitality from unforeseen causes. This may be done by spreading 100 average seeds on a piece of moistened blotting paper or cloth, covering with a similar moistened strip, laying them in a plate or pan and covering with

[1] Characteristics (c), (d), and (e) very largely determine the relative percentage of grain and cob.

another to prevent drying out, and setting in a room having a temperature of 65° to 80°. They should be examined occasionally, to see that they do not become too dry for the process of germination to take place. The number that germinate (out of 100 tested) will give the approximate percentage of germinable seeds, and will serve as a guide as to the quantity to plant.

In shelling the corn, the small grains on the tip and, where much unevenness occurs, the irregular ones at the butt, should be kept separate from those of the rest of the ear, as different sizes and shapes of grains mixed together will not plant evenly.

From the small grains and seeds all the smaller, weaker seeds should be, so far as possible, removed.

All seeds should be thoroughly clean, so that the drills will not become clogged, leaving parts of the field unplanted, and so that a portion of what is sown shall not be dirt instead of seed.

WEEDS AND THEIR ERADICATION

As stated in another connection, every plant has a place in the economy of nature — some relation of conditions to which it is adapted better than any other. To perform their greatest service, however, plants must be in their proper place. When sufficiently out of place to be of no economic value, they become weeds. Some grasses that are valuable fodder plants under some conditions, are very troublesome weeds under the conditions of other localities.

Those plants that are not of economic value in a given locality and are therefore termed weeds, should so far as possible be eradicated, as the moisture and nourishment required to produce these plants should be utilized in the production of some crop of greater value. No crop grown on the farm will make a maximum development if weeds are allowed to occupy the ground with it. Weeds may also interfere with realizing the value of the crop that is produced. The writer has seen pastures in which large areas were so thickly set with thistles and other weeds as not only to interfere materially with the growth of the pasture grasses but also to prevent the animals obtaining what little feed was produced.

As regards general methods of eradication weeds may be divided into three classes.

I. ANNUALS

Annuals are those plants that come from the seed each season. This is by far the most numerous group, and the method employed should be such as to prevent their seeding.

Eradication — Seeding may be prevented by thorough cultivation with ordinary tools and by the mowing of pastures and fence rows before the seeds are sufficiently matured to grow. The least amount of cultivation required to kill any of these weeds is while they are very small, and a great amount of extra labor may be saved by performing this operation at the right time.

If such plants can be entirely prevented from seeding and no weed seed is imported from neighboring farms or in purchased seeds, it will be only a question of time when practically all the seeds that are in the soil will have germinated and the farm will be entirely free from them.

There is one class of crops in which it is sometimes very difficult to prevent some of these plants from seeding — the various sorts of small grains. One of the best means of prevention in these cases is the thorough preparation of the soil, so that no weeds shall be left growing at seeding time, and there may be secured a good stand of strong, vigorous plants, that will keep the weeds smothered down.

Where there are a few large scattering annuals that run up to a considerable height above the grain, they may be clipped off with a scythe or sickle.

Some experiments have been made in the way of killing weeds in small grain by spraying with various poisonous solutions. All plants are not affected alike by these solutions, hence, it is possible to kill some kinds by this means without doing much injury to others.

For example, at the North Dakota Experiment Station a 10 per cent solution of blue vitriol was sprayed over an exceptionally weedy plat of wheat, the principal weeds being wild barley, wild rose, penny cress, shepherd's purse, wild buckwheat, lamb's quarter, great ragweed, and charlock or wild mustard. The spraying was done June 7th, when the wheat was 3 to 5 inches high, and on August 8th all the weeds, except the wild rose and the older plants of penny cress, were dead. Some of the leaf tips of the wheat had been slightly burned, but the yield of grain was considerably larger than from an equal area unsprayed.

On June 20th part of an oat field containing many weeds was sprayed with a solution of 1 pound of copper sulphate to 4 gallons of water. The oats at time of spraying were about 6 inches high. On August 1st the treated area was free from all weeds, except pigeon grass and wild rose. The oats on the treated area stooled well and were strong and vigorous, while those on the portion not treated were weak and had stooled but little.

These were stronger mixtures than have generally been found most satisfactory, but in this case appeared to result in no injury to the grain crops. Probably the best results will be obtained under general conditions by using a 2 per cent solution (1 pound to about 6 gallons of water) and applying at the rate of 40 to 60 gallons per acre.

Copperas is also quite effective for this purpose and its use will cause less danger from poisoning in case animals should gain entrance to the sprayed field. To have anything like the same effect on the weeds it must be used much stronger, about a 10 to 15 per cent solution being necessary.

II. SEEDING PERENNIALS

In this class are included those perennials (plants that live from year to year), which spread only by the distribution of their seed. A good example and one of the worst of this class in many localities is the common dock.

The weeds of this class should not only be kept from producing seed but should be cut below the crown with a thistle spud or a common spade and pulled up, as otherwise they will continue to send up their seed stalks and require constant cutting.

III. SEEDING AND SPROUTING PERENNIALS

In this class are included the perennials, such as the Canada thistle, wild morning-glory, quack grass, horse nettle, sheep sorrel, and many others that spread by means of seed distribution and also by underground stems or jointed runners.

Eradication — This is by far the most difficult group to eradicate. These jointed runners will not only send up new plants while they are attached to the parent plant, but if cut or broken and carried about, the pieces will grow, forming new centers of distribution. These runners have great vitality. They may often become dried and lie dormant for a long time ; then, like a seed, when the proper conditions are presented, spring into life. Thus it will be readily understood how ordinary cultivation is a means of spreading rather than of destroying such plants.

The general treatment for this class of pests is to put the land into some hoed crop, where practicable, and by constant cutting off at the surface of the ground smother them out by not allowing them sufficient leaf growth to gather the necessary food from the air.

Summer fallowing will accomplish the same result if thoroughly and properly done, not allowing the plants to make an appreciable growth at any time and using surface tools that will shave the whole surface, cutting off everything. Wild morning-glory may also be quite successfully eradicated by close pasturing with sheep, as these animals are fond of it and will keep it very close, soon smothering it out. It may also be destroyed by pasturing with hogs, and allowing them to root up and eat the rather fleshy roots and underground stems.

POISONOUS WEEDS

The worst kind of weed to let grow is one that not only occupies ground and consumes water and food that should be better utilized, but also actually endangers the life of man and beast. There are many plants that to a greater or less degree possess poisonous properties. Some will poison one kind of animal and not another. Some are poisonous for man only when eaten, while others are liable to induce poisoning by the handling, especially when they are wet. For a list of these plants, together with descriptions by which they may be recognized, and antidotes for cases of poisoning, the reader is referred to publications mentioned in the *Bibliography*.

Eradication — Use similar methods as for other weeds, working with great care about those that are poisonous to the touch.

J. J. Edgerton

PUBLICATIONS ON FIELD AND FORAGE CROPS, SEED SELECTION, AND THE ERADICATION OF WEEDS

NOTE — For additional publications on specific crops, see also the book list on page 108.

ALFALFA. By F. D. Coburn. *Orange Judd Co.*, N. Y. $0.50
A suggestive presentation of the best methods of growing this most valuable crop under various conditions.

ALFALFA, OR LUCERNE. Farmers' Bulletin 31. *United States Department of Agriculture* —

CATTLE RANGES OF THE SOUTHWEST. Farmers' Bulletin 72. *United States Department of Agriculture* . . . . —

CORN, BOOK OF. By Herbert Myrick. *Orange Judd Co.*, N. Y. 1.50

CORN CULTURE, INDIAN. By C. S. Plumb. *Breeder's Gazette*, Chicago 1.00

CORN CULTURE IN THE SOUTH. Farmers' Bulletin 81. *United States Department of Agriculture* . . . . —

COWPEAS. Farmers' Bulletin 89. *United States Department of Agriculture* . . . . . —

FARM GARDENING AND SEED GROWING. By Francis Brill. *Orange Judd Co.*, N. Y. . 1.00

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FORAGE CROPS OTHER THAN GRASSES. By Thomas Shaw. *Orange Judd Co.*, N. Y. . 1.00

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PEANUTS: THEIR CULTURE AND USES. Farmers' Bulletin 25. *United States Department of Agriculture*	——
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POISONOUS PLANTS OF THE SOUTH. Bulletin 9, Volume XXII. *North Carolina State Board of Agriculture*	——
PRINCIPAL POISONOUS PLANTS IN THE UNITED STATES. Bulletin 20, Division of Botany. *United States Department of Agriculture*	.05
RED CLOVER SEED. Farmers' Bulletin 123. *United States Department of Agriculture*.	——
SOILING CROPS AND THE SILO. By Thomas Shaw. *Orange Judd Co.*, N. Y. A comprehensive discussion of the crops best adapted to a line of work that should receive increasing attention from the farmers of the country.	1.50
SORGHUM AS A FORAGE CROP. Farmers' Bulletin 50. *United States Department of Agriculture*	——
SORGHUM SYRUP MANUFACTURE. Farmers' Bulletin 135. *United States Department of Agriculture*	——
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WEEDS: HOW TO ERADICATE THEM. By Thomas Shaw. *Thomas Shaw*, St. Anthony Park, Minn.	1.00
WEEDS, LEGISLATION AGAINST. Bulletin 17, Division of Botany. *United States Department of Agriculture*	.05
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Vegetable Garden and Trucking Crops

By Arthur T. Erwin
Assistant Professor of Horticulture, Iowa College of Agriculture

ESSENTIALS IN GARDENING

The Soil—Any fertile, well-drained soil, suitable for corn, will produce good garden crops. With a home garden a first requisite is convenience to the kitchen, hence, there is usually little choice as regards special soils. Certain soils have their specific adaptation to special crops, however, and the grower who devotes attention to particular kinds should make a close study of this local factor. In general, "quick," sandy soils are best adapted for early crops. On the other hand, they do not retain moisture so well in the heat of the summer, hence, for later crops a more retentive soil is preferable. Aside from this, on a rolling soil a variation in elevation will often produce crops which mature several days earlier, and even on a small plot this variation should be noted and used to best advantage.

Planning the Garden—It is a lamentable but indisputable fact that the farmer's table is not supplied with its daily quota of fresh vegetables as it should be. Poor planning and improper arrangement of the vegetable garden are no doubt in large measure responsible for this. As commonly laid out, the garden requires an endless amount of hand labor, which is always expensive and far in excess of that required for any other proportionate area on the farm. The work should be so planned that the "horse hoe" may be used whenever possible. To facilitate this, the garden should be oblong in shape and the crops planted in long rows (Fig. 24). At each end it is well to leave a strip of sod as a turning ground. Group crops according to their season of maturing, placing all perennial crops, such as rhubarb and asparagus, in adjoining rows, and early crops, such as peas and beans, together. The prevailing system of growing the various crops in raised beds is a poor one, except for a few of the very early crops. With these it has an advantage in providing a soil which warms up earlier, but for general crops it is expensive and unnecessary. The soil is also more exposed and likely to suffer from drought. Regarding this matter, I can not do better than quote the words of Professor Bailey, the truth of whose statement many a farmer's boy will verify:

"The old practice of growing vegetables in beds usually entails more labor and expense than the crop is worth, and it has had the effect of driving more than one boy from the farm. These beds always need weeding on Saturdays, holidays, circus days, and the Fourth of July."

Regarding the size of the area for the family garden, much, of course, depends upon the size of the family and their fondness for vegetables. Bailey recommends 100 by 150 feet for a family of five. This is based upon the constant use of the ground and a close succession of crops, a plan which is most essential in the limited area of the city man's garden. In the country, however, conditions are different. Land is more plentiful and help is the expensive item. In this case, less intensive succession of crops, less hand labor, and a larger area of land seem advisable. For the needs of the average farmer's family of five, including potatoes and vine crops, from one-half to three-fourths of an acre is none too large. Essential requirements in the family garden are variety and a regular supply, rather than a large crop of any given kind.

In the garden a limited rotation of crops is essential. Certain crops have their specific enemies, such as the club root of cabbage, and rotation is the only practical method of keeping these foes in check, as well as aiding in maintaining soil fertility.

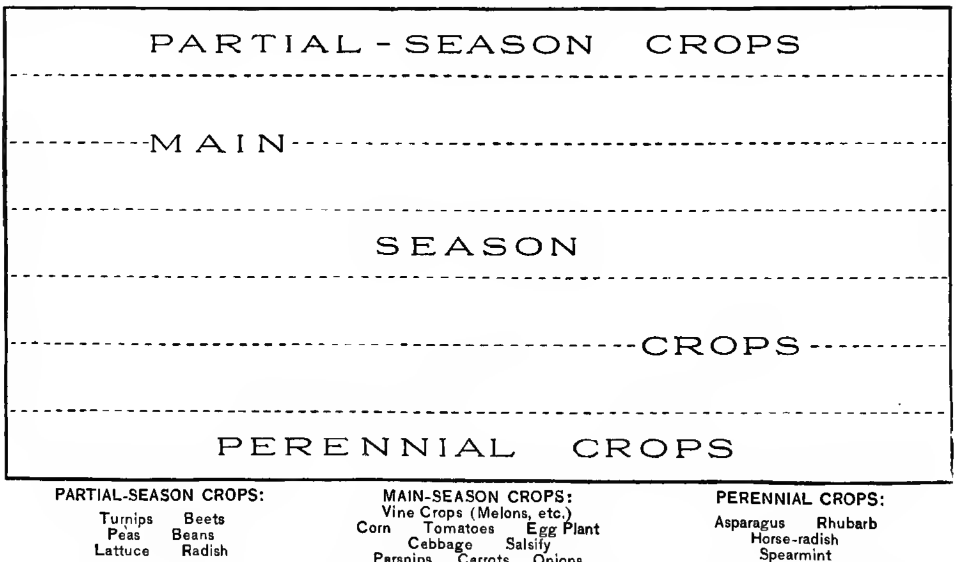

FIG. 24. Plan for garden. A convenient arrangement, with a view to securing long rows, for horse cultivation.

Seed — Seed should be purchased from a reliable seedsman and one should expect to pay a good price for a good article. Cheap seeds and bargain packages are invariably a dear investment at any price.

Varieties — The testing of new varieties is a fascinating line of work, and every grower should devote a small area to this purpose, but for the main crop,

> "The friends thou hast, and their adoption tried,
> Grapple them to thy soul with hoops of steel."

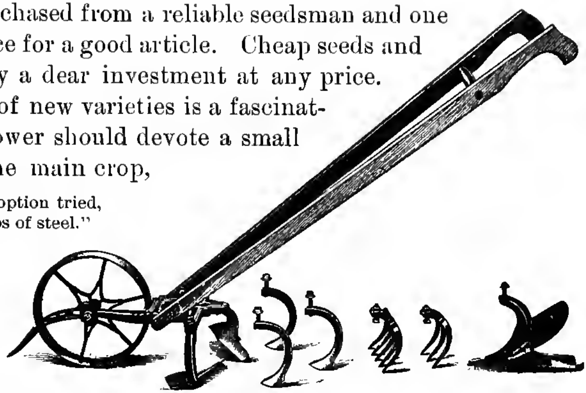

Fig. 25. Typical single-wheel hoe and cultivator.

The naming of varieties in the following pages should be regarded as tentative, those mentioned being named as the representatives of certain types which have a general adaptation rather than as specific varieties. Environment is a ruling factor with varieties, and one can determine the kinds best adapted to his peculiar conditions only by actual experience.

Implements — Among the most important of the implements for general cultivating and garden work may be mentioned the various types of horse hoes, hand cultivators, and wheel hoes. These types of tools are invaluable and in a single season will pay for themselves in labor saved. They should be regarded as an essential part of one's equipment.

In dry seasons thorough preparation of the seed-bed is of special importance. If the soil is cloddy and open it dries out quickly, and poor germination results. The soil particles should be fine and well worked together. Often the roller is of special advantage for this work. For summer planting the advice of Peter Henderson, to "place your foot on every seed you plant," may be followed with profit.

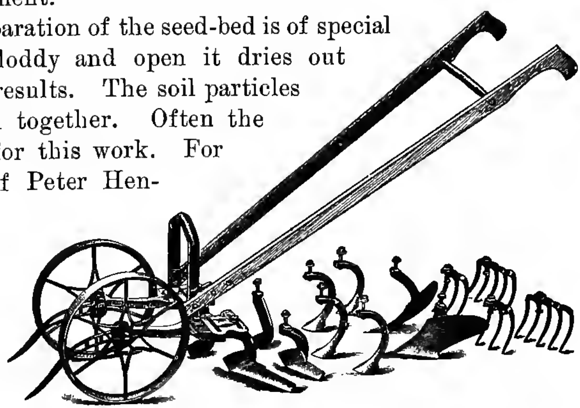

Fig. 26. Typical double-wheel hoe and cultivator, for straddling the rows.

Transplanting — In transplanting, it is best to do the work in the cool part of the day, as this enables the plants to revive during the night. Wilting is much less severe in a moist atmosphere, hence when possible it is an advantage to transplant cabbage and other seed-bed crops just before a rain. Wilting is caused by the uncompensated giving off of moisture from the leaves. In the plant there is normally an equilibrium between the root system and the foliage. In transplanting, the root system is partially destroyed and as a result the amount of moisture required for the foliage is in excess of the supply and wilting follows. Hence, in transplanting crops of any kind it is important to cut back the tops to make them balance with the root system. With such plants as celery and cabbage, about one-half of the leaf surface should be cut back. On a small scale, good results may be accomplished by placing a flower pot over each plant for the first day or two. This keeps the plant cool and moist and enables it to become reëstablished before being exposed to the hot sun. If the soil is dry, watering after transplanting is advisable, though under average conditions for work done in the spring of the year this is unnecessary. There is an ample water supply in the soil which will be rendered available if pains are taken to firm the soil well, bringing the moist particles into close contact with the delicate roots.

Hardening Off — Sudden changes in temperature are always trying on plant life. Plants which have been started within doors should be gradually accustomed to the outside temperature before being placed in the field. This process is known as "hardening off." In hardening off, the plants are usually watered less freely to harden up the growth somewhat, and the ventilation period is gradnally lengthened each day until the plants are accustomed to the outside temperature. As a result, such plants readily become reëstablished in the new soil, whereas, if suddenly withdrawn from the higher temperatnre the check in growth would be severe and earliness often would be sacrificed. This is of special importance, as earliness is the essential object in starting any plants indoors.

HOTBEDS

Location and Construction — For the starting of tomato plants, early cabbage, sweet potato, and similar vegetables, hotbeds are a necessity. The beds should be located upon a south or east slope with a building or fence to protect from the north and west winds. The soil for the frames is usually excavated to a depth of about two feet and filled in with manure. This should be piled and allowed to heat for a few days, and turned before being placed in the beds. It should be thoroughly tramped as thrown into the beds, taking special pains to firm around the edges. The temperature will again rise, and no planting should be done until the temperature has reached its maximum and has fallen to about 90°. Four inches of mellow garden loam should now be placed over the manure, and the bed is ready for use.

The seeds may be sown directly in this soil. Care must be taken, especially for the first few days, to provide proper ventilation, as the heat is quite strong and ammonia is given off freely.

In the prairie region the sash are apt to be blown off and broken by the wind. To avoid this the frames should be slightly wider than the length of the sash, and an inch strip placed along each side, extending up the height of the sash bar, to prevent the wind from getting under the sash. The accompanying illustration, Fig. 27, will indicate the general plan and structure of a simple hotbed.

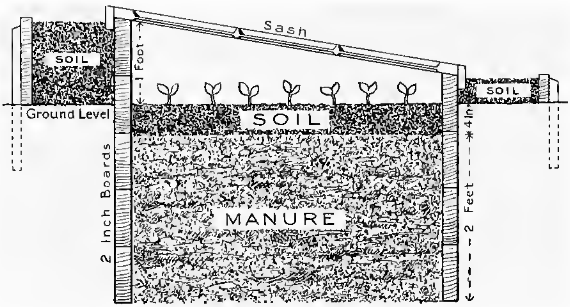

FIG. 27. A simple hotbed. (Erwin.)

Forcing Boxes—A forcing box is very cheap in construction, and will enable one to secure crops of lettuce and radishes two or three weeks earlier than from out-of-doors. These boxes are operated upon the principle that heat is readily stored up under glass. The soil is spaded and a bottomless box, the size of a window sash, is placed over the area. The sash should be left closed for several days, during which period the temperature will run up considerably if the weather be sunny. The seed should then be sown, and as soon as the plants germinate ventilation and watering will be necessary. If a number of sash are desired, 6-inch fencing boards may be used for the sides.

Those who are interested in the growing of special crops will find an extended list of literature at the end of this section. In addition to special works, every grower of garden plants should possess a copy of some general book on this subject, such as Green's *Vegetable Gardening,* or Bailey's *Principles of Vegetable Gardening.*

TUBER AND BULB CROPS

IRISH POTATO *SWEET POTATO* *ONION* *LEEK*

IRISH POTATOES

The Irish potato is a staple article of food throughout the civilized world, and probably ranks second only to wheat as a food product. It is essentially a northern crop, but thrives best in a warm soil of a slightly sandy texture. The pine lands of this quality in Wisconsin and Minnesota seem to furnish ideal conditions for its growth.

Culture —The most important point is an ample supply of moisture. Without this, good tubers can not be produced. It is not a bog plant, however, and good drainage is necessary. An ample water supply throughout the season may be secured by early planting and frequent surface tillage. The soil should be fertile, and it is a good plan to plow under a coat of manure in the fall of the year, leaving the ground in the rough until spring. The manure should be thoroughly decayed, however, as fresh manure seems to favor scabby potatoes.

It is often best, as a matter of fact, to apply a heavy coat of manure to some crop grown the previous season, rather than the year the potatoes are grown. In addition to the scab, grub-worms are also very much worse in freshly manured soil. The preparation of the ground should be deep and thorough, as the tubers develop better in a loose soil.

If plowed in the fall, the ground should be replowed just before planting and the rows then laid out, making the furrow at least four inches deep. With this thorough preparation before planting, the tubers have ample room to form below the surface and they are much less liable to grow above the soil and turn green.

FIG. 28. Some noteworthy varieties of Irish potato. (Erwin.)

Seed potatoes should be cut with at least one sound eye to each piece. Cutting machines are used, and for large planting are convenient, but no mechanical device can equal a knife in the hands of an intelligent operator. There is much speculation as to the proper size of pieces and number of eyes to a seed. It should be borne in mind that the eye is a young plant and the tuber contains a storehouse of material for it to feed upon until it becomes established in the soil; hence, the important thing is to have an ample supply of food for each eye. Medium-sized tubers are preferable, and a liberal-sized piece should be allowed to each eye. The use of peelings and small, inferior potatoes for seed purposes is to be condemned, as poor crop and the "running out of the variety" is an inevitable result Plant 15 inches apart, with 3½ feet between the rows. At this distance ten bushels of seed will be required per acre.

After planting, the ground should be harrowed, in order to make it firm and smooth and to kill young weeds, and the operation should be repeated frequently until the plants appear. Until the young plants have attained a height of 4 to 6 inches they may be cultivated with a light, slant-toothed harrow or weeder. This is a very effective method of cultivating, as it destroys the weeds in the hills, where they are difficult to get at with a plow, and it will not harm the potatoes. After this plowing alone can be practiced. This should be continued until the plants have attained full growth and the vines begin to spread, after which no cultivation is necessary except in very dry seasons. The cultivating should be shallow, and many prefer the one-horse cultivator to the double-shovel plow.

The last cultivating is done with a double shovel, throwing the furrow to the row, thus ridging the ground slightly.

Digging—The maturing of the tubers is indicated by the dying of the vines. With early varieties and a good market, it will pay to dig at once. Later varieties handle better if left in the ground until well ripened. If the soil is moderately dry it furnishes an ideal place for the maturing of the tubers. In wet falls, however, they will rot instead of ripening if left in the ground after the tops die away. Under such conditions it is advisable to harvest as soon as the tops are dead.

Hand digging is expensive and practiced only on a small scale. For large areas potato diggers are largely used and are quite satisfactory.

Sorting and Storage—After harvesting the grower is confronted with the problem of storing or selling at once. Spring prices are often glittering, but the fluctuation makes the risk of holding all the greater The shrinkage and loss in storage must also be taken into account. One must be one's own judge in taking account of existing conditions, but in general, Terry's advice that "Cash in the bank is better than potatoes in the cellar" is good.

Before selling, the tubers should be carefully assorted into uniform grades. Often a graded article will command a ready sale at a good price while a mixed crop will go begging, and in any case the first-class tubers in a mixed lot are rated in and sold at the price of the seconds. The very small tubers injure the sale of the product and should be kept at home for chicken feed. In the spring, the work may be done very much more rapidly with a sorting machine. In the fall, however, the use of this machine is not advisable if the potatoes are to be stored or kept any length of time, as the skin is quite tender and they are likely to be more or less peeled and bruised.

A dark, well-ventilated cellar with a temperature 6° to 8° above freezing is the best place for storing. Raised floors and an interval of a few inches between the bins and the wall should be provided to admit of proper ventilation. It is also an advantage to have the sides of the bins constructed of slats rather than solid boards. The exclusion of light is important, as the tubers develop chlorophyll and turn green in the presence of sunlight, which spoils the flavor of the tuber. Temporary storage may be provided in the fall by piling and covering with straw to protect from frost. Sprouting in winter usually indicates too high a temperature, and may largely be prevented by keeping the temperature down and excluding the light.

Varieties vary much in their adaptation to local conditions. Those grown on wet, swampy soils are watery and more or less tough in texture. The same varieties grown on upland soil will be higher in flavor and more mealy in character. Restaurant and hotel-keepers prefer the former for Saratoga chips and the latter for baking. *Early Ohio*, *Maggie Murphy*, *Carman*, and *Rural New Yorker* are standards. The *Burbank* is another favorite variety and regarded by many as of the first rank in quality, though not so productive as the others named.

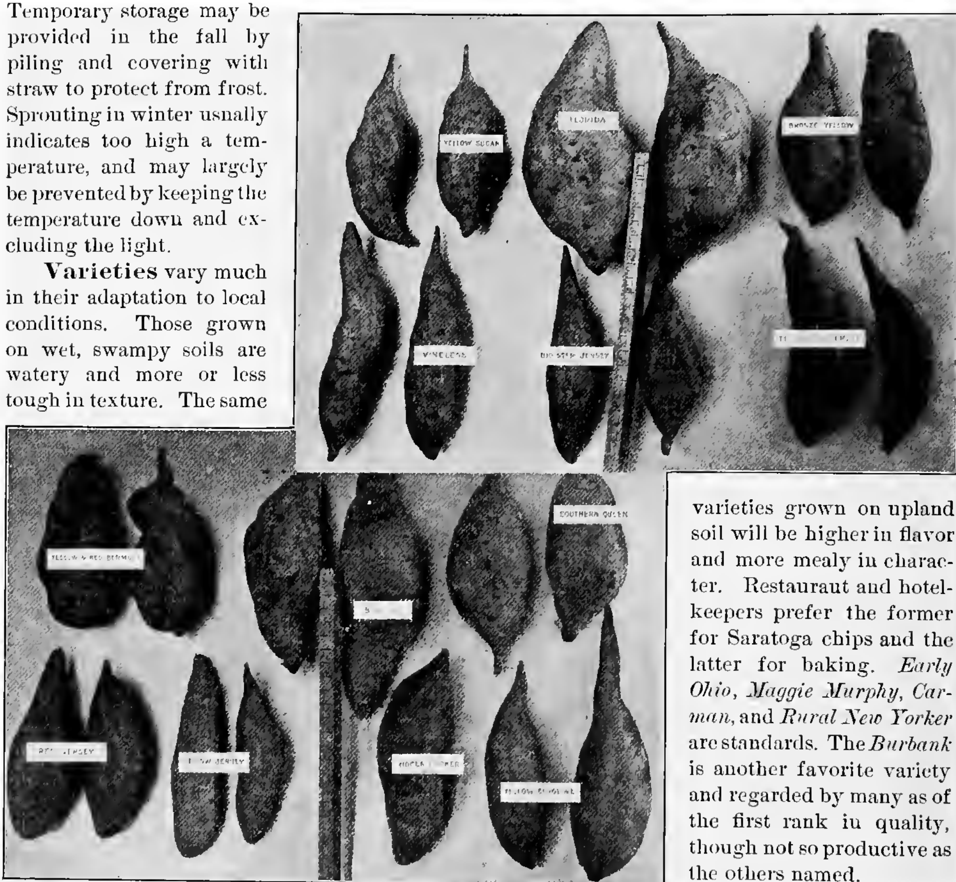

FIG. 29. Well-known varieties of sweet potato. (Erwin.)

SWEET POTATOES

The sweet potato is distinctly tropical in its requirements. A light, warm soil, rich in organic matter, is essential. Cold or heavy clay soils are unsuccessful. In the South, level culture is practiced. In the cooler sections of the North the ridge system secures a warmer soil, and is an advantage, especially in wet seasons.

Propagation and Culture — The sweet potato is usually propagated from shoots started in hotbeds The tubers are placed quite close together but not touching each other, and covered with 2 or 3 inches of soil. The shoots are taken off when 3 or 4 inches in height, and transplanted to the field when the ground becomes warm. Frequent cultivation of the surface soil is important and will do much toward producing good-sized tubers. The question is often asked as to whether or not it will pay to remove the vines in order to prevent their rooting. A number of experiments have been conducted along this line, and the consensus of opinion is that it will not, there being little difference in yield between the crops so treated and those where the vines have been allowed to grow unmolested.

The sweet potato is a main-season crop and the vines remain green until frost. Before digging, the vines should be mown off with a brier scythe If the crop is caught by an unexpected, heavy frost the vines should be cut away in the early morning before the sun blackens them, otherwise the keeping qualities of the roots seem to be affected. The tubers bruise readily, and require careful handling They must have a higher storage temperature than that of other root crops, keeping well in a temperature of 55° to 60° The roots are usually packed in barrels, buckwheat chaff or sawdust being used as a filler

Varieties — In popular parlance the term "Yam" is used to designate the yellow-skinned types of sweet potato. In the South this type reaches perfection and produces tubers with a high percentage of sugar and of a rich, mealy character In many parts of the North, however, the red sorts are preferred Vineless varieties of the sweet potato have attracted recent attention. Such a type is no doubt desirable, but the varieties produced thus far have generally proved poor bearers. *Florida*, *Red Jersey*, and *Yellow Jersey* are among the most productive sorts in the North.

ONIONS

The onion is a hardy plant and should be sown as soon as the ground will permit.

Culture — A convenient plan is to sow with a drill, placing the rows 12 to 15 inches apart. When the plants reach a height of 3 inches, thin to 4 inches apart. In doing this care should be taken that the remaining plants are left intact, with the soil firm around them. Careful hand-weeding is necessary until the plants become well established. If neglected in the early stages of growth, the young plants are easily smothered out by weeds. This is the most expensive period in the growing of onions, and the Hazeltine weeder is an invaluable tool for this work. Later, some form of a hand wheel hoe can be used to excellent advantage.

When the tops die off the crop is ready for harvesting Bunch three rows together and allow them to lie until perfectly dry. This period is a critical one in the care of the crop. If allowed to remain in the ground after the tops die they are likely to throw out new roots after the first rain. On the other hand, the bulbs must be thoroughly dry before storing. A cool, dry shed should be provided for this purpose. A series of shelves, four inches in depth and with ample space between for free circulation of air, furnishes excellent conditions for storage.

Freezing is not injurious, if the building is well enclosed to prevent sudden freezing and thawing. For small crops a portion of the haymow may be used for storage.

Onion Sets — Sets are produced by sowing the seed very thickly and preferably on a poor soil. On account of the crowded condition the young bulbs can not develop fully and growth is arrested when they are about half size. To prevent the sets from overgrowing the seed should not be sown until the middle of June. Bulbs one-half inch in diameter command the top price. The sets are planted as soon as the soil can be worked in the spring, and the crop is usually ready for market by the first of June. The bulbs are set 3 inches apart and about 3 inches deep, taking pains to firm the soil well around the bulb.

Varieties — There are three general types of varieties, white, red, and yellow skinned. The white are usually more mild in flavor. In many markets the demand for red exceeds all others. *Early Red Wethersfield, Yellow Strasburg,* and *Silver Skin* are general favorites.

LEEKS

These are a species of onion producing a straight stem. The stems are mild in flavor and are highly prized for winter soups.

Culture — The culture is similar to that of the onion. The leek requires the entire season for growth and is stored in the green state, as in the case of celery.

Varieties — *American Flag* is a desirable sort.

PULSE CROPS

PEAS *BEANS*

Peas and beans belong to the family *Leguminosæ*, and by the botanist are regarded as closely related. Horticulturally, however, they differ essentially as regards cultural requirements, beans being a tropical plant, while peas are hardy and a cool-season crop.

PEAS

Culture — Peas should be sown as soon as the ground can be worked in the spring. In many sections successional crops may be had by planting every two weeks. In the drier atmosphere of the Northwest, however, they do not thrive well in late summer, and the early-season crop is the main one. A fall crop may be secured by sowing early-maturing varieties the forepart of July. A good rotation may be secured by planting the ground to early potatoes, harvesting these in July, and sowing to peas for a fall crop

Varieties — There are two types of peas generally grown in the United States, those having a small, *round seed,* and those having *wrinkled seed.* The wrinkled sorts are the less hardy and should be planted later in the spring. While less vigorous than the smooth, round peas, they are regarded by many as superior in quality, and for this reason are preferable for the main-season crop. In addition to these there is a third type with an edible pod, known as the *sugar pea.* While popular abroad, they are little grown as yet in this country.

The tall-growing varieties of peas are usually grown in double rows 5 feet apart and supported by brush or wire netting. The dwarf sorts are equally productive, however, and are largely supplanting the tall kinds, because they require no support. On rich soil peas tend to vine too heavily, aud the best crops are secured on a moderately poor soil.

For early planting some of the best varieties are *First of All, Extra Early,* and *Gradus;* Main-season crop· *Junus, Nott's Excelsior,* and *Stratagem.*

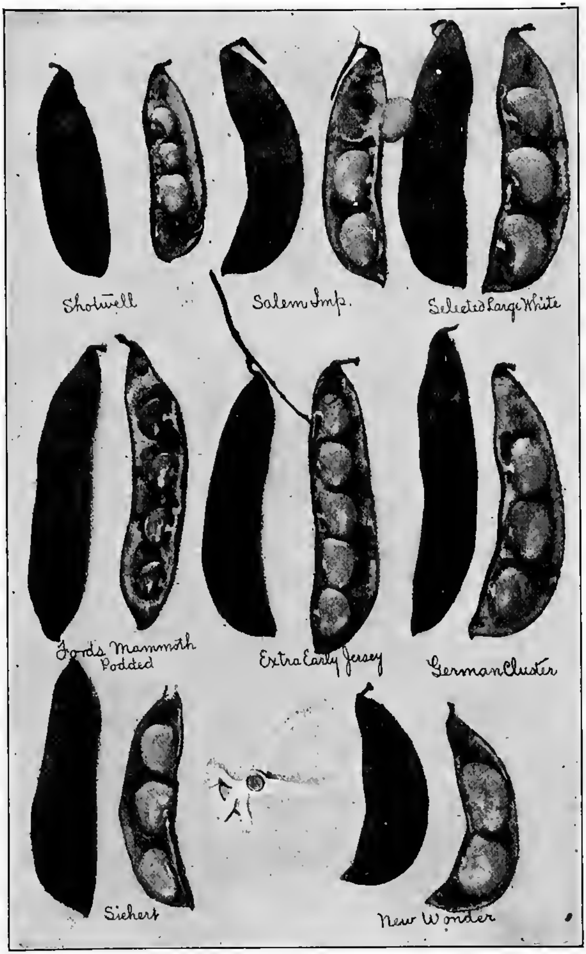

FIG. 30. Some standard varieties of Lima beans.

BEANS

The garden beans are natives of the warmer parts of South Africa, and are very tender to frost. For this reason they should not be planted until the ground has become warmed. A good guide for planting time is "when the oak leaves reach the size of squirrels' ears." If the seed is sown too early it decays quite readily.

In their cultural requirements beans are divided into two types: *Pole Beans*—climbing varieties which require a support—and the dwarf, compact-growing sorts, known as *Bush Beans.*

Pole Beans: Culture—The climbing Lima bean belongs to this type and is a kind, of high flavor, much prized in the South and East. It is more tender than the bush beans, however, and for this reason is not so successful in the Northwest. In that section the Dwarf Limas are more satisfactory. In planting pole beans it is best to place the poles, before planting, in rows 3 feet each way. If the soil is thin it is a good practice to apply a shovelful of well-decayed manure under each hill. To insure a good stand, 6 to 8 seeds should be sown to each pole. Wire netting is a convenient support and in many sections is preferable to poles. Some of the standard varieties of pole beans are *Dreer's Pole Lima, Siebert's Lima*, and *Large Lima.*

Bush Beans: Culture—Bush beans require a very much shorter growing season, and by successional sowings may be had for table supply throughout the summer. The last planting should be made at least seven or eight weeks before heavy frost.

To secure good snap or string beans a rapid growth is necessary. Otherwise the pods become stringy. It is also necessary to keep all pods picked, allowing none to mature, for the ripening seeds will check the growth of the plant and destroy the future supply of green pods. When grown as a field crop for market the plants are pulled by hand and piled with the roots upward, or harvested with a bean puller. If not allowed to stand until the pods shell too much they may be mowed and raked up as hay. For small quantities, a hand flail and fanning mill may be used for threshing and cleaning. By large growers, a regular bean thresher is employed.

Varieties—Bush Beans. *Yellow Podded, Golden Wax,* and *Valentine Wax.* Shell and String Beans: *Stringless Green Pod* and *Early Refugee.* For field use, the *Navy* is probably best known. *Dwarf Limas, Henderson's Bush Lima,* and *Burpee's Bush Lima* are common types. Dwarf Limas are not equal to pole Limas in flavor and quality, but have the advantage of maturing earlier and being more productive.

VINE CROPS

CUCUMBERS *MELONS* *PUMPKINS* *SQUASHES*

Vine crops are frost-tender and thrive best on a warm, sandy soil. They are grown in hills and cultivated both ways so long as the vines will permit. In the North they require the entire season for growth and should be planted as soon as the weather becomes well settled and warm. The flowers of vine crops are monecious, *i. e.*, the male flower is borne upon one branch and the female upon another. The pollen is transferred by bees, hence this insect plays an important part in the growing of this class of vegetables, failure being sometimes due to lack of proper pollenization.

Fig. 31. Popular varieties of cucumber. (Erwin.)

CUCUMBERS

Culture—Plant as soon as the soil becomes thoroughly warm, in hills 6 feet each way. To allow for insect ravages it is well to plant 6 to 10 seeds to a hill, and thin to 3 when the plants begin to vine well. Cultivate both ways as long as possible. No fruit should be allowed to ripen on the vine, as this will cause the plants to discontinue growth and cut short the crop.

Varieties — The *White Spine*, *Long Green*, and *Cool and Crisp* are standards.

MUSKMELONS

There is much confusion regarding the use of the term muskmelon and cantaloup. With some the terms are regarded as synonymous. According to Bailey's *Cyclopedia of American Horticulture* the cantaloup is a special form of muskmelon, having a deeper furrow and a hard rind.

Culture — The culture of the muskmelon is similar to that of the cucumber. The fruits are of a higher flavor if allowed to remain on the vines until they separate readily at the shoulder.

Fig. 32. An excellent variety of muskmelon, of the fine-netted skin type. (Erwin.)

Varieties—A large, nearly smooth-skinned type known as the *Montreal* muskmelon has recently aroused considerable interest in the West. While of a superior size it is coarse and low in quality. In fact, as a class, the medium-to-small-sized varieties with a finely netted skin are the *par excellence* of quality. Of this type the *Netted Gem* and the well-known *Rocky Ford*, which is a slight variation of the Gem, are good examples.

WATERMELONS

The watermelon thrives best in the South. Good crops may be grown in the North, however, if planted on an early "quick" soil.

Culture — The hills are usually placed 8 or 10 feet apart, and, if the soil is thin, a shovelful of well-decayed manure should be placed under each hill. The fruit is borne on the side branches, and many growers recommend the pinching back of the terminal buds to stimulate side growth.

Varieties — *Mountain Sweet* and *Hungarian Honey* are good northern sorts.

CITRON

Citron is a fruit very similar to the watermelon in appearance and culture, but bearing a thick, hard, fleshy rind, which is used for preserving.

PUMPKINS

Pumpkins are coarse growers and, hence, are generally planted in the field rather than the garden. A favorite plan is to plant in alternate rows in every second hill in the cornfield. The fruit should be stored or covered with fodder upon the approach of heavy frost. The crop is largely grown for stock, and finds only limited use as a table vegetable.

SQUASHES

The term "squash" is quite a broad one, including those classes of gourds which produce an edible fruit. It is a popular error that squashes, pumpkins, and melons will cross-fertilize if planted near one another. Those who have made careful investigation, however, are emphatic in their statements that such is not the case, and that squashes never cross with watermelons and spoil their flavor, as is sometimes stated. Hand crosses between the pumpkins and squashes failed in the majority of cases, and in no case were the results apparent until the second generation.

Culture—The general cultural requirements of the squash are similar to those of the cucumber except with the long-vined sorts, for which the hills should be ten feet apart. Sow 6 to 8 seeds per hill and thin to 3 Of the summer squashes, *Silver Custard* and *Crookneck* are good varieties; of the winter squashes, *Boston Marrow* and *Hubbard.*

Varieties—There are two distinct types of squashes—the summer and winter species. The summer varieties mature early and are used before the rind hardens. The fall and winter varieties are usually provided with a hard, flinty shell of a warty appearance. The Hubbard is a well-known and excellent representative of this class Winter varieties are readily stored if handled carefully and held at a temperature of 40° to 50°.

ANNUAL ROOT CROPS

BEETS *CARROTS* *TURNIPS* *SALSIFY* *PARSNIPS* *RADISH*

Root crops are of the easiest culture. The essential conditions are a deep, rich soil, with ample moisture. A straight, symmetrical root is required, and to secure this, deep plowing and a well-prepared seed-bed are necessary. The soil should be fertile, but it is not advisable to plow under fresh manure, as the roots are apt to acquire an astringent flavor and a forked growth. On poor, clay soils the roots are usually leathery and of inferior quality.

BEETS

There are two general types of beets — the turnip-rooted and the long-rooted. The turnip-rooted sorts mature the more quickly and are generally grown for the early-season crop.

Culture — The beet ranks with the onion and pea in point of hardiness, and should be sown as soon as the ground is in a tillable condition. Plant 1 inch deep in rows 3 feet apart. As the seed usually germinates unevenly, it is well to sow thickly. Thin as the plants reach 5 or 6 inches in height until they are 5 inches apart. The thinnings make excellent greens. By successional sowing a supply may be had throughout the summer and fall. Upon the approach of heavy frost the crop should be pulled and piled. The tops are cut off 2 inches above the crown. This is important, as, if the crown of the root is cut, they readily decay. Store in a cool cellar or root pit. If the atmosphere is dry they should be covered with slightly moistened soil or sand. If allowed to dry out the roots become wilted and corky. Good corn land is well adapted to beet growing, and for early varieties a quick, sandy soil is advantageous.

Varieties — The *Eclipse* is a general favorite. Other standard varieties are the *Early Turnip*, *Egyptian*, and *Long Dark Blood.*

CARROTS

Culture — Like other root crops, the carrot thrives best on a rich, deep, well-drained soil. The plants are quite hardy and of the easiest culture when once established. The seed germinates slowly, and hence it is a good practice to sow with it some companion crop, such as radish. This will keep the rows defined and insure early culture. Early culture is important, as the young plants are rather delicate and easily smothered out by weeds if neglected. The seed should be sown rather thickly and the plants thinned to 3 inches apart. Early varieties are sown as soon as the soil will permit. The winter crop should be sown about the first of June. Crops intended for storing should not be planted before this, as they may mature their growth and the tops will die off while still in the soil. The roots which are harvested while still in a growing condition store best and are of superior quality.

Harvesting — For convenience, the first step in gathering should be the mowing off of the tops with a brier scythe or cropping off with a hoe. Digging may be facilitated by plowing a furrow from the row on each side, or plowing out the roots.

Varieties — *Scarlet Horn* and *Improved Long Orange* are among the best.

TURNIPS

The turnip is a moisture-loving plant and does not thrive best in the hot, dry atmosphere of midsummer; hence it is grown almost entirely as a spring and fall crop.

Culture — The seed is sown early and the roots usually reach marketable size in eight to nine weeks. Turnips are often sown as a successional crop with early potatoes and cabbage. The seed is sown broadcast and the only important point in culture is that the plants have an ample supply of moisture. The soil is likely to be dry when the fall crop is sown ; hence, thorough preparation of the seed-bed is necessary. Germination may be assisted by rolling, which brings the moist particles of soil into contact with the seed. Turnips are injured by freezing, and should be stored in a cool cellar before heavy frost. The roots are largely used as stock food and find only a limited demand as a table vegetable.

Varieties — *Purple Milan, Early Snowball.*

RUTABAGAS OR SWEDISH TURNIPS

The rutabaga is identical with the turnip in its culture, with the exception that it requires a longer season for growth, and for the winter crop should be sown four or five weeks earlier.

Varieties — *Golden Heart* is a satisfactory variety.

SALSIFY

This is a delicious winter vegetable of the simplest culture. It is often called "oyster plant," on account of its oyster-like flavor. The plant is as yet comparatively little known in this country, but should be more generally grown.

FIG. 33. Sandwich Island Mammoth, the standard variety of salsify. (Erwin)

Culture — Salsify is a main-season crop and should be sown early in the spring. The roots are not injured by frost and may be left in the ground over winter or stored. They become woody and unfit for use after growth begins the second spring, however. The general culture requirements of salsify are similar to those of carrots and parsnips.

Varieties — *Sandwich Island Mammoth* is one of the most productive varieties.

PARSNIPS

Culture — Sow early and give the same culture as for the carrot. The roots may be stored or left in the ground over winter. If stored it is best not to dig them until after heavy frost, as the roots seem to be improved in quality by freezing. The seed is slow in germinating and radishes may be sown with them as in the case of carrots.

Varieties — *Hollow Crown* is an excellent sort.

RADISHES

Culture — To produce crisp, tender roots the radish requires a cool, moist season of growth, similar to the turnip. Sow early in the spring, and repeat at intervals of ten days for successional crops. Early varieties mature in from twenty to thirty days. Winter varieties with a long, tapering root are grown to a limited extent only. One of the best varieties of this type is the Black Spanish.

Varieties — *White Turnip, Scarlet Globe.*

PERENNIAL ROOT CROPS

ASPARAGUS *HORSE-RADISH* *RHUBARB*

The crops placed under this heading are not closely related botanically, and are arbitrarily placed in this section on account of their similar cultural requirements and their permanent location in the garden. Their permanency indicates the necessity of thorough preparation before planting. An asparagus bed, for example, should yield profitable crops for twelve to fifteen years, provided the preparatory work has been properly done. In preparing the bed for any of these crops the ground should be deeply plowed and a heavy coat of well-rotted manure worked in. If the soil is not in good mechanical condition it will also be an advantage to plow in the fall and leave the ground in the rough over winter.

ASPARAGUS

Culture — Asparagus is a hardy perennial, native of Europe, propagated by division of the roots or by seed. If propagated from seed, which is the best method, the plants should be grown in the seed-bed the first year and transplanted to the permanent bed the second spring. As the bed will last for a number of years if the crop is properly planted, thorough preparation is of special importance. The land should be deeply plowed and heavily manured with well-rotted stable manure the fall before planting. As the stalks are the edible portion and asparagus is a strong feeder, it will require annual applications of manure throughout the life of the bed.

The rows should be 6 feet apart and the plants 2 feet in the row. A convenient method of planting is to furrow out the rows to a depth of 8 inches, and plant in the bottom of the furrow. Cover the roots lightly at first, packing the soil well, however, around them, and gradually fill in the furrow as the stalks appear above the surface. This is a more convenient system than the old one of planting in solid beds, and will give good results.

The plants should become well established before any crops are harvested, and for this reason it is best not to gather any stalks until the second spring after the plants are put out, and even then it should not be cropped heavily the first time. During the first two years frequent tillage is important. After the plants become well established the ground is sufficiently shaded and mulched to give little trouble from weeds.

The shoots should be gathered as they appear in spring and before they are more than 8 or 10 inches in height. If allowed to grow taller than this they become woody. The stalk should be gathered by reaching 2 or 3 inches below the surface, grasping the stalk with the fingers and breaking off with a simple twist. A case-knife is often used for this work, but it is not to be recommended, as the young crowns are clustered together and the blade of the knife is likely to sever a number of them, spoiling the future crop. Cropping should cease about the middle of June and the tops thereafter should be allowed to grow at will. After frost in the fall the tops are mown off and the beds well dressed with rotted manure. Asparagus is a native of the seashore and occasional applications of salt will stimulate growth.

Varieties—Among the best varieties are *Conover's Colossal* and *Palmetto.*

RHUBARB

Culture—The most convenient method of propagating this vegetable is by division of roots. The plants may be set out in either spring or fall, planting 4 feet apart in rows 5 feet wide, in a rich, moist soil. No crop should be gathered until the second year after transplanting. Give clean culture during the summer and apply a coat of manure in the late fall. This should be plowed under the following spring. This mulch will prevent deep freezing, thus securing an early crop of stalks in the spring, and the additional supply of plant food will also aid in procuring a rapid growth. Rhubarb is essentially a moisture-loving plant and if properly supplied with water and an ample food supply, an excellent growth is insured.

Varieties—There are apparently no new varieties of superior merit. The old standards, the *Linneas* and *Victoria,* are favorites. The Linneas is an early variety and less acid than the Victoria. The Victoria is a strong, heavy-growing sort with pink stalks and a more decided acid flavor.

Forcing—Rhubarb is readily forced in a warm cellar; hence, winter crops of this delicious vegetable may be enjoyed by digging the roots late in the fall and storing them in a warm, dark cellar The roots should be dug upon the approach of heavy frost and left above ground for a couple of weeks for the purpose of freezing This freezing process is necessary, for without it the roots do not take on an active, vigorous growth when brought into a warmer temperature. The roots may be packed in closely, with only sufficient soil attached to supply moisture, and the cellar should be practically dark. Occasional watering may be necessary to keep them moist. The temperature should be 50° to 60°. This winter forcing is a very simple process and may be employed by any farmer who will comply with these conditions. Well-established roots should be used. Forced roots, of course, are very much weakened, and if again planted out-of-doors will not bear crops until the second year

HORSE-RADISH

Culture—Horse-radish is a hardy perennial of the simplest culture. A rich, deep soil furnishes the best conditions for the development of symmetrical roots. Propagation is by root cuttings, which should be one-half to three-fourths inch in diameter and 4 to 6 inches in length. To insure planting them with the crown end up it is well to make the upper cut sloping. The roots are used as a condiment with meats in late fall and early spring. A winter supply may be had by storing roots in moist soil or sand in the cellar. Grated horse-radish soon loses its strength. Freshly grated and neatly bottled packages find a ready sale in small towns, and one can nearly always find an excellent local trade for a limited supply.

COLE CROPS

CABBAGE *CAULIFLOWER* *BRUSSELS SPROUTS* *KOHLRABI*

CABBAGE

Cabbage is a hardy, partial-season crop. The plants are usually started in the hotbed or window box and set out when the second or third true leaves appear. An excellent seed-bed for starting the plants may be secured by burning straw or brush to warm the soil and kill weed seeds; then pulverize and sow at once.

Culture — The early varieties are set out as soon as the state of the ground will permit, and do not suffer seriously even if caught by late frosts, provided the plants have been properly "hardened off." The seed for the fall and winter crop is usually sown about the middle of May. The distance for planting varies much, as some varieties produce very large heads and others small ones. For the general run of varieties, 2 feet apart in the row is a convenient distance. If the plants are spindling they should be planted deeply and side roots will be emitted along the buried portion of the stem. A rich soil and frequent surface tillage to conserve the moisture and a uniform period of growth are the essential conditions for successful cabbage culture. If the soil becomes dry the heads "set." If rains follow later a second growth comes on, causing the heads to split and making them practically worthless for market.

Storing — Upon the approach of heavy frost the plants should be pulled and stored in a pile with the roots up. Cover with 3 or 4 inches of straw, and as winter approaches add layers of earth to protect from freezing and thawing. For storing purposes the heads which are not quite solid and mature preserve best. In storing out-of-doors, it is important to secure a site where the drainage is good. Ventilation should be provided by small openings through the sides of the pile. If the supply is to be used during the winter, a more convenient method is to store in a root cellar where the temperature is about 36°

In storing cabbage it is very important that the heads should be well drained. When growing in the field the leaves gather the dew, so that heads for storing should be pulled and piled with the roots upward for several hours to allow the water to drain out of the leaves. A method of storing, convenient for the farmer, is to store the heads in barrels; they will preserve better, also, if each head of cabbage is wrapped up in a newspaper.

Varieties — There are two general types of cabbage, the wrinkled and the smooth-leaved. The wrinkled-leaved sorts are regarded by some as superior in quality, but they are less productive than the common type and, hence, are not so generally grown. The smooth-leaved type may be subdivided into the purple-leaved and the green-leaved, or the common form. The purple-leaved is much prized by the Germans for pickling. The behavior of varieties of cabbage differs much according to local conditions. *Early Jersey Wakefield* is a standard early sort. *Flat Dutch* and *Drum Head* are valuable winter varieties.

BRUSSELS SPROUTS

This is a member of the cabbage family with small, lateral buds which are used similarly to cabbage. Its culture is practically the same as that of cabbage.

CAULIFLOWER

This is a variety of cabbage which has been improved by the enlargement of the terminal flower buds. Its cultural requirements are similar to those of cabbage. It requires more careful attention, however, and commands a better price on the market. The heads should be shaded for blanching when two-thirds formed. A convenient method of doing this is to break the midrib on the large, outer leaves and pin them together over the head.

Varieties — *Early Dwarf, Erfurt, Giant,* and *Nonpareil* are valuable.

KOHLRABI

This is another member of the cabbage family, with an enlarged, turnip-shaped stem, grown considerably as a winter food for stock and in a limited way as a garden vegetable. The tubers should be used when 2 or 3 inches in diameter, as they become tough and woody when older. *White Vienna* is one of the best known varieties.

SALAD CROPS

LETTUCE *CELERY* *CRESSES*

LETTUCE

As usually grown lettuce is a hardy, early-season crop of the simplest culture.

Culture — For the first crop it is an advantage to sow in raised beds, as such soil warms up earlier. Later crops are sown in rows and thinned to 8 inches apart. The last crop is usually cleared by midsummer, and the ground may be used for fall turnips. If the daily supply is gathered early in the morning before becoming wilted by the hot sun it will be the more crisp and palatable. There are two general types of lettuce — head or cos lettuce, and the loose or leafy type. The cos variety forms small cabbage-like heads, and is a type of superior quality. It requires a longer period of growth, however, and greater care in culture. For the farmer's garden the loose type will generally be found preferable.

Varieties — There is an endless list of good varieties which have their special adaptation to local conditions. *Black Seeded, Simpson,* and *Grand Rapids* are standard kinds.

CELERY

The growing of celery is largely restricted to the market gardener, for the reason that its cultural demands are more exacting than those of other crops. On the other hand, the value of the crop is greater in proportion. In fact, there is probably no plant grown which will bring as large returns per acre as celery, and in most towns and villages there is an excellent demand for a limited supply. The essential requirements for successful celery growing are a rich, moist soil and early transplanting, that the plants may become established before the hot, dry weather comes on. The grower who is not able to irrigate will find bottom lands most satisfactory. The plants should be started in the seed-bed and transplanted once before being put out. The first transplanting is usually done when the second or third true leaves appear. The crop is usually put out about the middle of June.

Culture — There are two general systems of culture for celery — the level culture and the trench system. In the trench system a furrow is laid out, a man following with a spade, to deepen the trench to 12 or 14 inches. The plants are then set in the bottom of this trench. At blanching time in the fall the trench is merely filled in. The level-culture system is similar to that practiced with other garden vegetables. Both systems of culture have their special points of advantage. In dry seasons the plants in the trench fare better on account of being protected from the dry winds and somewhat shaded. In wet seasons the level culture is very much more successful. This system involves less labor, and on the whole is probably to be preferred. The plants should be set out late in the evening, while it is cool, and it is also well to remove one-third or one-half of the top to prevent wilting. Frequent tillage should be given throughout the summer to insure a constant supply of moisture.

Blanching — Before the stalks can be used for the table the green coloring matter must be removed. This is brought about by any practical method which will exclude the light. For the early, dwarf varieties, 12-inch boards may be used, set up on each side of the row, with a strip across the top to hold them together. The placing of 4-inch drain tile over each plant is also a simple method. With the later crop, soil is often used for blanching. If soil is used, care must be taken to gather the stalks together before placing it around them A convenient method is for a man and boy to work together, the lad working on the opposite side of the row, gathering the stalks, and holding them in position until the soil is filled in around them. This can not be completed at one time, and two or three operations are necessary If the crop is to be stored in the cellar for the winter, outdoor blanching is not necessary. The roots should be taken up for storing upon the approach of heavy frost and placed in a cool cellar, packing a small quantity of soil around the roots to keep them moist. The plants may be packed quite closely together and if the light is excluded, blanching will be completed in three or four weeks. If the soil becomes dry, occasional watering may be necessary. A temperature of 50° to 60° is suitable. The crop may also be stored out-of-doors by covering with straw and layers of soil to protect from frost. This is not convenient for getting out supplies in cold weather, however, and cellar storage is preferable for the small grower.

Varieties — *White Plume* and *Golden Self Blanching* are good early varieties. For the main-winter crop, *Giant Pascal, Kalamazoo*, and *New Rose* are considerably grown. *Celeriac* is a variety of celery with a turnip-shaped root. The enlarged root is the edible portion and is used as a salad.

CRESSES

Water Cress is a species of nasturtium of perennial growth, used for garnishing and salads. It is a hardy, moisture-loving plant and readily establishes itself along streams after the bed has been prepared and the seed sown. There is little variation in varieties of cress.

Garden Cress is a partial-season crop which is used to a limited extent for garnishing. The crop is hardy and should be sown quite early. Plants mature in from six to eight weeks.

SOLANACEOUS CROPS

TOMATO *EGG PLANT* *PEPPER*

The plants mentioned in this group are tender and require a long, warm season for growth. They should be started in the hotbed or window box, and a better root system is secured by transplanting a second time before placing in the field. That the crop may have ample time to ripen it is of special importance to have strong, well-established plants to start with. This is especially true in the regions of the Northwest, where frost comes early.

TOMATOES

Culture — Where there is a choice of location, a warm soil is always preferable for the tomato. In a bad location or in cold, wet seasons plants set fruit poorly, the foliage takes on a yellow complexion, and a poor crop invariably follows. To secure fruit of good color and free from rot, a support of some kind is an advantage. Posts, wire netting, or any framework that will spread the vines and admit sunlight and air will fill the requirements.

The yield of the tomato is materially increased by proper training. Some experiments along this line with which the writer was connected at the Iowa Experiment Station showed the following results:

A row of untrained plants yielded 157 pounds of sound fruit and 34 pounds of rotten fruit. The same number of trained plants yielded 197 pounds of sound fruit and 15 pounds of rotten fruit. In the one case we have 20 per cent of decayed fruit and in the other only 7 per cent, which clearly indicates the importance of getting the vines up off the ground to prevent rot. The relative solidity of fruit is also an important factor in determining the shipping and keeping qualities. Fruits of the same size from different varieties vary much in weight, the heavy ones containing small seed chambers and a large proportion of flesh. Varieties showing this character of fruit invariably keep and ship better than the lighter

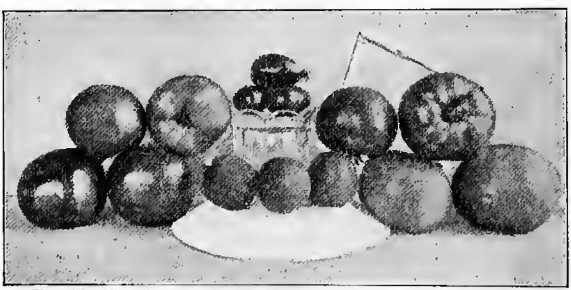

FIG. 34. Specimen tomatoes of standard varieties. (Erwin.)

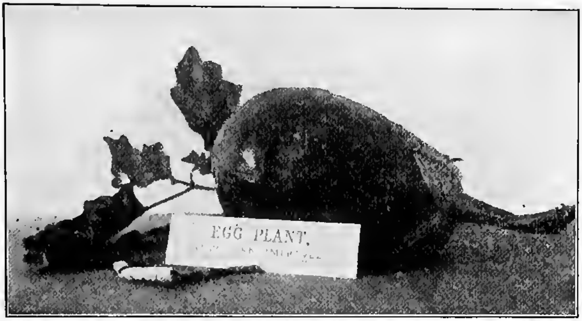

FIG. 35. One of the favorite sorts of egg plant. (Erwin.)

fruited sorts. For example, the *New Jersey*, a light tomato, rotted to the extent of 27 per cent, while the *Lorillard*, a well-known heavy variety, was affected only 5 per cent.

Upon the approach of frost the green fruit may be gathered and stored in a sunny room to ripen.

Varieties—There is a long list of varieties of tomatoes, many of which are of excellent quality. The ideal type of tomato is a smooth, medium-sized fruit with small seed cavities and a large proportion of flesh. If they are grown for market the medium-sized fruit, evenly graded, is preferable to the large varieties. *Acme, Dwarf Champion*, and *Livingstone Beauty* are much grown. The yellow-fruited sorts are more meaty than the reds. The flavor is distinctly peculiar, however, and while preferred by a few who have cultivated a taste for them, they are not in general demand.

EGG PLANT

Culture—The egg plant, like the tomato, should be started within doors. It is even more tender than the former plant, however, and should not be planted out until the weather becomes settled and warm. Well-drained soil is important, and without this or in cool seasons the crop is likely to be a failure. The plants are usually set 2 feet apart in the row.

Varieties—*Black Pekin* and *New York Improved*. There are also small scarlet and white varieties, the fruit of which is used for decorative purposes and is of little value as a vegetable.

PEPPERS

Culture—The plants may be started in the hotbed or sown directly out-of-doors after the weather becomes warm, and thinned to 12 inches apart. A variety collection of peppers shows a most interesting variation in size, shape, and color. The seedsmen's general list of standard varieties is quite successful.

FIG. 36. Some popular varieties of peppers for various uses. (Erwin.)

CORN

SWEET CORN *POPCORN*

SWEET CORN

The general cultural requirements of this crop are identical with those of field corn, for details of which see page 49.

Culture—For corn as a garden crop, earliness and a succession are matters of prime importance. For the early crop choose a warm soil and plant in hills. For the main-season crop many prefer to plant in rows. Especially for the early varieties, which are planted before the ground has become thoroughly warmed, should one make sure of having fresh, vigorous seed. Germination may be hastened by soaking the seed in warm water over night before sowing.

Varieties—Varieties vary much in the length of their growing period, and are often classed as early, medium, and late. The *Early Cory* and *Early Maine* are excellent varieties for the West, and mature in eight to nine weeks. *Stowell's Evergreen* is largely grown for the main-season crop. *Country Gentleman* and *Ne Plus Ultra* are valuable late varieties.

POPCORN

This crop adds to the enjoyment of the long, winter evenings, and a few rows should find a place in every vegetable garden. Its consumption is increasing, and popcorn is becoming a crop of commercial importance in a few localities. At one point in Northern Iowa a single grower devotes 500 acres to popcorn, and there are many others of less importance. Its general culture is largely the same as that of field corn. As the crop is not saleable until a year or more old, good storage room is important.

White Pearl is a variety which is largely grown.

MAKING AND CARE OF LAWNS

There is nothing that adds more to the external beauty of a home than a well-kept lawn. A perfect lawn is not obtained by simply seeding with certain kinds of grasses. A green surface may be obtained in this way in a few months under favorable conditions, but a soft, velvety turf that is a delight both to view and to walk upon, is obtained only after the exercise of intelligent care for a period of years.

Preparation of the Soil—It must be remembered that the lawn, when once formed, is to remain undisturbed; the sward is to be permanent, and hence the importance of most thorough preparation of the soil. The first essential is thorough underdrainage. Where the process of grading has involved much filling in time should be allowed for settling of the soil. If grading is done with soil removed in excavating the cellar, it should be covered over with 4 to 6 inches of good surface soil, as rich as possible in vegetable matter. If the soil is full of weed seed, it should be hoed one season, if possible, to get it cleaned up. Well-rotted manure should be used quite liberally and the surface put into the very finest condition possible, as the seeds to be used are very small and the plants, for a time, very delicate.

Selection of Seed — For sections of the country to which it is adapted there is no better grass than the Kentucky blue grass. This is made more thrifty in many localities by the volunteer entrance of white clover during favorable seasons. Some of the fescues or timothy may be sown with it as a protection while it is getting a start. The blue grass will crowd them out when it gets a hold. Too great care can not be observed in obtaining pure seed, as foul seed may cause a great amount of annoyance and extra work.

Seed should be sown very early in the spring to get a good start before the weather gets too dry and hot; or in the early fall after the rains and cooler weather have arrived. The seed should be sown evenly and not covered very deep, a light raking with a garden rake being all that is necessary. If there is no immediate prospect of rain, the ground should then be rolled, to press the seeds into close contact with the earth and aid in their germination. If a good growth is not obtained the first season, and especially if the lawn is in an exposed situation in a severe climate, it should be covered the first winter with coarse manure for protection. This manure should be as free from weed seeds as may be. It can be left on in the spring until the grass starts, giving opportunity for some of its finer and more soluble particles to be transferred to the soil by the spring rains, when it should be raked off.

Spring seeding, if followed by dry, hot summers, may also be advantageously protected from the sun in a similar way, using hay or straw for the covering, but only just enough to form a shade.

Transplanting Turf— A good turf may be obtained more quickly in this manner than by seeding. The ground that is to receive the turf should be well loosened and made smooth and even on the surface. A piece of smooth, tough sod of the desired grass and free from weeds should be selected from which to obtain the supply. Cut this turf in strips about one foot in width, two to three inches in thickness (great care should be taken to have the thickness uniform), and of such length as will make them of convenient weight to handle. These are rolled up into snug rolls for convenience in handling.

The turf is then transferred to the prepared soil, closely laid, rolled, and watered. This method has the advantage of providing a fine turf the first season and insures a good, clean sod, free from objectionable plants, a result not always readily obtained by seeding.

An occasional covering with manure during the winter, as above described, will be found of great benefit in keeping up a healthy, vigorous growth, and in giving a rich, green color to the grass.

A T Erwin

PUBLICATIONS ON SPECIFIC CROPS, TRUCK FARMING, AND THE MARKETING OF PRODUCE

A B C OF POTATO CULTURE. By T. B. Terry. *A. I. Root & Co.*, Medina, O. (1893) $ 0.50

Gives in detail the methods of one of the most successful potato growers in the United States.

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Fruit Culture and Forestry

By L. R. Taft, M. S.
Horticulturist, Michigan Agricultural Experiment Station

THE ORCHARD SITE AND ITS PREPARATION

Success in growing and handling an orchard should not be expected unless care is taken to provide a suitable location and a soil adapted to the particular kinds of fruit that are to be planted. In a general way it may be said that only such locations as are elevated above the surrounding country are adapted for orchard purposes. Mere elevation alone will not suffice, however, as a rolling tract of land, with a considerable area at a lower level near by, will give better results than a plateau that has a much greater altitude.

Water and Air Drainage — A rolling site is of value in providing both for water and air drainage, and while the former is essential — as none of our fruits will thrive when they have wet feet — the latter should never be overlooked. After severe winters it is often found that trees upon low land have been killed, while others but twenty feet higher up the slope have not only escaped without harm but produce a crop of fruit the following season.

The danger from spring frosts is also greatest on the low land, and it frequently happens that on a hillside, when there is a movement of the air, little harm may be done, while on the lower land all the blossoms are destroyed. This is due to the fact that cold air sinks to the lower levels almost as freely as water, and if there is a broad plain or a large lake at the foot of the slope the effect is increased.

Immunity from Fungous Disease — Another benefit from the use of a side hill rather than a hollow for orchard planting is that the fungi which prove so injurious to the foliage and fruit of most of our trees are far less troublesome in the former place than in the latter, as the dews are not so heavy and disappear much more quickly.

Orchard Soils — While neither sand, muck, nor clay soils are adapted for fruit growing, there is a wide range, which embraces everything from a moderately sandy loam to a fairly heavy clay loam, that can be used for this purpose. However, certain of these soils are rather better adapted for some fruits than for others, and when possible, this adaptation should be considered in selecting locations for orchards. The pear does best on clay loam soils, and most plums do well on heavy soils. Apples also do well on a strong loam soil, in which it makes little difference whether the sand or clay predominates. The cherry rather prefers a moderately heavy sandy loam, as does the peach. While peach trees make a good growth on soil of a sandy nature they are neither so productive nor so long-lived as on a heavier soil.

A soil to be used as a nursery for growing any of these fruits should be of the same nature as for an orchard, but should be richer and contain a considerable amount of humus, so that it will not suffer from drought.

Preparation for Planting—In preparing a tract of land for planting it should be plowed to a good depth and thoroughly dragged. Before putting out an orchard it will be desirable to secure a clover sod to be turned under. If this is not available, a crop of Canada or cow-peas may be grown. If the land lacks in fertility, decomposed stable manure should be used—if possible, a year before the trees are to be set. It may be applied before the land is plowed for the trees, or, if manure can not be secured, chemical fertilizers may be mixed with the soil when the trees are planted.

THE PROPAGATION OF PLANTS

The more common methods of growing plants are from seeds, cuttings, grafts, and buds. In the case of fruit plants it is seldom that varieties can be reproduced from seeds; accordingly grafting or budding is generally employed with tree fruits, and cuttings or layers for vine and bush sorts.

Growing of Stocks—In growing fruit trees it is customary to grow stocks, either from seeds or cuttings, upon which the improved varieties are worked by budding or grafting. Except in the case of the apple and peach, these stocks are for the most part imported from Europe.

Apple stocks are generally obtained from Iowa or Kansas, while the peach seedlings are grown in the nursery and budded the same year. For the apple, *French Crab* seed is preferred, and for the pear the French stock is giving rather better results than the Japanese, although the largest trees can be grown from the latter. In most sections *Mahaleb* stocks are used for the cherry, the *Mazzard* being employed mainly for sweet varieties. The *Myrabolan* stock is generally employed for plum trees, although native American stocks are hardier and are used in the Northwest. The *Marianna* stocks have not been satisfactory In some sections peach stocks are used for plums, especially for Japanese sorts, but they are not in favor in regions where yellows prevail. For propagating peach trees, the nurserymen generally use seedling pits from Tennessee and North Carolina. They give better results than the pits of improved varieties from canning factories.

For growing dwarf trees, the Angers quince is used for pears, and the Doucin and Paradise stocks for apples.

To grow apple, pear, plum, or cherry seedlings, the seed must be procured in the fall or early winter; after being placed in boxes in thin layers with moist sand between, they should be left out of doors in some shady place, to secure the action of frost upon them. In the spring a rich, moist soil, free from weed seeds, should be selected. It must be such as will bring the seedlings to a size of from one-fourth to one-half an inch in diameter in one year.

The land should be thoroughly prepared and marked off into rows 3 feet apart, the furrows being 4 inches wide and 2 inches deep. If the seed does not show signs of sprouting, it should be thoroughly moistened and placed in a warm spot for several days. When it begins to sprout it should be scattered in the drills about 1 inch apart each way. During the summer, the seedlings should have frequent cultivation and hoeing. If fungi appear upon them they should be sprayed with Bordeaux mixture. By fall they will be ready for digging, and after being assorted and trimmed they should be packed in sand, sawdust or sphagnum, until needed for root-grafting or for planting out in nursery rows.

The growing of peach seedlings is much the same, except that they are often planted in the fall. If dry when received, they should be placed in water for twenty-four hours, and then, whether for fall or spring planting, should be bedded out in some well-drained, sandy soil. A trench 1 foot deep and of the size required should be excavated, and in this the seed should be spread, the trench being filled with alternate layers of soil. Cover with 3 inches of soil and wet down thoroughly. If placed in the bed by the middle of October the seed may be planted in November, or it may be left until spring. For peach trees the drills should be 3½ to 4 feet apart and the pits should be dropped once in 2 inches. Some of the larger nurseries use peach-pit planters. Sometimes the pits do not crack well when left to be planted in the spring, so that it will be well to examine them in the early part of April; if they are not cracking the bed should be well wet down. When they have not cracked by planting time, which should be as soon as the ground can be prepared, some make it a practice to crack them with hammers, but this may injure the seed and better results are often obtained by using a little more seed.

Budding[1] is always used for propagating the peach, plum, and cherry, but root-grafting is often used for growing the apple and sometimes for the pear, although straighter trees can generally be grown by budding. If to be budded, the stocks of all kinds — except the peach, which is budded without being dug — are planted in nursery rows about 4 feet apart at intervals of 1 foot. Before planting, both roots and tops should be cut back to a length of 8 inches. Seedlings with branched roots are generally preferred. By the middle of July the pears should be ready for budding, and these will be followed at intervals of ten days by the plums, apples, cherries, and peaches. The budding of peaches is generally completed by the first of September, although in good growing seasons fair results can be obtained even after the middle of the month, provided there are no hard frosts within ten days after the work is completed.

Care of the Seedling Before and After Budding — Cultivation should be kept up at regular intervals up to the time of budding, in order to prevent any check to the growth of the seedling, which would make it impossible to bud them.[2]

Just before the trees are to be budded, the branches and leaves should be removed for a distance of 5 inches from the ground, and the bud should be inserted as near the ground as convenient, usually within 2 inches. After a week, the buds should be examined and, if they have not taken, another bud should be inserted. About this time it will be noticed that the wrapping material used in budding is beginning to cut into the stocks, and, except when the budding is done very late in the season, these should be cut with a knife on the side opposite the buds, as otherwise the stocks might be girdled.

The following spring the stocks should be cut off with a sloping cut just above the bud. The slope should be at an angle of about 45°, with the lower edge at the back and about even with the top of the bud. Soon after growth starts, a number of shoots will be seen coming out from the stub in addition to the one from the inserted bud. All but the latter should be rubbed off with the thumb and fingers when about 1 inch long, and this should be repeated if necessary. Under proper conditions, the buds will send shoots to a height of from 3 to 6 feet the first season. The peach trees should be taken up in the fall for orchard planting, but the other trees are generally allowed to grow for one or two years more.

Low Heads are to be preferred for pears, cherries, and plums, and to secure

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[1] For notes on the mechanical process of budding, see page 118.

[2] Pear, plum, and cherry seedlings are often attacked by leaf-blight, which destroys the foliage; the bark then becomes fast in the wood, so that the bud can not be inserted. To prevent this, make free use of Bordeaux mixture, especially if the weather is dry during June and July.

them the yearling trees should be cut back in the spring to a height of from 2 to 3 feet, according to the height of trunk desired. If they have not reached this height the first year, they should be trimmed up to a whip in the spring and topped when high enough. Before the trees are ready for digging, the branches on the lower portion of the trunks should be removed. Some do this in July or early August, but it will be better to take off about one-half of what is to be removed about the first of July, and the remainder the latter part of the month.

Under good conditions, budded trees can be dug when two years old, but if root-grafted it generally takes three years to bring them to the first-class size.

The growing of trees from root grafts is much the same as from buds, except that the grafts are made during the winter and are planted out the same as seedlings in the spring. Care must be taken that only one shoot is allowed to start, but this seldom requires much attention, if the grafts are planted so that the top bud only is above ground.

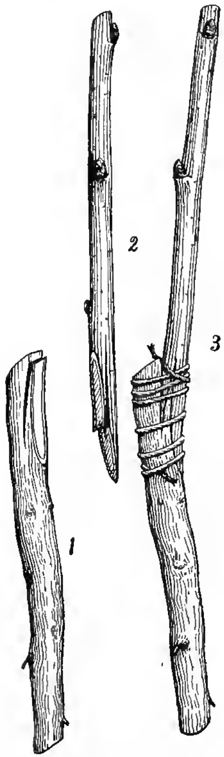

FIG. 37. Root whip graft: (1) root; (2) scion; (3) complete graft. (Taft.)

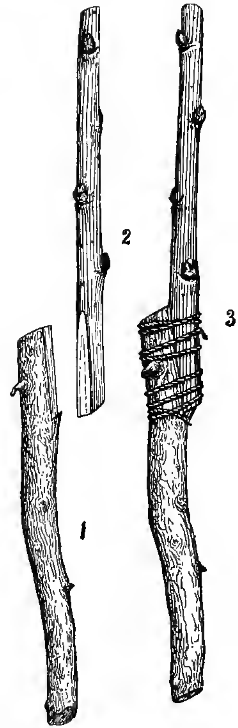

FIG. 38. Root veneer graft: (1) stock; (2) scion; (3) completed graft. (Taft.)

GRAFTING

Grafting is the art of so bringing together the parts of two plants that they will unite. Usually a portion of the last year's growth of one plant, with a length of 4 or 5 inches, called a *scion*, is united with another plant, called the *stock*, either on the root, at the collar, or on the trunk or branches. Grafting may be employed for several purposes: (1) To reproduce non-seed-bearing varieties, or those that do not come true from seed; (2) to increase the vigor or hardiness of weak and tender sorts; (3) to bring slow-bearing kinds into earlier fruitfulness; (4) to change varieties.

Grafting is generally performed at the beginning of the season's growth. At that time dormant buds can be procured, and although the union would take place more quickly after the sap becomes thickened, the chance of failure will be greater at that time, owing to the evaporation from the leaves. The method employed depends to some extent upon the size and kind of tree upon which it is to be used.

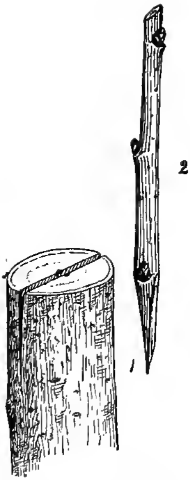

FIG. 39. Cleft graft: (1) stock; (2) scion. (Taft.)

Whip Graft — The form most commonly used upon small trees is known as the *whip* or *tongue graft*. It is especially adapted for root-grafting (Fig. 37). The stock (1) is cut off at an angle, and a shaving of the bark and wood is removed from the longer side at the end; a tongue is then cut near the end. The scion is prepared by cutting off the lower end so that the exposed surface will be about 1 inch long (2). In the middle of this a tongue is cut. The tongues on the stock and scion are then fitted together so that the inner bark on one side of the scion will be in contact with that on the same side of the stock. The graft should then be bound firmly together (3). This may be done either with waxed twine, paper, or cloth. These are prepared by dipping the string or cloth in melted grafting wax, and, in the case of paper, by applying the wax with a brush. The twine answers for root grafts, but the paper or cloth should be used where the grafts are above ground, unless grafting wax is used with the twine. For stem-grafting this method succeeds best where the stocks are from $\frac{1}{4}$ to $\frac{1}{2}$ inch in diameter. The scions should be about 3 inches long, with a bud near the end, as in Fig. 37, 2.

Root Graft — When used for root grafts the scions should be 5 inches in length and the root about 4 inches. From a good seedling, two stocks for root grafts can be obtained. These grafts are made during the winter and are then tied in bundles and packed in sand in a cool cellar. By spring a perfect union will have formed, and a callus will appear at the lower end of the root from which rootlets will soon appear after the root graft has been planted.

Veneer Graft — Although not in common use, a form known as *veneer grafting* has much merit for small stocks, either for root or stem-grafting. It is shown in Fig. 38, the parts being the same as in the illustration of whip-grafting. Its merit comes from the fact that cambium surface only is exposed, which makes it possible for a more perfect union to take place than when the pith is exposed, as in tongue-grafting. Greater care is required, however, to bring the parts into the close contact which must be secured in order to attain success.

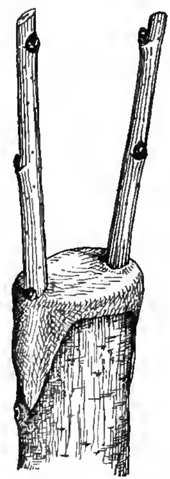
FIG. 40. Cleft graft completed. (Taft.)

Cleft Graft — When stocks that are more than ¾ inch in diameter are to be grafted, it will be best to use the cleft graft shown in Figs. 39 and 40.

In making this graft, the stock should be cut off at right angles and the end pared smooth. A split to the depth of 2 inches is then made in the center of the stub with a grafting chisel, or heavy knife, and this is held open with a steel or hard wood wedge. Two scions should be used for each stock. These should be about 3 inches long (2), with a wedge at the lower end, and with one bud near the upper end and another at the upper part of the wedge. In cutting the wedge, care should be taken to have the sides true, and the side of the wedge that is to be at the outside of the stock should be slightly thicker than the other.

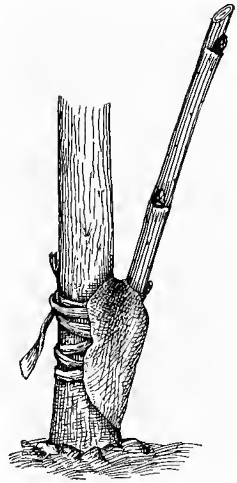

FIG. 42. Side graft completed. (Taft.)

The scions should be inserted as shown in Fig. 40, taking pains to have the inner barks in contact. If there is sufficient spring to the stock to hold the scions securely in place no wrapping will be required, but if not they should be wrapped the same as whip grafts. The graft is then completed by covering all cut surfaces, including the split at the sides, with either grafting wax, waxed paper, or cloth, in order to prevent evaporation and the drying out of the surfaces.

This form of graft can be used either on the trunks of small trees or the branches of larger ones. The best success will be obtained when the stubs are from 1 to 1½ inches in diameter, and none much over 2 inches should be used. When grafting large trees it is advisable to extend the period over several years, grafting about one-third at a time.

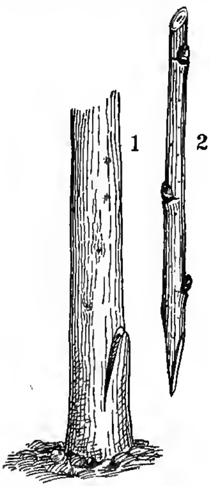

FIG. 41. Side graft: (1) stock, (2) scion. (Taft.)

Side Graft — The method of grafting shown in Figs. 41 and 42 is valuable when grafting young seedlings growing in the nursery or greenhouse. A slanting cut is made just under the bark on the stock near the ground, and the scion is prepared much the same as for cleft-grafting, except that the cut on what is to be the outside of the scion is shorter than the other. It is then pushed into the cut on the stock, so that the barks will be in contact, and then wrapped and waxed the same as the other grafts.

The scions used for grafts of all kinds should be well-ripened, healthy shoots of the previous year's growth. They should be cut in the fall and packed in sand or moss until needed. In the case of hardy sorts, good results can generally be secured with spring-cut grafts, but it is safer to cut them in the fall. April and May are the months for grafting.

The best results in grafting are obtained when stock and scion come from plants of equal vigor and belonging to the same species, but in many cases fairly good success can be obtained between plants of nearly related species. Thus, the apple, pear, quince, thorn, and mountain-ash can be grafted one upon the other, but the union in most cases will not be so perfect or durable as between plants of the same species.

BUDDING

Budding differs from grafting in that only a bud with a small piece of bark attached is used in place of the scion. Budding can be done with the greatest success toward the close of the period of growth, but it should not be delayed until growth has stopped, as then the bark of the stock will be firmly attached to the wood, making it difficult or impossible to raise the bark so that the bud can be inserted. Stocks from one to three years old are best for budding.

Operation of Budding—The scions may be cut as soon as the buds have developed on the new growth, generally in July or August, and the leaves are cut off so that a little of the petiole remains (Fig. 43, 1). A T-shaped cut is made in the bark. Usually the vertical cut is made first and in making the transverse cut the knife is given a downward slope, so that a slight twist will loosen and raise the corners of the bark, permitting the entrance of the bud. In cutting the bud the knife is placed about five-eighths of an inch below the bud, and a cut is made which will pass upward and beneath it, taking off a shaving of the wood, to a point three-fourths of an inch above the bud.

For most fruits, except the cherry, it will be found best to remove the wood from the bud, leaving only the bark. To do this, make a cross-cut one-half inch above the bud, taking pains to cut through the bark without cutting into the wood. Then by taking hold of the leaf-stalk and giving a slight twist, the bark will separate, leaving the wood attached to the bud-stick (Fig. 43, 2). In the case of a few varieties of pear, as well as the cherry, the removal of the wood injures the bud, and then the cross-cut should be deep enough to pass through the wood beneath the bark.

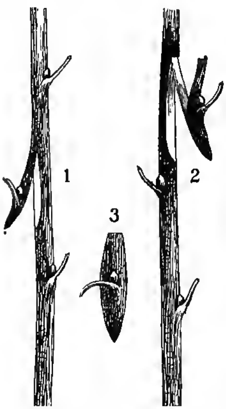

Fig. 43. Budding: (1) Cutting out the scion: (2) separating from the bark; (3) ready for insertion. (Taft.)

If the bark on the stock was in proper condition, and the cuts have been properly made, there will be no difficulty in inserting the bud and pushing it well down into place. If necessary, the corners of the bark may be lifted with the point of the knife blade, or the end of the knife handle. For tying the bark down upon the bud, raffia is most commonly used, although many prefer common cotton twine. Care should be taken not to cover the bud, and the bark should be securely bound in place. (Fig. 44.)

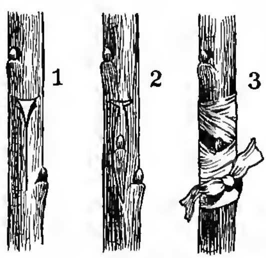

Fig. 44. Budding the stock: (1) ready for the bud; (2) bud inserted; (3) budding completed. (Taft.)

CUTTINGS AND LAYERS

Propagation by Cuttings — For growing the grape, currant, gooseberry, and many other plants, the simplest method is to use long cuttings of the hard wood.

These should be from 8 to 10 inches long, with one bud close to the lower end and another about 1 inch from the top. (Fig. 45.) There will generally be three buds upon grape cuttings and a dozen or more upon most others. They may be planted in the fall, but it is better to make them at that time and after tying in bundles place them in the ground for callusing. One way is to place them with the butts uppermost, and cover with 3 inches of soil and enough straw to keep out frost. Early in the spring remove the straw, and the butts, being near the surface, will soon callus. In planting the cuttings, select moist, rich land, and, making a trench about as deep as the cuttings are long, place them about 2 inches apart, pressing the soil closely about them as shown in Fig. 45. In one or two years they will be large enough to plant out.

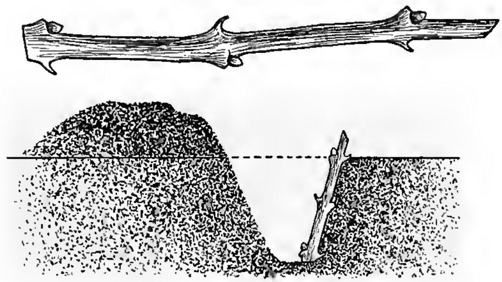

Fig. 45. Cuttings: Manner of planting in trench. (Taft.)

Propagation by Layering — Another method of growing these plants is to bend down branches and bury them about 3 inches deep, leaving the ends out of the soil. In the case of the grape vine, it will be best to cut a tongue or remove some of the bark at the point to be buried. When the vines are long they may be bent down at several points, forming what is called a *serpentine layer*. Black raspberries and dewberries are layered by covering the ends of the branches in August, forming what are known as *tip-layers*.

GRAFTING WAX

For covering all cut surfaces made in grafting, a wax made of resin, beeswax, and either tallow or oil should be used.

For use during the cool days of early spring the following formula will give good results:

Resin	4 parts.
Beeswax	2 parts.
Tallow	1 part.

All by weight. Oil, ¾ part, may be used instead of tallow. Melt together and when well mixed pour into cold water, after greasing the hands, pull like candy. When it reaches a light yellow color it can be used. If to be used in cold weather it may be softened with warm water, while for warm weather the amount of resin should be slightly increased.

TREATMENT OF WOUNDS

When the bark upon a tree has been injured, or when large branches have been cut off, the wood exposed should be covered to keep it from drying out. The best treatment will be to give it two coats of lead and oil paint. This is even better than grafting wax for the purpose, although the latter answers well for small wounds.

PROPAGATION AND PLANTING TABLE

Name	Average Planting Distance	How Multiplied	Stocks Commonly Used
Apple	33 to 40 feet	Seeds, budded or grafted seedlings	Seedlings. Doucin, crab or wild crab; for dwarfs, Paradise stock.
Apple, dwarf	10 to 15 "		
Apricot	16 to 30 "	See peach	Apricot in deep, rich soil; plum in cold regions, peach in mild.
Almond	20 to 24 "	Seedlings, budding	Peach, plum, hardshell almond.
Blackberry	4 x 7 to 6 x 9 ft.	Suckers, root-cuttings, tip-layering	
Cherry, sour	16 to 20 feet	Seedlings, budded	Seedlings, Mazzard stocks, Mahaleb for sweet and dwarf sorts; Morello seedlings and wild pin cherry for hardy stock.
Cherry, sweet	20 to 30 "		
Cranberry	1 or 2 "	Layering	
Currant	4 x 6 "	Cuttings, layering	
Fig	20 to 40 "	Hard or soft wood cuttings	
Gooseberry	6 x 8 "	Cuttings, layering	
Grape	6 x 8 to 8 x 12 ft	Hardwood cuttings, layering	
Mulberry	25 to 30 feet	Budded seedlings, hardwood cuttings	Downing stock in South; Russian seedlings for ornamental sorts.
Nectarine	13 to 20 feet	Seedlings, budding	
Orange	18 to 30 "	Seeds, budded or grafted, seedlings. A Florida plan is to bud cuttings from ¼ to ½ inch in diameter and 12 inches long, place in box and cover lightly with earth. Cuttings from roots transplanted.	Seedlings.
Orange, dwarf	10 to 12 "		
Peach	18 to 20 "	Seeds, budded seedlings	Seedlings, plum stocks for damp soils and for dwarfs.
Pear, standard	20 to 30 "	Seeds, budded or grafted seedlings	Seedlings quince for dwarfs.
Pear, dwarf	12 to 18 "		
Pecan	20 feet	Seedlings	
Persimmon, Jap.	20 to 25 feet	Budded or grafted seedlings	Native persimmon.
Plum	16 to 20 "	See peach; also root-grafting or top-grafting	Myrabolan seedlings, Chickasaw seedlings, peach.
Quince	8 to 14 "	Cuttings, grafted	Seedlings, fine varieties grafted on Angers stock, sometimes root-grafted on apple but when scion has rooted, apple root should be cut away.
Raspberry, black	3 x 6 to 5 x 8 ft.	Layering	
Raspberry, red	3 x 6 to 5 x 8 "	Suckers, root cuttings	
Strawberry	1 x 3 to 3 x 4 "	Runners	

Plants or Trees to Acre — Multiply together the two distances (in feet) at which trees are to be placed, and divide 43,560 by product. Quotient will be number required.

PRUNING

The trunk and branches of trees and other plants form a sort of framework whereby the leaves — the lungs of the plants — are exposed to the sunshine and air, and upon which the fruit is borne. To secure the best results, each tree of a given size should have a certain amount of leaf surface, but no two trees of the same size have exactly the same form and number of leaves. Some are so thick that the sun can not reach the fruit, while the leaves are so numerous as to shade and smother one another; others have but a few straggling branches, and are misshapen or poorly balanced. The object of pruning is to aid nature in securing an ideal form for the trees. In many cases the pruning is neglected while the trees are young, and then, when the tops get so thick that something has to be done, the large branches are cut away. In other cases, the trees have not been pruned at all and the tops are a mass of watersprouts. In most cases it will be possible to thin out the top of the tree by removal of small branches only, thus avoiding large wounds and the sun-burning of the bark, which follows when large branches are cut away. In the case of large trees it may be necessary to head back some of the branches, in addition to thinning out the surplus shoots.

Pruning Should Begin Early — To prune a tree properly, the work should commence with the nursery tree. When planted, only as many branches should be left as will be needed for the full-grown tree. Each year after this the trees should be looked over and all surplus shoots that have started should be removed. To do this work properly, one should not only know what form of tree is best suited to that region, but he must know the habit of growth of each variety, so that he may work in accordance with nature and when possible correct any of the defects that are natural to the variety.

Season for Pruning — In a general way it may be said that the best time for pruning is in the spring, just before growth starts. Wounds made at that time will not dry out as much as when made in the fall or winter, and when the ends of the branches are to be cut back, there is often danger that they will be killed back still more by the winter, whereas there is no danger of this when the trees are pruned in March or April, as soon as severe freezing weather is over. Spring pruning is especially desirable for tender varieties, as it not only lessens the tendency to winter-killing, but at that time it will be possible to tell how much the trees or plants have been killed back and to cut below the injured portion.

The rule, however, is not an inflexible one, and, in sections where there is little trouble from winter-killing, the pruning may be done at any time after the leaves drop in the fall and before growth starts in the spring.

It used to be said that fall and winter pruning induced leaf growth, while summer pruning promoted fruitfulness. It is not strange that, if we remove a portion of the branches during the winter, the full vigor of the tree being turned into those that remain, a stronger growth should be secured than with the trees unpruned. We can then say that to improve the growth of a tree the pruning should be done while it is dormant.

On the other hand, when a tree is making a strong growth without developing fruit buds it can often be brought into fruitfulness if it is given a severe pruning after growth is under way. This will result in a check to the growth and the tree will be able not only to develop and ripen up the remaining branches but to form fruit buds for the coming year.

How to Prune — For young trees a strong knife answers very well, and for larger ones much of the work can be done with hand shears. Pruning saws are needed for large branches, and for some purposes some of the lever shears may be used.

To secure the best results it is important that the cuts should be made at the right point. Fig. 46 shows the method of cutting small branches back to a bud and also the improper places to cut them. If cut too long a bad stub will be formed, while if cut too close beneath the bud, it will dry out. The proper way is to have the cut start on the side opposite the bud, about even with its tip, and, with a slant of about 30° from a cut at right angles, come out just above the bud.

Even greater care should be taken in cutting off large branches from the trunk or other branches. Sometimes the cut is made at right angles to the branch that is cut. This leaves a bad stub, which will be unsightly and the end of which will heal over very slowly, if at all. As a rule the interior of the stub decays, and a cavity is formed in the tree. On the other hand, the cut is often made parallel with the main trunk or branch. This is sometimes all right, but

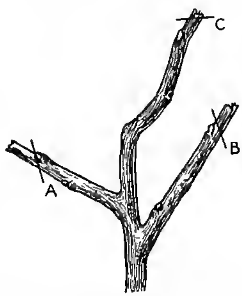

FIG. 46. Cutting small branches back to a bud; *A*, cut too close; *C*, cut too long; *B*, properly cut. (Taft.)

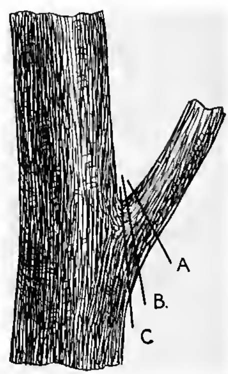

FIG. 47. Cutting large branches: *A*, stub too long; *C*, wound too large; *B*, cut making small wound and leaving short stub. (Taft.)

generally there is a large shoulder at the base of the branch and a wound of considerable size is produced. By cutting at an angle of 15° or 20° from the last-named cut, the wound would often be reduced in size fully one-half, and it would not project so far but that the healing would be even more rapid than with a parallel cut. The method of making the three cuts is shown in Fig. 47.

PRUNING THE APPLE

For the ordinary planter an apple tree should be two years old, 5 feet high and ¾ of an inch to 1 inch in diameter. When it is planted it should be pruned so that it will have about four branches (Fig. 48). The cross-marks in the illustration show where these branches are to be headed back; all the others should be removed. When the tree has a strong center shoot it is often desirable to leave this nearly twice as long as the other branches.

If the trees have large roots that have ragged ends or that have been broken in handling, they should be cut off smoothly. This applies to trees of all kinds.

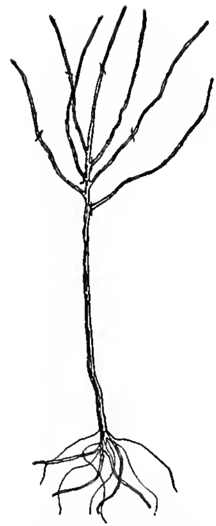

FIG. 48. Pruning young apple trees. (Taft.)

The head of an apple tree should not be more than 3 or 4 feet from the ground. They can be so pruned that it will not be difficult to work beneath them, and when they have low heads there is far less risk of the trunks becoming sunburned; further, as the trees grow it will be easier to prune and spray them, and to thin and gather the fruit, than when the heads are 6 or more feet from the ground.

During the first year the young apple trees will need but little pruning, but if the heads are very thick or sprouts appear on the trunk they should have attention The second and third springs the surplus shoots in the center of the tree should be cut out, giving particular attention to those that cross or grow close together. If the head is poorly balanced, an attempt should be made to improve its symmetry. The branches should be left longest on the southwest side, that they may shade the trunk, especially if that is the direction of the prevailing winds.

When the trees are of an open habit it is a good plan to head back the branches from one-fourth to one-half. This will strengthen the trunk and branches. The same rules can be followed as the trees develop. All dead branches and the watersprouts,[1] if not needed to fill up the head, should be cut out, and if the tree becomes too thick the thinning out process should be resorted to.

PRUNING THE PEAR

The pruning required by standard pear trees does not differ greatly from that for apples. The head should be not over 2 feet from the ground, and the top may be started with a central shoot, or the vase form may be used. By this method four or five branches are trained up from the main

1 Watersprouts are shoots (suckers) growing from the root or body of a tree.

crotches of the tree. This is especially useful where pear-blight prevails, as if one branch is attacked it can be cut away with much less danger of losing the tree than when there is a central shoot.

The variation in the form of pear trees is very great and the pruning should be suited to each. Thus, when they are of an upright habit, the upper branches should be cut back severely, while the spreading trees should have the side branches cut back to buds on the upper sides. This will tend to throw the growth upward. There are also many sorts that make a long slender growth each year; as a result the branches are weak and bend and break under a load of fruit. If headed back from one-half to three-fourths for a number of years after they are planted the branches will be strengthened.

This heading-in is of advantage for nearly all kinds of pear trees while young, and especially for those that make growths annually of more than 2 feet. Severe heading-back is of advantage in hastening the fruitfulness of tardy-bearing varieties, such as *Anjou* and *Sheldon*.

PRUNING THE CHERRY AND PLUM

In starting the head of the cherry and plum the height should not be more than 2½ feet, while 1½ will be better for sweet cherries. Five or six branches may be left and these should be cut back one-third. These fruits do not need very much pruning other than cutting out branches that are too thick, although some of the strong-growing kinds may often be cut back to advantage.

PRUNING THE PEACH

Peach trees are always planted when one year old and range in size from whips 2 feet high to well-branched trees 6 feet or more in height. For most purposes a medium-sized tree is to be preferred, although with proper care the smaller trees may overtake them.

The pruning when the trees are planted varies with the size of the trees. Thus, the large tree shown in Fig. 49 has developed into side shoots all of the buds that were first formed along the main stem, and if all of these are cut off close to the trunk, as is often recommended, the chances are that only a few weak shoots would be produced from latent buds that were not cut away in pruning. The proper way, when there are no strong buds on the main stem where the branches are desired, is to leave six or eight of the branches with one or two buds, cutting off all others, as well as the top of the tree at the height of perhaps 30 inches to 3 feet. The lowest branch should be 20 inches from the ground. Some prefer to leave only four spurs, but, as some of these may not grow, a safer way is to leave a larger number and then cut off the surplus ones after they have started.

When the trees have but a few side branches, with numerous side buds, like the smaller tree in Fig. 49, it will be better to remove the side branches and cut the top back to 30 inches.

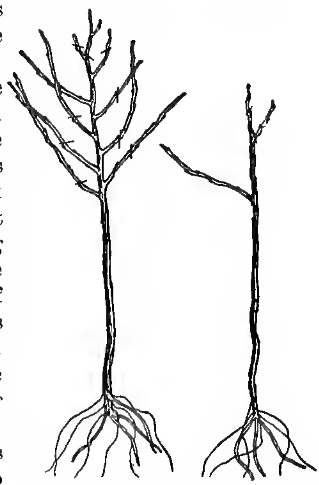

FIG. 49. Peach trees, large and small. (Taft.)

The second year all but four main branches should be removed, leaving those that are evenly distributed, and these should be cut back to about 18 inches. Each year after this the ends of the principal branches should be cut back and the others should be thinned out to keep the tree from becoming too thick. The amount of cutting back should be in proportion to the number of live fruit buds. Thus, when the trees are full of live buds it may be best to cut back some shoots three-fourths, whereas, if most of the buds are dead, very few fruit buds should be cut away.

PRUNING AND TRAINING THE GRAPE

The usual form of a grape vine when obtained from the nursery is shown in Fig 50. It should be planted slightly deeper than it was in the nursery and cut back to a strong bud. Only one shoot should be allowed to grow.

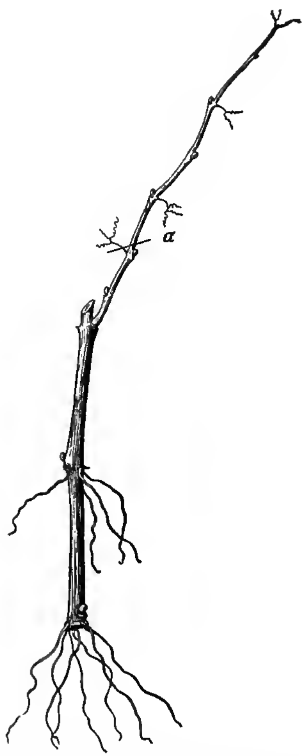

Fig. 50. Young grape vine: *a*, point where it should be pruned. (Taft.)

The next spring it should be again cut back to a strong bud, the length of the cane varying with its size. The terminal bud only should be allowed to develop and the cane should be tied to a stout stake as it grows.

The next spring it should be cut back at the height of 4 to 5 feet according to the kind of trellis to be used, and three buds at the top should be allowed to develop into shoots.

Forms of Trellis—The following spring the vines will be ready for a trellis. The favorite forms are known as *vertical* and *horizontal*. The vertical trellis consists of 8-foot posts set 2½ feet in the ground at intervals of 20 to 30 feet. These generally carry two lines of No. 10 galvanized wire, respectively 4 and 5½ feet from the ground. The end posts should be strong and well braced, and the wire should be so arranged that the slack can be taken up when necessary. The other posts need not be very large if 20 feet apart, but for 30 feet good-sized posts are desirable.

The horizontal trellis differs in having a 2 x 6-inch strip placed on edge horizontally at the top of the post, so as to form an arm 2 feet long, upon which three wires are carried.

Training the Grape—The previous year three shoots were grown on each vine. For the two-wire (vertical) trellis two of them should be placed on the lower wire and cut back to ten buds each. The other shoot should be cut off at the height of the upper wire, and a shoot from it should be trained in each direction. For the three-wire (horizontal) trellis, a shoot should be trained upon each of the wires, two in one direction and one in the other, and all should be cut back to eight buds.

The Kniffin System—The simplest and most satisfactory method of training the grape is by the Kniffin system.

The fruiting arms are tied to the wires in the spring and the new shoots as they come out are allowed to hang down.

To grow the best fruit, whatever system is used, the vines should be frequently cut back and renewed. Some prefer to renew all the canes each year, starting all of them from the main trunk of the vine, while others renew but once in two years. The two methods are shown in the illustrations. Fig. 51 shows a vine as it appears before pruning. At *a, a,* in the same illustration, are shown the eight cuts that would have to be made to renew the entire vine, under the four-arm Kniffin system. Fig. 52 shows the same vine pruned and with the arms tied to the wires. Figs. 53 and 54 illustrate the same points when but two arms are renewed and the others are cut back to two buds each.

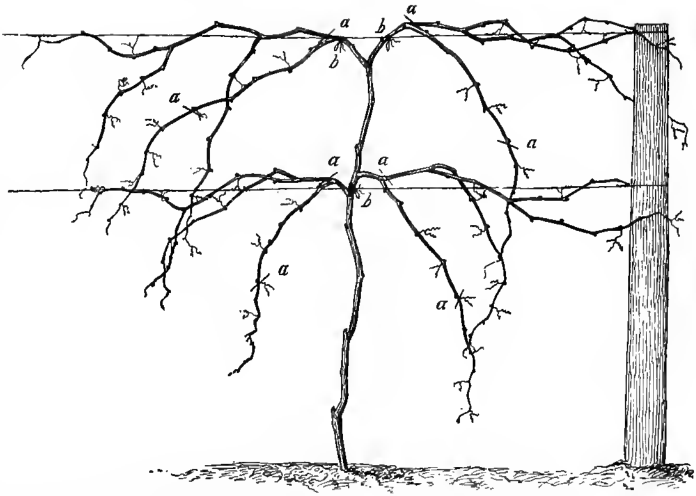

Fig. 51. Training the grape: Vine on vertical trellis, showing four-arm Kniffin system. *a*, Points for pruning for complete renewal; *b*, method of tying. (Taft.)

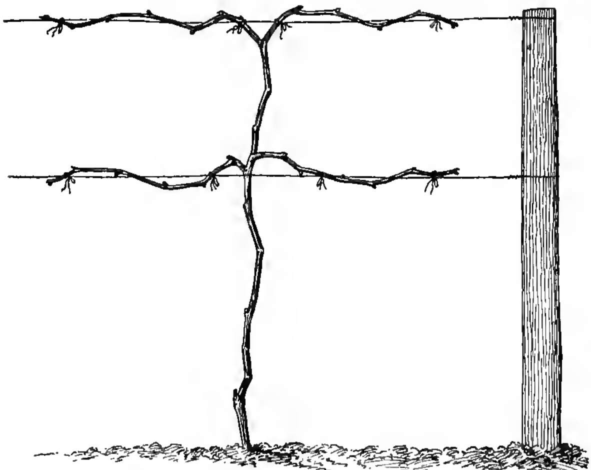
Fig. 52. Training the grape: Four-arm system, pruned and tied. (Taft.)

Whatever the method of pruning or training, one should endeavor to leave about forty buds upon each vine, and these should be as near the main trunk as possible.

PRUNING THE RASPBERRY AND BLACKBERRY

The stems of these fruits are biennial, growing one year and dying after fruiting the next summer, new canes appearing from the roots each spring. When the new canes of black raspberries and blackberries reach a height of from

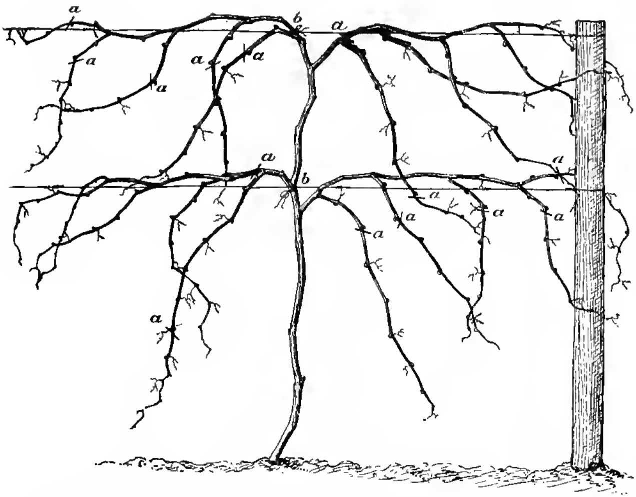

FIG. 53. Kniffin system of training the grape, showing two arms renewed and others cut to spurs. (Taft.)

3 to 4 feet, according to the variety, they should be pinched off. The old canes, and all but five or six of the new ones, should be removed in August. The following spring the side shoots should all be cut back to about 10 inches, and all canes that were not cut back the previous summer should be cut to 3 feet.

PRUNING CURRANTS AND GOOSEBERRIES

Five or six of the old shoots should be allowed to grow, besides two or three young ones. After the canes are four or five years old they should be cut out. If the growth of the branches is strong, they should be cut back one-half, and the tips of the new canes should be cut off.

PRUNING THE QUINCE

The trees should be started with a trunk about 1 foot long. When grown as a bush it is difficult to keep out the grass and weeds, while if there is a long trunk it is often injured by borers. The pruning is the same as for the apple, thinning out the head as needed and cutting back all long shoots.

PRUNING THE ORANGE

When set out, the trees should be headed back to a height of about 4 feet, and

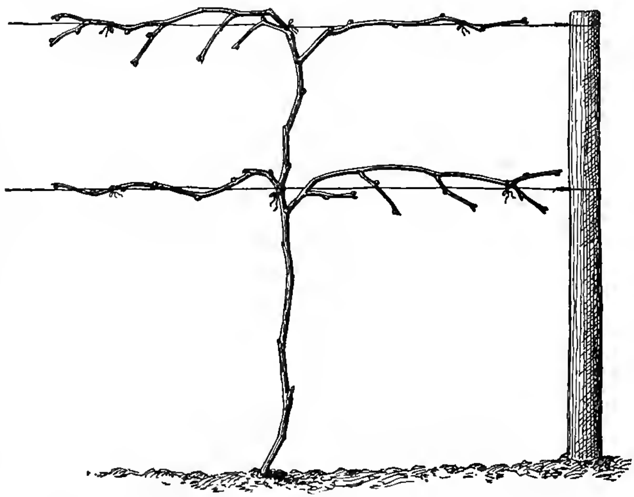

FIG. 54. Training the grape. Half-renewal, pruned and tied. (Taft.)

branches should be allowed to form so that the head will be about 2 feet from the ground. To prevent sun-scald it is often well to let all shoots above the bud grow the first year. The weaker branches should be cut out, if the head is too thick, and the strong shoots should be headed back.

PLANTING AND TILLING THE ORCHARD

After the soil has been thoroughly prepared the trees should be planted. Ordinarily the spring is the best time for planting all tree fruits, but for hardy varieties, upon well-drained soil, the fall answers fairly well if the trees are well banked up. The land should be laid off, either with a corn marker, or by means of a line or wire, with the places at which the trees are to be set marked upon them. The first method is the quicker, and if one does it carefully, setting stakes at the intersections where the trees are to stand, there will be little difficulty in correcting any slight errors that have been made.

The holes should be dug large enough to receive the roots of the trees without bending, the surface soil and subsoil being put in different piles as taken out. The tree should be set a little deeper than it was in the nursery and the surface soil should be scattered over the roots. As soon as every space has been filled among the roots more soil should be added and should be firmly packed, either with the feet or with wooden tampers. The soil from the bottom of the hole should be placed on top and the surface left without packing.

Care should be taken in handling the trees that the roots be not exposed either to the sun or to drying winds. If they can not be planted at once they should be heeled in, covering the roots with moist earth, and packing it well about them.

If the soil is fairly moist when the trees are planted, they will not require watering, but if the soil is dry and the weather hot, it will be well, after covering the roots with soil, to fill the holes with water, putting in the remainder of the soil after the water has soaked away.

CULTIVATION FOR ORCHARDS AND FRUIT GARDENS

For the first year after the trees and fruit plants have been set, some hoed crop can be grown between them. It should be one that requires cultivation up to the first of August and that does not require the stirring of the ground to harvest it during August or September. Tomatoes, squashes, melons, corn, and late potatoes answer very well. The cultivation should be frequent, and, if the weather is dry, the soil about the trees should be hoed occasionally to keep a crust from forming. Most orchard trees will admit of growing some crop between them a second year, but it will hardly pay after that time, except in the case of trees planted more than 20 feet apart. The injury to the trees and the increased labor of cultivating the orchard will be more than the value of the catch-crop.

Orchard Tillage Implements—Under average conditions it pays to cultivate all kinds of fruit trees after they come into bearing. In the spring, a cutaway or disk-harrow is desirable ; after that a spring-tooth harrow is to be preferred, and after the weather becomes dry a spike-tooth harrow or weeder may be employed. In a wet season, when the growth has been strong, young trees need not be worked after the middle of July. In dry seasons, and when trees are bearing full crops of fruit it is generally best to keep up the cultivation into August.

Cover Crops for Orchards—At the last cultivation some cover crop should be sown. In some sections, when the seeding can be done in July, 15 pounds of Mammoth or Crimson clover will bring excellent results. If not too far north, cow-peas and winter vetches also give good satisfaction. The former does best if sown in drills 2 feet apart early in July and cultivated once or twice. For early August, Canada peas and either barley or oats do well in the Northern States. After the middle of August it will be better to rely on either buckwheat or oats, the latter being the choice of the two.

A good cover crop will hold the snow and fallen leaves, and will lessen the depth of the frost and the alternate freezing and thawing, thus often preventing the root-killing of the trees. All of them provide a considerable amount of humus, when turned under in the spring, and the clover, and other legumes leave in the soil a considerable amount of nitrogen that they have taken from the air. The use of crops like oats, that winterkill, have an advantage in serving as a mulch in the spring, and, by conserving the water and keeping down the weeds, making it possible to postpone the working of the land for several weeks longer than would be desirable if it were bare, or covered with some growing crop. After turning under one or two cover crops the soil becomes spongy and friable, and is much better able to resist drought than soils that have had no cover.

Oats may be sown in August between the rows of currants, grapes, raspberries, and blackberries, and will serve a very useful purpose. When used among strawberries the sowing should be delayed until September 1st.

The only exceptions that are commonly met with — cases where it is not best to cultivate orchards — are : (1) Pears grown upon rich, moist land, and subject to blight ; (2) sweet cherries, on similar land, where the rank growth is injured by the winter ; (3) apples, under the same conditions. When trees are grown in sod it will be necessary either to use stable manure or to cut the grass and leave it on the ground to decay, so furnishing plant food and acting as a mulch.

FERTILIZERS FOR ORCHARDS

If a soil is in proper condition for planting the trees, it will generally contain plenty of plant food to supply them until they come into bearing, unless catch crops have been grown between the rows, when some fertilizing material will be required.

When it can be readily obtained, decomposed stable manure is the best fertilizer for fruits of all kinds. However, as farmyard manure contains a surplus of nitrogen, it will often be found most economical to supplement it with some form of commercial fertilizer. When unleached, hardwood ashes, free from refuse, can be secured for $5 a ton, they will be a cheap source for potash or phosphoric acid. Otherwise the best source of potash will be found in muriate of potash, and of phosphoric acid in acid phosphate or ground bone.

The amount of each of these required will vary with the age and condition of the trees and the nature of the soil. Of stable manure from 20 to 40 tons per acre could be used. If used with 50 to 100 bushels of wood ashes the amount could be reduced one-half, and the same reduction could be made for 200 pounds of muriate of potash and 500 pounds of acid phosphate. When a complete fertilizer,[1] to be used without manure, is needed for an acre of bearing orchard, good results will generally be secured from 100 to 200 pounds of nitrate of soda, 200 to 300 pounds of muriate of potash, and 500 to 700 pounds of acid phosphate.

The manure should be scattered broadcast during the winter, or early spring, and the commercial fertilizers can be sown in the spring at any time before the ground is worked. If sown in the winter time there would be but little loss, except of nitrogen from the nitrate of soda.

SUBSEQUENT CARE OF THE ORCHARD

THINNING FRUIT

If from one-half to three-fourths of the fruit on a tree is removed soon after it sets, the remainder will often bring more than when all of it is allowed to grow. This is especially true of peaches and pears and, under certain conditions, of plums and apples. The development of the seeds is what draws most heavily upon the trees and the soil, and when the number of the fruits is lessened, the quantity of fruit produced in a given season will often be as great as when all are allowed to

[1] One which contains all the essential elements — nitrogen, phosphoric acid, and potash — likely to be lacking in the soil.

remain, while the chances for a crop the following season will be much better. Even though the amount of fruit is less, its value per bushel will often be from two to four times as great, so that the expense for thinning will be repaid several times over. Really the cost of thinning is no large item, as when all of the fruit is left upon the trees it has to be picked in the end, and it takes longer to place it in baskets than to drop it to the ground.

In the case of the peach and grape, which produce their fruit on the wood of the previous year's growth, much of the thinning can be done by heading back the branches and in this way lessening the number of fruit buds upon the tree or vine. It is never safe, however, to rely entirely upon this, and, if too many fruits set the smaller ones should be removed after danger of dropping is over. Large varieties of peaches can often be thinned with profit so that the fruits stand 8 or 10 inches apart, when the trees have numerous branches, and 4 to 6 inches is none too much for the smaller kinds.

The pear can generally be improved if only one fruit is left upon a spur, and the same is true of the large varieties of plums. For the smaller kinds it is better to rely upon pruning to thin the fruit, and then feed and cultivate the trees so that they can bring the fruit to its full size.

Young apple trees can often be thinned to advantage, but it will seldom pay in the case of large trees. Raspberries, currants, and other bush fruits may be headed back to advantage, thus thinning the fruit in the same way, and with marked effect on the size.

SPRAYING FOR INSECTS AND DISEASES[1]

The injury done to fruit trees by noxious insects and fungous diseases has become so great that it is quite impossible to grow fruit to the best advantage without resorting to spraying to hold the various pests and blights in check.

Under ordinary conditions the insects that do the most harm are those that eat the leaves or fruit, and for all such a cheap and effectual remedy is at hand in paris green, white arsenic, green arsenoid, and other forms of arsenic. Nearly all the fungi which attack fruit trees are found also upon the fruit and foliage, and can generally be held in check by the use of Bordeaux mixture and other preparations into which copper sulphate enters. Both of these remedies may be combined and the treatment may be made for insects and diseases in one application.

Fungi multiply by means of spores, a simple form of seed, which germinate in moisture on the surface of plants and grow down into the interior. If a thin film of Bordeaux mixture, or of almost any salt of copper, can be spread over the foliage and fruit the germination of the spores can be prevented. From this it can be seen that the treatment for fungi must be preventive, as it will have but little effect if the fungi have gained entrance to the plants.

The same directions for the application of insecticides and fungicides answer for all fruits. The treatment should begin in the spring, before the buds open, using Bordeaux mixture combined

[1] For specific directions for combating the various insects and diseases injurious to fruits, see page 137 *et seq.*

with an arsenite. As soon as the fruit has set the application should be repeated. Another treatment is generally desirable in two or three weeks, and for late varieties of apples, pears, and plums a thorough spraying in the latter part of July is often worth while.

To be effectual the materials should be applied so as to reach all parts of the plants in a mist-like spray. For this a pump capable of maintaining a pressure of 70 pounds to the square inch is needed. It should be equipped with one or two lines of hose, an equal number of extension rods, and triple or quadruple nozzles. With a large and powerful pump three men can spray from 300 to 1,000 trees in a day, according to the size of the trees and the convenience of the supplies.

The first effect of spraying is to secure a healthy and uninjured foliage throughout the season. This makes it possible for the trees to develop their fruit and make a satisfactory growth. Of little less value is the benefit to the fruit by protecting it from insects, rot, and scab, and making it possible for it to reach its full size, in perfect form and without blemishes.

RENOVATING OLD ORCHARDS

Trees are often found which, although in full vigor, are unproductive. While this is sometimes due to location, or to the nature of the varieties, it frequently occurs in orchards that were at one time productive, and that seem to have proper surroundings. For such trees a treatment consisting of cultivation, manuring, pruning, and spraying, along lines previously outlined, will generally have a beneficial effect.

If in sod, the land should be plowed, harrowed during the early part of the season, and then sown to some cover crop. The dead branches should be taken out and, if the heads are too thick, some of the smaller limbs can be removed. When the twigs are very weak, with small buds, it will often be well to head them back. Generally the cutting off of three or four years' growth at the ends of the branches will suffice, but in some instances the pruning may be even more severe. This treatment is especially advantageous for old apple and peach trees. For peach trees, especially, the severe heading back of the old trees that have been grown without pruning will often result in renewing them. The main branches will thicken up, making them less likely to break down, and a new head will be formed. If done in years when the fruit buds have been killed, nothing will be lost while much may be gained. Stable manure will be especially valuable for old apple orchards and can be used in large amounts with profit, and the same is true of wood ashes.

Spraying should by no means be neglected. Sometimes this alone has sufficed to bring trees into bearing, and has secured large crops of fine fruit, but for the best results it should be combined with pruning and manuring, and in most cases the orchards should be cultivated.

FORESTRY HINTS

The average person is more interested in the simple care of the farm wood lot than in any more elaborate scheme of forestry. There are two things should always be kept out of the wood lot — fires and live stock. While fire is the more destructive to the large trees, the stock do fully as much harm to the young growth, and thus both permit the grass to grow and kill the saplings needed to take the place of the large trees as they are cut away.

When a tree reaches its prime it is best to cut it out and give the young trees a chance to develop. In doing this care should be taken not to injure the young growth. A judicious thinning out of the young trees will often be desirable. Enough firewood can generally be obtained to pay for the labor, and the trees that are left will be benefited. In the case of trees that will be used for timber purposes the removal of the lower branches will improve their quality for lumber.

While it will not be profitable in all sections to go into the growing of a forest by transplanting trees or scattering seeds, there are many places where a windbreak can be put out to advantage, or where waste pieces of land can be used for growing forest trees. While good results can often be obtained with nut-trees and others with large seeds, by scattering them in the fall and plowing them in, it will generally be most satisfactory to first grow or purchase seedlings and transplant. Unless a large number are needed it will be cheapest to purchase them, as they can be obtained at a low price.

The selection will depend upon the location. Thus, upon the prairies of the Central West, the catalpa will be found desirable, as it grows rapidly and is in demand for posts and ties. The black walnut also does well there. Farther north, the yellow locust offers many advantages for the same purpose. One good thing about this tree is that when cut down sprouts start and very quickly grow into a tree. The white pine, Austrian pine, and European larch are also promising timber trees.

The trees should be planted about 5 to 6 feet apart each way upon land that has been plowed, and should be cultivated often enough for two or three years to keep a sod from forming. After that the only care will be to thin them out as they need it and to keep out fires and live stock.

L. R. Taft.

PUBLICATIONS ON FRUIT CULTURE AND FORESTRY

APPLE CULTURE, FIELD NOTES ON. By L. H. Bailey, Jr. *Orange Judd Co.*, N. Y. . . $ .75

APPLE, HOW TO GROW Farmers' Bulletin 113. *United States Department of Agriculture* ——

BIGGLE BERRY BOOK. By J. Biggle. *American Garden Co.*, N. Y. . . .50

BULBS AND TUBEROUS-ROOTED PLANTS. By C. L. Allen. *Orange Judd Co*, N. Y. . 1.50

BUSH FRUITS. By F. W. Card. *The Macmillan Co.*, N. Y. . . . 1.00

CALIFORNIA FRUITS, THE, AND HOW TO GROW THEM. By Edward J. Wickson. *Pacific Rural Press*, San Francisco (1899) . . . 2.50

A special treatise on varieties and methods in local favor.

CAPE COD CRANBERRIES. By James Webb. *Orange Judd Co.*, N. Y. .40

CIDER MAKER'S HANDBOOK. By J. M. Trowbridge. *Orange Judd Co.*, N. Y. . . 1.00

COUNTRY HOMES, BEAUTIFYING. By J. Weidenmann. *Orange Judd Co.*, N. Y. 10.00

CRANBERRY CULTURE. By Joseph J. White. *Orange Judd Co.*, N. Y. . . . 1.00

CROSS-BREEDING AND HYBRIDIZING. By L. H. Bailey. *The Macmillan Co.*, N. Y. . . ——

DAHLIA, CULTIVATION OF. By Lawrence K. Peacock. *L. K. Peacock*, Acton, N. J. . .30

EVOLUTION OF OUR NATIVE FRUITS, THE. By L. H. Bailey. *The Macmillan Co.*, N. Y. . 2.00

Discusses at length the origin and development of the fruits peculiar to North America.

FLORICULTURE, PRACTICAL. By Peter Henderson. *Orange Judd Co.*, N. Y. . . . 1.50

FLORIDA FRUITS. By Helen Harcourt. *J. P. Morton*, Louisville, Ky. 1.25

FLOWER GARDEN, THE BEAUTIFUL. By F. S. Mathews. *W. A. Burpee & Co.*, Philadelphia .40

FOREST NURSERY, COLLECTION OF TREE SEEDS AND PROPAGATION OF SEEDLINGS. Bulletin 29, Bureau of Forestry. *United States Department of Agriculture* . . .10

FOREST PLANTING. By H. N. Jarchow. *Orange Judd Co.*, N. Y. . 1.50

FORESTRY, OUTLINES OF. By E. H. Houston. *J. B. Lippincott & Co.*, Philadelphia 1.00

FORESTRY, PRACTICAL. By Andrew S. Fuller. *Orange Judd Co.*, N. Y. . . . 1.50

FORESTRY, PRIMER OF (Part I.) Bureau of Forestry. *United States Department of Agriculture* 35

FORESTRY FOR FARMERS. Farmers' Bulletin 67. *United States Department of Agriculture* ——

FRUIT CULTURE. By W. C. Strong. *Rural Publishing Co.*, N. Y. . . . ——

FRUIT CULTURIST, THE AMERICAN. By John J. Thomas; revised by William H. S. Wood. *William Wood & Co.*, N. Y. (1897) 2.50

An elaborate treatise on fruit propagation and culture, with comprehensive notes on varieties.

FRUIT GARDEN. By P. Barry. *Orange Judd Co.*, N. Y. (1883) 1.50

Treats of the various operations of fruit culture, the prevention of disease and insect ravages, and the harvesting of the crop.

FRUIT GROWER, PRACTICAL. By S. T. Maynard. *Orange Judd Co.*, N. Y. 50

Fruit Growing, The Principles of. By L. H. Bailey. *The Macmillan Co.*, N. Y. (1898) $1.25

Contains, in addition to exhaustive treatment of the subjects of the propagation and management of fruits, a highly valuable chapter on harvesting and marketing the crop.

Fruit Packages. Edited by E. C. Powell. *Rural Publishing Co.*, N. Y. . . . ——

Fruits and Fruit Trees of America, The. By A. J. Downing. *John Wiley & Sons*, N. Y. (1881) 5 00

Gardening for Pleasure. By Peter Henderson. *Orange Judd Co.*, N. Y. . . 1.50

Garden Making. By L. H. Bailey, aided by L. R. Taft, F. A. Waugh, and Ernst Walker. *The Macmillan Co.*, N. Y. (1901). . . . . ——

Along with chapters on ornamental and vegetable gardening, this volume has a 45-page section on fruits for the home place.

Grape Culturist. By A. S. Fuller. *Orange Judd Co.*, N. Y. 1.50

Grape Growers' Guide. By Wm. Chorlton. *Orange Judd Co.*, N. Y. . . .75

Grape-Growing and Wine-Making, American. By George Husmann. *Orange Judd Co.*, N. Y. 1.50

Grape-Growing in the South. Farmers' Bulletin 118. *United States Department of Agriculture* . . . . ——

Grape-Training, American. By L. H. Bailey. *The Macmillan Co.*, N. Y. .75

Hedges, Windbreaks, Shelters, and Live Fences. By E. P Powell. *Orange Judd Co.*, N. Y. 50

Horticulture, Annals of. By L. H. Bailey. *Orange Judd Co.*, N Y . . 1.00

Horticulture, Cyclopedia of (4 vols.) By L. H. Bailey. *The Macmillan Co.*, N. Y. . 20.00

Horticulturists' Rule Book. By L. H. Bailey. *The Macmillan Co.*, N. Y. . . .75

A compendium of rules, practices, recipes, and figures likely to be of use to the horticulturist.

House Plants and How to Succeed With Them. By Lizzie Page Hillhouse. *Orange Judd Co.*, N. Y. 1.00

Irrigation for the Farm, Garden, and Orchard. By Henry Stewart. *Orange Judd Co.*, N. Y. 1.00

Landscape Gardening. By F A. Waugh. *Orange Judd Co.*, N. Y . . .50

Maple Sugar and the Sugar Bush. By A. J. Cook. *A. J. Cook*, Claremont, Cal. 35

Marketing Farm Produce. Farmers' Bulletin 62. *U. S. Department of Agriculture* . . ——

Nursery Book, The. By L. H. Bailey. *The Macmillan Co.*, N. Y. (1900), and *Orange Judd Co.*, N. Y. 1.00

A practical treatise on the multiplication of plants — by seedage, separation and division, layerage, and cuttage, with a full discussion of graftage, a nursery list, and a glossary.

Nut Culture in the United States. Division of Pomology. *United States Department of Agriculture* 30

Nut Culturist, The. By Andrew S. Fuller. *Orange Judd Co.*, N. Y. 1.50

Orchid Cultivator's Guide Book, The Amateur. By H. A. Burberry. *Blake & MacKenzie*, Liverpool, Eng. 2.50

ORNAMENTAL GARDENING FOR AMERICANS. By Elias A. Long. *Orange Judd Co.*, N. Y. $1.50

OSIER CULTURE. Bulletin 19, Bureau of Forestry. *United States Department of Agriculture* .05

PEACH CULTURE. By J. A. Fulton. *Orange Judd Co.*, N. Y. 1.00

PEACH GROWING FOR MARKET. Farmers' Bulletin 33. *United States Department of Agriculture* . . . . —

PEAR CULTURE FOR PROFIT. By P. T. Quinn. *Orange Judd Co.*, N. Y. . . . 1.00

PERSIMMONS (Experiment Station Work, XIII.) Farmers' Bulletin 107. *United States Department of Agriculture* . . . . —

PINEAPPLE GROWING. Farmers' Bulletin 140. *United States Department of Agriculture* —

PLANT-BREEDING. By L. H. Bailey. *The Macmillan Co.*, N. Y. 1.00

Discusses variation, pollination and crossing, and the origination of garden varieties, with detailed directions for crossing.

PLANT CULTURE, PRINCIPLES OF. By E. S. Goff. *E. S. Goff*, Madison, Wis. . . 1.00

PLANTS AND GENERAL HORTICULTURE, HANDBOOK OF. By Peter Henderson. *Peter Henderson & Co.*, N. Y. 3.00

PLANTS, THE PROPAGATION OF. By Andrew S. Fuller *Orange Judd Co.*, N. Y. 1.50

PLUMS AND PLUM CULTURE. By F. A. Waugh. *Orange Judd Co.*, N. Y. . 1.50

PRUNING BOOK, THE. By L. H. Bailey. *The Macmillan Co.*, N. Y. (1897) . 1.50

QUINCE CULTURE, THE. By W. W. Meech. *Orange Judd Co.*, N. Y. . 1.00

RECOMMENDED FRUITS, AMERICAN POMOLOGICAL SOCIETY'S CATALOGUE OF. Bulletin 8, Division of Pomology. *United States Department of Agriculture* 05

ROSE, THE. By H. B. Ellwanger. *Dodd, Mead & Co.*, N. Y. . 1.25

ROSE, THE. By Samuel B. Parsons. *Orange Judd Co.*, N. Y. . 1.00

ROSE CULTURE, SECRETS OF. By W. J. Hatton. *W. J Hatton*, Riverdale, N. Y. .50

SMALL FRUIT CULTURIST. By Andrew S. Fuller. *Orange Judd Co.*, N. Y. . 1.00

SPRAYING OF PLANTS. By E. G. Lodeman. *The Macmillan Co.*, N. Y. (1896) . 1.00

Written as a university thesis, this treatise goes more deeply into the history of spraying methods, solutions, and devices than is needful for the majority of orchardists, but the bulk of the matter is specific and easily available.

STRAWBERRY CULTURE, A B C OF. By Terry. *A. I. Root*, Medina, O. . . .35

STRAWBERRY CULTURIST. By Andrew S. Fuller. *Orange Judd Co.*, N. Y. .25

SURVIVAL OF THE UNLIKE, THE. By L. H. Bailey. *The Macmillan Co.*, N. Y. 2.00

A collection of evolution essays suggested by the study of domestic plants.

TIMBER AND ITS DISEASES. By H. M. Ward. *The Macmillan Co.*, N. Y. 1.75

TREE-PLANTING, PRACTICAL. Bulletin 127, Bureau of Forestry. *United States Department of Agriculture* 05

TREES OF THE NORTHERN UNITED STATES. By A. C. Apgar. *American Book Co*, N. Y. 1.00

WINDOW FLOWER GARDEN, THE. By Julius J. Heinrich. *Orange Judd Co.*, N. Y. .50

Important Injurious Insects and Diseases Affecting Field Crops, Fruits, and Shade Trees[1]

By E. S. G. Titus, M. S.
Field Assistant to the State Entomologist of Illinois

INTRODUCTORY

Clean Culture — Prevention is better than cure. Scientific tillage must include measures calculated to minimize the ravages of insect pests and plant diseases. Indeed, with not a few of the farmer's worst scourges preventive measures are the only successful ones, and in every case, when thoroughly carried out, they are the most efficacious.

One has only to walk through the fields in fall to find noxious insects hibernating in the stubble, and to be convinced of the necessity of clean cultivation. Clean the fields thoroughly after harvest, leaving a few rubbish piles to serve as shelter for hibernating pests. Burn these before winter opens, and the insects concealed therein will not have to be fought in spring, when the young crop is trying to grow. Destroy weeds and volunteer plants along with other refuse; cut out those around the fence corners and along the ditches, even going out into the road to destroy them. Burning over stubble ground is an effective precaution. Deep fall plowing kills many insects and buries many more, and proper drainage will keep other insects from multiplying. Wise tillage and careful fertilization often enable plants to withstand injuries that otherwise might prove fatal.

Rotation of Crops is one of the most, if not the most, important factor in insect control. It should be carried on in such a manner that no single crop nor any two crops closely related botanically shall be grown continuously on the same land.

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1 The anthor of this section desires to acknowledge the kindness of Dr. S. A. Forbes, State Entomologist of Illinois, for the loan of many of the illustrations and for numerous other favors. He desires also to express his obligation to Dr. T. J. Burrill, Botanist of the University of Illinois, for aid in treating the subject of plant diseases; to Prof. J. C. Blair, for the loan of the photograph of a bitter-rot canker, elsewhere reproduced; and to Dr. George William Hill, Chief of the Division of Publications, United States Department of Agriculture, for several illustrations.

Insects: Life Histories and Habits—Intelligence on this subject is indispensable to profitable farming. It will often enable one to choose the best time for planting, and will aid in determining the value of trap crops and in correctly timing all economic measures. Study the insects you combat, for it means economy of insecticides and time, and increased value of crops.

Some pests, the gnawing and biting insects—as the larvæ of butterflies, of moths, and of saw-flies, and both larvæ and adults of beetles and grasshoppers—devour the substance of the leaf—the plant tissues themselves; others, the sucking insects—as the young and the adults of the squash-bug, the leaf-hoppers, and the plant-lice—tap the plant with the beak and thus extract its juices. To kill the first class, aim to cover every part of the plant with an arsenical poison; so surely covering it that the insect must eat it and die, or leave it and starve to death. To kill sucking insects is a harder task. Try by spraying to drench them with some contact insecticide, as kerosene emulsion, whale-oil soap, or one of the scale washes. Each one that gets a coating of the spray over it soon smothers to death, for they breathe through little spiracles along the sides of the body.

Fungi—Insects either destroy or seriously damage the plant, or else they impair its vitality and affect the quality of its product, be it fruit or grain. Fungi, however, kill the plant by choking it to death. The purpose of spraying against fungi is to arrest the growths that are filling up the respiratory organs of the plant. The secret of success is to spray thoroughly and at the right time, as in treatment for insects.

Location of New Orchards—Do not make use of old orchard ground, for it may be filled with disease. Set trees at a distance from the farm boundary, for your neighbor may not be careful to control the insects in his orchard, and you would suffer thereby. Be sure that the stock you set out is free from disease and insects. Better destroy it than be obliged to fight some new pest for years to come.

Beneficial Insects—While it is always well to be on the lookout for injurious insects and find a way to destroy them, the farmer should also learn his friends among the insects. Without the beneficial insects, all our Paris green sprays and our methods of preventing injury by the handling of our crops would avail little. It would be next to impossible to prevent the enormous increase in a few short years of the injurious species, were they not checked by the ladybirds, the lace-winged flies, the syrphus-flies and the ground-beetles, to say nothing of the myriads of minute parasitic enemies that are continually preying on the remainder of the insect world.

The ladybirds are entitled to first rank as beneficial insects, for almost all the beetles and their larvæ in this large family feed on plant-lice and scale-insects. Two of the most efficient forms are illustrated in Figs. 55 and 56. The many-spotted one feeds on plant-lice; the other, on scale-insects.

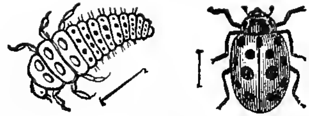

FIG. 55. Thirteen-spotted Ladybird (*Hippodamia convergens*), beetle and larva.

Besides these little beetles there are also the larvæ of some flies that feed on plant-lice, one of which, the syrphus-fly, may be seen in Fig. 57.

FIG. 56. Twice-stabbed Ladybird (*Chilocorus bivulnerus*), beetle and larva.

The larvæ of the lace-winged flies (Fig. 58) are among the most voracious of feeders, and while they destroy many plant-lice and psyllids they by no means confine their attention to such small insects, but feed on large leaf-feeding larvæ and their pupæ.

FIG. 57. Syrphus-fly, adult and larva.

The cutworms, tomato worms, corn worms, and many other of the larger destructive larvæ have a relentless enemy in the shape of the fiery ground-beetle (Fig. 59), so named because of its gold-dotted wing-covers. The larva of this beetle has strong, prominent jaws, and when once they are set in the body of a victim there is no chance of escape. They will attack insects several times their size and come from the combat victorious. Nearly all of the ground-beetles are beneficial.

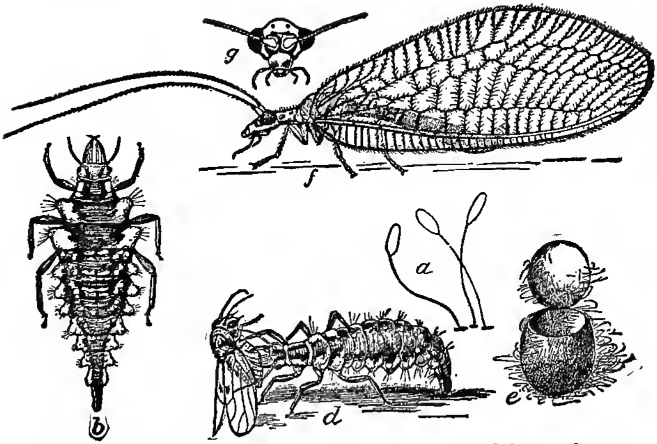

FIG. 58. Lace-winged Fly (*Chrysopa oculata*): *a*, eggs; *b*, larva; *d*, same, feeding on a pear-psylla; *e*, cocoon from which the adult (*f*) has emerged; *g*, head of adult enlarged. (Slingerland.)

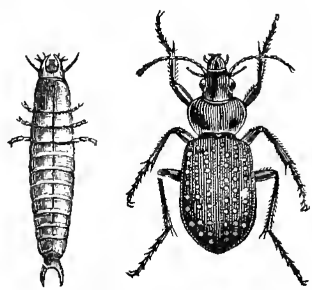

FIG. 59. Fiery Ground-beetle (*Calosoma calidum*), beetle and larva. (After Riley.)

There are also many insects that lay their eggs on larvæ of other species; when the young hatch they work their way inside and feed on their host. More are probably killed in this manner than in any other; some parasites living in eggs, some in larvæ, and others in the pupæ. These parasitic insects are usually delicately formed in the adult state, having transparent wings and often being brilliantly colored.

Birds and Agriculture — The relative benefit and injury received by the farmer from some of our common species of birds varies according to circumstances; yet in some cases the injury done to growing crops, or the protection against insect pests afforded, is so positive as to admit of no question. Take, for instance, the crow-blackbirds and the crows. They work both positive injury and positive advantage to the farmer, and so long as they are not overabundant it is likely that they are worth more than they cost. If too numerous, of course their numbers must be reduced. Then, again, take the diet of nesting birds — almost exclusively animal: It has been estimated that the passerine (sparrow-like) birds of Eastern Nebraska, by their destruction of locusts in the nesting season, save crops to the value of $1,744 a day.

The United States Department of Agriculture declares the following twenty-five species of birds *decidedly beneficial* and worthy of the fullest protection because of their consumption of insects, reptiles, rodents, and noxious weed seed: Marsh-hawk, Swainson's Hawk, Ferruginous Rough-leg, Squirrel-hawk, Sparrow-hawk, Robin, Bluebird, Chickadee, House-wren, Rose-breasted Grosbeak, Song-sparrow, Chipping-sparrow, Tree-sparrow, Baltimore Oriole, Meadow-lark, Flicker, Downy Woodpecker, Hairy Woodpecker, Black-billed and Yellow-billed Cuckoos, Barn Owl, and the Long-eared, Short-eared, Barred, and Screech Owls.

Five are *distinctly injurious* and should be destroyed, viz., the English Sparrow, Duck-hawk, Goshawk, Cooper's Hawk, and the Sharp-shinned Hawk.

INSECTICIDES

ARSENICAL POISONS FOR BITING INSECTS

Paris Green, London Purple, Scheele's Green, Paragrene, and Green Arsenoid are all arsenicals of the same general character. *Paris green* is composed of arsenic, copper, and acetic acid; *Scheele's green* is said to contain no acetic acid, is more easily applied, and, like *Paragrene,* remains in suspension longer; while *London purple* and *Paragrene* need more lime added to prevent foliage burns.

For Spraying — Make a thin paste of the arsenical substance used, by adding a small quantity of the poison to a small quantity of water and freshly slaked lime in same quantity. Strain this into a spray tank, and add water in the proportion of 100 to 300 gallons to each pound of poison. Apply the stronger mixtures to resistant foliage, such as the potato. For the apple, use 150 gallons to each pound of poison.

Never spray fruit trees when in bloom, lest bees be poisoned.

For Dry Use — For vegetables soon to be used for food, mix poison with 100 times its weight of plaster of Paris, flour, or lime, and apply lightly. Dust garden crops with poison from a bellows or bag. For low field crops, place in bags hung at ends of a pole and carry through field on horse or mule back. See under Cotton Worm.

Combined Mixture: Bordeaux with Paris Green or Other Arsenite — Prepare Bordeaux mixture in the usual way (see Fungicides) and add to it the poison to be used. In this combination the Bordeaux mixture simply takes the place of the water in the Paris green and other arsenical solutions.

Arsenite of Lead — Least caustic of all arsenites in its effect on foliage. Remains in suspension and adheres to foliage much better than ordinary arsenites. May be bought at from 15 to 18 cents per pound. Prepare as follows: Combine 3 parts of arsenite of soda with 7 parts of acetate of lead, dissolving each in water separately and then pouring together. They unite readily and form a white precipitate. May be used much stronger than any other arsenite on foliage.

Arsenite of Lime —This is a cheap insecticide, and does not burn the foliage, because the amount of arsenic is under perfect control. It is made by boiling together, for 45 minutes,

White arsenic	1 pound.
Fresh stone lime	2 pounds.
Water	1 gallon.

Put this in a tight vessel marked POISON. Before using, stir thoroughly, and use one quart of solution to a barrel of water.

Poison Fixative — To make poisons adhere to cabbage, etc.

Pulverized resin	5 pounds.
Concentrated lye	1 pound.
Fish-oil, or any cheap animal oil except tallow	1 pint.
Water	5 gallons.

"Place oil, resin, and a gallon of water in an iron kettle and heat until resin is softened; add lye solution made as for hard soap; stir thoroughly; add remainder of water and boil about two hours, or until the mixture will unite with cold water, making a clear, amber-colored liquid. If it has boiled away too much, add sufficient boiling water to make 5 gallons."—Sanderson. In using this, dilute 1 gallon of the solution with 16 gallons of water, and add 3 gallons milk of lime and a quarter of a pound of any arsenite.

Poisoned Baits — For cutworms, grasshoppers, etc.

Green Bait — Dip fresh clover or other green succulent vegetation in a strong arsenical solution and distribute in small bunches about infested fields. Cover with boards or stones to keep moist; renew when dry.

Bran Mash — For grasshoppers make a mash of 1 pound Paris green, or other arsenite, and 5 pounds bran; sweeten with molasses. For cutworms, army-worms, etc., use 1 pound Paris green to 20 pounds dry middlings or bran, sweetened with 1 quart molasses and mixed with enough water to make moist. Drop a tablespoonful of this in a place, along the front of the line of march of army-worms; or at the base of each plant in a field, for cutworms.

CONTACT INSECTICIDES FOR SUCKING INSECTS

Kerosene Emulsion — Dissolve 2 pounds whale-oil soap (or hard soap, or 1 quart soft soap) in 1 gallon boiling water, add boiling hot, away from the fire, to 2 gallons coal-oil. Churn rapidly by driving the liquid back into itself with a force-pump until the mixture assumes the consistency of cream. Use this solution diluted as desired. For 10 per cent. solution add this preparation to 20 gallons water. A stronger solution can be applied to plants before the buds open.

Whale-Oil Soap — This is a very effective wash against scales, slugs, and many other soft-bodied insects. For summer treatments use 1 pound to 7 gallons water. For winter use, dissolve 2 pounds of the soap in 1 gallon water and apply hot.

Lime, Sulphur, and Salt Wash, or "California Wash" — The most effective wash at present known for use against the San Jose scale. Prepare as follows:

Lime (not slaked)	15 pounds.
Powdered sulphur	15 "
Common salt	15 "

Slake the lime in a small quantity of hot water in an iron kettle over a fire, and slowly sift in the sulphur while the lime is slaking, stirring constantly. Boil this one hour, or until sulphur is all dissolved; then add the salt and boil 15 minutes longer. Put this solution in spray barrel and add sufficient hot water to make 50 gallons. Spray on trees hot. This wash needs to be *thoroughly boiled,* not simmered. If steam heat is available it has been recommended to put the sulphur and lime in a barrel and steam-boil for three or four hours, adding the salt and boiling a short time longer. One and a half pounds of *blue vitriol* may be used in place of salt.

GASES AND OTHER INSECTICIDES

Carbon Bisulphide — This is the cheapest and most efficient insecticide for use against weevils in granaries and warehouses, and against insects working on the roots of plants. The vapor of this liquid is not only highly poisonous but is inflammable and explosive; hence, *keep fire of every kind away from it.* It is a colorless liquid, costing about 10 cents a pound, and can be used to advantage in grain bins, as the vapors are heavier than air and will work down through the grain. For this purpose use 1 pound to every 100 bushels of grain, make the enclosure as nearly air-tight as possible, and, if necessary, cover grain with blankets. Leave for *not more than twenty-four hours,* then allow air to enter. For root-lice or other root insects use a teaspoonful to a hole made 2 or 3 inches away from the plant, and close the hole with the foot. For ant nests put 1 ounce in each of several holes made in the hill; then cover with a wet blanket for ten minutes.

Carbolic Acid Wash — To prevent egg-laying on bark. In a 6-gallon saturated solution of washing-soda dissolve 1 gallon soft soap, add 1 pint carbolic acid, mix thoroughly, add enough lime to make a thick whitewash, and stir in one-half pound of some arsenite.

Hellebore — Apply dry for saw-flies and other soft-bodied insects. It can also be used as a spray — 1 ounce to 2 or 3 gallons of water.

Pyrethrum (Buhach, Persian Insect Powder) — Not poisonous, in ordinary quantities, to man. May be used dry by means of a bellows. Thrown about the room in this way, it will materially decrease the number of flies. Burn in a room to destroy mosquitoes. Used as a spray, 1 ounce to 3 gallons of water.

Hydrocyanic Acid Gas — The best agent in use for disinfection or fumigation of nursery stock, and for destruction of some greenhouse insects and pests in dwelling houses, storehouses, mills, etc. Diffuses quickly, and is a *most deadly poison.*

FUNGICIDES

Bordeaux Mixture—

Copper sulphate (blue vitriol)	4 pounds.
Quicklime (not air-slaked)	4 pounds.
Water, to make	50 gallons.

Dissolve the copper sulphate in about two gallons of water in a wooden vessel, or suspend it in a cheese-cloth sack in a large bucketful of cold water. When dissolved, pour the solution into the apparatus used for spraying and fill about one-third full of water. Slake the lime in a small quantity of water, and when slaked, stir, adding more water. Strain this into the copper sulphate solution. If lime is left after straining, pour on more water and stir it. Repeat this until nothing but stone lumps and sand are left. Now add sufficient water to make 50 gallons in your tank. Thoroughly agitate the mixture before spraying it. Bordeaux mixture should be used when fresh, and none should be kept over for the next spraying.

If plants to be sprayed have very tender foliage and there is danger of burning it, use just half the above quantity of copper sulphate and lime to the 50 gallons and prepare as before. What is sometimes called the "1 to 11 formula" is made in the same way as the first one given, but using only sufficient water to make 44 gallons.

Ammoniacal Copper-Carbonate Solution—

Copper carbonate	6 ounces.
Ammonia, about	3 pints.
Water	50 gallons.

In a wooden pail make a paste of the copper carbonate by adding a little water. Pour into this the ammonia necessary to dissolve the copper carbonate — no more — and stir until all is dissolved. Dilute with water and use.

To MAKE COPPER CARBONATE — Dissolve 10 pounds copper sulphate in 10 gallons of water, and 12 pounds of carbonate of soda in same amount of water. When cool, mix the two solutions slowly, stirring well. Allow it to stand 12 hours and settle, then pour off liquid. Repeat this operation twice, and then drain and dry the resulting powder, which is copper carbonate.

Copper-Sulphate Solution —

Copper sulphate	4 pounds.
Water, to make	50 gallons.

Dissolve the copper sulphate as directed in preparation of Bordeaux mixture. This solution *will injure foliage;* use only before buds open, or on machinery and in granaries to disinfect.

Formalin —

For Oats, Wheat, etc.— One pound (1 pint) to 50 gallons water.

For Potatoes — One-half pint to 15 gallons water.

Corrosive Sublimate —

Corrosive sublimate	2 ounces.
Water	15½ gallons.

This can be used for *potato scab* and *disinfection* purposes. Label it POISON.

Bordeaux Wash — To paint over wounds on trees and to wash injuries to limbs. Make a mixture as for the carbolic acid wash, adding one half pound blue vitriol in place of Paris green.

I. FIELD CROPS

(a) IMPORTANT INJURIOUS INSECTS

Northern Corn-Root-worm (*Diabrotica longicornis*, Fig. 60) — From Nebraska east to the Atlantic Ocean, but injurious only from Ohio to Nebraska. Attacks corn in both larval and adult stages. Eggs laid in early fall, one to five inches deep in the soil and within a few inches of stalks. Hibernates in the egg, which hatches from June to August. At first eats entire root, but later burrows under outer layers of larger roots, thus killing them and weakening the support of the stalk, causing it to dwarf and produce small ears if on poor land, or to be

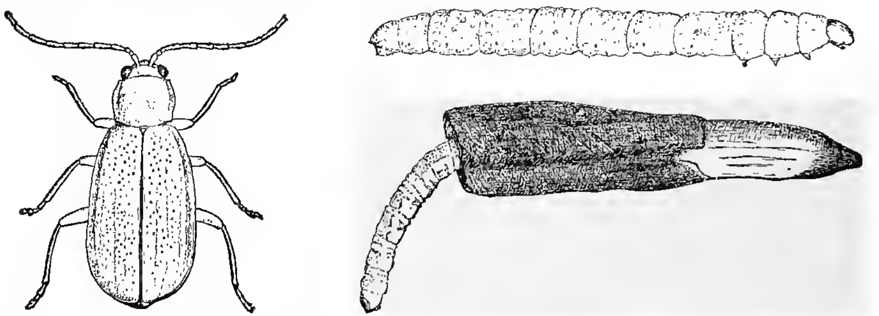

Fig. 60. Northern Corn-Root-worm: beetle, larva, and piece of corn root with larva. (Forbes, 18th Illinois Report.)

blown over when on rich loams. Larvæ are nearly white, with brown head; are not quite $\frac{1}{2}$ inch long, and are nearly cylindrical. Adult beetle is greenish or greenish yellow, $\frac{1}{4}$ inch long, somewhat resembling in form the striped cucumber beetle. Larvæ pupate near the roots in the soil, and adults emerge during the latter part of July and in August and feed on corn silks and pollen. Reports have been made of several other food plants for the beetles.

TREATMENT — So far as known these worms are never injurious after a crop of the smaller grains; corn crops following these will then be safe for two years. The remedy is, therefore, simple — *rotation*.

Southern Corn-Root-worm (*Diabrotica duodecempunctata*) — Abundant in Northern and Southern States. Attacks corn seriously only in the South. Well known, however, as a squash, melon, and cucumber pest, eating both leaves and fruit. Larva has habits very similar to those of the previous species. Beetle is larger than the northern corn-root-worm beetle, greenish yellow, with twelve black spots on wing-covers. The beetle injures corn by feeding on pollen, silk, and unripe kernels.

TREATMENT — Same as for northern corn-root-worm.

Wireworms (*Drasterius elegans, Melanotus cribulosus,* and other species, Fig. 61) — Occur in all the states, attacking grasses, grains, and potatoes. The wireworms are hard, cylindrical ground worms, feeding upon roots and seeds in the ground, and are often very destructive to crops. The beetles, which are narrow, elongate, and usually dark-colored, are generally known as "snapping-beetles,"

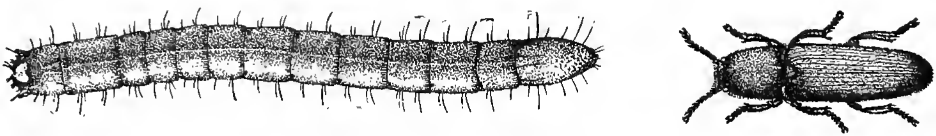

FIG. 61. Corn Wireworm larva, and beetle. (Forbes.)

"spring-beetles," or "click-beetles." They lay eggs during May or June in grass land or wherever vegetation is plentiful, and the larvæ feed upon roots. They develop slowly, taking in many cases two or three years to mature. When mature they pupate in the fall, and the adult stays in the pupal case until the following spring.

TREATMENT — Fall plowing and rotation of crops. Do not plant corn or potatoes immediately after grass crops.

Corn-root Webworm or Tobacco Stalk-worm (*Crambus caliginosellus*) — Eggs laid in grass land in May or early June by small whitish or yellowish moths. The young larvæ form loose silken tubes close to the surface of the soil, usually a little below, and thence burrow among the roots and feed upon stalk, outer leaves, and crown. The moths emerge by August, and eggs are then laid for another brood, which hibernate in the web over winter as partly-grown larvæ. Corn planted on sod land is thus often seriously injured by them.

TREATMENT — Do not plant on sod land, but after some other crop. Late fall plowing or harrowing deeply will destroy many of the larvæ.

Corn Root-louse (*Aphis maidi-radicis*) — All corn states. Presence of this plant-louse on corn roots can be detected by dwarfed appearance and yellowing and reddening of plant. Lice, found in masses on the roots, are readily recognized if an infested plant is pulled up. The nests of the small brown ant, if opened in winter, will be found to contain many of the little black eggs of this *Aphis* well cared for by these ants. On appearance of the first smartweed, the ants carry the newly-hatched lice to them and place them on the roots. Later, when the winged lice appear on these weeds and lay eggs, the ants transfer these to the corn roots. Late in the fall the females are housed by the ants in their nests, where the eggs are laid.

TREATMENT — Clean culture, eradication of weeds in early spring, destruction of ant hills in late fall, deep fall plowing and harrowing, rotation of crops.

Larger Cornstalk-borer (*Diatræa saccharalis*) — Maryland to Alabama and westward to Kansas and Oklahoma. Large white, brown-spotted caterpillars of this species may be found boring into stalks of corn, especially when young. Often occasion large loss in crop. Larvæ pass the winter in their cells in the tap-root of the cornstalk or sugar cane, and transform in early spring. Often make several holes in a single stalk, weakening it and causing it to fall.

TREATMENT—Where corn has been much infested in fall drag off and burn all old butts and stalks. Rotation will materially decrease injury by this insect.

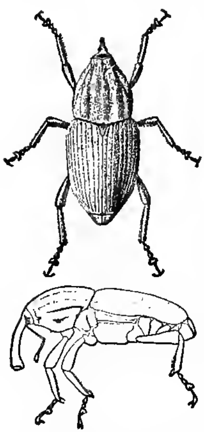

FIG. 62. Clay-colored Bill-bug. (Forbes.)

Corn Bill-bugs (*Sphenophorus ochreus*, and others, Fig. 62) — Corn-growing states. Attacks plant by feeding in the stalk when young. Adult beetles are hard oval insects with stout beak, by means of which they drill holes in the cornstalk near the surface of the ground and feed on the interior. As the corn continues growing and these leaves open out, many of them have a row of elongate holes across blade, where beetle has punctured it while it was rolled up. Beetles feed with the head downward. One species (*S. parvulus*) has been reported from Maryland and Nebraska as seriously injuring blue-grass. Another (*S. robustus*) has been known to breed in the roots of corn. Native food plants of this genus are the grasses, rushes, and sedges.

TREATMENT — Where land has recently been broken from swamp or marshes, plant at first some other crop than corn, such as flax or potatoes. Fall plowing of infested land will tend to drive the beetles to other fields.

Corn Ear-worm (*Heliothis armiger*) — All corn and cotton states, but not so destructive in the North as in the South, where it feeds on cotton bolls. It is the worst pest of sweet corn, injures tomatoes to an extent, and bores into the buds of tobacco. Olive-green moths appear about the time corn is silking and lay eggs on the silk. These hatch in a few days, and the young worms at first feed on silk, later working their way down into the ear and feeding on the tender kernels. When full grown the worms go to the ground to pupate, and in case of the fall brood stay in the cells as pupæ until spring.

TREATMENT—No practical remedy if in corn or tomatoes. Thorough breaking up of corn ground in fall reduces their number somewhat. For remedies for attacks on tobacco and cotton see under insects affecting those plants.

Army-worm (*Leucania unipuncta*, Fig. 63) — All states. The true army-worm is a brownish-white striped caterpillar growing to 2 inches in length, the larva of a moth with dull-reddish fawn-colored wings, each fore-wing with a white spot. They occur every year, but are only rarely so abundant as to justify the name. When this happens, they advance over the country in vast numbers, devouring all grasses and grains in their track, usually feeding by night or in cloudy weather. When mature they enter the ground and pupate, and a second brood of worms appears in September, hibernating as larvæ.

TREATMENT—Clean culture; burn stubble in winter; when army is advancing use poisoned baits, scattering them along in front of it; dig ditches to entrap them and then drag a log through to kill them.

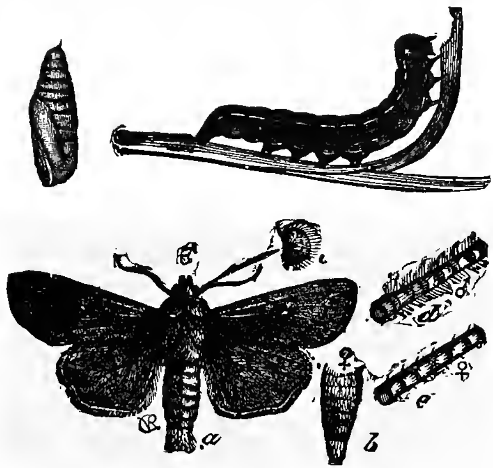

FIG. 63. Army-worm: *a*, adult male, *b*, *c*, *d*, details; larva on grass, and pupa. (After Riley.)

Fall Army-worm, Common Grass-worm (*Laphygma frugiperda*, Fig. 64) — All states, but especially the Central and Southern. Distinguished from the true army-worm by dark stripes along each side, separated by a stripe of grayish yellow, and also by the fact that the most destructive brood appears after August 1st — whence its common name. The worms are especially injurious to lawns, but feed on all grasses and cereals and on some garden vegetables. Moths

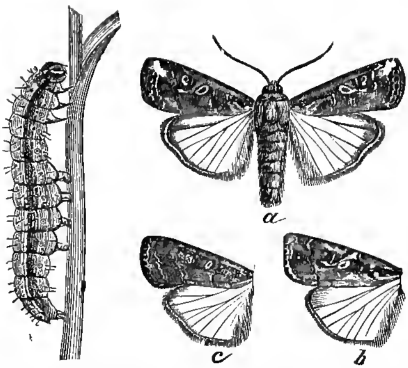

FIG. 64. Fall Army-worm: larva at left; *a*, adult moth; *b*, *c*, color varieties. (Bruner.)

are variable in color: hind-wings are pearly white; fore-wings range from dull grayish brown to almost black, but always have a light spot on upper side near outer edge.

TREATMENT — Same preventives as for the army-worm. Lawns may be rolled in early morning or late afternoon, or sprayed with kerosene emulsion and then thoroughly washed down with water.

Hessian Fly (*Cecidomyia destructor*) —All wheat states. Adult fly is a dark-colored, two-winged gnat ($\frac{1}{8}$ inch). Lays eggs in fall on upper surface of wheat leaf, or, in spring, beneath sheath. Maggots burrow into stem, spring brood remaining in portion above ground, fall brood going lower. Ravages are detected by stooling out of wheat, a darkening and broadening of leaves, absence of central stem, and a gradual yellowing and dying of plants. Damp springs favor the insect. Its emergence is retarded by drought, so that late sowing may fail as a remedy after summers with little rain.

TREATMENT — Delay sowing of wheat until after time for the fly to lay its eggs. Farm practice as to date of sowing is in some states as follows · Northern Ohio, September 10th; Central Ohio, September 25th; Southern Ohio, October 10th; Central Maryland, September 26th to October 5th; Northern Delaware, October 1st; New York, September 20th to 25th; Michigan, September 1st or not until October 1st. Clean cultivation, burning of stubble, rotation of crops.

Chinch-bug (*Blissus leucopterus*, Fig. 65) — Especially in Southern and Central States, and west to Rocky Mountains. One of the most destructive of pests, having doubtless caused more injury to the farmers of the Mississippi Valley than any other insect attacking grain. The adult bug is black, with white wings and two dark spots on the fore-wing. In all

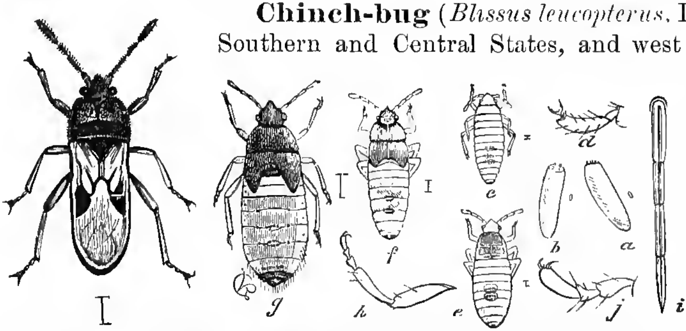

FIG. 65. Chinch-bug: adult at left; *a*, *b*, eggs magnified and natural size; *c*, young nymph; *e*, second stage of nymph; *f*, third stage; *g*, full-grown nymph; *d*, *h*, *j*, legs; *i*, beak, through which food is taken. Small lines show natural size. (Riley.)

stages it has a rank, fetid odor. Young bugs are mostly red but vary somewhat in the different stages. After wheat harvest it attacks first oats and then corn, later in the fall going to wheat again. In migrating from wheat to corn adult insects rarely fly. Eggs are laid on the corn, and this brood hibernates when full grown, and, coming out in the spring, lays eggs on the wheat stalks.

TREATMENT — Plow strip around corn field or along side from which attack is expected, pulverize the soil very thoroughly, and when bugs begin to migrate make a deep furrow in this soil with the steeper side toward the corn. On a hot day myriads of bugs will perish attempting to cross the fine soil, but if any seem to be getting across drag a log up and down the furrow. If a line of coal-tar is spread in front of their line of march and post-holes dug a foot deep every ten feet along the line, the bugs will turn as the line is reached and fall into the holes, where they may be killed. Ten per cent. kerosene emulsion may be sprayed on the bugs when they are on corn stalks. It will pay to use every effort possible to keep them out.

White Grubs, May Beetles, June Bugs (*Lachnosterna fusca, L. rugosa,* and others, Fig. 66) — The Lachnosternas are widely distributed. The larvæ are fleshy white, brown-headed grubs that feed on and sever grass roots and roots of some other plants. The adult beetle, which is generally known in some one, at least, of its many species, feeds on the leaves of trees, eating at night.

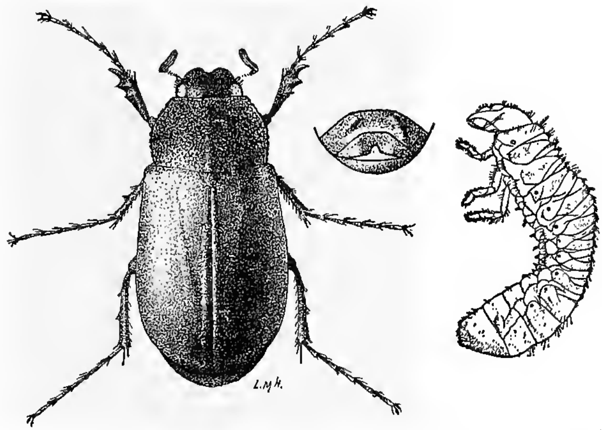

FIG. 66. White Grub: beetle, larva, and tip of posterior segment of beetle from beneath. (Forbes.)

TREATMENT—*Beetles*: Luring by means of lights into tubs with kerosene and water. The only objection to this is that many beneficial insects are also destroyed.[1] *Larvæ* Liberal sprays of kerosene emulsion, where they are affecting lawns; heavy potash fertilizers; allowing poultry to follow after the plow in breaking sod; letting hogs run in grass land before plowing; rotation of crops, frequent breaking of meadow lands.

Grasshoppers (*Melanoplus* species, *Schistocerca americana,* and others, Figs. 67, 68) — Numerous species, attacking all kinds of plants. There is no need

[1] See under Codling-moth, page 172.

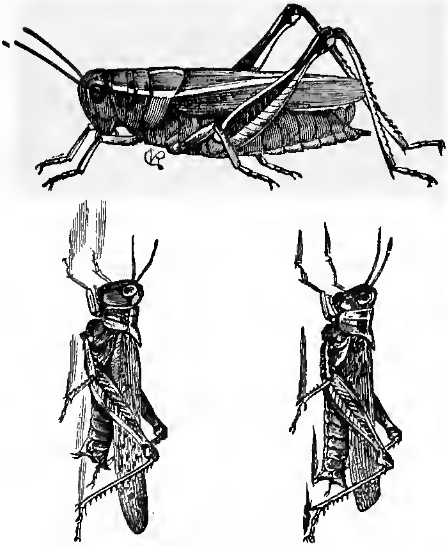

FIG. 67. Above — Two-striped Grasshopper, *M. bivittatus.* (After Riley.) At right—Common Red-legged Grasshopper, *M. femur-rubrum.* At left — The Rocky Mountain Locust, *M. spretus.* (Forbes.)

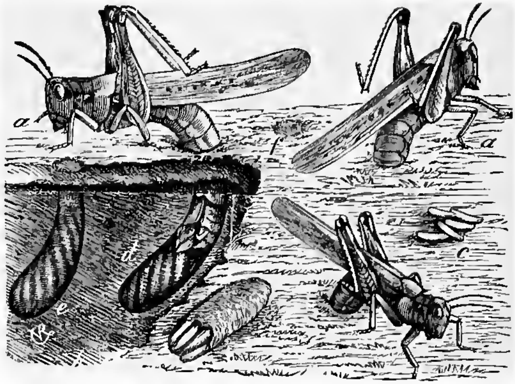

FIG. 68. Rocky Mountain Locust: *a*, female ovipositing; *b*, egg-pod removed from ground, end broken away showing eggs; *c*, eggs; *d*, *e*, egg-masses in ground; *f*, egg-mass completed and covered. (Riley.)

to describe these well-known pests. The figures given show in one instance the manner in which the grasshoppers deposit their eggs, and, in the other, three of the more important grasshoppers. The Rocky Mountain locust (*Melanoplus spretus*) has often caused an immense amount of damage in the regions it frequents — from the Mississippi westward to the mountains and from Canada south to Kansas. The other two species are well distributed over the country.

TREATMENT — Protect the insect-eating birds; place poisoned bait near crops to be protected; burn over stubble ground or roll hard ground in early spring to destroy the young. Where fighting on a large scale is needed, what is known as the "hopperdozer," Fig. 69, will be found the most successful means of destruction. This is made from 8 to 10 feet long, a foot wide, and an inch deep, set on runners, and provided at the back with a screen a foot high against which the "hoppers" strike and fall back into the pan. The pan

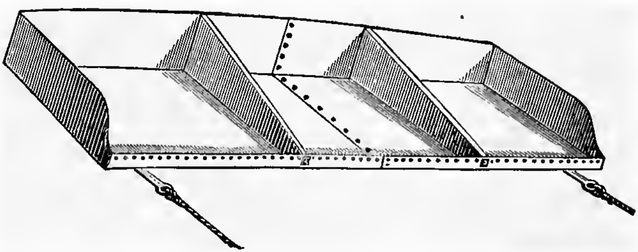

FIG. 69. Large Hopperdozer. (After Riley, United States Department of Agriculture.)

may be made of sheet iron and the screen of canvas. Put crude petroleum in the pan and smear it on the canvas; then hitch a horse to the machine and draw it through the fields where the grass-hoppers are abundant. They will jump up and either strike the screen and fall into the pan, or fall directly into the latter. Many will jump out again, but if they were even slightly wet with the coal-oil they will die. Tar may be used instead of petroleum for the screen and coal-oil on water for the pan.

Cutworms (*Agrotis ypsilon*, Fig. 70, *A. annexa, Peridroma saucia*, and many others)—All states. Though the life histories of the various species vary more or less, their general life is the same. Adults are moths with dark fore-wings and light hind-wings, as may be seen in the illustration. They feed at night, sucking nectar from various flowers. As a rule there is but a single brood of worms in a season, though a few species have two. Female moths lay their eggs on stones, leaves, sticks, etc., wherever there is plenty of vegetation, usually in midsummer; larvæ feed until winter, when they form an oval cell in the earth and curl in it

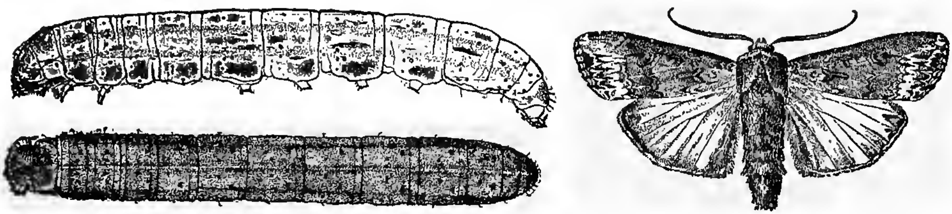

FIG. 70. Greasy Cutworm, *Agrotis ypsilon*. Side and upper views of larva and adult moth. (Forbes.)

until spring. Then they come forth and do the noticeable damage. They are rapid, voracious feeders, especially when attacking young crops. When full grown a cutworm is of a dull brown, gray, or greenish hue, usually marked with darker longitudinal lines, stripes, or dots. The head and next segment are reddish-brown and horny. When full grown the larvæ enter the ground and pupate, the moths soon after appearing and laying their eggs. Some species vary from the above history by laying the eggs early in spring and hibernating in the pupal or adult state.

TREATMENT—Plow land during midsummer or early fall, the sooner after midsummer the better. This treatment will cause many young larvæ to perish from lack of food. Thorough cultivation of the land in spring is good practice. The most successful remedies found have been the use of poisoned baits, especially the poisoned bran mash. Put this in field where plants are to be set, a tablespoonful near each hill, keeping chickens out of the field for several days.

Tobacco Stalk-worm or Corn-root Webworm (*Crambus caliginosellus*)—Some of the Atlantic States. Larva works in the stalk or at base of stalk near surface of ground; plant soon wilts and dies. Where larger plants are attacked, stalks may be hollowed out to the first leaves. Several larvæ often work on a single plant.

TREATMENT — Avoid planting on grass or timothy sod land. Advisable to put grass land in wheat, and then clover before tobacco.

Horn Worm or Tobacco-worm (*Protoparce celeus,* Fig. 71, *P. carolina*) — First named occurs in northern United States; the other species, in the South. Insects hibernate in pupal state; moths emerge early in spring, laying

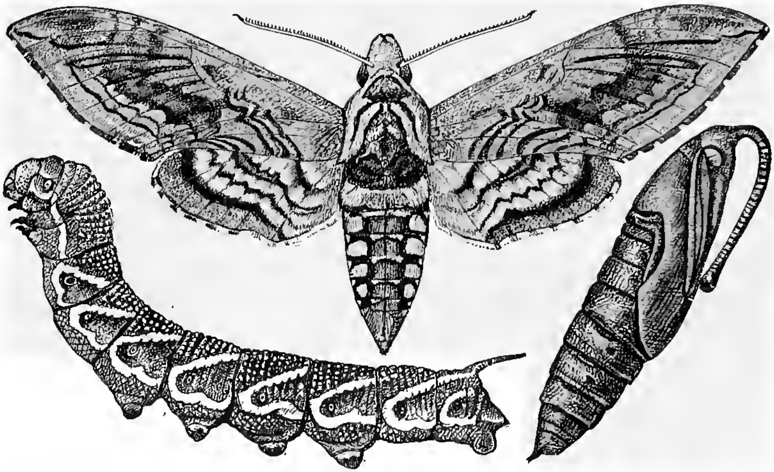

FIG. 71. Northern Tobacco-worm: adult moth, above; full-grown larva, at left; pupa, at right. All natural size. (From Howard, United States Department of Agriculture.)

eggs singly upon lower surfaces of leaves. During larval growth, which occupies about three weeks, they consume a great quantity of food, attaining a length of over two inches. Grown worm is green with oblique white stripes on the body, and a red or black "horn" prominent on posterior end. Moths are night-fliers, dark colored, with orange spots on sides of body.

TREATMENT — Hand-picking is most successful. Jimson-weeds may be used as means of poisoning the moths. Insects visit these at night for the nectar, and a solutiou of cobalt (1 ounce), molasses (½ pint), and water (1 pint) can be placed in the flowers. Spraying with Paris green has been found successful in Kentucky, and tests show that there is not enough poison left on the leaves to injure the consumer.

Tobacco Flea-beetle (*Epitrix parvula*) — All tobacco states. Minute, oval, reddish-brown beetle. Injury is done by adult beetle, holes being gnawed in leaves until they sometimes appear as if peppered with fine shot. Injury especially severe to young plants. Larvæ have been ascertained (Chittenden) to feed on the roots of common nightshade and jimson-weed.

TREATMENT — Bordeaux mixture has been found very successful. Spraying with Paris green will keep beetles in check on young plants.

Tobacco Bud-worm (*Heliothis armiger, H. rhexiæ*) — The latter, south of Maryland; the former, the ordinary corn-ear-worm in all tobacco states.

Larvæ of these two insects are very much alike, but the adults are readily distinguished. Eggs deposited in the buds; young larvæ do serious damage by feeding on the unrolled leaves. Later, as leaves become larger and worms grow, large holes are eaten, thus ruining tobacco for the best grade. The later broods seem to prefer unripened seed-capsules. Adult of *H. rhexiæ* is the smaller, and has green or dull sea-green wings, crossed by three white bands.

TREATMENT — Clean cultivation; arsenical sprays. Placing poisoned corn-meal on buds after heavy rains has been recommended.

Tobacco Suck-fly (*Dicyphus minimus*) — Southern States only. A small bug that sucks sap from leaves, causing them to turn yellow, wilt, and split. Adult, a small black bug with long, yellowish green legs, under side greenish, and a yellow line just back of head.

TREATMENT — Spray insects with "Nikoteen," one part to 60 gallons water, or with some other tobacco decoction. Clean up and burn trash in fields in fall.

Cigarette Beetle (*Lasioderma serricorne*) — Southern States, and well-warmed warehouses farther north. Damages cigars and cigarettes by boring into them; the leaves by puncturing them; fillers and fine-cut by actual feeding and offensive admixture.

TREATMENT — Cleanliness; whitewash woodwork, and fumigate with carbon bisulphide.

Cotton-worm (*Aletia xylina*) — Cotton-growing regions of United States and other American countries. Hibernates as a moth and lays eggs singly on leaves to number of 500 or less. Larvæ, greenish yellow worms, slightly hairy, growing to be fully an inch in length. Late in summer they pupate in leaves, emerging in fall as dull olive-gray moths an inch or more in wing expanse.

TREATMENT — Apply Paris green or other arsenite dry to leaves. Readily done by fastening a sack of cloth ("8 oz. Osnaburg" is recommended) containing the insecticide to each end of a pole and riding between rows on horseback, allowing it to be lightly jarred upon the leaves. The insect has many efficient parasites.

Cotton Boll-worm, Corn Ear-worm (*Heliothis armiger*) — For description see corn insects, page 147.

TREATMENT — The treatment given for the cotton-worm will aid. Late fall plowing to destroy pupa, trap crops of corn in the cotton field, and poisoned baits have all been used with varying success. Early varieties are often exempt.

Caterpillars and Cutworms (several species of each) — These as a rule do but slight damage. Caterpillars may usually be destroyed by spraying operations recommended for cotton-worm. Cutworms can be most easily handled by means of poisoned baits of clover or grass.

Mexican Cotton-boll Weevil (*Anthonomus grandis*, Fig. 72) — This dangerous enemy of the cotton-grower was imported from Mexico about 1893. It has spread over most of Texas and the invasion of other cotton-growing states seems only a question of time. Adult, a small gray snout-beetle ($\frac{1}{5}$ inch) which punctures and lays eggs in cotton bolls and "squares." Young buds usually fall off, and weevils then finish growth on ground. Those that remain on plant feed in bolls and effectually destroy their value. Larva matures and becomes a beetle in about four weeks from the egg. Hibernates as an adult in sheltered places in fields and timber.

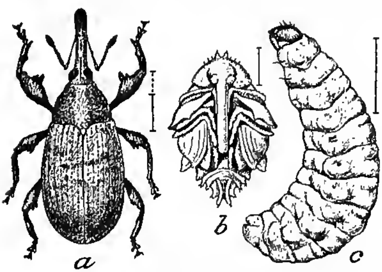

FIG. 72. Mexican Cotton-boll Weevil: *a*, beetle; *b*, pupa; *c*, larva. All enlarged. (From Howard, United States Department of Agriculture.)

TREATMENT — The planting of early varieties is possibly the most successful means of combating; hand-picking of beetles and infested squares will also aid. Plants should be cut up or plowed out and burned as soon as possible after crop is gathered, at least by October, thus killing many adult beetles before they leave plants for other hibernating places.

Plant-lice (*Aphis gossypii*) — Seldom of enough importance to justify treatment, the hardy and quick growth of plants overcoming any injury. However, a treatment of kerosene emulsion may be given when thought necessary.

Grasshoppers (several species) — Poisoned bran mash has been found very effectual in dealing with grasshoppers, and the hopperdozer might be used to advantage in thinning their numbers in adjoining grass or grain fields.

Leaf-hoppers, "Sharp-shooters" — These are sucking insects and have been known to injure young bolls severely. Thorough spray of strong kerosene emulsion, applied *not to the cotton plant but to the trees surrounding*, has been recommended. The young of these insects live on shade trees in early spring.

Hop Plant-louse (*Phorodon humuli*) — All hop regions, attacking hop plants and plum-trees. This plant-louse has what is called an "alternate food plant" — the plum-tree — upon which the winter and spring are passed. Louse spends summer on hop-vines, increasing greatly in numbers and doing much injury by sucking juices of plants. Lice fly to plum-trees as soon as hop-vines mature and die. Here eggs are laid, and in spring several generations appear and mature before plant-louse again returns to hop plant. The winged forms develop only at the time of the migrations.

Treatment — Destroy all wild plum-trees in vicinity; spray domestic trees in fall or spring with strong kerosene emulsion; spray hop-vines with same and destroy vines as soon as possible each year.

Hop-vine Borer (*Hydrœcia immanis*) — States east of the Mississippi River. Eggs laid on tip of vines just as they begin to climb. Larva bores into vine and later drops to the ground and bores into stem, emerging under ground and feeding on flowing sap. Injury recognized by vine growth stopping, the tips hanging limp soon after pest begins its work.

Treatment — Pinch off and burn "muffle-heads" when vines are tied, and early in June expose roots as far as junction of new vine with old, and apply a handful of ashes.

For mildews affecting hop-vine apply Bordeaux mixture as often as may be necessary.

(b) IMPORTANT DISEASES OF FIELD CROPS

General Treatment for Grain Smuts — It has been found that the grain smuts, at least of barley, oats, rye, and wheat, survive the winter on the seed of these grains; and hence any method whereby the spores can be destroyed without affecting the germination of the seed will be more or less successful in preventing the disease in the fields. The following treatments are those recommended:

Modified Hot-Water Treatment — For *barley*, *oats*, and *wheat*, soak seed, enclosed in sacks, four hours in cold water; remove, wait four hours, then dip in hot water at 133° F. for five minutes; dry and plant. Water should be at 130° only, for *barley*, according to Selby (Ohio Bulletin 121).

Formalin Treatment — For *oats*, *rye*, and *wheat*. Sprinkle seed with a preparation of formalin and water — 1 pint formalin to 50 gallons water. Shovel seed over several times and cover with a blanket or heavy canvas for several hours. Plant soon after treatment. Grains may be sprayed with the formalin as they are being put in the drill, but it is not so successful a measure.

Barley Smuts (*Ustilago Hordei*, *U. nuda*) — All barley regions. Known also as the covered and the naked barley smuts. The spores of the latter may be scattered by the wind.

Loose Smut of Oats (*Ustilago Avenæ*) — One of the most destructive smuts, the estimated loss from it in the United States being $18,000,000 annually. Where fields are affected, the spores by harvest time have often blown away to other heads, leaving large areas of affected heads entirely bare.

Rye Smut (*Urocystis occulta*) — Attacks leaves and stems. It has been recommended that the seed be treated with hot water (127° F.) for five minutes, and then dried and planted.

Loose Smut of Wheat (*Ustilago Tritici*) — This smut has no fetid odor as has the following species. It attacks both kernel and chaff, converting the head into a mass of spores.

Stinking Smut of Wheat (*Tilletia fœtens*) — The spores of this smut have a fetid odor, and a small quantity of infected grain will contaminate a whole bin-full, often making it useless for milling. Wheat attacked by this species grows as tall as unaffected grain. The kernels only become diseased, and usually all in the head will be affected. Granaries and implements may be disinfected with copper sulphate (2 pounds to 10 gallons of water), articles treated being sprayed or washed.

Wheat Rust (*Puccinia graminis, P. rubigo-vera*) — The only chance of prevention for this disease yet known is to plant resistant varieties and *keep farm clean of volunteer wheat.*

Corn Smut (*Ustilago Zeæ*) — This wide-spread disease attacks the ear, tassels, leaves, brace-roots and sucker-shoots, and produces the well-known black lumps on corn in the field.

TREATMENT — Cutting and burning the smut bolls before they burst will aid in its control. Every possible means should be used to control this disease, as it seems to be constantly growing worse.

II. GARDEN CROPS

(a) IMPORTANT INJURIOUS INSECTS

Variegated Cutworm (*Peridroma saucia*) — Occurs throughout the United States and attacks a very large variety of plants. Chittenden, in writing on the species in 1901, enumerated over fifty different food plants. This insect, in life history, is similar to other cutworms, the species usually hibernating as a larva, though in some localities it has been found in the winter as a pupa. The larvæ on coming from winter quarters will attack any garden plant, several weeds, some field crops, and even shade and fruit trees. This species has a number of insect enemies, and birds of several species feed upon it. The full-grown larva when first hatched is a decided green, with black head. It measures at maturity about $1\frac{3}{4}$ inches in length, and varies in color from very pale forms with faint markings to dark or dull brown mottled with gray or smoky black; along the sides of both forms, undulating velvety black lines. Moth has pale grayish brown fore-wings (darker at outer edges) and pale hind-wings.

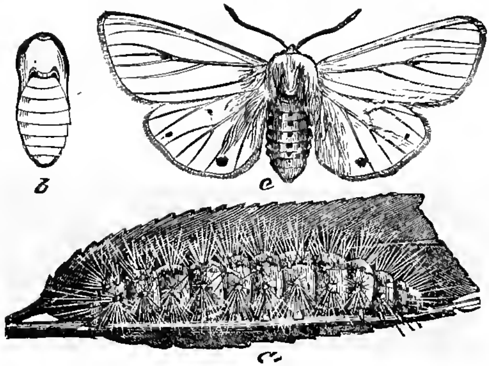

FIG. 73. Yellow Bear: *a*, larva; *b*, pupa; *c*, moth. (Forbes.)

TREATMENT — Poisoned baits, such as clover or pigweed, or the poisoned bran mash. Apply before planting if possible. Plants may also be protected with paper or tin cylinders.

Yellow or Woolly Bear (*Spilosoma virginica,* Fig. 73) — Occurs in all states, being one of the commonest of our pests; attacks all classes of vegetation. Caterpillars, large, dark red, and hairy; moths have yellowish white wings and yellow spots on body.

TREATMENT — Arsenical sprays and hand-picking.

Common Asparagus-beetle (*Crioceris asparagi,* Fig. 74) — New England and Middle States and as far west as Northern Illinois. Adult beetles hibernate, lay eggs on asparagus shoots early in spring, and also feed on them. Young larvæ upon hatching are slimy greenish slugs with black dottings and black head and legs. They do great damage to young plants. The beetles are about $\frac{1}{4}$ inch long; wing-covers black, with red or yellow markings; thorax red, with black dots.

TREATMENT—Dust young plants, when wet with dew, with plaster of Paris mixed with some arsenical poison; in hot weather simply brush larvæ from plants; allow fowls to run in beds; leave a few shoots when marketing, as the beetles will deposit eggs on these, which then may be cut down and destroyed.

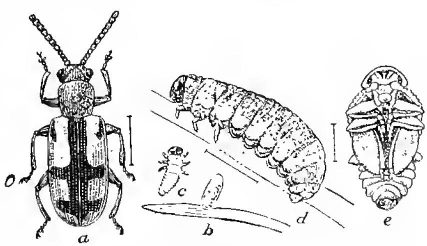

FIG. 74. Common Asparagus-beetle: *a*, beetle; *b*, egg; *c*, newly hatched larva; *d*, full-grown larva; *e*, pupa. All enlarged. (Chittenden, United States Department of Agriculture.)

Twelve-spotted Asparagus-beetle (*C. duodecempunctata*) — Middle States. Larva much like that of previous species; beetles red, with twelve black spots.

TREATMENT — Same as for common asparagus-beetle.

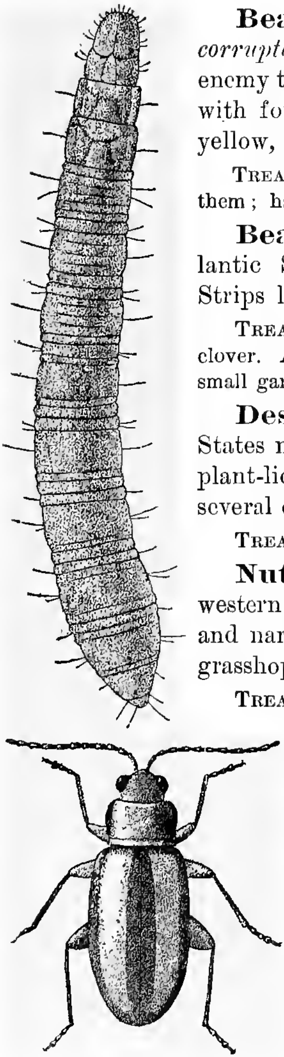

Fig. 75. Pale-striped Flea-beetle. Adult below; larva above. (Forbes.)

Bean Ladybird, Western Bean-beetle (*Epilachna corrupta*) — Western States; is working its way eastward. Serious enemy to bean crop in West. Beetles ¼ inch long, yellowish brown, with four black spots on each wing-cover; larvæ slug-like and yellow, feeding on under side of leaf; eggs laid in same place.

Treatment — Kerosene emulsion under-spray will help in controlling them; hand-picking still better.

Bean Leaf-beetle (*Cerotoma trifurcata*) — Gulf and Atlantic States. Somewhat resembles striped cucumber-beetle. Strips leaves, except midrib and larger veins.

Treatment — Clean culture, destroying especially all tick-trefoil and bush clover. Arsenical spray harmless to plant if used very early; hand-picking, in small gardens, successful, as beetles, larvæ, and eggs may be secured.

Destructive Green Pea-louse (*Nectarophora pisi*) — States north of North Carolina and east of Wisconsin. Greenish plant-lice, occurring in great numbers on peas, some clovers, and several other crops. They multiply very rapidly.

Treatment — Brush vines and follow up with cultivator to bury the lice.

Nuttall's Blister-beetle (*Cantharis nuttalli*) — Northwestern States. Bright metallic-green or blue-green beetle, elongate and narrow. Sporadic in attacks, usually most abundant after a grasshopper year; feeds on all legumes and some other plants.

Treatment — Larvæ of this beetle feed on the eggs of the Rocky Mountain locust and do much to hold it in check; unless very destructive it might be good policy not to destroy them. Can be controlled by beating into pans of kerosene and water or by driving from the fields, going up and down the rows, brushing the plants always in the same direction. This treatment will serve for all blister-beetles.

Pale-striped Flea-beetle (*Systena tæniata*, Fig. 75) — From New York to Colorado. Feeds on beets and many other plants in the garden.

Red-headed Flea-beetle (*Systena frontalis*) — East of Rocky Mountains. Feeds on several garden plants, including beets, and on gooseberry, grape, and pear among cultivated fruits. Flea-beetles eat small ragged holes in the leaves of the plants on which they are feeding, and often do considerable damage. The larvæ have been found feeding on the roots of wild plants, and in one instance in Illinois those of the pale-striped species on the roots of corn. The life history of the red-headed flea-beetle is not yet known. The adult has been found feeding on smartweed.

TREATMENT — Arsenical sprays or Bordeaux mixture will control beetles when found on the leaves.

Beet Aphis (*Pemphigus betæ*) — Washington, Oregon. Has done immense damage on the Pacific Coast. Insect is small, pale yellow or whitish, and covered with a flocculent mass much like the covering of the woolly aphis. Infests several wild plants; yarrows, knot-weed, and grasses — both native and introduced.

TREATMENT — In districts where present do not put beets on new ground nor continue beets in ground where it has appeared.

Sugar-beet Webworm, Garden Webworm (*Loxostege* species) — These webworms are widely distributed. They feed on the leaves of many garden plants, each individual under a separate web.

TREATMENT — Arsenical sprays will control them, as the web is not dense enough to prevent entrance of poison.

Zebra Caterpillar (*Mamestra picta*, Fig. 76) — Distributed over United States, and quite common on garden crops. Brilliantly marked with black and yellow and has a red head. Dr. Forbes has recorded about forty food plants for this species, including garden and field crops, ornamental plants, and trees.

TREATMENT — Arsenical sprays will control this insect. Where arsenites are not desirable, use pyrethrum or hellebore, dry or mixed with water.

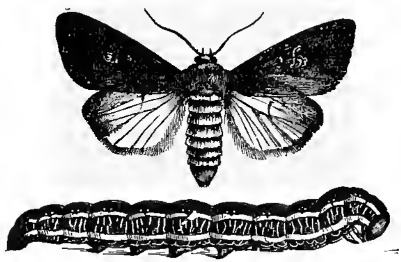

FIG. 76. Zebra Caterpillar. Larva and moth. (From Riley, United States Department of Agriculture.)

Cabbage Butterfly (*Pieris rapæ*) — Almost all the states. Larva, well known as a cabbage feeder, living on and in the head and eating large holes in the leaves; pure green and sparsely hairy. Adult, a white butterfly, commonly seen in gardens.

TREATMENT — Catch butterflies with a net. Dust plants with lime, or spray young cabbage plants with arsenites; older ones may be treated with hellebore.

Harlequin Cabbage-bug (*Murgantia histrionica*) — Probably occurs in all states, especially east of the Rocky Mountains. Brilliantly marked with red and yellow. In South very destructive to cabbage, sucking sap from leaves and stems.

According to most anthorities there are a large number of broods each season. They hibernate as adnlts.

TREATMENT — Hand-picking is usually successful; spraying with pure kerosene has also been tried with good results where bugs are gathered on trap crops of mustard planted along the gardens.

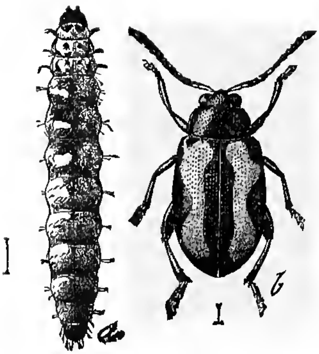

FIG. 77. Cabbage Flea-beetle: *a*, larva; *b*, beetle. (Riley.)

Cabbage Flea-beetle (*Phyllotreta vittata*, Fig. 77) — Many states. Especially destructive in larval state to cabbage, turnips, and radishes, feeding on roots; beetles also do appreciable damage by riddling the leaves with holes. Adult beetle about $\frac{1}{10}$ inch long, black, with two yellowish stripes which are sometimes broken into four yellow spots. Hibernates in this stage in sheltered places in fields.

TREATMENT — Endeavor to control beetles with arsenical or Bordeaux sprays. Destroy all leaves and rubbish in fields in fall.

Striped Cucumber-beetle (*Diabrotica vittata*, Fig. 78) — All states east of Rocky Mountains. Attacks melon, cucumber, and squash vines in both larval and adult stages. Many other plants are fed upon by the beetle. Larvæ are subterranean, feeding on roots of plants of the cucumber family; adults have been fonnd feeding on beans, peas, and ripe apples, on leaves, silk, pollen and unripe kernels of corn, and on several wild plants. Beetle is yellow, striped with black; hibernates.

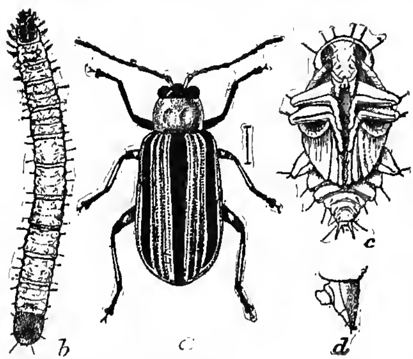

FIG. 78. Striped Cucumber-beetle: *a*, adult; *b*, larva; *c*, pupa; *d*, last segment of larva. (From Chittenden, United States Department of Agriculture.)

TREATMENT — Arsenical sprays must be used very early, as later the beetles seem to feed but little. Trap crops of early squash may be used to protect cucumber plants, or plants may be covered with netted boxes until they are well out of the ground; plants may be treated with Paris green either wet or dry. If trap crops are used, plant main crop as late as possible.

Squash-bug (*Anasa tristis*) — All states north of Virginia; farther west extends more to the south. Attacks all members of the cucumber family and some other garden plants. Adult bugs are popularly known as "stink-bugs." They are grayish brown, $\frac{3}{4}$ inch long; young bugs are greenish, and infest under side of leaves, sucking juices and causing them to wilt. Adults attack not only leaves but tender stems and lay eggs in masses on under side of leaves.

TREATMENT — Place chips or other shelters near vines and collect and kill bugs found beneath them. Look plants over twice a week and crush brownish egg-masses on under surfaces.

Squash-vine Borer (*Melittia satyriniformis*) — Quite widely distributed. Larva of one of the "clear-wing" moths. Eggs are laid on stems of young vines, especially near roots, about time vines begin to run; young larva bores into stem and devours interior. When full grown it is nearly or quite an inch long, tapering toward each end. It is whitish, semitransparent, and soft; head a dark brown. Larva leaves plant when full grown and forms cocoon in earth near by, where it remains until following season, when moths appear and lay eggs. Attacked vines droop, look sickly, and eventually die.

TREATMENT — When vines are first attacked cut out worms and destroy, else there is no chance to save plant. A good preventive is to bank up young vines with earth as far out as the first blossoms.

Pickle-worm (*Margaronia nitidalis*) — Melon and cucumber regions. There are two broods each year, the second wintering as pupæ in ground. Moths, having yellowish brown wings with purple reflections, lay eggs on vines and young fruit in early spring; larva eats hole in fruit, thus working its way inside. When full grown it is translucent, yellowish white, tinged with green, with yellow head, and is an inch, or more, long.

TREATMENT — Destroy larvæ by hand-picking; destroy infested fruit by gathering and feeding to hogs or by scalding.

Potato Stalk-borer (*Trichobaris trinotata*, Fig. 79) — Maryland, westward to Missouri and perhaps farther. These small ashen gray beetles appear early in spring and puncture base of potato stem, hollowing out small cavities and laying in each one a single egg. The grubs which hatch are white, with brown heads, and burrow in stalk or branches from early August to September. They pupate near the stalks close to the surface of the soil, and the beetles soon emerge and hibernate in pupal cell.

The larva of a moth (*Hydrœcia nitela*) also bores into potato stalks.

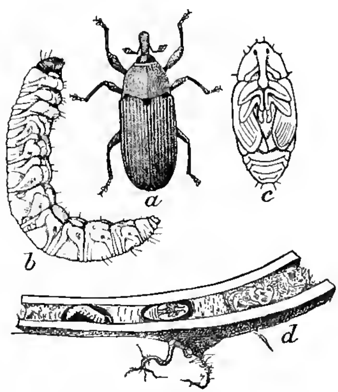

FIG. 79. Potato Stalk-borer: *a*, beetle; *b*, larva, from side; *c*, pupa; *d*, section of potato stalk, showing larva and pupa within; *a*, *b*, *c*, five times natural size; *d*, natural size. (From Chittenden, United States Department of Agriculture.)

TREATMENT — Rake up and destroy all vines in the fall as soon as potatoes are dug. Keep down all weeds belonging to this family — horse-nettle, jimson-weed, etc. Use fertilizer to enable plants to mature crop.

Potato Flea-beetle (*Epitrix cucumeris*) — Many states. "This small, blackish, faintly shining, minutely punctured species lives as a larva, so far as known, only on roots of solanaceous plants — potato, tomato, eggplant, tobacco, etc." (Forbes.) The beetles feed on these plants and many others, almost all garden plants being attacked.

TREATMENT — Bordeaux mixture has proved a first-class repellant for flea-beetles of all kinds. Mixture may be prepared in usual way, and Paris green added to destroy other pests; coat vines well.

Striped Blister-beetle (*Epicauta vittata*, Fig. 80) — Florida to Canada, and west to Rocky Mountains. Attacks principally potato and tomato, but feeds on many other plants, cultivated and wild. Beetle is yellow, with four or six black stripes, and is well known to most farmers and gardeners; often called "the old-fashioned potato-beetle." Larva probably feeds on grasshoppers' eggs.

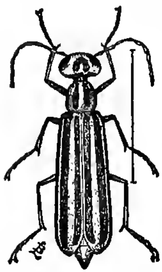
FIG. 80. Striped Blister-beetle. (Bruner.)

TREATMENT — Arsenites may be used, or the beetles may be driven from the fields as described under Nuttall's blister-beetle.

Colorado Potato-beetle (*Leptinotarsi decemlineata*) — All states; the worst of potato pests. Stout, yellowish beetle, with ten black stripes on wing-covers; lays orange-colored eggs beneath leaves. The reddish black-marked larvæ are voracious feeders. Several generations each year; hibernates in both pupal and adult stages.

TREATMENT — Hand-picking of eggs and insects. Thorough Paris-green spraying. Begin treating the pests as *soon as they appear*, and keep at it.

(b) IMPORTANT DISEASES OF GARDEN CROPS

Asparagus Rust (*Puccinia Asparagi*) — Generally distributed in Europe, but only recently reported from this country. Badly infested fields mature plants unusually early and the plants have a brown hue, as if sapped by insects or injured by frost. Rusted plants appear to have the skin blistered, and are brown beneath the ruptures, but other stages of this rust also occur in the fields.

TREATMENT — Bordeaux sprays appear to reduce affection about one quarter. (Halsted.) Burning rusted brush in fall is recommended. Mow field off clean, and burn all refuse and rubbish in the fall.

Brown Rot of Cabbage, Cauliflower, and Turnips (*Pseudomonas campestris*) — Eastern and Central States. Disease caused by bacterium which enters through wounds, is spread by transplanting from infested fields, or is carried by insects to plants. Diseased heads dwarf, rot, turn brown in places, and give off an offensive odor; stems often affected. Losses from this disease are at times large.

TREATMENT — Prevention is the only recourse. *Keep the insects down*; plant on new land and only from healthy seed-beds; avoid stable manures contaminated with cabbage refuse; keep tools clean; keep animals out of infested fields; destroy all mustard weeds; remove and destroy affected plants.

Beet Root-rot (*Rhizoctonia betæ*)—Some Eastern States. Leaves of attacked plants blacken at base and later fall; disease then works into the crown and root, causing them to crack; later they begin rotting. Whether this disease or another introduced through the cracks causes the rotting is not known.

TREATMENT — B. M. Duggar has recommended applying 60 to 70 bushels of air-slaked lime to acre before planting. He states that rot seems to work on soils lacking sufficient limy content.

Potato Scab — A well-known disease of the potato tuber. Organisms causing it usually found in soil on which potatoes have been grown the previous year.

TREATMENT — Soak seed potatoes in formalin solution (1 pint to 30 gallons water) for two or two and a half hours; then dry, and *plant on ground free from scab.*

Bacterial Rot of Onions, "Slippery Onions" — Outer or inner layers rot and leave contiguous layers sound. Damp or wet weather seems to favor disease; hence, clean cultivation, thorough drainage, and dry storage will aid in preventing it.

Downy Mildew (*Plasmopora Cubensis*) — Occurs in many states, but often not until late in the year. Attacks cucumbers and squashes. Angular yellowish spots appear on leaves, which turn yellow rapidly and die as if by frost. The mildew spreads very rapidly through the fields.

TREATMENT — Repeated applications of Bordeaux mixture at intervals of 8 to 10 days are recommended by Selby

Dodder of Cucumber and other Plants — Affected plants should be destroyed immediately upon appearance of the parasite.

Wilt Diseases — The various wilt diseases affecting cucumbers, melons, squashes, etc., are difficult to handle. Gathering and destroying infested vines, and waging successful war against insects, especially squash-bugs and cucumber-beetles, is good practice.

III. GRAINS AND SEEDS IN STORAGE

IMPORTANT INJURIOUS INSECTS

Some of the insects affecting stored grains begin their life history in the field; others, in the granary or warehouse. Preventive and remedial measures generally applicable are as follows:

General Treatment — Harvest as soon as grain is ripe; clean and fumigate granary before using; quarantine and fumigate infested grain; make bins as nearly air-tight as possible and fumigate with bisulphide of carbon. Heating seed-wheat to a temperature of 120° to 150° will destroy moths without injuring the germinating qualities of the seed.

Angoumois Grain-moth (*Sitotroga cerealella*, Fig. 81) — Very common throughout South and gradually working north; reported from Ohio and Pennsylvania. By far the worst granary pest known. The destructive caterpillar of this moth chiefly attacks corn (Fig. 82) and wheat. Eggs are laid in field on grains or in bin on the stored products. Moth is dull grayish brown with wing-spread of about ½ inch; caterpillar grows to be ½ inch long and is white with a yellow head.

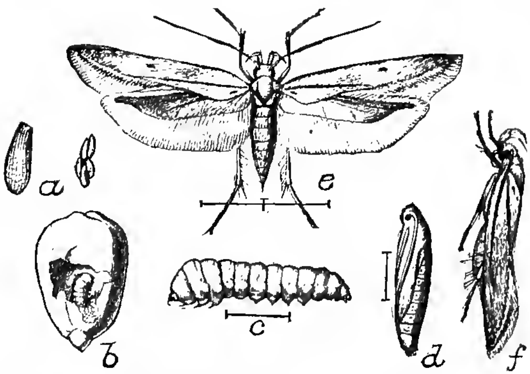

Fig. 81. Angoumois Grain-moth: *a*, eggs; *b*, larva at work; *c*, larva, side view; *d*, pupa; *e*, moth; *f*, moth, side view. (From Chittenden, United States Department of Agriculture.)

Indian-Meal-moth (*Plodia interpunctella*) — All states. The omnivorous whitish caterpillar of this gray or reddish brown moth lives in Indian meal and other cereals, dried fruits, English walnuts, etc. Kernels of grain are spun together with a web.

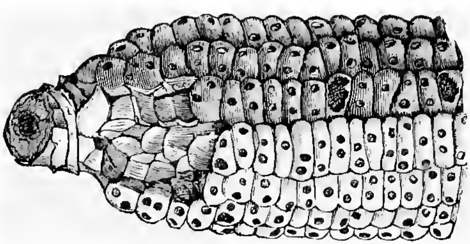
Fig. 82. Pop-corn showing work of Angoumois Grain-moth. (From Riley, United States Department of Agriculture.)

Mediterranean Flour-moth (*Ephestia kuhniella*) — Occurs along Atlantic coast and in Gulf States, Minnesota, Colorado, California, New Mexico, and doubtless other states; rapidly spreading. Moth has leaden gray fore-wings, with transverse markings and dirty white hind-wings. Caterpillar lives in flours and meals, spinning a web and making the mass lumpy; also feeds on honeycomb.

SPECIAL TREATMENT — Mills should be kept tightly closed at night and all incoming grain quarantined and fumigated.

Granary Weevil (*Calandra granaria*) — All states. Flattened, shining, chestnut-brown snout-beetle ($\frac{1}{8}$ to $\frac{1}{6}$ inch long). Punctures kernels of grain and inserts egg, or, in case of corn, several eggs, the larvæ feeding on interior of grain. Beetles do as much damage as larvæ, or even more, feeding on outside of kernels.

Saw-toothed Grain-beetle (*Silvanus surinamensis*, Fig. 83) — All states. Slender brown beetle ($\frac{1}{8}$ inch long), very common. Larva feeds on and infests cereals and dried foods.

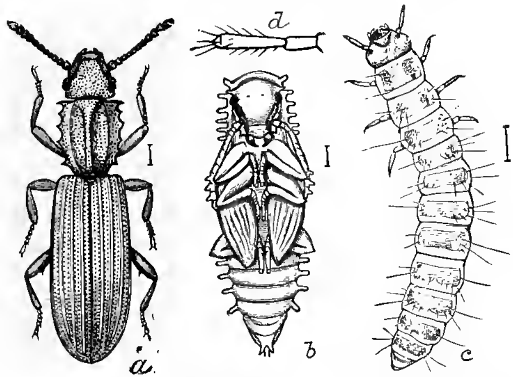

FIG. 83. Saw-toothed Grain-beetle: *a*, beetle: *b*, pupa; *c*, larva; *d*, larval antenna. All enlarged. (From Chittenden, United States Department of Agriculture.)

Confused Flour-beetle (*Tribolium confusum*) — Plump, shining, reddish brown beetle, less than $\frac{1}{4}$ inch long. Very prolific, causing much injury to flours, feeds, and prepared cereal foods.

Square-necked Grain-beetle or Cotton-beetle (*Cathartus gemellatus*) — Southern States and even as far north as New York. Glossy reddish brown insect. Breeds in the field in corn in the ear and in cotton in the bolls, and continues breeding in harvested crops. Feeds principally on germs of grains attacked.

Rice-weevil (*Calandra oryzæ*) — Many states, but especially destructive to rice in the South. Dull-brown beetle with four red spots on wing-covers. Feeds on soft wheat, corn, husked rice, etc.

Pea-weevil (*Bruchus pisorum*) — All states, attacking peas in storage and field. Beetle, a stout brownish or black insect, indistinctly marked with white. Eggs deposited on surface of pods. Larvæ bore into soft peas, and also live on stored peas. Beetles emerge in late summer or autumn, or in early spring before planting time.

SPECIAL TREATMENT — Keep seed peas in tight boxes over one season before planting; plant as late as possible; fumigate seed peas thoroughly; throw seed in water, and reject and destroy all that float.

Bean-weevil (*Bruchus obtectus*) — All states. Grayish brown beetle ($\frac{1}{8}$ inch long). Infests beans in storage, breeding there; often attacks other legumes.

Special Treatment — Same as for pea-weevil.

Cow-pea-weevil (*Bruchus chinensis*); **Four-spotted Bean-beetle** (*B. quadrimaculatus*) — Southern States, and west and north as far as Iowa. Resembles bean-weevil in habits and injurious work, and is amenable to same treatment.

IV. FRUIT TREES

The principal fruits grown in the United States that will be treated here in relation to the insects inhabiting them and the diseases affecting them are the apple, pear, peach, plum, cherry, and quince.

A brief statement of the general spraying treatment necessary for each will be given and the principal insects and diseases discussed. The scale-insect enemies will be treated as a group, separately.

Orchards of all kinds should be kept clean and free from rubbish, dead limbs, and old stumps. Care in pruning at the proper time and before the limbs get large will save many ugly wounds and prevent many diseases and insects from obtaining entrance to the trees.

THE APPLE

Spraying Calendar

The general spraying treatment required in the apple orchard, against both insects and fungi, may be summarized as follows:

Treatment	When to Spray	Against
1. Bordeaux mixture with Paris green.	Just as leaf buds expand.	Scab, canker diseases, leaf-spot, bud-moth, case-bearers.
2. Bordeaux mixture with Paris green.	7–10 days later, or just as blossoms swell.	Scab, leaf-spot, bud-worms, case-bearers, canker-worms, tent-caterpillars.
3. Bordeaux mixture with Paris green.	Just after blossoms fall.	Scab and other leaf diseases, canker-worms, tent-caterpillars, *codling-moth.*
4. Bordeaux mixture with Paris green.	10–14 days later.	Scab, leaf-spot, etc., codling-moth, palmer-worm, Bucculatrix, and leaf feeders.

The last spraying is often especially necessary after damp or wet weather. Some experiment stations recommend three sprayings before the one marked 3 in the calendar. This will depend somewhat on the weather and advancement of the season. For the apple scab another treatment may be necessary after the fourth given above — say, a week or ten days later.

For plant-lice, psyllids, and such leaf-sucking insects a 10 per cent. kerosene emulsion may be used, or, if applied before the leaves open out, it can be replaced by a stronger solution of whale-oil soap.

(a) Important Insects Injurious to the Apple

Woolly Aphis (*Schizoneura lanigera,* Fig. 84) — Thoroughly distributed over United States.

The plant-lice of this species are readily recognized on the trunk and limbs by the woolly secretion attached to their bodies. When abundant it appears bluish white, not unlike some molds, beneath which may be found a cluster of minute, dark plant-lice. Lice are usually most abundant on roots, but appear above ground on branches, trunk, and young shoots, often collecting in an old scar. On large and small roots alike, they form gall-like growths of all sizes; and by this fact and the smoothness of their galls these growths can usually be distinguished from those of the crown-gall. Fig. 85 shows galls of both kinds. Species multiplies through most of year by birth of living young from wingless females. In October, and later, winged females appear and fly freely, thus distributing the insect; females of next generation lay a single egg, and thus species is carried over winter.

Treatment — For the aërial form 10 per cent. kerosene emulsion, or whale-oil soap, 1 to 7, may be successfully used. For the root form, place powdered tobacco around the tree under the surface of the ground, or treat with carbon bisulphide (which see).

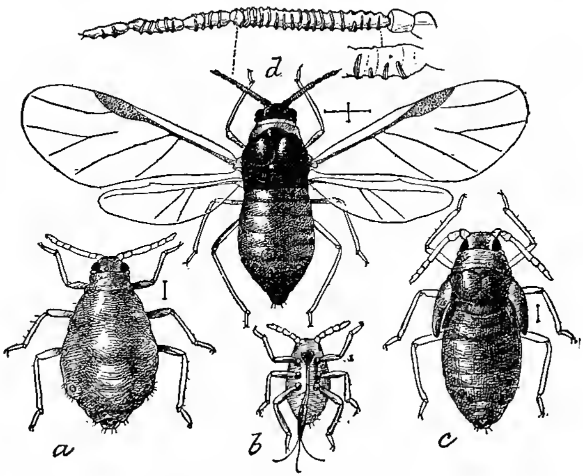

Fig. 84. Woolly Aphis: *a*, agamic female: *b*, larva; *c*, pupa: *d*, winged adult. (Marlatt.)

Apple-leaf Plant-lice (*Aphis mali*, and other species) —All apple-growing regions. On twigs of apple-trees in winter, especially on young stock, may be found oval shining black eggs, placed near buds along stem, in crevices of bark or on roughened places. Early in spring they hatch and young lice suck juices of young buds and unfolding leaves, arresting growth and causing them to curl. On young trees considerable injury is often done by preventing free growth of the twigs. The last generation of the year produces both sexes. These pair, and the eggs are laid for the succeeding spring's first brood. Some of the species live a part of the year on grains and grasses.

TREATMENT — Free use of 10 per cent. kerosene emulsion early in spring will aid in keeping these insects in check.

Apple Leaf-hoppers (*Typhlocyba mali*, and other species) — Several forms occur on apple leaves throughout United States. Leaf-hoppers are sucking insects. Adult is minute, slender, with narrow wing-covers, and tapering from the head back. Those found on apple leaves vary from bright green to yellow, and often have brownish markings. May usually be found in all stages at any time during summer, feeding on leaves, which appear spotted with white; rarely do serious damage.

TREATMENT — Kerosene sprays or other contact insecticides are the only means of combating these insects.

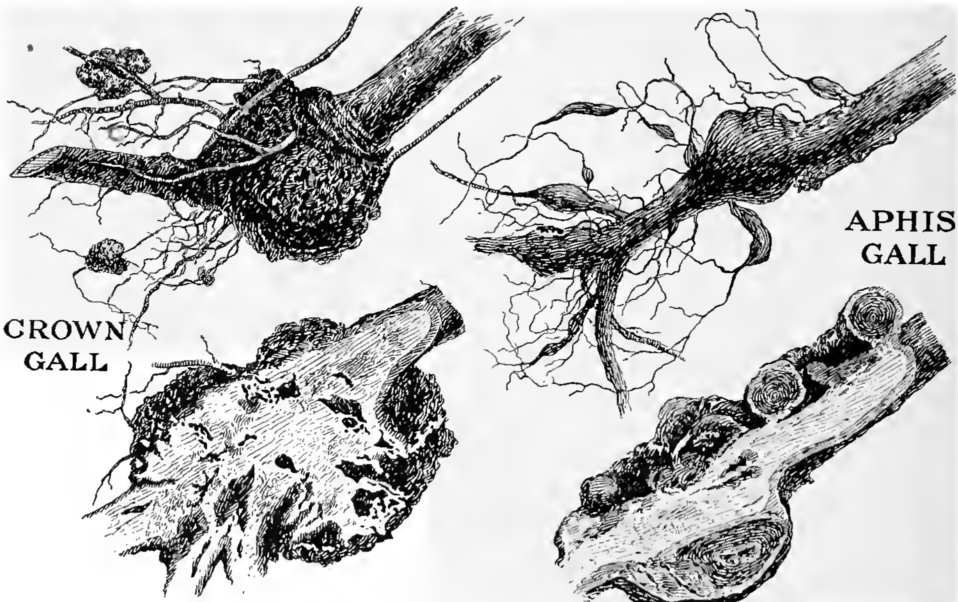

FIG. 85. Woolly Aphis and Crown-galls, exterior views and sections. (After Forbes.)

Flat-headed Apple-tree Borer (*Chrysobothris femoratus*, Fig. 86) — Larva has very flat head, wide, and with strong jaws; grows to about 1 inch in length. Beetle is bronze-colored, scarcely ½ inch long, with the head rounded and body tapering to a point.

TREATMENT — Borers may be dug out or killed by inserting a wire in the burrow. Preventive methods are undoubtedly best. Tarred paper, wire mosquito-netting, or even ordinary newspapers may be used to wrap around trunk of tree, extending from ground up for 18 or 20 inches. This must be tied tightly at top and mounded up with an inch or two of dirt at bottom.

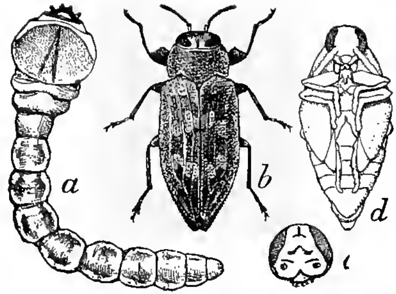

FIG. 86. Flat-headed Apple-tree Borer: *a*, larva; *b*, beetle; *c*, head of male; *d*, pupa. Twice natural size. (From Chittenden, United States Department of Agriculture.)

Round-headed Apple-tree Borer (*Saperda candida*, Fig. 87) — All apple-growing regions. Beetles are dark brown striped with white, and appear from late June to August; eggs are laid on bark, or in its crevices, close to surface of ground. Young larva lives a year in the sap-wood, and later bores into trunk, changing in spring of third year to adult beetle. Larva is legless, white, and distinguished from other apple-tree borers by its round head.

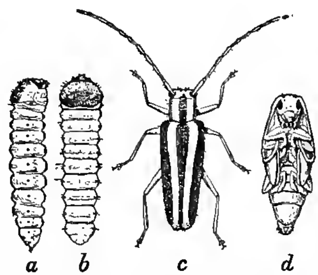

FIG. 87. Round-headed Apple-tree Borer: *a*, larva, from side; *b*, larva, from above; *c*, adult female; *d*, pupa. Enlarged one third. (From Chittenden, United States Department of Agriculture.)

Apple Twig-borer (*Amphicerus bicaudatus*) — Twigs are injured by a small beetle which enters near the bud and makes a channel several inches long; injury is done in winter or early spring. Larva lives full life in dead or dying green brier roots or in grape roots. Borers sometimes attack grape twigs.

TREATMENT — Clean up neglected brier patches and vineyards and burn refuse in fall.

Apple-tree Tent-caterpillar (*Clisiocampa americana*, Fig. 88) — New England, Middle and Central States; working on leaves of fruit trees. Egg-masses may be found during winter and spring on small twigs of trees, appearing as small belt of brown encircling twig. This mass when broken open is found to be a large number of eggs closely fastened together and covered with a varnish-like substance. Larvæ hatch early in spring before leaves open out, and as soon as feeding commences begin to spin a web or "tent" in smaller forks of tree; feed in

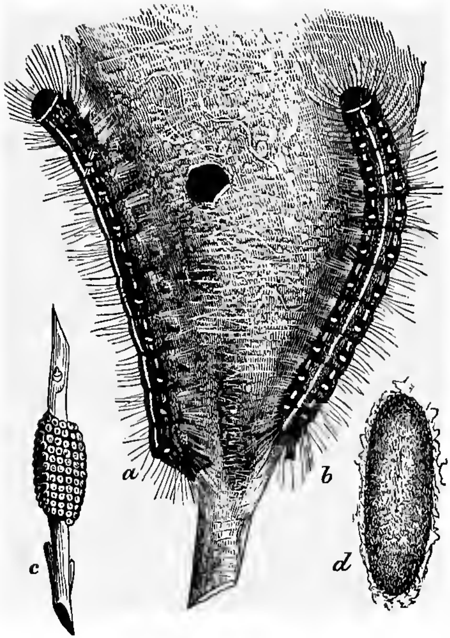

FIG. 88. Tent-caterpillar: *a, b,* larvæ on nest; *c,* egg-mass with gummy covering removed; *d,* cocoon. (Riley.)

colonies, and tent is enlarged, as larvæ grow, until it sometimes nearly envelops a small tree. Full-grown larva is about 1½ inches long, quite hairy, dull black, with white line down back and a series of white dots on each side. Cocoons are spun of thin yellowish silk and concealed in tree or in some sheltered spot near by. From these, in fall, emerge dull-reddish moths having two oblique pale stripes on the fore-wing. These soon lay eggs on twigs and life cycle is completed.

TREATMENT — Destroy egg-masses in winter and young nests in spring, burning latter with torch, or twisting them out and then burning. Branches around nest may be sprayed with an arsenite, which will prove effectual in killing worms.

Yellow-necked Caterpillar (*Datana ministra*) — Mississippi Valley and eastward. Eggs laid in masses in spring by brownish yellow moths on under side of leaves. Insect hibernates in pupal state and moths emerge early. Worms feed in colonies, but without forming any web or tent; grow to be nearly 2 inches long, have a black head and a yellow "neck," and are marked with yellow and black stripes. When not feeding they have a peculiar habit of clinging to the twig with their false legs, and throwing back both the head and anal end. Become full grown in late July or early August, and, descending to ground, pupate beneath the surface.

TREATMENT — Destroy colonies by hand when first noticed — several bare twigs near center of tree being usually the first thing to attract attention to them — and spray surrounding branches with a strong arsenite.

Fall Webworm (*Hyphantria cunea*) — United States generally; attacks both fruit and shade trees. Insect hibernates as pupa, emerging in spring as moth with very white wings, which sometimes bear scattering black spots. Eggs are laid on leaves or small limbs in quite large masses, and young larvæ make nest or web in which they stay when not feeding. As they grow older they separate more, and are able to defoliate a considerable area of the tree. They pupate in early summer, and the second brood does far more damage than the first. These pupate in fall and remain in cocoons over winter.

TREATMENT — Destroy webs when first seen; use arsenical sprays on trees affected. By keeping careful watch they can be controlled.

Leaf-crumpler (*Mineola indiginella*, Fig. 89) — Apple-growing regions, and especially in neglected nurseries and young orchards; attacks also most other fruits. Recognized in winter by presence, on twigs, of little irregular black masses, which prove on close inspection to be short-coiled tubes tightly fastened to twig. Early in spring larvæ in these tubes begin to feed on young leaves, later binding together a small bunch of leaves, often at end of branch. When very abundant they sometimes attack young fruit and the bark of tender twigs. Larva is reddish brown, with dark brown head; becomes full grown in latter part of May; and pupates within tube. In June a small gray moth emerges and begins to lay eggs. Larva upon hatching soon commences its case, and feeds on leaves throughout summer.

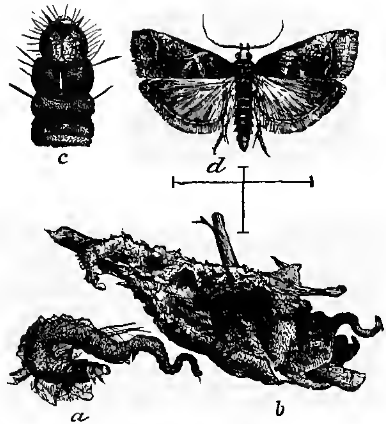

FIG. 89. Leaf-crumpler; *a*, tube of larva; *b*, cluster of tubes and leaves; *c*, head end of larva; *d*, adult moth. (Riley.)

TREATMENT — A single spraying with an arsenite applied when leaves are just unfolding will completely control pest.

Codling-moth or Apple-worm (*Carpocapsa pomonella*, Fig. 90) — Thoroughly distributed over United States. Common flesh-colored worm that is found in "wormy" apples; work so well known that it is not necessary to describe it. Pest hibernates as larva in tightly spun cocoon, hidden away in crevice of bark, under rubbish on ground, or in apple storage houses and cellars. Early in spring it pupates, and about middle of May moths commence emerging in time to lay eggs on the young fruit and leaves close by. Egg is a tiny, flattened, milk-white form, not commonly seen. Larva commences feeding by crawling into calyx-end of apple, thence boring its way to the center. From last of June and onward first brood become full grown; and soon pupate in crevices of bark. Moths emerge in a few days and lay eggs on apples. Larvæ hatching from these eggs rarely enter at end

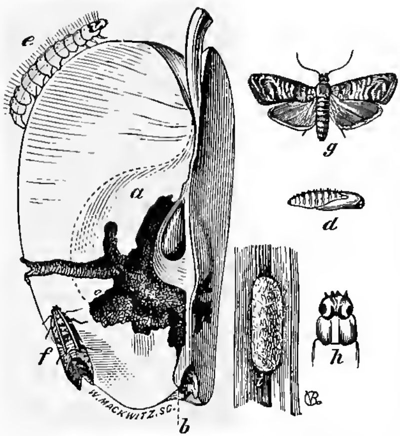

FIG. 90. Codling-moth: *a*, apple showing burrow; *b*, original entrance; *e*, larva; *d*, pupa, *f*, *g*, moth; *i*, cocoon. (Riley.)

of apple, but may bore in at any place. By first of August some of these are full grown, and descend to trunk of tree or to ground and spin a tight cocoon. There are but two broods in a year, the second brood hibernating as larvæ in tightly spun cocoons. Many worms are not full grown when apples are picked, and these thus find their way into storage houses or are shipped to other places.

TREATMENT — Spraying apple-trees immediately after the blossoms fall and before the calyxes of the fruit close, with a second spraying 7 to 10 days later with arsenites, will destroy most of these worms. In July trees may be banded with a piece of ordinary "gunny-sacking," 4 to 6 inches wide, which should be removed about every 10 days and worms destroyed. Storage houses and cellars should have screen doors and windows in order to prevent moths from escaping in the spring. Hogs allowed to run in orchard will destroy many worms in the fruit eaten. The "lantern-traps," and all the other so-called "moth-traps," in which lights are used to attract insects are of *no value* against the *codling-moth* or *plum curculio,* as neither is attracted by lights. In fact, the number of strictly beneficial insects caught by these "lantern-traps" is equal to, if not always much greater than, the number of injurious species captured. It will not pay the farmer to use them.

Green Fruit Worms (*Xylina antennata,* and other species)—Eastern and Central United States. Green or yellowish-green smooth worms which grow to a length of 1 to 1½ inches. Feed on young fruit of almost any kind, especially apple, peach, and pear. Hibernate as adult moths — dark, broad-winged night-fliers. Eggs are laid early in spring and young larvæ attack both foliage and fruit. Are full grown by middle of June and pupate in ground, moths emerging early in fall.

TREATMENT — Thorough cultivation late in summer may be of value in destroying the pupa; for the worms, jar from tree as for plum curculio. They seem to be able to resist the arsenites; probably because they eat but little of the surfaces treated.

Canker-worms, Spring (*Paleacrita vernata,* Figs. 91, 92) **and Fall** (*Anisopteryx pometaria*) — Distributed over United States, attacking fruit and shade trees, often causing serious damage. Early in spring, soon after leaves begin to put forth, small, green or dark green measuring worms may appear on trees, dropping to ground by a thread when disturbed. These pests, the canker-worms, usually occur in such numbers as quickly to defoliate a tree. They are full grown by middle or last of May, descend to the ground, and form cocoons several inches below surface. Fall species comes out late in autumn and lays eggs on trees, while spring species appears the first warm days in late winter or early spring. The two sexes of the moths are very different, the males having thin ashy-gray wings crossed by several lines and bars, while the females are wingless. Soon after emerging females crawl up trunks of trees and lay eggs on twigs, buds, and smaller branches.

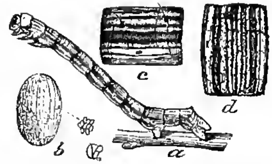

FIG. 91. Spring Canker-worm: *a*, larva; *b*, eggs; *c*, *d*, details. (Riley.)

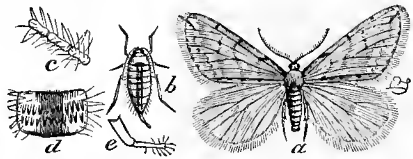

FIG. 92. Spring Canker-worm. *a*, adult male; *b*, adult female; *c*, *d*, *e*, details. (Riley.)

TREATMENT — Thorough spraying with arsenites early in spring will control this insect in orchards. The application should be made as soon as leaves begin to open, and, if necessary, another treatment should be given in a few days. (See under Shade-Tree Insects for other remedies.)

Pistol-case Bearer (*Coleophora malivorella*) — From Canada southward through Pennsylvania, and westward to Nebraska and New Mexico. Hibernates in its little case as a partly grown larva, attacking buds, leaves, and flowers in early spring. As it grows larger it builds on to the old case pieces of stems and leaves. It feeds openly, never mining the leaves as does the next species, but is most destructive to petals and stems of flowers. It pupates the last of May, and in a few weeks moths appear and lay cinnamon-colored eggs on the leaves. The young caterpillar hatches in about a week, beginning immediately to construct a case, and in September it migrates to twigs and fastens itself up for the winter.

TREATMENT — See under Bud Moth.

Cigar-case Bearer (*Coleophora fletcherella*) — Canada and Eastern United States, and perhaps to some extent in other states. This species, which bears a case having a fancied resemblance to a cigar, feeds on buds, leaves, and flowers of fruit trees. It hibernates in its case as a half-grown larva, the case being firmly attached to a twig. In early spring the insects commence feeding on most tender foliage, and as they grow larger discard their case and mine between the leaf surfaces. At times the larva feeds on young fruit, but after flowers fall it gets its food chiefly by mining the leaves. Pupation occurs last of June. Soon thereafter a tiny moth emerges and lays eggs among the leaf hairs. The caterpillars hatch in July, and soon construct the case in which they winter.

TREATMENT — See under Bud Moth.

Bud Moth (*Tmetocera ocellana*) — Probably occurs throughout most apple-producing states. During winter the larva lives securely fastened in a case concealed by a bud or rough place in bark; in early spring it comes forth and feeds on and in swelling buds and new leaves, tying them together with silk for a retreat, the dry brown leaves often being seen at the ends of the twigs. Larva dark brown, with darker head, being when full grown nearly ½ inch in length; pupates in May, the small, dark ashy-gray moth emerging early in June. Eggs laid by first of July; larvæ which hatch from them feed near tips of branches until hibernating time.

TREATMENT — For the last three pests foregoing — lesser apple insects, as they might be called — the same treatment can be applied — *early thorough arsenical spraying.* If buds are thoroughly coated with spray there will be but little trouble with these insects. The case-bearers may need a second treatment when flower buds are swelling. Do not spray open flowers.

Apple-leaf Bucculatrix (*Bucculatrix pomifoliella*) — Most Eastern and Northern States, and to a less extent in Central and Southern. Does but little damage as a general rule, though it may be found mining the leaves in early summer. Larva makes elongate white-ribbed cocoon and fastens it to branch of tree. Cocoons are often seen in fall and winter, and are sometimes objects of much concern to those who find them.

Apple-fruit Maggot (*Rhagoletis pomonella*) — New England, south to New Jersey, and westward at least to Michigan and Northern Illinois. Early in summer, from eggs laid by a small two-winged fly on the fruit, hatch small, white, footless maggots, which channel the fruit in every direction, utterly ruining it and causing it to rot and fall. Wherever the maggot occurs it is undoubtedly a serious pest.

TREATMENT — Destroy infested fruit by hand-picking or by allowing hogs to run in orchard. Thorough cultivation in fall may aid in checking the pest, as it pupates in ground.

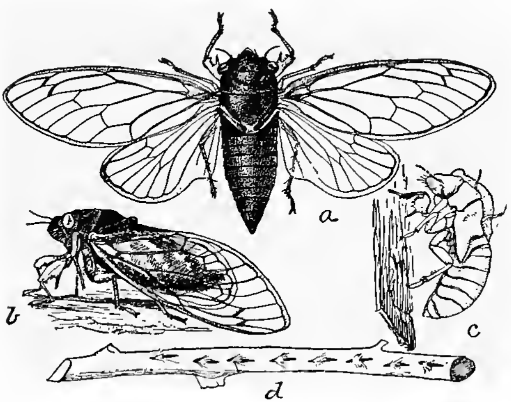

FIG. 93. The Seventeen-year Locust: *a*, adult; *c*, pupa from which *b*, an adult, has emerged; *d*, egg-punctures. (From Riley, United States Department of Agriculture.)

Seventeen-year Locust (*Cicada septemdecim*, Fig. 93) — Adults injure apple and many other trees and shrubs by laying eggs in tender twigs and smaller branches; larva, upon hatching from egg, falls

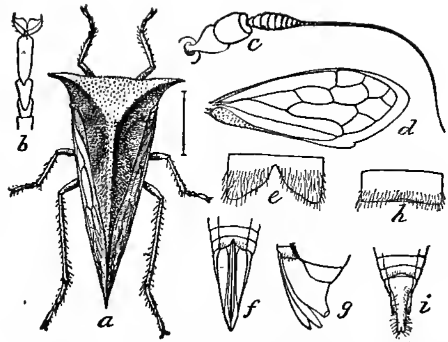

Fig. 94. Buffalo Tree-hopper: *a*, adult; *b*, *c*, *d*, tarsus, antenna, and wing; *f*, *g*, tip of abdomen, showing ovipositor; *e*, *h*, *i*, details. (From Riley, United States Department of Agriculture.)

to ground and burrows beneath soil, feeding on juices of roots; adult emerges in spring of seventeenth year after larva entered ground. Twigs in which eggs have been laid either break down later or become deformed in growth.

Treatment — There is no remedy for the trouble. It would be good practice to cut off the affected twigs, as they will never make healthy branches. Do not plant young trees the year a brood is to appear.

Buffalo Tree-hopper (*Ceresa bubalus*, Fig. 94) — This small grass-green insect often attracts attention by its triangular shape and leaping powers; may be seen on twigs and leaves of several orchard trees; damages apple twigs by laying eggs in slits in new growth.

Treatment — Insects difficult to combat; best remedy is vigorous pruning of affected twigs in fall.

Red Spider (*Tetranychus bimaculatus*, Fig. 95) — While this is not an insect it often occurs in countless numbers on trees in the orchard. The red spider is a small mite and feeds on juices of leaves of several trees and shrubs. On apple-trees they sometimes cluster in masses at base of larger limbs and on trunk, spinning a thick network of fine silken threads.

Treatment — Spraying thoroughly with ordinary cold water has been found beneficial.

(b) Important Diseases of the Apple

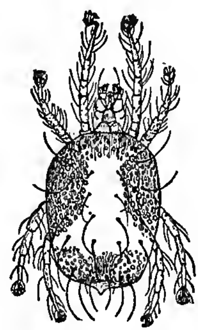

Fig. 95. Red Spider. Female; greatly magnified. (Harvey.)

Bitter-rot (*Gleosporium fructigenum*, Fig. 96) — A destructive disease, occurring over most of the United States, and at times causing immense losses in fruit. Disease may be readily recognized. It begins in the form of one or more small brown specks, which soon enlarge and become distinct dark-colored spots, circular and sunken; tissue beneath always remains dry and tough; numbers of pustules soon form over affected area, arranged in concentric circles and covering all but outer margin; pustules break and discharge a fine pinkish mass, which later turns ashy gray. The apples are affected with the disease throughout, and shrivel up into hard wrinkled bodies

FIG. 96. Bitter-rot canker. (Blair, Illinois Bulletin 77.)

known as "mummies," which sometimes remain on tree throughout winter and until late the following year. The disease lives over winter in the old dried fruits or in wound-like infected spots on limbs. It is distributed by means of spores carried from the mummies or cankers by splashing drops of rain, or by insects. The first infection of the year evidently comes from the cankers, and the spores are carried by rain drops to the apples below, thus spreading in a cone-shaped form.

TREATMENT — Disease travels slowly from orchard to orchard and even from tree to tree. Destroy every affected apple as soon as noticed, and search for and destroy the canker in the tree; look for these sources of infection just above the infected apples; remove and destroy all mummies. Disease can be kept in check by repeated applications of Bordeaux mixture.

Leaf-spot, Apple Blotch (*Phyllosticta pirina*) — Caused by fungi which attack leaves and sometimes fruit of apples and pears; appears on leaves soon after they unfold, in form of small reddish-brown spots, which later turn gray; often confused with "spray burn" which, however, leaves darker markings. On the fruit this disease occurs as small, black, irregular spots, a number of which often unite in a blotch; not known to do serious damage to fruit.

TREATMENT — Early Bordeaux spraying before leaves open, and again, if necessary, after fruit has formed.

Leaf-blight (*Entomosporium maculatum*) — Disease appears early, and much resembles the one just described; attacks quince as well as apple; leaves sometimes become so badly diseased that they fall.

TREATMENT — Spray early with Bordeaux, and if necessary several times, until August.

Apple Rust, Cedar Fungus (*Gymnosporangium macropus*) — Occurs wherever red cedars and junipers are grown; sometimes a serious pest on apple and quince.

On apple leaves this disease is first noticed in May or June, when bright yellow spots appear; fruit is often attacked in same manner; spots are caused by spores blown or otherwise carried from the common "cedar balls."

TREATMENT — Destroy surrounding cedar and juniper trees; or, if this is not desirable, pick off cedar balls in fall and burn them. Bordeaux spray on the cedars early in spring has been found in some cases quite effective.

Apple-scab (*Fusicladium dendriticum,* Fig. 97)—All apple regions. This fungous disease attacks both leaves and fruit of the apple and sometimes other fruits. On the upper surfaces of leaves irregular soot-colored spots are formed; on fruit the spots are at first of this same color, but later enlarge, get rough and black, check growth of apple, and cause it to become distorted and worthless as first-class fruit. Sometimes petioles and young twigs are attacked and even fruit stems injured.

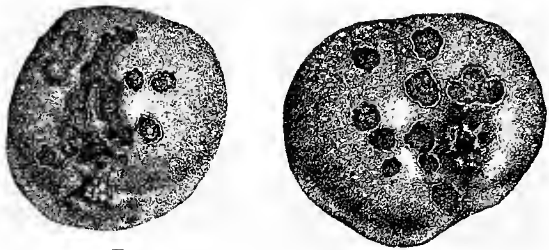

FIG. 97. Apple-scab on apples.

TREATMENT — While it is impossible to exterminate so wide-spread and common a disease, it can be thoroughly controlled by careful, conscientious spraying. Bordeaux mixture as the buds are swelling, just before the blossoms open, just after blossoms fall, 7 to 10 days later, and even again, if necessary, has been found to give best results. The last two sprayings may cause some burning of fair-skinned apples.

Crown-gall of Apple (Fig. 85)—Many portions of United States and spreading rapidly, being carried by infested nursery stock. The cause of the disease is not known but has been ascribed to some form of bacteria not yet isolated. It is a dangerous disease, and growers should be very careful to see that nursery stock is absolutely free from it. "It most commonly affects the crown of the tree, producing a dark, rough, abruptly protruding tumor, varying in size from a pea to that of the fist, or larger. A badly affected tree is likely to show signs of starvation, its growth ceasing and its foliage having a sickly yellow look. Young trees often perish from the disease, and even large orchard trees will die and break off at the base. It is certainly contagious in some forms and perhaps in all. What is apparently a form of this same gall is found growing above the surface of the ground, at first appearing on the trunk as a small lump or tubercle, which later grows into a large wart-like excrescence and eventually girdles the trunk." (Forbes.) Young galls of this kind also start out on the limbs, especially along the under side, and as they grow older darken and get rough in the same manner. On old galls small white or yellow points may be seen early in spring, which later take on the darker color, harden, and break open into rough cankery spots.

TREATMENT — There is no known cure for the disease. Destroy all trees found infested, or cut off the galls appearing on the limbs and paint over with Bordeaux wash.

Root-rot (*Telephora gallactina*) — A disease common in orchards, especially in those grown on old forest-land or where diseased trees formerly grew; usually fatal; trees affected suffer general loss of roots, and have a "starved and enfeebled look." Often a mass of gum and scaly bark collects at the base of the tree, or large irregular white layers of fungous growth spread between the bark and the wood or run through the ground from root to root. Several species of mushrooms that seem to be the fruiting bodies of some of these "rotten-root" fungi grow at the base of the trunk.

TREATMENT — As this fungus seems to be capable of spreading in the ground from tree to tree, it is well not to plant any young trees on land where old diseased ones have been until after thorough cultivation. An affected tree is worthless and should be at once destroyed.

Apple-tree Canker, Apple-fruit Black Rot (*Sphæropsis malorum*) — Occurs over a large part of the apple-growing area of the United States. Disease affects limbs and fruit of apple, pear, and quince. Large limbs blacken, and bark roughens and splits, disclosing wood and causing a very rough, ugly-looking canker. Can be distinguished from the bitter-rot canker by the fact that in that canker the bark does not split away and disclose wood beneath. Black rot of the apple is caused by the same fungus, but rarely becomes a serious menace to the grower.

TREATMENT — Remove and destroy affected limbs; cut out diseased bark, and paint over all wounds with Bordeaux wash. When spraying in regular orchard treatment, see that the limbs are well covered with the spray.

Apple-twig Blight (*Bacillus amylovorus*) — Caused by the same bacterium as the pear blight; rarely affects much more than the young growth on twigs. Spraying has not been found of much avail; cut off and destroy twigs affected. (See Pear Blight.)

Ripe Rot (*Monilia fructigena*) — See under *Plum.*

THE PEAR

The general spraying treatment recommended for the apple will apply to the pear, with the addition of a kerosene emulsion spray before the buds burst in the spring in order to control the pear-blister mite and psyllids.

The pear is attacked by many of the apple enemies, such as the codling-moth, green fruit worms, case-bearers, and tent-caterpillars, and several of the leaf fungi and canker diseases work on this plant as well as on the apple.

(a) Important Insects Injurious to the Pear

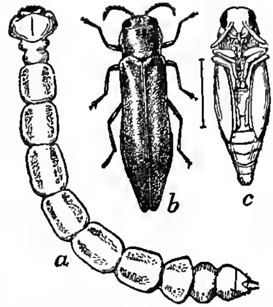

Fig. 98. Sinuate Pear-tree Borer: *a*, larva; *b*, beetle; *c*, pupa, enlarged. (Banks, United States Department of Agriculture.)

Sinuate Pear-tree Borer (*Agrilus sinuatus*, Fig. 98) — This dangerous enemy of the pear is proving difficult of control. It is as yet confined to some of the Eastern States, but will undoubtedly appear elsewhere Larva causing trouble is about two inches long when full grown, white or dirty white in color, with broad flat head and small jaws. Feeds for two years before attaining full growth, and in that time makes "immensely long zigzag galleries" between bark and wood, finally girdling tree and killing it. Beetle is small (½ inch long), narrow, and dark colored, looking very much like other species of its genus, being square-headed and tapering back almost to a point. It appears in May or early June and lays eggs in crevices of bark, the slender whitish larvæ soon hatching and commencing their fatal work.

Treatment — No absolutely successful treatment has yet been found. The general recommendations for the apple-tree borers will apply, and newspapers or other bands may be fastened about the tree to prevent eggs from being laid on it. Wire netting will not serve, as the beetle or young larva can readily pass through it. Thorough whitewashing of the trunks and lower limbs will aid in keeping the borers out. A little Paris green might be added to the whitewash.

Pear-leaf Blister (*Eriophyes pyri*) — Occurs wherever pears are grown. The injury done the leaf and known by the above name is "caused by minute, four-legged mites which live within the substance of the leaf, and pass the winter in the bud scales at or near the ends of the twigs." (Forbes.) There appear at first on the leaves "reddish, blister-like spots, ⅛ inch or more in diameter." These gradually change, through green, to black and unite, forming corky spots. The mites often destroy the larger part of the leaf tissue of a tree.

Treatment — Thorough spraying of infested trees in winter with strong kerosene emulsion diluted with 5 to 7 parts water, covering especially the terminal buds; hand-picking and destruction of leaves in early spring, when but a few are infested.

Pear-slug (*Selandria cerasi*) — Light-colored slimy larvæ of a "saw-fly," a four-winged fly, which appear on the leaves early in the year and often skeletonize them. Worms feed on upper surfaces only, but to such an extent that trees are sometimes completely defoliated.

Treatment — Usually controlled when spraying for other insects, but if not, give a thorough treatment with Paris green or other arsenical spray.

Other Insects Attacking the Pear — See Index.

(b) Important Diseases of the Pear

Pear-blight, Fire-blight, Apple-twig Blight (*Bacillus amylovorus*) — A contagious bacterial disease affecting several of the fruit trees, but doing greatest damage to the pear. Infests cells of plant, multiplying in sap and eventually permeating and destroying the whole tree. Bacteria are supposed to get entrance at blossoming time, the infection perhaps being carried by insects.

Treatment — Cut out affected part several inches below where it shows disease, and paint wound with Bordeaux wash. There being no known cure, trees should be cut out and burned after disease has once reached large limbs and body.

Other Pear Diseases — See Index.

THE PEACH

Spraying Calendar

The general spraying treatment for leaf-feeders and diseases affecting the peach is as follows:

Treatment	When to Spray	Against
1. Bordeaux mixture and Paris green.	Before buds swell.	Leaf-curl, brown rot, bud-moth.
2. Bordeaux mixture and Paris green.	After blossoms fall.	Leaf-curl, brown rot, plum-curculio, leaf-feeders.
3. Bordeaux mixture and Paris green.	Two weeks later.	Brown rot and leaf-feeders.
4. Ammoniacal copper-carbonate.	When fruit is well formed.	Brown rot.

On the peach, as on other fruit trees, kerosene emulsion may be used in 10 per cent. strength for such sucking insects as need treatment. As peach foliage is more tender than that of other trees, Bordeaux treatments need to be carefully given and the mixtures well prepared.

(a) Important Insects Injurious to the Peach

Peach-tree Borer (*Sanninoïdea exitiosa*, Fig. 99) — All peach regions. May be recognized by gummy exudations about lower parts of trunk and often by sickly appearance of tree. Insect passes the winter in a cocoon near outer portion of burrow; pupates and emerges as a moth in the spring. Male moths have clear wings and females purplish front wings and clear hind wings. Eggs are laid from May to July, according to latitude, and are placed singly on bark of tree near base. Larva, upon hatching, burrows into bark and mines between it and sap-wood

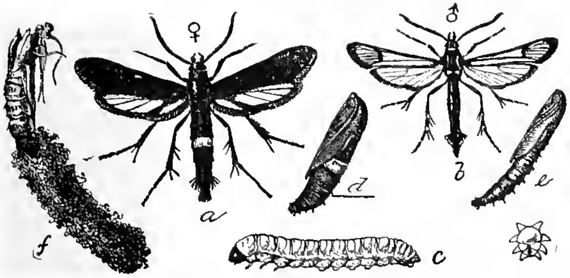

FIG. 99. Peach-tree Borer: *a*, adult female; *b*, adult male; *c*, full-grown larva; *d*, female pupa; *e*, male pupa; *f*, pupa skin extended partially from cocoon. All natural size. (From Marlatt, United States Department of Agriculture.)

until fall; is inactive in winter, completing growth early the next year; is soft, pale yellow in color, with a dark, shining head, and grows to be over 1 inch in length. Moths emerge in South very early in spring, but in the North usually not until May or June. There is but one brood a year.

TREATMENT—Digging out borers, killing by inserting a wire, and protecting trees from their entrance. Last named is undoubtedly the best measure, but it is not uniformly successful, and trees should always be looked over each year to see that no larvæ are getting a start. The same protective treatment as recommended for apple borers may be used; that is, banding with newspapers or tarred paper.

Fruit-tree Bark-beetle (*Scolytus rugulosus*, Fig. 100) — From Michigan south to Georgia and Alabama and from Massachusetts west to Arkansas. Beetle attacks all the orchard trees, but seems to be found more abundantly on plum and peach. Adult is a small brownish-black beetle, $\frac{1}{8}$ inch long, very active, and as early as the middle of March begins to form burrows in the bark. After penetrating to the sap-wood the female constructs a brood chamber, in which eggs are laid. Larvæ upon hatching soon excavate little side galleries which they widen as they grow, full-grown larvæ crossing and recrossing galleries until there is a network of grooves all under the bark. The injury is recognized from outside by tiny shot-hole-like openings scattered all over the bark. Larva is white, with yellowish head and brown jaws, and its surface is much wrinkled. Two broods occur in the North, and more have been reported from the South.

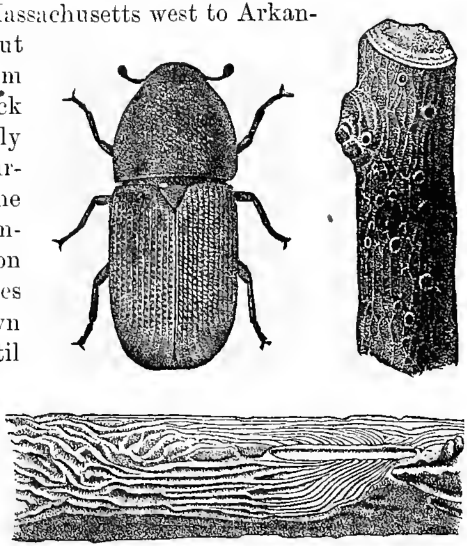
FIG. 100. Fruit-tree Bark-beetle: adult beetle, highly magnified; twig showing holes, natural size, and twig showing burrows. (Forbes.)

TREATMENT — Carbolic acid soap may be applied to trees to deter the beetles from making attempts to bore into the bark. This should be applied in March or April just before the warm days of spring. Clean culture will be found one of the best means of keeping this little pest out of the orchard.

Black Peach-aphis (*Aphis persicæ-niger*) — Most of the peach-growing regions. Works on peach roots in very much the same manner as does the woolly aphis on apple roots. The wingless lice live mostly on roots, but early in spring some climb up and infest the young twigs, where the winged form develops and then migrates to other trees. The wingless insects are reddish brown or black, and the winged females jet-black or dark brown, with yellow marks on legs. Affected trees have sickly foliage, the leaves being light green or yellowish, with the edges slightly rolled.

TREATMENT — Use tobacco about roots or kill with carbon bisulphide fumes. Kerosene emulsion used on infested trees in spring and early summer might prevent the infestation of other trees.

Other Insects Attacking the Peach — See Index.

(b) Important Diseases of the Peach

Crown-gall of Peach (*Dendrophagus globosus*) — Throughout United States, affecting peach, apricot, and almond. This crown-gall has been proved very satisfactorily by Professor Toumey to be a contagious disease caused by a minute parasitic organism belonging to the "slime molds." In appearance it is very much like the crown-gall of the apple.

TREATMENT — No treatment known which can be relied upon to cure. Dig up and destroy affected trees, and be careful to examine roots of nursery stock before planting.

Leaf-curl (*Exoascus deformans*) — Most peach-growing regions. Leaves become distorted and curled, first near end of twig and later along entire branch. As disease progresses, affected leaves get paler, then become covered with a grayish mealy substance, and often fall.

TREATMENT — Can be easily controlled by early thorough spraying with Bordeaux mixture.

Peach-yellows — A highly contagious disease attacking peach and some varieties of plums; cause, unknown. Presence may be recognized by yellowish foliage, general sickly appearance of tree, premature ripening of fruit, and presence of reddish spots in flesh of fruit; leaves often fall.

TREATMENT — Dig up and burn all affected trees, being careful that the diseased tree is not dragged against a healthy one, as it is believed that infection may occur in this manner.

Little Peach Disease — Another contagious disease of unknown cause. Trees, especially their leaves, look sickly, and fruit ripens late, scarcely attaining a third its ordinary size.

TREATMENT — Dig up and burn all affected trees.

Peach Fruit-spot, Plum-scab, Cherry-scab — This is evidently the same disease, whether occurring in the peach, plum, or cherry, and it also attacks the apricot. It at first produces purple blotches on the fruit, which later cause the skin to split. It works on young bark in the same manner.

TREATMENT — Thorough Bordeaux sprayings early in spring, and again, later, as given in calendar, will control this disease.

Brown Rot (*Monilia fructigena*) — Fungous disease of the peach fruit, somewhat more likely to be prevalent after warm, showery weather. Infection is from mummies remaining on the trees, and perhaps from other causes. The peaches rot rapidly when once started, many falling from the trees.

TREATMENT — Destroy all mummies and diseased fruit. The regular sprays for the leaf-curl, with additional ones as given in the calendar, will control this disease.

Other Peach Diseases — See Index.

THE PLUM

SPRAYING CALENDAR

The general spraying treatment for the plum is as follows:

TREATMENT	WHEN TO SPRAY	AGAINST
1. Bordeaux mixture and Paris green.	When leaf buds open.	Bud-worms, case-bearers, shot-hole fungus.
2. Bordeaux and Paris green.	When fruit is just formed.	Curculio, green fruit worms, fruit rot.
3. Bordeaux.	Two weeks later.	Brown rot.
4. Ammoniacal copper-carbonate.	When fruit is large.	Brown rot.

Kerosene emulsion for plant-lice in the early spring.

(a) IMPORTANT INSECTS INJURIOUS TO THE PLUM

Plum-curculio or "Little Turk" (*Conotrachelus nenuphar*, Fig. 101) — Ranges through Atlantic States and westward to Missouri River, working on plum, peach, pear, apple, cherry, and quince. The work of this pest is first noticed when the fruit is still small by the crescent-shaped spot cut by the beetle when preparing to deposit her egg. The larva is well protected from attack with any insecticide. Affected plums and some other fruits drop in a short time after larva begins feeding around stone. Larva is a small, stout, dirty white legless maggot, which when full grown pupates in the ground; beetle emerges from ground in latter part of summer, and immediately goes into hibernation until spring.

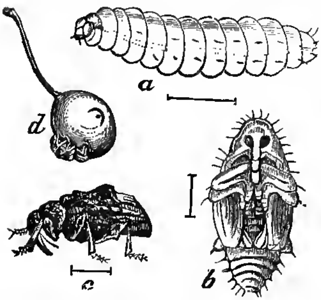

FIG. 101. Plum-curculio: *a*, larva; *b*, pupa; *c*, beetle; *d*, young plum showing crescent. (Riley.)

TREATMENT — Success is attained in treating this insect only by persistent and continued effort. Spraying with arsenites will aid to some extent, but the most successful measure is to spread a sheet or other cloth on the ground in early morning, soon after plums begin to form, and jar the tree, collecting and destroying beetles that fall. This must be kept up for several days. In commercial orchards the cloth is stretched on a frame and the persons bearing it stand one on each side of tree, while another jars it.

Other Insects Attacking the Plum — See Index.

(b) Important Diseases of the Plum

Black-knot (*Plowrightia morbosa*) — Widely distributed over the United States, in some places doing much damage to both plum and cherry-trees; also attacks wild plum and wild cherry.

Disease first appears as a thickening or swelling of the twig, which, becoming thicker on one side, soon breaks through bark, a spongy mass growing out, and large, sooty-black, wart-like masses appear, broken by deep fissures. Where the knot girdles the twig or branch it soon kills it. Disease is spread from tree to tree by spores carried by wind or other agency. The most destructive and deadly of plum diseases, and every effort possible should be made to stamp it out. Trees are sometimes killed by it in a couple of years.

TREATMENT — Cut off aud burn all parts showing any trace of the knots, cutting some distance below the last sign of affection, washing cut surfaces with Bordeaux mixture, or, if large, painting them over thoroughly with Bordeaux wash.

Shot-hole Fungus (*Cylindrisporium padi*) — Disease appears first as a minute brown spot with reddish margin on leaf. Spot soon gets darker, and finally brownish black, at which stage many spots break away from surrounding tissue and fall out. This causes the characteristic appearance from which the name is taken.

TREATMENT — Bordeaux sprays will control if applied early.

Yellows — Attacks Japanese plums. See under *Peach*.

Ripe-fruit Rot (*Monilia fructigena*) — Prevalent in most plum-growing regions. Due to attack of a fungus that probably lives over in a mummy on the tree; fruit ripens early and at the same time rapidly rots.

TREATMENT — Keep trees clear of infested fruit; use Bordeaux mixture according to calendar.

Plum-pockets (*Exoascus pruni*) — Not common over the country but often quite serious locally. Attacks fruit soon after blossoming time, causing it to turn yellow, then dark brown and black; fruit usually falls in June.

TREATMENT — Spray with Bordeaux mixture when buds are beginning to swell and again just before blossoms open.

Other Plum Diseases — See Index.

THE CHERRY

IMPORTANT INSECTS AND DISEASES

The cherry requires the same general treatment as the plum. It is infested by some of the worst pests of the other fruits, among which are the fruit bark-beetle, pear-slug, black-knot, fruit rot, and leaf-spots, besides many others.

Cherry Maggot (*Rhagoletis cingulata*) — Not common. The life history of this insect is very similar to that of the apple maggot.

TREATMENT — The chief recommendations have been fall plowing, to destroy pupa, and complete destruction of all infested fruit on trees as soon as seen. This last, if done in time, would probably prevent its spread in the orchard.

Cherry Aphis (*Myzus cerasi*) — Most cherry regions, but as a rule does little damage. A small black plant-louse, occurring as soon as leaves start in early spring. The young hatch from eggs laid on twigs and buds the preceding fall. Multiplies in the usual manner of plant-lice through summer; hibernates in egg state.

TREATMENT — Kerosene emulsion on tree just before eggs are laid, and perhaps in spring soon after eggs hatch.

Other Cherry Insects and Diseases — See Index.

THE QUINCE

IMPORTANT INSECTS AND DISEASES

The general treatment for the quince, in the matter of spraying, is practically the same as that for the apple.

The quince is attacked by nearly all the apple enemies of rank, and also by pear-blight and shot-hole fungus.

Quince Black Rot — This is identical with the black rot of apples.

Fruit-spot and Leaf-spot — These are caused by the bacillus of the pear leaf-blight.

Quince Rust — Caused by same fungus as rust of the apple, and remedied by cutting out cedar trees. Sometimes assumes on the quince a serious character, extending into tissue of young branches and deforming them.

Other Quince Insects and Diseases — See Index.

V. IMPORTANT SCALE INSECTS OF FRUIT TREES, BUSH FRUITS, AND VINES

Range and Importance — Within recent years the scale insects have attained such an importance through their multiplication and rapid spread over the United States, that they are regarded as highly dangerous pests, and in many states have necessitated stringent legislation.

All herein treated are capable of doing serious damage to trees and vines. A few general statements regarding their lives will apply to all the species treated. The scales belong to the same order of insects as do the plant-lice, squash-bugs, leaf-hoppers, and other sucking insects injurious to vegetation.

Life History — From the outward appearance, one not informed would scarcely consider them insects at all; but upon raising the tiny scale, the insect may be seen beneath it. This insect is a louse, appearing to the naked eye only as a soft mass affixed tightly to the bark. Its long thread-like beak or sucking tube is driven far into the wood, and by means of it the louse gets its food — the sap of the tree or vine. The scale is a protective covering secreted from the body of the louse after it has affixed itself to the bark. The larger number of scale insects hatch from eggs laid by the female under her scale, which protects them after she has died and dried away. In the case of the San Jose scale and the European fruit-scales, the young are usually brought forth alive, and this is occasionally true of some other scales also.

The peach Lecanium secretes no true scale, but remains exposed all its life. The other species here referred to affix themselves to the tender bark soon after hatching and begin in a short time to secrete their armor.

Difficulty of Combating — By reason of the protective scale it is often a difficult matter to destroy the occupant beneath. Where the period of hatching is well defined a thorough treatment with a contact insecticide may be made before the scale of the louse has had time to become protective. Treatment for the more fully developed insect in those species that pass the winter partly grown can best be given after the leaves have fallen in autumn and before the buds open out in the spring. Most authorities seem to agree that the later the spray can be applied in the spring the better the results will be. In the winter no injury need be apprehended from the use of substances for spraying which would cause the destruction of foliage and often the death of the trees in the growing months.

The scales to be treated have been divided into two classes: those belonging to the genus *Aspidiotus*, and often known as the "ring and nipple" scales; and those of various other genera, the most of which pass the winter in the egg stage beneath the female scale.

THE RING AND NIPPLE SCALES

To this genus belongs the most destructive of the scale insects — the San Jose scale. Several other species at times do considerable damage. The species all closely resemble each other, and it is difficult for the ordinary observer to distinguish them by the means usually at hand. Whenever a scale is found about which there is any doubt, the much safer plan is to send specimens to some competent authority for determination.

San Jose Scale (*Aspidiotus perniciosus*, Fig. 102) — Widely distributed over the United States and rapidly spreading. It infests practically all our fruit trees, many shade trees, and several shrubs.

Trees badly infested show dark scurfy patches on the bark, and the fruit, when present, is often well covered with the scale. On the fruit and young twigs there is usually a reddish

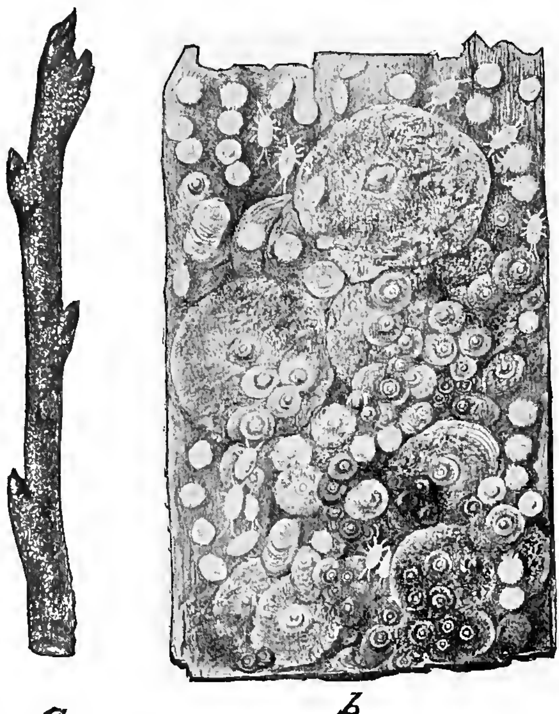

FIG. 102. San Jose Scale: *a*, natural size; *b*, magnified. (Howard and Marlatt, United States Department of Agriculture.)

discoloration where the scale is present. The single scale is nearly circular in outline in the female, grayish in color in mature specimens, with an almost jet-black central nipple surrounded by one or more distinct yellowish or grayish rings. The crowding of scales on bark often changes the circular outline. The young scale is jet-black, evenly circular, and shows the central nipple and two depressed rings very plainly. The San Jose scale differs from the European fruit-scale in general appearance only in the presence of the black nipple, and from the Forbes and the Putnam scales by the fact that it lacks the distinct brighter-colored exuvium located near the center of those scales. The insect passes the winter, partly grown, beneath scale. In spring it soon attains maturity, and the males, which are winged, appear and mate with females. No eggs are laid, female giving birth to living young. The number of broods is stated to depend on length of season, as females produce young when they are from "thirty-five to forty days old" and continue to do so for about six weeks.

TREATMENT — Use lime-sulphur-and-salt wash after leaves are off trees. If possible to treat trees just before buds swell in spring, do so, as treatment at that time will probably be the most effectual. Treat trees thoroughly, seeing that every branch and twig is well covered with solution. The wash will not injure the trees. If for any reason the materials for this wash cannot readily be obtained, whale-oil soap can be used on all trees but peach at the rate of 2 pounds soap to 1 gallon water. For summer treatment for control of scale use 10 per cent. kerosene emulsion.

European Fruit-scale (*Aspidiotus ostreæformis*) — Known as yet only in some of the Northern States. Occurs on all orchard trees. This scale passes the winter partly mature and by the last of June becomes full grown, the females soon afterward giving birth to living young. "There appears to be but one brood a year, at least in the Northern States." (Banks.) It very closely resembles the San Jose scale, although the young scales are paler, and the adult female scale is not so nearly circular and lacks dark central nipple.

TREATMENT — Same as for San Jose scale.

Putnam's Scale (*Aspidiotus ancylus*) — Widely distributed over the United States, and attacks all orchard trees and many shade trees; rarely occurs, however, in abundance on fruit trees. Hibernates as a full-grown insect, the females laying eggs late in spring or early summer, and the young hatching in July; one brood a year. Adult scales of this species also very closely resemble the San Jose scale, but have a visible, orange-colored exuvium and are less circular, while the young scales have no depressed ring about nipple. This scale is usually darker than the Forbes scale.

TREATMENT — Same as for San Jose scale.

Forbes or Cherry Scale (*Aspidiotus forbesi*, Fig. 103) — Widely distributed, attacking all orchard trees but rarely occurring in sufficient numbers to be considered serious. Very similar to the scale last described and to the European fruit-scale, but when found on cherry appears to be more shining. It has a grayish rim and usually appears flatter than the other closely related species. Hibernates as a partly grown insect. Eggs laid in late April and through May, and young hatch the last of May and in early June. Two broods, young again appearing in August and September.

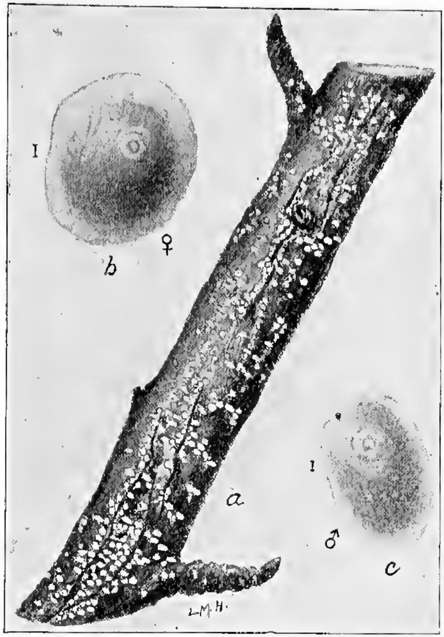

Fig. 103. Forbes Scale: *a*, natural size on cherry twig; *b*, female scale; *c*, male scale. (Forbes.)

Treatment — Same as for San Jose scale.

Grape Scale (*Aspidiotus uvæ*) — Occurs not uncommonly throughout all grape-growing regions; rarely becomes a serious pest. The scales are usually found on vines from ground up to end of the second year's growth. When abundant they cover surface so that it appears to have had a ragged coat of whitewash, and in such cases vines need immediate attention. "Female scale is flat, nearly circular, about $\frac{1}{15}$ inch long, pale yellowish brown or dingy white. When removed, a conspicuous white speck upon bark marks its former position." (Forbes.) Winters as an egg beneath old female scale, and the eggs begin hatching about middle of May; one brood a year.

Treatment — A spray of whale-oil soap (1 to 7) or of 10 per cent. kerosene emulsion applied at time young are hatching will kill them easily.

THE LESSER FRUIT SCALES

Oyster-shell Scale (*Mytilaspis pomorum*, Fig. 104) — All fruit states, infesting many fruit and shade trees, and several shrubs. The common name quite appropriately describes the shape of the female scale, which is about $\frac{1}{6}$ inch long. Scale is brownish or grayish white and two or three times as long as wide. In the

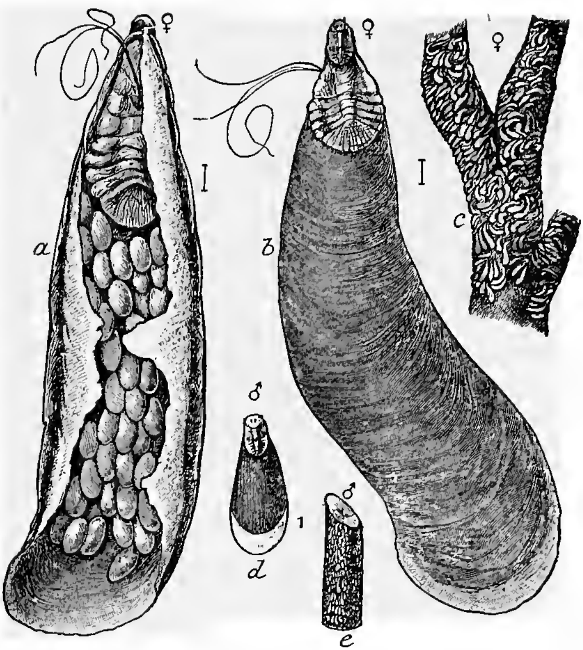

FIG. 104. Oyster-shell Scale: *a*, female scale, under side, showing the insect and its eggs within; *b*, same, from above; *c*, same, natural size; *d*, *e*, male scale, enlarged and exact size. (Howard, United States Department of Agriculture.)

winter the white or yellowish eggs may be found beneath old scale of female. These hatch in late spring and soon attach themselves to young twigs and smaller branches. The male scale is much smaller and more parallel-sided, as may be seen from Fig. 104.

TREATMENT—Spray young scales with kerosene emulsion in early summer. Thorough treatment of affected trees with whale-oil soap, or with the lime-sulphur-and-salt wash before buds open in spring will perhaps be effective. May be kept in check if closely watched and not permitted to get a foothold.

Scurfy Scale (*Chionaspis furfurus*, Fig. 105)—All fruit states, especially infesting apple, crab-apple, pear, and quince; occurs, however, on many other trees and sometimes on shrubs. This is the most common of orchard scales and may be readily known by its whitish color—in winter turning to dirty white. The female is ovate in shape, while the male is fully twice as long as broad, with parallel sides, and is also nearer snow-white in color. Insect hibernates in egg stage under female scale; eggs when crushed yield a reddish fluid. One brood a year in North, but more have been reported from South. Winged males appear in September, and soon thereafter eggs are laid and female dies; young begin to appear by the middle of May or soon after.

TREATMENT—Spray in the spring, immediately after eggs begin to hatch, as for oyster-shell scale. This scale rarely needs controlling unless it be present in large numbers on young trees.

Peach Scale (*Diaspis pentagona*)—Occurs throughout South and as far north as Pennsylvania, advancing northward each year. Attacks peach, plum, cherry, and some other plants. This has sometimes been called the "whitewash" scale, from the peculiar appearance it gives to trees badly infested. The female scale is grayish white, quite flat and irregularly circular; male scale, elongate, three times as long as broad, and snow white. Eggs are laid in May, last of June, and in August. Females hatch from last brood of eggs and hibernate partly or fully developed, but males pass winter in egg stage.

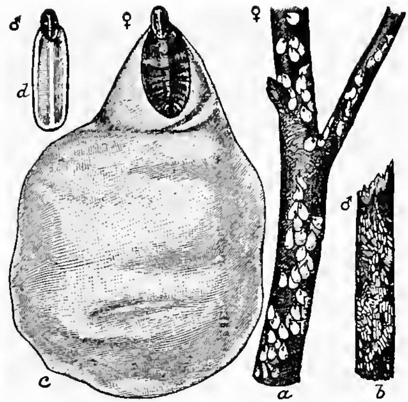

FIG. 105. Scurfy Scale: *a*, *b*, female and male scales, natural size; *c*, *d*, same, enlarged. (Howard, United States Department of Agriculture.)

TREATMENT — Spray as for other scales that hibernate as eggs. A winter treatment is also advisable.

Peach Lecanium (*Lecanium nigrofasciatum*, Fig. 106) — New York and Pennsylvania, southward to Virginia, and west to Arkansas and New Mexico. Attacks peach, plum, and, more rarely, apple. "This insect, formerly known as *L. persicæ*, is one of the largest of the scale insects, being about $\frac{1}{5}$ inch long and two thirds as wide. It is elliptical in outline and strongly convex." (Banks.) Its color is dull greenish brown, sometimes marked with distinct darker bands. Female hibernates as an adult and lays eggs about last of May, young hatching from early June to mid-July. Young larvæ are very fat, pale yellow, with a marginal rim. They become stationary in a short time, and the winged males appear by the latter part of July.

TREATMENT — Treat in July with kerosene emulsion, or in winter with some one of the stronger solutions. Very easily kept in check.

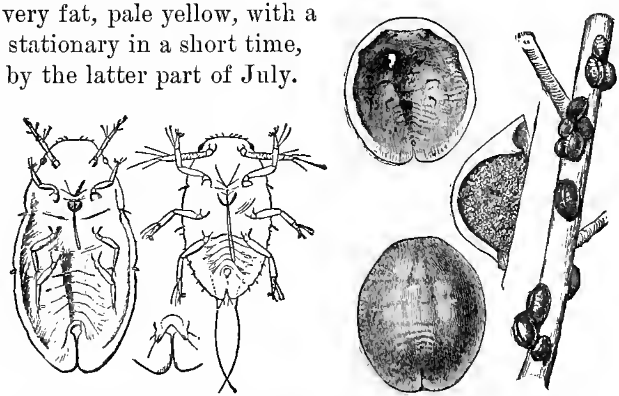
FIG. 106. Peach Lecanium: adults at right, young at left. (After Howard, United States Department of Agriculture.)

Rose or Raspberry Scale (*Aulacaspis rosæ*) — Quite widely distributed, attacking not only rose and raspberry but blackberry and other plants belonging to this family. In New Jersey it hibernates in the egg, but farther south some of the eggs hatch in fall, and in Florida it usually passes the winter beneath its scale as a partly developed insect. The scale is snowy white, circular in outline, and has a dark center. On account of its whiteness it may be readily seen on twigs and branches of infested plants.

Treatment — The cleaning up of canes, dead wood, and rubbish in the fall will usually serve to control this insect; kerosene emulsion spray may be used effectively at time of egg hatching. Insect rarely becomes a serious pest.

VI. SMALL FRUITS AND VINES

THE GRAPE

(a) Important Injurious Insects

Grape-vine Flea-beetle (*Haltica chalybea*)— Occurs wherever grapes are grown east of the Rocky Mountains. On the Pacific Coast a nearly related species does the same damage to buds and leaves. Beetles, which are small and steely blue or greenish blue in color, appear in May and June on buds and leaves. The grub of this beetle is slender; varies from yellow to yellowish brown in color, and has a black head; grows to be about $\frac{2}{5}$ inch long; and feeds on buds and leaves with adult beetles.

Treatment — Spray vines with Paris green (1 pound to 50 gallons water) before buds open in spring, and later, when leaves are out, with regular Paris green mixture (1 pound to 150 gallons water). Add lime to first spray — 1 or 2 pounds to each 50 gallons of mixture.

Grape Root-worm (*Fidia viticida*) — Distributed quite generally over the United States. The life history of this beetle has been worked out by Prof. F. M. Webster in Ohio. Eggs are laid on slightly loosened parts of bark early in year; and young, upon hatching, drop to ground, afterward finding their way to small fibrous upper roots through cracks in ground. Adult beetles feed on foliage early in year, doing considerable damage by eating irregular holes in upper surface of leaves. Larvæ at first feed on fibrous roots, but as they grow larger pass to large roots and gnaw off bark, working their way downward. In early autumn they form a little case near the root upon which they were feeding, and remain in this until the following spring, when they pupate, emerging in June.

Treatment — Remedial measures have not been uniformly successful. Spray foliage with strong arsenical mixtures, using lime to prevent burning. This will destroy many adults. Keep ground well cultivated, so as to have a deep powdery soil over roots. This will help keep larvæ from reaching food.

Grape Cane-borer or Apple Twig-borer (*Amphicerus bicaudatus*) — Occurs principally in Mississippi Valley states and Texas; closely related species works in the same manner in Pacific Coast states.

Eggs laid on stems (usually dead or dying) of grape or other plants early in spring by beetles that hibernated in burrows cut in twigs of apple and other fruit trees. Larva lives in these dead stems until autumn, when it pupates, and a cylindrical brown adult beetle soon appears. Adult leaves grape stems and goes to some fruit tree, where it bores a channel several inches in length in a small twig, in which it passes the winter.

TREATMENT — Carefully prune diseased wood and burn it; clean up all neglected brier patches, as these are also breeding places for the insect.

Grape Leaf-hopper (*Typhlocyba vitis, T. comes*, and others, Fig. 107) — Often erroneously called "Grape Thrips." Several species of leaf-hoppers infest grape-vine. Leaves are injured by their sucking the juices, and first show light spots, which later turn brown, the leaf appearing "burned." If plant is now disturbed, myriads of tiny insects, rosy red, green, and yellow will arise and then settle back on the leaves. The young insects are usually paler in color, and very active.

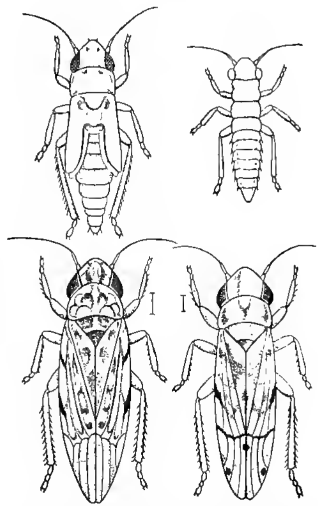

FIG. 107. Grape-vine Leaf-hoppers: above, young of different ages; at right, adult of *Typhlocyba vulnerata*; at left, *T. comes*. (Lugger.)

TREATMENT — Go through vineyard with a screen, or even a palm-leaf fan, upon which has been smeared coal-tar, and as you go, disturb the vines and keep the fan or screen constantly moving. Many insects will be caught in this way. Spray the vines with kerosene emulsion, 10 per cent. strength, at the same time jarring the vines to disturb the "hoppers," and filling air with spray.

Grape-vine Phylloxera (*Phylloxera vastatrix*) — Eastern States and parts of California; rare elsewhere in United States. This is one of the root-infesting plant-lice that form galls on roots of plant and sometimes also on under sides of leaves. Insects winter mostly as immature wingless forms on roots. In spring they rapidly increase in size and soon begin to lay eggs. Young from these eggs are wingless, and as soon as grown lay eggs, several generations of this character occurring and rapidly spreading over roots. In midsummer a form appears that crawls up to the surface, acquires wings, and migrates to other vines, laying eggs on under side of leaves. The female of this generation lays a single egg, from which hatches a form like that which had wintered over.

TREATMENT—American vines can usually resist the attack, but should any treatment be necessary apply carbon bisulphide. Inject this substance—¼ ounce to each injection—in four or five places on each square yard of surface over the whole vineyard. Put the fluid 8 to 12 inches deep and not less than a foot from base of vines, closing the holes tightly with the foot; repeat operation every year until insects are destroyed.

Grape-berry Moth (*Eudemia botrana*)—All grape states. Larvæ of first brood feed on leaves and blossoms; the next brood attacks fruit, burrowing in pulp and producing appearance like black rot.

TREATMENT—Arsenical spraying for first brood. For second brood, bag the fruit; *leave none on vines to decay*; keep vineyard clear of trash.

Grape Leaf-folder (*Desmia maculalis*)—East of the Rocky Mountains. Leaves are folded double and tightly fastened by a small greenish larva which skeletonizes them from the upper side. Moth black, spotted with white; about an inch across wings.

TREATMENT—Clean culture; hand-picking of affected leaves; burning rubbish.

Eight-spotted Forester (*Alypia octomaculata*)—East of Rocky Mountains. Especially common on Virginia creeper and often on grape leaves. Caterpillars are light brown, with black dots; occur on leaves in spring, and are sometimes very abundant. Moth, which appears in midsummer, has fore-wings black, with two yellow blotches; hind-wings varying, but with two white spots.

TREATMENT—Arsenical sprays when first noticed, and hand-picking.

Rose-chafer (*Macrodactylus subspinosus*)—States east of Colorado and north of Virginia and Tennessee. Attacks many plants. Blossoms are destroyed and leaves eaten by this awkward, long-legged, light-brown beetle (⅓ inch long) early in the spring.

TREATMENT—Vines may be covered with netting and clusters bagged; hand-pick from grapes and other plants. Spraying rarely seems to be of value. Insect often infests Spiræa, hence this may be used as a trap crop.

Grape-vine Saw-fly (*Blennocampa pygmæa*)—All grape states. Slugs are yellow, with black dots, and feed in the same way as the currant saw-fly, the same treatment sufficing when they become abundant.

(b) IMPORTANT DISEASES OF THE GRAPE

The following has been recommended as good practice in controlling grape diseases:

Spray with Bordeaux mixture (a) *just as pink tips of first leaves appear,* (b) *ten days or two weeks later, before blossoms open,* (c) *just after blossoming,* (d) *again in from ten to fourteen days. If another treatment seems to be necessary, use ammoniacal copper-carbonate solution after the fruit is well formed.*

Downy Mildew (*Plasmopora viticola*) — All grape regions. This disease attacks all parts of the vine, on fruit causing what is known as brown rot, the berries shriveling and drying.

TREATMENT — For the mildews and rots that infest the grape, Bordeaux mixture is always successful if applied at the right times.

Powdery Mildew (*Uncinula spiralis*) — Attacks both foliage and fruit, especially in midsummer, portions attacked being covered with the web-like threads of the fungus.

Black Rot (*Læstadia Bidwellii*) — One of the most common, wide-spread, and destructive of grape diseases. It chiefly attacks the fruit, causing dark spotting and rotting of the green berries, and may also work on leaves, petioles, and cluster branches, producing elongated dead spots. Rotted fruits dry and hang over winter on the vines, thus carrying the fungus over to the next season.

TREATMENT — Spraying treatment above outlined will control this disease. Destroy all fruit affected by the rot.

Chlorosis, Yellow Leaf — Disease shown by yellowing, browning, and dropping of leaves. Eventually kills vine. Supposed to be due to excess of lime in the soil. Small amounts of sulphate of iron have been recommended. Plant resistant stocks, such as *Concord, Catawba, Delaware, Moore's Early,* and *Niagara.* Some other varieties also may be resistant.

Anthracnose, "Bird's-eye Rot" (*Sphaceloma ampelinum*) — DARK spots form on surface of leaf, cracking tissue and causing well-defined sunken spots which usually have a lighter-colored center.

TREATMENT — Disease is entirely amenable to Bordeaux sprays. Swab surfaces of canes, early in spring before buds open, with a warm saturated solution of sulphate of iron, to which has been added 1 per cent. of sulphuric acid. Handle with care to avoid acid burns.

THE CURRANT

(a) IMPORTANT INJURIOUS INSECTS

Currant Saw-fly (*Pristophora grossulariæ*), **Currant-worm** (*Nematus ribesii*) — All fruit states. Small four-winged flies, with deep-yellow bodies. Lay eggs early in spring on under side of currant leaves along ribs. Larvæ feed on leaf tissue and, when abundant, rapidly defoliate a bush.

TREATMENT — Underspray with hellebore (1 ounce to 2 gallons water) when worms are very young; if not checked, use again at double this strength. For other currant worms, arsenical spraying in spring is required.

Four-lined Leaf-bug (*Pœcilocapsus lineatus*) — Bright yellow bug, $\frac{3}{10}$ inch long, with black antennæ and two black stripes on each wing-cover; young, bright red. Eggs are laid near growing tips of currant and other closely related plants, hatching the following May. Bugs suck juices of plant, especially working on leaves.

TREATMENT — Jar off in early morning into pans of kerosene and water; cut off tips containing eggs, use 10 per cent. kerosene emulsion on young.

Currant Stem-borers (*Sesia tipuliformis*, Saw-fly Borers) — Throughout the United States. The larva of the former species attacks lilac and currant, boring in the old wood. The saw-fly borers work in young shoots.

TREATMENT — Cut out and burn infested stems, which may be recognized early in spring by wilting of leaves soon after coming out.

(b) DISEASES OF THE CURRANT

Several leaf-spots and a mildew attack currant. They are amenable to treatment with Bordeaux mixture. Use same general treatment in spraying as for grape mildews.

THE RASPBERRY, STRAWBERRY, AND CRANBERRY

IMPORTANT INSECTS AND DISEASES

Cane Maggots (*Phorbia* sp.) **and Cane-borers** (*Oberea* sp.) — Can be controlled by cutting out diseased canes.

Saw-fly (*Monophadnus rubi*) — Larvæ may be brushed from bushes or treated with hellebore spray (1 ounce to 1 gallon water).

Raspberry Anthracnose (*Colletotrichum venetum*) — All states. This fungous disease appears on bark, and occasionally on leaves and fruit of raspberry, blackberry, and other closely related plants. Small purple spots will first be seen on canes near ground. These spread, acquire a grayish white center, and later attain large size, having purple outer edges.

TREATMENT — Carefully examine all nursery stock before planting. If disease is present, either destroy stock or dip in Bordeaux mixture. When present on planted stock, trim closely, burn all old canes and refuse, and treat young shoots with Bordeaux mixture.

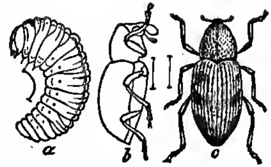

FIG. 108. Strawberry Crown-borer: *a*, larva; *b*, *c*, adult beetle. (After Forbes.)

Strawberry Crown-borer (*Tyloderma fragariæ*, Fig. 108) — Occurs in nearly all strawberry regions. Eggs are laid in June or July. Larva burrows downward, eating substance of crown in which it remains until full grown. Beetle emerges in August, and hibernates through winter. It is about $\frac{1}{6}$ inch long, brown, with several darker spots, and marked with lines and dots.

TREATMENT—Dig up and burn infested vines; transplant frequently.

Strawberry-weevil (*Anthonomus signatus*) — All strawberry regions. A very troublesome pest that feeds in larval stage on flower buds. Beetle a small black insect with a hard snout or beak. Lays eggs in bud and then so punctures the flower stem that it dries and breaks off. A number of wild flowers are attacked in like manner.

TREATMENT — Plant chiefly pistillate varieties, covering, until danger is over, the staminate varieties that are necessary.

Strawberry Grubs — Larvæ of May beetles, feeding on roots. Avoid use of sod land for berries until it has been several years in cultivation.

Strawberry Leaf-spot (*Sphærella fragariæ*) — Also called rust or leaf-blight. This fungus may be kept in check by the use of Bordeaux mixture when plants are first set out and 3 or 4 times thereafter. Spray in spring before blossoming, and again about two weeks later; burn off beds in fall and destroy all old leaves.

Cranberry Fire-worm (*Teras minuta*) —All cranberry regions, attacking cranberry, apple, huckleberry, and other plants. On cranberries this larva often does much damage by spinning up and eating tips of growing shoots. Larva is small, green, with black head. Another worm (*Rhopobota vacciana*), closely resembling it but with a yellow head, also does considerable damage to cranberry plants.

TREATMENT — Prof. J. B. Smith states that the only successful treatment is that of keeping the bogs covered with water until rather late — "until at least the middle of May."

VII. SHADE TREES

IMPORTANT INJURIOUS INSECTS

White-marked Tussock-moth (*Orgyia leucostigma*, Fig. 109) —All of Eastern and Central United States. Caterpillar does great damage to shade trees in city parks and along streets, and also attacks fruit trees. Adult moth is a pale ashy-gray insect; the female, quite stout and wingless, the males, with ash-gray

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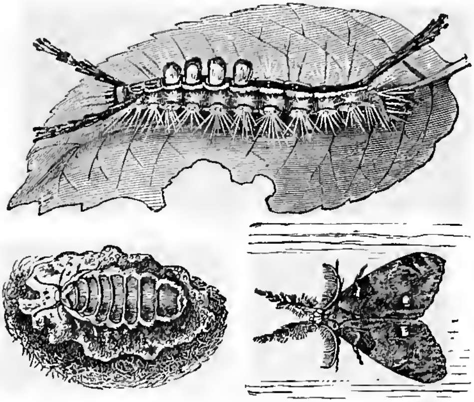

FIG. 109. Tussock-moth: larva above, adult female at left, adult male at right. (After Forbes.)

wings and feathered antennæ. During July and August there may be seen on leaves, trunks, and branches of trees a silky-white cocoon, often partly hidden in crevices of the bark and later discolored by soot and dirt, and from this cocoon soon emerge the adult insects. Female rarely travels far, and usually lays eggs on old cocoon — 100 to 500 in a place, fastened together and enveloped in a white frothy substance, which soon hardens and becomes impervious to rains and snows. Young larvæ hatch in April or May in warm springs, and immediately begin feeding on buds and young leaves. By July they are about full size, and then and in August make their cocoons. The larva is from $\frac{3}{4}$ to $1\frac{1}{2}$ inches in length when full grown; general color yellowish, the body with three darker stripes, and the head brilliant red; three long black plumes, two near the head and one at the anal end, and four large white tufts along the center of the back, standing out prominently from the remainder of the long, scattered, yellowish pubescence.

TREATMENT — Destroy egg-masses in fall and winter, and use arsenical sprays early in spring. In the North there is probably but one brood; two are reported in the South.

Gipsy Moth (*Porthetria dispar*) — At present confined to New England, and principally to Massachusetts. Without doubt one of the most serious of the imported pests, feeding on all kinds of shade and fruit trees and on shrubbery. Eggs are laid in clusters of 400 to 500 on trees, fences, and in various other places, each cluster being covered with yellow hairs from the female's body. Larvæ hatch early in spring and feed on foliage. When full grown they are about 2 inches long, have a mottled gray appearance, and are covered with long yellow and black hairs which arise from tubercles, blue at the anterior and red at the posterior end of the body. They pupate in July, and the moths emerge in August, soon laying eggs for the next year's brood. Adult female has whitish wings with dark spots along outer margins, but male is darker, and both have dark curved lines and spots on wings.

TREATMENT — Destroy egg-masses and cocoons; spray with arsenites as soon as caterpillars hatch in the spring.

Brown-tailed Moth (*Euproctis chrysorrhea*) — A most dangerous shade- and fruit-tree pest, at present confined to some parts of Massachusetts. Egg-masses may be found in midsummer, 200 to 300 in a cluster, attached to the under side of a leaf, and usually near end of branch. Cluster is covered with dense mass of brown hairs from female's body. Larvæ hatch in August and feed near ends of branches in colonies, drawing leaves together into a sort of tent in which they hibernate, beginning early in spring to feed on young leaves and buds. Full-grown larvæ are dark brown, mottled and spotted with orange, and are clothed with reddish brown hairs; two rows of dense white tufts stand prominently out of upper side of body. Pupate in June, moths soon emerging. Adults have white wings and female a brown tip at end of body.

TREATMENT — Destroy tents in fall and winter by collecting or burning out, and collect and destroy egg-masses in summer.

Forest Tent-caterpillar (*Clisiocampa disstria*)—Ranges from New York westward and southward to Texas and New Mexico, attacking both fruit and shade trees. Eggs are laid by brown moths in July and August, in belts encircling smaller twigs of many shade and fruit trees; from these egg-masses in spring hatch larvæ which, when full grown, are dark and hairy, with silver spots along back and a blue head. Larvæ live in colonies, but contrary to their common name *do not spin a tent*; sometimes a slight web is made along a limb. When not feeding they collect in bunches on trunk or large limbs. Cocoons are formed in June and fastened to the bark or at the forks of small limbs. One brood a year.

TREATMENT—Destroy egg-masses when on fruit trees or shrubbery; kill caterpillars when they are massed on limbs or trunk, jarring them from trees, then collecting and destroying them. Spraying would be a costly process when they are working in large trees.

Bagworm (*Thyridopteryx ephemeræformis*, Fig. 110) — From New York westward to Mississippi River and south-

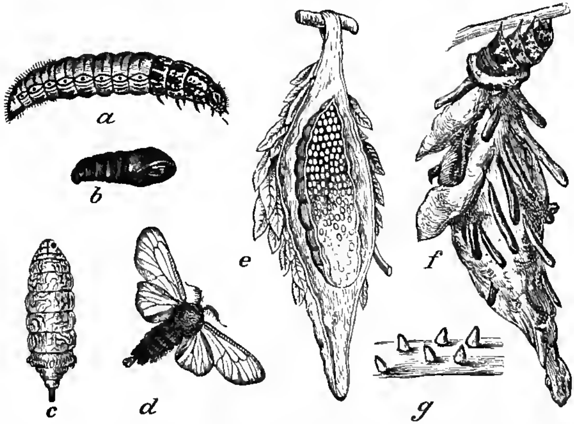

FIG. 110. Bagworm: *a*, larva, removed from case; *b*, chrysalis; *c*, adult female taken from case; *d*, adult male; *e*, cross-section of bag and female within, latter full of eggs; *f*, bag and larva from evergreen; *g*, very young larvæ in their cases. (After Forbes.)

ward to the Gulf. Most common on evergreen shade-trees, such as cedar, pine, and arbor-vitæ, but feeds also on many others, and on fruit trees of all kinds.

Cases may be readily recognized on trees in winter. They are oval, soft, sack-like bodies, an inch or more in length, pointed at both ends, and attached by one end to a twig. Eggs hatch in May and June and the larva immediately commences a case, forming it from bits of leaf and stem. In early fall it pupates in this case. The males, which are dark moths with semitransparent wings, emerge and mate with the females. These have no wings and never leave cases until after laying eggs—and then only to fall out and die.

TREATMENT — Destroy cases in winter by picking from trees. They may be piled in a convenient spot away from trees until later in the spring, when all parasites have had a chance to emerge, and then be destroyed. Arsenical sprays early in the summer will aid in controlling the worms.

Canker-worms, Fall (*Anisopteryx pometaria*) **and Spring** (*Paleacrita vernata*, Figs. 91, 92) — Canker-worms occur throughout the United States and attack many kinds of fruit and shade trees. (For descriptions see *Apple Insects*, page 172.)

TREATMENT — Band trees the first warm days late in winter or in very early spring. In case of threatened injury from fall species, banding must be done in fall before eggs are laid. A successful means of banding is as follows: Put a narrow band of rough cotton batting around the tree, cutting the bark smooth if it is very rough and uneven. Around this tie an 8-inch band of building or tarred paper, and on this spread a thin layer of ordinary cheap printer's ink, to which a little car-oil has been added to render it more sticky. If the ink gets crusted over, another coat of the car-oil will be required. The last of May, or when danger is over, these bands may be easily cut from the trees, leaving them clean and free from any sticky substance. Avoid putting sticky preparations directly on the trees, as many of them are very injurious. Where worms have already appeared on the leaves arsenical sprays may be used.

Elm Leaf-beetle (*Galerucella luteola*, Fig. 111) — Occurs commonly in New England and Middle Atlantic States and is gradually spreading westward. Appears to prefer English elms. Both beetles and larvæ feed on the elm leaves and have proved to be serious pests, especially in cities and towns. Beetle is yellowish, with black stripes, and about ¼ inch long; appears early in spring, and begins laying eggs on leaves in May. Larvæ finally attain nearly the color of mature beetle. When full grown they pass down tree and pupate in ground.

TREATMENT — Arsenical sprays applied early on under side of leaves just after buds burst, and several times more if necessary. Kill larvæ in latter part of June, when they are clustered on larger limbs and trunk preparatory to pupating.

Cottonwood and Poplar Borers (species belonging to several genera) — These insects lay eggs on trunk of tree or near a wound, the larvæ hatching

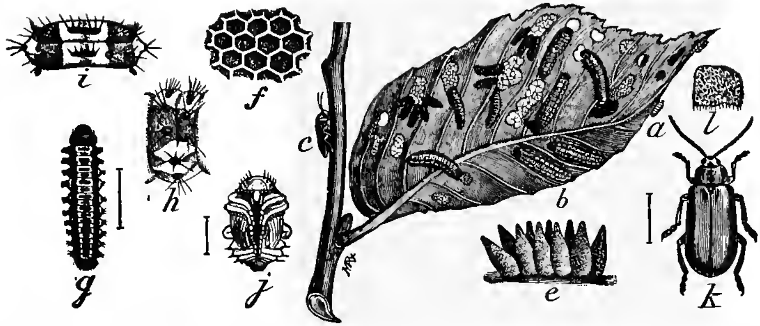

FIG. 111. Elm Leaf-beetle: *a*, egg; *b*, larva; *c*, adult; *e*, egg; *g*, larva; *j*, pupa; *k*, adult; *e*, *g*, *j*, *k*, enlarged; *f*, *h*, *i*, *l*, details. (From Riley, United States Department of Agriculture.)

therefrom burrowing into the trunk or limbs of the tree and often killing it. Larvæ may be destroyed by running a wire into their burrows.

Cecropia (*Attacus cecropia*, Fig. 112) — Found attacking walnut and many other shade trees during latter part of summer. It is a large green worm with red and yellow tubercles on upper side of body. It pupates in a dense silken cocoon among branches, or at base of tree on ground. Larvæ often defoliate shade trees in parks and along boulevards.

TREATMENT — Hand-picking or arsenical spraying. Gather cocoons in fall and destroy.

Elm Scale (*Chionaspis americana*) — Female scale fawn-color until late in the year, when it becomes a dirty white. Much resembles scurfy scale but is more convex. Male scale pure white, sides nearly parallel, narrow and three-ridged. Eggs purplish, and concealed beneath old female scale. Insect hibernates in the egg stage, hatching about May 1st.

TREATMENT — Kerosene emulsion applied early in spring, just as eggs are beginning to hatch.

Cottony Maple-scale (*Pulvinaria innumerabilis*) — Quite common on maple and other shade trees throughout the United States. Usually noticed as a white cottony mass on under side of small limbs and twigs; later in year young scales may be found on under side of leaves arranged along ribs, but without any cottony covering. They pass to limbs and

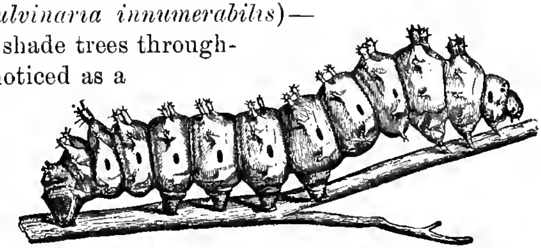

FIG. 112. Cecropia larva.

twigs, and eggs are laid under the cottony covering, hatching in spring and early summer.

TREATMENT — Trees may be freed from the large scales by fastening a sponge or cloth on the end of a pole, saturating it in kerosene, and swabbing the scale from the under side of the limbs.

Oyster-shell Scale (*Mytilaspis pomorum*) — See *Apple Insects.*

Walnut Scale (*Aspidiotus juglans-regiæ*) — Well distributed over the United States. While this may be found at times on almost any of the fruit trees, it chiefly infests walnut, locust, and other shade trees. It is the largest of the "ring and nipple" scales, is irregularly circular in outline, and pale gray or dirty white in color.

TREATMENT — Same as for San Jose scale, if it becomes abundant.

E. S. G. Titus

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INSECT LIFE. By J. H. Comstock. *D. Appleton & Co*, N. Y. $1.75

The first part of this attractive book is designed as a course of study in insect life. The latter part contains directions for the collection and preservation of insects.

INSECTS AFFECTING DOMESTIC ANIMALS. Bulletin 5, New Series, Division of Entomology. *United States Department of Agriculture* . . . . —

Treats of the insects affecting horses, cattle, sheep, hogs, dogs, and other domestic animals. Many illustrations are given and descriptions are so written that most of the insects will be readily recognized.

INSECTS AFFECTING THE COTTON PLANT. Farmers' Bulletin 47. *United States Department of Agriculture* . . . . —

INSECTS AFFECTING THE TOBACCO PLANT. Farmers' Bulletin 120. *United States Department of Agriculture* . . . . —

INSECTS INJURIOUS TO FARM AND GARDEN CROPS. By Hopkins and Rumsey. Bulletin 44. *West Virginia Agricultural Experiment Station*, Morgantown, W. Va. . . . —

Gives plainly and briefly character of injuries, insect responsible for each, and means of prevention and remedy.

INSECTS INJURIOUS TO FRUITS. By William Saunders. *J B. Lippincott & Co.*, Philadelphia 2.00

Though written several years ago, this is still the best work on the subject published. Treats insects attacking apple, peach, plum, cherry, orange, raspberry, strawberry, currant, etc. Many illustrations.

INSECTS INJURIOUS TO GARDEN AND ORCHARD CROPS. Bulletin 19, New Series, Division of Entomology. *United States Department of Agriculture*. 10

INSECTS INJURIOUS TO GARDEN CROPS. Bulletin 23, New Series, Division of Entomology. *United States Department of Agriculture* 10

This bulletin, like several others mentioned later, deals with recently-discovered facts regarding many of the more important insects in their relations to the farmer, gardener, and fruit grower.

INSECTS INJURIOUS TO ORNAMENTAL PLANTS. Bulletin 27, New Series, Division of Entomology. *United States Department of Agriculture* 10

INSECTS INJURIOUS TO STAPLE CROPS. By E. Dwight Sanderson. *John Wiley & Sons*, N. Y. 1.50

A book for the practical farmer. One of the most thorough of its kind recently issued. Treats of the life histories, habits, enemies, and ravages of insects affecting grains, grasses, and roots, cotton, tobacco, and hops, the means of combating, and includes a chapter on insecticides.

INSECTS INJURIOUS TO STORED GRAINS. Farmers' Bulletin 45. *United States Department of Agriculture*	——
INSECTS, STUDY OF. By J. H. Comstock. *Comstock Publishing Co.*, Ithaca, N. Y. .	$ 3.75
LARGER APPLE-TREE BORERS. Circular 32, Second Series, Division of Entomology. *United States Department of Agriculture* . . . . Treats of the Round-headed, Flat-headed, and Spotted Apple-tree Borers.	——
LAWS CONCERNING INJURIOUS INSECTS. Bulletin 13, New Series *United States Department of Agriculture* (1898)	.05
MEXICAN COTTON-BOLL WEEVIL. Farmers' Bulletin 130. *United States Department of Agriculture*	——
MISCELLANEOUS RESULTS. Bulletins 7, 10, 22, New Series, Division of Entomology. *United States Department of Agriculture* . . . . Each. These treat of various insects and significant features of their life histories. Many of those treated are of considerable economic importance.	.10
ORTHOPTERA, OR GRASSHOPPERS, LOCUSTS, CRICKETS, AND COCKROACHES, OF MINNESOTA. By Otto Lugger Bulletin 55. *Minnesota Agricultural Experiment Station*, St. Anthony Park, Minn.	——
PEACH LEAF-CURL. Bulletin 20, Division of Vegetable Physiology and Pathology. *United States Department of Agriculture* . . . . Full account of this disease, its distribution, and remedies applicable.	.25
PEACH TWIG-BORER. Farmers' Bulletin 80. *United States Department of Agriculture*	——
PEACH YELLOWS AND PEACH ROSETTE. Bulletin 1, Division of Vegetable Physiology and Pathology. *United States Department of Agriculture*	.20
PERIODICAL CICADA. Bulletin 14, Division of Entomology. *United States Department of Agriculture* . . . . Treats of the "Seventeen-year Locust," its broods, and their life history. Useful to the fruit grower to enable him to avoid losses in "locust years."	.15
POTATO DISEASES. Farmers' Bulletin 91 *United States Department of Agriculture* . .	——
PRINCIPAL INSECTS LIABLE TO BE DISTRIBUTED ON NURSERY STOCK. Bulletin 34, New Series, Division of Entomology. *United States Department of Agriculture*	——
SAN JOSE SCALE. Bulletin 3, New Series, Division of Entomology. *United States Department of Agriculture.* . . . . Full account (illustrated) of this scale and its enemies.	.10
SOME COMMON BIRDS IN THEIR RELATIONS TO AGRICULTURE. Farmers' Bulletin 54. *United States Department of Agriculture.* . . . . Notes on the lives, food, and habits of cuckoos, woodpeckers, crows, blackbirds, and other common birds.	——
SPRAYING OF PLANTS. By E. G. Lodeman. *The Macmillan Co.*, N. Y. . . . An unusually exhaustive treatise on methods and results in spraying.	1.00

THREE INSECT ENEMIES OF SHADE TREES. Farmers' Bulletin 99. *United States Department of Agriculture.* . . . . —

Treats of the Elm Leaf-beetle, Tussock-moth, and Web-worm.

TRAP-LANTERNS OR "MOTH-CATCHERS." By M. V. Slingerland. Bulletin 202. *Cornell University Agricultural Experiment Station,* Ithaca, N. Y. . . . . —

An excellent bulletin, giving the *facts* about the trap-lanterns. Tells just what they *do catch.*

The Division of Entomology, of the United States Department of Agriculture, publishes *Circulars* on important insects whenever information is particularly needed. Many of these are still available. Among those already published are: Circular 4, The Army Worm; Circular 9, Cankerworms; Circular 20, The Woolly Aphis of the Apple; Circular 26, The Pear Slug; Circular 31, The Cucumber Beetle; Circular 37, The Use of Hydrocyanic Acid Gas; Circular 43, Destructive Green Pea-louse. Almost all the bulletins of this division are of value to the farmer.

The Division of Vegetable Physiology and Pathology publishes bulletins treating of plant diseases, their characters, and the remedies needful in combating them.

The reports of several of the state entomologists are valuable publications, containing accounts of many injurious insects and the most approved methods of treating them.

Selecting and Feeding Farm Animals for Profit

By Herbert W. Mumford, B. S.
Professor of Animal Husbandry, College of Agriculture, University of Illinois, and Chief of Animal Husbandry, Illinois Agricultural Experiment Station

I. LEADING BREEDS OF LIVE STOCK

A stroll through the various exhibits at our leading fairs and expositions tends to emphasize the fact that we have a large number of breeds in each department of live stock. Those who are interested in animal husbandry from a business standpoint have their preferences. They are reasonably familiar with the origin, history, and characteristics of their favorite breeds. They are apt to look with too much disfavor upon other breeds with which they are less familiar, and at times fail to see the weak points in the breeds which they champion.

It is hardly to be expected that a breeder of pure-bred stock, much less the stock farmer, will be equally familiar with all breeds — a life of thorough study and closest observation is all too short for such knowledge — yet until one becomes fairly conversant with the strong and weak points of the various breeds he could hardly be looked upon as an intelligent breeder or feeder. It may as well be admitted that there is no *best* breed of horses, cattle, sheep, or swine. Practically all breeds have been developed to meet certain local needs. If the originators have followed wise methods the breeds which they have developed to meet their requirements are undoubtedly the best breed from their point of view. But to conclude that, because a breed is the best under certain local conditions, it is the best breed for all conditions, is an absurd assumption. Every breed has its faults, and no breed in existence is so utterly worthless as to possess no redeeming qualities. There are but very few breeds, if indeed any, that do not possess advantages in certain particulars over all other breeds.

This then, in the judgment of the author, should be our frame of mind when we come to study breeds. We must not expect perfection in any breed, and still we must demand some advantageous qualities in every bree

The American people are not a nation of strong prejudices, but they are a people who are too apt to base their judgments on insufficient evidence. Caution, therefore, is necessary that final judgment of the value of a breed be not too quickly passed. Impressions of breeds should not be based on the behavior or performance of individual animals, but should rather be based upon the possibilities of the best, or, at any rate, the average of the breed.

Oftentimes the selection of a breed hinges upon personal preference. A man may select a breed not because he believes it the best, but because it is as good as others and suits his fancy. This is a competent reason, for a man seldom succeeds with a breed of stock he does not like, while often a man achieves great success with a commonplace breed that just "fills his eye."

In our discussion of the various breeds of improved live stock we shall confine ourselves largely to a discussion of the characteristics of the various breeds, as we find them, and of their adaptability to certain localities and for particular uses. It is evident that in a brief treatise of this nature it will be impossible to go into details as to the history and development of these breeds, no matter how important or how interesting such facts might be to the reader.

The farmer and stock-raiser, as distinguished from the breeder of pure-bred stock, is interested in the production of animals for the open market, and only to a much less extent in animals which are to be used subsequently as breeding animals. The stock-raiser, therefore, looks upon pure-bred animals as a means to an end. He is interested in those characteristics which, if judiciously made use of, will make the common stock of his farm more profitable producers of meat or of other animal products. The discussion of the breeds which follows is intended solely for the benefit of stock-raisers. Stock breeders require a more intricate and comprehensive knowledge than it is possible to give in the limited space at our disposal.

BREEDS OF CATTLE

All the breeds of cattle belong to one or more of the following classes, viz.: beef, dairy, and dual purpose.

The beef breeds are: *Shorthorns, Polled Durhams, Herefords, Aberdeen Angus,* and *Galloways.*

The dual purpose breeds are *Red Polled, Shorthorns, Polled Durhams, Brown Swiss,* and *Devon.*

The dairy breeds are *Jerseys, Guernseys, Ayrshires, Holsteins,* and *Dutch Belted.*

It will be noted that Shorthorns and Polled Durhams are included in both the beef and dual purpose class. This is because numerous representatives of each of these breeds are distinctly of the beef type, while still others are as certainly of the dual purpose type.

BREEDS OF BEEF CATTLE

The leading breeds of beef cattle are the *Shorthorns, Polled Durhams, Herefords, Aberdeen-Angus,* and *Galloways.*

Shorthorns — Shorthorns have been variously called Teeswater Cattle, Durhams, and Shorthorns. It is no longer correct to speak of Shorthorns as Durbams, and this term should not longer be used, since it is now applied to a more recently established classification of our improved breeds of beef cattle, namely, Polled Durhams. Both the names Durham and Teeswater were formerly given the Shorthorns from the fact that the breed originated in the valley of the Tees and largely in Durham. They soon spread over the shires of Northumberland, Lincoln, and York.

At this time it is hard to conceive that but little more than one hundred years ago Shorthorns, and in fact all of the older breeds of beef cattle, were scarcely uniform enough to be looked upon as distinct breeds. They had little to recommend them to the attention of farmers and breeders above the common stock of the country.

If tbe literature referring to early agriculture and live-stock conditions may be depeuded upon, the first popular idea of a beef animal was one of huge bulk. It was the breeder who produced the largest bullocks regardless of age that received the greatest consideration and patronage. It was this characteristic of the Shorthorn as is evidenced in the Durham Ox and the White Heifer that Traveled, that first brought them into popular favor. This occurred something over a century ago, and from that time until this Shorthorns have remained the most universally popular breed of beef cattle in existence. The idea of the necessity of securing enormous size in order to get a profitable beef animal has long since been abandoned. Efforts to improve the Shorthorn breed have been along the line of getting refinement of bone and general form, with early maturing qualities, rather than the increase of bulk, yet without lessening that valuable characteristic of plenty of scale and growthiness, Shorthorn characteristics which have ever been valuable ones, especially wherever the Shorthorn has been used as an improver of native cattle.

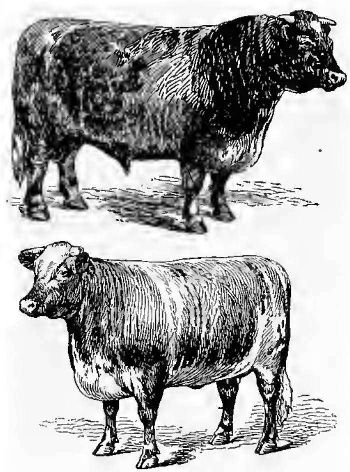


Fig. 113. Shorthorn bull (Merry Hampton 132572) and cow (Mary Abbotsburn 7th [Vol. XXXIX, A. H. B.] owned by W. A. Boland, Grass Lake, Mich.)

Originators and early improvers of the Shorthorn breed recognized the importance of an abundant supply of milk and they were careful to preserve, as far as possible, the strong milking tendencies of the old Shorthorn stock. So characteristic of the Shorthorn breed did this milking tendency become that it is undoubtedly true that no breed of beef cattle possesses it to the same extent as do the Shorthorns. While other breeds of beef cattle crossed upon the common stock of the country often have a tendency to reduce the production of milk in their offspring, Shorthorns appear to have the opposite influence — in fact, Shorthorns seem to have the happy faculty of blending admirably with native and common stock. No other breed of beef cattle will so rapidly improve native or common stock as well-bred Shorthorn bulls of creditable individual merit. Even the breeds of beef cattle blend well with the Shorthorn blood. The Shorthorn cow, with her deep milking tendencies, makes the best dam for a bullock.

While the modern Shorthorn has lost many of the faults of those of early times, the breed as a whole needs careful attention in the way of selection and weeding out of inferior animals. From the very fact that Shorthorns have been so popular and have become so widely disseminated, many herds have fallen into the hands of careless feeders and indifferent breeders who have allowed their herds to deteriorate so that the average pure-bred Shorthorn is hardly up to the standard of the average pure-bred beef animal of the other beef breeds. The most common faults among modern Shorthorns are their long legs, their prominent hips, and plain rumps, with a tendency to bunch at the tail-head and elsewhere when highly fitted. To be sure, these faults are not always present, but as we have said they are all too common. The breed is noted for its quiet disposition and, therefore, is well adapted for putting into small feed lots in preparing for the market.

Herefords — The Herefords were named after the shire in the west of England where they originated. This country, which was a grass country and largely devoted to dairying, subsequently became the home of one of the most profitable and useful breeds of improved live stock for which Great Britain has become famous. Lovers of " white faces " look upon Benjamin Tompkins as the first improver of Hereford cattle who paid especial attention to beef tendencies among the breed.

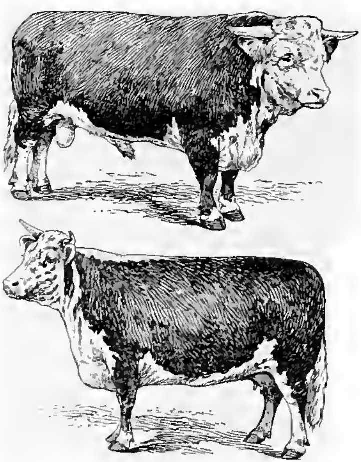


Fig. 114. Hereford bull (Dale 66481, sold at Chicago for $7,500) and cow (Dolly 2d 61799, sold, with heifer calf, for $5,000).

The characteristic colors and markings of Herefords and their prepotency in transmitting these characteristics to their offspring have made them quite popular for crossing upon native and common stock, especially upon the range.

It is generally conceded that no other breed of beef cattle quite equals the Herefords as a producer of beef when grass alone is depended upon. Herefords, as a rule, are closer to the ground, but not quite as massive as the Shorthorns, nor as good milkers. They mature rather more quickly than do the Shorthorns, but have the same tendency to become uneven and patchy when fed long and heavily on grain. They are well adapted to good grazing lands, but are not suited for conditions requiring cows to furnish a liberal amount of milk. They are hardly as quiet in disposition as are the Shorthorns.

Aberdeen - Angus — The Aberdeen - Angus breed originated in the eastern part of Scotland under conditions well calculated to make a hardy race of cattle. Their continued improvement, from the origin of the breed up to

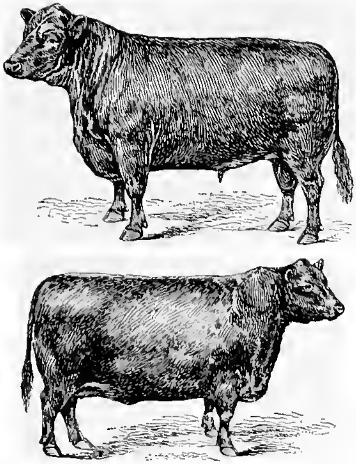


FIG. 115. Polled Angus bull (Woodlawn 33923) and cow (Lena Estill 3d 22069).

the present time, was somewhat interrupted, about the year 1810, by the widespread popularity of Shorthorns in Great Britain. It was at one time thought that the breed had become almost extinct. It is undoubtedly true that had it not been for William McCombie, this valuable race of cattle would have lost its identity. Its brief setback, owing to the somewhat unnatural boom enjoyed by the Shorthorns at an early date, has been more than regained, and it is to-day one of the most formidable breeds with which other beef cattle are compelled to compete. Its general smoothness of outline, its early maturity, and its even fleshing tendencies have made it a general favorite among the producers of beef cattle for the market. No other breed has won greater or more signal honors at recent live-stock shows than has the Angus breed. It seems next to impossible to feed an Angus steer in such a way that he will become bunchy. They are, therefore, well adapted for long feeding periods. The quality of their beef is excellent, being well marbled and containing about the right proportion of lean and fat beef. Their refinement of form and feature makes them invariably dress a high percentage of beef. No other cattle of equal quality and condition will sell better in the open market than the Angus, a fact which emphasizes their good killing qualities together with the desirable quality of their flesh.

Those selecting bulls of the Angus breed for use on grade or pure-bred herds should look well to secure a smoothly laid shoulder, not too open on top, and a straight, well-muscled hind leg.

Galloways — No breed of beef cattle in recent years has made the improvement that has been made by the Galloways. They were formerly angular, rough, coarse, and noticeably lacking in width. They were proverbially flat-ribbed and late maturing. During recent years several progressive breeders have wrought such an improvement in the breed that their animals are hardly looked upon as typical Galloways. These improved herds, however, show the possibilities resting in the Galloway breed. Their beef has always been considered of the highest quality on the English market. They usually dress out a high percentage of beef carrying good grain. Their long, thick, woolly coats have made their hides valuable for the manufacture of coats,

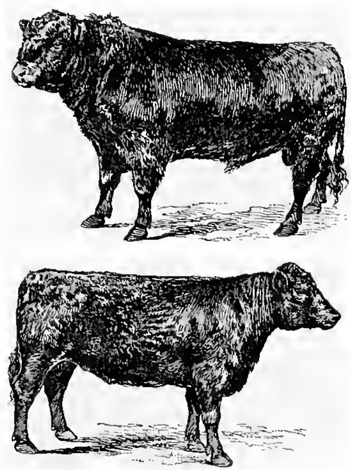


FIG. 116. Galloway bull (Druid of Castlemilk 17054 [6159], champion of Scotland, 1899, and of America, 1901; bred by Sir Robert Jarden, owned by O. H. Swigart, Champaign, Ill.) and heifer (Norma 3d of Avondale, senior champion, International Live Stock Exposition, Chicago, 1901; same owner).

robes, and mittens. The Galloways and Shorthorns make a very desirable cross for the production of steers for the feed lot and subsequently for the block.

Polled Durhams—It should be clearly understood that Polled Shorthorns and Polled Durhams are not necessarily the same breed. The Polled Shorthorn is eligible for registry in the American Shorthorn Herd Book and in the American Polled Durham Record. Polled Durhams are not eligible for registry in the American Shorthorn Herd Book. When an animal is spoken of as a "double standard Polled Durham" it is to be understood that such an animal is eligible for record in the American Shorthorn Herd Book and in the Polled Durham Herd Book as well. The Polled Durhams have practically the same characteristics as those possessed by the modern Shorthorns. The standing of the breed has been somewhat endangered by a tendency among breeders to reserve all of the polled animals dropped in their herds rather than to discard a few inferior ones. The temptation to sell such unworthy polled cattle at a good price has been too strong to resist.

BREEDS OF DAIRY CATTLE

The leading breeds of dairy cattle are the *Jerseys, Guernseys, Ayrshires, Holstein-Friesians*, and *Dutch Belted.*

Jerseys—The Jersey may be light or dark fawn in color and may be all fawn or fawn and white. When they are all fawn their color is spoken of as solid; when spotted with white, as broken colored Jerseys. The solid fawn color is preferred. A black tongue and a black switch are also desirable markings. Formerly there was such a strong prejudice in favor of solid colored Jerseys with the desirable markings that many very good individual broken colored Jerseys were discarded much to the detriment of the breed. Breeders of Jerseys as well as breeders of all classes of live stock are not permitting color to stand as the chief basis for selection. While in many instances its importance is and should be recognized, it does not take precedence of more important factors. The following are the most important characteristics of the Jersey breed:

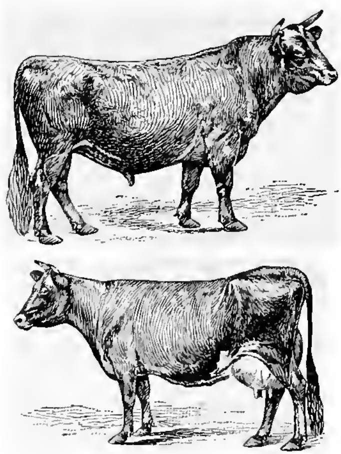


Fig. 117. Jersey bull (Pedro 3187) and cow (Brown Bessie 74997).

1. A tendency to convert a large part of the food consumed into milk and not flesh and fat.

2. Their milk contains the highest percentage of butter fat of any of the dairy breeds. In other words, they give the richest milk. They are noted for quality rather than quantity of milk.

3. The fat globules in the milk are large, thus facilitating creaming by the shallow or deep setting gravity methods. Largely owing to this fact the cream gathers more rapidly in churning than the cream taken from the milk of other breeds of cows.

4. Their early maturity makes it possible to breed them at an early age, hence, avoiding the necessity of long periods of waiting while they are coming into usefulness.

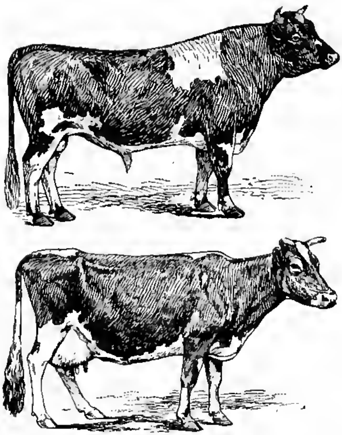


FIG. 118. Guernsey bull (Sheet Anchor 3934) and cow (Vrangue's Favorite IV. 1923, owned by Alfred Le Patourel, Island of Guernsey).

Guernseys — Like Jerseys, Guernseys are sometimes spoken of as one of the Channel Island breeds because they originated on the Island of Guernsey in the English Channel. While these two breeds have been bred and developed independently they doubtless had a common origin, and as they have been developed for similar uses they resemble each other in their general appearance and in their characteristics as well.

Guernseys are larger, somewhat coarser in bone, and carry more flesh than Jerseys. They are noted for the rich color of their milk and cream and the natural high color of the butter made from Guernsey cream. It is generally believed that they produce slightly more milk than the Jerseys; whether or not their milk possesses a higher percentage of butter fat than Jersey milk is a disputed question.

The color of the Guernsey is characteristic; they are usually of a light yellowish, reddish, or orange fawn with large and small patches of white unevenly distributed over the body and legs. The Guernseys are said to possess quiet dispositions. At any rate, they are cared for in their native home largely by women. Mature cows of this breed should weigh from 950 to 1,200 pounds, bulls from 1,200 to 1,600 pounds. Guernseys are persistent milkers; like the Jerseys, the fat globules in the milk are large. They are not usually bred so young as the Jerseys.

Ayrshires — Ayrshires originated in the country or shire of Ayr, Scotland. Their flesh-carrying and flesh-taking tendencies are undoubtedly the result of the free use of Shorthorn blood in the development of the breed. As a dairy breed they are especially valuable to furnish milk well suited for cheese-making. They give a large quantity of milk not containing a high percentage of butter fat but a high percentage of casein. In general type, they are short-legged and their thin necks, clean-cut heads, roomy paunches, and deep hind quarters give them a characteristic wedge-shaped appearance from the side. Mature bulls should weigh from 1,300 to 1,700 pounds. The udders of the Ayrshires are level, spreading, broad and flat rather than large and pendant. They are a very hardy race of cattle with a tendency to be somewhat nervous. In color, they are red and white, either color predominating or in most cases an indefinite spotting of white over the red is characteristic. The fat globules in the milk are quite uneven in size although mostly small.

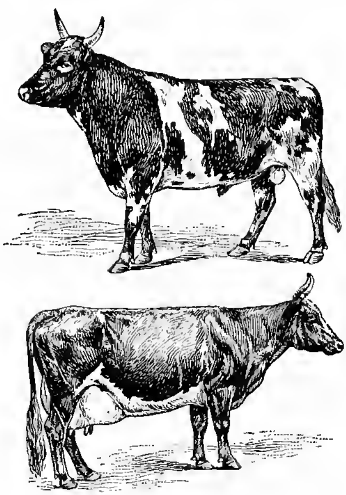


FIG. 119. Ayrshire bull (John Webb 5180) and cow (Red Rose 5566).

Holstein-Friesians.—This breed originated in North Holland and Friesland, a low, level, rich country. It is not surprising, therefore, that this breed, surrounded by such environment for centuries, is the largest and heaviest breed of dairy cattle in existence. Mature cows should weigh from 1,150 to 1,600 pounds, bulls from 1,900 to 2,400 pounds. In color they are black and white, black predominating in some and white in others; disposition, quiet; constitution, strong; udders, usually large, being long and extending well up behind. Teats inclined to be large, milk veins prominent. No other breed equals them in quantity of milk. Their milk is, however, deficient in fat and solids. Where kept on the farm their abundant milk is very useful for young growing calves and pigs. The fat globules in Holstein milk are small.

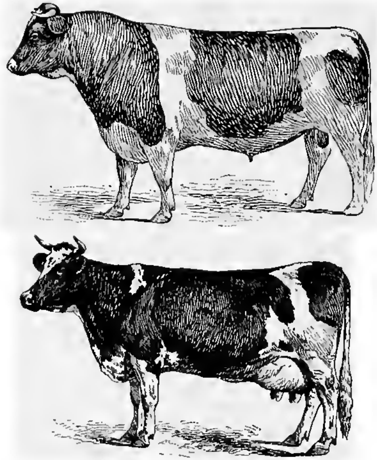


FIG. 120. Holstein-Friesian bull (De Brave Hendrik 230) and cow (Rosa Bonheur 5th 11277, owned by Michigan State Agricultural College).

Holsteins are sometimes recommended for beef production. In this regard the author believes they are apt to possess thin flesh of a coarse nature and to be too coarse in bone. Their beef does not possess the juiciness of the beef cut from the beef breeds. They are distinctly a dairy breed and should be looked upon as such.

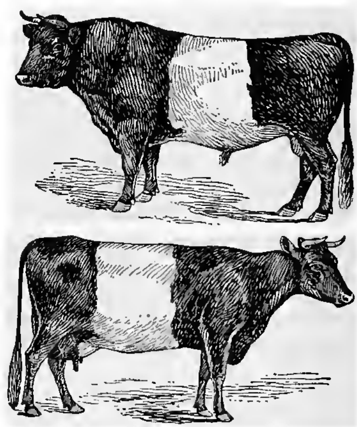


FIG. 121. Dutch Belted bull (Duke of Ralph 255) and cow (Lady Aldine 124).

Dutch Belted.—The original name of these cattle was "Lakenfield cattle," a name now sometimes used in their native country, Holland. As their name indicates they are belted, a broad band of white encircling the body, the main color being black. The cows weigh from 1,000 to 1,200 pounds, and the bulls from 1,300 to 1,800 pounds. They give a large amount of milk containing a small percentage of butter fat. In this respect they are similar to Holsteins. Their heads are long; horns, fine; necks, thin; udders, square and well placed.

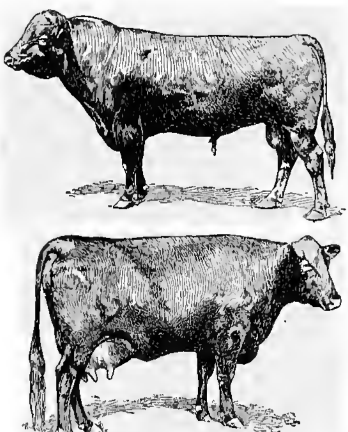


FIG. 122. Red Polled bull (Boss 3398) and cow (Popsy 3d 9689).

DUAL PURPOSE

The leading dual purpose cattle are the *Red Polled*, *Brown Swiss*, and *Devons*.

Red Polled — The Red Polled breed originated in Norfolk and Suffolk counties in the east of England. While they are looked upon as a general or dual purpose breed, their dairy qualities are rather better than their qualities as beef producers. As the name indicates they are polled; in weight they are somewhat heavier than the Devon and longer in leg and body. They are usually of a deep dark red color.

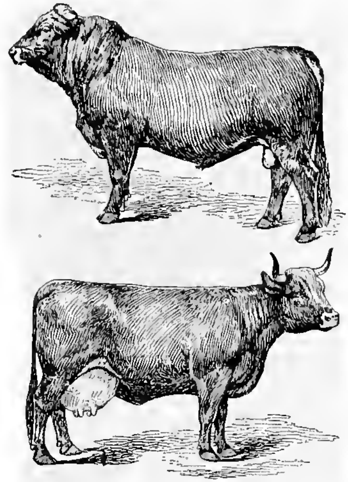


FIG. 123. Brown Swiss bull (Gilbo 720) and cow (Brienzi 168).

Brown Swiss — In color these cattle are gray or brown with dark extremities except muzzle which is "mealy." The bulls are usually darker colored than the cows. Some individuals of the Brown Swiss breed might be mistaken for Jerseys, but they are generally much heavier and coarser. Mature cows weigh from 1,200 to 1,400 pounds and bulls from 1,600 to 2,100 pounds. Udder and teats large; bones, heavy; hide, thick; disposition, dull. Brown Swiss calves are large and vigorous at birth and with proper care grow quite rapidly, sometimes weighing 600 pounds at six months of age.

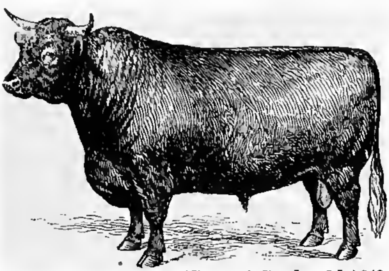


FIG. 124. Devon bull (General Gordon 2d 5243, owned by W. F. Morse, Verona, Wis. (From the *Breeder's Gazette*.)

Devons — This dual purpose breed is very popular in Southwestern England. They were formerly more common in the United States than at the present time. Their active temperament made them desirable as work cattle. Their milk is rich and the quantity average. They are not very persistent milkers. Their beef is of excellent quality, but their lack of size and growth has prevented their becoming universally popular as a beef breed in the United States.

BREEDS OF HORSES

In general, horses may be classified as draft, coach, carriage, and saddle horses.

The draft breeds are *Percheron*, *Clydesdale*, *English Shire*, *Belgian*, *Suffolk Punch*.

The coach breeds are *French Coach*, *German Coach*, and *Cleveland Bay*.

The carriage breeds are *American Trotter* and *Hackney*.

The saddle breeds are *English* and *American Thoroughbred* and *American Saddler*.

In a technical sense the above classification may not be correct, but it is sufficiently accurate to aid materially in a clear understanding of the uses to which the various breeds are put.

FIG. 125. Typical Percheron stallion. (*Breeder's Gazette.*)

DRAFT BREEDS

Percheron — The Percheron is the best known of all the draft breeds in the United States. The breed originated in France. When mature, stallions weigh from 1,800 to 2,000 pounds; mares from 1,600 to 1,800 pounds; color, black, brown, bay, or gray; grays and blacks are most common. Percherons have an attractive style and finish, being nicely turned, good actors, and spirited. They have a quiet disposition. Percherons cross well with the common draft stock of the country and stallions are more freely used for the production of heavy draft horses than those of any other breed. They are apt to be a trifle light in bone, hence, by mating a grade shire mare of naturally heavy strong bone with a Percheron stallion an ideal market draft horse is produced.

English Shire — The Shire is the heaviest breed of draft horses in existence, mature horses weighing from 1,800 to 2,100 pounds. They range in height from 15½ to 17½ hands. Legs and body short and massive. A mass of fine, silky hair from knee and hock to fetlocks is often spoken of as the "feather." The Shire is chiefly noted for its bulk, heavy bone, and good feet. In temperament they are somewhat dull and sluggish, and are adapted for slow trucking where strength is the most important consideration. Many Shires are marked with a strip of white in the face and with two or more white stockings. Prevailing colors, bay, brown, and black.

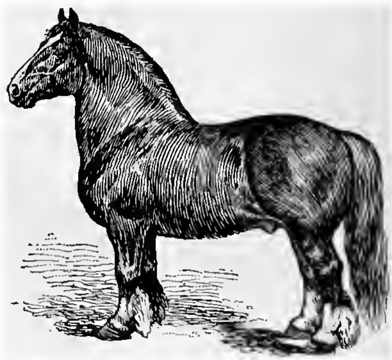


FIG. 126. Typical English Shire stallion. (*Breeder's Gazette.*)

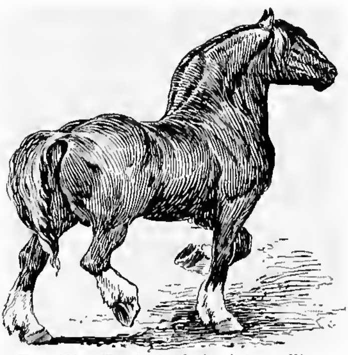


FIG. 127. Typical Clydesdale stallion.

Clydesdale — The Clydesdale is hardly as low or massive as the Shire, but rather more active. In fact, the long stride of the Clydesdale at the walk is especially characteristic. A trifle more slope in pastern and shoulder makes greater action possible. Otherwise than the points noted above, the Clydesdale is very similar to the Shire. They are similarly marked, had a common origin, and formerly were more or less freely crossed. It is probably true that the Clydesdale is less beefy in the leg than the Shire and more stylish.

Belgian — In its characteristics and origin, the Belgian is quite similar to the Percheron. As a rule, however, they are a little heavier in bone and often shorter legged. They are good actors for draft horses and noted for their good feet. While they have not been imported to the United States in large numbers, the few that have been imported have given a good account of themselves and there is no reason why they should not increase in popularity.

Suffolk Punch — Prevailing colors, sorrel and chestnut. Stallions weigh from 1,600 to 2,000 pounds. Their general rotund appearance has led many to speak of them as too beefy. They have great courage and strength in draft work. They are without the feather or hair on the legs possessed by the Shire and Clydesdale; legs short and bodies heavy. While they are quite popular among the farmers in the south of England, they have never become so in the United States. Considering their bulk and the shortness of their legs they are good actors.

COACH BREEDS

French Coach — The French Coach horse has been developed in France under conditions well calculated to produce a horse of perfect conformation, good action, and endurance. The lighter class of native French mares were crossed with Arabian and English Thoroughbred stallions, so we can see that the French Coach has a considerable amount of Arabian blood. This undoubtedly accounts for the pleasing conformation of this breed of horses. The high quality of these horses is undoubtedly largely due to the interest taken by the French Government in their breeding. The Government seems to have taken more pride in the development of this coach horse than any other class of French horses. A large number of stallions of this breed are annually let to farmers and breeders throughout France at a nominal fee. In addition to this the Government has a system for the inspection of all stallions used in the country.


Fig. 128. Typical French Coach stallion.

All the stallions in France, outside of the Government stables, belong to one of three classes: 1st. *Approved stallions* — Approved stallions are such as the Government inspectors consider excellent individuals and of equally good breeding. The owners of such stallions receive a bonus from the Government of from $75 to $150 for standing them in France. 2d. *Authorized stallions* — These are stallions which Government inspectors believe to be good enough to be used on the common stock of the country, but which are not considered good enough to offer a bonus to their owners for standing them. 3d. *Unauthorized stallions* — There are a large number of stallions in France which are not good enough individually nor well enough bred to be used for breeding purposes so they are used for common work horses on the street and on the farms.

The desirable action of the French Coach may be partially due to the method of developing, training, and speeding. This class of horses is sometimes spoken of as French Trotters. The races in France are seldom less than two or three miles in extent and usually over a sod track, so it is a trial of endurance as well as of speed. A sod track makes higher action necessary, and while it is

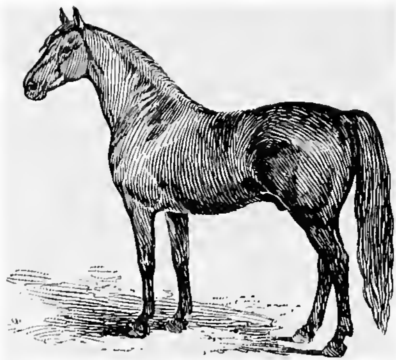


Fig. 129. Typical Cleveland Bay stallion. (*Breeder's Gazette.*)

not conducive to high speed it influences knee and hock action. A mature French Coach horse weighs from 1,000 to 1,200 pounds. The predominating colors are bays, browns, and sorrels.

German Coach — The German Coach and German Coacher is similar to the French Coach horse, but is heavier in body and limb. Their origin was very similar to that of the French Coach, except that native German mares were used as a foundation. They weigh from 1,050 to 1,350 pounds; are bays, browns, and chestnuts. These horses are heavy enough for most farm work.

Cleveland Bay — The Cleveland Bay is the English Coach horse. They are the result of crossing large, native bay mares with thoroughbred stallions. Cleveland bays are the most uniform in color of any of the coach or carriage breeds, being usually a bright bay with black points; larger than the French Coach and fully as heavy as the German or Oldenberg Coach horses; weigh from 1,000 to 1,400 pounds. They are not so good actors nor have they produced so good results where they have been used on the common stock of the United States as has the French coach. In disposition they are quiet and gentle. The breed as a whole lacks greatly in uniformity.

CARRIAGE BREEDS

American Trotter — The American Trotter has been developed for the race course. There is a great lack of uniformity among standard bred horses. As to general appearance and conformation they have been developed with one object in view, that of securing great speed. The American Trotter undoubtedly stands at the head of the trotters of all nations for high speed at the trot.

There are quite a number of standard bred horses that possess size, conformation, aud action most desired in market, carriage, or coach horses, hence, many American Trotters are used as carriage and coach horses. More attention is being paid by breeders of American Trotters to the development of size, action, aud conformation than formerly. The principal use to which American Trotters are put is the race course. This class of horses has been developed largely by breeding the lighter graded common mares of the United States with English thoroughbred stallions.

Hackney — The Hackney is another carriage or coach horse that is not nearly so tall nor so heavy as the Cleveland Bay. They weigh from 950 to 1,200 pounds. For a

Fig. 130. Typical Hackney stallion. (*Breeder's Gazette.*)

coach breed they are short legged and very compact and exceptionally well muscled. They are noted for their knee and hock action which in some instances is excessive. In some parts of England they are spoken of as the Norfolk Trotter. In the United States they are not considered fast, and they are used for the production of fancy drivers rather than for the production of speed.

SADDLE BREEDS

English Thoroughbred — The English Thoroughbred is the running horse of Great Britain. They are very slim of build and devoid of flesh. They had their origin largely in the Arabian horse. Bays, chestnuts, and browns predominate. In disposition they are fearless and ambitious. These horses have great endurance. They are used principally for racing purposes and for mating with heavier horses possessing less spirit. The characteristics of the English and American Thoroughbred are so nearly alike that it is unnecessary to describe the latter.

American Saddler — The American Saddler, like the American Trotter, had its origin very similar to that of the American Thoroughbred, the blood of the English Thoroughbred being the most conspicuous factor. The most desirable saddlers are those with the most graceful carriage and springy saddle gait. The American Saddler is bred quite largely in Missouri and Kentucky, and he is rapidly becoming an important factor in the horse-breeding interests of the United States. Horses largely of thoroughbred and trotting or pacing blood, which have shown especial adaptability for saddle purposes, have been selected until a breed has been developed which for intelligence, easy, and clean-going action is not surpassed. They are a breed of remarkable beauty and graceful carriage. In size they rank with the English Thoroughbred.

BREEDS OF SHEEP

The breeds of sheep best known in the United States belong to one of the following classes: First, fine wooled; second, medium wooled; and third, coarse or long wooled class. The various races of *Merinos* are practically the only fine wooled breeds. The *Southdown, Shropshire, Hampshire, Oxford, Dorset Horned,* and *Cheviot* are the principal medium wooled breeds. The *Leicester, Cotswold* and *Lincoln* belong to the coarse or long wooled class.

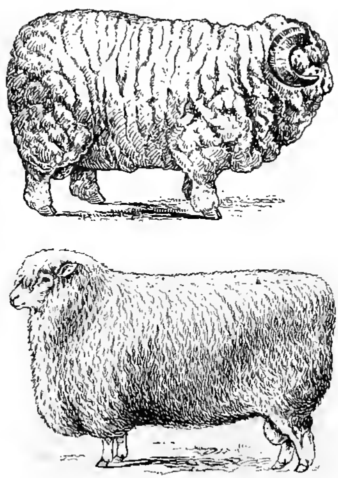


Fig. 131. Typical Merino and Cotswold.

FINE WOOLED

Merino — There are two great subdivisions of Merinos: First, those which are bred primarily for wool, like the *American, Spanish,* and *Saxon Merinos;* and second, those which are bred for both wool and mutton. This latter sub-

FIG. 132. Typical Delaine Merino.

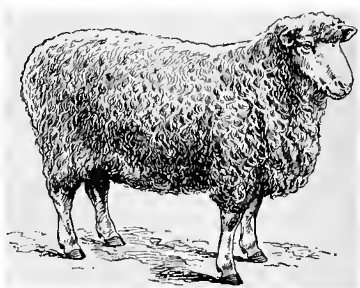
division includes the various breeds of *Delaine Merino* sheep and the *Rambouillet* (Fig. 1).

Of the Merinos bred primarily for wool, the *American Merino* is by far the most important breed. They shear a fleece of great fineness and weight. The body is more or less covered with wrinkles which lengthen into folds of considerable prominence on the shoulder and neck. The wool is rather short of staple and very oily. It is used for the manufacture of the finest woolen fabrics. Owing to the inability of the American Merino to produce a good carcass of mutton at an early age, and to the fact that fine wool has sold at a discount, the breed has been in disfavor in the United States for a few years past.

A united effort has been made among the breeders of Merino sheep to develop breeds of wool-mutton Merinos. Considerable progress has been made along this line in the United States, France, and Germany. There are a number of breeds belonging to this subclass, among which are the *Standard Delaine,* the *Black Top,* the *Dickinson Delaine,* and the *Rambouillet.* The first three originated in the United States and the Rambouillet in France.

The American breeds of Delaine Merinos are quite similar in their characteristics. They possess bodies carrying more flesh than the American or Spanish varieties so that they are considered fairly satisfactory for mutton production. It can hardly be said, however, that they rank with the English mutton breeds in this respect. They are more early maturing than the American Merinos and produce a fleece of good length of staple. Their wool commands a ready sale at a good price in the wool markets of the United States.

The Rambouillet is considerably larger than the wool-mutton American Delaines. They are more rangy and coarser in conformation throughout. While they are not as good shearers or as close to the ground as our American Delaines, they are more vigorous and growthy, being especially adapted for use on the western range.



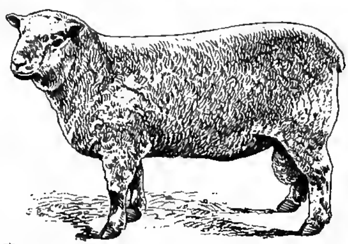


FIG. 133. Typical Lincoln and Southdown.

MEDIUM WOOLED

Southdown—The Southdown conforms more nearly to the ideal mutton type than does any other breed of sheep. They are low set, broad, deep, and thick-fleshed. They are noted especially for their development of the leg of mutton, their well fleshed backs, and the quality of their mutton. Their fleeces are somewhat lighter than those of the other middle-wooled breeds, but it is fine in quality. Mature rams should range in weight from 175 to 225 pounds and ewes from 135 to 165 pounds. The Southdown ram is highly

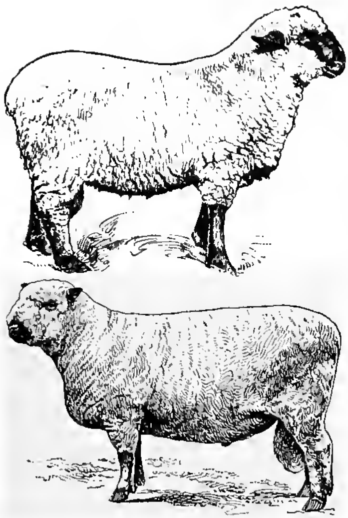


FIG. 134. Typical Hampshire and Shropshire. (Hampshire, from a photograph of Columbian Exposition sweepstakes winner, furnished by *The American Sheep Breeder.*)

prized as a sire for early lambs. The faces and legs of the Southdowns are usually gray or cinnamon brown in color. Like all other Down breeds they are hornless. The Southdown has been extensively used in the improvement and refinement of some of the other middle-wooled breeds.

Shropshire — The Shropshire is the most numerous and the most universally popular of the English mutton breeds. They are of medium size, mature rams ranging in weight from 175 to 250 pounds with ewes about 50 pounds lighter. They carry a fleece of medium fineness and length. The average weight of the Shropshire fleece ranges from 8 to 12 pounds. While Shropshire rams have been known to shear 18 pounds, fleeces of such weight are exceptional. Breeders of Shropshires have made an effort to preserve the Southdown ideal mutton type in a larger, more growthy sheep. In many respects they have been eminently successful. The Shropshire has more wool on the face and legs than the Southdown, while the color of the face and legs is a blackish or grayish brown. In its wide distribution and universal popularity, the Shropshire bears the same relation to sheep husbandry that the Shorthorn does to the cattle-raising industry.

Hampshire — The Hampshire may be distinguished from the Shropshire by its greater scale and weight, its heavier bone, coarser head and ear. The face, legs, and ears are considerably blacker, and the head is not so well covered with wool. The fleece is similar to that of the Shropshire, but usually a little shorter in the staple, although quite often more dense. Mature rams should weigh from 225 to 300 pounds and ewes from 160 to 250 pounds. Like the Shropshire, the Hampshire ram crossed upon native or grade Merino ewes produces an excellent lamb for fattening purposes, especially where the lamb is to be marketed under one year of age. This breed is largely used in its native home for crossing with the larger, less compact, long-wooled breeds.

Oxford — The Oxford is the largest of the middle-wooled breeds. In fact, their wool is long enough to frequently grade as combing wool. Mature rams should weigh from 275 to 400 pounds and ewes from 175 to 260 pounds. The Oxford is undoubtedly the result of crossing the Cotswold with the Hampshire. They are a very hardy race and well adapted to low, luxuriant pastures and liberal feeding.

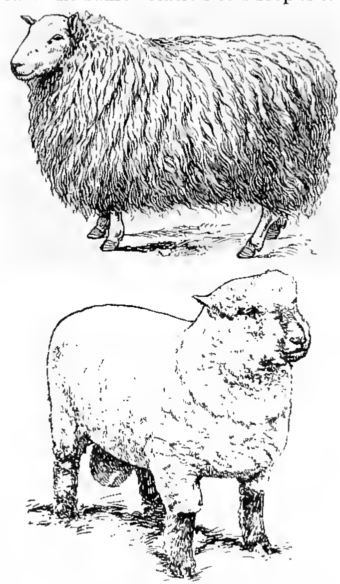


FIG. 135. Typical Cheviot and Oxford.

Dorset Horned — The Dorset Horned breed is the most prolific breed of sheep in the United States. They are the only medium-wooled breed that have horns, both the ewes and the rams possessing them. Their faces and legs are white. The legs show but little wool below the knees or hocks. Mature rams weigh from 175 to 200 pounds, and ewes from 35 to 50 pounds lighter. Dorset Horned sheep have a tendency to be light in the fore quarter and deficient in the girth. They produce a light fleece of wool possessing but little natural oil. As has been said, however, they are the most prolific of breeds and withal heavy milkers, hardy, and early maturing. They have given excellent satisfaction when used to produce early lambs.

FIG. 136. Typical Dorsetshire ram.

Cheviot — The Cheviot is a native of the Cheviot Hills. They are scattered over England and Scotland wherever conditions for their proper development are favorable. They are known as a "hill" breed in Great Britain and are well adapted to what is known as the "green hills" of England and Scotland. They are a good mutton sheep, being low, compact, and broad. Mature rams should weigh not less than 175 pounds and ewes not less than 135 pounds when bred in the United States. The range of weights in imported stock is somewhat less than this. Their wool contains but very little oil. They are very hardy and moderately early maturing. Their grazing qualities are excellent, but not on coarse grass, as they prefer short, fine herbage. They like the freedom of the hillside and do not take kindly to confinement. They are regular, but not what might be called prolific breeders. They shear from 6 to 9 pounds of wool.

COARSE OR LONG WOOLED

Leicester — The Leicester bears the same relation to other long-wooled breeds that the Southdown does to the Down breeds; that is, they have been used to improve and to refine the somewhat coarser breeds of their class. They were much improved by Robert Bakewell about 1780, at which time they were the most popular of the mutton sheep in England. At the present time they are looked upon more as a valuable breed for crossing purposes than where bred pure. They are, perhaps, more compact than the other long-wooled breeds, and rather more early maturing. Their fleece, however, is not as heavy as either the Cotswold or Lincoln. In size they are similar to the Hampshire.

Cotswold — The Cotswold (Fig. 131) is a very old race of sheep. Their characteristics are said to have been fixed as early as the thirteenth century. Some improvement was wrought after Bakewell's time by the use of the Leicester cross. Mature rams weigh from 250 to 300 pounds. Their heads are long, rather large, and decorated with a long forelock of curly wool. The ewes of this breed are said to be very good mothers. The lambs are somewhat delicate at birth. Cotswolds are noted for the production of combing wool. Their faces and legs are white with often a light grayish tinge. Their fleeces range from eight inches to a foot in length and weigh from 12 to 18 pounds.

Lincoln — Lincolns (Fig. 134) are the largest framed, heaviest, and longest wooled breed of sheep with which we have to deal. They are a hardy race and adapted to low land where pasture and succulent food are abundant. It is believed that the Lincoln, like other long-wooled breeds, contain slightly more fat throughout their carcasses than the Down breeds. Owing to this fact they are not so well liked by many American markets.

BREEDS OF SWINE

All breeds of swine belong either to the fat or the bacon class. This appears to be a legitimate and reasonable basis for classification.

The leading breeds of fat hogs are *Poland China, Berkshire, Chester White, Duroc-Jersey, Cheshire,* and *Victoria.*

The leading breeds developed especially for the production of bacon are the *Tamworth* and *Large Yorkshire.*

FAT HOGS

Poland China — The Poland China breed originated in the United States in Butler and Warren counties, Ohio. They are now, after being bred pure for over half a century, the most popular breed in the corn belt of America. Some few have been exported to Canada, but they are not popular there. Poland Chinas are sometimes classed as the heaviest of the medium breeds. They were formerly larger and coarser than at the present time. For several years breeders of Poland Chinas have selected them for early maturity and quick fattening qualities. Besides their early maturing qualities the Poland China is unusually good in the hams. They lack somewhat in prolificacy and strength of bone. For crossing with the coarser, less refined, common stock of the country, they are unsurpassed. Mature boars in good flesh should weigh not less than 500 pounds; sows, same age and condition, not less than 450 pounds.

Berkshire — This breed (Fig. 138) derives its name from the locality in which it originated, viz., Berkshire, England. They are the most popular breed of swine in Southern England and they have been more largely imported to the United States than any other foreign breed. They are hardly as large as the Poland Chinas, but they mature at an early age, which is more important. Boars in good flesh, two years old or over, should weigh not less than 450 pounds; sows, same age and condition, 400 pounds. Berkshires are good grazers, being active and possessed of good quality of bone. They dress a high percentage of meat and their flesh makes excellent pork or bacon. Advocates of this breed insist that the fat and lean are more evenly distributed throughout the carcass than in the Poland China. There is less uniformity in this breed than in Poland Chinas, but they are rather more prolific.

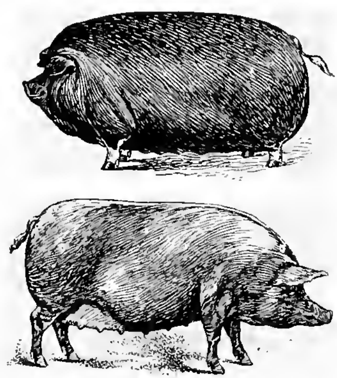


Fig. 137. Typical Poland China and Tamworth sows.

Chester White — Like the Poland China the Chester White is purely an American breed. They originated in Chester County, Pennsylvania. They are an older breed than the Poland China, and considerably larger and coarser. They are more numerous in Pennsylvania and Ohio than in other States, although they are to be found in nearly every State in the Union. Mature boars should weigh not less than 500 pounds and sows not less than 450 pounds. They are not quite so early maturing as the Poland Chinas. Their larger size seems to require a longer time for maturity. Chester Whites are good grazers. They are considered valuable for crossing upon finer boned and more compact breeds. In their leading characteristics they are similar to the Berkshire and Poland China, making them desirable for those preferring a white hog.

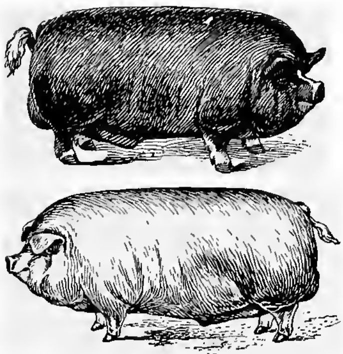


FIG. 138. Typical Berkshire and Chester White boars.

Duroc-Jersey — The Duroc-Jersey is the most recent of our American breeds of swine. Perhaps no breed of swine has improved so much in the last ten years as has the Duroc-Jersey. As a result they are rapidly growing in favor in the corn belt, and give promise of permanent popularity. Owing to the fact that the breed is not an old one, the Duroc-Jersey type is not as uniform or as well fixed as in some of the older breeds. They vary much in color, size, and early maturing qualities, consequently it can hardly be said that they are as early maturing as the Poland China, but they possess an advantage in being more prolific. Their grazing qualities are excellent and they are hardy. They have a good side, but need improvement in their hams.

Cheshire — The Cheshire undoubtedly had their origin in the native white hogs of Jefferson County, New York, which were crossed with large improved Yorkshires and Suffolks. They are chiefly bred in the Eastern States, rarely being seen in the corn belt or farther west. They are considerably smaller than the Poland China, early maturing, and fair grazers. Their flesh is firm and fine-grained. In disposition they are quiet.

Victoria — Victorias may belong either to the strain originated by Colonel Curtis of New York or Mr. Davis of Indiana. The characteristics of these two varieties are very similar. In size they rank with the Berkshire, and in other characteristics they resemble the Chester White, although they undoubtedly are finer and more early maturing.

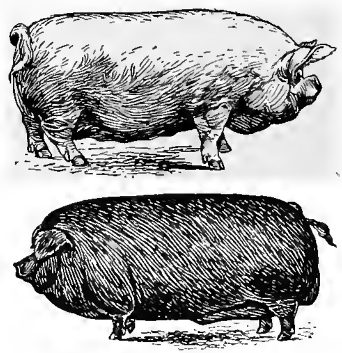


FIG. 139. Typical Yorkshire sow and Duroc-Jersey boar

BACON HOGS

Large Yorkshire — Yorkshires originated in York shire, England. No other breed is as popular for the production of bacon either in Great Britain or America. They are especially highly prized in Canada. Their bodies are very long and while they do not possess the width of the Chester White, they are usually longer, deeper, and heavier. They have scarcely the depth of the Tamworth. They are strong boned, but rather late maturing. They are good grazers and the quality of the meat is excellent.

Tamworth—The Tamworth (Fig. 137) is another English breed which originated in Staffordshire, England. They are remarkable for their depth of body, thus furnishing an excellent foundation for the production of good bacon. They are similar in size to the Large Yorkshires. They can not be made a satisfactory fat hog without considerable age, but are especially adapted for the production of bacon. As grazers they are probably unexcelled. Their carcasses are said to contain a higher percentage of lean to fat than any other breed of swine. Tamworths are very prolific.

II. THE BREEDING OF FARM ANIMALS

ADVANTAGES OF STOCK RAISING[1]

The majority of farmers believe that there are distinct advantages in the keeping of live stock on the farm; few, however, appreciate that for permanent success the keeping of stock is imperative. To emphasize this thought it is advisable to enumerate the advantages of the keeping of live stock on the farm, before attempting to discuss the general principles upon which the successful breeding of domestic animals depends.

Soil Improvement—The most important reason why live stock should be kept on the farm is that the fertility of the land may thereby be maintained or increased. A system of grain farming is a constant drain on the fertility of the land, unless an expensive system of green manuring or fertilizing is frequently resorted to. It should be borne in mind also, that farmyard manure has the double function of improving the physical as well as the chemical properties of most soils. Without the use of farmyard manure commercial fertilizers lose a large part of their effectiveness. No other system of maintaining or increasing the fertility of the soil has been found so generally effective or so cheap as has the use of farmyard manure.

The source of farmyard manure is live stock, and under proper, intelligent management it will return a profit to the farmer beyond the fertilizing value of the manure produced. It would seem that the possibility of marketing crops grown on the farm in the form of cash live-stock products at a higher price per bushel than that which can be secured for the grain, and having the manure left for keeping up and rendering more available the plant food in the soil, is an argument which ought to appeal to every practical man. Not only this, but, notwithstanding the

[1] See also page 31.

fact that a system of stock farming involves more labor than one of grain growing, a modest profit may be secured upon all such labor.

Profit in Rotation — The maintenance of soil fertility is undoubtedly one of the greatest problems connected with successful agriculture. In considering it, two important factors should receive attention: First, the amount of plant food in the soil, and second, whether or not such plant food is available. While tillage does not add to the fertility of the soil, it renders the plant food in the soil more available. A proper rotation of crops may perform the same function, while farmyard manure has, as has been said, the double function of actually adding plant food to the soil and rendering the supply already in the soil more available for use of the plant. Animal production on the farm renders the probability of profit from a rotation of crops greater. Certain crops that can not be sold as grown upon the land can readily be converted into cash products in the form of meat or dairy products.

Since it is desirable to grow a variety of crops on the land, we would mention as the second advantage of keeping live stock on the farm, the possibility of growing a greater variety of crops.

Utilization of Wastes — Third, live stock consume the residues of the farm, such as straw, corn stover, and the like.

Distribution of Labor and Income — Fourth, the labor necessary to carry on the farm is much more evenly distributed throughout the year where stock raising is a part of the general plan. It is a well-known fact that in a system of grain growing it is necessary to keep a large number of horses and men during certain seasons, while at others these teams are idle and but little work, if any, can be furnished to the men. It is an advantage to keep the men and to have profitable employment for the teams throughout the year. No successful business man or manufacturer would think of running his plant but six or eight months in the year. Fifth, animal production distributes the farmer's income throughout the year.

Granting, then, that the keeping of live stock is advisable, we are ready to consider the principles underlying the breeding of farm animals. It is not our purpose in this chapter to discuss the question of how to select a good cow, either for dairy or for beef; a good sheep, for wool or for mutton; a good pig, for hams or for bacon; nor yet a good horse, for draft or for carriage purposes, but rather to consider some of the fundamental principles which apply alike to the breeding of all animals. The subjects enumerated will be discussed elsewhere.[1]

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[1] See page 249, *et seq.*

There are several different systems of stock farming. In the interest of clearness it is well to distinguish between: *First*, the man who is making the business of breeding stock for breeding purposes only, in which instance it would be a question largely of breeding pure-bred animals; *second*, the man who is breeding market animals — either horses, cattle, sheep, or swine — the man who looks upon pure-bred animals as a means to an end, but who is not engaged in their breeding and sale; and, *third*, the man who is a feeder and not a breeder of live stock. The business of such a man is to fit animals bred by others for the market. Manifestly, what follows relative to the principles of stock feeding would be of little interest or importance to the man who simply feeds stock. An effort is made to make what is said applicable to the two other classes of stock farmers.

In breeding live stock the first necessary operation is the selection of breeding stock.

GENERAL RULES FOR SELECTION

1. **Fundamentals in selection**—In selecting animals, two things are to be considered: The *individual excellence* of the animal, and its *ancestry* or breeding.

2. **Select toward an ideal type**—Select pure-bred animals, or high grades of a breed conforming as nearly as possible to that ideal type. Do not try to remodel a breed, nor, in general, attempt to establish new breeds.

Do not confuse the terms *breed* and *type*. A *type* refers to a class of animals which in their leading characteristics, adaptability, and usefulness are very similar. It will be seen from this that it is possible for a type to include individual animals of various breeds. As, for example, Shorthorns, Herefords, Aberdeen-Angus, Galloways, and Polled Durhams all conform, or should conform, to the beef type; and again, Jerseys, Guernseys, Holstein-Friesians, and Ayrshires conform to the dairy type. The term *breed* refers to a group of animals closely related in general blood lines which may or may not bear a close resemblance to one another in size, form, and color, and which have the ability to reproduce other animals that will inherit their various characteristics, some of which may be nothing more than breed characteristics.

It is possible, but not often the case, that a breed includes more than one type, as is seen in the Shorthorn breed. Some Shorthorns are distinctly of the beef type, while others conform more nearly to the dairy type. The term *breed* is never used except in referring to pure-bred animals, while it is entirely correct to use the term *type* in speaking of grade or cross-bred animals.

3. **Personal preference** is an important factor in the selection both of a class and of a breed of stock.

4. **Choose deliberately**—It is economy to take plenty of time to decide

the class, type, and breed of animals best suited to your conditions, so that, once a choice is made, a *permanent policy* may be pursued.

5. **Select for uniformity** — In the breeding of market stock, a uniform load of steers, hogs, or sheep will command their full value in the market, whereas a mixed consignment might be sold at a discount. Careful attention to the question of uniformity in the selection of the breed of animals to comprise a breeding herd of pure-bred stock is of still greater importance than in the breeding of market animals. The history of successful stock breeders of the past leads us to conclude that many a breeder's reputation has been won by persistent adherence to a definite type. In other words, the individuality of herds and flocks has made many a breeder famous.

6. **Select animals with pronounced constitutional vigor** and from strains of blood known to possess *longevity* and *sustained fertility.*

7. **Select for quality** rather than for size. Unusually large animals belonging to a particular breed or class of animals are spoken of as possessing "plenty of scale," or "great scale." Quality refers both to the feeding quality of an animal (as indicated by conformation and good handling quality) and to general quality, or a refinement of form and feature — characteristic evidences of good breeding.

8. **If breeding animals for the open market,** select animals with reference to their being adapted for feed lot, stable, or harness rather than for so-called "fancy points" of breed type.

9. **If breeding registered or pure-bred stock,** due importance should be attached to these so-called characteristic points of breed type. The successful breeder of pure-bred stock realizes that it is not to his advantage to breed animals for which there is no sale, whether it be on account of their color, pedigree, or general conformation.

10. **Adaptation** — Select animals with *temperaments* adapted to the purpose for which they are intended.

11. **Finally,** having satisfied yourself as to the individual excellence of the animal, the ancestry or breeding should be taken into account, since this factor materially affects the *prepotency* of the animal, an important subject which will be considered elsewhere.[1] All animals need proving; the best breeding animals are those that produce the best individuals, and not necessarily the ones that show best individually.

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[1] See page 229.

HEREDITY, PREPOTENCY, AND REVERSION

Of all the laws affecting the breeding of live stock, the one most important to the majority of stock farmers is the law of heredity, or that "like produces like." It is doubtless the oldest recognized law of animal reproduction. No other law has been so much discussed, and it would seem that nothing could be added to give greater force to this important law. Notwithstanding these facts, no author discussing the principles of animal breeding can do other than consider this subject at length, not alone because its importance demands it, but because of the widespread indifference to its workings.

Heredity — So far as we can judge from our present knowledge of the workings of the law of heredity it appears that there is a *tendency* for each individual characteristic in the parent to be transmitted to and reappear in the offspring. When offspring appear which bear only a remote resemblance to their ancestors, skeptics are inclined to lose their faith in the unvarying law of heredity. A few of the best authorities on animal reproduction are beginning to look for the inheritance of individual character from generation to generation rather than the inheritance of characteristics in groups — characteristics which go to make up the individuality of the animal itself. This leads to the thought that in the past our ideas of hereditary transmission have been somewhat at fault, since we have been demanding that the characteristics of animals should reappear in the offspring in bulk rather than as individual characters. A study of the workings of the law of heredity should, therefore, involve chiefly a study of the inheritance of individual characteristics from generation to generation.

Experienced stock breeders expect that certain characteristics — for example, such as are normal or natural to the race or breed — will be transmitted with greater certainty than others.

Breeding with Definite Aim — It is evident that where two animals possessing similar characteristics are mated, the characteristics of the family or breed to which the parents belong will be transmitted much more certainly than where animals are mated possessing noticeably different characteristics. If, therefore, we are especially anxious to improve a certain point in animal form, it is obvious that we should mate animals which possess that particular characteristic to a high degree. In theory this is what is done by all breeders of pure-bred stock. Owing to carelessness in the selection of breeding animals and their mating, few breeders succeed in making permanent improvement in their herds. In fact, they are frequently obliged to purchase high-class bulls at long prices to maintain the excellence of their foundation stock.

Prepotency — When an animal has the ability to transmit its characteristics to its offspring with great certainty it is said to be *prepotent*. Among the conditions that are believed to affect the relative prepotency of an animal are: *First,* the breeding of the animal; *second,* its age or maturity; and *third,* the prepotency of the animal with which it is mated.

THE BREEDING OF IMMATURE STOCK, which is all too common, can not be too vigorously discouraged. The great popularity of the mutton breeds of sheep and their relatively high price, a few years ago, led to the extensive use of ram lambs. The author has reason to believe that such practice, except in rare instances, has proved unwise. It is best, from a monetary standpoint, not to permit ewes to drop their lambs before the ewes are two years old, or beef cattle their calves before the heifers are from two and a half to three years of age. The animal should be practically mature before called upon to reproduce itself. If any other system of breeding is followed the chances are that either the parents or offspring become dwarfed or unprofitable animals. The best results in breeding are to be expected when the animals reach full maturity and are in the prime of life, being neither too young nor too old.

RELATIVE PREPOTENCY OF PARENTS — Since the sire often appears to be more prepotent than the dam, many have come to look upon the sire as having a greater influence upon the offspring than the dam. The sire has undoubtedly been selected with more care, both as to his individuality and, more especially, as to his breeding, than the dam. Granting that the inherent prepotency of the sire and dam are the same, or that the simple question of sex is involved, each parent will have an equal influence in adding the characteristics of the offspring, since, so far as our present knowledge goes, sex as such has little or no bearing upon the prepotency of an animal. The fact that the sire is usually better bred and a better individual fully accounts for the impression that prevails.

Breeding and Prepotency — It is true that prepotency is influenced to a greater extent by the breeding of an animal than by any other factor. When an animal of low breeding and inferior merit is mated with a well-bred animal of high individual excellence, the offspring will resemble the well-bred parent much more than the one of low breeding. This question can not be too carefully considered by stock farmers who are breeding market animals. After good foundation breeding stock has been selected, the question of success hinges upon the ability of such animals to reproduce their kind. The fact of the relatively high prepotency of well-bred animals has long since become well established. No other fact or law connected with animal reproduction is more important, for it places within the reach of every stock farmer the possibility of producing animals of high individual merit which will meet every demand of the open market at a price that will render their production highly profitable. It makes it possible for the stock farmer to select females of only ordinary merit and of indifferent breeding at a low price and mate them with well-bred sires possessing to a high degree characteristics demanded by the market.

Comparative Influence of Sire and Dam — The relative importance of the sire and dam in stock breeding is not fully appreciated by American farmers. It should be borne in mind that the sire becomes the parent of numerous offspring, while it is possible for the dam, at best, to produce only a few individuals annually. As an illustration of how completely this idea is lost sight of by some inexperienced men, we relate the following incident: Not long since a young man in the Central West decided to become a breeder of Shorthorn cattle. He purchased ten cows at prices ranging from $250 to $500. After the cows and heifers were delivered at his farm, the purchase of a bull appeared to him to be the next necessary step. Instead of taking plenty of time and asking the advice of experienced breeders, this young man found a bull which could be bought for $125 — a bull without individual merit and of indifferent breeding. This animal was purchased and placed at the head of the herd. Such a course, every experienced breeder will understand, can have but one outcome, namely, a failure to maintain the excellence of the foundation females, much less to improve them.

At the present time females among pure breeds in the United States are selling at a much higher price, relatively, than our bulls. If a breeder can afford to pay $1,000 for a cow, he can afford to pay at least $5,000 for a bull. And yet, while we find many men who are anxious to pay $1,000 for a cow, how few would care to buy bulls at the figure stated. To be sure, the figures quoted are exceptional and not within the reach of the average breeder. However, the principle holds true, whether the quality of the stock commands $5,000, $1,000, or $100.

Much of what is good in our breeding of live stock has been copied from the best breeders of live stock in Great Britain. A study of the conditions in Great Britain will at once convince the most careless observer that good sires are appreciated to a much greater extent there than in the United States. The writer can not recall a single breeder of improved live stock, whose reputation and the excellence of whose stock is well known, who has not achieved this success largely through the intelligent or fortunate selection of one or more great sires.

Breeding of Mules — Successful rearing of mules consists, principally, in the judicious selection of the mare. The dominant features of the ass require modification. The ass is too large of head, too short of neck, too flat in sides, too low in shoulders, too narrow in croup, too thin in arms and thighs, and too narrow in hoof. These defects must be altered by the mare.

On the other hand, the ass is preferable to the horse as a beast of burden, more patient in work, hardier, thicker-skinned, surer-footed, and especially adapted to warm climates.

The natural defects of the ass indicate what should be avoided in selecting a sire-ass for breeding. He should have relatively, a small head, thin neck, round body, high shoulders, broad croup, well-formed legs, and flat hoofs.

The mare, on the other hand, should have a small head, short, round body, broad chest, muscular thighs, and wide, round hoofs. She should be fourteen or fifteen hands high, to insure a foal that will at maturity reach thirteen or fourteen hands.

The foal, therefore, it is to be borne in mind, takes form and peculiarities from the sire; size, from the mare. It rarely inherits physical unsoundness from the mare, which may therefore be used where she would be excluded as a breeder of horses. The mule is rarely serviceable before it is four years old, but often works until thirty years of age.

Reversion — It is sometimes discovered that characteristics appearing in the offspring, apparently entirely different from those present in either parent, are characteristics which were present in some ancestor more or less remote. When an animal resembles quite closely a distant ancestor it is a case of *reversion*. Other terms sometimes used to mean the same thing are "throwing back" and "breeding back."

If the various ancestors of an individual animal have possessed to a marked degree desirable characteristics, and have not possessed undesirable characteristics to a marked degree, instances of reversion or atavism, in such cases, are not to be dreaded. On the other hand, if in the pedigree of an animal there appear a number of animals which possessed undesirable characteristics to a marked degree, it is not known at what time these undesirable characteristics will reappear in our breeding operations. It will be seen from this that a good pedigree, or good breeding, means that an animal shall be descended from a long line of ancestors of pronounced merit and that there shall be but few inferior animals in the pedigree. Naturally, the longer the line of good ancestors, the more prepotent they will be, and their prepotency will extend along desired lines. It should be borne in mind that the laws governing hereditary transmission, atavism, and prepotency are equally operative upon internal as well as external characteristics of the animal, and with reference to undesirable characteristics as well as to those which are desirable.

Pedigree in Grade Animals — Stock farmers quite generally are more or less indifferent as to the principles of animal breeding, believing such principles to concern only breeders of pure-bred animals. For example, the question of pedigree in grade animals is universally disregarded, although, as a matter of fact, every animal has a pedigree, whether it be native, grade, cross-bred, or pure-bred. The same things that make a good pedigree in pure-bred animals make a good pedigree in grade or cross-bred animals. The matter of selection of breeding stock is of greater importance in the breeding of pure-bred animals than in the breeding of grades, not only because a larger amount of capital is invested in each individual animal, but because pure-bred animals bred in line for generations are more prepotent than grade animals, and when we remember that prepotency is just as effective in the transmission of undesirable as desirable characteristics, and since we know that pure-bred animals are more prepotent than grades, we must be especially careful in the selection of pure-bred animals to get high individual merit.

Breeders of registered animals too often attach too much importance to pedigree and too little to individual excellence, while breeders of animals for the market frequently attach too little importance to pedigree and too much to individual excellence.

Registry no Absolute Criterion—It is well to remember that not all pure-bred animals are well bred, or in other words, not all pure-bred animals have good ancestors. Breeders' registry associations in the United States have thus far made but little progress in an attempt to make high individual merit a factor in the eligibility for registry; about all that is expected is that satisfactory evidence shall be furnished that the animal is descended from registered stock. Many stock farmers have made a mistake in believing that because an animal is registered, it is one of high individual excellence, and that a certificate of registry is a guarantee of the future usefulness of an animal. In most breeders' associations, a certificate of registry simply guarantees to the purchaser that the animal is descended from registered stock.

In buying pure-bred animals, the reader should satisfy himself on two points: *First*, the presence in the pedigree, close up to the animal involved, of a large number of animals of high individual merit; and, *second*, the absence of any considerable number of inferior animals, especially during the last few generations.

CORRELATION AND FECUNDITY

It has been observed that certain groups of characteristics in animals vary simultaneously, or in other words, that any circumstance or condition which affects one character is more than likely to change some other characteristic of the animal. For example, an unusual development in the fat-forming tendencies in animals appears to be detrimental to prolificacy and often to fecundity, as well as to any natural tendency for the production of a large amount of milk. Another example along the same line is that the horns of a wether never develop as do those of a ram. Many other examples might be cited, but as all would simply illustrate the same principle, those given will be sufficient.

The important thing for the breeder to consider in this connection is that a successful attempt to improve to any considerable extent a characteristic which from his standpoint is particularly desirable, may be followed by alterations desirable or otherwise in some other character of the animal, and that the unduly high development of one part or characteristic of an animal is usually at the expense of some other part.

Conditions Affecting Fecundity—An animal is said to be *fecund* when it is fertile or has the ability to reproduce itself. An animal is said to be *prolific* when it is not only fecund, but also has a tendency to produce, at regular intervals, young in abundance. In general, the domestication of animals appears to have been favorable both to fecundity and to prolificacy. This is doubtless due to the fact that domesticated animals may be more regularly and intelligently nourished. Confinement of wild animals, on the other hand, has been shown to be unfavorable to fecundity.

The amount and kind of food also affects fecundity. In general, a laxative diet of succulent foods is favorable to fecundity, while dry foods and those which are designated as heating foods are unfavorable. Food-stuffs containing a large percentage of sugar are, in good practice, withheld from breeding animals, because it has been shown that such a diet is not well adapted to the securing of good results from breeding animals. Animals in the prime of life are more fecund than the immature, or than animals of advanced age. Young sows farrowing their first litter, for example, seldom produce as large litters as do fully matured sows, and the same has been observed in the breeding of immature ewes.

GRADING, CROSS-BREEDING, IN-AND-IN-BREEDING, AND LINE-BREEDING

A system of breeding which involves the use of females of a common grade of more or less indifferent breeding, and the use upon these and their female progeny of pure-bred sires of merit for a series of years, is spoken of as *grading-up* or *upgrading*, the thought being that with each successive generation improvement upon the original stock is effected. Such a system of breeding is the most rational and valuable one within reach of the conditions which surround the average farmer. By starting even with females which have little to commend them, and mating them with pure-bred sires possessing to a marked degree the characteristics desired, rapid improvement is effected.

It is of course unnecessary to start with distinctly inferior common stock. It is often economy to buy the best grade stock obtainable and buy pure-bred sires of correspondingly high merit. The first introduction of the blood of the pure-bred sire upon the common stock of the country is followed by the greatest improvement; successive crosses show less rapid improvement until the fifth or sixth generation, when the grade females resulting from a system of grade breeding are practically as good for the production of market animals as pure-bred females would be, provided purebred sires of high individual merit are always selected.

The economy of such a system of breeding for the production of market animals will at once appeal to stock raisers, since it places within their reach the possibility of producing animals that will in every way meet the demands of the open market, without the necessity of purchasing highbred females which, at best, during their whole period of usefulness, can influence only comparatively few offspring.

Cross-breeding — The correct use of the term *cross-breeding* is in applying it to a system of breeding involving the use of pure-bred parents of different breeds. It is not difficult to see that if such a system of breeding were persistently and universally followed it would not be long before our improved breeds would lose their identity and individuality. There can be but little question that such a system of breeding has been followed by good results in certain instances, especially in the production of market animals. While such a system of breeding has been employed in one or two instances in the origination of breeds of live stock, an attempt to use it for this purpose has usually been followed by failure; especially has this been found true where breeds of widely different characters have been crossed.

The valuable Oxford breed of sheep is undoubtedly the result of crossing the Old Hampshire and Cotswold breeds. It is not, however, for the production of new breeds that this system of breeding should be employed. For the production of animals for the block this system has been followed by good results where intelligently employed. By "intelligently employed" is meant the mating, for the production of meat-producing animals, of pure-bred individuals, of breeds bred for, and possessing, leading characteristics of a similar nature. This holds true only in some instances, as certain breeds do not appear to "nick" well, even though bred with the same object in view.

In the use of this system it is necessary to hazard the possibility of a failure by experimenting with new crosses or cross-breds, or use only such crosses as experience has long since proved will be followed by good results.

The crossing of the Berkshire and Poland China breeds of hogs for the production of pork has proved a good one. The cross-bred animal resulting from the mating of the Shorthorn and Galloway breeds for the production of prime steers has also been found successful. Scotch and English farmers often cross the Cheviot and the Leicester with good results. Other examples might be given, but in the judgment of the author, such a system of breeding will seldom be followed by any considerable number of stock raisers, and largely because of the practical reason that no matter how successful it may be it is open to the same objection as a system of breeding market animals from pure-bred dams and pure-bred sires of the same breed, viz., the expense of pure-bred females is in general prohibitive if the progeny can be sold only in the open market for prices which are little, if any, better than those which it is possible to secure for high grades produced by the intelligent and systematic use of pure-bred sires on common stock that has been graded up.

In-and-in-breeding — Inbreeding may be defined as a system of breeding together parent and offspring, or own brother's and sister's blood. No arbitrary rule has been agreed upon whereby we are able to define the term *close-breeding;* it may be looked upon, in general, as the mating of animals as closely related as second or possibly third cousins. No other system of breeding has been so generally resorted to by breeders who have achieved marked success in the improvement of breeds.

In the early history of all breeds, when it was highly desirable to establish a uniform type, and when there were but few animals of merit from among which to select breeding animals, it was found that a system of somewhat close breeding was not only the quickest and most satisfactory, but it was practically the only available system of breeding that would bring about satisfactory results. It was followed as a means to an end; it was used, not because the great breeders believed in a system of inbreeding, but because it was apparently necessary. A system of inbreeding, as practiced by the originators and early improvers of breeds, was a far different proposition from what it is at the present time. Breeds were founded by animals only distantly related, if at all. Now, a majority of our improved breeds contain scores of individuals closely related.

Inbreeding has been so generally practiced that its further use should be left to the master spirits of the breeder's art, and should not be pursued by novices in the business of breeding fine stock. Even those famous breeders who made extensive use of a system of inbreeding to improve their flocks and herds agreed that inbreeding, long persisted in, was bound to be followed by loss of size, vigor, and fecundity. In the hands of our best breeders, where only occasionally resorted to, it may prove a valuable system of breeding, to refine evidences of coarseness, to improve early maturing qualities, to establish uniformity, and to increase prepotency.

Line-breeding—Line-breeding is the breeding together of animals possessing a family relationship, but not close enough to be looked upon as close inbreeding. This system is the one usually advocated by adherents of the inbreeding system. It is the one which has been found more safe and satisfactory than the mating of more closely related animals. Its advantages, although somewhat longer in manifesting themselves, are the same as those which have in former years resulted from a system of inbreeding. If too long persisted in, the evil effects of the system will be the same as those noted in connection with a system of inbreeding followed by unskilled breeders.

VARIATION

All animals are more or less influenced by their environment or surroundings. Animals of the improved breeds deteriorate much more quickly when proper regard is not given to their comfort, feed, and other conditions surrounding them, than inferior animals improve, when surrounded by conditions well calculated to contribute to their general health, more rapid growth, and more uniform and perfect development. A very important factor in the improvement of our leading breeds of live stock has been the careful attention given to the surroundings of the animals at all times with conditions favorable for growth and development. Remove these conditions from animals of our improved breeds and they at once begin to deteriorate, and at a rapid rate. The excellence of pure-bred stock can not be maintained, much less improved upon, unless conditions under which these animals were developed and improved are continued. The feeding of animals, therefore, is an important factor in successful stock management.

Good Foundation Stock Essential—Before considering the subject of stock feeding, however, the importance of stock breeding should be emphasized. To the man who appreciates the differences between well-bred stock and inferior stock, there appears to be a vast amount of inferior stock throughout the country. This inferiority is due more to careless methods of breeding than to insufficient or injudicious feeding. The highest type of animal production is impossible without the right kind of animals with which to begin. Intelligent breeding is necessary to secure the right kind of animal. The breeding of animals is not an exact science, and although we make use of the best methods of breeding, we are not always certain of reaching the desired end. It is doubly important, therefore, that the possibilities of breeding inferior animals should be as far as possible eliminated. As our country grows older and the prices of land and food-stuffs increase in value, the possibility of securing a profit from the keeping of inferior stock will become less and less, and better quality in live stock will be a necessity.

In this connection it is interesting to note that the average quality of the live stock of Great Britain is much above that of the United States. In order to pay the rent the British farmer must keep profitable stock. Inferior stock has been found to be unprofitable; hence the uniformly good quality of their live stock. Conditions in the United States which have made it possible to render profitable the keeping of any grade of live stock, no matter how inferior, have not contributed to the upgrading of the common stock of the country. We must look to the future, with its conditions more nearly comparable with those of Great Britain, to bring about this desired end.

Management of Sires — The number of females a sire may cover without injury to himself or the quality of his get depends largely upon the age or maturity of the sire; the care in, or method of, standing him; his condition; his constitutional vigor; and the length of the breeding season. A bull may usually be depended upon to serve forty to sixty cows; a stallion, fifty to seventy-five mares; a ram, forty to sixty ewes; and a boar, fifteen to twenty-five sows, without injury to the male or his progeny.

IMPORTANT DATA REGARDING BREEDING

Animal	Age to Begin Breeding	Duration of Heat	Interval between Heats	Period of Gestation or Incubation	Return for Breeding after Parturition	Useful for Breeding
	Years	Days	Days	Days	Days	Years
Horse	4	5–7	21–28	337–419	7–10	10–12
Cow	3	2–4	21–28	226–326	21–28	10–12
Hog	1	2–4	17–28	104–127	35–42	6
Sheep	2	1–2	9–12	143–160	120–180	6
Goat	2	1–2		148–162	120–180	6
Rabbit	½ to 1			30		5–8
Hen	1			21		3–5
Turkey	1			28		10
Guinea	1			25		10
Duck	1			28–35		10
Goose	1			30–35		10
Dog	2			55–70		8
Cat	1			48–60		6

GESTATION CALENDAR

Average period of gestation with horses, 337 days; cattle, 282 days; swine, 113 days; sheep, 148 days.

Date of Service	Date on which Animal is Expected to Give Birth: Mare	Cow	Sow	Ewe
January 1	Dec. 2	Oct. 8	Apr. 22	May 27
" 6	" 7	" 13	" 27	June 1
" 11	" 12	" 18	May 2	" 6
" 16	" 17	" 23	" 7	" 11
" 21	" 22	" 28	" 12	" 16
" 26	" 27	Nov. 2	" 17	" 21
" 31	Jan. 1	" 7	" 22	" 26
February 5	" 6	" 12	" 27	July 1
" 10	" 11	" 17	June 1	" 6
" 15	" 16	" 22	" 6	" 11
" 20	" 21	" 27	" 11	" 16
" 25	" 26	Dec. 2	" 16	" 21
March 2	Feb. 1	" 5	" 22	" 27
" 7	" 6	" 13	" 27	Aug. 1
" 12	" 11	" 18	July 2	" 6
" 17	" 16	" 23	" 7	" 11
" 22	" 21	" 28	" 12	" 16
" 27	" 26	Jan. 2	" 17	" 21
April 1	Mar. 3	" 7	" 22	" 26
" 6	" 8	" 12	" 27	" 31
" 11	" 13	" 17	Aug. 1	Sept. 5
" 16	" 18	" 22	" 6	" 10
" 21	" 23	" 27	" 11	" 15
" 26	" 28	Feb. 1	" 16	" 20
May 1	April 2	" 6	" 21	" 25
" 6	" 7	" 11	" 26	" 30
" 11	" 12	" 16	" 31	Oct. 5
" 16	" 17	" 21	Sept. 5	" 10
" 21	" 22	" 26	" 10	" 15
" 26	" 27	Mar. 3	" 15	" 20
" 31	May 3	" 8	" 20	" 25
June 5	" 7	" 13	" 25	" 30
" 10	" 12	" 18	" 30	Nov. 4
" 15	" 17	" 23	Oct. 5	" 9
" 20	" 22	" 28	" 10	" 14
" 25	" 27	April 2	" 15	" 19
" 30	June 1	" 7	" 20	" 24

Date of Service	Date on which Animal is Expected to Give Birth: Mare	Cow	Sow	Ewe
July 5	June 6	April 12	Oct. 25	Nov. 29
" 10	" 11	" 17	" 30	Dec. 4
" 15	" 16	" 22	Nov. 4	" 9
" 20	" 21	" 27	" 9	" 14
" 25	" 26	May 2	" 14	" 19
" 30	July 1	" 7	" 19	" 24
August 4	" 6	" 12	" 24	" 29
" 9	" 11	" 17	" 29	Jan. 3
" 14	" 16	" 22	Dce. 4	" 8
" 19	" 21	" 27	" 9	" 13
" 24	" 26	June 1	" 14	" 18
" 29	" 31	" 6	" 19	" 23
September 3	Aug. 5	" 11	" 24	" 28
" 8	" 10	" 16	" 29	Feb. 2
" 13	" 15	" 21	Jan. 3	" 7
" 18	" 20	" 26	" 8	" 12
" 23	" 25	July 1	" 13	" 17
" 28	" 30	" 6	" 18	" 22
October 3	Sept. 4	" 11	" 23	" 27
" 8	" 9	" 16	" 28	Mar. 4
" 13	" 14	" 21	Feb. 2	" 9
" 18	" 19	" 26	" 7	" 14
" 23	" 24	" 31	" 12	" 19
" 28	" 29	Aug. 5	" 17	" 24
November 2	Oct. 4	" 10	" 22	" 29
" 7	" 9	" 15	" 27	April 3
" 12	" 14	" 20	Mar. 4	" 8
" 17	" 19	" 25	" 9	" 13
" 22	" 24	" 30	" 14	" 18
" 27	" 29	Sept. 4	" 19	" 23
December 2	Nov. 3	" 9	" 24	" 28
" 7	" 8	" 14	" 29	May 3
" 12	" 13	" 19	April 3	" 8
" 17	" 18	" 24	" 8	" 13
" 22	" 23	" 29	" 13	" 18
" 27	" 28	Oct. 4	" 18	" 23

III. PRINCIPLES OF STOCK FEEDING

Familiarity with the science, or the principles governing the processes, of stock breeding and stock feeding is highly desirable from the standpoint of the stock raiser. It is not to be asserted that such knowledge is absolutely necessary, for it is well known that we have many successful stock breeders and stock feeders who know little, if anything, about the principles of the enterprise to which they look with confidence for a competency. Success in farming is dependent more upon a thorough familiarity with the art or practice than with the science or fundamental principles of the business. The art is the practice of stock feeding. Successful stock feeding practice may be acquired from personal contact and experience, and by carefully observing the methods of our most successful feeders. Such experience is acquired, at best, but slowly, and often at great expense. However, a knowledge of the scientific principles of stock feeding makes it possible for the inexperienced to learn the art more quickly, at less expense, and withal more thoroughly. Fewer mistakes will be made in stock feeding practice by men who are thoroughly familiar with the principles of the business than by those ignorant of the same principles. Mistakes in feeding practice are more serious now than formerly, and with the lapse of time this factor will get worse instead of better, because competition will be keener, land and food-stuffs more valuable, and labor more expensive.

Professor Brooks of Massachusetts well says: "Some knowledge of the composition of animal products and of foods; some knowledge of the laws of nutrition, and of the facts discovered by scientific men regarding the most economical production of meat, of fat, of milk, and work, will help even the best practical feeder. Such knowledge will not render the exercise of the observing faculties and of the judgment the less important. It will rather sharpen the one and broaden the other."

Chemistry of Stock Feeding—In an attempt to discover principles of stock feeding, investigators have given much attention to the chemical problems, neglecting to some extent, perhaps, the physical and the physiological factors involved. It is a pardonable oversight, since investigations tending to throw light upon the subject should begin with a study of the chemical substances necessary for the development of plant and animal life. The existence of our farm animals is dependent upon plant life. There must, therefore, be certain elements or compounds in the plant that contribute to the upbuilding of animal tissues.

Of the seventy recognized chemical elements which in their infinite combinations form all organic and inorganic substances, only fifteen are involved in plant life, viz., *calcium, carbon, chlorine, fluorine, hydrogen, iron, magnesium, manganese, nitrogen, oxygen, potassium, phosphorus, silicon, sodium,* and *sulphur.*

In making application of the chemistry of plant and animal bodies to the subject of stock feeding it is seldom necessary to deal directly with these elements, but rather with certain compounds made up through various combinations of these elements, a knowledge of the nature of which combinations is unnecessary for a proper understanding of the chemistry of animal nutrition. These classes of compounds are practically the same in plant and animal bodies and are usually referred to as *ash, crude fiber, fat, nitrogen-free extract, protein,* and *water.* The percentages of crude fiber and nitrogen-free extract are commonly grouped together and referred to as carbohydrates.

We reproduce a table from Doctor Jordan's *The Feeding of Animals,*[1] which

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[1] New York: The Macmillan Co.

will aid the reader to understand the relation between the chemical elements and the chemical compounds to which we have referred.

		COMPOUNDS	ELEMENTS
All Vegetable or Animal Matter	Incombustible or Inorganic Matter	Water	Oxygen Hydrogen
		Ash	Oxygen Sulphur Chlorine Phosphorus Silicon. Fluorine Potassium Sodium Calcium Magnesium Iron Manganese
	Combustible or Organic Matter	Protein	Carbon Oxygen Hydrogen Nitrogen Sulphur (generally) Phosphorus (sometimes) Iron (in a few cases)
		Carbohydrates and Fats	Carbon Oxygen Hydrogen

COMPOSITION OF FOOD-STUFFS

It is necessary, first of all, that the stock raiser recognize the fact that the elements with which he fertilizes his soil will reappear later on, in a measure large or small, in the bodies of the animals he fits for market. These elements will have suffered two transformations in the meantime,—being assimilated, first, by the plant, and second by the animal. All the undigested portion of the animal's food will have been returned to the land as fertilizer, and all the digested portion as well, except so much as has been permanently incorporated in the animal body, supposing, of course, that all the manure including the urine will be returned to the land. In fixing on the crops to be raised and the feeds to be bought, therefore, the intelligent farmer has in mind (1) availability for the purpose desired (depending on composition and digestibility) and (2) fertilizer value.

Water and Dry Matter—All food-stuffs contain a considerable proportion of water. The residue is included under the general term "dry matter." A proper ration for a farm animal will contain a quantity of dry substance which is practically uniform for animals of the same species, type, age, and condition. (See Table II., Page 246, Column A.)

Because water is abundant in plant and animal life we should not conclude that it is valueless, but rather, as in the case of carbohydrates, that it is essential. The leading functions of water related to animal life are as a solvent and distributor of other compounds, while it gives elasticity and firmness as well to animal tissues. Investigations as to the percentage of water in animal bodies under normal conditions have shown that usually more than 50 per cent of the total weight of an animal is water, the percentage varying with the age, condition, and species of animal.

Ash and Organic Matter — The dry matter of a food is subdivided into *ash* (inorganic, or mineral components) and *organic matter*. The mineral substance is called "ash" because it alone remains when the organic matter is driven off by burning.

From the foregoing chart (page 240) it will be observed that the constituent in plants and animals containing the greatest number of chemical elements is ash, and yet ash seldom constitutes more than one-tenth of the animal, and still less of the plant, seldom exceeding in general, one-twentieth. Clover hay contains a relatively high percentage of ash, while corn yields only a small amount. In the former case there are about 6.2 pounds, and in the latter 1.5 pounds ash per hundredweight. While the relative amount of ash in all food-stuffs is small, it is absolutely necessary to promote both animal and vegetable growth. As a matter of fact, little attention has been paid to the ash constituent of plants intended for animal food, largely because there has seemingly been a sufficient supply in most food-stuffs. The author is of the opinion that future investigations will reveal the fact that the ash constituent in food-stuffs is more closely related to economical production of animal products than has been generally supposed.

Protein, Fat, and Carbohydrates — The organic components of feeding-stuffs fall into three groups: *Proteids, fats,* and *carbohydrates.*

PROTEIN — Protein is the nitrogenous element in vegetable and animal structure. Compounds of this class vary much in their nature, composition, and relative feeding value. They have one thing in common, namely, the possession of nitrogen. They are, therefore, frequently spoken of as nitrogenous compounds. The most expensive constituent in fertilizers is nitrogen; likewise the most costly food-stuffs are those possessing the highest percentage of digestible protein. Whatever other functions protein may have, its chief one is that of a flesh-former.

CARBOHYDRATES — The carbohydrates are of two kinds: *Fiber* and *nitrogen-free extract.* The fiber (composed principally of cellulose) is the hard, woody framework of the plant. The portion available for nutrition appears to be digested in the intestines. Nitrogen-free extract includes the more easily digested starches, sugars, and gums. The carbohydrates are the cheapest food-sources of heat, energy, and fat. Since their function is the same as that of the digestible fats found in feeding-stuffs, and since the fats are about 2¼ times as effective as the carbohydrates, it is customary for simplicity's sake to reckon them together. The fat-content of a feeding-stuff is multiplied by 2¼ and the product is added to the amount of carbohydrates present.

Carbon, oxygen, and hydrogen — elements which may be derived from air and water — are the only elements found in the carbohydrates; they are frequently spoken of as *nitrogen-free compounds.*

No other class of chemical compounds comprises so large a part of stock foods as the carbohydrates. In some cases, as in certain varieties of hay and grain, they comprise 80 per cent of the dry matter. While abundant in most food-stuffs, they are nevertheless a valuable constituent, as being the chief source of energy and fat.

FAT OR ETHER-EXTRACT—The percentages indicated in the column headed "Fat" (pages 244-5) include several compounds, mainly, however, fats that are soluble in ether. Some authorities prefer the use of the more accurate term of *ether-extract* in referring to these compounds. The value of the ether-extract in a given food-stuff depends largely upon its nature.

DIGESTION AND GROWTH

Only a part of the nutrients in food-stuffs ever nourishes the animal, since only a part is digested. We speak of a given food-stuff as containing a certain number of pounds of protein per hundredweight. While this knowledge may in certain instances be useful to the feeder, the important thing to know is: How much digestible protein is there in a hundred pounds of a given food-stuff? or, in other words, *How much protein is there which is available for the use of the animal?*

Conditions Affecting Digestion — In the processes of digestion such portions of the food nutrients as are digestible are converted into a form which may be readily taken up by the absorbent vessels of the stomach and intestines. The undigested portions of food-stuffs are believed, in certain instances, to serve the purpose of distending the stomach and intestines. In general, a much higher percentage of the food nutrients in concentrates is digested than in roughages containing a large amount of crude fiber. Other conditions, also, affect the relative digestibility of nutrients in food-stuffs: (1) Certain classes of animals, such as cattle, sheep, and other ruminants, digest a higher percentage of crude fiber than do others; for example, horses. (2) Not only is there a difference in classes of animals as to their digestive capacities, but there are marked differences in animals of the same class in this regard. In other words, some animals are more economical producers of animal products than others.

Processes of Digestion — To be of any use, the digested food must be assimilated by the animal. The process of assimilation consists in the taking up or absorption of digested food particles, which are conveyed by the blood to every part of the animal. A general knowledge of where the various food nutrients are digested is desirable; hence, a brief reference to the subject seems pertinent.

The changes which take place in food during the processes of digestion are mainly chemical; but the first change or process is a mechanical one — that of mastication, the process during which the food is broken or ground up into fine particles, rendering it more susceptible to the chemical action of various juices with which the food particles come in contact during passage through the alimentary canal. The only food nutrient that is partially or wholly digested by the action of the digestive ferments with which the masticated food is brought in contact in the mouth is a portion of the starch constituent of carbohydrates. Whether the amount digested is large or small depends upon the thoroughness of mastication and the length of time the food remains in the mouth. Under ordinary conditions, since the food remains there but a short time, the amount of starch digested is small.

The remainder of the digestible starch is digested partly in the stomach and partly in the intestines. In general, then, we may say that carbohydrates are digested partly in the mouth, partly in the stomach, and partly in the intestines. It should be borne in mind, however, that the best authorities believe that the digestion of carbohydrate compounds in the stomach is but slight at best.

The food nutrients digested in the stomach under the action of the different ferments in gastric juice, the digestive agent with which the food comes in contact in the stomach, are proteids. The remaining digestible proteids are digested in the intestines. Fats and oils are mainly digested in the intestines.

COMPOUNDING OF RATIONS

Agricultural investigators can not hope to attain to mathematically exact results. Food constituents vary from sample to sample; digestive power varies from animal to animal. The farmer must concern himself with average results, to meet individual conditions and requirements. Table I. (pages 244–5) is a compilation of the results of American analyses of most of the common food-stuffs, expressly arranged for use by the practical farmer in connection with Table II. (page 246), which is a compilation of the recommendations of German experimenters as to the average ration required by animals of various types and ages.

In examining any ration to ascertain how nearly it conforms to the standard, and what modifications, if any, are needful, attention must be paid to five points: (1) Total amount of dry matter; (2) amount of digestible protein; (3) amount of digestible carbohydrates and fat; (4) amount of ether-extract or fat; (5) total amount of digestible nutrients, and (6) nutritive ratio.

The Nutritive Ratio of a food-stuff or a ration is the relation that exists between the quantity of digestible protein and the quantity of digestible carbohydrates which it contains. Thus, if 100 pounds of brewer's grains contain 15 pounds of digestible protein and 45 pounds of digestible carbohydrates and fat, the nutritive ratio is expressed thus:

Protein is to Carbohydrates and Fat as 15 is to 45, or, *Protein is to Carbohydrates and Fat as 1 is to 3*, or, written mathematically, *Protein : Carbohydrates + Fat : : 1 : 3.*

To find the nutritive ratio, then, of a feeding-stuff — that is, to find how many pounds or what fraction of a pound of digestible carbohydrates and fat it contains for each pound of digestible protein — we divide its digestible carbohydrates and fat content by its digestible protein content. The medium ratios lie between 1 part protein to 5½ parts carbohydrates and fat (1 : 5.5) and 1 part protein to 8 parts carbohydrates and fat (1 : 8.0). If the carbohydrates largely predominate, the ratio is said to be *wide;* if the proportion of protein is above the medium, the ratio is said to be *narrow*. Thus, timothy hay, with a nutritive ratio of 1 : 16.6, makes a wide ration, vetch hay (1 : 3.2) a narrow one.

Narrow Nutritive Ratio — The following common and commercial food-stuffs are relatively high in digestible protein and low in digestible carbohydrates:

Concentrates — Wheat bran, linseed oil meal, wheat middlings, cotton-seed meal, gluten meal, pea meal, cow-peas, and soy beans.

Roughage — Clover, alfalfa, cow-pea, and vetch hay.

Wide Nutritive Ratio — The following food-stuffs are relatively high in digestible carbohydrates and low in digestible protein:

Concentrates — Rye, corn, corn meal, and corn and cob meal.

Roughage — Timothy, oat, red top, millet, and Hungarian grass hays, and corn stover.

TABLE I.—Digestible Nutrients Per Pound of Various Feeding-stuffs, and Fertilizing Constituents Per 1,000 Pounds (Compiled by WILLIS MACGERALD)

Total Dry Matter	Digestible Nutrients				Nutritive Ratio	Authorities for Digestible Nutrients	Food	Fertilizer Content				
	Protein	Carbohydrates and Fat in Terms of Carbohydrates	Fat (ether extract) alone	Total	Protein to Carbohydrates and Fat			Authorities for Fertilizer Content	Nitrogen per 1,000 Pounds	Phosphoric Acid per 1,000 Pounds	Potash per 1,000 Pounds	Manurial Value per Ton of 2,000 Pounds
In Decimal Fractions of 1 Pound												
A	B	C		D	E				lbs.	lbs.	lbs.	
							Green Fodders					
.383	012	.205	.006	.217	1 to 17.0	H	Timothy	H	4.8	2.6	7 6	$2.31
.349	.030	.216	.008	.247	1 to 7.2	H	Kentucky Bluegrass	----	----	----	----	----
.289	020	.169	.004	.189	1 to 8.4	H	Hungarian Grass	H	3 9	1 6	5 5	1.77
.347	021	.226	.006	.247	1 to 10.8	H	Redtop	----	----	----	----	----
.270	.015	.125	.005	.140	1 to 8.3	H	Orchard Grass	H	4.3	1.6	7 6	2 06
.282	.039	.138	.005	.177	1 to 3.5	H	Alfalfa	H	7.2	1 3	5.6	2.74
.292	029	.164	.007	.193	1 to 5.6	H	Red Clover	H	5 3	1 3	4.6	2.49
.166	.018	.092	.002	.109	1 to 5.1	H	Cowpeas	H	2.7	1.0	3.1	1.16
.249	.032	.121	005	.153	1 to 3.8	H	Soy Beans	H	2.9	1.5	5.3	1.44
.234	.021	.150	.004	171	1 to 7.1	H	Rye Fodder	H	3.3	1 5	7 3	1.72
.210	.019	.111	.004	.130	1 to 5 8	H	Barley Fodder	----	----	----	----	----
.378	.026	.212	.010	.238	1 to 8.2	H	Oat Fodder	H	4.9	1 3	3.8	1 90
.160	.018	.076	.002	.094	1 to 4.2	H	Oats and Peas	----	----	----	----	----
.160	.017	.077	.002	.094	1 to 4.5	H	Barley and Peas	----	----	----	----	----
.207	.010	.125	.004	.135	1 to 12.5	H	Green Corn Fodder	H	4.1	1.5	3.3	1.64
.206	.006	.131	.004	138	1 to 21.8	H	Green Sorghum Fodder	H	2.3	0 9	2 3	0 96
.140	.015	.086	.002	.101	1 to 5.7	H	Rape	H	4.5	1.5	3.6	1.79
.269	.014	.178	.005	192	1 to 13.0	A	Barnyard Millet	A	6.1	1 9	4 1	2.35
----	----	----	----	----	----------	----	Common Vetch	E	5.9	11.9	7.0	3.52
							Fermented Roughage					
.209	.009	.129	007	.138	1 to 14.3	H	Corn Silage	H	2.8	1.1	3 7	1.25
.239	.006	.154	.002	.160	1 to 25.6	H	Sorghum Silage	----	----	----	----	----
.207	.015	.106	.009	.121	1 to 7.0	H	Cowpea Silage	----	----	----	----	----
.258	027	.116	013	.143	1 to 4.3	H	Soy Bean Silage	----	----	----	----	----
.280	.020	.158	.010	178	1 to 7.9	H	Clover Silage	H	5.3	1 3	4 6	2 09
.275	.030	.128	019	.158	1 to 4.3	H	Alfalfa Silage	----	----	----	----	----
							Hay and Straw					
.868	.028	.466	014	.494	1 to 16.6	H	Timothy Hay	H	12 6	5.3	9 0	5.03
.859	.064	.417	.015	481	1 to 6.5	H	Mixed Grass and Clover Hay	H	17.4	3 3	18 8	7 05
.788	048	.418	.020	466	1 to 8.7	H	Kentucky Bluegrass Hay	H	11.9	4 0	15 7	5 23
.901	.049	.455	.014	504	1 to 9 2	H	Orchard Grass Hay	H	13.1	4 1	18.8	5.84
.923	.045	.540	.013	585	1 to 12.0	H	Hungarian Hay	H	12.0	3.5	13 0	4 99
.890	.072	.400	.010	472	1 to 5.5	A	Barnyard Millet Hay	----	----	----	----	----
.871	.059	.436	012	495	1 to 7.4	H	Mixed Grass Hay	H	14.1	2 7	15 5	5.74
.834	.079	.435	.015	514	1 to 5.5	H	Mixed Rowen	H	16.1	4.3	14.9	6.45
.916	110	.423	.012	.533	1 to 3.8	H	Alfalfa Hay	H	21.9	5.1	16 8	8 42
.847	068	.396	.017	464	1 to 5.8	H	Red Clover Hay	H	20 7	3.8	22 0	8 35
.903	.084	.459	.015	543	1 to 5.4	H	Alsike Clover Hay	H	23.4	6.7	22.3	9.47
.893	108	.410	011	.518	1 to 3.8	H	Cowpea Hay	H	19 5	5 2	14.7	7.55
.887	.108	.422	.015	.530	1 to 3.9	H	Soy Bean Hay	H	23 2	6 7	10.8	8.49
.887	.129	406	.031	.535	1 to 3.1	D	Vetch Hay	----	----	----	----	----
.911	.048	.492	010	540	1 to 10.3	H	Redtop Hay	B	11 5	3.6	10 2	4.63
.911	.043	498	015	541	1 to 11.6	H	Oat Hay	----	----	----	----	----
.869	.078	.393	.004	471	1 to 5.0	F	Oat and Vetch Hay	----	----	----	----	----
578	.025	.373	.012	.398	1 to 14.9	H	Corn Fodder (Field Cured)	H	17 6	5.4	8 9	6.53
.595	.017	.340	.007	.357	1 to 20.0	H	Corn Stover (Field-Cured)	H	10 4	2 9	14 0	4 53
.924	068	.487	.030	.555	1 to 7.2	F	Peanut Hay	C	17.6	2 9	9 8	5.85
.904	.004	.372	.004	.376	1 to 93.0	H	Wheat Straw	H	5 9	10 2	5.1	2.30
.908	.012	.404	.008	416	1 to 33.6	H	Oat Straw	H	6.2	2.6	12 4	3.05
.858	.007	.426	006	.433	1 to 60.8	H	Barley Straw	H	13.1	3.0	20.9	5.90
.929	.006	.415	.004	421	1 to 69.1	H	Rye Straw	H	4.6	2.8	7 9	2.29
.864	.043	.341	.008	384	1 to 7.9	H	Peavine Straw	H	14 3	3 5	10 2	5.46
899	.023	.423	010	.446	1 to 18.4	H	Soy Bean Straw	H	17.5	4.0	13.2	6.71

TABLE I.—(*Continued*)

Total Dry Matter	Digestible Nutrients: Protein	Digestible Nutrients: Carbohydrates and Fat in Terms of Carbohydrates	Digestible Nutrients: Fat (ether extract) alone	Digestible Nutrients: Total	Nutritive Ratio: Protein to Carbohydrates and Fat	Authorities for Digestible Nutrients	Food	Fertilizer Content: Authorities for Fertilizer Content	Nitrogen per 1,000 Pounds	Phosphoric Acid per 1,000 Pounds	Potash per 1,000 Pounds	Manurial Value per Ton of 2,000 Pounds
In Decimal Fractions of 1 Pound												
A	B	C		D	E				lbs.	lbs.	lbs.	
							Grains and Seeds					
.895	.102	.730	.017	.832	1 to 7.2	H	Wheat	H	23 6	7 9	5.0	8.27
.891	.079	.764	043	.843	1 to 9.7	H	Corn (average of all analyses)	H	18.2	7 0	4 0	6.48
.884	.099	.700	.011	.499	1 to 7.1	H	Rye	H	17.6	8 2	5 4	6 53
.891	.087	.692	.016	.779	1 to 7.9	H	Barley	H	15 1	7.9	4 8	5 70
.890	092	.568	.042	.660	1 to 6.1	H	Oats	H	20 6	8.2	6.2	7 50
.874	077	.533	.018	.610	1 to 6.9	H	Buckwheat	H	14 4	4.4	2.1	4.93
.895	.168	.534	.007	.702	1 to 3.2	H	Peas	H	30.8	8 2	9.9	10 85
.897	125	.689	.173	.814	1 to 5.5	H	Whole Cottonseed	H	31 3	12.7	11.7	11.60
							Roots, Tubers, Etc.					
.091	.011	.056	.001	.067	1 to 5.1	H	Mangel Beets	H	1.9	0.9	3.8	0 96
.135	.011	.104	.001	.115	1 to 9.4	H	Sugar Beets	H	2 2	1 0	4 8	1.14
.114	008	.083	.002	.091	1 to 10.3	H	Carrots	H	1.5	0 9	5 1	0 95
.095	.010	.077	.002	.087	1 to 7 7	H	Flat Turnips	H	1.8	1.0	3.9	0 95
.211	.009	.165	.001	.174	1 to 18 3	H	Potatoes	H	3 2	1 2	4 6	1.45
.153	.018	.091	.004	109	1 to 5.1	H	Cabbages	H	3.8	1 1	4 3	1 59
.200	.020	.173	.002	.193	1 to 8.7	H	Artichokes	H	2 6	1.4	4.7	1.30
091	010	.065	.003	.075	1 to 6.5	H	Field Pumpkins	----	----	----	----	-----
.447	.021	.382	.017	.403	1 to 18.2	H	Acorns (Fresh)	----	----	----	----	-----
							Mill Products					
.881	.122	.453	.027	.575	1 to 3.7	H	Wheat Bran	H	26.7	28 9	16.1	12.19
.882	.122	586	.038	.708	1 to 4.8	H	Wheat Shorts	H	28 2	13 5	5 9	10.28
.903	.135	.658	.020	.793	1 to 4.9	H	Dark Feeding Flour	H	31 8	21 4	10.9	12.55
.876	.082	.647	.009	729	1 to 7.9	H	Low-Grade Flour	H	28 9	5 6	3 5	9.51
.850	.070	.717	.033	.787	1 to 10.2	G	Corn Meal	B	15.8	6.3	4.0	5.69
.849	.044	.665	.029	.709	1 to 15.1	H	Corn-and-cob Meal	H	14.1	5 7	4 7	5.18
.895	.168	.532	.007	.700	1 to 3.0	F	Pea Meal	B	30.8	8.2	9.9	10 85
.921	.115	.654	.059	.769	1 to 9.3	H	Oat Meal	H	23.5	----	----	-----
.884	.115	548	.020	.663	1 to 4 8	H	Rye Bran	H	23.2	22 8	14 0	10.36
.881	.074	.661	.020	.735	1 to 8 9	G	Barley Meal	B	15.5	6.6	3 4	5 58
.895	074	.347	.019	.421	1 to 4.7	H	Buckwheat Bran	H	----	----	----	-----
.873	220	.456	.054	.676	1 to 2.1	H	Buckwheat Middlings	B	13.8	6.8	3 4	5.09
							By-Products, Wastes, and Animal Products					
.889	075	.705	.068	.780	1 to 9.4	H	Hominy Chop	H	16 3	9.8	4.9	6 26
.918	.258	681	.110	.939	1 to 2.6	H	Gluten Meal	H	50 3	3.3	0 5	15.46
.922	.204	.682	.088	.886	1 to 3.3	H	Gluten Feed	H	38 4	3 1	0 3	11 95
.898	.186	.409	017	595	1 to 2 2	H	Malt Sprouts	H	35 5	14.3	16 3	13 38
.243	.039	.125	.014	.164	1 to 3 2	H	Wet Brewer's Grains	H	8 9	3.1	0 5	3 02
.918	.157	.478	.051	635	1 to 3 0	H	Dry Brewer's Grains	H	36 2	10.3	0 9	11.96
.908	.293	.485	.070	778	1 to 1.6	H	Linseed Meal (Old Process)	H	54 3	16.6	13.7	19 05
.899	282	.464	028	.746	1 to 1.7	H	Linseed Meal (New Process)	H	57.8	18 3	13 9	20 28
.918	.372	.444	.122	816	1 to 1 2	H	Cottonseed Meal	H	67 9	28 8	8.7	23 95
.889	.003	.369	.017	373	1to123.0	H	Cottonseed Hulls	H	6 9	2.5	10 2	3.14
.893	.429	.383	069	812	1 to 0.89	H	Peanut Meal	H	75.6	13 1	15.0	25 19
.120	017	.051	002	068	1 to 3.0	H	Sugar-beet Leaves	H	4.1	1.5	6.2	1.88
.102	006	.073	----	079	1 to 12.0	H	Sugar-beet Pulp	H	1 4	0 2	0 4	0.47
.233	.010	.144	.011	175	1 to 14.4	W	Apple Pomace	B	2.3	0 2	1.3	0 81
.096	.031	.065	.008	096	1 to 2.1	H	Gravity Skim-milk	H	5 6	2 0	1 9	2.03
.094	.029	.059	003	.088	1 to 2.0	H	Separator Skim-milk	H	5 6	2 0	1 9	2 03
.099	.039	.065	011	104	1 to 1.7	H	Buttermilk	H	4.8	1.7	1 6	1.74
.066	.008	.054	.003	.062	1 to 6.8	H	Whey	H	1 5	1 4	1 8	0 73
.128	036	.132	.037	.168	1 to 3.6	H	Whole Milk	H	5 3	1 9	1 8	1 92

TABLE II.—German Feeding Standards for Daily Rations, Adapted for Use in Connection with Table I. (Arranged by WILLIS MACGERALD)

Kind of Animal	Notes on Daily Rations	Particulars	Total Dry Matter	Digestible Nutrients: Protein	Digestible Nutrients: Carbohydrates and Fat	Digestible Nutrients: Fat (ether extract) alone	Digestible Nutrients: Total	Nutritive Ratio
			In pounds and decimal fractions thereof					
		Age in mos. Live wt. lbs.	A	B	C		D	E
Growing Dairy Cattle	Per Head	2- 3 150	3.45	0.60	2.63	0.300	3.23	1 to 4.5
		3- 6 300	7.20	0.90	4.52	0.300	5.42	1 to 5.1
		6-12 500	13.50	1.00	6.81	0.250	7.81	1 to 6.8
		12-18 700	18.20	1.26	9.38	0.280	10.64	1 to 7.5
		18-24 900	23.40	1.35	11.41	0.270	12.76	1 to 8.5
Growing Beef Cattle	Per Head	2- 3 165	3.80	0.69	2 89	0.330	3.58	1 to 4.2
		3- 6 330	7.92	1.16	5.35	0.495	6.51	1 to 4.7
		6-12 550	13.75	1.38	8.14	0.385	9.52	1 to 6.0
		12-18 750	18.00	1.50	10.20	0.375	11.70	1 to 6.8
		18-24 935	22.44	1.68	12.06	0.374	13.74	1 to 7.2
Fattening Beef Cattle	Per 100 lbs. Live Weight	Preliminary period	3.00	0.25	1.61	0.050	1.86	1 to 6.5
		Main period	3.00	0.30	1.61	0.070	1.91	1 to 5.4
		Finishing period	2.60	0.27	1.66	0.070	1.93	1 to 6.2
Milch Cows	Per 100 lbs. Live Weight	Milk yield 11 lbs. daily ..	2.50	0.16	1.07	0.030	1.23	1 to 6.7
		Milk yield 16½ lbs.	2.70	0.20	1.19	0.040	1.39	1 to 6.0
		Milk yield 22 lbs.	2.90	0.25	1.41	0.050	1.66	1 to 5.7
		Milk yield 27½ lbs.	3.20	0.33	1.48	0.080	1.81	1 to 4.5
Work Oxen	Per 100 lbs. Live Weight	At rest	1.80	0.07	0.82	0.010	0.89	1 to 11.8
		Light work	2.20	0.14	1.07	0.030	1.21	1 to 7.7
		Moderate work	2.50	0.20	1.26	0.050	1.46	1 to 6.5
		Heavy work	2.80	0.28	1.48	0.080	1.76	1 to 5.3
Horses	Per 100 lbs. Live Weight	Light work	2.00	0.15	1.04	0.040	1.19	1 to 7.0
		Moderate work	2.40	0.20	1.24	0.060	1.44	1 to 6.2
		Heavy work	2.60	0.25	1.51	0.080	1.76	1 to 6.0
Growing Wool Sheep	Per Head	Age in mos. Live wt. lbs.						
		4- 6 60	1.50	0.20	1.02	0.042	1.22	1 to 5.0
		6- 8 75	1.88	0.21	1.14	0.045	1.35	1 to 5.4
		8-11 85	1.96	0.18	1.07	0.043	1.25	1 to 6.0
		11-15 90	1.98	0.16	1.09	0.036	1.25	1 to 7.0
		15-20 100	2.20	0.15	1.15	0.030	1.30	1 to 7.7
Growing Mutton Sheep	Per Head	4- 6 65	1.69	0.29	1.14	0.035	1.43	1 to 4.0
		6- 8 85	2.21	0.30	1.41	0.060	1.71	1 to 4.8
		8-11 100	2.40	0.30	1.54	0.050	1.84	1 to 5.2
		11-15 120	2.76	0.26	1.64	0.060	1.90	1 to 6.3
		15-20 150	3.30	0.30	1.94	0.060	2.24	1 to 6.5
Fattening Sheep	Per 100 lbs. Live Weight	Preliminary period	3.00	0.30	1.61	0.050	1.91	1 to 5.4
		Main period	2.80	0.35	1.59	0.060	1.94	1 to 4.5
Mature Sheep	Per 100 lbs. Live Weight	Coarse wool	2.00	0.12	1.10	0.020	1.22	1 to 9.1
		Fine wool	2.30	0.15	1.27	0.030	1.42	1 to 8.5
		Ewes, suckling lambs ..	2.50	0.29	1.61	0.050	1.90	1 to 5.6
Growing Breeding Swine	Per Head	Age in mos. Live wt. lbs.						
		2- 3 45	1.98	0.34	1.36	0.045	1.70	1 to 4.0
		3- 5 100	3.50	0.50	2.49	0.080	2.99	1 to 5.0
		5- 6 120	3.84	0.44	2.66	0.048	3.10	1 to 6.0
		6- 8 175	4.90	0.49	3.40	0.053	3.89	1 to 7.0
		8-12 260	6.50	0.55	3.98	0.052	4.53	1 to 7.5
Growing Fattening Swine	Per Head	2- 3 45	1.98	0.34	1.36	0.045	1.70	1 to 4.0
		3- 5 110	3.85	0.55	2.74	0.088	3.29	1 to 5.0
		5- 6 150	4.95	0.65	3.56	0.090	4.21	1 to 5.5
		6- 8 200	6.00	0.72	4.28	0.080	5.00	1 to 6.0
		8-12 275	7.15	0.83	5.23	0.083	6.06	1 to 6.4
Fattening Swine	Per 100 lbs. Live Weight	Preliminary period	3.60	0.45	2.66	0.070	3.11	1 to 5.9
		Main period	3.20	0.40	2.51	0.050	2.91	1 to 6.3
		Finishing period	2.50	0.27	1.89	0.040	2.16	1 to 7.0
Mature Swine	Per 100 lbs. Live Weight	Brood sows	2.20	0.25	1.64	0.040	1.89	1 to 6.6

How to Use the Tables[1]—Suppose a herd of dairy cows, with an average weight of 1,000 pounds, and an average daily milk-yield of 22 pounds, is being fed a ration of 25 pounds of red clover hay, 2 pounds of cotton-seed meal, and 6 pounds

Kind of food	A Dry Matter	B Protein	C Carb.	D Total Dig.Nut.	E Nut. Ratio
Standard (Table I)	lbs. 29.00	lbs. 2.50	lbs. 14.10	lbs. 16.60	1:5.7
Red Clover hay lbs. 25	21.18	1.70	9.90	11.60	1:5.8
Cottonseed meal 2	1.84	.74	.89	1.63	1:1.2
Oats 6	5.34	.55	3.40	3.96	1:6.1
	28.36	2.99	14.19	17.19	1:4.7

14.190 ⌊2.99
11.96 ⌊4.7
2230
2093
137

of oats. In order to compare this ration with the standard, let us make a little blank, ruled precisely as are Tables I. and II. (pages 244-6). Above the double

[1] **NOTES ON TABLE I.—Coefficient of Digestibility**—The percentage of a given element of nutrition (as, for example, protein) that is digested by an animal is called the *coefficient of digestibility*, and is expressed in the decimal form. Multiplying together the protein content (for example) of timothy hay and the coefficient of digestibility for timothy-hay protein when consumed by ruminating animals, we obtain the percentage of protein in timothy hay that may be digested, on the average, by ruminants.

Authorities—The following references give the authorities for the figures in the foregoing Table:

(A) United States Department of Agriculture: Yearbook for 1898.
(B) United States Department of Agriculture: Yearbook for 1895.
(C) United States Department of Agriculture: Farmers' Bulletin 25.
(D) Composition, Farmers' Bulletin 22; coefficients of digestibility (average for ruminants and swine). W. A. Henry: *Feeds and Feeding.*
(E) Farmers' Bulletin 16.
(F) W. H. Jordan: *The Feeding of Animals.* Digestibility calculated for ruminants only.
(G) Herbert Myrick: *Key to Profitable Feeding.*
(H) W. A. Henry. *Feeds and Feeding.* Based on experiments with ruminants and swine.
(W) F. W. Woll: *Handbook for Farmers and Dairymen.*

For references to the original sources from which all these figures have been drawn, the reader is referred to the several authors in question.

Manurial Values—In computing the "Manurial Value per Ton" of each feeding-stuff, the following arbitrary values have been assigned: *Nitrogen*, 15 cents a pound; *phosphoric acid*, 5 cents a pound; and *potash*, 4 cents a pound. It must be remembered that the figures given in the last four columns of Table II., giving, as they do, the total fertilizer content, merely furnish a basis for the comparison of manurial values, the portion of a feeding-stuff that is available to enrich the soil being only that part that is not assimilated by the animal.

horizontal line we set down the standard, obtained by multiplying by 10 the standard per hundredweight for a cow yielding 22 pounds of milk, as given in Table II.

In the first vertical column we set down the names and amounts of our several feeding-stuffs.

To fill out the horizontal line showing the constituents of clover hay, we multiply the constituents of 1 pound (as shown in Table I.) by 25.

To fill out the cotton-seed meal line we multiply by 2 the quantities found in Table I. For oats, we multiply by 6.

The nutritive ratio of each feeding-stuff is set down in column E, of course, exactly as it appears in Table I.

Lastly, we foot up columns A, B, C, and D, and divide the sum of the C column (carbohydrates) by the sum of the B column (protein). That gives us the nutritive ratio of the whole ration, 1:4.6. Comparison with the standard shows that while the totals of dry matter and digestible nutrients and the quantity of carbohydrates are not far out of the way, protein is in excess, while the nutritive ratio shows the same thing—that the ration as fed is too narrow.

Since cotton-seed meal is a purchased product, and an expensive one, let us try cutting the amount in half, also reducing the oat ration to 5 pounds. Let us substitute, in order to widen the ration and increase palatability, 12 pounds of corn silage (80 per cent water). Then our trial sheet will stand thus:

Kind of food	lbs.	A Dry Matter	B Protein	C Carb.	D Total Dig. Nut.	E Nut. Ratio
Standard (Table I.)		29.00	2.50	14.10	16.60	1:5.7
Red Clover hay	25	21.18	1.70	9.90	11.60	1:5.8
Cottonseed meal	1	.92	.37	.44	.82	1:1.2
Oats	5	4.45	.46	2.84	3.30	1:6.1
Corn silage	12	2.51	.11	1.55	1.66	1:14.3
		29.06	2.64	14.73	17.38	1:5.58

This ration is balanced, it is seen, to conform very closely to the standard. The nutritive ratio (1:5.58) is nearly what is desired, and the total of digestible nutrients is less than a pound in excess of standard requirements. An animal will digest more of an appetizing ration than of an uninviting one, but if the bulk of roughage is too great, the feeder will soon know it, and may reduce the whole ration uniformly, leaving the balance of nutrients unchanged.

The foregoing is given for purposes of illustration, and not as a model ration. It is far better for a farmer to *think*, and to build up, on the groundwork of what he knows, an individual system of economical, scientific feeding, than to try to follow blindly the model rations recommended by anyone else. The accompanying feeding standards tabulated on page 246 must be studied in the same open-minded spirit. Their use must vary with circumstances. Model rations are the fruit of individual experience; standard rations are the summing up of average experience. Study of feeding standards tells the farmer when he is on the right track; study of model rations suggests how rations in use may be modified along lines other feeders have found profitable.

IV. THE JUDGING OF LIVE STOCK

CHARACTERISTICS OF PRIME STEERS

When the word "prime" is used to designate the quality and condition of cattle, we should understand it as signifying the very best grade, unless possibly we were to except a few fancy cattle of show-yard merit that occasionally reach the market. Prime steers are taken largely by buyers for the eastern markets and by packers for the dressed-beef trade, the former taking the bulk of such cattle. Such steers are practically above criticism as to both quality and condition.

The prime steer should present conclusive evidence to sight and touch that he possesses to a high degree the form, condition, and quality demanded by the dealer in high-class beef.

Form—The butcher demands not so much that parallelogramic form popularly spoken of by many authorities, as he does a high state of development in loin, crops, back, thighs, twist, and rump. He demands development in these regions because they are the parts from which are secured the high-priced cuts. The animal should show plenty of depth and breadth, furnishing a large surface for flesh, without that tendency to be paunchy which is objectionable to the butcher.

The butcher seeks, also, smooth, well-rounded general outlines, which indicate both thickness and evenness of flesh, and an absence of that tendency to be rough and coarse, which would mean loss to him, since the waste in the dressing of a rough, coarse beast would be out of proportion with the weight of marketable beef.

Then, too, the butcher is not unmindful of the fact that, having secured satisfactory development of the parts from which are taken the high-priced cuts, there is an added value in securing thick, even flesh throughout, on the cheaper as well as on the more valuable parts of the carcass.

FIG. 140. Typical prime steer: High-grade Hereford fattened on the University of Illinois farm, Urbana, Ill. (Mumford.)

To the untrained eye, an unusual development of loin, crops and thighs would detract from the beauty, style, or gracefulness of the beast. To the butcher, such development would increase rather than lessen its value. It should be clearly borne in mind, therefore, that no beauty of outline, style, or gracefulness of carriage will ever take precedence of proper development in the most important and valuable parts of the bullock.

We should not assume, however, that the highest development in these most valuable parts is incompatible with ideal beef form; the truth of the matter is, we seldom get high development in the parts from which are taken the high-priced cuts except in animals which are symmetrically developed. It is entirely consistent and desirable, therefore, that we hold up as our ideal standard of the prime steer a combination of well-developed parts from which are taken the high-priced cuts, and a uniformly high development in all parts capable of taking on flesh, which gives to the animal symmetry and smoothness of outline, and that style and that beauty otherwise impossible. Correct conformation and prime condition must accompany each other in order to secure a high percentage of dressed beef.

Quality and Condition — Quality may be considered as (a) general quality and (b) quality of flesh and condition of animal.

(a) GENERAL QUALITY — General quality in a fat steer is indicated by a medium-sized, fine, clean cut, breedy-featured head, bearing ears of moderate size and texture; short legs with clean, fine bone; a fine, nicely tapering tail; fine hair; a pliable skin of medium thickness, and smooth, well-rounded outlines.

(b) QUALITY OF FLESH AND CONDITION OF ANIMAL — The quality of beef depends largely upon the condition of the animal. By condition we refer to the degree of fatness of a bullock. It should not be assumed, however, that the highest quality of beef is found in the fattest beast.

There are three principal reasons for fattening a steer: (1) In order that, when dressed, there shall not be a high percentage of offal or waste, as a fat animal, other things being equal, will dress a higher percentage of carcass than a half fat or a thin one; furthermore, in the fat animal, the proportion of those parts, which, from their very nature are unsaleable, is reduced to the minimum; (2) in order that the flesh or lean meat shall be rendered more tender, more juicy, and of better flavor by the deposition of fat throughout its substance; (3) in order to permit of proper ripening of the meat, as a thin carcass, being full of moisture and lacking the protection of a covering of fat, will rot before it will ripen.

Conditions Influencing Beef Quality—The possibility of securing the highest quality in beef is influenced by the breeding and general quality of the animal. Methods both of growing and fattening the beast also influence the quality of its flesh. There is, too, a quality of flesh which is peculiar to the individual, and which is independent both of breeding and methods of feeding. Desirable quality in flesh is indicated by a firm, yet mellow and springy, consistency of the flesh at

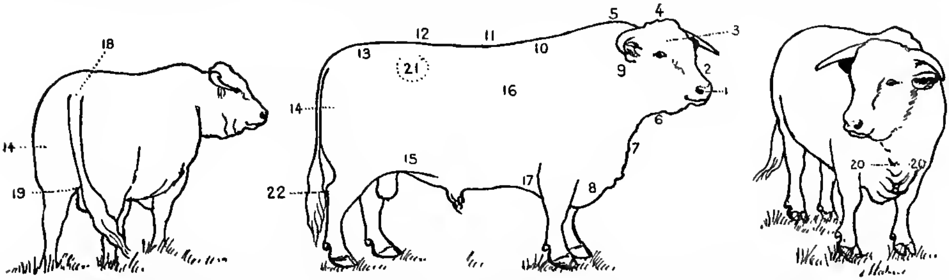

Fig. 141. Names and location of points of external conformation of beef cattle. 1, muzzle; 2, face; 3, forehead; 4, poll; 5, crest; 6, throat; 7, dewlap; 8, brisket; 9, neck; 10, crops; 11, back; 12, loin; 13, rump; 14, thigh; 15, flank; 16, fore ribs; 17, fore flank; 18, setting on of tail; 19, twist; 20, breast; 21, hip; 22, hock. (Mumford.)

the crops, along the back, at the loins and even on the sides, beneath the gentle pressure of the outstretched hand. Good quality of flesh is indicated in the fat steer by the absence of ties and rolls, or patches of gaudy, flabby fat.

A tendency to lay on fat in bunches and to roll at the loin indicates that the fat has been deposited in large masses and has not been so evenly distributed throughout the animal as to give to the flesh that marbled character so necessary to the highest quality in beef. An animal without a tendency to lay on fat unevenly may become bunchy about the tailhead and show other indications of a lack of a well-marbled condition of the flesh simply by being carried to the point of excessive fatness.

Judging Beeves on the Hoof—Outstanding coarseness and lack of general quality in the live animal without doubt are inseparably linked with undesirable texture in the beef cut from such a beast. Fulness at base of tongue, fulness or a roll of fat in front of point of shoulder, a full twist, a large mellow cod, a low, full, thick flank that stands out and rolls visibly as the animal walks, with fulness and smoothness at rump and tailhead indicate that degree of fatness which is essential to the highest quality in beef.

These points, which are to be judged by sight rather than by touch, are the ones most depended upon by buyers at the yards. If a close examination is desirable and possible we find that when the ends of the fingers are gently pressed into the flesh on the side of the beast in an effort to find the ribs, there should be a firmness of flesh that does not admit of freely and easily forcing the fingers to the ribs and between them. A lack of firmness indicates the presence of too large a proportion of fat, which may be due either to a too-fat or overdone condition of the animal, or to an inherent lack of flesh, either of which is decidedly undesirable. A proper degree of firmness shows the presence of plenty of flesh or lean meat. Such an examination reveals the quality of the surface flesh, but can not always be relied upon to determine the quality of the beef throughout the carcass.

It sometimes occurs that a steer may cut too fat on the block and yet not have exhibited on foot bunchiness or other indications of an overdone condition. Animals which are carried to an extreme degree of fatness, as is seen in some show animals and occasionally among market animals, give evidence of an overdone condition, being very soft in flesh — a condition which often passes into a very hard, unyielding one. It sometimes happens, too, that certain individual animals become hard in the surface fat without ever having shown by softness of their flesh that they were approaching an overdone condition. There is such a thing, however, as an animal becoming too firm in the flesh, and such firmness indicating an overdone condition.

What the Market Demands—Prime steers weighing from 1,200 to 1,400 pounds are wanted by shippers, by packers, and by exporters. The demand for steers of these weights, of good, choice, and medium quality, is greater than for steers of any other weight; hence the market is less likely to be overstocked with these grades. Especially is this true with the steers of choice and prime quality.

It is as difficult as it is unnecessary to decide whether form, condition, or quality is of greatest importance to the butcher. The main point to bear in mind is, that an animal characteristically deficient in any one of the foregoing requirements, is disqualified to meet the full demands of the dealer in high-class beef and consequently is not to be considered as a prime steer. Whether a lack of quality or a lack of condition is more evident in the cattle seen at the Union Stock Yard, Chicago, depends largely upon the prevailing prices for food-stuffs and the prices for cattle on foot. When high prices for food-stuffs have prevailed for some time, and when market prices for cattle have been ruling high, the tendency among feeders is to send their cattle to market in a half-fat condition, in order to take advantage of the prevailing high prices and avoid feeding too much of high-priced food-stuffs, in which case many cattle would lack condition rather than quality.

CHARACTERISTICS OF CHOICE FEEDERS

It is highly desirable to describe in detail a standard grade of stockers and feeders; otherwise we should confuse rather than define. If the animals in one grade of stockers and feeders are more uniform than in the others, it is in the choice grade. Steers of this grade will, under proper management, develop into choice and prime steers. It would seem wise, therefore, to consider in detail their desirable characteristics.

FIG. 142. Typical choice feeder: High-grade Hereford photographed at the Union Stock Yard, Chicago. (Mumford.)

It may be said then that we demand in choice stockers and feeders, *first*, the ability to finish as choice or prime steers; and *second*, the ability to make economical gains in flesh and fat. As far as our present knowledge of the matter goes, we look for indications of these tendencies in the form, quality, and constitution.

Form — The general form should be low-set, deep, broad, and compact rather than high up, gaunt, narrow, and loosely made. Stockers and feeders should be low-set, or on short legs, because animals of this conformation are almost invariably good feeders and capable of early maturity. They should be deep, broad, and compact, because this conformation indicates good constitution, capacity for growth and for producing ultimately a relatively high percentage of the most valuable cuts.

Select feeders with broad, flat backs and long, level rumps. They should possess straight top and underlines, which should be nearly parallel; and should be low at the flanks, thus forming what we have just spoken of as "good depth," for the barrel of stockers and feeders as well as dairy cows should be roomy. An animal which is too paunchy, however, as has been remarked, is objectionable to the butcher. The matter of low flanks should be emphasized, as it is an almost unfailing sign of good constitution and good feeding quality. It should be borne in mind that the stocker and feeder, thin in flesh and largely destitute of external or surface fat, affords the best possible opportunity of determining the covering of natural flesh characteristic of the animal.

Secure as much smoothness of outline as is consistent with low flesh, being especially careful to avoid too great prominence in hips, tailhead, and shoulders. Avoid rough, open shoulders, sway backs, and large coarse heads with small eyes set in the side of the head. Short, broad heads and short, thick necks indicate strong tendencies toward beef making. A large, prominent, and mild eye is to be desired. The mild eye denotes that the animal has a quiet disposition, which all feeders know is so desirable in a steer intended for the feed lot. The distance between eye and horn should be short and the horn should be flat and of medium fineness, rather than round and coarse. The lower jaw should be heavily coated with muscle; the muzzle, lips, and mouth should be large but not coarse.

Quality—It is well to distinguish between what might be called (a) general quality and (b) handling quality.

(a) General Quality—By general quality is meant general refinement of external conformation as seen in the head, horn, bone, compactness, and smoothness of outline. General quality is affected by nothing so much as by breeding; in fact, the two are very closely associated. Good quality is seldom found in a plainly bred steer, but is generally characteristic of a well-bred animal. The desirability of general quality can not be too strongly emphasized. While it is a characteristic that involves many points and is difficult to describe, its presence or absence is quickly discerned by the trained eye of the intelligent buyer. It is this characteristic in the stockers and feeders more than any other that we depend upon as indicating that the animal has within it the possibility of making a prime steer.

The ability to select stockers and feeders which have within them the possibility of making prime steers, is one of the first and most important lessons for the stockman to learn. Profits in steer feeding come not so much from skill in feeding and management as from intelligent buying and selling. The profit resulting from an increase, during the fattening period, of the value per pound of the total weight of the animal is as important as that resulting from the method employed in the feeding and management. It is seldom possible to produce at a profit gains which do not increase the value per pound of the total weight of the animal. Hence the importance of intelligent buying, or the selection of feeders and stockers of good quality.

(b) Handling Quality—Good handling quality indicates that the possessor is a good feeder. It shows that the animal is in good health or thrift and capable of beginning to gain as soon as an abundance of food is supplied. We speak of cattle as possessing good handling quality when the skin is mellow and loose. A thick, mossy coat of hair of medium fineness and a moderately thick skin are also desirable.

Constitution — The points indicative of good constitution have practically been covered under "Form" (page 253). Good constitution is indicated by a wide, deep chest, by fulness in the heart girth, depth, and breadth of body, and good handling quality. While we want refinement of form and bone, otherwise spoken of as general quality, we do not want that refinement carried to the point of delicacy. Too much refinement means delicacy, or a lack of constitution, and no animal lacking in constitution should find its way into the feed lot.

Breeds — The desirable characteristics of beef form, quality, and constitution should be found in well-bred high grades of any of the leading beef breeds. In the interest of uniformity in the finished product it should be observed that high grade Herefords can usually be put on the market in the fewest number of days and suffer most from carrying beyond the point of ripeness; that Shorthorns and Aberdeen-Angus grades, while a little slower to mature, are in fully as strong demand in the market as are grade Herefords; and that Aberdeen-Angus and Galloways may be carried longer on full feed than other breeds of beef cattle without indications of the bunches or rolls of fat which are so strongly discriminated against in our markets.

After all that may be said, however, as to breed, the important consideration is to see that the steer should be a high grade of some one of the beef breeds, and that the selection of the individual should receive more attention than the selection of the breed.

Age and Condition for Feeding — The question of age should not be overlooked. A thrifty young steer of good weight and in good flesh is to be preferred to an older stunted steer. It should be said, furthermore, that a stunted steer of any age or weight is a profit spoiler in the feed lot. Uniformity in color of feeders is desirable, but the mistake should not be made of getting uniformity of color at the expense of more important characteristics. It is possible to secure good colors, reds and blacks, in steers of very poor quality and containing very little beef blood. If it is a question of choosing between a combination of good quality and correct conformation on the one hand, and good colors on the other, take the quality and conformation and let someone else have the colors. A one-eighth blood Hereford may have Hereford markings, or a one-eighth blood Angus, the color and polled characteristic of the pure Angus, and yet both grades may have but little beef character.

HOW TO TELL A GOOD COW

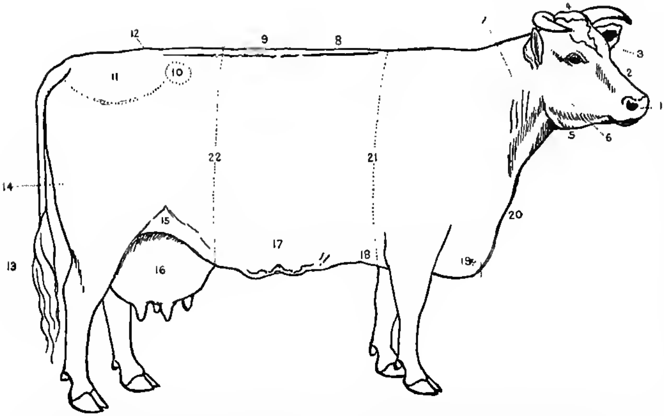

Fig. 143. Names and location of points in external conformation of the cow. 1, muzzle; 2, face; 3, forehead; 4, poll; 5, lower jaw; 6, cheek; 7, neck; 8, back; 9, loin; 10, hip or hook; 11, rump; 12, pelvic arch; 13, switch; 14, thigh; 15, flank; 16, udder; 17, barrel or belly; 18, fore flank; 19, brisket; 20, dewlap; 21, heart girth; 22, loin girth. (Mumford.)

For Dairy—Head small and clean-cut; muzzle large; forehead straight or concave; neck long and thin without being scrawny; horns relatively small; eyes bright and prominent; shoulders thin, loin broad but not thickly fleshed as in beef cattle; thighs thin; hind quarters long, deep, and powerful; flank high; legs short and wide apart; tail long, slim, and loosely jointed; frame markedly wedge shaped; tapering from rump to shoulder; udder set broadly on abdomen, of generous size, extending high up behind, well held up to abdomen, not loose, pendulous or fleshy; milk veins large and prominent, on both udder and belly; teats medium size, evenly placed, and wide apart. A fleshy udder, firm to touch when empty, and retaining its size and form after milking, indicates predisposition to inflammatory disease. Skin clean, with a fresh bright color; hair fine, thick, and soft; temperament active and docile; large feeder.

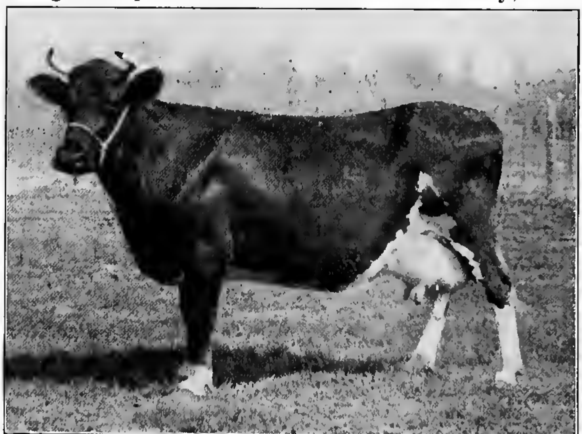

Fig. 144. Typical dairy cow: Rose, grade Shorthorn, owned by the University of Illinois, Urbana, Ill. Record at 10 years of age: Milk in one year, 11,388 pounds; butter fat, 565.13 pounds; butter, 678.16 pounds; average fat content of milk, 4.96 per cent. Milk in one week, 317 pounds; butter in one week, 19.77 pounds.

The main points in the selection of a cow are to secure large udders that are not fleshy, and large roomy bellies, showing capacity for consumption of large quantities of food. Of course, great eaters and large producers are not always profitable cows, but they generally are. Cows are seldom profitable unless they produce at least 250 pounds, or more, of butter per year.

HOW TO TELL A GOOD HORSE

For Speed — Height, 15½ hands; minimum weight, 1,000 pounds; ears, pointed, flexible, set on side, not on top of head; head, symmetrical, full under forelock and between ears; neck, long and slim, with little or no arch, set well up on "top corner" of body; front legs reaching out true, strong and straight; front feet not thrown sidewise when speeding; shoulders, set on obliquely; body, short top line, long lower line; hips well forward; muscles along back prominent, development judged by pressure with thumb and fingers; hind legs crooked at hock (but not too much so or they will be weak, and not too little or animal will "pound"); portion of leg from hock to fetlock and also from knee to fetlock relatively short and broad (not roundish) when viewed sidewise, but thin when seen from the rear; line drawn from hock to fetlock nearly straight, concave rather than convex; if convex it is "curby"; hoofs not pointing out; skin moderately thick and firm; chest capacity large; body round.

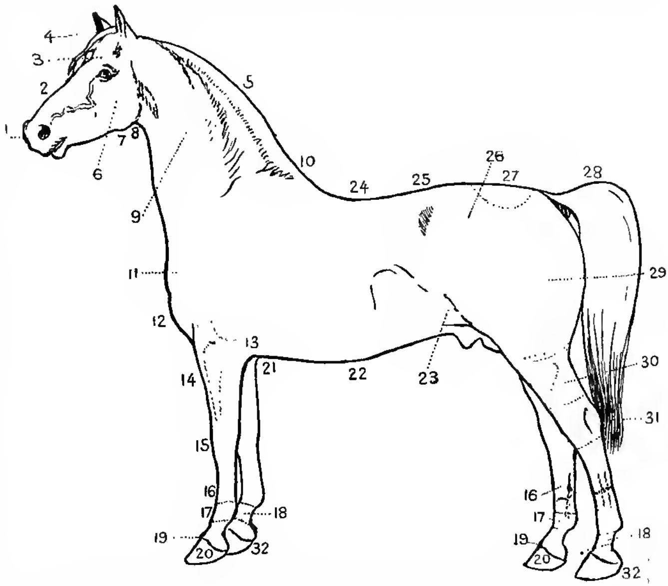

FIG. 145. Names and location of points used in referring to the external conformation of the horse. 1, muzzle; 2, face; 3, forehead; 4, poll; 5, crest; 6, cheek; 7, lower jaw; 8, throat; 9, neck; 10, withers; 11, point of shoulder; 12, breast; 13, elbow; 14, forearm; 15, knee; 16, cannon or shank; 17, fetlock; 18, pastern; 19, coronet; 20, foot; 21, girth; 22, belly; 23, flank; 24, back; 25, loin; 26, haunch or hip; 27, croup; 28, dock; 29, thigh or quarter; 30, lower thigh or gaskin; 31, hock; 32, heel. (Mumford.)

For Work — Full forehead; intelligent face; shoulders strong and sloping; gait free and easy; stride long; arm muscular; legs strong, rather short and flat; pastern sloping; feet large and not too flat; body large in girth and round; back broad, with muscular quarters; croup wide; weight (not clumsy) from 1,200 to 1,600 pounds, according to work required; horse docile, hearty, and easily kept.

Stallion for Breeding — As nearly as possible a perfect type of the sort of animal desired in the colt. First essentials, soundness, freedom from defects and blemishes, and good size. Should be thoroughbred of good disposition, 15½ or 16 hands high; minimum weight, about 1,200 pounds. American horse as a rule too small, and while size is usually the gift of the mare, heredity must not be limited by undersized sire. Good size of prime importance for track, road, or farm. Disposition is imparted by sire, therefore avoid vicious or logy stallions. Other points:

Body, well coupled up ; color uniform and bright ; quarters, full ; shoulders, full ; chest, broad ; head, finely shaped , ears, large, flexible, pointed, straight, and alert ; eye, quick, full, and gentle ; nostrils, large ; hair, soft and silky ; skin not thin ; legs flat, not roundish, and muscular ; hoofs, black ; feet broad, flat, and round ; in speeding, feet thrown not sidewise, but straight forward. Do not expect a good colt from service of a traveling stallion, concerning whose antecedents you know nothing.

Mare for Breeding — Of good size and color, sound in every particular ; in the vigor of life ; large powers of endurance, good traveler, active gait, well bred ; disposition gentle ; feet having neither toe nor quarter crack. The best breeding mare is not too good to use. More of the good physical qualities of the colt come from the mother than from the sire.

HOW TO SELECT A BREEDING BOAR

Fat Hogs — The breeding boar should be a good representative of some one of the leading breeds of swine. The question of selecting a good individual is more important than the selection of the breed. The use of grade boars and those of inferior pedigree can not be too strongly dis-

Fig. 146. Typical fat hog. (From a photograph furnished by *Wallace's Farmer.*)

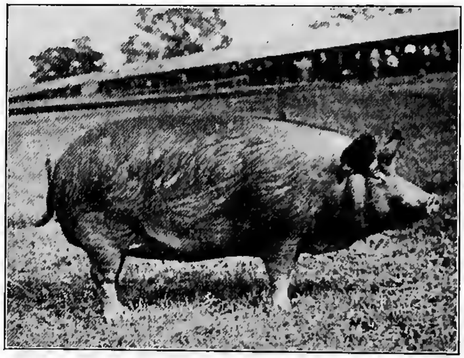

Fig. 147. Typical bacon hog : English prize-winning Tamworth sow. (*Breeder's Gazette.*)

couraged. The character of the head should be such as to indicate masculinity — broad, and in length, medium to short ; the neck should be short and broad, and smoothly joined to the shoulders ; the jowl of good size, as indicating good feeding quality ; the legs should be short, strong, and straight, well placed to the outside of the body ; back and loin straight or slightly arched, with plenty of width ; the chest should be wide and deep ; the flanks continuing the straight underline, making the sides deep ; the girth should be large, both at the heart and flank ; hams and shoulders well developed. Compactness and symmetry throughout are desirable points, while strength of limb and masculine character should not be sacrificed to less important points. Such a boar selected from the Poland China, Berkshire, Chester White, or Duroc-Jersey breeds and bred to sows of merit that are high grades of some one of the above breeds will produce pigs which, if properly fed, will weigh 200 pounds at six months of age, and which will possess the desirable characteristics of the fat hog for American markets, namely, well-developed hams and shoulders, good loins, and sides without too much waste.

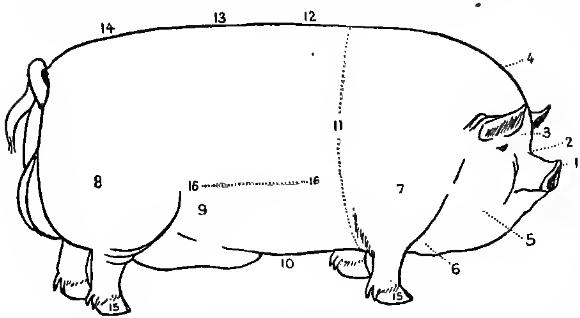

FIG. 148. Names and location of points of external conformation of the pig. 1, snout; 2, face; 3, forehead; 4, neck; 5, jowl; 6, breast; 7, shoulder; 8, ham; 9, flank; 10, belly; 11, heart girth; 12, back; 13, loin; 14, rump; 15, toes; 16, side. (Mumford.)

Bacon Hogs — In breeding hogs to produce the highest class of bacon, it is necessary to select animals which have been especially bred for this purpose, and feed them upon a ration best calculated to produce fine quality. The large Yorkshire and Tamworth are most extensively used for producing bacon hogs. They do not have the heavy jowls so prevalent in fat hogs, nor do they possess such a large amount of superfluous fat. The lean and fat in the pork is evenly distributed, while the sides are long and deep; the belly wide and thick, and the back thinly fleshed. The fat should cover the body in an even layer throughout — it should not be more than about $1\frac{1}{2}$ inches in thickness, nor should it be less than about 1 inch.

CHARACTERISTICS OF MUTTON SHEEP

The student of animal form soon discovers that the important points in all animals bred and fed for meat production are noticeably similar. In considering the form of the prime steer, the fat hog or the mutton sheep, it is the same low-set, broad, and compact conformation that is demanded.

Producers must cater to the demands of dealers and consumers or, owing to lessened consumption or to lower prices for an undesirable product, sacrifice what they have to offer.

The butcher's ideal of a mutton sheep involves form, fleece quality, and condition, the main points being form, condition, and such points of general quality as contribute to the better-killing qualities. The

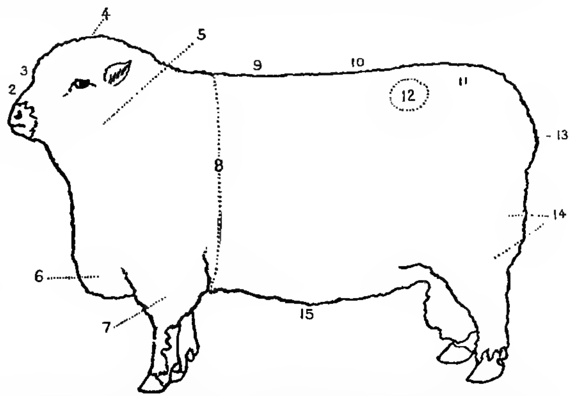

FIG. 149. Points of external conformation of the sheep. 1, muzzle; 2, face; 3, forehead; 4, poll; 5, scrag or neck; 6, brisket; 7, forearm; 8, heart girth; 9, back; 10, loin; 11, rump, 12, hip; 13, dock; 14, thigh, or leg of mutton; 15, belly. (Mumford.)

FIG. 150. Carload lot of fat sheep: Grade Shropshires (2-year-old wethers owned by G. H. Hoxie, Thornton, Ill.), champions at the International Fat Stock Show, Chicago, 1901. (From a photograph furnished by *The American Sheep Breeder*.)

question of fleece is important only in so far as it increases or decreases the total value of the sheep to the slaughterer. Good killing or dressing quality is indicated by an absence, in the general appearance of the animal, of all wideness or coarseness. The bones of the leg and the head should be as fine as is consistent with good feeding quality and constitutional vigor.

FIG. 151. Typical fat sheep: Shropshire wether, champion in middle wool class, International Fat Stock Show, Chicago, 1901. (Photograph furnished by *The American Sheep Breeder*.)

The butcher's ideal mutton sheep might be one possessing bone so fine that the animal would be too delicate to make a profitable feeder. A thorough knowledge of the butcher's ideal is essential, but if the butcher's ideal animal for the block is at variance with the feeder's ideal for the feed lot, shed or pen, the feed lot ideal is bound to receive the most serious consideration at the hands of the producer. Fortunately, the butcher's ideal and the most profitable type of mutton sheep to feed are not materially different. By careful study the feeder can meet the demands of the butcher in almost every particular without sacrificing anything in animals so selected as profitable feeders.

Breeding — To make a profitable carcass of beef and a profitable animal in the feed lot, it has been said that well-bred beef steers are necessary. The statement applies with equal force in speaking of mutton sheep. The importance of breeding, as affecting the profitableness of a mutton sheep, is not generally enough recognized. High grades of almost any of the mutton breeds possess the qualities most sought by producer, dealer, and consumer, viz.: short legs and neck; broad back and loins; long, level rumps, well fleshed thighs, low, full flanks, and thick flesh.

FIG. 152. Typical fat sheep: Lincoln wether, champion in long wool class. (Photograph furnished by *The American Sheep Breeder*.)

Judging the Mutton Ram — The presence or absence of these characteristics is not so easily recognized in a sheep as in a pig or a steer, because of the thick covering of wool, which may, in the hands of the expert shepherd, be made to disguise the real form

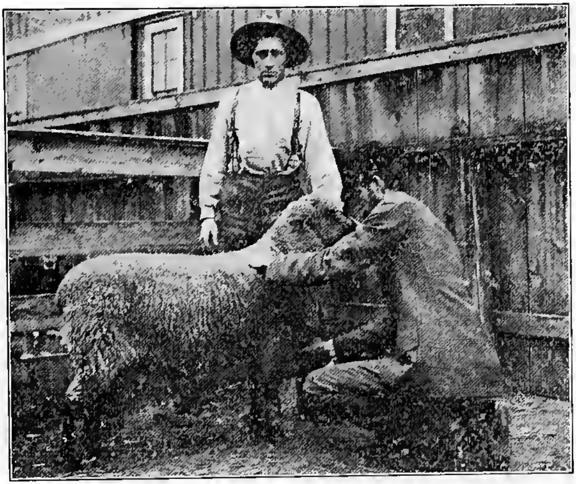

FIG. 153. Judging mutton sheep: Depth of chest. (Mumford.)

of the sheep. It is important, therefore, to follow a definite method of examination in order to determine their value.

The figures[1] accompanying this discussion will be found suggestive, and if the method illustrated is persistently followed, what appears to the novice an almost impossible task, will be found, in a remarkably short time to be reasonably simple. The better a sheep appears to be — that is, the smoother he has been made, either with feed or with the shears — the greater the possibility of deception; consequently, the more urgent the need of a careful and intelligent examination.

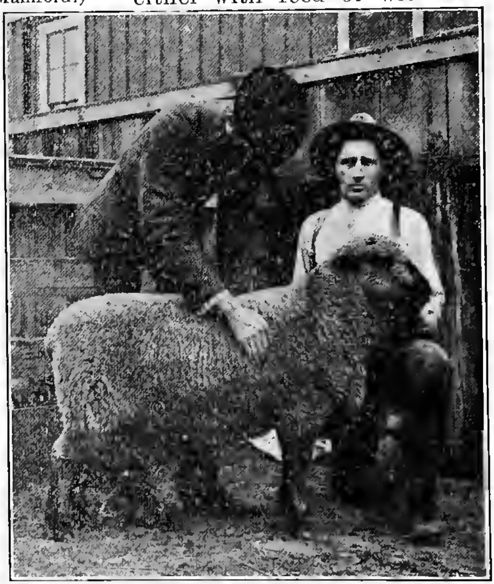

FIG. 154. Judging mutton sheep: Thickness through the heart. (Mumford.)

The majority of sheep raisers are interested, at one time or another, in the selection of a ram of some one of the mutton breeds; hence, it is thought that a discussion of this subject in connection with the illustrations will be found of most widespread interest. Mutton rams are so generally used on grade ewes for the production of grade lambs for winter fattening purposes that a description of the points of a ram suitable for such purpose is given.

Considering the use to which the ram is to be put it can readily be seen that relatively more importance should be attached to the mutton points of the sheep than to the so-

[1] For permission to use in this new connection the author's photographs reproduced in Figs. 153-161, the courtesy of Prof. L. R. Taft, Inspector of the Michigan State Board of Agriculture, is acknowledged.

called "fancy" points of breed type. On the other hand, were a ram to be selected to head a high-class, pure-bred flock, care should be taken to secure characteristic breeding points. It simplifies the discussion materially, however, to confine ourselves to mutton points. The mutton type should be possessed to a high degree by every individual of every breed of mutton sheep. It may be said to be almost the only breed-type characteristic that is held in common by all mutton breeds. True, more perfect development of the leg of mutton is expected in the Southdown than would be looked for in the Oxford, but a glaring defect in the leg of mutton should be a disqualification from the standpoint of mutton production, no matter what breed of mutton sheep is involved. It can be seen how even the breeder of pure Oxfords might pass over a deficient leg of mutton on a sheep possessed of excellent quality, breed-type, and finish. It would not be necessary for the farmer in quest of a good mutton ram to put up with a poorly developed ram, *i. e.*, in so far as mutton points are concerned.

FIG. 155. Judging mutton sheep: Flesh-covering of back and loin. (Mumford.)

Every breeder recognizes the fact that a pure-bred ram possessing an almost ideal mutton form may have to be sold at a low figure if lacking in breed-type points, while another possessing better breed-type, but no better mutton form than the former — perhaps not so good — will bring a price relatively much higher.

Just here is the lamb raiser's opportunity; he wants, first of all, a ram possessing as nearly as possible an ideal mutton form, with sufficient breeding to give a reasonable guaranty that he will transmit his characteristics to his offspring. Such a ram can often be purchased at half the price that the good breeder would be required to pay for a ram combining good breeding, good breed-type, and ideal mutton form. It is not an easy task to select a ram simply for mutton points. A ram to do the most good must be in good breeding condition, neither too fat nor yet too lean.

The novice in judging sheep is often deceived in purchasing an overfat sheep because it looks good. While a sheep too thin in condition is a puzzle alike to the novice and experienced judge, a sheep in a condition bordering on either extreme is an unprofitable sheep to the purchaser.

Systematic Examination — The safest plan to follow in selecting a ram is to adopt a systematic method of examination. Thus one will generally avoid

Fig. 156. Judging mutton sheep: Width of loin. (Mumford.)

overlooking either the strong or deficient points of the animal. It goes without saying that one should know how a properly developed sheep should look and handle. It is not enough to make an examination with the eyes. It is safe to say that less can be told of the real characteristics of a sheep by general appearance than of any other farm animal. More dependence must be placed upon the use of the hands. Not all judges agree as to the best method of examining a sheep. Some begin with an examination of the most important points, while others think it best to begin at the head, taking the points in passing to the rear of the sheep. The latter is the safer method.

Head and Face — Careful students of physiognomy can judge much of the characteristics of a man or woman by a good look at the face. So, much can be seen in the head and face of a sheep to indicate its masculinity The ram with a long narrow head is seldom a prepotent or satisfactory sire. Passing from the head back to the neck we should look for a short, thick neck, one that gradually thickens toward the body, joining the shoulder smoothly and evenly. There should be no drop just in front of the top of the shoulders, constituting what is known as a "ewe neck."

Fig. 157. Judging mutton sheep: Length of hind quarter. (Mumford.)

Depth of Chest — Fig. 153 shows the method of judging of the depth of chest by placing one hand on top of shoulders and the other between the front legs of the sheep, noting also the width between the forelegs, which should be relatively great. Examine at this time also the fulness of the brisket, as well as the covering of the point of the shoulder and the shoulder blade. It is well, too, to press firmly on top of the shoulders to determine whether the shoulders are well overlaid.

Fig. 158. Judging mutton sheep: Fulness of rump. (Mumford.)

Thickness Through the Heart—Fig. 154 shows the method of getting an idea of thickness through the heart, which should always be great, since it indicates a good, strong constitution and fulness of the heart girth. The animal should not, as we say, be "tucked up in the girth."

Flesh-covering of Back and Loin—By placing the hands a little higher and nearer the middle of the back, the spring of the ribs should be noted. Fig. 155 shows the proper way to handle the back and loin to determine the covering of flesh. The hand should be open and laid flat on the back, then on loin; the hand should be pressed firmly and moved slightly back and forth, pressing firmly all the time. If the back and loin is not well covered, the spine will be more or less prominent.

Fig. 159. Judging mutton sheep: "Leg of mutton." (Mumford.)

Width of Loin—Fig. 156 shows the proper method of judging the width of the loin. At the same time the thickness of the loin can also be noted, together with the distance between point of hips and the first rib. This distance should be relatively short. Where the width of the loin is not too great one hand may be used in such a manner as to span the loin. Where it is desirable to compare the width of the loin of two sheep this method can often be used to good advantage.

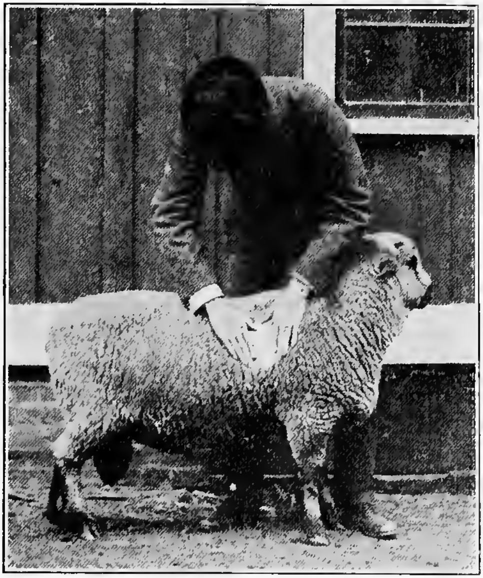

Fig. 160. Judging mutton sheep: Fleece. (Mumford.)

Length of Hind Quarter—Fig. 157 shows the method of determining the length of the hind quarter. It should be of good length and carried as level as possible.

Fulness of Rump—Fig. 158 shows one way of noting the fulness or deficiency of the rump. By this method one should be able to judge whether a sheep carries its width well back. In all of these examinations it is well to bear in mind that it is the form of the carcass of the sheep, regardless of the covering of wool, for which we should look. To do this the hand, or fingers, as occasion may require, must be firmly laid on the sheep.

The "Leg of Mutton"—Fig. 159 shows manner of examining the "leg of mutton." The fleshing of thigh and the filling of the twist should be taken into consideration at this point.

While the danger with the beginner in judging sheep is to judge too much by the general appearance of a sheep, such an examination is of practical utility. For example, by a careful view of the sheep as a whole, at some little distance, we judge of carriage and style. The general outlines, providing the sheep has not been blocked by the professional trimmer, should indicate whether the top and bottom lines are straight and parallel, whether the body is deep, the flanks full, and the legs short. At such a distance the sheep should present a low, massive, blocky appearance, the short legs standing well

Fig. 161. Judging mutton sheep: Fleece. (Mumford.)

apart and well to the corners of the body. The legs should be reasonably straight as viewed from the side, front, and rear, which indicates strength and feeding type.

A sheep with rather heavy bone is to be preferred to one with a tendency to be too fine boned. As a rule, too fine-boned sheep lack vigor and growth, being delicate and undersized.

The fleece of a mutton sheep is practically the last point to be looked to, but it is a point that has been too much neglected. To go into a discussion of the proper examination of the fleece would require a treatise of too great length. Perhaps it will be sufficient to say that the wool should be opened as shown in Fig. 160. Such an examination should give a general idea of the quality, length of staple, and density of wool.

The best wool on the sheep will be found at the point indicated, while the fleece should be opened as indicated in Fig. 161, on the thigh, to see if the quality, density, and length of staple is fairly uniform over the whole body. The wool on the lower thigh is often coarse, open, and shaggy — not a good sign.

In conclusion, it may be said that one never learns all there is to be learned about judging sheep. By one who is really anxious to learn, one with a love for sheep and a keen sense of discernment, much can be learned in a short time. The first step is to become familiar with a correct method ; the next, to know that the most important points of the mutton sheep are the leg of mutton, the loin, and the back. With a well-developed loin, back, and thigh, couple a low, massive form on short, strong legs, fronted with a masculine head, and you have a ram that is safe to depend upon as a producer of good feeding lambs.

V. THE PRODUCTION AND MARKETING OF WOOL[1]

WOOL OR MUTTON, OR BOTH?

It is very doubtful whether the time will ever come when the keeping of sheep for the production of wool alone can be made profitable in many localities in the United States.

Wool growing upon such a basis must, in the future, be confined to localities remote from the great meat consuming centers, where farmers are unprovided with rapid transportation to these centers, or where the cost of transportation of mutton would be so high as to render the carcass of little or no value.

A moment's consideration would suggest that wool growing under such conditions could only be made profitable upon cheap lands, where the herding of large flocks would be possible and where the climate and other conditions would be favorable to the development of sheep and the healthy growth of the wool fiber.

1 From Bulletin 178 of the Michigan Agricultural Experiment Station, by the author.

We can conceive how present conditions might be so changed as to render sheep husbandry profitable, if the wool product only were taken into account. It is not probable, however, that we shall ever see a repetition of conditions which existed earlier in this century. It is not probable that the price of the finer grades of wool will go so high that the breeder, even of that class of sheep, can afford to entirely overlook the ultimate value of the carcass for the block.

It is not difficult to see that the ranchman who can run large flocks of sheep in bands, and who has at his command an almost unlimited grazing ground, can produce wool more economically than the general farmer who keeps a flock and looks upon it simply as an incidental contributor to his income.

The owners of small flocks, then, soonest feel the effects of depression and are most apt quickly to dispose of their flocks after one or two unprofitable years. We believe future conditions will bear us out in the statement that there will be very few years when a man who has a flock of sheep of good quality, who pursues careful and painstaking methods in handling them, will fail to secure a net profit.

There is a promising outlook for the American farmer who economically produces wool and mutton. I doubt if we shall again see the time when the flock master can secure a net profit from his flock unless he makes a thorough study of the industry, knows what he is trying to do, how he is to accomplish his ends, and is willing to settle upon a policy in breeding and rigidly adhere to it.

May I venture to suggest here that one of the greatest sources of loss to the American farmer has been his vacillating from one line of breeding to another, from one rotation of crops to another, and from one system of farming to another? Use all of the means at hand to decide the wisest line of sheep husbandry to pursue under your conditions, and then do not deviate from it without the best of reasons. Remember that a constant, persistent, and settled policy is best.

In connection with this subject the question naturally arises: Can sheep husbandry be made profitable by disregarding entirely the wool product? In some few favored localities such a course of sheep husbandry may be pursued with profit, but under ordinary conditions the wool product contributes materially to the net income from the flock. In some instances breeders of mutton sheep have realized as much for their wool as the men who have been keeping sheep primarily for the wool which they produce. In making such a claim it should not be forgotten that the American markets in the past have not been glutted with a large supply of the medium and coarse grades of wool, while the scarcity of fine wools, owing to the common stock of the country being largely Merino grades, has not been apparent until quite recently, although a few of the breeders of Merino sheep have persistently prophesied that former conditions would return, and that the grading up of flocks for the production of the finer grades of wool would again profitably engage the attention of American sheep men.

Fashion in the manufacture of woolen fabrics, which has always been a potent factor in the price of different grades of wool, has seemed to encourage the growth of medium and coarse wools. While the future of the wool industry will be settled by conditions almost entirely beyond the control of the growers of this country, still everything points to a brighter prospect for the wool grower than for several years past, and especially for the producer of fine delaine wools.

WORLD'S WOOL PRODUCTION

The number of sheep in the world in 1894, according to S. N. D. North, was 571,163,062, and the amount of wool produced was 2,692,986,773 pounds, showing the average weight of fleece per head to be 4.7 pounds.

Wool Product of the United States—From the same authority we learn that in the United States, during the same year, there were 45,084,017 sheep, producing 325,210,712 pounds of wool. By this we see the United States produces about one-eighth of the world's supply of wool. The average weight of fleece in the United States is 7.21 pounds; more than two pounds per head above the world's average.

For the last twenty years the number of sheep in the United States has varied from approximately 40,000,000 to 50,000,000; the latter figure was exceeded in 1884, while in 1894 the number was estimated at 45,048,017.

Current prices for wool and mutton, combined with other conditions, which have made the production of one or the other of these products unprofitable, have caused this variation in the number of sheep kept, and a similar variation in the amount of the mutton and wool produced. It has not been due to an overproduction of wool, for statistics show that never has home-grown wool excelled, or even equaled, the consumption of wool in the United States.

Outlook for the Future—No one can consistently say that we ought not to produce at home every pound of wool consumed within our borders. The natural adaptability of many parts of the country for sheep-raising suggests that we should, in every way possible, so adjust our farming operations, and our commercial and economic conditions, that the farms in the United States can produce at least all of the wool needed for home consumption, and that at a fair profit.

From statistics furnished in the Wool Book for 1895, issued by the National Association of Wool Manufacturers, we learn that 453,048,456 pounds of wool were consumed in the United States during the year 1894. The wool produced in the United States during the previous year, which would naturally contribute to such consumption, amounted to 348,538,138 pounds. This shows that we produce little more than three-fourths of the wool consumed. Since it is a well-known fact that the per capita consumption of the wool in the United States has steadily increased from 4.49 pounds in 1840 to 9.07 pounds in 1890, it is clear that wool growers have a prosperous future before them, if only they will give more careful attention to growing, preparing for market, and to developing markets for their home-grown products.

An advance in prices of wools tends to stimulate the industry. More wool is grown, but the manufacturer is obliged to pay higher prices for the raw material. It is difficult for clothiers to get a correspondingly high price for manufactured goods, so that the usual result is that manufacturers substitute, where possible, part cotton. The consumer gets his clothing just as cheap, but does not get all-wool goods. Sheep growers in the United States have been urged to grow all the wool consumed in the United States. We would go still farther and call attention to the vast undeveloped markets for manufactured products. When we remember that of the inhabitants of the world there are 250,000,000 who do not wear clothes, and 100,000 000 more who wear only about one-half as many as they should, we can see great opportunities ahead in the way of markets for manufactured goods. Perhaps woolen goods would not in all cases be suitable;—then let garments manufactured from cotton and other fibers be used, leaving a clearer field for the wool producer who must now compete in a measure with producers of vegetable fibers grown at a minimum of cost.

MANAGEMENT OF THE FLOCK AND ITS RELATION TO CONDITION AND VALUE OF WOOL

Continuous Care Requisite—The sooner we, as wool growers, fully appreciate the difference in value to the manufacturer between wools well grown and those poorly grown, the sooner will all our wools command a better price.

We must banish forever the idea that condition, quantity, quality, and length of staple are all of the important factors affecting its value. But we must give more attention to the growing of wool fibers of great strength. Strength of the wool fiber depends, to a considerable extent, upon the quality of wool or the size of the fibers. The important point, however, in this connection, and the point which we wish to emphasize, is that there is a great difference in the relative strength of fibers of the same quality or grade of wool. When a difference of this kind exists it is largely due to the way it has been grown.

The strongest fiber of wool is produced on sheep when the animal has been supplied with an abundance of nourishing food throughout the year.

If, on the contrary, a sheep is poorly nourished, the strength of the wool fiber will sooner or later be seriously affected. If proper care is not continuous throughout the year and the flock is neglected during any period, then a break in the fiber occurs, which greatly weakens the fiber at that particular point. The strength of the weakest place in the fiber decides the strength of the whole fiber.

So far as the writer has been able to discover there is no special ration, which, if fed to sheep, will produce wool of great strength, nor can it be said that any special ration is to be recommended to produce a large quantity of wool. It has often been observed that sheep and lambs which have been on full feed for long periods shear heavy fleeces of wool. This would indicate that any ration calculated to keep the sheep in a thrifty condition would be a suitable one for growing large quantities of wool.

From what has been said, the wool grower will understand that it is highly desirable to provide the sheep proper nourishment throughout the year, permitting no periods of neglect to intervene to destroy the strength of the fibers of the fleece. Liberal and judicious feeding does not change the quality of the wool, but it does affect the strength and the quantity of the wool produced by a given sheep. The weight of wool produced is affected both by increase in the length of fiber and by increase in the amount of *yolk*, or natural oil, in the fleece.

Condition of Wool refers to the cleanliness of the fleece — the absence of all foreign substances, such as sand, burs, chaff, and all other substances looked upon by the wool manufacturer as *litter*.

It is not because these naturally light substances affect the weight of the fleece to any considerable extent that wool manufacturers so strenuously object to their presence in the fleece, but that they must be removed from the fleece before it is ready for manufacturing purposes. The process of separating these substances from the fleece is not only very tedious, but very expensive, and, as a rule, it can not be done without more or less injury to the wool fiber. Knowing the above facts we can easily see how condition affects the price of wool, since it directly affects its value.

It is not a difficult matter for the wool grower to so manage his flocks that the wool produced by them will be practically free from all litter. He must provide racks for the sheep which will permit them to eat without getting their necks full of chaff, seeds, and dust. (It is, of course, unnecessary to mention the old straw stack.) He must keep his farm free from bur-bearing weeds; his flock will keep most other weeds in check. If we needed any proof that the farmers of our country are negligent about allowing weeds to grow and seed in abundance on their farms, we might visit some large wool-scouring or woolen mill, and carefully examine the refuse or waste from the mills. We would have abundant proof in the millions of weed seeds found. At some mills where such refuse is so dumped that seeds can germinate and grow, we find a large number of species and varieties of weeds.

Breeds and their Fleeces — That we might get more definite information concerning the wool produced by the various breeds of sheep, more or less common in the United States, we tried to secure, for each of the breeds, a ewe's and a ram's fleece, which should be average typical fleeces of the breed. In most cases we were successful in securing what we desired, but in other instances we were not fully satisfied that the fleeces submitted were typical of the breed.

In examining the tabulated facts below, we make the request that the reader should not consider the figures there exhibited as settling the relative merits of the various breeds as wool producers. Certain general conclusions may be drawn from the table, but it must be obvious to every thoughtful reader that it would be very nearly impossible to secure two fleeces which would in every way be representative of the various breeds.

TABLE SHOWING WEIGHT OF FLEECE, PER CENT OF SHRINK, COMMERCIAL GRADE, AND PRICE PER POUND OF FLEECES FROM DIFFERENT BREEDS OF SHEEP

BREED	Sex	Age, years	Weight of Fleece in Grease		Weight of Fleece after Scouring		Per cent of Shrink	COMMERCIAL GRADE	Price[3] per pound in Grease before Scouring	Price[3] per pound after Scouring
			LBS.	OZ.	LBS.	OZ.				
American Merino	Ewe	3	17	12	4	14½	72.36	X Clothing	$0 14	$0 50
American Merino	Ram	4	26	12½	6	10½	75.15	XX Clothing	.13	.52
National Delaine Merino	Ewe	4	9	10	4	1	57 70	Fine Delaine	.21½	.51
Improved Black Top Merino	Ram	1	18	11⅔	5	11	60.64	Fine Delaine	.20	.66¾
American Rambouillet	Ewe	2	8	1¾	3	9¾	55.42	X Clothing	20	.44½
American Rambouillet	Ram	1	7	15	4	9⅓	44.19	Fine Delsine	.22	39¼
Cross Bred [1]	Ewe	1	11	1	4	5½	60 73	½ Clothing	.19	.48¾
Southdown	Ram	1	7	5½	3	4	55 75	⅜ Combing	.22	.50
Southdown	Ewe	1	7	1	3	8½	50.00	⅜ Combing	.23	.46
Southdown	Ewe	3	7	12	4	11½	39.11	⅜ Combing	.23	.37¾
Shropshire	Ewe	1	10	12	5	9	48 25	¼ Combing	.22	.42¼
Suffolk	Ram	1	6	15½	3		56.95	Low ⅜ Combing	.23	.53½
Hampshire	Ewe	3	9	6	5	4½	43 67	⅜ Combing	.23	.41
Oxford Down	Ewe	3	12	9	7	13½	37.56	Braid Combing	.20	.32¼
Oxford Down	Ewe	3	15	2	8	13½	41.53	¼ Combing	.19	.32¾
Leicester	Ram	*10	12	8½	8	5⅔	33 33	Low ¼ Blood	.19	.28¼
Cotswold	Ram	2	15	3	9	13	35.39	Coarse Combing	.19	.29¼
Cotswold	Ewe	1	12	3½	7	12	36 57	Braid Combing	.19	.30¼
Lincoln	Ram	*11	14	8¾	10	4¾	33.77	Braid Combing	.20	.30¼
Lincoln	Ewe	1	14	11	10	2½	30 85	Braid Combing	.20	.29
Tunis	Ewe	*11	8	12¾	4	5	43 75	⅜ Combing	.22½	.39¼
Dorset Horn	Ewe	2	6	12½	4	1	40 09	⅜ Combing	.22½	.37
Dorset Horn	Ram	1	8	2½	4	4½	47 51	¼ Combing	.22	.42¼
Dorset Horn	Ewe	2	8	15	4	10½	47.90	⅜ Combing	.22	.42¼
Dorset Horn	Ram	*13	9	1½	4	14½	46.04	¼ Combing	.22	.40¾
Cheviot	Ewe	2	9	2	6	10	27.30	¼ Combing	.22½	.31
Cross Bred [2]	Ewe	1	7	4	4	4	41 38	⅜ Combing	.21½	.34

[1] Hampshire and Cotswold. [2] Rambouillet and American Merino. [3] Prices quoted Aug. 31, 1899. * Months old.

That there might be absolute fairness in securing representative fleeces of each breed, the writer appealed to the secretaries of the various sheep breeders' and registry associations to aid in securing the fleeces. In most instances much valuable assistance was rendered.

The weight of all fleeces is computed upon the basis of 365 days' growth.

Commercial Grade — For the benefit of those who may not understand fully what is meant by the terms used in the column headed "Commercial Grade," a few brief explanations are made:

General Grades — All domestic wools may be classified according to their quality, strength, and length of staple as (a) clothing or carding wools; (b) combing wools; (c) Delaine wools.

(a) Clothing Wools are short wools and incidentally of relatively fine quality. In a general way all wools less than $2\frac{1}{2}$ inches in length are clothing or carding wools.

(b) Combing Wools are both long in staple and strong. Most of the coarser long wools are graded as combing wools. However, when a wool is long enough for combing and has the necessary size of fiber it may still be disqualified as a combing wool if it has been poorly grown. Breaks in the fiber caused by insufficient nourishment destroy the value of wools for combing purposes.

(c) Delaine Wools are fine wools clipped from all varieties of Merinos or high grade Merinos which grow wool of long, strong staple. We might say that Delaine wools are combing fine wools.

Subdivision of Grades — Each one of the three classes of wools above mentioned is subdivided according to quality or size of fiber, as follows.

(a) Clothing wools	(b) Combing wools	(c) Delaine wools
Picklock	$\frac{3}{8}$ blood	Fine
XXX	$\frac{1}{4}$ "	Medium
XX	Coarse or common	Low
X	Braid	
No. 1, or $\frac{1}{2}$ blood		
No. 2, or $\frac{3}{8}$ "		
No. 3, or $\frac{1}{4}$ "		

Picklock is a grade that is rarely found in the markets at the present time. Formerly a large quantity of this wool reached our markets. The wool from pure Saxony Merino sheep usually grades Picklock. *XXX* also is hard to find. When the Saxony Merino was crossed with the common American or Spanish Merino, the cross-bred resulting usually produced wool grading XXX.

XX is considered the standard for a pure-bred Merino.

Some three-quarter blood Merino, nearly all of the high-grade Merino, and much of the coarser pure-blood Merino wool, grades as *X*.

The terms $\frac{1}{2}$, $\frac{3}{8}$, and $\frac{1}{4}$ blood do not necessarily mean that the wools were grown on sheep possessing just that fraction of Merino blood. Many sheep containing no Merino blood grow wool grading $\frac{3}{8}$ and $\frac{1}{4}$ blood. No. 1 or $\frac{1}{2}$ blood is the next coarser grade than X. No. 2 is coarser than No. 1, and so on.

Coarse and *Braid* wools are invariably combing wools, and are the grades most frequently produced by Lincolns, Leicesters, and Cotswolds, which have fleeces coarse and long in staple, but bright and lustrous.

Fine Delaine is the grade next coarser than the Braid Combing, while *Low Delaine* is long enough to be Combing, but a grade finer than the finest Combing wools, namely, ⅝ blood.

Special Grades—Other grades of wool which are occasionally quoted in the markets are (a) felting wools and (b) noils.

Upon request, Mr. Charles F. Avery of Boston, has defined felting wools and noils as follows:

(a) "FELTING WOOLS are wools which are adapted for felting purposes, usually of short staple, and having properties which cause them to felt quickly. We presume that you understand that felting is a process whereby the fibers are interlocked in such a way that a solid fabric is produced without the intermediate processes of spinning and weaving."

(b) NOILS—"In the process of combing wool the fibers are drawn between fine needles and the dead and tender wools are broken off in the process and produce what are called *noils*, or what might be called combing waste. The long and healthy fibers are carried along through the combing process and are formed into what are called *worsted tops*."

WASHING AND SHEARING SHEEP

Washing sheep is not nearly so prevalent as formerly. Most manufacturers agree that wool which has been washed in the country is not so desirable as that which has been sent to market unwashed. It is an unsatisfactory process at best, and many times the country washing makes scouring at the mills more difficult.

Injury to the Wool—After a careful investigation of the subject we are convinced that, in the long run, it is more profitable to dispense with washing altogether.

We have secured better results by shearing our sheep during the first half of April than later in the season. This, of course, makes it impossible to wash sheep before shearing. We are satisfied that we can get not only a heavier average fleece, but also a wool of better strength from the same flock by shearing during the first half of April than by shearing in May or June.

If reasonable care is taken to keep the wool free from dirt and litter while on the sheep's back, then there is little to be gained by washing. By an examination of the wool market quotations a class of unmerchantable wools will be noted. This class includes wools poorly washed.

Injury to the Sheep—The subject of washing should not be dismissed without saying that if the author could believe the washing process an advantage to grower and consumer alike, he would still think the custom of doubtful utility on account of injury to the sheep. Sheep are often roughly handled, and not infrequently more injury is done to the sheep than good to the fleece. The sheep will suffer no inconvenience from early shearing, except for the first few days, if they are properly sheltered and protected from the cold, and more especially from storms. The wool makes a rapid growth during the cool months of spring, and the sheep are not sweltering under a thick blanket of wool. In the latter case the sheep are not only uncomfortable, but the wool makes little if any growth.

For several years, in a majority of instances, the Eastern wool markets have been better in April than in June. This would give the grower who makes a practice of early spring shearing a slight advantage as to markets.

Shearing — The best job of shearing is that which secures the largest amount of wool in the best condition for market without injury to the sheep. It is highly desirable that the sheep be closely shorn and that there should be no second cuts. The fleece should be kept intact, not torn apart, and the skin of the sheep should not be wounded.

Nearly all of the sheep east of the Mississippi River are shorn by hand, while many in the West and on the ranges are shorn with machines.

MARKETING WOOL

Unlike most other farm products, wool can not be consumed on the farm. It is true that in the days of our grandmothers and the spinning wheel, a large part of the then small wool product of the United States was manufactured and used upon the farm. Now we neither spin the wool upon the farm, nor is it possible for us, when low prices prevail, to use up the surplus by feeding to our farm animals, thus converting it into meat products, as is possible with grains and hay produced upon the farm.

The question of wool markets and the preparation of wool for the market is, therefore, one of vital importance to the wool grower. Dealers in and manufacturers of wool make the following objections to the majority of wool marketed in the United States: (a) Either by neglect or intent, tags and litter are often incorporated in the fleeces. (b) Too much twine of an inferior grade is used. (c) The use of the wool box results in packing fleeces into a square bundle that is too compact. Let us consider these objections.

(a) **Tags** — If tags are understood to refer to bunches or locks of manure which have accumulated on small bits of wool about the thighs and hocks, then by all means they should be left out of the fleece, and either sold separately as tags, for what they will bring, or used as manure. We have known breeders of fine wool sheep who have thoroughly washed and dried the tags and then put a handful or so in each fleece. There is no great objection to this, providing the tags are well washed and thoroughly dry. It would be more businesslike, however, to sell the washed tags separately, as the wool will never be so valuable as the rest of the fleece. It is perfectly legitimate to tie up all the wool that grows on the sheep in the fleece, provided that the wool is free from all foreign substances which would add to the natural weight of the fleece.

It is worth while to offer here one reason why a majority of wool growers incorporate tags and litter in the fleeces which they sell. There are two distinct classes of growers who put tags into the fleece. The first class includes growers who put tags into the fleece either through absolute carelessness or with the evident intent of deceiving the buyer. This class of men is small and undeserving of consideration. The second class includes growers who are progressive and businesslike. This statement sounds inconsistent, but it is not. These men have cut out tags and litter very carefully, it may be, for two or three years; they have observed that, as a rule, they get no more for their wool than the men who put tags and all into their fleeces. This suggests that buyers are not careful enough in recognizing painstaking methods on the part of progressive growers. Buyers know the extra value of clean wool. Let them encourage the honest, painstaking growers in a substantial manner by giving more per pound for their wool, a thing which they can well afford to do. Let them at the same time, discriminate against wool carelessly tied, or that which contains chaff, burs, and other litter. Until buyers rigidly adhere to that policy, but little improvement can be expected among wool growers.

(b) **Twine** — Besides weight, there is still another reason why buyers object to coarse twine. The coarse, hard fibers of the twine are apt to work in among the wool fibers. Manufacturers find it difficult to separate these foreign fibers from the wool, and unless they are removed they work injury to goods manufactured from such wool. We believe the time has come when wool growers should adopt a small twine of better quality.

A small linen twine used by nearly all wool growers in Australia is to be recommended in every way. While such twine costs about 25 cents per pound, it runs nearly 2,700 feet to the pound. A pound of linen twine should, therefore, tie 270 fleeces, allowing 10 feet to each fleece, or 135 fleeces, allowing 20 feet to each fleece. This linen twine is soft, and should the fibers become mixed with the wool no material injury would be done.

No. 18 hemp twine is also to be recommended. There are about 1,600 feet of this twine to the pound and it can be purchased for about 10 cents per pound. The only objection that can be raised to the use of a small, fine twine for tying wool is that it is hard on the wool packers' hands.

(c) **Wool Boxes** — The majority of wool boxes which tie the fleeces in a square bundle are too small. The most of them were made for fleeces from Merino sheep, and new ones have not been made for handling more bulky, coarse wool; consequently the fleeces are packed too snugly together. This gives them a heavy, soggy appearance, whereas they should present a light, loose, and bulky appearance.

The method of tying wool in Canada is quite satisfactory. The fleece is spread out on a clean shearing floor with the outer ends of the wool up. The skirts of the fleece are folded in toward the center, only a trifle at each end, but considerable on the sides, so that the sides lap well ; then the fleece is rolled from end to end, making a short, cylindrical roll of wool. A small hemp twine is then run snugly around the roll a little distance from each end.

Ten Points for Wool Growers — In conclusion, the following items should receive careful consideration :

1. The manufacturer buys wool on the basis of its true value for manufacturing purposes. The grower, the local dealer, the commission man, and the scourer should each make an honest effort to satisfy his reasonable demands.
2. Breed and feed affect the value of wool from the manufacturers' standpoint. Indiscriminate crossing is unprofitable.
3. A small linen, or flax or hemp twine is best for tying wool.
4. Coarse, heavy paint-marks should be avoided in marking sheep.
5. More and better wool can be secured by early shearing.
6. Loose, bulky fleeces sell best in the market.
7. Avoid lime and sulphur as a sheep dip.
8. Every pound of wool consumed in the United States can be profitably grown here.
9. It is very doubtful, indeed, if the American wool grower can ever afford to ignore the ultimate value of the carcass producing the fleece.
10. Mutton-growing with wool as an incidental product will continue to be a profitable industry.

VI. SUGGESTIONS FOR INTERPRETING CATTLE MARKET QUOTATIONS

1. Learn to distinguish between a market class and a market grade. Speaking generally, the market classes of beef cattle are *beef*, *butcher-stock*, *cutters* and *canners*, and *stockers* and *feeders*. The grades are *prime*, *choice*, *good*, *medium*, *common*, and *inferior*.
2. The names of the various classes indicate the uses to which cattle in those classes are put. The grades refer to quality, condition, and conformation, the relative importance of which factors, so far as they influence market values, is indicated by the order in which they have been enumerated, quality being of greatest importance, condition next, and conformation of least importance.
3. Weight has relatively but small influence in determining the grade and price of fat cattle. Quality and condition largely govern both.

4. As a basis for comparison and study of other grades, become thoroughly familiar with the characteristics of prime steers and choice feeders; these are the standard grades of fat cattle and feeders. Fluctuations in the market affect these grades less than others.

5. It is, therefore, more difficult to determine an approximately correct valuation for a lot of low-grade cattle than for cattle of higher grades.

6. Where practicable, follow your consignments to the market; find out the desirable and undesirable characteristics of your cattle from the standpoint of the market.

7. Observe other cattle on the market and compare their quality, condition, conformation, and the prices paid for them, with the quality, condition, conformation, and price of your own cattle, with which you are more familiar.

8. Compare price for which various lots of cattle have been sold with market quotations and note what grade of cattle is bringing similar prices.

9. The terms *export, shipping,* and *dressed beef* steers are no longer significant of any particular grade of cattle. Several different grades and even different classes are exported, shipped, and used for dressed beef.

10. The most desirable steer for export, for shipping, and for the best grade of dressed beef either for domestic or foreign trade is the same in each instance.

11. The best grade of any class of cattle must be practically above criticism.

12. When cattle grade the best of their class they command a premium on the market. Such cattle usually sell at strong prices and for their full value.

13. Cattle of the lower grades, necessarily deficient in certain particulars, sell at a discount which in many instances is greater than their inferiority demands.

14. Thus it will be seen that the tendency is to spring the market for choice, prime, and fancy grades, while the common and medium grades are seldom, if ever, sold for more than they are worth; while many times they do not bring their full value, owing to a tendency on the part of buyers to magnify defects of minor importance.

Herbert W Mumford

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[1] Angora goat raising.

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HOME FISHING AND HOME WATERS. By Seth Green. *Orange Judd Co.*, N. Y. . . .50
TRAINING VS. BREAKING. By S. T. Hammond. *Forest and Stream*, N. Y. 80
TROUT, DOMESTICATED: HOW TO BREED AND GROW. By Livingston Stone. *Orange Judd Co.*, N. Y. 2.50

FIG. 162. "BABES IN THE WOOD." Sixteen head of two-year-old grade Angus steers, bred, raised, and fed by L. H. Kerrick, Bloomington, Ill. Sold, December 13, 1899, at Union Stock Yard, Chicago, for $8.25 per hundredweight on the hoof. Average weight, 1,535 pounds; dressed weight, 1,009 pounds: per cent of beef, 65.64. The price paid for these steers topped the market by 75 cents for sixteen years.

Beef Making

By L. H. Kerrick, Bloomington, Ill.
President of the American Aberdeen-Angus Breeders' Association

THE CORN BELT FARMERS' OPPORTUNITY

Beef is the imperial flesh food of the race; it always has been and probably will continue to be. Therefore we may expect that the demand for beef, especially good beef, will be as constant as that for any other product of the farm. Intelligent beef production will certainly be rewarded with fairly constant and reasonable profits. Where conditions favor it, we strongly advise farmers to convert some part of the products of their farms into beef. Beef making is more intimately connected with the maintenance of soil fertility than any other branch of animal husbandry. Many kinds of forage and roughage and other farm products, which it is not practicable to harvest and prepare for market, may be converted into beef to sell and manure to enrich the soil of farms that have a beef herd.

When prices of corn and oats and hay are very low — when a great amount of these brings a small amount of money, they may be stored in the form of beef upon young, growing cattle, with chances gained of marketing in that way at a higher and profitable price.

Beef making is a business of absorbing interest. It may be called a higher branch of farm study. The care of a herd of beef cattle affords room for the exercise of faculties only partially engaged in the ordinary routine of planting and tilling and harvesting. The boys are sure to become interested in it, and likely all the family.

The world must look to the Corn Belt of the United States for its chief supply of fine beef. Over all this vast region all the feeds required to make the best beef are produced in great abundance. The climate is well adapted to the production of beef. The average farm equipment and improvement with little change or addition, can be well suited to raising and feeding cattle for beef. Costly barns for close housing of feeding cattle are not now deemed necessary or even desirable. Farmers of the Corn Belt have the capital and intelligence needed in the business of making high-class beef. They have shipping facilities almost complete. They have already a good but not adequate stock of beef cattle which is being rapidly increased and improved.

There are indications that Corn Belt farmers are being awakened to the peculiar opportunities and advantages which they may enjoy in the business of furnishing the world its good beef. More are engaging in the business than formerly and still more may engage in it with profit. The middle Western States — the corn States, should become, and I think will become, noted as the great beef-producing region of the world — noted not only for the amount, but for the fine quality of the beef produced. When Corn Belt farmers are fully aroused to their advantages it will not be long till a handsome share of the world's money will be coming their way to buy their good beef.

It is the object of this article to encourage our farmers generally to engage in the business of breeding, raising, and feeding cattle for beef, and also to outline, as well as we can, the present state of knowledge of cattle feeding. We do not know so much yet about beef making that anyone need be discouraged about learning what is known about it. However, the less we know, the more important is it that prospective cattle feeders know the little that is known.

THE THREE-YEAR-OLD STEER MUST GO

Injudicious and wasteful methods of handling and feeding cattle should be promptly discarded. Our lands are now high priced, but not nearly so high as we believe they will be in the not distant future. In the days of cheap lands and cheap feed, half a bushel of corn a day to a steer and two or three acres to graze him on, and three to three and a half years to prepare him for market, might go for cattle business, but not now. With the passing of cheap lands the three-year-old steer must go, too. The Corn Belt beef must be made, if made with profit, in thirty months and under.

Prime Beeves at Twenty to Thirty Months — It is entirely practicable by simple, natural, economical methods to produce prime beeves of 1,400 to 1,600 pounds weight at twenty to thirty months old. We have produced them in carloads weighing over 1,700 pounds at about thirty-one months old. But this implies that they be fed continuously and fed properly from calves to ripe beeves. I am confident this will become the general practice with beef producers in the Corn Belt.

High-priced land makes intensified farming necessary. It will also make intensified beef making, *i. e.*, constant good feeding from calf to beef, equally necessary. The greatest weight of beef can be made with a given amount of feed during the first twenty or twenty-four months of a steer's life. Why not then let him have the feed during that period? The whole mission of a steer is to convert our feed into beef. Why not keep him busy every day at his proper work? If we let him go a month or a day with less feed than he can make into beef, that month or day he fails to make us the money he might be making.

Best Beef by Early, Constant Feeding — It is my opinion that not only the greatest weight of beef for the amount of food consumed, but also the best beef, is made by supplying a steer liberally and constantly with the right kind of feed during the first twenty or twenty-four months of his life. It stands to reason, and our experience points to the fact, that the thickest red meat, so desirable and valuable, with the richest intermingling of fat, must be made during the period of the steer's most rapid growth. If a steer be permitted to run until two or two and a half years old on barely living rations, we suspect his red meat can hardly be thickened or increased very much after that, by any kind of feeding. The fat may be put on him and put inside of him after he is two years old, and the quality of his red meat may be improved by good feeding. But I believe he has missed his chance to make the greatest thickness and best quality of red meat that he was capable of making.

FEEDING FOR MARBLED FLESH

The steers represented in Figs. 162 and 163 were fed a grain ration continuously from five to six months of age until they went to market. They ran with their dams on blue grass pasture until weaned. About five weeks before weaning we began to teach them to eat a little corn meal and ground oats mixed. At the first, very little — in fact, but a taste — was spread in their troughs. When finally taken off the cows they knew as well as older steers how to eat.

For the next six or seven mouths they were fed all they could safely take of a mixed ration of corn in some form; oats, ground or whole; oil meal; and wheat bran. *Not all of these different feeds are given all the time, but two or three at each feed.*

Corn is our principal and constant feed from start to finish. Four-fifths of all concentrated feed used is corn — sometimes ground, again soaked; sometimes broken and sometimes whole corn fodder, shuck corn and all, just as it comes from the shock.

Full Feed at Twelve Months — Until twelve months old we feed our steers cautiously. It is not so bad to give them somewhat less than they can safely take up to that age, as it is to give them more. When about a year old they go on full feed, *i. e.*, all they will clean up and *digest well.* Steers will readily learn

Fig. 163. Grand Champions, International Live Stock Exposition, Chicago, 1900. Fifteen head of two-year-old grade Angus steers, bred and fed by L. H. Kerrick, Bloomington, Ill. Sold for $15.50 per hundredweight on the hoof — the highest price ever paid in any market for a carload of cattle.

to eat up clean much more than they can digest and assimilate. The point to make in good feeding is to keep steers eating up to the amount they can assimilate and make into good beef. The feeder must be the judge of what that amount is, and not the steer. I conclude that a peck of good sound dry corn, or at the most, one-third of a bushel, with two or three pounds of old process oil meal or the same quantity of gluten meal, and a pound or so of wheat bran with suitable roughage, will make as much beef on a steer twenty to twenty-four months old as any larger ration. And it will make a better quality of beef. Younger steers will need a proportionately smaller amount.

At this time we have on full feed sixty-four high-grade Angus steers. Their average age is about twenty-five months. They are fed twenty pounds of good sound ear corn soaked, one and one-fourth pounds oil meal, and one pound of wheat bran for every steer daily in two feeds, morning and evening. We will increase the oil meal to about two and a half pounds. They have mixed clover and timothy hay in quite moderate quantity, and the run of about twenty-six acres of blue grass pasture. These steers are preparing for the Christmas market. At this time, September 20th, they are making entirely satisfactory gains. By the first of December they will be finished, ripe, prime beeves, heavy enough and fat enough and not too fat to meet the highest market demand. These steers and all the steers we have fed for many years are raised and fed in the open. They are never closely housed. They have sheds open to the south, to which they may go for protection from storms. Sometimes, in the height of fly time, we have arranged for a cool, darkened place into which a load or more of steers which are receiving special fitting may retreat from the flies and extreme heat.

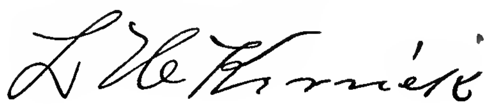
Importance of Roughage — All our steers are fed in open troughs out of doors; never less than a carload and sometimes three or four carloads eating together. It is of the utmost importance in full-feeding cattle to have them consume a proper amount of roughage. If steers are given all they will eat of concentrated feed they are likely to acquire a morbid appetite for it and a capacity for making away with an extravagant amount of it, while they lose the natural appetite for more bulky food.

In order to compel our cattle on full feed to consume a due proportion of roughage, we often "bed" the feeding bunks or troughs with mixed clover and timothy hay, or shredded fodder. Over this layer or bedding of roughage we carefully distribute the concentrated feeds — corn, oil meal, etc. In this simple way, roughage and concentrated feeds are so mingled that the steers are obliged to take both at the same time. It should never be forgotten that a steer is a ruminant. His digestion will suffer and assimilation will be imperfect if there is failure to maintain some just proportion between the concentrated feeds and roughage which he consumes. Without doubt much larger gains will be secured for the corn and other concentrates consumed by judicious mingling with suitable roughage.

Beef or Tallow: Which?—Referring again to the pictures of the "Babes in the Wood" and the "Grand Champions," their great thickness is apparent. Which is it, beef or tallow? Buyers and judges are prone to believe that such cattle are excessively fat—"overdone." It is true that the majority of steers showing such great thickness are too fat; but not these. The majority of steers do not go on full feed till past two years old. They are then generally fed an excessive amount of corn—a fat-making food, without the protein-bearing oil meal or gluten meal to supplement it; and the result is, frequently, overdone and overfat cattle. Not so with steers fed during their rapid-growing period with corn, properly balanced by the addition of oats and bran and some oil meal or gluten meal. The steers represented in the figures showed a great development of red meat richly mottled with fat; but there was no excessive percentage of fat. And none need be feared from such feeding as they had. On this point we can speak from many years of experience.

CONCLUSION

Summing up, we advise farmers generally throughout the Corn Belt to breed and feed cattle for beef. Feed liberally, feed for beef all the time, from calves to finished ripe beeves. Instead of growing a steer to be afterward "fattened," grow a beef, ripe, finished, fat, and prime, in twenty to twenty-four months. You will thus make better beef, and make it in less time, and make more of it with a given amount of feed than by the old method of growing a steer to be afterward fattened. Aim to maintain good variety in the feed. Supplement the corn with oats, bran, oil meal, or gluten meal. Supply good roughage, and feed in such a way as to secure the consumption of a due amount of it. Breed for the early maturing type. Handle your cattle gently, always; treat them humanely, kindly; the very best results may not be expected without such treatment and handling.



Feeding Native Cattle for Beef

By John P. Stevenson, Tarkio, Mo.

Practical farming, in a nutshell, is the farming that is planned and carried out, year by year, with a view to making the most of every natural advantage, and turning even what might seem to be disadvantages to profitable account. The practical farmer is the farmer who studies and solves his own problem, taking whatever he can get, to be sure, in the way of side-light from the experience and research of others, but never forgetting that bushels can not be measured with yard-sticks, and that what is gospel truth in one part of the country may be rank heresy in another. Many an Eastern farmer, for instance, seeing hundreds of bushels of ear corn hauled out daily to the steers in an Atchison County feed lot, doubtless would exclaim at what he would consider a willful waste. Willful waste it might, indeed, be for him; but for us, it is the most profitable way of marketing our staple crop. The hogs that follow the steers see to it that scarcely a kernel, scattered, tramped in, or undigested, goes to waste.

Natives vs. Rangers — The feeders of the Missouri Valley who make it their business to put six months of beef-and-fat-growing on to the steers other farmers and ranchers have raised, have merely adapted themselves to the circumstance that their acres lie in the richest part of the Corn Belt, and convenient both to stocker markets and to beef markets. When it comes to choosing what sort of stockers they shall feed — whether natives or rangers — they must again accommodate themselves to circumstances. A large feeder — and by that I mean one who turns out beeves by the thousand annually — can scarcely obtain for his feed lots native cattle of desired quality exclusively. Nor can one whose feeding operations extend to no more than 500 or 600 head a year be always sure of getting them. My own preference, however, is for Kansas feeders — any fairly well-bred cattle, regardless of breed. If native cattle of proper form and even condition are not obtainable, Westerns must be used; but with me they are a second choice.

The best time of year for buying feeders in the stocker markets of the Missouri River is between the middle of August and the middle of November. To buy them at that time means carrying the bunch through the winter, but at the age I buy them — two years or more — there is growth in the steers still, and the fleshing-up they get is not simply a matter of laying on fat where there is room for it.

FIG. 164. An average bunch of native feeders: Age, about 2 years; weight, about 1,000 pounds. Photographed at the Union Stock Yard, Chicago.

Summer Feeding of Young Steers — I have obtained my best results with summer feeding of steers that will weigh, when bought, about 900 pounds. For from four to six months before putting in the feed lot, I run them on stalk-fields and pasture (blue grass preferred, because of the way it withstands frost). In the stalk-fields I give them a light ration of corn in extremely cold and stormy weather. They are turned on to grass in early spring, and in from two to four weeks, by slowly increasing their ration, they are safely got onto full feed of corn — half a bushel per head, salt being kept where they can always get at it. The feeding period lasts for about 180 days. There is profit, in my experience, in winter fattening, but not so much as in summer feeding. In the case of winter feeding, the steers are fed — under sheds, with free access to the open feed lot — all the hay or corn fodder they will eat, with a full ration of corn — snapped, husked, or shelled, the shelled corn being used especially at finishing time. In the winter I have fed up to 4 pounds per day of cotton-seed meal with excellent results, and either bran or linseed meal, or both, in moderate quantities, has proved beneficial, though one can not count on the hogs receiving any appreciable share in the benefit from these feeding-stuffs. On the other hand, in the case of corn, when we run a shoat after every steer, as I do, we figure that the hogs get 15 per cent of the grain fed, and while the steers are making an average daily gain of about 3 pounds (on full feed of corn, with grass in summer) the hogs are laying on profits at the rate of from ¾ to 1 pound a day. In winter, on full feed of corn with dry roughness, we count on average daily gain, for the steers, of from 2 to 2½ pounds.

Results — The cattle thus fed are shipped to the Chicago and Missouri River markets at from 3 to 3½ years, when they weigh from 1,300 to 1,350 pounds, the aim being to turn out beef steers of the market grade known as *good*.[1] The year 1902 has been one of exceptional prices, for which the state of the beef-cattle supply has furnished sufficient explanation, without need of any allegation that a "corner" in the finished product was responsible. Under ordinary circumstances, in ordinary years, however, I should consider that a difference of from \$1.50 to \$1.75 between buying and selling prices gave an ample margin of profit on feeding, while a difference of only \$1 would let me out without loss.

J. P. Stevenson

[1] *Prime* beef comes from about one year's full-feeding of balanced rations, and is a higher grade than we make.

FIG. 165. The morning "round-up" at David Rankin's home barn; teamsters starting for the fields. This octagonal barn representative of the most modern type of farm-building construction.

Feeding Range Cattle for Beef

By DAVID RANKIN, Tarkio, Mo.

The feeding of beef cattle with me is, to all intents and purposes, a manufacturing business. Where my farm practice is in harmony with scientific theory, it is because I have found that the theory brings profit in practice. Where I depart from theoretical practice, or stop short of following out an accepted theory to its extreme, it is because I can make more money the other way.

Circumstances Govern Methods—You can not get away wholly from local conditions. I do not mean to imply by that that for the sake of present returns one is justified in misusing his land. The man who feeds all he raises and sells the concentrated product—beef—is not misusing his land; for the fertility is returned to the soil. The man who feeds all he raises and buys more feed besides is doing even better by his land, even if he may not be doing so well by his pocketbook. I should make more money if I could raise all the corn I want to feed; but I do not begrudge the $100,000 or such a matter that it costs a year for extra feeding-stuffs.

The point I make is simply this: The feeding of farm stock is a science, but it's a science that we follow for profit. To lose sight of the practical side is as bad as to ignore what the experiment stations are finding out for us. A man can not afford to sell cheap corn and buy dear cotton-seed meal just because he will get a better-balanced ration out of the combination; whereas, on the other hand, when corn is high, he can better afford to make his rations "narrower" by the purchase of nitrogenous concentrates.

Very likely anyone who feeds range steers on a similar scale and under like conditions might be interested in my way of doing things; but if the general run of farmers and feeders find what I have to say helpful, it will be because my experience emphasizes the need of sound business management on the farm, instead of a reckless running after every new thing. Sometimes the farmer can afford to try experiments; sometimes he can't. Sometimes he can afford to do exactly the scientific thing—and can not afford *not* to do it; sometimes he can't. *He* must be the judge, and not afraid to stand by his own judgment—not afraid to be in a measure unscientific, if he finds that in all the circumstances it will pay him; not slow to adopt new, scientific methods, if they commend themselves to his business sense.

All that is precisely what the agricultural colleges and experiment stations are careful to tell the farmer: That no general rule can be followed blindly; that every man must think for himself, feed as well-compounded a ration as he can afford, and keep his eye all the time on the profit.

Shredded Fodder for Winter Feeding—In buying my range stockers, grown chiefly in Texas and on the Northwestern plains, I necessarily take what I can get in the way of breed—any good breed, well bred up and in fair flesh, not less than three-year-olds and weighing generally 1,000 pounds or over. If I were able to take my choice, I probably should prefer white-faces—Herefords.

Fig. 166. Plowing and planting on David Rankin's ranch No. 12. Soil conditions in Northwestern Missouri make it possible to list in the seed-corn, combining the preparation of the seed-bed and the planting in one operation.

I used to say that summer feeding was the thing to follow, but I am not so sure of it now that we are using shredded fodder. I believe that with shredded fodder the steers do as well as on grass. So I lay in my stockers according to my needs and the state of the range cattle market, but generally between August and October, and get them on full feed as quickly as possible, frequently in as short a time as ten days or two weeks. This sort of feeding is a wholesale matter. Labor must be economized. I never have a man do for a bunch of steers what the steers can just as well do for themselves; so they are fed husked corn from behind the shredded-fodder stacks during the winter, the shredded fodder giving them all the roughage they need; for they have all they will eat.

Feeding Method and Rate of Gain — For pasture, I have dropped blue grass in favor of clover and timothy, and I run my cattle on it the year round, whenever the grass gets good. With the grass, in summer, I feed ear corn. From 150 to 200 steers are as many as I find it desirable to run in the feed lot together, and from 200 to 300 will get pasturage, if they have plenty of corn, after the grass gets well up, from every 160 acres. The heavy feeding begins about the first of March, and when corn is dear, each steer has from 5 to 6 pounds of cotton-seed meal daily. The salt is kept before them all the time. Feeding in that way, the bulk of the steers are finished during the summer months, when prices are best, and before fall poultry comes into competition with beef. The selection for shipping goes on daily during the shipping season, the weights of the beeves ranging from 1,200 to 1,400 or 1,500 pounds. A steer well bred up and in fair flesh at the start ought to be a beef in four months' time, though some take as much as six months to be fit for market. I figure on an average daily gain per head, for the feeding period, of from 2 to 2½ pounds; and with average conditions (say corn at 35 cents, hay at $8, and other feeding stuffs in proportion) I should want $1.50 margin over cost price in order to make a satisfactory profit.

D Rankin

BUSINESS METHODS ON THE FARM

David Rankin's ranches are situated near Tarkio, Northwestern Missouri, and comprise between 22,000 and 23,000 acres of land, most of which is valued in the neighborhood of $100 an acre. As a practical illustration of the profit farming may be made to yield by the application of business principles to all its details, the following summary statement of Mr. Rankin's operations for the year 1900 will be found of interest:

STATEMENT OF FARMING OPERATIONS FOR 1900

Ranch	Foremen	Number of Acres	Number of Cattle	Net Proceeds of Cattle	Net Proceeds Per Head	Number of Hogs	Net Proceeds of Hogs
1	Ross	3,280	1,828	$ 44,598.90	$ 24.39	1,232	$ 17,954.19
2	Kenney	560	447	10,457.17	23.39	320	4,675.96
§4	Ramey	800	162	3,750.23	23.14	343	4,545.98
5	New	2,880	650	13,197.68	20.30	567	7,634.31
6	Mullen	2,000	638	16,979.67	25.04	693	9,190.07
7	Hanna	3,080	700	18,599.53	22.28	1,327	17,288.80
8	Sunderland	1,680	500	8,613.33	17.23	666	9,226.72
9	Kendall	690	423	7,608.79	17.98	458	6,301.53
10	Smithson	800	510	12,432.61	24.37	384	5,344.76
11	Wreath	2,519	331	7,404.28	21.97	705	9,542.04
12	Town	941	621	13,115.21	21.11	458	6,175.43
13	Rankin & New	960	300	6,271.00	20.90	274	3,866.83
14	Rankin & Cowden	2,000	429	9,491.79	22.12	822	10,099.52
	TOTALS AND AVERAGES	22,190	7,539	$172,520.19	$ 22.88	8,249	$111,846 14

Ranch	Expenses Including Interest	Expense Per Acre	Corn Bought Bushels	Amount Paid for Same	TOTAL NET RECEIPTS	TOTAL DISBURSEMENTS †	NET PROFIT OR LOSS	NET PER ACRE
1	$14,355.89	$4.37	98,720	$ 25,455.81	$ 62,553.09	$ 39,811.70	$22,741 39	$6.93
2	2,302.21	4.11	37,191	10,522.00	15,133.13	12,824.21	2,308 92	4.12
§4	3,191.96	3.98	2,800	840 00	8,296.21	4,031.96	4,264 25	5.33
5	12,286.75	4.27	10,743	3,222 90	20,831.99	15,509.65	5,322.34	1.85
6	9,552.85	4.77	41,601	12,462.08	26,169.74	22,014.93	4,154.81	2.08
7	16,633.73	5.40	15,636	4,690.80	35,888.33	21,324.53	14,563.80	4.73
8	8,510.24	5.06	27,002	7,412.59	17,840.05	15,922 83	1,917.22	1.14
9	3,111 25	4.51	24,354	6,513 00	13,910.32	9,624 25	4,286.07	6.21
10	3,371.94	4.21	37,442	9,691.00	17,777.37	13,062.94	4,714 43	5.89
11	10,506.54	4.18	42,362	10,768.00	16,946.32	21,274.54	* 4,328.22	* 1 71
12	8,027.77	8.53	47,898	13,968.00	19,290.64	21,995.77	* 2,705.13	* 2.87
13	‡	‡		‡	10,137.83	‡	** 5,337.83	** 5.55
14	‡	‡		‡	19,591 31	‡	** 9,591 31	** 4.79
	$91,851.13	$4.77	385,749	$105,546 18	$284,366 33	$197,397.31	†† $86,969 02	3.92

* Loss. Ranch 11 is bottom land, and suffered from excess of rain and from overflow. Ranch 12 is the home ranch, where all the ranch teams go to feed when in town. Thus its profits were eaten up by the other ranches. † From net proceeds. ‡ Included in stock acconnt for these ranches. § Ranch 3 has been consolidated with another. ** These figures are obtained by subtracting an assumed average expense per acre of $5. †† This total is made without the subtraction of assumed expense.

Diseases of Farm Animals

By R. A. Craig, D. V. M.
Instructor in Veterinary Science, Purdue University, LaFayette, Ind.; and Assistant State Veterinarian of Indiana

RECOGNIZING THE DISEASE

Health and Disease—To understand the meaning of the many symptoms or signs of disease in the domestic animals, we must have some knowledge of the structure and physiological functions of the different organs of the body. We must be familiar with the animal when it is in good health in order to be able to recognize the deviation from normal due to disease. Laymen, as a rule, do not consider the difficulty of making a correct diagnosis, and few have an opportunity to learn from personal observation the different symptoms that characterize different diseases. All well-informed stockmen who give personal attention to the animals under their care know when any of them are sick, as soon as the first symptom of disease manifests itself, by the changes in general appearance and behavior. In order to ascertain the exact condition, however, a general and systematic examination is necessary. The examiner, whether he be a layman or a veterinarian, must not be careless in the inspection, but observe the animal carefully, noting the behavior, appearance, general condition, and surroundings.

The general symptoms of disease inform us of the condition of the animal, help us to arrive at a correct diagnosis, and guide us as to the progress of long and severe affections. Thus we have symptoms connected with the condition of (a) the pulse, (b) the respirations, (c) the body temperature, (d) the surface of the body, (e) the visible mucous membranes, (f) the secretions and excretions, and (g) the behavior of the animal.

Before making a general examination it is well, if one is not already acquainted with the history of the case (care, surroundings, behavior, etc.) previous to seeing it, to learn as much about this from the attendant as is possible. Inquiry should be made as to the feeding, the conditions under which the animal has been kept, the length of time it has been sick, its actions, and various other points that may be of help in forming a diagnosis as well as in indicating in part the treatment to be followed.

(a) **Pulse**—The normal pulse beats per minute in domestic animals are as follows:

Horse	36 to 42
Cattle	38 to 50
Sheep and Goat	70 to 80
Hog	70 to 80
Dog	80 to 100

The frequency of the pulse in the different species is subject to great variation. Especially is this true of ruminants. In young animals the number of beats per minute is greater than in adults; excitement and a nervous temperament may cause more rapid pulse; during exercise and for a short time afterward the rate is higher than when at rest; small animals have a more rapid pulse than large ones.

The Horse's Pulse is generally taken from the artery (*submaxillary*) at a point near the inside and in front of the angle of the jaw. Here the artery winds around the lower border of the bone in an outward and upward direction, is quite superficial, and can be readily located with the finger

In Cattle the same artery is used but the finger is placed a little higher up on the side. It is more difficult, however, to catch the pulse in this class of animals than in the horse, as the part is more fleshy. The pulse may be taken from the small artery on the under side and near the base of the tail.

In Sheep and Goats the artery (*femoral*) on the inner side of the thigh is used. By pressing the hand over the region of the heart, one can also judge of its condition.

In Dogs the beats of the heart can be counted in the same manner, as the artery (*brachial*) toward the inner side of the arm above the elbow can be used. In dogs the heart beats can be counted.

The following varieties of pulse are recognized in disease: *frequent, infrequent, quick, slow, large, small, hard, soft,* and *intermittent.* The terms frequent and infrequent have reference to the number of pulse beats in a given time; quick and slow, to the length of time it takes the pulse wave to pass; large and small, to its volume; hard and soft, to its compressibility; intermittent, to the occasional missing of a beat.

(b) **Respirations**—In all domestic animals excepting ruminants, a somewhat close relation exists between the number of pulse beats per minute and the respirations. This relationship is about 1 to 4 or 1 to 5, and during exertion is usually maintained. In ruminants the respirations may be about ten per minute and the pulse beats seventy or eighty. In disease the relationship between the two is disturbed and the following varieties of breathing may be observed: *Abdominal,* when the movements of the walls of the chest are limited and the muscles of the abdomen are brought into play; *thoracic,* when the muscles of the abdomen are kept as quiet as possible and the movements of the walls of the chest make up for the deficiency. In spasms of the diaphragm or "thumps," we notice a jerking movement in the region of the flank, accompanied by a short, jerking expiration.

A Cough is generally due to some irritation of the air passages and is called **moist, dry,** and **chronic.** A moist cough occurs when the secretions in the air passages are abundant; a dry cough, when the mucous membranes lining the air passages are dry and inflamed. In the different animals the character of the cough will vary. The chronic cough occurs in chronic diseases and varies in intensity. In pleurisy the cough is short and painful, and in broken wind shallow and suppressed. The odor of the expired air, character of the discharge, and the respiratory sounds found out by auscultation, are important helps in arriving at a correct diagnosis.

(c) **Temperature**—The temperature of domestic animals is taken in the rectum, the regular Fahrenheit fever thermometer being used. Before introducing it into the rectum the column of mercury must be shaken down below the normal body temperature of the animal and the bulb moistened. It should be inserted full length and left in position from two to five minutes, depending on the rapidity with which it will register. This must be done as gently as possible, especially in the case of the larger animals; if they are vicious one must guard against kicks. The average normal temperatures of domestic animals are as follows:

	Range	Average
Horse	99.5 to 101.5	100.5
Cattle	100.2 " 102.2	101.2
Sheep and Goat	101.3 " 105.0	103.0
Hog	101.0 " 105.0	103.0
Dog	100.0 " 102.0	101.0

The body temperature may be higher or lower than this and still be considered normal. During exercise or when the weather or stable are warm and close it is elevated; in cold weather or after drinking cold water it may be lower. Especially is this true of ruminants. In order to get at the normal temperature in those animals showing wide variations it is well to take two or more readings at different times; also to take that of some healthy animal in the herd and compare this with the temperature of the sick one.

(d) **Condition of the Surface of the Body**—When a horse is in good condition and well cared for, the coat is short, fine, glossy, and smooth, the skin pliable and elastic. Healthy cattle have a smooth, glossy coat and the skin feels mellow and elastic. The fleece of sheep should look smooth and have plenty of yolk; the skin, light pink in color. When the coat loses its luster and gloss, and the skin becomes hard, rigid or scurvy (hide bound), it indicates a lack of nutrition and an unhealthy condition of the body. In sheep, during sickness, the wool may become dry and brittle and the skin pale and rigid. When affected with external parasites the fleece looks taggy or the wool is lost over large areas of skin, the skin itself being greatly changed. During fever the temperature of the surface of the body is very unequal, and in serious diseases, or diseases about to terminate fatally, the surface feels cold; frequently the hair is wet with a cold sweat.

Horses and cattle that are allowed to "rough it" during the cold, changeable seasons of the year have a heavy, rough coat of hair, a provision of nature to protect them against the severe weather.

When horses accustomed to hard work are kept in a stall for a few days the hind extremities are apt to fill. This is seen in disease and frequently in mares toward the latter period of pregnancy. In diseases of the heart and kidneys dropsical swellings are often seen. In lymphangitis, pleurisy, etc., swellings may appear under the chest and abdomen. Sheep that are debilitated and weak, especially if the condition is caused by internal parasites, may show swellings under the jaw and in different parts of the body.

(e) **Visible Mucous Membranes** — The visible mucous membranes in a state of health are usually a pale red, and during exercise or excitement redder and more vascular. In cold in the head the membranes of the eye and nose are of a bright red color. When any of the internal organs become congested the various mucous membranes (mouth, nose, eye) may assume a violet hue, and if the liver does not perform its functions properly may become tinged with yellow. In internal hemorrhage, and in anæmic (bloodless) conditions, they are pale. In chronic indigestion the mouth is often foul and soapy; in the dog the tongue is furred. When any irritation from the teeth is present, the mouth is excessively moist; if the animal is feverish, dry.

(f) **The Character of the Excretions** from the bowels, kidneys, and skin is often modified. This will be taken up later in the description of the symptoms of the different diseases.

(g) **General Behavior** — The animal may appear normal in so far as nervous manifestations are concerned; or it may be nervous and easily excited, travel in a circle, have spasms or convulsions, or become actually rabid. The nervous tone may be depressed; the animal may be stupid, may stand leaning the head against some object, or lie quiet and unconscious. Locally there may be paralysis of either motion or feeling, or both.

ADMINISTRATION OF MEDICINE

Drugs may be administered by the following channels: (a) By the mouth, (b) by injecting into the tissues beneath the skin, (c) by rubbing into the skin, (d) by the air passages and lungs, and (e) by the rectum.

(a) **Drenching**—The most common method of administration is by way of the mouth. Whenever possible, drugs should be given with the feed or drinking water, as this gives the attendant the least trouble. Bulky drenches are often hard to give, and one must count on a part being wasted.

In drenching **horses** it is best to put a bridle on the head instead of a halter; tie a small rope or line to a strap fastened to the ring on each side of the bit, and elevate the head by throwing one end of the rope over a beam and having it held there by an attendant. A heavy, long-necked glass bottle can be used. If the mouth is filled with the drench and the animal refuses to swallow it, a tablespoonful or so of water can be dropped into the nostril. This forces the horse to swallow. A drench should never be given through the nose, as it may cause a fatal inflammation of the air passages and lungs. In giving small drenches the head can be elevated with the hand and a dose syringe or a small bottle used.

Cattle are quite easily drenched. **Sheep** can be drenched in the standing position or when thrown on the haunches and held between the knees. The standing position is to be preferred, and it is best to use a small dose syringe. Care should be exercised in giving bulky or irritating drenches to sheep, as a part may get into the air passages and cause serious trouble.

The easiest method of drenching a **dog** is to hold him between the knees, pull out the cheek so that a pocket is formed between it and the teeth, and then pour the medicine into the pocket.

Balls—The most common method of giving horses drugs that do not go into solution readily is in the form of balls. They can be made by mixing the medicines with syrup, honey, and linseed meal and rolling the mass into the form of a cylinder about three-quarters of an inch in diameter, and a few inches in length. Tissue paper is then wrapped around it.

Veterinarians seldom use balls, as gelatin capsules are more convenient. A powder may be rolled up in tissue paper alone and this is very often the handiest way to give it. In giving a ball, care must be used or the hand will be injured by coming in contact with the teeth. The ball must be held between the ends of the first finger and the thumb, the tongue pulled out as far as possible and held to one side with the left hand, and the ball passed backward between the two rows of upper molars and deposited on the back part of the tongue. The tongue is then quickly released and the head elevated for about a minute. If the animal is at all restless it is well to have an attendant help hold the head, as the patient may work the ball between the teeth and quid it.

(b) **Hypodermic Administration**—Injections beneath the skin are suitable when the drug is non-irritating and the dose small, or when prompt, energetic effects are required, as in acute pain or collapse. For this purpose the active principles of drugs are generally used.

The point of injection is usually on the side of the neck or shoulder. A fold of the skin is picked up with the fingers and the needle quickly introduced, care being taken not to prick or scratch the muscular tissue, as this might cause the animal some pain and make it struggle. In order to prevent an abscess from forming at the point of injection, it is necessary that the needle and syringe be sterile. If the hair is long, it should be clipped at the point of inoculation and the skin washed with an antiseptic solution, as carbolic acid or creolin.

(c) **Superficial Application**—Drugs are not absorbed through the unbroken skin, but when applied with friction or when the outer layer is removed by blistering they may be absorbed. Liniments, blisters, and poultices are applied for a local effect only.

(d) **Administration by the Air Passages**—Volatile drugs are absorbed very quickly by the enormous vascular surface of the lungs. Chloroform and ether are administered by way of the respiratory tract for the purpose of producing general anæsthesia. Anesthetics are not so often used in veterinary surgery as in human surgery, but for some operations are indispensable. Inhalation of medicated steam is used for its local effect on the air passages and is useful in affections of the respiratory tract.

In steaming large animals a pail about half full of boiling water should be used, an ounce or two of turpentine, creolin, or whatever drug is required, mixed with it, the pail held within about a foot of the animal's nose, and a light stable blanket thrown over its head so as to direct the steam toward the nostrils. Dogs can be placed on a cane-seated chair, a pail or pan of boiling water placed under it, and a sheet thrown over all.

(e) **Administration by the Rectum**—Medicines are administered by way of the rectum at times when the animal can not be drenched, when it can not retain them in the mouth, and when a local action is desired. An *enema* or *clyster* is a fluid injection into the rectum and is employed for the following purposes. To accelerate the action of a purgative; to stimulate the peristaltic movement of the intestines; for local effect in inflammation of the intestines; to kill intestinal parasites; to reduce body temperature; to administer medicine, and to supply food.

The best method of administering a clyster is to allow water to gravitate into the bowels from a height of from 2 to 4 feet. In giving large injections the hind parts of the animal should be raised. For large animals a good sized funnel to which are attached a few feet of rubber tubing or, in emergencies, of garden hose, is all the apparatus needed. The ordinary fountain syringe can be used for small animals and from half a pint to a quart of water injected. From one to several gallons of water may be required for horses or cattle.

The Dose—The doses given in the treatment of the different diseases, unless otherwise mentioned, are for adult animals. The dose for a colt one year old is about one-third the quantity given the adult; two years of age, one-half; and three years, two-thirds. In well-matured colts a larger dose can be given. In other immature animals the same proportion is followed, depending upon the degree of development. The character of the action of drugs is frequently entirely changed by varying the size of the dose. When drugs are administered at short intervals the size of the dose is reduced.

DISEASES OF THE DIGESTIVE TRACT

STOMATITIS

(*Inflammation of the Mucous Membrane Lining the Mouth*)

STOMATITIS IN HORSES

Causes—Stomatitis frequently follows irritation from the bit, teeth, irritant drenches, or roughage containing beards of grasses, burs, etc. It occurs when prehension of the food is impaired, the mucous membrane of the mouth not being kept clean by the secretions, so that particles of food or parts of the lining membrane of the mouth that are shed, decompose, thereby setting up an irritation. Rust and molds on grains may cause it. Stomatitis may occur as a complication in any of the ordinary febrile diseases, especially if of long duration.

Symptoms—At the outset the mucous membrane of the mouth is congested, hot, and dry, and portions of it may have a dark red color, especially that part lining the cheek. Other portions are coated with a slimy, grayish matter, and in a short time the odor from the mouth is fetid. Following this dry stage is the period of excessive secretion; saliva dribbles from the mouth, and in bad cases is mixed with shreds of epithelium. Little blisters or vesicles in some cases may be scattered over the lining membrane of the lips, cheeks, and sides of the tongue. In the severe form the membrane becomes reddened and thickened: the swelling so great and the mouth so sore at times that the animal can not take food of any kind. When properly treated, recovery takes place very quickly.

Treatment—Roughage and grasses that will irritate the mouth must be withheld. If due to a severe bit, its use must be discontinued; sharp or diseased teeth should receive the proper attention. When the mouth is inflamed, mashes and gruels may be given, and plenty of clean water allowed. Twice a day the mouth should be washed out with a 2 or 3 per cent water solution of boric acid. It is advisable in some cases to use a water solution of some of the creolin preparations (2 parts to 98 parts water). The wash should be thoroughly applied and plenty of it used.

ULCERATIVE STOMATITIS IN HORSES

Causes—This form of inflammation of the mouth is not common among horses. It is more apt to be seen in weak and debilitated animals than in animals in good condition. It is seen in some infectious diseases.

Symptoms—At first the symptoms are much the same as in the simple inflammation. Sores form along the gums, lips, and cheeks, considerable tissue is lost, and the ulcers may become deep and extensive. When these sores form the breath becomes fetid and the saliva is usually tinged with blood. The ulcers are tardy in healing, but unless complicated with some other disease recovery takes place.

TREATMENT—Weak and debilitated animals should be built up if possible with nourishing foods, tonics, and good care. After washing out the mouth with a 4 or 5 per cent solution of some of the creolin preparations, the surface of the ulcers should be touched with lunar caustic. This treatment must be kept up until the ulcers show signs of healing.

STOMATITIS IN CATTLE AND SHEEP

Causes—The lining membrane of the mouths of cattle is thicker and more resistant to the attacks of bacteria than that of the horse, but still this does not protect them from mechanical and chemical irritants, especially when on dry feed. Stomatitis is frequently seen in the infectious diseases that affect ruminants. Sheep have a more delicate buccal membrane, but the care with which they select their feed prevents this from being a very common disease.

Symptoms—The symptoms are much the same as in the horse. Mastication is difficult, and the parts are congested, swollen, and inflamed. Saliva dribbles from the mouth.

TREATMENT—The treatment is the same as for stomatitis of the horse.

ULCERATIVE STOMATITIS IN CALVES AND LAMBS

Causes—This disease seems to be communicated from one animal to another, and is no doubt due to some of the pathogenic germs. It is more common in lambs and calves that are debilitated and kept in unhygienic quarters (poorly-ventilated, filthy, damp stables).

Symptoms—The gums become dark red, spongy, and bleed easily. In a short time a part dies, sloughs out, and a deep, ragged-looking ulcer forms. These ulcers are seen on the lips and gums and may become extensive, the teeth loosening and dropping out, and perforations occurring in the lips. Threads of saliva dribble from the mouth, and the breath is fetid. The first symptom noticed is that the young animal is careless with the teat or refuses to suckle. The animal soon becomes weak, refuses to eat, and a fetid diarrhea sets in. The disease frequently results in death. Recovery takes place slowly.

TREATMENT—The preventive treatment consists in improving hygienic conditions and isolating diseased animals. The quarters should be thoroughly cleaned, and the floors and walls washed with a disinfectant. The local treatment consists in removing the dead tissue from the ulcers and using antiseptic washes liberally. The ulcers should be touched with lunar caustic.

STOMATITIS IN SWINE

Causes—Irritating drenches, hot foods, and putrid or decomposed slops are among the common causes. The most common form of sore mouth is the infectious or ulcerative form and is due to bacteria. It usually attacks suckling pigs.

Symptoms—When a hog has a sore mouth, froth will accumulate around the lips, otherwise, in the simple form the symptoms are much the same as in other animals. In the infectious form the usual seat of the inflammation is on the inside of the lips and the gums. In bad cases it may extend to other parts of the mouth and outside of it so as to include the snout. The number of sores or ulcers may range from two to half a dozeu. The ulceration progresses rapidly and considerable pieces of the gums, lips, or snout may drop off. The teeth may also fall out.

TREATMENT—The preventive treatment is very important. If the disease is present in a herd, special measures must be taken to keep the pens clean. The diseased pigs must be separated from the healthy ones. The medicinal treatment consists in applying creolin preparations to the diseased parts of the mouth and washing the sow's udder with a solution of the same.

LAMPAS

(*Congestion of the Hard Palate of the Horse*)

In young horses at the time of eruption or replacement of the teeth, or during digestive trouble, the hard palate often becomes swollen and projects down to or beyond the wearing surface of the incisor teeth. Horses with lampas often suffer barbarous treatment at the hands of the ignorant.

TREATMENT— When due to the irritation caused by eruption or replacement of the teeth, the horse should not be fed hard grains, ground feed being preferable. If the teeth are sharp, long, or diseased they should receive the proper treatment. If the trouble is with the essential digestive organs, the disease should be treated. In cases where the hard palate projects beyond the teeth and the animal has difficulty in taking hold of the food, the mucous membrane may be nicked with a sharp knife and a weak alum wash used on the parts.

SALIVATION

Causes—Salivation may be due to a number of different causes. The irritation causing it may come from the food, medicine, or teeth. Certain drugs, as calomel and pilocarpine, may cause it. In late summer, horses running on white clover salivate. The most common cause, perhaps, is the irritation from uneven teeth. Foreign bodies in the mouth or gullet (œsophagus) will cause it.

TREATMENT—The treatment consists in removing the cause. If the animal has uneven or long teeth, they should be floated[1] and leveled by cutting off the projections with cutters. If due to drugs, their use must be discontinued ; if to dietetic causes, it should be corrected. Sometimes it is necessary to wash out the mouth with an astringent wash. Alum washes are useful. Horses in poor conditiou should not be turned on white clover pastures.

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[1] Filed level.

DEPRAVED APPETITE

(*Licking Disease*)

Depraved appetite is especially common in ruminants. They seem to have an irresistible desire to lick, chew, and swallow indigestible and disgusting objects.

Causes—Licking disease in most cases seems to result from example and is nothing more than a bad habit. In some localities, however, it seems to be due to improper food, especially food deficient in salts. This aberration is a common condition in countries where the soil is poor and lacking in lime salts. By some it is considered to be due to a depraved sense of taste, and is classified as a nervous disease. When sheep are shut up during the winter, they may get into the habit of chewing one another's fleeces. Lambs are especially apt to contract this habit when suckling ewes having on the udder long hair soiled with urine and feces.

Symptoms—The only noticeable symptom at first is the desire to chew, lick, or eat indigestible or disgusting objects. The digestive tract is soon involved, the appetite lost, and nutrition impaired, the animal becoming debilitated and weak. The animal is generally constipated, the feces having a fetid odor and containing foreign bodies. The course of the disease varies from a few months to a year, or even longer. It frequently terminates in death.

Treatment—In localities where the disease is common, preventive treatment is important. When it occurs on poor pastures, a change to better land and a liberal allowance of salt will stop it, or a well-balanced ration of grain can be added. When indigestion is present, bitter tonics should be given. In sheep we must avoid keeping them in closed quarters, and allow plenty of exercise. The wool on the udders of the ewes should be clipped off, and if the lambs contract this habit, they must be separated from the mothers, except when nursing.

INDIGESTION

(*Gastro-intestinal Catarrh*)

INDIGESTION IN THE HORSE

Causes—Indigestion is more common in the horse than in any of the other domestic animals. Very young or very old animals, especially if fed on a poor diet, are predisposed to it. Overloading the digestive organs with food, poor teeth, and working immediately after meals may cause it. The character of the food is also important, and it may follow the feeding of an unaccustomed ration or irritation from foreign bodies, or frozen, moldy, decomposed, or unclean foods. It is not a very serious disease if properly treated, and a spontaneous cure will follow the removal of the cause. It may, on the other hand, terminate in chronic indigestion.

Symptoms—In acute indigestion the horse may show evidence of abdominal pains after eating; the intestinal sounds are louder than normal, the animal pants, looks at the flanks, and lies down. The feces are very often covered with mucus and contain imperfectly digested material.

Constipation or diarrhea are sometimes present and the abdomen is distended with gas. In some cases the body temperature is unequally distributed and the animal is feverish. It usually acts dull, yawning frequently, and the appetite is absent or greatly impaired. When the disease becomes chronic nutrition is seriously disturbed. The horse loses flesh, sweats easily, and the membranes in the mouth are pale, the coat rough and dull, and the skin inelastic (*hide bound*). Constipation and diarrhea frequently occur and "colics" are common. We often observe nervous complications (*staggers*).

TREATMENT — In acute indigestion the treatment is mainly preventive, feeding good food, the proper amouut, and at regular intervals. The horse should not be fed grain immediately after a severe drive, neither should it be driven hard immediately after a hearty meal. It is always best to water before feeding grain. If the horse is unable to masticate the food properly, due attention should be given to the teeth. The medicinal treatmeut depends on the various symptoms manifested. At first, dieting the animal will rest the stomach and intestines. For a few days it is best to feed foods that are easily digested. If constipated, a laxative can be given (from 1 pint to 1 quart raw linseed oil). We can generally stop the diarrhea by a special diet (dry feed, flour in the feed, etc.); if not successful, prepared chalk (1 ounce) or laudanum (from ½ to 1 ounce) can be given. If colicky pains are present, fluid extract of *cannabis indica* given in ½ ounce doses will relieve the animal. In treatment of chronic indigestion bitter tonics and alkalines are quite important. The following tonic can be given in the feed or in a ball two or three times a day: Powdered gentian (2 ounces), powdered nux vomica (1 ounce), bicarbonate of soda (4 ounces). Mix and give in ½ tablespoonful doses. Or, give artificial Carlsbad salts mixed in the following proportions: Sulphate of soda, chloride of soda, and bicarbonate of soda, equal parts; 1 tablespoonful in the feed three times a day.

INDIGESTION IN CATTLE

Causes — The causes are improper care and feeding. Permanent stabling, feeding too little roughage or too much slop or grain, and crowded, poorly ventilated quarters. More common causes are abrupt changes from dry to green food, foreign bodies (hair-balls, sand, gravel, etc.,) overloading the stomachs, and frosty, moldy, or decomposed foods.

Symptoms — At first the animal will not ruminate and the appetite is lost or irregular. It stands with the ears dropped, back arched, and abdomen tucked up, and grunts frequently. Sometimes the food is regurgitated. The body temperature may be unequal. In some cases colicky pains are present, animal lies down, rolls, gets up and continues restless and in pain for some time. When the disease is acute, improvement takes place in a few days or a week; if chronic, especially if due to some general disease, it is serious. When chronic the animal is greatly emaciated, with coat dry and rough, skin hard and inelastic; is usually quite weak, dull, and feverish, and has a very irregular appetite. Defecation is very irregular; sometimes constipation and diarrhea alternate.

TREATMENT — The treatment for cattle is mainly preventive and, as in the horse, consists in avoiding any condition that may cause it. Until the animal begins rumiuating all food must be withheld or at most only such foods as are easily digested should be given. Green food is to be preferred. It is advisable to give a cathartic of linseed oil (1 quart) or Glauber's salts (1 pound) dissolved in plenty of water. Following this a bitter tonic can be given, powdered nux vomica (1 ounce), powdered gentian (1 ounce), sulphate of soda (6 ounces); mix and give 1 tablespoonful three times a day. Artificial Carlsbad salts may be given in tablespoonful doses three times a day. In chronic indigestion the same agents may be used and the animal dieted. If the indigestion continues for many weeks it is apt to end fatally.

INDIGESTION IN SHEEP

Causes and Symptoms — The causes and symptoms of indigestion in sheep are about the same as in cattle. When sheep are poorly cared for and given an improper diet, especially if subjected to severe weather, their weak constitution predisposes them to all sorts of affections, especially indigestion. Under these conditions the mortality may be high. Some breeds suffer much more than others.

Treatment — In large flocks of sheep it is impossible to treat each sheep individually. The preventive treatment is very important and with proper precautions we can prevent it from affecting a large number of animals in the same flock. The medicinal treatment consists in giving a cathartic — castor oil (from 4 to 6 ounces), dieting the animal, and giving a saline or bitter tonic — artificial Carlsbad salts (1 teaspoonful three times a day) or powdered nux vomica (½ ounce), powdered gentian (½ ounce), sulphate of soda (3 ounces); mix and give 1 teaspoonful two or three times a day.

INDIGESTION IN SWINE

Causes — The causes of indigestion in swine are foreign bodies; fermented foods, as spoiled swill, rotten corn, and musty grain; easily fermented food, as green corn; irritants, as wash waters, and indigestible and poisonous substances.

Symptoms — The pig acts dull, bristles are erect; is restless and goes off by itself, grunts, lies down, and roots in the litter; breathing is rapid; animal is thirsty, feverish, and will not eat. Vomiting usually occurs. There is no rule as to the duration of the affection; it may last but a short time or continue for a week or more.

Treatment — The treatment consists in the removal of the offending material with the least irritation possible. This usually requires a purgative, and raw linseed oil or castor oil may be given (4 ounces of the former or 1 ounce of the latter). Very often the animal will relieve itself by vomiting. If in pain, 1 teaspoonful of opium may be given to relieve it and repeated every hour till it is quiet. Use soap suds injection if necessary to evacuate the bowels. Allow the pig all the water it will drink, but give no food till convalescence begins; then give sweet slops.

TYMPANITIS

(*Hoven*, *Bloating*)

TYMPANITIS IN CATTLE

Causes — Bloating is usually due to the animal eating large quantities of food that ferments easily, as clover, alfalfa, green corn, and second-growth sorghum. It is more common when first going on pasture, in the spring of the year, and in the fall, than at other times. Stormy, damp weather seems to favor it. In weak, ill-fed, and poorly-cared-for cattle the movements of the paunch are weak, hence bloating takes place quite readily, and especially is this true in diseased conditions of the rumen. Sometimes bloating will occur through drinking freely of water, especially if it is cold, after eating large amounts of food. If these causes are not removed tympanitis will become chronic. In some chronic diseases, especially tuberculosis, this condition may be present as one of the symptoms of the malady. Diseases of the œsophagus may also cause it.

Symptoms — On account of the paunch or rumen occupying the left side of the abdomen, the distension or swelling is principally on that side ; the distension occurs very quickly, is elastic and resonant. The animal stops eating and ruminating, arches the back, drops the ears, and has an anxious look ; the eyes are prominent, the pulse small and quick, the mucous membranes congested, respirations rapid, and the feet are gathered up under the animal or spread out, according to the severity of the trouble. Belching of gas occurs frequently, the breathing is rapid and becomes labored, the extremities feel cold, and the animal sinks to the ground and dies in a convulsion. Death is due to the pressure on the lungs by the distended rumen and the absorption of poisonous gases. The course of the affection is very rapid.

Treatment — Preventive treatment is very important. Any change to green, easily fermented food must be made gradually, and we must not allow the animal to engorge itself with this kind of food. Cattle must not be allowed to eat large quantities of clover or similar forage, if wet with dew or a light shower. The quickest relief is obtained by using the trocar and cannula. The operation is quite simple and is not followed by any bad results. The seat of the operation is on the most prominent portion of the left flank. The instrument is plunged through the walls of the abdomen and rumen, the trocar withdrawn and the gas allowed to escape through the cannula. After the gas has escaped, the trocar is replaced and both are then withdrawn. After using the instrument, it should be boiled a few minutes in water. This will insure us a perfectly clean instrument when needed. In chronic tympanitis the gas will form so rapidly that it is necessary to keep the cannula in position by tying a tape to the flange, running it around the abdomen and tying it. Cold water thrown on the flank, or pressure with the hand, will sometimes stimulate the movements of the rumen, and the gas is then worked off by the natural channels. Strychnine injected beneath the skin in the region of the paunch is useful in stimulating its movement. As a cathartic we may give 1 quart linseed oil and 2 ounces turpentine, or one pound Glauber's salts, dissolved in plenty of water.

TYMPANITIS IN SHEEP

Causes — The causes of bloating in sheep are about the same as in cattle, especially succulent feeds, as clover, grass, and rape, covered with dew or wet by a light shower ; and frosted roots.

Symptoms — The gas forms in the rumen quite rapidly, the sheep is unwilling to move, is dull, breathes rapidly and with difficulty, and shows evidence of abdominal pain.

Treatment — As in cattle, the quickest relief is obtained by using the trocar and cannula. The method of puncturing the rumen of sheep is about the same as in cattle. A smaller trocar can be used, and we must use even more care in guarding against septic infection than in cattle, as this animal is more susceptible to peritonitis. When a number of sheep in the flock are affected, this method of treatment is too slow and it is necessary to treat the whole flock. If there is a running stream in the pasture or near by, the flock can be driven into it, and the action of the cold water coming in contact with the abdomen may stimulate the movement of the paunch. Preventive measures are very important in sheep.

OVERLOADING OF THE RUMEN IN CATTLE

Causes — When cattle are not accustomed to green feed they are greedy and eat so much that the paunch is filled with it and digestion is interfered with. This generally occurs when cattle break into the grain bin, or clover or corn field. Apples or potatoes will cause it, if too many are eaten. Dry food may cause it, if the animal does not have access to plenty of water. When the digestive tract is diseased and the movements of the paunch are weak overloading is very apt to occur.

Symptoms — The animal may show the same symptoms at first as in simple indigestion; is in some pain, does not ruminate or eat, is dull and feverish. The thirst is often increased. The distended abdomen feels doughy, and after pressing on it with the fingers the impression remains. This enables us to differentiate this from bloat. Some gas will form in this trouble, owing to the food fermenting, but the most of the distension of the walls of the rumen is due to the mass of food. The general symptoms resemble those seen in bloat, but generally the disease does not make so rapid progress and is less acute. When the ear is placed to the abdominal walls we can detect no movement of the rumen. The disease may last for several days or may terminate fatally in a few hours.

Treatment.— This is one of the diseases that can be prevented by using the proper precautions. By stimulating the movements of the paunch the mass of food will be worked off through the proper channels. Hypodermics of strychnine or eserine, pressure on the flank with the hand, and cold water thrown on the sides of the abdomen may stimulate it. If gas forms, the trocar must be resorted to. As soon as possible a drench of 1 or 2 pounds of Glauber's salts dissolved in a gallon or more of water should be given. As a last resort rumenotomy may be performed. This operation consists in incising the walls of the abdomen and rumen and removing the food with the hand. It is not a dangerous operation when properly performed and should not be postponed until the animal is too weak to make a recovery.

OVERLOADING OF THE RUMEN IN SHEEP

Causes — Overloading of the rumen is often due to an excess of dry, innutritious fodder or a sudden change in the diet from indifferent food to palatable food given in excess.

Symptoms — The symptoms are about the same as in cattle. The paunch when manipulated with the hand feels doughy. The animal is dull, shows evidence of pain, breathes with difficulty, does not eat or ruminate, and is constipated. In severe cases the malady may terminate fatally in a few hours.

TREATMENT — This disease can be guarded against in the majority of cases by using the proper precautions. The sick animals should be subjected to a rigid diet and given a cathartic of Glauber's salts (4 ounces) dissolved in plenty of water. Powdered nux vomica (in 20-grain doses) may be given three times a day. Rumenotomy is a dangerous operation in sheep.

FOREIGN BODIES IN THE STOMACHS OF CATTLE

Causes — Foreign bodies are found more commonly in the stomachs of cattle than of any other domestic animal. This is due to the habits of the animal and its mode of prehension of food. Cattle usually eat hastily and do not pick their food over as carefully as does the horse. The foreign bodies are of different kinds; some are smooth and round, as pebbles and hair balls; others are sharp, as nails, knives, wire, etc.; in some cases concretions of sand or dirt form on the lining membrane of the stomachs.

Symptoms — Small round objects do no appreciable harm unless they block the openings. When large and rough they may cause an inflammation of the rumen. Incrustations of sand or dirt will cause symptoms of chronic indigestion. Sharp-pointed objects, unless they penetrate the walls of the stomach and injure the surrounding tissue or organs, will cause no trouble; if they do, then grave digestive troubles arise. The animal suffers pain, looks anxious, and becomes emaciated and weak. It is very difficult to make a correct diagnosis in these cases, as the disease comes on without any apparent cause and one may not suspect the presence of foreign bodies. The heart and its coverings very often become injured and acute cardiac symptoms are manifested.

TREATMENT — Medicinal treatment as a rule does no good. When one is positive of his diagnosis, rumenotomy may be attempted and the foreign body removed. Prevention is very important. Cattle should not be fed dirty food or slops, and in feeding baled hay care should be exercised to remove all the wire from the bales.

INFECTION OF THE OMASUM IN CATTLE

Causes — This disease may occur during any of the digestive troubles or febrile diseases. Any of the causes bringing on indigestion are liable to render this organ torpid. Food in excessive quantities, lack of water and sudden changes from dry to rich green food may cause it.

Symptoms — The appetite is diminished, rumination occurs at irregular intervals, the body temperature is uneven, the animal is feverish, and it will grunt as if in pain. Bloating sometimes occurs and the bowels are constipated. The animal soon falls away in flesh, the appetite is lost, it becomes weak, presents an unthrifty appearance, walks stiffly, and arches the back. The disease may last several days and during its course the animal becomes delirious, or merges into drowsiness or stupor. Chronic cases sometimes continue for months. When recovery takes place, a diarrhea is usually present, the feces containing black particles with polished surfaces, looking as if they h been baked.

TREATMENT — The preventive treatment, as in other dietetic diseases, consists in avoiding t causes. Plenty of salt should be allowed. When the disease manifests itself, a purgative of Gla ber's or Epsom salts (from 1 to 2 pounds in 1 gallon or more of water) should be given. One dra of powdered nux vomica may be given three times a day. Hypodermic injections of strychnin eserine, or pilocarpine are very useful in this disease. When convalescence begins, the anim must be allowed moderate exercise and must have food of a laxative nature.

GASTRO-ENTERITIS

(*Inflammation of the Stomach and Intestines*)

ENTERITIS IN THE HORSE

Under this head the different forms of inflammation of the stomach and inte tines will be discussed.

Causes—The same conditions that produce acute indigestion may cause a inflammation of the stomach and intestines, the only difference being one of inte sity. Inflammation is most frequent at times when there are great variations temperature. Sudden cold or any influence that chills the surface of the body m cause it. Internal cold, caused by drinking icy water or eating frozen food, is frequent cause. The infectious forms of enteritis are due to injurious matters the feed (germs and ptomaines); the toxic forms to acrid poisons (caustic acids an alkalies, meat brine, etc.)

Symptoms—The pain is somewhat severe. In slight cases we notice colicky pains af meals, the animal lies down a great deal; recovery takes place in a few days. In severe cas the animal is dull and feverish and the mouth is hot, with a fetid odor. The belly is tender, t colicky pains severe, respirations rapid, and the pulse hard and quick. The movements of t intestines may be suppressed at first and the animal bloats and is constipated; later the intestin sounds are increased and a diarrhea sets in that is sometimes mixed with blood and has a dis greeable odor. In the toxic form the symptoms vary according to the character of the poiso There may be spasms and convulsions, followed by collapse and stupefaction. Death occurs coma. Simple enteritis usually does not persist more than a few days and in the majority of cas proves fatal.

TREATMENT — The necessary lines of preventive treatment are good care and careful feedin If symptoms of the disease are manifested, no matter how light the attack, warm, comfortal quarters with a rigid diet and, in cold weather, drinking water slightly warmed. It is best keep the bowels as quiet as possible, so that purgatives or enemas are not desirable. If t animal is suffering severe pain, morphine given hypodermically will relieve it, or 1 or 2 teaspoo fuls of laudanum in from 1 to 2 ounces of linseed oil may be given every two hours. If the pa is not severe the intervals between the doses may be made considerably longer. Calomel in dra doses twice a day is useful as an intestinal antiseptic and to relieve the constipation. When convalescence is reached we should be very careful as to the kind and quantity of food, as the digestive tract is not capable of performing its normal functions.

ENTERITIS IN CATTLE

Causes — The causes of enteritis in cattle are about the same as in the horse. Exposure to cold, damp, chilling winds, or drastic purgatives may cause it. Frozen foods, ice cold or foul water, and eating musty or acrid substances are common causes. It may be prevalent in low-lying, marshy tracts of land.

Symptoms — The loss of appetite and suspension of nutrition, weakness, and general debility first attract attention. The animal is feverish and is often constipated. This is followed by a bloody diarrhea. During the first stages of the disease, and especially in the acute form, the animal is restless and shows evidence of suffering abdominal pain. The stools may contain fibrinous matter infiltrated with blood (croupous form). Enteritis may terminate in death in a short time or take on a lingering course.

Treatment — If due to the diet or to unhygienic conditions these should be corrected. The medicinal treatment is similar to that used in the horse. When greatly depressed strong coffee or alcoholic stimulants may be given.

ENTERITIS IN SHEEP

Causes — This is not a very common disease in sheep and frequently occurs as a complication of some other disease. The common causes are mistakes in the care and feeding, and irritating foods and water.

Symptoms — The sheep stops ruminating and the appetite is impaired. There is some abdominal pain. The abdomen is sensitive, pulse and respirations quickened, and body temperature elevated. Constipation is present at first, followed by a foul-smelling diarrhea mixed with mucus or blood.

Treatment — If the trouble can be traced to faulty feeding or care it must be corrected. The constipation is combated with cathartics and injections. Mucilaginous drinks may be given. If the animal is in pain, a teaspoonful of laudanum may be given two or three times a day.

ENTERITIS IN SWINE

Causes — The nature of the food fed to this class of domestic animals and filthy pens are the main causes. Meat brine and washing powders are exceedingly irritating and even poisonous to swine. Any chemical irritant in the swill may pave the way for the germs by irritating the lining membrane of the intestines.

Symptoms — The animal is dull, abdomen tender, the body temperature high, movements stiff, walk staggering, and there is a tendency to lie under the litter and leave the rest of the herd. The bowels are at first constipated. This is later followed by a diarrhea. The animal becomes very dull, weak, and emaciated. The malady may end in death in a day or pursue a course of several days or a week. In meat-brine poisoning the symptoms come on very suddenly.

At first there is great weakness and evidence of pain. Vomiting and diarrhea nearly always occur. The breathing is short. The posterior parts may become paralyzed and there will be convulsions (fits). The symptoms of poisoning by washing powders are diarrhea, vomiting, fever, partial paralysis, and nervous disturbance. Most of those attacked die.

TREATMENT — When constipated give the animal about 2 ounces of castor oil or from 15 to 30 grains of calomel. It is highly beneficial to give the pig flaxseed tea or gruels to drink The abdomen may be irritated by applying turpentine to the hide and covering it with a blanket until the skin looks red. Care should be taken in feeding the animal during the convalescent stage. If traceable to alkaline wash powders, vinegar given to the animal in a drench may help neutralize them.

GASTRO-ENTERITIS IN YOUNG ANIMALS

(*Scours, Diarrhea*)

Causes — When scours affects a large proportion of the young animals in a herd it is due to germs present in the quarters in which the young are kept and gaining entrance to the system by way of the umbilical cord. Infection usually takes place at the time of birth. Withholding the first milk, raising the colt on cow's milk, irregular feeding, and allowing the colt to suckle when the dam is warm, are common causes of digestive troubles or diarrhea in the young. When the mother is sick the milk is very apt to be irritating to the young animal. Sudden changes in the ration of the mother or too much milk may cause it. Dark, cold, damp, filthy quarters predispose the young to this disease. In case they are brought up artificially, too rapid swallowing of the milk and fermented milk are common causes.

Symptoms — When the disease is due to infection the symptoms are manifested within the first few days after birth; if to other causes, generally within the first few weeks. Constipation may precede the other symptoms. The animal acts dull and droops the ears, is careless of the teat, and sometimes will not suckle or drink milk at all. There is evidence of suffering, the diarrhea is foul smelling, the tail and hind parts become soiled. and the animal is very weak and loses flesh rapidly. There is an elevation of body temperature, and the respirations and pulse are quickened. Death may result from exhaustion. In the infectious form in calves the mortality is rather high.

TREATMENT — This is mainly preventive. Dry, clean, well-ventilated quarters should be provided, and when the infectious form is known to be present in a herd, the umbilicus must be disinfected soon after birth by washing it with a 10 per cent solution of carbolic acid or some of the creolin preparations. The quarters must be thoroughly cleaned and disinfected. The first milk of the mother should be given to the newborn as this acts as a natural laxative and clears out the intestinal tract. The young animal must be fed regularly, and not too much; the mother's diet should not be changed, and if too much milk is furnished the young, she must be dieted. In mares that are worked, when warm, it is best to milk a little from the udder before allowing the colt to suckle. When a colt is brought up on cow's milk, about two-fifths water and a little sugar should be added to it. When fed artificially it is best to warm the milk. We should always strive to get strong, vigorous, healthy young. The medicinal treatment is less satisfactory than the preventive.

It is always best to give a laxative at first (1 or 2 ounces of castor oil for the colt or calf; 2 drams for the lamb). Following this we may give the following mixture: Bicarbonate of soda (1 ounce), salol (½ ounce), bismuth subnitrate (½ ounce); mix, and to the colt and calf a small teaspoonful may be given in a little milk three or four times a day. Lambs receive from one-fourth to one-half as much. To cases suffering from a painful watery diarrhea it is well to give laudanum two or three times a day (1 teaspoonful for the colt or calf and 8 or 10 drops for lambs).

DIARRHEA

Causes—Diarrhea often occurs as a complication or as one of the symptoms of inflammatory diseases of the digestive tract. It is frequently seen in the various infectious diseases.

Symptoms—An animal having a diarrhea is usually dull, weak, and thirsty, and may have colicky pains. Sometimes it is quite feverish, and, if the diarrhea continues for some time, falls away in flesh rapidly. The evacuations are thin and offensive. The hind parts and tail become soiled.

Treatment—Diarrhea can be guarded against by using preventive measures. When occurring as a symptom of disease, the cause must be removed before we can hope to treat the condition successfully. In all cases we should first give a cathartic of linseed (1 pint) or castor oil (4 ounces). In recent cases a hypodermic of morphine will check it, or laudanum may be given in good-sized doses and repeated if necessary (horses and cattle, 1 ounce). An ounce of prepared chalk and a dram or two of powdered opium given in a ball is useful in checking it.

Other drugs that may be used are salol, bicarbonate of soda, and bismuth subnitrate.

COLICS IN THE HORSE

FLATULENT OR WIND COLIC

Causes—Wind colic is due to foods that are easily fermented, sudden changes in the food, eating when tired, too severe work after a hearty meal, drinking a large quantity of water after feeding, improper mastication of the feed, or any of the common causes of indigestion.

Symptoms—At first the horse is restless and has colicky pains. The abdomen on the right side soon becomes distended with gas, and when we place the ear to the right flank we can hear loud intestinal sounds, rather metallic in character. As the swelling increases, the animal becomes anxious and has great difficulty in breathing; the nostrils are dilated, eyes prominent, and it staggers. Sometimes the horse regurgitates gas, vents wind, and passes some feces. Unless relieved, death will take place very quickly, owing to the pressure on the lungs by the distended viscera and the absorption of poisonous gases by the vessels in the walls of the intestines, or to the rupture of the stomach or intestines.

Treatment—The preventive treatment is important and consists in proper methods of feeding. We can facilitate the escape of gas by way of the rectum by giving cold water injections. The quickest relief is obtained by puncturing the distended intestine with the trocar and cannula, nor should one put off doing this until too late. We must keep the horse from throwing himself down or becoming injured. The pain in some cases is violent. Fluid extract of *cannabis indica* in ½-ounce dose and repeated in an hour or two is useful in keeping the animal quiet. It is always well to give a cathartic in order to drive out the irritating substance, and it is well to diet and rest the animal for at least a day after it has recovered from the attack. A quart of raw linseed oil and 2 ounces of turpentine is a useful cathartic. Other drugs that may be used hypodermically are pilocarpine, eserine, barium chloride, and arecolin. One should allow the animal to run in a grass plot or give him a large, comfortable stall when sick, for if in much pain it may injure itself.

COLIC DUE TO OVERLOADING OF THE STOMACH

Causes — This form of colic may occur in horses that are overfed, when the owner is fitting them for sale or for the show ring. It may result when the horse gets into the grain bin and eats a large quantity of grain.

Symptoms — The animal shows evidence of colicky pains, but is not so restless at first as in other forms of colic. A flatulent condition of the stomach and intestines is usually present. The expression of the face is anxious; the animal tries to vomit, and sometimes does, small amounts of alimentary matter coming out of the nostrils. In colic due to overloading, the horse takes unusual positions (the dog sitting position is one), in order to ease the pain or the pressure on the lungs. A rupture of the walls of the stomach is always to be feared in overloading. As a rule, this accident can be recognized by the animal becoming more quiet, the surface of the body cold, and the pulse small and weak. When the disease is about to terminate fatally, the expression is anxious, the respirations quick, pulse imperceptible, and the mucous membranes pale; the animal staggers and dies very quickly. In some cases death does not occur for several days after the rupture has occurred.

TREATMENT — Keep the horse as quiet as possible, as there is danger of rupture of the stomach if the animal throws itself down or rolls violently. The following drugs are useful in keeping it quiet: Fluid extract of *cannabis indica*, morphine, and chloral hydrate. Flatulence should be treated the same as in flatulent colic. Bulky drenches must not be used, and the animal should be subjected for a few days to fasting.

SPASMODIC COLIC

Causes — Nervous, highly bred horses are more susceptible to spasmodic colic than coarse, lymphatic animals. The malady may be classed as a nervous colic, as irritation to the nerves of the intestines by cold, both internal (cold food and water) and external (wading frozen streams, etc.), will produce cramp in the intestines. Indigestible food and foreign bodies also may cause it.

Symptoms — The attack occurs very suddenly and the pain is severe, violent, and of short duration, but returns in the form of successive attacks. The peristaltic movement of the intestines is increased and we hear loud intestinal sounds. The horse usually makes frequent efforts to urinate. This is caused by the irritation being communicated to the urinary apparatus and must not be mistaken for kidney trouble.

TREATMENT — All that is necessary in this form of colic is to give the animal comfortable quarters where it can not injure itself. In cold weather it must be covered with warm blankets and if necessary the limbs rubbed and bandaged. Morphine given hypodermically is almost a specific for this colic. Fluid extract of *cannabis indica* may be given (in from 2 to 4-dram doses) and repeated in an hour if necessary, or laudanum ($1\frac{1}{2}$ ounces) may be given in a little oil. If the colicky pains do not disappear in a short time the following ball may be given: Powdered aloes (6 drams), powdered ginger (2 drams), extract of belladonna ($\frac{1}{2}$ dram); mix and give as one dose.

COLICS DUE TO OBSTRUCTIONS ALONG THE INTESTINAL TRACT

In colics due to constipation the symptoms are not well marked and may run along for several days before colicky pains are manifested. The pains are generally very mild, the horse lies down more than usual, and does not eat. The abdomen is more or less distended with gas, and if the oiled hand is introduced into the rectum it is found to be filled with hard feces.

TREATMENT — Constipation is very often due to feeding too much roughage and can be largely prevented by balancing the ration with grain and giving the horse sufficient exercise to keep it in good health. If the colic has not been neglected, enemas and cathartics (linseed or castor oil) will relieve the animal. Laxative foods and plenty of water should be given till recovery is complete. Eserine, strychnine, pilocarpine, and arecolin given hypodermically are useful in this form of colic.

HAIR BALLS

Hair balls, composed of the vegetable hair found on clover, grains of oats, etc., and sometimes of hair from the horse's own coat or that of his mates, may be found in the cæcum or some other part of the large intestine. It is only when the hair ball is large and some part of the intestine is blocked by it that colic occurs. If the obstruction of the intestine is complete death usually takes place in a short time.

INTESTINAL CALCULI

Intestinal calculi composed of the different earthy salts, together with intestinal mucus, deposited layer upon layer around some central nucleus, as, sand, a pebble, hair, etc., are sometimes found in the cæcum or colon. In appearance they are smooth, irregular in shape and sometimes so worn that one can make out the different layers that compose them. Calculi sometimes give rise to intermittent colics.

COLICS DUE TO CHANGES IN THE RELATION OF THE INTESTINES

VOLVULUS

The causes that result in the intestines sometimes becoming twisted are most obscure. It may be due to the unequal weight or volume of the different parts of the organ and its forcible contractions and movements that accompany some colics. All unusual movements (rolling, kicking, jumping, etc.) of the animal may cause it.

At first it is very difficult to diagnose the presence of this condition, but when the colic is persistent, the pains severe, and the treatment seemingly without benefit to the animal, one may at least suspect that this condition is present. An up-and-down movement of the head and neck and a peculiarly anxious, drawn expression of the face is frequently seen in volvulus. The prognosis is very unfavorable.

Invagination

This consists in the slipping of a portion of the intestine into that which is immediately next to it. This may occur as a complication in the different forms of colic. When this condition exists, the colicky pains may persist for some time and finally result in the death of the animal.

Hernia

When the bowel passes down into the scrotum (scrotal hernia) of the stallion or colt, or into the canal leading to the scrotum (inguinal hernia), it may be compressed by the walls of the inguinal canal (become strangulated). In case it does, the pain is severe and the symptoms resemble those of an enteritis. A diagnosis can not be made without a careful examination, and very often the hernia can not be reduced without castrating the animal. The treatment must be prompt or the strangulated loop of intestine will become gangrenous.

DISEASES OF THE LIVER

Primary diseases of the liver are not common in domestic animals. Inflammation of the liver is seen in some of the infectious and contagious diseases. In some sections of this country "liver rot" occurs among cattle and sheep, but it is only in European countries that the liver fluke is at all common. Liver diseases are not common among our domestic animals and when this organ is involved, especially in the larger domestic animals, the symptoms are so obscure that it is difficult to make a diagnosis.

JAUNDICE

(*Icterus*)

Jaundice is not uncommon among horses. It can not be called a disease in itself, but rather a symptom of disease, and is caused by the retention of bile and its absorption into the blood.

Causes — Icterus, or yellows, may be seen in any of the febrile diseases when the excretions and secretions of the body are interfered with. It is one of the symptoms seen in congestion or inflammation of the liver. Obstruction of the bile duct by gall stones or an inflammation of the duct will cause it. Overfeeding and lack of exercise are very common causes.

Symptoms — The digestive apparatus is generally disturbed, the animal has a poor appetite, is constipated or may have a diarrhea. The feces are grayish colored and foul-smelling. The animal acts dull, is sometimes feverish, and the visible mucous membranes (those lining the eyelids, mouth, etc.) are stained yellow by the bile pigment. When of recent origin recovery takes place very quickly.

TREATMENT — When due to an improper diet and lack of exercise these conditions must be corrected and the animal dieted. It is advisable to produce a free action of the bowels by administering a cathartic (for the horse, 6 to 8 drams powdered aloes; cattle, 1 pound Glauber's salts; sheep, 4 to 6 ounces Epsom salts). Two or 3 drams of calomel is a very useful purgative in horses and cattle. After clearing out the intestines it is usually best to give the following mixture: Glauber's salts, bicarbonate of soda, and common salt (equal parts); 1 tablespoonful of this can be given to horses and cattle and 1 teaspoonful to sheep three times a day.

DISEASES OF THE PERITONEUM

(a) ACUTE PERITONITIS

Acute peritonitis occurs in all domestic animals, but not all are equally susceptible to it. The peritoneum of the horse is the most sensitive; next come ruminants (sheep and cattle); then comes the dog, and last the pig. Because of the accidents that sometimes happen during pregnancy and at the time of parturition, and the intimate relations existing between the peritoneum and the genital organs, peritonitis is more common in the female than in the male.

Causes — Accidental injuries of various kinds, such as wounds penetrating the walls of the abdomen and blows on the abdominal wall, may cause it. Operations of different kinds — especially castration, if carelessly performed with dirty hands and unclean instruments — are frequently followed by acute peritonitis. In inflammatory diseases of the organs contained in the abdominal cavity the inflammation may extend to the peritoneum. Perforations or rupture of the stomach or intestines are followed by acute peritonitis.

Symptoms — Peritonitis can be easily diagnosed if the inflammation follows an operation on the abdominal cavity or an injury to its walls. When it occurs as a complication of another disease the symptoms shown may not vary greatly from the original disease. The pain is generally severe from the first, but in some cases this is not a prominent symptom. The animal refuses to eat, the severe pain is manifested in the usual manner, the body temperature is high, there are chills, the respirations are painful, the pulse quick and hard, the abdomen tucked up and sensitive, and the movements slow and stiff. Constipation may alternate with a diarrhea and the abdomen become distended with gas. At times the temperature is normal. In a local peritonitis the symptoms are not nearly so marked and recovery usually takes place. In diffused peritonitis recovery rarely takes place, and if it continues for some time, the inflammation becomes chronic.

TREATMENT — This is one of the diseases in which preventive measures are highly important. Local applications to the walls of the abdomen are useful in combating the inflammation, and especially is this true in small animals and in circumscribed peritonitis. The counter-irritants used are mustard or turpentine. In small animals, and if localized, applications of heat (flannel cloths dipped in hot water and wrung out) to the walls of the abdomen are reasonably satisfactory when kept up. If one can not do this, cold applications may help and are less trouble. If the disease follows an operation or infected wound, antiseptic solutions must be used freely and the part kept perfectly clean. When the pain is very acute morphine or chloral hydrate may be given. To clear out and disinfect the intestinal canal, calomel (1 to 2 drams for the horse or cow, ½ dram for sheep) may be given twice a day for a few days. Enemas of warm water should also be given.

(b) CHRONIC PERITONITIS

Causes — Chronic peritonitis may succeed the acute form of the disease. In the ox it is generally due to tuberculosis or foreign bodies in the stomach. In chronic disease of internal organs peritonitis may occur as a secondary disease.

Symptoms — As in all chronic diseases the symptoms, though generally the same, are not so intense as in the acute form. The abdomen becomes increased in size and edematous swellings may be present along its lower walls. The appetite is poor, bowels irregular, the animal weak and emaciated, mucous membranes pale, and heart action weak. Slight colicky pains are sometimes noticed.

TREATMENT — When it occurs as a secondary disease, treatment is of little use. Counter-irritants may be applied to the walls of the abdomen and laxatives and bitter tonics (gentian, nux vomica, etc.) may be employed. It may be necessary to puncture the abdomen in order to remove the fluid.

DISEASES OF THE URINARY ORGANS

Examining the Urine — In diseases of the urinary apparatus a careful examination of the urine is often necessary before we can make a correct diagnosis. In domestic animals it is impossible to determine the exact amount of urine passed during the day, but we can judge the amount by noting the condition of the stall in which the animal is kept. It is often hard to get a sample of urine for examination and we have to watch the animal carefully in order to collect. Normal urine is more or less of a yellow color, rather turbid or cloudy and more or less slimy in the horse, less so in other domestic animals. The reaction in horses or cattle is usually alkaline. This depends on the kind of food. In disease the urine may be lighter or darker (pale, red, brown) than normal. When a large amount is passed it is usually pale; when mixed with blood it is red, and dark when a small quantity is passed, or when colored by bile pigment, drugs, or blood. We can discover, by testing the urine with certain reagents, whether the normal substances present in the urine are present in abnormal amounts or whether abnormal substances are present in it. A microscopic examination of the sediment is also of great importance in making a diagnosis of some diseases.

FREQUENT URINATION

Causes—This disease is characterized by an excessive secretion of urine. The horse is the most frequent sufferer. The most common cause is musty feed (hay, grain, bran, etc.) New oats, watery feed, and acrid plants will sometimes cause it.

Symptoms—The most prominent symptom at first is frequent urination, a large amount of pale colored urine being passed each time, the stall in which the animal is kept being continually wet. The animal drinks more water than usual, the appetite is poor, and it rapidly falls away in flesh. Gradually it becomes weak and finally dies from exhaustion unless the cause of the trouble is removed. If the poisonous substances have been acting for some time it is difficult to cure the animal.

TREATMENT—A change in the food and a good nourishing diet generally are all that is necessary. If the animal is emaciated and weak, bitter and saline tonics are called for. In obstinate cases, treatment does but little good. The quantity of water drunk by the animal should be limited.

CONGESTION OF THE KIDNEYS

Causes—Irritation of the kidneys from acrid or moldy food and impure drinking water may cause it. It may occur as a complication of some of the infectious diseases, especially influenza.

Symptoms—When the congestion is active, the amount of urine passed is increased, clear, and transparent. In some animals swelling and tenderness in the region of the loins is a very prominent symptom. The back is held slightly arched, and the gait is stiff and straddling. In passive congestion, the quantity of urine passed is less than normal and the affection is chronic. The animal may show general symptoms of ill health, stocking of the limbs, etc.

TREATMENT—The cause of the disease must be removed, if possible. Laxatives of linseed or castor oil and mucilaginous drinks are needed. Hot applications to the loins are useful in combating the congestion. These must be kept up continuously, and in cold weather the animal must be kept warm.

INFLAMMATION OF THE KIDNEYS

(*Acute Nephritis*)

Causes—The action of cold on the skin and the different infectious diseases are common causes. The disease may follow a congestion of the kidneys. The toxic effect of such drugs as cantharides, turpentine, etc., may also cause it.

Symptoms—At the beginning of the disease colicky pains are often present. In ruminants this is not a prominent symptom. The animal moves stiffly, the back is arched, urination is painful, and water is passed in small quantities, frequently drop by drop, in spite of the efforts of the animal. The appetite is suppressed, pulse strong at first, but soon becomes weak, and the body temperature is elevated. In making a rectal examination, we find the bladder empty and the kidneys enlarged and sensitive. When the kidneys are no longer able to perform their function properly, uremia occurs. In the later stages of the disease the animal is weak, staggers, and may have spasms, and finally dies while in a comatose condition. The prognosis is very unfavorable, death occurring in the majority of cases. It seldom passes into a chronic inflammation, but this may develop from the first. Chronic inflammation of the kidneys generally develops very slowly and without giving rise to any very prominent symptoms at first In the chronic form the appetite is gradually lost, pulse hard, the limbs stock, and the animal gradually becomes weak and out of condition.

Treatment—The animal must be given warm, comfortable quarters and absolute rest. The diet must be such that it does not irritate or increase the work of the kidneys. As in congestion of the kidneys, hot applications to the loins are useful, but if not kept up will do but little good. We must encourage the elimination of waste products by way of the intestines and skin. This can be done by administering a purgative and by energetic rubbing of the skin and encouraging perspiration by blanketing. If the animal becomes weak, general and heart tonics must be given.

PURULENT NEPHRITIS

During the course of blood-poisoning (*septicæmia* and *pyæmia*), pus-forming germs may reach the kidneys by way of the circulation and cause abscesses in the kidney tissue. The symptoms of the disease are not well marked at first and may not be recognized until the autopsy.

RETENTION OF THE URINE

Causes—This may be due to a variety of causes. In the ox or ram it is generally due to calculi in the curvature of the urethra or at the terminal extremity. In the horse the calculi are generally present in the bladder. Compression of the urethra by growths or tumors, strictures of the urethra, spasms of the neck of the bladder, paralysis of the bladder, and injuries to the penis are other causes. In cattle calculi or a soft putty-like material may collect in the sheath and obstruct the flow of urine. Calculi usually form through the collection of the urinary salts around some foreign body, the excess of the urinary salts being due to an excess of lime or other salts in the water or food.

Symptoms—Pain is the first symptom manifested in the horse, and it makes frequent efforts to urinate. In ruminants it may be a day or two before any characteristic symptoms arise. The efforts to urinate are not marked, the tail is elevated, and contractions are noticed along the perineum, just beneath the anus. Sometimes the urine dribbles from the sheath drop by drop.

If a rectal examination is made, the bladder is found distended with urine. The appetite is soon lost, the pulse is accelerated, and the countenance sad. When a collection of material in the sheath obstructs the flow, the sheath becomes inflamed and the trouble is easily located. If the animal is not relieved the bladder ruptures and peritonitis results. Death may result from uræmic poisoning.

TREATMENT—When due to spasm or paralysis of the bladder the catheter can be used. If due to spasm, spreading fresh litter under the horse and keeping it quiet may induce it to urinate. A gradual and even pressure on the bladder with the hand may cause the animal to urinate if no obstructions are present in the urethra. The treatment for calculi is entirely surgical. When a collection forms in the sheath it should be removed with the fingers or washed out by injecting water into the sheath with a syringe. The sheath should be washed out with warm water and a little vaseline smeared over the inflamed tissues.

INFLAMMATION OF THE BLADDER

(*Cystitis*)

Cause—Irritation to the bladder due to the retention of the urine and toxic matters (molds, turpentine, cantharides, etc.) that are eliminated from the blood by way of the kidneys. Exposure to cold may also cause it. It may occur in the different infectious diseases.

Symptoms—The animal is sometimes feverish, with poor appetite, and stiff movements, and it falls away in flesh. It frequently tries to urinate and passes small quantities of urine each time. If we press on the bladder with the hand it causes the animal pain.

TREATMENT—The animal should be rested. The cause of the inflammation should be removed if possible. We can administer remedies that will modify the condition of the lining membrane. The following mixture may be given: Chlorate of potassium (2 ounces), salol (½ ounce), powdered nux vomica (1 ounce); mix and divide into sixteen powders; give one powder in the feed three times a day.

DISEASES OF THE CIRCULATORY SYSTEM

PALPITATION

Palpitation is a sudden, violent, tumultuous beating of the heart. In spasms of the diaphragm the symptoms produced are similar to those seen in true palpitation, but do not seem to have any connection with the beats of the heart.

Causes—Excitement, overexertion, and a debilitated condition of the system may cause palpitation. It generally accompanies acute diseases of the heart. Spasm of the diaphragm is frequently seen in horses not accustomed to severe exercise, especially if exercised after feeding, and also in horses having digestive troubles.

Symptoms—The pulse is small and irregular, the respirations quickened, and the impulse of the heartbeat may be so violent as to shake the whole body. In some cases the impulse can be heard when standing a short distance from the animal. In spasm of the diaphragm we observe in the costal region and flank abrupt shocks that are accompanied by a short, jerky respiration. The animal is uneasy and anxious, the appetite partly lost, and the pulse quickened.

TREATMENT — We must keep the animal quiet and avoid any excitement. Palpitation generally occurs as a symptom of disease; it is necessary, then, to treat the disease. In spasm of the diaphragm a strict diet is sufficient to cure mild cases. Morphine (in 2 or 3 grain doses, hypodermically), if necessary, repeated at intervals of three or four hours, is very useful Laudanum in small doses may be given in linseed oil.

PERICARDITIS

(*Inflammation of the Membrane Around the Heart*)

PERICARDITIS IN THE HORSE

Causes — Pericarditis in the horse frequently develops as a condition in some of the infectious diseases (influenza, contagious pneumonia, etc.); it may result from rheumatism, cold, and wounds from sharp-pointed objects (nails, broken ribs, etc.)

Symptoms — When pericarditis develops as a complication of influenza or pneumonia, the symptoms at the beginning are not always recognized, but soon become quite marked. Palpitation may be present. The pulse beats are quite rapid and small. If fluid collects around the heart, the beats are weak. The body temperature is elevated and the animal does not eat, is restless, will lie down for only a short time or not at all, and seems to suffer severe pain. If the disease continues for some time the horse becomes greatly emaciated. In most cases the disease runs a very acute course. The prognosis is very unfavorable.

TREATMENT — The animal must have well ventilated, comfortable quarters and must be kept as quiet as possible. Heart tonics, alteratives, and bitter tonics must be given. Digitalis is the most useful heart tonic. Febrifuges may be necessary to control the temperature. Mustard drafts and blisters applied to the walls of the chest, just over the region of the heart, are very useful in easing the pain and combating the inflammation. If fluid collects around the heart it may be necessary to puncture the sac and remove it.

PERICARDITIS IN CATTLE

Causes — This disease in cattle is generally due to traumatic causes (injuries from sharp foreign bodies passing through the walls of the second stomach). Cold, rheumatism, and pleurisy also cause it.

Symptoms — When due to foreign bodies the cardiac symptoms are associated with those accompanying chronic indigestion The respirations are painful, and the animal soon becomes emaciated. The heart beats are at first strong and palpitating, but later become weak. The body temperature is high and the heart sounds abnormal. The expression is anxious and the animal does not lie down. The disease may pursue a long course. The prognosis is unfavorable.

TREATMENT — It is not practical to treat cattle suffering from this disease.

ENDOCARDITIS

(*Inflammation of the Lining Membrane of the Heart*)

Cause—This disease is generally due to rheumatism or to the after-effects of influenza.

Symptoms—The symptoms so nearly resemble those seen in pericarditis that it is hard to differentiate between the two in domestic animals.

TREATMENT—This consists in treating the primary disease. The other treatment is along the same lines as in pericarditis.

DISEASES OF THE RESPIRATORY TRACT

Examination of the Respiratory Organs in Disease—In the larger domestic animals examination of the respiratory tract can not be carried out so completely as in the smaller animals. This is especially true if the animal is fleshy. If it is restless, or if there is very much noise around the stable, it greatly interferes with our hearing the respiratory sounds. The greatest help in diagnosing and watching the progress of respiratory diseases is auscultation—application of the ear over some part of the respiratory tract and listening to the respiratory sounds. Auscultation can be learned only by examining healthy animals to determine the normal sounds. Respiratory sounds can be heard over the nose, throat, windpipe, and a small portion of the lungs. Percussion is not so commonly used in diagnosing respiratory diseases as auscultation. The former consists in striking or tapping the walls of the chest, sinuses, etc., with the hand or fingers. Sometimes a hard, solid body is placed on the part and the taps delivered on this. If the percussion is over a hollow space or spongy tissue the sound is drum-like or resonant. If over a solid body, it is dull, or wanting.

ACUTE CATARRH

(*Cold in the Head*)

CATARRH IN THE HORSE

Catarrh is an inflammation of the mucous membrane lining the nasal cavities and usually extending to the membrane lining the sinuses of the head. Sore throat is very often a complication, the membrane of the pharynx and larynx becoming inflamed.

Causes—This disease is much more common in the horse than in any of the other domestic animals. The most common causes are exposure to cold and wet and standing in a draft. Colds are common during changeable weather, especially if the animal is not cared for properly. Horses that are accustomed to warm stables are very apt to take cold if changed to a cold stable or improperly cared for after being driven or worked. Irritation to the mucous membrane from dust or smoke may sometimes cause it. The different infectious diseases (distemper, influenza, etc.) are very common causes. In sheep the larva (grub) of the bot-fly will cause catarrh.

Symptoms — The early stage of the disease, unless accompanied by the general symptoms, will pass unnoticed by the owner. In mild cases the symptoms are not marked. The lining membrane of the nostrils is at first dry and red. In a few days a discharge appears. This is at first watery, but may become catarrhal, heavy, mucus-like, and turbid; sometimes it is pus-like (purulent). The eyes are generally affected, the lining membrane of the lids looks red, and tears flow over the cheeks. The appetite may be impaired at first and the animal acts dull. Sometimes fever is present, but this lasts only a short time unless the cold becomes complicated. When the throat is inflamed, the horse coughs and has some difficulty in swallowing. It may breathe heavily. If the throat is manipulated it causes the animal to cough. The disease may terminate in about a week if the case is mild, or it may become chronic or cause the animal to be thick-winded. The throat occasionally remains sore for some time and the horse loses flesh.

Treatment — Colds can be largely prevented if the proper precautions are used. Mild cases require nothing but good care and good quarters. Steaming the animal is useful during the early stages of the disease. Easily digested food, and, if the throat is so sore that the animal can not eat the ordinary feed, soft foods and slops should be given. A mild liniment may be rubbed on the throat and later, if the animal continues to cough, a cantharides blister (1 part powdered cantharides to 8 parts vaseline) may be applied to the throat. The following mixture may be given: Tincture aconite (6 drams), tincture belladonna (1 ounce), syrup of squills (add enough to fill an 8-ounce bottle); give one tablespoonful three times a day. Chlorate of potassium may be given in the drinking water. Iodide of potassium in dram doses in the feed three times a day is also useful. If the animal becomes run down in flesh, bitter tonics are indicated. In chronic catarrh it is sometimes necessary to trephine the animal and wash the sinuses with an antiseptic solution. The treatment is very much the same in the different species of domestic animals.

CATARRH AND SORE THROAT IN SWINE

Causes — Exposure, irritating gases, dust, and overcrowding in pens and around straw stacks are common causes.

Symptoms — The symptoms and different stages of catarrh in pigs are much the same as in other animals. Sore throat usually occurs as a secondary disease. The symptoms are as follows: Distressed and noisy breathing; slightly swollen throat; dry, hard cough; difficulty in swallowing; fever and loss of appetite. The disease develops rapidly and as a rule terminates favorably in about four days.

Treatment — Preventive precautions are important. The only treatment necessary is good care.

BRONCHITIS

Bronchitis is an inflammation of the bronchial tubes and may be either acute or chronic. When the smallest bronchial tubes are involved, it is termed capillary bronchitis. Acute bronchitis is especially common in the horse, the chronic form being unusual.

Causes — During the changeable seasons of the year this disease is frequently encountered. In general the causes are about the same as in other respiratory diseases. Cold is the principal cause. Overheated, poorly ventilated stables, and irritating vapors and gases are common causes. It may be associated with some of the contagious diseases.

Symptoms — The disease comes on very quickly, the fever is high, and the pulse and respirations rapid. The visible mucous membranes are red, the animal does not eat and acts stupid. Frequently chills are observed. If we place our ear along under the neck or at the side of the chest, we can hear the respiratory sounds, which are rough and louder than normal. The cough is at first dry, then moist. The general symptoms subside in a few days, generally in about a day, but unless the animal is cared for may become complicated. In the horse bronchitis is not a serious disease, but in other domestic animals is more apt to run a longer course and become complicated. If the causes continue to act the disease may then become chronic. In this form the secretions are abundant, whitish curdled matter being discharged. This discharge is more abundant when the horse is first exercised than at any other time. Symptoms of broken wind are usually noticed, the animal is weak and unfit for work, and runs down in flesh quite rapidly.

Treatment — Good care and comfortable, well-ventilated quarters are all that are necessary in mild cases. The animal must be protected with warm blankets, and, if chilling, it is best to rub the legs and then bandage them with woolen bandages. A laxative and easily digested diet should be given. Fumigations with steam every four or five hours are useful in allaying the inflammation. Liquor ammonia acetate in 2-ounce doses every three hours till the temperature falls to the normal, then three times a day for a few days, is very useful. If the animal coughs and has some difficulty in swallowing, a liniment should be rubbed on the throat and the following mixture given: Tincture aconite (6 drams), tincture belladonna (1 ounce), syrup of squills (add enough to make 8 ounces); give one tablespoonful three times a day. Animals affected with chronic bronchitis should not be worked. We should guard against their taking cold, give them good nourishing foods, and tonics if necessary. The following mixture may be given: Fluid extract of gentian (2 ounces), Fowler's solution (6 ounces); mix and give half an ounce in the feed or as a drench three times a day. Alkalies and strong alteratives may be given.

HEMORRHAGE FROM THE LUNGS

Causes — Pulmonary hemorrhage is generally due to overexertion and excitement. It may occur if the animal is forced to do severe work or exercised when sick or exhausted. It may accompany severe pulmonary congestion and pneumonia.

Symptoms — The characteristic symptom is a discharge from the nostrils or mouth of red frothy blood. The discharge is usually intermittent and may occur in large quantities. The mucous membranes are generally pale, the animal trembles, looks anxious, is restless, coughs, and has a weak pulse and a high fever. Difficult breathing is a prominent symptom. Death may occur in a short time.

Treatment — The animal must be kept as quiet as possible. The quarters should be comfortable and well ventilated. By using good judgment in handling the animal serious pulmonary hemorrhage can be largely avoided. In severe cases treatment is of little use.

CROUPOUS PNEUMONIA

PNEUMONIA OF THE HORSE

Causes — The causes are very much the same as in other respiratory affections. During the cold weather it is more common than at any other time of the year. It may be due to contagious causes. If the animal is already suffering from some respiratory disease, such conditions as exposure to cold and wet, drafts in the stable, chilling suddenly after perspiring freely, washing with cold water, and neglecting the proper protection of clipped horses during cold weather, are very likely to cause pneumonia.

Symptoms — When the disease first affects some other part of the respiratory tract and the lungs are affected secondarily, the earliest symptoms are confounded with those of the first disease and will vary according to the severity of the attack. At first we notice chilling, the temperature of the surface of the body is uneven, and the animal has a high fever. The mucous membranes are reddened, the nostrils dilated, the respirations quickened and difficult, the expired air hot, the appetite diminished, and the pulse accelerated. We may hear the animal cough, and generally a rusty discharge accumulates around the margins of the nostrils. The horse is inclined to be constipated and remains standing. If it lies down at all it is on the diseased side. In severe cases the expression is anxious, the respirations labored, the general symptoms aggravated and the horse stands with elbows turned out and the front feet spread apart. The course of pneumonia is typical, and unless it terminates fatally in the first stages, the periods of *congestion*, *hepatization* (consolidation), and *resolution* will generally follow each other in a regular manner. Auscultation and percussion are valuable aids in diagnosing and watching the progress of the disease. During the period of congestion, which lasts about one day, one can hear sounds in the diseased lung tissue. Consolidation follows, the lung tissue becoming red or reddish-gray in color, and dense, like liver. In the latter stage of the hepatization the dissolution and absorption of the matter in the air cells begins. In this period, which lasts several days, the respiratory sounds are suppressed. In the last period, resolution, the exudates undergo liquefaction and are absorbed or expelled with coughing. The disease is at its height, as a rule, in a little less than a week, but the convalescent period may extend over several weeks. In subacute cases the symptoms are mild and may terminate favorably in a short time. In serious cases death by asphyxia occurs. In some cases abscesses may form in the lung tissue. The disease may be the cause of broken wind.

TREATMENT — Good quarters and careful nursing are highly important in treating pneumonia. A comfortable, well ventilated, and clean box stall, free from drafts, should be provided. As the animal can use only a limited portion of the lungs, the air that he breathes should be pure. The droppings and wet bedding should be removed from the stall several times a day The body of the horse during cold weather should be well protected with woolen blankets and the limbs bandaged. A laxative, easily digested diet should be given. Such measures, if taken early in the disease, may greatly modify it. In the early stage, when the animal is chilling, alcoholic stimulants and quinine can be given. In cases where the temperature runs high the following febrifuge may be given: Acetanilid (1½ ounces), quinine sulphate (1 ounce), bicarbonate of soda (1 ounce), and powdered nux vomica (½ ounce); mix and divide into eight powders; give one powder every three or four hours. In mild cases liquor ammonia acetate may be given, and when the heart action is weak, digitalis. In most cases mustard paste rubbed into the hair and covered with oil cloth or brown paper will give material relief. Ground mustard (about 1 pound) is mixed with enough warm water to form a paste and applied to the walls of the chest. In about half an hour it must be thoroughly washed off with hot water and a mild stimulating liniment applied to the skin. This should be repeated as often as necessary. In the latter convalescent stage iodide of potassium and bitter tonics should be given.

PNEUMONIA IN CATTLE

Causes — This is not a common disease in cattle. It may follow other respiratory diseases. The causes are very much the same as in the horse. *Traumatic pneumonia* may result from the food entering the trachea, as it sometimes does in paralytic diseases.

Symptoms — The disease is usually subacute. The general symptoms are much the same as in the horse. The mouth is often dry and the tongue protruded to facilitate breathing. In severe cases the animal usually remains standing. In mild cases it often lies down.

TREATMENT — The treatment does not differ much from that used in the horse. A cathartic of Epsom salts (1 pound) may be given in the early stage of the disease, and repeated if the animal becomes constipated.

PLEURISY

(*Inflammation of the Pleura*)

Causes — Pleurisy is more common in the horse than in any of the other domestic animals. The causes are the same as in pneumonia. In many cases it is due to exposure and cold (rheumatismal form). It frequently develops as a complication of pneumonia.

Symptoms — Pleurisy generally starts with chills. The body temperature is quite high; the pulse accelerated and the respirations quick, labored, and abdominal, the abdominal muscles forming a ridge along the lower ends of the ribs. The animal does not stand still as in pneumonia, but changes its position occasionally, its movements in many cases being accompanied by a grunt. Pressure on the walls of the chest causes pain and the animal rarely lies down. The cough is short and painful. The appetite is impaired or absent and the patient is weak. By auscultation we recognize friction sounds. In a day or two effusion takes place in the pleural cavities and the pain is greatly relieved, but this relief is only temporary in most cases. If the fluid collects in large quantities there is pressure on the heart and lungs, the pulse is weak, the respirations labored, and the countenance has a haggard appearance. Dropsical swellings are noticed beneath the breast and abdomen and there is an absence of respiratory sounds over the lower region of the chest; instead a splashing gurgling sound may be heard. Suffocation may take place; the animal moves unsteadily, and finally dies. In favorable cases improvement begins in from four days to a week, the appetite returning, the effusion gradually disappearing, and the respirations becoming normal. Convalescence takes place very slowly. In severe cases the animal may continue weak and may have defective wind.

TREATMENT — As in pneumonia, careful nursing and good quarters are important in the treatment of pleurisy. Mustard drafts should be applied to the walls of the chest and febrifuges given to reduce the fever. When the effusion occurs in the chest cavity we should give drugs that will stimulate the action of the heart and help in getting rid of the effusion. Such drugs as iodide of potassium, or acetate of potassium in combination with digitalis, are especially valuable for this purpose. Nitrate of potassium can be given in the drinking water.

DISEASES OF THE NERVOUS SYSTEM

CONGESTION AND ANEMIA OF THE BRAIN

Causes — Congestion of the brain is more frequent in the horse than in any of the other domestic animals. In this disease the blood-vessels of the brain become engorged with blood. It may be either active or passive. Horses that are overfed and receive too little exercise are predisposed to it. It may be due to changing stables, shipping in poorly ventilated cars, poorly ventilated stables, improper feeding and foods hard to digest, excitement and excessive exertion. Congestion may occur in some of the contagious diseases and is sometimes caused by organic heart troubles. Extremely fat animals having short, thick necks are said to be predisposed to it. Passive congestion of the brain may be due to a narrow collar pressing on the jugular vein and obstructing the flow of blood from the brain. Pressure on the jugular vein from other causes may cause the same condition.

Anemia of the brain is due to an insufficient amount of blood in the brain and is caused by abundant hemorrhage, obstruction of blood going to the brain, and cardiac weakness.

Symptoms — The congestion in most cases comes on very suddenly, in others it develops slowly. The disease may manifest itself as soon as the animal is moved out of the stall, or it may come on while it is feeding. In the latter case, the horse stops suddenly, becomes restless, and later quite violent. The pulse is quick and hard, the animal is nervous, respirations hurried, and eyes staring. It braces itself, raves, or staggers and falls. It may regain its feet or have convulsions and pass into a comatose condition. Death may occur in a very short time. We will sometimes find the animal with its fore feet in the manger, or pressing the head hard against objects. Grinding the teeth, neighing, and shaking the head are some of the other symptoms that may be seen in this disease. Cattle leave the feed suddenly, are restless and excited, bellow, rotate the eyes in their sockets, butt the head against objects, and, if they fall, have convulsions. Coma is manifested by the animal becoming sleepy, stupid, not eating, without expression in the face, taking unusual positions, and staggering in its gait. It may take a recumbent position and appear as if dead. In cerebral anemia the gait is staggering and the pulse weak. The same symptoms as described in congestion may be manifested. In some cases congestion of the brain leads to an inflammation of the organ. Apoplexy due to rupture of capillaries may occur, or it may lead to vertigo or "staggers."

TREATMENT — Preventive treatment is very important in this disease. Bleeding at the beginning will give good results. Cold applications to the head also are useful. A cathartic of linseed oil should be given. In anemia we must give stimulants. Recovery from the attack should be followed for at least a few days by a careful diet and rest.

INFLAMMATION OF THE BRAIN AND ITS MEMBRANES

(*Encephalitis*)

Causes — These are very much the same as in congestion of the brain. Unhygienic conditions, as unsanitary and poorly ventilated stables, are common causes. It is more common in the spring and fall than at any other time of the year. It is sometimes seen in acute infectious diseases. Feeding too rich or constipating a diet, overfeeding, changes in diet, changes in climate, high temperature, excessive exertion, excitement, and injuries to the head may cause it.

Symptoms — The symptoms vary in different individuals, but in a general way are the same, and at the beginning similar to those seen in congestion of the brain. The animal is extremely nervous at first, is very sensitive to sounds, and the eyes are staring. The pupil of the eye is dilated, the pulse quick and hard, and the respirations more rapid than normal. The body temperature is elevated. In some cases the attack comes on so quickly that these symptoms are not noticed. The gait is uncertain, the animal does violence to itself and goes through uncontrollable movements. Recovery may take place gradually, or a partial paralysis may follow. Sometimes the animal becomes comatose. The disease may run a course of a week or more to a fatal termination, or death may be very sudden. The prognosis is very unfavorable.

Excitement is the most prominent symptom in cattle. They bellow, eyes are prominent, they tremble, shake the head, butt with the horns, climb into manger, and run against objects. Saliva dribbles from the mouth. The disease will very often pursue a very rapid course. The patient may live for several days and show the usual symptoms of inflammation of the brain. The prognosis in cattle is even more unfavorable than in horses.

TREATMENT — The preventive treatment is the same as in congestion of the brain. When the animal becomes diseased it must have quiet, well-ventilated quarters and be made as comfortable as possible. If partly paralyzed slings can be used to good advantage. If violent we should try to prevent its injuring itself. Bleeding, as in congestion, is useful during the early stages. The following ball may be given to the horse: Powdered aloes (6 drams), powdered ginger (1 dram), and extract of belladonna (½ dram). Cattle should receive full doses of Glauber's salts. If necessary a cathartic should be given often enough to keep the bowels open. The diet should be light and easily digested. Blisters may be applied along the side of the neck and to the poll of the head. If the weather is cold the animal must be protected and made comfortable. Large doses of powdered nux vomica or strychnine should be given if paralysis is present.

CEREBRO-SPINAL MENINGITIS

IN THE HORSE

Spasm of the neck, as this disease is sometimes called, is an inflammation of the membranes covering the brain and the anterior part of the spinal cord. It is more common in horses and sheep than in any of the other domestic animals and may occur in isolated cases, but usually as an enzoötic disease in a certain stable or country district.

Causes — This disease has been attributed to a variety of different causes. Poorly ventilated, unsanitary stables, impure food and water, and undrained lands are said to cause it. As in human pathology, the cause is said to be a specific one and the history of many outbreaks seems to point to this as a fact.

Symptoms — In its acute and rapidly fatal form it is difficult to distinguish this disease from inflammation of the brain. The animal is at first weak, staggers, swallows with difficulty, saliva dribbles from the mouth and there are twitching and cramps of the different sets of muscles. The animal is soon unable to stand, and becomes violent and delirious. The temperature may be high in some cases and the pulse small and accelerated. When the symptoms come on gradually we notice a weakness or partial paralysis of the different sets of muscles. The animal is unable to switch its tail, becomes sleepy or comatose, snores, is delirious, and has cramps of the muscles of the neck and jaw. Sometimes death takes place without the development of violent symptoms, the animal passing into a deep sleep. The duration of the disease is from one to fifteen days. The prognosis is very unfavorable.

Treatment — If the disease appears as an enzoötic in a stable, the animals should be removed to other quarters and the stable cleaned and disinfected. If in an unsanitary condition, this should be remedied. A change in the food and water supply is to be recommended. Treatment is seldom followed by success. The medicinal treatment is similar to that used in inflammation of the brain.

CEREBRO-SPINAL MENINGITIS IN SHEEP

The symptoms are generally acute. The sheep are very sensitive ; weak ; saliva dribbles from the mouth; they fall to the ground; the shoulders are bent upward and backward ; they grind the teeth, and have spasms and convulsions. Death may take place in a short time. In mild cases the disease may persist for a few weeks. The prognosis is unfavorable.

INFLAMMATION OF THE SPINAL CORD AND ITS COVERINGS

(*Myelitis and Spinal Meningitis*)

Causes — Blows and injuries to the back, fracture of the spine, exhaustion, and exposure are common causes. It may occur in such diseases as blood poisoning, influenza, and rheumatism.

Symptoms — The disease may be ushered in with a chill and the temperature may be higher than normal. The gait is stiff and back rigid; the animal may stagger, fall, and become partially or wholly paralyzed. The animal seems to suffer pain and is sometimes extremely sensitive. Small animals drag their hind parts, large animals are very often unable to stand at all and remain in a recumbent position. The disease is generally chronic, and the animal loses control of its hind parts.

TREATMENT — The animal should be given comfortable quarters and kept as free from excitement as possible. If it will eat, easily digested food should be given. If constipated a cathartic must be administered. Cold applications along the spine are recommended. The paralysis can be combated with nux vomica or strychnine. Chronic cases should be destroyed.

ECZEMATOUS DISEASES

PRICKLY HEAT

(*Heat Pimples, Summer Eruption*)

This is an eruption of the skin and occurs in nearly all domestic animals, and generally during the warm weather.

Causes — Young and thin-skinned animals at the time of shedding are especially predisposed to this affection. Local irritation to the skin from sweat, harness, and dirt is the common cause. Heating food, high feeding, and diseases of the digestive tract are the internal causes. Heat pimples sometimes occur during the course of strangles.

Symptoms — Eruption is usually limited to the region of the neck, withers, back, thighs, and shoulders, but it may invade most of the surface of the body. At the beginning the little elevations or papules may be found by passing the hand over the surface of the skin. The papule vary in size and may be as large as a pea. In some cases they become confluent and cover quite an area of the skin. They soon dry and harden and the hair becomes erect. Scabs or crusts form and adhere to the hair, and then drop out, carrying the hair along with them. Spots denuded of hair then remain. If the inflammation has not been severe this is replaced with hair of the same color. It is sometimes accompanied by a severe itching.

TREATMENT — When due to high feeding or overheating food the diet should be corrected. Diseases of the digestive tract should be treated, and if the papules occur in poorly cared for horses they should be given shelter, a good diet, and groomed every day. As an alterative, Fowler's solution (liquor arsenitis) may be given in teaspoonful or tablespoonful doses in the horse's feed three times a day. Two or three weeks is generally a long enough period to give it. Horses in high condition should be given two or three doses of Glauber's salts (½ pound at a dose) at intervals of three or four days. Unthrifty animals should be given bitter tonics and the skin thoroughly washed with a 2 per cent water solution of a creolin preparation. This should be repeated if necessary.

URTICARIA

This is an eruption of flattened, well-defined nodules, or elevations in the skin, caused by an infiltration of the deeper layers of the skin with fluid from the capillaries.

Causes—Urticaria is more common in the spring and fall than at any other time of the year and is frequently seen in fat, plethoric animals or those that are rapidly gaining in flesh. Sudden changes in the weather or food and abrupt chilling of the skin may cause it. It may occur in animals having digestive troubles. Irritation to the skin from the bites of insects will cause it. Urticaria is not attended as a rule by any marked symptoms.

TREATMENT—This consists in giving a cathartic of powdered aloes or Glauber's salts, following this for a week or more with artificial Carlsbad salts in the feed.

SCRATCHES ON THE HORSE

(*Cracked Heel*)

This is an eczema of the flexor surfaces of the limbs; its most common seat is the back part of the pasterns, in the hollow of the heel.

Causes—The causes are overfeeding, dirty stables, irritation from urine, manure, wind, dust, cold, snow, and freezing mud. Any condition leading to the filling of the limbs may cause it.

Symptoms—At first the part is hot, swollen, and tender and the animal may go lame. The part soon becomes moist, cracks from across its surface, and the skin becomes thick and rigid. In some cases portions of the skin become gangrenous and drop off. Some animals are predisposed to scratches.

TREATMENT—The first step is, if possible, to remove the cause. In overfed animals it is well to give a cathartic (Glauber's salts) and feed a laxative, easily digested diet. It is best in the majority of cases to rest the animal. The part must be kept as clean as possible. The following lotion may be applied to the part twice a day: Sulphate of zinc (¾ part), acetate of lead (1 part), water (30 parts), or, the following ointment may be used: Oxide of zinc (1 part), vaseline (8 parts); this may be applied once or twice a day. Cases that do not respond to this treatment may be washed with a 1 to 1,000 water solution of corrosive sublimate once a day, and a flaxseed poultice may be applied every evening, until improvement begins.

GREASE IN THE HORSE

This disease affects the extremities of horses and is due to a parasitic fungus. One can distinguish it from scratches by the disagreeable odor, the discharge, and the formation of thick folds and crevices in the skin, and red, raw granulation ("grapes"). It is generally due to filthy stables and is treated by washing the parts with a strong water solution of creolin or other antiseptic. When hot and tender a poultice may be applied. It is necessary to clean and disinfect the floors of the stable.

DISEASES OF THE LOCOMOTOR ORGANS

MUSCULAR RHEUMATISM

Causes — This disease is more common in the horse than in any of the other domestic animals. Cold seems to be the exciting cause. It may be caused by cold, damp, chilly weather; drafts in the stable; cold, damp stables; damp pastures or yards; sudden chilling when the animal is heated, and allowing it to stand without blanketing in cold weather. A first attack always predisposes an animal to a second.

Symptoms — The disease is usually local in the horse. In ruminants it may be generalized. The regions most commonly affected are the muscles of the shoulder and back. The disease may shift from one part to another. When generalized the animal moves about and gets up with great difficulty, and the affected muscles are sore and sensitive. In these cases general symptoms are present. When the rheumatism is located in the muscles of the shoulder the limbs are not moved freely, there is a tendency to step short with the lame member and to drag the toe. When the muscles of the back are affected there is great difficulty in getting up and down and cattle frequently take the recumbent position. In ruminants it is usually complicated with the articular form. In localized rheumatism the prognosis is favorable. In order to prevent its recurrence the exciting causes must be removed.

Treatment — When the disease is localized the principal treatment is rubbing the part for several minutes with the hand every day and the application of some mild liniment. The following liniment may be used: Spirits of camphor (10 parts), turpentine (2 parts). The following mixture may be used internally: Salicylate of soda (2 ounces), fluid extract of gentian (1 ounce), and water (enough to make an 8-ounce mixture); half an ounce can be given three times a day to horses and cattle. A febrifuge should also be given in the generalized form. Warm, comfortable quarters must be provided and the animal should not be driven or worked until the lameness is gone.

ARTICULAR RHEUMATISM

Causes—Cold and dampness seem to be the predisposing factors in this as well as in muscular rheumatism. It is very probable that the cause is of an infectious nature.

Symptoms — Articular rheumatism is a common form in cattle. It appears very abruptly and is accompanied by certain general symptoms. One or more of the articulations of the extremities becomes greatly enlarged in a very short time. The animal is lame, or stiff, feverish, and in severe pain. Where several of the articulations are involved the disease may last for several months, the animal becoming badly emaciated. Sometimes the lameness disappears, but the enlargement is permanent. The prognosis is very unfavorable.

Treatment — This is similar to that used in the muscular form. Blisters may be applied to the enlarged joints.

AZOTURIA

(*Monday Morning Disease*)

Azoturia occurs solely in solipeds and is especially common at certain seasons of the year. Plethoric horses and mules seem to be predisposed to it. In work animals it usually follows a short rest. It rarely occurs when the animal is running in the pasture or while standing in the stall.

Causes — Some investigators attribute the disease to irritation of the muscles from cold, and classify it among rheumatismal diseases. The cause advanced by most American veterinarians is an excess of proteid matter in the system, due to feeding the animal a strong ration during rest following a period of regular work. When suddenly put to work, this material, along with poisonous substances from the portal circulation, is thrown onto the system.

Symptoms — When the animal is put to work it is usually full of life; suddenly it begins to lag, goes lame, usually in the hind limbs, trembles, breaks out in a sweat, looks around toward the flanks, staggers, knuckles over in the hind pasterns, and may fall down and be unable to get up. The expression is anxious and the animal shows evidence of suffering severe pain. The symptoms may become manifest when the horse is first led out of his stall, or when first turned in the pasture. The muscles of the fore quarters are sometimes affected, but it is usually the heavy muscles of the hind quarters that are involved. The respirations and pulse are quickened and the affected muscles are hard, sensitive, and swollen. If the animal goes down it may be quite restless and have spasms. The urine is dark or coffee-colored. In most cases it is necessary to remove the urine, as the animal is unable to pass it. The paralytic symptoms may continue for several days and the animal be quite violent. In this class of cases the prognosis is not favorable. In the mild form, paralytic symptoms are not manifested and recovery takes place in a very short time. Atrophy of the affected muscles may follow. One attack predisposes the animal to a second.

Treatment — The curative treatment of azoturia is frequently unsatisfactory. The preventive treatment will give better results than the medicinal. At the seasons of the year when the animal is being worked steadily, if rested, the ration must be reduced. Horses should have access to plenty of salt and be watered regularly. As soon as the first symptoms of the disease become manifest, we must stop working the animal, blanket it if necessary, and allow it to stand until it is in fit condition to go to the stable. This precaution will often prevent the disease from becoming serious. Plenty of bedding and a good box stall are best for the sick animal, especially if unable to get up. If the urine has not been passed it must be removed, and if the horse is violent it should be given a sedative; fluid extract of gelsemium (2 to 4 drams) may be given every few hours if necessary. Nitrate of potassium (½ ounce) may be given in a ball or in the drinking water three times a day. The animal should be encouraged to drink plenty of water. To physic it, raw linseed oil may be given. If the horse will eat, it must be fed nothing but bran mashes for a few days The paralytic symptoms must be combated with tincture nux vomica (2 drams) three times a day, or strychnine, given hypodermically. Unless the patient can stand fairly well, it is useless to keep it in slings. We must make the patient as comfortable as possible, keep the bed dry and turn it over two or three times a day. Azoturia patients often require very careful nursing.

FOUNDER

(*Laminitis*)

Laminitis is an inflammation of the sensitive and very vascular laminæ of the foot. This structure lies within the horny walls of the foot; when the laminæ become inflamed the walls do not yield to the swelling and, hence, cause severe pressure on these very sensitive tissues.

Causes — Laminitis may be due to various causes. The most common are: Overfeeding, feeding grain and allowing the horse to drink large quantities of water when in an overheated condition; heavy foods as wheat, rye, etc., especially if animal is not accustomed to it; chilling of the body by cold winds; overexertion, and exhaustion. Laminitis may be associated with other diseases, as colic, influenza, rheumatism, or pneumonia.

Symptoms — The disease appears suddenly, usually in the front feet, rarely in all four feet. The pain is generally severe and the animal will try to avoid throwing weight on the affected feet. To avoid doing this, the front limbs are thrust well forward, moved very rapidly, and the hind limbs placed well under the body and most of the weight thrown on them. The animal may refuse to stand on his feet at all, or frequently they remain standing nearly all the time in order to avoid the pain caused by lying down and getting up again. The general symptoms are rapid, hard pulse, accelerated respirations, high body temperature and loss of appetite. The affected feet are hot, dry, and very sensitive to pressure. In mild cases the sensitive condition of the feet and the peculiarity of the gait, which is especially noticed when the animal is first moved or when turned, are about the only symptoms manifested. With the proper attention the disease usually terminates favorably in from four days to a week. When the inflammation becomes chronic, which it sometimes does, changes may occur in the shape and in the nutrition to the foot and the animal goes lame. One attack of laminitis will predispose the animal to a second.

TREATMENT — The preventive treatment consists in avoiding conditions that may cause the disease. If the horse should become affected, it must have a comfortable stall, free from drafts, and deeply bedded with straw. In cold weather the body should be covered with heavy blankets; in warm weather a light stable blanket is sufficient; the stall should be darkened, the animal protected from flies, and kept as quiet as possible. It is best to remove the shoes. Large flaxseed poultices may be applied to the feet and renewed once or twice a day. Nitrate of potassium may be given in from 2 to 4 ounce doses three times a day in a ball or drench. Hot or cold water fomentations are sometimes preferred to poultices; if used they must be kept up continually until the inflammation subsides. In mild cases, standing the animal in a running stream will stop the inflammation. When convalescence begins the shoes should be replaced. Iodide of potassium (in dram or 2-dram doses) in the feed is useful in this stage. A light diet should be given, a blister applied to the coronet, and in a few days the animal may be turned out to pasture. In chronic cases the feet may need careful attention. In shoeing it is best to raise the heel and slightly shorten the toe.

INFECTIOUS DISEASES OF DOMESTIC ANIMALS

STRANGLES

(*Colt Distemper*)

Strangles is an acute infectious disease associated with a catarrhal condition of the air passages and suppuration of the lymphatic glands in the region of the throat. It is most common in young horses, as one attack confers considerable immunity for the future.

Causes — The specific cause is a germ, the infection taking place by bringing a susceptible animal in contact with the diseased one, or allowing it to run in the same pasture or stable. When the disease is once introduced into a stable of horses, it will affect every susceptible animal. The predisposing causes are cold and sudden changes in the weather; for this reason the disease is more common during the cold, changeable seasons than at any other time in the year. The period of incubation (the time between the exposure and the development of the first symptoms) is from four to eight days.

Symptoms — At the beginning of the attack the body temperature is elevated several degrees and the appetite is partially lost. The respirations and pulse may be accelerated and the animal appears quite stupid. The nasal mucous membranes are at first red and dry; the animal sneezes and frequently coughs. The secretory stage soon begins, the secretions are first watery, but become heavy, purulent, and abundant, especially in young horses. The glands in the region of the jaw become hot, swollen, and painful; the animal may be unable to eat and the respirations are difficult. In a few days the abscesses that form will break, sometimes on the inside of the throat, and the symptoms may then become easier and the temperature fall to about normal. If other abscesses form the temperature may again rise. The disease may be accompanied by an eruption of nodules or vesicles on the skin. In old horses the symptoms are generally mild. In severe cases abscesses may form in different parts of the body and the animal becomes weak and emaciated and finally dies.

TREATMENT — The disease will run a definite course and can not be abated. A comfortable stall, nourishing feed, and good care constitute the principal part of the treatment. When the abscesses mature they must be opened and the cavity washed out with some antiseptic solution.

Steaming the animal will modify the inflammation of the mucous membranes. If the abscesses are tardy in forming or the glands remain thickened, a blistering ointment (powdered cantharides 1 part, vaseline 8 parts) may be applied to the region. If necessary, bitter tonics may be administered, or artificial Carlsbad salts given in the feed. We should avoid exposing susceptible animals to the disease.

INFLUENZA

(*Pink-eye, Catarrhal Fever*)

INFLUENZA IN THE HORSE

This is a well-known infectious disease of the horse, and generally rages as an epidemic in certain years. One of the most serious epidemics in this country was in the early part of the 70's, when the disease received the name of "pink-eye." The last epidemic in this country was in 1900. The disease is present at all times in the horse centers of the country.

Causes — The cause of the disease is a specific one, but the exact nature of the germ is not known. When an epidemic appears in a country it is first present in the large cities, whence it is scattered to the outlying districts. The germs are present in the breath, nasal secretions, and the excreta. Close proximity to an affected animal is not necessary in spreading the disease, as it may be carried by the harness, blankets, etc., or by the air. The predisposing causes are cold, exposure, and changes in climate. The interval between exposure to the disease and its development is from four days to a week.

Symptoms — At the beginning of the disease the temperature is high, the appetite is partially or entirely lost and the animal is greatly depressed. The horse holds his head down and acts sleepy. In different epidemics certain organs are more likely to be involved than others, so that the symptoms may differ. The respiratory mucous membranes are generally affected by a catarrhal inflammation, the respirations are quickened, and the animal coughs. The submaxillary glands may become swollen and the influenza be complicated by a pneumonia, pleurisy, or bronchitis. The eyes are frequently affected, the lids are swollen, hot, and painful and are kept closed. The secretions are at first watery, but may become purulent and the cornea and deeper tissues of the eye become inflamed. The digestive tract is commonly affected, the animal yawns, the lining membrane of the mouth is hot and dry. At the beginning colicky pains are sometimes present. The animal is sometimes constipated or may have a diarrhea. The legs and sheath usually become swollen or filled, this disappearing when the animal begins to improve. Complications frequently occur in influenza. The death rate is higher at the beginning of an epidemic than at the close. But a small proportion of the cases will prove fatal.

Treatment — When the disease is present in a locality we should avoid exposing susceptible animals to it. Horses that are bought in the market should be kept apart from the other horses for a week or two. When influenza is present in a stable the stalls, mangers, floors, and walls should be cleaned and disinfected. The treatment required for sick animals is largely good nursing and care. A comfortable, clean, and well ventilated stall should be provided and the animal fed a laxative and easily digested diet. If the eyes are affected the stall must be darkened and the following lotion injected into the eye. Zinc sulphate (8 grains), boric acid (12 grains), and distilled water (2 ounces). In most cases this is all the treatment required. If the stable is cold the horse must be well blanketed and bandages rolled on the limbs as high as the knees. In the catarrhal form inhalation of steam is very beneficial. Stimulants are indicated when the animal is greatly depressed. We may be able, by careful nursing at the beginning, to shorten the course of the disease. Colicky symptoms can be treated with tincture of opium (from 2 to 4 drams in a little linseed oil every three or four hours). If the horse is constipated a cathartic of linseed oil (1 pint) can be given. Complications are common even in mild cases.

INFLUENZA IN CATTLE

This disease resembles influenza in the horse and is apparently due to a specific cause. It generally occurs during the cold, changeable seasons and in cattle that are not provided with proper shelter. It usually affects several cattle in the herd and in a considerable proportion of cases proves fatal.

Symptoms — The respiratory passages are primarily affected. At the beginning the temperature is high, the animal is depressed and ceases to eat or ruminate. In milch cows there is a falling off in the milk. We may frequently hear the animal grinding its teeth. Complications are common and if the disease continues for several weeks the animal becomes weak and emaciated. It may terminate fatally in a few days by becoming complicated with congestion of the brain.

TREATMENT — Prevention is the principal treatment and consists in providing good quarters for the herd and isolating the sick animals. Inhalations of steam are useful in helping to allay the inflammation in the respiratory membranes. Mild liniments should be applied to the throat. The following mixture may be given: Tincture of aconite (½ ounce), tincture of belladonna (4 ounces), and water (enough to make an 8-ounce mixture), half an ounce may be given three times a day. When the animal becomes weak, stimulants may be given.

LOCKJAW

(*Tetanus*)

This is an infectious disease and is caused by a small club-shaped germ. This organism is very common in some localities and is present in the soil, dust, and stable litter. This disease occurs in all domestic animals excepting the dog, and is more common in warm than in cold countries.

Causes—The disease is due to the germs entering the body by way of a wound, generally a punctured wound, as the conditions here are very favorable for its development. In some cases the wound is so small that it is not noticed and the symptoms may manifest themselves after the wound has healed. Infection may take place through some wound in the mucous membrane lining the digestive tract. It may follow a surgical operation. The period of incubation varies from a few days to a few weeks.

Symptoms — The first symptom observed is a stiffness of the muscles. Those of the neck, back, and loins are affected at first, and when pressed on with the fingers feel hard and rigid. In breathing the ribs show less movement than normal, the head is held higher than usual and the ears are stiff or pricked, the nostrils dilated, the lips rigid or drawn back, the eyes retracted, and the third eyelid protrudes over a portion of it. The tail is slightly elevated. In most cases the muscles of mastication and swallowing are involved and the animal is unable to open its mouth and swallows with difficulty. It is usually very nervous and sensitive to noises. The gait is stiff and it stands with the limbs spread out so as to increase the base of support. Constipation usually occurs and the abdomen is tucked up. When the disease is about to terminate fatally the animal falls down, the pulse is quick and small, it breathes with difficulty, sweats profusely, the body temperature may be elevated, it struggles and has spasms. The disease may take on a subacute form with the symptoms mild. When the diet is not looked after carefully colic may occur as a complication. When recovery begins the muscles gradually relax. The course of the disease will vary. In the acute form it may terminate fatally in from one to three days. In the subacute form it may last several weeks. In sheep the disease is very acute.

TREATMENT — The preventive treatment consists in the careful disinfection of wounds, especially punctured wounds, and observing the proper antiseptic precautions in the various surgical operations. In countries where tetanus is a common disease as a result of wounds, tetanus antitoxine should be used as a preventive. The sick animal should have a comfortable box stall where it may be least annoyed by the noises about the stable. If the animal can eat, easily digested food should be given and but little roughage allowed. If the jaws are set, gruels can sometimes be given. A fresh pail of water must be left in the stall. We must avoid, so far as possible, annoying the animal with drenches. One may give bromide of potassium (1 dram every three or four hours), or chloral hydrate (2 drams every three hours) in the drinking water or feed. Fluid extract of gelsemium or cannabis indica may be given in half ounce doses three times a day. Hypodermic injections of a water solution of carbolic acid may also be used. Tetanus antitoxine is sometimes used as a curative agent.

BLOOD POISONING

(*Pyæmia and Septicæmia*)

In surgery, simple septicæmia and pyæmia are called blood poisoning. This is an infectious disease and may be due to several different kinds of organisms that gain entrance to the system by way of an extensive or badly cared for wound. The germs of pyæmia may, if conditions are favorable, give rise to abscesses in different parts of the body. In septicæmia the pathological symptoms may be due to the poisons elaborated by the germs. In most cases the two diseases exist together.

Symptoms — The body temperature is high, the animal acts stupid and sleepy and does not eat. The pulse may be small and weak. Marked nervous disturbances may be present. The local lesions are extensive doughy swellings and the wound may slough considerably and have a characteristic disagreeable, sweetish odor. If the injury is on the extremities the animal is very lame. The blood is thin, coagulates imperfectly and changes in color. Toward the latter stage of the disease the swelling may disappear quite rapidly. Fatalities are much more frequent some years than others.

TREATMENT — Preventive treatment consists in thoroughly cleansing and disinfecting all wounds and, if necessary (if the bottom of the wound is lower than its mouth), making an opening at the lowest point in order that the secretions from the cut surfaces may have an opportunity to escape. It is usually best not to close extensive lacerated wounds with sutures. Salicylate of soda or quinine may be given (in 1 or 2-dram doses) three times a day. Calomel may be given (in dram doses) once a day.

BLACK LEG

(*Symptomatic Anthrax*)

This is a rapidly fatal, infectious disease of young cattle, and is characterized by external swellings that give a crackling sound when pressed on with the fingers. The most common age at which young cattle are affected is around six months. Cattle are seldom affected after they reach the age of four years. One attack confers immunity to the animal.

Cause — Black leg is caused by a specific germ, rod-shaped and called a bacillus. It has the power of forming spores which enable it to withstand any ordinary condition, and therefore prolong the life of the germ. It is especially common on lowlands or in seasons that are warm and moist. When the disease once develops among the cattle grazing in a pasture it is apt to again develop in following years if the season is a favorable one. The germ enters the body by way of a wound in the skin or the mucous membrane of the mouth or intestines. The period of incubation for this disease is from one to five days.

Symptoms — The disease runs a very short course and is attended by a very high mortality. The fever is high, there is a loss of appetite, the animal becomes stupid, and exhaustion rapidly follows. Swellings may develop on different parts of the body. Their outline is very distinct and the swelling seldom goes below the knee or hock. The animal is lame in the affected quarter. At first these swellings are very sensitive, but become cold, insensitive, and gangrenous toward their centers, and when cut into are dark colored and contain gas. The blood is black, tarry, and slow to coagulate readily.

TREATMENT — Medicinal treatment is of little benefit. Prevention is the only satisfactory treatment. In localities where the disease is common, the black leg vaccine should be used on all the younger animals each year. When this is practiced, the loss is insignificant. Dead animals should be burned, or buried so deeply with unslaked lime that there will be no chance of infection from the cadaver.

ANTHRAX

(Charbon)

This is an infectious disease that, no doubt, has existed for many centuries and is very widely distributed. It may occur in any part of this country, but it is only in the southern section of the United States (lower Mississippi Valley) that it occurs from year to year. The disease is more apt to occur in sheep and cattle than in any of the other domestic animals.

Cause — Anthrax is caused by a rod-shaped germ which in the presence of oxygen forms spores. It is called the *Bacillus anthracis*, and sometimes several are arranged together so as to form chains. The germ itself is readily destroyed, but the spores are highly resistant to outside conditions. The organisms gain entrance to the body by the intestinal tract, the skin, and the lungs and air passages. The most common route is by way of the intestines, the animal becoming affected by eating forage grown on infected fields, the spores on the surface of the ground becoming attached to the grass or grain; if by way of the skin, the germ enters through a wound or bites of insects; if by way of the lungs, it is due to the inhalation of dust containing spores. Man may become affected by handling the carcasses of animals that have died from this disease.

Symptoms — This disease may take on several forms. In the apoplectic form the symptoms are acute, and the animal, in a short time, dies in a convulsion, from cerebral apoplexy. There is generally a bloody discharge from the mouth, nose, and anus. This form is common among sheep and cattle. In the acute form the disease lasts somewhat longer. The animal has a high temperature, is restless, has convulsions, grinds the teeth, staggers, becomes insensible, and dies. The respirations may be accelerated and difficult, the heart palpitates, and the animal pants and groans. The mucous membranes of the head become dark colored, the animal has convulsions and dies from suffocation. Bloody discharges may occur from the body openings.

In the subacute form the course of the disease is longer and the symptoms are about the same as in the acute form, but more clearly marked. It may run an intermittent course and last from one to three days.

The carbuncles or swellings of the skin that sometimes appear are at first hard and painful, but later become cold and painless. The diagnosis of the disease is based on the symptoms, autopsy, and bacteriological examination. The death rate is from 70 to 100 per cent.

Treatment — It is not advisable to attempt curative treatment. Preventive treatment is important. As soon as the disease occurs in a herd all the animals should be vaccinated with the anthrax vaccine. We must avoid scattering the disease over pastures and roads by dragging the anthrax carcasses over them. They should be burned as near the spot where they died as possible. If buried there is a danger of the spores working to the top of the ground. The spot on which the animal lies must be thoroughly disinfected.

HYDROPHOBIA

(Rabies)

This is one of the oldest known diseases. Erroneous opinions about the cause of the disease are held by some people, and by others it is not considered a specific disease. It does occur, however, and its true character should be better known. Dogs, cats, horses, cattle, sheep, goats, and pigs are the domestic animals chiefly affected, and man, when bitten by a rabid animal, generally a dog, may develop the disease.

Causes—The specific cause of rabies is not yet known. The virus is contained in the brain, spinal cord, nerves, glands, and their secretions, and is transmitted by the bite of a rabid animal. The time that may elapse from the bite to the development of the disease varies in the different species of animals. It may vary from seven days to one year, but the usual time is from twenty to seventy days.

Symptoms—Rabies occurs in two forms, the *dumb* and the *furious*. The furious form is the more common. The symptoms differ somewhat in the different species.

In the dog the symptoms are divided into three stages: melancholy, rabid or violent, and paralytic. The first stage lasts from twelve to forty-eight hours, the behavior of the animal is altered, it becomes swollen, irritable, and nervous. Sometimes it is quite friendly. It may have a tendency to gnaw or swallow indigestible objects. Frequently the bite seems to itch and it will bite and lick it. Slight difficulty in swallowing, labored respirations, fever and constipation are sometimes noticed. The second stage may last four days. The violent or rabid symptoms are manifested, and the dog will leave home and take long journeys. It may move quite rapidly and generally does not return home. It acts strangely and shows an inclination to bite, snapping at persons, animals, and imaginary objects, and biting sticks or anything held toward it. The bark is peculiar, the appetite is lost, and the patient very rapidly becomes emaciated. In the third, or paralytic stage the dog is usually greatly emaciated and disfigured. The lower jaw drops, the tongue is lolled, and the eyes are sunken and glassy. Paralysis of the hind parts may be present. Death takes place in a short time.

In the dumb form the first two stages are absent and the paralytic one predominates. Death occurs in a few days, usually during a convulsion.

In the horse the symptoms come on quite rapidly and the course of the disease is short. Some animals become aggressive, and lacerate and mutilate their bodies. They are nervous and look about as if attracted by strange sounds. The bite is often the seat of an intense itching. The efforts to bite and kick are well directed and the animal may at times try to drink or eat. The dumb form may occur in the horse.

Cattle butt with the horns and sometimes show a tendency to bite. They bellow more than usual and the sexual desire is increased. They are not very aggressive. The course is longer than in the horse. Finally the paralytic symptoms manifest themselves and the animal frequently falls down and is unable to rise for a few minutes. Patient usually becomes greatly emaciated.

Pigs are restless, squeal, dig up the litter, and exhibit a desire to bite. Other symptoms are about the same as those already given.

The diagnosis is determined by the character of the symptoms shown by the affected animals and the inoculation of susceptible animals (rabbits, usually) with a portion of the spinal cord of the dead animal.

The disease is incurable and the affected animals should be destroyed. When rabies appears in a neighborhood all the dogs in that section should be tied up until all danger is over. In the human patient the disease is amenable to the Pasteur system of treatment. Madstones are condemned as worthless, in so far as any curative effects are concerned, by all medical authorities.

GLANDERS

(*Farcy*)

Glanders of the horse has been known since ancient time and has long been regarded as a contagious disease. It is present in all parts of the United States, but has grown less common within recent years. All solipeds are susceptible. Men, when exposed to infection, may contract the disease.

Cause — The specific cause of glanders, *Bacillus mallei*, was not known until 1882. The germs are present in the secretions from the nostrils and the ulcers that may be present on different parts of the body. These discharges may become deposited upon the feed troughs, mangers, stalls, harness, buckets, watering troughs, and feed. It may be conveyed in this way to other animals or by direct contact. Frequently, however, the healthy animals escape infection for months. It is usually the diseased animal's mate or the one that stands in an adjoining stall that is first affected. Catarrhal diseases predispose horses to glanders, as the normal resistance of the mucous membranes is thereby in part overcome. The most common route by which the germs enter the body is by way of the respiratory tract. The germs may enter the body by inoculation through a wound in the skin, or through the digestive tract.

Symptoms — There are two forms of the disease, the *chronic* and the *acute*. Acute glanders rapidly ends in death. The chronic form develops slowly, may last for years, and sometimes becomes acute. This is the more common type. The most frequent seat of the disease is in the respiratory organs, lymph glands, and skin. The early stage of the disease usually escapes notice. The first symptom is a nasal discharge of a dirty-white color from one nostril or from both. This is usually small at first, and sometimes intermittent, but becomes quite abundant. The discharge is very sticky, and adheres to the hair and skin. Nodules and ulcers appear on the nasal membrane. These may be high up and escape observation. The ulcers are very characteristic, are angry looking, with ragged raised margins and, when they heal, leave a puckered scar. The submaxillary glands are enlarged and, at first, more or less hard and painful, but they become nodular and adhere to the jaw or skin. Nodules and ulcers, known as "farcy buds," may form on the skin, usually on the hind limbs and under part of the abdomen; the lymphatic vessels are swollen and hard. The animal loses flesh rapidly, does not stand hard work, and the limbs usually swell. When the disease is acute, the animal has a fever, is stupid, does not eat, and may have a diarrhea. In this form the lymphatic glands suppurate, and the animal becomes emaciated. Mules usually have the acute form of the disease.

In the chronic form it is sometimes difficult to diagnose the disease. The ulcers on the nasal mucous membrane and elsewhere are very characteristic and, when present, enable one to form a diagnosis. A bacteriological examination of the nasal discharge also may be made. Mallein, a product of the germ when grown artificially, is a help in diagnosing obscure cases. When injected beneath the skin of a suspected animal, it causes a rise in temperature and a hot, characteristic swelling at the point of injection.

Treatment — Curative treatment is not to be recommended. The protective treatment is to stamp out the disease wherever found by killing all affected animals and disinfecting the stables, harness, or anything else that has been used around the affected animals.

TUBERCULOSIS

(*Consumption*)

Tuberculosis is a very widespread disease and is of great concern to the stockman. Cattle are by far the most susceptible to the disease. Pigs, sheep, and horses are only occasionally affected. The disease exists in all parts of the United States, but is more common in the Eastern States than in any other section. In European countries and in Canada a larger proportion of the cattle are affected than in this country. Tuberculosis has been known to exist in cattle for centuries, laws restricting the use of the flesh of such animals for food having been included in the Jewish code. It was not until 1882 that Koch discovered the germ that causes the disease.

Causes — The specific cause of the disease is the *Bacillus tuberculosis.* Unsanitary conditions favor the spread of the disease in a herd, so that we would expect to find fewer animals affected where these sanitary conditions are perfect or nearly so. Animals having a low resisting power are predisposed to it. This is noticed in the different breeds of dairy cattle. Infection takes place by healthy animals herding or stabling with diseased ones, and frequently the disease is introduced by the purchase of a single diseased animal. The tubercle bacillus may enter the body by four different routes: By way of the respiratory tract, the digestive tract, or the genital passages and through a wound in the skin. The most common modes of infection are by inhalation and taking the germs in with the food. The disease is frequently transmitted to the calves through the milk of tuberculous cows. In adults infection probably takes place by their licking each other, by taking in the germs with the food and water, and by inhalation of dust containing the dried virus. In pigs infection is due to drinking the milk of tuberculous cattle.

Symptoms—Tuberculosis usually runs a chronic course lasting for years and frequently without visible symptoms. At other times it takes on the acute form, the symptoms are marked, and death may occur in a few months or weeks. The symptoms vary with the different organs that are affected and the species of animal. In advanced pulmonary tuberculosis there is a short, dry cough, especially noticeable when the animal moves around, and when it drinks; the respirations are quickened and the mouth is sometimes held partly open; chronic indigestion may be manifested, the appetite decreases, the coat is rough, the eyes sunken, and the animal is weak and emaciated. By auscultating one gets no sounds over the solidified areas of lung tissue. If we hear a decided blow we suspect a cavity. Friction sounds are frequently heard. If the lymphatic glands are affected we may find enlargements under the throat and at various points under the skin. If the udder is affected there is a gradual enlargement and hardening of the quarters, but this condition is not painful. Abscesses may form and discharge through the teats or break on the outside. If there is tuberculosis of the genital organs of the cow she will come in heat more frequently, will not become pregnant so readily, and in some instances will be sterile. Abortion may be common in a dairy herd having tuberculosis. There may be some nasal discharge in tuberculous cattle. In cold weather they may chill after drinking cold water; in hot weather, when moved about, they may pant. Usually they become very thin, the neck becoming wedge-shaped and clean-cut and the space back of the shoulders depressed. Cattle frequently maintain a good appetite and stay in good flesh if well cared for. The extent to which the disease may progress without producing more profound symptoms is astonishing.

During the first stages, the disease can not be detected by a physical examination. Certain symptoms may be manifested, but they are like those seen in other diseases. In the latter stages of the disease we can express an opinion with some certainty. A physical diagnosis then must be based upon a number of definite symptoms and a general history of the disease.

The most certain and only practical method of diagnosing is by the application of the tuberculin test. Tuberculin is a product of the tubercle bacillus and is obtained by growing the germ on bouillon. When this is injected into the tissue beneath the skin in tuberculous animals it causes a characteristic rise in temperature. *Tuberculin is germ-free and can not produce tuberculosis.*

The post-mortem lesions are very characteristic. Scattered through the diseased tissues are the tubercles, which may vary in size from that of a mustard seed to that of a grape, and when cut into usually contain soft, yellow, cheesy matter. When several of these nodules are close together they may unite, break down and form abscesses. Sometimes the tubercles contain a gray pus, or if of long standing become infiltrated with lime salts and are gritty. Masses of tuberculous material weighing many pounds may be found in the lungs and liver of advanced cases. No tissue of the body is exempt from the disease.

Suppression of Tuberculosis Among Cattle—In foreign countries, since the application of the tuberculin test, tuberculosis has been found to be more widespread than one would formerly have believed. In well kept herds it may appear as an innocent disease at first, but it is sure in the end to cause serious financial losses, as well as a continual menace to public health. The greatest loss falls on the farmer and stock raiser, but until these classes become educated to this fact they presumably will continue to take no interest in the suppression of the disease. Sick or suspected animals should be isolated or slaughtered; stables should be disinfected and kept as sanitary as possible. The milk of diseased animals should not be fed unless it is boiled; only those cattle that have been proved by the tuberculin test to be free from tuberculosis should be retained on the farm.

HOG CHOLERA AND SWINE PLAGUE

Hog cholera is not an old disease in the sense of having been known and described for a long time, as have glanders and anthrax, nor is it a new disease, as outbreaks occurred as long ago as 1833–1840 in the Middle and Southern States. Swine plague was not recognized as a separate disease until about 1890. The total loss to the swine industry from the two diseases has been enormous.

Causes — There is a specific germ for each disease. Hog cholera is caused by the bacillus of hog cholera, and swine plague by the bacillus of swine plague. The two germs differ in size, shape, activity, method of growth, resistance to outside conditions, and their effect on the body. The hog cholera germ is larger, more active, and is better able to resist outside conditions than the swine plague germ. *When a hog is inoculated with cholera germs the intestines are affected; if inoculated with swine plague the lungs are affected.* There are other differences one might mention, but these are sufficient to satisfy the general reader. Swine plague germs are widely distributed, but are not harmful unless their virulence is increased or the resistance of the animal diminished by certain conditions. The germ may become virulent, if conditions are favorable, spreading to other farms the same as the germ of hog cholera. This latter organism is not usually present and must be introduced from diseased herds. There are secondary or predisposing causes that are of great importance.

Injudicious management and unsanitary conditions are factors of the same importance here as in some of the other infectious diseases. Among the agents which may carry the germs are streams, wind, birds, dogs, persons walking from one farm to another, buying hogs from infected cars, and exhibiting at fairs. The time that elapses between the infection of the herd and the appearance of the first symptoms of the disease varies from four to twenty days. In hog cholera the virus is taken into the system with the food, by inhaling it along with the air and dust, and sometimes through the surface of a fresh wound. The swine plague virus is generally inhaled along with the air.

Symptoms — Cholera assumes several different forms and, therefore, one is frequently unable to recognize any specific set of symptoms. In the acute form the course is rapid; running from a few hours to two or three days; in the subacute form the course is from three days to a week, and in the chronic form from a week to a month or longer. The symptoms as here described are for the more common cases, that live from three to seven days. About the first symptom to be observed is a general droopy condition; the eyes are more or less closed and dimmed, the ears drop more than usual, there is a certain amount of sluggishness, and, although the hog eats, it is not with the greediness that is customary. The appetite becomes depraved and the animal will eat clay, earthy substances, and the droppings from other hogs or from chickens. The hog lies about more than usual, hiding in fence corners, under litter, and in out-of-the-way places. If he should have access to a manure pile, that will be a favorite place. During the hot days he will prefer to lie in the scorching sun rather than in the shade. At first he will respond to calling for feed, but later he will not get up unless urged to do so. During the progress of the disease and sometimes from the very beginning, there will be pronounced rheumatic symptoms. The hog will be lame first in one leg and then in another. The back will be arched. Diarrhea usually makes its appearance with the onset and is almost always present at some time during the course of the disease. The discharge at first is thinner than normal, but very rapidly becomes tarry and has a characteristic odor Constipation may occur and is almost sure to be present in those animals that eat earth. Vomiting is also present. There is rapid emaciation. The fever is high and the breathing rapid, but not labored.

In acute cases death occurs so suddenly that the symptoms may not be developed. In the chronic type, the ears and tail swell and crack, and sometimes drop off. Ulcers and sores may form on various parts of the body. Portions of the skin may become dry and gangrenous, and crack, the hair dropping off.

In swine plague the cough may be the first symptom. It is noticed when the pig first gets up or after exercise. The breathing is short and rapid, with a jerking of the flanks. It soon becomes more labored, the throat swells, and the nose may bleed. Pressure on the ribs causes pain. The eyes are inflamed and watery, and constipation may be present. Swine plague is particularly common among old hogs. The course is usually longer than in hog cholera. Both diseases may be present in the same animal.

Diagnosis—The history of the outbreak will help in making a correct diagnosis. We may be able to differentiate between the two diseases, hog cholera and swine plague, by noting the symptoms, and by making an autopsy. In nearly all cases of cholera the post-mortem lesions are so characteristic that one should be able to recognize the disease. Red blotches are seen on the skin. The spleen may be enlarged. The intestines show inflammatory changes. Ulcers varying in size from that of a millet seed to that of a dime are seen in the cæcum and other parts of the digestive tract. These ulcers are especially common in the region of the opening from the small intestine into the cæcum (ileo-cæcal valve), and are quite characteristic in appearance. The edges project above the surface of the membrane, the ulcer may be irregular in shape and is of a reddish, brownish, or yellowish color. Hemorrhagic spots may appear in the different organs The lymph glands are hemorrhagic, red, or enlarged. Swine plague germs may cause red patches also. The primary organs affected are the lungs and a bronchitis, pneumonia, or pleurisy may be present. In hog cholera the lungs are not usually affected.

TREATMENT — The preventive treatment is to admit no hogs to the general herd that have been purchased from unknown sources, at sales, or from stockyards, or exhibited at fairs, without quarantining for twenty days. Keep the hogs in comparatively small pens, so that the disease may not be distributed over the whole farm. Separate the well from the sick and not the sick from the well. Give plenty of comfortable shelter and room to prevent crowding. Above all secure good well water, from a driven well, and allow no wallows. Give the hogs plenty of water to drink and withhold all feed for a few days to a week. They will not starve. When beginning feed again use only sloppy food, as bran and meal mashes. Allow only small quantities at a time. Avoid green corn or wheat. If the bowels are constipated use calomel to move them. With these attentions to care and diet, as much can be accomplished as by elaborate medicinal treatment.

All litter should be kept cleaned up, all carcasses promptly burned or buried with quicklime in order to limit the duration of the infection.

It is to be hoped that some method of prevention and cure will soon be discovered, but in the meantime cleanliness is the essential.

LUMPY JAW

(*Actinomycosis*)

This is an infectious disease and may affect cattle, horses, and swine. It is generally local in character, affecting the bones or soft parts of the head, but may involve other parts, as the lungs or intestinal tract. It is very widely distributed.

Causes — Actinomycosis is produced by a vegetable organism of a somewhat higher order of life than the bacteria and called the *ray-fungus*. The germs grow in colonies and can be seen in the diseased tissues or the pus from an actinomycotic abscess as spherical bodies about the size of a grain of sand, yellow, white or dark in color. They are made up of a large number of filaments that branch out around a central portion like the spokes of a wheel. The fungus is found originally on plants and enters the body in various ways, supposedly, as a general thing, through an abrasion of the lining membrane of the mouth, or of the skin, through diseased teeth or ducts of glands, and by inhalation.

Symptoms — The disease is characterized by tumors or abscesses, usually in the region of the jaw The tumor may involve only the softer tissues, or affect the jawbone, causing enlargement and later honey-combing, finally breaking down and discharging pus. When the tongue is affected it is swollen and painful, and prehension and mastication of the food are frequently impossible. When the larynx or pharynx is the seat of the disease, breathing and swallowing are difficult and painful. Actinomycosis of the lungs may present the appearance of a chronic affection of those organs. Other internal organs may become affected, but these cases are rare. In generalized cases the usual course is slow emaciation and death. These tumors are quite common in cattle, and one has little difficulty in diagnosing the disease. In doubtful cases a microscopic examination of the pus or of a section of the tumor may be necessary.

TREATMENT — When the tumor is small and external, it may be dissected out or laid open and tincture of iodine or Lugol's solution injected into it. From one to two drams of iodide of potassium should be given internally in the feed or drinking water every day for two or three weeks. One should not be sparing in the use of the drug if improvement does not follow. This treatment is a specific and, unless the disease is general and the animal weak, will result in a cure. In the large abattoirs, unless the disease is generalized, the carcass is not condemned, only the affected part being rejected.

PARASITES

PARASITES OF SOLIPEDS

INTESTINAL WORMS OF THE HORSE AND MULE

Intestinal worms are generally seen in young or weak and debilitated animals. Horses running in pasture are frequently affected by them. The following varieties may be found in the intestines of the horse:

Large Round Worm (*Ascaris megalocephala*) — This is a large round worm, yellowish white in color, and from 4 to 12 inches in length, sometimes much longer, and varying in thickness from that of a straw to that of a lead pencil. They are rigid-looking worms, tapering toward the ends; at the anterior extremity one can see three well-developed lips. They are common in the small intestines of the horse.

Pin Worms (*Oxyuris curvula*) — These parasites are slender worms from 1 to 2 inches in length, and partly transparent or white in color. They are very common parasites of the horse, and are present in the posterior part of the intestinal tract. They are often seen projecting from the anus or fixed to its margins.

Varieties of the flat or tape worms may be found in the intestines, but are not common. Other varieties of round worms may also be present.

Symptoms — When large numbers of round or pin worms are present in the intestines they may give rise to certain symptoms, such as colicky pains, itching, unthrifty condition, constipation, diarrhea, and depraved appetite. In thrifty, well cared for animals they do but little harm. Pin worms in particular may cause some annoyance by their irritation to the walls of the rectum or anus.

TREATMENT — In poorly cared for, unthrifty animals better care and bitter tonics constitute part of the treatment. Injections of soapsuds will assist in removing the pin worms.

EXTERNAL PARASITES OF THE HORSE AND MULE

Biting Lice (*Trichodectodes*) — The biting louse is the most common external parasite of the horse. It is most troublesome during the winter, and in colts and horses that are roughing it or running out in pasture. In poorly cared for, unthrifty animals it may do considerable harm.

Symptoms—Animals infested with this parasite have a very rough, ragged looking coat, and on the neck and around the base of the tail, or wherever the lice are abundant, the hair may be rubbed off in their attempts to rid themselves of the annoyance.

TREATMENT—It is very easy to rid an animal of lice. A thorough washing with a 2 per cent water solution of some of the coal tar products is generally sufficient. It is best, however, to repeat the bath in about a week. During the cold weather one must guard against the animal catching cold. The stalls and walls of the stable in which the animal is kept should be whitewashed or sprayed with an antiseptic wash in order to prevent infection.

Sucking Louse (*Hæmatopinus*)—This is not so common a louse as the preceding variety. Its principal seat is at the mane and near the base of the tail. It gives rise to very much the same symptoms as the biting louse. The treatment is the same as for the former variety.

Mange in Horses, Texas Itch (*Sarcoptic Scabies*)—Mange is not a common disease of the horse and occurs principally on the range. Native horses may become infected with this parasite by coming in contact with animals brought from infected herds. Itch is due to a mite that burrows into the skin forming galleries in which it deposits its eggs. The disease exists in both the warm and cold weather. The itching is greatest at night.

Symptoms—The principal symptom at first is an intense itching, to allay which the animal rubs himself against posts or the sides of the stall. Little papules appear on the skin, in small patches at first, but gradually spread; crusts form at the base of the hairs and cause matting. The hair finally drops out and large dry patches are formed, covered with debris and crusts. Sores may be seen on different parts of the body, due to the animal rubbing and scraping itself in trying to relieve the itching. One may find the mites in the crusts on the affected parts.

TREATMENT—Washing the infected animals with a strong solution of any of the coal tar products will destroy the parasites. About a 4 per cent watery solution is sufficient. It is usually best to repeat the wash in about one or two weeks after the first application. We must take certain precautions against reinfecting the animals by washing the harness, stalls, mangers, and walls of the stable with an antiseptic wash.

PARASITES OF CATTLE

INTESTINAL WORMS

Cattle are seldom affected with intestinal parasites. Several varieties may be found, including varieties of tape and round worms. The large round worm, the *ascaride*, is found in calves. It is reddish white and from 5 to 10 inches in length. This parasite causes some irritation in the intestines and may give rise to symptoms of indigestion.

Treatment — One teaspoonful of turpentine may be given in the milk for a few days. To large calves a tablespoonful may be given.

Lung Worms (*Verminous Bronchitis*)—Verminous bronchitis in calves is not uncommon. It is due to a small thread-like worm, *Strongylus micrurus*, from 1½ to 2 inches in length. This disease may exist as an enzoötic in a drove of calves.

Symptoms—If the parasites in the bronchial tubes are not present in large numbers the symptoms are mild and develop slowly. The cough is broken and husky and may come on in paroxysms, in one of which the animal may die. In coughing the animal may expel mucus containing worms. The animal presents a very unthrifty appearance, the appetite is impaired or lost, the eyes are sunken, and the animal is weak and may become greatly emaciated. The disease is most severe during the cold weather and usually runs a long course, the calf gradually becoming weaker, or it may finally become strong enough to throw off the disease. In poorly cared for animals the prognosis is unfavorable.

Treatment — Infection takes place by the calves running on infected pastures, especially during the spring and early summer. We must keep the diseased calves separate from the healthy ones and avoid turning the latter into infected stables or pastures. The lungs of animals dying from the disease must be destroyed and we should try to limit the infection to as few pastures as possible. The principal treatment for sick animals is summed up in good quarters, good care, and plenty of nourishing food. Bitter tonics may be given if necessary.

EXTERNAL PARASITES OF CATTLE

Long and Short Nosed Cattle Lice—These are the two common varieties of lice found on cattle. By irritating the skin they impair the thriftiness of the animal, especially when poorly cared for. They are most noticeable in the winter.

Treatment — Lice on cattle are hard to destroy, and if found must receive prompt and thorough treatment, which is the same as recommended for the horse.

Ring Worm, Barn Itch — This is an affection of the skin caused by a vegetable parasite, *Tinea tonsurans*, and is a common skin affection among young cattle in the winter and spring. It is readily transmitted from one animal to another.

Symptoms—Patches of the skin on the head and neck are most commonly affected. The skin is first slightly inflamed, vesicles may form, followed by the formation of scaly, brittle crusts. The affected areas are gray in color and denuded of hair. The part itches, and the animal is frequently seen scratching it. In a few months the affection may disappear without any treatment.

Treatment — The stables and sheds should be whitewashed or disinfected in order to destroy the spores scattered around by the crusts. The affected skin areas should be washed thoroughly and the scales removed. Sulphur ointment may then be rubbed on the part once a day.

PARASITES OF SHEEP

PARASITES IN THE STOMACH AND INTESTINES

Twisted Stomach Worms (*Strongylus contortus*) — This is a very common parasite of sheep, found in the fourth stomach. It is a very small, thread-like worm about ¾ inch in length, usually reddish in color and present in large numbers. This parasite is widely distributed and is especially common on low, wet pastures and in wet years.

Symptoms — The symptoms are first manifest in the lambs and it is not until early summer that they begin to show evidence of the disease. The animal acts dull and lags behind the flock. The ears drop and the animal looks unthrifty. Later it is affected with scours, becomes badly emaciated and weak, stands with arched back, and walks with stiff gait. The skin is pale and dropsical swellings appear under the jaw or on the neck. The usual termination is death.

TREATMENT — The sheep usually becomes infested with stomach worms by grazing on infected pastures. Permanent sheep pastures are common sources of infection. The preventive treatment consists in changing pastures and destroying the parasites in the old sheep by administering a vermicide. If this is practiced the number of lambs lost from this cause will be greatly lessened. One should begin the treatment early in the disease. The cause can be determined by destroying a sick lamb and examining it carefully. Various remedies are proposed. The most common drench is turpentine (1 ounce to 16 ounces of milk, the dose being 2 to 4 ounces, repeated once a day for three days). Better results have been obtained with the following recipe: Coal tar creosote (1 part), wáter (99 parts); the dose is from 2 to 4 ounces. It need not be repeated as in the turpentine treatment. In drenching, some advantage results from keeping the sheep in the standing position.

Intestinal Parasites — Two forms of tape worm and several varieties of round worms are commonly found in sheep. These intestinal round worms generally seem to cause but little harm, but no doubt they add to the unthriftiness of the animal when it is affected by the stomach worm. The tapeworms cause heavy losses in the Western States, but are seldom seen east of the Mississippi River, except in animals shipped in from the West.

TREATMENT — The treatment for the stomach worm is usually sufficient to drive them out. If a water solution of coal tar creosote is used, the effect on the intestinal worms will be greater if from 30 to 80 grains of thymol are added to each dose after it is measured out.

Nodular Disease — Nodular disease of sheep is caused by a very small worm (*Œsophagostoma columbianum*). In the larval stage it becomes lodged beneath the lining membrane of the intestines in tumors varying in size from that of a millet seed to that of a hazel nut. It is one of the most common intestinal parasites of sheep.

Symptoms — These are not characteristic. Usually the sheep are debilitated and have diarrhea, or the opposite condition, constipation, may be present. The disease is easily diagnosed by making a post-mortem examination. Small tumors are found in the mucous membrane of the intestines. The contents of the largest are cheesy in character and of a greenish color. The affection is most noticeable in yearling sheep while on dry feed in the winter.

TREATMENT — The treatment is wholly preventive. It consists in avoiding, if possible, the pasturing of sheep on undrained and permanent pastures, and destroying the adult worms by administering a vermifuge. As soon as possible put the sheep on rye or wheat pasture, or feed roots. The nodules will disappear the following spring and summer.

EXTERNAL PARASITES OF SHEEP

The Sheep Tick (*Melophagus ovina*)—This is a very common external parasite of sheep. It is about $\frac{1}{4}$ inch in length, of a reddish or gray brown color and easily detected if present in any number on sheep. Ticks, abundant on sheep, cause unthriftiness. Upon lambs the damage is greater, and if not relieved, may result in death. The immature form of the tick is seedlike and brown, and adheres to the wool or skin.

TREATMENT—Ticks are easily destroyed by dipping. This should be done as soon after shearing as possible, as it is then that the ticks leave the old sheep and attack the lambs. Any of the coal tar preparations make effective dips, as this parasite is easily destroyed.

Common Scab—This disease is caused by a small animal parasite, the itch-mite (*Psoroptes communis*). These mites are small, almost white in color, and about the same size as the dot over the letter *i*. If scabs and wool from an infested sheep are placed upon a black surface and in the warm sunlight one may see the mites crawling about. The scab mites live on the exudations from the skin caused by their bites. The bite causes irritation and considerable exudation, which dries, forming crusts. The parasites live under the crusts and scabs thus formed. The female deposits her eggs on the surface of the skin, to which they readily stick. Each female lays from fifteen to twenty eggs, which become mature parasites in about a week. This period may be longer under unfavorable conditions.

Symptoms—The first symptom noticed is the uneasiness of the animal. The presence of the mite causes an intense itching, which the sheep attempts to relieve by scratching, biting, and rubbing itself. The fleece soon becomes "taggy," owing to the loose locks of wool that have been pulled out of the affected areas on the back and sides of the sheep. If we examine the surface in these regions the infested spots are seen to be covered with little elevations that give the skin a whitish or yellowish appearance. These patches gradually increase in size, the wool drops out, and the skin becomes thickly covered with scales and scabs. The mites soon abandon the center of the scabs, which gradually heal and the disease slowly progresses on the margins of the spots. When badly infested the sheep becomes weak and emaciated, and if much of the fleece is lost the animal is unable to withstand cold weather.

Treatment — The treatment is both preventive and curative. The preventive measures consist in guarding against infesting the flock by quarantining all newly purchased animals unless satisfied that they are free from scab. The curative treatment consists in using some good dip, allowing the sheep to stay in the bath a sufficient time for it to soak through the crusts and destroy the parasites, and again dipping in about ten days in order to kill those that have hatched from the eggs. The tobacco dips are to be preferred. After dipping, the sheep should be put into fresh quarters, and the old quarters cleaned and disinfected by spraying the floors and walls with the dip. The old quarters should not be used again for sheep for at least six weeks.

PARASITES OF SWINE

INTESTINAL PARASITES

Thorn-headed Worm (*Echinorhynchus gigas*) — This is a large worm, from 2 to 8 inches in length. Its body is cylindrical, wrinkled, curved, and about the thickness of a lead pencil. The anterior extremity is armed with a proboscis surrounded with several rows of hooks. It is by means of this proboscis that the parasite attaches itself to the walls of the intestines. The home of this parasite is in the small intestines but it may migrate to other parts of the alimentary tract.

Large Round Worm (*Ascaris suilla*) — This worm is from 3 to 5 inches in length, the body is white, smooth, and tapering toward the extremities. It is a very common parasite of swine and inhabits the small intestines. It may be found on other parts of the tract.

Pin and Whip Worms (*Œsophagostoma dentatum* and *Trichocephalus crenatus*) — These parasites inhabit the large intestine, especially toward its anterior extremity. The pin worm is small, about ½ inch in length, white, straight, and pointed at both ends. The whip worm is very slender and hair-like at the anterior portion, posteriorly it is thicker. It is about 1½ inches long and white in color.

The habits of swine are such that they are predisposed to all forms of intestinal parasites. In pigs these parasites are more common than in older animals. In unthrifty pigs they are usually present in large numbers. From half a dozen to a dozen of the thorn-headed worms may be present in one animal. The round worms are usually present in larger numbers.

Symptoms — Thorn-headed worms are said to cause loss of appetite, constipation, diarrhea, restlessness, emaciation, weakness of the loins, and in young pigs convulsions and death. The symptoms attributed to the round worm are depraved appetite, unthriftiness, and restlessness. When present in large numbers they may cause obstruction of the intestinal canal.

Treatment — This is the same for all varieties of intestinal worms. One teaspoonful of turpentine per hundred pounds of body weight may be given in the milk. This may be repeated the following day One teaspoonful of a mixture of equal parts of powdered worm seed and areca nut may be mixed with a little corn meal and fed to the animal. Santonine (5 grains) and calomel (2 grains) may be given in the swill or feed. This dose should be repeated.

KIDNEY WORM IN SWINE

This worm is from $\frac{3}{4}$ to $1\frac{1}{2}$ inches in length, dark colored, and pointed at both ends. It is found principally in the tissues around the kidneys, but it may be found in other parts of the abdominal cavity. Swine breeders attribute a weak back or paralysis of the hind parts of swine to this parasite. Post-mortem examinations do not bear out this theory, as it is seldom found in animals in this condition.

BRONCHITIS IN SWINE

The parasite causing this trouble is the *Strongylus paradoxus*. It is from $\frac{3}{4}$ to $1\frac{1}{4}$ inches long, very slender and whitish or brown in color. It is rather a common parasite in pigs. The female lays a number of eggs, which may be expelled by coughing and undergo a part of their development outside of the animal body. The pig probably becomes infested by drinking surface water or rooting in the mud.

Symptoms—The bronchial tubes may become more or less inflamed and the inflammation may extend to the lung tissue and cause small patches of pneumonia. In some cases a large portion of the lung tissue may become affected. The first symptom is a cough that may occur upon leaving the bed, after exercise, and after eating. In badly infected cases the paroxysms of coughing are quite severe, and the condition may be such as to be mistaken for swine plague. In most cases the pig is unthrifty, but is usually able to overcome the disease.

TREATMENT—The treatment is preventive. The pigs should be removed from the infected pasture and should have pure water Nourishing food and good care will help the pig to overcome the disease.

EXTERNAL PARASITES OF SWINE

Hog Louse (*Hæmatopinnus suis*)—This is the largest member of the louse family. The favorite points of attack are along the lower part of the neck, under and behind the forelegs, and on the belly. The itching is often severe, especially in young hogs, and may cause urticaria.

TREATMENT—The louse is easily killed and at little expense. The method of treatment should depend on the number of hogs to be treated. Where the drove is small, the hogs can be driven into a pen and sprinkled or sprayed with a 2 per cent solution of some of the coal tar products or a little kerosene. If a large number are to be treated, crude petroleum, a cheaper material, can be used. If a dipping vat is used, an inch or two of the crude petroleum may be poured on the surface of the water and the pigs driven through it. The hog houses and pens must be cleaned or the hogs will become reinfested from them.

BOT-FLIES

The bot-fly is important because the larval form is a parasite in the different species of domestic animals. The bot-flies form a distinct family and are easily recognized both in the larval and adult stages. The body of the fly is heavy and usually hairy, the head large and the eyes prominent. During the warm, bright, sunny days they can be seen flying around the animals and depositing their eggs or larvæ in places whence they can readily gain access to the proper part.

The body of the larvæ is segmented, thick, and fleshy. It is found in various parts of the body of its host — in the digestive tract, under the skin, in the sinuses of the head, and sometimes on the surface of the brain.

BOT-FLY OF THE HORSE

This fly (*Gastrophilus equi*) is about $\frac{3}{4}$ inch in length, the body is hairy, and its general color brown, with black or yellowish spots. The female fly is the one generally seen. It hovers near the horse and when ready to deposit its egg, it darts toward the animal and fastens the egg to the hair. These eggs are yellow and in horses running in pasture may be so plentiful that the entire part takes on a yellowish tinge. The eggs hatch in from two to four weeks. The hatching of the larvæ is aided by the animal licking the part. At the same time the larvæ are transferred to the mouth and thence they pass to the stomach. As soon as the larva reaches the stomach it fixes itself on the walls of that organ, remains there until late the following spring, and when fully developed loosens its hold and passes out with the excrement. The next stage, the pupa, lasts for several weeks and is passed in the ground; then the pupa is transformed into the fly, ready to deposit its egg.

Symptoms — Unless the "bots" are present in large numbers in the stomach, they cause no appreciable symptoms. It is only in old, unthrifty, poorly cared for horses or in colts running in the pasture that they are at all numerous. They cause injury to the horse by irritating the walls of the stomach and obstructing the free passage of food; by drifting along the intestines and becoming attached to the walls of the rectum, they may cause great irritation. The symptoms shown by the horse are those seen in indigestion. Irritation to the rectum is manifested in the usual way.

TREATMENT — The treatment is principally preventive. This consists in destroying the eggs before the escape of the larvæ by washing the infested parts with a 2 or 3 per cent water solution of carbolic acid, or rubbing the hair lightly with kerosene. Other methods by which the eggs can be destroyed are by clipping the hair from the part or scraping off the eggs with a sharp knife. This should be done every two weeks during the time the fly is about. Remedies for the destruction of bots in the stomach should be used with considerable care. Prevention is the most successful method of treating them.

There are other species of the horse bot-fly, but the one just described is the common bot-fly of this country.

BOT-FLY OF THE OX

This species (*Hypoderma lineata*) is the common bot-fly of cattle in this country. It resembles a honey bee in appearance, is about ½ inch long, and its general color is black. A portion of the front part of the body is covered with long, whitish hairs, and the upper part of the head, the thorax, and a portion of the abdomen, together with the legs, are covered with brownish black hairs. The fly appears during the warm months of the year and deposits its eggs on the lower portions of the body and the extremities. The act of depositing the eggs causes a great deal of annoyance and sometimes terror to the cattle.

Nature of the Injury and Symptoms — On the large ranges, during the spring and summer months, these flies annoy and excite the cattle and interfere with their fattening. The annoyance from the larvæ must be greater than that caused by the adult fly, as the former produce a great amount of inflammation in the surrounding tissues during their development within the animal's body. The larvæ reach the mouth in the same manner as in the horse, by the animal licking the part. It then penetrates through the walls of the anterior part of the alimentary tract, and wanders through the tissues of the body until finally it reaches a point beneath the skin of the back. Here it develops rapidly, and can be felt as a small tumor. Finally it works its way out through the hole that it has made in the skin, drops to the ground, and in from three to six weeks develops into the adult fly. Besides the damage caused by the annoyance to the animal, the loss every year in the hides amounts to a very large sum.

Treatment — Some of the preventive measures recommended are not practical when applied to cattle in general, such as housing the cattle or applying substances to the surface of the body that will prevent the female from depositing the eggs. A better way is to destroy the grubs either by closing the opening in the skin through which they breathe with mercurial ointment or a little kerosene, or by pressing on the skin in such a way as to squeeze the "grub" out and destroy it. This may be done as early as January or as late as March.

BOT-FLY OF THE SHEEP

This fly (*Œstrus ovis*) is greatly dreaded by sheep. It resembles an overgrown house fly and has a brown appearance. It is quite lazy, flying about but little.

Symptoms — The fly makes its appearance in June or July and deposits live larvæ in the nostrils of the sheep. The larva works up the nostrils and finally reaches the sinuses of the head. Here it attaches itself to the lining membrane until developed. It then passes down to the nostrils, drops to the ground, buries itself, and in forty or fifty days becomes a mature fly. During its stay in the sinuses of the head it causes great annoyance to the animal. A catarrhal inflammation of the membranes is generally present. Nervous symptoms may be manifested, the appetite lost, and the animal quite weak. Frequently the animals die.

Treatment — The most practical method of treating this disease is by using preventive measures. First, by providing shade in the pastures, and, second, by tarring the noses of the sheep every few days during the summer months to prevent the fly from depositing the larvæ. Valuable animals may be treated by trephining into the sinuses and so removing the grubs.

WOUNDS

CLASSIFICATION AND MODES OF HEALING

Classes of Wounds — Whenever any part of the body is injured by a mechanical cause to such an extent as to cause the severing of the tissues it is called a wound.

If the injury is of such a character as to cut the parts clean, as with a sharp knife, it is called a *cut* or *incised wound.*

If the parts are severed but the edges of the wound more or less ragged or torn, as when cut with a barb wire, it is called a *torn* or *lacerated wound.*

If the wound be produced by some pointed object, as a nail, sharp splinter or fork tine, the opening small and deep, it is known as a *punctured wound.*

If the object causing the injury is large and blunt and the tissues are injured but not torn, it is a *bruise* or *contused wound.* In the latter variety there may be no injury to the skin or even to the superficial tissues, but the contusion may be deep seated, at a point where the tissues meet with the greatest resistance from the bone.

Sometimes wounds are given special names, as gunshot or poisoned, but these only indicate the manner in which they were inflicted, or some special character. They may also receive a special name from the region involved, as open joint. For all practical purposes wounds may be considered as cut or incised, torn or lacerated, bruised or contused, and punctured.

Method of Healing — No matter how clean-cut a wound may be, there is always some destruction of tissue and the parts do not return to exactly the original place. In a clean-cut wound this destruction of tissue is small and the tissues when brought together may unite at once. Healing under such conditions is said to be by *primary union.* This form of union rarely occurs in the lower animals. Practically, it never occurs excepting after a surgical operation and then only when the greatest care has been used to secure cleanliness and the exact bringing together of the parts.

The common method of union is known as *healing by granulation.* In this case nature throws out small granulations between the gaping edges of a wound or over its surface, and these granulations finally develop into the same kind of tissue as that from which they originated, grow together, and thus make the necessary repair. At times the weak granulations on the surface and the exudations thrown out may coagulate and a hard surface is formed known as a *scab.* Healing then takes place under the scab. Other methods of healing may occur, but practically all wounds heal by the methods just described.

Where wounds heal by the first method, or primary union, there is no appreciable scar, for the reason that so little new tissue has been formed. Where wounds heal by granulation there is a scar of greater or less magnitude, as the new tissue which replaces that destroyed is not the same in character as the original.

The rapidity with which wounds heal will depend upon the kind of tissue injured, the amount to be replaced, the degree of motion in the part, the infection and irritation, and the general condition of the animal. In general, skin and muscles heal rapidly, tendons often quite slowly, cartilage poorly, and nerve tissue very slowly. Healing is interfered with by motion. The more nearly absolute rest the better the result. Healing by primary union is seen only when no pus is present; the more pus, the slower the healing process. Irritation by biting, licking, bandages, or dirt retards rapid union. Finally, an animal in poor condition physically, or one kept under unfavorable conditions, can not make a rapid recovery from an injury.

TREATMENT — Wounds in domestic animals may heal without attention. It is fortunate that such is the case, but this does not make it less desirable that one administer proper treatment and thus decrease the chance of a bad result or lessened value of the animal. The time to begin treatment is as soon after the accident as possible, but the method of treatment will vary according to the character of the wound.

If there is serious hemorrhage, the first step in the treatment is to check it. Serious bleeding ordinarily does not occur, owing to the fact that the ends of the vessels are so injured that a clot quickly forms. Stockmen often become alarmed, without sufficient reason, when an animal is cut. It requires the loss of a very considerable quantity of blood in the larger animals to constitute a serious hemorrhage. For bleeding from small blood-vessels, the wound may be bathed with hot water (from 115° to 120° Fahr.) Cold water may be used in the same manner, but is not so useful as when hot. The better method of stopping a hemorrhage is by the compress bandage, wherever it can be applied. A good one can be made by cutting cheese-cloth into strips about 4 or 5 inches wide and 20 feet long. A pack of jute or oakum should be applied directly to the surface of the wound and the bandage applied over this. It may be necessary, where the bleeding is from a good-sized vein or artery, to bandage the part heavily, allowing the bandage to extend some distance above and below the injury. Physicians and veterinarians have forceps, needles, and thread for the purpose of checking hemorrhage from medium-sized and large-sized vessels, but they are not always available. Other methods that can be used are the actual cautery and medicines which, when applied to a cut surface, constrict the vessels. What should be avoided in all cases is the use of road dust, puff-balls, cobwebs, and dirty rags. These all contain germs which may infect the wound, retarding healing and even causing blood poisoning. It is well for every stockman to prepare for accidents of this kind and keep on hand some clean, soft material that can be torn into bandages when needed.

The cleansing of the wound is an important step in the treatment. Pure boiled water is to be preferred for this purpose. The hair should be clipped along the margins of the wound, the detached or torn shreds of skin or tissue cut off, and the wound cleansed with a 2 per cent water solution of carbolic acid, creolin, or any of the other antiseptics or disinfectants. If necessary, the parts around the injury should be washed with soap and water, and if we suspect the presence of a foreign body (splinters, etc.) they should be looked for and removed. If the secretions that afterward form do not drain off properly, but pocket on the inside of the wound, an incision in the tissues should be made, lower down if possible, and proper drainage secured. A wound having a deep non-draining pocket on the inside may permit the escape of pus along the muscular sheath and cause extensive suppuration or death.

In domestic animals healing is impeded by a bandage, and it is better to leave the wound uncovered. If a bandage is used it must be changed twice a day, a clean one being used each time, and the wound dressed.

Deep and gaping wounds may be drawn together with stitches or sutures. In clean-cut wounds, parallel to the muscular fibers, this is indicated. In lacerated wounds, if the direction is across the muscular fibers, or if one can not control the motion in the part, stitches are apt to tear out and may do far more harm than good.

In the after treatment of the wound we must resort to agents that will destroy or retard the growth of the germs and at the same time not irritate the tissues. There are any number of such agents, but the two liquid disinfectants that are most satisfactory for general use are carbolic acid and creolin. Crude preparations resembling creolin are sold as sheep dips and are quite cheap. In general the strength of the wash for wounds should be 2 parts of the disinfectant to 98 parts water. The best dry antiseptic dressings are boric acid, calomel, and acetanilid. Equal parts by weight of boric acid and calomel makes a good dressing. The best means of applying powders to the surface of a wound is with a small insect-powder blower. In dressing the wound we should first wash it with the antiseptic wash, taking care not to injure the granulatious, and remove all the pus and foreign matter that may have collected on its surface. A syringe or small piece of cotton may be used in applying the wash. A fresh piece of cotton should be used each time the wound is dressed. After cleansing it, the dry dressing may be applied. The length of time that may elapse between the dressings will depend on the condition of the wound. At first it may be necessary to treat it once or twice a day. Later, when healing begins, it will require less attention. If the hair and skin around the wound become soiled with the discharge, it should be washed off with soap and water and vaseline rubbed on the part. When a scab forms and no pus is discharged, cease dressing it. Sometimes, as soon as healing begins, the animal will lick and bite the part. If this is the case the horse must be confined in such a way that he can not get at the wound.

In poorly cared for wounds granulations may pile up and form immense, hard, easily bleeding tumors. The whole limb may swell and become two or three times the natural size. Excessive or unhealthy granulations must be kept in check from the very beginning, as later they are difficult to control. Pure carbolic acid applied with a small swab is sufficient to destroy them if not too advanced. A good wash for a wound that is not granulating as it should, is zinc sulphate and lead acetate (1 ounce of each) in water (1 quart). In some cases it is necessary to cut off the granulations with a sharp knife, down to a level with the surrounding skin. A red hot iron may also be used.

The general treatment of punctured wounds does not differ from that of other wounds. The opening should be enlarged and the proper drainage secured. It is impossible to judge the extent or the probable consequence of this kind of injury. We must examine the wound carefully for foreign bodies and if present remove them. Punctured wounds most often occur in the foot. The tissues here are hard, yielding but little to swelling, and the pain is severe. The opening of such wounds should be enlarged, taking care not to remove too much of the horn, and washed once or twice a day with an antiseptic wash. This will insure the proper cleansing and drainage and thus tend to a speedy repair and greatly diminish the dangers of tetanus and blood poisoning.

Wounds of the joints are always serious and are usually punctured. At the earliest possible moment the wound should be cleansed and a blister applied at once to cause swelling and thus check the escape of the synovia. If the joint becomes infected, inflammation will follow, the part becomes badly swollen, the pain is severe and the articulation may be destroyed. It is very necessary that the part should be kept quiet even if a cast or splint needs to be applied. The swelling that may occur sometimes remains for months. It may be reduced and sometimes driven away by the frequent application of blisters

HARNESS INJURIES

Causes — In horses not accustomed to heavy work the skin over the parts having to bear most of the weight is tender and easily irritated. The colt suffers worst. A large proportion of the injuries are due to ill-fitting harness. A harness, when not adjusted properly, may distribute the load unevenly, thereby injuring the parts on which the most of the weight is thrown. If the surface of the leather coming in contact with the skin becomes covered with sweat and dirt, making it rough and hard, it will act as an irritant to the part. The character of the work, too, is a factor; heavy work over rough ground, or fast work, especially if the animal goes about it awkwardly, is likely to cause sprains and bruises.

SORE NECKS AND GALLING

These are the simplest forms of injuries and are quite common on the farm when the rush of work begins in the spring. When horses are not hardened into work, we must keep in mind the fact that the skin on the shoulders and back is tender and easily inflamed. Especially is this true of the colt, but the older animals are not exempt from it and preventive measures should be used until the animal becomes accustomed to the work. The harness for each animal should be properly adjusted, cleaned, and oiled. One set should not be made to serve for several different horses, and especially is this true of the collars. Galling may be prevented to a certain extent by stopping and lifting the collar or saddle every hour or oftener and rubbing the skin with the hand. Bathing the skin every noon and evening will also do much toward preventing galling. If the animal is cared for in this manner until the skin becomes hardened to the work, it will keep in better condition and be able to do more work throughout the season. A green horse should not be worked steadily or made to do heavy work at first.

TREATMENT — Zinc and smooth leather pads will not only prevent but often cure sore necks or saddle galls. Felt pads are useful, but should always be made dry and soft before putting them on in the morning. Sometimes a pad may be so adjusted as not to rest on the sore spot. Such adjustment should be made with care and judgment, lest the misfit cause strain or undue pressure on some muscle. Bathing the inflamed skin with the following lotion will harden it and reduce the inflammation: Lead acetate (4 ounces), zinc sulphate (3 ounces), water (1 gallon); the parts should be well sponged with this lotion on coming in from work at noon and in the evening. If sores are present the following preparations are useful: Tannic acid (1 ounce), carbolic acid (1 dram), glycerine (4 ounces); mix well and apply to the sore once a day; or, calomel (4 drams), boric acid (4 ounces), tannic acid (1 ounce), mix and dust on the part once or twice a day.

"SIT-FASTS"

A sit-fast is generally due to wearing a collar that is too short and too tight at the top. Too much weight on top of the neck may cause it.

TREATMENT — The treatment consists in removing the cause and cutting out the sit-fast. If this is not done the neck may continue sore and the horse will sometimes become disagreeable to handle. To encourage the separation of the sit-fast or "core" from the healthy tissue and to reduce the inflammation, a hot flaxseed poultice should be applied to the top of the neck. It is well to renew the poultice every three or four hours during the day by dipping it in hot water. In a day or two the sit-fast can be removed. The after treatment is to keep the part clean and use dry dressing.

ABSCESSES

Abscesses on the shoulder are due to an unequal distribution of weight by the collars, the parts becoming bruised and the abscesses developing as a result.

TREATMENT — Abscesses must be promptly opened and the contents allowed to escape. The opening must be large — at the lowest part and well to one side, so that the collar will not rest on the small scar that will result. The abscess should be washed out every day with an antiseptic wash, until healing begins, and after that at less frequent intervals. The opening should not be permitted to close until the abscess has filled in from the bottom. The animal should not be worked, at least not in a collar until the healing is complete. A breast harness may be used temporarily and the horse made to do light work.

TUMORS

Tumors of the skin and muscles of the shoulders are caused in the same manner as the abscesses and sometimes result from abscesses that are not cared for properly. Tumors should be dissected out and the resulting wound treated in an antiseptic manner.

SPRAINS

Sprains are common in horses doing heavy work. Green horses, when made to do heavy work over rough ground soon become tired, pull awkwardly, and are very liable to a strain. When an animal has a sore shoulder, he may pull sidewise to avoid pressure on the part; thus, the weight will be distributed unevenly, and a sprain will often result. Unequal distribution of weight from an ill-fitting harness may also cause it. Sprains of the shoulder are frequently serious. The animal may not be very lame, but the muscles of the shoulder become atrophied, or "sweenied," in the more common expression.

TREATMENT — Sometimes the animal is lame as well as "sweenied." In this case it should be placed in a warm stall as long as the lameness continues. In bad cases it is best not to take the animal out for any purpose, but to carry all water and feed to him. Sometimes it is good policy to tie the animal so that he can not lie down in the stall, as the getting up and down may be such an effort as to retard recovery. Nervous animals do better when turned out in a yard or in a small pasture by themselves.

SHOULDER SLIP

This is nothing more than a sprain of the shoulder muscles and should be treated in the same way.

TREATMENT — The following liniment should be used: Oil of turpentine, aqua ammonia, and linseed oil (equal parts); or, spirits of camphor (10 parts), oil of turpentine (2 parts); apply to the part once a day. The latter liniment is a mild one, and considerable friction should be used in applying it. To help fill out atrophied muscles and treat a sprain of long standing, a blistering ointment (1 part powdered cantharides to 8 parts vaseline) should be used.

SPRAINS OF TENDONS AND JOINTS

These are treated in about the same manner as sprains of muscular tissue. Repair does not take place so rapidly, however, and sometimes will require very careful treatment.

TREATMENT — Rest is essential. When in a region where a plaster cast can be applied, great benefit is derived from it. Other lines of treatment are hot and cold applications. These should be used until the inflammatory stage is passed, and then counter irritation from a blister or the firing iron can be applied.

CHOKING

Foreign bodies in the pharynx or œsophagus of animals may be due to penetration of the mucous membrane by sharp objects swallowed, to the attempt to swallow objects too large to pass down, or to foreign bodies becoming crossed in the gullet. If the animal eats greedily and swallows the food hastily it may choke. Sometimes choking results from a paralysis of a portion of the gullet or a constriction in its walls that will not allow the food to pass along the canal. Frequently a dilation or sac-like distention occurs just in front of the constriction.

Symptoms — The animal stops feeding, may cough and salivate, and has an anxious look. If the choke is complete it is unable to drink water, and if it tries, the water will be discharged from the nostrils. The respirations may be hurried and difficult. In ruminants bloating may occur. Foreign bodies in the neck portion of the gullet may be detected with the hand, by pressing on the part. In cattle death may take place in a few hours. In horses the symptoms usually develop more slowly. When the choke is incomplete the symptoms may not be marked.

TREATMENT — Foreign bodies in the upper part of the gullet and in the pharynx in cattle can be removed with the hand. In the larger domestic animals one may be able to gradually force the body back into the mouth by pressure with the hands just below the object. Mucilaginous drinks, as flaxseed tea, oil, etc., may be given. These may prove a source of danger, however, by passing into the air passages, causing a pneumonia. In most cases it will be necessary to resort to the probang. This iustrument is for the purpose of pushing the obstruction on down the œsophagus and into the stomach. The probang is easily passed in the ox, but in the horse the operation is more difficult and will reqnire the assistance of the veterinarian. Broomsticks, rakes, or fork handles should never be substituted for the probang. The injury to the parts as a result of their use will often prove fatal. As a substitute for a probang in cattle a piece of ordinary garden hose, well oiled, may be used. The head should be well extended on the neck and held as quiet as possible. In cattle it may be necessary to puncture the rumen with the trocar and cannula and remove the gas.

DISEASES OF THE REPRODUCTIVE ORGANS

INFLAMMATION OF THE WOMB

(*Metritis*)

Causes — This may be caused from injuries to the womb at the time of parturition, dirty instruments or hands used in assisting in delivery, and from retention of the fœtal membranes. Unless antiseptics are used, this complication is of frequent occurrence in difficult cases of parturition.

Symptoms — The inflammation will vary in intensity, depending upon its extent. If all the coats including the peritoneum are involved the symptoms are quite severe. The temperature becomes elevated, pulse small and quick and the respirations hurried and shallow. The pain is often severe, the animal grinding the teeth and showing evidence of colicky pains. Constipation is present at first, but gives way to diarrhea. There is abundant foul smelling discharge from the vulva The larger animals remain standing but finally become weak and lie down. Death usually occurs in from two to six days in fatal cases. It may terminate in a chronic inflammation (*leucorrhea*).

Prevention — The prevention consists in using the utmost care in securing cleanliness in all obstetrical operations. In difficult birth and in all cases where it is necessary to remove a dead fœtus or membranes, the womb should be washed out with an antiseptic solution (creolin 2 parts and boiled water 98 parts). The same antiseptic wash twice a day should be used in any case of inflammation of the womb. The following may be given to reduce the fever Acetanilid (2 ounces) and quinine sulphate (1 ounce); mix and divide into eight powders. Give one powder every three or four hours. If the animal is constipated a cathartic may be given. Tonics and good food must be allowed until recovery takes place.

INFLAMMATION OF THE VAGINA

Causes — Vaginitis generally accompanies inflammation of the womb. It may follow difficult parturition, owing to injury of the parts by manipulation with the hands or instruments.

Symptoms — When the vagina alone is inflamed the symptoms are not well marked. The parts are redder than normal, more or less swollen, and when the animal passes water there is evidence of pain. Ulceration and sloughing sometimes follow. The general symptoms are similar to those of metritis. In mild cases recovery takes place without treatment. It may become chronic and a discharge be kept up continuously.

Treatment — The treatment consists in washing the parts with an antiseptic solution, the same as used in inflammation of the womb.

STERILITY

Causes — Sterility may be temporary or permanent, and may be due to either the male or female. In the male it may be a functional trouble due to some condition that prevents copulation, or to an absence of spermatozoa. In the female it may be due to obstruction at the os uteri or neck of the womb, to failure to ovulate, or to a chronic diseased condition of the uterus, causing secretions that destroy the vitality of the male element. Other causes in both are abuse of the generative organs, bad hygiene, insufficient exercise, and overfeeding. Hybrids are nearly always sterile.

Treatment — The treatment will depend upon the cause. If due to unhygienic conditions or to overfattening, as is often the case with show stock, these should be corrected. All animals should have a reasonable amount of exercise, but should not be overworked. The male should not be permitted to copulate too frequently. If the trouble be due to obstruction at the mouth of the womb, this should be dilated. This operation is usually not very difficult. The introduction of the oiled hand will nearly always suffice. Occasionally surgical means are necessary. If there is chronic disease, this must be treated as already indicated for inflammation of the womb. Stimulating drugs are of less service than is usually attributed to them.

LEUCORRHEA

This is a chronic inflammation of the mucous membrane of the vagina or womb, and associated with a whitish discharge.

Symptoms — The discharge may be white, glutinous, and odorless, or it may be chocolate colored and foul smelling. The tail and hind parts are usually soiled with it. The discharge may be continuous or intermittent. In mild cases the health is not impaired, but the animal is usually barren, or if it does become impregnated is quite likely to abort. Loss of appetite and unthriftiness occur in severe cases.

Treatment — The disease, if not of too long standing, will yield to treatment quite readily. The use of the following wash is advisable: Permanganate of potash (2 parts) and boiled water (98 parts). Inject twice a day and keep up the treatment for several weeks or until the secretions become normal. The 2 per cent creolin solution will answer very well.

CONGESTION AND INFLAMMATION OF THE UDDER

Congestion of the udder is more common in the cow than in any of the other domestic animals. The most common cause is incomplete milking or milking at irregular times. It may be due to obstruction of the milk duct. Other causes are injuries, as from running or being stepped upon by the stable mate; infection from germs; and cold. Congestion may lead to active inflammation.

Symptoms — The udder is swollen, tense, and hard This may be limited to one-quarter or a half, or may involve the whole gland. The secretion is diminished and may be streaked with blood. At times it may be lumpy or coagulated. This condition will pass away in a short time or may go on to inflammation, the symptoms becoming more intense. The udder becomes swollen, hard, and painful. The milk from the affected quarters is changed. The general symptoms are loss of appetite, dullness, increase in temperature, and rapid pulse. The udder is hard and pits on pressure. Recovery takes place very quickly in the mild form, but in the severe cases abscesses sometimes form and a portion of the gland is destroyed.

Treatment — Milk out the gland at frequent intervals. Apply a camphorated ointment over the affected part twice a day, and in mild cases this will be all that is necessary. In the more severe cases hot applications to the udder for several hours, or until the inflammation has subsided, will be found the best treatment. If the milk becomes mixed with pus it is advisable to wash out the udder with a weak solution of creolin, using a milking tube to which is attached a syringe, or a few feet of rubber tubing carrying a funnel at one end. If abscesses form they must be opened and drained the same as in any other part of the body. The following mixture is very good in relieving a sore, hardened condition: Vaseline (4 ounces), camphorated ointment (2 ounces), extract of belladonna (½ ounce); mix and rub on the gland for about five minutes daily.

Another preparation is linseed oil (4 ounces) and spirits of turpentine (4 ounces) rubbed on in the same manner.

SORE TEATS, SCABBY TEATS

Causes—Any irritation of the teats will cause them to become sore and scabby. During cold weather the wetting of the teat in milking is a common cause. Filth also may cause it.

TREATMENT—An ointment of vaseline (10 parts) and acetate of lead (1 part), rubbed on the sores after milking, will give good results. One or two drams acetate of lead to a pint of water also will answer.

MILK FEVER

(*Parturient Paresis*)

This affection occurs in the cow, especially in heavy milkers in good condition. It occurs most often after the third, fourth, and fifth calving. There are many theories to account for the disease, the latest being that it is a form of self-poisoning as a result of unusual work thrown on the milk-secreting cells.

Symptoms—This affection generally sets in between six hours and three days after calving. The cow stops eating or ruminating, becomes uneasy, switches the tail, stamps the feet, and sometimes strikes the abdomen with the feet. There is more or less trembling at first and finally the animal will go down. Attempts will be made to rise, and at first with partial success. The paralytic symptoms become more prominent, the animal becomes stupid, throws the head from side to side in a half conscious manner, and finally draws the head up to one flank and remains unconscious. There is no movement of the bowels or from the bladder. The temperature is not increased, or only slightly. In the natural course the animal may make a sudden recovery after a few days or may linger along for five days or a week and die. The cases occurring shortly after calving are more unfavorable than those occurring the second or third day.

TREATMENT—The treatment is much more successful now than formerly. The udder must be emptied and washed clean. A dram of iodide of potassium is dissolved in a quart of boiled water, and by means of a milking tube and a piece of rubber tubing and funnel it is introduced into each of the four quarters of the udder. The urine should be drawn with a catheter. Along with this treatment we may administer tincture of nux vomica (about 2 drams) three times a day. No attempt should be made to give large drenches. In emergency the udder may be injected with sterile water alone. If improvement is not noticed within twelve hours the operation should be repeated. Unless the udder and teats be carefully washed, the milking tube clean, and the water boiled, the udder may become inflamed.

RETENTION OF AFTERBIRTH OR FŒTAL MEMBRANES

This accident is more common in the cow than in any of the other domestic animals. In ruminants the membranes are firmly attached to the walls of the uterus by a large number of cotyledons. In the mare the attachment is uniform and not nearly so firm, so that it comes away shortly after birth. Retention is most frequent after abortion, especially after contagious abortion. Abnormal adhesions between the maternal and fœtal membranes may occur, or occasionally a lack of sufficient expulsive energy may cause its retention.

Symptoms — The symptoms are so marked that a mistaken diagnosis is seldom made. Usually more or less of the membranes hang from the vulva, the tail and hind parts are more or less soiled, and decomposition begins early, causing an offensive characteristic odor. If only a portion of the membranes have been retained, decomposition will begin in a few days and a shreddy discharge will occur. In many cases the membranes will all be discharged in about a week, and but little harm will result. In the more serious cases there is loss of appetite, with weakness, and the animal is generally sick. When retention occurs in the mare the condition is more serious than when it occurs in the cow.

Treatment — The most successful method of removing the afterbirth is with the hands. The objection to other methods is that they are too slow, that a part may be left behind and give rise to trouble. One should not wait longer than one or two days in the cow, and in the mare but a short time after birth before removing the membranes, as the mouth of the womb may contract and imprison them. The operator should take special precautions to thoroughly wash off the parts with antiseptics (as a solution of creolin) and to use plenty of antiseptics and oil on the hand and arm. Loosen and remove the membranes with as little manipulation as possible, and work quickly. After the membranes are removed the uterus should be well washed out with a 2 per cent watery solution of creolin. *The operator must learn by experience not to mistake the large cotyledons on the walls of the uterus for a part of the afterbirth.*

PROLAPSUS OF THE VAGINA

This accident occurs in pregnant animals, especially cows, toward the latter part of pregnancy or after parturition. The exciting cause is usually standing or lying in stalls that are lower behind than in front. Pasturing on hilly ground may also have the same effect. The tissue connecting the walls of the vagina with the walls of the pelvis may be lax and the heavy uterus, pressing back, displaces the vagina. Prolapse of the uterus may also occur after a difficult parturition.

Symptoms — In slight cases the prolapsus occurs only when the animal lies down. At first it appears as a small, round tumor the size of an egg within the lips of the vulva, and afterward may become the size of the fist. At first the parts do not protrude outside the vulva, but as the ligaments relax more and more the protrusion becomes greater. When the animal rises the parts return to the normal. In aggravated cases they do not return, but gradually protrude more and more, become irritated, and the surface denuded. Voiding the urine is interfered with and if the condition has been present for many hours the bladder will be greatly distended. This is an accident that is likely to recur after apparent recovery.

Treatment — The first essential in preventing this accident is to have level floors for the cows and shallow gutters to receive the manure. Replacement treatment should follow the accident as early as possible. Draw the urine with a catheter and replace the protruding part by careful, direct pressure. If the case is of moderate degree, tie the animal in a narrow stall and place sufficient litter under the hind feet to raise her at least six inches above the forefeet. Keeping the animal in such a stable for a few days may suffice. In animals that strain badly it is advisable to place several strong deep sutures in the skin on each side of the vulva and across it after the vagina has been replaced. A cord tied tightly around the body just in front of the udder will tend to prevent straining.

ABORTION

When pregnancy is terminated by an early delivery, so that the young is unable to live, it is termed an *abortion*. If delivery occurs at too early a date, but the young is alive and can live, it is called a *miscarriage*.

Causes — Abortion may be due to improper methods of handling or feeding, to too severe work, to accidents, and to acute and general diseases. Some females seem to have a predisposition to abort. There is also a form of abortion that is infectious or contagious and due to a specific germ. When introduced into a herd it usually causes a large proportion to abort, and it requires considerable time to stamp it out. Mares are also subject to an infectious form of abortion.

Symptoms — The symptoms of abortion vary and depend upon the period at which the accident occurs as well as on the cause. If occurring in the later period of pregnancy and caused by an accident, the symptoms are well marked; if due to contagion or occurring in the early period of gestation, there may be little to indicate that anything is amiss. When due to contagion abortion nearly always takes place between the third and the seventh month, in the cow, and from the fourth to the ninth month in the mare. In the contagious form the act is usually easy, the fœtus slipping away with so little evidence of labor that the cow often pays no attention to it. If the membranes do not come away with the fœtus they soon disintegrate and are discharged a little at a time, keeping the hind parts soiled. If the accident occurs on pasture, the recurrence of heat may be the first intimation of its occurrence. After abortion from contagion the cow may have an unnatural rutting of a very exciting or violent character.

Abortion due to accident is nearly always accompanied by more or less labor pain, as the parts are unprepared and rigid. The animal gives evidence of sickness. The fœtal membranes are more often retained until they pass away as a discharge. Leucorrhea is a common complication.

TREATMENT — The prevention consists in not exposing animals to conditions that will cause abortion. Cows should be excluded from pastures where there are steers, or where there are deep ditches; they should have reasonable protection; and spoiled ensilage or moldy food should be avoided. When the disease has been determined to be of a contagious nature, all aborting animals should be separated from the healthy and a rigid course of disinfection should follow. The fœtus and placental membranes should be burned, the buttocks and tail washed free of all soiled material, using a strong carbolic or creolin solution. The vagina should be washed out with an injection of a 2 per cent creolin solution. This should be repeated daily for two weeks. The cows should not be permitted to breed for at least three months and then should be given a treatment a few days before breeding as a precautionary measure. The male should be washed out to avoid carrying the infection from one animal to another. This treatment has proved successful in our hands in a number of herds. Of the untreated non-aborting cows in a herd, a large proportion aborted the second year, while of those treated only a few aborted.

LAMENESS

Good legs are essential in a good horse, and the value of the animal depends largely on the condition of his extremities and their ability to do the work for which they are intended. This fact is frequently overlooked by experienced horsemen, who pay more attention to general form and action than to sound legs. Imperfect conformation may not interfere with a horse's usefulness, but if he be unsound in one or more of his limbs his capacity for work is greatly diminished, the degree depending upon the degree of the lameness or defect and the character of the work.

Locating the Seat of the Lameness—Lameness is not a disease but a symptom, and greatly assists us in diagnosing the injury. The seat of the injury may be in a muscle, tendon, bone, or ligament. The degree of the lameness will vary, depending on the location and the character of the injury. When slight or hidden more skill may be required in diagnosing or locating it than the average horse owner possesses. Such cases require the services of a competent veterinarian.

Two points are involved in the diagnosis: (a) the identification of the lame leg and (b) the locating of the disease. When there are local lesions, as a bony enlargement, swelling, or inflammation, or if the action be characteristic, diagnosis is not difficult. The majority of cases are not so simple, but require systematic examination in order to determine accurately the point involved.

Examination—It is usually best to examine the animal under as many different conditions as possible; while standing, at rest in the stall or on level ground, when moved at a walk, at a brisk and at a slow trot, when resting after exercise, or when moved after a brief period of rest. While the horse is being subjected to these different conditions the examiner should observe very closely every movement of the animal, and at the same time remember that negative symptoms of lameness in a part are almost as valuable in forming a diagnosis as are the positive symptoms.

If a horse rests either front foot when standing at ease, it indicates some soreness in the rested member. It is not uncommon, however, for a horse when standing quietly to rest a front and a hind foot of opposite sides, or rest the hind feet alternately. This is natural.

When a front foot is carried forward in a position of "pointing" or is held more or less suspended, the front or the toe of the foot resting on the floor, a soreness in some part of the limb is indicated.

When a hind limb is affected it may be flexed or extended, the weight resting on the toe or the front part of the wall of the foot; sometimes it is held clear of the ground.

If both front feet are affected the animal may stand with the front feet forward, "pointing," and the hind ones well under the body.

Aftêr observing the horse when at rest we should next examine him while in motion. This is the more important part of the examination, and is best done when the harness or blanket is removed and the animal is led with a loose halter and at a slow trot over a level road. The attendant should allow the animal full freedom of his head and trot him toward the observer as well as away from him.

After making observations from these two positions the horse's movements should be studied from the sides. The effort of the animal to "favor" the lame member enables us to detect the one in which the lameness exists. The pain suffered every time weight is thrown on the diseased limb causes him to step quickly with it and shift as much weight as possible to the well one.

Injuries in various parts of the limb cause the horse to "favor" the limb differently, but in general the movements are much the same.

When the foot of the injured extremity comes in contact with the ground it is jerked up rather quickly, and, if a front one, gives the head a decided upward movement.

When the foot of the sound limb comes to the ground more weight is thrown on it.

If the lameness is in front the movement of the head is downward, or, using the common expression, the animal "nods."

If the seat of the lameness is in the posterior extremity the haunch settles downward when weight is thrown on the sound leg, and when thrown on the diseased one the horse "nods," and there may be a decided upward movement of the hip.

When lame in both front feet locomotion may be difficult, and in order to throw the weight on the limbs better able to bear it, the hind extremities are placed well under the body and the animal takes short, quick steps with the feet of the sore extremities, and vice versa, if the posterior ones are affected.

If all four are affected, as is sometimes the case in laminitis or founder, the animal may lie down most of the time and generally refuses to move, or, when standing, shifts his weight from one foot to the other and changes as little as possible.

The examiner should observe the animal very closely when it turns to the right or left, as the reluctancy with which it throws weight on the affected limb and the manner of "favoring" the part may point out the seat of the trouble. In some forms of lameness manipulating the limb with the hand may reveal the seat of the pain. This should be done by subjecting the affected region more or less forcibly to the different varieties of natural movement: extension, flexing the joints, drawing the limb out, or pulling it in.

SHOULDER LAMENESS

Causes—Heavy work, rapid driving, or work on rough roads or icy streets may cause the animal to sprain or wrench the softer structures in the region of the shoulder. In addition to these, rheumatism is a common cause of shoulder lameness.

Symptoms—The animal may point with the foot of the lame extremity, holding it forward but squarely on the floor. Sometimes the limb is suspended from the side. When moved, the motion in the upper part of the lame limb is more or less limited, the member being swung outward and not lifted so high from the ground as the well one. Other peculiarities in the gait may be shown, as difficulty in stepping over moderately high objects. Manipulating the limb by moving the shoulder joint through the different natural movements may help in locating the soreness In hidden forms of shoulder lameness a diagnosis is difficult and may be confounded with lameness in the region of the foot.

TREATMENT — Rest is a very important part of the treatment. It is best to tie the patient in a single stall and keep it as quiet as possible. For a week or two it may be best to restrict his movements by tying him in such a way that he can not lie down, and by watering and feeding him in his stall. If nervous or restless, better results will follow if the horse is allowed to run in a small yard. Mild liniments or blisters may be applied to the affected region. The following recipe may be used: Oil of turpentine, aqua ammonia, linseed oil (equal parts); mix and apply to the part once a day; or, powdered cantharides (1 part), vaseline (8 parts); make into an ointment and rub on. Tie the animal up so that he can not rub or bite the part.

SPLINTS

Causes — The seat of the splint is between and on the sides of the splint and cannon bones. This is a very common blemish or unsoundness and is generally located on the splint bones of the front foot, especially the inner one. The inflammation which is due to a sprain or a blow begins in that part of the covering of the bone and tissue that fixes the splint to the cannon bone and leads to a swelling and growth of bone varying in size according to the extent of the inflammation. Young horses are predisposed to splints.

Symptoms — The lameness will vary and is seldom absent during the time the splint is developing. "High" splints are more apt to cause a lameness than a "low" one, and there is danger of the lameness continuing for a longer time. The knee is sometimes held stiffly and the animal limps worst when trotted over a hard road. The observer has such local symptoms as heat, swelling, and pain to guide him in forming a diagnosis. The lameness usually lasts about three weeks.

TREATMENT — Rest and cold applications to the part are indicated during the inflammatory period. Following this a water solution of iodine can be used, iodine crystals (2 parts), iodide of potassium (1 part), water (30 parts); mix and apply to the part with a stiff brush once a day. In obstinate cases the firing-iron should be used.

SPRAINS OF TENDONS AND LIGAMENTS OF THE FOOT

The structures most commonly injured here are the large tendons just back of the cannon bone and the large ligament, the suspensory, that lies along the face of this bone, and the back and sides of the fetlock.

Causes — The character of the work and the condition of the road predispose horses to this form of lameness. Trotting and running horses more often suffer from injuries to tendons and ligaments than draft horses. Catching the foot in a rut, car track, etc., may also cause it.

Symptoms — The symptoms will vary with the severity of the injury. The lameness appears suddenly. When at ease the fetlock joint is flexed and the foot is rested on the toe. The lameness is sometimes very severe and the animal refuses to use the affected foot. The injured tissues are usually warm and swollen, and when the tendon is ruptured it has a bowed appearance. Soreness in the fetlock region may cause the animal to knuckle over.

TREATMENT — If the injury is slight, rest and cold bandages will remove the soreness in about a week. When the lameness is severe complete rest to the part can be obtained by the application of a plaster-of-paris bandage. The bandage can be made by cutting cheese-cloth into strips about four or five inches wide and about fifteen or twenty feet long. The plaster of paris can be rubbed on the bandage as it is being rolled. It is then placed in warm water in which a little salt has been dissolved, until wet through, and then rolled on the part. The cast should reach as high as the knee and as low as the hoof, and in the majority of cases should remain on from two to four weeks. To protect the skin it is best before applying the plaster bandage to use a light cheese-cloth bandage. When removed a cantharides blister can be applied. Good results sometimes follow a period of rest and the application of a mild liniment.

RING-BONE

A ring-bone is a bony enlargement in the region of the coronary joint. The size of the enlargement or exostosis will vary and may be seen on the back, front, or the sides of the region, sometimes forming a thick ring encircling the foot just above the hoof. In the articular form of ring-bone the articulation between the first two bones of the digit is involved. In the periarticular form the thickening is on the outside of the articulation and on the faces of the two first bones of the digit.

Causes — Bruises, sprains, blows, or any injury to the region of the coronet may cause it. A predisposition to ring-bones may be transmitted to the offspring and may be traced to small, badly shaped joints and faulty conformation of the limbs of the sire or dam.

Symptoms — There may be difficulty in locating this form of lameness unless the enlargement is well developed. Lameness is nearly always present. It may disappear after a long rest or when the animal is exercised. The degree of soreness will vary and does not always depend upon the size of the enlargement, and is more marked when the weight is thrown on the foot. In chronic cases of lameness, and when the enlargement is large and low down, the prognosis is unfavorable.

TREATMENT — Proper attention given to the foot of young animals, keeping the walls of the hoof pared and in balance, and the careful selection of breeding animals, are useful preventive precautions. The treatment consists in resting the animal, balancing the foot, and counter-irritation over the diseased region by means of blisters or the firing-iron. The latter is to be preferred.

SIDEBONES

This is a disease of the lateral cartilages of the foot and is especially common in draft horses and peculiar to the fore feet. Occasionally sidebones appear in the hind feet, but seldom cause lameness. These cartilages are attached to the heel of the pedal bone and can be detected by pressing on the side of the heel just above the coronary band. They form part of the elastic apparatus of the foot and when inflamed, lime salts may be deposited in the cartilaginous tissue and it is transformed to bone.

Causes—Weak, poorly formed feet predispose a horse to sidebones. Certain conditions, such as heavy work over paved streets, high-heeled shoes or high calkings may excite their growth. Injuries to the cartilages may set up an inflammatory process and result in the formation of the bony growths.

Symptoms—A sidebone develops slowly and may not cause lameness at first. The animal may have a "stilty" action, step short with the affected feet and its movements lack the normal elasticity. After exercise the gait may be more nearly natural. When the animal is lame the toe of the foot touches the ground first and it steps short with the diseased feet. Instead of the cartilage feeling elastic when pressed on, it is rigid and may form a prominent enlargement.

TREATMENT—The growth of the sidebone may be arrested by rest and counter-irritation from a blister or the firing-iron and the soreness partially removed. Animals with sidebones should generally be discarded for breeding purposes.

NAVICULAR DISEASE

(*Coffin Joint Lameness*)

This is a chronic inflammation of the structures in the region of the "coffin joint," the gliding surface of the navicular bone, and the navicular bone with the flexor tendon of the foot at this point.

Causes—Well bred horses are more commonly affected with this form of lameness than roughly bred ones. Narrow, high heels, long pasterns and too long a toe may predispose a horse to the disease. The character of the work is also a predisposing factor. Hurried, rapid movements throw considerable strain on this region and may result in injury to the part. This is one of the reasons why it is more common in driving and running horses than in slow-going work animals. Bad shoeing and punctured wounds in the region of the articulation may also cause it. One or both front feet may be affected.

Symptoms—The lameness begins gradually and at first the soreness may disappear with exercise or after a long rest. The character of the gait is stiff and the horse frequently stumbles; this is especially noticeable when trotted over rough ground. When the disease is well advanced the animal may suffer severe pain when weight is thrown on the diseased foot. When standing in the stable it will "point" with the diseased foot, resting it on the toe, sometimes on the front of the opposite foot. The articulation is so hidden that it is difficult to detect the local inflammation or cause the animal to flinch by applying pressure over the region. In time, as but little weight is thrown on the foot it becomes smaller, contracted at the heel, more upright, the frog atrophies, and the wall frequently appears uneven. One or both front feet may be affected. The prognosis is very unfavorable.

Treatment — Allowing the animal to run on pasture, keeping the feet moist, and blisters applied to the coronet, may check the disease in its first stages. In shoeing the horse it is best to shorten the toe and raise the heel. The lameness can be removed by performing neurectomy (cutting the nerve supply to the foot and destroying the sensation in the part).

CORNS

A corn is an injury to the sensitive tissue of the sole, quarters, or bars of the foot. It consists in a bleeding from capillary blood-vessels that are pressed on or ruptured, and the surface of the horny tissue becomes stained a reddish color. If the part is infected by pus germs and matter forms it is termed a moist corn. If the inflammation is absent and the tissue dry it is called a dry corn.

Causes — Weak, badly formed feet are predisposed to corns. The principal external causes are faulty shoeing and allowing the shoes to stay on for too long a time.

Symptoms — Corns sometimes cause considerable lameness. Suppurative corns are the most troublesome and require immediate attention. The foot is inflamed and may be swollen at the coronet.

Treatment — In badly formed feet it is impossible to stop the development of corns. The shoeing should receive the necessary attention. In bad cases removing the shoes and turning the horse on pasture is the best line of treatment. In dry corns little more is required. If the foot is inflamed a flaxseed poultice should be applied, and when pus is formed an exit should be provided for it, the foot kept clean, and the corn washed daily with an antiseptic wash (creolin, 2 parts, to 98 parts of water).

SANDCRACKS, QUARTERCRACKS

A sandcrack or quartercrack is a fissure in the wall of the foot running in the same direction as the horny fibers. Its position and extent varies and may occur at the toe, quarter, heel, or bar, and may be deep and extend from the lower margin of the wall to the coronary band, or only a portion of the distance. When deep and complete it may cause the animal to go lame. The pain is caused by the crack opening up when weight is thrown on the foot, and when the weight is removed it will close, pinching and injuring the sensitive laminæ that lie just beneath the horny wall. Cracks of long standing usually have thick rough margins.

Causes — The horny wall is secreted by the coronary band. Any injury to this secreting tissue may cause a fissure in the wall. This is one of the most common causes of sandcrack. If the bearing surface of the hoof is not properly trimmed, or the bearing surface of the shoe is uneven, a fissure may form. Weak walls and excessive drying of the feet may also cause it. Contracted upright feet are predisposed to sandcracks.

Treatment — Preventive treatment is very important and consists in avoiding conditions favorable for their development. Recovery can be assisted by preventing motion between the margins of the crack. This can be done by thinning the wall along the margins of the fissure and cutting out the bearing margin of the wall on each side of the fissure. If the sandcrack is at the toe extra nail holes should be made in the shoe and a nail driven in the wall a little to each side of the crack. If on the quarter, that portion of the wall lying back of the crack and below it should be pared down till quite thin and the wall shortened so that it does not rest on the shoe. A bar shoe that does not give frog pressure is better in quartercrack than a common shoe, as it limits the expansion of the foot at the heel. To stimulate the secretion of horn a cantharides blister can be applied just above the coronary band, every two or three weeks.

"STIFLE OUT"

(*Luxation of the Patella*)

This is a common accident in horses and mules. Young, immature animals are more apt to suffer from a luxation or displacement of the patella than when mature. The displacement is usually upward or outward.

Causes — The patella is applied to a pully-like surface at the lower extremity of the thigh bone, the outer lip of the pully being small. It is held here by ligaments below that attach it to the leg bone and by tendons above. If these tendons or ligaments become relaxed or weak, it may permit of a slipping out of the patella. Strains of the ligaments, or a rupture of the internal lateral one, may also cause it. Upright limbs and oblique quarters are said to predispose an animal to it.

Symptoms — The animal stands quietly as a rule, the affected leg held stiffly and extended backward. If both hind limbs are affected the animal can not move. When the animal moves forward, it hops on the well leg and carries the affected one or drags it on the toe. The symptoms are so characteristic in luxation of the patella that it can be diagnosed from a distance. In complete or incomplete lateral displacement of the patella the joints may be flexed and the animal is very lame when weight is thrown on the affected leg. In most cases of luxation of the patella the prognosis is favorable. The condition may return to the normal without any assistance, but is apt to return again when the animal takes a few steps, and finally disappears after the animal has been worked a short time. When due to a rupture of the internal ligament or to weakness, it may terminate less favorably. It is not uncommon for the accident to recur.

Treatment — It is not difficult to return the patella to its natural position, but its retention is more difficult. The animal should be rested and prevented from throwing weight on the affected leg. This can be done by tying the animal in a single stall, putting a collar on the neck, tying one end of a rope about 12 feet long to it, and running the other end back between the front legs to a ring in a strap buckled around the pastern of the affected leg, then back to the collar. The leg can then be pulled forward and the luxation reduced. After this has been done the rope can be tied and the toe allowed to touch the ground. The animal should be confined in this manner for at least one week. A blister (1 part cantharides to 8 parts vaseline) should be applied to the front and the outside of the joint.

SPAVIN

A spavin is a chronic inflammation of the hock, involving the articular surfaces of the small bones, the ligaments, and synovial membranes. The upper extremities of the cannon or splint bones may be involved as well, and in advanced cases the articulations between the smaller hock bones are entirely obliterated.

Causes—A predisposition to spavin depends on the conformation of the hind limb and body. Heavily muscled hind quarters and straight hind legs predispose an animal to strains or injuries to the hock. The external causes are sprains caused by slipping, turning quickly, rearing, rapid work, and pulling heavy loads. Kicks on the hock may also cause it. Spavin is more common in young than in old horses, due to the incomplete development of the bones, ligaments, etc.

Symptoms—When no enlargement is present on the hock, the diagnosis is sometimes difficult and uncertain. The enlargement is usually toward the front and side of the hock and when small will require considerable knowledge of the appearance of the normal hock joint in order to detect it. The best position to observe a spavin is from the front or a little to one side in order to compare the two hock joints, and note their differences in shape. Coarse hocks, however, should not be mistaken for a spavin. Both hocks may be enlarged and the animal go lame in both, or an enlargement may be present and not be accompanied by lameness. The lameness usually begins gradually and disappears shortly after exercise but will reappear if the horse is rested and again exercised. In old cases the lameness persists. The extension of the hock is incomplete, the step is short and quick, there is an extra movement of the quarter and the animal goes on the toe. When the animal is turned toward the well side the soreness may be increased. The "spavin test" may be of value in diagnosing an "occult" spavin, and consists in picking up the foot, flexing the limb and keeping it flexed for several minutes, then letting the foot down quickly and moving the animal in a trot. This will increase the soreness and the animal will limp badly. The prognosis is always uncertain and should be guided by the conformation of the limb, character of the work required of the animal, position of the enlargement, and the degree of the lameness. The enlargement usually remains about the same.

Treatment—The object of the treatment is to bring about a union between the smaller bones. This may require weeks or months. To do this it is necessary to rest the horse, and the more complete the rest the better are the chances for recovery. He should be kept in a single stall and must not be led out for the purpose of feeding or watering. To promote a secondary inflammation in the part and favor the bony union, counter-irritation from a blister or the firing-iron should be used. Blisters, unless in the very first stages of the disease, are too superficial in their action to cause a permanent recovery. The firing-iron is to be preferred. In all cases the horse should be rested at least four weeks and in some cases it is necessary to repeat the irritation.

BOG SPAVIN

This consists in a distention of the capsular ligament and synovial membrane of the hock joint. Bog spavins are more commonly seen in young horses and in upright or "fleshy" hocks. The exciting cause is frequently a sprain, causing an inflammation of the synovial membrane and an abundant secretion of synovia. Unless the part is inflamed the horse does not go lame. The most noticeable symptom is the swelling toward the anterior and inner part, sometimes the posterior part of the joint. In mature animals the swelling is generally permanent, but in immature, growing animals may disappear, sometimes without treatment.

TREATMENT — When lame and if the inflammation is acute, rest and cooling applications (cold bandages) are necessary. Following this treatment the hock should be blistered or cauterized with the firing-iron. In colts it is well to blister the spavin every few weeks with a blistering ointment (powdered cantharides 1 part, vaseline 8 parts).

CAPPED HOCK

All swellings on the point of the hock are called "capped hock." This injury is generally due to a bruise caused by the animal kicking against the side of the stall or when in harness. The swelling may be due to an injury to the skin and subcutaneous tissue alone, or more important structures may be involved, as the tendinous cap over the point of the hock and the synovial bursa. When the skin is involved it pits on pressure; if the tendon, it is hard, and if the bursa, soft and elastic. When the injury is of recent origin the part is warm and tender. In some cases the swelling is very large. Unless badly inflamed it does not cause lameness.

TREATMENT — When of recent origin cold applications should be used. This must be followed by blisters. If the swelling feels soft it should be opened and the fluid allowed to escape. The operation requires skill and should be attempted only by an experienced veterinarian.

CURB

This term is applied to all swellings on the posterior part of the hock. In some individuals an excessive development of the bones in this region gives to the hock the appearance of being curbed. Horses with "cow hocks" are predisposed to this form of unsoundness, due to the fact that its extreme length gives the powerful muscles attached to its summit a greater strain on the ligaments at the back part of the hock. "Tied in" hocks are weak at this point. The exciting causes of curbs are jumping, rearing, heavy pulling, and kicks or blows on this region.

Symptoms — The shape of the back part of the hock is changed and when observed from the side, instead of a straight line from the point of the hock to the upper end of the cannon region, a swelling that bulges backward is seen toward the lower part. The thickening in the part may be due to a disease of the tendon, its sheath or the skin. It may also be due to an inflammation of the bone and the resulting long enlargement. A careful examination with the fingers will enable us to detect the different tissues involved. It is only when the parts are sore and inflamed, as a result of the injury, that the animal goes lame. The lameness will resemble that caused by a sprain, and will disappear in a few weeks. The enlargement usually persists.

TREATMENT — At the beginning, if the ligament and surrounding tissues are inflamed, cold bandages should be used, together with rubbing of the part. After the inflammation has subsided a water solution of iodine or blisters can be applied. Rest is a necessary part of the treatment during the inflammatory stage, and one should not be in too much of a hurry to put the animal to work, as the part may again become injured. If the curb does not respond to the ordinary treatment, cauterization with the firing-iron should be resorted to.

R. A. Craig

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ANIMAL CASTRATION. By A. Liautard. *Wm. R. Jenkins*, N. Y. $2.00

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The Silo in Modern Agriculture[1]

By F. W. Woll
Assistant Professor of Agricultural Chemistry, University of Wisconsin

WHY BUILD A SILO?

Economy of Nutrients — The silo enables us to preserve a greater quantity of the food materials of the original fodder, for the feeding of farm animals, than is possible by any other system of preservation now known. The necessary losses of nutrients incurred in the siloing process need not exceed 10 per cent, and by beginning to feed from the silo soon after it has been filled, the loss will be reduced to a minimum which may not be far from 5 per cent. In haymaking or field-curing of coarse fodders, there is an unavoidable loss of leaves and other tender parts, and in curing fodder corn there will be a fermentative loss of toward 10 per cent under the best of conditions, or about as much as is lost in the silo. The loss of dry matter will approach 25 per cent in ordinary farm practice, and will even exceed this figure unless special precautions are taken in the handling of the fodder.

Economy of Material — Crops unfit for haymaking may be preserved in the silo and changed into a palatable food. In case of fodder famine the silo may thus help the farmer to carry his cattle through the winter.

Where haymaking is precluded, as is sometimes the case with second-crop clover, rowen, etc., on account of rainy weather late in the season, the silo will preserve the crop.

Economy of Land — More cattle can be kept on a given area of land when silage is fed than is otherwise the case. The silo in this respect furnishes a similar advantage over field-curing fodders as does the soiling system over that of pasturing cattle. Pasturing cattle is an expensive method of feeding, as far as the use of the land goes, and can only be practiced to advantage where this is cheap. As the land increases in value, more stock must be kept on the same area in order to correspondingly increase the profits from the land.

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[1] Condensed from *A Book on Silage*, Chicago : Rand, McNally & Co.

Economy of Time and Storage Space — Rainy weather is a disadvantage in filling silos as in most other farm operations, but when the silo is once filled, the farmer is independent of the weather throughout the season.

Less room is required for the storage in a silo of the product from an acre of land than in cured condition in a barn.

Economy of Labor — An acre of corn can be placed in the silo at less cost than the same quantity can be put up as cured fodder. To derive full benefit from the food materials in the field-cured fodder corn, it must be run through a feed cutter in small portions at a time; the corn must, in most cases, be husked, cribbed, and either ground, cob and all, or shelled and ground. In siloing the whole corn plant, the cutting is all done at once.

Uniformity of Feed — The silo furnishes a feed of uniform quality, available at any time during the whole winter or year. This is of advantage perhaps particularly in case of dairy cows and sheep, since these animals are especially sensitive to sudden changes in the feed.

Silage as a Preparatory Ration — Silage is of special value for feeding preparatory to turning cattle on to the watery pasture grass in the spring. When turned out in the spring, steers will be apt to lose weight, no matter whether silage or dry feed has been fed, unless they are fed some grain during the first week or two after they are let out.

Silage as a Bowel Regulator — Succulent food is nature's food. The influence of well-preserved silage on the digestion and general health of animals is very beneficial, according to the unanimous testimony of good authorities. It is a mild laxative, and acts in this way very similarly to green fodders.

By filling the silo with clover or other green summer crops early in the season, a valuable succulent feed will be at hand at a time when pastures in most regions are apt to give out; then again, the silo may be filled with corn when this is in the roasting stage, and the land thus entirely cleared earlier than when the corn is left to mature and the corn fodder shocked on the land, making it possible to finish the fall plowing sooner and to seed the land down to grass or to winter grain.

THE FEEDING OF SILAGE

Silage may be fed with advantage to all classes of farm animals — milch cows, steers, horses, mules, sheep, swine, and even poultry — but always in connection with some dry roughage. The nearer maturity the corn is when cut for the silo, the more silage may safely be fed at a time, but it is always well to avoid feeding it excessively.

SILAGE FOR MILCH COWS

Silage is par excellence a cow feed. As with other farm animals, cows fed silage should receive other roughage[1] in the shape of corn stalks, hay, etc.

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[1] To illustrate the quantities and combinations in which silage may be fed to milch cows, we give herewith a number of practical feed rations published in two bulletins by the author, viz.: Nos. 33 and 38, of the Wisconsin Experiment Station (October, 1892, and January, 1894):

American Silage Rations for Dairy Cows

1. Corn silage, 30 lbs.; hay, 6½ lbs.; corn and cob meal, 5 lbs.; ground oats, 5 lbs.; linseed meal, 3 lbs.
2. Corn silage, 27 lbs.; dry fodder corn, 8 lbs; clover hay, 6 lbs.; oat straw, 1½ lbs.; wheat bran, 4 lbs.; linseed meal, 4 lbs.
3. Corn silage, 35 lbs.; hay, 5 lbs.; malt sprouts, 4 lbs.; wheat bran, 2¼ lbs.; cotton-seed meal, 1½ lbs.
4. Corn silage, 30 lbs.; cut sheaf oats, 6 lbs.; mixed meadow hay, 10 lbs.; wheat bran, 4 lbs.; linseed meal, 2 lbs.
5. Corn silage, 30 lbs.; cut cornstalks, 12 lbs.; wheat bran, 3¾ lbs.; corn meal, 3 lbs.; oats, 3¼ lbs., with a sprinkling of peas.
6. Corn silage, 32 lbs.; clover silage, 22 lbs.; clover and timothy hay mixed, 5 lbs.; wheat bran, 6 lbs.; ground oats, 4 lbs.; cotton-seed meal, 3 lbs.
7. Corn silage, 35 lbs.; hay, about 11 lbs.; wheat bran, 3⅓ lbs.; ground oats, 2⅓ lbs.; linseed meal (O. P.) 2⅓ lbs.
8. Corn silage, 30 lbs.; hay, 8 lbs.; corn fodder, 5 lbs.; ground oats, 4 lbs.; pea meal, 2 lbs.
9. Corn silage, 40 lbs.; clover hay, 8 lbs.; wheat bran, 6 lbs.; pea meal, 2 lbs.
10. Whole corn silage, 25 lbs.; clover hay, 10 lbs.; wheat bran, 10 lbs.
11. Corn silage, 40 lbs.; clover hay, 5 lbs.; timothy hay, 5 lbs.; wheat bran, 4½ lbs.; middlings, 4½ lbs.
12. Corn silage, 45 lbs.; clover hay, 12 lbs.; wheat shorts, 8 lbs.; corn meal, 4 lbs.
13. Corn silage, 24 lbs.; corn fodder, 15 lbs.; clover hay, 5 lbs.; wheat bran, 5 lbs.
14. Corn silage, 40 lbs.; alfalfa hay, 15 lbs.; wheat bran, 4 lbs.; corn chop, 4 lbs.
15. Corn silage, 35 lbs.; hay, 10 lbs.; wheat bran, 3 lbs.; corn and cob meal, 3 lbs.; cotton-seed meal, 2 lbs.; gluten meal, 2 lbs.
16. Corn silage, 50 lbs.; wheat shorts, 4 lbs.; grano-gluten feed, 4 lbs.
17. Corn silage, 30 lbs.; clover hay, 5 lbs.; corn fodder, 3 lbs.; straw, 2 lbs.; wheat bran, 5 lbs.; linseed meal, 2 lbs.; cotton-seed meal, 2 lbs.
18. Corn silage, 40 lbs.; timothy and clover hay, 5 lbs.; wheat bran or shorts, 7 lbs.
19. Corn silage, 40 lbs.; English hay, 5 lbs.; clover hay, 5 lbs.; wheat bran, 2 lbs.; gluten meal, 2 lbs.; cotton-seed meal, 1 lb.; linseed meal, 1 lb.
20. Corn silage, 40 lbs.; hay, 6 lbs.; gluten meal, 2 lbs.; corn and cob meal, 2 lbs.; wheat shorts, 2 lbs.
21. Corn silage, 50 lbs.; hay, 8 lbs.; wheat bran, 3 lbs.; wheat shorts, 2 lbs.; ground rye and oats, 3 lbs.; barley, 2 lbs.
22. Corn silage, 35 lbs.; clover hay, 10 lbs.; oat straw, 2 lbs.; corn meal, 5 lbs.; wheat bran, 5 lbs.; oats, 5 lbs.
23. Corn silage, 35 lbs.; hay, 7 lbs.; brewers' grains, 20 lbs.; gluten meal, 1½ lbs.; cotton-seed meal, 1½ lbs.; wheat shorts, 1½ lbs.; linseed meal, 1½ lbs.
24. Corn silage, 24 lbs; corn meal, 8 lbs.; wheat bran, 2 lbs.; oats, 4 lbs.; linseed meal, 2 lbs.
25. Corn silage, 40 lbs.; corn fodder, 10 lbs.; cotton-seed meal, 2½ lbs.; N. P. linseed meal. 2 lbs.; wheat bran, 4 lbs.
26. Corn silage, 40 lbs.; timothy hay, 10 lbs.; wheat bran, 5 lbs.; corn meal. 3 lbs; linseed meal, 2 lbs.
27. Corn silage, 50 lbs.; hay, 5 lbs.; wheat bran, 4 lbs.; linseed meal, 2 lbs.; cotton-seed meal, 1 lb.; ground rye, 1 lb.
28. Corn silage, 40 lbs.; cotton-seed meal, 3 lbs.; corn starch feed, 18 lbs.
29. Corn silage, 30 lbs.; clover hay, 12 lbs.; wheat middlings, 8 lbs.; linseed meal, 1 lb.
30. Corn silage, 42 lbs.; clover and timothy hay, 5 lbs.; corn and cob meal, 8 lbs; dried brewers' grains, 1½ lbs.
31. Corn silage, 30 lbs.; fodder corn, 8 lbs.; corn meal, 3 lbs.; wheat bran, 3 lbs; cotton-seed meal, 1 lb.
32. Corn silage, 50 lbs.; clover hay, 8 lbs.; wheat shorts, 5 lbs.
33. Corn silage, 30 lbs.; corn stover. 8 lbs.; wheat bran, 5 lbs.; malt sprouts, 4 lbs.; linseed meal, 1 lb.
34. Corn silage, 50 lbs.; clover hay, 9 lbs.
35. Corn silage, 45 lbs.; mixed hay, 7 lbs.; wheat bran. 6 lbs.; cotton-seed meal, 2 lbs.
36. Corn silage, 15 lbs.; sugar beets, 22 lbs.; hay, 10 lbs.; oats, 5⁴⁄₁₀ lbs.; corn meal, 7 lbs.
37. Corn silage, 40 lbs.; clover hay, 8 lbs.; coarse linseed meal. 6 lbs.
38. Corn silage, 30 lbs.; sorghum hay, 13½ lbs.; corn meal, 1³⁄₁₀ lbs.; cotton-seed meal, 2⁶⁄₁₀ lbs.; cotton-seed, 2²⁄₁₀ lbs.; wheat bran, 1³⁄₁₀ lbs.
39. Corn silage, 35 lbs.; mixed hay, 10 lbs.; wheat bran, 2 lbs.; corn meal, 3²⁄₁₀ lbs.; linseed meal, 1 lb.; cotton-seed meal, ⁸⁄₁₀ lbs.
40. Corn silage, 20 lbs.; hay, 14 lbs.; wheat bran, 3 lbs.; gluten meal, 2 lbs.
41. Corn silage, 30 lbs.; hay, 10 lbs.; corn meal, 2 lbs.; gluten meal, 2 lbs.; wheat bran, 2 lbs.
42. Corn silage, 48 lbs.; corn and cob meal, 2½ lbs.; ground wheat, 2½ lbs.; oats, 2½ lbs.; barley meal, 2½ lbs.
43. Corn silage, 40 lbs.; hay, 5 lbs.; straw, 5 lbs.; wheat bran, 4½ lbs.; oats, 4½ lbs.
44. Corn silage, 15 lbs.; turnips, 45 lbs.; wheat chaff, 7 lbs.; oats, 2½ lbs.; pea meal, 2½ lbs.
45. Corn silage, 30 lbs.; hay, 12 lbs.; ground oats, 10 lbs.
46. Corn silage, 40 lbs.; turnips, 30 lbs.; clover hay, 8 lbs.; straw, ½ lb.; oats, 2 lbs.; wheat bran, 2 lbs.
47. Corn silage, 50 lbs.; clover hay, 10 lbs.; straw, 3 lbs.; pea meal, 5 lbs.; oats, 2 lbs.

The rations given were fed in the following States: Nos. 1-13, Wisconsin; No. 14, Colorado; No. 15, Connecticut; No. 16, Illinois; No. 17, Indiana; No. 18, Iowa; Nos. 19, 20, Massachusetts; No. 21, Minnesota; No. 22, Nebraska; No. 23, New Hampshire; No. 24, New Jersey; Nos. 25-30, New York; No. 31, North Carolina; Nos. 32-34, Ohio; Nos. 35-37, Pennsylvania; No. 38, Texas; Nos. 39-41, Vermont; No. 42, West Virginia; and Nos. 43-47, Canada.

How Much to Feed — The quantities of silage fed should not exceed 40 or, at the outside, 50 pounds per day per head. It is possible that a maximum allowance of only 25 to 30 pounds per head daily is to be preferred where the keeping quality of the milk is an important consideration. The silage may be given in one or two feeds daily, and, in case of cows in milk, always after milking, and not before or during the same, as the peculiar silage odor will, in the latter case, be apt to reappear in the milk.

Effect on Milk Secretion — Silage exerts a very beneficial influence on the secretion of milk. Where winter dairying is practiced, cows will usually drop considerably in milk toward spring, if fed on dry feed, causing a loss of milk through the whole remaining portion of the lactation period. If silage is fed there will be no such marked decrease in the flow of milk before turning out to grass, and the cows will be able to keep up well in milk until late in the summer, or early in the fall, when they are to be dried up preparatory to calving. Silage has a similar effect on the milk secretion as green fodder or pasture, and if made from well-matured corn, so as not to contain an excessive amount of acid, is more like these feeds than any other at the disposal of the farmer.

There is an abundance of evidence at hand showing that *good* silage fed in moderate quantities will produce an excellent quality of both butter and cheese. According to the testimony of butter experts, silage not only in no way injures the flavor of butter, but better-flavored butter is produced by judicious silage feeding than can be made from dry feed.

The combinations in which corn silage will be used in feeding milch cows will depend a good deal on local conditions; it may be said in general that it should be supplemented by a fair proportion of nitrogenous feeds like clover hay, wheat bran, ground oats, linseed meal, and cottonseed meal.

SILAGE FOR STEERS

Silage may be fed with advantage to steers, in quantities up to forty or fifty pounds a day. The health of the animals and the quality of the beef produced on moderate silage feeding leave nothing to be wished for.

If the silage is made from immature corn, care must be taken not to feed too large quantities at the start and to feed carefully, so as not to produce scouring in the animals. Young stock may be fed half as much silage as full-grown ones, with the same restrictions and precautions as given for steers. Experience obtained at the Kansas Experiment Station suggests that corn silage is not a fit food for breeding bulls, unless fed only as a relish; fed heavily on silage, bulls lose virility and become slow and uncertain breeders.

SILAGE FOR HORSES

When fed in moderate quantities, not to exceed twenty pounds a day, silage is a good food for horses.

It should be fed twice a day, a light feed being given at first and gradually increased as the animals become accustomed to the food. Some farmers feed it mixed with cut straw, two-thirds of straw, and one-third of silage, and feed all the horses will eat of this mixed feed. Some horses object to silage at first on account of its peculiar odor, but by sprinkling some oats or bran on top of the silage and feeding only very small amounts to begin with, they soon learn to eat and relish it. Some horses take it willingly from the beginning. Horses not working may be fed larger quantities than work horses, but in neither case should the silage form more than a portion of the coarse feed fed to the horses. Silage-fed horses will look well and come out in the spring in better condition than when fed almost any other food.

What has been said about silage as a food for horses will most likely apply equally well to mules, although only very limited experience has thus far been gained with silage for this class of farm animals.

SILAGE FOR SHEEP

Silage is looked upon with great favor among sheep men; sheep do well on it, and silage-fed ewes drop their lambs in the spring without trouble, the lambs being strong and vigorous.

Silage containing a good deal of corn is not well adapted for breeding stock, as it is too fattening; for fattening stock, on the other hand, much corn in the silage is an advantage. Sheep may be fed a couple of pounds of silage a day and not to exceed five or six pounds per head. Professor Cook reports as follows in regard to the value of silage for sheep: "I have fed ensilage liberally to sheep for three winters and am remarkably pleased with the results. I make ensilage half the daily ration, the other half being corn stalks, or timothy hay, with bran or oats. The sheep do exceedingly well. Formerly I was much troubled to raise lambs from grade Merino ewes. Of late this trouble has almost ceased. Last spring I hardly lost a lamb. While ensilage may not be the entire cause of the change, I believe it is the main cause."

Mr. J. S. Woodward, the well-known New York farmer who has made a specialty of early lamb raising, says regarding silage as a feed for lambs: "In order to be successful in raising fine lambs, it is imperative that the ewes and lambs both should have plenty of succulent food. Nothing can supply the deficiency. For this purpose roots of almost any kind are good. Turnips, rutabagas, and mangolds are all good. Corn silage is excellent. Could I have my choice I would prefer both silage and roots. If I were depending on silage alone for succulent food, I would give four pounds per hundred pounds live weight of sheep, all at one feed, at the forenoon feed; but when feeding both silage and roots, I would feed silage in the morning and roots in the afternoon."

SILAGE FOR SWINE

The testimony concerning the value of silage as a food for swine is conflicting, both favorable and unfavorable reports being at hand. Many farmers have tried feeding it to their hogs, but without success. On the other hand, a number of hog raisers have had good success with silage, and feed it regularly to their swine. It is possible that the differences in the quality of the silage and of the methods of feeding practiced explain the diversity of opinions formed.

According to Professor Cook, Col. F. D. Curtiss, the great American authority on the swine industry, states that silage is valuable to add to the winter rations of swine.

Mr. J. W. Pierce of Indiana writes in regard to silage for hogs: "We have fed our sows, about twenty-five in number, for four winters, equal parts of ensilage and corn meal put into a cooker, and brought up to a steaming state. It has proved to be very beneficial to them. It keeps up the flow of milk of the sows that are nursing the young, equal to when they are running on clover. We find, too, when the pigs are farrowed, they become more robust, and take to nursing much sooner and better, than they did in winters when fed on an exclusively dry diet."

In feeding silage to hogs, care should be taken to feed only very little, a pound or so, at the start, mixing it with corn meal, shorts, or other concentrated feeds. The diet of the hog should be largely made up of easily digested grain food; bulky, coarse feeds like silage can only be fed to advantage in small quantities, not to exceed three or four pounds per head, per day. As in the case of breeding ewes, silage will give good results when fed with care to brood sows, keeping the system in order and producing a good flow of milk

THE BUILDING OF A SILO

GENERAL CONSIDERATIONS

Several important points have to be observed in building silos. First of all, *the silo must be air-tight*, and the fodder well packed in it, so as to exclude the air as far as practicable.

In the second place, *the silo must have smooth, perpendicular walls*, which will allow the mass to settle without forming cavities along the walls. In a deep silo the fodder will settle several feet during the first few days after filling. Any unevenness in the wall will prevent the mass from settling uniformly, and air spaces in the mass thus formed will cause the surrounding silage to spoil.

The walls must furthermore be rigid, so as not to spring when the siloed fodder settles, on account of the lateral pressure in the silo, as air would thereby be admitted along the silo walls, causing decay and loss of silage.

Size — In planning a silo the first point to be decided is how large it shall be made. We will suppose that the farmer has a herd of twenty-five cows, to which he wishes to feed silage during the winter season, *e. g.*, for 180 days. As a rule, it will not be well to feed over forty pounds of silage daily per head. If this quantity be fed daily, on an average for a season of 180 days, we have for the twenty-five cows 180,000 pounds, or ninety tons. If ninety tons of silage is wanted, about one hundred tons of fodder corn must be placed in the silo.

We may take forty pounds as the average weight of one cubic foot of corn silage. One ton of silage will accordingly take up fifty cubic feet; and 100 tons, 5,000 cubic feet. If a rectangular one-hundred-ton silo is to be built, say 12 x 14 feet, it must then have a height of 30 feet. If a square silo is wanted it might be given dimensions 12 x 12 x 35 feet, or 13 x 13 x 30 feet. (See also under "Handy Rules.")

APPROXIMATE CAPACITY OF CYLINDRICAL SILOS FOR WELL-MATURED CORN SILAGE, IN TONS

DEPTH OF SILO, FEET	INSIDE DIAMETER OF SILO, FEET												
	10	12	14	15	16	18	20	21	22	23	24	25	26
20	26	38	51	59	67	85	105	115	127	138	151	163	177
21	28	40	55	63	72	91	112	123	135	148	161	175	189
22	30	43	59	67	77	97	120	132	145	158	172	187	202
23	32	46	62	72	82	103	128	141	154	169	184	199	216
24	34	49	66	76	87	110	135	149	164	179	195	212	229
25	36	52	70	81	90	116	143	158	173	190	206	224	242
26	38	55	74	85	97	123	152	168	184	201	219	237	257
27	40	58	78	90	103	130	160	177	194	212	231	251	279
28	42	61	83	95	108	137	169	186	204	223	243	264	281
29	45	64	88	100	114	144	178	196	215	235	256	278	305
30	47	68	93	105	119	151	187	206	226	247	269	292	310
31	49	70	96	110	125	158	195	215	236	258	282	305	335
32	51	73	101	115	131	166	205	226	248	271	295	320	340

The silo should always be emptied from the top in horizontal layers, and the surface kept level, so as to expose as little of the silage as possible to the air. It should be fed out rapidly enough to avoid spoiling of the silage; in ordinary northern winter weather a layer of a couple of inches should be fed off daily. Professor King estimates that there should be a feeding surface in the silo of about five square feet per cow in the herd; a herd of thirty cows will then require 150 square feet of feeding surface, or the inside diameter of the silo should be 14 feet; for a herd of forty cows a silo with a diameter of 16 feet will be required; for fifty cows, a diameter of 18 feet; for one hundred cows, a diameter of 25½ feet, etc. These considerations are at the foundation of the following table:

SIZE OF SILO NEEDED — (*Harder*)

Number of Cows.	Estimated Consumption of Silage. Tons.	Size of Silo Needed Diam. Height.	Average Acres of Corn Needed.
6	20	9 x 20 **10 x 16**	1 to 2
9	30	**10 x 22** 11 x 20	2 to 3
13	45	10 x 29 11 x 25 **12 x 22** 13 x 20	3 to 4
21	74	11 x 37 12 x 32 **13 x 29** **15 x 24** 16 x 22	5 to 6
25	90	12 x 38 13 x 33 **14 x 30** **15 x 27** 16 x 25	6 to 7
30	108	13 x 38 14 x 34 **15 x 30** **16 x 28** 17 x 25	8 to 9
35	126	15 x 35 **16 x 31** 17 x 29	9 to 10
40	144	16 x 35 **17 x 31** 18 x 29	10 to 11
45	162	**18 x 32** 19 x 29	11 to 12
50	180	17 x 38 **18 x 34**	12 to 13

Form of Silos — One of the essentials in silo building is that there shall be a minimum of surface and wall exposure of the silage, as both the cost and the danger from losses through spoiling are thereby reduced. The round silos are superior to all other forms in regard to this point, the cylindrical form being also the most economical to build of the three types, because lighter material and less of it may be used in their construction.

Silage of all kinds will usually begin to spoil after a few days, if left exposed to the air; hence the necessity of considering the extent of surface exposure of silage in the silo while it is being fed out. In a deep silo there is less silage exposed in the surface layer in proportion to the contents than in shallow silos.

Location — The feeding of the silage is an every-day job during the whole winter and spring, and twice a day at that. The silo should be as handy to get at from the barn as possible. If the ground is dry outside the barn, the best plan is to build the silo there, in connection with the barn, going 4 to 6 feet below the surface, and providing for doors opening directly into the barn. The bottom of the silo should be on or below the level where the cattle stand, and, if practicable, the silage should be moved out and placed before the cows at a single handling. While it is important to have the silo near at hand, it should be so located, in case the silage is used for milk production, that silage odors do not penetrate the whole stable, at milking or at other times.

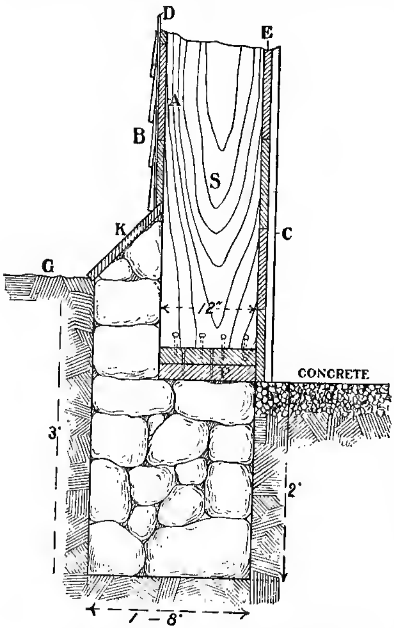

FIG. 167. Foundation of silo. Bottom of silo one foot below ground. (Cook.)

Bottom of Silo — The bottom of the silo may be clay, or, preferably, a layer of small stones covered with cement. In some silos considerable damage has been done by rats burrowing their way into the silo from below, and destroying a great deal of silage, both directly and indirectly, by admitting air into the silo. The silo may be built 4 to 6 feet down into the ground, if this is dry. Stave silos are built entirely above ground.

Foundation and Wall — The silo should rest on a substantial stone foundation, to prevent the bottom of the silo from rotting and to guard against spreading of the silo wall. The foundation wall should be 18 to 24 inches thick Professor Cook recommends making the bottom of the silo one foot below the ground, so that the stone wall on which it rests may be sustained by the earth on the outside, as shown in Fig. 167.

In building rectangular silos sills made by two 2 x 10 planks (P) rest on the inside ten inches of the foundation wall; one of these projects at each corner. The studdings (S), which are 2 x 10 planks, and as long as the silo is high, or two lengths toe-nailed together, are placed 12 to 16 inches apart, large silos requiring the smaller distance.

As there is a considerable lateral pressure in the silo before the fodder has settled, it is very important to make the walls rigid and to place the studding sufficiently close together to prevent spreading of the wall. Mr. James M. Turner states that it was found necessary to use 2 x 12 studding, 22, 24, or 26 feet in length for the outside wall, as well as for the cross-partitions in his first silo. In addition to this, three courses of bridging in each side-wall were inserted. When the silage has settled there is no lateral pressure in the silo. While silos provided with partitions must be filled simultaneously on both sides of the partition to avoid bulging or even breaking of the partition, the silage in one compartment can be completely removed before that in the other is uncovered, without causing the partition to spring.

To insure ventilation in rectangular wooden silos, the sills may be two inches narrower than the studding, so as to leave air spaces between the sills and the lining; in the same way the plate is made narrower than the studding to provide for an escape at the top. The same end may be reached by boring a series of holes at the bottom of the outside wall between every two studs, leaving an open space of about two inches on the inside at the top of the plate. Wire nettings should be nailed over ventilation openings to keep outs rats and mice.

Roof — Where the silo is built in the bay of a barn, there will be no need of making any separate roof, which otherwise generally will be the case. The roof may be either board or shingle, and should be provided with a cupola, so as to allow free ventilation in the silo. In extreme cold weather this should be shut, to prevent freezing of the silage.

Material — Silos are at the present built almost exclusively of wood, stone, or concrete, or partly of one, partly of another of these materials.

STONE OR BRICK SILOS

These silos are usually more expensive than wooden ones, but, in return, they will last longer when carefully built.

Stone silos are easily built, being just like a cellar wall, if possible without any opening except the door, and provided with a roof like any other silo. The walls should be at least 16 inches thick, and *should be jacketed with wood on the outside,* to prevent injury from frost, and to form dead-air spaces, *which will insure perfect preservation of the silage clear up to the silo wall.* This applies still more to brick than to stone walls. With the outside covering nailed to studdings, 2 x 4, no trouble will, however, be experienced in either case. Ventilation of the silo frame must be provided for as in the case of wooden silos.

The following mode of constructing stone silos has proved very convenient, and will make good, substantial silos: The silo is built 5 to 6 feet into the ground, if it can safely be done; the foundation wall is made two feet thick, and at the level of the ground a 4 x 6 sill is laid on the outer edge of the wall and bedded in mortar; a wooden frame is then erected of 2 x 6 studding, sheeted on the inside with common flooring, and on the outside with ship lap boarding, with or without building paper on the studding. The stone wall is then continued on the inside of this wooden frame up to the plate, the corners well rounded off, and the whole inside cemented.

The stone or brick wall must be made smooth by means of a heavy coat of a first-class cement. Since the acid juices of silage are apt to gradually soften the cement, it may be found necessary to protect the coating by a whitewash with pure cement every other year before the silo is filled. If this precaution is taken, the silo will last for generations; some of the earliest stone silos built in this country have now been filled every season for over twenty years without deteriorating perceptibly.

Like the wooden silos, stone silos may be rectangular, square, or circular; if built according to either of the first two forms, the corners should be rounded off so as to assist the settling of the siloed mass, and avoid loss through insufficient packing of the mass in the corners.

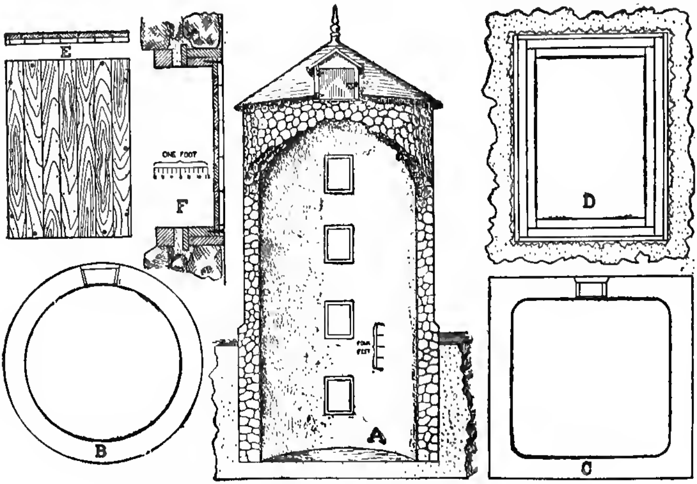

Fig. 168. Construction of circular, all-stone silo. (King.)

The construction of a round, all-stone silo given by Professor King is shown in Fig. 168. A shows a section of the silo, with conical roof, and the arrangement of filling and feeding doors; B and C are ground plans of circular and rectangular stone silos. D, E, F show construction of feeding doors. The construction of the door jambs, to make them air-tight, will be seen in the illustration. The doors are made from two layers of 4-inch matched flooring, with a layer of 2-ply saturated acid and alkali-proof paper, and are held in place with large screws or lag bolts, as shown in E and F. The face of the jambs should be lined with 2-ply P. and B. "Ruberoid" paper or its equal; this will act as a gasket to make the door perfectly air-tight.

GROUT SILOS

Where stone is scarce, and lumber high, the best silo is made of grout. Grout silos may be made according to the following directions:

Having excavated for the silo, dig a trench all around the bottom, and fill it with cobblestone, and from one corner lead a drain, if possible, so as to carry off all water. The trench under the proposed walls of the silo being filled with cobblestones, place standards of scantling long enough to extend 12 inches higher than the top of the wall when it is finished. Place these standards on each side of the proposed wall, and if you desire the walls to be 20 inches thick, place the standards 23 inches apart, a pair of standards being placed every 5 or 6 feet around the entire foundation; be particular to have the standards exactly plumb, and in line; fasten the bottoms of standards firmly in the ground, or by nailing a strip of wood across at the bottom of the standards, and a little below where the floor of the silo will be; fasten the tops of the standards by a heavy cross-piece securely nailed, and fasten the pairs of standards in their plumb positions by shores reaching the bank outside. Planks 1½ inches thick and 14 inches wide are now placed edgewise inside the standards, 20 inches apart, thus forming a box, 14 inches deep, and running all along and around the entire foundation of the proposed wall. Fill this box with alternate layers of cobblestone or any rough stone, etc., and mortar or concrete. First a layer of mortar, and then a layer of stones, not allowing the stones to come quite out to the boxing plank, but having concrete over the edges: the concrete must be tamped down solid.

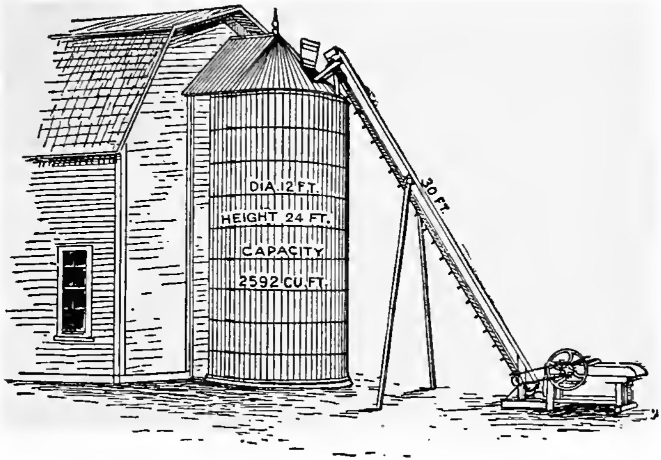

FIG. 169. Stave silo, 12 feet diameter, 24 feet high; capacity, 50 tons. (Elias.)

The concrete is prepared as follows: One part of good cement is mixed thoroughly with four parts of dry sand, and then with six parts of clear gravel: make into a thin mortar, sprinkling with water over the same by means of a sprinkler, and use at once. Put an inch or two of this mortar into the box, and then bed in cobblestones; fill in with mortar, again covering the stones, and again put in a layer of stone. When the box is filled, and the mortar "set" so that the wall is firm, raise the box one foot, leaving two inches lap of plank on wall below, and go around again, raising the wall one foot each day, or every second day, according to the amount of labor on hand. If no gravel is obtainable, use five barrels of sand to one of cement, and bed in all the cobblestones possible. Stones with rough edges are better than smooth ones, as they bind the wall more thoroughly, but any flat stones found about the fields will do as well. A layer of loose cobblestones should be placed against the outside wall before the earth is brought against it, so as to have an air space, and a free passage for water.

As in case of the stone silos, the inside walls of grout silos must be made perfectly smooth, and preserved from softening by means of occasional whitewashings with pure cement; they must also be protected from frost by an outside wooden lining nailed on the 2 x 4 studding.

STAVE SILOS

The stave silo is the simplest type of the various separate silo buildings. Stave silos are, generally speaking, similar to large railroad or fermentation tanks, and to make satisfactory silos should be built at all events as well as a No. 1 water tank.

The stave silos sent out by manufacturing firms will generally be more expensive than such as a farmer can build himself, because they are built better. The writer believes that it does not pay to build a poor silo except to bridge over an emergency, yet if a farmer can not afford to build a *good* silo, he is not necessarily barred from the advantage of having silage for his stock, since a temporary silo may be built at a very small cash outlay.

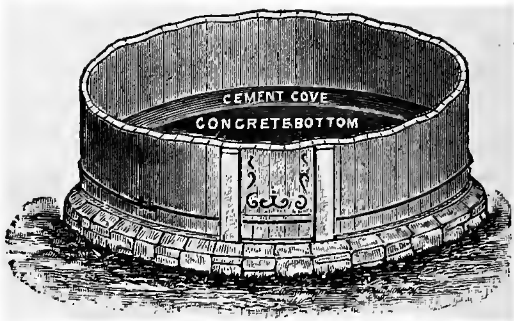

FIG. 170. Base of stave silo. (Harder.)

We can therefore consistently, in most cases, recommend that persons intending to build stave silos patronize the manufacturers who have made silo construction a special business; their advertisements will be found in any of the standard dairy or agricultural papers. These firms furnish all necessary silo fittings, with complete directions for setting up the silos, and, if desired, also skilled help to superintend their building. Perhaps a large majority of the farmers of the country can not patronize manufacturers of stave silos because the expense of shipping the lumber and fixtures would be prohibitory. For the convenience of such persons and others who may prefer to build their own stave silos, directions for their construction are given in the following. The specifications for a 100-ton stave silo, printed below, were furnished at the request of the author by Claude & Starck, architects, Madison, Wis.:

SPECIFICATIONS FOR A 100-TON STAVE SILO

Masonry — Excavate the entire area to be occupied by the silo to a depth of 6 inches; excavate for foundation wall to a depth of 16 inches; in this trench build wall 18 inches wide and 20 inches high, of field stone laid in rich lime mortar. Level off top and plaster inside, outside, and on top with cement mortar, one part cement to one part sand. Fill inside area with 4 inches of good gravel, thoroughly tamped down; after the woodwork is in place, coat this with 1 inch of cement mortar, one part cement to one part clean sand. Cement shall be smoothly finished, dished well to the center and brought up at least 2 inches all around inside and outside walls.

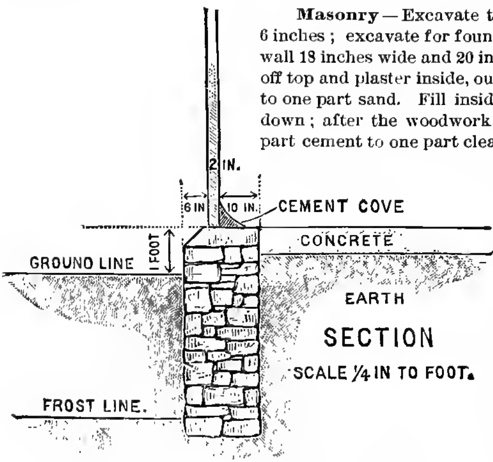

FIG. 171. Foundation of stave silo. (Harder.)

Carpentry — All staves shall be 26 feet long in two pieces, breaking joints, and made from clear, straight-grained cypress 2 x 6 inches, beveled on edges to an outside radius of 8 feet, mill-sized to the exact dimensions, and dressed on all sides. There shall be three doors in the fifth, eighth, and tenth spaces between hoops, made by cutting out from staves 28 inches long cut to a 45-degree bevel sloping to the inside. (See Fig. 174.) The staves shall then be fastened together with two 2x4-inch battens cut on inside to an 8-foot radius and bolted to each stave with two ¼-inch diameter carriage bolts, with round head sunk on inside and nut on outside. The staves between the doors shall be fastened together, top and bottom, with ¾-inch diameter hardwood dowel pins, and abutting ends of staves shall be squared and toe-nailed together.

Bottom Plates — Bottom plates shall be made of 2x4-inch pieces about 2 feet long, cut to a curve of 7 feet 10 inches radius outside. They shall be bedded in cement mortar and the staves shall then be set on the foundation and well spiked to these plates.

Hoops — Hoops shall be made from two pieces of ⅝-inch diameter round iron with upset ends, threaded 8 inches, with nut and washer at each end; as a support for the hoops a piece of 4x6-inch shall be substituted for a stave on opposite sides and holes bored in it and the ends of hoops passed through these holes and tightened against the sides of the 4x6-inch. The hoops shall be twelve in number, starting at the bottom 6 inches apart and increasing in distance 6 inches between each hoop, until a space of 3 feet 6 inches is reached; from this point up this distance shall be preserved as near as possible to the top.

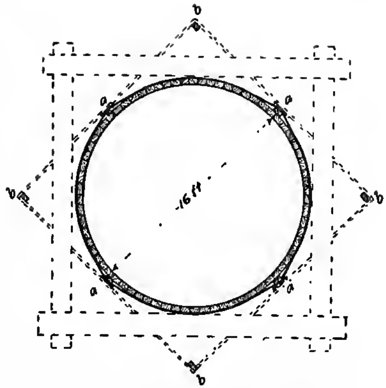

Fig. 172. Cross-section of stave silo. The dotted lines are to show how scaffolding may be put up. (Clinton.)

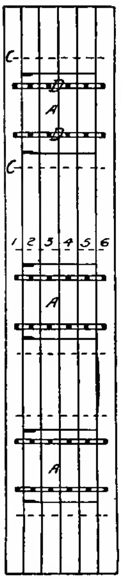

Fig. 173. Six-stave silo front, ready to be put up: A, A, A, doors; C, C, C, dowel pins; D, D, D, door battens (Cap. Lbr. Co.)

Roof -- Roof shall be made to a half-pitch of 6 inches clear siding, lapping joint, nailed to 2x4-inch rafters, 2-foot centers, 1-foot by 4-inch ridge, and 2x4-inch plates. These plates to be supported on two 4 x 4-inch pieces resting on top of hoops. (See Fig. 178.) Three 1x4-inch collar beams shall be spiked to end and middle rafters to tie side of roof together.

Painting — The entire outside of the silo, including roof, shall be painted two coats of good mineral paint; the entire inside surface of staves and doors shall be thoroughly coated with hot coal tar.

Note — Before filling silo, tarred paper should be tacked tightly over doors and the entire inside of silo examined and all cracks tightly calked.

Notes on Construction — The method of making the foundation of a stave silo recommended by a New York manufacturer is shown in Figs. 170 and 171.

A good way of starting the building of a stave silo is illustrated in Figs. 173 and 175. Some manufacturers of stave silos furnish such silo fronts, all joined together and ready to set in place, at a small extra charge, with battens D, D, bolted on, and dowel-pinned together; after the front is up and braced, so that it stands perfectly perpendicular every way, the silo is built by adding a stave at a time to this front, each stave being firmly fastened by cleats on the inside, one near the top, one in the middle, and one near the bottom. (Fig. 176.)

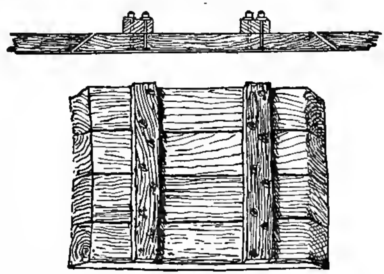

Fig. 174. Appearance of door in stave silo after being sawed out, and side view of door in place. (Clinton.)

Before filling the silo the hoops should be drawn somewhat tight, but not perfectly so, so as to allow for the swelling of the staves from the moisture which they will take up from the corn. The hoops should be watched closely for some days after the silo has been filled, and if the strain becomes very intense the nuts should be slightly loosened so that the hoops will not be broken or the thread stripped.

FIG. 175. Setting up the stave silo in sections. (Harder.)

In order to prevent the collapse of the silo during the summer when it is empty and the staves have become thoroughly dried out, the hoops should be fastened with numerous staples; these will prevent the hoops from sagging or dropping down, and will also hold the staves in place.

SQUARE OR RECTANGULAR WOODEN SILOS

Bays of the barn may be easily changed into silos according to the following directions given by Professor Whitcher:

"Remove floors, and if there is a barn cellar, place sills on the bottom of this and set 2 x 8 scantling vertically, bringing up the inside edges even with the sills of the barn. The bottom may or may not be cemented, according as the ground is wet or dry. If to be cemented, three casks of cement and an equal amount of sharp sand or gravel will cover a bottom 16 x 16 and turn up on the sides two feet, which will give a tight silo. Common spruce or hemlock boards, square-edged and planed on one side, are best for boarding the inside of the silo; these are to be put on in two courses, breaking joints, and, if thoroughly nailed, will give a tight silo. No tonguing or matching is needed. Tarred paper may be put between the boarding, if desired, but I doubt if it is of great utility.

"At some point most easily accessible, an opening extending nearly the height of the silo must be made, to put in the corn and take out the silage. The courses of boards should be cut shorter than the opening, to allow loose boards to be set in, lapping on the door-studding and making an air-tight joint. For all this work medium lumber is good enough, and a very limited amount of mechanical skill and a few tools, which all farms should have, will enable most farmers to build their own silo.

"A few iron rods, one-half inch in diameter, may be necessary to prevent spreading by side pressure, but this will depend upon the strength of the original frame of the barn. Narrow boards, from 5 to 8 inches wide,

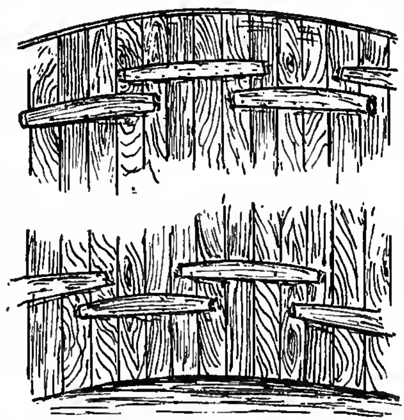

FIG. 176. Use of barrel staves in setting up a stave silo; they should be removed before the silo is filled.

are better than wide ones, as they are not likely to swell and split. Eight-penny nails for the first boarding and twelve-penny nails for the second course will hold the boards in place.

"A silo constructed as above outlined will cost from 50 cents to $1 for each ton of its capacity, according as all materials, including lumber and stone, are charged, or only labor and nails, rods, and cement."

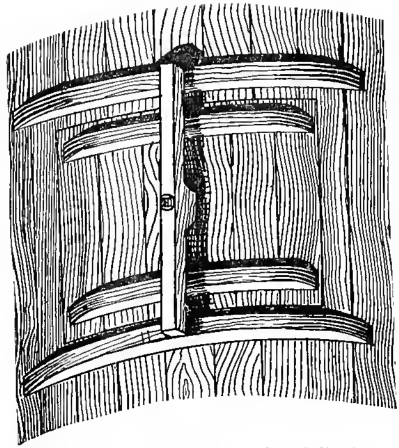

Fig. 177. Door of stave silo. (Elias.)

CROPS FOR THE SILO

CORN SILAGE

The varieties of corn to be planted for the silo must differ according to local conditions, as of climate and soil.

Ideal Varieties —The ideal silage corn, according to Shelton, is a variety having a tall, slender, short-jointed stalk, well eared, and bearing an abundance of foliage. The leaves and ears should make up a large percentage of the total weight, and the yield per acre should be heavy. The lower leaves should keep green until the crop is ready to harvest, and it is desirable to have the plant stool well and throw out tall, grain-bearing suckers. A silage variety should mature late, the later the better, so long as it only matures, as a long-growing, late-maturing sort will furnish much more feed from a given area than one that ripens early.

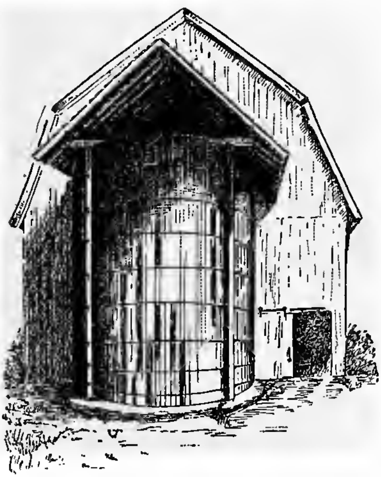

Fig. 178. A cheap roof of stave silo. (Clinton.)

Thickness of Planting — In planting corn for the silo we want the largest quantities of food materials that the land is capable of producing. This, evidently, can be obtained by a medium thickness of planting. If too thin or too thick planting be practiced, the total yields of food materials obtained will be decreased — in the former case, because of the small stand of plants; in the latter, because of insufficiency of light, moisture, and other conditions necessary to bring the plants forward to full growth.

Corn should be planted in hills or drills, and not broadcast. The objection to sowing corn broadcast is that the land can not be kept free from weeds in this case, except by hand labor; that more seed is required, and that plants will shade one another, and therefore not reach full development, from lack of sufficient sunshine and moisture. As a result, the yield will be greatly diminished.

When to Harvest—The largest amount of food materials in the corn crop is not obtained until the corn is well ripened. When a corn plant has reached its total growth in height, it has attained only one-third to one-half the weight of dry matter it will gain if left to grow to maturity; and although there is a slight decrease in the digestibility of the dry matter and a marked decrease in that of the crude protein and crude fiber with the greater maturity of the fodder, we nevertheless find that the general practice of cutting corn for the silo at the time when the fruit has reached the roasting-ear stage, is good science, and in accord with our best knowledge on the subject.

CLOVER AND ALFALFA SILAGE

When properly made, clover silage is an ideal feed for nearly all kinds of stock. Aside from its higher protein content it has an advantage over corn silage in point of lower cost of production. The late A. F. Noyes of Dodge County, Wisconsin, who siloed 1,200 tons of clover during his last eight years, estimated the cost of one ton of clover silage at 70 cents to $1, against $1 to $1.25 per ton of corn silage.

When to Cut—The common practice of farmers is to cut clover for the silo when in full bloom, or when the first single heads are beginning to wilt, that is, when right for haymaking, and we notice that the teachings of the investigations made are in conformity with this practice.

What has been said in regard to the siloing of clover refers to alfalfa as well. Alfalfa silage compares favorably with clover silage, both in chemical composition and in feeding value. It is richer in flesh-forming substances (protein) than clover silage, or any other kind of silage, and makes a most valuable feed for farm animals, especially young stock and dairy cows.

OTHER SILAGE CROPS

Sorghum is sometimes siloed in the Western and Middle States.

Sorghum for silage is sown in drills, three and one-half inches apart, with a stalk every six to ten inches in the row, and is cut when the kernels are in the dough stage, or before. According to Shelton, the medium-growing saccharine and non-saccharine sorghums are all excellent silage materials. The sorghums are less liable to damage by insects than corn, and they remain green far into the fall, so that the work of filling the silo may be carried on long after the corn is ripe and the stalks all dried up. The yield per acre of green sorghum will often reach twenty tons, or one-half as much again as a good crop of corn.

Cow-pea Silage is greatly relished by farm animals after they once become accustomed to its peculiar flavor; farmers who have had considerable practical experience in feeding this silage are of the opinion that cow-pea silage has no equal as a food for cows and sheep. It is also a good hog food, and for all these animals is considered greatly superior to pea-vine hay.

Soja Beans (*soy beans*) are another valuable silage crop. The vigorous late varieties are well adapted for silage. The crop is frequently siloed with corn (two parts of the latter to one of the former), and like other legumes it improves the silage by tending to counteract the acid reaction of corn silage.

Mixed Silage—Professor Robertson of Canada has recommended the *Robertson Ensilage Mixture* for the silo.

The mixture is made up of cut Indian corn, sunflower seed heads, and horse beans in the proportion of one acre corn, one-half acre horse beans, and one-quarter acre sunflowers. The principle back of this practice is to furnish a feed richer in flesh-forming substances (protein) than corn, and thus avoid the purchase of large quantities of expensive protein foods, like bran, oil meal, etc. Feeding experiments conducted with the Robertson Silage Mixture for cows at several of our experiment stations have given very satisfactory results, and have shown that this silage mixture can be partly substituted for the grain ration of milch cows, without causing loss of flesh or lessening the production of milk or fat. Fifteen pounds of this silage may be considered equivalent to three to four pounds of grain feeds.

Beet Pulp Silage—In districts near sugar beet factories, where sugar beet pulp can be obtained in large quantities and at a trifling cost, stock feeders and dairymen have a most valuable aid in preserving the pulp in the silo. As the pulp is taken from the factory it contains about 90 per cent of water.

The pulp packs well in the silo, being heavy, finely divided and homogeneous, and a more shallow silo can therefore be safely used in making pulp silage than is required in siloing corn, and especially clover and other crops of similar character. If pulp is siloed with other fodder crops, it is preferably placed uppermost, for the reason stated. Beet tops and pulp may also be siloed in alternate layers in pits three to four feet deep, and covered with boards and a layer of dirt.

Beet pulp silage is relatively rich in protein and low in ash and carbohydrates (nutritive ratio 1:5.7). Its feeding value is equal to about half that of corn silage.

FILLING THE SILO

If the corn is to be cut before being filled into the silo, it is unloaded on the table of the fodder-cutter and run through the cutter, after which the carrier elevates it to the silo window and delivers it into the silo.

Fine vs. Coarse-cut Silage—The length of cutting practiced differs somewhat with different farmers, and according to variety of corn to be siloed. The general practice is to cut the corn in one-half to one-inch lengths, a few cut in two-inch lengths. The corn will pack better in the silo the finer it is cut, and cattle will eat the larger varieties cleaner if cut into inch lengths or less. On the other hand, it is possible that fine cutting implies larger losses through fermentations in the silo; fine-cut silage may, furthermore, not keep as long as silage cut longer after having been taken out of the silo. There is, however, not sufficient experimental evidence at hand to establish either of these points; the majority of farmers filling silos, at any rate, practice cutting corn fine for the silo.

Spreading and Packing — The carrier should deliver the corn as nearly in the middle of the silo as possible ; by means of a chute attached to the carrier, the cut corn may be delivered to any part of the silo desired ; and the labor of distributing and leveling the corn thus facilitated. If the corn is siloed "ears and all," it is necessary to keep a man or a boy in the silo while it is being filled, to level the surface and tramp down the sides and corners ; if left to itself, the heavier pieces of ears will be thrown farthest away and the light leaves and tops will all come nearest the discharge ; as a result, the corn will not settle evenly, and the feeding value of different layers of silage will differ greatly. To assist in the distribution of the corn it is recommended that a pyramidal box be hung in front and below the top of the carrier ; this may be made about three feet square at the base and tapering to a point, at which a rope is attached for hanging to rafters. The descending mass of cut corn will strike the top of the box and be divided so as to distribute to all parts of the silo. Another simple device is to place a board vertically, or nearly so, in front of the top of the carrier, against which the cut corn will strike; or, to tie a bag, open at the bottom, over the top of the carrier.

Rapid vs. Slow Filling — Generally speaking, rapid filling has the advantage in point of economy, both of labor and of food materials. The fermentations are left to proceed farther in case of slow filling than when the silo is filled rapidly, being greatly aided by the oxygen of the air, which then has better access to the separate layers ; this is plainly shown by the higher temperature reached in slowly filled silos. The rise in the temperature is due to the activity of bacteria, and a high temperature, therefore, means greater losses of food constituents. More silage can be obtained in the same silo by slow than by rapid filling, as the fodder will settle more in the former case than when the silo is filled at once, and refilled after a few days.

As there may be some farmers who still hold slow filling to be preferable, we give the directions for filling the silo in this way : When enough corn has been added to fill three to six feet of the silo, the filling is discontinued and the mass allowed to heat up to 120° to 140° Fahrenheit. This may take a day or two; the filling is then continued, and another layer of three feet or more filled in, which is left to heat as before. This method of intermittent filling is continued until the silo is full.

Carbon Dioxide[1] Poisoning — As soon as the corn in the silo begins to heat, carbon dioxide is evolved, and if the silo is shut up tight, the gas will gradually accumulate directly above the fodder, since it is heavier than air and does not mix with it under the conditions given. If a man or an animal goes down into this atmosphere, there is great danger of asphyxiation, as is the case under similar conditions in a deep cistern or well. Poisoning cases from this cause have occurred in filling silos where the filling has been interrupted for one or more days, the carbonic acid generated in the meantime having replaced the layer of air immediately above the corn, and men who have gone into the silo to tramp down the cut corn have been asphyxiated. If the doors above the siloed mass are left open when the filling is stopped, or at least the first door above the surface of the corn, and the silo thus ventilated, the gas will slowly diffuse into the air. Carbon dioxide being without odor or color, to all appearances like ordinary air, it can not be directly observed, but may be readily detected by means of a lighted lantern or candle. If the light goes out when lowered into the silo, there is an accumulation of this gas in it, and a person should open feed doors and fan the air in the silo before going down into it.

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[1] Popularly called "carbonic acid gas."

After the silage is made and the temperature in the silo has gone down considerably, there is no further evolution of carbon dioxide and therefore no danger in entering the silo, even if this has been shut up tight.

Covering the Siloed Fodder — Straw, marsh hay, sawdust, finely cut corn stalks or green husked fodder, cotton-seed hulls, etc., are used in various localities to cover the siloed fodder, but none of the materials recommended for the purpose can perfectly preserve the uppermost layer of silage, as far as my experience goes, some six to eight inches of the top layer usually being spoiled. The wet or green materials are better for cover than dry substances, since they prevent evaporation of water from the top layer.

The practice of applying water to the fodder in the silo has been followed in a large number of cases. The surface is tramped thoroughly and a considerable amount of water added. By this method a sticky, almost impervious layer of rotten silage, a couple of inches thick, will form on the top, which will prevent evaporation of water from the corn below, and will preserve all but a few inches of the top.

None of the different methods foregoing will preserve all of the silage intact, and the author knows of only one way in which this can be accomplished, viz.: by beginning to feed the silage within a few days after the silo has been filled. This method is now practiced by many farmers, especially dairymen, who in this manner supplement scant fall pastures.

F. W. Woll

PUBLICATIONS ON THE CONSTRUCTION AND MANAGEMENT OF SILOS

NOTE — In addition to the few publications on the subject of Silos and Silage here listed, many of the State agricultural experiment stations have issued bulletins which are sent free to residents of the respective States. For convenience in ordering these and other bulletins, a directory of the experiment stations is given in this connection. Directors should be addressed in their official capacity, and not personally, to obviate the possibility of delay in the supplying of bulletins in their absence from their stations.

A BOOK ON SILAGE. By F. W. Woll. *Rand, McNally & Co.*, Chicago . . .	$0.75
PHYSICS OF AGRICULTURE. By Franklin H. King. *F. H. King*, Madison, Wis. .	2.00
Thirty-four pages of this work are given over to a treatment of mechanical considerations in silo-building.	
SILOS, ENSILAGE, AND SILAGE. By Manley Miles. *Orange Judd Co.*, N. Y.	.50
SILOS AND SILAGE. By C. S. Plumb. Farmers' Bulletin 32. *United States Department of Agriculture*	——

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[1] College Station.
[2] Canebrake Station.
[3] Tuskegee Station.
[4] State Station.
[5] Storrs Station.
[6] State Station.
[7] Sugar Station.
[8] North Station.
[9] Fruit Station.
[10] State Station.
[11] College Station.
[12] State Station.
[13] Cornell Station.

Making Poultry Pay

By P. H. Jacobs, Editor *The Poultry Keeper*, Hammonton, N. J.

CAUSES OF FAILURE

While it may safely be asserted that all farms have their flocks of poultry, and that in proportion to capital invested larger profits are derived from that source than from any other live stock, yet farmers, as a rule, do not give that consideration to the poultry department to which it is justly entitled.

Everything depends upon the *man* in the management of poultry; that is, success or failure rests entirely upon the management, and in studying the causes of failures the poultry keeper must hold in view the fact that the fowls are creatures in his charge, and that upon his judgment hinges the question of profit or loss. What have been the causes of failure with the many who have ventured into the poultry business, only to fail and then to decide that "poultry keeping does not pay"? The following are the chief reasons, and they should be carefully considered:

1. Endeavoring to keep two fowls where room for one only can be obtained; that is, saving in expenses by cheapening the cost of houses and space.

2. Buying fowls from other farms and thus bringing disease and lice into the flocks.

3. Overfeeding, the fowls being supplied with the greatest abundance under the supposition, "the more feed the more eggs."

4. Cold drafts over the fowls at night, with a view to supplying fresh air, when the thermometer is low.

5. Wasting time with sick fowls instead of destroying all birds that can not be quickly cured.

6. Disregarding the breeds by keeping anything that is a fowl.

7. Lack of exercise, the fowls being idle, discontented, and consuming food because they have nothing to do.

8. Failure to provide sufficient warmth in winter, a season when eggs are highest.

9. Feeding corn and wheat exclusively and omitting foods which supply albumen for the eggs.

10. Feeding three times a day, the result being indigestion and the introduction of disease in the flock.

11. Lice, both mites and the large lice that are found only on the bodies of the fowls and at all seasons of the year.

12. Failure to keep the houses and yards clean. Labor is withheld at the most important periods.

Success, therefore, depends upon the observance of certain rules, a negligence of the one being almost equivalent to disregard of the whole. Let us now consider what the enterprising poultryman should do, and take up each of the rules above by way of explanation :

1. **Too Many Fowls** — Some fowls, such as Brahmas, are not so active foragers as others, but they should have room in which to exercise.

The proper plan is to allow at least *five square feet of space on the floor for each fowl;* hence, a house 10 x 10 feet (100 square feet) should not contain more than 20 fowls in winter. Such a house in summer, with the south side open, and protected by wire netting, with suitable roosts (all on a level, not stepped), may contain 30 or 40 fowls, as the yard affords room for exercise.

The yard should have at least *ten times the space of the house*, but the larger the better. In winter the grain food should be scattered on the floor of the house, in chaff, cut straw, leaves, or even dry dirt, that each bird may scratch and work for its share, thus compelling exercise. More eggs will be obtained from ten hens having plenty of room than from twenty that are crowded; while the cost of food and labor will be largely reduced.

2. **Buying Fowls** — Never allow a bird from elsewhere in your flock unless you are absolutely sure that it is free from disease and lice. It is cheaper to quarantine all purchased birds for a week, or even a month, than to battle a whole year with a flock of diseased birds, as one bird will infect all the others. Keep neighbors' pigeons away from your yards, also the sparrows, if possible, as they may carry disease on their feet.

3. **Overfeeding** — The large majority of poultrymen feed too much. It is better to underfeed than to overfeed, for should a fowl become too fat it will be in excellent condition for market but will produce few, if any, eggs. Indigestion results, the generative organs become weakened, fatty degeneration of the heart and liver occurs, while baggy crops, the crop-bound condition, laziness, and general susceptibility to disease, will prevail. It is the eggs from overfed hens that fail to hatch in incubators, the chicks dying in the shells at an early stage, or just before they should come out. Always keep the fowls busy. Never feed three times a day,

as there should be a long interval between meals for digestion and to prevent the filling of the crop before the previous food is digested and assimilated.

FIG. 179. Brown Leghorn cock and hen.

4. **Cold Drafts**—Our dwelling houses are tight, plastered, and warm, and even then the cold "fresh air" is forced in by atmospheric pressure. Poultry houses are seldom plastered and can not easily be made tight. The fowls usually roost near the upper part, which is not always close in winter. Ventilation does not mean cold drafts coming in upon the fowls. Never have an open ventilator at the top when the weather is damp or cold, and, as much depends upon the direction of the wind, just how to ventilate is a matter for observation. The conditions for to-day may not be suitable for to-morrow. Have the poultry house tight in winter, especially at the top, and keep the doors and windows open during the day. If the house is not crowded there will be no liability of insufficient air at night. To test this, go into the house at night with a lighted candle, or a lighted cigar, and it will be noticed that fresh air is coming in from somewhere. It is more difficult to keep it out than to let it in. In summer have the house just as close, but open on one side. In other words, aim to have summer conditions in winter.

FIG. 180. White-faced Black Spanish cock and hen.

FIG. 181. Silver-spangled Hamburg cock and hen.

5. **Sick Fowls**—Do not waste several days' time "doctoring" a hen worth perhaps 50 cents. Always value your time and labor. Have a place for sick fowls. If it appears that a hen can not be cured within a reasonable time it is cheaper to get rid of her, for it does not pay to have her lose time, and such hens seldom amount to anything when they recover. Take no risk of spreading disease. Better kill a few than lose all.

6. **Disregarding the Breeds**—The dairyman who overlooks the differences between the beef breeds, milk breeds, and butter breeds, falls behind his more enterprising competitor. The *strongest competitor of the poultryman is some*


Fig. 182. Black Minorca cock and Blue Andalusian hen.

other poultryman, and the one who understands the importance of the various breeds will win. It is not pleasant to say that the man who of all others should know one breed from another — the farmer — really knows less about fowls than those living in the suburbs of cities and towns, and the farmer would consider it an affront to be so informed, as he is supposed to be as skilled in his calling as are those engaged in other industries. But all farmers are not ignorant in that respect, for many of them realize the value of the breeds. Do not begin by going out and buying fowls of all kinds, from all sources, but start with a few and raise them for yourself. One year only will make a great change in a flock by the use of pure-bred males. One good fowl is worth two worthless ones. Try to have them uniform. You may begin even with common hens, but always use pure-bred males, and your young stock will then be improved every year.

7. **Lack of Exercise** — No farmer keeps his horse standing idle continually if he can prevent it. Keep the fowls busy. When they seem to have nothing to do keep the food away. Many flocks appear hungry all the time, but do not scratch. The cause is too much attention and too much food, as such fowls soon learn to wait for their owner to feed them, running to him every time he appears. They do not work because they do not have to work.

8. **Lack of Warmth in Winter** — It is not necessary to have a fire in the poultry house in winter unless the house is severely cold or damp, and even then a stable lantern hanging from a wire will give sufficient heat; but have the house close on the north, east, and west sides, with large windows on the south, so as to admit heat from the sun during the day. Keep the floor littered six inches deep with leaves, cut straw, etc., which shuts off cold drafts along the floor and provides litter for scratching. Wire fences admit winds through the yards. Always provide hedges or boards as windbreaks. If the combs of the fowls become frozen they will not lay. Warmth will make the hens lay more eggs than will the food.

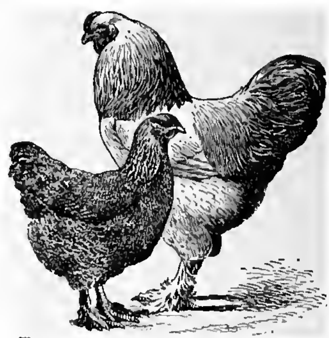
Fig. 183. Light Brahma cock and Dark Brahma hen.

9. **Feeding Grain** — Throwing down corn and wheat, and nothing else, is a lazy method, and it

induces no results. Give a variety. Hens can not possibly produce eggs in large numbers from corn and wheat alone, as such foods do not contain all the essential elements of egg production. They will lay eggs for a while, and apparently liberally, but sooner or later they will fall off in number.

10. **Feeding Three Times a Day**—Do not do it, for the reasons already given.

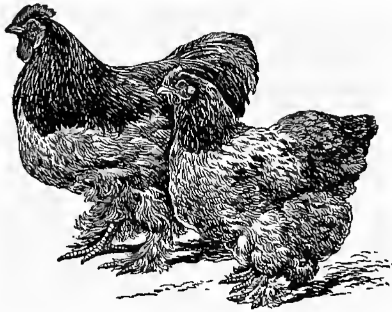

FIG. 184. Buff Cochin cock and hen.

11. **Lice**—All poultrymen are willing to get rid of lice, but they seldom know when their fowls are infested. They examine the poultry houses and destroy the mites, retiring with the satisfaction of being rid of the pests. The real depredators are those seldom seen. They exist at all seasons, winter and summer, on the bodies of the fowls, usually close to the skin, on the heads, under the wings, and wherever they can hide. As soon as chicks are hatched these large lice go to them from the hens. Thousands of young turkeys die from that cause, as a single large gray louse can torture a chick to death. Examine for lice frequently.

There is but one remedy for lice — work. When mites infest the poultry house, apply kerosene (adding a gill of crude carbolic acid to every quart of kerosene), using a brush. With a sprayer the carbolic acid and kerosene may be sprayed over the house if an emulsion with soap is prepared. This is done by shaving a pound of hard soap in half a gallon of water, boiling until the soap is in the solution. While hot remove from the fire, adding the kerosene and acid, churning briskly for 15 minutes until a creamy substance results. Then add 20 quarts of cold or hot water, and spray.

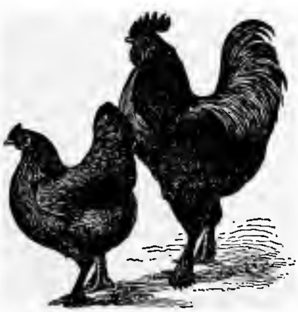

FIG. 185. Black Langshan cock and hen.

For lice on the bodies use melted lard, but never use grease or oils too freely on fowls. A mixture of a gill of lard and ten drops each of sassafras, cedar, and pennyroyal oils may be applied daily, until the lice are destroyed. The premises must be kept clean, a dust bath provided for the birds, and whitewash used freely Work performed at the proper time will save many hours' labor.

12. **Lack of Cleanliness**—The poultry house and yards must be kept as clean as possible. An excellent plan is to have two yards to each house, growing green food in one while the other is occupied, changing the fowls to the cultivated yards as occasion requires. In this manner the filth is turned under, the manure

utilized, and no loss of space occurs, as the extra yard will produce a portion of the food. Fowls delight to work on spaded or plowed ground.

The poultry keeper is disposed to consider his fowls as "flocks" instead of individuals, overlooking the fact that a flock may contain a number of fowls, no two of which are alike. The individual peculiarities and characteristics of each individual must be a daily study, and the management must be regulated accordingly.

THE BREEDS OF POULTRY

The farmers who can not distinguish the breeds, and who allow their flocks to inbreed for generations, are legion, though there are many enterprising farmers, nevertheless, who keep only pure breeds and endeavor to make a profit therefrom. Such farmers know that eggs sell for cash, and that the supply from the flocks can be maintained every month in the year with good management.

Those who give the fowls over to their wives and daughters to manage do not use judgment, for the reason that there is considerable labor to be performed in winter which is too severe for the female sex, the result being that on hundreds of farms the hens lay in the summer season, as they are then free to forage and secure for themselves all that may be required, but do not lay in winter because the conditions are changed. It is possible that the farmer's wife will occasionally give the hens a good meal when the weather is very severe, but there will be more irregularities in the periods of feeding than should be the case.

Another cause of lack of profit is the adherence to grain only as a food for poultry, corn and wheat being relied upon almost exclusively, resulting in indigestion and inability to produce eggs because the food is not properly balanced in the essential requisites for egg production.

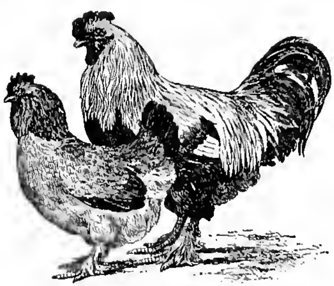

Fig. 186. Faverolle cock and hen.

Fig. 187. Plymouth Rock cock and hen.

Strictly speaking, there is no "general-purpose" fowl, hence no "best breed" both for eggs and for market. The best breed for laying may be unprofitable because it can not endure the climate. The best breed for market may not prove satisfactory for producing eggs. A breed may be best for one purpose and sadly deficient in some other respect. Another point is that the "best" breed may have some families better than the others, and in these families may be some undesirable individuals. Some Jersey cows have produced more than 20 pounds of butter per week (one very close to 40 pounds, according to the claim), but there are hundreds of Jersey cows that do not produce 10 pounds of butter per week. Much, therefore, depends upon the individuals of each breed. It has been claimed that Leghorns, Hamburgs, Minorcas, and Black Spanish will surpass all other breeds as layers, yet some flocks of these breeds do not prove satisfactory.

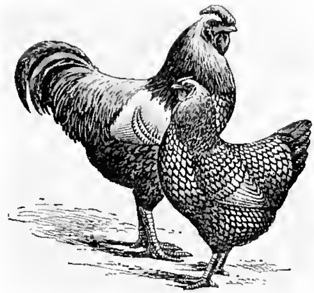

FIG. 188. Silver-laced Wyandotte cock and hen.

FIG. 189. Black Java cock and hen.

The really best layers are the Hamburgs, but unless kept under conditions adapted for them they are almost worthless, being tender, delicate, and inbred. The large combs of the Minorcas, Leghorns, and Black Spanish make them susceptible to the frost in winter, while they are not desirable in market. If you live in Texas, or south of the Ohio River, such fowls may prove excellent for laying. If you live in those States where the winters are severe use breeds that can endure the cold. After all, so far as the breeds are concerned, there is not a dozen eggs' difference in a year between the "best" and most of the others.

By using the pure breeds you can at least know what kind of fowls you have. For the farmer, we are willing to ask him to rely upon the Brahmas, Plymouth Rocks, Wyandottes, Cochins, and Leghorns, the latter thriving well if given extra care in winter. These breeds are not the best for every purpose but they are probably as hardy as any that can be tried.

FIG. 190. Dominique cockerel.

Some breeds, such as the Leghorns and other non-sitters, will become restless in confinement and pull feathers, as well as learn to eat eggs. They are active and prefer plenty of room, but under suitable conditions they do well and pay.

Eggs may bring more in winter but they cost less in summer. Many farmers sell eggs in summer that cost nothing but the food picked up on the farm, and while higher prices may be obtainable in winter, the cost of food, shelter, and labor are items which must be deducted from the gross receipts.

NON-SITTING BREEDS

The non-sitting breeds are usually small, or of medium size; disinclined to incubate, especially when young; of timid temperament; easily frightened, and given to roaming; destructive of insects, and addicted to flying if confined. They do not put on flesh readily and are tough if much more than one year old. To this class belong the *Leghorns, Spanish, Hamburgs, Minorcas, Andalusians,* and *Red Caps.*

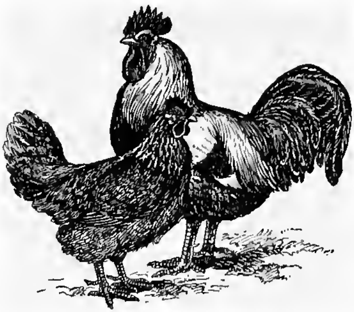

FIG. 191. Colored Dorking cock and hen.

The Leghorns (*White, Silver Duckwing, Dominique, Black, Brown,* and *Buff,* Fig. 179) are entitled to first consideration. They have trim, rather small bodies; are too active to fatten readily; are hardy, and moderate feeders. They are persistent, regular layers of rather large, snow-white eggs, a fairly well-kept hen dropping 150 or more in a year. They begin to lay at 5 months of age and preserve their habit until 6 years old. These qualities may deteriorate from inbreeding, hence a new strain should be introduced into the flock every two or three years at most.

The Black Spanish (Fig. 180) return large quantities of eggs. The bird, however, is not well feathered, more males are required to the same number of females than are necessary with the Leghorns, the young are more tender, and the breed requires more attention in winter.

FIG. 192. Houdan cock and hen.

The Hamburgs (*Silver-Spangled, Golden-Spangled, Silver-Penciled, Golden-Penciled, White,* and *Black,* Fig. 181) are small, active, and great fliers, requiring a large range to do well. They are persistent layers, and, when properly kept, will equal the Leghorns. The chicks are rather delicate, and the adults demand more attention than any of the other egg-producing breeds to be equally profitable.

The Minorcas (*Black* and *White,* Fig. 182) are the heaviest of the egg-yielding breeds, and rank next to the Leghorns as layers. Weight: Cock, 8 pounds; hen, 6½ pounds. The eggs are large. Both varieties are heavier than the Hamburgs.

The Andalusians (Fig. 182) rank with the Minorcas as hardy and excellent layers (being really Minorcas). Their plumage combines the light and dark shades of blue.

The Red Caps resemble the Hamburgs, but are larger. They are extremely good layers. Plumage is black and red.

SITTING BREEDS

The principal sitting breeds are the *Brahmas*, *Cochins*, *Langshans*, and *Faverolles*, prized as being excellent layers and mothers, and also for their market qualities. All these breeds are slow in their motions, not easily frightened, not given to roaming, easily confined by low fences, readily tamed, heavy feeders, and excellent layers.

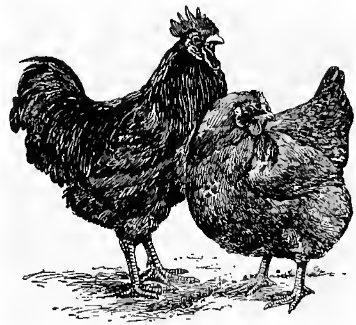

FIG. 193. Rhode Island Red cock and hen.

The Brahmas (*Light* aud *Dark*, Fig. 183) are the best types of the meat producers. Weight: Cock, 12 pounds; hen, 9½ pounds. *Dark* variety, 1 pound less in each case. The young mature rather slowly. So inactive are the Brahmas that a fence 4 or 5 feet high suffices to restrain them; they are persistent sitters, but so clumsy on the nest that they sometimes break many of the eggs. They are above the average as egg-producers, the *Light* being the better of the two varieties. The flesh is of excellent quality, but they lack in breast meat.

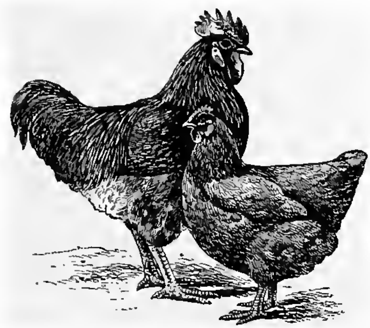

FIG. 194. Buff Orpington cock and hen.

The Cochins (*Buff*, *Partridge*, *Black*, and *White*, Fig. 184) are good sitters, and, when properly managed, good layers, but are disposed to fatten readily. They equal the Brahmas as market fowls. Weight: Cock, 11 pounds (except *Black Cochin*, 10½ pounds); hen, 8½ pounds.

The Langshans (*Black* and *White*, Fig. 185) are smaller and more active than any of the other Asiatics, and their flesh is of excellent quality. They are preferable to the Brahmas or Cochins only because they are better foragers. Weight: Cock, 10 pounds; hen, 7 pounds.

The Faverolles (Fig. 186) are the result of a cross among the Brahmas, Dorkings, Cochins, and Houdans. The chicks mature remarkably early, and are hardy and easily reared; the flesh of the young birds is excellent.

"GENERAL-PURPOSE" BREEDS

The "general-purpose" breeds (if such term may be used) are the *Plymouth Rocks*, *Wyandottes*, *Javas*, *Dominiques*, *Dorkings*, *Houdans*, and *Rhode Island Reds*, ranking as to excellence in the order named.

The Plymouth Rocks (*Barred*, *White*, and *Buff*, Fig. 187) have plump, square bodies, mature early, and are above the average as winter layers; the hens make excellent mothers, and this is considered by many as the general-purpose breed *par excellence*. The *Barred* variety is most popular. Weight: Cock, 9½ pounds; hen, 7½ pounds.

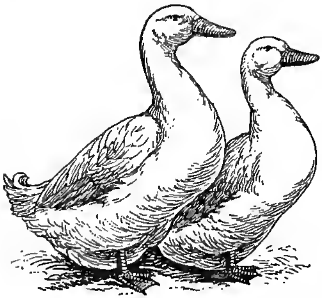
Fig. 195. White Pekin duck and drake.

The Wyandottes (*White, Silver-laced, Golden, Buff,* and *Black,* Fig. 188) are smaller than the Plymouth Rocks, and can be kept more economically. They have fuller breasts than some other varieties, are hardy, mature early, are well feathered, and attractive in appearance. The *White* variety is most desirable. Weight: Cock, 9½ pounds; hen, 7½ pounds.

The Javas (*Black, Mottled,* and *White,* Fig. 189) are an old American class of fowls that for no good reason have lost popularity. They are excellent as egg producers and for market purposes, maturing early, and having the yellow shanks and toes, the absence of which constitutes an objection to some of the dark-colored breeds. The hens make good sitters and mothers, and the Javas bear confinement well. The *Black* variety is most commonly kept. Weight: Cock, 9½ pounds; hen, 7½ pounds.

The Dominiques (Fig. 190) resemble the Plymouth Rocks. They bear confinement well and do not appear to deteriorate from inbreeding to the extent observed in some of the other breeds. They mature early, are hardy, make good mothers, and are valuable as a farm variety. Weight: Cock, 8½ pounds; hen, 6½ pounds.

The Dorkings (*White, Silver-Gray,* and *Colored,* Fig. 191) have short legs and heavy bodies and are hardy if properly cared for, but still are too delicate to endure confinement in damp, cold houses. They rank high for quality of flesh. Weight: *White,* cock, 7½ pounds; hen, 6 pounds; *Silver-Gray,* cock, 8 pounds; hen, 6½ pounds; *Colored,* cock, 9 pounds; hen, 7 pounds.

The Houdans (Fig. 192) are the most popular of all the French breeds. Wright says of them: "Better table fowls there are none; the laying powers are great; the chicks fledge and grow faster than almost any other breed, and the eggs are prolific." Their objectionable features are the fifth toe, heavy beard and crest, and their flying habit. Weight: Cock, 7 pounds; hen, 6 pounds.

Rhode Island Reds (Fig. 193) are smaller, more active, and mature earlier than the Plymouth Rocks. They are hardy, prolific, furnish a good quantity and quality of meat, and are excellent layers.

Buff Orpingtons (Fig. 194) are a favorite fowl in Canada, where they are raised for export to England. The breed has been received with favor in the United States, because of the excellence and quantity of the flesh and the pullet's capacity as an egg-producer. Weight: Cock, 10½ pounds; hen, 8½ pounds.

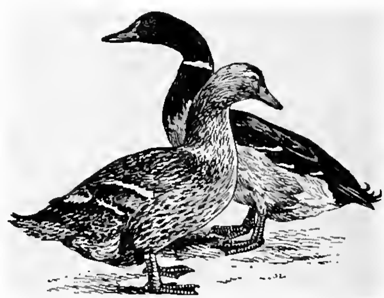
Fig. 196. Rouen duck and drake.

"FANCY" BREEDS

The "fancy" breeds, as a rule, present few claims either as layers or as food producers.

Unless kept by themselves they will vitiate any other strain. The most celebrated of the fancy varieties are the *Polish, Games, Silky, Sultan, Frizzle, Rumpless,* and *Bantams* of several varieties. All these are more or less delicate, and require extra care, with the exception of the Bantam, which is undesirable in any poultry yard except as a pet.

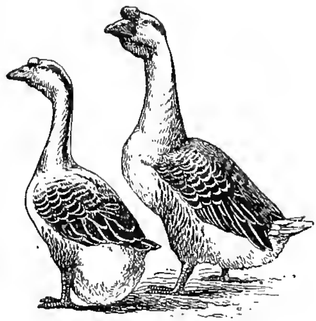

FIG. 197. Gray African goose and gander.

DUCKS

The White Pekin (Fig. 195) is the most popular of the profitable breeds of ducks; pure white, hardy, an excellent layer. Weight: Drake, 6 pounds; duck, 7 pounds. Birds 10 weeks old may be fatted to 5 pounds for marketing.

Aylesburys by many are preferred to the Pekins, as being hardier, heavier, and more prolific, and by others are crossed upon the lighter breed. Weight: Drake, 9 pounds; duck, 8 pounds.

Rouens (Fig. 196) also are heavier than Pekins, but dark plumage is a disadvantage, as the white birds make better appearance when dressed; flesh fine-grained and of good flavor; development rather slow. Weight. Drake, 9 pounds; duck, 8 pounds.

Black Cayugas are hardy, domestic, and thrive in confinement, but are open to objection as to color; mature early. Weight: Drake, 8 pounds; duck, 7 pounds.

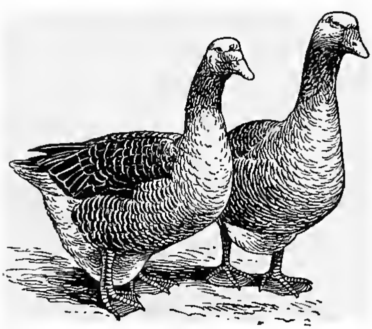

FIG. 198. Toulouse goose and gander.

GEESE

Gray African geese (Fig. 197) resemble the Pekin ducks in that they require little care, thrive in moderately close confinement, and mature early. Many raisers consider them the most profitable of all breeds. Young Africans can be marketed at 10 weeks, fattened to from 8 to 10 pounds. Flesh is of fine texture and good flavor.

Toulouse geese (Fig. 198) are large framed;

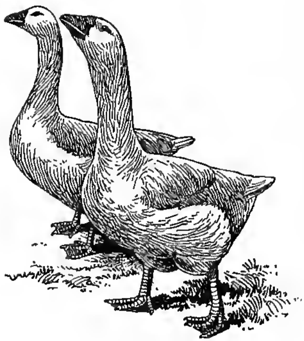

FIG. 199. Embden goose and gander.

good layers; thrive in confinement; color, gray; abdominal pouch hangs almost to ground. Weight: Gander, 20 pounds; goose, 18 pounds. The Toulouse and Embden are the largest of the breeds.

Embden geese (Fig. 199) are pure white, resembling Toulouse somewhat in form; lay fewer eggs, and are more inclined to sit; hardy, and of rapid growth.

FIG. 200. Bronze turkey cock.

TURKEYS

Bronze turkeys (Fig. 200) are most generally kept because of their surpassing size, despite their roving disposition and the large range they require. Weight: Gobbler, 36 pounds; hen, 20 pounds.

White Holland turkeys are persistent layers, and disinclined to sit early in season; mature early. Weight: Gobbler, 26 pounds; hen, 16 pounds.

Narragansetts are gray, with bronzed wings; mature early, with plump, marketable bodies. Weight: Gobbler, 30 pounds; hen, 18 pounds.

The Buffs, Slates, and Blacks are perhaps less profitable fowls than any of the foregoing, although the Buff is somewhat heavier than the White Holland. The Bronze and White Holland varieties are the most popular.

POULTRY HOUSES

There is no kind of poultry house that will suit all. One may prefer one design and another something different. All depends upon the cost. There is much disagreement in the ideas of poultrymen regarding poultry houses, and even if one selects a style that suits his ideas, the cost may be an objection. The accompanying illustrations (Figs. 201-208) show some designs of poultry houses that have proved useful in practice.

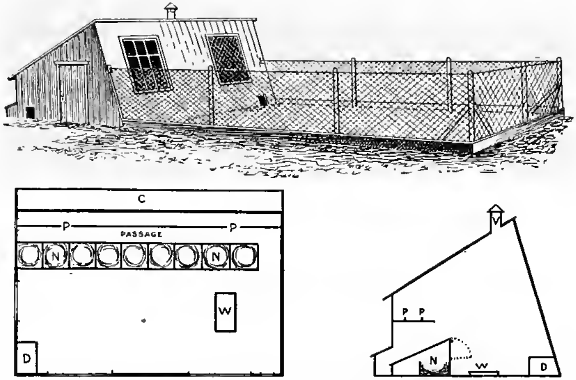

FIG. 201. House and yards for confined fowls: This house is so arranged as to be easily cleaned from the outside, the droppings falling into a trough at the rear, the floor under the roost being on an incline. C, incline; P P, roosts; N N, nests; D, dust box; W, water trough; V, ventilator.

Lathing and Plastering—All poultry houses should be lathed and plastered in order the more easily to destroy lice, but as such an item of expense is seldom incurred, more or less cold air always comes in. The majority of those designing poultry houses are more concerned about ventilation than about anything else, overlooking the fact that the houses are not plastered, and more failures occur from this cause than from all others combined. Avoid open ventilators in winter; you will have more difficulty in keeping the cold air out than in getting it in.

Roomy Quarters—While there is no "best" poultry house, one of the most desirable is that which provides a roosting place at night and a scratching place during the day It may take up considerable space, but one will get more eggs and have more vigorous fowls by giving plenty of room. As regards space required, the kind of fowls must be considered. One can keep three Leghorns on the space that two Brahmas will occupy. The floors should be of concrete, but should always be kept covered with cut straw or leaves. Any other floor will harbor rats underneath, but concrete is cold unless covered. Always protect poultry with wire against dogs, cats, rats, hawks, owls, and other enemies.

Construction for Comfort—The main object to desire in poultry houses should be warmth in winter and cool air in summer. Use plenty of glass, as fowls and chicks detest darkness, preferring the cold outside to a cheerless interior.

Hens steal their nests to escape from lice, from too much warmth in summer, or from nests or houses which for one reason or another are uncomfortable. They will lay in comfortable quarters rather than steal away to any other place.

Do not construct the house for your convenience, endeavoring, at whatever cost to the fowls, to save labor for yourself. True, one may as well take advantage of all opportunities, but keep in view that the poultry house is for the comfort of the hens more than for the convenience of their owner.

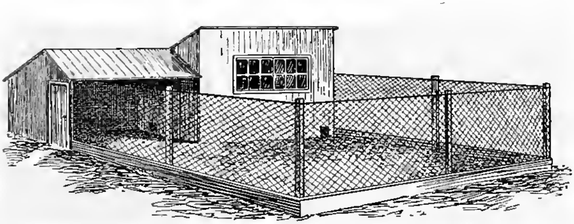

FIG. 202. Single house and scratching shed: Showing an excellent arrangement of house, shed, and yard for a small flock.

The open side of a poultry house should face the southeast, as more warmth will be thus obtained, especially in the morning. Windows may be placed on the southeast side, and on the east and west sides if preferred. The climate, soil, and location must also govern the selection of a design. Dampness must always be avoided.

INCUBATORS AND BROODERS

At the present day the incubator performs an important part in the management of poultry, and as incubators and brooders have been perfected to a high degree, they are as easily operated as farm machines, and with much less labor. The introduction of incubators, instead of reducing prices for early broilers, has increased them, as a larger number of consumers has been educated to enjoy such luxuries.

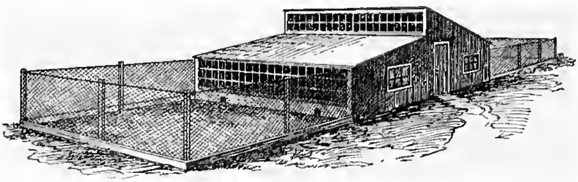

Fig. 203. Poultry house with brooder apartment: Designed to show how glass may be employed to give light and warmth to front and rear apartments.

At one time a breeder known to the writer put upon the market a large supply of ducklings, for which he had no sale. Being forced to almost give them away he did so, much discouraged, but those to whom he sold them returned for more, and the next season he could barely supply the demaud. To-day the same man hatches annually over 10,000 ducklings, for which he receives sometimes as much as 30 cents per pound.

Incubator Egg Supply—Prices of broilers are always high in April and May, and good every other month in the year. Many, however, make the mistake of selling inferior chicks, and conclude that the broiler business does not pay. One of the serious difficulties is to secure the eggs, as they are usually scarce in winter. When eggs are purchased they must be secured in small lots, from separate farms, the result being that many of them do not hatch, as each lot of fowls contributing to the supply is kept under different conditions. In some yards, or on some farms, the hens may be too fat, the males may be impotent, and the pullets may be immature; in fact, there are more drawbacks than one can easily enumerate.

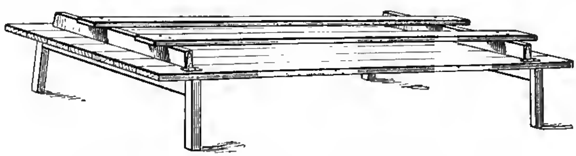

Fig. 204. Movable roost, designed for heavy fowls.

Selecting the Egg-Producing Flock—To succeed, the farmer must control his egg supply, and to do this he should keep a large number of hens, or select neighbors to do so for him. If he desires hardiness and quality in his broilers he should use Brahma, Plymouth Rock, Wyandotte, or Cochin hens, the males to be Colored Dorkings. No pullets should be retained, as the Dorkings are only moderate layers, and a flock of Dorkings should be kept solely for the purpose of producing males. The coöperating neighbors also should be provided with such males.

Cross-bred hens or pullets may be used, provided they are part Brahma, Cochin, Plymouth Rock, or Wyandotte. No attempt should be made to select the "best laying breeds," as that would entail the use of breeds not so suitable for producing broilers. The chief desideratum is *hardiness*, as the object should be to hatch only such chicks as can be raised, kept thrifty, and marketed to advantage. One good chick is worth more than two or three inferior ones, consumes less food, and entails less labor. The Dorking is the finest of all table fowls, and will give quality to the chicks. While it is not a very hardy breed, yet, if crossed with the breeds mentioned, the chicks should prove hardy.

In this connection, however, it is well to urge that before venturing too far experiments should be made with a few Dorkings, for the reason that the breeds which feather out rapidly when young are not so hardy as those which begin to feather later and slowly. The Dorking, like the turkey, feathers rapidly, the vitality of the chicks being heavily drained to produce feathers. Beginners should use Brahma or Cochin hens, or crosses of the same, and Plymouth Rocks or Wyandotte males. Avoid black fowls, as the pin-feathers show on the carcasses when dressed.

It will thus be seen that the "best" breed, even for producing broilers, is selected only with difficulty, as there are some faults in each breed. Even the hardy Brahma or Cochin is deficient in plump breast, and does not fatten readily when young, seeming to make use of all the food for purpose of growth. The Plymouth Rocks and Wyandottes are freer from faults than many other breeds intended for broilers or market fowls. Either the White or the Barred Plymouth Rocks, or any variety of Wyandottes may be selected, as there is no difference in the several varieties, except color.

A brood consisting of Leghorns and Brahmas, or of any two breeds, will not always thrive so well together as when separate, for the reason that the Leghorn requires more warmth than the Brahma. It is best to have chicks as uniform as possible.

Feeding for Eggs—Use hens in preference to pullets for producing broilers, as many pullets are immature. Chicks from eggs laid by hens are usually stronger and more vigorous than those from pullets. A hen is one that is at least one year old. When feeding the hens which are to produce eggs for incubators bear in mind that they may become too fat. Give meat, ground blood, clover hay (cut fine), green cut bone, and mixed grains, instead of feeding too much wheat and corn, and never feed mature fowls three times a day. A light meal in the morning and a full meal at night may be allowed, but always scatter about a gill of millet seed in the litter, in order to induce the hens to scratch and work. A hen that is a good scratcher, one that is constantly busy, is always a good layer.

Hints about Incubators and Brooders—As directions are always sent with incubators it is not necessary to attempt to tell how to operate them. The temperature for hatching is 103° Fahrenheit. If the incubator hatches some of the eggs, but not all, the fault is with the eggs, as no two eggs (nor two hens) are exactly alike. The fact that an incubator hatches some of the eggs is proof that only the perfect eggs were suitable for the purpose. The hen does no better. Eggs placed under hens are usually selected, a dozen of the best in a large lot being used, while those placed in incubators are of all kinds.

When operating an incubator do not depend entirely upon the regulator. Brains are more important than regulators. Do not hesitate to give care and hard work to the business. It is labor and brains that bring success. The operator who depends entirely upon the machine makes a mistake.

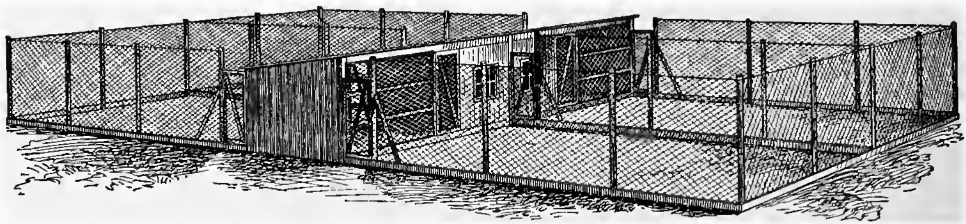

FIG. 205. Double poultry house and sheds: The sheds are shown at the ends, the roosting rooms in the center. This plan permits of any number of such houses, the interior arrangement being shown in Figs. 206 and 207. (Plan submitted by Mr. M. K. Boyer, Hammonton, N. J.)

Constant Warmth Neccssary—Early broilers are not summer chicks. A hen's success in hatching and rearing a brood in the spring is not to be compared with the brooder's work in winter. Everything depends upon warmth in the brooder for the chicks, and the warmth must be constant and regular. The most successful broiler raisers are those who have an attendant in the brooder house to watch the chicks and the temperature, and another attendant to go on duty at night; for it is in the night, when the fires get low, that the chicks become chilled, owing to lower temperature or changes in the direction of the wind.

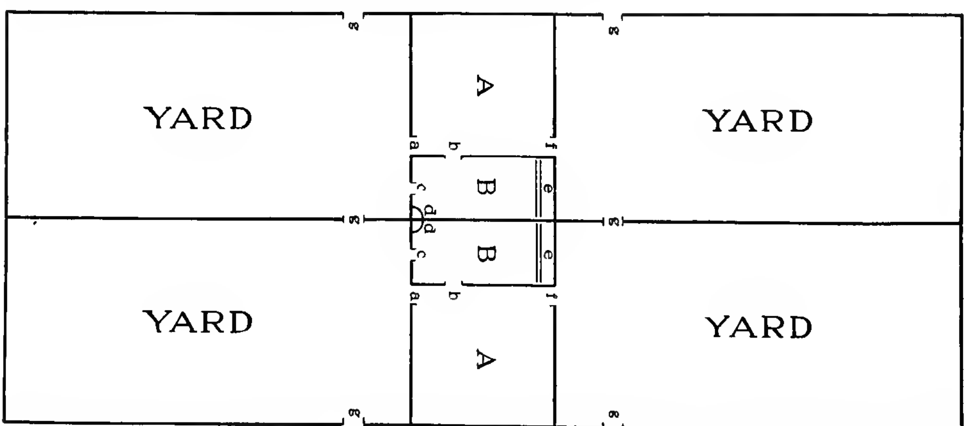

FIG. 206. Double poultry house and sheds: Floor plan. A, scratching shed; B, roosting pen; a, door to scratching shed; b, door from scratching shed into roosting pen; c, window; d, offset for drinking vessel; e, roost; f, small door into yard; g, gate in yard. Crops may be grown in alternate yards, the other yards being occupied by the fowls.

Keep in view, then, that hatching broilers with incubators is winter work. It can be done only with the incubator and brooder, as hens seldom become broody in winter. The incubator is always ready for work, and more chicks can be attended to with the aid of brooders than when hens are used. It would require 100 hens, each having 10 chicks, to hover 1,000. And, to make it plainer, a hen can not successfully hover 10 chicks in winter. True, she does it—in summer, but if turned out to care for her chicks in the winter season, she and her brood would perish.

FIG. 207. Closer view of double poultry house and sheds, showing the fowls confined during cold weather.

Care of Brooder Chicks—There is no mystery in the care of brooder chicks. They require no food for 48 hours after they are hatched, but they should have warmth in the brooder—a temperature not lower than 95° the first three days, and gradually reduced to 80°. A clean board floor, on which sharp sand has been spread, and a mess of pinhead oatmeal every two hours, for the first two days, will be all that they will require, but a teaspoonful of millet seed should be scattered on

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the floor, so as to keep them at work. Do not turn them out to get "fresh air." They will get more than you may desire if the weather is cold. More chicks are killed by fresh air than are saved, as but few brooder houses are plastered, or too close for ventilation.

Overcrowding — Do not keep too many chicks in one brooder. Fifty chicks together will thrive where a hundred will perish. Crowding is fatal. The great bane of those who raise broilers is the attempt to economize in space by keeping too many fowls or chicks together. It is better to hatch fifty, and get them to market, than to hatch a hundred and send only twenty-five to be sold.

Feeding Brooder Chicks — The first two days give pinhead oatmeal and millet seed. On the third day allow cooked potatoes (the small ones will answer), and the chicks will pick them to pieces unaided. Continue the pinhead oatmeal and millet seed until the chicks are two weeks old, but after the first week give cooked bread, consisting of 2 pounds corn meal, ½ pound of wheat middlings, 1 pound sifted ground oats, ½ pound of ground dried blood, ¼ pound linseed meal, 2 ounces bone meal, and 1 tablespoonful of salt. Mix with milk or warm water, somewhat dry, and bake. This food may be given once a day. Crumble the bread and give only as much as they will eat up clean. Never leave any food over after a meal.

Feed three times a day, using the bread at night. In the morning give cracked corn and cracked wheat. At noon give potatoes, finely cut clover, scalded, or scalded clover meal, and cracked corn. Between the meals scatter a gill of millet seed for every fifty chicks. In fact, give the chicks anything they will eat, the same as to a hen, but give a variety. When the chicks are a month old, double the proportion of blood. Hard-boiled eggs may be allowed once a week only, but a raw egg, thickened with corn meal, may be given once every day to about 20 very young chicks, the ration being increased for those of more advanced age.

BOWEL DISEASE, should it appear, indicates that at some time the heat may have been too low, that the chicks are being forced too much, or that some kind of food given is unsuitable. In such case remove ailing chicks and reduce the food of the rest, or change it somewhat. Never force them too rapidly. Bone meal, just large enough for grit, may be kept in a box where they can help themselves. Do not use sawdust on the floor, as chicks sometimes eat it. Clean dirt or sand is better; even coarse bran will answer Fine grit should be allowed, and every day the floor of the brooder must be cleaned. Be sure to maintain sufficient warmth.

LICE should never be found on a brooder chick, as lice must come from some infested fowl. Never allow an adult fowl near the brooders, for should a single chick become infested with lice the others will soon share the same fate.

The Possible Profits — All this means work, but it is work that pays. Under proper conditions a man can attend to several thousand chicks and not lose more than 10 per cent. It is impossible to avoid some loss, as there will be chicks that can not survive, even under hens. Do not overlook the fact that a brood of chicks means a great many individuals, all differing one from another in many respects.

A thrifty chick should weigh a pound and a half at ten weeks. Some weigh more, but a pound and a half is the market weight, and if one can get a large proportion of the chicks to market when ten weeks old it will be doing well. The food will cost 5 cents for every pound of chick produced. The chicks may bring as much as 50 cents a pound, according to the market, the season, and the demand. It requires about three months from the shell to market.

An industrious operator should get three broods to market from each brooder in a year, or seven broods in two years. Chicks do not bring high prices in summer, and the weights required are heavier, but there is less expense for care, food, etc., in summer than in winter.

Marketing Broilers—When selling broilers assort them. Never put choice and inferior ones together, and never ship until you have arranged with the buyer or commission merchant. Never send live chickens to market in winter, as they will perish on the journey. Kill by hanging the chicken by the legs and sticking a sharp knife into the brain, through the mouth. Pick as quickly as possible, without scalding, and then carefully remove the pin feathers. Ship in boxes or barrels, packing in ice, if necessary, and using no packing material. Upon the neat appearance of the chicken in market largely depends the price.

Always learn, before selling, how fowls are to be dressed for your particular market, as customs and laws differ.

FEEDING

Feeding regulates the number of eggs produced and also the health of the fowls. More harm is done by overfeeding than by underfeeding. Never feed soft food if it can be avoided. The gizzard is intended for grinding the food, and to deprive it of that function is to induce disease. There are some foods, however, that must be moistened, but the hard foods should be preferred, giving soft foods not oftener than once every other day.

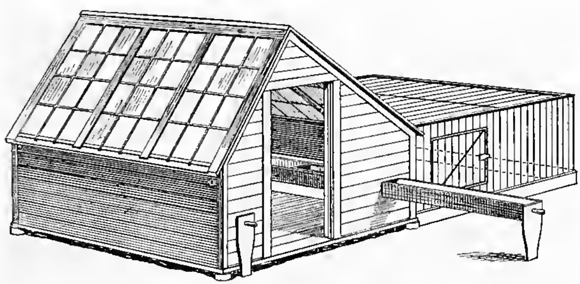

FIG. 208. Fattening house: Has movable trough, the attendant feeding the birds without going inside. The small yard permits of limited exercise while birds are being fattened for market.

Hard Foods—If poultry must be fattened for market there is no better food than corn, but for laying hens corn is too heating in summer, contains an insufficient supply of mineral matter, and is not well supplied with protein. Corn and wheat should be a portion of the winter ration, as the bodies of the fowls must then be kept warm. In the summer season a less concentrated ration is more suitable. Some of the best hard foods that may be given daily with corn are cow-peas, soy beans, or cheap white beans, the former being quickly, easily, and cheaply grown, and may be fed at all seasons. A morning food of equal parts of wheat and cow-peas, with corn and cow-peas at night, will prove satisfactory The next day, for the morning meal, use ½ pound of clover hay, cut fine, and scalded the night before. To this add ½ pound of bran, ½ pound of ground meat, and ½ pound of dried ground blood, using enough corn meal to make the mess somewhat dry. At night give mixed corn and wheat. Keep a box of mica grit, and also of coarse ground bone, always within reach.

How Much to Feed — That is a problem. No two hens eat the same quantity, nor will a flock eat the same amount every day. No fixed quantity can be suggested, as only observation can guide the poultryman. Always scatter the whole food, feeding the soft food in a trough, carefully removing all that is not eaten. Do not leave food constantly before fowls. The liability is that overfeeding will make the laying hens too fat. Between meals a gill of millet seed, scattered in litter, will keep them busy. It is estimated that one quart of corn per day, for a dozen fowls, or its equivalent, is the proper average allowance.

Method in Poultry Feeding — To know when a hen is too fat weigh her. Make it a rule to weigh some of the hens, at least, once a week. If they have lost in weight give more food; if they have gained reduce the grain ration. Hens, when very fat, lay soft-shell eggs, abnormally large eggs, very small eggs, double-yolk eggs, and then begin to cease laying. Fat hens are usually also inclined to sit. Even a non-sitter will become broody when fat.

Another plan is to weigh the food and give the hens all they will eat, or until they walk away from the trough. Weigh that left over, and the difference between the weight of all the food and that left over is the amount eaten. You will then know how much your hens will eat at a meal, but it does not imply that all hens will eat that quantity, and the same hens may consume less the next day. After learning the maximum quantity they will consume reduce it one-half for the morning meal, but give as much as they will eat at night.

In Summer, as the wants of fowls will be fewer, less grain and even less food is necessary. Fowls that forage, and have abundant opportunities for securing food, may not require any assistance at all, no food being necessary. Very young rye, grass, or clover, may be laxative at first, and fowls should not be compelled to subsist on green food too early in the spring.

The fact is, that a hen is somewhat like a hog; she will eat almost anything, and may therefore, be fed on a large variety of foods, even hay (cut fine and scalded) being accepted, while cooked potatoes, carrots, turnips, and table refuse will be relished. The main point is not what to feed, but how not to feed too much, always giving a suitable allowance of animal food, such as ground meat or ground blood.

CAPONIZING[1]

Caponizing serves the same purpose in the case of poultry as does castration in the case of other farm stock. The operation, if practiced on any considerable scale,

[1] For the illustrations that accompany this section the author is indebted to Mr. W. H. Wigmore, of Philadelphia, expert caponizer and manufacturer of caponizing instruments, the drawings being from photographs taken during operation.

enables the farmer to provide for market an article above the ordinary and to secure high prices for the product. Capons grow larger than cockerels, being less active, and their flesh has a finer flavor and a more delicate grain. The same is true of poulardes (pullets from which the ovary has been removed).

On the score of cruelty — an objection sometimes urged — there is little to be said, for the operation is no more painful than castration, and not to be compared, in point of pain suffered, with the punishment a cockerel undergoes in a single fight. Capons do not fight, and a larger number may with safety be housed together than in the case of a mixed flock of pullets and unaltered cockerels.

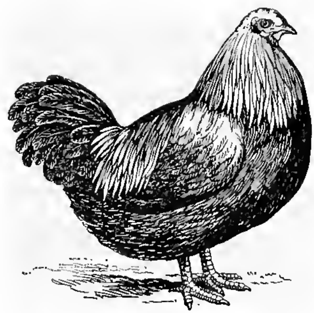

FIG. 209. Dorking capon, showing the effect of the operation on development.

BREEDS FOR CAPONIZING

The heaviest and largest capons are produced by crossing a Colored Dorking cock on Buff Cochin or Light Brahma hens. If two successive crosses are to be employed, the best results may be obtained by mating (1) a Houdan cock with Brahma, Cochin, or Langshan hens, and then (2) the pullets of the cross with Plymouth Rock cockerels, from which breeding yellow legs and skin will result.

Other Good Crosses — A fair-sized capon, with an excellent development of breast meat, may be obtained by mating a strong, large Game cock with Brahmas or the pullets of the crosses named above.

A Brahma cock on Cochin hens, or a Plymouth Rock cock on Brahma or Cochin hens, will produce a fine capon. The Wyandotte may be used on large, coarse hens, but one should avoid such breeds as the Leghorns, Hamburgs, Black Spanish, and Polish for capons.

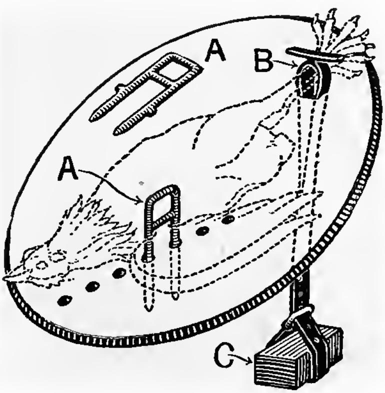

FIG. 210. Caponizing board.

INSTRUMENTS AND THEIR USE

A good caponizing board may be made by following the suggestion embodied in Fig. 210.

Staple (A) is used to slide over the bird's wings; the two lugs, about an inch from the points, are to prevent forcing the wings too close together, as would be done without them. The bar crossing the staple in the middle enables the operator to use the upper part for a handle. One point is longer than the other, to make its introduction into the board easier. With seven holes in the board a bird of any size may be held. The strap loop (B) has a pin across the top, to prevent the strap from falling through the board when not in use. At the other end of the strap is a weight (*C*) for keeping the feet down.

The various instruments required for caponizing will be named and illustrated as we proceed.

Preparatory Care—Birds must be kept in vigorous growth from the start, so that they will be well developed and in good condition for a safe operation when from 3 to 4 months old. The proportion of birds that die under the knife is very small, not exceeding 2 per cent in the hands of an experienced operator.

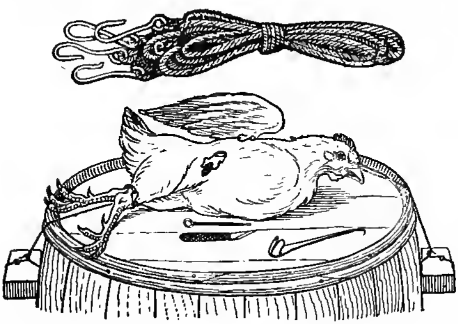

Fig. 211. Fowl in position for caponizing. (Hooks and cords above.)

The fowl will die, if at all, in a very few minutes, and if at once bled it is as good for table use as if killed in the ordinary way. Thus the possibility of loss is reduced to the vanishing point.

It is desirable for the beginner to proceed cautiously. Caponizing is surgery, and is not to be carelessly undertaken. If possible, one should watch closely the work of an experienced operator. In any case it is well to practice on a few dead birds before attempting to alter live ones. Thus, and by the aid of the printed directions that accompany the caponizing instruments of all makers, one may in a short time become reasonably expert. The beginner may gauge his proficiency by the fact that the operation, when well done, occupies less than two minutes.

OPERATING ON COCKERELS

First, have a narrow table, box or barrel, so that it can be moved around to get the sun on the fowl in any desired position. Good light is necessary for the expert, and sunlight for the learner. Lay the fowl upon its left side. Wrap the cord twice around the bird's legs above the knees. With only one wrap they are liable to kick themselves out of the loop. This style of hooks enables one to make a slip-loop quickly. Put the other cord once around the fowl's wings. The opposite ends of the cords attach to a half brick, or a weight of some kind, then let them hang down over the sides of the table as shown in Fig. 211. By this means they are held securely.

Fig. 212. Caponizing: Making the incision.

Wet the bird's side and feathers with cold water, to prevent bleeding, and enable you to make the feathers stay where you desire them, by twisting them under as a man would his mustache. This will enable you to perform the operation without pulling a feather. Pull the flesh on the side down toward the hip, so that when the operation is over the hole between the ribs will be entirely closed by the skin going back to its place. Therefore the opening in the skin will be ¾ of an inch above that between the ribs, enabling the wound to heal up in a day or two. The incision must be made *between the first and second ribs,* about ½ inch long.

Fig. 213. Combined knife and forceps for caponizing.

The First Incision—When ready to cut (Fig. 212), push the point of the knife (Fig. 213) in quickly, ¼ of an inch, and hold it there a second, as the fowl will work its ribs up and down just at that moment. When it becomes quiet, the incision may be increased to ½ inch.

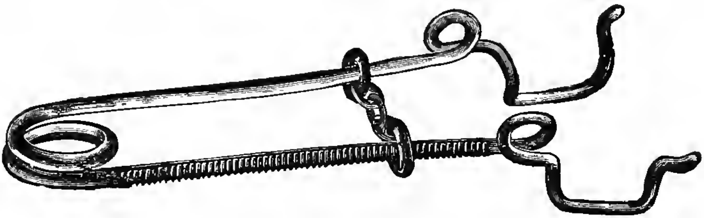

Fig. 214. Caponizing spreader.

Lay the knife down, keeping the skin in place with the left hand. Now you are ready for the spreader (Fig. 214). Take the spreader between the thumb and first finger, press it until the two ends come together, and then insert the hooked ends in the incision (Fig. 215), making sure to have the hooks between the ribs. Hold the spreader in position with the left hand.

Enlarging the Incision—Take up the knife again. Enlarge the opening by cutting (Fig. 216) toward the backbone, and forward on a line between the ribs, until it is large enough to admit the free passage of the *scoop twister* (Figs. 217, 218). Care must be taken not to go too near the backbone. After a little practice you will be able to do this cutting and draw little or no blood, by cutting on a line with the veins instead of crossing them. Should they bleed much wipe with a damp rag, or small sponge, before you tear open the thin skin. Otherwise the blood will run in on the testicles and make the lower one harder to find.

Fig. 215. Caponizing: Inserting the spreader.

Completing the Operation—Take up the *scoop twister* (Figs. 217, 218). With the hook end tear open the thin skin until you have the right testicle well in view and an incision large enough to press the *scoop twister* through. This hook must be used with care, or an artery or the bowels may be punctured.

Take the *cannula spatula* (Fig. 220) in the left hand; with it push the bowels aside, and just below will be seen the left testicle. With the right hand introduce the *scoop twister*, as shown in Fig. 221; catch the lower or left testicle endwise in the scoop, as seen in Fig. 222, and shake

FIG. 216. Caponizing: Enlarging the opening with the knife.

gently to get it all in and to make the spermatic cord settle well down into the slot. Then begin to twist the testicle off.

At this point the learner will find the *spatula* very useful for forcing the testicle into the scoop (as it sometimes slips out), and for preventing the bowels from being twisted up by the scoop. A number of these difficulties disappear with a little practice.

Now remove the right or upper testicle (Fig. 223), the same as the left. Both testicles are shown in Figs. 222 and 223, in order to show their exact position. The left testicle should always be taken out first, as it is the hardest to remove. If you remove the right one first and cause the bird to bleed, it will flood the cavity so that the lower one can not be seen so well, and the operator will have much more trouble in getting it out, but when the left one is out it will not be over ten seconds before the right one can be removed. Most beginners prefer to remove the upper one first. They contend that they have a better view when the right one is out of the way, but that is only because it appears easier; the correct practice is as just set forth.

FIG. 217 Caponizing scoop and hook.

Notes on Various Difficulties—If a small piece of the testicle should be left in, by failure to get it all in the scoop properly, put the scoop in again and catch it in the slot, even if it be no larger than a pin's head, as these are the pieces that produce "slips."

If the testicle is very large, which you will find is the case with a 4-month-old Leghorn, take it out by the scoopful, continuing to go after the remainder until all is removed.

If much blood flows, spoon it out with the *scoop twister*.

The next day after the operation, if capons have a windy swelling, run a darning needle through the skin and the gas will all escape.

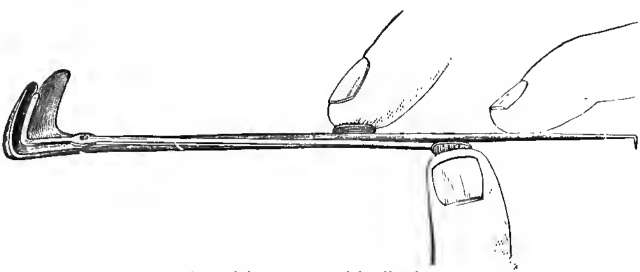

FIG. 218. Caponizing scoop with clipping knife in scoop.

If an artery be cut in the operation, the dead fowl is as good for food as if it had been bled in the neck.

If the operation is successful, as it usually is, capons generally have a movement of the bowels.

Slips—*Slips*, which are partly caponized fowls, are not easily distinguished from the cockerels, except by their large size and the scar on their side. They are often as large as the full capon. Slips, as already explained, are the result of leaving a portion of the testicle in the abdominal cavity This piece grows to a considerable size, sometimes larger than the normal size of the entire gland, and is filled with a watery substance. Slips are a nuisance in the yard, as they are constantly chasing the hens. There seem, at the present time, to be more slips than full capons on the market, and they bring within 2 or 3 cents of the capon price. There is no need of producing slips in caponizing, since it is extremely easy to spoon out any small piece of testicle remaining, by the aid of the slot in the *scoop twister*.

FIG. 219. Caponizing: Using the hook to tear the skin around the testicle.

Ducks and Turkeys—It is more difficult to caponize drakes than any other fowls, as they are exceedingly compact, their entrails filling them up completely At three months the testicles of a drake are much harder to get hold of than are those of a cockerel. The glands are longer and narrower, and lie closer to the backbone than in cockerels; their bowels, furthermore, very commonly protrude through the incision while the operator is trying to catch the testicles in the scoop —something that never happens with any other fowl.

Turkeys are caponized in the same manner as cockerels, but the operation requires larger instruments.

OPERATING ON PULLETS

Pullets that do not lay in due time may be made poulardes—an operation productive of the same good market results as in the case of caponized cockerels.

Preliminary Examination—Open the *left* side, *between the first and second ribs*, the same as would be done in case of a cockerel, but do not tear open the thin skin covering the bowels until a preliminary examination has been made. Let bright sunlight shine into the cavity, and through the translucent membrane the egg-cluster (ovary) can be seen quite plainly. If the ova are fine, like fish-roe, the operation had better proceed; but if any of the eggs are as large as a small pea, the pullet will begin laying soon, and had better be saved. The incision will quickly heal, and the pullet will be none the worse for the knife.

FIG. 220. Caponizing cannula spatula, using steel wire instead of horsehair.

Removing the Egg-Cluster—Tear open the thin skin, and you will see two milky-white cords or tubes leading down from the egg-cluster. The upper or larger one, which should be about the size of thin wrapping string, is the egg passage. This passage, in a pullet about to lay, is consider-

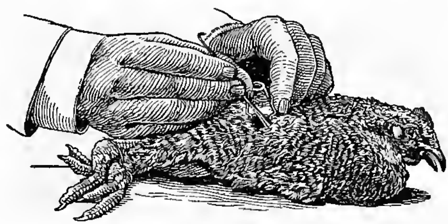

FIG. 221. Caponizing: Using the scoop.

FIG. 222. Caponizing: Dead bird, showing internal operation of the scoop.

ably enlarged, and after she has laid awhile it becomes the heaviest of the entrails.

Take hold of the egg duct with a pair of tweezers, or a bent piece of wire for a hook, and cut out about 1 inch, which will stop the production of eggs and make the pullet grow larger and lay on finer, better-flavored flesh, the same as a capon.

Dissecting for Practice—Those desiring to make poulardes should kill a 4-month-old pullet and an old laying hen and dissect them for practice. Cut off the left leg at the hip joint, and then the plate from the second rib down, which will expose the bowels. Ease them out toward the front, and the bowels and egg passages in each will readily be seen, the bowel passage being on the right and the egg passage on the left side.

To make sure of the egg passage in the pullet, introduce the probe just below the egg-cluster, pushing it gently down the passage until it makes its exit at the proper place. Without this dissecting it is impossible to know what to cut, unless one has been shown by an experienced person.

Some advise cutting, in the actual operation, below the flank, but the foregoing method is better, because the operation is safer, and a preliminary examination of the state of the ovary is possible.

AFTER CARE OF CAPONS AND POULARDES

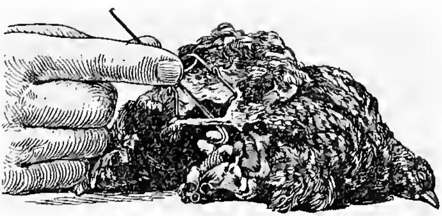

FIG. 223. Caponizing: Dead bird, showing how right testicle is removed.

For from 24 to 37 hours before the operation the fowls are kept without food, so that they are exceedingly hungry. They should be fed very sparingly for the first day or two on scalded corn meal with a little salt, then they may have more. After a week give them plenty of food; you will find them very ravenous for a month or two, after which they gradually ease up and eat considerably less. If they are confined give them some bone meal, and broken clam and oyster shells. They should have plenty of the best water available. Do not allow them to drink from dirty little puddles or stagnant ponds, which gives the flesh a bad flavor, besides causing fowls to droop.

DISEASES OF POULTRY

The various breeds of poultry are subject to many diseases, much depending upon the care and management, as flocks not allowed to come in contact with others having diseases usually escape, but when once the safeguard is broken down and a single diseased fowl from some other farm is brought in as a member of the flock, it means that every fowl on the premises becomes liable to the ailment.

Administration of Remedies — Treatment of disease in flocks is difficult. While a horse, cow, or sheep may be handled and treated the case is very serious when fifty or a hundred fowls are ill, as each individual must be attended to, the difference in size between the horse and the fowl, though great, not being in proportion to the work required for the latter. If but two minutes were devoted once a day to administering medicine to each sick fowl it would require an hour to attend to thirty, and it is doubtful if such rapid progress could be made.

Few fowls will eat if very ill, hence remedies must be forced upon them, or given in the drinking water, which they sometimes refuse when it is medicated. Prevention of disease is therefore better than medication.

A remedy which, when tried once, gives no results, may be excellent if given every hour for two or three days. The impossibility of using remedies so frequently when large numbers of fowls are ill is apparent, as the work could not easily be done. To handle the birds singly, and force the medicine down their throats, is not only tedious but also dangerous to human beings.

The two diseases that have done more damage to poultry than any other are roup and cholera. Roup includes many diseases, though really it is of a scrofulous nature. Cholera was at one time a scourge, but has almost disappeared, the term being now used by the inexperienced for indigestion. The majority of the ills of fowls are due to overfeeding.

ROUP

Roup may be known by the discharge from the nostrils, of an exceedingly disagreeable odor, the fowl being dejected and gradually wasting away. It is a contagious disease, which rapidly spreads, even the ground being contaminated from occupancy by the birds. Being of a scrofulous nature, large lumps frequently appear on the face, or other portions of the body There is no *sure cure*, and it is useless to waste time with remedies, for even should a cure be made the bird would be of less value than before. To attempt a cure is to retain the bird as a source of contagion. It is the poultryman's plain duty to stamp out contagious disease as soon as it appears, burning the bodies of all dead birds.

Another name for roup is contagious catarrh, a term usually applied to "pip," which is a thickening of the secretions of the nostrils.

CONSUMPTION

Birds are subject to consumption, catarrh, bronchitis, pleurisy, pneumonia, and other mouth, throat, and lung diseases. It is difficult to diagnose such cases, but difficult breathing, running at the nostrils, and general debility are the indications. The symptoms may be relieved by providing a warm room, in winter, and nourishing foods; but it is best to destroy the birds. When they are apparently well, and have hoarseness, or difficulty in breathing, especially after exercising, or when on the roost at night, the cause may generally be traced to overfatness. Omit all food for a few days, allowing once or twice a day about a teaspoonful of raw eggs, beaten, adding ¼ grain of quinine. Sometimes a draft of air at night will aggravate this ailment.

PIP

Pip is due to dryness of the mouth and throat, the nostrils being clogged and the bird forced to breathe with the mouth open, which dries the tongue and causes the formation of a hard scab. The remedy is 1 or 2 drops camphorated oil in each nostril, and a few drops in the mouth, given with the point of a sewing-machine oil can, two or three times a day.

APOPLEXY

Apoplexy occurs when birds are overfed, they being found dead from no apparent cause, though previously apparently healthy. Lack of exercise, too much grain, and sometimes excessive warmth in summer induce the apoplectic condition. The remedy is bulky food, such as cut clover, grass, cabbage, or any green material.

CROP DISEASES

The crop may be compacted and the bird may die of starvation because the food can not pass into the gizzard. A piece of string, rag, long grass, feather, or other article picked up, may be responsible, in which case the crop must be emptied of its contents by drawing the outer skin aside and making an incision, then thoroughly cleaning the crop and washing it with warm water containing a little borax or carbonate of soda, sewing with silk stitches, and tying the ends of each stitch. The crop may also become baggy or inflamed, due to indigestion as well as overfeeding, the membrane at times being inflamed. Withhold food until the crop is completely empty and then feed but little food, twice a day, for a week or two, giving a teaspoonful of melted lard occasionally.

ORDINARY DIARRHEA

Diarrhea, if the discharges are large and frequent, may be checked or relieved by giving a pill or tablet composed of a grain of subnitrate of bismuth, following with 2 drops of laudanum, half an hour later, and repeating the dose every hour until a change is noticed.

GAPES

Gapes attack young chicks, any indications of gaping on the part of the adults being symptoms of something else, usually of colds, catarrh, or an overfat condition. Gapes in chicks are caused by round, thread-like worms attached to the windpipe, which obstruct breathing. It is a theory that the earthworm is the host which introduces them to chicks, though they may be picked up from the ground in certain stages, or taken in unclean foods, as they are coughed up by older birds. The remedy is to clean the yards, or keep chicks on new locations, using lime freely in the yards. A drop of turpentine on a bread crumb sometimes gives relief. Some use a horse hair, or tip of a small feather, in the trachea, twisting it, and withdrawing quickly; but such practice requires experience. A pill of garlic, asafetida, and turpentine, somewhat soft, given every hour, is known to afford relief.

SCABBY LEGS

This is the work of invisible mites, which form the rough scales or scabs. Any kind of grease frequently applied will effect a cure. Sulphur and melted lard, twice a week, applied quite warm, is excellent. The disease spreads from one fowl to the others.

CANKER

Canker is a form of sore throat, similar to diphtheria, and contagious. The remedy is to swab the throat with chlorinated soda, and give a ½-grain quinine pill three times a day, but it is better to destroy such birds as soon as they are attacked and burn their bodies.

INDIGESTION

This is the great bane of the poultryman, being often denominated "cholera." Diarrhea, dysentery, and nearly all forms of bowel disease may be attributed to indigestion. It is caused by overfeeding, by continuous use of the same foods and lack of variety, by inactivity, and by close confinement. The remedy is to confine the fowl without food for 48 hours, giving 1 teaspoonful tincture of nux vomica in a quart of drinking water. At the expiration of the 48 hours allow one meal a day for a week, giving 1 ounce of lean meat and no other food. Then give a variety, feeding sparingly. Endeavor to induce the fowl to scratch by scattering a little millet seed in litter. Green rye, early in the spring, exposure to storms, filthy quarters, and unwholesome food will also sometimes cause bowel disease.

CONSTIPATION

Constipation is caused by sameness, or excess of food and lack of exercise. Using green food is an excellent remedy, and a teaspoonful of linseed meal, in the food once a day, will prove beneficial.

WORMS

There are a number of different kinds of worms peculiar to poultry. Filth, decayed food, and the condition and period of occupancy of the yards are factors to be considered. The remedy is to add a teaspoonful of spirits of turpentine, and the same of sulphur, to a pint of corn meal, moisten, and let the birds eat as much as they will, twice a week.

FAVUS

Favus is a skin disease, due to parasites, popularly known as "white head," the feathers coming out and the head having a scabby or warty appearance. Favus is contagious. An excellent remedy is to mix sulphur and carbolized vaseline, applying once a day, first washing the head with whale-oil soapsuds, and rinsing in warm water.

Such diseases as *Asthenia* (going light) in chickens, and *Black Head* in turkeys (the one being a wasting away of the body and the other a parasitic disease of the liver and intestines), need no description, as the only plan to pursue is to destroy the birds and disinfect the premises.

Such ailments as *bumble foot, corns,* and *lameness* are frequently local, being due to high roosts, or causes peculiar to the surroundings.

NOTES ON TURKEYS, GEESE, AND DUCKS

TURKEYS

The turkey is discontented under confinement and prefers to forage. It destroys many worms and insects, and after it is three months old is very hardy. Many farmers allow them to roost on the trees. Thus they are exposed to storms and become lame from alighting daily from the high roosts, being also rendered liable to roup and other diseases.

Have, for turkeys, an open shed with a moderately high roost with wire mesh front as a protection. Feed them in the same manner as suggested for hens in winter and they will soon learn to come up at regular hours. In summer give only a light meal of wheat at night. One gobbler is sufficient with an ordinary flock, and should be procured from a distance every year.

Young turkeys are easily raised if properly kept, though on most farms the majority perish, owing to the large gray lice on the heads and necks, which pass from the hen to the chicks. Dampness is also fatal to them.

When first hatched give no food for 26 hours, then give stale bread dipped in fresh milk, feeding four times a day, allowing also finely chopped boiled eggs and chopped onions (bulbs and tops). Give also lettuce, parsley, cabbage, clover, and similar green vegetable matter, chopped, and as they grow give cracked corn, wheat, cracked cow-peas, and millet seed, the latter being excellent from the start. A few drops of melted lard (too much should be avoided) on the heads of the young will destroy the lice, and should be followed by a thorough dusting with fresh insect powder. Examine them every two or three days. Keep them well fed and sheltered until they "shoot the red," or are about ten or twelve weeks old.

GEESE

Geese require almost no care, but should have dry quarters. They prefer grass on the pasture on which they will thrive. In winter one good meal a day, as much as they will eat, of cooked potatoes or turnips, with cut clover, ground oats, and ground meat added, will be sufficient.

Goslings — The same food is excellent for goslings, which should be fed three times a day the first week and twice daily thereafter until two or three weeks old, when they can help themselves on the pasture if given a light meal at night. Keep goslings from ponds until well feathered, but keep drinking water within reach. As a rule, geese instead of hens are allowed to hatch out the goslings. The young geese only should be sold, as the old ones will perform service for many years.

DUCKS

What has been said of geese applies also to ducks, excepting that where large numbers are kept for supplying eggs for incubators the Pekin variety is usually preferred, and can be kept without ponds if an abundance of drinking water is provided. Ducks will become lame if their quarters are damp. Cut straw, litter, or chaff may be used on the floors. When laying they should be fed twice a day as much as they will eat, as suggested for geese, but green food must also be given. When not laying they should be turned out to consume grass, having a meal only at night. Animal food is essential for geese and ducks.

Ducklings are fed entirely on soft food, consisting of cooked turnips, thickened with corn meal, ground meat, bran, and sifted oatmeal, not too wet, four times a day. Cleanliness is essential with them, and they must have water in troughs always within reach. Never use very cold water in winter as it causes cramps. Ducks sell best in May, June, and July. A duckling of the Pekin variety should weigh at least 4 pounds when ten weeks old.

One drake and six ducks make a pen. Ducks will lay over 100 eggs each, beginning in January and February and finishing in a few months. Pekin ducklings sometimes weigh 5 pounds when ten weeks old, but such weights are the exception except in the experience of experts.

P. H. Jacobs.

PUBLICATIONS ON POULTRY AND PIGEONS

AMERICAN BREEDS OF FOWLS: I. THE PLYMOUTH ROCK. Bulletin 29, Bureau of Animal Husbandry. *United States Department of Agriculture* $0 15

AMERICAN STANDARD OF PERFECTION, THE. Supplied by *Orange Judd Co.*, N. Y . 1.00

Gives detailed descriptions of the various breeds, and sets forth also the points of excellence for the show-room.

BROILERS FOR PROFIT. By M. K. Boyer. *I. S. Johnson & Co.*, Boston, Mass. . .50

Designed for the beginner in artificial hatching.

BUSINESS HEN, THE. By J. Collingwood. *Rural Publishing Co.*, N. Y. . . .75

CAPONS FOR PROFIT. By T. Greiner. *Farm and Fireside*, Springfield, Ohio . . .30

CHICKENS, APOPLECTIFORM SEPTICÆMIA IN. Bulletin 36. Bureau of Animal Industry. *United States Department of Agriculture* 10

CHICKENS, GAPES OF. By H. Carman. Bulletins 70 and 74. *Kentucky Agricultural Experiment Station*, Lexington, Ky. . . . . —

CHICKENS, STANDARD VARIETIES OF. Farmers' Bulletin 51. *United States Department of Agriculture* . . . . —

DISEASES OF POULTRY, THE. By D. E. Salmon. *Orange Judd Co.*, N. Y. . . .50

DUCK CULTURE. By James Rankin. *James Rankin*, South Easton, Mass. 25

Mr. Rankin speaks with the authority of a poultryman who hatches and markets 10,000 ducklings annually.

DUCKS AND GEESE. Farmers' Bulletin 64. *United States Department of Agriculture* —

EGGS AND THEIR USES AS FOOD. Farmers' Bulletin 128. *United States Department of Agriculture* . . . . —

FARM POULTRY. By George C. Watson. *The Macmillan Co.*, N. Y. 1.25

FOWLS: CARE AND FEEDING. Farmers' Bulletin 41. *United States Department of Agriculture* . . . .

FOWLS, ROUP IN. By J. B. Barlow. Report, *Rhode Island Agricultural Experiment Station*, Kingston, R. I. (1898) . . . . —

INVESTIGATIONS CONCERNING INFECTIOUS DISEASES AMONG POULTRY. Bulletin 8, Bureau of Animal Industry. *United States Department of Agriculture* 15

PIGEON KEEPER, PRACTICAL. By Lewis Wright. *Cassell & Co.*, N. Y. . . . 1.50

PIGEON QUERIES. By E. E. Quick. *Orange Judd Co.*, N. Y. 25

POULTRY, PROFITS IN. *Orange Judd Co.*, N. Y. 1.00

POULTRY: THE ILLUSTRATED BOOK OF. By Lewis Wright. *Cassell & Co.*, N. Y. . 5.00

An English publication, profusely illustrated.

POULTRY APPLIANCES AND HANDICRAFT. Compiled by G. B. Fiske. *Orange Judd Co.*, N. Y. 50

POULTRY ARCHITECTURE. Compiled by G. B. Fiske. *Orange Judd Co.*, N. Y. . . . $0.50

POULTRY BOOK, REVISED COMPLETE. *Farm and Fireside*, Springfield, Ohio 50

POULTRY CULTURE. By I. K. Felch. *American Agriculturist*, N. Y. 1.50
Includes matter on show-room judging.

POULTRY CULTURE, PRACTICAL. *Epitomist Publishing Co.* 5.00

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An English work.

POULTRY RAISING, FIVE HUNDRED QUESTIONS AND ANSWERS IN. *Practical Poultryman*, Whitney's Point, N. Y .25

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POULTRY RECORD BOOK, MONEY IN. *Orange Judd Co.*, N. Y. 25

TURKEYS AND HOW TO GROW THEM. By Herbert Myrick. *Orange Judd Co.*, N. Y. 1.00

TURKEYS, BLACK-HEAD OF. By S. Cushman. Report, *Rhode Island Agricultural Experiment Station*, Kingston, R. I. (1894) . . . . ——

CALENDAR FOR 1902 - 1952

And for 150 Years Previous to 1902, Specially Arranged for Ready Reference.

											JAN. (31 days).	FEB. (28 or 29 days).	MARCH (31 days).	APRIL (30 days).	MAY (31 days).	JUNE (30 days).	JULY (31 days).	AUG. (31 days).	SEPT. (30 days).	OCT. (31 days).	NOV. (30 days).	DEC. (31 days).
1902 1806 1755	1913 1817 1766	1919 1823 1777	1930 1834 1783	1941 1845 1794	1947 1851 1800	---- 1862 ----	---- 1873 ----	---- 1879 ----	---- 1890 ----	---- ---- ----	3	6	6	2	4	7	2	5	1	3	6	1
1903 1801 1761	1914 1807 1767	1925 1818 1778	1931 1829 1789	1942 1835 1795	---- 1846 ----	---- 1857 ----	---- 1863 ----	---- 1874 ----	---- 1885 ----	---- 1891 ----	4	7	7	3	5	1	3	6	2	4	7	2
1904	**1932**	----	**1808**	**1836**	**1864**	**1892**	----	**1768**	**1796**	----	**5**	**1**	**2**	**5**	**7**	**3**	**5**	**1**	**4**	**6**	**2**	**4**
1905 1809 1758	1911 1815 1769	1922 1826 1775	1933 1837 1786	1939 1843 1797	1950 1854 ----	---- 1865 ----	---- 1871 ----	---- 1882 ----	---- 1893 ----	---- 1899 ----	7	3	3	6	1	4	6	2	5	7	3	5
1906 1810 1753	1917 1821 1759	1923 1827 1770	1934 1838 1781	1945 1849 1787	1951 1855 1798	---- 1866 ----	---- 1877 ----	---- 1883 ----	---- 1894 ----	---- 1900 ----	1	4	4	7	2	5	7	3	6	1	4	6
1901 1805 1754	1907 1811 1765	1918 1822 1771	1929 1833 1782	1935 1839 1793	1946 1850 1799	---- 1861 ----	---- 1867 ----	---- 1878 ----	---- 1889 ----	---- 1895 ----	2	5	5	1	3	6	1	4	7	2	5	7
1908	**1936**	----	----	**1812**	**1840**	**1868**	**1896**	----	----	**1772**	**3**	**6**	**7**	**3**	**5**	**1**	**3**	**6**	**2**	**4**	**7**	**2**
1909 1802 1762	1915 1813 1773	1926 1819 1779	1937 1830 1790	1943 1841 ----	---- 1847 ----	---- 1858 ----	---- 1869 ----	---- 1875 ----	---- 1886 ----	---- 1897 ----	5	1	1	4	6	2	4	7	3	5	1	3
1910 1803 1757	1921 1814 1763	1927 1825 1774	1938 1831 1785	1949 1842 1791	---- 1853 ----	---- 1859 ----	---- 1870 ----	---- 1881 ----	---- 1887 ----	---- 1898 ----	6	2	2	5	7	3	5	1	4	6	2	4
1912	**1940**	----	----	**1816**	**1844**	**1872**	----	----	----	**1776**	**1**	**4**	**5**	**1**	**3**	**6**	**1**	**4**	**7**	**2**	**6**	**7**
1916	**1944**	----	----	**1820**	**1848**	**1876**	----	----	----	**1780**	**6**	**2**	**3**	**6**	**1**	**4**	**6**	**2**	**5**	**7**	**3**	**6**
1920	**1948**	----	----	**1824**	**1852**	**1880**	----	----	**1756**	**1784**	**4**	**7**	**1**	**4**	**6**	**2**	**4**	**7**	**3**	**5**	**1**	**3**
1924	**1952**		----	**1828**	**1856**	**1884**	----	----	**1760**	**1788**	**2**	**5**	**6**	**2**	**4**	**7**	**2**	**5**	**1**	**3**	**6**	**1**
1928	----	----	----	**1804**	**1832**	**1860**	**1888**	----	**1764**	**1792**	**7**	3	**4**	**7**	**2**	**6**	**7**	**3**	**6**	**1**	**4**	**6**

Leap Years in foregoing table are in bold-face type.

	SUN.	MON.	TUES.	WED.	THURS.	FRI.	SAT.
1	..	1	2	3	4	5	6
	7	8	9	10	11	12	13
	14	15	16	17	18	19	20
	21	22	23	24	25	26	27
	28	29	30	31	..	..	..

	SUN.	MON.	TUES.	WED.	THURS.	FRI.	SAT.
2	..	..	1	2	3	4	5
	6	7	8	9	10	11	12
	13	14	15	16	17	18	19
	20	21	22	23	24	25	26
	27	28	29	30	31	..	..

	SUN.	MON.	TUES.	WED.	THURS.	FRI.	SAT.
3	..	..	..	1	2	3	4
	5	6	7	8	9	10	11
	12	13	14	15	16	17	18
	19	20	21	22	23	24	25
	26	27	28	29	30	31	..

	SUN.	MON.	TUES.	WED.	THURS.	FRI.	SAT.
4	..	..	..	..	1	2	3
	4	5	6	7	8	9	10
	11	12	13	14	15	16	17
	18	19	20	21	22	23	24
	25	26	27	28	29	30	31
	..	..	..	..	..	..	..

	SUN.	MON.	TUES.	WED.	THURS.	FRI.	SAT.
5	..	..	..	..	..	1	2
	3	4	5	6	7	8	9
	10	11	12	13	14	15	16
	17	18	19	20	21	22	23
	24	25	26	27	28	29	30
	31	..	..	..	..	..	..

	SUN.	MON.	TUES.	WED.	THURS.	FRI.	SAT.
6	..	..	..	..	..	..	1
	2	3	4	5	6	7	8
	9	10	11	12	13	14	15
	16	17	18	19	20	21	22
	23	24	25	26	27	28	29
	30	31	..	..	..	..	..

	SUN.	MON.	TUES.	WED.	THURS.	FRI.	SAT.
7	1	2	3	4	5	6	7
	8	9	10	11	12	13	14
	15	16	17	18	19	20	21
	22	23	24	25	26	27	28
	29	30	31			..	..

NOTE.—To find on what day of the week any calendar day of any year fell or will fall, find desired year in upper left-hand table and desired month at the right. The reference figure opposite the year and under the month will indicate the appropriate monthly calendar beneath.

Handy Rules and Useful Information

WEIGHTS AND MEASURES

MEASURES OF LENGTH

Linear Measure—

League		*Miles*		*Furlongs*		*Rods (Poles or Perches)*		*Yards*		*Feet*		*Inches*
1	=	3	=	24	=	960	=	5,480	=	15,840	=	190,080
		1	=	8	=	320	=	1,760	=	5,280	=	63,360
				1	=	40	=	220	=	660	=	7,920
						1	=	5½	=	16½	=	198
								1	=	3	=	36
										1	=	12

Surveyor's or Chain Measure—

Mile		*Chains*		*Rods (Poles)*		*Links*		*Inches*
1	=	80	=	320	=	8,000	=	63,360
		1	=	4	=	100	=	792
				1	=	25	=	198
						1	=	7.92

Occasional Measures—3 inches = 1 palm; 4 inches = 1 hand; 9 inches = 1 span; 2½ feet = 1 military pace; 6 feet = 1 fathom; 6,080.26 feet = 1 nautical mile, or knot; 3 nautical miles = 1 league; 60 nautical miles = 1 degree at the equator (69.168 statute miles); 360 degrees = circumference of earth at equator; 6,072 feet = 1 geographical mile.

MEASURES OF SURFACE

Square Measure—

Square Mile		*Acres*		*Square Rods*		*Square Yards*		*Square Feet*		*Square Inches*
1	=	640	=	102,400	=	3,697,600	=	27,878,400	=	4,014,489,600
		1	=	160	=	4,840	=	43,560	=	6,272,640
				1	=	30¼	=	272¼	=	39,204
						1	=	9	=	1,296
								1	=	144

Surveyor's Surfaee Measure—

Township		*Square Miles*		*Acres*		*Square Chains*		*Square Rods*		*Square Links*
1	=	36	=	23,040	=	230,400	=	3,686,400	=	2,304,000,000
		1	=	640	=	6,400	=	102,400	=	64,000,000
				1	=	10	=	160	=	100,000
						1	=	16	=	10,000
								1	=	625

Oeeasional Measures—1 circular inch (area of circle 1 inch in diameter) = 0.7854 square inch = 1,000,000 circular mills (area of circle .001 inch in diameter); 1 rood = 40 square poles or rods.

MEASURES OF VOLUME

Cubic Measure —

1,728 cubic inches = 1 cubic foot.
27 cubic feet = 1 cubic yard.
128 cubic feet = 1 cord of wood (a pile 4 x 4 x 8 feet).
$24\frac{3}{4}$ cubic feet = 1 perch of masonry ($1 \times 1\frac{1}{2} \times 16\frac{1}{2}$ feet).

Liquid Measure —

Tun		*Pipes (Butts)*		*Puncheons*		*Hogsheads*		*Tierces*		*Bbls.*		*Gals.*		*Quarts*		*Pints*		*Gills*
1	=	2	=	3	=	4	=	6	=	8	=	252	=	1,008	=	2,016	=	8,064
		1	=	$1\frac{1}{2}$	=	2	=	3	=	4	=	126	=	504	=	1,008	=	4,032
				1	=	$1\frac{1}{3}$	=	2	=	$2\frac{2}{3}$	=	84	=	336	=	672	=	2,688
						1	=	$1\frac{1}{2}$	=	2	=	63	=	252	=	504	=	2,016
								1	=	$1\frac{1}{3}$	=	42	=	168	=	336	=	1,344
										1	=	$31\frac{1}{2}$	=	126	=	252	=	1,008
												1	=	4	=	8	=	32
														1	=	2	=	8
																1	=	4

Apothecaries' Fluid Measure —

Gallon		*Pints*		*Fluid Ounces*		*Fluid Drams*		*Minims (Drops)*
1	=	8	=	128	=	1,024	=	61,440
		1	=	16	=	128	=	7,680
				1	=	8	=	480
						1	=	60

Dry Measure —

U. S. Struck Bushel		*Pecks*		*Quarts*		*Pints*
1	=	4	=	32	=	64
		1	=	8	=	16
				1	=	2

The U. S. heaped bushel is a cylinder $18\frac{1}{2}$ inches in diameter and 8 inches deep, heaped to a cone 6 inches high. It is equal approximately to $1\frac{1}{4}$ struck bushels.

MEASURES OF WEIGHT

Avoirdupois, or Commercial Weight —

Net or Short Ton		*Hundredweight*		*Pounds*		*Ounces*		*Drams*		*Grains*
1	=	20	=	2,000	=	32,000	=	512,000		
		1	=	100	=	1,600	=	25,600		
				1	=	16	=	256	=	7,000
						1	=	16	=	437.5

The original "long ton" of 2,240 lbs., divided into 20 cwt. of 112 lbs., and these into 4 quarters of 28 lbs., is still used. The hundredweight of 100 lbs. is also known as a cental, or quintal. The metric ton contains 2,204.6 lbs. A stone is 14 lbs.

Troy, or Jewelers' Weight —

Pound		*Ounces*		*Pennyweights*		*Grains*
1	=	12	=	240	=	5,760
		1	=	20	=	480
				1	=	24

The carat, used in weighing diamonds = 3.168 grains.

Apothecaries' Weight—

Pound		*Ounces*		*Drams*		*Scruples*		*Grains*
1	=	12	=	96	=	288	=	5,760
		1	=	8	=	24	=	480
				1	=	3	=	60
						1	=	20

The grain, in the three tables of weight, is identical.

CIRCULAR MEASURE

Circumference		*Quadrants*		*Signs*		*Degrees*		*Minutes*		*Seconds*
1	=	4	=	12	=	360	=	21,600	=	1,296,000
		1	=	3	=	90	=	5,400	=	324,000
				1	=	30	=	1,800	=	108,000
						1	=	60	=	3,600
								1	=	60

NUMBERS FOR RAPID CONVERSIONS

Inasmuch as multiplication is easier than division, the following table of decimal multipliers will be found useful for rapid conversions. In case no high degree of accuracy is desired, the multiplier may be abridged by omitting one or more figures at the extreme right, adding 1 to the last figure of the decimal fraction remaining if the omitted figure is 5 or greater than 5. Thus, Pounds Avoirdupois multiplied by 0.00454 equal Quintals, approximately.

Relations of Common Weights and Measures

Feet	multiplied by	0.0001894	equal	miles.
Yards	"	0.0005682	"	miles.
Links	"	0.2202	"	yards.
Yards	"	4.5454	"	links.
Links	"	0.66	"	feet.
Feet	"	1.515	"	links.
Square Inches	"	0.00694	"	square feet.
Square Feet	"	0.11111	"	square yards.
Square Yards	"	0.0002066	"	acres.
Acres	"	0.4840	"	square yards.
Cubic Inches	"	0.000466	"	U. S. struck bushels.
Cubic Inches	"	0.004329	"	U. S. gallons.
Cubic Feet	"	7.4805	"	U. S. gallons.
U. S. Struck Bushels	"	2,150.42	"	cubic inches.
U. S. Gallons	"	231.0	"	cubic inches.
U. S. Gallons	"	0.13368	"	cubic feet.
Cubic Inches	"	0.000364	"	U. S. heaped bushels.
U. S. Heaped Bushels	"	2,747.7	"	cubic inches
Cubic feet of Water (at 62° Fahr.)	"	62.355	"	pounds avoirdupois.
U. S. Gallons Water (at 62° Fahr.)	"	8.3356	"	pounds avoirdupois.
Cubic Feet of Water (at 62° Fahr.)	"	0.031177	"	short tons.
Diameter of Circle	"	3.14159	"	circumference.
Circumference	"	0.31831	"	diameter.
Pounds Avoirdupois	"	0.0089285	"	hundredweight (112 lbs.)
Pounds Avoirdupois	"	0.00044643	"	long tons.
Pounds Avoirdupois	"	0.0005	"	short tons.

Metric and Common Equivalents

Inches	multiplied by	25.4001	equal	millimeters.
Millimeters	"	0.03937	"	inches.
Inches	"	2.54001	"	centimeters.
Centimeters	"	0.3937	"	inches.
Feet	"	0.304801	"	meters.
Meters	"	3.28083	"	feet.
Yards	"	0.914402	"	meters.
Meters	"	1.093611	"	yards.
Miles	"	1.60935	"	kilometers.
Kilometers	"	0.62137	"	miles.
Square Inches	"	6.452	"	square centimeters.
Square Centimeters	"	0.155	"	square inches.
Square Feet	"	9.250	"	square decimeters.
Square Decimeters	"	0.108108	"	square feet.
Square Yards	"	0.836	"	square meters.
Square Meters	"	1.196	"	square yards.
Acres	"	0.4047	"	hectares.
Hectares	"	2.471	"	acres.
Square Miles	"	259.0	"	hectares.
Hectares	"	0.003861	"	square miles.
Cubic Inches	"	16.387	"	cubic centimeters.
Cubic Centimeters	"	0.061023	"	cubic inches.
Cubic Feet	"	0.02832	"	cubic meters.
Cubic Meters	"	35.314	"	cubic feet.
Cubic Yards	"	0.765	"	cubic meters.
Cubic Meters	"	1.308	"	cubic yards.
Bushels	"	0.35242	"	hectoliters.
Hectoliters	"	2.8375	"	bushels.
Fluid Drams	"	3.70	"	milliliters, or cubic centimeters
Milliliters	"	0.27	"	fluid drams.
Fluid Ounces	"	29.57	"	milliliters.
Milliliters	"	0.033818	"	fluid ounces.
Quarts	"	0.94636	"	liters.
Liters	"	1.0567	"	quarts.
Gallons	"	3.78544	"	liters.
Liters	"	0.2641	"	gallons.
Grains	"	64.7989	"	milligrams.
Milligrams	"	0.01543	"	grains.
Ounces Avoirdupois	"	28.3495	"	grams.
Grams	"	0.03527	"	ounces avoirdupois.
Pounds Avoirdupois	"	453.59242	"	grams.
Grams	"	0.0022045	"	pounds avoirdupois.
Pounds Avoirdupois	"	0.45359	"	kilograms.
Kilograms	"	2.20462	"	pounds avoirdupois.
Ounces Troy	"	31.10348	"	grams.
Grams	"	0.03215	"	ounces troy.
Pounds Avoirdupois	"	0.0045359	"	quintals.
Quintals	"	220.46	"	pounds avoirdupois.

THE METRIC SYSTEM AT A GLANCE

Number of Units.	Length.		Surface.		Volume.
	Name.	Equal to	Name.	Equal to	
10,000	Myriameter	6.2137 mi.			Myriaster
1,000	Kilometer	0.12137 mi.			Kiloster
100	Hectometer	328 ft. 1 in.	Hectare	2.471 acres	Hectoster
10	Dekameter	32.8 ft.			Dekaster
UNIT	METER	39.37 in.	ARE	119.6 sq. yds.	STER=1 cubic meter
1-10th	Decimeter	3.937 in.			Decister
1-100th	Centimeter	0.3937 in.	Centare	1,550.0 sq. yds.	Centister
1-1000th	Millimeter	0.03937 in.			Millister

Number of Units.	Weight.		Capacity.	
	Name.	Equal to	Name.	Equal to
1,000,000	Millier or Tonneau	2,204.6 lbs.		
100,000	Quintal	220.46 "		
10,000	Myriagram	22.046 "		
1,000	Kilogram or Kilo	2.2046 "	Kiloliter or Stere	264.17 gals.
100	Hectogram	3.5274 oz.	Hectoliter	26.417 "
10	Dekagram	0.3527 "	Dekaliter	2.6417 "
UNIT	GRAM	15.432 grains	LITER	1 0567 qts.
1-10th	Decigram	1.5432 "	Deciliter	0.845 gill
1-100th	Centigram	0.1543 "	Centiliter	0.338 fl. oz.
1-1000th	Milligram	0.0154 "	Milliliter	0.27 fl. dr.

PRINCIPLES OF THE DECIMAL SYSTEM

The decimal system, on which the United States currency is subdivided, is so widely used, especially in scientific work, in this country, that familiarity with its notation is indispensable.

Under the decimal system, every fraction is represented with 10, or some multiple of 10 (as, 100, 1,000, 10,000) for its denominator.

Integers and fractions are written on the same line, the whole number to the left, and the fractional to the right, of a point called the *decimal point*. Thus, $87.1=87\frac{1}{10}$. A *decimal number* is a number which includes a decimal fraction.

In a decimal fraction, the denominator never is written. The denominator is always understood to be 1 with as many ciphers annexed as there are figures (called *decimal places*) in the fraction (*i. e.*, to the right of the decimal point). Thus, $0.7 = \frac{7}{10}$; for as there is only one decimal place, the denominator is 1 with one cipher, or 10. $0.879 = \frac{879}{1000}$.

Annexing ciphers to a whole number multiplies it by 10; annexing ciphers to a decimal fraction does not change its value.

Moving the decimal point one place *to the left divides* a decimal number by 10; moving the decimal point one place *to the right multiplies* it by 10.

To Add Decimals—Arrange so that one decimal point falls under another, and proceed as in adding integers.

```
819.063
 21.236
  0.008
-------
840.307
```

To Subtract Decimals—Write as for adding, and proceed as in ordinary subtraction.

```
819.063
 21.236
-------
797.827
```

To Multiply Decimals—Proceed as in ordinary multiplication; then point off as many figures from the right of the product as there are decimal places in both the multiplicand and the multiplier. In the example given, the multiplicand has 3 decimal places, and the multiplier 4. The product, therefore, must have 7, and we prefix a cipher to make the required number before setting down the decimal point.

```
  21.236
   .0018
--------
  169888
  21236
--------
.0382248
```

To Divide Decimals—Proceed as in ordinary division; then point off from the right of the quotient as many decimal places as the number of decimal places in the dividend exceeds the number of decimal places in the divisor. Ciphers must be annexed to the dividend, if necessary, so that its decimal places shall at least equal in number those of the divisor. If the dividend and divisor contain the same number of decimal places, the quotient is a whole number.

```
21.9)819.063(37.4
     657
     ----
     1620
     1533
     ----
       876
       876
       ---
```

To Reduce a Common Fraction to Decimal Form—Annex ciphers to the numerator, and divide by the denominator. In the example given, $\frac{6}{72}$ is reduced to its equivalent decimal.

```
72 )6.0000( .0833 etc.
    5.76
    ----
     240
     216
     ---
      240
      216
      ---
       24
```

TO COMPUTE INTEREST

In some banks interest is calculated on a basis of 12 months of 30 days each (360 days to the year); in others the 365-day year is used as a basis. The following table provides for either usage:

RULE: *Multiply* principal by number of days, and *divide* product, for rate of:	365 Days to Year.	360 Days to Year.
1 per cent ... by	36,500	36,000
2 per cent ... by	18,250	18,000
3 per cent ... by	12,166.66	12,000
4 per cent ... by	9,125	9,000
5 per cent ... by	7,300	7,200
6 per cent ... by	6,083.33	6,000
7 per cent ... by	5,214.29	5,142.85
8 per cent ... by	4,562.50	4,500
9 per cent ... by	4,055.55	4,000
10 per cent ... by	3,650	3,600
12 per cent ... by	3,041.67	3 000
15 per cent ... by	2,433.33	2,400
18 per cent ... by	2,027 77	2,000
20 per cent ... by	1,825	1,800
24 per cent ... by	1,520.83	1,500

RULES, TABLES, AND DEFINITIONS

LUMBERING, CARPENTRY, ETC.

Height of Standing Tree, to compute: Set a stick of known length vertically in the ground. Measure length of its shadow. Multiply length of shadow of tree by length of stick above ground, and divide product by length of stick's shadow. All dimensions in feet.

Volume of Standing Tree, in cubic feet. Divide circumference (in feet) at breast height by 3.14, to get diameter. Multiply square of half the diameter by 3.14 and the product by half the height of the tree.

Round Timber, volume in cubic feet: Multiply length by one-quarter of product of average girth and average diameter, all dimensions feet. If only length is in feet, divide result by 144. If all dimensions are in inches, divide result by 1,728.

Square Timber, to compute contents in board measure (linear feet of equivalent board 1 inch thick and 12 inches wide): Multiply together length and breadth in feet and thickness in inches.

Value and Weight of Various Woods

VARIETY.	Weight of 1 Cord.	Equivalent in Coal (lbs.)
Hickory	4,500	2,000
White Oak	3,850	1,715
Beech	3,250	1,450
Red Oak	3,250	1,450
Black Oak	3,250	1,450
Poplar	2,350	1,050
Chestnut	2,350	1,050
Elm	2,350	1,050
Pine	2,000	925

Fencing — One mile of fence requires, for each board in height, 2,640 linear feet of 1 x 6-inch stuff.

Length of Rafters for given pitch of roof, to compute:

If pitch is $\frac{1}{4}$,	multiply span by	.559,	or	$\frac{7}{12}$, nearly.
If " $\frac{1}{3}$,	" "	.6	"	$\frac{3}{5}$
If " $\frac{3}{8}$,	" "	.625	"	$\frac{5}{8}$, nearly.
If " $\frac{1}{2}$,	" "	.71	"	$\frac{7}{10}$, "
If " $\frac{5}{8}$,	" "	.8	"	$\frac{4}{5}$
If " full,	" "	1.12	"	$1\frac{1}{8}$, nearly.

and in each case add length to which rafters project at eaves.

Span is the horizontal distance between studdings on which roof rests at eaves. A roof has $\frac{1}{4}$ pitch when the height of the ridgepole above level of roof-plates is $\frac{1}{4}$ of the span; full pitch, when height and span are equal.

Siding — One bundle of clapboards, laid $3\frac{1}{2}$ inches to the weather, will cover 26 square feet.

Shingles: Required for Roof, to compute: Multiply area of roof in square feet by 9, if shingles are exposed 4 inches; by 8 if exposed $4\frac{1}{2}$ inches, and by $7\frac{1}{5}$ if exposed 5 inches to the weather. For hip-roofs add one-twentieth to result.

Paint, to estimate amount necessary for given surface: Divide number of square feet of surface to be covered by 200; quotient is approximate number of gallons required for two coats; to obtain approximate number of pounds of pure ground white lead required for three coats, divide by 18.

Nails Required for various purposes: To case and hang *door,* 1 lb.; to case and hang *window,* $\frac{3}{4}$ lb.; *base,* per 100 linear feet, 1 lb.; to put up *rafters, studding, joists, etc.,* per 1,000 feet, 3 lbs.; to lay 6-inch pine *floor,* per 1,000 feet, 15 lbs.; for bundle of *lath,* $\frac{2}{5}$ lb. 3-penny nails; *shingles,* per 1,000, 6 lbs. 4-pennies.

Cut Nails, Length and Number to the Pound

Designation.	Length.	Common.	Clinch.	Fence.	Finishing.	Fine.	Barrel.	Casing.	Shingle.	Brads.	Tobacco.	Cut Spikes.
----	¾ inch	----	----	----	----	----	800	----	----	----	----	----
----	⅞ inch	----	----	----	----	----	500	----	----	----	----	----
2d	1 inch	800	----	----	1100	1000	376	----	----	----	----	----
3d	1¼ inch	464	----	----	720	800	224	----	----	----	----	----
4d	1½ inch	296	----	----	523	368	180	398	----	----	----	----
5d	1¾ inch	224	----	----	410	----	----	----	178	----	130	----
6d	2 inch	168	95	84	268	----	----	224	----	126	96	----
7d	2¼ inch	120	74	64	188	----	----	----	----	98	82	----
8d	2½ inch	88	62	48	146	----	----	128	74	75	68	----
9d	2¾ inch	70	53	36	130	----	----	110	60	65	----	----
10d	3 inch	60	46	30	102	----	----	91	52	55	----	28
12d	3¼ inch	48	42	24	76	----	----	71	----	40	----	----
16d	3½ inch	36	38	20	62	----	----	54	----	27	----	22
20d	4 inch	24	33	16	54	----	----	40	----	----	----	14½
30d	4½ inch	17	20	----	----	----	----	33	----	----	----	12½
40d	5 inch	13	----	----	----	----	----	27	----	----	----	9½
50d	5½ inch	9½	----	----	----	----	----	----	----	----	----	8
60d	6 inch	8	----	----	----	----	----	----	----	----	----	6
----	6½ inch	----	----	----	----	----	----	----	----	----	----	5½
----	7 inch	----	----	----	----	----	----	----	----	----	----	4½
----	8 inch	----	----	----	----	----	----	----	----	----	----	2½

Steel-wire nails run about one-half more to the pound.

MASONWORK, LATHING, AND PLASTERING

Brick — Common brick measure about 2 x 4 x 8¼ inches and contain 66 cubic inches, 26 occupying the space of a cubic foot, or 706 a cubic yard. Brickwork is estimated by the thousand. A bricklayer, supplied with materials by a tender, will average from 1,500 to 2,000 bricks a day. Work is estimated thus:

Wall	1 brick	(8¼ inches)	thick,	14	bricks per square foot of surface.
"	1½ bricks	(12¾ ")	"	21	" " "
"	2 "	(17 ")	"	28	" " "
"	2½ "	(21½ ")	"	35	" " "

Paving brick run 36 to the square yard, if laid flat; 82 if on edge.

Lime, Sand, and Cement — To lay 1,000 brick, 1⅛ barrels of lime and ⅝ yard of sand. To lay 100 feet of rubble stone, 1¼ barrels lime and 1 yard sand, or 1¼ barrels of cement and ¾ yard sand (150 feet is a day's work for one man and tender).

Chimneys — For 1 foot in height, 5 courses of brick. For flue 4 x 12 inches, 8 bricks in a course. For flue 8 x 16 inches, 16 in a course. To find inside sectional area, in square inches, of smallest point in chimney for stationary engine, multiply pounds of coal consumed per hour by 12, and divide product by square root of height of chimney in feet.

Cement — One bushel of cement and 2 bushels of sand will cover $3\frac{1}{2}$ square yards 1 inch thick. With 1 bushel of sand, 1 bushel of cement will cover $2\frac{1}{4}$ square yards 1 inch thick.

Lathing and Plastering — One bundle of (100) lath, dimensions $\frac{1}{4}$ x $1\frac{1}{4}$ x 60 inches, will cover 5 square yards; 2 barrels of lime, $1\frac{1}{4}$ yards of good sand, and $1\frac{1}{2}$ bushels of hair will lay one coat of plaster on 100 square yards of lathing; $3\frac{1}{2}$ barrels of lime are required for two coats.

MISCELLANEOUS COMPUTATIONS

Capacity of Cylindrical Tank, Silo, etc., to compute: Multiply together the square of the diameter (inches) and the height (inches). Multiply product *for U. S. gallons,* by 0.0034; *for U. S. struck bushels,* by 0.0003652; *for tons of silage* (averaging 50 cubic feet to the ton), by 0.00000909.

Calculation of Staves Required for Stave Silos — The following table will be found useful in calculating the number of staves required for silos of different diameters, and the feeding areas which these will give:

Circumferences and Areas of Circles

Diameter, Feet.	Circumference, Feet.	Area, Square Feet.	Diameter, Feet.	Circumference, Feet.	Area, Square Feet.	Diameter, Feet.	Circumference, Feet.	Area, Square Feet.
8	25.1	50.3	17	53.4	227.0	25	78.5	490.9
9	28.3	63.6	18	56.5	254.5	26	81.7	530.9
10	31.4	78.5	19	59.7	283.5	27	84.8	572.6
11	34.6	95.0	20	62.8	314.2	28	88.0	615.8
12	37.7	113.1	21	66.0	346.4	29	91.1	660.5
13	40.8	132.7	22	69.1	380.1	30	94.2	706.9
14	44.0	153.9	23	72.3	415.5	31	97.4	754.8
15	47.1	176.7	24	75.4	452.4	32	100.5	804.2
16	50.3	201.1						

To find the circumference of a circle, multiply the diameter by 3.14159.

To find the area of a circle, multiply the square of the diameter by 0.7854.

To find the cubical content of a cylinder, multiply the area of the base by the height.

Capacity of Boxes, Square Silos, Cisterns, and Hay Mows, to compute: Multiply together the inside length, breadth, and height, in inches, and multiply, *for struck bushels*, by 0.000466; *for gallons*, by 0.004329; *for tons of silage* (averaging 40 lbs. to the cubic foot), by 0.00001157; *for tons of hay* (roughly, assuming 400 cubic feet to the ton, which is about the minimum), by 0.000001447.

Quantity of Hay in Stack, to estimate: Multiply together the length, breadth, and height to eaves *plus* one-half the vertical distance from level of eaves to crest — *all in feet*. Divide product by number of cubic feet allowed for a ton. Or, *if slope from ground to crest is uniform*, multiply together the length, breadth, and one-half the vertical height, *all in feet*, and divide by number of cubic feet to the ton (see above). The space occupied by a ton of hay will vary with the depth of the mow or stack and the kind of hay, whether coarse and hollow-stemmed or fine and compact.

Corn in Crib, to estimate amount: If sides of crib are vertical, divide product of length, breadth, and height (in inches) by 2,748. Quotient is contents in heaped bushels. If crib has inclining sides, multiply half the sum of the top and bottom widths by the vertical height, and the product by the length (all in inches). Divide the product by 2,748. For amount of shelled corn ears will yield, take one-half the number of bushels of ears.

Grain in Bin, to estimate amount: Find capacity in cubic inches, as above, and multiply, for small grain or shelled corn, by 0.000463; for corn in the ear, by 0.000232. The result will be United States bushels. Small grains run about $1\frac{1}{4}$ bushels, and ear corn about $2\frac{1}{2}$ bushels, to the cubic foot, the figures varying somewhat with the condition and quality of the grain, the depth of the bin, and the length of time grain has been allowed to settle.

Coal in Bin, to estimate quantity: Multiply together length, breadth, and thickness (in feet) and multiply product by .024. Result will be tons.

Contents of Hopper, in U. S. bushels: Multiply together the length, breadth, and one-third the depth (measured vertically to the point), all in inches. Multiply the product by 0.000466.

Cost of Mixed Feeds, Fertilizers, etc., to compute: Multiply the quantity of each ingredient (in pounds) by its price per pound; add the products, and divide their sum by the total quantity (in pounds). Quotient will be average price per pound.

Dimensions of an Acre — A square 12.649 rods, or 69.57 yards, or 208.72 feet, on a side, contains an acre. An acre is contained, also, in a rectangle having any of the following dimensions (in rods):

1 x 160	4 x 40	7 x $22\frac{6}{7}$	10 x 16
$1\frac{1}{2}$ x $106\frac{2}{3}$	$4\frac{1}{2}$ x $35\frac{5}{9}$	$7\frac{1}{2}$ x $21\frac{1}{3}$	$10\frac{1}{2}$ x $15\frac{5}{21}$
2 x 80	5 x 32	8 x 20	11 x $14\frac{6}{11}$
$2\frac{1}{2}$ x 64	$5\frac{1}{2}$ x $29\frac{1}{11}$	$8\frac{1}{2}$ x $18\frac{14}{17}$	$11\frac{1}{2}$ x $13\frac{21}{23}$
3 x $53\frac{1}{3}$	6 x $26\frac{2}{3}$	9 x $17\frac{7}{9}$	12 x $13\frac{1}{3}$
$3\frac{1}{2}$ x $45\frac{5}{7}$	$6\frac{1}{2}$ x $24\frac{8}{13}$	$9\frac{1}{2}$ x $16\frac{16}{19}$	$12\frac{1}{2}$ x $12\frac{4}{5}$

Thermometer Scales

	Freezing Point.	Boiling Point.	Intermediate Divisions.
Fahrenheit	32°	212°	180°
Centigrade	0°	100°	100°
Réaumur	0°	80°	80°

To convert Centigrade degrees into Fahrenheit, multiply by $\frac{9}{5}$ and add 32. To convert Réaumur degrees into Fahrenheit, multiply by $\frac{9}{4}$ and add 32. Remember that degrees below zero are minus quantities, and that adding minus quantities to positive quantities diminishes the latter by the amount of the former.

Weights of Various Substances for Given Volumes

MATERIAL.	Volume.	Weight.
Bitumiuous Coal	1 bushel.	76 lbs.
Bitumiuous Coal	1 cubic foot.	50–55 lbs.
Anthracite Coal	1 cubic foot.	55–66 lbs.
Charcoal (hardwood)	1 cubic foot.	18.5 lbs.
Charcoal (standard)	1 bushel.	20 lbs.
Gravel (in bank)	18 cubic feet.	1 ton.
Gravel (dry)	27 cubic feet.	1 ton.
Sand	25 cubic feet.	1 ton.
Earth (in bank)	18 cubic feet.	1 ton.
Earth (dry)	27 cubic feet.	1 ton.
Clay	17 cubic feet.	1 ton.
Cement (Portland)	1 barrel.	400–430 lbs.
Cement (Rosendale)	1 struck bushel.	62– 70 lbs.
Lime	1 struck bushel.	72– 75 lbs.

Legal and Customary Weights, per Bushel, in various States

STATE.	Anthracite Coal.	Apples.	Apples, Dried.	Barley.	Beans.	Bluegrass Seed.	Buckwheat.	Clover Seed.	Corn on Cob.	Corn, Shelled.	Corn Meal.	Flax Seed.	Oats.	Onions.	Peaches.	Peas.	Potatoes, Irish.	Potatoes, Sweet.	Rye.	Salt.	Timothy Seed.	Turnips.	Wheat.
Alabama	--	--	--	47	60	--	48	60	--	56	48	--	32	57	--	--	60	--	56	--	--	55	60
Arkansas	80	--	24	48	60	14	52	60	70	56	48	56	32	57	--	46	60	50	56	50	60	57	60
California	--	--	--	50	--	--	40	--	--	52	--	--	32	--	--	--	--	--	54	--	--	--	60
Colorado	--	--	--	48	60	--	52	60	--	56	50	--	32	--	--	--	60	--	56	--	45	--	60
Connecticut	--	--	--	48	60	--	48	--	--	56	50	--	32	50	--	60	60	--	56	--	--	50	60
Delaware	--	--	--	--	--	--	--	--	--	56	48	--	--	--	--	--	--	--	--	--	--	--	60
District of Columbia	--	--	--	47	62	--	48	60	--	56	48	--	32	57	--	--	56	--	56	50	45	55	60
Florida	--	--	--	48	60	--	48	60	--	56	48	--	32	57	--	--	60	--	56	--	45	55	60
Georgia	80	--	24	47	--	14	52	60	70	56	48	56	32	57	38	60	60	55	56	56	45	55	60
Idaho	--	--	--	48	--	--	42	60	--	56	--	--	36	--	--	--	60	--	56	--	--	--	60
Illinois	80	--	24	48	60	14	52	60	70	56	48	56	32	57	33	--	60	55	56	50	45	55	60
Indiana	--	--	25	48	60	14	50	60	68	56	50	--	32	48	33	--	60	--	56	50	45	--	60
Iowa	80	48	24	48	60	14	52	60	70	56	--	56	32	57	33	--	60	46	56	50	45	--	60
Kansas	80	--	24	48	60	14	50	60	70	56	50	54	32	57	33	--	60	50	56	50	45	55	60
Kentucky	76	24	24	47	60	14	56	60	*	56	50	56	32	57	39	60	60	55	56	50	45	60	60
Louisiana	--	--	--	--	--	--	--	--	--	56	50	--	32	--	--	--	--	--	--	--	--	--	--
Maine	--	44	--	48	62	--	48	--	--	56	50	--	32	52	--	60	60	--	--	--	45	60	60
Maryland	--	--	--	--	62	--	--	--	--	--	--	--	26	--	40	--	56	--	56	56	--	--	--
Massachusetts	--	48	--	48	60	--	48	60	--	56	50	--	32	52	--	--	60	56	56	--	45	--	60
Michigan	--	48	22	48	60	14	48	60	70	56	50	56	32	54	28	60	60	56	56	56	45	58	60
Minnesota	--	--	28	48	60	--	50	60	--	56	--	--	32	57	28	--	60	--	56	--	45	52	60
Mississippi	--	--	--	48	60	--	--	60	--	56	48	--	32	--	--	--	60	--	56	--	45	--	60
Missouri	--	48	24	48	60	14	52	60	--	56	50	56	32	57	33	--	60	--	56	50	45	42	60
Montana	--	--	--	48	60	--	52	60	--	56	50	--	32	57	--	--	60	--	56	--	45	50	60
Nebraska	--	--	--	48	60	--	52	60	--	56	--	--	32	52	33	--	60	--	56	50	45	55	60
New Hampshire	--	--	--	--	62	--	--	--	--	56	50	--	32	--	--	60	60	--	56	--	--	--	60
New Jersey	--	50	25	48	--	--	50	64	--	56	--	55	30	57	--	60	60	54	56	--	45	--	60
New York	--	--	--	48	62	--	48	60	--	58	--	55	32	--	--	60	60	--	56	--	44	--	60
North Carolina	--	--	--	48	--	--	50	64	--	54	46	--	30	--	--	50	--	--	56	--	--	--	60
North Dakota	--	--	--	48	60	--	42	60	--	56	--	--	32	57	--	--	60	--	56	--	42	60	60
Ohio	--	48	22	48	60	--	50	60	70	56	--	56	32	55	48	60	60	50	56	--	45	60	60
Oklahoma	--	--	--	48	--	--	42	60	--	56	--	--	32	52	--	--	60	--	56	--	42	60	60
Oregon	--	45	--	46	--	--	42	60	--	56	--	--	36	--	--	--	60	--	56	--	--	--	60
Pennsylvania	--	--	--	47	--	--	48	62	--	56	48	--	30	50	--	--	60	--	56	85	--	--	60
Rhode Island	--	--	--	48	--	--	--	--	--	56	50	--	32	50	--	--	60	--	56	--	--	--	60
South Carolina	--	--	26	48	60	14	56	60	70	56	50	44	32	57	--	60	60	50	56	50	--	--	60
South Dakota	--	--	--	48	60	--	42	60	--	56	--	--	32	52	--	--	60	--	56	--	42	60	60
Tennessee	--	50	26	48	60	14	50	60	72	56	50	56	32	56	50	60	60	50	56	--	45	50	60
Texas	--	--	--	48	60	--	42	60	--	56	--	--	32	57	--	--	60	--	56	--	45	55	60
Vermont	--	46	--	48	62	--	48	60	--	56	--	--	32	52	--	60	60	--	56	70	45	60	60
Virginia	80	--	28	48	60	14	52	64	70	56	50	56	32	57	40	60	60	56	56		45	56	60
Washington	--	45	--	48	--	--	42	--	--	56	--	--	32	--	--	--	60	--	56	--	40	--	60
West Virginia	--	--	--	48	60	--	52	60	--	56	--	--	32	--	33	--	60	--	56	--	45	--	60
Wisconsin	--	57	28	48	60	--	48	60	70	56	50	56	32	57	28	--	60	--	56	--	45	42	60

* November 1 to May 1, 70 lbs.; remainder of year, 68 lbs.

Milk, quarts and pounds: To convert quarts of milk into pounds, multiply by 2.15; to convert pounds into quarts, multiply by 0.47.

Dried Fruit and Cider—A bushel of average apples will make from 6 to 7½ lbs. of dried fruit; 7 to 17 bushels of apples make 1 bbl. of cider.

Strength of Ropes, in Pounds

Circumference	1 in.	1½ in.	2 in.	2½ in.	3 in.	4 in.	5 in.	6 in.
Manila	100	225	400	625	900	1,600	2,500	3,600
Hemp	200	450	800	1,250	1,800	3,200	5,000	7,200
Steel Wire	2,500	5,625	10,000	15,625	22,500	40,000	62,500	90,000

The breaking weights greatly exceed the foregoing, which are considered safe strains.

Strength of Chains

Diameter inches.	Weight per ft. lbs.	Strength lbs.	Diameter inches.	Weight per ft. lbs.	Strength lbs.
¼	0.875	1,288	$\frac{11}{16}$	5.000	9,660
$\frac{5}{16}$	1.000	1,932	¾	5.875	11,592
⅜	1.700	2,790	⅞	8.000	14,989
$\frac{7}{16}$	2.000	3,864	1	10.700	19,712
½	2.500	5,182	1⅛	12 500	25,050
$\frac{9}{16}$	3.200	6,440	1¼	16.000	30,800
⅝	4.125	7,942	1⅜	18.400	37.165

Hydraulic Rams—Used for pumping, where considerable flow of water, but only moderate fall (from 2 to 30 feet) can be obtained. With drive pipe 25 to 50 feet long, set in bed of stream, water can be conveyed half a mile and elevated 200 feet. Inexpensive after first cost, which is moderate.

Windmills and Pumping—One horsepower will raise 59 gals. water 56 ft. per minute. A windmill with 8½-ft. wheel, wind at 16 miles per hour, will raise 3 gals. water per minute to a height of 56 ft.; 10-ft. wheel, 9.5 gals. per minute; 12-ft. wheel, 18 gals.; 14-ft. wheel, 22.5 gals.; 16-ft. wheel, 32 gals.; 18-ft. wheel, 52 gals.; 20-ft. wheel, 64 gals.; 25-ft. wheel, 107 gals.

Waterpowers—*Overshot Wheels.*—With fall of 10 feet from water-level in penstock to level in wheel-pit (wheel running) the flow of a body of water 2 inches deep over weir 5 feet wide will produce about 1 H. P. For greater depths the power increases more rapidly than the depth.

Wholesome Cooking Without Waste

Adapted from François Tanty

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Wholesome Cooking Without Waste

Adapted from François Tanty [1]

The best cooking is as easily accomplished as is that of inferior sort. Assuming that the housewife is well grounded in the fundamentals of her art, there is none who may not gather, from the experience of the chefs of a nation that has made gastronomy a fine art, suggestions for making dainty dishes even daintier, and for enlarging the variety of the daily menus. In the following cooking rules, most of which have been selected from among the recipes worked out for American use by the late M. Tanty, there is no departure from the essential principles he lays down, but the extreme of simplicity has been sought, lest the reader be needlessly appalled by elaborate and oft-repeated admonition. The recipes for sweet cakes herein given, however, are not M. Tanty's, and such other additions and modifications have been made as have seemed expedient.

The question of using wines and spirits in cooking and as beverages is with some a matter of choice; with others, of conscience. The preferences of the one class, and the scruples of the other, are entitled to respect, and although wines and spirits are included in some few of the recipes that follow, they may quite as well be omitted, if the housewife prefers.

A Family Dinner is essentially composed of:

A Soup
A Fish or Meat, with sauce and vegetable — called an "entrée"
A Roast — meat, poultry, or game
A Vegetable of the season, or one dried or canned, called an "entremet" (side dish)
A Sweet Dish — ice cream or pastry
Cheese and Fruit

Provided the dinner becomes more fashionable, one should serve two kinds of soup, a clear one and a purée or cream, from which the guest may choose; and should increase the number of entrées and entremets.

Setting the Table —As regards the setting of the table, we will give only practical hints, taking for example a quite fashionable dinner, leaving to the housewife the simplifying of the scheme to serve for family dinners.

The table should be spacious enough to avoid the crowding of dishes or covers and the too close seating of guests. Around a centerpiece of flowers may be disposed (if the size of the table will permit) smaller pieces, with fruits, bonbons, etc., and also the "hors d'œuvres," served in special small dishes. Candlelight being more fashionable than gas, candelabra should be placed in sufficient number.

Before each plate place the necessary number of glasses, according to the wines that are to be served. This number will not exceed five, viz.: A glass for water; a glass for white wine, claret,

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[1] *La Cuisine Française:* French Cooking for Every Home. By François Tanty. Chicago: Rand, McNally & Co. Copyright, 1902, by Rand, McNally & Co., Chicago.

and Burgundy; a glass for Madeira, sherry, and sweet dessert wines; a glass (usually green or amber) for Rhine wine (if served); a glass for champagne.

Do not fill the water glass before the dinner, but place decanters and crystal bowls filled with pieces of ice within easy reach of the guests.

At the *right* of each cover place the knife, fork, and spoon (the knife having a sharp steel blade). These should be changed with each course. Before the cover place a smaller knife, fork, and spoon (the knife with a silver blade) for the sweet dishes and dessert. The napkin should be of good size, placed on the plate, folded, with a small roll between the folds. Between each two covers should be pepper and salt. Before each cover, and supported by the glass, should be a menu, printed or hand written. For menu use, where desired, the French name of each dish is given hereafter (See Index). On each card one may write the name of the particular guest who is to occupy the place.

Service of Wines — In every dinner "à la Française" wine is served; the number, kinds, and quality varying, of course, according to the importance of the dinner. The general order in which they are served is as follows: *After the soup* — a strong, dry wine, such as Madeira or Sherry; *with the fish* — a white, dry wine, such as the Sauternes, Chablis, Chateau d'Yquem, Rhine wine, etc.; *after the fish and until the roast* — Claret; *with the roast* — Burgundy; *with sweet dishes* — champagne or dessert wines, such as Tokay, Malaga, or Constance.

A word as to the manner of serving wine is necessary. White wine ought to be chilled and is placed in cold water for one hour before serving. It is the same with ordinary claret. Fine wines, as claret of good quality, Burgundy, Madeira, sherry, and port wine, ought to be taken from the cellar at least one hour before serving, so as to take the temperature of the air. Do not disturb the dust which with age has accumulated on the bottle. Draw the cork with great care, so as not to mix the dregs with the wine, and pour into the glasses without shaking the bottle. In the case of champagne, break the wires that hold the cork, but preserve the threads; place in a tub or pail, and pack around the bottles cracked ice mixed with salt (5 pounds ice to 2 pounds salt). Stop freezing as soon as the champagne begins to be a little cloudy.

As a last admonition, remember the old adage: "The dinner never should await the guests, but the guests the dinner; because, however well cooked, a dish can not be warmed over."

SOUPS

By modifying some of the recipes that follow — for instance, by replacing one kind of vegetable in a purée with another, by using game instead of fowl, or by varying the garnishing — the housewife will have an infinite number of soups at her disposal. She should always be careful, however, to follow closely the general rules, and especially in those essential points emphasized by heavy type.

PUREE OR CREAM: GENERAL NOTE

The purée, or cream, is quite a thick soup, very palatable and substantial. It is made out of fowl, game, vegetables, or fish. In every case one must first cook the particular materials until tender, and then strain them, to obtain a reasonably clear liquor, to which must be added what the French cooks call a "*liaison*" (binding), to unite all the parts. This is made with yolks, cream, and butter, sometimes flour or starch. **One must never forget that this liaison should be added only when ready to serve; that the saucepan must be placed on a corner of the range; that one should add some of the hot liquor to the liaison before**

pouring the latter into the saucepan; and that never, under any circumstances, should a soup be permitted to boil after pouring in a liaison.

BOUILLON, STOCK SOUP

Stock being the foundation of many soups, and serving also for the basis of many sauces and dishes, it would prove advantageous for a housewife always to have some stock on hand. Stock may be kept fresh for several days in an earthen jar in an icebox, the only precaution necessary being to let it boil awhile, in case of a very hot or stormy day, to prevent souring.

For 1 gallon, wash thoroughly 5 pounds cheap beef and bones and 2 pounds hock veal. Put in kettle and cover with **cold water.** Boil slowly, skimming until clear, and adding from time to time a tablespoonful of cold water, to hasten separation of scum. When clear, add 2 carrots, ½ turnip, 1 onion, and some celery, and boil for 2 hours. Remove the veal, add 1 old fowl (cut in pieces), and boil slowly 3 hours more. Skim off floating grease and strain soup. Bouillon should be only lightly salted. Half of the onion should have been browned on the stove, to give color and taste.

CONSOMMÉ

Consommé is the name given to a stock stronger and more palatable than the common one. It forms the foundation of the soups for the more fashionable dinners, or is served in cups at ball suppers or luncheons.

Cut in pieces 1 old fowl and 2 pounds veal hock; let them brown lightly in butter; then put them in a kettle with 3 to 4 quarts of stock. Cook slowly for 2 hours, skimming from time to time. Remove floating grease and pass through strainer, or, better, a cloth.

JULIENNE

Slice 1 carrot, ½ turnip, ¹⁄₁₀ cabbage, and ½ leek (or onion) into thin strips; put them in saucepan with a little butter and a teaspoonful of sugar, and let cook awhile. Pour over them 2 quarts stock or consommé and cook for 1½ hours.

CONSOMMÉ WITH RICE

Wash 1 tablespoonful rice and boil in water until soft; let drip, and **cool with cold water;** then let drip again. Warm 2 quarts stock or consommé, and when ready to serve put rice in soup, which must not be allowed to boil again.

MACARONI

Break 2 ounces macaroni in ½-inch pieces, cook in boiling water, and proceed as for consommé with rice.

OXTAIL SOUP

Cut 1 oxtail in 1-inch pieces; boil in water until tender; let drip, and remove grease and small bones. Put in a saucepan with 2 or 3 quarts bouillon. ½ glass Madeira, 1 onion, 1 carrot, and some thyme and laurel; let the whole cook for 3 hours. Pour the bouillon through a strainer into another saucepan; take off floating grease; add ½ glass Madeira and a little red pepper; cook awhile, and when ready to serve, add while stirring, 1 tablespoonful cornstarch mixed with 1 glass **cold** bouillon. Serve in tureen in which the pieces of tail have been placed.

BARLEY SOUP

Wash 3 tablespoonfuls barley, and let stand ½ hour in cold water; let drip, drop into boiling water, and cook until soft. Let drip, cool with cold water, and drip again. Put the barley in a saucepan with 2 quarts stock and cook for 1 hour. When ready to serve, beat together 1 yolk, 1 glassful cream, 1 tablespoonful butter; add little by little, while stirring, some of the soup; then pour the mixture in, all the time stirring, but do not let the soup boil again.

TOMATO SOUP

Put in a saucepan 1 quart can (or 3 pounds fresh) tomatoes (first scalded, if fresh), with 1 carrot and 1 onion minced, and some thyme and laurel; cook 1 hour. Pass the whole through a strainer, add 1 quart stock or water, salt, and white and cayenne pepper. Pour in 1 tablespoonful cornstarch mixed in a little cold water and add 1 tablespoonful butter. When ready to serve add 1½ tablespoonfuls cooked rice.

BEET SOUP

Clean and mince 2 red beets, 1 onion, ⅛ cabbage; put the whole in a saucepan with some butter, cook awhile, then add ½ tablespoonful flour and 2 to 3 quarts stock; cook 1 hour. Grate 1 red beet, press through a cloth, and when ready to serve pour the juice into the soup and add a glass of milk.

CREAM OF FOWL

Take 1 hen or chicken and cook for 2 hours in 2 quarts of water with ½ veal or beef knuckle, 1 onion, 1 carrot, and 1 stalk of celery. When the chicken is very tender, let it drip and strain the stock through a cloth. Remove chicken meat from bones, set the fillets (tenderloins) aside, and pound the remainder of the flesh in a chopping bowl. To the pounded flesh add the stock little by little, while beating, and pass the resulting pulp through a strainer, to obtain a rich liquor. Melt in a saucepan 2 tablespoonfuls butter with 1½ tablespoonfuls flour, into which pour the liquor; let it become hot, but not boiling. When ready to serve, add the chicken fillets, cut into small dices.

CREAM OF CELERY

Wash 5 stalks of celery, and let them boil in water 5 minutes; let drip, cool with cold water and let drip again. Chop the celery stalks, put them in saucepan with 2 tablespoonfuls butter and 3 tablespoonfuls flour, cook awhile, and add 2 to 3 quarts stock; cook all together for 1 hour; pass through strainer and heat liquor in saucepan. When ready to serve add a liaison made of 3 yolks, 1 glass cream, and 2 tablespoonfuls butter, taking care not to let it boil again.

CREAM OF ASPARAGUS

Proceed as for Cream of Celery, but use 3 bunches asparagus instead of celery.

CREAM OF CAULIFLOWER

As for Cream of Celery, but use the white part of 1 cauliflower.

CARROT SOUP

Cut 6 carrots in small dices and cook in saucepan with some butter and a chopped onion. Add, while stirring, 1 tablespoonful flour and 2 to 3 quarts stock or water, and cook slowly for 1 hour. Pass through a strainer, and when ready to serve add 1 tablespoonful butter and 1½ tablespoonfuls cooked rice.

GREEN PEA SOUP

As for White Kidney Bean Soup, but take fresh or dried peas instead of beans. Serve with fried dices of bread sprinkled over it.

WHITE KIDNEY BEAN SOUP

Cook 1 pint white kidney beans in salted water with 1 sliced onion. When well cooked, strain. Heat in saucepan with 2 or 3 quarts stock or water, and when ready to serve add 2 tablespoonfuls butter. Serve hot with small pieces of dry toast.

VEGETABLE SOUP

Mince ⅛ cabbage, 1 carrot, 1 potato, ½ turnip, ½ onion and some celery; wash and let drip. Put the minced vegetables in saucepan with 2 to 3 quarts water and a little salt; boil for 1½ hours. When ready to serve add 1 glass milk, 1 tablespoonful butter, and some pieces of toast.

VELVET SOUP

Boil 2 to 3 quarts of milk or stock, and add 1 tablespoonful cornstarch mixed with a glass of cold water, milk, or stock. Boil for 5 minutes; then add 2 whole eggs, beaten with 1 glass milk, and 2 tablespoonfuls butter.

POTATO SOUP

Fry ½ minced onion until light brown, add 2 to 4 minced potatoes, and fry a little more. Add 2 quarts bouillon or water and boil for 20 minutes; strain, and put the purée back in the saucepan. When ready to serve, add 1 glass cream, mixed with 1 tablespoonful butter, not allowing the soup to boil again.

CREAM OF PUMPKINS

Cut in dices 1 inch square 3 to 4 pounds pumpkin; boil in water till tender; strain, and put the liquor in a saucepan with 4 tablespoonfuls butter, 1 teaspoonful sugar, and a little salt; heat, then add 2 quarts boiling water. Stir well, and serve with some fried toast.

OYSTER SOUP

Pour into kettle 1 quart boiling water; then 1 quart good rich milk; stir in 1 teacupful rolled cracker crumbs, seasoned with pepper and salt to taste. When all comes to a boil, add 1 quart good fresh oysters; stir well, so as to keep from scorching; lastly add butter the size of an egg; let it boil up once, remove from fire **immediately**, and serve.

RELISHES—COLD

The relishes (*hors d'œuvres*) are to be served more often at luncheons than at dinners, although a fashionable dinner must not lack some of them—or at least some of the cold ones. Usually the cold relishes are placed on the table in advance. They should always be served in special and appropriate dishes of china or glass. (See also *Salads*, page 469.)

RADISHES

Radishes should be young and fresh. Trim off the end of the root and leave only enough of the leaves to permit of taking them easily with the fingers.

OLIVES

Olives should be very green, and served on relish dish.

SARDINES

These should be taken from the box just before serving and laid gently on relish dish, with some of their own oil poured over them.

SMOKED OR DRIED MEAT OR FISH

Should be sliced very thin, and the slices disposed in a circle, with some parsley in the middle.

CUCUMBER SALAD

Pare and slice the cucumbers, sprinkling a little salt over them. After 10 minutes let drip, and mix with olive oil, pepper, and vinegar.

OYSTERS

Oysters should be opened just before serving and placed on the hollow shell, not on the flat one. Serve with lemons, cut in halves or quarters, not with vinegar.

RELISHES—WARM

The warm relishes belong rather to the restaurant than to the family dinner, but some are quite simple of preparation and are desirable for a fashionable dinner. They should be served when the guests are finishing their soup, and should be cooked just before serving; from which it follows that they are served with difficulty to more than eight or ten guests and are to be recommended for luncheon and tea parties rather than for regular dinners.

CROQUETTES OF FOWL

The flesh of fowls used to make soup stock may be utilized for croquettes. Remove the flesh of one fowl and chop fine, chopping also a few mushrooms and truffles (if obtainable) and a little parsley, and mix all together. Melt in saucepan 2 tablespoonfuls butter, mixed with 2 tablespoonfuls flour; add, little by little, while stirring, 2 glassfuls of stock. Boil, stirring constantly, until stock thickens a little; then add the chopped fowl, stir and add two yolks, stirring until well mixed.

Pour into a dish a layer 1 inch thick, and let cool, taking care to cover with buttered paper, to prevent drying and darkening of surface. When cold, cut in squares 1 x 2 inches, roll in flour, and dip in beaten egg; roll again in bread or cracker crumbs; fry in butter.

FILLETS OF FOWL

Remove the fillets and legs of 2 young chickens; cut the fillets in 2 and the legs in 3 pieces; dip them in milk, roll in flour or fine bread crumbs, and fry in butter. (The bodies of the chickens may be used in making stock, page 457.)

FRIED OYSTERS

Remove oysters from shell, dip in beaten egg, roll in bread or cracker crumbs, and fry in butter to a golden brown.

RAMKINS

Put in saucepan 1 glass water and 3 tablespoonfuls butter, let boil and while stirring add, little by little, 3 tablespoonfuls flour. When thick enough, let cool a little on corner of range, and add, one by one, 4 eggs, beating mixture all the while. Add 6 ounces grated cheese, stir well and drop on a pie plate in the form of small cakes about 1 inch apart. Sprinkle over the little cakes 2 ounces cheese, cut into small dices; bake in hot oven until a light brown.

FRIED TOMATOES

Select smooth, large, green tomatoes, wash, but do not peel, and slice ⅜ inch thick. Roll in cracker dust or flour and fry in butter, salting and peppering well. Must be well browned on both sides and served hot.

FISH

(For Fish Sauces, see Page 461)

Do not forget that the first requisite in a fish is absolute freshness, and that the tests of freshness are bright scales and gills, full and prominent eyes, and firm, unyielding flesh.

BOILED SALMON, TROUT, PIKE, ETC.

Clean and wash fish, removing gills and fins, but leaving on tail and head; place in fish kettle (having grate at bottom to remove without breaking) with 2 carrots and 1 onion, sliced, some thyme and laurel, 6 grains whole pepper, and enough water to cover. Bring to a boil and **immediately** place kettle on corner of range; let simmer for 1 hour, without letting boil. Serve in long dish, on folded napkin, with whole boiled potatoes as garnish, or separate. Serve any desired fish sauce separately.

STUFFED AND BAKED BASS, SHAD, FRESH COD, ETC.

Mix bread, softened in boiling water, with 1 or 2 tablespoonfuls of butter, salt, pepper and 2 raw eggs. Stuff and sew up fish, and place in dripping pan with water and a little butter. Bake 45 minutes.

BROILED SALMON

Sprinkle the steaks with salt, pepper, and a little olive oil; turn them two or three times, and broil over a moderate fire, taking care to turn from time to time. Sprinkle with the juice of 1/6 lemon, garnish with sixths of lemon, serving a maître d'hotel or other fish sauce separately.

FRIED BROOK TROUT

Clean and wash the fish, dip in milk, roll in flour, and fry in butter slowly for about 15 minutes, turning often to prevent burning of butter or fish. Serve on a **warm** dish, sprinkle with hashed parsley, squeeze a lemon over the fish and pour over them the butter in which they have been fried.

PICKEREL, JEWISH STYLE

Clean and wash a 5 or 6-pound fish and place in a kettle of ample size, with 3 or 4 sliced onions, 1 handful parsley, 1/4 pound butter, 1 pint white wine, 1 glassful stock, and some salt and pepper. Cover and cook slowly, while basting, for about 30 minutes. Take the fish with care from the kettle and place on a **warm** dish; then add, while stirring, about 1/4 pound butter to the liquor, and pour it over the fish.

FRIED PERCH

Clean and wash the fish, dip whole in milk, and roll in flour. Bring fat or lard in skillet to such a heat that a little piece of bread dropped into it will brown instantly; yet fat must not burn. In this fry perch until well colored, and serve garnished with parsley and lemon.

BOILED BLACK BASS WITH CHOPPED PARSLEY

Clean and wash a 5 or 6-pound fish; place on lower grate of fish kettle, plunge in boiling salted water and keep boiling for 10 or 15 minutes, according to size; drip and place on **warm** dish; sprinkle with juice of a lemon and 2 tablespoonfuls melted butter, mixed with 1 tablespoonful chopped parsley. Serve with boiled potatoes as garnish, or separate.

BROILED BLACK BASS OR WHITEFISH

Clean and wash the fish, divide lengthwise into two parts, place on dish and sprinkle with salt and pepper; also with 2 tablespoonfuls olive oil, to prevent sticking to broiler. Broil on moderate fire, turning from time to time. Sprinkle with a little lemon juice and serve with tartar sauce and sixths of lemon, or with maître d'hotel sauce.

BROILED EELS

Clean and wash 3 or 4 pounds eels, remove skin, and cut in 3-inch lengths; put in saucepan with 2 quarts **cold** water, 1 glassful vinegar, 1 onion and 1 carrot sliced, some thyme, laurel, salt, and pepper. Bring to a boil; then let simmer for 15 minutes on corner of range. Let the pieces drip on cloth, dip in melted butter, roll in bread crumbs, and broil on light fire, turning from time to time. Serve with tartar sauce.

BROILED SHAD ROE

Handle carefully, so as not to break membrane containing roe; broil as for black bass, and serve with a maître d'hotel sauce.

FRIED FROGS' LEGS

Skin the frogs, saving only the hind legs and quarters; let stand for 1 hour in cold water to whiten the flesh. Dip in milk, roll in flour, and fry in butter until well colored. Serve with quarters of lemon.

SALT COD

Freshen cod for 24 hours, changing water 4 or 5 times; 1 hour before time to serve, place in a kettle with **cold** water; as soon as it boils remove to back of range and let simmer for 45 minutes. Serve on a warm dish, with caper sauce or generous lumps of butter (melted by heat of fish), and **always** with boiled potatoes.

BOILED SALT MACKEREL

Freshen over night, let drip, place in boiling water, and let cook 15 or 20 minutes, according to size; let drip, place in baking pan with pepper and lumps of butter, and bake in hot oven 10 or 15 minutes. Garnish with parsley.

SHELL FISH

FRIED OYSTERS (*Entrée*)

Drip oysters and dry on a cloth; dip in beaten egg and roll in cracker dust; fry until a golden brown in butter or equal parts of butter and lard. Serve with garnish of peppergrass or cress, with a quarter of lemon for each guest.

ESCALLOPED OYSTERS (*Entrée*)

Drip oysters and spread on a layer of bread crumbs in bottom of baking pan, pepper and salt, adding lumps of butter; spread another layer of crumbs and another of oysters, seasoning as before, and so continue, sprinkling bread crumbs over the top. Cover with oyster liquor or milk (cream is better), and bake not more than 30 minutes. A glass of sherry, **just before serving**, improves the flavor for some palates. Serve **hot** in baking dish.

"PIGS IN BLANKETS" (*Entrée*)

Choose large oysters, roll each in a very thin slice of bacon and pin with tiny wooden skewers; fry brown on both sides in fat of bacon, and serve on small triangles of toast, with garnish of parsley.

ESCALLOPED CLAMS (*Entrée*)

Same as for Escalloped Oysters, only that clams should be chopped, and a suspicion of mace or nutmeg should be added to other seasoning.

DEVILED CRABS (*Entrée*)

Remove meat from as many boiled crabs as there are guests, carefully preserving shells intact; mix meat with bread crumbs (1 cup to 6 crabs), mustard (1 teaspoonful to 6), butter (1 rounding tablespoonful to 6), and strong vinegar (2 teaspoonfuls to 6); salt and pepper to taste; mix well, fill shells with the forcemeat, and bake 10 minutes. Serve with garnish of lettuce.

FRIED SOFT SHELL CRABS

Crabs should be cooked immediately, and by no means should be kept over night after being taken from the water. Pull off spongy substance from sides and remove mouth aud eyes; wash thoroughly and fry until brown in hot butter and lard (half and half). If preferred, dip in beaten eggs and roll in bread or cracker crumbs.

BROILED LOBSTER

Cut lobster in two lengthwise; place halves on a dish; pour over it 2 tablespoonfuls olive oil, salted and peppered; broil on moderate fire for about 30 minutes, turning from time to time; serve with green parsley garnish, and sauce (tartar or mayonnaise) separate.

COLD BOILED LOBSTER

Choose heavy live lobster, wash and brush thoroughly, tie claws and tail with twine, and plunge iuto kettle of boiling salted water. Let boil awhile; then let simmer for 30 minutes on corner of range. Drip and cool. Serve with tartar or mayonnaise sauce.

SAUCES FOR FISH

Hollandaise Sauce — Place in saucepan on back of range ¼ pound butter, into which 2 tablespoonfuls flour have been mixed with wooden spoon; add juice of 1 lemon, a little salt and pepper (and a little nutmeg, if liked), and 1 glass water; stir until liquor becomes uniform, and while stirring add 3 yolks, and then, in small pieces, about ¼ pound butter. At no time permit sauce to boil. Serve apart.

Caper Sauce — As for Hollandaise Sauce, with the addition of 2 tablespoonfuls pickled capers when ready to serve.

Butter and Parsley Sauce (*Maître d'Hotel*) — Mix chopped parsley thoroughly with cold, unmelted butter. Lay this in lumps over fish or meat, to be melted by the heat of same.

Mayonnaise Sauce — Beat 2 yolks with some salt and pepper; then add, **drop by drop,** while stirring, about ½ pint olive oil; still stirring, add, little by little, 1 tablespoonful white or cider vinegar. If this sauce is made as it should be, in a cold dish (preferably set in cracked ice) and a cold room, the vinegar will form a creamy emulsion with the oil; yet its compounding will require practice.

Tartar Sauce — As for Mayonnaise Sauce, but when ready to serve add 2 tablespoonfuls chopped green onion and gherkins.

Mustard Sauce — Melt in saucepan 2 tablespoonfuls butter mixed with 1 tablespoonful flour, and while stirring add 1 glass warm water, 2 tablespoonfuls mustard, and some salt and pepper. Boil until quite thick and serve apart.

Tomato Sauce — Chop 1 onion and let brown in 1 tablespoonful butter; add 3 tablespoonfuls tomato catsup and 2 tablespoonfuls butter and hashed parsley; stir well and pour over the fish.

Vinegar Sauce — Chop ¼ handful parsley and the same amount of onion, cut 12 gherkins in small dices, and put all in a bowl with 1 small glass each of olive oil and vinegar; salt and pepper to taste and mix thoroughly.

Horse-radish Sauce — Grate 2 or 3 roots horse-radish; put in a bowl with a little salt and white pepper, and pour over it 1 glassful vinegar.

EGGS

HARD-BOILED EGGS

Cook the eggs for 10 minutes in boiling water, then dip in cold water.

EGGS WITH CREAM

Slice or cut in quarters 10 hard-boiled eggs and place in saucepan. In another saucepan brown lightly in a little butter 1 chopped onion; sprinkle over it 2 tablespoonfuls flour, add 1 pint milk, and cook, while stirring, for about 5 minutes. Pour this cream over the eggs, warm the whole without allowing to boil, and when ready to serve, place in deep dish and sprinkle with hashed parsley

EGGS A LA TZARINE

Cut pieces of bread from which the crust has been removed into cylinders 3 inches in diameter and 3 inches in height. Make in the middle of each a hole 1½ inches in diameter and 2 inches deep. Brown cylinders in butter; when crisp, break an egg in every hole, sprinkle with salt and pepper, place 1 teaspoonful butter on each egg, and bake for 5 minutes in a buttered dish.

SHIRRED EGGS

Butter as many small dishes as there are guests; break eggs, one at a time, in a saucer; slip them into the small dishes, sprinkle with salt and pepper, cook 5 minutes in a hot oven, and serve on the same dishes.

SCRAMBLED EGGS WITH TOAST

Break 10 eggs, one at a time, and slip them into a saucepan; beat up with ¼ pound butter, and salt and pepper to taste; then cook over a light fire, stirring constantly, for 5 minutes. When batter becomes quite thick, serve in shallow dish, with fried toast on and around the eggs.

SCRAMBLED EGGS WITH CHEESE

As for Scrambled Eggs with Toast, but add ¼ pound grated cheese while mixing the eggs with butter.

SCRAMBLED EGGS WITH ASPARAGUS TOPS

Cut the tender tops of asparagus in ½-inch pieces, cook in salted water for 10 minutes, and let drip. Prepare the eggs as to serve with toast; when quite cooked add the asparagus and mix well with a wooden spoon. Serve in a shallow dish with toast.

OMELETS

In making an omelet, care should be taken that the pan is clean, smooth, and hot, as otherwise the omelet will stick. If one has had no experience in making this dish, it would be well to experiment on small omelets.

PLAIN OMELET WITH HASHED PARSLEY

Break 10 eggs, one at a time, slipping into a salad dish as soon as each is ascertained to be fresh; beat well, together with salt, pepper, and ½ handful hashed parsley, also 1 glass milk, if wished. Mel pound butter in frying pan on hot fire, and when bu is hot, pour in eggs and stir with **fork** until mixt becomes quite thick. Tip the pan, holding it by handle and shaking, so as to bring the omelet near of the edges and begin to fold it. If necessary, us knife or pancake turner to finish folding it double, **properly, the omelet should not be touch** but should be folded in the act of turning the fry pan over the warm dish in which it is to be served. good omelet should be long, thick in the middle, soft inside.

DEVILED EGGS

Boil eggs hard and cut lengthwise, remove yolks and mash them with salt, pepper, celery sal little butter, and a little mixed mustard, adding eno vinegar to make the mixture stick together. Ret this paste to the cavities in the whites and serve c with garnish of parsley.

ESCALLOPED EGGS

Chop fine some ham and bread, adding salt pepper to taste; add 1 tablespoonful melted butter reduce to the consistency of soft paste by additio milk; half fill individual baking dishes with forcem and carefully slip an egg from the dish into whic was broken on the top of each; sprinkle with crac dust, add salt and pepper for egg, bake 10 minu and serve hot with Maître d'Hotel sauce (page 461)

SCOTCH EGGS

Boil the eggs as lightly as will permit of remov shells without breaking whites; remove shells cover eggs (which will flatten out somewhat as they on their sides) with forcemeat made of minced ha bacon, bread crumbs, and parsley, bound together w the yolk of an egg. Fry to a golden brown and se hot, garnished with parsley or cress.

MEATS

(For Meat Sauces, see Page 467)

The meats are ordinarily classified as Relevés, Entrées, and Roasts.

Relevés, which usually appear only at a great dinner (after the fish), are highly seaso meat dishes, intended to sharpen the appetite. They consist of rather large pieces of me roasted or baked, brought to the table or sideboard entire, garnished and accompanied by a sau and carved immediately before the individual portions are served. In all particulars except s soning the relevé is similar to a roast.

Entrées are meats reduced to serving size before being cooked; they may be broil roasted, boiled, or stewed, but always are served with a sauce (or gravy) and some vegetable garnish. They are essentially family dishes, but are also served at most dinners, however fashionable, being presented after the relevé (if there is one).

Roasts are whole roasted pieces of meat, served with a salad after the entrée and its accompanying side dishes (vegetables), and before the sweet dishes.

The meats should be carved in the kitchen, but the parts put together in a way to represent the whole piece; they should be distributed by the host or hostess, or, better, the dish should be presented at the *left* of every guest, so that each may serve himself, with the right hand, according to his taste.

GENERAL NOTES ON MEATS

The quick application of a high degree of heat sears over the cut surfaces of the meat-pores and prevents the loss of the juices. Therefore:

Meats **roasted** should be popped into a **hot** oven.

Meats **broiled** should be held at first as close as is safe to a **hot** bed of coals.

Meats **boiled** should be plunged into **boiling** water.

Contrariwise, to extract the juices, as for soups, meat must be placed in cold water and gradually brought to a boil.

Meats should boil gently, if they are to be tender and of even flavor.

The addition of a couple of tablespoonfuls of vinegar in the pot will go far to make tender a tough piece of meat boiled.

A large ham requires at least four hours' boiling; a small one, two hours.

Meats fried or broiled (or even roasted) are better for searing over before salting.

Sticking a fork in meat already seared over permits the escape of the juices.

Meats should be fried always in butter; never in lard.

All fillets (tenderloins) should be cut **across** the grain, set on end (cut fibers setting on the block), and smashed with the flat of the cleaver. Otherwise they will be leathery.

ROAST BEEF (*Relevé or Roast*)

Place the meat (loin or foreribs of beef) in roasting pan; sprinkle with salt; add a cup of water and roast in hot oven, allowing 15 minutes to the pound. Baste frequently. When well cooked, roast will be firm when pressed with the finger.

After removing roast from pan, add 1 cup stock or water; boil, while stirring, for a minute or two; skim off floating grease and pass the gravy through a strainer. This gravy is considered best to serve with roast beef, but if thickened gravy is desired, see page 467.

Roast beef, when served as a relevé, should be accompanied by a vegetable as a garnish, preferably potatoes fried in butter, stuffed tomatoes, or others similarly cooked. If served as a roast, it should be accompanied by a salad.

ROAST TENDERLOIN (*Roast*)

As for Roast Beef, but roast not quite so long in proportion to weight.

BRAISED TENDERLOIN JARDINIÈRE (*Relevé*)

Lard the tenderloin with bacon strips ¼ inch thick; place in roasting pan and sprinkle with salt; add, in pan, 2 onions and 1 carrot, sliced, 2 cupfuls stock, and 1 cupful Madeira; baste frequently, allowing 15 minutes to the pound. Make gravy same as for roast beef; serve with Jardinière Garnish (page 467).

BROILED STEAK (*Entrée*)

Have steaks cut 1 inch thick, and divide into individual portions before cooking. Broil on bright fire 5 minutes; then turn and broil other side about 5 minutes; put them on warm dish, and place on each 1 teaspoonful butter mixed with chopped parsley.

BEEF SAUTÉ (*Entrée*)

Slice tenderloin or other steak in pieces the size of a half-dollar, but twice as thick; brown 1 chopped onion in butter; add sliced meat and fry for about 5 minutes; sprinkle with a little flour and add a cupful of cream and a tablespoonful of Worcestershire sauce to the pound of meat. Add some chopped parsley, cook awhile, and serve in a warm shallow dish.

TENDERLOIN WITH GREEN PEAS (*Entrée*)

Slice tenderloin about 1 inch thick, brown in butter in shallow stewpan 5 to 10 minutes; place on dish and keep in warm place. Add in the pan 1 scant tablespoonful flour and ½ glassful stock or water; boil awhile and pour this sauce over the tenderloin; serve with French peas (page 470) in separate dish.

TENDERLOIN STEAK WITH MUSHROOMS (*Entrée*)

Same as for Tenderloin with Green Peas, but add in the pan ¼-pound can of mushrooms, sliced in their own juice, and 1 tablespoonful flour. Brown awhile and pour over tenderloin.

TENDERLOIN STEAK A L'AMERICAINE (*Entrée*)

Same as for Tenderloin with Green Peas, but pour into the same pan 4 tablespoonfuls tomato catsup, 2 tablespoonfuls Worcestershire sauce, and 1 cupful stock; boil for 5 minutes and pour over tenderloin steak.

MINCED BEEF (*Entrée*)

Slice 2 pounds boiled beef quite fine; place in shallow dish; fry 1 chopped onion in butter 5 minutes, sprinkle over it some chopped parsley and 1 tablespoonful flour; stir, and add 1 glassful white wine and 1 glassful stock. Boil awhile and pour over the beef. Sprinkle with bread crumbs and bake 15 minutes.

BEEFSTEAK SMOTHERED IN ONIONS (*Entrée*)

Put a generous piece of butter in a hot frying pan; then a thick layer of sliced onions; when these are slightly browned, add the steak, and cover with more sliced onions; turn often until done, seasoning to taste.

POT ROAST OF BEEF (*Family Roast*)

Fry a generous piece of suet in a kettle for a few minutes; sprinkle a lean piece of beef with flour, salt, and pepper (a cheap cut of meat may be used for this purpose); put in the pot and fry until brown on all sides; pour in water to half cover the beef; cover tightly and cook until tender, adding a little water at intervals to prevent burning. Thicken the gravy with flour and serve apart.

Or, put good-sized piece of suet in kettle and add enough water to half cover roast when it shall be put in; salt the water, add 2 tablespoonfuls vinegar, and bring to a boil. When **boiling**, drop in the beef. Let boil 10 minutes to the pound; then remove cover and boil down until beef is sizzling in the grease; let fry, turning over and over, until brown on all sides; make gravy in kettle, and serve it apart. By learning the proper time to remove cover and boil down, beef may be pot-roasted as rarely or as thoroughly as desired.

COLD SALTED OR SMOKED TONGUE (*Entrée*)

Freshen a beef tongue in cold water for about 4 hours, changing water at least 4 times; place in kettle with enough cold water to cover; add 3 carrots, 2 onions, and 1 stalk of celery, all sliced; cook 4 hours; dip in cold water, skin it, and serve cold for breakfast, luncheon, or picnic.

CREAMED DRIED BEEF (*Entrée*)

Brown 1 tablespoonful butter in frying pan; put in ½ pound chipped beef and heat thoroughly; pour in about 1 cup of milk and thicken with a little flour and water; scrambled eggs around the dish make an excellent addition.

BEEF CROQUETTES (*Entrée*)

Chop 2 pounds boiled beef very fine; brown 3 chopped onions in 2 tablespoonfuls butter; mix with the chopped meat 6 chopped boiled potatoes, 3 raw eggs, salt, and pepper, and divide into croquettes about 4 inches long and 1½ inches in diameter; roll in flour and fry. Serve with tomato sauce apart.

MOCK DUCK (*Entrée*)

Salt and pepper both sides of a round steak; prepare stuffing as for duck and spread upon the steak; roll it up and tie; roast for ½ hour; serve with Maître d'Hotel sauce (page 461) poured over it.

STUFFED BEEF HEART (*Family Roast*)

Boil heart 3 hours over slow fire; make dressing by mixing 3 cups bread crumbs, ½ cup minced salt pork; pepper, sage, and onion to taste; enlarge cavity in cooked heart, fill with dressing, and place in roasting pan with liquor in which boiled; bake 20 or 25 minutes. Make rich gravy, which serve apart.

BEEF LOAF—VEAL LOAF (*Entrées*)

Chop fine 3 pounds rare beef or veal (left over from roast), with ½ pound salt pork; add small cupful cracker crumbs, 3 tablespoonfuls milk, and 3 beaten eggs; salt and pepper to taste, mix well, form into a loaf, over which pour ½ pint water; bake about 1 hour and set aside to cool; serve sliced, with garnish of parsley.

ROAST LOIN OF VEAL (*Roast*)

Remove kidney and kidney fat, unless kidney roast is preferred; stuff if desired, roll lengthwise and tie with twine. Place in a pan with 1 onion and 1 carrot sliced; sprinkle with salt, add 1 glassful water, and bake in hot oven, allowing 18 or 20 minutes to the pound and basting frequently. Cut off the twine and serve in a warm dish, with thick gravy made the same as for roast beef.

VEAL POTPIE (*Entrée*)

Cut 2 pounds veal ribs in pieces 1 inch square, and place in pot (upon a small plate, to prevent burning) with 2 quarts cold water; boil for 1½ hours; then make biscuit dough of 3 cups flour, and half an hour before serving drop small lumps of the dough into the pot, which must still contain sufficient water to entirely cover the meat; cover and boil for 20 or 25 minutes. Serve with mashed potatoes apart.

VEAL A LA BOURGEOISE (*Entrée*)

Place 3 or 4 pounds chump end of veal in a stewpan with 2 tablespoonfuls butter; brown awhile and add 2 glassfuls stock or water, 6 carrots cut in quarters, and 12 small onions. Cook slowly, basting occasionally, for 1½ hours. Serve with a vegetable as garnish, skimming floating grease from gravy and serving latter apart.

BROILED VEAL CHOPS (*Entrée*)

Dip the chops in melted butter, roll in bread crumbs, and let them brown over a slow fire. Serve on warm dish, placing on each chop a little chopped parsley mixed with butter.

VEAL CHOPS WITH FRENCH PEAS (*Entrée*)

Melt ¼ pound butter in shallow stewpan, and fry the chops about 20 minutes, turning frequently. Serve on warm dish, pouring over chops the gravy in which they were fried, with French peas (page 470) served apart. Spinach (page 471) may be served instead of peas.

VEAL CHOPS WITH MUSHROOMS (*Entrée*)

Same as foregoing, but after placing chops in warm dish, add in saucepan 2 tablespoonfuls flour, stir well, add ½ glass white wine, and ¼-pound can mushrooms (minced) with their juice; boil awhile, and pour over the chops.

SMALL PARISIAN PATTIES

Chop ⅜ pound veal trimmings and ½ pound kidney fat, first separately and then together; mix with 2 eggs and ½ handful chopped parsley; salt to taste. Roll puff-paste (see page 476) quite thin and cut with circular cutter 3 inches in diameter; roll the paste trimmings thinner than before and cut same number of pieces with same cutter. Place the thicker pieces on baking dish, and on each some of the chopped veal (pieces the size of a walnut), cover with the thinner pieces of paste, moistening the edges of under and upper crust; brush with beaten egg and bake until well colored.

CALF'S LIVER WITH PARSLEY (*Entrée*)

Slice liver in pieces the size of the hand and ⅜ inch thick; fry in butter or bacon fat; when ready to serve, sprinkle with chopped parsley and serve in a warm dish, pouring over slices gravy in which they have been fried.

SWEETBREADS WITH SPINACH (*Entrée*)

Freshen sweetbreads for 1 hour in cold water; dip 5 minutes in boiling water, and then in cold water; let drip well; place in shallow stewpan, adding for each pound of sweetbreads ½ onion, ½ carrot, both sliced, and ½ glassful stock; bake 1 hour in hot oven, basting frequently; serve in warm dish, pouring over the sweetbreads the sauce in which they have been baked, having first skimmed off grease and strained it. Serve spinach (page 471) separately. Instead of the spinach, tomato sauce (page 467) may be served separately.

SADDLE OF MUTTON ROASTED (*Roast*)

Trim off the fat and remove the membranous skin that covers the back of the saddle; place in baking pan, sprinkle with salt, add 1 glassful water and roast in hot oven, allowing 18 to 20 minutes to the pound. Serve with potatoes fried in butter as garnish, and gravy in gravy dish.

LEG OF MUTTON À LA FRANCAISE (*Roast*)

Remove outer skin and place in roasting pan; sprinkle with salt, add 1 glass water, and roast in hot oven, allowing 18 to 20 minutes to the pound; baste frequently. Serve with potatoes fried in butter, or a salad.

BOILED LEG OF MUTTON (*Entrée*)

Prepare the same as for foregoing; then tie leg in napkin and place in kettle of boiling salted water; let boil steadily 15 minutes for each pound; serve with boiled potatoes in a dish apart. Leg may also be served with caper sauce (page 461).

IRISH STEW (*Entrée*)

Cut mutton brisket in pieces one-half the size of the hand; place in a stewpan, add water to cover well, and skim while boiling, having added a few small onions and a small bunch of parsley, tied. Cook half an hour; add 3 tablespoonfuls flour beaten with 2 glassfuls stock or water, and some potatoes cut in halves or quarters; then cook again for half an hour.

LEG OF LAMB WITH MINT SAUCE (*Roast*)

Roast same as Leg of Mutton à la Française and serve with mint sauce (page 467) in a separate dish.

STUFFED SHOULDER OF MUTTON (*Roast or Entrée*)

Remove bones, and stuff with dressing made as follows: Brown 1 chopped onion in butter, mix with ½ pint bread crumbs wet with ½ pint milk, add ¼ handful chopped parsley and 1 pound sausage meat chopped fine; mix well. Roast the same as roast beef; serve with potatoes fried in butter or mashed.

FRENCH MUTTON CHOPS BROILED (*Entrée*)
ENGLISH MUTTON CHOPS BROILED (*Entrée*)

French chops are small rib chops, the end of the bone having been trimmed off, and the fat cut away from the end, leaving the round piece of meat attached to one end of the bone. English chops are thicker than the French, and are cut from the loin or tenderloin and trimmed into good shape.

Broil the chops on a bright fire, turning frequently. Serve with potatoes fried in butter, mashed potatoes, or French peas (page 470).

ROAST PORK (*Roast*)

Prepared and roasted the same as for roast beef (page 463), but add a little pepper and season with sage if desired.

PORK CHOPS BROILED, WITH TOMATO SAUCE (*Entrée*)

Dip the chops in melted butter or beaten egg, roll in bread or cracker crumbs and fry until well done (pork chops grilled, owing to the necessity for thorough cooking, being "broiled" only in name). Salt and pepper to taste, and serve with tomato sauce in separate dish.

BOILED PIGS' FEET (*Entrée*)

Clean feet thoroughly and cook until bones will slip out, using cold water if salted feet are used, hot water if fresh; boil down, remove bones, and cut in 2-inch lengths; salt and pepper to taste, and pour with liquor into shallow dish; let cool to jelly and cut in slices; serve with garnish of cress, peppergrass, or parsley.

BROILED PIGS' FEET (*Entrée*)

Wash and clean 6 to 8 feet; place in kettle with 2 onions, 2 carrots, and 1 celery stalk, sliced, and some thyme and laurel. Cover with cold water and cook for about 4 hours, or until tender; cut them in two lengthwise (after cooking), dip in butter, roll in bread crumbs, and broil 10 to 15 minutes. Serve with mustard and mashed potatoes for breakfast or luncheon.

SUGAR-ROAST OF HAM (*Roast*)

Freshen ham for 10 hours, entirely cover with water in kettle, and boil until tender. Let drip, remove rind, and sprinkle well with flour and coffee sugar or brown sugar (equal parts); stick full of cloves, about an inch apart, and roast until a coffee brown; garnish with parsley and serve either hot or cold.

ROAST SPARERIB (*Family Roast*)

Trim ribs closely and chop in 6-inch lengths; place in roasting pan, dredge with flour, sprinkle with pepper, salt, and sage, add 1 cup water, and roast, basting frequently, until tender and brown. Thicken gravy with flour, and serve with baked apple or apple sauce and mustard sauce (which see). Mashed potato and mashed turnips should be served in side dishes.

FRIED SALT PORK WITH CREAM SAUCE (*Entrée*)

Slice thin fat salt pork, drop into boiling water in skillet and allow to freshen for 3 minutes; pour off water, let drip and roll in flour; fry in skillet to a golden brown; lay on hot platter. Into fat in skillet pour ½ pint cream or milk, stir in flour and water to thicken; let come to a boil, and pour over pork. Serve with baked potatoes for breakfast.

NEW ENGLAND BOILED DINNER (*Entrée*)

Take a good-sized piece of corned beef and smaller pieces of salt pork and ham, cover with cold water, and cook over a moderately slow fire until nearly done; add potatoes, onions, turnips, and carrots, and continue to cook until vegetables are done. Have cooking in separate stewpans a cabbage, quartered, and beets. Garnish the meats with all the vegetables except the cabbage, which serve as side dish. Provide sharp cider vinegar and sour, sharp mustard.

HEAD CHEESE (*Entrée*)

Take 1 pig's head, clean and wash thoroughly, removing eyes, and digging out internal ears and nostrils; singe, wash again, and cut in pieces as small as possible, removing tongue, which should be left whole. Put in pot with 4 pig's feet, well cleaned, and 3 pounds neck beef. Boil all together until bones slip out. Remove bones, salt and pepper to taste, and chop very coarsely. Place in molds, or deep, square tin pans, into one of which the whole tongue, after skinning, should be put. Cover, with weights to give pressure, and when cold slice and serve with garnish of cress, peppergrass, or parsley.

RABBIT SAUTÉ (*Entrée*)

Skin and clean the rabbit, and cut in pieces the size of an egg; melt in a saucepan 3 tablespoonfuls butter; add the rabbit, with 2 onions, chopped, ¼ handful parsley, chopped; sprinkle with salt and pepper and cook covered for about 50 minutes. Add juice of ½ lemon and serve for breakfast or luncheon.

KIDNEY SAUTÉ (*Entrée*)

Slice kidneys, place in cold water, bring to a boil, place again in cold water, bring again to a boil, pour off water and rinse in hot water; let fry in butter in skillet, dredging with flour; when browned, add ½ glassful stock and (if desired) ½ glassful Madeira, boil awhile, sprinkle with hashed parsley and serve in warm, shallow dish.

VEAL KIDNEYS BROILED (*Entrée*)

Cut each kidney lengthwise in such a way as to open it but not to divide entirely; pass two wooden skewers through them to keep them flat; sprinkle with salt and pepper, dip in melted butter, and broil on bright fire; serve with Maître d'Hotel sauce, page 461 (to which add a little lemon juice) or mustard sauce.

SAUCES FOR MEATS

Gravy—After removing meat from pan, skim off any excess of fat, and set pan on range; scrape sides and bottom of pan, and after browning as much as may be without burning, add a little water and let boil up. Thicken, by gradually pouring in, while stirring, a cold paste of flour and water.

For boiled meats, make drawn butter sauce, thus: Melt 2 tablespoonfuls butter in saucepan; pour in 1½ cups boiling water, or equal parts boiling water and milk; mix 1 tablespoonful flour in a little cold milk, which add, stirring constantly. To this sauce add capers, parsley, etc., if desired, according to kind of meat with which sauce is to be served.

Béarnaise Sauce (*Yellow*)—Place in saucepan ¼ glass white vinegar, with 1 tablespoonful butter, 1 onion, and a little pepper; boil on bright fire until vinegar is half boiled down; set on back of range, and add, while stirring, a little butter and 3 yolks; place saucepan in another larger one, half full of boiling water, and add, little by little, while stirring, 2 tablespoonfuls butter; cook until quite thick.

Soubise Sauce (*White*)—Peel and slice 12 onions, and cook for 15 minutes in boiling water; drip; dip in cold water; drip again; melt in saucepan 2 tablespoonfuls butter mixed with 2 tablespoonfuls flour, and add, while stirring, 1 pint water; as soon as it boils, add onions and cook whole slowly 30 minutes; strain, and serve separately with steaks and chops.

Tomato Sauce (*Red*)—Slice 2 onions and 2 carrots quite fine; cut in dices about 1 pound cold boiled ham (or omit if wished), cook 5 minutes with 1 tablespoonful butter in saucepan; clean and slice 12 ripe tomatoes, add them in saucepan with 1 glassful stock, some thyme, laurel, salt, and pepper, and cook about 1 hour; strain into another saucepan with 2 tablespoonfuls butter; warm, and when ready to serve add, while stirring, 2 tablespoonfuls cornstarch, mixed with a little stock or water; add a little cayenne pepper and serve separately.

Pepper Sauce (*Brown*)—Melt in saucepan 1 tablespoonful butter; add 1 onion and 1 carrot finely chopped; cook 5 minutes, sprinkle with 1 tablespoonful flour, stir well, and add 1 glassful vinegar, 1 of stock, and high seasoning of thyme, laurel, salt, and pepper; cook slowly ¼ hour; strain, add cayenne pepper, and serve separately, or pour over meat. For Sauce Piquant (brown) add 6 gherkins, sliced fine.

Mint Sauce (*Green*)—Chop 1 handful mint leaves, mix with ½ glassful vinegar and 1 tablespoonful sugar; serve with leg of mutton or lamb.

GARNISHES FOR MEATS

Jardinière Garnish—Fry from 2 to 4 potatoes in butter, and cook a number of other vegetables (as green peas, green beans, small carrots, cauliflower, cut in pieces the size of a hazel nut, etc.) separately in boiling water, afterward frying separately in butter. Place tenderloin or loin on platter, a potato at each end and on each side, and the other vegetables arranged around the meat according to color effect.

Nivernaise Garnish—This garnish serves for veal loin, tenderloin, or saddle of mutton. Wash and pare 1 quart small carrots; place in saucepan with 1 glassful stock and 2 tablespoonfuls butter; cook until tender and when ready to serve, add 2 tablespoonfuls butter.

Brêtonne Garnish—This garnish serves for leg or shoulder of mutton. Soak 1 pound kidney beans in cold water about 4 hours. Drip, and cook in salted water until tender; when ready to serve, chop 1 onion and brown in 1 tablespoonful butter; add the beans, dripped; stir, and add 2 tablespoonfuls butter; sprinkle with some chopped parsley, and serve with individual portions of meat.

POULTRY

GENERAL REMARKS

Select young fowls, as a rule, for roasting. Older birds should be served only in fricassée or boiled. Remove feathers carefully, without scalding; clean and wash the inside thoroughly;

singe with a burning newspaper on top of the range, and tie legs and wings to the body before roasting. In removing giblets care must be taken not to break the gall-bladder in cutting it away from the liver.

ROAST TURKEY (*Roast*)

Place turkey in roasting pan, rub it with about 2 tablespoonfuls butter, add 1 glassful water, and roast, allowing 15 minutes to the pound. Make gravy same as for roast beef. Instead of rubbing with butter, if desired, a few thin slices of bacon may be bound with twine on breast. If desired, before placing in roasting pan, stuff with dressing made of bread crumbs moistened with scalding water, adding a lump of butter the size of a walnut, salting and peppering, and seasoning with a chopped onion and sage to taste; or, with thyme, sweet marjoram, summer savory, mace, or nutmeg. With salt and pepper alone for seasoning, oysters, chopped or whole, may be added, and in any case, dressing should be mixed up with a beaten egg

TURKEY GIBLETS (*Entrée*)

Brown giblets (wings, gizzard, liver, etc.) in saucepan with 1 pound bacon cut in dices; sprinkle with 1 tablespoonful flour, and add 1 glassful water and 1 glassful stock, or 1 pint water, some salt and pepper, ½ handful parsley tied, 10 or 12 small onions, 3 carrots cut in quarters lengthwise and then in thirds crosswise; cook slowly 1¼ hours; skim off floating grease, and serve in shallow dish for breakfast only.

ROAST CHICKEN (*Roast*)

Prepare and roast the same as for turkey.

BROILED CHICKEN (*Entrée*)

Cut chicken in two lengthwise, dip in melted butter, and broil on both sides over bright fire until thoroughly cooked. Serve for breakfast or luncheon.

FRIED CHICKEN (*Entrée*)

Cut each chicken in about 8 pieces; sprinkle with salt and pepper, dip the pieces in milk, roll in flour, and fry in fat until well colored. Serve with parsley fried in same fat, and a lemon cut in fifths, lengthwise.

CHICKEN PIE (*Entrée*)

Cut 1 chicken in pieces, place in stewpan, cover with water, and boil until tender; when half cooked, add 1 teaspoonful salt. Remove chicken, placing in warming oven, and thicken gravy with 1 tablespoonful flour; salt and pepper to taste, add lump of butter the size of a walnut, and boil 5 minutes. While chicken is cooking for the first time, following paste should be prepared: Mix, as for biscuit, 3 cups flour, 2 teaspoonfuls baking powder, a dash of salt, and ½ cup butter; roll out half of this to a thickness of ¼ inch, and with it line a baking dish, letting crust hang over the edges enough to turn up over top crust; put in chicken and gravy; roll remainder of paste for top crust; slash in the center to permit escape of steam, moisten top crust around edge, turn up overhanging lower crust, and pinch tightly; butter the top, and bake until a light brown.

SPRING CHICKEN SAUTÉ (*Entrée*)

Remove legs and cut them in two; take off wings, but not the fillets; cut body in two lengthwise, between back and breast; then each half in two crosswise, and again the breast in two lengthwise. Brown one chopped onion in ¼ pound butter, and add chicken; sprinkle with salt and pepper, and fry on bright fire 15 to 20 minutes; sprinkle with chopped parsley and serve hot.

CHICKEN FRICASSÉE (*Entrée*)

Prepare and cut chicken same as for preceding; soak in cold water 15 minutes; place in stewpan with 2 sliced onions, 2 carrots cut in 4, and ½ handful parsley tied; cover with water and cook slowly until tender, 1 or 2 hours. Let drip, and place in saucepan in which have been melted 2 tablespoonfuls butter, mixed with same quantity of flour; stir, and add through strainer liquor in which chickens have been boiled; when ready to serve, place saucepan on corner of range and add 2 beaten yolks, with 2 tablespoonfuls milk; serve in shallow dish, with Rice à la Georgienne (page 473) in separate dish.

ROAST GOOSE (*Roast*)

Select a goose with clean white skin, plump breast, and yellow feet, red feet denote age. Hanging a few days improves the flavor. Pluck, singe, draw, and carefully wipe the fowl; cut off neck close to back, leaving skin long enough to turn over; cut off feet and beat breastbone flat; put a skewer across the back, through under part of each wing; draw legs up closely and tie. Make stuffing of bread crumbs, 1 or 2 onions, a little sage, butter, and salt and pepper to taste, the whole mixed with a beaten egg. Baste frequently while roasting. Serve with its own gravy, and with apple sauce if desired.

ROAST DUCK (*Roast*)

Draw legs as closely as possible to body and tie. If cooking a pair, stuff only one (making dressing as directed in case of turkey), as flavor is not relished by everyone. Another excellent dressing is made of mashed potatoes, seasoned with chopped onions, pepper, and salt, and with just enough bread crusts stirred in to give body. Sage may be added if desired. Roast in hot oven, basting often. Skim off any floating grease, and serve gravy (thickened if desired), to which may be added giblets, previously stewed in water with a lump of butter. Peas and currant jelly should accompany this roast.

BROILED PIGEONS (*Entrée*)

Prepare pigeons as indicated in "General Remarks"; cut in two lengthwise, flatten, dip in melted butter, roll in bread crumbs, and fry on a not too bright fire; serve with Maître d'Hotel (page 461), to which has been added a little lemon juice; garnish with a lemon cut in 6 slices.

GAME

GENERAL REMARKS

Game birds should not be plucked until a day or two after they are killed, and, if the weather will allow, they are better flavored for hanging three or four days in a cool place before cooking. Tastes vary, however, as to the length of hanging. To remove the fishy taste which waterfowl sometimes have, baste them for a few minutes while roasting with hot water, to which an onion and a little salt have been added; after that baste with butter only. Snipe, woodcock, and quail usually are not drawn, but are eaten, like oysters, clams, lobsters, and some small fish, entrails and all.

ROAST SNIPE (*Roast*)

Snipe may be drawn if preferred. If left undrawn, they should be wiped on the outside after plucking. Skin head and neck and truss them with head under wing; twist legs at first joint, press feet upon thighs, and pass a skewer through feet and body. Roast in quick oven, in pan with butter or bacon cut in dices. Serve on toast, with own gravy poured around. Should be sent to table very hot.

Undersized snipe are best grilled over a hot fire, and served on toast, with butter spread over the birds, which are set in the oven for a few moments before sending to table.

ROAST WOODCOCK (*Roast*)

Woodcock should not be drawn; pluck and wipe well; truss with legs close to body; skin neck and head and bring beak under wing; set each bird on a piece of toast in dripping pan, and roast twenty to twenty-five minutes, basting frequently. Serve on same toast on which roasted, pouring some of the gravy over them, and serving remainder apart.

ROAST PARTRIDGE (*Roast*)

Let the birds hang as long as the weather will permit; then pluck and draw; wipe, but **do not wash** them inside or out; truss them without the head, same as for roast fowl; roast in hot oven, basting frequently; serve on buttered toast soaked in dripping pan, with own gravy or mustard sauce (page 461), apart.

ROAST QUAIL (*Roast*)

Precisely the same as for woodcock.

ROAST SADDLE OF VENISON (*Roast*)

Soak in water over night; then with a knife remove the three skins; in taking off the inner skin, begin at the lower side and go upward to the top of the bone; then lard with small pieces of salt smoked pork and wrap the roasting piece in a cloth saturated in vinegar, in which let it remain until the next day. Place in roasting pan a few slices of pork and dry bread crusts; salt meat well, put it into the pan with a little water and pour over it ½ cup cream; baste frequently, roasting 15 minutes to the pound. Serve with potato croquettes (page 473).

SALADS

CHICKEN SALAD (*Entrée*)
VEAL SALAD (*Entrée*)

Chop finely and mix desired quantity of chicken or veal and one-third to one-half as much celery. Cover the bottom of salad dish with large, bright lettuce leaves, on which heap up the salad daintily, and pour over it a mayonnaise dressing; may be garnished also with hard-boiled eggs, cut in halves lengthwise.

FISH SALAD (*Entrée*)

Remove skin and bones from 1 can salmon, or any cold fish, either boiled or baked, mixing in 3 large boiled potatoes, chopped. Serve on lettuce leaves, or garnished with parsley, pouring over the salad a dressing made by seasoning 3 hard-boiled yolks with pepper, salt, and mustard, mashing fine, adding ½ cup vinegar and a wineglassful cream, and stirring thoroughly.

EGG SALAD (*Entrée*)

Slice 10 hard-boiled eggs, place in salad dish, and pour over them 4 tablespoonfuls olive oil, mixed with 3 tablespoonfuls vinegar, some hashed parsley, and a little salt and pepper. Garnish with parsley.

PIGS' FEET SALAD (*Entrée*)

After cooking feet as in preparation for broiling, cut in pieces about 2 inches long and place in salad dish; pour over them a dressing made by mixing 1 tablespoonful mustard, 3 tablespoonfuls oil, ¼ handful chopped parsley, the same quantity of chopped young onion tops, and 4 tablespoonfuls vinegar, salted and peppered to taste. Serve for luncheon or picnic party.

POTATO SALAD (*Cold Relish*)

Place in chopping bowl 1 small onion and a stalk of celery, chop fine, slice thin 10 or 12 cold boiled potatoes into the salad dish, in which lettuce leaves have been placed. Mix onion and celery thoroughly with 1 wineglassful olive oil, 1 tablespoonful mixed mustard, 3 tablespoonfuls vinegar, and pepper and salt to taste. Pour this dressing over the potato.

COLD SLAW (*Cold Relish*)

Shred, slice, or chop very fine desired amount of cabbage, and place in salad dish; pour over the cabbage a sauce made thus: Bring 1 cup vinegar to a boil; add mixture of 1 teaspoonful mustard, 3 tablespoonfuls sugar, and 1 teaspoonful salt, scalded together with ½ cup boiling water; add ½ cup milk or cream and a lump of butter; let boil again, stirring constantly, and stir in the beaten yolks of 3 eggs; pour hot over cabbage as soon as sauce is stirred to an even consistency; let cool, place in ice-box, and serve cold.

LOBSTER SALAD (*Entrée*)

Remove shell from boiled lobster, being careful to remove vein in back; chop meat, or pick it fine; chop together some celery, lettuce, or endive, with hard-boiled eggs, mix with lobster meat, saving the larger, reddest slices of meat for garnish; place on lettuce leaves in salad dish, using 12 olives for additional garnish; pour over it 1 pint mayonnaise dressing; let cool awhile, and serve.

LETTUCE SALAD (*Cold Relish*)

Take 1 head of lettuce, separate leaves and dispose in salad dish, spreading over them 1 cold boiled potato, cut in dices, and 2 hard-boiled eggs, sliced; pour over salad either a mayonnaise or a vinegar dressing.

SALAD DRESSINGS

Mayonnaise Dressing— See page 461.

Vinegar Dressing Without Oil—Mix 1 cupful hot vinegar, 1 teaspoonful salt, 1 tablespoonful sugar, a pinch of pepper, and a rounding tablespoonful butter; when cool, pour over salad.

French Dressing—For lettuce, potato salad or cold slaw: Grate ⅛ onion; mix with ½ teaspoonful salt, a pinch of pepper, 2 tablespoonfuls olive oil, and 1 tablespoonful vinegar; stir to a creamy consistency.

Cream Dressing Without Oil—For cabbage, lettuce, tomato, or other vegetable salad: See Cold Slaw (page 470).

Drawn Butter Dressing—Put 2 cupfuls boiling water in saucepan and stir in 2 tablespoonfuls flour into which an equal amount of butter has been thoroughly mixed; let melt, stirring constantly; stir in ¼ handful hashed parsley, pepper and salt to taste, and serve immediately.

VEGETABLES

FRENCH PEAS

Melt in stewpan 2 tablespoonfuls butter, add 1 quart shelled peas, 1 glassful water, 1 whole onion; ½ handful parsley, tied, and some salt and pepper; cook slowly for ¾ hour; when ready to serve, take out onion and parsley, add 2 tablespoonfuls butter, mixed with 1 tablespoonful flour, stirring until thickened, and serve in warm shallow dish as side dish, or as a garnish (2 teaspoonfuls sugar may be added while cooking).

GREEN PEAS WITH BACON

Cut 1 pound bacon in dices, and brown in saucepan; sprinkle with 1 tablespoonful of flour, add 1 glassful water, 1 quart peas, 1 whole onion, ½ handful parsley, tied, and some salt and pepper; cook 1 hour; when ready to serve, remove onion and parsley, and serve in warm shallow dish as side dish.

GREEN PEAS, ENGLISH STYLE

Pour peas into boiling water; cook quickly 15 minutes, salt, and drip; place in warm shallow dish and over them ¼ pound butter, divided into small slices; serve as side dish.

STRING BEANS, ENGLISH STYLE

Clean green beans; break off stem ends, at the same time stringing them on one side; break off blossom ends also, stringing them on the other; if too long, break in two; cook quickly in a quantity of boiling water, salt, let drip, and serve as preceding.

STRING BEANS

Prepare as for preceding; melt in saucepan 2 tablespoonfuls butter; add 1 quart beans, ½ glassful water, 1 whole onion, ½ handful parsley, tied, and some salt and pepper; cook slowly 15 minutes; when ready to serve, add 2 tablespoonfuls butter and 2 eggs beaten with ½ glassful milk; stir, but do not allow to boil; serve in warm dish as side dish.

LIMA BEANS WITH BUTTER

Same as for preceding.

BAKED BEANS

Soak 1 quart white beans, well picked over, over night; drip and cover well with fresh water; add 1 pound lean salt pork; boil until beans are tender; place in baking dish with meat, its rind slashed ready to slice, in the center; sprinkle with pepper and bake until a light brown. To serve, cut meat in slices, dispose in center of platter, and garnish with beans.

BOSTON BAKED BEANS

Soak 1 quart picked-over beans over night; place in kettle with ½ pound salt pork and 3 quarts water; boil slowly 1 hour, adding ½ teaspoonful saleratus just before taking them up; strain beans into an earthenware jar, adding 3 tablespoonfuls molasses and 1 teaspoonful salt; place pork in middle, leaving rind even with top; add just enough of the liquor in which beans were cooked to cover them; bake 5 or 6 hours in slow oven, adding more of the liquor if required; when cooked, remove dried beans from top.

SUCCOTASH

Stew in least possible quantity of water equal parts green corn and Lima or string beans, until tender; add ½ cupful cream or milk, a lump of butter, pepper and salt. Serve in warm dish as side dish.

ESCALLOPED CORN

Cut the tops of the kernels from 6 ears tender sweet corn; then scrape carefully, so as to get out all the juice with but little of the hull; add a dash of pepper and salt, 1 teaspoonful sugar, a lump of butter, 2 eggs beaten slightly, and a little milk to mix; beat all together and bake 10 minutes; add ½ cup cream, stir well, and bake another 10 minutes; serve hot or cold as a side dish.

CORN FRITTERS

Cut from the cob the kernels of 3 ears cooked sweet corn; beat thoroughly 1 egg; mix ½ teaspoonful baking powder in ½ cup flour, stir into the egg, salt to taste, and add the corn, stirring thoroughly; add flour, if more is needed to form a moderately stiff batter. Have ready in skillet **hot** lard or bacon drippings ⅜ inch deep. Into this drop batter, a spoonful in a place, and fry a few fritters at a time, serving when a golden brown Be careful to cook thoroughly.

SWEET CORN WITH BUTTER

Husk and wash the corn, and cook (on the cob) for ½ hour in boiling salted water, to which has been added 1 glassful of milk; serve on folded napkin with butter in dish at side.

BROILED SWEET CORN

Broil (on cob) over bright fire, and serve with butter, salt, and pepper.

SPINACH WITH CREAM

Clean and wash 3 or 4 times about ½ peck spinach; cook 10 minutes in quite large quantity salted water, pour off water, let drip, cover with cold water, drip again, and chop fine; 10 minutes before serving place in saucepan with 4 tablespoonfuls butter, 1 tablespoonful flour, a little sugar and some salt; cook awhile, and add, while stirring, 1 glass milk; serve as a side dish or garnish, or may be served with pieces of toast fried in butter.

SPINACH WITH POACHED EGGS

Same as with cream, but place on spinach 6 poached eggs.

CELERY WITH GRAVY

Take lower part of 8 small stalks celery, clean and cut in pieces 5 inches long, place in saucepan, cover with stock, add a little salt, and cook slowly 1 hour; drip and place in shallow dish, and keep in warm place; boil down stock in which cooked; when ready to serve, thicken with 1 tablespoonful cornstarch mixed with a little cold stock and 2 tablespoonfuls butter; pour on celery and serve as side dish.

CARROTS FRIED IN BUTTER

Pare 3 bunches small carrots, slice crosswise as thick as a half-dollar, and cook in boiling water until tender; melt in saucepan 2 tablespoonfuls butter, add carrots, carefully dripped, sprinkle with a little sugar and fry about 10 minutes; serve as side dish. Carrots are excellent also cut in quarters lengthwise, stewed until tender in salt water, and served with drawn butter dressing (page 470).

ASPARAGUS WITH WHITE SAUCE

Clean and wash 3 bunches asparagus, cook in boiling salted water until tender, and serve on folded napkin with Hollandaise Sauce (page 461) separate.

CAULIFLOWER WITH WHITE SAUCE

Clean 2 cauliflowers, cut in quarters and wash carefully; cook in boiling salted water until tender; drip and place in shallow dish, in original shape; serve with Hollandaise sauce.

CAULIFLOWER AU GRATIN

Prepare and cook same as foregoing; melt in saucepan 2 tablespoonfuls butter, mixed with 3 tablespoonfuls flour; add, while stirring, 1 pint milk or cream, boil, stirring, until sauce becomes quite thick; add 2 tablespoonfuls butter; pour some of sauce in bottom of shallow dish, add cauliflower, cut in 4 or 5 pieces, pour over remainder of cream sauce, sprinkle with bread crumbs and grated cheese, brush with melted butter, and bake until well colored.

STUFFED TOMATOES

Cut out a small core at top of tomato and squeeze slightly, so as to remove some of seeds; then stuff with mixture of 1 chopped onion, 2 tablespoonfuls flour, 4 ounces chopped cooked meat, 3 ounces white bread (dipped in milk or stock), and a little chopped parsley, all of which is put in saucepan and cooked awhile; sprinkle stuffed tomatoes with bread crumbs, grated cheese, and small lumps of butter. Bake 15 minutes.

FRIED TOMATOES

Wash firm green tomatoes and slice (without peeling) ⅜ inch thick; roll in flour, sprinkle with salt and pepper, and fry in butter or bacon fat until a cinnamon brown. Serve 3 slices to a guest, on square or triangle of daintily browned toast. For breakfast or luncheon.

Cucumbers (peeled and sliced) may be fried and served in the same fashion.

CREAMED CUCUMBERS

Peel 6 cucumbers, cut in quarters, remove seeds, and cut in pieces 2 inches long; melt ¼ pound butter in shallow stewpan, and when warm add cucumbers; cook on bright fire 10 minutes; add 2 glassfuls cream and a little salt and sugar; boil awhile and serve as side dish.

FRIED PARSNIPS

Cut boiled parsnips in thick slices lengthwise, roll in flour, and fry in butter or bacon fat to a deep brown. Salt and pepper before removing from skillet, and serve hot.

MUSHROOMS WITH CREAM

Pour 2 pounds mushrooms (fresh or canned) into saucepan and boil awhile in their juice, if canned, in a very little salted water, if fresh; place saucepan on corner of range and add 2 yolks, mixed with 1 tablespoonful cornstarch, 1 tablespoonful cream, and some chopped parsley; serve on toast, or as garnish for fashionable dinners.

MUSHROOMS ON TOAST

Prepare mushrooms as in foregoing, meanwhile frying in butter, for each guest, a piece of bread 1½ x 3 x 5 inches, in which a hole 2 x 4 inches and 1 inch deep has been cut. Place on buttered dish, the holes in the toast filled with mushrooms and their cream, sprinkle with grated cheese and a little butter and bake for 10 minutes.

PARSNIP CROQUETTES

Boil parsnips, well scraped and washed, in salted water until very tender (in which state they may be served, if desired, with lumps of butter melting over them); mash and season with butter, pepper, and salt; stir in 2 beaten eggs to which a little flour has been added; mold into croquettes and fry in butter or bacon fat until a golden brown.

BOILED BEETS

Beets require especial care in preparation, lest they bleed, and come to the table pale and unappetizing, the stalk must not be cut down closely or the root broken off. Boil until tender; rub off skins while hot, and serve sliced, with lumps of butter melting over, peppered, and salted; or, sliced in vinegar, with pepper and salt.

CREAMED ONIONS

Boil 6 onions in ample water for 1 hour; let drip, cut in small pieces, salt and pepper, and serve **hot,** with drawn butter dressing (page 470) poured over.

FRIED EGG PLANT

Peel egg plant and slice ⅜ inch thick; soak 1½ hours in salted water; let drip, wet on both sides in beaten egg, roll in bread or cracker crumbs, and fry to a golden brown. Pepper to taste, salt lightly, and serve hot.

BOILED TURNIPS

Peel and slice turnips, and pour over them cold water; cook until quite tender, remembering that more time must be allowed than to most other vegetables; let drip thoroughly, mash with a little milk or cream, and serve as side dish, with lumps of butter melting over, pepper, and salt.

SQUASH

(*Hubbard, Marrow, Summer; Baked or Boiled*)

Hubbard squashes are generally preferred baked, as their rinds are too hard to be removed easily; remove all seeds and pith, cut in halves, put a teaspoonful of sugar in each hollow, and bake an hour or until tender;

when done, remove hard crust, scrape from shell with spoon, and mash, sweetening, peppering, and salting to taste, and serving as side dish with melting lumps of butter

Any of the marrows or summer squashes may be simply pared and cooked, seeds and all, if very young; in any case they should be cut in small pieces and steamed or boiled until tender, peppered, and salted to taste, mashed with a small quantity of rich cream, and served as side dish with melting lumps of butter.

BOILED SALSIFY (*Vegetable Oysters*)

Scrape well, cut in thin slices, boil an hour or until tender, and when done add a little salt codfish picked very fine, having previously let the water boil nearly away; add plenty of milk or cream to make gravy, and season with salt, pepper, and butter; thicken slightly with flour and serve with small bits of toast.

SWEET POTATOES, BOILED

Wash, cut off the ends, and boil in salted water until tender (about 30 minutes). Serve with butter. When cold, may be peeled and sliced lengthwise and fried in butter.

POTATOES WITH CREAM

Slice 8 or 10 boiled potatoes, place them in saucepan with 2 tablespoonfuls butter and 1 cup cream; sprinkle with salt and pepper, and chopped parsley, and boil 10 minutes.

POTATOES AU GRATIN

Prepare and cook potatoes already boiled same as foregoing; place in baking dish, sprinkle with grated cheese, bread crumbs, and small lumps of butter; bake to a light brown.

POTATOES DUCHESSE

Peel, slice, and cook until tender in just enough water to cover; let drip and place in warm saucepan; mash with 3 yolks and a little flour; roll out on board sprinkled with flour, and divide into oblong cakes ¾ x ½ x 3 inches; fry on both sides in butter to golden brown and serve as garnish for roasts.

POTATO CROQUETTES

Prepare, cook, and mash the same as for the foregoing, but add a little butter while mashing; roll in form of small cylinder 1¼ by 3 inches; dip in beaten egg, roll in bread and cracker crumbs, and fry in butter; serve for luncheon or as a garnish.

FRIED POTATOES

Heat well enough fat or lard to cover potato slices; peel raw potatoes, slice, and fry until well colored. **Fat must be extremely hot, or it will soak into potatoes, making them sodden and unpalatable.**

PUFFED POTATOES

Peel the potatoes, cut them lengthwise in slices about ¼ inch thick, put them in warm, **but not hot** fat, and cook until tender (about ten minutes). Remove from fat and drip, heat the fat **very hot,** place potatoes in it again, and fry quickly.

MACARONI A L' ITALIENNE

Cook 1 pound macaroni in salted water (with no fear of using too much water) until quite soft; drip, throw away water, and replace macaroni in the same warm kettle; add 4 tablespoonfuls butter, ½ pound grated cheese, salt, and pepper; allow butter and cheese to half melt while stirring, but do not replace kettle on range.

MACARONI WITH TOMATO SAUCE

Same as for foregoing, but add 3 tablespoonfuls tomato catsup.

MACARONI AU GRATIN

Cook as for "Macaroni a l' Italienne." Place macaroni in baking dish, pour over it some bread or cracker crumbs, grated cheese and lumps of butter, and bake until well colored.

SPAGHETTI WITH TOMATO SAUCE

Cook ½ package spaghetti 30 minutes in kettle with 4 cupfuls boiling water and 3 or 4 (or ½ can) tomatoes; stir frequently, add lump of butter the size of a walnut and pepper and salt to taste, with ¼ saltspoonful cayenne pepper.

RICE A LA GEORGIENNE

Wash ½ pound rice several times in cold water (ceasing when water is clear); cook in boiling water until quite soft; let drip, cool, and drip again; melt in saucepan, ⅛ pound of butter, add the rice and some salt and pepper, mix well, cover saucepan, and bake ¼ hour; serve as side dish or garnish.

OATMEAL A LA AMERICAINE

Mix in saucepan 1 pound of oatmeal with 1 tablespoonful butter, 1 pint water, and a pinch of salt; bake in hot oven for 15 minutes, and serve with butter and milk or cream.

BREADS

GENERAL NOTES ON BREAD MAKING

How to Choose the Flour—A good flour will be dry, heavy, and very soft to the touch; it should have a clear white color, sometimes a little yellowish; it should be adhesive to the dry fingers, and when pressed between the hands it should form a kind of ball, which will not immediately scatter.

The "Rising"—Peel, slice, and boil 2 large potatoes; when tender, mash, and add 1 cupful soft yeast or 1 cake dried yeast dissolved in a little lukewarm water, 1 cup flour, 2 teaspoonfuls sugar, and a saltspoonful of salt. Mix with the water (cooled) in which the potatoes were boiled. Set in moderately warm place (**not** a hot one) and let rise until light. The "rising" is best mixed up toward midday, as it requires about 2 or 3 hours to become light.

The Sponge—Mix in bread pan, in evening, 2 tablespoonfuls sugar, ½ tablespoonful salt, 1 tablespoonful lard or drippings, and 1 heaping kitchenspoonful flour, to which add 1 small cupful boiling water, stirring well to cook flour. Add 1 quart cool water or (better) milk, mix thoroughly and add "rising." Stir again, adding flour until batter can only just be stirred; stir for 5 minutes, and set in a warm, **but not hot,** place until morning. In the morning add flour sufficient to make a dough that can be kneaded on the board; knead 20 minutes and replace lump in bread pan (which has been floured to prevent sticking); cover with towel and let rise; when light, make into loaves and let rise in baking pans. When light, bake from 30 minutes to 1 hour, according to size of loaves.

The Oven—Success or failure in bread making depends in large measure on the fire. The oven, when bread is put in, should be hot enough to bake, but not so hot as is needed for pie-crust. To insure even heat, the fire must be planned beforehand, with enough fuel **burning** to last throughout the baking of the bread. **The housewife must understand her range,** knowing precisely when fire must be checked or drafts opened, in order to keep an even heat. Adding fuel during baking first checks fire, then intensifies it. Too hot a fire makes dense, sodden bread; too slow a fire makes bread light, dry, and crumbly. If baking is done with wood, heavy, well-dried sticks (that will form lasting bed of hot coals) must be used, lest fire flash out during the baking.

Cooling—When taken from oven, loaves should be turned from the pan and laid on sides, not touching one another. The crusts will be rendered soft by brushing with a cloth dipped in melted butter. When thoroughly cool, put away in bread boxes. Bread that is "sweated" by cooling while wrapped in a cloth is no better for it, and **will mold much more quickly.**

SOFT YEAST

Take 2 quarts water to 1 ounce hops; boil 15 minutes; add 1 quart cold water, and let boil a few minutes; strain, and add ½ pound flour, putting the latter into a pan and pouring the water on slowly to prevent its getting lumpy. Add ¼ pound brown sugar, and a handful of fine salt; let stand 3 days, stirring occasionally; when it ferments well, add 6 potatoes which have been boiled, mashed, and run through a colander, making as smooth as possible. This yeast will keep a long time, and has the advantage of not requiring any yeast to start it. It rises so quickly that a less quantity than of ordinary yeast must be put in.

RYE BREAD

Put 2 quarts rye flour into a stone jar; stir into it 1 cup yeast (or 1 cake, dissolved in water), 2 teaspoonfuls salt, and enough water to moisten well; let rise over night in warm place; in the morning stir it down well; do not add more flour, but put into well-buttered pans as soon as light. Bake in slow oven.

BOSTON BROWN BREAD

Sift together 3 cups cornmeal, 2 cups rye flour, and 1 cup wheat flour; mix 3 cups sour milk and 1 cup New Orleans molasses, 2 even teaspoonfuls salt, and 1½ teaspoonfuls soda, the soda having been dissolved in a little warm water. While mixture is effervescing, pour it into the flour, beating until smooth. Grease a pudding boiler (or 1-pound baking powder cans), pour in the batter, filling only to within 2 inches of the top; cover closely and place in kettle of boiling water; let steam 4 or 5 hours.

CREAM BISCUIT

Mix 2 heaping teaspoonfuls baking powder with 4 cups flour and 1 level teaspoonful salt; add a lump of butter the size of an egg and enough cream to make soft dough; roll thin, cut out, and bake in hot oven.

SODA BISCUIT

Mix 2 teaspoonfuls cream of tartar with 1 teaspoonful soda, stir it well into 4 cupfuls flour; add a heaping tablespoonful butter or lard and a little salt, mixing all together quickly with enough milk, or milk and water, to make a soft dough; roll out, cut, and bake quickly.

FRENCH ROLLS

Mix 2 heaping teaspoonfuls baking powder with 4 cups sifted flour and ½ teaspoonful salt, adding sweet milk, or milk and water, to make a soft dough; roll, and cut out in round pieces, placing a small lump of butter in the center of each, and folding dough over in form of half circle; bake in quick oven.

BREAKFAST ROLLS

Mix at evening 4 cups flour with 1 cup warm milk, 2 beaten eggs, ¼ cake yeast, and a little salt; work over thoroughly and set in warm place to rise over night; knead in butter the size of an egg, make into rolls, and bake.

DROPPED BISCUIT

Make a stiff batter of 2 cups warm (but not hot) milk, 2 tablespoonfuls butter, a pinch of salt, 1 cup of soft yeast (or 1 cake dry, dissolved in water), and white flour. When light, drop from spoon on to buttered pans to bake, being careful not to agitate batter.

PARKER HOUSE ROLLS

Mix in bowl 1 heaping tablespoonful butter, 1 tablespoonful sugar, and ½ teaspoonful salt, with 8 cups flour; make hole in flour and pour in 1 pint scalded milk, still warm, and ½ yeast cake dissolved in a little water; stir in part of the flour, mixing thoroughly, and let rise over night; knead again, using remainder of flour, and let rise until afternoon; roll out, cut, butter, and fold as for French rolls; set in warm place and when light enough, bake.

GRAHAM MUFFINS

Mix 1 beaten egg, 4 cupfuls graham flour, 2 heaping teaspoonfuls baking powder, ½ teaspoonful salt, 2 tablespoonfuls butter, and milk enough to make soft batter; bake in muffin or gem tins.

CORN MUFFINS

Mix 2 teaspoonfuls baking powder with 1 cup flour, 1 cup cornmeal, a little sugar, and some salt; add 2 beaten eggs and milk enough to make soft batter; bake quickly.

CURRANT BUNS

To be served hot from the oven. Mix 2 heaping teaspoonfuls baking powder and ½ teaspoonful salt with 4 cups flour; mix in well butter the size of an egg, and add enough milk to make a soft dough; roll out ½ inch thick, spread with sugar, then with English currants, then with another sprinkling of sugar and a dusting of cinnamon; roll up as for jelly roll; cut in 2-inch lengths, and bake on end, in buttered pans, in quick oven.

JOHNNY CAKE

Scald 4 cups cornmeal with 2 cups boiling water; while hot, add 2 tablespoonfuls butter or lard, 1 tablespoonful sugar, and 1 teaspoonful salt; when cool add 1 pint sour milk or cream, mixed with 1 teaspoonful soda and 1 beaten egg; mix well and bake in well-buttered, shallow pans. Serve hot.

CORN WAFFLES

Mix 2 teaspoonfuls baking powder with 2 coffee cups cornmeal and some salt; add 1 tablespoonful melted butter, 2 yolks beaten in 1 pint of milk; stir, then add the beaten whites of the eggs, and bake quickly in very hot, buttered waffle iron.

RAISED WAFFLES

Mix 2 cups flour with one pint scalded milk, cool; add ¼ yeast cake dissolved in water, and a little salt; let rise over night; then add the whites and yolks of 2 eggs beaten separately and 1 tablespoonful melted butter; bake in very hot waffle iron.

WHEAT CAKES

Mix 2 teaspoonfuls baking powder with about 3 cups flour and a little salt; beat 1 or 2 eggs and add, with enough milk to make batter.

CORN PANCAKES

Mix 2 teaspoonfuls baking powder with 1 pint cornmeal, ½ pint flour, and a little salt; add 2 beaten eggs and enough sweet milk to make a batter. Or, put 1 teaspoonful soda in 1 pint sour cream, add a beaten egg, a little salt, 4 tablespoonfuls flour, and enough cornmeal to make soft batter.

BUCKWHEAT CAKES

Dissolve ½ yeast cake in a little water, mix enough buckwheat flour with 1 quart lukewarm water to make a thin batter; add yeast and a pinch of salt; let rise over night; in the morning add ½ teaspoonful soda to sweeten, and bake on hot griddle. A little wheat flour may be added when mixing batter, and the addition of 1 tablespoonful syrup will make cakes brown nicely. For three or four days a little of the left-over batter may be used instead of yeast, stirring in buckwheat, water, and salt each night, letting rise till morning, and adding soda before baking. Left-over cakes may be broken up and stirred into the next day's batter in which they will dissolve.

PASTRY

REMARKS ON PASTRY

In making pastry always sift the flour. Rub the butter or lard into it before adding the water, which should be as cold as possible. If lard is used add salt; mix quickly. Many prefer cutting with a knife instead of rubbing in shortening with the hands.

French Puff Paste—Take equal quantities of flour and butter, say 1 pound of each, ½ saltspoonful of salt, the yolks of 2 eggs, and rather more than ½ pint of water; sift the flour, and press all the water from the butter. Put the flour on the paste board, work lightly into it 2 ounces of the butter, then make a hole in the flour, and into it put the yolks of 2 eggs, the salt, and about ¼ pint of water, knead quickly, and, when smooth, roll it out into a square ½ inch thick. Put the remainder of the butter in a ball on the paste, and fold the paste securely over it; roll it lightly with the rolling-pin, but not thin enough to allow the butter to break through; keep the board well dredged. This rolling gives it the first turn; now fold the paste in three and roll again; if weather is warm, cool paste between each two rollings, for unless butter is kept cool, paste will not answer at all. Continue this process until paste has had six rollings. If properly made and baked, this crust should rise in the oven 5 or 6 inches. Paste or pie-crust never must be squeezed up, for squeezing consolidates the laminæ that give it flakiness. The trimmings from pies, or the waste after cutting out patties or tarts, must be laid **flat,** one on another, and rolled together.

Plain Pie-crust—Work 1 cup lard, or lard and butter together, into 3 cups flour, to which has been added 1 teaspoonful salt; add enough **cold** water to make a stiff dough; turn dough on floured paste board, sprinkle with flour, and roll out; spread thickly with butter, sprinkle with flour, fold three-ply, and roll again; repeat three times (or a few times more, if a puffy crust is desired), spreading with butter each time. This makes enough crust for two large pies.

LEMON CREAM PIE

Stir into 1 teacupful boiling water 1 tablespoonful cornstarch dissolved in cold water; add 1 tablespoonful butter and 1 teacupful **powdered** sugar; let cool; then add juice and grated rind of 1 lemon and 1 beaten egg. Bake in tart without upper crust.

LEMON MERINGUE PIE

For filling, dissolve 2 tablespoonfuls cornstarch in 1 cup sweet milk; add 6 yolks and 4 whites, beaten, 2 cupfuls white sugar, a pinch of salt, and the juice and grated rind of 2 large lemons; bake slowly until set. Meanwhile beat white of 2 eggs, and beat in 6 tablespoonfuls powdered sugar; spread this meringue over pies, and bake to a light brown.

APPLE PIE

Fill pie-crust with juicy apples, pared and sliced thin. To each pie take ½ teacupful sugar, butter the size of a walnut, 1 teaspoonful flour, and ⅛ nutmeg grated; strew this seasoning over apples, and add 2 or 3 tablespoonfuls water, according to the juiciness of the apples. Pinch close the edges of upper crust, and bake **at once**.

COCOANUT PIE

Mix 1 cupful grated cocoanut, 1 cup sugar, 1 quart milk, 1 tablespoonful butter, and 3 eggs. Flavor with nutmeg, and bake in deep pie plate, lined with pie-crust.

CUSTARD PIE

For 1 pie, beat 2 or 3 eggs, add 1 pint milk, sweeten to taste, and flavor with nutmeg; line pie plate with crust, pour in custard, and bake.

RHUBARB PIE

Peel and cut stalks in ¼ inch pieces and cook in saucepan with very little water; when done, sweeten to taste, pour into crusts and sprinkle with cornstarch or a little flour; cover with crust or meringue and bake in quick oven. Serve as soon as cold.

MINCE PIE

To 3 pounds finely chopped boiled beef add 6 pounds apples, 1 pound suet, 2 pounds raisins. 2 pounds currants, 1 pound citron, 2 ounces candied lemon, 1 ounce mace, 1 ounce cinnamon, 1 ounce nutmeg, 1 pound sugar, 1 pint molasses or syrup, and 1 quart boiled cider. Seed raisins, and chop half of them; chop apples, thoroughly wash currants, and slice citron very thin; mix well, put on fire, and cook slowly until apples are done. Increase amount of cider, if too stiff; add sugar, if desired. To each pie, 1 tablespoonful brandy may be added.

PUMPKIN PIE

Stew pumpkin with just enough water to prevent burning; when soft, rub through colander, and to each coffee-cupful add 1 pint milk or cream, 2 eggs, 1 cup sugar, and flavoring to taste (ginger or mixed spices).

GOOSEBERRY PIE

Fill crust-lined pie dish with ripe or canned gooseberries, sweeten to taste, dredge with flour or cornstarch, cover, and bake; when ready to serve, dredge with powdered sugar

CHERRY PIE

Same as for Gooseberry Pie, but omit dredging with flour or cornstarch.

APPLE TARTS

Cook soft 6 tart apples, rub them through a colander, and add 1 well-beaten egg, grated rind and juice of 1 lemon, butter the size of a walnut, and 1 cup sugar; mix well. Line tart pans with French puff paste, fill with the sauce, and bake quickly.

PUDDINGS

The pudding bag, in the case of boiled puddings, must be scalded before each using, then wrung out and allowed to cool. The bag must be liberally dredged with flour, to prevent sticking, and the pudding must not completely fill the bag, which must be securely tied. If a boiled pudding is to be a success, care must be taken that the water is boiling so briskly that dropping in the pudding will not bring it below the boiling point. A teakettle should be kept boiling on another hole of the range, so that none but boiling water need be added, for if the water stops boiling at any time, a soggy pudding will result.

FRUIT PUDDING

Mix 1 pint sugar with 4 beaten eggs; add ½ pint sour cream mixed with ½ teaspoonful soda, a little salt, and 3 cups flour; stir in 1 quart fruit (blackberries, raspberries, huckleberries, blueberries, or sweet cooked elderberries); place in baking dish and bake. Serve hot, with any pudding sauce preferred. If no sour milk is at hand, use the same quantity sweet milk, stirring 2 teaspoonfuls baking powder into the dry flour, and omitting the soda.

APPLE DUMPLING

Pare and core medium-sized, juicy, tart apples. Make dough same as for soda biscuit, cut into thick biscuits, roll out, and wrap each piece around an apple, which must first be liberally sugared and dusted with powdered cinnamon or nutmeg. Place in a steamer over kettle of boiling water, and cook until apples are soft. These dumplings, if preferred, may be baked until a deep golden brown, in which case, apples should be sliced. Serve with sweetened cream or hard sauce, the latter, if used, flavored with cinnamon or nutmeg.

STRAWBERRY SHORTCAKE

Mix 1 good half-teaspoonful soda with 1 large cupful sour milk or sour cream; add 1 beaten egg, 1 tablespoonful sugar, and a little salt; rub 3 tablespoonfuls butter into 4 cupfuls flour, and mix with the other ingredients, handling as little as possible (as in case of pie-crust, to avoid toughening). Roll into two ½-inch layers, place one layer on top of the other, and bake in buttered pans. When done, separate the layers while warm, spread with butter, and place strawberries (or peaches, raspberries, or other fruit) thickly sprinkled with powdered sugar, between them. Cover top layer with fruit (if with strawberries, small ends up). Serve hot, dusting with powdered sugar just before bringing to the table.

ROLY-POLY PUDDING

Roll soda-biscuit dough ½ inch thick and spread to about the same thickness with preserves or ripe fruit, cut fine; roll up like a jelly roll, pinching the ends to keep fruit in, and pinching up the outer edge. Tie tightly in pudding bag and boil for about 1 hour. Serve hot, in slices crosswise, with wine sauce (or other liquid sauce) poured over individual portions.

ENGLISH PLUM PUDDING

Mix ½ pound bread crumbs, ½ pound flour, 1 pound each of currants, seedless raisins, brown sugar, and mixed candied peel, 1 teaspoonful salt, 1 tablespoonful mixed spices, and 1 cup chopped suet. When thoroughly mixed, add 8 eggs, beat for 25 minutes, and stir in ¼ pint brandy (if desired). Butter a mold and fill it, and place in pudding bag; tie rather loosely over top of mold, and boil for 13 hours.

BREAD PUDDING

Pour 1 quart boiling milk into a dish filled with bread crumbs; stir in 2 beaten eggs and ½ cup sugar; sprinkle with cinnamon and bake 20 minutes, serve with cream and sugar. The pudding may be improved by the addition of any kind of fruit before baking.

RICE PUDDING

To 1 cupful boiled rice add 4 beaten eggs, 1 cupful each of sugar and seedless or seeded raisins, a little nutmeg, and 1½ pints milk; bake until milk is like custard, and brown on top.

RICE PUDDING WITHOUT EGGS

Wash ½ teacupful rice, and stir, with a little less than a teacupful sugar, the same quantity of raisins, and a teaspoonful of cinnamon or allspice, into 2 quarts milk; bake rather slowly from 2 to 3 hours; stir 2 or 3 times the first hour of baking.

APPLE TAPIOCA PUDDING

Peel ½ dozen sour apples; if perfect, simply core, otherwise cut in halves, core, and place halves together; place in buttered pudding dish, sprinkle with sugar, cover with a plate, and bake until well done. Then over them pour 1 cupful tapioca which has been softened by soaking 3 hours in 3 pints water on back of range. Hard tapioca is an abomination; the proper degree of softness can only be obtained by applying a gentle heat for a long time, or soaking over night. The tapioca should be sweetened slightly and flavored with lemon extract. Return to oven and bake until browned on top. Let cool to a jelly, and serve with cream and sugar.

BOILED CUSTARD

Boil 1 pint cream or rich milk, strain, and when cold mix well with 6 beaten eggs, and sugar and nutmeg to taste. Pour into cups and bake in slow oven for about half an hour.

BAKED INDIAN PUDDING

Scald 1 quart milk; stir into a little cold milk 1 teacupful yellow cornmeal, and add to the boiling milk, stirring until it thickens, **but no longer,** or it will not bake well. When nearly cold, add 2 well-beaten eggs, a pinch of salt, a pint of cold milk, and sweeten with half sugar and half molasses; flavor with nutmeg, if at all; bake about 1 hour, or until water bubbles from the top. Serve hot.

STEAMED SUET PUDDING

Mix 3 cups flour with 2 cups sweet milk, 1 cup molasses (into which 1 teaspoonful soda has been stirred), and 1 cup each of seeded raisins, currants, and chopped suet. Put in 2-quart basin or individual cups, and steam for 2 hours. Serve with any liquid sauce preferred.

CHOCOLATE PUDDING

Pour 1 pint boiling milk over 4 ounces grated chocolate (bitter or sweet). Dissolve 3 tablespoonfuls cornstarch in 1 pint milk, add 3 beaten eggs, 1 teaspoonful vanilla extract, and sweeten to taste. Mix and pour into the milk and chocolate. Boil 1 minute, stirring briskly; pour into cups or molds and set away in a cold place until wanted. This pudding may be improved by the addition of a meringue (see page 476).

VANILLA SOUFFLE

Break 3 eggs, put whites aside, and yolks in saucepan with ½ pound sugar, 3 tablespoonfuls flour, some vanilla, the grated rind of a lemon, and 1 pint milk. Cook, while beating, about 10 minutes, until thick. Beat the whites stiff and pour, little by little, into the saucepan, stirring constantly. Pour into a buttered cake mold, and bake in oven not too warm, until it swells and has an attractive yellow color. Serve with granulated sugar sprinkled over, or with a little green-grape or currant jelly on each individual plate.

SNOW EGGS—FLOATING ISLAND

Place the yolks of 10 eggs in a saucepan and whip the whites separately. Poach the whites, spoonful after spoonful, in boiling milk (1 quart of milk, with 4 tablespoonfuls sugar and a little lemon or vanilla extract added, boiling quickly in a somewhat shallow pan); lift out carefully the poached spoonfuls of egg, and let drip on a platter. Mix yolks with 4 tablespoonfuls sugar, and pour into the same pan of hot milk, stirring constantly until somewhat thickened. Pour into a shallow dish and over the top carefully dispose the poached whites. When cool, place on each "island" a small piece of any preferred jelly.

CHARLOTTE RUSSE

Take 18 ladyfingers (or oblongs of sponge cake ½ x 1 x 3 inches); brush edges with white of egg, and with these line the bottom of a plain round mold (placing cakes in form of star, or rosette), likewise standing cakes upright around the edge, placing so closely that the white of egg will cement them. Place in oven for 5 minutes to dry the egg; whip ¾ pint of cream to stiff froth, add 1 tablespoonful powdered sugar, ½ ounce melted gelatin, and 1 teaspoonful vanilla; beat thoroughly and pour into mold, covering top with circular slice of sponge cake. Place on ice. When cold, turn upside down on dish, remove mold, and serve.

PICK-UP PUDDING

Place in steamer slices of dry cake; while steaming, rub together ½ tablespoonful butter and 3 tablespoonfuls sugar, flavor with cinnamon and pour into a little boiling water; thicken with a little cornstarch wet in cold water. Serve 1 or 2 slices to a person, with sauce poured over.

SAUCES FOR PUDDINGS

Cream Sauce—Beat together 1 yolk and 1 teaspoonful flour, sweeten to taste, and stir into 1½ cups boiling milk; cool and flavor; may be used in place of cream.

Hard Sauce—Cream together 1 cup sugar and ¼ pound butter; flavor with nutmeg and add the juice and grated rind of a lemon (for which, if desired, 2 or 3 tablespoonfuls sherry may be substituted). Serve in small individual dish apart, or place a lump on top of each individual service of hot pudding.

Vanilla Sauce—Mix 3 beaten eggs, ¼ pound butter, and ½ pound sugar; flavor with vanilla and add a little boiling water to thicken.

Sherry (or Madeira) Wine Sauce—Place in saucepan 2 tablespoonfuls butter and 1 teaspoonful flour; stir over fire until it thickens, then mix in beaten yolks of 4 eggs, 2 tablespoonfuls sugar, a pinch of salt, and ½ pint sherry or Madeira, stirring wine in briskly. Let remain on fire until on point of simmering, but do not let it boil, or it will curdle. For plum, suet, and bread puddings.

Brandy Sauce—Warm (but do not melt) ¼ pound butter and rub in 1 pound powdered sugar and flavor with a saltspoonful ground cinnamon (and same quantity of nutmeg if desired). Beat in 4 tablespoonfuls brandy, and place on ice.

White Sauce—Rub to a cream ½ cup butter and 1 cup sugar; add the beaten white of an egg, ½ teaspoonful extract lemon or rose, and 1 cup boiling water, into which has been stirred 1 teaspoonful cornstarch (in a little cold water).

Lemon Sauce—Prepare as for Sherry Wine Sauce above, but grate into the sugar the rind of 1 lemon, substituting for the larger amount of sherry (or Madeira) 1 large wineglassful each of sherry and water and the juice of 1 lemon, strained.

ICE CREAMS AND ICES

VANILLA ICE CREAM

Place in saucepan 6 to 8 yolks, well mixed with 1½ cups sugar; add 2 teaspoonfuls vanilla, and also add, little by little, while stirring, 1 quart cream. Place saucepan on corner of range, allowing mixture to warm, but **not to boil**. Cream will be ready when it sticks to the spoon. Cool and freeze.

CHOCOLATE ICE CREAM

Same as for Vanilla, but add ¼ pound shaved chocolate.

STRAWBERRY ICE

Clean 1 quart strawberries and press through sieve (or potato "ricer"). Pour into bowl with ¾ pound sugar, 1½ pints water, and juice of 4 lemons. Mix all and put aside, stirring from time to time until sugar is dissolved. Then freeze.

RASPBERRY ICE

Same as foregoing, but use raspberries.

LEMON, ORANGE ICE

Same as foregoing, but instead of other fruit use grated rind of a lemon or orange, and the juice of 6.

STRAWBERRY, PEACH ICE CREAM

Same as for Vanilla, but when partly frozen, add in freezer whole strawberries or peaches cut up, and revolve briskly to distribute fruit.

CAKES

GENERAL REMARKS

The prime essentials for good cake, as for good pastry, are good flour and good butter. Some cooks prefer unsalted butter, some butter from which the salt has been washed, some salted butter, and some butter and lard mixed.

Always sift the baking powder with the flour (or, in a soda cake, soda must first be dissolved in warm water or sour cream).

Always rub butter and sugar to a cream, adding next the well-beaten yolks of the eggs, then the milk and flour by degrees, and, lastly, the whites, beaten to a stiff froth.

After these are added batter should be beaten as little as possible, **on which success in cake making largely depends.**

Fruit must always be dredged with flour before adding to batter, or it will settle to bottom.

Raisins should be seeded (unless the seedless are used) and chopped (except for fruit cakes, when some should be left whole).

Currants, as bought, are full of grit and dirt. They must be washed in many waters in a colander, spread on tins to dry, and put away in bulk for future use.

Almonds may be quickly blanched by scalding with water, after which skins may be rubbed off.

The economical housewife economizes, first of all, her time. There is no need to waste time and risk failure in experimenting with new recipes for plain cakes, when a few standard cakes of all the various sorts needed so readily lend themselves to all possible combinations.

STANDARD CAKES

1. Gold Cake — One and one-half cups sugar; ½ cup butter; 1 cup sweet milk; 2 teaspoonfuls baking powder, mixed with 3 cups flour; beaten yolks of 6 eggs. Flavor with nutmeg or vanilla, or other flavoring if needed for combination.

2. Silver Cake — One and one-half cups sugar; ½ cup butter; 1 cup sweet milk; 2 teaspoonfuls baking powder; 3 cups flour; whites of 6 eggs beaten to a froth and added last. Flavor with bitter almond or lemon, or as desired.

3. Plain (Cup) Cake — Three eggs; 1½ cups sugar; ½ cup melted butter; 1 cup water (or milk, in which case reducing butter by ⅓); 3 cups flour; 3 teaspoonfuls baking powder; flavor with vanilla, or as desired.

4. Fruit Spice Cake — One cup sugar; 1 cup molasses; ⅔ cup butter; 1 cup sour milk; 3 cups flour; 3 eggs; 1 teaspoonful each of soda, nutmeg, and cloves. (Mix soda with molasses and sour milk.) One-half teaspoonful cinnamon; ½ cupful citron, chopped; 1 cupful each of raisins and currants.

5. Sponge Cake — Pour 1 cup boiling water over 2 cups sugar; separate yolks and whites of 4 eggs, and beat both well, the whites to a stiff froth; add yolks to sugar and hot water, beating quickly; then add 2 cups flour, in which 1½ teaspoonfuls baking powder have been sifted; add small pinch of salt and 1 teaspoonful lemon extract; lastly, add whites of eggs, mixing as lightly as possible. Bake in quick oven.

COMBINATION CAKES

BASED UPON STANDARD CAKES AS ABOVE

Cream Cake — Bake desired number of layers of *Silver Cake* (No. 2 or 3) and put together with the following filling: Place in saucepan 1 pint milk, sweetened to taste; bring to a boil, and stir in 2 beaten eggs, add 1 tablespoonful cornstarch mixed with a little cold water. Let boil up once and flavor with lemon or vanilla. Frost with desired icing, or sprinkle upper layer with powdered sugar.

Orange Cake — Bake desired number of layers of *Plain Cake* (No. 3), (using, however, the yolks of 5 eggs and the whites of 3, and flavoring with orange extract). Put together and frost with cooked icing, in which are used the other two whites, and to which is added (when a little cool) the grated rind and juice of one orange. Between the layers dispose thin slices of orange, seeded.

Nougat Cake — Bake desired number of layers of *Silver Cake* (No. 2). Put together and frost with cooked icing to which are added chopped nuts of various sorts. Flavor icing with a suspicion of bitter almond.

Chocolate Nut Cake—This cake has layers of two colors. For light layers, bake from *Silver Cake* batter (No. 2); for dark layers, stir into same batter 1 ounce finely grated chocolate; or, better, use *Gold Cake* batter (No. 1), adding chocolate. Put together with filling made of 4 ounces melted chocolate, to which are added 2 tablespoonfuls butter, ½ pound sugar, and ½ cupful cream, boil until it forms a soft cake when "tried" in ice water, and stir in 1 cupful finely chopped English walnuts. Frost with same icing, or, better, with a plain chocolate icing, over which are disposed the halves of walnuts.

Cocoanut Cake—Bake desired number of layers of *Plain Cake* (No. 3) and put together and frost with plain uncooked icing to which has been added all of 1 grated cocoanut except enough to sprinkle dry over top and sides.

Fig Cake—Bake desired number of layers of *Silver Cake* (No. 2) and put together with 1 pound chopped figs cooked to a paste with ½ cup sugar and 1 cup water, stirring to make smooth. If desired, only two layers may be baked, and these split to make four. Frost top and sides with plain white icing, cooked or uncooked.

Loaf Cocoanut Cake—Use *Plain Cake* batter (No. 3), stirring in, the last thing before baking, 1 grated cocoanut. Leave plain, or ice as for cocoanut layer cake.

Chocolate Cake—Use recipe for *Silver Cake* (No. 2) or *Plain Cake* (No. 3), the former being daintier, putting together and frosting with plain chocolate icing, or with cooked white icing into which 4 tablespoonfuls grated chocolate have been stirred. Flavor both cake and frosting with vanilla.

Hickory Nut Cake—Employ recipe for *Plain Cake* (No. 3), but if desired use 4 eggs, 2 cups sugar, and 1 cup butter. The last thing before baking, stir through batter 2 cups chopped hickory nut meats, dredged with flour. Flavor to taste and bake in loaf, sprinkling with powdered sugar, or icing if desired.

Ribbon Cake has layers of two colors; if a quantity of cake is being baked, use recipes for *Silver* and *Fruit Spice Cakes* (Nos. 2 and 4); for a single cake, fill two layer tins with *Silver Cake* batter (No. 2), then for the middle layer stir into the remainder of the batter ½ cupful chopped raisins, ¼ cupful citron, a little ground cinnamon, cloves, and nutmeg. Put together and frost top and sides with generous quantity of fruit icing.

Rolled Jelly Cake—Bake *Sponge Cake* (No. 5) in thin sheets in oblong tins. Turn from tin onto a double towel wrung out of cold water; spread the bottom with any preferred jelly or jam, roll, and dust outside with powdered sugar.

SPECIAL CAKES

Angel Cake—This is a very delicate cake, every condition prescribed for the making of which must be observed, or it will prove a failure. Take 1¼ tumblers pulverized sugar, or the very fine granulated, 1 tumbler flour, whites of 10 eggs, 1 teaspoonful cream of tartar, and 1 teaspoonful extract lemon or vanilla. Beat whites to a stiff froth; then sift sugar, flour, and cream of tartar together **four times**, so as to make it extremely light. Stir in quickly the whites, and with as little beating as possible; put batter in an **unbuttered** tin (one with a pipe in the center to insure even baking is preferable), and bake 40 minutes in a slow oven. Turn upside down to cool, but put something under the edges to prevent its lying on a flat surface and becoming heavy. Tin used for Angel Cake should be used, from the first, for nothing else.

Pound Cake—Beat the whites and yolks of 8 eggs separately; cream together 1 pound sugar and 1 pound butter, add the beaten eggs, and stir in 1 pound flour. Flavor to taste and bake in moderate oven, preferably in small pans.

Fruit Pound Cake—Same as foregoing, but stir in 1 cup citron and 1 cup raisins (seeded but unchopped), dredged with flour.

Rich Fruit Cake—Cream together 1½ pounds butter and 2 pounds sugar; add 6 beaten eggs, 1 grated nutmeg, 1 teaspoonful cloves, and 1 teaspoonful cinnamon, ½ cup milk, and 3 teaspoonfuls baking powder mixed with 2½ pounds flour. Stir in 2 pounds each of raisins and currants and ¾ pound citron. Bake in a slow oven.

Black Fruit Cake—Cream together 1 pound each of brown sugar and butter; add 10 beaten eggs, 2 teaspoonfuls each of nutmeg and cinnamon, 1 teaspoonful of cloves, and 1 pound browned flour into which 1 teaspoonful baking powder has been stirred. Stir in 2 pounds each currants and raisins, and ½ pound citron. Bake in slow oven, 2 or 3 days before using.

Old-fashioned Pork Fruit Cake—Put in mixing bowl 6 cups sifted flour, and sift in 4 cups more which have been well browned, mixing well. Chop 1 pound fat salt pork very fine, pour over it 2 cups boiling water, and set to cool. Into a hole in the flour pour 6 beaten eggs, mixed with 1 pound dark brown sugar and 1 teaspoonful each of allspice, cinnamon, cloves, and nutmeg. Then stir in 1 cupful molasses and 1 pint sour milk, into which 1 level teaspoonful soda has been stirred; add the minced pork and water, and stir in the flour, adding more if batter is too thin. Lastly, add 1 pound chopped raisins, 1 pound whole seeded raisins, 1 pound currants, and ¾ pound citron, all well dredged with flour. Stir gently through the batter, and bake in a slow oven. When done set away in stone jars, and **do not use for four weeks, or more.** This cake will keep a year.

Quick Sponge Cake—Beat 2 eggs, add 1 cup sugar and 1 teaspoonful baking powder mixed in 1 cup flour; add 2 tablespoonfuls boiling water; stir well, but do not beat. Bake in a loaf in shallow tin, or in gem tin.

Soft Molasses Cake—Mix 1 cup butter, 1 pint molasses into which 2 teaspoonfuls soda have been stirred, 1 pint flour, ½ pint milk, 2 eggs, 1 tablespoonful ginger, and enough more flour to make somewhat less stiff batter than for Cup Cake. Bake in moderate oven.

Soft Gingerbread—Pour 1 cup boiling water over ½ cup butter and 1 cup molasses, into which 1 teaspoonful soda has been stirred; add 1 teaspoonful ginger, a small pinch of cloves, 1 egg, and 2 cups flour.

ICINGS FOR CAKES

Boiled White Icing—Allow 1 cup of granulated sugar to the white of 1 egg; put sugar in saucepan with ½ cupful water and boil without stirring until syrup hairs; beat the whites of eggs in bowl to a stiff froth, and when syrup is done, pour it, boiling hot, in a thin stream into the egg, beating vigorously meanwhile, lest the egg cook in lumps. If desired, a pinch of cream of tartar may be added; flavor to taste.

Uncooked White Icing—Beat whites of eggs in bowl to stiff froth; then pour in pulverized sugar gradually, beating until smooth, and allowing ¼ pound sugar to each egg. Add more sugar if needed, and flavor as desired.

Lemon Icing—Beat together the juice and rinds of 1 or 2 lemons, 3 beaten eggs, 1 teaspoonful butter, ½ glass water, and 2 cupfuls sugar. Boil to a creamy consistency.

Chocolate Icing—Mix together 1 cup sugar, 1 tablespoonful butter, ¼ cake shaved chocolate, and 4 tablespoonfuls boiling water. Stir until dissolved, boil a little, and flavor with vanilla.

Fruit Icing—Add to Boiled White Icing, 1 cupful chopped raisins or figs (or both) to each egg used. Chopped blanched almonds may be added if desired.

Almond Cream Filling—Whip 1 pint thick cream to the stiffest possible froth; sweeten well, flavor with vanilla, and add 2 cupfuls chopped blanched almonds. Spread thickly between layers very shortly before serving.

SMALL CAKES, CRULLERS, AND COOKIES

Spice Cakes—Mix 6 beaten eggs with 4 cups brown sugar and 2 large cups flour; add cinnamon and cloves to taste and 2 level teaspoonfuls baking powder. Drop from spoon onto buttered tin in cakes the size of a hickory nut. Bake quickly.

Cocoanut Drops—Mix together the beaten white of 1 egg and 1 cup sugar; add 1 tablespoonful flour and 1 large cup cocoanut; line tin with buttered paper, drop from spoon in balls the size of a hickory nut, sprinkle with powdered sugar, and bake 20 minutes in slow oven.

Macaroons—Mix ½ pound blanched almonds, pounded fine, with a little rosewater to moisten, and ½ pound sugar; add the whites of 2 eggs, beaten to a stiff froth; then, with a little flour on the hands, mold into little cakes, and bake in a moderately hot oven.

Walnut Wafers—Mix 3 even tablespoonfuls flour with ½ teaspoonful baking powder, a little salt, 2 beaten eggs, ½ pound brown sugar, and 1 cupful walnut meats broken into small pieces. Drop onto buttered paper and bake slowly to a light brown.

Doughnuts—Mix 1½ cups sugar with 2 beaten eggs, 2 cups milk or cream, and flour enough to roll out, mixing 1 teaspoonful baking powder with each cup of flour. Flavor with nutmeg. Roll quite thin and cut out in rings. Fry in a kettle of hot lard to a reddish brown, and roll while hot in powdered sugar.

German Crullers—Mix 2 cups sugar with butter the size of an egg, 2 cups milk, 3 beaten eggs, and enough flour to roll out without sticking, allowing 1 teaspoonful baking powder to each cup of flour. Flavor with nutmeg and cinnamon. Fry in hot lard and dust with powdered sugar.

English Wine Cakes—Work 2 pounds leaf lard in the hands on molding board until all the strings are removed; add 2 pounds sugar, a little salt, and flour enough to roll out in a stiff dough. Cut ¼ inch thick with small cake cutter, and bake in a moderately quick oven. These cookies should be kept in a stone jar from a fortnight to a month before using.

Sugar Cookies—Mix ½ cup butter with 1 cup sugar, 2 beaten eggs, 3 tablespoonfuls sweet milk, and flour enough to make a soft dough, in which is mixed 1 teaspoonful of baking powder to the cup of flour. Flavor with a suspicion of nutmeg, mix expeditiously, roll thin, sprinkle with coarse granulated sugar (rolling it in lightly), cut out, and bake in a quick oven to a light brown.

Molasses Cookies—Mix 1 cup brown sugar with 1 cup lard; add 1 cup molasses and 1 cup boiling water, with 1 teaspoonful soda, 1 teaspoonful ginger, and ½ teaspoonful powdered alum, put in last. Mix as soft as can be rolled and bake in a quick oven.

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