BOARD OF AGRICULTURE AND FISHERIES.

LEAFLETS

(Nos. 101 to 200).

TENTH EDITION.

WITH INDEX.

LONDON:
PRINTED UNDER THE AUTHORITY OF HIS MAJESTY'S STATIONERY OFFICE
BY DARLING AND SON, LIMITED, BACON STREET, E.2.

TO BE OBTAINED *only* AT THE OFFICE OF THE BOARD OF AGRICULTURE AND FISHERIES, 3, ST. JAMES'S SQUARE, LONDON, S.W.1.

1919.

Price One Shilling Net (Post free.)

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The leaflets are also issued singly, and may be obtained free of charge and post free on application to the Board. Letters of application need not be stamped.

London, S.W.1,
August, 1919.

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BOARD OF AGRICULTURE AND FISHERIES.

Prevention of White Scour in Calves.

In order successfully to combat the disease known as White Scour in calves, a disease which yearly claims a large number of victims, the following procedure should be fully and carefully attended to :—

Disinfection of Premises.

The floors of cow-houses and calf-houses should be thoroughly cleaned and disinfected at least once each week with a solution of blue-stone (*Copper sulphate*), made by adding 2 lb. of blue-stone to 3 gallons of water. The floor of the calf-house should be of concrete, and should be swept daily and disinfected with a solution of blue-stone of the above strength.

Navel Treatment.

(*a.*) When a cow is about to calve she should be given a good bed of clean fresh straw to keep the calf clean.

(*b.*) When she shows signs of calving her "bearings" should be washed with a warm 5 per cent. (minimum) solution of carbolic acid (containing not less than 95 per cent. of actual carbolic acid) or an equivalent disinfectant in rainwater. The solution, at half strength, should also be injected into the passage through which the calf is to be born.

(*c.*) Immediately the calf is born the navel cord should be tied with twine which must be kept ready in the carbolic acid solution. The person who ties the cord should first scrub and wash his hands with the solution.

(*d.*) Immediately the cord is tied the portion adhering to the calf, as well as the surrounding part of its body, should be carefully painted with a solution of iodine in methylated spirits (35 grains of iodine to 2 pints of methylated spirits).

(*e.*) After a few minutes the navel cord should be painted with a layer of collodion containing 1 per cent. of iodine, or with Stockholm tar.

General Recommendations.

1.—Navel treatment without repeated and careful disinfection will NOT be successful.

2.—Newly-born calves should be placed in a spot which has been freshly disinfected. Carbolised sawdust will be found a useful litter.

3.—Healthy calves should not be housed or fed with those that are diseased.

4.—Separated milk should not be given until the calf is four weeks old. The change from new to separated milk should be gradual. The calf should have a substitute for the cream removed by the separator. One to two oz. per day of the best cod liver oil, or a mucilage prepared by steeping linseed or good linseed cake in hot water, will be found useful for this purpose. The quantity, however, should be carefully regulated in accordance with the state of the bowels.

For further hints on the treatment of calves reference should be made to Leaflet No. 142 on Calf Rearing.

London, S.W.1,

March, 1904.

Revised, October, 1913.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

Blackquarter, Quarter Ill, or Black Leg.

Blackquarter is a bacterial disease caused by the blackquarter bacillus.

Distribution.

Although blackquarter is known to have occurred in many parts of Great Britain for a great many years, no statistics of the number of animals which become affected annually, or of the districts in which it is prevalent, are available, as the disease has not been scheduled under the Diseases of Animals Act. The disease appears to be very irregularly distributed, and even on the same farm it may occur in some fields and not in others. The danger of infection is greatest on permanent pasture, and on uncultivated land, and often disappears when the land is drained, and cultivated. Although low lying, damp land is more favourable to the disease it is also found on high land. The disease is usually prevalent in the early spring and summer, but it also occurs to a less extent at other times of the year.

Animals which contract the Disease.

Cattle and sheep are the only farm animals which become affected in Great Britain. Cases have been recorded of horses and swine dying from blackquarter, but these animals can be disregarded for all practical purposes.

In this country cattle are the principal sufferers from the disease, the mortality ranging from 2 to 20 per cent. of the total young cattle on infected farms. There are, however, certain districts in which great numbers of sheep are attacked, notably Romney Marsh, where death-rates of from 2 to 40 per cent. have occurred on certain farms in certain seasons. In the case of Romney Marsh this high mortality in sheep is probably not due to any peculiar character of the bacillus found in the locality, but to the custom of grazing sheep during the spring and summer to the exclusion of cattle.

Cattle usually become affected between the ages of 6 and 18 months. Although calves under six months are susceptible they seldom contract the disease. Cattle above two years are rarely affected, and it may be said that they become less susceptible with advancing age.

The Bacillus of Blackquarter.

The bacillus is usually rod-shaped, but it may also assume the form of a drum-stick or a racket.

As it can maintain its existence in the soil apart from a living animal body, it is called a "soil" organism. The bacillus forms spores, and in this resting stage resists great variations of temperature, and retains its activity for long periods.

Symptoms.

The period of incubation is usually about three days, but in some cases it may be five days.

In *cattle* the earlier symptoms are sometimes not characteristic, and diagnosis is difficult, but as the disease progresses distinctive symptoms appear, and in districts where it is prevalent most farmers recognise them.

In the early stages the symptoms are dullness, cessation of rumination, loss of appetite, high temperature, harsh and staring coat, trembling, and coldness of the legs, feet and horns. Later, stiffness, lameness, and arching of the back are also noticeable. On closer examination the characteristic blackquarter swelling may be observed under the skin on those parts of the body covered by thick layers of muscle, such as the upper leg, loin, buttocks, shoulder, chest or neck. The swellings also sometimes affect the tongue, throat, dewlap, genital organs or mammary glands, but are never seen below the knee or the hock, or on the tail. They are at first hot and painful, but rapidly become cold and painless, and in prolonged cases they may even become hard and parchment like. On pressing the swelling a crackling noise, due to the formation of gas by the bacilli in the tissues, is heard.

As the disease progresses more gas is produced in the swellings, respiration becomes hurried, the animal is greatly distressed, and the temperature may rise to a high point. The pulse is rapid and feeble, and tympanitis (hoven) may be present. Dung, which may be blood-stained, is passed involuntarily. Towards the end the animal usually lies motionless, the temperature rapidly falls, and death follows.

The disease usually lasts from 12 to 48 hours, but in some cases it may be prolonged for 4 to 10 days. The swelling is not apparent in every case, as it occurs in the more deeply situated muscular tissues. In the absence of the characteristic swelling, colic, or digestive disturbance may be the most apparent symptoms, or there may be lameness and stiffness.

In *sheep* the course of the disease is not so prolonged as in cattle. Death usually occurs without symptoms of ill-health being noticed. Sometimes a sheep is seen to falter, fall to the ground, and die in a few moments. In some cases, however, symptoms of the disease are displayed for a considerable time before death occurs. The affected sheep stands stiffly with feet together, back arched, champs its jaws, and breathes heavily. Diarrhœa may be present with blood-stained excreta, and a frothy blood-stained discharge from the nostrils may be seen.

Swellings on the body may occur as in cattle, but they are not so apparent.

Post Mortem Appearances.

In *cattle* the carcase is usually very distended with gases, and blood-stained froth may be discharged from the mouth, nostrils, and anus. As a rule the characteristic swelling is also present. When pressed, the swelling emits a crackling sound due to the presence of the gas, and if it is cut, a blood-stained fluid, possessing a typical rancid odour, distinct from the putrid odour given off by a decomposing carcass, exudes from the cut surface. Owing to the formation of gas the muscular tissue appears to be dark red, almost black in colour, and porous looking. The blood in the vessels clots and is generally normal in appearance. In some cases lesions are absent in the superficial muscular tissues, but they are usually to be found elsewhere in the carcase.

In *sheep* the muscular lesion is the same as in cattle, but it is not so noticeable. It may be found almost anywhere in the carcass, but is usually present in the upper parts of the limbs. On a close examination of the carcass of a sheep which has died of blackquarter it will usually be found that some part of the carcass is swollen ; the fleece overlying the swollen portion pulls away easily, and the skin so exposed is of a dark purple colour. The characteristic crackling of gas is heard if the swollen part is pressed, and if the swollen part is cut into, the appearance is identical with the cattle lesion. Even in districts where blackquarter is prevalent, stockowners should always bear in mind the possibility that an animal which has died after a short illness, or has been found dead, may have died of anthrax. If an animal has shown symptoms of blackquarter during life, and the characteristic swelling distended with gas is also present after death, stockowners would be justified in forming the opinion that death was due to blackquarter, but, if these characteristic signs are not present, it is possible the animal may have died of anthrax.

Infective Material and Method of Infection.

The spores may remain active in the soil for years, but their number may be added to by material from new cases, especially if infected carcasses have been cut up on the pastures. The flesh or fluid of the swellings contain highly infective material, and the same applies to the blood-stained discharges. Animals do not infect each other directly, but pick up infection from the soil either by swallowing infected food or by contaminating a wound.

Prevention.

As the spore is capable of living in the soil, the greatest care should be exercised to prevent any addition to the number of bacilli already in the soil by the careless disposal or unnecessary cutting up of the carcass. An animal which has died from the disease should not be skinned, as the small amount received for the pelt is out of all proportion to the risk which is run of further infecting the farm.

All carcasses should be properly buried or burnt, especially in the season of castrating and docking.

Several methods of inoculating young stock to protect them against the disease are in use in different parts of the world. Arloing's method consists of two injections of vaccines at an interval of ten days, and it gives the inoculated animal immunity against the disease for about one year. Unfortunately, fatal accidents may follow the operation. The deaths do not amount to much—under 1 per cent. if reckoned on a large number of animals—but, since many deaths may occur on one farm, or in the same district, this form of inoculation should not be adopted unless the losses from the disease are annually very high. A safer method of protection is to use a serum together with a dose of pure culture of the bacillus. Before adopting preventive inoculation the owner of an infected farm should consult a veterinary surgeon who can advise him whether the annual losses from the disease make it worth the attendant risks. The choice of the method of vaccination and the age at which the animals should be treated should be left to the veterinary surgeon who probably knows which method has been most successful in the district.

Treatment.

No form of medical treatment has been discovered which can be relied on to cure blackquarter. Certain remedies have been widely advertised, but they have all proved valueless. Some success has been claimed in the past for the method of treatment which consists of incising the swellings and dressing the wounds with antiseptics. This method, however, is now seldom adopted, for, if the patient recovers, as it very rarely does, a large area of tissue sloughs, and the convalescent period is in consequence long and expensive to the owner.

London, S.W.1,
February, 1904.
Rewritten, May, 1916.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

The Pine Sawfly (*Lophyrus pini*).

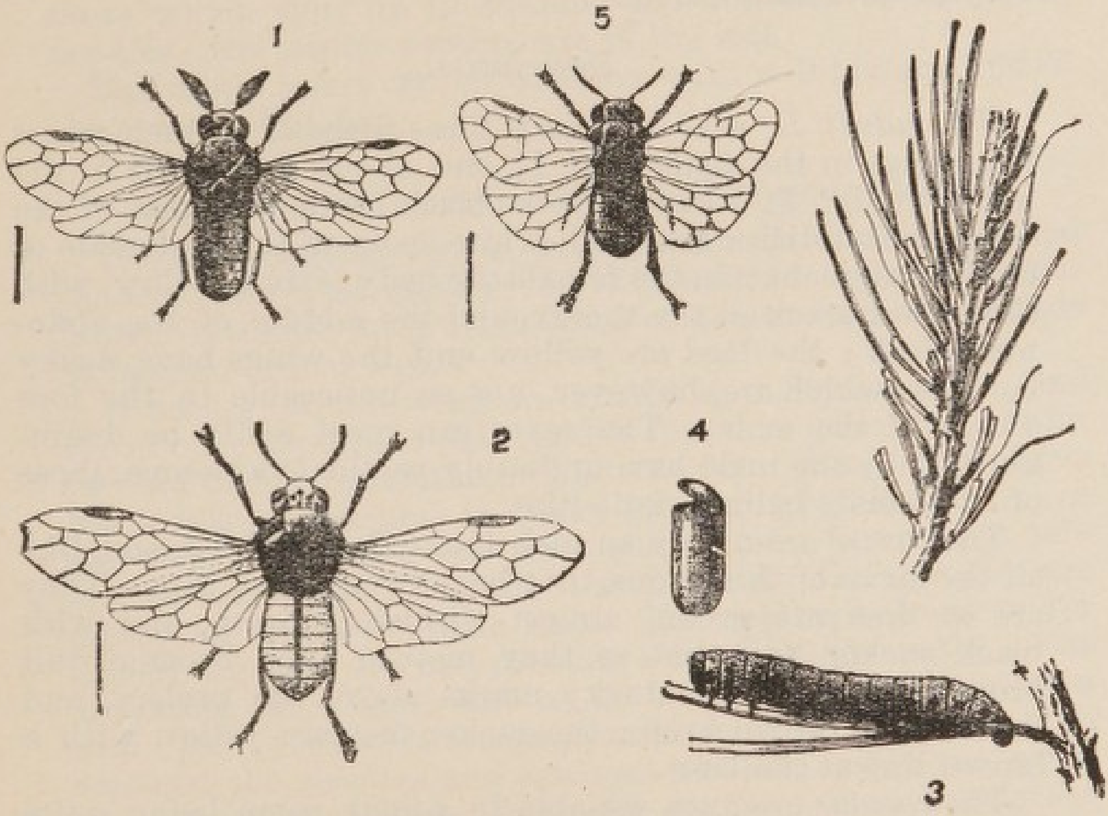


Fig. 1, *Lophyrus pini*, Male; Fig. 2, Female; Fig. 3, Larva; Fig. 4, Cocoon; Fig. 5, *Lophyrus rufus;* Fig. 6, Pine shoot attacked by Sawfly larvæ. Lines show natural size of Figs. 1, 2, and 5.

Young Pine trees, especially the Scots Pine and Black Austrian Pine, are frequently seriously damaged by the larvæ of sawflies. The chief culprit is the Pine Sawfly (*Lophyrus pini*), but *Lophyrus rufus* may, in Pine plantations, be very destructive.

The Pine Sawfly prefers trees with a sunny aspect, and hence it will be noticed in greatest abundance at the borders of plantations or around clearings. Trees from ten to thirty years old are subject to the ravages of this pest, but younger and older trees may sometimes be seen severely attacked. The damage they do is soon noticeable owing to the larvæ feeding in companies; these colonies number sometimes as many as a hundred individuals, but as the larvæ grow they disperse. The harm done is two-fold; the needles are eaten, and the bark of the shoots bearing these needles is also gnawed away. The young caterpillars eat the needles from the side, the midrib being left hanging. Older caterpillars eat the complete needles right down, or almost right down, to the dwarf shoot. Another sign of attack is the characteristic greenish excrement lying below the food plant. There may be two broods during the year.

This forest pest often attacks large areas at the same time. In one instance 2,000 acres were invaded. The caterpillars are not hardy, and may disappear suddenly, as they are susceptible to climatic changes, cold and wet weather being very prejudicial to them.

Description.

The adult L. pini is nearly three-fifths of an inch across the wings in the male (Fig. 1), and about four-fifths in the female (Fig. 2). The male is black, with the apex of the abdomen reddish; and with white spots on the underside of the first segment; in the female the body is dull yellow, with three dark areas on the thorax, and the middle of the abdomen black; the legs are yellow and the wings have dusky borders, which are, however, not so noticeable in the fore wings of the male. The sexes can most easily be distinguished by the male having doubly pectinate antennæ, those of the female being bristle-like.

The *larvæ* are nearly an inch long when full fed, and, like all the larvæ of this genus, they have twenty-two legs. They are at first pale green, almost whitish beneath, and with black sucker feet, but as they mature they become dull brownish-green with dusky marks above the prolegs, and with a dark brown head; the sucker feet are yellow with a brown line at the base.

The *cocoons* are very variable in colour, some being quite dark, others dull brownish-grey; they are about a quarter of an inch long, rounded at the ends, and hard and compact.

Life History.

The *adult sawflies* may appear at the end of April or in May and the beginning of June. The female is sluggish and seldom flies. She lays her eggs in the needles in slits cut by the saw-like processes common to the sawflies. As many as ten to twenty may be placed on each needle, but a smaller number is common. The eggs are usually laid in close proximity, each one being covered over with a resinous secretion and so protected from various enemies.

The *larvæ* hatch in from two to three weeks, appearing at the end of May and in June. They are full-fed by or in July when pupation may take place, a second generation of sawflies issuing in July and the beginning of August. The eggs from these hatch out caterpillars which feed on until the autumn, when they make a cocoon under cover of which they lie until the next spring, when pupation takes place—the adults issuing in April or May. Or there may be only one generation in the year, the caterpillars full-grown in July lying sheltered in their cocoons until the following spring, when they pupate.

There is much overlapping however among individuals of different broods, and even of the same brood. Some caterpillars taken in August made cocoons from August 14–17, and the first adults issued on April 27th. The cocoons of those which spin up in summer are attached to bark and needles; the winter cocoons are in the soil.

The adult issues by an opening with a lid at one end of the cocoon (Fig. 4).

The Fox-Coloured Sawfly (*Lophyrus rufus*).

The male is glossy black, with the first abdominal ring and the feet (except the claws) red. The larger female is reddish-brown in colour, with black spots on the thorax, and yellow to reddish-brown legs.

It occurs on the wing in August and September. One brood only appears to exist, and is found in larval form from the end of May until the middle or end of June. The larva has a black head and is dusky greenish-grey in colour; a pale line runs along the back, and a dusky line with a pale one on each side of it above and below; the spiracles are placed on the lower pale line. The sucker feet and under side of the body are pale green. When full grown the larvæ are rather more than half an inch in length, and then form oval, pale yellowish-brown, parchment-like cocoons, both amongst the needles and amongst heather, and in the earth, &c., beneath the trees. Like the common Pine Sawfly the caterpillars also are met with in colonies, two individuals usually sitting on each needle. They pupate in June, some specimens kept under observation going into this stage in the third week in June. Although needles and other "cover" lay on the ground in the breeding cage, they pupated in the earth just as described by Kollar. The females which come from such cocoons lay their eggs in August and September in the needles as is done by *L. pini*. Other caterpillars fed in captivity made their cocoons in July. The first adults issued from these on August 24th, and adults continued to issue during the first half of September. Apparently the eggs remain in the needles all the winter and hatch out in early May.

Preventive and Remedial Measures.

(1.)—It does not appear certain that sickly trees are more attacked than healthy ones, but in any case attention should be given to maintaining plantations in robust growth. All the Pine Sawflies have many enemies. Amongst these may be mentioned the cuckoo, goat-sucker, and starling, which devour numbers of the larvæ and adults. Numerous Ichneumon flies also prey upon them.

(2.)—When young trees are invaded, the larvæ may be easily destroyed by crushing them with a gloved hand. This should be attempted in the early stage of an attack, as at that time the larvæ are present in fairly compact groups, and are readily dealt with.

(3.)—Shaking the larvæ from the trees on to cloths spread on the ground is recommended, but is a less satisfactory method of destruction than the other.

(4.)—Another plan is to place fresh pine boughs beneath the trees and then jar the larvæ off. All those that fall to the ground collect on the boughs strewn about, and can then easily be burnt.

(5.)—Trees that have been attacked may have the ground around their trunks examined in winter, when the dead leaves, moss, etc., containing the cocoons may be raked together and destroyed.

(6.)—Ornamental trees in parks and gardens may be speedily cleared by spraying with hellebore wash or arsenate of lead.

London, S.W.1,
March, 1904.

Revised, June, 1905.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

Aphides or Plant-Lice.*

Nearly all plants, both in garden and field, and under glass, suffer from the ravages of Aphides. These universal pests are most common in temperate climates, but even in the tropics whole crops are ruined by them. Aphides are known by a variety of common names, such as Plant-Lice, Green or Black Fly, Smotherers, and Dolphins, while the disease they cause is sometimes termed " Blight."

Aphides are soft-skinned insects with antennæ generally longer than the body. When wings are present they are delicate, and have few veins. On the upper surface of the abdomen two tubes are generally present—sometimes short, sometimes long—from which a liquid can be discharged. The mouth parts are fitted for piercing and sucking; the plant tissues are first pierced and then the sap is drawn away. The skin of plant-lice is provided with glands which secrete a waxy or mealy substance or woolly masses which have the power of throwing off water.

The young differ little in form from the full-grown insects, and their feeding habits are the same.

Development from the young stage to adult takes a very short time, and hence multiplication of individuals is rapid. Dry, hot weather is specially favourable for Aphides.

The summer generations of Aphides are produced without the presence of males, and the females may be wingless or winged, both conditions being found in the same life-history. The winged generations spread the infestation. These females—wingless and winged alike—can give rise to live young, and this power of viviparous multiplication and the appearance of winged forms are to be associated with abundance of food at certain times of the year. As the cold part of the year comes, males as well as females are produced and fertilised eggs are laid.

Some Aphides confine themselves to one species of plant; others migrate so that part of the life-cycle is spent on a plant of a different species. Migration of the same kind of Aphid may take place to a number of quite unrelated species of plants.

Aphides damage plants in two ways; (1) by sucking away the sap and so weakening the plant, and (2) by their excrement falling on the leaves and clogging the stomata and so interfering with gaseous interchange. Further, the excrement, consisting partly of a sweet gummy substance called " honeydew," is a favourable germinating medium for the spores of some fungi, and spoiled sooty-coloured patches show on twig, leaf, and fruit.

* The following species of Aphis are dealt with separately, viz.: Woolly Aphis (Leaflet 34), Currant Aphides (Leaflet 68), and Hop Aphis (Leaflet 88).

Natural Checks.—Several insects prey upon Aphides, and should be encouraged. The chief of these are Ladybirds and their larvæ (*Coccinellidæ*); Hover-fly larvæ (*Syrphidæ*); and the larvæ of the Lace-wing Flies (*Chrysopidæ*). Various minute Hymenopterous parasites (*Chalcididæ*) lay their eggs in the bodies of Aphides, those parasitised being destroyed. Man cannot, however, rely solely on the services of these beneficial insects, but should check the increase of the Aphides by washes as soon as they appear upon his plants.

THE BEAN APHIS (*Aphis rumicis*, Linn.).

The Bean Aphis, known variously as Black Fly, Collier, and Black Dolphin, is in some years a very severe enemy of the bean crop, shoots and pods being quite smothered with the insects. Harm results not only from the weakening of the plant by the draining away of the sap, but also from the masses of excrement which cover and clog the outside of the plant. Important points in the biology of this Aphis are: (1) It does not confine itself to the bean crop, but is found on many other plants in widely separated Natural Orders, examples being docks, thistles, furze; (2) There are regular migrations to these plants and back to the bean again; and (3) Various generations with somewhat dissimilar individuals are found at different stages in the life-history. The following are recognisable:—(*a*) The early wingless female, on the bean, black in colour with ochreous tints on the shanks and the middle joints of the antennæ. This female produces live young; the young are slate-grey to black. At certain times a stage is found when the insects show dusky wing-cases or wing rudiments, and the abdomen is black, with white spots; this is the stage preceding (*b*) the winged females. These winged females are black or black with a brownish tinge; the shanks and middle joints of the antennæ are yellowish; the wings are yellow at the base, greenish in front, and have brown veins. These females produce live young. (*c*) Wingless females found in autumn and resembling the females of (*a*); the females of (*c*) lay eggs. (*d*) Males, appearing late in the season; they have wings, and are black or black-brown in colour.

Life-History.—The wingless females of the early part of the year are found on the bean tops, and give rise to live young. Multiplication is rapid, and ultimately winged females appear which spread the infestation to other beans and to different food plants. In the autumn, with the appearance of the males and egg-laying females, fertilised eggs are laid on the plants to which the Aphides have migrated.

Treatment.—(1) The infested tops should be cut off and burnt. This should be done early. (2) The beans should be sprayed with soft-soap and quassia. Dissolve 5 lb. of soft-soap in 100 gallons of soft water; boil 6 to 8 lb. of quassia chips in water and add the extract to the 100 gallons of wash.

The Cabbage Aphis (*Aphis brassicæ*, Linn.).

In the case of this species, infested leaves drained of their sap become yellow and bleached. Blistered patches show, and under these the Aphides are found. As the numbers increase the pests are found both on the upper and lower surfaces of the leaves.

The wingless viviparous females have their bodies covered with a mealy secretion that gives them a white appearance and masks the grey-green colour of the body; dark spots are present on the upper surface; the antennæ are green or yellow-green with dark tips; legs and eyes are dark-brown or brown-black; the cornicles or tubes on the back are short and dark-brown; the young, until the mealy secretion appears, are bright yellow or yellow-green.

When the mealy secretion is removed the winged viviparous females are seen to have the front part of the body black, and the hind part yellow-green; legs and cornicles are dark-brown.

The males are green with black antennæ, and the cornicles are dark at the base.

The egg-laying female is green, with rows of dark spots on the back; the eggs are green at first, but later are black.

Life-History.—Young Aphides hatch from eggs laid in the previous autumn on cruciferous plants (both wild and cultivated). During the summer the wingless and winged virgin females are found. The winged females spread the infection. Both the wingless and the winged females produce live young. Towards the end of the season, when infestation is worst, males and wingless egg-laying females pair, and fertilised eggs are laid from which in the next year come the individuals which start the colonies for the year.

Treatment.—(1) Cruciferous weeds should be kept down as far as possible. (2) The insects should be attacked early with soap and water, and the watering should be repeated.

On large areas, as in field cultivation, no treatment will avail when widespread attack has been neglected.

Rose Aphides.

Different species of the genus *Siphonophora* are found on roses. One of these, *S. rosæ*, migrates to teasel and returns later in the year.

Treatment.—Spraying should be done with the soft-soap and quassia spray (p. 2), but only 4 lb. of soap should be used. Spraying should be carried out twice in the same week.

The Plum Aphis (*Aphis pruni*, Reaumur).

The Plum Aphis is a serious pest on plum, damson, and allied Rosaceous fruit trees. The loss of sap due to its feeding causes the leaves to curl and discolour, and the young fruits fall off.

The eggs found in autumn and winter are shining black The young from the eggs are green or dark green; they develop into wingless viviparous females, which vary in colour from green to olive-brown. The pupal stage or stage preceding the winged viviparous female is characterised by rudiments of wings or wing-cases; the body is green and the wing-parts brownish. The winged viviparous female is apple-green, with the antennæ, head, upper surface of thorax, and the feet, black.

Of the sexual individuals, the males are small; they have wings and are yellow-brown or black in colour; egg-laying females are small and wingless; they are greenish-yellow in colour and transparent.

Life History.—Fertilized eggs are laid in the autumn on the twigs and at the base of the buds. The winter is passed in the egg stage. Hatching takes place in spring, the young from the eggs developing into adult females, which are wingless and give rise to live young. These in turn become adult wingless viviparous females. As the season advances some of the young, instead of developing as stated, show wing rudiments and develop into winged viviparous females. These may spread the infection. Late in the year males and wingless egg-laying females are found and fertilized eggs are laid, which remain unhatched over the winter.

Treatment.—(1) Spraying should take place with soft-soap and quassia wash, or with paraffin emulsion, early in the year, when the young Aphides are noticed to have hatched out. The spray should always be applied before the leaves have curled. (2) Spraying should also be done in the autumn with paraffin emulsion, in order to kill the egg-laying females, *e.g.*, late in September or during October. (3) Theobald writes favourably of a late winter wash, where the pest is abundant, the plums and damsons to be heavily sprayed with lime-wash, salt, and water-glass *just before* the bursting of the buds. This wash is said to prevent the hatching of eggs; the formula given is 1 cwt. lime, 30 lb. salt, and 5 lb. water-glass to 100 gallons of water.

Another Aphid found on plums and allied fruit plants is *Hyalopterus pruni*, Fab. As a spray against this Aphid, which is found on the under surface of the leaves, Theobald quotes a correspondent's treatment as very satisfactory, viz., paraffin emulsion, with 1 lb. of liver of sulphur added for every 100 gallons of the wash.

A third Aphid which in certain stages of its life-history is found on the genus *Prunus* is *Phorodon humuli*, described in Leaflet 88. This species is distinguished from the others by two marked projections from the forehead, between the antennæ.

London, S.W 1,
June, 1904.
Re-written, January, 1911.

BOARD OF AGRICULTURE AND FISHERIES.

Wart Disease (Black Scab) of Potatoes.

(*Synchytrium endobioticum.* Percival.)

External Appearance.—The disease here described is popularly known as Wart Disease, Black Scab, or Cauliflower Disease, the last-name being given owing to the characteristic outgrowth which bears some resemblance to the head of a cauliflower, and not because the disease attacks that plant. In some places it is called Potato Canker, or "Fungus," while in recent years a variety of other names such as Black Wart and Potato Wart have been given to it. The name Black Scab, under which it was at one time best known, is not well chosen, since the symptoms bear no resemblance to those of any of the diseases which pass under the name of "scab," and in the earlier stages the affected potatoes do not lose their natural colour. In advanced stages the haulm and tubers rot and assume the dark colour usually found in decaying plants, while a dark brown liquid oozes from the putrid remains.

In the early stages of the disease, when it is most commonly seen, the small swellings which appear in the eyes of affected tubers bear a distinct resemblance to warts, though, in the latter stages or when the attack is very severe, several warts run together and form an irregular spongy mass such as is shown in the illustrations.

This outgrowth, however, is not confined to the tubers. It is frequently found at the collar of the haulm either just below or just above the ground, and in some cases distorts the leaves growing either on the stem near the collar or at the end of the underground stem, the tips of which rise above the surface. (*See* Fig. 1.) It does not follow that all the tubers on a diseased plant are affected. As a rule those which lie nearest the surface suffer the most severely, and it has been noted that late-formed tubers sometimes escape infection altogether. Every stage of attack may be found on a single plant.

The vigour of the haulm is not affected in the early stages, and it has been observed that diseased plants frequently grow larger and bear larger and greener leaves. The leaves may also remain green longer than those of unaffected plants. Owing to this fact diseased plants can sometimes be distinguished at a distance from healthy plants growing in the same field.

The intensity of the disease varies somewhat with the season. In certain localities with a light dry soil, the disease in dry seasons has been noted to be almost absent. The soil, however, remains infected, and if a wet season follows Wart Disease appears again as badly as ever.

Except in its very early stages, when it can only be discovered with the aid of a microscope, the disease can easily be detected, and can hardly be confused with any other potato disease. The similar warty outgrowth which appears in Hollyhocks, Loganberries and some other plants is not due to Wart disease, but to a disease known as Crown Gall (*see* Leaflet No. 245), and is probably brought about by the presence of a bacterium. The disease known as Finger-and-Toe (*see* Leaflet No. 77), which attacks turnip and other cruciferous plants and produces an appearance somewhat similar to Wart Disease, is due to a microscopic organism, *Plasmodiophora brassicæ*, Wor.

Life History of the Fungus.—In its earliest stages the fungus which causes Wart Disease exists in the cells of the potato as minute masses of living matter, without any of the mycelium usually associated in the popular mind with a fungus. The parasite lives in the cells just beneath the skin, and stimulates these to active sub-division, and thus to the production of warts. During the growing season the disease is said to be spread by means of summer spores, from which numerous motile *zoospores* escape and penetrate still healthy potato tissue. Later on, this stage is replaced by a winter or resting stage. The resting-spores are encased in a hard, resistant wall, and, on decay of the diseased tubers, pass into the soil and may remain there, in that form or in some other stage not yet discovered, with undiminished vitality for many years. On germination the resting-spores are known to give rise to numerous actively motile *zoospores*, similar to those arising from the summer spores, and these infect fresh potato tubers and so spread the disease to succeeding crops.

The exact length of time that the resting spores remain alive is not known. In a dry state they probably lose their vitality sooner than if left in the ground. In the soil the fungus is known to live for several years, and several well-authenticated cases have occurred in which the disease has re-appeared after an interval of eight years.

Spread of Disease.—Although the disease is extremely persistent when once established in the soil, and is capable of renewed activity even after the lapse of many years, it spreads very slowly and only by five direct methods.

(1) The spores of the fungus may be carried through the soil by the natural drainage of the water. The progress under these conditions is extremely slow.

Experiments carried on two years in succession and by different tests gave the same result, viz., that the normal rate of progress on level ground is nine inches a year. On a slope the progress may be as much as 28 inches, but always on the lower side. Infection does not travel uphill.

This result is supported by the fact that, even in some of the most seriously infected districts in England one spot may be incapable of producing healthy potatoes except those of the immune varieties, while another spot a few yards away, not separated by any natural obstacle, may be quite uninfected.

(2) Disease may be spread by infected potatoes or haulms. It is in this way that a great deal of the disease at present in England and Wales has been brought about. Growers have, of course, very seldom, if ever, deliberately planted potatoes visibly diseased. Instead of burning diseased haulms and tubers, careless growers, however, have frequently thrown them into a corner to rot, or even on to adjoining allotments or gardens, where they have infected the soil. Several cases of disease have been definitely traced to this practice. It is now made compulsory in England and Wales, under a penalty of ten pounds, to burn all haulms and roots of diseased plants, and, unless they are burnt, to boil thoroughly all infected tubers. Either process destroys the spores. A few cases have, however, occurred in which seed tubers, apparently sound when planted, have yielded a diseased crop. This suggests that late formed potatoes, which, being smaller, are those generally selected for seed, may contain spores of the fungus without showing any external signs of disease. Growers, therefore, should be careful where they buy seed potatoes of susceptible varieties.

(3) Many growers have been in the habit of throwing diseased potatoes and the peelings of diseased potatoes on the manure heap, or of feeding them unboiled to pigs or other live stock. In the latter case the spores pass through the animal's body uninjured, and if the manure is applied to land infection is conveyed directly to the plant in a manner very favourable to the spread of disease as soon as potatoes are planted in such land, though it may be some years afterwards.

(4) Disease may be carried on the boots of persons walking over infected soil, or on the wheels of carts passing over infected fields. It might also be conveyed in the earth clinging to plants other than potato plants, or to spades or other implements.

(5) Disease might be carried by birds or other animals feeding on land from which a diseased crop has been lifted.

These instances illustrate all the known ways of spreading the disease. It is obvious that since the spores are inside the potato or in the soil, disease cannot be spread by the wind, as in the case of the common potato disease (*Phytophthora infestans*), though it is possible that, on very light land, soil containing spores may occasionally be lifted and transported in the form of dust by a high wind.

Distribution of the Disease in England and Wales.—Although Wart Disease did not attract much attention until within recent years, it has now gained world-wide notoriety on account of the restrictions imposed on the exportation of English potatoes to foreign countries and to British Dominions. The first scientific description appearing in English was published by Professor Potter of the Armstrong College, Newcastle-upon-Tyne, in the *Journal of the Board of Agriculture* for December, 1902. It was there identified with a potato disease described by Schilbersky in Hungary. It was afterwards investigated by Professor Percival of the University College, Reading, who suggested that it should properly be called *Synchytrium endobioticum*, instead of *Chrysophlyctis endobiotica*, the name given by Schilbersky. It has since been investigated by many scientific writers, who have worked out the life history of the fungus more completely. Many investigations and experiments have also been made by the Board of Agriculture and Fisheries, while Mr. Malthouse of the Harper Adams Agricultural College, Newport, Salop, has made a special study of the subject and contributed much to our knowledge of the disease and of the varieties of potatoes which are found to be immune from it.

In spite of the fact that the disease was not described in England till 1902, there is no doubt whatever that it was common in many places for at least fifteen years before that date, and probably for much longer. In one district—where the disease has since almost entirely disappeared—the Board's officers have been assured that it was known fifty years ago, and there is abundant evidence that most of the districts now badly affected have been attacked since the childhood of the present generation.

It is a peculiarity of Wart Disease that it is largely confined to the industrial districts of England and Wales. It is known to exist in its greatest intensity in the neighbourhood of Manchester and Birmingham, and is common in the mining towns and villages of South Lancashire, Staffordshire, Glamorgan, Derbyshire, and West Nottinghamshire. It is also found in the manufacturing districts of Cheshire, North Worcestershire and the West Riding of Yorkshire. among the quarries of Cumberland, Carnarvonshire and Leicestershire, and in a few spots on the outskirts of London, Bristol, Swindon, Lincoln and other important manufacturing towns.

Fig 1.

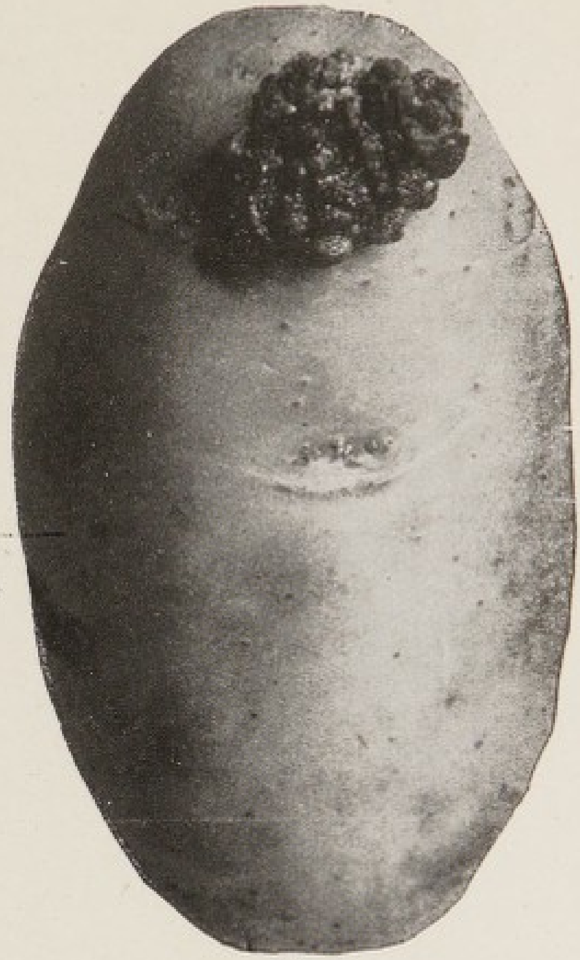


Fig. 2.

Fig. 3.

WART DISEASE OF POTATOES.

Fig. 1.—Affected stem. Fig. 2.—Tuber slightly attacked. Fig. 3.—Tuber badly attacked.

The disease is not confined to cottage gardens and allotments, and a considerable number of fields, especially in the area lying between Carlisle and Birmingham are infected. In a few badly affected districts there are some farms on which the potato plants, unless they are of the immune varieties, are usually diseased, but these farms have been for many years past cropped either with potatoes continuously or on a very short rotation. Outside the districts in question

Fig. 4.—Tuber badly attacked by Wart Disease and commencing to decompose.

disease exists on a number of farms, but the infection is generally confined to such parts of fields as the spots where he pits were made or the neighbourhood of the road.

Remedial Measures.—The only successful method at present known of keeping the disease in check is by restricting cultivation to varieties which resist the attacks of the fungus. A selection of the best of these varieties is given below.

Many experiments have been made with fungicides of all kinds. Lime and sulphur, either separately or mixed in various proportions, have been tried. Soot, sulphate of copper, formalin, potassium permanganate, copper arsenate, ammonium sulpho-cyanide, calcium hypochlorite, copper nitrate and many other fungicides have also been tried. But in no case did they meet with any success when the soil was seriously infected.

Deep cultivation has been tried. The ground has been dug three spits deep, the top layer being placed at the bottom, and covered by the other layers. It was unsuccessful in preventing disease.

Until quite recently Wart Disease was only known to attack the potato itself, but it has now been found to be capable of infecting also, though apparently only to a very small extent, the Woody Nightshade (*Solanum dulcamara*) and the Black Nightshade (*S. nigrum*). This fact should be borne in mind when attempts are being made to clear the ground of the Wart Disease fungus, and any specimens of these two weeds should be uprooted and burned. There is no record at present of any other Solanaceous plants being attacked by the fungus.

Resistant Varieties.--The trials carried out at Ormskirk by the Board of Agriculture and Fisheries during the past three years demonstrate beyond all doubt the absolute immunity, for the present at any rate, of certain varieties. Disappointment in the past as to resistant varieties has been due either to (*a*) wrongly named seed, or (*b*) to the presence of "rogues," or (*c*) to the use of varieties which, though formerly supposed to be immune, had not been properly tested on badly and uniformly infected soil. As far as is known the immunity of no variety which has been thoroughly tested has as yet broken down.

The following is a selection of some of the best immune varieties recommended by the Board of Agriculture and Fisheries for planting on infected land. A fuller list, with descriptions and notes as to culture, is given in Food Production Leaflet No. 21 (*Wart Disease of Potatoes: Reports on the Immunity Trials at Ormskirk in* 1915–16–17), copies of which may be obtained gratis and post free on application to the Board, 3, St. James's Square, London, S.W.1. It should be remembered that every year new varieties are tested by the Board, and that the list is subject to revision.

Early Varieties.—Edzell Blue, King George, Great Scot, Favourite.

Late Varieties.—Ally, Abundance, Golden Wonder, Lochar, Kerr's Pink, Irish Queen.

There are several variations of these types, details as to which are given in the Board's Annual List.

Wart Disease of Potatoes Order of 1918.—Wart Disease of Potatoes (*Synchytrium endobioticum*) has been scheduled as a notifiable disease under the Destructive Insects and Pests Acts, 1877 and 1907, and all occupiers of land on which the disease occurs must at once report its appearance to the Board, or to an Inspector of the Board or of the Local Authority. In reporting an outbreak occupiers must state their names in full and their postal addresses. It is illegal to sell or offer for sale for any purpose potatoes which are visibly affected with Wart Disease.

Apart from exceptional cases, only approved immune varieties of potatoes may be planted within an area which is an "Infected Area" for the purposes of the above Order, or in land to which the provisions of the Order relating to Infected Areas apply. A list of approved immune varieties can be obtained from the Board on application.

It is an offence under the Order to sell or purchase or use potatoes grown in any area or land mentioned in the preceding paragraph for planting in land not in an infected area or not affected by the Order.

Approved immune varieties of potatoes may not be sold for planting, except to a dealer in seed pototoes, unless the seller has a licence granted by the Board, and growers should, before purchasing seed potatoes of such varieties, ascertain whether the vendor has received the requisite licence.

Any contravention of Orders dealing with this disease renders the person offending liable on conviction to a penalty not exceeding Ten Pounds.

London, S.W.1,
April, 1904.
Revised, July, 1918.

Copies of this leaflet may be obtained free of charge and post free on application to the Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

Fertilisers for Market Garden Crops.

This Leaflet has been temporarily withdrawn.

Leaflet No. 107.

BOARD OF AGRICULTURE AND FISHERIES.

The Mussel Scale (*Mytilaspis pomorum*, Bouché).

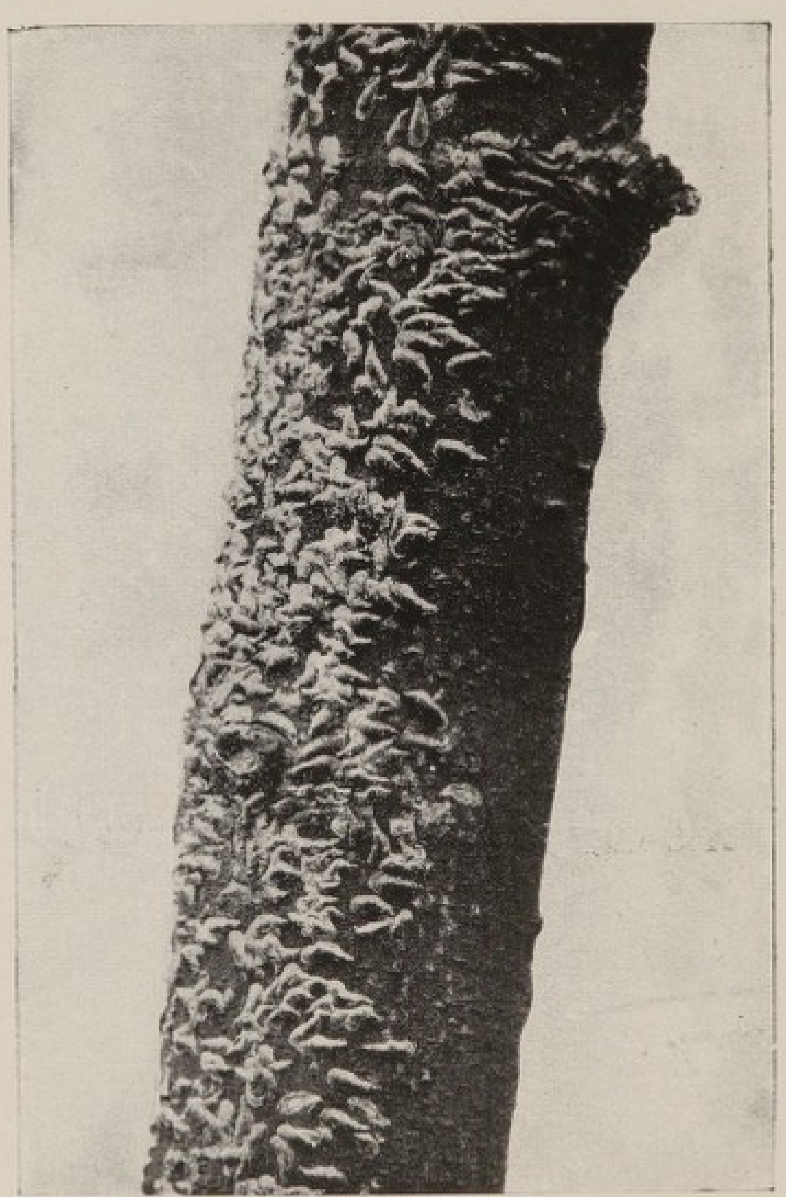


FIG. 1.—Piece of Branch infected with Mussel Scale.
(Twice natural size.)

The Mussel Scale is one of the most abundant scale insects in the British Isles ; it also occurs on the Continent of Europe, in North America, South Africa, Australia and New Zealand, having been introduced into the three latter countries on infested nursery stock. As a pest the insect is most conspicuous in neglected apple orchards, but it is always present on apple and certain other trees in all the fruit-growing districts in the kingdom, and wherever it is allowed to increase unchecked is likely to cause serious damage. In America it is regarded as an insect of considerable importance to apple growers and is there known as the Oyster Shell Scale from its resemblance in shape to American oysters.

Description and Life-History.—The Mussel Scale lives on the stem and branches, and occasionally on the leaves and fruit of the plants, such as the apple, which it attacks. If a branch infested by this insect be examined, it will be found that the surface of the bark is more or less covered by small brown objects (Fig. 1) about $\frac{1}{8}$ inch in length, which are shaped somewhat like a mussel shell. Each mussel-like scale forms a roof or covering over the living insect during the summer, and over its eggs in winter.

Life-History.—The winter is spent in the egg stage, the eggs—exceedingly minute and like a whitish dust—lying underneath the scales. At the end of May or early in June very small wingless, louse-like insects (larvæ) are hatched from the eggs and crawl from under the scale on to the bark of the tree, where they wander about for three or four days, and may during

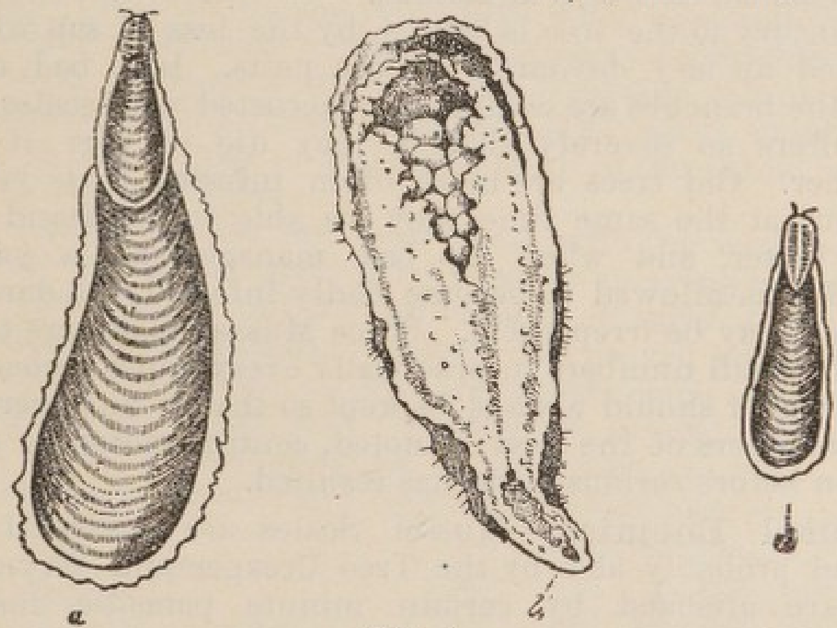


FIG. 2.
a. Female Mussel Scale, dorsal view ; *b.* The same, ventral view ; *c.* Male scale.

this period be carried to other trees by means of the wind or by clinging to birds and insects. When one of these "lice" (larvæ) reaches a suitable spot, it drives its "trunk" (or proboscis) into the bark and begins to feed by sucking up the sap—just like a Green Fly or a Capsid Bug. Unlike either of the latter pests, however, it soon loses all power of movement and remains fixed to the bark into which its trunk is buried. As it grows it forms the scale under which it lives, building up the scale in such a way that the insect itself is always completely covered (Fig. 2).

In the case of the Mussel Scale, the insects are practically all females, and when they become adult towards the end of summer they lay eggs (as a rule without the intervention of a male) under the scale, continuing until there may be as many as 80 eggs under one scale. The female then dies and the eggs remain in safety under the scale during the winter. Mussel Scale insects of the male sex do occur, but they are very rare on fruit trees. When young, the males, like the females, live under scales, but the male scales are somewhat different, being straighter and not so large (Fig. 2c). Under the scale the young male passes through a pupal (chrysalis) stage, and on becoming adult emerges as a minute fly-like insect with two wings. The males pair with the females and soon die, having no mouth parts for feeding.

Plants attacked and Nature of Injury.—Mussel Scales are injurious to apples, and less frequently to pears and currants (both black and red). The insects also attack sallow, hawthorn, broom, and other plants. Trees growing against walls suffer more than others, as the pests flourish most in warm, sheltered situations.

The injury to the tree is caused by the loss of sap which is sucked up and devoured by the pests. In a bad case, where the branches are completely encrusted with scales, the tree suffers so severely that it may die in part if not altogether. Old trees are more often infested than young trees, but at the same time they are able to withstand the attack better, and when by bad management, a young plantation is allowed to become badly infested, the damage sustained may be irreparable. Since Mussel Scales are to be found in small numbers in practically every apple orchard, a careful watch should always be kept so that if any increase in the numbers of the pest is noted, control measures may be taken before serious harm has resulted.

Natural Enemies.—Mussel Scales are devoured by Tits and probably also by the Tree Creeper and Wryneck. They are attacked by certain minute parasitic insects (Chalcids) which, however. are not a sufficient check on the pest to render artificial measures of control unnecessary.

Control Measures.—(1.) In the case of a bad attack, the trees or bushes should be sprayed when dormant (November to February) either with an oil emulsion or with Woburn wash (*see* Leaflet No. 70). There are now on the market several makes of oil which mix (or form an emulsion) with water, and if used they should be diluted in the proportions recommended by the makers for a winter wash. A home-made emulsion for winter use may be mixed as follows :—

Paraffin oil	1 gall.
Soft soap	$1\frac{1}{2}$-2 lb.
Water	10 gall.

The soap is first dissolved in about a gallon of boiling water. The soap solution is then removed from the fire, and the paraffin is at once added, the whole being well mixed by squirting the liquid back into itself with a hand syringe. The strong emulsion may be kept until required for use, when the remaining nine gallons of water should be added and the whole thoroughly stirred—or better, mixed as before with the hand syringe.

Oil emulsions, whether bought or home-made, must be applied carefully so as to wet every portion of the tree, not forgetting the undersides of the large branches. The eggs under the scales will be killed only where the scales themselves are thoroughly wetted, and if a few escape the trees will be re-infested.

(2.) In America good results have been obtained by the use of lime-sulphur washes, and although in England lime-sulphur has proved rather disappointing in the case of bad infestations, it will probably be found satisfactory in keeping moderate or slight attacks in check. Lime-sulphur should be bought ready made, and be diluted when required for use (not before) with water in the proportions recommended by the makers to form a winter wash (usually 3 quarts of lime-sulphur to 10 gallons of water). The wash should be applied in late winter or early spring up to the period when the buds begin to open.

(3.) If the pest has not been dealt with in winter—the best time—it may be greatly reduced by spraying when the eggs are hatching, about the end of May or early June. At this period a weak paraffin emulsion has proved satisfactory, and probably any other contact insecticide, such as nicotine and soap, would do as well. A suitable paraffin emulsion may be made as recommended in paragraph (1) above, but using the ingredients in the following proportions :—

Paraffin	2 pts.
Soft soap	1 lb.
Water	10 gall.

(4.) Growers when buying fruit trees, especially apple, should examine them for Mussel Scale (and also such pests as Woolly Aphis) before making a purchase.

(5.) It is better to prevent attacks by occasional winter washing than to wait until it has become necessary to deal with a serious infestation, and in this connection it is worth noting that trees which are regularly sprayed and kept free from moss, lichen, &c., seldom suffer from Mussel Scale, even though the washes used have not been specially directed against Scale.

London, S.W.1,
June, 1904,
Rewritten, February, 1919.

BOARD OF AGRICULTURE AND FISHERIES.

Epizootic Abortion in Cattle, or Slipping Calf.

This disease may be defined as a contagious disease affecting chiefly the pregnant womb and caused by the bacillus of cattle abortion. It usually, though not always, results in the immature calf being slipped.

Animals affected.—The disease is essentially a disease of cattle, but the other domesticated animals, such as the mare, the ewe, the goat, and the bitch, can be experimentally infected, and it is probable that they very occasionally contract the disease by natural infection owing to gross carelessness in the disposal of infected material from aborting cows.

The Microbe.—The microbe is a very small bacillus which may assume either an oval or a rod shape. In the discharges, and in material taken from the after-birth of an aborting cow, the microbes are often found in characteristic clumps consisting of many bacilli, and these clumps are so typical in appearance that their presence in such materials enables the disease to be diagnosed with great certainty. The bacilli can be stained with any of the aniline dyes.

Virulent Material and Methods of Infection.—The contents of the infected womb, that is to say, the immature calf, its membranes, and the discharge which the microbe has caused to appear on the lining inside the organ, are all infective. In many cases the microbes are also very plentiful in the stomach and intestines of the calf. The milk may also contain the bacilli. The infected animals, however, are not really dangerous to others until they begin to discharge the contents of the womb, but once these are discharged, they may soil the food and water supply. They may also be brought in contact with the genital organs of other animals by the latter lying on soiled litter or dipping their tails into the gutter which is so frequently to be found in cow-sheds behind the stalls. The infected material may be carried some distance by dogs and foxes. It may also be carried on the hands and the boots of attendants. If the animal aborts at a very late stage of pregnancy, and the calf is born alive, it may carry infection to another establishment owing to infective material which is in its intestines. It is particularly to be noted that unless the infective material is disinfected it may preserve its power of infecting for several months. The most common and the most important way whereby infective material is carried from one establishment to another is through the agency of affected in-calf cows and cows which have recently aborted, and are still discharging. The former by slipping calf may infect the new premises. An animal on infected premises may, although infected, calve at full time. Such cows are very dangerous, because they escape suspicion.

As regards the methods of infection, recent inquiry shows that infection of the pregnant womb is readily brought about if infective material be taken in by the mouth, and that this is the most important way in which natural infection takes place. The pregnant animals, therefore, can become infected by eating grass at pasture, or other food stuffs, or by drinking water, soiled by the discharge from an infected animal. Infection can also take place owing to infective material gaining entrance to the genital organs, but this method is not of so much importance in practice as infection by way of the mouth.

With regard to the bull as a source of infection, it is possible that if a bull serves a clean cow a very short time after having served an animal which has very recently aborted it may infect the former. Under the ordinary conditions of farming, however, it is seldom that an animal which has aborted goes to the bull for a month or more after the act of abortion. By this time the discharge has usually ceased, so that the bull does not run a great risk of becoming contaminated. Moreover, except in cases where a bull is under no responsible supervision and promiscuously serves a large number of cows whose owners have no particular interest in their health, it is comparatively seldom that the bull will have the opportunity of serving a clean cow immediately after it has served one which has recently aborted. The bull, then, cannot be regarded as a carrying agent of the first importance, but admittedly plays a part in the spread of abortion, and infection in this way must be guarded against.

It is to be noted that the great majority of animals, at least, acquire a considerable degree of resistance to the disease after one attack, but a proportion of them fail, owing to some defect in their system, to acquire this immunity, and they may abort more than once.

Symptoms.—No symptoms immediately follow infection, but the disease runs an insidious chronic course, and, given an infected herd, one can never be sure which animal will carry its calf to full time. Some animals may abort a little more than a month after infection, but the majority do not do so until three or four months afterwards. Indeed, an infected animal may sometimes carry its calf practically to full time, and give birth to it alive. When this happens it may usually be concluded that the animal contracted the affection at a late stage of pregnancy. When a cow aborts in the first, second, or even third month of pregnancy, the slipped calf is often expelled completely enclosed in the membranes. At later stages the membranes are frequently retained after the calf has been expelled.

Warning symptoms are more likely to be observed in animals which abort after the third month of pregnancy. These warning symptoms may last one or two days or only a few hours. A discharge from the genital organs precedes the act of abortion, it may even be by one or two days. Usually, however, the discharge does not appear until immediately before the act. The discharge generally lasts for about a month after the act or somewhat less. At first only a little blood-tinged material is observed, but later the discharge is rather typical in appearance, and in the ordinary way is a good aid to diagnosis. Its colour is usually distinctly yellow, but it may be very dark brown. The more fluid parts are like pus, but clotted masses of the material are also frequently thrown out. They can be seen soiling the root of the tail or on the floor behind the animal. The condition of the udder often furnishes a valuable symptom of approaching abortion. The gland becomes somewhat swollen, and the animal is said to be making a bag before time. The gland may even become suddenly and prematurely active when an animal is about to abort in the later stages of pregnancy. The commonest period for abortion is in the sixth or seventh month of pregnancy.

Prevention.—Since abortion is spread chiefly through the agency of cows which have recently aborted and those which are pregnant and infected, it is of great importance, even though the latter have not yet aborted, to keep them away from other pregnant cows.

Although the bull, as recent enquiry shows, cannot be considered of the first importance in spreading abortion, it would be wrong to disregard it altogether as a means of spreading disease. The danger from the bull arises where it promiscuously serves a large number of cows and is not under responsible supervision. When contagious abortion is prevalent among the animals belonging to owners who make use of this class of bull it would be well for those with clean herds not to send their cows to such a bull unless effective measures have been taken to prevent any cows which have recently aborted being sent to it for service. In fact, it will always be well not to send a cow to any bull on premises where contagious abortion exists, unless a reliable guarantee can be obtained that the bull has not been used for the service of cows which have aborted recently.

If, however, it be impossible to avoid sending cows to a bull which comes in contact with animals which have aborted, it should be a rule that the genital organs of the male be thoroughly washed with an antiseptic solution (such as corrosive sublimate 1—2,000) some little time before it serves, unless an assurance be given that it has been disinfected immediately after a service which might have infected it. Similarly, owners of cows which have recently aborted should not send them to a bull which is being used for clean cows, or should only do so after they have been disinfected.

It has already been mentioned that an infected cow is not really dangerous until it begins to discharge the contents of the uterus, and that the first symptoms of abortion frequently show themselves before the act takes place. On every establishment where breeding cows are kept these warning symptoms should always be carefully looked for, and should they be observed, the animal concerned should be removed immediately to a special shed. The stall and the immediate surroundings should at once be disinfected with a liberal quantity of quicklime or other disinfectant. Should an animal abort before such measures can be taken it should, nevertheless, be removed from the other pregnant animals, and every part of the building with which the discharges have come in contact (these would be mainly the flooring, gutter, and stall) should be immediately disinfected. Everything which comes from an aborting cow should be destroyed, and everything which has been used for lifting or carrying the material (barrows, spades, forks, &c.) should be thoroughly disinfected. The best way to destroy the material from an aborting animal is to burn it, but if this cannot be carried out, it should be put in a pit 4 ft. deep and completely covered three or four inches deep with quicklime. After this has been done the lime should be quickly slaked by pouring very hot water into the pit, and immediately the lime has absorbed the water the pit should be filled in with earth, so as to cause the heat from slaking to be retained for some time. In using quicklime as a disinfectant for material on floors, &c., a large quantity should be employed, not less than four times the bulk of the material upon which it is to act. It should be well mixed with this material, and then slaked with water as hot as possible, the object being to get a sufficient amount of heat developed during the slaking process to destroy the infective material. For general disinfecting purposes (for implements) a 3 per cent. solution of carbolic acid, or a 1 in 2,000 solution of corrosive sublimate, may be usefully employed. Infected litter should be removed from the cowshed, soaked in paraffin and burned, for if this contaminated material is not disinfected it may drain on to food or litter or into drinking water.

So long as there is any discharge from the genital organs of an animal which has aborted the genital passages should be syringed out twice a day with a mild antiseptic solution, (3 per cent. solution of carbolic acid or corrosive sublimate 1—2,000, or permanganate of potash 1—1,000), and the flooring behind the animal should be disinfected at least once daily. When the heavy discharge has ceased it is a good plan, in addition to douching the vagina, to insert a pessary of cocoa butter and corrosive sublimate, 1—2,000, well up the passage twice weekly for two weeks. A cow after aborting seldom discharges for more than a month. Such an animal should not be brought in contact with any pregnant females until the discharge has ceased; even if the latter appears to have ceased before a month is up, it will be well to keep the animal isolated for that period at least. It must be remembered also that a discharging animal should not be isolated on a pasture or in contact with a water supply because the discharges can infect the grass and water, and, as has already been pointed out, the infective material may retain its activity for months, and so be infective. When the isolation period is completed, it is advisable to wash at least the posterior half of the animal with soap and water followed by a disinfecting solution such as a 1 in 2,000 solution of corrosive sublimate before putting the cow back amongst its fellows. It is advisable to kill or isolate a calf which has been aborted alive, as it may distribute infection from its bowels.

No animal which has aborted should be sent to market or sold to another establishment until it has undergone the proper period of isolation, and been disinfected, otherwise it may carry infection elsewhere. With some farmers it is customary to get rid of animals which have aborted. It should be particularly noted, however, that most animals which have suffered from an attack of the disease are usually more resistant to it than those which have not, and that by keeping animals which have aborted one may be better enabled to get rid of recurring losses in infected herds, as immunised stock is much more useful for this purpose than new animals. In infected herds it is bad policy to dispose of good milkers or otherwise valuable cows simply because they have aborted, and it is erroneous to imagine that infection can be got rid of in this way. On the contrary, to sell off aborted animals one by one and to bring in new ones to replace them, is simply adding fresh fuel to the fire in place of material which in most cases has burned itself out. It is common experience that after abortion has run through a herd, say in about three to four years, the subsequent losses are confined almost entirely to the new animals brought in. It is also a common experience that the chief losses may occur in second calvers, that is to say, in those animals which pass the period of pregnancy for the first time inside the byres where infection is established. It may be mentioned that immunisation methods may be of considerable service in saving calves and hastening the production of herd immunity. It is also possible, in some cases, to stop further spread by testing for infection and isolating the infected animals. The Board are prepared to issue vaccine for use in infected herds, under certain conditions, for the inoculation of infected herds and to advise generally on methods. Applications should be made to the Chief Veterinary Officer, Board of Agriculture Laboratory, New Haw, Weybridge, Surrey.

London, S.W.1,
December, 1904.
Revised, March, 1919.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square,, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 109.

BOARD OF AGRICULTURE AND FISHERIES.

Cabbage Caterpillars.

The caterpillars which are so often destructive to cabbages, cauliflowers and similar vegetables, are usually those of White Butterflies (three kinds) or those of the Cabbage Moth. Frequently they are all present together and combine in rendering the crop worthless.

Plants attacked and Nature of Injury.

White Butterfly caterpillars attack all vegetables of the cabbage family, flowering plants such as stocks and, among weeds, Charlock and Shepherd's Purse—in fact almost any plant of the natural order *Cruciferæ* to which all the above mentioned belong. They are also very abundant on garden nasturtium (*Tropæolum*). When the caterpillars are exceptionally numerous and are reduced almost to starvation, they may attempt to subsist on many kinds of plant. "Cabbage White" caterpillars, for instance, have been noted as attacking onions, but this is exceptional and it is most improbable that the insects could live for long on such a food.

The caterpillars of the Cabbage Moth are more general feeders and will live upon plants of many kinds—both cultivated and wild. In addition to crops of the cabbage tribe, they have also attacked tomatoes, tobacco, lettuce, onions, maize, &c., and they are always troublesome to flowering plants in gardens.

The damage done to all crops, both by White Butterfly caterpillars and those of the Cabbage Moth, is similar. The leaves of the plant are eaten or skeletonised while, in the case of vegetables, the crop is also fouled by excrement. White Butterfly caterpillars perhaps feed more on the outer leaves of cabbages, while those of the Cabbage Moth burrow more into the hearts of the plants, where the results of their feeding are particularly objectionable.

Description and Life-History.

1. **White Butterflies.**—The most destructive species is the Cabbage White (*Pieris brassicae L.*), which is too familiar to need any description (Fig. 1). The butterflies first appear in spring and early summer and lay their eggs on the leaves of their various foodplants. These eggs are yellow in colour, oval and pointed at one end, and are laid in batches of 20 to 100, being quite conspicuous on the leaves. In about a fortnight the eggs are hatched and the young caterpillars remain together, forming a small colony. They feed continuously and grow rapidly, always showing a tendency to keep together, so that many caterpillars are usually found on one leaf (Fig. 2). The general colour of these caterpillars is dark bluish or greenish black with a yellow line down the back and

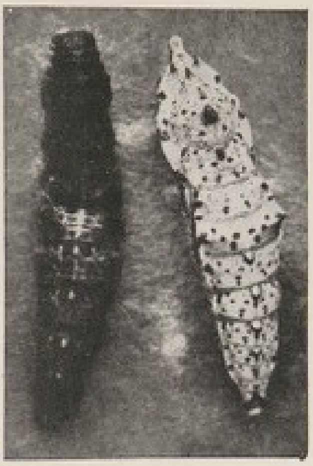


Photo. R. A. Malby.

FIG. 3.

Photo. R. A. Malby.

FIG. 4.

FIG. 3.—Caterpillar of Cabbage White Butterfly about to pupate and chrysalis of same.

FIG. 4.—Parasitized caterpillars of White Butterfly and cocoons of the parasite. (A parasite larva is just leaving the lower caterpillar.)

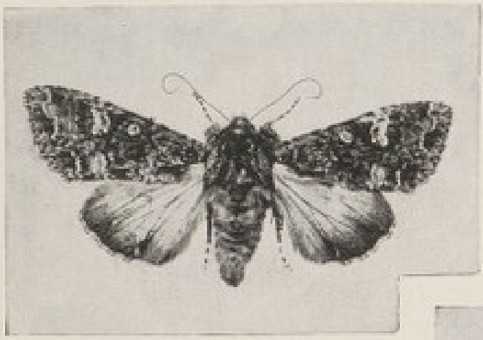
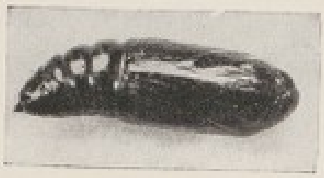


Photo. R. A. Malby.

Male.

(Almost natural size.)



Chrysalis.

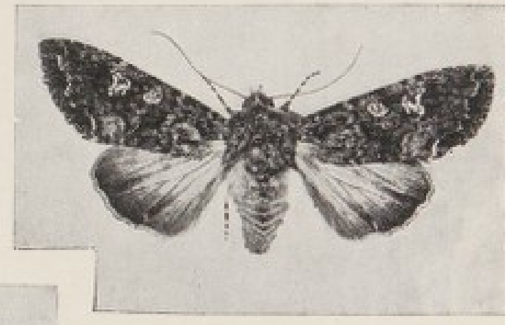


Photo. R. A. Malby.

Female.

(Almost natural size.)

FIG. 5.—Cabbage Moths (*Mamestra brassicæ L.*) and chrysalis of same.

Photo. B. Reid.

FIG. 6.—Caterpillars of Cabbage Moth.

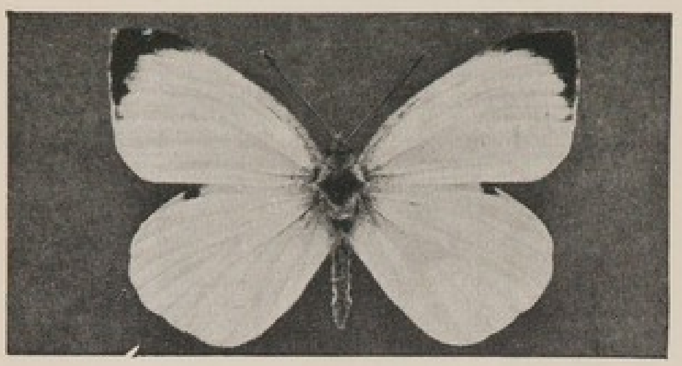


Photo. R. A. Malby.

Male.

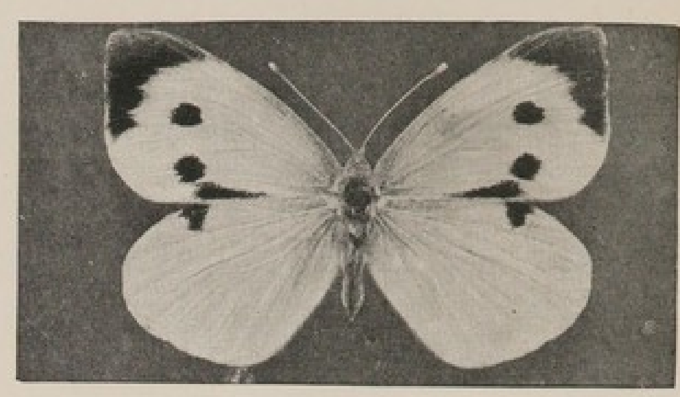


Photo. R. A. Malby.

Female.

FIG. 1.—Cabbage White Butterflies (*Pieris brassicæ L.*)
(About five-sixth natural size.)

Photo. R. A. Malby.

FIG. 2.—Caterpillars of Cabbage White Butterfly on a Cabbage leaf.

yellow along the sides, and they are rather thinly clothed with hairs. After feeding for about a month the caterpillars are full-fed and crawl away to turn to chrysalides, which are greyish or yellowish white in colour with black spots (Fig. 3). They are suspended by the tail and by a silk thread round the middle and are found in a variety of situations—fences, walls or trees in the neighbourhood of cabbage plots being often chosen. In about three weeks (that is to say at the end of July and in August, largely according to the weather) butterflies appear from the chrysalides, eggs are laid, and a further generation of caterpillars is produced. The caterpillars of this second brood feed through August and September and are responsible for very great damage, large areas of cabbage, etc., often being destroyed. In a very favourable season caterpillars may sometimes be found feeding through October into November, and it is possible there may be a partial third generation. As a rule, however, the chrysalides formed by the second brood of caterpillars remain in this stage until the following spring before giving rise to butterflies.

In company with the caterpillars of the Cabbage White Butterfly are often found those of the Small White (*P. rapae, L.*) and the Green-Veined White (*P. napi, L.*). The life-history of these species is similar to that of the Cabbage White. Their eggs are, however, laid singly and not in groups. The caterpillars of these species are green in general coloration and have a peculiar velvety appearance. There are several minor differences between the two species, among which may be mentioned the presence of a narrow yellow line down the back of the caterpillar of *P. napi* and its absence in *P. rapae.*

2. **The Cabbage Moth** (*Mamestra brassicae, L.*) —Cabbage Moths are dingy greyish brown in colour with white markings and have the general appearance shown by Fig. 5. They appear towards the end of May and in June, but since they fly only at night they are not often seen, though occasional specimens may be found at rest on palings, tree trunks, or in sheds. Eggs, which are globular in shape, are laid singly on any of their numerous foodplants and from these eggs are hatched small light green caterpillars which feed voraciously on the leaves of the plant. As these cater pillars become older their coloration varies greatly. They may remain light-green as when young, or they may become brown, dark-green, or even black as regards the upper surface, the legs and under surface varying from greenish to yellowish (Fig. 6). The caterpillars feed for a month or five weeks and when full-grown—about 1¼ inches in length—they crawl down to the soil into which they burrow, and become shining brown chrysalides (Fig. 5). These chrysalides frequently produce moths during the latter half of summer, which again give rise to a further brood of caterpillars. Caterpillars may be found feeding up to October and, in

exceptional instances, on into the winter. Generally, however, some of the chrysalides of the first brood and probably almost all of the second remain as such during the winter and produce moths in the following summer. It is difficult, however, to distinguish the different broods as there is much overlapping, and moths may be found practically from May to September and caterpillars from June to October.

The caterpillars of the Cabbage Moth are often confused with those of the White Butterflies. Owing to their variation it is difficult to give colour differences, but the caterpillars of the moth may be known by the smoothness of the surface and comparative lack of hairs. They have not the velvety appearance of the Small and Green-Veined White caterpillars nor the somewhat conspicuous hairs of the Cabbage White Butterfly.

Natural Enemies.

White Butterflies and the Cabbage Moth are subject to the attacks of various insect parasites and this is notably the case with regard to the former. Caterpillars of the Cabbage White, when full-fed or turning to chrysalides, are frequently noticed with a large number of little yellow cocoons near them, the caterpillars themselves being dying or dead (Fig. 4). These cocoons are made by the larvæ of a small parasite (*Apanteles glomeratus*) which have fed within the body of the caterpillar, and ultimately brought about its destruction. A mistake often made is to suppose that the parasite cocoons are "caterpillar eggs" and they are in consequence destroyed. Caterpillars of course cannot lay eggs. The parasite cocoons should always be left undisturbed since they will produce allies of the greatest value in checking the ravages of White Butterflies.

Methods of Control.

1. **Handpicking.**—In *small* gardens handpicking should not be despised—in a normal year the pests can be kept under control by this measure alone. During the periods when White Butterflies are seen on the wing in some number, crops liable to attack should be examined about once every 7 to 10 days, and all clusters of eggs, and also single eggs, should be crushed. It is more simple to deal with the eggs than with the caterpillars. If any eggs are missed, small holes will be noticed in the leaves and a search should at once be made for the young caterpillars, which can then be destroyed before the plants have been reduced to skeletons. In the case of the Cabbage Moth searching is less easy, though some can find the eggs without difficulty. The caterpillars also are not difficult to pick off when young. Later, if they have burrowed into the heart of a cabbage they are, of course, inaccessible.

2. **Spraying.**—Since it is better not to use a poisonous spray on green vegetables, the usual caterpillar poisons are not available, and it is necessary to depend on less efficient insecticides which, nevertheless, can be quite satisfactory if applied thoroughly while the caterpillars are still young. The number of sprayings required can only be found by observation. The first spray should be applied as soon as the earliest signs of attack appear, subsequent washings being given if further feeding is observed. In spraying against the caterpillars the work must be done very thoroughly so that the plants are drenched. Further, it is no use waiting in the hope that the attack may not be serious, for by the time it is possible to be certain the caterpillars will be too large to deal with easily. The following simple solutions have been used with success :—

(*a*)	Soap	$1\frac{1}{2}$–2 oz.
	Water	1 gallon.

If the water is hard, up to 2 oz. of soap will be needed to each gallon of water ; with soft water $1\frac{1}{2}$ oz. will usually be enough. The solution should give a good "lather." Disinfectant soaps, perhaps, give better results than ordinary soft or bar soap, but they vary in strength and should be tested on a few plants first to see that no injury is done.

(*b*)	Common salt	2 oz.
	Water	1 gallon.

This is a solution which has long been in use and seems often to have given good results, though failures have also been reported.

If the above simple solutions do not prove sufficiently effective, the following suggestions may be considered. Naphthalene emulsion, which may be bought from insecticide makers, is recommended in India in connection with similar problems, and is worth a full trial in this country. Reports have also been received of the successful use of hot water (temperature about 130° Fahr.) without the addition of any insecticide. The water must be applied by means of a watering can—if sprayed on the temparature will probably fall too rapidly for successful results to be obtained.

3. **Dusting.**—Slaked lime in powder or lime and soot are sometimes dusted on the plants when damp. There are also proprietary powder insecticides which are said to have proved effective.

4. Fences, etc., surrounding allotments should be searched for the chrysalides of White Butterflies, which are usually seen without difficulty. When the ground is dug a look-out should be kept for the shining brown chrysalides of the Cabbage Moth, which should also be destroyed.

London, S.W.1,
October, 1904.
Re-written, February, 1919.

Leaflet No. 110.

BOARD OF AGRICULTURE AND FISHERIES.

Carriage of Goods by Rail at Owner's Risk Rates.

Owner's risk rates are rates made by special contract, under the provisions of Section 7 of the Railway and Canal Traffic Act, 1854. They are generally lower than the ordinary rates, and in consideration of the reduction in the rate, the contract, which must be signed by the trader, and is only enforceable at law if its conditions are held to be just and reasonable, relieves the railway companies from their ordinary liability as carriers, except in the case of the wilful misconduct of their servants. Sometimes the consideration for the contract is not a reduction in rate, but the acceptance unpacked of goods liable to breakage or damage.

Traders have frequently complained that the terms of the existing contract pressed unduly upon them, and the subject came before the Railway Conference in 1908 for consideration. The Railway Conference, on which the Board of Agriculture and Fisheries were represented, was constituted by the Board of Trade, with the object of reviewing some of the more important questions that are raised from time to time between the railway companies on the one hand and the traders and general public on the other.

The grievances put forward on the part of the traders were mainly twofold :—(1) that the companies ought not only to be liable for wilful misconduct, which was difficult of proof, but should also pay compensation in extreme cases in which, for example, loss or damage was occasioned by the grosser forms of negligence on the part of the companies' servants; and (2) that owing to the lowness of the owner's risk rates as compared with the corresponding company's risk rates, they are the only rates commercially possible for the ordinary trader.

The answer of the railway companies was that the reduced rates at owner's risk are a concession to the trader, and are the subject of a purely voluntary contract between the parties, which is almost invariably based upon other considerations as well as that of risk, and that it is always open to a trader to have his goods carried subject to conditions applicable to railway carriers at a rate within the company's statutory maxima, and that these had been recently settled by the Acts of 1891 and 1892.

The subject was fully discussed at the Conference, and certain amendments were suggested and it was ascertained that with a view of settling this controversy railway companies generally were willing to adopt these suggestions.

The Board of Trade have since been informed that the English and Scottish railway companies adopted as from January 1st, 1910, the recommendations made by the Conference.

The amendments are as follows :—

I.—*Goods carried in Merchandise Trains.* — The following addition to be embodied in the present consignment note for goods to be carried at owner's risk in merchandise trains, after the words "wilful misconduct of the Company's servants," viz. :—

But nothing in this agreement shall exempt the Company from any liability they would otherwise incur in the following cases of non-delivery, pilferage or mis-delivery except on proof that such non-delivery, pilferage or mis-delivery has not been caused by negligence or misconduct on the part of the Company or their servants.

1. Non-delivery of any package or consignment fully and properly addressed, unless such non-delivery is due to fire or accidents to trains.

2. Pilferage from packages of goods protected otherwise than by paper or other packing readily removable by hand, provided the pilferage is pointed out to a servant of the Company on or before delivery.

3. Mis-delivery where goods fully and properly addressed are not tendered to the consignee within twenty-eight days after despatch.

II. — *Perishable Merchandise carried in Passenger Trains* (*other than Milk in Cans*).—The following addition to be embodied in the consignment note for perishable and other merchandise (other than milk in cans), carried at owner's risk in passenger trains, after the words "wilful misconduct of the Company's servants," viz. :—

But nothing in this agreement shall exempt the Company in the case of perishable merchandise as defined by the Railway Rates and Charges Order Confirmation Acts, 1891–92 (other than milk in cans), from any liability they would otherwise incur in the following cases of non-delivery, pilferage or delay, except on proof that such non-delivery, pilferage or delay has not been caused by negligence or misconduct on the part of the Company or their servants.

1. Non-delivery of any package or consignment, fully and properly addressed, unless such non-delivery is due to fire or accidents to train.

2. Pilferage from packages of goods protected otherwise than by paper or other packing readily removable by hand, provided the pilferage is pointed out to a servant of the Company on or before delivery.

3. Delay in transit exceeding forty-eight hours of any package or consignment, fully and properly addressed, as a result of which the value of the goods is deteriorated to the extent of three-fourths, if such deterioration is pointed out to a servant of the Company on or before delivery. Provided that in such case the Company's liability shall not exceed one-half the diminution in value of the goods.

III.—*Milk in Cans carried in Passenger Trains.*—The following modification to be embodied in the conditions of carriage for milk in cans carried at owner's risk by passenger train, viz. :—

Except in the case of milk carried oversea nothing in this agreement shall exempt the Company from any liability they would otherwise incur in the following cases of loss or delay, except on proof that such loss or delay has not been caused by negligence or misconduct on the part of the Company or their servants.

1. Loss of milk through non-arrival at the station to which it was consigned of a can fully and properly addressed, unless such non-arrival is due to fire or accidents to trains.

2. Delay in transit exceeding twenty-four hours to the station to which it was consigned of milk in cans fully and properly addressed, as a result of which the value of the milk is deteriorated to the extent of three-fourths, if such deterioration is pointed out to a servant of the Company on or before receipt by the consignee. Provided that in such case the Company's liability shall not exceed one-half of the diminution in value of the milk.

Carriage of Milk by Rail in Sealed Churns.—Attention is drawn to the fact that, according to information furnished to the Board by the Railway Companies Association, milk cans with lids sealed or otherwise fastened are conveyed by the Railway Companies at the same rates as are charged for milk in cans not sealed or otherwise fastened, provided the tare weight is stamped on the outside of the cans.

The Companies will in such cases accept the declaration of the senders as to the quantity contained in the can. They reserve to themselves the right to open the can to ascertain that the quantity contained therein agrees with the quantity declared, but this reservation is only intended as a protection against fraud and a can would only be opened in a case where there was reasonable ground for believing that it contained a greater quantity of milk than had been invoiced.

It is, therefore, open to farmers to protect themselves against loss or other interference with milk while in transit by sealing or otherwise fastening their cans.

London S.W.1,
May, 1910.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 111.

BOARD OF AGRICULTURE AND FISHERIES.

INCREASING PROFITS FROM EGGS.

Value of Co-operative Selling.

£9,500,000 spent in Foreign Eggs in 1913.—The people of this country paid the enormous sum of £9,500,000 in the year 1913 for imported eggs. There is no reason why the greater part of this money should not have been spent in the purchase of eggs produced at home. One of the best means of encouraging the increased production of eggs is to form Co-operative Egg and Poultry Societies.

The Co-operative Societies.—In a district where a Co-operative Egg Society is established, increased prices may reasonably be expected for eggs graded by the society. Poultry keepers, therefore, should at once combine and establish, in their own interests, local societies of this character. As an example of what a Co-operative Society may do to stimulate production it may be said that one of the most successful societies sold over 8,000,000 eggs in 1916.

How to Form such a Society.—The first step should be to obtain the advice of the Agricultural Organisation Society, Queen Anne's Chambers, Westminster, S.W., who will give all necessary assistance. The next step is to register the society under the Industrial and Provident Societies Act of 1893, in order that it may have a legal existence and be able to enter into contracts. If, as is often the case, there is already in the district an Agricultural Co-operative Society it would probably be better to add the sale of eggs and poultry to its operations rather than form a new society.

Method of Working and Collecting the Eggs.—The method of working adopted by a society usually involves the establishment of a depôt in a convenient position, as near as possible to a railway station, and arrangements must be made for collecting, receiving, testing, grading, packing and selling the eggs on behalf of the members. In order to secure a good reputation for the society's eggs and to obtain the best prices, eggs should be sent to or collected by the depôt daily, or at the least three times a week, no matter how few there may be from each individual member. This method will ensure that the eggs are fresh and of the highest value in the market.

When birds are broody, eggs should be taken from the nests twice a day, as if they remain under the hen for several hours they are apt to be spoiled. Every care should be taken to keep the shells free from dirt. The nests should, therefore, be kept clean and the eggs collected frequently, especially during wet weather. Washed eggs lose much in appearance and do not keep so well.

Testing Eggs at Depot.—When received at the depôt every egg should be tested for freshness by means of a special lamp. The trade requirements for "new-laid" eggs are that they shall be—

(1) Clean in the shell and of good shape.
(2) Full, *i.e.*, have a small air space.
(3) Bright, *i.e.*, perfectly clear without any spots or shadows.
(4) From 2 to 2¼ oz. in weight.

Eggs should be packed in conformity with trade requirements, *i.e.*, in 10, 20, 30, or 40 dozen boxes, and forwarded to their destination.

How to Obtain Best Prices.—Societies should endeavour to deal directly with retail traders. The societies have a great advantage over individual producers, who are unable to ensure a regular supply to meet the requirements of traders. In the case of poultry for table purposes it frequently happens that, owing to a more regular demand, better returns are obtained in the wholesale markets.

Preserving Eggs.—In the spring supplies are often in excess of the demand, and in order to avoid throwing large quantities on the market at low prices, societies have found it profitable to preserve their surplus eggs. A Leaflet (No. 83) on *The Preservation of Eggs* can be obtained on application to the Board.

Supply of Poultry Requisites.—Societies may also find it advantageous to buy poultry foods and appliances at wholesale rates for sale to members at prices below the usual retail prices.

Area covered by a Society.—A society can be formed for two or three adjacent villages or for a still larger district. In the latter case, to minimise the cost of collection, sub-collecting stations should be established in conjunction with a central packing depôt.

London, S.W.1,
August, 1904.
Revised, April, 1917.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 112.

BOARD OF AGRICULTURE AND FISHERIES.

Weeds and their Suppression.

Owing to the shortage of labour, the unfavourable nature of the last two autumns, and the necessity for increasing the proportion of corn to root crops, much land which was formerly clean and well cultivated is rapidly becoming foul, and the Board desire to urge farmers not to relax their efforts in combating weeds, which are responsible for serious reduction in the yield of crops. The ploughing up of grass land does not in any way affect the necessity of securing the maximum yield of foodstuffs from the existing arable land. This can only be done by keeping the land free from weeds, and in a high state of cultivation, and by sowing pure seed of high germinating power. The present leaflet is devoted to a general consideration of weeds and their eradication.

In this connection it may be remarked that in a Memorandum issued in 1915 by the Farmers' Club it is observed that, "The biggest waste in agriculture is caused by weeds. As a rule, weeds are permitted by bad farmers only, and a determined attempt, notwithstanding all difficulties, should be made to get rid of the weeds so that the yield per acre of the crops we grow may attain the highest standard."

Damage done by Weeds.

The most serious objections to weeds may be stated as follows :—

1. They absorb from the soil moisture and plant food which would otherwise go to nourish and increase the crop which is being cultivated.
2. They "crowd" the crop and hinder the access of light, which is essential for healthy growth and for the proper assimilation of plant food. The effect is to hamper the growth of the plants during early life, especially in the case of crops of slow growth. Weeds also prevent free circulation of air amongst the crop plants, thus retarding ripening and drying, particularly in the case of corn crops.
3. Weeds, especially such climbing kinds as bindweed and cleavers, hamper harvesting of corn crops, both as regards cutting and drying.
4. Weeds interfere with, and render more expensive, proper and thorough cultivation, and the "singling" of root crops.
5. Weeds may harbour, or favour the development of, insect and fungus pests.
6. The value of samples of cereals is reduced by the presence of cockle, garlic, cleavers, and wild vetch ;

the value of most farm seeds is lowered by the presence of the seeds of weeds*; and the market value of hay and other farm produce is similarly reduced by certain weeds or their seeds.

7. Some weeds—*e.g.*, garlic—taint the milk of cows which eat them, whilst others—*e.g.*, meadow saffron and water hemlock—are poisonous to stock generally.
8. Other weeds (dodder, broomrape, yellow rattle) are parasitic or semi-parasitic, and obtain their food by direct robbery of the crops they infest.
9. The underground stems and roots of weeds may cause the stoppage of drains.

All farmers will admit that it is impossible to obtain the best returns from the land when weeds are allowed to grow unchecked, but many do not appear to realise the full extent of the loss for which weeds are responsible. Experiment has shown that on a properly weeded area of arable land the crop may be double that on an unweeded area; *e.g.*, in one case mangolds, grown under otherwise exactly similar conditions on the same field, yielded 37¼ tons per acre where two hoeings were given, and only 16¼ tons where there was no weeding after singling.

Manner of Distribution.

Before the suppression of weeds can be intelligently dealt with, it is essential to have a clear conception of the manner in which weeds obtain access to the farm, and the methods by which they are spread broadcast amongst cultivated crops. The manner of distribution is very varied, but amongst the commoner processes are:—

a. Distribution by means of the wind. Many seeds, like those of the poppy, are so small that they are readily blown considerable distances from the parent plant.
Other seeds such as those of the thistle, groundsel, dock, etc., are rendered buoyant by parachute-like arrangements of fluffy hairs or by flattened wing-like projections, and are easily carried about in a light breeze.

b. Distribution by means of farmyard manure. Screenings from threshing and winnowing machines, and sweepings from barns and hay-lofts, often find their way to the manure heap, while manure from cattle fed on inferior hay is also likely to contain weed-seeds. Many seeds of weeds may be uninjured by the heat of fermentation, and will in due course pass on to the fields. Some seeds may even

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* See also Leaflet No. 297 (*Seed Testing*) and Food Production Leaflet No. 18 (*The Testing of Seeds for Farmers at the Official Seed Testing Stations*).

germinate better after lying in the manure heap, or after passing through the stomach of an animal. Well-rotted farmyard manure will, however, contain fewer germinable weed seeds than fresh manure, and is therefore less liable to introduce weeds.

c. The use of impure seed* is a potent means of introducing weeds to a farm. The presence of 1 per cent. of dock seed in a mixture of grass and clover seed means *ten or more dock seeds per square yard* all over the field wherever such a sample is sown at the ordinary rate for leys.

d. Some weeds—*e.g.*, creeping thistle, couch, field bindweed, onion couch—are spread by means of broken portions of the rootstock, which may be carried from field to field or farm to farm in a variety of ways.

e. Farm machinery and implements—*e.g.*, self-binders and travelling threshing machines—are often responsible for the wide distribution of weed seeds.

f. The seeds of certain weeds—*e.g.*, burdock and cleavers—adhere to the skins of animals or the clothes of human beings, and may be carried considerable distances.

Methods of Suppression.

Weeds may be *annual*, *biennial* or *perennial*, and must be combated by somewhat different methods according to their habit of growth. It must be emphasised that, whatever methods are adopted, they must be promptly, vigorously and faithfully carried out : systematic well-timed effort is the foundation of success.

1. The most obvious means of suppressing weeds is to prevent them seeding. When it is recognised that an ordinary charlock plant produces from 1,000 to 4,000 seeds, and a moderate-sized poppy 10,000 to 15,000, and large plants 50,000 seeds, the force of the adage that "one year's seeding is seven years' weeding" is obvious. Further, as many weeds produce seeds which do not germinate uniformly, the mischief is greater than appears at first sight, for they may lie dormant in the soil and grow after several years. In destroying weeds of this type the frequent recurrence in the rotation of root and other crops which permit thorough cleaning is an advantage (*see* also 4, 9, 13). Seeding of weeds growing in hedgerows, on roadsides and waste places, and round farm buildings, should be prevented.

* *See* Leaflet No. 297 (*Seed Testing*), which clearly shows the need which exists for farmers to exercise the greatest possible care in purchasing their seeds.

2. In no circumstances should imperfectly cleaned seed be either purchased or sown. *The Board desire to impress upon farmers the great importance at the present time of taking steps to ensure that there shall be no failure of crops due to the sowing of poor seed.* Farmers are urged to take advantage of the facilities for having seeds tested at the Board's Seed Testing Station for a nominal charge. (*See* Food Production Leaflet No. 18.)

   Care should be exercised as to the disposal of refuse seeds from threshing, screenings, sweepings of haylofts, etc. Such refuse should be burnt.

3. Deep ploughing is sometimes resorted to with considerable success, many seeds rotting when deeply buried. Others, however, remain dormant under such conditions, without losing their vitality, and may subsequently be brought to the surface. Where practicable, shallow cultivation and the preparation of a good tilth prior to the sowing of a crop will encourage the weed seeds to germinate, and the seedlings may then be destroyed by further stirring of the soil. Such a method will help to clear the ground of many annual and biennial weeds, such as poppy, charlock, and some species of thistle.

4. In view of the present shortage of manual labour, in districts where hand-hoeing is usually largely practised, corn crops may usefully be drilled in rows wide enough apart to permit of horse-hoeing, say, 8 in. to 9 in. apart. This is especially useful in the case of spring-sown corn.

5. Where horse-hoeing cannot be practised, the wetter the climate, or the more the land is subject to the growth of annual weeds, the closer the drill coulters should be set. When weeds are plentiful it is advisable immediately after harvest to disc or lightly scarify the surface, with a view to encouraging the germination of annual weeds. These should afterwards be ploughed down.

6. The eradication of perennials, such as couch, field bindweed, and creeping thistle, needs careful and well-directed effort. These plants are propagated by underground runners bearing buds, and the object should be to remove the rootstocks as far as possible unbroken. This will usually be best accomplished by shallow ploughing followed by grubbing or cultivating, rolling and harrowing. As a rule the weeds should be collected and either be burnt or made into a compost with lime. Sometimes, however, as in fallowing, they may first be brought to the surface and left to the drying effects of wind and sun.

7. Hand-pulling, digging with fork or spade, and total removal of weeds are efficient means of destruction, but these methods are all expensive, and are only resorted to when other plans have failed or are inapplicable. In every case the weeds collected should be burnt.
8. Any perennial weeds may be cut down frequently to exhaust the supplies of food stored up in their root-stocks, and prevent storage of further supplies. Judicious cutting with spade, hoe, or scythe, will destroy all weeds if the cutting is repeated often enough. Many weeds when cut near the ground send up new stems, and these are produced at the expense of food stored below ground in the previous season. The growth of these secondary stems weakens the plant as a whole, and if, when produced, they are cut off, and the process repeated, total destruction will be the result, no matter what the plant may be.

   The first cutting should be made early in the year, and as often after that, during the summer, as new shoots appear. If left too long the weeds may either seed, or again store up food in the roots in preparation for the next season's growth. One cutting in the case of perennials like creeping thistle, field bindweed, couch, and coltsfoot is almost valueless.
9. Fallowing, either bastard or bare, as a cleaning process, is largely practised with good results on the heavy classes of soils on which root crops are uncertain and expensive to produce. At present, however, bare fallowing should be reduced to a minimum, "smother" crops being substituted (*see* 13).
10. Rushes, sedges and horsetails are indicative of a sour, damp soil, which can be remedied by draining and liming. A dressing of lime is, more or less, a specific against sheep's sorrel, corn marigold, spurrey, and some other weeds.
11. The application of dung and artificial manures induces considerable changes in the character of the herbage on pastures, and of the weeds on arable land. The application of 5 to 8 cwt. of basic slag per acre to pastures on stiff clay land often has a wonderful effect in encouraging clovers and generally improving the herbage, while a mixture of superphosphate and sulphate of ammonia is often an effective means of reducing such weeds as buttercups, daisies and plantains. Suitable manuring may so stimulate cultivated crops that many of the worst weeds will be crowded out, a fact which is of especial signifi-

cance at the present time in connection with the growing of successive corn crops.

12. Farmyard manure, believed to contain weed seeds in any quantity, should be applied to land on which they are unlikely to cause damage. For example, manure containing the seeds of charlock or spurrey could be applied quite well to permanent meadows.

13. Weeds may often be suppressed or much reduced by the growth of dense, heavy "smother" crops which choke them out. On foul land such crops may be of much value before a root crop. Suitable crops for the purpose are vetches, or a mixture of vetches, peas, oats or beans to be mown in early summer and either used green or made into hay or silage; mustard, rape, and maize. The last-named casts a dense shade, but it must be kept clean by horse and hand hoeing in the early stages of its growth. It can, however, be grown only in the warmer southern counties.

14. In every system of arable farming the growth of a root crop is the most important means of suppressing weeds of all kinds, and as a rule the state of a farmer's root crop towards the end of summer is a pretty good indication of the level of his farming. Wherever possible the first cleaning operations in connection with the root crop begin in the previous autumn as soon as the stubbles have been cleared. Given a fine September and October, couch can then be easily separated from the soil and dragged to the surface to be collected and burned. The methods of attaining this object naturally depend on circumstances. On a light or medium soil a cultivator will penetrate sufficiently deeply to drag out the weeds, but in most cases it is safest to give a preliminary shallow ploughing, followed by the cultivator and harrows. On very foul land it may be necessary to take off two or three "crops" of weeds and the operations may have to be continued in spring, but particularly on heavy land the preliminary autumn cleaning should be as thorough as possible, as at no other time does the same amount of work have such a great effect. Furthermore, in the case of crops, such as potatoes and mangolds, which are sown comparatively early, there is little chance of cleaning the ground in spring before the seed is put in.

Potatoes are one of the most effective cleaning crops, and their value in this direction is enhanced by the fact that they are best suited for the light soils which become foul so quickly. They require deep cultivation, and on couch-infested land the deep winter ploughing, if properly done after the couch has been dragged to the surface, will itself be a cleaning operation of no little importance. There is usually little chance of cleaning in spring before potatoes are planted, but repeated harrowing (with chain or saddleback harrows) and scufflings may be given at a small cost before the young plants appear, and prove effective in dealing with both annual and perennial weeds. Once the potatoes have secured a good start, if the soil is in good heart and a vigorous variety of potatoes has been selected, weeds will have little chance of asserting themselves, and even couch will often be suppressed.

On suitable land a crop of drumhead cabbages probably comes next to potatoes as a cleaning crop. If planted out so that they can be scuffled in two directions, they are easily kept clean in the early stages, and if well manured their later growth is so rapid and strong that the ground is soon completely covered.

Mangolds are perhaps the least satisfactory root crop on very foul ground. They have to be sown comparatively early, leaving little time for preliminary cleaning, and their growth at first is almost invariably slow and irregular. Even when well established they do not cover the ground in the way that even a good crop of swedes or turnips will do.

At the present time labour difficulties make it necessary to consider means of reducing the work involved in dealing with a large area of roots, and one of the best methods is to sow a part of the root break in autumn with a vetch mixture to be mown not later than the end of June, either for use as green forage or for making into hay or silage. This crop will smother out a large proportion of the perennial weeds, it will be cut before the annuals have formed seed, and it will be removed in time to allow either a half fallow or the sowing of a crop of white turnips, rape or mustard.

15. Close grazing with sheep in spring and early summer will often check certain plants and prevent them seeding, *e.g.*, ragwort, yellow rattle, and hardhead or knapweed.

16. Finally, spraying crops with chemical substances, more especially with sulphate of copper* (bluestone) and sulphate of iron, has been found exceedingly

* This material is scarce and dear at present.

useful in destroying weeds. The destruction of charlock in corn crops by spraying is dealt with in Leaflet No. 63. Solutions of the sulphates of copper and iron, however, may be employed against other weeds, some of which may be destroyed and others crippled. Persicaria or red-shank and spurrey may be killed by spraying with 4 and 5 per cent. solutions of copper sulphate respectively; while the following weeds are more or less crippled and seeding largely prevented by spraying with a 5 per cent. solution of copper sulphate, or a 15 per cent. solution of sulphate of iron :—Poppy, corn cockle, black bindweed, dock, groundsel, dandelion, perennial sow thistle, cornflower, thistles, and coltsfoot.

Yellow rattle may be killed by dressing the infested meadows with salt at the rate of 5 or 6 cwt. per acre as soon as the seedlings make their appearance in spring, usually about the end of April.

Labour.

The shortage in manual labour may largely be met, in so far as the destruction of weeds is concerned, by the employment of women and children, working when necessary in gangs in charge of one or two older and practised hands; and of temporary workers who may be in a position to do work of this kind for short periods. Any difficulty experienced in securing such labour should be reported to the County Agricultural Executive Committee.

London, S.W.1,
June, 1904.
Revised, December, 1917.

NOTE.—Other Leaflets dealing with weeds and weed seeds are :—

No. 63. The Destruction of Charlock.
No. 166. Some Common Thistles.
No. 180. Dodder.
No. 194. Coltsfoot.
No. 222. Meadow Saffron.
No. 226. Broom-rape.
No. 249. "Couch" or "Twitch."
No. 251. Some Common Weeds.—I.
No. 297. Seed Testing.
F.P. No. 18. The Testing of Seeds for Farmers at the Official Seed Testing Station.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 113.

BOARD OF AGRICULTURE AND FISHERIES.

Dry Rot.

In practically every house in this country fungi are to be found growing on the woodwork or floor. Some of these are mere moulds, feeding feebly and slowly on the surface of the wood; others obtain their food from the soil or from dirt. Both of these classes are relatively or absolutely harmless so far as the destruction of wood is concerned. On the other hand, some of the remaining fungi met with cause deep-seated rotting and eventual destruction of the wood-fabric, and are known as "dry rot" fungi.

Popular Distinction between Dry Rot and Wet Rot.—Practical men distinguish between "dry rot" and "wet rot." They describe as "wet rot" such decay as is started in the standing tree or is already present in the unconverted log. As the fungi causing this form of rot chiefly attack the standing tree, they are known as parasites (even though in reality they often attack only the dead wood of such trees). By "dry rot" practical men mean the form of decay induced in timber that is apparently sound when first used as constructional material. Inasmuch as fungi commonly causing dry rot in houses in this country are largely not parasitic on trees, this popular distinction between "dry rot" and "wet rot" is partly justified.

Fungi causing "Dry Rot."

The fungi causing "dry rot" in different structures (houses, mines, railway sleepers) in this country, and in different regions of the world, are by no means identical. For instance, *Merulius lacrymans*, the most malignant and widespread species occurring in the houses of north-temperate lands, is said to be lacking in the tropics; and this is borne out by experiments showing that moderately high temperatures, lower than those prevailing in the tropics, normally stop the growth of this fungus. There is no exhaustive list of fungi causing dry rot in this country available, and only a few of the species chiefly responsible have been investigated. This is to be regretted for two reasons: first, the enormous annual loss due to dry rot in this country will increase because of the wider use of sapwood, the lack of proper seasoning, and inadequate ventilation; secondly, the most efficacious method of treatment of each variety of dry rot can be adopted only when detailed knowledge of the conditions of existence and distribution of the particular fungus concerned is available.

At this stage a brief account may be given of the domestic form of *Merulius lacrymans*, by far the most common and destructive of all dry rot fungi, supplemented by comparative references to two other important types, *Coniophora cerebella* and *Polyporus vaporarius* (=*Poria vaporaria* of some authors).*

The mycelium (or spawn) of the fungus forms white spreading strands which grow very rapidly and spread in every direction over surrounding objects. Under certain conditions the mycelium forms thicker cushion-like plates which are the fructifications. These are usually pancake-shaped, flat, rust-coloured structures showing white margins (*see* figure). The rusty surface is marked by meandering ridges, the flanks of which bear spores innumerable by means of which the fungus is reproduced. Such flat fructifications occur on horizontal supports, but some of them, especially those facing upwards, are sterile. On vertical or oblique supports the fructifications assume the form of brackets, the rusty, fertile surface facing downwards. This surface often shows the ridges uniting and thus producing irregular "pores" recalling those of a *Polyporus*. The margins of these pores may be drawn out into more or less large teeth, resembling small stalactites. The fructifications of *Polyporus vaporarius* being white in colour, are easily distinguished from those of *Merulius*, though their "pores" may be shallow and uneven depressions, or deep, fringed tubes. The fructifications of *Coniophora cerebella*, on the other hand, are often mistaken for those of *Merulius*, but the surface of the former is raised into isolated little bosses rather than into folds.

The spores of *Merulius lacrymans*, though thin-walled, are, when kept dry, long-lived and retain their vitality for at least many months. It is quite erroneous to suppose that they germinate only in alkaline solutions: on the contrary they germinate in water and in various neutral and acid solutions (including one per cent. citric acid). Until recently, however, investigators failed to cause these ubiquitous spores to germinate upon and infect wood: but it has now been proved that they germinate freely and invade wood previously attacked by certain other wood-destroying fungi, including *Coniophora cerebella*. This incidental co-operation between the two species goes further and has important practical bearings. *Coniophora* demands for its growth in wood a large supply of moisture; hence, if wood be protected against excess of moisture it is guarded against this fungus directly, and *Merulius lacrymans* indirectly. *Merulius lacrymans*, on the other hand, once established, can manufacture water and thereby moisten and attack the driest wood, and incidentally render the latter open to attack from *Coniophora*.

* Under this name a number of different races or even species are included.

Merulius lacrymans, having once gained entrance to the wood, exhibits two different forms of active growth. On the one hand it sends into the wood numerous fine hyphae, which feed upon the wood-substance and so

Dry Rot,

Showing the fructifications with white sterile margins of the fungus *Merulius lacrymans.*

destroy the whole fabric. On the other hand, the fungus gives forth numerous hyphae which run over the surface of the wood, weaving themselves into cord-like strands, thin skin-like sheets, or producing thick soft cushions. This superficial mode of development is important, for it characterizes certain fungi causing the worst forms of dry rot and enables them to spread rapidly. As the superficial mycelium spreads, it sends fine hyphae into the underlying wood. The usual method of behaviour of certain other fungi attacking the wood of living trees or felled timber is quite different. These, having once penetrated the wood, develop mainly inside it, growing in various directions but keeping at some distance within the surface except when producing fructifications; their advance is consequently slow compared with that of *Merulius*, *Coniophora*, and *Polyporus vaporarius*. By means of its superficial mycelium *Merulius lacrymans* can advance far over innutritious surfaces, such as brick-walls, along metal tubes (for bell-wires, water), and can even penetrate the mortar of walls, and thus gain entrance to other rooms. In this manner, especially by means of the skin-like mycelium or of the long string-like strands (often many yards in length), infection is transmitted to distant wood-work. Similar cords are possessed by *Polyporus vaporarius* and *Coniophora cerebella*, those of the latter being very abundant and familiar, as slender, often nearly black, threads branching over moist decaying wood in buildings.

Apart from giving strong *prima facie* evidence of the presence of the dry rot, these fungal cords are of practical importance in that they possess greater powers of resisting drought than other growths of the fungus. In addition as their structure varies with the species they aid in the identification of the *particular* species of fungus present.

In *Merulius lacrymans* such a cord shows three different kinds of tubular hyphae :—(1) ordinary hyphae, of normal width and normal thickness of cell-wall; (2) very wide long tubes, comparable with the vessels of flowering plants, and serving to convey water containing nutritive material; (3) strong, fibre-like hyphae, whose thick walls enable them to act as mechanically strengthening constituents. Without going into details, it may be stated generally that the older accounts with reference to the structure of the cords of the different species are not correct, and that the broad differences are quantitative rather than qualitative. For instance, *Polyporus vaporarius* has only very scanty vessel-like hyphae, but very abundant fibre-like ones, so that even when old and dry its cords are tough, not brittle as are those of *Merulius lacrymans*.

Other features in the mycelia facilitate the recognition of the different kinds of fungi. While the cords of *Coniophora* are characterized by their very early assumption of a brown colour, the general white mycelium of *Merulius lacrymans* when growing in a confined space often has the unique character of undergoing a *subsequent* change to a bright yellow colour.

Conditions favourable to Dry Rot Fungi.

The fungi causing dry-rot are active or even existent only when certain conditions are present.

Moisture.—Wood-destroying fungi during activity demand appropriate supplies of water and oxygen; such fungi cannot grow inside wood except when it contains moisture within certain limits. These limits vary with the species, though they seem to be approximately constant in range for the same species. On the one hand *Coniophora cerebella* requires that the wood shall be thoroughly moist, and is therefore most frequently found in damp cellars (and in Germany is termed the "cellar fungus"). This characteristic is so marked that the mere presence of this fungus suffices to indicate excessive dampness in a building. On the other hand *Merulius lacrymans*, when it has once gained a footing, can grow in the driest wood. This remarkable faculty *Merulius* owes to its power of producing water, which is to be seen on the tips of its exposed hyphae and is responsible for the specific name *lacrymans*. This water is not pumped out, as in the case of the leaves of certain plants, but is the result of specialised chemical activity. The fungus indirectly converts portions of its main food-material, wood, into carbon dioxide and water. *Polyporus vaporarius* possesses the same power but to a less extent. It is largely this high power of adding moisture to dry wood that renders *Merulius lacrymans* the most malignant source of dry rot in this country. When the fungus has attained a certain size local shortage of water leads to the production of cords and skin-like mycelia on exposed surfaces, as well as of fructifications.

Temperature.—The fungi causing dry rot in this country are also considerably affected by temperature. *Merulius lacrymans* and *Polyporus vaporarius* both behave as plants thriving only at moderate temperatures; according to R. Falck the highest temperatures at which the normal domestic form of the former will grow is between 26° and 27° centigrade.* The mycelia of both species are rapidly killed by exposure to a temperature of only 40° centigrade,† so that wood infected by them can easily be sterilized by heat that does not damage it. Spores and the fungi themselves are rapidly killed by steam. The resistance to low temperatures is greater, for *Merulius* can endure freezing cold.

Measures of Control.

The various kinds of fungi causing dry rot show widely different powers of attacking timbers. At the one extreme stands *Merulius lacrymans*, capable of destroying the

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* 26–27° C. = 79 80° F. approximately.
† 40° C. = 104° F.

sapwood and heartwood of many kinds of "softwoods" and "hardwoods," ranging from ordinary pine to resistant teak. At the other extreme is *Lenzites saepiaria*, a fungus occasionally causing trouble in buildings and coal mines, which causes decay only in softwoods (conifers) and especially pine. The virulent versatility of *Merulius lacrymans* helps to render it the most dangerous destructive agent of woodwork in buildings.

In adopting practical measures to deal with dry rot it is necessary to distinguish sharply between preventive and remedial measures. In both instances a knowledge of the identity and behaviour of the fungi concerned is of paramount importance, but unfortunately at present this knowledge is very incomplete.

Preventive Measures.—1. The first obvious preventive measure is to store wood under conditions least likely to encourage dry rot and to guard against contact with infectious material, including spores. In this connection it should be borne in mind that the domestic form of *Merulius lacrymans* never grows on the wood of living trees, and is probably very rare in woodlands. Original infection of wood in houses by this form of dry rot must probably be traced in the overwhelming majority of cases to the timber yard or builder's yard, or to neighbouring buildings. Lack of proper sanitation in places where sawn wood is stored, and carelessness in allowing the diffusion of infected material removed from buildings, are responsible for the original infection in probably the majority of cases: all such material should be destroyed on the spot, and tools which have come into contact with it should be thoroughly disinfected before removal.

2. A second means of preventing infection is to avoid conditions favourable or essential to the development of fungi. Modern methods of building, involving hasty work and rapid completion and the use of inadequately seasoned timber, induce conditions favourable to the spread of dry rot. The older method of completing the carcass of the house and leaving it to dry for the winter and early spring before joinery was fixed undoubtedly prevented the development of fungi. Equally important was the use of sound timber for joinery; dry timber kept dry is resistant to dry rot, and sound, air-dried, well-seasoned timber should alone be used in building. But in order that timber may remain sound it is necessary that the building should be so constructed as

(*a*) to avoid the use of methods or materials which will bring woodwork into contact with moisture, and

(*b*) to ensure a thorough system of ventilation throughout so that no corner remains unventilated, where air can stagnate and moisture accumulate, whether between floors or behind woodwork. Such precautions directly keep at bay fungi, such as *Coniophora cerebella*, that confine their attacks to moist wood, but they also indirectly greatly decrease the chances of infection by *Merulius lacrymans*.

In the construction of foundations, burnt ballast and hygroscopic stones should as far as possible be avoided; in some districts, however, clean gravel or impervious stones are unobtainable and too costly to import; burnt ballast or local stone must then be used, and if cost allows cement substituted for Lias lime in concrete. The top soil, especially if containing vegetable matter, should be removed before filling is commenced, and all filling material should be perfectly dry and free from infection. The use of iron and cement in the construction of underground rooms and ground floors gives the greatest security against dry rot; cement should in any case be substituted, wherever possible, for mortar, but the cost is usually prohibitive.

Woodwork should be prevented from contact with masonry and mortar. This may be secured by enveloping the ends of beams in cement, asphalt, lead or zinc; in most cases the cost is prohibitive, and as an alternative the beam ends may be treated with a disinfectant. Although in all houses there is now a damp course, the common method of arranging the sleeper walls on the main walls appears to be dangerous, since the back of the plate is in direct contact with the wall and there is usually a bed of mortar between the wall and the plate. If the sleeper wall is erected independently, the plate is entirely detached from the wall and need have no mortar on the underside: the ends of the joists and boarding can also be kept clear of the wall, thus affording the maximum protection both from rising moisture and condensation on the walls.

The underside of floors need thorough ventilation. Air bricks should be placed in such numbers and position as to secure that a current reaches to all parts. It should be remembered that air bricks measuring 9″ × 3″ have actually an inlet of only 9 square inches. The most effective ventilation is provided by an air flue connected with the spaces under the floors: this may adjoin the smoke flue with a thin tile wyth between, the heat thus assisting the updraught. The efficiency of a vent flue for ventilating the whole of the space under a floor depends entirely upon its position in relation to the external wall in which the air-bricks are placed: more than one flue may in some cases be necessary.

The close-jointed flooring now in common use admits of no ventilation between the boards, and it is advisable when this is used to insert gratings in the floors or skirtings (in the latter case connected with the underside of the floor by flues).

The pugging of floors in order to deaden sound is a frequent source of dry rot*: lime and hair pugging which must always be put in wet is objectionable; slag wool, silicate cotton or mack slabs are preferable; if lime and hair are used an adequate time for drying should be allowed before floor boards are laid. Pugging should not be permitted to interfere with ventilation.

Floor coverings of oil-cloth or linoleum should be avoided, especially at first in new houses: where such material is used, a stained border (say, 6″ to 9″ wide) should invariably be left round the room.

Similar principles to those governing the construction of floors should be observed when putting in panelling and skirtings, especially if a large air space is left at the back of the woodwork.

3. The antiseptic treatment of wood constitutes a third means of protection. Absolute protection can be secured only by thoroughly impregnating timber with an antiseptic, but the cost and difficulty of such treatment are usually too great to render this practicable. Coatings of a suitable antiseptic, however, very greatly decrease the chances of infection of sound wood. Unfortunately no antiseptic is yet known which is perfectly satisfactory in the case of dwelling houses. As a means of guarding against *Merulius lacrymans* the following substances often recommended may be dismissed at once: copper sulphate, iron salts, zinc chloride and mercuric chloride (very poisonous and volatile). Creosote and even tar are effective, but their odour and colour restrict their use. Among inorganic substances boric acid may be recommended. Among organic substances the first place must be given to the di-nitro cresates of potassium or sodium.

Remedial Measures.—Before adopting remedial treatment it is advisable to ascertain the nature of the fungi which are present. They may be practically harmless, *e.g.*, species of *Coprinus*. Even when the woodwork itself is vigorously attacked, however, the measures to be adopted vary with the kind of fungus present. For instance, the rotting of the wood may be due to a fungus which limits its attack to soft woods. In such a case it may suffice to remove the infected pieces and to replace by sound wood, preferably not a "softwood."

Where the presence of a serious attack of dry rot has been established more drastic methods are essential. Not only must the infected wood be removed, but the adjoining woodwork showing no external signs of decay should be tested. In extreme cases it may ultimately involve less loss to destroy the whole building. In less severe

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* *See* Journal of the Royal Institute of British Architects, 1910, pp. 220–222.

cases, after the removal of the infected wood, the exposed surfaces (walls, woodwork, and sub-flooring) should be disinfected. A blast flame applied to the brick or stonework serves to sterilize the surface, and, if applied sufficiently long, will kill parts of the fungus that have penetrated for some distance into the mortar. A wash of dilute formalin, or dilute corrosive sublimate, serves to kill spores and fungus on the surface, but both these substances are useless for prolonged protection of the woodwork as the former evaporates, and the latter volatilizes; of the two formalin is preferable because its vapour has a powerful lethal action on spores. Finally, the wood, especially at the ends, should be coated with the antiseptic selected, which preferably should also be applied to the brickwork and other constructional material. In addition to these measures all practicable steps (proper ventilation, suitable pugging) should be taken to keep the wood as dry as possible.

A fuller account of Dry Rot will be found in the Journal of the Board of Agriculture, Vol. xxiii., August, 1916, pp. 465–474.

London, S.W.1,
June, 1904.
Re-written, August, 1917.

BOARD OF AGRICULTURE AND FISHERIES.

The Feeding of Poultry.

This Leaflet has been temporarily withdrawn.

Leaflet No. 115.

BOARD OF AGRICULTURE AND FISHERIES.

Coral-Spot Disease.

(*Nectria cinnabarina*, Fr.)

One of the most common and most generally distributed of British fungi is that to which the name of Coral-Spot Disease has been given. The first stage of the disease takes the form of bright coral-red warts, which are about the size of millet seed, and are thickly scattered over the surface of dead or dying branches of the tree attacked. These red warts are very conspicuous, and at one time this condition of the fungus was considered to be an independent plant, and was termed *Tubercularia vulgaris*. At this stage numerous and exceedingly minute spores are produced, and readily scattered by the wind or by insects.

At a later stage the coral-red changes to a rusty-brown colour. The surface becomes rough with projecting points, and a second form of fruit is produced. In many instances the fungus passes through all its stages on dead branches, and in such a case no direct injury will be done, but rather a certain amount of good consequent upon the hastened decay of the wood on which the fungus is growing. The indirect danger arising from its presence on dead wood is the possibility of infection of living plants by the spores produced. The earliest indication of disease caused by *Nectria cinnabarina* is the drooping and yellowing of the leaves, which soon die and fall to the ground. In a few weeks the bark becomes slightly shrivelled, and the characteristic coral-red warts appear on the surface. Death of the leaves, and finally of the branch, is due to the choking of the wood vessels by the *mycelium*, which cuts off the supply of water and food.

The fungus is remarkable for the great number of species of woody plants upon which it can grow and produce perfect fruit, being met with on all fruit and forest trees, excepting conifers, and also on various shrubs. Amongst plants especially susceptible to the attacks of *Nectria* may be mentioned sycamore, elm, hazel, apple, pear, and red and black currants.

Preventive Measures.

1. Whenever diseased branches are observed they should be removed and burned without delay, as, after infection, recovery is impossible, and any delay in removal permits the formation of spores and probable infection of neighbouring plants.

2. Fallen branches, stored pea-rods, poles, &c., are often literally covered with the bright coral-pink warts of the *Nectria*, and should then at once be destroyed.

3. When pruning, it is a wise precaution to protect every cut or damaged surface with a coat of gas-tar, and also to remove and trim the ends of branches broken by the wind or by other agency.

London, S.W.1,
July, 1904.

Leaflet No. 116.

BOARD OF AGRICULTURE AND FISHERIES.

Sleepy Disease of Tomatoes (*Fusarium lycopersici*, Sacc.).

Description, and appearance of Plants attacked.

The "Sleepy-Disease" of tomatoes, although known for some seasons in Great Britain, has acquired an increased importance among growers, owing to the extended cultivation of the plant in recent years.

The plant may be diseased inside when quite young, but the outward manifestations do not necessarily appear at once. The first indication that the tomato is affected is shown in the drooping of the leaves and their bad colour. If the root is split, the woody portion is seen to be of a dingy yellowish brown colour, which becomes more marked if left open for half a day. When the plant has been attacked about three weeks the lower portion of the stem is usually covered with a delicate white bloom of mildew. Eventually the stem is covered with patches of a dull orange colour, and becomes very much decayed. The disease can always be identified by a brownish ring just within the bark at the base of the stem or thicker branches of the root.

The disease is due to a fungus which flourishes in the soil and enters the plant by the root. During its development it passes through three stages, the first of which usually lasts about a week, the stem at the end of that time being much decayed and covered with a gelatinous mass. During the last stage the spores are resting and preparing to attack the young plants another year, or whenever a suitable opportunity presents itself. The plant can only be attacked by the fungus in the last stage of its existence.

Treatment.

1. It must be remembered in the first place that diseased plants never recover, and therefore no attempt to save the plant is successful.

2. As the disease grows inside the plant it is useless to spray with a fungicide.

3. As the resting spores of the fungus live and thrive in the earth and attack the plant through the root the disease must be attacked in that quarter.

It is therefore recommended that :—

1. All diseased plants should be uprooted and burnt immediately the disease is noticed.

2. The soil in which the plants grew should be removed and sterilised by heat,* or mixed with a liberal allowance of quicklime.

3. If the disease appears in a glass house, every part of the house should be washed with a solution of carbolic acid and water (1 of the acid to 20 parts of water) after the soil has been removed.

4. As much lime as the plants will allow should be mixed with the soil in which tomatoes are grown, more especially if they are grown in the same beds during successive seasons.

5. The infected soil from a bed should not be thrown out at random, but should be sterilised by admixture of quicklime, and care should be taken not to bring it in contact with tomato beds.

6. Only short-jointed sturdy plants should be used, and those should be fairly hard and the foliage of a dark bronze appearance. All spindly or drawn plants should be rejected.

7. The plants should be allowed plenty of air, light, and room for growth.

NOTE.—Other leaflets dealing with diseases of tomatoes are No. 75 (Root-knot Disease in Cucumbers and Tomatoes); No. 152 (Bacterial Disease of Tomatoes); No. 225 (The Septoria Disease of Tomatoes); No. 230 (Cucumber and Tomato Canker); No. 242 (Bacteriosis of the Potato and Tomato); and No. 262 (Tomato Leaf Rust).

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* See *Journal of Board of Agriculture*, January, 1913, "Partial Sterilisation of Soil for Glass-house Work."

London, S.W.1,

November, 1904.

Revised, July, 1913.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

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Leaflet No. 117.

BOARD OF AGRICULTURE AND FISHERIES.

"Black-Leg" of Potatoes.

(*Bacillus atrosepticus.*)

Although not so widely recognised as it should be, black-leg of potatoes is a common disease in Britain. It is well known on the continent of Europe, where it was first studied in detail, and it is to be found in practically every country where the potato is cultivated. The losses caused by black-leg are often not regarded as serious since the disease is not epidemic in character as is the ordinary potato blight (*see* Leaflet No. 23). Nevertheless, the losses in the aggregate reach in an average season a considerable amount, and in unfavourable and wet seasons they may be really severe.

The disease is caused by bacteria; and although the parasitic organisms found in the various countries in which the disease has been investigated, show certain differences and have received different names, yet recent researches tend to show that most of the organisms described are, if not actually identical, very closely related. For practical purposes the disease may be regarded as being caused by the same species of bacterium.

Symptoms of the Disease.—Black-leg is one of the earliest potato diseases to show itself. Affected plants may be seen as early as the middle of June, but they may continue to make their appearance till considerably later. Diseased plants are somewhat stunted and are conspicuous even at a distance by their pale green or yellow foliage. The upper leaves show a tendency to remain small, stiff, and erect, whilst the margins of the leaflets are generally rolled inwards.

The most characteristic feature is to be found at the base of the stem. If affected stalks are pulled up they will be noticed to come away easily and to be rotten and inky black at their bases (*see* illustration). In some plants all the stalks will be affected in this way, in others only one or two. The outer or cortical tissues will be soft and decayed, or perhaps entirely rotted away, and if cut open the pith will be found to be blackened or destroyed. In some cases the destruction of the pith extends upwards for a considerable distance. The old "set" or "seed" potato will be completely rotted away.

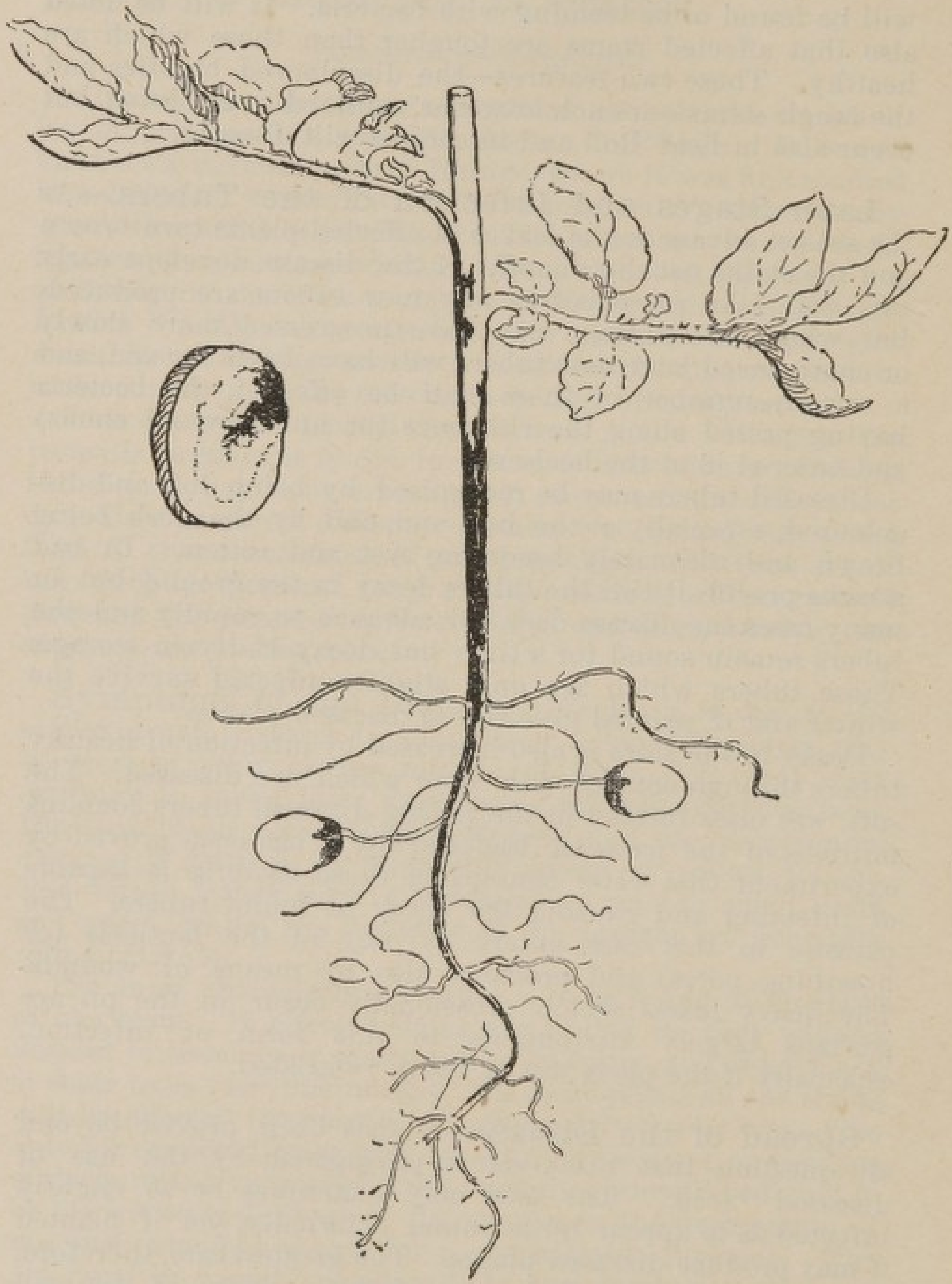
Another indication of black-leg is seen when affected stems are cut transversely. The section will show near its outer part three brown spots which are the woody portions of the principal vascular bundles. The brown colour is due to the action of the bacteria, and in bad cases it extends to the extreme apex of the shoot and sometimes manifests itself externally in the form of black streaks on the stem, If such vascular bundles are examined with the microscope, the tissues, at any rate in the most recently affected portions, will be found to be teeming with bacteria. It will be noted also that affected stems are tougher than those which are healthy. These two features—the discoloured bundles and the tough stems—are not, however, confined to black-leg, but occur also in Leaf Roll and in certain wilt diseases.

Later Stages and Infection of the Tubers.—As the season advances the leaves of affected plants turn brown and the stalks usually die off. If the disease develops early this will take place before any new tubers are produced, but where the disease may have progressed more slowly or commenced later new tubers will have been formed, and a certain number of these will be affected, the bacteria having passed along the rhizomes (or underground stems) and entered in at the heel-end.

Diseased tubers may be recognised by being soft and discoloured, especially at the heel-end, and by the flesh being brown and ultimately becoming wet and rotten. In bad attacks practically all the tubers decay in the ground but in many cases the disease does not advance so rapidly and the tubers remain sound for a time but decay badly in storage. Those tubers which are only slightly affected survive the winter and if planted give rise to diseased plants.

Decay in the store is also increased by infection of healthy tubers through contact with those which are diseased. The soft, wet mass formed in the rotting diseased tubers contains millions of the parasitic bacteria, and it has been proved by experiment that water containing these bacteria is capable of infecting and causing the decay of sound tubers. The parasite in this case enters by way of the lenticels (or breathing pores) and probably also by means of wounds. The heavy losses which occasionally occur in the pit are perhaps largely attributable to this form of infection, especially if the pit is wet or badly ventilated.

Spread of the Disease.—It has been proved beyond all question that black-leg is propagated by the use of diseased "seed." The seed may sometimes be so slightly infected as to appear quite sound externally, yet if planted it may produce diseased plants. The greatest care, therefore, should be exercised that none of the progeny of diseased plants be saved for planting purposes. It should be remembered that tuber-infection is liable to take place, not only when plants are so badly attacked that they die, but when only one or two shoots are affected and the plants as a whole continue to live.



Black-leg of potatoes : attacked stem and diseased tubers.

Land which has borne a diseased crop will be certain to contain the parasitic bacteria in more or less abundance, and it is possible that such soil will be capable of producing disease in a new crop even though planted with healthy tubers. Direct infection of the young tubers from the soil has not, however, been proved for this country, and recent work in America tends to show that in the potato-growing districts of Maine and Virginia the bacillus does not live through the winter in the soil.

Tubers from infected land would moreover be contaminated owing to the soil adhering to them, and might be suspected of giving rise to a diseased crop or carrying infection to new localities. In England no evidence has as yet been advanced to prove that black-leg is increased by this means, but, in the event of it being proved, it would be possible to disinfect the seed tubers with formalin.

Control.—1. It is of the utmost importance to use only sound seed. Tubers which are the produce of affected plants, however sound they may appear to be, should never be saved for seed purposes. If possible, seed should be obtained only from areas where black-leg is not prevalent.

2. As far as is practicable all diseased plants should be dug up and destroyed as soon as noticed, and the young tubers removed from the soil. Tubers which are sound may be used for immediate consumption. The remainder should be destroyed.

3. Black-leg is widely distributed in some of the "seed" growing districts. When potatoes are especially grown for seed purposes it is most important to inspect the crop during the growing season, from June to August, with the special object of removing affected plants. It is only by this means that a clean sample of seed can be hoped for.

4. Care should be exercised in constructing the pits. All tubers showing any trace of disease should be excluded or serious loss may result, and the pits made as dry and as well ventilated as possible.

London, S.W. 1,
September, 1904.
Re-written, July, 1917.
Revised, April, 1919.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

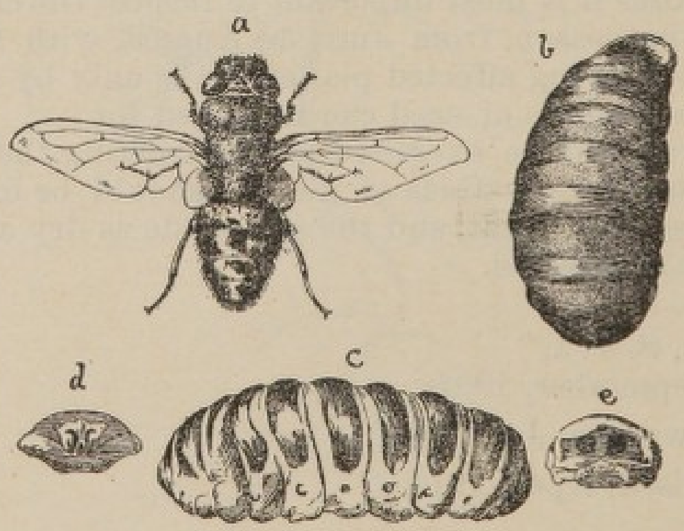
The Sheep Nostril Fly.

The Sheep Nostril Fly (*Oestrus ovis*) belongs to the family Oestridae or Bot Flies. The mouth parts of this species, as of the other bot-flies, are either abortive or rudimentary, so that as adults they do not feed. The harm is done by the larva or maggot which is parasitic on one of the higher vertebrates; in the case of *Oestrus ovis* the sheep is the host.

The Sheep Nostril Fly has a wide distribution, and the harm done by its maggots is known to flock-masters in Britain from north to south.

Description.

The Fly.—The somewhat hairy fly (Fig. *a.*) measures about half an inch in length; the upper surface of the head is light brown, and that of the thorax light brown or yellow to grey. Dark-coloured tubercles are seen on the thorax; the ringed abdomen is brownish yellow with dark spots; and the legs are brown. The wings are glassy, and extend, when the insect is at rest, beyond the body. The balancers (behind the pair of flying wings) are white, and are covered by well marked winglets. These winglets are present at the hinder margin of the flying wings.



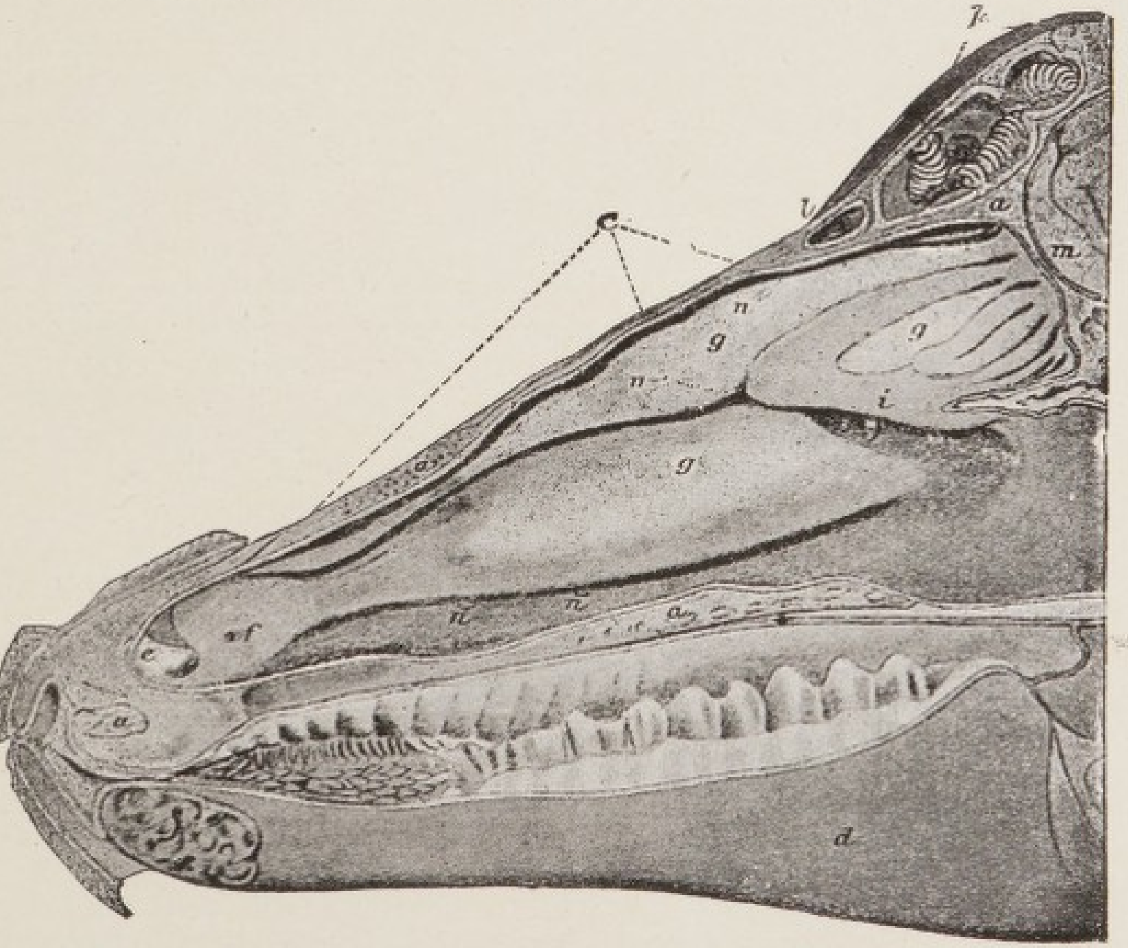
THE SHEEP NOSTRIL FLY (*Oestrus ovis*): *a.* Fly; *b.* pupa case; *c.* larva; *d.* head end; *e.* tail end. (*a.*, *b.* and *c.* original and twice natural size; *d.* and *e.* after Ormerod, enlarged.)

The Egg.—The eggs are somewhat curved or kidney-shaped.

The Larva.—The newly-hatched maggots are at first very small, white, and wormlike, but they become longer and more rounded at a later stage. They have two hooks directed backwards at the head end, between which is the mouth. Along the under surface of the abdomen are transverse rows of little projections, and on the free end of the last segment are the spiracles or openings of the breathing tubes. Below these is a lobe with spines, and on each side a little process, both of which play their part in the movement of the maggot. The full-grown maggot (Fig. *c*) measures between three-quarters of an inch and an inch.

Life History.

The flies leave their shelter places when the weather is sunny and warm. The sexes pair, and afterwards the females fly towards the sheep. Eggs may be laid round the sheep's nostrils, as seen by Mr. Fred. V. Theobald, or live larvæ may be deposited in the sheep's nostrils. The maggots by their mouth-hooks, anal processes and spines, draw or push themselves up the nostrils (*e*). The pricking and wounding of the lining mucous membrane cause much irritation to the



SECTION OF SHEEP'S HEAD INVADED BY *Oestrus* LARVÆ (*after Curtice*).

attacked sheep. The larvæ feed on the secretions resulting from the irritation caused by their presence and their prickings, and they become mature in the frontal (*k*) and maxillary sinuses of the sheep. Ultimately, the full-grown larvæ return to the passages, and are sneezed out on to the ground. (Occasionally maggots wander into the recesses of the turbinated bones [*g*, *g*], where they become imprisoned owing to increase in size, and ultimately die.)

The larvæ ejected from the nostrils pass the nymphal stage a little below the surface of the ground, under a clod, or sheltered in a tuft of grass. The fly matures and issues from the puparium during the summer, the complete development requiring about 10 months. The number of maggots in a head varies, but it is usually small. Maggots of very different sizes and in different stages of development may be found in the head at the same time.

The following quotation of Bracy-Clark's, from the Volume of the Linnæan Society's Transactions, for the year 1797, describes the behaviour of sheep when their enemy is at work :—" The moment the fly touches the nose of the sheep they shake their heads and strike the ground violently with their forefeet, at the same time holding their noses close to the earth, they run away, looking about them on every side to see if the fly pursues ; they also smell to the grass as they go lest one should be lying in wait for them. If they observe one they gallop back or take some other direction. As they cannot, like the horses, take refuge in the water, they have recourse to a rut, dry dusty road or gravel-pits, where they crowd together during the heat of the day, with their noses held close to the ground, which renders it difficult for the fly to get conveniently at the nostril." On occasion, however, the sheep may remain quite restful.

Symptoms attending infestation.

A discharge, which often agglutinates round the nostrils, is observed. The sheep sneeze in their endeavour to get rid of the larvæ. They toss their heads and rub their noses on the ground or with their feet. Sometimes they walk along with a high stepping gait and with their heads in the air. They may also exhibit difficulty in breathing from the obstruction of the air passages.

There is a loss of condition attendant on the constant irritation.

Treatment.

In combating the sheep nostril fly *prevention* is to be aimed at rather than later remedial measures.

1. Attempts may be made to deter the fly from laying its eggs or maggots by repeated dressings of the nostrils of the sheep, with such materials as tar or fish oil. As this is an onerous task, contrivances are employed for making the sheep dress themselves. These take the form of salting troughs made in the shape of the letter V, the sides of which are smeared with tar, and as the sheep lick the salt they get the tar on their noses. In other cases the boxes containing the salt are closed, save for a hole painted over with tar.

2. Where a pasture is known to be infested the sheep should be removed before the flies issue from the pupa cases.
3. Infested sheep should be isolated so that the maggots when mature may not be sneezed out on to the pasture.
4. To prevent further development the maggots when seen should be destroyed.

Remedial measures are not of much avail, and they may be too troublesome and expensive to be generally practised, save with very valuable prize sheep.

Such measures consist in fumigation to kill the maggots or induce a violent sneezing, which may result in the maggots being ejected. Fluids which, if they reach the maggots, would kill them, may be injected up the nostrils. Cutting into the cavities where the maggots are resident, and picking them out has also been tried with fair success.

London, S.W.1,

August, 1904.

Revised, May, 1911.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 119.

BOARD OF AGRICULTURE AND FISHERIES.

Sturdy or Gid in Sheep.

The disease, known commonly under the names of sturdy, gid, turn-sick, &c., is caused by a cyst, or little bladder, called "*Coenurus cerebralis*," which develops in the nerve centres and more particularly in the brain.

The animals which most frequently suffer from it are lambs and shearlings; it is rarer in sheep over two years of age. The disease occurs occasionally in goats, oxen, and other ruminating animals. It is very rarely found in horses. The disease is, however, spread by other animals than these. The tapeworm, which lives in the small intestine of a dog, and is by no means uncommon in sheep dogs and sporting dogs, is the real source of infection.

The tapeworm is made up of a square-shaped head, with a long thin neck and a number of segments. These segments contain eggs, and when ripe they drop off. They are easily seen with the naked eye, being about half an inch long and one-fifth of an inch wide. They may go on increasing in number till the tapeworm is quite forty inches long. They fall off as they become ripe, and are passed through the bowel of the dog to the ground, and it may be on to the pastures where the sheep are feeding. They then decay, and the rain washes the eggs over the grass or into ditches or pools from which animals drink. These eggs die if they cannot get moisture. It is known that a fortnight's exposure in warm dry air will destroy them entirely, whereas even after three months' exposure on damp grass the eggs remain alive, and lambs pastured thereon have caught the disease by browsing the infected grass. This is one reason why sturdy or gid is more common in flocks which feed on damp pastures, especially when the spring and summer have been rainy, but it should be understood that moisture only acts by favouring the reservation of the eggs.

If swallowed by a sheep the eggs hatch out embryos with six hooks, which bore their way through the wall of the stomach or intestines and enter a blood vessel. They are eventually carried in the blood to the brain, spinal cord, and other parts of the body, but they only develop into fully-formed cysts or bladders in the two former. This cyst gradually increases in size and brings about the symptoms by which the disease is usually recognised.

The cyst, which is the sole cause of "gid," is a little bag of variable size, and though originally very small, may in two or three months become as big as a hen's egg. Its outer coating is very thin, and it is more or less expanded by a clear colourless liquid. The parent cyst develops on its surface 100 to 200 little chambers like white spots about the size of a millet seed, and each contains the head of a future tapeworm. They cannot develop further till the sheep dies, and the brain or the part containing the cyst is eaten by a dog. When this happens each little worm-head is set free from the cyst by the digestive juices. It becomes fixed to the wall of the intestine, and grows for about $2\frac{1}{2}$ months, when the segments are passed out on to the grass in the manner which has already been described.

Symptoms.

A sheep affected with gid may be excitable, and very timid when approached, or it may be dull and stupid. Usually it is seen apart from the rest of the flock walking about unsteadily. Frequently it turns round in a circle. It is seldom at rest for any length of time and if disturbed may try to run away, but it can only move helplessly round in one direction, often with its head carried unevenly on one side. In advanced cases the sheep may become blind.

If the cyst exist in the usual place near the surface of the brain and on one side, the animal usually walks round to that side; if a cyst exists on both sides it may circle to one side or the other at different times; if it be situated in the fore part of the brain, the sheep raises its nose and walks straight forward, only stopping as a rule when it knocks up against something; whilst if the cyst is lodged in the back of the brain, the head is raised and the sheep stumbles forwards with a jerking uncertain motion of its limbs, breaking into a sort of shambling run ending in a fall and a violent struggle to get up. If there be several cysts in various parts, the abnormal movements vary.

In the course of time the affected sheep refuses to eat, and by the combined effects of starvation and almost constant movement it rapidly wastes away and dies. The sheep may live for about six weeks after the appearance of well-marked symptoms.

The cyst may be lodged in the spinal cord, usually at the region of the loins. In this case weakness and drooping of the loins is noticed. Eventually the sheep becomes completely paralysed in its hind quarters, which it cannot raise from the ground. In such cases the animal may live for months.

Preventive Treatment.

1.—Do not keep more dogs than is necessary to tend the flock. In the spring time of each year, the dogs should be tied up for a few days and treated for worms. The object of tying them up is to see if any tapeworms are passed and if so to collect and complete their destruction by burning.

2.—The heads of sheep which have been affected with "gid" should be burned or boiled, and never left for dogs to eat.

Curative Treatment.

In consequence of the serious nature of the disease, and the frequently unsatisfactory results of treatment, nothing is, as a rule, attempted in the way of a cure, and affected animals are generally sent to the butcher. This is the least expensive course to adopt and usually the most satisfactory. It should be done as soon as distinct symptoms of gid appear, and the butcher should be warned to destroy the heads.

In exceptional circumstances, however, as when the sheep is of considerable individual value, operative treatment may be attempted. The operation consists in piercing the skull, and puncturing the bladder. It is desirable to remove the contents of the bladder, and as much of the latter as possible. Although the operation is sometimes performed with considerable success by intelligent farmers and shepherds, it is, on the whole, of such a delicate nature as to demand the services of a veterinary surgeon.

London, S.W.1,
September, 1904.

Revised, September, 1905.

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BOARD OF AGRICULTURE AND FISHERIES.

Peach Leaf-Curl (*Exoascus deformans*).

Distribution, and Plants attacked.

This disease, also known as "curl" or "leaf blister," proves very injurious to peaches and nectarines during certain seasons, whilst almond trees are also sometimes attacked. Occurring in every part of the world where these trees are cultivated, it is most abundant and destructive in humid regions, although not entirely absent from districts where the air is exceptionally dry.

Description, and Appearance of Plants infested.

The leaves and young shoots are the parts attacked by the fungus; on rare occasions the blossom is also infected. Diseased leaves become fleshy, much puckered and twisted or curled, and grow to a larger size than usual; the colour is at first a pale yellowish-green, often becoming more or less tinged with rose colour; finally, the upper surface of diseased leaves becomes covered with a delicate bloom, somewhat resembling that on a plum: this represents the fruit on the fungus. After the fungus has formed fruit, diseased leaves fall to the ground, this usually taking place before midsummer. Young shoots infested by the fungus become swollen and twisted or curved, and the internodes are very short; consequently the diseased leaves usually form a tuft at the end of a stunted shoot. When a branch is once infected, the fungus continues to grow in the tissues, and passes into the new leaf-buds formed each season. The appearance or intensity of the disease, even in the case of leaf-buds originating from infected shoots, depends almost entirely on prevailing climatic conditions. During a genial spring, when growth is unchecked until the leaves are full-grown, "curl" is practically absent; whereas if a cold, damp period occurs while the leaves are young, the disease at once appears, and its rapid spread is much favoured by alternating short spells of warm and cold weather.

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Injury caused by the Disease.

The injury caused by the disease consists of the dropping of the fruit at an early stage, and the strain on the tree due to the growth of a second crop of leaves about midsummer, this second crop usually remaining free from disease. In

PEACH LEAF-CURL.

the case of nursery stock, consecutive attacks for three or four seasons usually kill the tree, or stunt its growth to such an extent that it is practically valueless.

Sources of Infection and Remedial Measures.

In the United States it is contended that "curl" can be held in check by spraying with a fungicide alone; unfortunately, repeated experiments have proved that this is not true for this country. In the case of diseased trees, all the terminal shoots bearing infected tufts of leaves should be removed and burned; diseased fallen leaves should also be collected and destroyed. By removing the diseased shoots one source of infection, namely, that arising from the spores formed on leaves originating from these diseased shoots, is removed; besides, there is no advantage in retaining such contorted twigs on the tree.

A second source of infection depends on the presence of spores that have passed the winter in the angle formed between leaf-buds and the branch on which they grow, inside the bud-scales, or in minute cracks in the bark. Such spores should be destroyed by spraying with Bordeaux mixture, spraying to commence when the buds show the very first indication of swelling. Two sprayings, at intervals of ten days, if thoroughly well done, should suffice. The leaf-buds should not be sprayed after they begin to expand, or the foliage will be destroyed or injured.

The mixture should be made with 20 lb. of sulphate of copper and 10 lb. of lime to 100 gallons of water. The sulphate of copper must be dissolved in a vessel of cold water, and the lime, which must be pure and fresh, slaked in another vessel. The contents of the two vessels should be poured together into a tub and the proper quantity of water added. Sulphate of copper solutions are poisonous, and tubs, pails, or other vessels which have contained the mixture must not be used for other purposes.

London, S.W.1,

November, 1904.

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Leaflet No. 121.

BOARD OF AGRICULTURE AND FISHERIES.

The Construction of Pigsties.

Contrary to popular opinion, no farm animal is really so clean in its habits as the pig, and probably none suffers so much if obliged to exist in wet, foul, cold surroundings. In the case of all stock, any reasonable expenditure incurred in making them thoroughly comfortable is likely to be well repaid by the better return given for the food consumed, to say nothing of the prevention of those diseases which may arise from bad hygienic conditions.

The pig is an accommodating animal in many respects, but it is not fitted like other farm stock to withstand great changes of temperature, it is very sensitive to damp, and it may be said that pig-keeping is not likely to be a success unless warm, dry, fairly roomy, well ventilated sties are available. It is equally essential that the buildings should be so constructed that they can be easily kept clean, and disinfected from time to time. If these requirements are not satisfied, the most expensive and elaborate building will most certainly give poor results, while on the other hand, so long as these essentials are obtained, there is no reason why good results should not be obtained in the cheapest possible erection.

The common conception of a pigsty is the small low lean-to building opening into an open court. This type of erection has the important advantage of being cheap, but it has serious disadvantages. The only opening into the sty proper is usually so low as to necessitate creeping into it, a fact which militates against frequent cleaning, particularly in wet weather; it is difficult to inspect the pigs except about feeding time; it is too small and in other ways unsuitable for sows with litters; the building as commonly constructed is dark, badly ventilated, and owing to the absence of a door is either too cold in winter or too close and hot in summer. Furthermore, if it is not required as a pigsty, it is of little use for anything else, whereas a small building, say 10 feet by 8 feet, about 5 feet high at the eaves, suitably lighted and ventilated, and provided with a door in two sections, would not only be much superior as a pigsty, but would be useful for other purposes, *e.g.*, poultry, storage of fuel, etc., if not required for pigs.

On farms it is doubtful if, in ordinary cases, the erection of the common kind of sty is necessary or justifiable. As a general rule, all pigs except sows with litters, boars, and those nearly fat can be most economically and advantageously kept in the covered yards with fattening cattle. (It is necessary to say that for the comfort of the cattle the number of pigs should not be too large, and for the sake of the pigs themselves they should have a dry corner fenced off for feeding and sleeping. If the manure from the stables is thrown into the yard, it is important to see that it is well distributed, or the pigs will choose it to sleep in, and "cramp" or "rheumatism" will almost certainly follow.) For young litters, buildings of the loose-box type, opening and draining into the covered yards, or pens cut off from the yards by walls about 5 feet high, are most suitable, and can be used for a great variety of purposes when not employed as pigsties. There is no trouble with drainage or in the disposal of manure, provided the floors are well above the level of the manure in the yards.

Where pigs are kept in large numbers, accommodation such as that suggested is not sufficient, and special piggeries have to be provided. As already mentioned, the essential conditions required by pigs are warmth, dryness, sufficient room, and good sanitation, and so long as these are secured the arrangement and construction of the piggeries can, if desired, be regulated entirely by economy of erection and upkeep, and of labour involved in feeding and tending the pigs.

There are, however, certain essential conditions which should be secured in whatever kind of building is erected.

Situation and Aspect.—If at all possible, a fairly high and dry position should be selected, and in no case should the level of the floor be below the level of the surrounding ground, since buildings so constructed are almost certain to be damp and cold. The doorways, courts, windows, and openings should as far as possible be on the south side. Sties facing north may in some cases be unavoidable, but should never be used for young pigs, except possibly during the hot summer months.

Sties for boars, especially sties used for boars to which sows from other premises are sent for service, should be isolated from the sties in which other pigs are kept.

Floor.—This is in many respects the most important part of the building, and the part in which it is most difficult to combine conditions which are desirable from all points of view. For instance, for cleanliness, durability and cheapness there is no doubt whatever that a floor of concrete with a skin of smooth cement is the best. Such floors are, however, unsuitable for, at any rate, the sleeping quarters of pigs; they are always cold, and young pigs reared in houses with cement floors generally do badly, even if they do not develop cramp or rheumatism. Furthermore, if even slightly dirty they are as a rule very slippery. A compromise often made, is to have a cement floor, but to provide a movable wooden platform for the pigs to lie on, and this is good if the sty is roomy enough to allow of the platform being lifted frequently for cleaning purposes. Otherwise, dirt and manure will accumulate underneath. Probably a better plan is to have at least part of the floor laid with asphalt, or to make it of bricks set on edge in cement on a bed of concrete. Such floors are warmer than cement, give a much better foothold, and are fairly easily kept clean, though a slightly greater slope is required for efficient drainage.

Walls.—The walls must be weather proof, substantial and easily kept clean, and may be made of brick, concrete, or stone. Wooden walls can only be regarded as a makeshift, since with them it is impossible entirely to avoid cracks or joints in which manure lodges, while the junction with the floor is always a source of trouble, and unless protected by sheet iron or some such material, the lower part of the wall is gradually gnawed away by the occupants of the sty. If the wall is made of brick or stone, all joints should be smoothly pointed with cement, or, better still, the wall should be faced with cement to a height of at least 3 feet from the floor. When the sty is intended for breeding-sows, a rail, which is best made of iron tubing about an inch and a half in diameter, should be fixed about 10 inches from the floor, and the same distance from the walls, to protect the young from being crushed. Partition walls need not be more than about 4 feet high, though in the case of a long building some should be taken up to the roof. In the case of extensive piggeries it is convenient to have some of the partitions so constructed that if required two or more sties can be thrown into one.

Roof.—The roof should be weather-proof and non-conducting, and may suitably be tiled, or boarded and covered with galvanized sheeting or thoroughly tarred felt.

In the case of lean-to sties, the roof should be not less than 4 feet 6 inches above the floor in its lowest part, and about 7 feet at the back. This is necessary in order to allow the sty to be thoroughly cleaned, and also to enable the animals to be examined and tended in case of sickness. It also ensures sufficient airspace and facilitates proper ventilation.

Airspace and Ventilation.—The airspace should not be so large that the buildings are cold, nor yet so small that, in order to secure efficient ventilation, draughts are unavoidable, Ventilation should be secured by openings in the wall and roof. Lighting, which is most easily done by panes of glass in the roof, should be sufficient. In order to avoid scorching of the pigs the glass should be roughened and thick. Sunlight is a cheap and good disinfectant, apart from its direct effect on the health of animals.

Drainage.—Drainage is a most important point. It may be laid down as a general rule that there should on no account be a closed drain in any sty, and furthermore the drainage from each sty should be conducted separately to a main drain outside. The plan of draining a row of sties by one channel which passes through each in turn should never be adopted ; the last one is apt to be wet and unhealthy, and if disease—*e.g.*, husk—breaks out in any sty, all the pigs below it are likely to become infected by means of the drain.

Troughs.—The simplest and best trough is made of glazed fireclay, semicircular in section, and set in concrete. It should be set in the centre of a partition which, immediately above the trough, should consist of a hanging door supported on an iron rail. When hanging freely, this door is immediately over the centre of the trough, but it may be pushed inwards, thus completely shutting off the trough from the sty, or it may be pulled outwards, leaving the trough open to the pigs. The advantages of the system are obvious : the pigs can be fed, or the trough cleaned out, without the attendant entering the sty, while there is no chute where food is apt to lodge.

Courts and Runs.—Whether separate courts for the sties are provided or not an extensive outdoor run is essential for sows and young pigs, and if possible a dry sunny paddock should be provided for the purpose.

London, S.W.1,

Re-written, June, 1912.

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Leaflet No. 122.

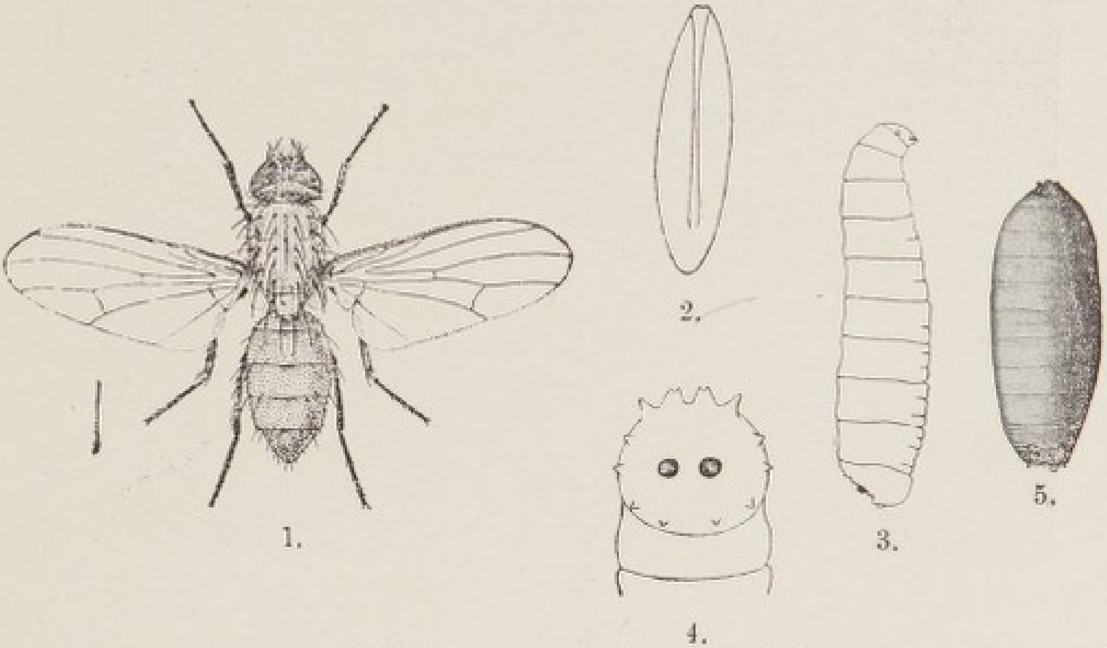
BOARD OF AGRICULTURE AND FISHERIES.

The Cabbage Root Fly (*Chortophila brassicæ*, Bouché).

Introduction.—This fly is one of the most destructive insect pests with which growers of cabbages, cauliflowers and related vegetables have to contend. It is prevalent throughout the greater part of the British Isles and other European countries, and also in Canada and the United States. It belongs to the family *Anthomyidæ*, a very large assemblage of flies, the members of which may be easily mistaken for ordinary house flies, to which they are closely related.

Plants attacked and Nature of Injury.—The Cabbage Root Fly is an enemy of plants belonging to the cabbage and turnip tribe (natural order *Cruciferæ*); although the heaviest losses are occasioned to cabbages and cauliflowers, other crops — brussels sprouts, broccoli, radishes, turnips and swedes — are also attacked; though in some of them the damage may be due to a closely allied species, *Chortophila floratis*, Fallen. Instances are known of garden stocks (*Matthiola*) being killed by the Cabbage Root Fly, and it by no means confines its attacks to cultivated plants. Among wild cruifers, shepherd's purse, charlock, hedge and black mustard, winter cress and jack-by-the-hedge have been recorded as being infested with the maggots of this insect. Young vegetables suffer more severely from attack than older plants. As a general rule, vegetables grown on a light soil are attacked to a greater extent than those grown on soils of a heavier nature. When a plant is attacked growth is checked, the leaves droop and discolour, the roots are largely destroyed and the plant either dies or its market value is greatly reduced. If an affected plant be pulled up it will be noticed that most of the small lateral roots have been eaten away (Fig. 7), and the maggots are to be found around the main root or in the soil close by. It is in the maggot stage that the insect is injurious, the flies themselves causing no direct harm.

Description and Life History.—The Fly (Fig. 1) is an ashy-grey insect, not unlike the house fly in general appearance, and measures about ¼-in. long. The first brood of flies appears at the end of April or beginning of May, according to locality and prevailing climatic conditions; warm dry weather favours its early appearance. The female insect lays her eggs close around the main root of the plants just below the soil surface, and in the course of about 3 to 7 days the maggots hatch out.



FIGS. 1*—Fly (after Theobald): the actual length of the insect is indicated by the line on the left side of the figure; 2—Egg, magnified; 3—Larva, mag.; 4—Tail end of Larva, highly mag.; 5—Puparium, mag.

The *Eggs* (Fig. 2) are clearly visible to the naked eye as tiny white cylindrical objects about $\frac{1}{25}$th of an inch long. The young maggots commence injury by gnawing the outer layers of the young roots, and afterwards tunnel into the substance of the larger roots; often the main root is invaded and they may also occasionally extend their attacks to the lower part of the stem.

The *Maggot* (or *Larva*) is white or cream coloured and devoid of legs; at the head end it narrows considerably and carries two minute black mouth-hooks. The body consists of 12 successive rings or segments which are largest at the tail end, where it appears as if obliquely sliced off (Fig. 3). If the last segment be examined with a good pocket lens a ring of 12 minute projections can be seen, and in the centre are two conspicuous brown dots; these are the spiracles or breathing pores of the maggot. The characteristic features are clearly shown in Fig. 4. When fully grown (in about three weeks from hatching) the maggot measures nearly $\frac{1}{3}$rd

* FIG. 1 is reproduced, by permission, from 2nd Rept. Econ. Zool., British Museum, 1904.

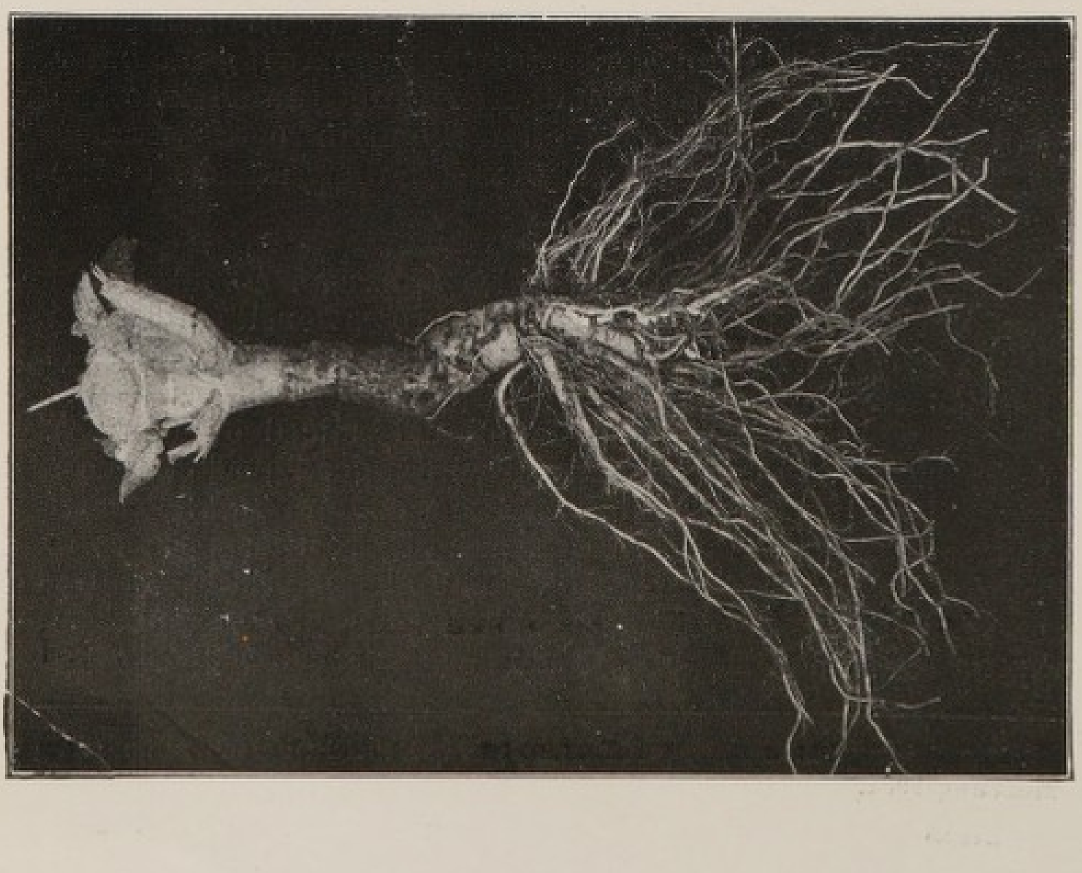


FIG. 6.—Healthy unattacked plant showing normal root development.

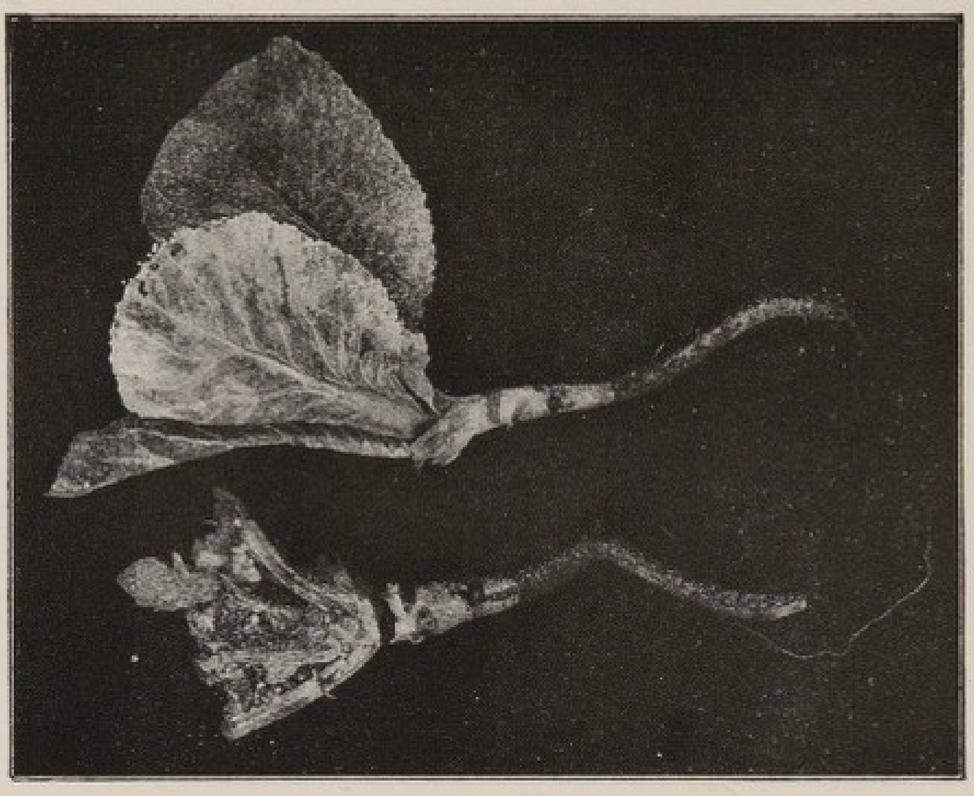


FIG. 7.—Badly attacked plants, with rootlets quite eaten away

of an inch long; it then usually works its way through the soil a little way from the attacked plant and changes to the *pupa*.

The Puparium (or case which encloses the *pupa*) is ¼-in. long and varies from pale to dark reddish brown; its general appearance may be readily gathered from Fig. 5.

There are two generations of flies in the course of the year, and very possibly a third generation may occur in favourable years, though definite proof is needed on this point. The maggots of the late summer remain as pupæ all the winter, and give rise to the first brood of flies of the following year.

Methods of Control.—1. The most satisfactory method is that of protecting the plants by means of tarred felt "discs," a measure which has now been successfully employed for some years in Canada and the United States. Recent experiments* have shown that the "discs" are also reliable for use in this country. The "discs" (Fig. 8) act as a mechanical device preventing the flies from laying their eggs near the roots of the plants. In order to obtain good results, it is desirable that the soil should be in a friable condition to enable the discs to be placed quite flat on the ground. They must be placed round the stems of the plants directly the latter are planted out in the field. Failure to take this precaution often results in the plants becoming infested prior to the discs being applied, and the value of the latter is then lost. It is also advantageous if the soil be earthed up slightly around the plants, so as to form a flattened ridge. In the case of vegetables planted out earlier

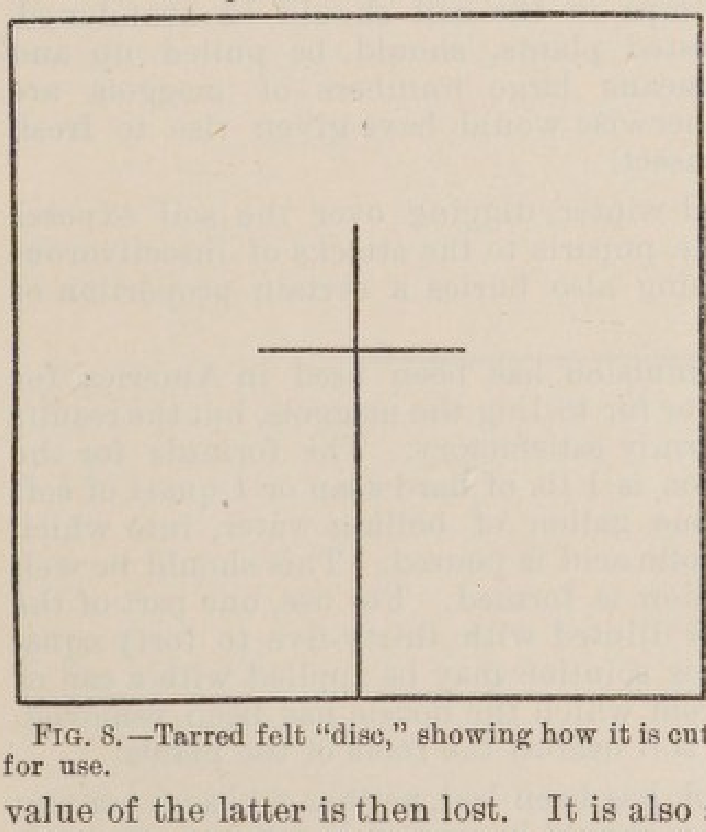


FIG. 8.—Tarred felt "disc," showing how it is cut for use.

* *Vide* A. D. Imms, *Journal Board of Agriculture*, vol. XXIII, No. 12, March, 1917, pp. 1222 1224, and XXV., No. 1, April, 1918, pp. 59–61. Further references on the Cabbage Root Fly are also given in this article.

than May, this precaution is not so urgent, but the date of appearance of the flies varies according to the prevailing climatic conditions, and the location of the particular district concerned. The main function of the disc is to act as a mechanical device to prevent flies from laying their eggs in the usual position, close round the plants. It is, furthermore, important to keep the surface of the discs free from soil, otherwise the insect will deposit its eggs thereon, and the young maggots will gain access to the protected plants. Their application is extremely simple, and can, if necessary, be undertaken by children. If they are placed carefully on the plants no further attention as a rule is necessary. Once the plants have made good growth they have been tidied over the most vulnerable period, and the soil can be earthed up over the discs, as the latter are then no longer necessary.

NOTE.—To place a disc in position open the main slit and lift up the two flaps in the centre, slip it round the stem and press down the flaps close around the latter. When properly applied the disc should be perfectly flat on the soil. The cost of the discs averages 1*s*. per 100, or 8*s*. per 1,000, excluding postage. The discs are now advertised in most Horticultural Journals.

2. Whenever the maggots are prevalent the custom of leaving the cut stumps in the soil should be abandoned. These, and all infested plants, should be pulled up and burned. By this means large numbers of maggots are destroyed which otherwise would have given rise to fresh generations of the insect.

3. In autumn and winter, digging over the soil exposes large numbers of the puparia to the attacks of insectivorous birds; deep ploughing also buries a certain proportion of them.

4. Carbolic acid emulsion has been used in America for destroying the eggs, or for killing the maggots, but the results have not been uniformly satisfactory. The formula for the carbolic acid emulsion is 1 lb. of hard soap or 1 quart of soft soap, dissolved in one gallon of boiling water, into which 1 pint of crude carbolic acid is poured. This should be well stirred till an emulsion is formed. For use, one part of the emulsion should be diluted with thirty-five to forty equal parts of water. This solution may be applied with a can or spraying machine from which the nozzle has been removed, so as to saturate the soil nearest the roots of the plants.

5. Where the attack has been bad, neither cabbages nor any other cruciferous crop should immediately follow; all cruciferous weeds, which may serve as host plants for the cabbage maggot, should be destroyed.

6. Sheltering the seed beds with frames covered with cheese cloth is of value. It allows of sound healthy plants being removed for transplanting to permanent quarters.

Natural Enemies.—The puparia of the Cabbage Root Fly are subject to the attacks of several insect enemies. The grubs and adults of two small rove beetles, *Aleochara bilineata* and *A. nitida*, destroy considerable numbers. An insect of the Gall-fly tribe known as *Cothonaspis rapae* is also of some value as its grubs (or larvæ) similarly destroy the puparia of the Root Fly. Under normal conditions probably quite 20 per cent. of the puparia are destroyed by various insect agencies. Any small black rove beetles met with in the soil, among plants of the cabbage tribe, should in no circumstances be destroyed.

London, S.W.1.,
December, 1904.
Re-written, July, 1917.
Revised, May, 1918.

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Leaflet No. 123.

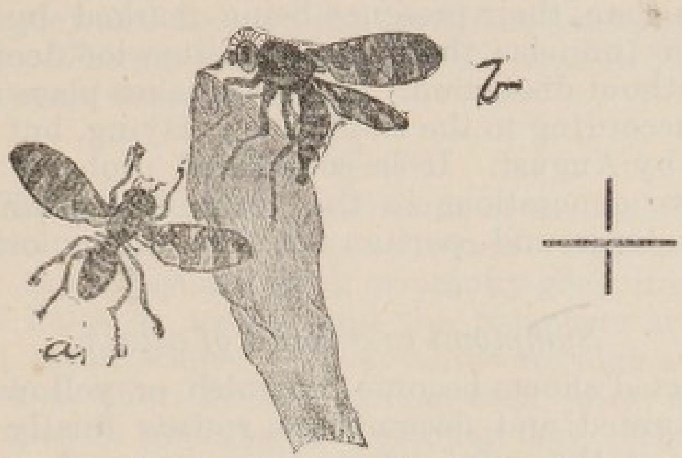
BOARD OF AGRICULTURE AND FISHERIES.

The Shoot and Fruit Moth of Red and Black Currants.

This leaflet has been temporarily withdrawn.

BOARD OF AGRICULTURE AND FISHERIES.

The Asparagus Fly, *Platyparea poeciloptera* (*Ortalis fulminans*).



a. Male. *b.* Female, both magnified (after Taschenberg)

This fly belongs to a family, some of the mature members of which have, as a characteristic, beautifully banded wings, whilst the maggots or larvæ have a boring habit.

Description.

Imago.—The Asparagus Fly is a small fly—the lines in the figure represent its actual length and spread of wings—with brown as the prevailing colour. The thorax, head, and legs are glossy brown, and the antennæ and face yellow-brown; the abdomen is brown-black, and shows at its hinder end four rather light transverse lines. The two wings, somewhat rounded at their ends, are marked by brownish zig-zag stripes. The body of the female is pointed and bears a well-marked ovipositor, whilst the end of the male is rounded. Both male and female are hairy.

Larva.—The larva is a roundish, glossy, and legless maggot, which is yellowish in colour; at the dark head end are two easily distinguishable gnawing mouth hooks; at the hind end, which is somewhat flattened, is a black-brown plate, to which are attached two hook-shaped or anchor-like processes. Full grown the maggot measures about half an inch.

Pupa.—The pupa is barrel-shaped; at first it is light yellowish-brown in colour, but later it becomes darker, and is slightly flatter on the under surface than on the upper; a short anchor-like double hook is at the hind end.

Life History.

The flies, issuing from early in April onwards until about the middle of July, lay their eggs beneath the scales of the asparagus heads as these are appearing through the soil, or in the neighbourhood of the leaves on the already tall stems which are even approaching flowering.

In a few days—a fortnight to three weeks according to some authorities—the larvæ hatch out, and boring into the tender stalks and young shoots, feed in a downward course. The maggots working downwards, follow the longitudinal axis of the stem, their presence being marked by yellowish galleries or tunnels; these last are often too deep-seated to be seen without dissection. Pupation takes place from June onwards, according to the time of egg-laying, but is practically over by August. It is considered probable that there may be two generations in the year. The pupæ hibernate in the underground portion of the stem, often many together.

Symptoms and result of attack.

The affected shoots become brownish or yellow in colour and are stunted and decomposed, rotting finally below the ground, or at the point where they emerge from the soil. The affected stems occasionally show a bluish colour.

Treatment.

1. Where the area to be treated is small and easily examined, good results may follow if small rods, dipped in a sticky substance, are stuck in the ground early in spring. The flies will settle on these and be caught.

2. Collect the flies early in the morning when they are resting on the tops of the asparagus shoots.

3. Taschenberg recommends sprinkling the tops of the shoots, when the dew is on them, with powdered charcoal; this discourages the flies at the time of egg-laying.

4. During the summer all injured stems should be cut away with the asparagus knife and burned.

5. In autumn all remaining stem parts showing larval tunnels, and all dry stumps, should be deeply dug up and burned, so that injury in the next year may be lessened or prevented by the destruction of the pupæ.

London, S.W.1,

December, 1904.

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BOARD OF AGRICULTURE AND FISHERIES.

The Hessian Fly (*Cecidomyia destructor*).

Plants Attacked.

Wheat, Barley and Rye are the favourite food-plants of the Hessian Fly. There are also records of infestation on Timothy Grass and Couch Grass in Russia.

Description.

Adult.—The fly measures one-tenth of an inch in length. It is dark-coloured, with the abdomen reddish in fresh specimens; the wings are black or smoky-grey, due to their covering of hairs or scales; and the balancers are yellow-brown with black scales. The antennæ are long and many-jointed, with a whorl of fine hairs at each joint, and there are black scales on the long and slender legs. The male is somewhat smaller and more slender than the female and its slightly longer antennæ have the hairs more marked.

Egg.—The egg is glossy, and reddish in colour; it is one-fiftieth of an inch in length.

Larva.—The larva is a legless maggot, having thirteen segments including the head, and tapering somewhat both in front and behind. It is yellowish-white, with slight differences in colour and external appearance according to the stage of growth.

Puparium and Pupa.—The puparium, or pupa-case in which the pupa is enclosed, is the last moulted skin of the full-grown maggot; it is brown in colour and resembles a flax-seed in shape and size. The pupa, which is whitish, has a very delicate investing membrane.

Life History.

The eggs are laid, in May and June, in the furrows on the upper surface of the young leaves of the cereal; and a number of eggs may be laid on the same leaf. The maggots, which hatch in a few days, move from the place of hatching to their feeding place between the leaf-sheath and the stem of the plant; a favourite position being just above the second or the first joint or knot, on the stem. The infested plants become weakened by the loss of sap; and the affected crop may appear to have been severely weather-beaten, the stems becoming "elbowed," and bending over just above the place where the maggots are located. The length of the larval stage varies with the climatic conditions from less to more than a month. The full-grown maggot pupates at the place of feeding. The number of possible generations in the year varies with climatic and other conditions. There may possibly be an issue of adult flies from the pupæ in the same year in Great Britain, but the issue to be feared is the one which causes the attack in the next year, at the end of April or in May.

Treatment.

1. When the crop is harvested many of the "flax seeds" or pupa-cases will be left in the stubble owing to the position of the infestation low down in the stem. The stubble should, therefore, whenever practicable, be burnt, or so deeply ploughed under that flies from the buried pupa-cases will be unable to reach the surface. All screenings and "flax seeds" that fall away in thrashing should be burnt.

2. The grain from an infested crop should not be used for seed. The value of the grain depends to a large extent on the reserve material stored up by the seed during the process of ripening, and plants stunted and weakened by attack will naturally produce poorer seed.

3. Fertilisers, especially in the case of a mild infestation, would prove useful in aiding the plant to tide over attack. Stout, coarse-stemmed varieties of wheat and barley should be grown, as they are less likely to "elbow."

4. Clover following a cereal crop is quite safe, as the Hessian fly does not attack clover, but flies from the "flax seeds" in the stubble may pass in a favourable season the following year to other cereal plants; in order to prevent such a contingency, the cereal crop might be sown without "seeds" so that the stubble could be ploughed in, or burnt, as suggested above.

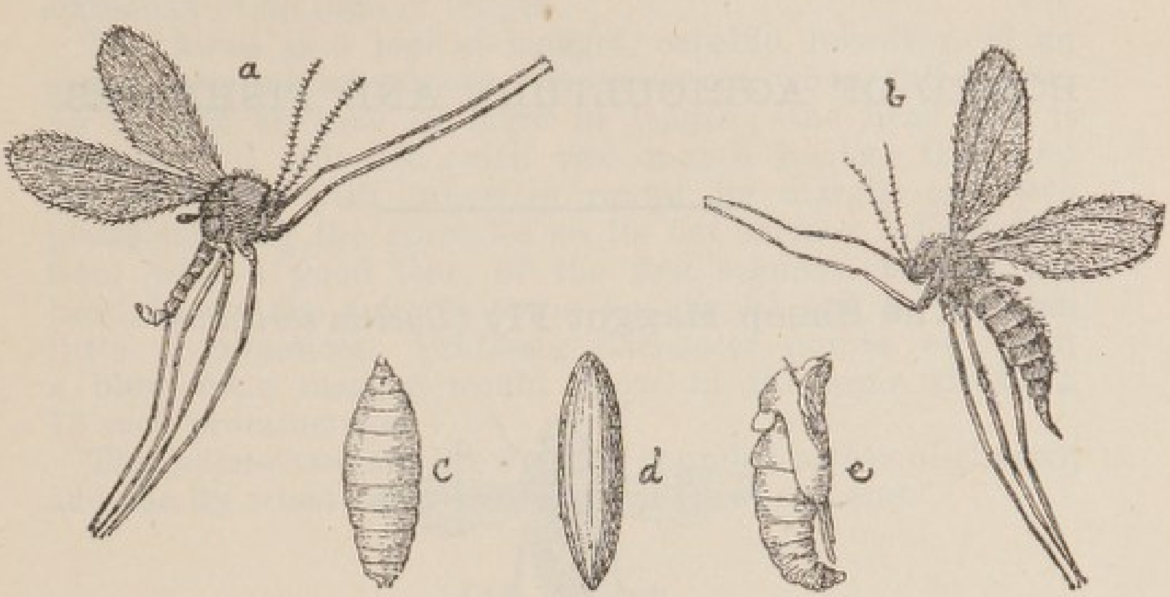
5. Winter wheat should be sown as late as practicable, in order to avoid a possible attack by flies that may issue in the autumn.

6. The Hessian Fly maggot is preyed on by a number of parasites belonging to the Ichneumonidæ, a family of Hymenopterous insects.

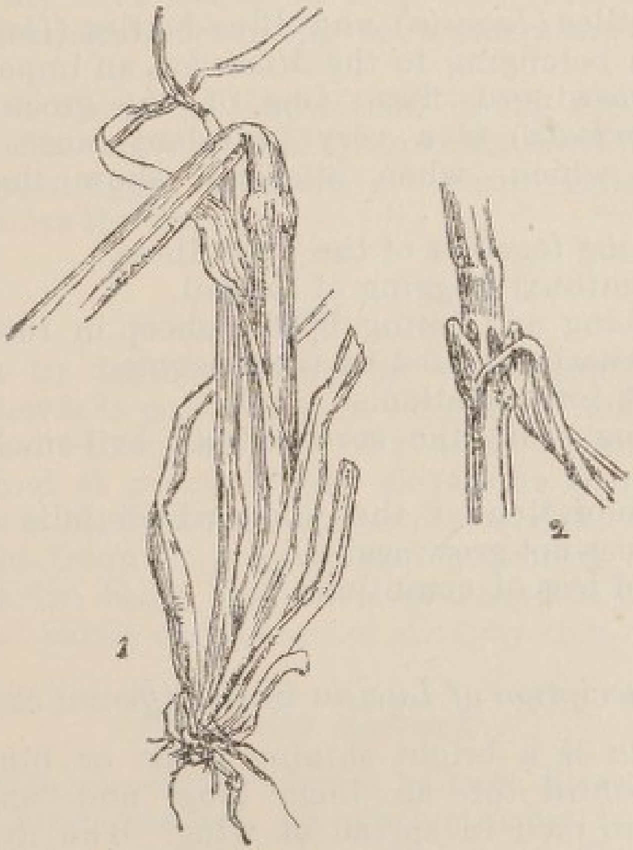
Although this fly is occasionally met with, it has not in recent years been the cause of any very serious damage, but in 1886 and 1887 the insect became somewhat widely distributed throughout Great Britain, twenty counties in England and ten in Scotland being affected.

London, S.W.1,
December, 1904.
Revised, February, 1907.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters or postcards of application so addressed need not be stamped.



HESSIAN FLY.—*a*. Male; *b*. Female; *c*. Larva; *d*. Puparium; *e*. Pupa. All much magnified. (*b*. after Ormerod.)

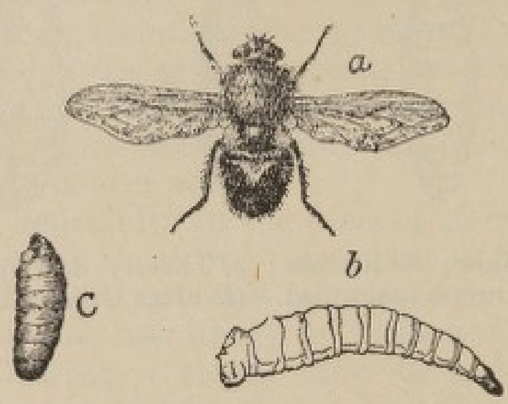


1. Barley stem "elbowed" by Hessian Fly larvae. 2. Showing position of puparia, or so-called "flax-seeds" (after Ormerod).

Leaflet No. 126.

BOARD OF AGRICULTURE AND FISHERIES.

The Sheep Maggot Fly (*Lucilia sericata*).



a. Fly; *b.* Maggot; *c.* Pupa Case Showing Place of Exit of Fly. (All twice natural size.)

Green-bottles (*Lucilia*) and Blue-bottles (*Calliphora*) are two genera belonging to the *Muscidae*, an important family of the two-winged flies. One of the green-bottle flies (*Lucilia sericata*) is a very prevalent cause of maggots on sheep, which, when attacked, show the following symptoms :—

(1.) Matting together of the wool fibres.

(2.) A continual wagging of the tail.

(3.) Rubbing and biting by the sheep in their efforts to allay the irritation caused by the maggots.

(4.) Much inflammation.

(5.) Oozing from the sores of an evil-smelling sticky fluid.

(6.) Discoloration of the wool, which falls out, and in bad cases does not grow again.

(7.) Rapid loss of condition.

Description of Lucilia in its different Stages.

L. sericata is a bright shining green or blue-green fly, about one-third of an inch long, and about seven-eighths of an inch in spread of wing. The fly, examined with a lens, is seen to be covered with dark bristles, the arrangement of these bristles being used as an aid in distinguishing this and allied species.

The *eggs* are yellowish-white and measure about one-sixteenth of an inch in length.

The *larva* is a legless maggot, capable, however, of an active crawling movement. It measures, when full-grown, up to half an inch or more in length; the head end is pointed and provided with two mouth hooks; the hind end is blunt with tubercles round its margin and two plates carrying the spiracles on its flat surface. Examination, with a good lens, of the first segment behind the head, shows the spiracle to be fan-shaped and to bear ten little prominences. Professor Carpenter points out that a blue-bottle maggot would show in the same situation 13 such prominences.

The *pupa-cases* are brown and rounded or barrel-shaped, and the fly when ready issues by a hole at one end.

Life History.

The female fly is capable of laying as many as 500 eggs, and fixes these to the wool in clusters of 20 or more. These eggs may hatch in 24 hours, the resulting maggots feeding at first externally and later boring into the skin and flesh. In a fortnight they may be full grown, when they drop away from the sheep and become pupae under cover of the barrel-shaped cases. In certain experiments which have been carried out the flies issued in from less than a fortnight to over a fortnight, according to temperature and other conditions.

An attack is worse on lambs than on old sheep and the flies are found at work from May onwards until the autumn. Moist, warm, muggy weather, or warm sunshine after showers favours the fly.

Loss.

Direct loss by death is infrequent where careful oversight by the shepherds is possible, such loss being most likely on hill pastures. Unfortunately, for some reason, maggots are now found at much higher elevations than formerly. Indirect loss is heavy owing to the disturbance to the flock caused by the frequent hunting and collecting. "Struck" sheep also thrive badly and are depreciated in value partly from this and partly on account of disfiguration.

Preventive Measures.

(1.) *Cleanliness.*—Sheep should be kept thoroughly clean about their hind quarters. A good measure is to clip the wool of the tail and between the hind legs. The purpose is to clear away any filth and to give as little opportunity as possible for lodgment, for the flies have a keen sense of smell and are attracted to dirty places for their egg laying. Hence it is that sheep suffering from diarrhœa fall such easy prey to the fly.

(2.) *Destruction of Carcasses.* — Carcasses of all dead animals, including birds, should be burned or buried so that they may not serve as breeding places for the fly.

(3.) *Dipping.*—As a preventive measure dipping is useful, but as immunity does not last beyond a fortnight or so the dipping must be repeated. Sulphur is regarded as an indispensable ingredient in any such treatment, the odour keeping away the fly. Carbolic dips are valueless for this purpose.

(4.) *Dressing.*—Dress the neighbourhood of wounds with some deterrent dressing, *e.g.*, an ointment of butter and flowers of sulphur, or spirits of tar.

Remedial Measures.

(a.) Infested sheep should be isolated.

(b.) The maggots are not difficult to kill. They should be picked or rubbed off, or where they have got to work the wool may be shorn a little, the affected parts being dressed with a mixture of turpentine and rape oil in equal parts, or with dilute paraffin oil, finishing off with a dusting of sulphur.

London, S.W.1,

February, 1905.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

The Stalk (Sclerotinia) Disease of Potatoes and related Sclerotinia Diseases (*Sclerotinia sclerotiorum*, Bref.).

The diseases dealt with in this leaflet are caused by the fungus *Sclerotinia sclerotiorum*, Bref., a parasite well known both in Europe and America, and capable of attacking a wide range of cultivated plants, both annual and herbaceous. The method of infection and behaviour of the fungus have been most carefully studied in the case of the potato and, as the life-history of the parasite and the treatment to be adopted are the same when other crops are concerned, the potato disease only is described in detail.

S. sclerotiorum is allied to *S. trifoliorum*, one of the fungi associated with clover sickness and described in Leaflet No. 271, and also to *S. bulborum*, a fungus which attacks various bulbous plants in gardens.

The stalk disease of potatoes is most destructive in the northern and damper parts of the country. In the west of Ireland the loss occasioned by it is so great that, with the exception of the ordinary potato blight (*Phytophthora infestans*), it is stated to be the most serious disease with which growers have to contend. The fungus attacks the stem, either near the ground or at some distance above it. Subsequently it penetrates the inner tissues and destroys them so that the stem falls over at the affected spot and dies. Though the tubers are not attacked the yield is reduced owing to the death of the shoot, and in districts where *Sclerotinia* is widespread the crop may suffer very severely.

Description and Life-History.

In the earliest phases of attack, usually about the beginning of July, the disease shows itself in the form of white patches of fungus threads or *mycelium*, on the outside of the stem (Fig. 1).* In contrast to most stem diseases there is little yellowing of the foliage, with the result that infected plants are easily overlooked. If dull, damp weather prevails the mycelium develops rapidly and begins to form oval or spherical cushions, white in colour, and from which minute drops of water exude (Fig. 2). These cushions represent

* For the illustrations used in this Leaflet the Board are indebted to the Department of Agriculture and Technical Instruction for Ireland.

the youngest stages of the resting bodies known as *sclerotia*. The sclerotia consist of a compact mass of mycelium, which later becomes firm and finally hard and black, though internally it remains white. They are spherical or oval in shape, and usually about the size of a pea, but frequently much elongated. When ripe they fall off and remain dormant in the soil until the following spring. It is owing to the presence of these sclerotia that the fungus derives its generic name *Sclerotinia*, though it should be remembered that sclerotia are also produced by many other fungi.

In addition to forming external mycelium and sclerotia the fungus gradually penetrates the inner tissues of the stem. The cells are invaded, and the pith-cavity is filled up with fluffy white mycelium in which sclerotia, similar to those produced externally, develop (Fig. 3). The latter remain inside the stems, but ultimately reach the soil if the stems are allowed to decay on the land. The result of this internal development of mycelium is the blocking up of the water-conducting channels. At the point of attack the tissues are killed and the stem bends over, and sooner or later dies.

The fate of the sclerotia in the soil has been carefully studied by several observers. They remain dormant until early summer, when they germinate and give rise to small disc- or cup-shaped bodies which produce the spores (Fig. 4). The cups are borne on slender stalks, and appear just above the surface of the soil. They are pale, brownish yellow in colour and from one-quarter to one-half an inch in diameter. These disc-shaped cups which form a characteristic feature of the very large group of fungi known as *Discomycetes* are termed *apothecia*. When ripe the apothecia discharge their spores into the air, usually in large numbers at a time. If the apothecia are carefully watched, smoke-like puffs of spores may be seen arising from them. The intermittent discharge of spores from a single cup may continue for two or three weeks.

It was previously thought that potato plants were infected by vegetative mycelium present in the soil, but recent investigations carried out in Ireland have shown that this is not the case, but that infection is brought about exclusively by air-borne spores derived from the apothecia. The spores are blown across the fields and alight on the foliage. On germination they are capable of infecting the older and fading leaves, and from the leaf the fungus passes into the stem. In some cases direct infection of healthy tissues apparently also takes place, especially in parts of the plant such as leaf axils where moisture is preserved.

S. sclerotiorum possesses no conidial form of reproduction. The *Botrytis* found on potato haulms, and formerly thought to be a stage in the life cycle, is now known to be an entirely

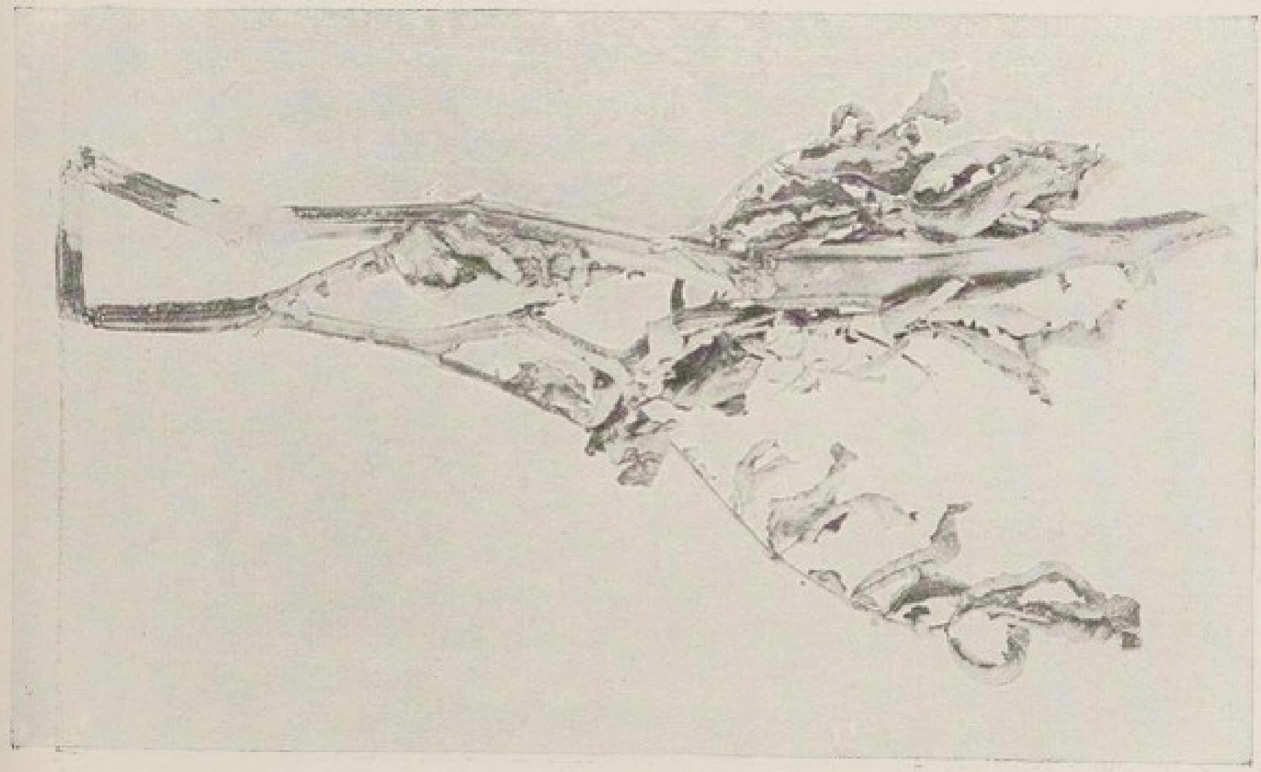


FIG. 1.—STALK DISEASE. A stalk attacked in two places, at one of which fracture has occurred.

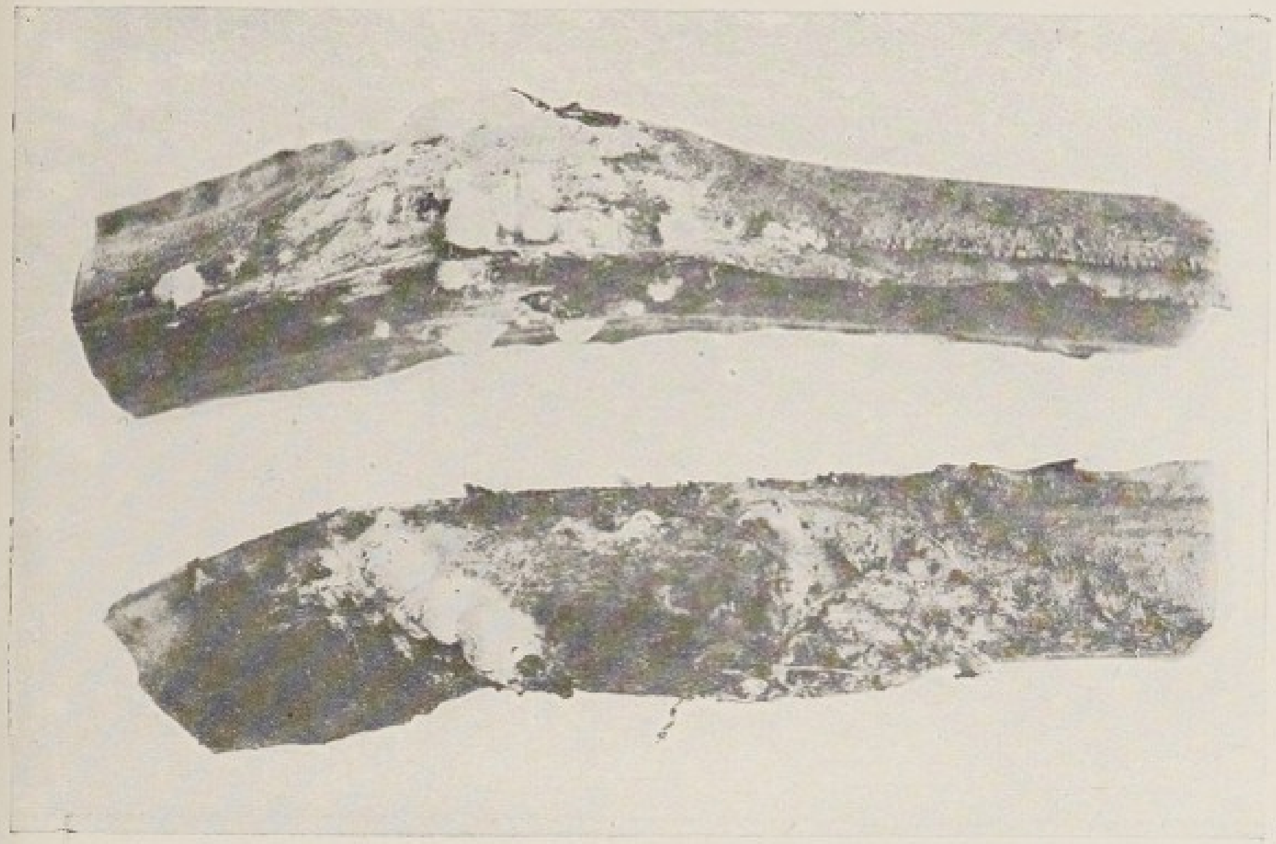


FIG. 2.—STALK DISEASE. The white bodies on the surface of the stalks are immature sclerotia.

FIG. 3.—STALK DISEASE. Three potato stalks split open showing numerous sclerotia in their hollow interiors.

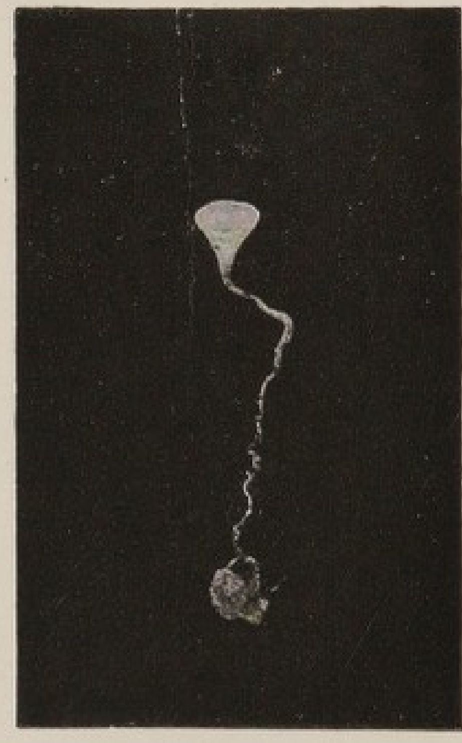


FIG. 4.—STALK DISEASE. A single sclerotium which, after lying dormant during winter, has produced a spore-bearing cup or apothecium (nat. size).

distinct fungus.* In winter, Sclerotinia is perpetuated by the hard, black sclerotia in the soil, and in early summer it is propagated by means of the spores liberated from the cup-shaped apothecia.

Infection of other Crops.

As mentioned above many other cultivated plants, of which the following are amongst the most important, are attacked by *S. sclerotiorum* :— Tomato, artichoke, sunflower, bean, marrow, cucumber, carrot, and turnip. Though the fungus-attack has not been carefully studied in the case of most of these plants, it is safe to assume that infection takes place by means of spores or by mycelium derived from a spore, though infection by mycelium produced from sclerotia may, perhaps, also take place. In most cases spore-infection probably occurs, as in the potato, through old leaves or wounded surfaces, though under conditions of exceptional moisture direct infection of healthy tissue also may be expected. In all cases sclerotia are produced in abundance. These fall to the ground or remain in the dead tissues of the plant, where they lie dormant till the spring, when they germinate or form spore-cups in the usual way. Disease seldom appears before midsummer, and is favoured by warm damp weather.

Treatment.

(1.) The most important measure to adopt is systematically to collect and burn all diseased portions of the plant in order to prevent the sclerotia from reaching the soil. If this is carried out thoroughly, the number of spore-bearing cups produced in spring will be largely reduced.

(2.) Applications of lime and spraying with fungicides have not yielded satisfactory results.

(3.) For greenhouse or garden work sterilisation of the soil by steam may be recommended.

(4.) Unless the soil has been sterilized, plants liable to be attacked by Sclerotinia should not be grown for at least three years in infected soil. The fresh site selected should be well removed from the old one.

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* The fact that both these fungi produce sclerotia, and that frequently they both occur on the same plant, has been the cause of much confusion in the past. In *Botrytis* the sclerotia are small and wrinkled and are almost always flattened. They remain attached to the potato stems and on germination give rise to the mould stage of *Botrytis cinerea*. In *S. sclerotiorum* the sclerotia are much larger and rounded in form. Microscopically, also, they show a slightly different structure. They easily fall from the plant and produce on germination the small cup-shaped apothecia. *Botrytis cinerea* is much more common than *S. sclerotiorum*. For Botrytis diseases, *see* Leaflet No. 234.

(5.) In the case of potatoes, in the west of Ireland, late planting has proved successful, the explanation being that fewer old leaves (which provide the fungus with an easy means of entry) are available at the time of the main spore-discharge.

(6.) When root crops are concerned, the greatest care should be exercised as to storage, and all diseased or damaged roots should be rejected.

London, S.W.1,
January, 1905.
Re-written, March, 1917.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

Advice to Beginners in Bee-keeping.

The keeping of bees is much more common now than forty years ago, when the fall in the price of sugar had nearly driven from the country markets the coarse honey gathered by the old straw skep system. This increase of bee-keeping has been chiefly brought about by the perfecting of the modern moveable comb hive, which enables the home of the bee to be laid open to view, and allows of the stores being taken, fit for immediate use, without injury to the bees or their owner. Within the last few years, however, the prevalence of Isle of Wight disease has led many bee-keepers to abandon the pursuit.

First Steps.– One of the first steps to be taken by those desirous of becoming bee-keepers is to obtain a good book on apiculture, and to study it carefully. There are several books from which a choice may be made. It would also be advisable to join a County or District Bee-Keepers' Association, as in this way much advice and information can be obtained, whilst Secretaries of such societies will be able to furnish names of expert bee-keepers willing to render assistance if needed.

A personal explanation of the terms used and of the outfit required is a great help, and an interview for that purpose should, if possible, be obtained with an experienced bee-keeper.

Appliances.—The appliances required are : Black net veil ; smoker, for subduing bees ; wax comb foundation (brood and super) ; bottle-feeder ; section boxes ; and a frame-hive, fitted with brood-foundation in ten or twelve standard frames, two division boards, section-rack or box of shallow frames, a queen excluder and quilts. If the hive is to be worked for extracted honey, a centrifugal honey-extractor will also be needed.

Additional useful articles are : Scraper-knife for cleaning floor-boards, frames, &c. ; comb-uncapping knife, for use when extracting ; spare coverings of felt or carpet ; and a super-clearer, for clearing bees from the supers.

The Hive.—There are many patterns of hives, all made to take the one British Standard frame. A simple one should be chosen possessing accuracy of workmanship and soundness of material, so as to stand exposure to the weather for years. The outside of the hive should be thoroughly painted, to keep it rain and damp proof. It must be placed on its stand in a spot sheltered, if possible, from the cold north and east winds, and with a free flight for the bees in front. Space should be left at the back and at the sides for easy access, so that all manipulations can be carried on from behind or from the side ; this avoids irritating the bees going to and from the entrance.

The Swarm and its Treatment.—The swarm should be ordered either from a recognised dealer or from a neighbouring bee-keeper. The safest way for a beginner to start is with a first swarm. By this means he will avoid all the pitfalls of disease or lack of condition, which only a practised eye can detect, but which beset the purchaser of established stocks. Given a good season, a swarm should be able to establish itself, and provide some surplus for its owner in its first year.

When the box or skep containing the swarm arrives, it must be placed in the shade near the hive the bees are to occupy. The screws of the lid of the box should be taken out ; or in the case of a skep the cording and wraps should be removed, and in the latter case the skep should be placed on a board, with a fair-sized stone under its edge, to allow of ventilation. The bees will soon quieten down, and cluster, after the shaking up of their journey, and thus will be in a condition for handling easily.

In the early evening the hive must be prepared to receive the swarm. The shallow-frame box or section-rack should be taken away, leaving only a thin quilt over the frames, which have already been fitted with full sheets of wired-foundation. Then the front of the hive must be raised from the floor-board about two inches, by means of two wedges. Next, a board, the width of the hive, is placed in front of, and level with, the alighting-board, sloping down to the ground. This temporary board and the alighting-board are covered with a cloth hanging over the sides to the ground, to prevent bees from crawling underneath. Then the skep or box is taken between the palms of the hands, and carried mouth downwards, until it is just above the sloping board. With a smart jerk, the bees are thrown out in front of the hive, and they will at once begin to take possession of their new home. As they run in, watch should be kept for the queen. It is a satisfaction to see her safely enter her abode. When all are in, the wedges should be taken away and the front of the hive lowered to its proper place. Crushing of any of the bees must be avoided. Any that are in danger may be cleared away with a feather.

If the swarm has been a long time on its journey, or if the weather is bad on its arrival, the bees will be greatly benefited by being supplied with half a pint of warm thin cane sugar syrup, given through an opening in the quilt by means of the bottle feeder.

On the second day after hiving, the quilts should be turned back from the ends of the frames to ascertain if the "foundation" remains properly fixed, and to see if the work is going forward well. If this is the case the quilt may be taken off and the queen-excluder put on in its place. Over this a box of shallow frames should then be placed and covered warmly with a quilt and carpets. The stock may now be left alone till the end of the honey season. More skill is required for obtaining comb honey in sections in good condition, but the section rack may be used instead of the shallow frames, if desired.

Conditions conducive to Success.—It is important that the beginner should clearly understand the principles that underlie successful bee-keeping. A colony of bees consists of a queen, a large number of worker-bees, and (during summer) a certain proportion of drones. The strength of a healthy stock depends on the vigour and laying power of the queen, who is at her best in her second season, *i.e.*, a queen hatched in June, 1912, will be at her best in May, 1913, and should be replaced by a young one in 1914, either by natural swarming or by re-queening. Queens may be purchased, or raised by the methods described in text-books. The economy of a hive depends, *first*, on the keeping up of the warmth of the brood nest (by means of the heat evolved from the bodies of the clustering bees) to such a point as will stimulate the queen to lay eggs, and enable young bees to be reared; *secondly*, on the feeding of the queen, the nursing of the brood, and the cleansing of the cells for the queen's use; *thirdly*, on the collection of pollen, water, and nectar for the brood; and *lastly*, on the building of storage combs and collecting nectar for the future supplies of honey.

The first three of these conditions must be fulfilled before the last can be begun; therefore, it is only by means of a large and vigorous surplus population that a stock can gather enough stores for its future use, and provide also for the bee-keeper. *The aim of the bee-keeper is to keep his stocks strong*, for a weak stock is always unprofitable.

The next consideration is, that the crowded condition of the hive should be secured at the right time, *i.e.*, at the honey-flow. Honey is the concentrated nectar of flowers. Spring and early summer are the times when the land is gay with a wealth of blossom, and the honey-crop is gathered. Late summer and autumn are times of seed and fruit, and only a gleaning of nectar from bramble and wild flowers then remains. There is a period every year, varying in each district according to soil and altitude, when the supply of nectar is most abundant. This time should be ascertained by the bee-keeper, who will then stimulate his stocks beforehand, so that they may have their largest population ready to gather the produce of the various flowers.

Diseases.—Diseases are best guarded against by having dry, weatherproof hives and vigorous young queens, and by giving suitable food when feeding is necessary.

The following are the chief maladies to be apprehended :—*Bee-pest*, better known as *Foul-brood*, an infectious disease which attacks the larvæ or brood and so destroys the colony. This is described in Leaflet No. 32. *Microsporidiosis*, better known as *Isle of Wight Disease*, a highly infectious disease which attacks the adult workers, and occasionally the queens. This is described in Leaflet No. 253. Both these diseases are now common in many parts of Great Britain, and should be dealt with promptly whenever they occur. *Dysentery* : it is doubtful if this is a real disease. It is a common symptom in Isle of Wight Disease, but it may be caused by undue winter confinement, unsuitable food and damp hives. It may also be caused by fermenting pollen, and many cases of supposed Isle of Wight Disease are in reality due to this cause. In the former case it is infectious—in the latter it will not spread if the defect be remedied. *Chilled-brood* and *Paralysis* are caused by damp and cold, though it is probable that many of the deaths attributed to this are really due to an attack of Isle of Wight Disease.

A word of warning and encouragement on one other point must be given. One can seldom keep bees without being stung : the sting of a bee is painful but harmless (except in rare instances), and in time, after several stings, the effect is so slight as to be quite disregarded. It is advisable to wear a veil to protect the face and head, but the hands should be left bare. Their best protection is the gentle, careful manipulation of the bees while attending to them. Those who propose to keep a few stocks of bees only, may proceed in the manner outlined above : anyone intending to keep a large number of stocks is advised to get a season's instruction in a well-managed apiary before laying out capital in the business. In conclusion, it may be remarked that bee-keeping is an interesting and, to some extent, a profitable occupation, but it requires considerable patience and care, without which success cannot be attained.

The preparation of honey for market is dealt with in Leaflet No. 141.

London, S.W. 1,
July, 1905.
Revised, April, 1919.

BOARD OF AGRICULTURE AND FISHERIES.

Winter Egg Production.

The bulk of the eggs produced in late autumn and early winter are laid by pullets, and it is on the number of eggs produced at this time, when prices are highest, that the financial success of most poultry farms very largely depends.

The first steps towards the production of such eggs must be taken in February.

Heavy Breeds.—From the second week in February to the end of the first week in March, eggs from the heavy breeds should be put into incubators and under hens. If they are of good laying strain and have been properly reared March-hatched pullets of the heavy breeds should begin laying in October and continue laying until the following March or April before becoming broody. Pullets hatched *before* March are likely to begin laying in August or September, moult in October and practically cease laying for the rest of the year. Pullets of heavy breeds hatched *after* March cannot be relied on to lay until near Christmas.

Light Breeds.—Eggs from the light breeds should be put down for hatching from the second week in March to the end of the first week in April. These will hatch in April, and, under suitable conditions, the pullets will begin to lay at the same time as the March-hatched pullets of the heavy breeds.

The results obtained will depend on three factors: (1) Breed, (2) Strain, (3) Conditions (including management).

(1.) **Breed.**—An examination of the results of recent Laying Competitions in England will show that at the present time the two most profitable breeds *for egg-production alone* are the White Wyandotte and White Leghorn. For those whose object is to produce *both eggs and table birds for their own use*, the Light Sussex, Rhode Island Red, and Buff Orpington may be recommended.

Before making a choice of breed, local conditions should be carefully studied. In cold, flat, badly-drained country White Leghorns and light breeds generally will not lay well in winter unless they have ample scratching space on a dry floor, in a well-lighted house, facing south or south-east.

There are good-laying strains of many other breeds, besides those mentioned. If in any locality it is found that a number of poultry keepers are doing well with any particular breed, it will generally be safe to follow their practice.

(2.) **Strain.**—Strain is more important than breed. It is quite possible to find flocks of chance-bred White Wyandottes which will be no more productive than a flock of barndoor hens. A study of Laying Competition results will show the enormous difference between such birds and those of the best "bred-to-lay" strains. In making the choice of a strain much the same judgment is required as is exercised by an expert breeder in the choice of birds for his breeding pen. Egg records are important, but soundness and stamina are equally so. A little time and money spent at the start in discovering where to obtain the best stock, satisfactory in all these points, will be repaid many times by results.

(3.) **Conditions—Including Management.**—The difference in the results to be obtained from good and poor strains is no greater than the difference in results due to good and bad management. Success in utility poultry-keeping depends on careful and intelligent attention to a considerable number of small details: there is not much "luck" about it. What appears to be due to "good luck" is nearly always due to good management, and "bad luck" to bad management.

For winter egg production it is essential to have clean, dry, well-ventilated houses with floors covered with loose dry litter, in which the birds can get exercise in bad weather: it is necessary that the birds should have plenty of exercise, and not perpetually suffer from cold feet. (For information on poultry houses see Leaflet No. 294.)

OTHER ESSENTIALS.—Other essentials are :—

(*a.*) Food of the right kind, in the right quantities, given at regular times. (Information on this subject will be found in Leaflet No. 114, *The Feeding of Poultry*.)

(*b.*) Plenty of clean fresh water—slightly warmed in very cold weather.

(*c.*) Abundance of grit, and some calcareous material for shell production.

It is difficult to exaggerate the importance of hatching at the right time in order to get the highest output of eggs in winter. To make certain of the best results it is best to use incubators. Incubator-hatched and brooder-bred chickens if well looked after, will thrive as well as, if not better than those hatched and reared by hens.

The important small details of management can only be learned by practical work. Very valuable help can often be got by a visit to a fellow poultry-keeper, and in many counties the Educational Staff includes a Poultry Instructor or Instructress, who will gladly give help or advice.

London, S.W.1,
February, 1905.
Re-written, January, 1918.

Copies of this leaflet may be obtained free of charge and post free on application to the Board, 3, St. James's Square, London, S.W.1.

Leaflet No. 130.

BOARD OF AGRICULTURE AND FISHERIES.

Navel Ill and Joint Ill in Newly-born Animals.

This disease is met with, under such local names as Big Joint, Joint Evil, Schooley, in most parts of the British Isles.

Cause.

The disease is caused by the entrance into the system of the newly-born animal, through its unclosed navel, of germs which may give rise to the formation of pus or matter. It is possible, however, that germs which are not pus-forming, but which may cause serious illness in animals, may also enter the system by the navel wound. These germs are widely distributed in nature, but are found in greater numbers and probably in a more virulent form on those spots frequently soiled by animals, such as farmyards, lambing yards, &c., than in the fields. For this reason permanent foaling and calving boxes and lambing sheds or sites for temporary yards used continually are more dangerous places than the pastures.

Symptoms.

Affected animals are noticed a few days after birth to be moving stiffly and to be disinclined to walk or suck. They lie down continually, and with difficulty are got on to their legs. Their joints begin to swell, and often it is apparent that abscesses have formed—the hock, stifle, point of the shoulder and knee being the joints usually affected. In the worst cases abscesses form in different parts of the body (particularly the kidney and liver), and the lamb dies from exhaustion or from the poisons produced by the germs of the disease. Other germs which do not necessarily cause Joint Ill may give rise to blood-poisoning, and kill the lambs more quickly, with symptoms of brain trouble and diarrhœa.

Prevention.

Every outbreak on a farm may add to the number of these germs, and so increase the probability of future attacks. On the other hand, if outbreaks are prevented, the germs become fewer in number.

Efforts must then be made to prevent the occurrence of cases on a farm by preventing the germ gaining access to the navels of newly-born animals, and to the system through the imperfectly closed navel. In foals and calves this object is best attained by ligaturing the umbilical cord (navel string) immediately after birth with a piece of strong string which has been soaked in 5 per cent. solution of carbolic acid in water or in any equally effective disinfectant and by applying a disinfectant to the navel in the form of an ointment or in solution.

If an affected animal is housed in a building, the final disinfection of the building and the litter after its removal must be very thorough.

As this disease among lambs more often assumes epizootic characters than among foals and calves, the preventive measures to be adopted to safeguard lambs are given in greater detail.

1.—A site for lambing the ewes must be chosen as free from infective material as possible, and there is no doubt, other things being equal, that ewes lambing in the fields rear a greater number of lambs than those in temporary or permanent lambing yards. Shelter, if necessary, can be provided by strawed hurdles set up about the fields in the form of a cross, or arranged to break the prevailing winds. The lambing field should, if possible, be changed each year.

2.—The system in vogue in some counties of passing the whole flock of ewes, if a big one, through one lambing yard cannot be too severely condemned. A large flock should be split into as many divisions as convenience will allow ; it is then possible to confine disease to the division in which it occurs. If the lambing yard system is adopted it is imperative that a fresh site should be chosen each year.

3.—All dead lambs and the membranes in which they are born should be buried promptly. Straw on hurdles and for bedding should be renewed occasionally, and hurdles should be lime-washed. Manure and straw from hurdles should be placed in a heap and burned, and should never go on to sheep pastures. At the end of the season the site of the yard should be sprinkled with lime and the hurdles lime-washed.

4.—Care should be taken that the shepherd does not carry disease from ewe to lamb or from lamb to lamb. A shepherd's hands must be continually and scrupulously cleansed with soap and water. They must also be disinfected, nails being kept short and scrubbed with a nail brush. His clothes should be covered with a lambing coat which should be frequently washed and disinfected. Dead ewes or lambs should not be skinned by the shepherd.

5.—A little disinfectant should be applied to the navel of each lamb immediately after birth. Stockholm tar has been found useful for this purpose.

6.—A ewe which has given birth to a dead lamb should not be allowed to run with the healthy ewes and lambs. If a ewe loses her lamb from this disease it is not safe to "mother" a fresh lamb on to her, as this lamb often becomes attacked. The expedient of putting the skin of a ewe's dead lamb on another to be adopted by her should on no account be resorted to.

7.—Ewes which have lost their lambs should be carefully watched, as it is possible that germs from the lamb may have found their way into her teats and produced inflammation of the udder, which, if it does not kill the ewe, will probably prevent the gland secreting milk in the future, and so render her unfit to breed again.

8.—The site of the lambing yard in which diseased lambs became infected should be immediately changed and the hurdles re-strawed and disinfected. If an infected field is believed to be responsible, the sheep should be moved on to fresh ground. In this way it is possible to avert a serious outbreak.

Treatment.

The disease in foals and calves should be treated by a veterinary surgeon, for the animal's life and future usefulness often depend on careful nursing and skilful administration of drugs, while surgical knowledge is indispensable when it is necessary to open deep-seated abscesses.

When the disease appears in lambs the advice of a veterinary surgeon should be sought as regards treatment of the affected, prevention of spread of the disease in the flock, and means to avoid unnecessarily soiling the farm.

If the smallness of the flock or distance from a veterinary surgeon renders veterinary advice out of the question, the following measures should be adopted.

The affected lambs, with their mothers, should be isolated on a spot not likely to be used for sheep for some time. If only a few lambs are attacked it will be found cheaper to kill them and dry off the ewes, as only a small percentage of survivors grow into sheep which show a profit. If a large number are attacked, it is then worth while employing a man to nurse them who does not go near the healthy flock.

The symptoms should be treated as they arise. Superficial abscesses should be opened with a sharp knife and then washed with a disinfectant. The evacuated matter should always be disinfected. The udders of the ewes should be carefully examined for the lambs sometimes infect them. Bottle feeding will be necessary for the worst cases, and care must be taken that a lamb does not lie always on one side, as the limbs of that side are likely to waste or become paralysed.

London, S.W.1,
February, 1905

Revised, September, 1912.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 131.

BOARD OF AGRICULTURE AND FISHERIES.

Apple and Pear Scab (*Venturia inaequalis*, and *V. pirina*).

Scab is probably the most general and most widely distributed fungus disease which attacks apples and pears. The well-known black blotches or scabs on the fruit caused by this fungus are familiar to everyone (Figs. 1 and 2).*

In this country the disease causes an enormous amount of damage in apple orchards and plantations; the annual losses amounting to many thousands of pounds. During certain seasons entire crops are much depreciated in value and even rendered unsaleable. Scab is a disease, however, which can be perfectly controlled if growers will take the trouble to carry out the necessary treatment of spraying.

Although the fungi causing apple and pear scab respectively are different species they are very closely allied. The general appearance and method of treatment are the same in each case so that separate descriptions of the two diseases are unnecessary.

Description.—*On the Leaves.*—The first active stages of the fungus-attack appear on the leaves during the early spring. The general appearance at this stage varies according to the variety; in every case the part of the leaf which actually bears the fungus becomes a dark olive green or sooty colour. Sometimes the fungus confines its attack almost entirely to the veins of the leaf, while in other cases it forms distinct and sharply marked patches scattered over the surfaces (Fig. 3). The spores, which are produced on these sooty patches in enormous numbers, are distributed by air currents, and in this way spread the infection to other leaves, young fruit and also new wood. It is most important to remember that the early infection of the fruit takes place almost entirely from the leaves, hence unless these are kept healthy a clean crop cannot be expected.

On the Fruit.—Figure 1 depicts the disease as it occurs on the fruit. The spores alighting on the fruit germinate and penetrate the skin, beneath which they form a mass of fungus tissue or "mycelium." This does not, however, grow deeply into the flesh of the fruit, but spreads immediately beneath the surface. In course of time the covering skin of the fruit is broken, with the result that thousands of dark coloured spores escape from the open wound or scab. At the margin of the scab the silvery fragments of broken skin may often be seen. The extent and nature of the injury depend largely on the date of infection and the variety of apple or pear. When attacked quite young the fruits are often much distorted and may even be injured to such an extent that they fall off. In other cases, especially with pears, more or less severe cracking takes place (Fig. 2). If the attack occurs late in the season the fungus does not make so much headway, small scabs or spots only being formed.

The spores produced on the fruit, as in the case of those formed on the leaves and wood, may infect leaves, young twigs, or other fruit. From this it will be noted that the fruits of apples and pears are subject to infection right through the growing season. Susceptibility to fresh infection ceases when the growth is completed and the fruits are picked and stored.

The Board are indebted to the courtesy of Mr. E. S. Salmon, South Eastern Agricultural College, Wye, Kent, for permission to use figures 2, 3 and 4. For more detailed description of the scab fungus Mr. Salmon's article in the Board's *Journal* (Vol. XV., 1908–9, pp. 182–195) may be consulted.

On the Wood.—For many years the manner in which the scab fungus lived through the winter was unknown. The matter has, however, been recently investigated at Wye College and it has been clearly established that the fungus passes the winter in a dormant condition on the young wood of many varieties of apples and pears. These diseased shoots provide for the initial infections the following season. Affected wood is readily distinguished by its blistered appearance (Fig. 4) due to the formation of numerous, small, cushion-like growths of mycelium, just beneath the bark. These cushions remained dormant during the winter. As soon as the spring arrives they recommence growth and finally liberate thousands of spores which infect the young leaves and thus start afresh the life-cycle of the fungus. The infected wood varies considerably in appearance with the variety of apple or pear, the blisters being large or small, scattered as in Cox's Orange Pippin (Fig. 4), or crowded together, as is often the case with Lord Suffield. So far as is possible this scab-infected wood should be cut out when pruning the trees in winter.

The fungus is probably capable of existing in the wood of most varieties of apples and pears, but it is known to occur plentifully on the following :—

Apples.—Councillor, Cox's Orange Pippin, Cox's Pomona, Ecklinville Seedling, Lord Suffield, Gladstone, Warner's King, Wellington, White Transparent, Yellow Ingestre.

Pears.—Beurré Bosc, Beurré Diel, Clapp's Favourite, Doyenné Boussoch, Doyenné du Comice, Jargonelle, Le Lectier, Marie Louise, Pitmaston Duchess, St. Germain.

The young wood of Cox's Orange Pippin and Lord Suffield amongst apples is often severely crippled by scab, but on other varieties the occurrence of this stage of the disease is to be dreaded more from the spring-infections which it causes than from any actual damage to the wood.

Nature of Damage.—In addition to the loss due to cracked and deformed fruit and to the disfigurement of less infected specimens, apple scab causes a considerable amount of damage in a way less familiar perhaps to many growers. Scabbed fruits keep badly. They shrivel and in many cases, as the result of moulds and other fungi entering through the scab wounds, they rapidly decay. Once a fruit becomes rotten any sound specimens which it touches become similarly affected. In this way considerable loss in storage may be incurred.

Susceptibility of Varieties.—The degree of intensity with which the fungus attacks the fruit varies considerably. Difference in variety, soil, locality, and seasons are all determining factors. Whilst all varieties are probably more or less subject to scab, the following may be mentioned as liable to attack wherever grown :—

Apples.—

Bismarck,	Keswick Codling,	Quarrenden,
Cox's Orange Pippin,	King of the Pippins,	Warner's King,
Cox's Pomona,	Lord Grosvenor,	Wellington,
Duchess's Favourite,	Lord Suffield,	Yellow Ingestre.
Ecklinville,		

Pears.—

Beurré Clairgeau,	Duchesse d'Angoulème,	Souvenir de Congress,
Beurré D'Amanlis,	Glou Morceau,	Vicar of Winkfield.
Doyenné du Comice,	Pitmaston Duchess,	

The following varieties of *apples* are more or less resistant :—

Beauty of Bath, Bramley's Seedling, Grenadier, Lane's Prince Albert, and under ordinary conditions need not be sprayed.

FIG. 1.—Affected apple showing small scabs.

FIG. 2.—Affected pears. The fruits are badly scabbed and as a result are cracked and deformed. The black blotches on the leaf indicate infection of the leaves from which the fungus spreads to the fruit.

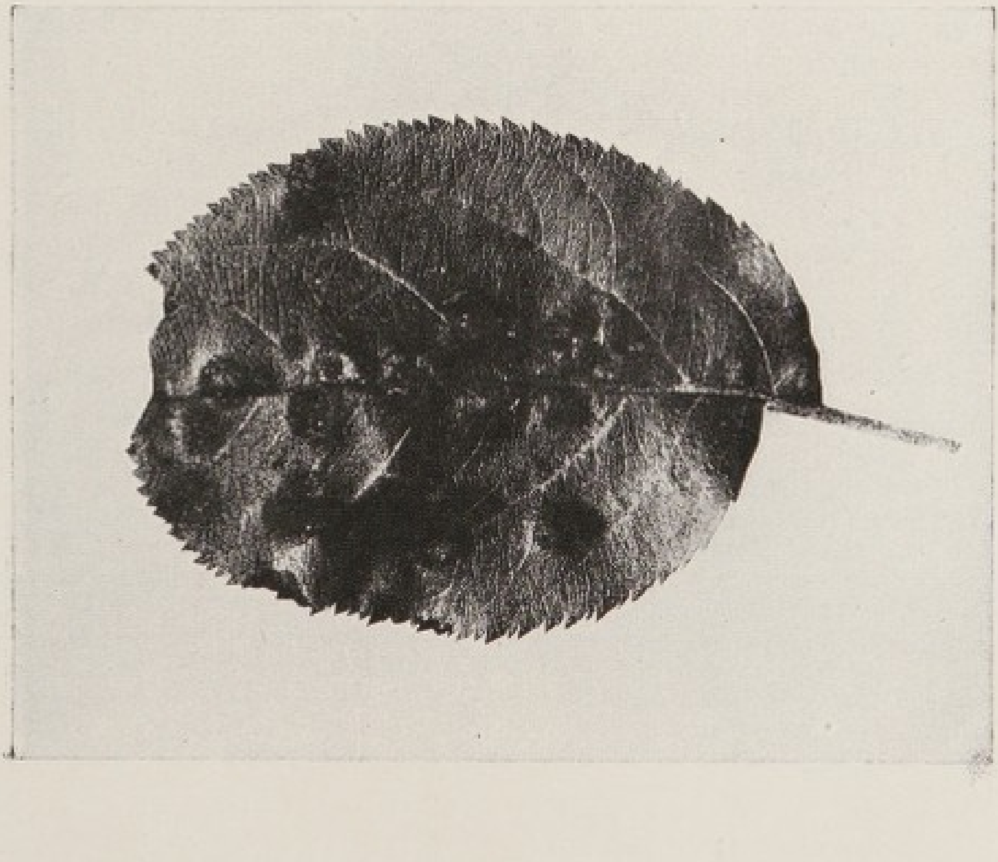

FIG. 3.—Infected apple leaf—Warner's King.

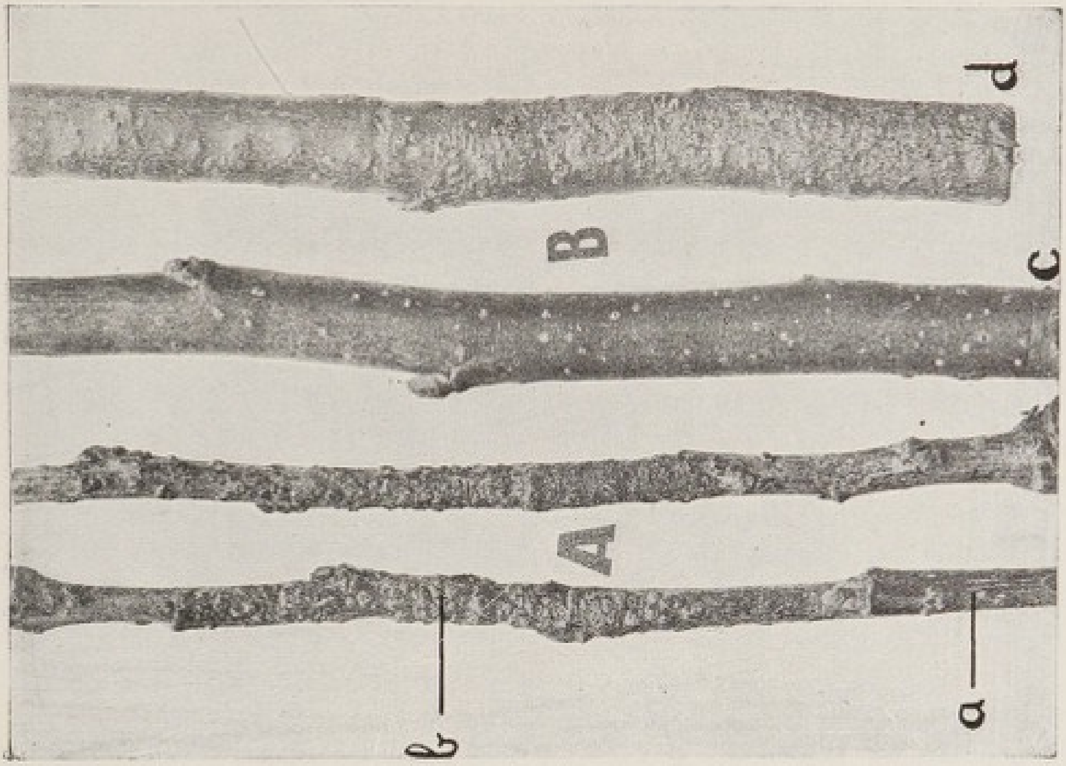

FIG. 4.—Young wood infected by the scab fungus.
A. Cox's Orange Pippin (a) healthy wood, (b) diseased wood.
B Wellington (c) healthy wood (d) diseased wood.

Control.—In cases where the young wood is affected with the scab pustules, the diseased shoots should be cut out as far as possible. It is doubtful if any really good results are obtained from the winter spraying often recommended, as lime-sulphur and the usual winter washes do not kill the scab-pustules. To prevent the disease obtaining a foothold on the foliage it is absolutely necessary to spray the trees in spring with a summer spray.

Spraying.—There are two mixtures which may be used for spring and summer control, namely Bordeaux Mixture and Lime-sulphur* (Burgundy Mixture has *not* been found suitable). Lime-sulphur is the most easy to prepare, but Bordeaux Mixture is undoubtedly the most effective, though in the case of a few varieties of apples it is apt to cause scorching. These varieties include :—Beauty of Bath, Cox's Orange Pippin, Duchess's Favourite, Gladstone, Lady Sudely, Miller's Seedling. On all of these a lime-sulphur spray only should be used. Bordeaux Mixture is safe to use on all varieties of pears and can be relied upon to prevent scab.

Application of Mixtures.—The dates at which the mixtures should be applied are of considerable importance. In very bad cases of *apple* scab two or even three applications are necessary, the first immediately before flowering, the second as soon as the petals fall, and the third about three weeks later. As a rule, except in bad attacks, the first spraying may be omitted. Where labour and time necessitate one spraying only, the third should be omitted in preference to the second. On *pears* the first spraying should be given directly the fruit is set and a second spraying three weeks or a month afterwards. The under surfaces of pear leaves should be sprayed as far as possible.

The spraying should be carried out on a still day, and the mixture applied through a fine nozzle with a strong pressure and the leaves uniformly wetted with a very fine mist. Spraying should cease before the leaves begin to drip.

Preparation of Bordeaux Mixture.—The best formula for apple spraying in this country is: Copper sulphate, 4 lb., best quicklime (in lump form), 4 lb., and water, 50 gallons.

The copper sulphate† should be dissolved in a small *wooden* vessel at the rate of 1 gal. of water per 1 lb. of sulphate (iron or tin vessels must not be used). The lime should be slaked to a fine paste with a little water in another vessel, and water added gradually to make a milk, and finally diluted in a large barrel to the requisite amount (46 gal.). The

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* If caterpillars are likely to prove troublesome, lead arsenate paste may be added to either of these mixtures at the rate of 1 lb. to 20–25 gal. of the mixture. Further details as to the use of this substance, which it should be remembered is highly poisonous, will be found in Leaflet No. 4 (*Winter Moths*).

† Growers are strongly advised to buy their own copper sulphate and lime, and prepare their own mixture. It is of great importance also that only pure copper sulphate be used and a guarantee of 98 per cent. purity should be obtained.

4 gal. of copper sulphate may now be poured slowly into the diluted milk of lime and the mixture stirred thoroughly during the process. The two solutions may be kept separately for a long time, but after mixing the solution should be used as soon as possible—at all events within 24 hours.

It should be remembered that fresh quicklime is essential for making Bordeaux Mixture and that the air-slaked lime so often found in builders' yards is useless for the purpose. When used on a large scale it may be convenient to make up *stock solutions* of each ingredient which may be diluted down and mixed as required. For this purpose 50 lb. of copper sulphate may be dissolved in 50 gal. of water, and 50 lb. of lime, slaked and diluted to 50 gal. of milk of lime. Each gallon will then represent 1 lb. of copper sulphate and 1 lb. of lime. When required for use, the barrels should be thoroughly stirred and the requisite number of gallons taken out and diluted according to the above formula. For a 50-gallon barrel, for instance, 4 gal. of lime-milk should be removed and diluted with 42 gal. of water and when thoroughly stirred and strained the 4 gal. of copper solution may be slowly added.

Safety test for Bordeaux Mixture.—If the copper sulphate and quicklime have been accurately weighed out and properly mixed there is no need to test the Bordeaux Mixture before use. Should there, however, be any doubt on this point a simple and reliable test is the use of a bright blade of a knife which, however, must not be greasy. The blade should be immersed in the liquid for at least a minute ; if at the end of this time the blade remains unchanged in appearance the mixture may safely be used, but if it assumes the yellow colour of copper more lime must be added.

Lime-sulphur.—This fungicide should always be used for delicate varieties such as those noted above (p. 5), and it may also be resorted to in cases where it is not convenient to prepare Bordeaux Mixture. It has the great advantage over the latter in that the concentrated wash may be purchased ready-made in large or small drums so that it is only necessary to dilute it to the proper strength. Numerous brands of lime-sulphur of a guaranteed strength of 1·3 sp. gr. are on the market and these are to be preferred to those of which the strength is not guaranteed.

For spraying against scab "summer-strength" lime-sulphur, namely 1 gal. of concentrated solution mixed with 29 gal. of water, should be used. The lime-sulphur should be poured slowly into the water, stirred well, and used at once. It must be noted, however, that Cox's Orange Pippin is particularly sensitive, and for this variety, and also for Wellington, half "summer strength" is necessary, namely 1 gal. to 59 gal. of water.

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Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 132.

BOARD OF AGRICULTURE AND FISHERIES.

Slugs and Snails.

Slugs (Family *Limacidae*) and Snails (Family *Helicidae*) belong to the class of Invertebrate (without a backbone) animals known as MOLLUSCA; they live entirely on land. The majority of snails prefer a green diet, *i.e.*, living plants of all kinds. Many slugs also live upon green plants but others prefer dry vegetable and animal substances and take green matter only when compelled to.

Slugs are very destructive to crops. Fields of cabbage and wheat have been destroyed; in a case reported from Yorkshire in 1909 half the crop of barley and oats was destroyed and the grass fields were seriously damaged by the grey slug. Sometimes in gardens it has been impossible to grow a crop of early peas or beans; young potato sprouts are eaten; flowering plants of many kinds have been attacked; and the blooms and young fruitlets of gooseberry suffer severely.

Snails have a spiral shell into which the whole animal can be withdrawn. There is no horny lid on the snail's "foot" to close up the opening of the shell like that on the foot of a whelk, but after a snail has withdrawn itself into the shell for the winter the opening can be closed by a plate composed of a mixture of lime and the slimy substance known as mucus exuded by a part of the mantle called the collar.

Except in the genus *Testacella*, where the beginnings of a shell are found at the hind end of the body, slugs have no external shell. Most species, however, have an undeveloped plate-like shell or at least a few limy granules hidden below the skin of the back. The region over this shell is known as the "shield."

Snails and slugs have a fairly well developed head region, and a muscular "foot" on which they crawl. They also possess a rasping tongue-like ribbon known as the "radula"; this radula" bears rows of horny teeth, and under the microscope resembles a file; it is worked by muscles, and is used to scrape off particles of food. On separating the lips of the snail a horny crescent-shaped jaw can be seen on the roof of the mouth; this acts with the rasper, and enables the animals to cut leaves and leaf-stalks.

Both slugs and snails have male and female sexual organs in the same individual. Eggs are laid on or in the soil, or under heaps of leaves, or under stones. The young snail or slug resembles the adult externally.

Slugs and snails usually work at night or dusk, but in damp weather or after heavy rain they may be found in numbers in the daytime.

Slugs.

The commonest slug is the *Grey Field Slug*, which may be found in almost every garden and field in Great Britain.

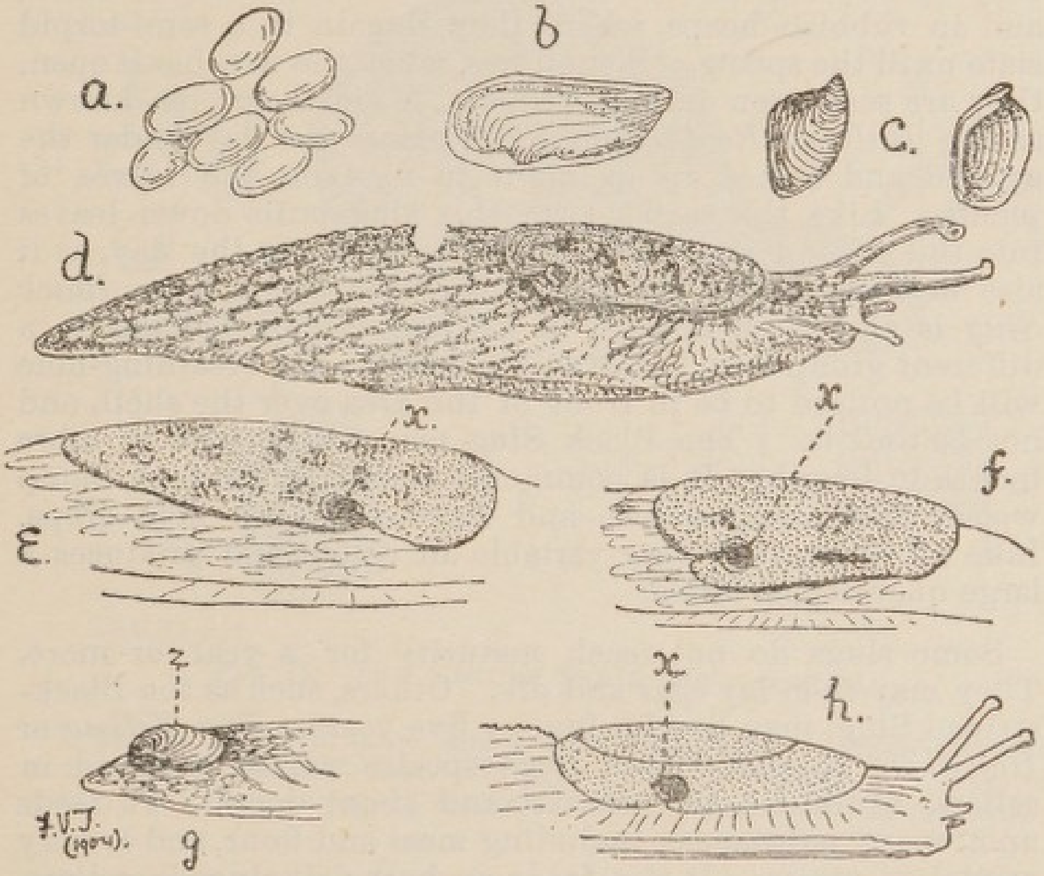

FIG. I.—CHARACTERS OF SLUGS.—*a.* Eggs; *b.* Shell of Slug (*Limax*); *c.* Shells of *Testacella*; *d.* Grey Field Slug (*Limax agrestis*); *e.* Shield showing respiratory pore (*x*) of an *Arion*; *f.* of a *Limax*; *g.* Tail end of a *Testacella* showing shell (*z*); *h.* Shield showing respiratory pore (*x*) of *Milax.*

It is one of the most prolific species of its race. A single individual is capable of laying as many as 500 eggs during the year. This slug resembles in general structure all other species. The upper portion of the body is long and rounded above, whilst the lower portion is flat and forms the so-called "foot." On the back will be seen an oval area which marks the site of the hard, thin shell-plate hidden under the skin. The hole seen at the edge of this area is the breathing pore. The grey slug lays its eggs in the earth and under rubbish, &c., from May to November. The eggs are round, milky, opaque bodies, and are deposited in batches of from six to fifteen. In from three to four weeks they develop into young slugs. When first hatched they are only one-twelfth of an inch long, and are very pale and soft. In common with other slugs, the grey field slug loves moisture. It works chiefly at night, and hides away during the day under stones, &c., and in the soil or under clods of earth when young. A shower of rain, however, soon brings it out during the day.

Slugs may be found at all times of the year, but in winter they usually take shelter under stones or logs, in the earth, and in rubbish heaps, where they remain in a semi-torpid state until the spring. Sometimes, when the weather is open, they are seen even in mid-winter. A small species, known as the *Bulb* or *Root-eating Slug*, passes the day under the ground and comes up at night to feed on the leaves of plants. Like the earth-worm, this slug pulls down leaves into the ground and feeds upon them during the day, as it also does upon any roots or bulbs near it. A large *Black Slug* is also often noticed in gardens. This belongs to a different group from the Grey Field Slug; the breathing-hole will be noticed to be in front of the area over the shell, and not behind it. The Black Slug may reach four or more inches in length. It is commonly found in gardens, damp woods, and along dykes, and seldom attacks field crops. Like all slugs, it is very variable in colour and produces a large quantity of slime.

Some slugs do not reach maturity for a year or more. They may then lay eggs and die. Others, such as the Black-striped Slug, may live for four or five years. The *Yellow* or *Household Slug* is also a large species which is found in cellars, sculleries and dairies, and about doors. It feeds upon many substances, including meal and flour, and is very partial to cream. It also feeds on beer drippings in cellars. It is of a dull yellowish colour, frequently speckled with white and black, and has a bluish head and tentacles.

Slugs of the genus *Testacella* may be recognised by their small external shell. They feed on worms and small animals which get caught in the teeth of the rasping ribbon and are then drawn into the mouth.

Snails.

Snails usually feed above ground and so can be more easily destroyed than slugs.

The *Large Garden Snail* is one of the most widely distributed species and is very common in gardens. It is the largest garden species and is easily distinguished by its brown shell marked with pale zigzag lines. Eggs are laid in small batches in the earth, about 60 to 70 in each heap. Snails' eggs are white, shining, globular bodies and hatch in about 15 days. The young snails have very thin, transparent shells and grow rapidly. At the approach of cold weather they come together in heaps amongst rubbish in rockeries and ferneries, amongst the exposed roots of trees, and at the foot of hedgerows. They often occur in

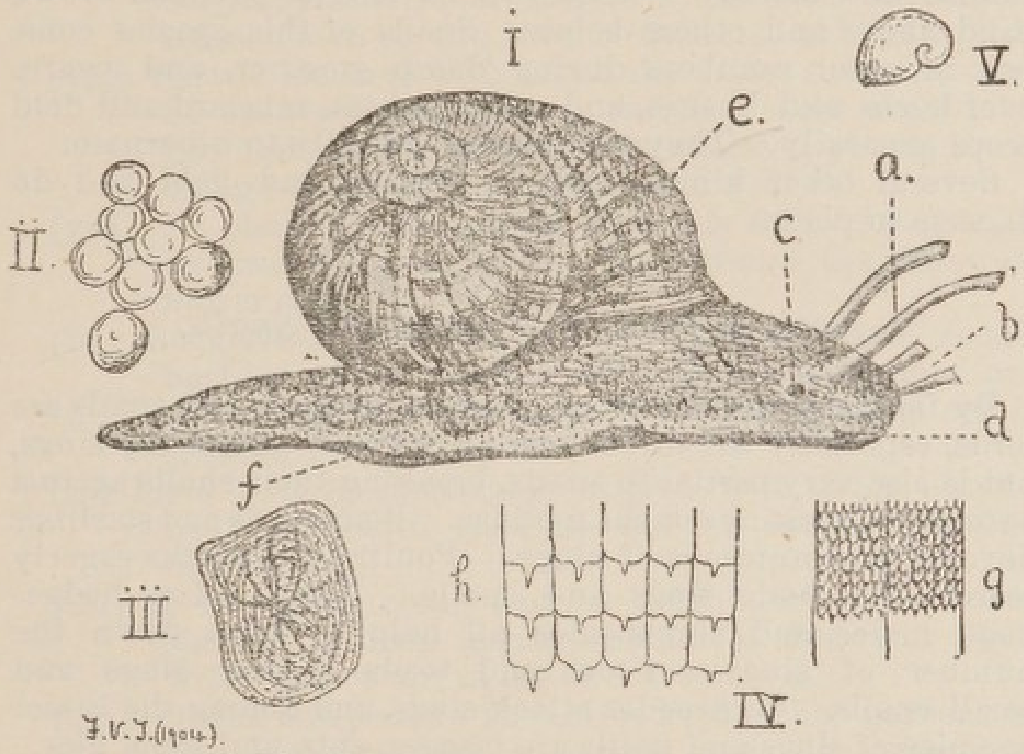

FIG. II.—THE GARDEN SNAIL (*Helix aspersa*).

I. Mature snail; *a.* large, and *b.* small tentacles; *c.* genital aperture *d.* mouth; *e.* shell; *f.* foot. II. Eggs. III. Epiphragm. IV. Part of radula; *g.* a piece enlarged; *h.* teeth further enlarged. V. Young snail.

large masses united by the so-called epiphragms, *see* Fig. II., which they form to close the mouth of the shell.

Clover, sainfoin and upland pastures are often attacked by the *Wood Snail.* This is one of the first to make its appearance in the spring. The shell is very variable in colour, being white, grey, pale yellow, pink, and brown, with one to five spiral brown bands and a black edge round the mouth.

The *Strawberry Snail* is a small snail, seldom more than half-an-inch long. It is essentially a garden pest and is particularly troublesome in strawberry beds and amongst violets. Iris and other garden plants are frequently ruined by it. The shell is much flatter than in the common large snails and is dirty-grey, reddish-brown or brown in colour, with numerous brown transverse streaks and a white spiral band around the last whorl. It feeds at night and is seen during the day only after rain. The eggs are laid between August and November, and hatch in from 20 to 25 days. Each snail may lay as many as 60 eggs, either in or on the ground. They hibernate like the large garden snail.

In fields and gardens near the sea the *Small Banded Snail* is one of the worst culprits. It is also found further inland and especially along "down-sides." The shell is conical and creamy white, with a single purplish-brown band above and others below. Snails of this species come out in great numbers during damp weather, and swarm over herbs and bushes, and attack wheat, mustard and field crops generally. They never seem actually to hibernate.

Several other kinds occur in garden and field and do damage to plants.

Natural Enemies of Slugs and Snails.

By far the greatest natural enemies to slugs and snails are birds, especially the thrush, which not only eats many slugs, but is also very partial to snails, breaking their shells against a stone and picking out the mollusc. Blackbirds and starlings devour large numbers of slugs. Poultry and ducks eagerly search for both slugs and snails. Rats, voles, hedgehogs, moles and shrew-mice all help to keep down the number of slugs. Frogs and toads devour slugs and small snails. Centipedes attack slugs, and among the insect enemies of slugs and snails are beetles, ants, and some flies.

Prevention and Remedies.

The following measures will help to prevent or lessen the attack of these pests :—

(i.) Damp land should be drained.

(ii.) Where slugs are abundant the use of long manure or organic manures generally should be avoided. Artificials should be used *for a time* instead.

(iii.) Dry dressings of some irritant to kill the pests may be tried. (*a*) Soot and lime ; (*b*) salt and lime ; (*c*) lime and caustic soda ; or to act mechanically, (*d*) powdered coke.

The lime should be in a very finely-divided state and quite fresh. *Two or three dressings should be given*, the second some 15 to 30 minutes after the first. A mixture of lime and caustic soda is found to act best—four parts of caustic soda to

96 of lime well mixed. Dry dressings, except powdered coke, should be applied after sunset or very early in the morning.

(iv.) "Rings" of slaked lime or fine ash soaked in paraffin may be put round choice plants. Heavy applications of soot keep off snails.

(v.) Rows of peas, etc., can be protected either by spreading barley sweepings or cinders and lime along the rows, or by applying heavy dressings of slaked lime.

(vi.) In gardens and hop plantations heaps of bran-mash or moist oatmeal or cabbage and lettuce leaves may be placed here and there. These baits attract the slugs, which should then be collected and destroyed.

(vii.) Boards, smeared with fat on the under side, may also be used with satisfactory results; these should be laid along garden beds or in infested places, room being left below for the snails to collect.

(viii.) In plant houses tender blossoms may be protected by twining some cotton-wool round the stem or flower stalk.

(ix.) Rockeries, ferneries, hedge bottoms, and rough herbage at the base of walls should be cleaned out in winter and the masses of hibernating snails crushed.

(x.) Land that is thoroughly fouled with slugs should be treated with gas-lime and be deeply trenched in winter.

(xi.) If the pests come from a neighbouring copse or spinney, a deep trench should be dug and filled with lime or tar, in order to trap them.

(xii.) Ducks and poultry should be kept in hop gardens in late autumn, and in spring, and also whenever possible should be penned on garden land.

(xiii.) Thrushes should be encouraged. It is easier to keep them off the fruit than to suppress the snails and slugs which they largely devour.

London, S.W.1,
March, 1905.
Amended, September, 1917.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 133.

BOARD OF AGRICULTURE AND FISHERIES.

Powdery Mildew of the Vine
(*Uncinula spiralis*, Berk. and Curt.).

Description and Life History.

This destructive disease is caused by a minute parasitic fungus, which in the first instance is supposed to have invaded European vineyards from the United States, where it is commonly met with on both wild and cultivated vines. In its native country two kinds of fruit are produced by the fungus—the summer form, appearing as a white mildew on the foliage, and an autumnal form, in which the spores are enclosed in special receptacles, and remain in an unchanged condition until the following season. In this country the summer or mildew form of fruit only has been observed, and this was described by the Rev. M. J. Berkeley so long ago as 1845 under the name of *Oidium Tuckeri*. During the spring the fungus forms very delicate white patches on the upper surface of the leaves, and on young shoots and fruit; as the season advances these patches spread until, frequently, the entire surface of the leaf is covered.

The spores are formed in immense numbers, and remain on the leaf in the form of a white powder until scattered by wind, insects, spraying, &c. If preventive measures are commenced sufficiently early the disease is not difficult to check, but if spores are allowed to mature and become dispersed, success is by no means certain.

Treatment.

(*a*.) On the first appearance of small, scattered white patches of mildew on the upper surface of the foliage, every part of the plant should be sprayed with a solution made by dissolving one ounce of potassium sulphide in three gallons of water. Spraying should be repeated as occasion demands. Even in the absence of any evidence of disease, but more especially if the disease has previously existed in the neighbourhood, all vines should be sprayed. The first application should be made about a fortnight before the flowers expand, the second when in full bloom—care being taken at this time not to use too much force in spraying, in order not to injure the flowers. A third spraying may follow after an interval of three or four weeks if the mildew was present and has not been completely destroyed.

The use of a soluble sulphide for spraying, as recommended above, is preferable to the older methods of dredging with flowers of sulphur, or of placing sulphur on hot pipes. If spraying is properly done, the advantages are: (1) the greater certainty of covering every part of the plant with the solution; (2) greater cleanliness; and, (3) the avoidance of danger from too concentrated sulphur fumes.

Diseased Leaf and Grapes.

(*b.*) The winter form of fruit, the use of which is to start the disease afresh the following season, has not been found in this country, and only on very rare occasions in any part of Europe; nevertheless the fungus possesses the power of living over the winter by means of mycelium which hibernates in the bark and buds of the vine. On the return of spring this mycelium produces the first crop of spores, which on being scattered over the young leaves, soon attain the proportions of an epidemic if not promptly checked.

To ensure the destruction of this hibernating mycelium during the winter, when the vine is resting, the trunk and branches should be thoroughly drenched with a wash consisting of one pound of sulphate of copper dissolved in twenty-five gallons of water. The soil, walls, glass, etc. should also be drenched with this solution, which, it is very important to remember, should only be applied during the winter, before the leaf-buds begin to swell, otherwise the foliage will be completely destroyed.

(*c.*) All diseased leaves and fruit should be collected and burned.

London, S.W.1,
March, 1905.

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BOARD OF AGRICULTURE AND FISHERIES.

Apple Culture.

The information given in this leaflet is not intended to be exhaustive, and in many respects may need some modification according to the general nature of the climate and soil of any given district. It is hoped, however, that sufficient information is given concerning the broad principles of apple culture to prove of substantial assistance to cultivators.

Situation of the Land.

If possible, the land selected should be well above the level of streams, but not so high as to be fully exposed to the prevailing winds. Land that slopes gently to the south-west and is sufficiently sheltered is best, if other conditions are favourable, as land inclining in this direction does not receive the full rays of the sun in the early morning before the temperature has risen, and the blossoms of the trees are, therefore, not so liable to suffer in frosty weather.

The Soil and its Preparation.

Land that will grow good wheat will grow good apples. Very light sandy soil should be avoided, as should also heavy clays. It is most important that the land should be free from weeds previous to planting the trees, as it is impossible to clean it after they are planted.

Draining.—If necessary the land should be drained, but this point may be decided by digging trial holes 3 ft. deep in various places. After a good rain the holes should be inspected. If water has collected in them the land must be drained, but if they are practically dry draining will not be necessary. If draining is to be done, 2-in. drains should be laid, making them about 2 ft. to 3 ft. 6 in. deep, varying the depth of the drain according to the nature of the soil. The drains on heavy land should not be so deep as those on a lighter soil. Very deep drains are not so effectual in carrying the surface water from heavy land. The lateral drains should be formed across the slope, if possible, terminating in a main drain of 3-in. pipes for an area of not more than four acres. If a larger area is to be drained, the main towards the lower part should be of pipes proportionately larger. The distance between the lateral drains should vary according to the texture of the land, but two lineal rods is a very convenie...

distance, and is generally effectual in medium land; 15 to 18 feet will be more suitable for heavy land. The drains should, if possible, be so arranged that they are between the rows of trees, and they should all be perfectly straight. The main drain should be slightly deeper than the laterals, the latter being connected with the top of the main. Lateral drains should not be at right angles to the main, but inclined in "herring-bone" fashion. If lateral drains must run at right angles to the main, a few feet near the junction should be inclined, otherwise the main drains may choke.

Manuring and Cultivating.—The land being drained, the next step is to manure and cultivate it. It is a mistake to make the land very rich for young trees. They are not capable of taking up large quantities of plant food; indeed, if the land is too heavily manured, they develop soft and coarse wood which ripens imperfectly. Soil that will produce good crops of cereals will grow apples well if a moderate dressing of manure, say 20 tons per acre, is applied for the young trees, followed by additional supplies when they are carrying heavy crops of fruit. The land should be cultivated to a depth of at least 18 in., either by trenching, by sub-soiling, or by steam scarifying. The last named is the cheapest method for large areas.

Protecting the Trees.

Hedges of damsons may be planted around the area to protect the trees from the wind, but if the land is of a heavy nature, black Italian poplars may be substituted for the damsons. The poplars should be cut in close and topped every year, thus forming a very stiff wind screen. In very exposed places a double row of Scotch or Austrian pines will be found effectual, but these will require more room than the poplars. If standards only are to be planted, wire netting may be placed around each of the trees as a protection against rabbits, or against sheep if planted in grass, but if a mixed plantation is to be formed it will be preferable to enclose the whole area.

Selecting the Trees.

The trees should be selected during the latter end of summer. The ordinary standard is the most suitable if the land is eventually to be used for grazing purposes; but low or bush trees may be planted more thickly, while they also give quicker returns. If possible, the intending purchaser should visit the nursery and inspect the trees previous to purchasing, thus avoiding, to some extent, the risk of getting unsatisfactory trees. No hard and fast line can be laid down as to the exact varieties to plant in various localities, but great care must be exercised to obtain the trees on suitable stocks. The crab is, in general, the most suitable for standard trees, and the Doucin or broad-leaved Paradise for bush trees; but the very free-bearing kinds, such as Lane's Prince Albert, do well as bush trees on the crab.

Types of Trees.

Two forms of trees, viz., the standard and the bush, are generally used for orchard planting, either separately or together. The bush trees give quicker returns and produce finer fruit than the standards, while the latter last longer, and, in favourable seasons, produce large crops of medium-sized fruit. To form an orchard that will serve the double purpose, viz., give quick returns and last for a long period, it will be advisable to plant standards with bush trees between. Standards may be planted 30 ft. or 36 ft. apart, with bush trees between, 10 ft. or 12 ft. apart. The distance between the trees must be regulated by the space required according to their habit of growth and the general character of the soil. The bush trees will commence to bear the second season after planting, and may be expected to produce good crops until the standards grow them out; the latter will not fruit so quickly, but will in time produce large crops of useful fruit. The average quality of the past will not withstand the keen competition of the present and, as the bush trees can be planted more closely, give quicker returns and produce fruit of finer quality and appearance than the average standard, the planter will do well to consider his line of action before purchasing. The matter may be summed up as follows :—

Standards give but small returns the first few years, but last a long time if properly managed, and, in favourable seasons, yield good crops of fruit; but the crops are often severely reduced by wind.

Bush trees give quick returns, the fruit is generally clean, good in quality and appearance, and larger than that of a similar kind grown on standards.

Standards and bush trees mixed give crops extending over a long period, the heaviest early crops coming from the bush trees, and a long continuous supply from the standards when once they are brought into a fruit-bearing state.

*Kinds to Plant.**

COOKING.

Standards.	Bushes.
Beauty of Kent.	Bramley's Seedling.
Bramley's Seedling.	Ecklinville.
Ecklinville.	Golden Noble.
Gascoyne's Seedling.	Lane's Prince Albert.
Grenadier.	Potts' Seedling.
Lord Derby.	Sandringham.
Lord Grosvenor..	Stirling Castle.
Newton Wonder.	Warner's King.
Wellington.	Newton Wonder.
	Bismarck.

Ecklinville and Wellington should not be planted as standards on heavy land.

* A statement showing the best varieties for planting for market purposes in different districts of Great Britain was published in the Board's *Journal* in April, 1908. (The *Journal* may be obtained direct from the Offices of the Board, price 4*d*. per month, post free.)

DESSERT.

Standards.	Bushes.
Adams' Pearmain.	Adams' Pearmain.
Blenheim Orange (slow to come into bearing).	Allington Pippin.
Christmas Pearmain.	Beauty of Bath
Devonshire Quarrenden.	Christmas Pearmain.
Fearn's Pippin.	Cox's Orange Pippin.
King of Pippins.	Lady Sudeley.
Allington Pippin.	King of Pippins.
Worcester Pearmain.	Worcester Pearmain
	James Grieve.

Planting.

October, or early in November, is considered the best time for planting, but the trees should not be removed from the nursery quarters until the ground has been well soaked with rain, or the roots may be materially damaged. To define the position of the trees various methods have from time to time been advocated, many of them taking up a considerable amount of valuable time. All methods aim at one common end—viz., to get the trees into their proper position, and it is a rule that all newly-planted standard trees need staking. If a straight line is taken along one side of the proposed orchard, and another opposite, quite parallel, and one at each end at right angles, the four sides are defined. A stout, whitened stake should be placed at each corner. Stakes for sighting should then be placed at the distances apart that the trees are to be planted all along the four sides in straight lines. Three men should be employed, one directing from one of the base lines, another from one of the lines at right angles, the third to place the stakes to define the positions of the trees. If stakes suitable for the trees are used for this work, they may be driven into the ground firmly, and the holes dug around them for the trees. This method will avoid any further measurement or sighting. If standards are to be mixed with bush trees, care must be taken to place long stakes at the proper places.

The holes should be dug shallow and broad. Any damaged roots of the trees should be carefully pruned *from the under side* before planting, and the trees should be so planted that the roots are just below the surface of the soil. On land inclined to be wet, the roots may be slightly above the ordinary ground level in shallow mounds of earth. The trees should be secured to the stakes, care being taken to use straw bands to keep the trees secure yet quite clear from them, so that they do not get their bark chafed. Mulching with short manure should then follow, this mulching covering a space equal to the size of the hole before planting.

Pruning.

In order to ensure good results, pruning must receive careful consideration and be judiciously carried out. The question is fully dealt with in Leaflet No. 252 (*Pruning of Fruit Trees*).

Manuring.

Sufficient plant food or manure should be applied to the trees to keep them in a healthy but not too vigorous state of growth. If they have a tendency to grow strongly, manure must be withheld, but if they carry heavy crops of fruit it is quite evident that the supply of plant food taken from the land by the trees must be replenished or failure will ultimately ensue. If necessary a dressing of farm-yard manure at the rate of 20 tons per acre may be applied each winter, previous to cultivation, between the trees. The manure should extend as far from the stems as the boughs are long. Superphosphate and kainit are valuable plant foods for the apple, and may with safety be applied at the rate of from 3 to 5 cwt. each per acre, in addition to the farm-yard manure, if necessary. The amount applied should be regulated by the growth of the trees and the crops they produce. It is important that the soil should not be allowed to become deficient in lime, on account of the greater susceptibility of the trees to canker and other fungus diseases where lime is deficient. A good dressing of lime from time to time is very beneficial.

Washing.

The trees must be washed in the spring, when the caterpillars of the winter moth* appear—usually about the time the buds begin to burst, from the middle of March to the middle of April. Older trees, infested with lichen, &c., affording protection for many pests in embryo during winter, should be washed about the middle of February as described in Leaflet No. 70 (*The Treatment of Neglected Orchards*).

Sufficient whitening may be added to the winter wash at the time of spraying to define where the wash has actually been applied. This will ensure the whole of the trees being dressed.

Renovation of Old Trees.

The renovation of old-established standard trees is well worth close attention if they are good kinds. If the sorts are not of the best the trees may be headed down and good saleable kinds grafted on to them. Bramley's Seedling

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* The methods of prevention and the washes recommended for use against the caterpillars of the winter moth are given in the Board's Leaflet No. 4. Among the other pests of apple trees dealt with in separate leaflets are Apple Blossom Weevil (No. 15); Apple Sucker (No. 16); Codling Moth (No. 30); Woolly Aphis (No. 34); Fruit Tree Beetle (No. 49); Apple Canker (No. 56); Tent Caterpillars (No. 69); Brown Rot of Fruit (No. 86); Fungus Disease (No. 87); The Pith Moth (No. 90); Mussel Scale (No. 107); Apple and Pear Scab (No. 131); Apple Tree Mildew (No. 204); Apple Sawfly (No. 205); Oyster-Shell Bark Scale No. (210); and Apple Leaf Spot (No. 281).

and Loddington will prove useful cooking kinds for grafting on trees of discarded varieties, while for dessert Allington Pippin and Worcester Pearmain may be used. If the trees are of good kinds, but impoverished, a dressing of 20 tons of farm-yard manure per acre, together with 3 to 5 cwt. each of superphosphate and kainit, should be applied early in the autumn, and should be well dug in if the land is arable. If the land has been laid down to grass the same manures may be applied as a top dressing, but their action will not be so apparent as on cultivated land.

All useless boughs, particularly those growing crossways in the trees, should be removed. When the thinning process is completed there should be room for a man to move freely between the main boughs. The trees should be thoroughly sprayed in February with the caustic winter dressing recommended in Leaflet No. 70, which deals generally with the treatment of neglected orchards.

*Packing and Grading the Fruit.**

Apples of the early kinds should be picked before they are quite ripe. They are not then so liable to bruise in transit as when quite ripe, and, moreover, they will ripen quickly when enclosed in the packages on the way from the grower to their destination; whereas, if allowed to become quite ripe, they would be softer, and would bruise far more freely in transit. The later kinds, that are to be stored, should be allowed to mature, or they will shrivel after they are picked.

The fruit is generally packed in bushel and half-bushel baskets, while some of the most successful growers use small barrels. These are better than baskets, as, the insides being smooth, the fruit does not bruise so freely. For the choicer dessert kinds light boxes may be used, in which case the lids should be fixed and placed downwards. The fruit should then be placed evenly upon what is then the lower part of the box, finishing at the top—which, when the remaining wood is nailed on and the box reversed, proves to be the bottom. The lid, which was originally the bottom of the box, is then at the top, and when removed exposes the carefully placed fruit to the eye of the purchaser. The boxes should be properly branded at the ends.

All fruit when packed should be carefully graded and sorted, so that only apples of an even, uniform size are packed together. At least two sizes should be made from each bulk. Mixed fruit of various sizes is practically unsaleable, more particularly as the foreign supplies are so very carefully sorted as to size.

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* Information as to the grading and packing of fruit and vegetables is given in Leaflet No. 98.

Storing.

For preserving late kinds until selling time a suitable store-house must be erected. Fruit will keep no better in elaborate expensive buildings than in an inexpensive building of thatch and earth. A very suitable building may be made as follows :—

Place a row of posts, about 4 in. square, in a line, 2 ft. apart, say for a distance of 100 ft.; then place a second row parallel, and 12 ft. from the first, inside measurement. The posts should be 5 ft. high from the ground line. Place boards along the outsides of the posts on either side and also at the ends, where suitable doors should be arranged. Dig a ditch on each side of the posts, 3 to 4 ft. from them, and place the earth against the boards. This will prevent the frost from getting in at the sides. Suitable plates and rafters may then be put on to the two rows of posts, thus making a span-roof building. The top may then be thatched with reeds, straw, or heather. The ends should be double-boarded, and the cavities filled with sawdust. A ventilator should be placed in the apex at the ends. The floor line inside the house should be slightly above the outside ground level, and, if possible, the building should be erected on a gentle slope. The inside may be fitted with three rows of shelves or benches on either side.

An inexpensive store-house may thus be erected, and the later kinds of fruit stored until selling time. Free ventilation should be afforded for a period of six weeks after picking the fruits to allow the moisture to exude from them. Afterwards the store-house may be kept closed, maintaining an average temperature of from 38 to 42 deg. Fahr., as nearly as possible, but sudden changes in the outside temperature will naturally have some influence upon that inside the fruit store.

London, S.W.1,
April, 1905.
Revised, December, 1911.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1 Letters of application so addressed need not be stamped.

Leaflet No. 135.

BOARD OF AGRICULTURE AND FISHERIES.

Mange in Cattle.

Definition.

Mange is a contagious disease of the skin caused by parasitic mites or acari belonging to the family *Acaridæ*, a family which includes the mite causing Sheep Scab (*See* Leaflet No. 61) and Parasitic Mange in horses, asses and mules (*See* Leaflet No. 274).

Three forms of mange occur in cattle, viz.: *sarcoptic*, *psoroptic*, and *symbiotic*. These forms are named after the species of parasite which is the cause of the ailment. Sarcoptic mange in cattle is uncommon. The most prevalent forms are the psoroptic and symbiotic, and these two forms may exist together in the same animal. Cows are most often affected.

Sarcoptic mange is the most serious form. Its gravity arises from the fact that the sarcoptes burrow under the outer skin, forming minute tunnels in which the female lays her eggs. The eggs are hatched and the parasites multiply in the subcutaneous tunnels. The presence of the parasites gives rise to great irritation and discomfort to the animal, and a severe inflammation of the invaded skin is set up. Owing to the burrowing habit of the sarcopt this form of mange is often exceedingly difficult to cure as local applications to the skin cannot reach all the mites.

It is believed that cattle are liable to contract the sarcoptic mange of the horse and of other domesticated animals. In this respect sarcoptic mange differs from the other two forms of mange, which are not regarded as capable of spreading from one species of animal to another.

Mange is spread to healthy cattle by direct contact with affected animals or indirectly by contact with contaminated pastures, cowsheds, and utensils employed about mangy cattle.

The three forms of parasites differ in their habits, and show certain variations in size, shape, and anatomical characters which are readily distinguished when examined under a low power of the microscope.

The causal parasites of the two common forms may under favourable circumstances be seen by the naked eye, and their movements may be followed with the aid of a suitable hand lens. When they are only comparatively few in number, they are not so readily detected amongst the scab and debris.

The Sarcoptes are the smallest in size. They are more or less spherical in shape, the head is short and rounded, and they are capable of cutting through the outer skin under which they burrow.

The Psoroptes are the largest variety. They are oval in shape, the head is elongated, and the legs are long and thick, especially the anterior ones. The pedicle at the end of the legs which carries the sucker is long and articulated. These mites do not burrow under the skin but they bite, and feed upon the inflammatory secretions which ooze out on the surface of the skin in consequence of the irritation set up.

The Symbiotes occupy a middle position with regard to shape and size. They are also oval, the body is slightly notched along its posterior border, and the head is about as broad as it is long. These mites are the least harmful to the animal. They have a tendency to remain in one situation and feed upon the scurf and debris of the skin without biting.

All three forms are provided with hairs on the body and long hairs on the legs, and all have suckers at the extremity of two or more pairs of legs.

The females are larger than the males and more numerous; they lay a varying number of eggs, according to certain conditions, which appear to have a controlling effect on the multiplication of the parasites and the spread of the disease. The eggs are laid over a period (not all at one laying), and some female parasites may lay as many as twenty, thirty or perhaps more. Within a week, at incubative temperatures, the eggs hatch and the minute young parasites (larvæ) with three pairs of legs emerge from the tiny shells.

The larvæ, after they are hatched, commence to feed. After a full meal they are engorged, and become torpid and motionless. In this condition they undergo what is termed a moult. The interior of the parasites begins to shrink into a ball-like mass, and separation takes place between it and the outer horny covering of the body.

The parasites remain in this dormant condition, for from one to two days.

At the end of the first moult a fissure or crack appears along the back of the old parasite, and a new form appears emerging from the opening in the cast or thin outer covering of the previous form.

This new form is termed a nymph, and the parasite has acquired an additional pair of legs during the process. The nymph in turn feeds and undergoes a moult (second moult). The second nymph stage is followed by another moult (third moult) when the fully developed adult male or female emerges from the separated cast. The males pair with the pubescent nymphs. The newly liberated ovigerous female begins to feed, and in the course of one or more days commences to lay eggs. In this way the various stages are repeated, and the parasites rapidly multiply. The length of time necessary for a complete cycle to take place, under favourable conditions, is about twelve days. The eggs retain their vitality off the animal for about a week, the time depending on temperature and moisture.

All forms are capable of living away from the animal's body for some weeks, and fresh cases of mange in healthy cattle may occur even after mangy animals have been removed. A knowledge of this fact should at once serve as a warning against the practice of putting healthy cattle into cowsheds, which have been recently occupied by mangy cattle, until such places have been cleansed and disinfected. An infected stall or shed, unless its construction and state of repair allows of its being thoroughly disinfected should not be used for healthy cattle for at least a fortnight, or better, for three or four weeks.

Symptoms.

Psoroptic mange is the most common form amongst cattle, but a general description can be applied to the symptons seen in all forms.

The most common sites of mange are the root of the tail, the neck, the buttocks and the withers. The parts under the jaw and around the base of the horns may also be affected, and if the ailment is neglected the psoroptic form may spread over the shoulders and chest to almost any portion of the body, but it is rare for the legs to be involved.

As a result of the bite by the mite, a small spot of inflamed skin can be seen in the form of a red spot or pimple. The bites increase in number and the pimples become soft and yellow in appearance from the collection of plasma which has escaped from the minute vessels in the injured parts.

These papules break down, run into each other, and form a superficial sore of varying extent.

The exuded plasma dries, sticks the hairs together into hard tufts and in this way the coat begins to look ruffled, and even unsightly in appearance. The biting of the parasites gives rise to an itchy condition of the skin, which causes the animal to scratch or rub itself against other animals, or any fixed object, with the result that the hairs over the affected parts gets rubbed off exposing a bare scabby patch of skin.

From the presence of the parasite, and owing to the continued rubbing by the animal to relieve the irritation, scurf and scales are thrown off, and can be seen on the surface of the skin. Closer examination shows red and yellow blood scabs. The inflammation of the skin is increased by rubbing and there may be wounds or bleeding sores, if the animal has been rubbing against rough objects. Large raw scabby areas of skin denuded of hair may be seen.

Amongst the scab, and more especially round the margin of the crust, the mites are usually to be met with in greatest numbers. They may be seen with the naked eye or better still with a hand lens. The multiplication and feeding of the mites goes on around the main scabby parts, and in this way the scabby area is increased in size. Some of the parasites wander on the body and set up fresh centres of scab, or they may be rubbed on to other cattle or objects.

As the parasites leave the older centres of disease these parts become dry and hard. The skin loses its elasticity, becomes parchment-like. It is sometimes wrinkled, and has a corrugated appearance.

The denser scabby parts crack across in all directions and deep fissures or crevices appear, from which blood or plasma escapes. This condition is best seen on the neck and fore part of the body.

As the disease progresses and the irritation is increased the animals become very restless, they are continually rubbing, biting and scratching themselves. They go off their food, the milk yield is diminished, they rapidly lose condition and flesh, and have a very unthrifty and wasted appearance. The affected cattle may become weak, anæmic and debilitated.

It can only be the result of negligence when cases become advanced, as with ordinary care and attention the disease can be detected in its earliest stages, and with proper treatment cured. A good watch should be kept for a chronic case, in which the mites are few in number and the affected parts small in extent. Such a case in a herd of cattle, while it may be the means of spreading the disease amongst the other animals, may itself escape attention.

It is advisable that examination should be extended to the head, particularly under the jaw and around the base of the horns. The point and under surface of sternum or breast should also be inspected, as occasionally in individual animals a number of mites may be collected in these situations, showing little, if any, inclination to spread, and causing no special inconvenience to the animal so affected.

The symbiotic form, also spoken of as tail mange, is usually confined to the parts around the base of the tail. It has a distinct tendency to remain localised ; only rarely and in badly neglected cases does it spread over the body. With the prompt use of effective remedies it should quickly yield to treatment.

In cases of rapid wasting it should be borne in mind that the wasting may be due to some serious internal trouble such as tuberculosis or other wasting diseases, which reduce the animal's natural power of resistance to the less serious disease.

It has not infrequently been observed that cows appear to become cured spontaneously when turned out to grass in the spring. This usually means, however, that under open air conditions the parasites do not increase at the same rate, and hence the active symptoms are merely less marked.

When the animals are again brought into the sheds in the autumn the acari (parasites) which have persisted in small numbers resume their activity, and this sometimes leads to an erroneous belief that re-infection has taken place.

Treatment.

In some countries, where cattle are kept in large herds and a number of them are affected at one time, the affected and contact cattle are dipped like sheep in a prepared dip. If the numbers are large the cattle can be driven through a swimming bath, or should a dipping tank for cattle not be available the dip can be applied by means of a spraying pump.

Another method of treatment is to wash the affected patches on the animal's skin with soap and warm water, and then dress the parts with one of the common mange dressings, such as spirit of tar, linseed oil, and sulphur, or an efficient sheep dip might be used. The dressing should be applied twice or even three times at intervals of ten days. In serious and rebellious cases necessitating treatment of the whole body, veterinary advice should be sought.

The litter from an infected animal should be removed and burnt each time after dressing, and the flooring and wood, or other fittings used about affected animals should be well sprayed with a five per cent. solution of carbolic acid in water or other standard carbolic preparations which are miscible with water.

London, S.W.1,
April, 1905.
Re-written, September, 1913.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

The Bulb Mite (*Rhizoglyphus echinopus*).

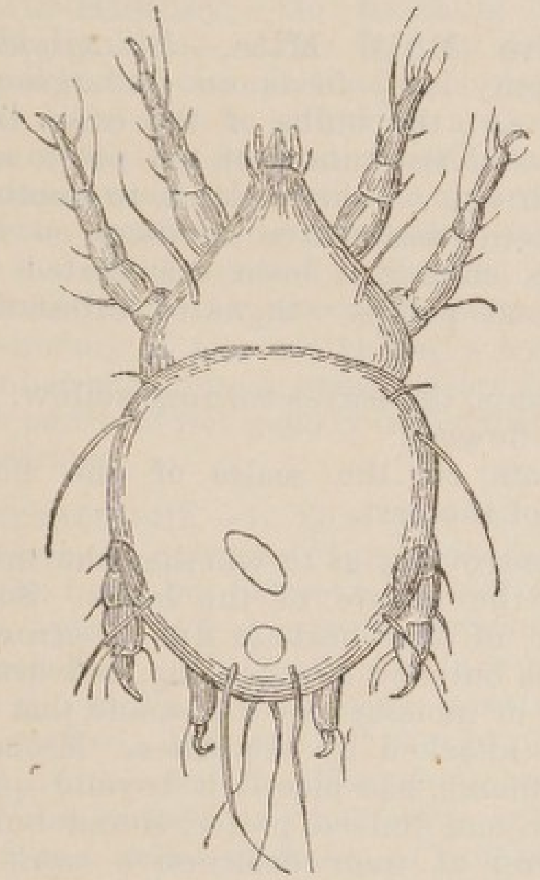

FIG. 1.
Adult Male, magnified 95 times.

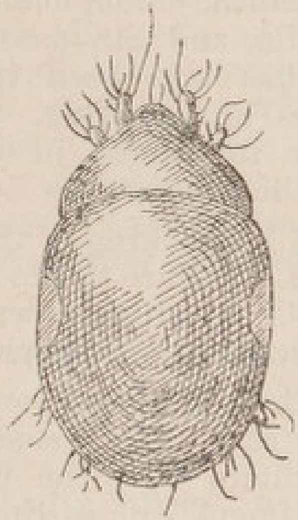

FIG. 2.

Hypopus, magnified 100 times.

(Both figures after A. D. Michael.)

The genus *Rhizoglyphus* belongs to the family *Tyroglyphidæ*, a family of mites with a comparatively small number of genera and species, but a great number of individuals, which may be found together in masses. Familiar examples of the family are the cheese mites, the hay mites, and a species which has several times been found swarming over furniture, curtains, &c., in houses. The family is interesting biologically, as amongst its members is found, in addition to the stages in the life-history of mites in general, the *hypopus* stage, this being a stage developed for the purpose of the spread of the species. Besides other differences, it is characteristic of the hypopus that it possesses suckers by which it can adhere to flying or passing animals, and thus be conveyed to fresh feeding grounds. In this stage the mite is able to resist conditions which would be fatal to it in its other stages. All the individuals of the same generation do not pass through this hypopial stage.

There are two British species of *Rhizoglyphus*, viz., the Bulb Mite or Tulip Mite (*R. echinopus*) and *R. agilis*. The latter, discovered by Michael on decaying cabbage stalks in the South of England, is narrower in body, lighter in colour, and more active in habit than the Bulb Mite.

Food Plants of the Bulb Mite.—*Rhizoglyphus* (root eater) *echinopus* (spiny legs) feeds on underground swollen stems and roots, *e.g.*, the bulbs of the tulip, lily, hyacinth, onion, eucharis, and the tubers of the potato and dahlia, and can pass from one of these plants to another. It has also been taken in destructive numbers on the roots of the vine. This mite has been distributed all over the world in its food plants. Signs of infestation by the mite are :—

(1.) Checking of the plants, the leaves turning yellow.
(2.) Failure to produce flowers.
(3.) Reddish-brown spots on the scales of the bulb, indicating feeding places of the pest.

There has been some controversy as to whether the mites are really the cause of the failure of the bulbs. Some maintain that the decay of the bulb is due to error in treatment, *e.g.*, in Eucharis bulbs to over-forcing, bad drainage, faults in temperature or moisture, or shade, and that the decaying bulbs are then attacked by the mites. Michael, however, by many experiments, has placed it beyond question that the mites attack, and indeed prefer, sound bulbs, and they have been found at their destructive work in otherwise good tulip bulbs.

Description.—*R. echinopus* can be found in the stages of egg, larva, nymph, hypopus, adult males of two forms, and female. The adults have a smooth body, which is yellowish white in colour, and tinged with pink. The legs and rostrum are red. Each mandible ends in a pair of pincers, the branches of the pincers bearing three teeth. Just behind the second pair of legs on each side of the body is a projecting hair. There are four pairs of short thick legs, the two front pairs being the strongest; the legs are five-jointed, bearing spines and hairs, and each ending in a single claw. The male has the abdomen more rounded at the end than the female; the hind part of the cephalo-thorax in the male is as wide as the abdomen, but in the female it is not quite so wide. In one of the two forms of male the third leg on each side is thicker, and is not used in locomotion. The hypopus carries on the middle of the under surface of the hind region a horny plate with twelve suckers; in front of this plate are two additional suckers.

The mites, which are extremely minute, need for their examination a good lens or microscope. There is very considerable variation in their size; Michael gives ·53 mm. for the male and ·55 mm. for the female as typical lengths for British specimens.

Life-History.—On hatching from the egg the larva bears six legs. After feeding for a short time this six-legged larva becomes inert and moults. The new form has eight legs, and is known as a nymph, and it is during this stage that the greatest growth takes place. In ordinary circumstances the nymph—according to Michael's experiments—probably moults twice, each moult being preceded by a sluggish period; the last moult of the nymph is succeeded by the sexually mature adult. Where, in the life-history of the individual, a hypopial stage appears, the number of moults is greater than the above. Larva, nymph, and adult do not greatly differ from one another in external appearance.

Treatment.—1. This pest is very difficult to combat because the extremely tiny mites feed not only on the outside of the bulb, but between the leaf scales of the bulb, feeding and laying their eggs in the interior, where they can scarcely be reached. The best plan is to burn badly infested bulbs, for the mites which have penetrated into bulbs cannot be reached. Infested soil should not be used for other bulbs.

2. In the case of mites which are more external the bulbs may be washed in potassium sulphide (liver of sulphur), 1 oz. to 1 gallon of water, or brushed with this solution after removal of the outside scale leaves. This treatment is useful against fungi which follow the attack of the mite.*

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* At a meeting of the Scientific Committee of the Royal Horticultural Society (see *Gard. Chron.*, Dec. 20, 1902, p. 465) Mr. Saunders, in the course of a report on hyacinth bulbs containing a large number of *R. echinopus*, stated that "When bulbs are thus infested with these mites nothing can be done to save them. When only a few mites are at the base of the bulb, where the attack generally commences, they may be killed by immersing the bulbs for five minutes in water at a temperature of 115° to 120° Fahr. If some sulphide of potassium (6 oz. to the pint) be added to the water, this remedy would be all the more efficacious; indeed it is said that soaking the bulbs in this solution cold for twenty minutes will kill the mites."

London, S.W.1,
April, 1905.
Revised, March, 1919.

BOARD OF AGRICULTURE AND FISHERIES.

Potato Scab.

The Common Potato Scab or Brown Scab is one of the most widespread diseases affecting the potato, and is exceedingly abundant in small gardens and allotments, especially where potatoes have repeatedly been grown, and where ashes, lime, and other alkaline substances have freely been used. Scab is caused by a minute soil-organism which attacks the surfaces of the tubers and causes the production of dark scattered scabs, or large eroded patches which appear to have been worn away or gnawed. The scabs increase in size with the growth of the tubers, and they may in bad cases cover almost the entire surface.

Although not so serious as some potato diseases the losses caused by scab are not by any means as insignificant as might at first sight be imagined. As a commercial article the tubers are rendered unsightly and their market value is considerably depreciated. The consumer also suffers as, owing to the deeper peeling which is necessary, there is excessive waste of the best part of the potato.* Further, affected tubers when stored are liable to decay or to be attacked by fungi. For eating purposes, however, the sound part of a scabbed tuber is not injured.

Causes of Scab.

In spite of the many investigations which have been carried out on brown scab it is only comparatively recently that its true nature has clearly been defined. The scab known as Oospora scab has long been regarded as common in this country, but great confusion existed in the literature owing to the fact that much of the ordinary brown scab had often been attributed to mechanical injury, or to the effect of various irritating substances in the soil. It is now known that these substances are merely influences assisting in the development of the scab and not the primary cause of it, for experiments have shown that soil which has been disinfected, and does not contain the scab organism will not produce scabbed potatoes from clean seed, however full of ashes, road sweepings or other irritating matter it may be. Oospora scab and the common brown scab are one and the same thing, and they are due to a bacterium known formerly as *Oospora scabies*, but now more correctly referred to the genus *Actinomyces*.

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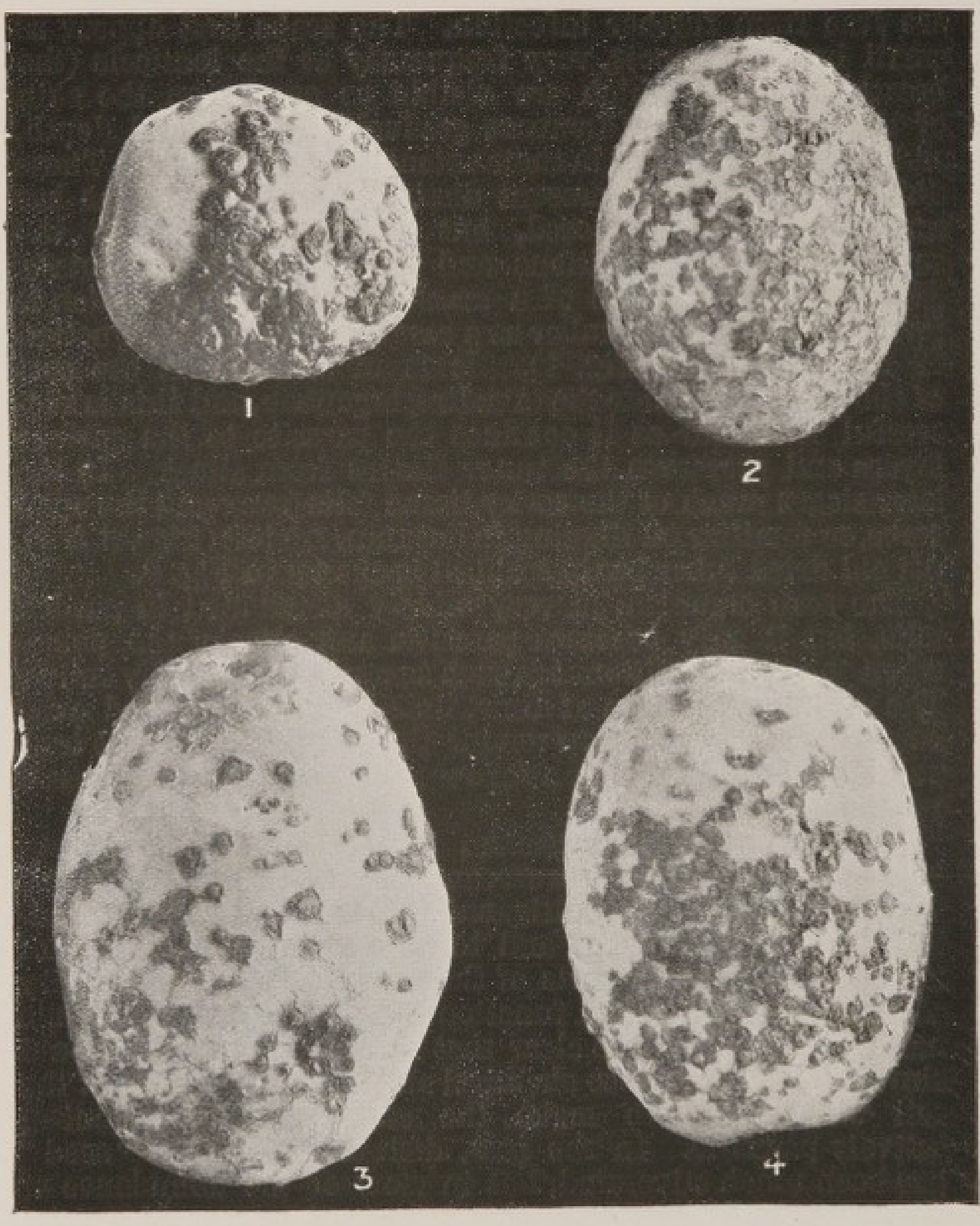
* *See* Leaflet No. 318 (*Economy in Using Potatoes*).

The method of attack has been carefully studied by American botanists. The organism may infect the tubers at any stage of their growth, from mere buds to fully grown tubers. It does not, however, attack potatoes after they are ripe or in storage, and when once the tubers are lifted they are free from further infection. The scabs first appear as small brownish spots, very frequently at the lenticels (the breathing pores which are visible as specks on the skin of the tuber). They increase gradually in size and depth, and vary considerably in their extent and appearance. These differences do not represent distinct kinds of scab, as has sometimes been supposed, but are largely due to the surrounding soil-conditions and the variety of the potato. The scab itself consists of a mass of corky tissue which is formed by the potato tuber as a result of the irritating action of the bacterium (Fig. 1). It is an attempt on the part of the plant to exclude the invading organism, and this is successful in so far as it confines the parasite to the surface layers and preserves the inner tissues from attack. In the later stages much of the corky tissue falls away and the open scabs, so familiar on digging in autumn, are left (Figs. 3 & 4). An old dried tuber badly scabbed is shown in Fig. 2.

The scab organism is very widely distributed in garden soils, but it only becomes parasitic and attacks the potato when the soil-conditions are such as render it specially active. The recent application of lime, lime-rubble, ashes, and even farmyard manure tend to render the soil alkaline or at least neutral, a condition which favours the virulence of the scab organism.

Although the scab-organism is especially abundant in humus and farmyard manure, and in gardens and allotments which have been long cultivated, it is believed to be exceedingly widely distributed and to be a normal inhabitant of the soil in almost all parts of the world. In all probability also it performs a useful function as a decomposer of organic matter. It is therefore clear that remedial measures should aim at preventing those chemical and other conditions of the soil which tend to make the scab-producing organism actively parasitic. In the past, disinfection of the "seed" has been much advocated, but in view of the abundance of the organism in most soils, this treatment, except in special cases, would not appear to be of much value. Badly scabbed "seed" should, however, not be planted, as by its use, not only is a known virulent strain introduced in the very spot where it is not wanted, but such tubers are often of poor sprouting-capacity, and consequently yield a poor crop.

The only other plant which is known to be seriously attacked by the scab-organism is beet, which in some districts is liable to be badly scabbed. Some writers, however, believe that turnip and radish may also be affected.



Ordinary or Brown Scab.—Fig. 1 represents a young tuber freshly dug from the soil showing the scabs in their early stages. Figs. 3 and 4 show later stages, flat open scabs, as commonly seen on digging in autumn. Fig. 2 represents the appearance of a badly scabbed tuber when thoroughly dried.

(For the use of three of these photos the Board are indebted to the Department of Agriculture and Technical Instruction for Ireland.)

Other Forms of Scabs.

Certain animal-injuries such as those produced by millipedes, and possibly wireworms, may at times resemble brown scab. In the absence of the animal concerned it is not always possible to state the exact cause, and hence such damage has for convenience sometimes been spoken of as "mechanical injury." The disease known as Corky Scab is a perfectly distinct malady, as is also the very much more serious Wart Disease or Black Scab. These two diseases are dealt with in Leaflets Nos. 232 and 105 respectively.

Control.

1. The most important preventive measure is suitable treatment of the soil. The organism thrives in alkaline soils, and in those rich in humus. Hence the application of lime, ashes, and soot, and also farmyard manure, should be temporarily suspended in soils where scabbing is prevalent. Alkalinity of the soil may be counteracted by the use of superphosphate of lime and sulphate of ammonia. In small gardens and allotments a dressing of flowers of sulphur at the rate of 1 oz. per square yard should prove beneficial. Its effects, however, may not be fully noticeable the first season.

2. If possible scabbed tubers should not be used for seed. If they must be used, and if they are at all seriously scabbed, they should be disinfected by steeping for two hours in a weak solution of formalin (40 per cent. formaldehyde). Half a pint of formalin to 15 gallons of water is a suitable strength. The sprouting-power of badly scabbed tubers is poor, and hence these should never be used as seed, even after disinfection, unless absolutely necessary.

3. Scabbed potatoes and peelings from affected potatoes must not be thrown on the manure heap, neither should they be given to pigs unless they have been previously boiled.

4. Crop rotation is always a commendable practice and should be adopted as far as possible even in small gardens. As a preventive for scab, although it cannot be regarded as altogether effective, it doubtless assists in keeping in check a special potato-attacking strain of the scab organism. Beet also should be excluded from the rotation in badly infected land.

London, S.W.1,
March, 1905.
Revised, September, 1917.

Copies of this Leaflet may be obtained free of charge, and post free, on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters or postcards of application so addressed need not be stamped.

Leaflet No. 138.

BOARD OF AGRICULTURE AND FISHERIES.

PINE WEEVILS.

This Leaflet has been temporarily withdrawn.

Leaflet No. 139.

BOARD OF AGRICULTURE AND FISHERIES.

A Mushroom Disease (*Hypomyces perniciosus*, Magn.)

DISEASED MUSHROOMS.

During certain seasons cultivated mushrooms are destroyed in a wholesale manner by this disease, not merely in this country but also on the Continent; more especially in the neighbourhood of Paris, where mushroom culture is conducted on a very extensive scale. The primary cause of the mischief is a minute parasitic fungus, which when once introduced, spreads very quickly under the conditions of temperature and moisture essential for the rapid growth of mushrooms.

Description.

Well-marked symptoms are evident from the earliest stages of disease, the mycelium of the parasite growing up with that of the mushroom. The latter, instead of gradually developing into a cap and stem, becomes an irregularly-shaped monstrous soft mass, which if allowed to grow, often exceeds in size that of a full-grown mushroom. Sometimes a small, deformed cap is present, but as a rule the entire mass of a diseased mushroom consists of a much swollen stem. After a time the parasite forms its spores on the surface of the diseased mass, appearing under the form of a snow-white, minutely velvety covering. After the spores are scattered the diseased mushroom rapidly decays, forming a putrid mass having a very disagreeable pungent smell.

Remedial Measures.

Numerous toadstools and other fungi suffering from the parasitism of different kinds of *Hypomyces* are common in our woods and pastures every season, and spores are probably introduced into the mushroom bed along with the manure or road sweepings commonly used.

(1.) In some instances it is certain that the spawn is infected before it is placed in the mushroom bed. In such cases, when the spawn commences to "run," the threads, instead of having a clear and sharp outline like white cord, present a fluffy appearance, due to the presence of the parasite on the surface of the strands; the branches are also much fewer in number than when the spawn is healthy and growing vigorously.

Under such circumstances the entire bed should be removed before the parasite produces spores; otherwise, if the house becomes thoroughly infected, common experience has shown that the disease is exceedingly difficult to eradicate.

(2.) When infection occurs through the introduction of spores into the house by wind or other causes, the disease may be confined to certain portions of the bed, and the prompt removal of infected mushrooms as soon as the slightest symptoms are observed may check the disease from assuming the proportions of an epidemic.

(3.) After removing the soil and manure of an infected bed, great care should be taken in cleansing the tools, boots, and even clothing; otherwise there is great risk of infecting other beds. Rejected soil and manure should be at once removed from the neighbourhood of the mushroom beds. They may be applied to the land, as the contained spores, so far as is known, can only develop on some kind of fungus, and do not attack any other cultivated crop.

(4.) When a house or other structure in which mushrooms are grown has become infected, it should be completely emptied and thoroughly sprayed, both roof, walls, and floor, three times at intervals of ten days with a solution of sulphate of copper—one pound of sulphate to fifteen gallons of water.

During this period of spraying the house should be kept warm and moist, for the purpose of favouring germination of the spores of the parasite, which are destroyed with greater certainty when growing than when in a resting condition.

London, S.W.1,
June, 1905.

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Leaflet No. 140.

BOARD OF AGRICULTURE AND FISHERIES.

The Felted Beech Coccus (*Cryptococcus fagi*).

Distribution.

This insect confines its attacks exclusively to the beech (*Fagus sylvatica*), and is one of the most destructive pests against which the arboriculturist has to contend. It is widely distributed throughout England, and has occurred in many parts of Scotland. It is common in the counties of Flint and Denbigh in North Wales; while in Ireland it has, so far, been recorded from one locality only. Its attacks are often restricted to a comparatively small area, or even to single isolated trees, this being especially noticeable where the tree-trunks are sheltered from the prevailing winds.

Signs of Infestation.

Owing to the whiteness of the felted covering with which the female protects its body, and also to its exposed position upon the trunks and main branches of the trees, the beech coccus is at all times a conspicuous species, and more especially so when the white secretionary coverings unite and almost completely cover the bark of the tree.

Young and old trees are alike attacked; and the insects usually confine themselves to the main trunk and larger branches; but the smaller branches, especially those of young trees, are sometimes infested to a serious extent: in a case recently recorded a beech hedge 13 to 14 feet high was here and there badly infested. Where the infested trees are growing in exposed situations the insects almost invariably select the sheltered side of the tree. Many badly infested trees which have been under close observation for the last sixteen years are still apparently vigorous and healthy, while others have been totally destroyed. The first sign of decay is usually seen in the foliage, which becomes discoloured and sparse or thin, accompanied by the death of the smaller branches; this is followed by the death of the larger branches and, finally, the tree trunk; while the bark peels off from the branches and falls away. Whether the work of destruction is aided by the joint action of a bacterial or fungoid disease is not at present known, but it is probable that such is the case.

Description and Life-History.

The beech coccus belongs to the generally destructive family of Scale insects (COCCIDÆ). *The adult female* is of a lemon-yellow colour, and measures about one twenty-fifth of an inch in length. It is both wingless and legless: is somewhat hemispherical in shape being flattish beneath and highly convex above; and to the naked eye or under low magnifying power it appears like a small yellow egg. The mouth organs are placed on the underside of the body, and are composed chiefly of three hair-like appendages which in life are united to form a long sucking tube; with this slender apparatus the insect pierces the bark and sucks up the juices of the tree. She has no power of locomotion, remaining stationary throughout life, anchored to the tree by her mouth organs, motionless and apparently senseless. Almost immediately after leaving the egg she covers her body with the white felted secretion, composed of fine filaments of wax, which gradually thickens and forms an excellent protection to her body, being practically impervious to rain. Within this covering the insect lives, lays her eggs, and dies.

The *larvæ* or "lice" as they are sometimes called, are very tiny active creatures, and are scarcely visible to the naked eye. They possess three pairs of legs and a pair of horns (antennæ), and, like their parents, are of a yellow colour. Although they can and do travel over the bark of the tree they usually settle down in the immediate neighbourhood of the parent, the majority working their way under the bodies of their dying or dead parents, taking up their positions, by preference, in the deepest parts of the fissures in the bark, where they remain for the rest of their lives pumping up the juices of the tree. Each individual protects its body with secretion, which adds to that already secreted above them by the insects of the previous generations; thus the secretion gradually thickens and spreads over the tree-trunk, forming a more or less continuous mass, often attaining a considerable thickness. Larvæ which wander over the bark are liable to be borne away by the wind or, inadvertently, by birds and insects, and this is undoubtedly the means by which fresh colonies are started.

Fig. 1.

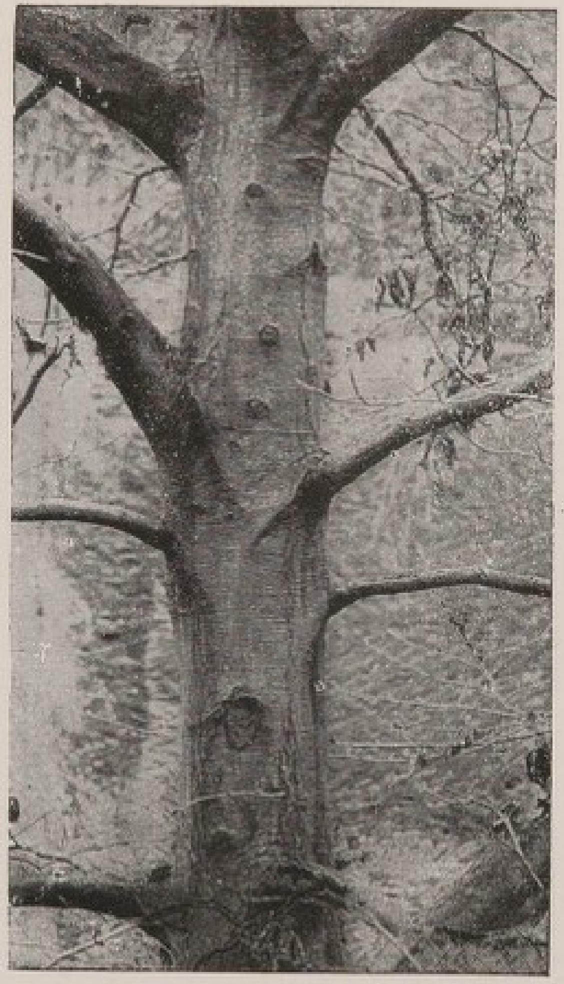

Fig. 2.

Fig. 3.

Fig. 1.—Main trunk of young beech badly infested with coccus. Fig. 2.—Young beech which was similarly infested to that shown in Fig. 1, 21 months after treatment with paraffin emulsion; now free from the pest. Fig. 3.—Upper branches of very old beech killed by the coccus; the bark has peeled off in patches.

The *male* is unknown in any stage, the females being parthenogenetic, reproducing their species without the intervention of the opposite sex.

Many of our indigenous Scale insects are subject to the attacks of minute parasitic insects related to the wasp family; but, so far, the beech coccus has proved immune from their attacks. Birds do not appear to feed upon them.

Treatment.

Owing to the comparatively smooth nature of the bark of the beech, and also to the fact that the insects are often confined to the trunk and main branches, this pest is more easily accessible for treatment with insecticides than are many other pests. They are, however, so well protected by their waxy coverings that the application of an insecticide must be carried out in a thorough manner or the result will be anything but satisfactory.

1.—The trees should be sprayed, when in the dormant condition, with the following emulsion-soda wash, as used at the Woburn Fruit Farm:—Paraffin, 2 gallons; soft-soap, 1½ lb.; caustic soda (98 per cent.), 6 lb.; water, 28 gallons.

In order to prepare the wash the soft soap should be dissolved in a gallon of boiling water; the paraffin should then be added and the mixture churned thoroughly until a cream-like mass results. The thoroughness of the churning is important.

The 6 lb. of caustic soda should next be dissolved in the remaining 27 gallons of water and then poured into the paraffin emulsion. The whole should be well mixed and used immediately.

Recent experimental work at Woburn, however, indicates that there are advantages in using a wash composed of:—Sulphate of iron, ½ lb.; lime, ¼ lb.; paraffin (solar distillate), 5 pints; caustic soda (98 per cent.), 2 lb.; and water to make 10 gallons.

This may be prepared for use by proceeding as follows:—(*a*) Dissolve the sulphate of iron in about 9 gallons of water; (*b*) slake the lime in a little water, and then add a little more water to make it into a "milk"; (*c*) run *b* into *a* through a piece of coarse sacking to remove grit; (*d*) pour the paraffin into the mixture *c* and churn the whole thoroughly; (*e*) add the caustic soda in powdered form just before using, and stir thoroughly.

In using either of these mixtures the face and hands must be protected, as the mixtures are caustic in character.

One advantage of the caustic soda is that it helps to clear the tree of such growths as lichens and algae.

2.—On a trunk which is clean save for the Felted Beech Coccus paraffin emulsion would prove satisfactory.

Even with the most careful spraying there would be crevices and protected places in the bark that would almost certainly not be reached, and for such places a good scrubbing brush with stiff bristles—wire bristles are good—should be used. The brush should be dipped in the wash and the spots referred to scrubbed.

In dealing with an isolated infested tree, or with a few trees only, brushing would be more effective than spraying, and once the treated trees are clean they should be kept under observation, so that any places showing new or increased infestation could be brushed over.

London, S.W.1,
May, 1905.
Revised, June, 1908.

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BOARD OF AGRICULTURE AND FISHERIES.

The Preparation of Honey for Market.

Qualities of Good Honey.

The bee and honey classes of the shows now held during each season, both in London and the country, have taught the consumer what to require in a first-class honey, but it remains none the less true that it is often difficult to obtain remunerative prices for honey. Before bee-keeping is embarked in on a large scale, therefore, arrangements for marketing the produce should be made. Comb-honey (in section cases) should be translucent, showing the clear bright colour of the contained honey, evenly and delicately worked out to the sides and bottom of the section, and with a scrupulously clean surface. The finest liquid extracted-honey should be bright and clear, of a light straw colour, and delicate in flavour and aroma. Granulated extracted-honey should be of fine, even grain, creamy white in colour, and of good flavour. There are many grades of medium and dark-coloured honeys below this first-class standard, but the latter is what the bee-keeper must strive to attain, in order to command a ready sale for his produce.

Preparation for Comb-Honey in Sections.

In regard to comb-honey, the preparation commences with the fitting of the wax foundation in the sections. To ensure a well worked out section this should be cut so as just to clear the sides of the wood and hang to within one-sixteenth of an inch of the bottom, thus allowing for a slight stretching of the foundation caused by the heat of the bees clustering on its surface. The fitted sections must next be placed in the section rack, with separators between the rows, reaching to within three-eighths of an inch of the top and bottom, and wedged up perfectly square and tight; this is important, for the bees will place *propolis* over every crack or small space, causing disfigurement and entra work in cleaning; also sections "out of square" are much more liable to breakage when packed for travelling, owing to the unavoidable spaces between them. The rack must be placed perfectly level on a hive containing a strong colony of bees; it will then be filled with good, straight, and even combs.

Removing filled Racks.

Removing filled racks from the hives should be done with as little disturbance to the bees as possible; the best method is to (1) place a "super-clearer" on a stool or box by the side of the hive, raise up the bottom edge of the rack and insert a small wedge ; (2) puff a little smoke between the rack and tops of the frames, remove the rack steadily with a screwing motion, and put it down gently on the "super-clearer" ; (3) place a cloth, on which a few drops of carbolic acid have been sprinkled, over the top of the frames ; (4) in about ten seconds remove the cloth, and it will be found that the bees have been driven down, leaving the tops clear ; (5) then immediately take up the rack with the "super-clearer" and place it on the frames. If this operation is carried out in the afternoon, by next morning every bee will have found its way down to the body of the hive through the bee-escape in the centre of the "super-clearer," and the rack can be removed with comfort to the bee-keeper and without disturbance to the apiary.

The full racks should be carried into a bee-proof room, the wedges and back-board removed, and the centre section of the exposed row taken out. It should not be lifted straight out, as the result would probably be a damaged section, but if tilted backward on its bottom edge, it will loosen and come away easily, as also will the two side ones. The sections should be sorted as they are taken out, placing all well-filled clear ones in the first grade ; those not well-worked to bottom and sides, and therefore not fit for travelling, will make a second grade ; and any only partially filled must be given back to the bees to finish, unless the "honey-flow" has ceased, in which case they must be emptied by the extractor (*see* p. 3). All propolis must be carefully scraped from the edges of the sections, which, if not already sold, should be stored in a dry, warm cupboard, and protected from dust by tying them in packages of four or six in clean paper ; care must be taken not to place anything having a strong odour near the honeycomb, or it will spoil the flavour of the honey.

Packing Sections.

If the sections are sold to wholesale dealers for re-sale to traders, no further preparation is needed. To pack them so as to travel safely, not more than from four to six dozen, preferably the smaller quantity, should be put into one package.

Packing may usefully be done as follows :—(1) Procure a strong wooden box, bore two holes in each end, about one-third down, and knot firmly into them rope handles, by which the box can be safely and easily lifted ; (2) in the bottom of the box put a bed of straw, and on this place, quite close together, a layer of the wrapped-up packages of sections, leaving at least two inches between the sides of the box and the sections ; this space must be filled with straw, tightly pressed in, and, to prevent possible damage to the comb, the ends of the packages may be protected by pieces of straw-board or thin wood; (3) continue with layers of packages, filling in round the sides as before until within two inches of the top; (4) then fill up tightly with straw, and *screw* on the lid. Packages should be plainly labelled: "Comb-honey, With Care." Retailers of honey-comb prefer to have the sections sent to them glazed, the comb being thus preserved from injury by careless handling, and, what is still more important, kept free from the dusty impurities unavoidably present in shops.

Glazing the Sections.

For glazing sections, glass cut to the correct size may be purchased of any dealer in bee appliances, together with the strips of paper lace edging, which, when pasted round the angle formed by the glass and wood, serve to fix the glass on. In country towns the local glazier will gladly cut up waste glass to the small size (viz., $4\frac{3}{16}$ in. by $4\frac{3}{16}$ in.) required, while neatly printed bands of coloured paper, 19 in. by 3 in., can be used instead of the lace edging. These bands cost about 7s. per 1,000. They are more easily pasted on than the paper lace edging, and make much firmer and neater work, while they also give an opportunity of placing the names of the apiary and retailer on each section. Neat cardboard cases, plain or glazed on one or both sides, can be purchased cheaply from appliance manufacturers.

"*Extracting*" *Honey.*

"Extracted" or "run" honey has been greatly improved in quality by the modern method of obtaining it; and the use of the centrifugal extractor compels the abandonment of the skep system of bee-keeping, with its waste of bee life, waste of combs, and taint of sulphur. This method also necessitates the adoption of the frame hive, which enables the gathered surplus to be stored in frames apart from the brood-nest and to be removed at will by the bee-keeper.

Honey improves in flavour and density while ripening in the hive, therefore the shallow frames should not be removed until the honey is well sealed over. The full sealed frames of comb having been carried into the store-room, they should be sorted by holding them up to the light, and all those containing dark or second quality honey may thus be separated from the better ones. Fermentation is the great enemy of extracted honey, but it can only affect badly ripened honey or honey exposed to moisture and warmth; if therefore it should be necessary to extract unripe honey, it should be returned to the bees for re-storing and ripening.

Extraction is done by means of a machine consisting of a tinned-iron can, within which is a vertical spindle carrying a pair of cages to hold the frames of honey-comb and made to revolve rapidly by means of a simple hand-gear. Before placing the frames of comb in the cages they must be uncapped. To do this quickly and without waste special uncapping knives are used; they should be heated in a tin of water kept hot over a small spirit or oil lamp. The full frame, held by one lug in the left hand, the other lug resting on a large dish and with the top edge overhanging, has its capping removed with the sharp, hot knife by a gentle, slightly sawing, downward cut, passing just beneath the surface and removing as little as possible of the honey. If held with sufficient overhang the detached sheet of capping will fall clear of the frame. A pair of frames having been uncapped they are placed in the cages of the extractor and made to revolve rapidly with their bottom bars leading; the centrifugal force throws out the honey, and when one side has been emptied the frames are reversed and the other side treated in the same manner.

Packing Extracted Honey.

After uncapping and extracting the contents of the best combs, the honey should be strained through a bag made of muslin in order to remove all loose particles of wax. Tin cans, with strainer and honey tap, made to contain 56 lb. or 112 lb., can be obtained, in which, if the honey is allowed to stand for twenty-four hours after straining, it will be freed from air bubbles, and can then be drawn into whatever jar, or tin will best suit the local market. Best honey is usually put into 1 lb. or ½ lb. glass jars, with metal screw caps having a cork wad inside the cap. To prevent any leakage the cork wad should be dipped in melted wax and placed on the jar while still warm, the cap being screwed down upon it. A neat label (of which varieties are obtainable from appliance makers or from the Secretaries of many of the County Bee-keepers' Associations) will set off the honey jar and make it more attractive. The darker honey is more suitable for marketing in its granulated state; when extracted and strained it should be run into 14 lb. or 28 lb. tins, the contents of these being stirred gently, now and again, while granulating; the stirring tends to produce a more even and finer grained honey. It may also be run into wide-mouthed glass or earthenware jars, covered down with parchment paper, and stored in a cool, dry place. Dark and coarse-flavoured varieties may be sold for manufacturing and confectionery purposes, or for that now almost forgotten process the making of mead.

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Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

Calf Rearing.

The object of the present Leaflet is to give a summary of methods of calf-rearing which have proved successful in different parts of the country. In matters of detail a wide range of variation is found in the practice of different districts, but these differences turn mainly upon the extent to which whole milk or separated milk enters into the dietary, the variations ranging from the unrestricted use of milk on the one hand to the practical exclusion of milk on the other.

The particular method adopted depends largely upon the system of farming practised. In upland districts where plenty of cheap grass is available, or in non-dairying districts generally where the grass is of good quality and winter keep can be grown cheaply, or in the rearing of the highest class pedigree dairy stock, milk is fed liberally to the calf. On milk-selling and cheese-making farms, on the other hand, strict economy must be exercised in the use of milk for calf-rearing, whilst the butter-making farm occupies an intermediate position between these two extremes in that, although whole milk cannot be used freely, a plentiful supply of skimmed or separated milk or butter milk is usually available for calf-rearing.

Before proceeding to describe the various methods of calf-rearing, the question of the housing and care of the calf in early life may be dealt with briefly.

The Calf-House.—The essential requirements that the calf-house should fulfil are that it should be light, warm and airy, and should afford reasonable provision for exercise. No stereotyped set of buildings is required. If the existing buildings are not quite suitable a little adaptation will usually suffice. A cement floor, however suitable from the sanitary point of view, is too cold unless covered with several inches of peat moss or straw litter. A floor formed of either bricks, or earth, or rammed chalk is preferable. As a useful example the calf-house on a north-country farm, where calves have been reared with considerable success for many years, may be described.

This is a spacious "lean-to" building on the south side of a higher one, and is lighted by means of single panes of glass at regular intervals in the roof. The floor is of concrete, with no drains either open or covered. The two doors, each in halves, are on the same side so that there may not be cross-draughts. The pens (6 ft. by 5 ft.) are on each side of a central gangway with board partitions not quite down to the floor, and palings in front, so that the calves may see each other across the gangway. Each pen contains a small trough and hay-rack.

Before a new-born calf is placed in its pen the floor is littered with about an inch of well-broken moss-litter, and this is covered with a fair bedding of straw. A little extra straw is added day by day as required, and at the end of a week the pen is cleaned out. Afterwards moss-litter only is used, a bucketful being scattered on the top as frequently as appears to be necessary, the pens being cleaned out about once in three weeks. Moss-litter is such a good absorbent and deodorant that no offensive odour is noticeable. When removed from the calf-pens it is still too dry to place on the manure heap, but it forms an excellent substance to place round the heap to absorb the liquid drainings ; when saturated it is thrown on the top.

It will thus be seen that provision is made for comfortable and dry beds, sunlight, and fresh air, while an incentive is given to exercise on the part of the calves by the sense of companionship which they feel in seeing one another. These conditions are not difficult of attainment, and might well be aimed at in the construction of every calf-house.

The New-born Calf.—There should be a plentiful supply of clean straw immediately behind the cow for the reception of the calf at birth. As soon as the calf is "dropped" it should be removed to its pen and the navel cord rubbed at once with an antiseptic as a precaution against the ingress of disease-producing bacteria at that part. A lump of "bluestone" (copper sulphate) is commonly used for the purpose, and has the added advantage of causing the cord to shrivel up quickly. If a fluid antiseptic be preferred a mixture of 1 part of Calvert's No. 4 carbolic acid with 19 parts of Gallipoli oil will serve the purpose. It is essential, however, that the cord shall be dried up within the first day or two.

The calf should now be thoroughly rubbed down with wisps of straw and allowed to lie covered over with straw till its mother has been milked.

Feeding the Young Calf.—*Suckling.*—If the calf is strong and is to be suckled, as in the case of pedigree animals, very little special attention need be given. In a comparatively short time the animal will get on its feet and begin to suck.

Hand-feeding.—If the animal is to be hand-fed, some rearers allow the calf to be with the cow for two or three days, whilst others regard it as best for the calf to be removed at once and hand-fed from the start. In the natural way, the calf would not suck the cow until it got well on its feet, and in mild or warm weather there need be no hurry, for half an hour or so, to give it its first meal when separated from the cow; but in cold weather it is important that the calf should have a drink of warm milk as soon as possible. In all cases milk should be given to the young calves at the blood-heat of the cow (101° to 102° F.) which is the temperature at which a calf would get it from the cow by sucking. To ensure this temperature it will usually be necessary to warm the milk, either by the addition of a little hot water or otherwise. It may be well here to give a special caution against serving milk too hot either at this stage or later; it is better to err on the side of not having it warm enough than of having it too hot. To induce the calf to drink, the two forefingers should be placed in the calf's mouth, and the hand lowered into a bowl of the colostrum. Usually the calf at once sucks vigorously, but sometimes a little patience is required before it discovers its ability to suck. A quart is ample for the first meal; most calves readily take this amount, and many would take more if allowed. On the third day the use of the fingers may be discontinued and the calf made to drink from a small pail, and by this time it will take greedily two quarts at each meal.

The milk given to the calf at the outset should be the first drawn milk—colostrum or biestings—of the mother, since this possesses special nutritive and laxative properties which are essential for the well-being of the calf and difficult to supply in any other form. The mother's milk retains this character for the first week or so, throughout which period, however, it steadily approximates more and more closely to ordinary milk.

It sometimes happens, however, that a newly-calved cow is sold a day or two after calving, or a calf a day or two old is purchased, or a cow dies at calving, and no colostrum is available for the calf; in such a case a useful substitute for the first three days is made by whipping up an egg with half a pint of warm water, adding half a teaspoonful of castor oil, and stirring in one pint of new milk, for each meal.

After the preliminary difficulties have been overcome, the calf should be fed at regular hours three times daily on whole milk until it is at least a fortnight old, by which time it can profitably consume 4 to 6 quarts per day. The subsequent feeding will vary according to the conditions, as will be indicated later.

A word is necessary as to the proper treatment of purchased young calves brought from a distance often under very trying conditions. Such animals are usually thirsty on arrival and the natural tendency is to give a good meal at once. This is a great mistake and is probably largely responsible for the scour to which purchased calves are so subject. The methods adopted by successful rearers vary greatly ; one of the best is to give a small dose of castor oil and some stimulant in a little warm milk, as soon as the calf arrives, and after an hour or so to give a small meal of milk, which should not be too rich. For the first few days the calf should continue to receive very small quantities of food at a time, though it should be fed as frequently as possible, and at least four times a day. If the least sign of scour appears, a dose of castor oil should be administered at once, the quantity of food reduced by one-half, and a little chalk or lime-water given. It is indeed a good plan in any case to leave a lump of chalk in the calf-house, so that the calves can lick it as they like.

Before passing on to deal with different methods of rearing, a word of caution, which is generally applicable throughout the rearing, may be given as to the importance of regularity in the times of feeding and in the quantity and quality of the food supplied. For the first eight weeks the food should be given in at least three meals per day. At all times changes in the amount or character of the feeding should be introduced gradually. A sharp look out should be kept for lice and ring worm, which are easily dealt with if taken in time. The more scrupulous attention paid to details such as these doubtless accounts for the common experience that the small farmer, whose wife or family looks after the calves, is so often more successful in rearing than the large farmer who is mainly dependent upon more or less careless hired labour. No information derived from experiments or otherwise will ensure the best calves being reared unless it is accompanied by that watchful eye which is absolutely essential in the attendant.

Methods of Rearing.

A.—Liberal Use of Whole Milk.

At any time rearing ordinary commercial stock on whole milk is a costly process ; in these times, with restricted supplies of milk available for human consumption, it is neither profitable nor patriotic to give much of it to calves. The feeding of whole milk in considerable quantity to calves is at present only justifiable, if at all :—

(*a*.) On somewhat inaccessible farms where milk-selling is impossible and where facilities for making butter or cheese do not exist.

(*b*) Where milkers cannot be obtained and recourse must be had to suckling.

(*c*) In the rearing of valuable pedigree stock.

1. Unrestricted Suckling.—On upland farms in the South of Scotland and North of England where plenty of cheap grass is available, cows are often allowed to rear their own calves entirely. Such a method obviously saves labour, but is profitable only when the stock are of first-class quality and can be kept throughout the year at little expense, or when the sale of milk and its products is not the primary consideration. Galloway cows are crossed with a white Shorthorn bull with the object of producing blue-grey calves about the month of April. The calves run out at grass with their dams and are weaned about the end of October; afterwards the cows remain out of doors till Christmas, or even throughout the winter if provided with some form of shelter.

In other cases Angus cows are housed and calved down in sheltered yards and turned out to grass with their calves in spring, while in districts where the grass is of somewhat better quality, cows or heifers of Shorthorn breeding crossed with an Angus bull will rear their own and another calf in the course of the summer.

Calves thus reared are admirably adapted for the production of "baby beef" and usually command top prices when sold either as weaned calves or as stores or butcher beasts at from one to two years old.

2. Restricted Suckling.—In non-dairying districts where the grass is of good quality, and winter keep can be grown cheaply, three or even more calves per cow, per annum, may be reared, according to the milk-yielding capacity of the cow. Under this system the best results are obtained when the cow calves in the early winter. Milk can be used most economically when hand-feeding is practised, but where this is impracticable the cow's own calf and another are put on to suck three times a day. In the intervals between meals they should be kept tied up near the cow or turned loose in an adjoining box. Preferably for the first month or so calves should be tied up; afterwards, when they commence to ruminate and there is less likelihood of their sucking each other, they may be turned, a few together, into a loose box, and be given some crushed oats or maize, linseed cake and bran, together with some "fingered" roots and well-got hay. At the end of about 4 months the calves may be weaned and, if the weather is suitable, turned out to grass. The cow may then be given another calf, or two if she is a good milker, and be brought in from grass three times at first and later twice a day for suckling. On the whole foster calves are likely to do best when penned up and the cow is brought home for them to suck. They should, however, have the run of an open yard and be supplied with green food.

Cows calving in winter are likely to yield most milk in the course of a year, as the flush of grass in spring and early summer tends to prolong the period of lactation. Where plenty of roots or other succulent food and good straw are available in winter, a cow, suckling two calves, should not require more than 2 to 3 lb. of cake or meal daily in addition. Where, however, winter keep is scarce, it will be better to let the cows calve down in April or May, when a more intensive system of suckling may be adopted.

A cow calves, say in the month of May, and within a day or two another calf is obtained, and the cow is made to rear both. Some cows can even rear three calves at a time. Three times a day for the first week, and twice a day afterwards, the cow is brought in from the pasture, tied up, and given a feed of some kind to occupy her attention. The calves are then let out of their yard or crib, and in a few minutes suck her dry. Most cows at first rather object to the foster calf, but if their attention is taken up with a little trough food they do not usually make much difficulty. If gentler measures fail, a restive cow may usually be controlled by haltering and tying to the fodder-rack overhead, or by passing a rope tightly round her body immediately behind the shoulder

The calves soon learn to go to a particular cow. In about a month they will begin to pick hay or green food, and to eat linseed cake, or crushed oats. When they have reached the stage (usually in 6–8 weeks) when they are consuming half a pound of linseed cake or oats per day, they may be weaned, and given up to 2 pounds per head per day of, say, a mixture of linseed cake, crushed oats, and bean meal, or other digestible concentrated food, except cotton cake. Two more calves are then bought and put on to the same cow, and in 6–8 weeks they also are weaned. Some farmers leave each pair of calves on for 10–12 weeks, but there is no need to wait so long before weaning. When the second pair are weaned two more calves are similarly put on. The calves put on after the first pair should be at least 10 days to a fortnight old. They need only be fed twice a day.

The number of calves that can be reared in this way by one cow depends on the quality of the cow, and on the time each pair of calves remains on her, but there is no reason why a good cow should not rear 5 to 10 calves.

Very often, after she has nourished two or three pairs the cow may only be giving milk enough for a single calf. An observant farmer or stockman can tell whether she can rear another pair, or should only be given one calf.

Calf-rearing on the lines described is peculiarly adapted to the circumstances of the small-holder. Where close personal attention, either on the part of the owner or a member of his family, can be given, it is not unusual for as many as eight or nine calves per annum to be reared on a good-milking cow.

3.—Hand-feeding.—The rearing of calves by suckling has the merit of requiring the minimum of labour, but does not allow the milk-producing capabilities of the cow to be utilised to the fullest possible extent. Where adequate labour is available hand-feeding methods are undoubtedly superior in this respect, since they enable a systematic and thorough milking of the cow, and moreover, permit of a more careful rationing of the calf in accordance with its needs. A general outline of the method of feeding has already been given, and it is only necessary to emphasise again the importance of giving the milk always in warm and sweet condition, of thoroughly scalding the pails, &c., after each meal, and of avoiding too large quantities at any one meal.

B.—Restricted Use of Whole Milk.

Although it is found by experience to be undesirable, if not practically impossible, to eliminate whole milk entirely in the rearing of calves, it is a very common practice to restrict its use to the first few weeks of the calf's life, and to replace it subsequently by cheaper materials, the nature of which varies according to the character of the farm and the supplies available. Generally speaking, some new milk will be given throughout at least the first four weeks. On butter-making farms the whole milk will by the end of that time be replaced by separated or skim milk, to which is added an oil or meal preparation, which is devised to serve as a cream substitute. On milk-selling and cheese-making farms, however, when whole milk-feeding ceases recourse must be had entirely to meal mixtures which are made up for feeding with water or with whey. It will thus be convenient to deal separately with these different cases.

1. *Butter-making Farms.*

Where butter is made, skimmed or separated milk or butter milk is usually available for calf-rearing, and, in the absence of whole milk, there is no better basis for a calf-food. Hand-skimmed milk, or butter milk obtained in the churning of whole milk, contains more fat than separated milk, and has been used alone for calf-rearing more or less successfully.

The essential difference between whole milk and separated milk is that the latter has been almost entirely deprived of its cream or butter-fat. In other respects the two are practically identical. In using separated milk, therefore, the aim obviously should be to replace as much as possible of the fat removed, by another fat possessing similar properties. Various meals, however, are also used as cream substitutes.

Separated Milk and Oils.—Cod liver oil is the most commonly used for this purpose, but linseed oil has been used when cheap enough, and satisfactory results have also been obtained with a form of dripping obtainable from large slaughter-houses.

Cod liver oil is usually much cheaper than milk-fat, it would appear to be easily digested, and the calf very soon becomes accustomed to its taste. It is necessary, however, to see that the oil is perfectly wholesome. Only the best commercial oil of a clear amber colour should be used. In experiments at Garforth deaths occurred amongst calves receiving a low-grade oil, whilst there were no deaths amongst calves receiving a better oil.

In using the oil a tablespoonful is measured into a calf bucket, and the warm separated milk for one meal poured on to it; the mixture is poured into another bucket so as to mix or emulsify the oil, and is at once served to the calf. A calf thus gets three tablespoonfuls (say 2 oz.) a day, or half this quantity during the second fortnight, while having part new and part separated milk. If desired, double this quantity, *i.e.*, six tablespoonfuls a day, can be given quite safely to a calf a month or six weeks old, though more than this is apt to cause scouring.

Stewart, in experiments at Garforth, used a low-grade form of dripping, of which he found it practicable to give to each calf six ounces per day along with separated milk. The results were fully equal to those obtained previously with cod liver oil.

Separated Milk and Meals.—A great variety of calf meals or cream substitutes has been successfully used, but most contain linseed as a prominent ingredient. Linseed alone may be used either as boiled whole linseed or in the ground form.*

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* Linseed porridge should not be kept for long periods, since some samples of linseed slowly develop poisonous properties (due to prussic acid) on keeping in a moist state. The risk is avoided if the porridge be well boiled.

Lawrence, at Newton Rigg, prepares boiled linseed as follows :—Two pounds of linseed are put to soak over night in three gallons of water, boiled and stirred the next day for twenty minutes, and five minutes before the boiling is finished ½ lb. of flour (previously mixed with enough water to prevent it being lumpy) is added to this gruel to counteract the laxative tendency of the linseed. This will keep sweet for several days, and may therefore be made in considerable quantity; one pint of this gruel is added to four pints of separated milk.

Where ground linseed is preferred, unground linseed is obtained—to ensure having the whole of the oil—and is ground by ordinary farm mills. (The common types of steel grist mill will grind linseed alone without difficulty, but with stones it is advisable to add one part of Indian meal to seven of the linseed to prevent it clogging the mill.) This meal is scalded and stirred with boiling water at the rate of one quart of the meal to one gallon of water. This makes a porridge of much nicer consistency than the boiled linseed, and is more quickly and easily prepared; one pint of the porridge added to four pints of separated milk will be sufficient for a calf 4 to 5 weeks old. Linseed cake meal is frequently employed for making a calf porridge which is added to skimmed or separated milk, but, although a wholesome food, it does not enrich the milk with fat as linseed itself does, for linseed cake does not contain more than 12 per cent. of oil, whereas linseed contains up to 36 per cent.

In experiments at Woburn, in Ireland, and in the West of Scotland, good results have been obtained by using crushed oats along with separated milk. The calves were kept on whole milk until 3 or 4 weeks old, and towards the end of this period a handful of the crushed oats was mixed with the milk, and by the 6th week, when they were put entirely on to the separated milk, each calf was eating about a pound per day along with 1½ gallons of separated milk. After the calves were 12 weeks old the oats were given dry. Calves will soon take to oats in this form if they are put into the pail just before the milk is finished.

Campbell, at Garforth, obtained satisfactory results with a mixture of linseed meal (2 parts), oatmeal (1 part), rice meal (1 part), and locust bean meal (1 part), all ground as finely as possible and passed through a sieve. In Irish experiments good results have been obtained with a mixture of ground flaxseed (1 part), oatmeal (2 parts), and maize meal (2 parts). Various other mixtures of meals have been tried with success elsewhere. Many of the proprietary "cream equivalent" meals on the market are also said to have given satisfactory results.

The procedure in rearing is much the same whether oil or meals be used as cream substitute. Where the utmost economy of whole milk is desired it is usual to allow the calf for the first two weeks of its life about a gallon per day of whole milk in three meals. Separated milk is then gradually substituted for the whole milk, and at the end of the fourth week the calf will be getting $1\frac{1}{2}$ to 2 gallons of separated milk daily, with the addition of some meal. As an example of subsequent practice the method followed by Lawrence* may be quoted.

New milk is discontinued at the end of the first month, and for the next month the allowance of separated milk for each of three meals is three quarts with cream substitute. If the calf is intended for veal an extra pint of milk is given, and the fattening is hastened by a further addition of boiled oatmeal to the milk. Calves not intended for veal are given sweet meadow hay in the fifth week, at which age they begin to chew the cud. At the ninth week the mid-day milk is replaced by a handful of linseed cake (6 oz.), and the calves get a good drink (five quarts) of separated milk morning and evening without cream substitute. As they get older the hay and linseed cake are gradually increased until in the fifth month the calves receive half a pound of linseed cake a day and eat about 5 lb. of hay. A little crushed oats ($\frac{1}{4}$ lb.) is now added to the cake, and sliced swedes are given. At six months milk may be discontinued altogether, but this comes about gradually, the evening's milk being first stopped; in fact, all food-changes with calves should be gradual.

Calves born before March are turned out to grass as soon as the weather is mild (June probably), but do not lie out at night until hoar frosts are well at an end, and they continue to receive their daily allowance of linseed cake and meal. Calves born in the spring and summer months are not turned out that year, experience having shown that these calves thrive much better off the grass, escape that very troublesome calf disease—hoose, and turn out better stores the following spring. Indoor calves begin to receive green-meat, such as cut grass or vetches, in the summer, and sliced swedes in the winter, when five months old. Their feeding during the second half of the first year simply consists in foddering with hay and serving with cut swedes morning and evening in steadily increasing quantities, giving cake and meal at mid-day up to 1 lb. of cake and $\frac{1}{2}$ lb. of meal per head at the age of from nine to twelve months, and letting out to water and exercise at 10 a.m. A lump of rock-salt lies at each end of their trough for them to lick. Regularity of feeding is a matter of prime importance in the management of all kinds of cattle.

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* This description refers to pre-war practice.

The calf dietary for the first six months as above described may be shortly tabulated as follows :—

First Week.—Its own mother's warm milk three times a day, commencing with about a quart and increasing to two quarts at each meal by the third day.

Second Week.—Two quarts of warm new milk (not necessarily its own mother's) three times a day.

Third week.—Two pints of new and three pints of skim (or separated) milk, with half a pint of linseed porridge or half a tablespoonful of cod-liver oil, three times a day.

Fifth week.—Three quarts of warm skim milk, with one pint of linseed porridge or one tablespoonful of cod-liver oil three times a day, and a little sweet meadow hay, increased week by week.

Ninth week.—Mid-day milk and cream substitute omitted. Five quarts of separated milk are given morning and evening, a handful of broken linseed cake (6 oz.) at mid-day, and hay, increasing week by week.

Thirteenth week.—Milk as before, ¾ lb. mixed linseed cake and crushed oats, ½ gallon pulped swedes (green-meat in summer), gradually increasing, hay *ad lib.*

Twenty-first week.—Milk as before, 1 lb. of mixed linseed cake and meal, increasing quantities of roots, hay *ad lib.*

Twenty-fourth week.—Evening milk discontinued.

Twenty-seventh week.—Milk altogether discontinued.

Although skim-milk is somewhat richer in fat than separated milk, the latter has an advantage over the former in being perfectly fresh and sweet when given to the calves, and if served to them morning and evening shortly after being separated, needs no warming. It will pour into the calf pail clear of the froth if allowed to stand for a short time, or the froth may be held back with the hand.

2. *Milk-selling and Cheese-making Farms.*

On dairy farms where the milk is sold or made into cheese, separated milk is only available, if at all, in very limited quantities, and the problem of calf-rearing becomes more difficult.

In view of the price obtainable for both milk and cheese, the ideal in these cases would be to rear on a milk substitute. Unfortunately, both experience and experiments show that to eliminate milk altogether in rearing is extremely undesirable, if not practically impossible. Much, however, may be done with a little milk judiciously supplemented with other foods. These foods should be selected to furnish as nearly as possible an equivalent for the milk when the use of the latter is entirely suspended. It is not difficult to devise from a table of food-stuffs a calf meal that shall closely resemble milk in its digestible constituents, but this cannot be done without at the same time introducing indigestible matter which is absent from milk. The consequence is that, unless the greatest care is taken, calves reared on calf meals alone are "pot-bellied," badly-grown animals, instead of having the well-grown, level-fleshed, and alert appearance of milk-fed calves.

This question of indigestible matter, and that of choosing meals that will agree with the calf, constitute the practical difficulties; and yet probably most milk-sellers and cheese-makers would be glad to rear the heifer calves from their best milking cows if there were a fair prospect of doing so successfully with very little milk. The following meals have been found by Lawrence to be good milk substitutes, and, used as directed, provide an albuminoid ratio about the same as that in new milk—

CALF MEAL No. 1.—Used when a small quantity of separated milk is available:—

8 parts of oatmeal (by weight).
1 part of ground linseed.

Scald 2½ lb. over night with five pints of boiling water, boil for ten minutes next morning, and add five pints of separated milk with about ¼ oz. of salt and 2 oz. of sugar*.

No. 2.—When no separated milk is available:—

2 parts linseed cake meal.
2 parts oatmeal.
1 part ground linseed.

Mix 2½ lb. with 5 quarts of boiling water over night, and boil for ten minutes next morning; serve with salt and sugar as with No. 1.

No. 3.—Requiring no boiling:—

14 parts linseed cake meal.
5 parts ground linseed.
2 parts wheat flour.
2 parts locust bean meal.

Mix 2½ lb. with 5 quarts of boiling water and a sprinkle of salt.

In each case the gruel should be thinned down with water to the required consistency.

Where No. 2 or No. 3 is used it is introduced and the new milk reduced very gradually.

The following mixture also gave satisfactory results in trials at Garforth:—

1 part ground linseed.
3 parts malt, ground and sifted†.
6 parts pea meal, ground and sifted.

The mixture was scalded and then reduced to the proper temperature (about 100° F.) with cold water, and fed as a gruel. In preparing gruels of this meal mixture, the most suitable proportions at the beginning are $\frac{1}{4}$ lb. meal to 1 quart of water (or 1 lb. meal to 1 gallon of water), and 1 pint of the gruel can be substituted for 1 pint of new milk every three to four days, until gruel only is given at the age of seven to eight weeks. The amount of gruel may be gradually increased to $1\frac{1}{2}$ gallons per day, and the proportion

* The use of sugar must be omitted under present conditions.
† The use of malt is now prohibited.

of meal also increased until each calf is getting $1\frac{1}{2}$ to 2 lb. of meal (as gruel) per day. The total quantity of new milk required for each calf in this system of feeding is approximately 50 gallons ; some strong thriving calves may do with less, but others with more delicate digestions may require more.

When the calves are about six weeks old a little good meadow hay should be given, and from eight weeks onwards some dry trough food, such as crushed oats, finely broken linseed cake, or bran. The allowance of gruel should be gradually reduced during the sixth month. By this time the calves should be well accustomed to dry foods, and should receive $1\frac{1}{2}$ to 2 lb. per day, and grass, green forage or " fingered " roots according to season.

Dry Meals as Milk Substitutes.—Owing to the time and care required in the preparation and feeding of gruels, and the difficulty of finding reliable labour for this work at the present time, trials in which the milk substitute was given in the form of a dry meal have recently been carried out. New milk was given for the first four weeks and during the next three to four weeks the new milk was gradually reduced and dry meals and water (in separate receptacles) given instead.

The following meal mixtures have been used with success at the Midland Agricultural and Dairy College :—

Linseed cake (finely nutted) ...	4 parts.
Wheat germ meal	5 parts.
Dried yeast	1 part.

The mixture, with a little salt added, was given at the rate of $\frac{1}{4}$ lb. per calf daily at the beginning, and it was increased gradually, as there was no difficulty in getting the calves to take it. During the transition period a little was given as a gruel in the milk—an excellent gruel being obtained simply by soaking in water 12 hours before feeding.

Linseed cake (finely nutted) ...	4 parts.
Bean meal	5 parts.

This mixture, also with a little salt, was fed in the same quantity as the previous mixture and with equally satisfactory results.

The total quantity of new milk consumed by each calf was from 35 to 40 gallons ; the allowance of dry meal was gradually increased from $\frac{1}{4}$ lb. per calf per day when 4 weeks old, to $2\frac{1}{4}$ lb. per day when 14 weeks old. Hay was given from the sixth week onwards. During the period of experimental feeding (11 weeks) the calves in both lots increased in live weight at the rate of fully 1 lb. per head per day and were equal to another lot reared on separated milk and crushed oats.

In the Woburn experiments in 1915–16, crushed oats, palm-nut cake meal, crushed maize and crushed beans respectively were tested, the maize being scalded, but the other foods given dry. In the following year crushed oats and palm-nut cake were again tested, as well as mixtures of crushed oats with beans and with palm-nut cake, and a mixture of maize and fish-meal. In each year whole milk was given only for the first two weeks, the change to the meal and water diet being made in the course of the third week. A little linseed cake was given when the calves were eight weeks old. The calves were allowed a little long hay as soon as they would take it, and when 5 or 6 weeks old a little hay chaff was mixed with the meals. The results, judged by the cost of rearing, were on the whole fairly satisfactory, although the rate of gain in live-weight was less than that obtainable with separated milk. In the latter respect the best results were obtained with the maize-fish meal and the oats-palmnut cake mixtures. Oats alone gave only a low rate of increase in each year. Great difficulties were experienced in getting the calves to eat palm-kernel cake alone, but admixture with oats greatly reduced the trouble.

Use of Whey in Calf-Rearing.—Whey can be used for calf-rearing, but, for the reason that the casein as well as the fat of the milk have been removed in the making of the cheese, a greater degree of care has to be exercised. Calves fed on whole milk for the first month, however, have been known to thrive well subsequently on about 1½ gallons daily of warmed whey, together with crushed oats or maize given dry.

On cheese-making farms in Cheshire the following method of using whey for rearing calves is successfully practised.

"Directly the whey is run from the curd, it is put into a large copper, and then heated over a quick fire. The albumen coagulates, and, just before boiling point, rises to the top in flakes, known as 'fleetings.' These are skimmed off as they rise. The whey must on no account be allowed to boil, or the 'fleetings' will sink to the bottom. To assist them to form it is often helpful to add two or three quarts of cold whey. This also checks the bulk from boiling.

The boiler must be thoroughly cleaned out each day after use, and for this purpose a soft brick or rubbing-stone is best.

The calves are fed twice a day as follows :—

1st week—4 quarts milk per day.
2nd week—6 quarts milk per day.
3rd week—6 quarts—half milk and half 'fleetings' per day.
4th week—8 quarts—2 quarts milk and 6 quarts 'fleetings' per day.
5th week—8 quarts—1 quart milk and 7 quarts 'fleetings' per day.
6th week—8 quarts 'fleetings' per day.

Milk is rarely given after the calves are six weeks old. As soon as possible a little soft meadow hay is given to the calves, and after about a week's time a little bran as trough food. When the calves are six weeks old, and are getting no new milk, a little linseed-cake and kibbled oats in equal proportions are added to the bran. Each calf is allowed about ½ lb. of the mixture. This is gradually increased to about 1 lb. per calf per day. The calves are put out to pasture when they are finally weaned (about five months old), generally about the second week in June. The quantity of 'fleetings' is gradually reduced, and in the last week only one feed per day is given. The weaning process extends over two weeks. If the weather is very wet or cold, the calves are brought in for a few nights, and get a little corn and cake, otherwise they are left out at pasture for about three months, and are entirely dependent upon the grass."

Experiments at Kilmarnock.—Recent experiments (1916, 1917) at Kilmarnock have demonstrated that calves can be reared fairly satisfactorily on ordinary whey supplemented by meals. In these experiments palm kernel cake meal alone, a mixture of oatmeal (2 parts) and fish meal (1 part), and a similar mixture of fine thirds and fish meal were tested separately along with whey. The mixtures were given in the form of porridge, but the palm kernel meal was fed dry. The replacement of the whole milk by whey began when the calves were 3 weeks old, and the change of diet was spread over 3 weeks, *i.e.*, the calves were 6 weeks old before the whole milk was entirely withdrawn. By this time each calf was receiving about 1 gallon of whey and ½ lb. of meal daily, and the consumption for the remainder of the experiment averaged about 1½ gallons of whey and 1 lb. of meal per day. Hay was fed from the time that calves were 5 weeks old, and linseed cake introduced into the ration 3 weeks later, starting with a handful and increasing up to an average of ¾ lb. daily. In each case the rate of growth was not much lower than that with other calves reared on separated milk and crushed oats, but was obtained far more cheaply. The cheapest rearing was effected in each year by the use of palm kernel cake.

Experiments at University College, Reading.—The most recent experiments concerned with the use of whey for calf-rearing were those conducted by the Board in 1918 on the College farm at Reading.

The Board were led to conduct these experiments because the efforts which have been made since 1915 to increase the production of cheese in this country have resulted in the adoption of the practice of cheese-making in several districts where butter-making and calf-rearing were previously the chief industry, and there was need in these areas of evidence that calves can be reared from an early age onwards by the use of whey in place of separated milk. In designing these experiments particular care was taken to use food materials which are readily available and have the effect when mixed with whey of bringing it as nearly as possible to the same food value as milk.

The experiments were decidedly successful. The calves thrived well and presented throughout the full rearing period a "bloom" indicative of healthy growth. A full report concerning them is published in a Memorandum, A $\frac{309}{1}$, issued by the Board.

The following is a summary of the practical conclusions arrived at as a result of the experiments :—

(1) Any of the following meal mixtures may be selected for use :—

I.	II.
Linseed meal, 3 parts. Linseed cake meal, 2 parts.	Linseed meal, 3 parts. Bean meal, 3 parts. Fish meal, 1 part.
A.	**B.**
Linseed meal, 2 parts. Fish meal, 1 part.	Linseed meal, 1 part. Coconut meal, 1 part.
C.	**D.**
Bean meal, 5 parts. Linseed cake meal, 4 parts.	Linseed meal, 3 parts. Fish meal, 1 part. Ground oats, 1 part.

Of the above mixtures the experiment indicated that a slight preference is to be attached to the bean meal mixtures (II and C).

(2) The meal mixture should be used at the rate of 1 lb. to each gallon of whey, the whey to be warmed to blood heat.

(3) To each gallon of whey there should be added $\frac{1}{2}$ oz. of precipitated bone phosphate.

(4) From the age of four weeks the calves should be given hay *ad lib.*, and, as soon as they will eat it, linseed cake or a mixture of linseed cake, coconut cake and gluten feed should be allowed, starting with 2 oz. and rising eventually to 12 oz. per head.

(5) The system of feeding up to the age of 17 weeks should be as follows :—

Age.	Feeding.
(*a*) Birth to 2 weeks ...	Colostrum followed by new milk.
(*b*) 2 to 4 weeks ...	At two weeks commence substituting whey and meals (prepared as directed under 2 and 3 above) for milk. Daily increase the amount of the substitute and decrease the milk given until at the age of four weeks the calf is getting one gallon of whey, 1 lb. of meal, and no milk. At the outset the meal should be mixed with the whey, but as soon as the calves will eat it in the dry form they should be allowed to do so and the warmed whey containing the precipitated bone phosphate given as a plain drink.
(*c*) 4 to 5 weeks ...	Continue to feed one gallon of whey and 1 lb. of the meal daily, and from this time forward allow, in addition, as much hay as the calf will eat.
(*d*) 6 to 7 weeks ...	Increase above ration by starting to feed linseed cake or a mixture of linseed cake, coconut cake and maize gluten feed at the rate of 2 oz. per day, given after morning feed, gradually increasing the amount up to 6 oz. per head per day.
(*e*) 8 to 9 weeks ...	Increase the daily feed of whey to 1½ gallons and the weight of meal mixture to 1½ lb.
(*f*) 10 to 12 weeks ...	During this period the calves remain on full ration.
(*g*) 13 to 14 weeks ...	Reduce the meal mixture gradually from 1½ lb. to 1 lb. per day while maintaining the full supply of other foods.
(*h*) 15 to 16 weeks ...	Reduce the whey to 1 gallon and the meal mixture to ½ lb. per day. The calves will now get 1 gallon whey, ½ lb. meal mixture, 6 oz. cake (or cake mixture), hay *ad lib.*
(*i*) 17 weeks	If the calves can be put out to grass, or if a supply of succulent farm foods is available, the whey and meal mixture may be discontinued at the end of 17 weeks, but in this case the quantity of the cake allowed should be increased to ½ lb. per head per day.

(6) Should any digestive trouble in the form of "blowing" occur in the calves during the early stages of feeding whey, it can be successfully dealt with by adding a little precipitated chalk to the whey.

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*Loss of Calves.**

One of the first signs that a calf is out of health is loss of appetite; it is advisable, therefore, whenever a calf hesitates to take its milk, to remove the milk at once and administer a tablespoonful of castor oil shaken up with twice this quantity of hot water. This usually puts matters right, even when "white scour" is commencing.

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* For information as to White Scour in Calves, *see* Leaflet No. 101 *Prevention of White Scour in Calves*).

Loss among calves is often attributed to the feeding of cotton cake to the cows, but there seems to be no reliable evidence in support of this opinion. On Mr. Lawrence's farm, where the cows regularly receive cotton cake, there have been only five calves lost in nine years out of a total of 180 calves born.

London, S.W.1,
May, 1905.

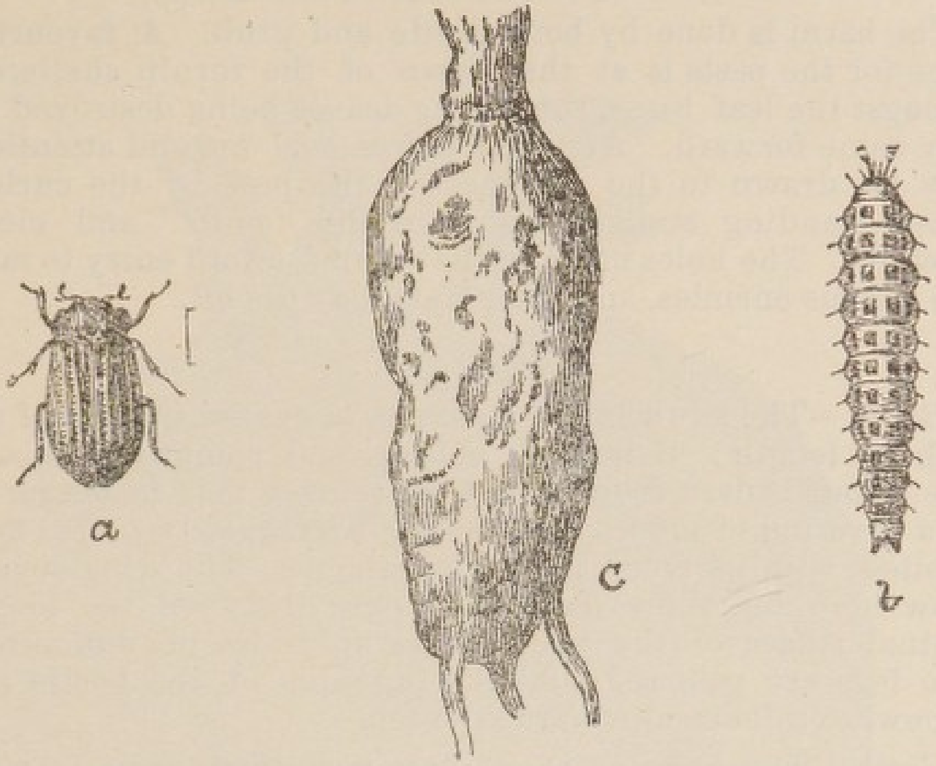
Re-written, November, 1917.
Revised, March, 1919.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 143.

BOARD OF AGRICULTURE AND FISHERIES.

The Turnip Mud-Beetle (*Helophorus rugosus*)



HELOPHORUS RUGOSUS.—*a*. Beetle, magnified, with line showing nat. size *b*. Larva, magnified (after Ormerod). *c*. Turnip, showing gnawings of grub.

The Turnip Mud-Beetle (*Helophorus rugosus*) belongs to a family of beetles the life histories and food habits of many of which are imperfectly known. The best known members of the family are aquatic, both as adults and as grubs, and the grubs may be vegetable feeders or they may be carnivorous. The species of the genus *Helophorus* are non-swimmers, although they can be found on water, near water, and in mud. They are capable of flight, and species have been found away from water on herbage.

Distribution.—As to the distribution of *Helophorus rugosus*, Fowler describes it as "rather local, but widely distributed through England and Wales inland and near the coast, not so common in the north; Scotland, scarce: Lowlands, Tweed, Forth, Solway, and Dee districts." Up to 1905, so far as is known, all the complaints made as to the destructive work of this beetle came from Aberdeenshire. In 1906, however, the insect was reported to the Board as having done considerable damage to turnips on a farm in North Lincolnshire, and the attacked turnips were described as "stunted in growth, hard and woody, and full of galleries." Again in November, 1912, the grubs were found damaging several large patches of turnips at Chichester.

Method of Attack.—(1.) The leaves may be eaten. (2.) The leafstalks may be holed and tunnelled. (3.) The swollen "bulbs" may be irregularly gnawed and tunnelled on the outer surface, especially in the upper part.

The harm is done by both beetle and grub. A favourite place for the pests is at the crown of the turnip sheltered amongst the leaf bases, the young leaves being destroyed as they come forward. Attacked leaves curl up, and attention may be drawn to the presence of the pest by the curled leaves standing straight up from the "bulb" and close together. The holes made in the "bulb" afford entry to rain and fungus enemies, and the plants may die off.

Description.

Beetle.—The adult insect measures about one quarter of an inch in length; it is oval, oblong, and somewhat broad. The colour is dark reddish, but the redness may be obscured by a covering of mud. The thorax is irregularly ridged and knotted, with its front angles prominent. The wing-covers show here and there dark markings; between the longitudinal ridges of the wing-covers are rows of punctures. The legs are pale red, and the antennæ of the beetle are somewhat thickened towards the top.

Grub.—The appearance of the magnified grub is well shown in the illustration. The dark coloured head has brownish jaws. The three segments behind the head each carry a pair of legs; on the upper surface of these thoracic segments is a dark transverse curved line, whilst down the back of the remaining segments there are two rows of large square spots, with rows of smaller spots below down each side. The body ends in two processes. Some grubs sent to the Board of Agriculture and Fisheries early in October, 1904, were over one quarter of an inch in length, and were not full-fed. The pupa like the larva has two spines at the end of the body and hairs projecting from the sides.

Remedial Measures.

It is strongly recommended that, as far as is practicable in the rotation, turnips should be sown at a distance from a field that has been infested. In fighting the pest the most successful measure has been the application to the crop of stimulating dressings; 1 cwt. of nitrate of soda per acre proved satisfactory on that portion of the field least infested. As pupation takes place in the soil a deep ploughing should follow attack.

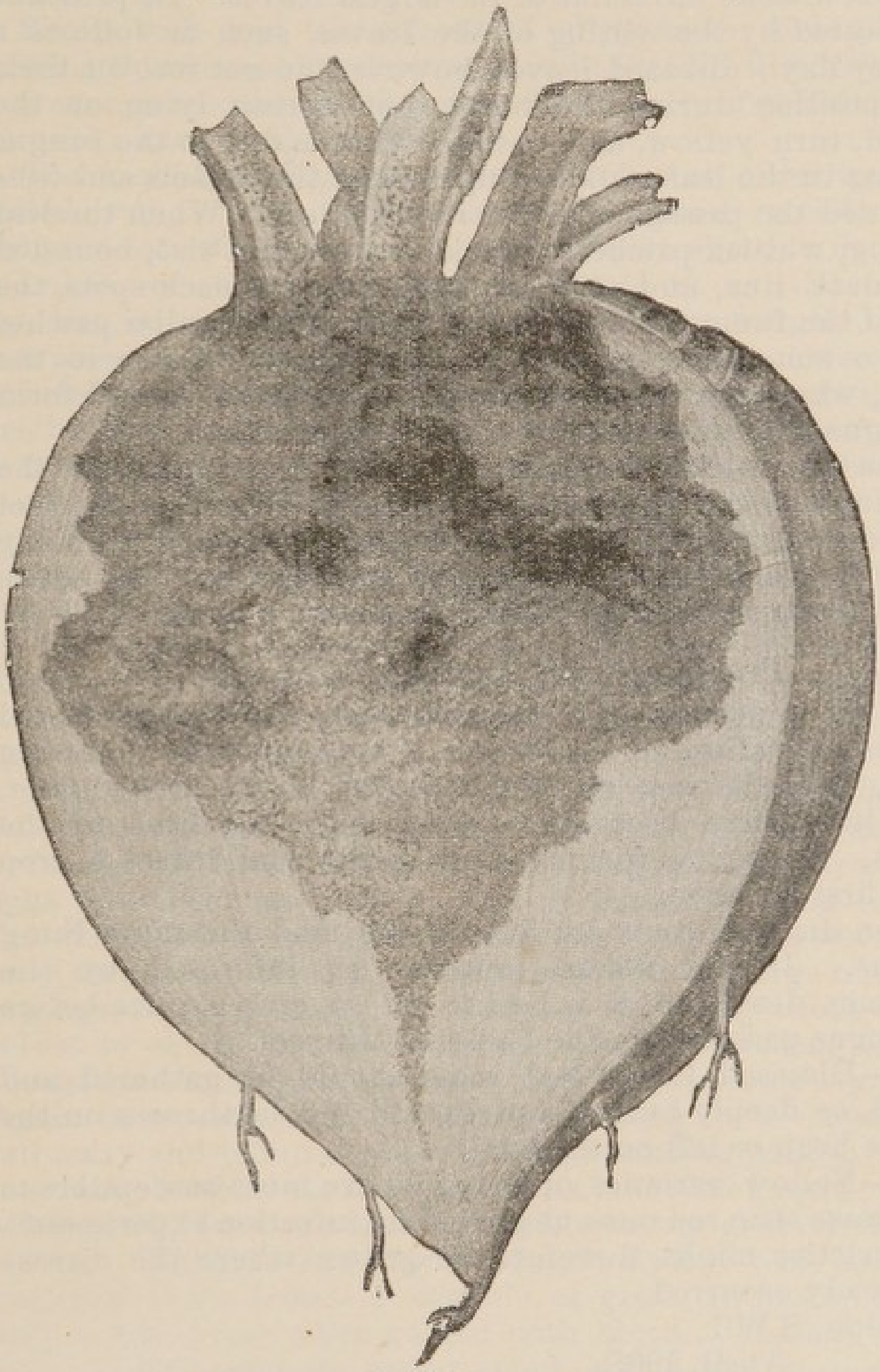
London, S.W.1,
June, 1905.

Revised, February, 1913.

BOARD OF AGRICULTURE AND FISHERIES.

Heart Rot of Beet, Mangold and Swede.

(*Sphaerella tabifica*, Prill. et Del.).



Yellow Globe Mangold, showing Heart Rot.

This disease is not uncommon in France, where it often causes considerable damage to sugar beet. In this country it has of late years been frequently reported on the mangold and swede. An instance recently occurred where nearly every root grown on a four-acre plot of "Yellow Globe" mangold was badly diseased. At the time of its discovery workmen were busily engaged in cutting off the sound portions for cattle food, and chopping up the diseased parts and scattering them over the land to be ploughed in.

Description and Appearance of Plants Infested.

The disease rarely appears before the middle of August, and first attacks the stalks of the largest leaves. Its presence is indicated by the wilting of the leaves, such as follows a hot, dry day ; diseased leaves, however, do not recover their erect position during the night, but remain lying on the ground, turn yellow, and decay. This is due to the fungus growing in the leaf-stalk having choked the vessels and thus prevented the passage of water into the leaf. When the leaf is dying, whitish patches of variable form and size, bounded by a dark line, and studded with minute black spots, the fruit of the fungus, appear on the leaf-stalk. Similar patches are also sometimes present on the leaves. Later in the season, when the leaf-stalks are dead and dry, a second form of fungus-fruit appears on the bleached patches.

Some time after the leaves have been infected the mycelium of the fungus passes into the crown of the root and thence gradually extends downwards, its progress being clearly indicated by a darkening of the tissues. The entire root is finally reduced to a blackish, decayed mass.

Preventive and Remedial Measures.

(1).—If a portion of a diseased root, which is crowded with the mycelium of the fungus, is kept until the following season, it undergoes no change until about midsummer, when its surface becomes covered with the fruit of the fungus. Such fruit furnishes the spores that infect a crop in the first instance.

When diseased roots are left on the land the same thing happens. If the disease appears, as indicated by the symptoms described, it is best to lift the crop at once before the fungus passes from the leaves to the root.

(2).—Diseased leaves and roots should be gathered and burned, or deeply buried, and should not be thrown on the manure heap or left on the land.

(3).—Yellow varieties of mangold are more susceptible to the disease than red ones, as proved by infection experiments. Red varieties might, therefore, be grown where the disease has already occurred.

London, S.W.1,

April, 1906.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London S.W.1. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

Sheep Dipping.

Sheep scab and the effects of dipping on the parasite causing this disease are dealt with in Leaflet No. 61. Dipping, however, is recommended for the destruction of certain other parasites, such as Keds and Lice.

The Ked (*Melophagus ovinus*).—This pest, often wrongly called "the tick" is probably the most widely distributed of the parasites which attack sheep. It is a member of the same order (*Diptera*) as the house fly, but is wingless. It is about ¼ inch in length, has a compressed leathery body, brown-grey in colour, and covered with short hairs. The Ked does not lay eggs; these are hatched in the body of the parent insect and the maggot is nourished there. When the maggot is deposited development is so far advanced that it at once becomes a pupa under cover of the puparium. The brown pupal cases (*puparia*) may be found at the base of the wool fibres. Reproduction is slow, each female producing about three to five pupæ at intervals of a few days, after which it dies. Keds are for the most part spread by contact of one sheep with another. The mature creatures cause great irritation and loss of condition.

The Sheep Tick.—*Ixodes ricinus* and *Haemaphysalis punctata* are not true insects, but belong to the *Ixodidæ*, a family of the order *Acarina*. On hatching from the eggs ticks bear only three pairs of legs, but when mature they have four pairs. (True insects in the mature state have only three pairs of legs.) The eggs are laid in large numbers amongst damp herbage; the larvæ on hatching attach themselves to sheep or other animals and after feeding fall to the ground and moult, after which they become *nymphæ*. Again they reach a sheep and after feeding for a short time fall away and moult a second time, becoming adults. Once more they feed on the sheep as adults, and after gorging themselves with blood the females tumble to the ground for egg laying. When fasting they are flat, and move with ease, but the body of the female is capable of great distension and is very much larger when gorged with blood. The large ticks begin to be found on sheep about March, and reappear in autumn. They are notably common on the hill pastures of the Border districts and in the Western Highlands, though they occur also in other districts.

Lice.—Lice infesting sheep do considerable harm by cutting the wool and causing itching, irritation and unrest. The head of the louse is large and broad; the body is compressed and wingless. The louse is chiefly found on young animals or on animals in poor condition.

Maggots.—The larvæ of certain flies (especially the green-bottle *Lucilia sericata*) are a source of great trouble and loss to flock-masters during the summer months. The flies deposit their eggs in clusters amongst the wool, and the resulting maggots feed on the live flesh of the sheep. (For particulars of this pest *see* Leaflet 126.)

The operation of dipping is performed in a variety of ways, several types of bath being in common use.

The Hand Bath.

The simplest form of bath is made of wood, galvanized iron, or earthenware, and measures 4 feet in length and depth and $1\frac{3}{4}$ feet in width. In this the animal is immersed by turning it on to its back, and holding its head above water. The advantages of this form of bath consist in its low cost, and in requiring comparatively little liquid to fill it; while its disadvantages are (*a*) the unnatural position of the sheep and the consequent risk of poison "running" into its mouth and nose; (*b*) the laborious and slightly dangerous character of the work for the labourers; and (*c*) the danger of abortion to in-lamb ewes. The hand bath requires more men to work it than the swim bath.

A very convenient arrangement consists of a portable wooden bath 6 feet long, 2 feet 6 ins. wide, and 2 feet 3 ins. deep at one end, the exit slope commencing 3 feet from that end. The exit end is bolted to a specially built, crate-like tip-cart, into which the dipped animals walk to drip. The body of the cart is kept horizontal, the shafts being turned down to the ground, the whole being fixed. The sheep leave at the front end by walking down a slope fixed over the shafts. The whole outfit, not including wheels and axles, may cost about £6 10*s*. When not in use for dipping, the cart may be usefully employed as a closed conveyance for calves, sheep, pigs, &c. For a fuller account of this type of bath, together with illustrations, *see* the *Journal of the Board of Agriculture* for July, 1908.

The Swim Bath.

The swim bath is made in two forms, being either so narrow (under two feet) that a sheep can only swim forward, or so broad ($3\frac{1}{2}$ feet) that sheep can swim round in it. A bath much used on the larger pastoral farms in Scotland consists of a trough with sloping ends, 33 feet long at the top, 20 feet 6 ins. long at the bottom, and 5 feet deep. The width is about 20 inches, only allowing room for the sheep to pass through the bath in single file. The bottom of the trough is somewhat narrower than the top. The sheep are put in at one end, and after swimming through the bath, pass up the inclined plane at the other end to a dripping pen.

A permanent swim bath constructed of cement, or stone or brick faced with cement, may be built at a cost of about £10. The walls would be 4 to 6 ins. thick, and the bath 3 feet deep, 20 ins. wide at the top and 12 ins. at the bottom, and 12 feet in length. The sloping walk-out commences 6 feet 6 ins. from the deep or "well" end. There is a man-hole on either side, a collecting pen at the one end and a double draining pen at the other. The bath will accommodate two lowland or three Fell sheep, or four to five lambs at a time, and 500 to 600 sheep can be handled in a short day's work. (This bath is also described and illustrated in the *Journal* referred to above.)

The Cage Bath.

A third form of dipper consists of a galvanised tank sunk in the ground with its upper edge flush with the surface. In this a cage is raised and lowered by means of a hand windlass. One sheep at a time walks into the cage, and is lowered into the bath. In due course the cage is raised and the sheep walks on to the draining floor. Under this method the sheep are scarcely handled at all, the labour is easy, and risks of all kinds are reduced to a minimum.

Further information on baths will be found in the Minutes of Evidence of the Departmental Committee referred to below.*

Dips.

In some experiments conducted by Professor Winter, at the University College of North Wales, Bangor, sixteen dips were tested, and of these five (Nos. IV., V., X., XV., XVI.) were proprietary.* The sheep were immersed in an ordinary swim-bath for a period of one minute, every sheep being carefully examined at the end of 24 hours, and again at intervals until shorn a month later. A brief summary of the principal dips employed is given below :—

I.—2½ lb. arsenious acid (ordinary arsenic), 1¾ lb. washing soda, per 100 gallons dip-bath.

II.—2½ lb. arsenious acid, ½ lb. good dry caustic soda, per 100 gallons.

III.—As No. I., with the addition of 4 lb. of flowers of sulphur.

IV.—Combination of arsenic and sulphur, dip-bath containing 5 lb. free sulphur per 100 gallons.

V.—Soluble sodium compounds of sulphur, with free sulphur.

VI.—25 lb. of sulphur and 12½ lb. of lime boiled in water until of dark red-brown colour ; strain and make up to 100 gallons.

VIII.—Carbolic acid ¾ gallon, soft soap 5 lb. per 100 gallons dip-bath.

X.—A fluid carbolic dip readily soluble in cold water.

XIII.—1 gallon of a mixture of 29 per cent. tar acid, 36 per cent. paraffin, 8 per cent. lanoline, 17½ per cent. anhydrous soft soap, and 9½ per cent. water, in 100 gallons dip-bath.

XIV.—Extract of 35 lb. finely ground tobacco and 10 lb. flowers of sulphur per 100 gallons dip-bath at 110° F.

XV.—Small proportion of tar acid in addition to tobacco and sulphur.

XVI.—A tobacco, soft soap, and sulphur dip.

* Report, Departmental Committee on Sheep Dipping, 1904, Cd. 2258 ; Minutes of Evidence, Departmental Committee on Sheep Dipping, 1904, Cd. 2259 ; to be obtained from H.M. Stationery Office, Imperial House, Kingsway, London, W.C.2. Price 3*d*. and 2*s*. 4*d*. respectively.

Effects of Dips.

Keds.—With the exception of Nos. V. and VI. all the above dips were effective in killing keds, but were less successful in their action on the puparia. The tobacco dips were nearly as active, while the sulphur and arsenic preparations required a little longer time.

As the puparia appear to hatch out about 21 days after being deposited by the female, a second dipping at the end of three weeks would doubtless have a marked effect in getting the sheep clear of keds. By that time the puparia left in the fleece after the first dipping would have hatched out, and as there is no evidence to show that keds produce puparia within three weeks after they are hatched, it would only be necessary for the second dipping to destroy the keds which had appeared since the previous dipping.

It was evident that where some of the poisonous dips were used, a second dipping after an interval of 12 days was injurious to the health of the sheep, so that where a second dipping is desired for the destruction of keds, the proper time would appear to be about three weeks after the first immersion.

Lice.—There is every reason to believe that any dip which is destructive to other parasites is effective also against lice.

Ticks.—Much misunderstanding has arisen regarding the efficacy of dips for ticks, owing to the fact that in the natural course of their life history ticks leave the host whether the latter is dipped or not. Arsenical dips appear to give the most satisfactory results.

Maggots.—Sulphur is indispensable for dips against maggots, as the smell keeps off the fly. Carbolic dips, although they may destroy maggots actually present on the sheep, are practically valueless in warding off an attack. (*See* Leaflet 126.)

General.

Carbolic dips are effective in destroying all sheep parasites, and, when skilfully prepared, leave the wool and skin in a nice condition. The strength should, however, be carefully regulated to prevent irritation of the sheep. Nos. X. and XIII. were found to be the best though X. discoloured the wool somewhat.

Spirits of tar and pitch oil are apt to discolour the wool and reduce its value.

The arsenic and sulphur dips are thoroughly effective in curing scab and destroying other parasites, but the experiments clearly show that the use of strong dips of this character is attended with some danger when treating sheep affected with scab, especially if they are in low condition or have sores on them. These dips had no bad effects on the quality of the wool. (On the subject of preparing wool for market *see* Leaflet No. 82.)

Tobacco and Hellebore dips, if properly compounded, may also be regarded as quite satisfactory.

The exact composition of some dips is given above, and in Leaflet 61, but farmers will find it more satisfactory to use one of the proprietary dips now on the market. Those which have been tested by the Board, and approved for use against sheep scab, bear a label to that effect.

The dippers should be instructed to pay particular attention to the upper region of the neck, which often escapes saturation when the swim bath is used. It is advisable to swab this region with dip as the sheep swim through.

Before dipping, all dung-bound wool should be removed by clipping.

Too much care cannot be exercised in keeping the bath free from gross impurities, both by skimming floating particles off the surface, and by changing the fluid at intervals. An old and dirty dip laden with manure encourages rather than retards the attacks of insects.

London, S.W.1,
July, 1905.

Revised, July, 1908.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 146.

BOARD OF AGRICULTURE AND FISHERIES.

The Value of Records of the Milk Yield of Cows.

The practice of keeping records of the quantity and quality of the milk yielded by dairy cows has made very great progress during recent years both on the Continent and in the United States and Canada. It has also been adopted in this country by the leading breeders of pedigree cows, and to some extent by the more progressive farmers in the south of Scotland, and elsewhere.

The system is of value to the milk-seller, to the butter-maker, and to the breeder, according to the object for which the cows are kept. It enables the milk-seller to know exactly what yield his cows are giving and the quality of the milk given by each individual animal. He can thus identify cows which systematically give a low yield or produce milk of low quality, and, by disposing of them, prevent the loss due to maintaining cows that are not worth their keep. Where milk is made into butter, the importance of obtaining a high percentage of fat in the milk is obvious, while to the breeder the practice of milk-testing is perhaps even more important, as by this means he can select his best cows for breeding purposes.

Simple Records of Milk Yields.

In its simplest form a record of the milk yield of cows may be kept without difficulty, and the small amount of time and trouble involved is well repaid by the value of the information obtained. All that is required is a spring balance to which a pail can be hung. Balances provided with dials on which the weight of the pail is allowed for should be used. The milk of each cow can thus be easily recorded (in pounds or in pints, according to which figure is preferred) and should be noted on a sheet ruled for the purpose and fastened up in some convenient position. If such records are kept systematically, an accurate account of the yield of each cow will be obtained and the farmer can thus distinguish between superior and inferior cows. It is true he can do this in a general way without the help of a record, but it must be remembered that some cows give large daily yields for a comparatively short period while others give moderate daily yields over a long lactation period and in any case a difference of 100 or even 200 gallons is not so easily appreciated when spread over the whole period. A difference of

100 gallons at $6\frac{1}{2}d.$ per gallon represents $54s.$, and it is probably not too much to say that cows in the same herd frequently differ in their annual production by as much as £5 without their owner being aware of it.

If the trouble of recording the milk of each cow twice daily, viz., morning and evening, is felt to be too great, an approximately accurate result can be obtained by recording the yield morning and evening on a fixed and corresponding day every week, and multiplying by 7. Experiments made in Lancashire and in the United States have shown that the error is not likely to be more than 3 per cent.

Value of Milk Records to the Dairy Farmer.

Apart from the benefits of the practice to the milk-seller and to the butter-maker, the keeping of milk records, in addition to enabling the dairy farmer to distinguish between superior and inferior cows, has many other advantages. Among these advantages are the following :—

1. Any slight reduction in yield will be noticed and investigations as to the cause can be made at once. For instance, when a cow is unwell her milk yield generally diminishes; milk records therefore may often be the means of detecting an ailing cow.

2. Feeding may be carried out more economically. Since the market price and milk-producing values of foods are not necessarily directly proportionate, it is quite possible to feed a cow expensively and not produce any better results than could be obtained from cheaper foods.

3. Where milk records are kept the influence of change of food, and the effect of different climatic conditions can be noted.

4. There is increased interest on the part of both farmer and stockman in their labours. The faculty of observation is developed, cause and effect in milk production are studied side by side, and a stimulus is given to the further study of data bearing on the work. Records have therefore a distinct educational value.

5. Milk records supply data which allow of breeding, selection and feeding of cows being conducted in an intelligent manner and thus materially assist in placing dairy farming on a sound business footing.

6. Milking qualities are largely hereditary, and the progeny of a heavy milking cow are likely to inherit the characteristics of their dam. It is therefore of the first importance that the dairy farmer should have a record of the performances of his cows, and should select the heavy milkers to breed from for his own herd. Dairy qualities are also transmitted through the bull used, and it is equally important to be able to show that he is descended from a heavy milking strain.

The possession of a satisfactory milk record becomes in this way a very valuable asset, not only as a guide to breeding, but also for sale purposes. In Denmark the prices of dairy cows are in many instances regulated by their milking records. It is in the compilation of these records that the Danish Milk Control Associations have proved of great service, and as many of them have now been in operation for upwards of fifteen years, a reliable and authentic life-history is available for several generations of the cows belonging to the herds tested. The owner of the herd can produce for the information of a purchaser a complete record, not only of the production of any particular cow, but of its dam as well, and also evidence of the milking qualities which were likely to be transmitted through its sire. He is in possession, in short, of a "pedigree of performance" in regard to his particular strain of milking cows.*

Testing Milk for Butter-fat.

Though a careful record of the milk yield is, in itself, of very great value, it is advisable that the milk-seller should also know the percentage of butter-fat in the milk of his cows. In the majority of cases the milk given by the cows of this country exceeds in butter-fat and other milk solids the percentages specified in the Sale of Milk Regulations, 1901, but it may happen that certain cows in a herd may give milk which does not contain those percentages (3 per cent. of butter-fat and 8·5 per cent. of other milk solids). This is particularly liable to be the case where the milking is done at unequal intervals. The seller of milk containing less than the percentages specified runs a risk of being charged under the Sale of Food and Drugs Acts and the Sale of Milk Regulations with selling adulterated milk. It is therefore of great importance to him that he should ascertain by testing at regular intervals whether the mixed milk of his cows is being maintained at a satisfactory level of quality. The morning and evening milking should be tested separately for this purpose. In the event of this mixed sample falling dangerously near the percentages in question a sample of the morning and evening milk of each cow should be taken in order to identify the cows which are giving milk of low quality. Experiments have shown that if a cow is well nourished, no alteration or improvement in feeding will permanently alter the quality of her milk, but in some cases circumstances admit of other alterations in the

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* An account of the effect of these Societies on Cattle Breeding in Denmark appeared in the *Journal of the Board of Agriculture*, Vol. xvi., March, 1910, p. 1002.

management of a herd or changes in the conduct of a business which will enable the dairy farmer to avoid the risk referred to above.

Where milk is used for butter-making it is essential that the dairyman should ensure that all his cows are yielding milk with a high percentage of butter-fat, otherwise (unless a very high price is obtained for the butter) the value obtained for the milk is very low. For instance, 3·6 per cent. of fat in the milk is equal to a butter ratio of 1 : 25—that is, every 25 lb. of milk will produce 1 lb. of butter; so that if the butter only fetches 1*s*. a pound, it represents less than 5*d*. a gallon for the milk.

The testing of milk for butter-fat can be done on the farm by means of the Gerber or Babcock testing apparatus. The use of this apparatus requires a certain amount of skill and care, but an intelligent dairyman will quickly learn to use it properly. Samples of milk can also be sent to most of the Agricultural Colleges for the purpose of determining the percentage of butter-fat, the fee charged being usually 6*d*. per sample. In addition Milk Recording Societies, of which a description is given below, are now being formed in many districts and in such cases the testing for butter-fat may be arranged for by the Recorder attached to the Society.

Instructions for taking Samples.

In taking samples of milk for the purpose of determining the percentage of butter-fat the following procedure should be observed. Samples should be taken in all cases immediately after milking. It is of the utmost importance that the milk which is about to be sampled should be thoroughly mixed, and should not be allowed to stand after mixing before the quantity of the sample is taken.

The mixing may be carried out by agitation with a plunger. The plunger should consist of a circular metal plate, 6 to 7 inches in diameter, perforated with a number of half-inch holes, and attached to a handle sufficiently long to reach the bottom of the milk to be mixed. In mixing the milk the plunger should be pushed to the bottom of the vessel and brought to the top of the milk as rapidly as possible not less than ten times. The position of the plunger should also be moved from place to place to ensure that the whole of the milk at the bottom of the vessel is thoroughly roused and mixed with the upper layers.

If more convenient the milk in a particular vessel may be mixed before sampling by pouring the entire contents of the vessel into an empty vessel and back again three times.

A. *Testing the milk of one cow.*—All the milk, including the "strippings" drawn from the cow at a milking should be brought together in one vessel and thoroughly mixed. A portion of the milk should then be at once removed with a jug or a dipper and transferred to a clean dry bottle capable of holding at least a quarter of a pint. The bottle should be immediately corked and sealed.

If it is desired to take the sample in duplicate, the whole of the milk required to fill the two bottles should be taken from the mixed milk at one filling of the jug or dipper.

B. *Testing the milk of a herd:—*

(a.) *Where the total quantity of milk from the herd can be placed in one churn, or vessel, or mixing tank.*

All the milk should be placed in one churn or receptacle, and mixed thoroughly, as described above. A sample should then be taken as under A.

(b.) *Where the total quantity of milk from the herd fills more than one churn, and there is no single vessel available in which it may be mixed.*

The milk should be distributed as equally as possible among a number of churns or similar vessels. This may be conveniently carried out by pouring the milk as received from the milking of the herd into as many churns as may be required. The churns should not be filled, but the *same quantity* should be placed in each. If there remains a quantity of milk less than sufficient to fill a churn to the same content as the others, this quantity should be divided as equally as possible among the churns already used. When this has been done the contents of each churn should be thoroughly mixed, and one gallon taken from each. These portions should be placed in another churn or vessel, thoroughly mixed, and a sample taken as under A.

An important point in connection with these tests for butter-fat is the frequency with which they are required to be made in order to give an accurate indication of the average richness of the milk. Cows vary so much in the amount and quality of their milk from one milking to another that exact results cannot be obtained by testing the milk from one milking at distant intervals.

Formation of Milk Recording Societies.

Under the Scheme for the Improvement of Live Stock the Board of Agriculture and Fisheries may make grants to Milk Recording Societies, if their rules conform substantially to the model rules issued by the Board.

These model rules and the regulations as to the award of grants by the Board are as follows:—

Model Rules for a Milk Recording Society which is formed for the purposes of the Board's Scheme.

1. The Society shall be called the   Society, and shall consist of the original members who determine to form the Society, and of members elected under these rules.

A person on becoming a member shall sign a copy of these Rules as evidence of his agreement with the Society to be bound by these Rules of any amendment thereof duly made. The copy shall be retained by the Society.

Until the first ordinary general meeting the Committee of Management shall consist of the original members.

2. The object of the Society shall be to improve the standard of Dairy Cattle and the methods of feeding them by encouraging the keeping of reliable records by members of the Society of (*a*) the yield of milk, and also (*b*) the quality of milk, or (*c*) the food consumed by the cows, or both of these matters.

3. Members other than original members shall be elected at any meeting by the Committee of Management.

The election of a member during a Society's year of operations shall take effect as from the commencement of the next year of operations, unless otherwise agreed between the member and the Society.

4. The Society may accept subscriptions of not less than 2*s*. 6*d*. from persons who do not desire to become members. Such persons are in these Rules referred to as honorary members.

5. The members shall, at the commencement of each year of the Society's operations, pay to the Society such annual subscription (if any) as may be fixed by the Society, and shall, half-yearly, pay to the Society on demand such further sums as the Society may determine to be necessary to defray the expenses of the Society for the ensuing half-year and any deficit from the preceding half-year, and such estimated expenses shall be apportioned by the Committee of Management among the members in proportion to the number of dairy cows owned by them at the date of apportionment.

6. Resignation of membership shall take effect only at the end of a year of the Society's operations and if the member concerned has paid all moneys due from him to the Society and has given in writing to the Secretary of the Society at least three months' notice of his resignation.

7. An annual general meeting of members shall be held at the commencement of each year of the Society's operations to receive a report and statement of accounts for the past year, to elect the necessary officers and a Committee of Management (hereinafter called "the Committee"), consisting of not less than three ordinary members, together with such honorary members as they may wish to co-opt, and to transact any general business of the Society. The Secretary shall give each member ten days' notice of the annual general meeting of the Society, the date of which shall be fixed by the Committee, and shall also notify him of any special business to be transacted.

8. The Secretary shall at any time call a special general meeting of members by direction of the Chairman or the Committee. The Secretary shall give each member five days' notice of any special general meeting of the Society, and shall also notify him of any special business to be transacted.

9. Three members of the Society at any meeting shall form a quorum. In the event of equality of votes the Chairman of any meeting shall have a second or casting vote.

10. The Committee shall be empowered and authorised to transact all business in connection with the Society. They shall fix the date of the commencement of the Society's year of operations, *i.e.*, the period during which the milk records are to be taken.

11. The Committee shall be authorised to proceed through the Secretary of the Society against any person for any subscription or other sum of money due from him to the Society.

12. The Committee shall submit to each member, at least ten days prior to the annual general meeting, an annual report and a duly audited statement of accounts setting forth all expenses incidental to the working of the Society, the income derived from members' subscriptions, levies grants, and also, if any, donations and honorary members' subscriptions.

13. *No dividend or bonus shall be paid to members*, and, in the event of the Society ceasing operations, any surplus of assets over liabilities shall be divided between the existing members of the Society in such manner as a general meeting of the Society shall determine.

14. The Committee shall bring before a general meeting the name of any member whose payments are in default or whose conduct or action appears to them to be in contravention of these Rules or detrimental to the interests of the Society; and, failing a satisfactory explanation of such default, conduct or action, the member in question shall, by a majority vote of members present, be expelled from the Society and shall forfeit all rights to which he may, as a member, be entitled.

15. Each member shall periodically weigh the milk of each cow in milk in his possession on such days as the Committee shall direct, and furnish the Committee by such date as may be required with a signed annual record of such weighings. He shall also afford facilities for the weighing of the milk and examination of the records of milk yield by any officer appointed for that purpose by the Society, or by the Live Stock Officer for the Province, and for the marking of his cows by the Society's officers for purposes of identification.

16. All moneys belonging to the Society shall, immediately on receipt by the Secretary or Treasurer, be placed to the credit of the Society's banking account. All payments on behalf of the Society shall be made by the person or persons authorised by the Society.

17. It shall be the duty of the Secretary to summon (by notice to each member) and to attend all general meetings and committee meetings, and to report in a minute book the names of the members present and the proceedings thereat; to keep the accounts of the Society; to keep a register of members and of the days on which each member is required to weigh the milk of his cows and of the hours at which the milkings commence; to furnish the necessary information and forms to any officer appointed to examine milk records, and generally, to carry out the instructions of the Committee.

The remuneration of the Secretary shall be fixed at a general meeting.

18. Any proposed revocation or alteration of, or addition to, the Rules may be adopted by the Society at a general meeting if the Secretary had given each member particulars of such proposals at least ten days prior to the date of the meeting.

The Secretary shall notify the Board of Agriculture and Fisheries of any revocation or alteration of, or addition to, the Rules.

19. If any matter or question not provided for in the foregoing Rules arises, the decision of the Committee shall be final.

Regulations as to the Award of Grants to Milk Recording Societies.

The Board are prepared to make grants to Societies in accordance with the following regulations:—

1. Applications for grants shall be made by a Society to the Live Stock Officer of the Province, who will report thereon to the County Live Stock Committee. No application will be entertained unless the ordinary members of the Society are not less than ten in number and own between them at least one hundred cows in milk.

2. The Rules enable a Society to raise part of their income by annual subscription, payable by each ordinary member of such amount as the Society determine. The Board will not award a grant to a Society which imposes an annual subscription exceeding £2. The rest of the necessary income will be raised by levies based on the number of cows of the several members.

3. Grants will be made to Societies only if their Rules conform substantially to those issued by the Board.

Registration of Societies (under the Industrial and Provident Societies Act or the Friendly Societies Act) is not essential.

4. Members must agree to keep milk records of each cow* in their herds. The milk of two consecutive milkings of each cow must be weighed separately, evening and morning, not less frequently than once a week during the whole period of lactation, and on the same days in each week. The days for each member will be selected by the Committee. If records are not taken daily, Saturday evenings, Sundays, and Monday mornings must not be selected.

5. Recorders whose main duties will be to check at proper intervals the Milk Records, shall be appointed by the societies subject to the appointments being approved through the Live Stock Officer by the County Live Stock Committees. The Recorders shall carry out their duties in accordance with the Board's instructions.

The Recorder shall not be a member of the Society nor have any financial interest in the business of any member of the Society.

6. Societies shall pay Recorders such salaries as they may think fit.

7. Members must allow Recorders or the Live Stock Officer to be present at any reasonable time to see their cows milked, and the milk weighed, and must also allow the Recorders or Live Stock Officer to examine all or any of their books or papers relating to the keeping of Milk Records.

8. The Society must arrange that a Recorder, without notifying the owner, will visit each herd not less than once in every six weeks.

9. The milk shall be weighed on a spring balance with a dial of a description approved by the Live Stock Officer.

10. Records shall be kept by all members on forms supplied by the Board for the purpose, giving the particulars required by the Board.

11. A Society shall determine the date on which its year of operations, *i.e.*, period during which the milk records are to be taken, shall commence. The milk yield of each cow belonging to a member of a Society is to be recorded by the member during a complete year, or during such part of the year as the cow is in the member's possession. The record of such yield shall contain the date of the last calving, the date when the next calving is due, and such other particulars as may be required by the Board. An estimated yield will not be allowed for the time during which a calf is sucking a cow. The milk yielded during the first four days after calving or before the date when the calf is weaned is not to be included in the record.

12. Cows shall be marked at the expense of the Society with an identifying mark and number in the ear by the Recorder or other person appointed by the Society for the purpose.

13. A Society will not be eligible for a grant unless the ordinary members are not less than ten in number and own between them at least 100 cows in milk.

14. The maximum annual grant payable by the Board to a Society is £50, unless the herds of the members of the Society exceed twenty-five, in which case the Society shall be eligible for a proportionately increased grant.

For the purposes of this rule cows of one owner which are milked at different places which do not enable the Recorder to check their milk yields at one visit shall be treated as separate herds.

A Society may employ, as Recorders, whole time or part time officers, but unless there are at least twenty herds to be examined the Board will not recognise the employment of a whole time officer as reasonable. Subject to these provisions the grant will be equivalent to one-half of the expenses reasonably incurred by the Society.

15. Societies must furnish the Board with copies of the annual milk yields of every cow belonging to its members. Forms for this purpose will be provided by the Board free of cost and all the particulars asked for on these forms must be given.

16. The Board reserve the right to publish any milk record, or any information relating thereto, except that the name of a Society, or the

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* In these rules and regulations the word "cow" includes heifer in milk.

name and address of the owner of a cow, will not be published unless the Board first obtain the written consent of the Society or owner, as the case may be.

17. Societies applying for a grant must submit their rules to the Board for approval.

18. As soon as the Recorder or Recorders have visited and checked for the first time the milk records of all cows under their supervision which are in milk and have marked all these cows with an identifying number, the Secretary of the Society may apply to the Board for a grant of 1*s.* per cow for all these cows, on account of the grant payable to the Society.

19. At the end of the milk record year, the Board will pay any part of the grant that may not have been paid to the Society for any additional cows whose records are checked by the Recorder, and for any other expenditure incurred in accordance with the Regulations.

20. Certificates of the annual milk yield of any individual cow or cows in a herd will be issued by the Board on the application of the owner of such cow or cows through the Secretary of the Society in the following form, or to the like effect.

BOARD OF AGRICULTURE AND FISHERIES.

Certificate of Milk Record.

Identifying Mark and No. of Cow.	Description of Cow, name (if any) and breed.	Age of Cow.	Number of calves the Cow has produced to the close of the year mentioned below.	Date when Cow last calved previous to close of the year mentioned below.	Date when the Cow is again due to calve.	Number of days the Cow was in milk during the year mentioned below.

Owner of above cow : Address :

The Board of Agriculture and Fisheries hereby certify that from the records kept by the owner of the above cow under the supervision of the Society, and, subject to inspection by an approved Recorder, it appears that the **yield of milk* given by the above cow during the *year* commencing , 19 , and ending , 19 was lbs.

The records were taken . (Insert daily or weekly.)

In witness whereof the Board of Agriculture and Fisheries have hereunto set their Official Seal this day of , 191 .

(L.S.)

Secretary.

* This yield does not include the yield during the four daynext after calving nor the yield prior to the when the calf was weaned

Duties of Recorders.

1. A Recorder shall, at least once in every six weeks, without notifying the owner, visit each herd under his supervision at milking time both at evening and the following morning.

2. He shall see each cow milked and the milk weighed, and shall state on the Form with which he will be provided the number of each cow, her name (if any), her description, the date of the last calving, the weight of milk given at each milking, the weight of milk given by the cow as recorded by her owner when he last weighed her milk, and at previous weighings, if necessary, and any other information required by the Board.

3. He shall, if directed by the Society, take a sample as prescribed in Leaflet 146, of the mixed milk from all the cows in the herd at his evening and morning visit, and shall, as directed, forward such samples to be tested for Butter Fat. The cost of carriage and testing is to be paid by the Society.

4. He shall, if requested by the owner of the herd, take a sample of the mixed milk (if not taken by direction of the Society) or samples of the milk from any individual cows for the purpose of having them tested for Butter Fat, as prescribed in Leaflet 146. In such cases the cost of carriage and testing is to be paid by the owner.

5. He shall, if requested by the owner, take particulars of the feeding rations of the cows, and shall forward them to the Live Stock Officer of his Province for advice thereon, as opportunity offers.

6. If a Recorder considers that through ignorance, carelessness, fraudulent intention or any other reason the milk records are not being kept by the cow-owner or anyone in his employ in a proper manner, he shall draw the attention of the cow-owner to the fact, and shall also draw up a report in writing and send it to the Live Stock Officer who shall, if necessary, bring the matter to the notice of the Board.

7. At the end of the milk recording year, the Recorder shall check the additions and calculations which it is necessary to make to arrive at the milk yield per annum of each cow which he has supervised, and shall countersign the return furnished under Rule 15 to the Secretary of the Society.

London, S.W.1,

May, 1905.

Revised, June, 1914.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

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Leaflet No. 147.

BOARD OF AGRICULTURE AND FISHERIES.

Fences and Hedges.

One of the difficulties with which landed proprietors, farmers, and others interested in estates have to contend is the formation and maintenance of hedges and fences. The difficulty is often increased by neighbouring owners of boundary fences paying little or no attention to their maintenance. A little timely assistance on the part of the landlord and the tenant might have preserved many good thorn fences in those parts of the country which are now practically denuded of them. The expenditure and trouble necessary to put in a thorn hedge, to erect guard fences, and to keep them in proper condition for twelve or fifteen years (the time it takes to rear a thorn hedge strong enough to turn heavy stock), should be an inducement to all concerned to take care of those hedges which are in fairly good growing condition. Fences erected as boundaries between farms should be well kept up, more especially those marking the boundaries of estates.

Thorn Hedges.

There are several causes that tend to produce ill-kept thorn hedges, and they may be briefly stated as follows :—(1) Throwing of several grass fields into one and neglect of the old division fences. (2) Bad yearly switching or dressing of hedges, with little or no attention as to how they are cut or the proper shape they ought to assume. (3) Want of proper protection to fences newly cut and layered. These ought to be protected for at least three years, and be kept free from weeds. (4) Non-fulfilment of agreement between landlord and tenant as to the up-keep of fences. (5) Changing of farm hands, and consequent lack of consecutive management or treatment. (6) Hares and rabbits. These, where they are numerous, do a considerable amount of harm to quick fences, by barking the stems.

The whitethorn or hawthorn (*Cratægus Oxycantha*) has been proved to be the most useful plant for forming hedges as barriers against stock. Its adaptability to situation and soil are important factors in its favour ; it is long-lived and stands cutting even to an old age and is therefore easily kept within bounds.

The time it takes to rear a thorn hedge depends on (*a*) the quality and preparation of the soil ; (*b*) the situation ; (*c*) the care that is exercised in keeping it clean ; (*d*) protection from stock ; and (*e*) the method adopted in training. Before laying out hedges there are many things which ought to be considered. If the proposed fence is intended to divide fields, or to serve as a boundary between estates, it is nearly always advisable that it should be straight. There are, however, certain lines of division which cannot be altered, such as streams serving as boundaries. In laying out fences between estates a give-and-take line may often be advantageously adopted by mutual consent of the landlords concerned.

Soil, Draining and Trenching.—The soil most suitable for the thorn is a strong loam. The land must be thoroughly drained, and for this purpose the open ditch is in most general use. This form of drain, however, is frequently undesirable on arable land as it wastes space and harbours rabbits and the labour required to keep it clean is also considerable. The better method is to run a pipe drain 5 or 6 ft. from the fence on both sides. Drains already in the ground may sometimes be utilised for the purpose. The conformation of the ground does not always admit of the drains being run parallel to the hedge, but the main point is to carry out the work in the way that will best keep the hedge dry. In running through hollows where it is occasionally difficult to drain thoroughly, the soil may be raised and a drain-pipe put through the fence to allow the water to pass from one side to the other. Hedges should never, if it can possibly be avoided, be planted on these raised beds.

Although banks are often undoubtedly of use in making a fence, the system of planting hedges on banks possesses certain grave disadvantages, especially on arable land. The banks occupy a considerable area of ground, being frequently 5 or 6 ft. across. In the course of time they become full of the roots of trees, brambles, &c., so that it is quite impossible to keep them free from weeds. These weeds spread their seeds throughout the field and undoubtedly greatly add to the difficulty of keeping the land clean. Even if the weeds are cut down annually with a hook large numbers of their seeds are distributed throughout the fields.

The ground having been drained, trenching operations can be proceeded with, the bed being kept on the level. Trenching ought to be done in the autumn previous to planting. In making the trench or bed it should be 3 ft. or 4 ft. wide, and 18 in. or 20 in. deep. If the soil is good to that depth, the bottom soil may be brought to the top, the top soil, if grass land is being trenched, being laid in the bottom of the bed. The soil should be thrown up roughly in the middle, to expose it as much as possible to the influence of frost, care being taken to remove all weeds, especially deep-rooted ones, such as docks, thistles, &c., which if left in will be difficult to eradicate without considerable damage to the thorns.

Planting.—Good, healthy, strong plants, which have been previously twice transplanted to ensure fibrous roots should be used. Before planting takes place the stems should in most cases be cut off 2 to 3 in. above the soil line—that is, 2 to 3 in. above the depth at which they stood in the nursery row. Long or damaged roots should be neatly cut back. In fencing pastures there are some advantages in planting thorns in double rows, the rows being placed 8 in. or 9 in. apart, and plants in the rows the same distance, each plant in a row dividing the space between the two opposite in the other row.

The thorn thus planted is given more room, and the result is the production of strong lateral growth. If a double-rowed thorn fence should in after years, through neglect, assume a spreading habit, one of the rows may be cut off at the base some years in advance of the other to encourage fresh growth ; when strong enough to act as a fence, the other side may be treated in the same way. Care should be taken not to allow a double-rowed hedge to become foul, for there is great difficulty in cleaning out the weeds ; and if there is reason to fear that the hedge may be neglected the thorns are better planted in a single row. In planting hedges on arable land a single row of plants 6 in. to 8 in. apart would be most satisfactory. Having consolidated the soil somewhat in the centre of the bed by treading, the operation of putting in the plants can be begun. It takes two men to put in the plants properly. After the first spadeful of soil is laid on the roots, the plant should be drawn lightly up and down so as to cause the soil to run into the interstices formed by the rootlets. The placing of the thorn being completed, more soil is laid on the roots and carefully firmed round the stems, finishing by drawing the soil to the plants, leaving them just pointing the surface.

There is another plan which has been adopted with considerable success. The stems are left a little longer than is advocated above, and the soil is made to cover the whole of the plant, which is left in this condition until it shows signs of vitality in the spring. The soil is then taken from the plants to the depth of 3 or 4 in., forming a V, with the plant in the middle. The shoots, it is said, come away stronger, and are more numerous than when the thorns are left standing above ground at the time of planting.

Cost.—The cost of trenching, purchasing plants, and planting, runs from 4*d*. to 6*d*. a yard, the cost being principally affected by the nature of the ground. Very often this is not the only expense to be met in putting in a quick fence. Protection rails may have to be erected on one or both sides, and this adds considerably to the initial outlay and up-keep. A three-barred fence, using sawn morticed oak posts and larch rails, can be put up for about 1*s.* 2*d.* per yard, while a four-barred fence will cost 1*s.* 6*d.* per yard.

Protection is absolutely necessary in the case of pastures, but with arable land this expense is often saved. Temporary protection from the sheep that consume the crops of tillage land must be given, or otherwise the quicks will be damaged, not only by the teeth of the sheep but also by the wool that is left on the lateral growth. One of the greatest drawbacks to the forming of thorn hedges is the fencing required for protection, and the outlay is certainly heavy when it is found necessary to protect the fence on both sides, and occasionally wire-netting must be used to ensure success if rabbits abound. Assuming, then, that protection from stock and rabbits is necessary, the expense works out as follows :—Trenching, purchasing and planting thorn, 5*d.* per yard ; two guard fences, including cost of erection, 2*s.* 6*d.* per yard ; wire-netting, 6*d.* per yard, making a total expense of 3*s.* 5*d.* per yard. But it is seldom found necessary to go to this expense. The prices quoted are for first-rate material, which ought to last until the hedge is in a condition to act as a fence, and then be of further use for repairs.

Trimming.—Except for cutting back the thorn at the time of planting, a thorn hedge should not be trimmed or dressed until four or five years after planting. The stems of the plants then thicken more than when they are trimmed from the first, and when cut back to, say, 2 ft. from the ground they present a strong appearance. A great many of the thorns will have developed two, three, or four shoots, some of which can be dispensed with, and should be cut near the bottom to encourage further growth at that place.

After first commencing to trim into shape a hedge which is not growing well, it is an advantage to trim every alternate year instead of yearly ; this treatment has a tendency to strengthen it.

The way in which hedges are trimmed determines both their shape and stability. In order to ensure success dressing should be done with an upward stroke, making the hedge wedge-shaped, while there should be no haste to raise the hedge to its full height. Hedges which have been raised too rapidly are often unable to act as a fence owing to the weakness and looseness of growth. Those which are trimmed regularly for many years sometimes get, in spite of attention, so unshapely and unnecessarily large, that it is desirable to rib in, or cut back the lateral growth to the main stem to bring them back to their former shape, and it is equally necessary to encourage growth by cutting back to the base all weakly or suppressed stems. Adjoining pastures, this operation is rather risky unless the fence is protected for a time.

Hedges which are well cared for and regularly trimmed may be trimmed in February if in exposed situations, or at any time from August to February if sheltered. Neglected hedges, however, which require hard pruning, should be taken in hand in autumn in ordinary situations, or in early spring in cold, exposed positions. The whitethorn is very hardy, but might suffer if severe frost followed soon after pruning.

Weeding.—Too much cannot be said in favour of keeping hedges clean, and it is often necessary to clean twice or three times during the year where weeds are troublesome. If hedges are allowed to become very foul there is always a danger of the plants getting damaged in the attempt to root out the weeds, and there is also a great loss of nutriment, to say nothing of the soil thrown off with the weeds. Weeds also harbour insect pests which may attack the hedge. The first cleaning should take place in spring, before any seeding occurs. On land which is very weedy and of a tenacious character, it is often found that, owing to the great amount of cleaning necessary, the soil on the roots of the plants becomes deficient. This is rarely experienced before the fence is of sufficient size to do without hand weeding, and at this period it is well to add fresh soil, and to keep clean by cutting down the weeds with a sickle twice annually, or oftener if required. When a hedge is laid beside a ditch, the latter should be cleaned out and the mud plastered round the roots of the hedge, in order to protect them, and to keep the soil from gradually falling away.

Maintenance of Hedges.—The layering of old thorn hedges must be carefully done, and some protection is necessary until the new growth is strong enough to resist cattle, and until the "layers" are firmly fixed in their new position.

In the case of a moderate-sized hedge, the layering may be performed at any time from November to April. Where a big old hedge which has been neglected in the past has to be dealt with, the work should be performed in April, just when the sap is beginning to rise. In the spring time it is found that the layers of an old hedge are less brittle and less liable to break off than in the dead season.

Stakes.—About every 2 or 3 ft. in the hedge an upright stake is necessary, in order to keep the "layers" in their proper position. These stakes may be "dead" or "live." "Dead" stakes, about five feet in length, are cut out of the hedge as opportunity arises. They are driven into the ground until firm, and are then cut until at the general level of the finished hedge. The thickness of the stakes is not a matter of great importance, provided they are strong enough to keep the layers in their proper position.

If live stakes are used, they should be reduced to the desired height and then cut about half-way through at the bottom. The object of this is to encourage young shoots from below the cut and not from the top of the stake. An objection sometimes made to live stakes is that careless or inefficient hedgers frequently neglect to cut their stakes partly through at the bottom, so that many good farmers insist that only dead stakes shall be used. All brambles and undergrowth should be cut away before commencing to lay the hedge.

Layers.—The tallest thorns in the hedge should be used as layers. They should be partly cut through, leaving a tongue, with bark, attached to the parent stump, the thorn being bent over so that it stretches along, and is worked in and out amongst the live stakes. The parent stump should be trimmed clean, so that no ragged portions project ; if this is not done rain will enter the stump and gradually rot it. If dead stakes are used it will frequently be convenient to insert them after some of the layers are down.

The layers should be so arranged that their thorny part projects on that side of the hedge on which there is most danger of damage by cattle, and on the opposite side to that on which the man is working. Some hedgers recommend that the layers be bent over in such a way as to leave the stumps free. If this is done the growth from the latter does not become entangled with the layers, so that in the course of years, when it is desired to lay the hedge again, difficulty is not experienced in dragging out the old layers. The objection to it, however, is that should land on both sides of the hedge be open to grazing animals, the young shoots from the stumps will be eaten off, so that it will be necessary to erect a dead fence of thorns to protect the shoots.

If the layers are arranged directly over the stumps, the shoots from the latter will find their way amongst the layers, and in the course of years form an almost impenetrable fence—a mixture of layers and upright shoots.

At the end of a hedge, near gateways and trees, and where the fence is very thin, it will frequently be necessary to place some of the layers in an opposite direction to that in which the hedge is being laid. In fact, a skilled man will use every available piece of live thorn in a thin fence, working it into the laid hedge in various directions.

Layering, while suitable for most parts of England south of the Tees, is not much practised in the north or in Scotland. In some experiments recently made in connection with the renewing of old hedges in Fifeshire, it was found that shoots half cut through near the ground are apt to die off in the cold northern climate, but that the following method of renewing irregular and overgrown hedges is successful.

If the fence is ultimately required to be 4 ft. high, the hedge should be cut clean across to a height of under 3 ft., any supple shoots being tied down to cover as many gaps as possible. The tying should be done with No. 18 galvanised wire, but care should be taken to tie down the shoots loosely, to allow for growth. The hedge being only cut to a little under 3 ft., it is not necessary to keep the roots of the hedge clean otherwise than by cutting the long weeds that might grow up through the naked hedge. In this state the hedge should be left for three years, when it should be switched up, leaving the top shoots. These shoots should be thinned to the required distance, and laid down and tied horizontally across the top of the hedge to cover all blanks. If this single process did not suffice to make a close fence, the hedge could be allowed to grow for the necessary time, the operation being then repeated. The hedge after laying should be perfectly close, and could be kept trimmed every year or every second year according to taste.

The fences dealt with in the experiments were upon arable land under rotation and grazed for two or three years. As the lands are in crop for five or six years, the operation described may be commenced when the grass is broken up, so that by the time the land comes into pasture again the operation should be finished, leaving a suitable fence for stock. It is not, therefore, necessary to protect the hedge against stock during the process of renewal.

Binding.—After the fence has been laid along its entire length, it is "bound." Brambles, briars, &c., are cut off and twisted along the top of the hedge from stake to stake to keep the layers neat, and in their proper position. These will become rotten in a few years, but then they are no longer needed. Occasionally live material is used for binding. It cannot usually be worked up so neatly, however, as dead stuff. It may also be noted that live bindings increase the risk of accidents in the hunting field.

Subsequent Treatment of Hedge.—After a fence has been laid, it should be trimmed annually with the slasher until such time as it becomes thin at the bottom, after which it may be allowed to grow up to a height of, say, 12 to 15 feet, when it should be again laid.

In pastures, and where it is desired to maintain a good thick fence for shelter, it may occasionally be better not to slash the edge, but simply to allow it to grow up until it again requires laying. If either of these methods is adopted, a thoroughly good fence should be maintained.

Neglected Hedges.—It often happens that hedges have been neglected for long periods, and much of the thorn may have died. Where this is the case it may be necessary to replant the thinnest portions.

A really skilful hedger will, however, utilise existing material so that a most unpromising fence may often be restored to a respectable condition in a few years.

Hedging Tools.—In order that hedgers may perform first-class work it is absolutely essential that they should be provided with proper tools.

The principal tools necessary are a bill-hook and a good axe. A pair of strong leather mittens or gloves should also be available.

The bill-hook used should have two cutting edges, the one straight at the back of the hook, the other gradually curved. The straight edge is used for cutting all the lighter wood, the axe being reserved for thorns exceeding four inches in diameter. In some parts of the country a type of bill-hook is used which has only one cutting edge, with a very sharply curved hook at the end. This is a most inconvenient tool, and should be rejected in favour of the type described above.

All tools should be kept extremely sharp, or good clean work cannot be performed.

Other Hedge Plants.

The Beech makes a splendid hedge for screening and sheltering, and grows best on a gravelly soil holding plenty of lime. It stands exposure well. Since it is a shade-bearing tree, it can be grown where thorn or any other light-demanding plant would not be a success, while it may be trained to a good height without losing its closeness of growth. The annual trimming induces it to retain part of its leaves during winter, thereby enhancing its value as a shelter. The cost of putting in a beech hedge is from 4*d.* to 6*d.* per yard. Beech ought not to be cut over at the time of planting.

Hornbeam also may be used. It is a slow grower but has much greater reproductive power than beech and will grow in badly drained and wet soils where beech and thorn will die.

The Holly is a good hedge plant, and has the advantage of being evergreen, but it grows slowly, and is specially liable to be eaten by rabbits. The soil in which this plant grows best is a sandy loam. It should be planted in May or September, using twice transplanted roots; these should have as much soil as possible adhering to them, and be lifted and planted the same day. Should the roots become dry, watering at the time of planting is necessary. A bed should be prepared somewhat similar to the one advocated for the thorn, and if the soil is thin it would be an advantage to give a mulching of manure. Little attention is required for some years as regards training to any particular shape, beyond what is necessary to check the lateral and top growth of any plants which have for some reason grown faster than the rest, so as to bring the hedge to a uniform height and thickness. Annual trimming with shears, which ought to be done in summer, need not be commenced until the hedge is nearly high enough to act as a fence. The holly being a shade-bearing tree, can be trained into almost any shape, as the bottom growth is not much interfered with by the spreading of the top. It makes a good screen for gardens, orchards, &c., and can be grown to a great height with an unbroken face from top to bottom. The cost is about 10*d.* to 1*s.* per yard when 12-in. plants are used.

Evergreen Privet makes a nice garden fence, and is easily reared and tended. It may be put in as cuttings, or the cuttings may be allowed to stand two years in a nursery, and then be planted out. In a very short time it will grow into a nice neat fence if cut in closely.

Wire Fencing.

This class of fence is much used in Scotland, and is now owing to its cheapness and durability, becoming more common in southern districts. Often, however, wire fences are erected in positions where they are very liable to breakage. The most suitable places are plantations, road-sides, clumps, and pleasure grounds. If a wire fence has to be erected between pastures—a position somewhat unsuitable for such a fence—a rail should be run along the top in place of wire. This gives stock a better chance of seeing the fence when galloping. The cost of erecting a good wire fence, composed of oak or larch posts, standing 6 ft. apart and using galvanised wire, is 10*d.* to 1*s.* per yard.

Stone Walls.

A stone wall forms a good fence and is durable. The cost varies considerably, depending on the distance the stone has to be carted and the ease with which it is obtained. To build a wall 4 ft. 6 in. high, with two rows of throughs, tapering from 2 ft. to 10 in., and limed top and throughs, costs about 3*s.* 6*d.* to 4*s.* per yard when carting and material have to be paid for. If the cost of carting and material is not considered, then the price would be about 2*s.* per yard.

Creosoted Fencing.

The cost of erecting a fence of creosoted redwood to turn heavy stock is as follows :—Two top rails, 12 ft. by 4 in. by 1½ in., at 10*d.* each ; two bottom rails, 12 ft. by 3½ in. by 1¼ in., at 8*d.* each ; two posts, 6 ft. by 6 in. by 3 in., at 9½*d.*

each; erection at $2\frac{1}{2}d.$ per yard; making a total of about 1*s.* 4*d.* per yard. It is advisable to obtain, if possible, material free from knots, as the rails are easily broken at the places where the knots are, besides which many of the knotty rails are either cut out of young trees or from the tops of old ones and are therefore immature, decay sooner, and are lighter. In erecting a fence of the above material, the rails having the least knots should be nailed on the upper part of the fence.

Seasoning of Fencing Material.

The object in seasoning is to get rid of all the moisture or sap, and to accomplish this various methods may be adopted. The only method referred to here will be that of drying in open sheds, *i.e.*, admitting a free current of air and protecting from rain. In order to check decay, no time must be lost in placing sawn timber under cover. It should be allowed to remain so protected for at least one year, and during this time should be re-stacked or turned over to facilitate drying. In the case of timber which is used for outdoor purposes, the gain from proper seasoning would amply repay any expense incurred in erecting necessary plant.

Durability being a most important quality in fencing material, a primary object must be to obtain matured timber, which is the best to use, whether seasoned or unseasoned. Mature timber contains less sap wood than immature, and there is consequently less shrinkage and less liability to attract organisms which hasten decay.

Preservative Methods.

The common methods are painting, tarring, and charring, but the work should never be done until the timber is seasoned.

The cost of painting rough outside work is prohibitive, but work, such as dressed paling, gates, &c., erected in places where people are liable to come in contact with the woodwork, is better painted than tarred. Tarring is the most common method employed in preserving outside rough woodwork. Gas tar should be kept for some time before using as it improves by keeping. Charring is very useful for preserving posts, as it forms an outer coat of charcoal which is immune to the attacks of insects and fungi, and is almost indestructible when placed in the ground. The disadvantages of charring are a loss of wood and cracking; the charred parts should be tarred over, thus plugging up the external cavities of the wood, and preventing the entrance of air and water.

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BOARD OF AGRICULTURE AND FISHERIES.

Planning and Planting a Fruit Plantation.

This leaflet is intended to deal primarily with the planning and planting of a plantation of "Top Fruit," *i.e.*, of apples, pears, plums and cherries. Interplanting with the "Soft" fruits (strawberries, gooseberries, red and black currants and raspberries) is included, but the general cultivation of such fruits will be dealt with separately.

PLANNING.

General.—Planning means (1) deciding the purpose or class of trade for which the fruit will be grown; (2) choosing varieties suitable, not only for this purpose, but also for the land which it is intended to plant; (3) deciding the manner in which the trees are to be trained; and (4) arranging the plantation so that it can be cultivated with economy of labour and so that the trees have sufficient space to grow normally without overcrowding.

The ultimate financial success of a plantation depends to a great extent on judicious planning. Each grower must decide the foregoing points for himself. The plan decided upon must depend not on one of the points only, but upon all together. It must also depend on the amount of working capital available, the local labour supply, the proximity to markets, the road and rail transport facilities, the local climatic conditions, the character of the soil, and the system of "under-cropping" which it is proposed to carry out Lastly, the importance of looking ahead cannot be emphasized too strongly. "Top" fruit plantations do not generally reach their prime until about 30 years after planting. For this reason it is necessary to have imagination and foresight in planning so that the final composition of the plantation is not inadvertently neglected in the anxiety to obtain profitable returns soon after planting.

Markets.—The majority of growers do not experience great difficulty in deciding the manner in which they will market their fruit. They generally already possess sound knowledge of the chief markets, and all that is needed is the expansion of the system already in operation to embrace the produce grown in the newly-made plantations. At the same time, "How can I obtain better returns for my fruit?" must always be the question of the moment and the answer usually is: "By better methods of packing and grading, by increasing the bulk produce of the varieties already grown, and by acquiring a name on the markets for produce of high quality, packed in the best possible manner."

The question is not so easily decided by the small grower. In his case the quantity produced of each variety, although it may be of very high quality, must necessarily be small, and he cannot secure a name on the large markets like the large grower. He must, therefore, sell the bulk of his fruit either direct to a retailer or through a salesman for some special purpose. His returns will then be higher in proportion to those obtained for similar produce marketed by the larger grower. For a local retail trade, the chief essentials are high quality and continuous supplies of the special classes of produce required by the market or markets to be served.

Choice of Varieties.—The choice of varieties to suit local soil and climatic conditions is always extremely difficult, even when plantations exist in the neighbourhood from which valuable conclusions can be drawn. Success is fairly certain, however, if the selection is confined to the chief standard varieties, but careful inquiry should nevertheless be made to ascertain which of them have been most successful in neighbouring plantations so that the selection can be based still further on local knowledge.

As a general rule, local or little known varieties should not be planted, because they are difficult to market unless there is a definite local demand.

Shape of Trees.—The shape in which the trees are to be trained depends partly on the soil and situation of the land. For instance, "Bush" apples on "Paradise" stocks are not suitable for heavy clay soils because the fibrous root systems usually found with this type of stocks do not develop as rapidly as the branch system, and as a result a large number of the trees invariably blow over. Further, such land is usually very difficult to keep thoroughly cultivated, and, after the trees have become established, it is good practice to lay the land down to grass for close grazing with sheep. For this purpose "Standard" trees are required. On light friable land the shape of the tree will depend chiefly on the proposed undercropping. Thus, if market garden crops are to be grown and a quick return of fruit is not required, "Standard" trees are best, as they are always planted widely apart and do not shade the land to any very great extent until they are 15 or 20 years old; but if a quick return is essential, and the necessary extra labour is available, then "Bush" or "Cordon" trees should be trained.

SHAPE OF TREES.

Commercially grown "Top Fruit" trees are trained in four shapes as "Standard," "Half Standard," "Bush" or "Cordon" trees, each shape being suitable for a different purpose.

"**Standard**" **Trees** have large branching heads from 5 ft. 6 in. to 6 ft. above ground level and can be grown either on cultivated land or on grass. This shape is the most suitable for the latter purpose as sufficient headroom is obtained to prevent grazing sheep from damaging the trees.

Trees trained in this way have a span of 25 ft. to 35 ft. when full grown. They are very long lived, and, although slow in commencing to bear, they eventually produce very heavy crops of fair quality.

The trees for this shape must always be worked on strong-growing stocks, and should usually be planted from 30 ft. to 40 ft. apart according to variety. Apples, pears, plums and cherries (with the exception of Morello cherries) can all be grown satisfactorily as standards. The apples must be worked on "Crab" or selected "Free" stocks, the pears on "Wild Pear," the plums either on the "Mussel," "Common" or "Myrobalan" stocks, and the sweet cherries on the "Wild Gean" (*Prunus Cerasus*) stock. Sweet and acid cherries of the Kentish or Flemish type must always be grown as "Standard" trees so that the land can be laid down to grass ten to fifteen years after planting. This is necessary to prevent disturbance of the roots which are found close to the surface.

"**Half-Standard**" **Trees** have a clean main stem about 4 ft. 6 in. above ground level, and should not as a rule be grown on grass land as the head is not sufficiently high above the ground to allow grazing. Apples should be trained in this way when large trees are required and a quick return is not essential, but the trees must be sprayed and pruned as carefully as the smaller shapes. When a "half-standard" plantation is full grown, horse cultivation is difficult, but comparatively little hand work is then required because the shade of the trees prevents the growth of weeds. "Half-standard" apples or plums worked on stocks similar to those used for standards, are most commonly used for the "top trees" in districts where the plantations are intercropped with cob nuts and filberts. The distance apart should be varied from 24 ft. to 30 ft. according to variety.

"**Bush**" **Trees** have a clean main stem 2 ft. to 3 ft. from the ground level and require cultivated land. Preference should be given to trees with a main stem 3 ft. high to enable a grease band to be applied satisfactorily, and also to allow of horse work close to the tree. Strong-growing varieties can only be trained in this shape by "working" them on "dwarfing" stocks to reduce their vigour; thus strong-growing apple varieties should be worked on "paradise" stocks, although the weaker-growing kind unsuitable for "standard" and "half-standard" trees, must be "worked" on "crab" or selected "free" stocks to ensure sufficient freedom of growth. Plums are not usually as vigorous as apples and the same stocks should be used as for standards and half-standards. In this connection it should be remembered that our knowledge of the most suitable plum stocks is as yet very incomplete and that at present there is no dwarfing plum stock similar to that used for apples. Pears, on the other hand, should be dwarfed by means of a "quince" stock. The Morello cherry is always grown as a bush tree and is grafted on to the "Mahaleb" stock.

For "bush" trees intensive cultivation is essential, but they commence bearing at an early age, and, as they form smaller trees, they can be planted more closely together than "standard" or "half-standard" trees, and an early and heavy yield may be obtained. Moreover, with proper cultivation, the fruit is of much higher quality as a result of the ease with which pruning, spraying and other cultural operations can be effected and this type of tree is, therefore, most suitable for the best dessert apples and pears. The cost of cultivation is heavier, however, as little horse work can be done without damage to the trees after they are ten or twelve years old.

"Bush" trees are used for two purposes, either in plantations by themselves or as "filler" trees interplanted amongst "standard" or "half-standard" trees. In the latter case only those varieties which form very small trees and which commence cropping soon after planting must be used. The "bush" trees provide a source of revenue until the permanent trees require the whole of the ground, when they have to be "grubbed."

"**Cordons**" consist of one main stem without any lateral branches, preferably trained obliquely. They are usually supported by a system of wire-work to which bamboo rods or wooden stakes have been attached. The fruit is produced from spurs arising from the main stem. Cordons are always grown on cultivated land.

Apples worked on "paradise" stocks and pears on "quince" stocks are the only kinds of fruit which should be trained in this manner for commercial purposes. This system is the most intensive form of outdoor fruit culture practised, and in view of the large number of trees planted to the acre, should only be adopted if sufficient labour is available to ensure proper attention being paid to training, spraying and general cultivation.

The fruit obtained from "Cordons" is of the highest quality, and therefore requires packing and grading in the very best possible manner. It should be sold through special salesmen who deal in this class of produce.

ARRANGEMENT OF THE TREES.

Very careful forethought is required concerning the general arrangement of the trees to ensure that cultural operations can be carried out with the greatest economy of all kinds of labour. Headlands and roadways should be wide enough to allow implements or lorries to be turned without damage to the trees, or here and there should be left an extra wide space for turning, and generally the plantation should be designed so that horse work can be carried out as much as possible in order to reduce hand labour. Care must be taken that each tree is allowed sufficient space for growth. If freely growing, healthy trees are pruned very severely to prevent over-crowding as a result of planting too closely, the annual yield of fruit is greatly diminished. If any doubt exists as to the correct distance apart at which to plant the trees, too much rather than too little space should be allowed.

There are four systems of planting top fruit trees :—

1. Square.
2. Quincunx.
3. Triangular.
4. Cordon.

Square (Figs. 1 and 4).—The land in this case is marked out in a series of squares and the permanent trees are planted in the corners of each square ; the sides of the squares, therefore, correspond to the distance apart at which the trees are planted.

If "fillers" or soft fruits, or both, are to be interplanted among permanent trees, then each of these large squares must be subdivided into four, sixteen or sixty-four smaller squares, each side of which corresponds with the required distance apart. The position of the interplanted trees or bushes is at the corners of the squares not already occupied by permanent trees.

"Thinning" plantations of this kind is effected in the following manner :—

The "small" fruits must be grubbed as soon as the permanent trees or "fillers" require more space, and later on the alternate "fillers" themselves are removed, thus leaving a tree in the centre of each square formed by the permanent trees. Finally, when the permanent trees are nearly full grown, the remaining "fillers" must also be grubbed. This is the most remunerative method of raising a permanent plantation of "top fruit," and is very satisfactory if carried out properly. In practice, however, the "thinning" is often delayed too long, with the result that the trees, both "fillers" and permanent, so overcrowd each other that their fruiting capabilities are seriously impaired. Such overcrowding takes place either through want of foresight in the first place by miscalculating the life of the "fillers" when the plantation was planned, or later by neglecting "thinning" when the first tendency to overcrowding is noticed. This neglect is encouraged by the fact that the profitable life of a healthy "filler" is much longer than many imagine, and when the time for "grubbing" comes round the grower is tempted to put off the operation year after year in order to obtain the income which the "fillers" produce, even though damage results to the permanent trees.

A "bush" plantation, planted on the "square," should not require thinning, but if at a later date sufficient space has not been allowed, then "thinning" can be effected by removing alternate trees in each row.

Quincunx—(Figs. 2, 5 and 6).—This method of planting is very like the "square" system. The plantation is arranged in a similar way except that a tree is planted in the centre of each square. As a rule, the trees planted in the centre of the squares are "fillers," but if they are to be retained permanently, an upright variety must be selected so that all chance of overcrowding is avoided. Interplanting with "fillers" and "soft fruit" can be carried out quite as easily as with the "square" system; the intermediate land should be divided into smaller squares in an exactly similar manner. In "thinning" the "soft fruits" should be removed first, then the "fillers" intermediate to the main plant, and finally if necessary the trees in the centre of the squares

This system of planning is best suited for a plantation consisting of two kinds of "standard" or "half-standard" trees, interplanted with "bush fillers" of another variety. It will be noticed that a "quincunx" plant is obtained by removing the alternate trees from a "square" plant and that a "square" plant is obtained by removing the trees in the centre of each square of the quincunx plant.

Triangular or Hexagonal—(Figs. 3 and 8).—In this case the trees are planted at the corners of a series of equilateral triangles, and are, therefore, equidistant. Such plantations cannot be thinned satisfactorily, and the system is only suitable for plantations consisting entirely of permanent trees.

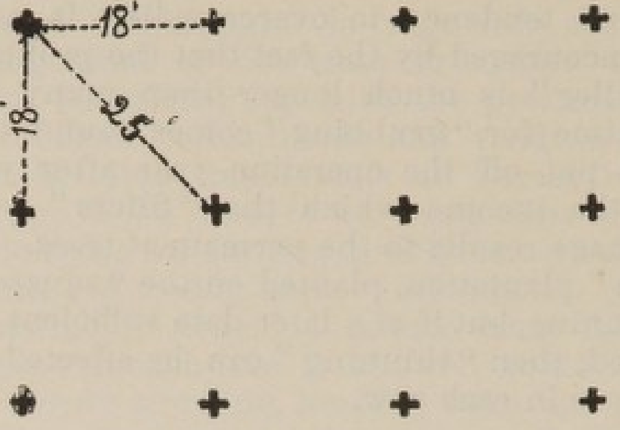
Cordon.—In this system the trees are planted in rows 6 ft. apart and 2 ft. apart in the rows.

VALUE OF INTERPLANTING.

Many varieties of the "top fruits" are more or less self-sterile, that is, the flowers cannot be fertilised by pollen of the same variety but require to be cross-fertilised if the fruit is to

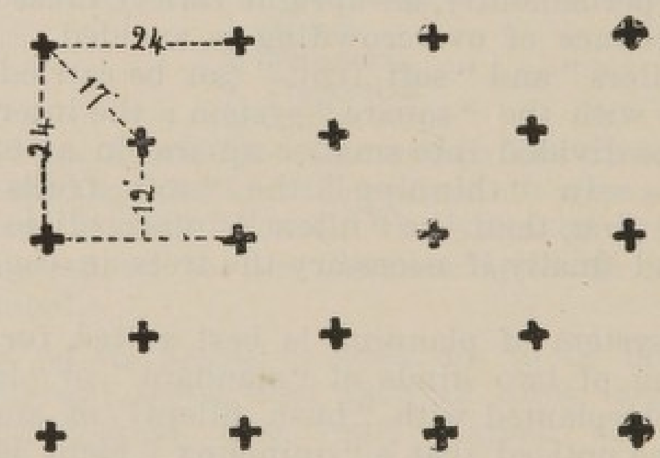
18' Square Plant. (135 trees per acre.)

Fig. 1.



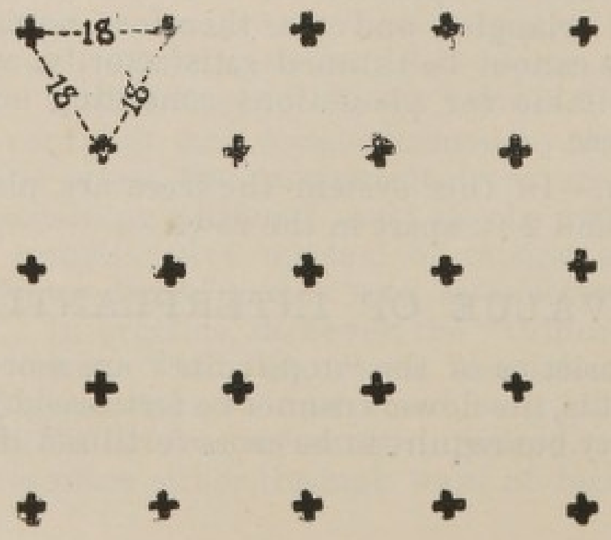
24 Quincunx Plant. (230 trees per acre.)

Fig. 2.



18' Triangular Plant. (155 trees per acre.)

Fig. 3.



set. The interplanting of two or three varieties of the same kind of fruit is recommended, not only for this reason, but because greater use can be made of the land if spreading and upright varieties, or strong and weak-growing varieties are planted alternately. The only disadvantage of interplanting in this way is the extra labour which is involved in spraying, owing to the difference between the dates in which the several varieties commence growth in the spring. Thus, if late and early "breaking" varieties are planted alternately, it may necessitate spraying the plantation twice within a short period. To avoid waste of labour from this cause, it is sometimes advisable to plant blocks consisting of not more than four rows of each variety, but the disadvantages of this method usually outweigh the advantages. If alternate blocks consisting of four rows of each variety are planted, the plantation has a patchwork appearance, besides which, as the distance apart of the trees throughout the plantation must remain the same, there is some difficulty in choosing varieties which have similar habits of growth. *Judicious interplanting allows a much wider range of varieties for the same distance apart and is therefore recommended.* At the same time it is best to choose varieties for interplanting which commence growth at approximately the same time and have flowering periods which overlap, so that pollination is assured and spraying need only be carried out once. The exact coincidence of the flowering period of two interplanted varieties is not of paramount importance, owing to the fact that the flowering period of each is usually extended over at least three weeks, and provided that the periods overlap effective pollination will take place.

Notwithstanding the fact that judicious interplanting is essential, a warning must be given against planting too many varieties. The number selected should be only sufficient to give a succession of crops throughout the season so that the markets can be supplied continuously and the period of picking extends as long as possible. In general the greater the quantity of apples and pears obtained from a few late-keeping varieties the better, as continuous supplies in bulk of these varieties ensure easy marketing.

CHOICE OF VARIETIES.

It is not proposed to deal here with the choice of varieties from the point of view of suitability for special localities or for special purposes, but rather so as to ensure that the arrangement of the plantation is such that the trees are planted at the correct distance apart and are properly interplanted.

The varieties of apples, pears, plums and cherries can be classified in two separate ways, either according to the vigour of growth, *i.e.*, weak, medium, or strong, or according to their habit of growth, *i.e.*, upright or spreading.

The correct distance apart will vary, not only according to the vigour and habit of the variety, but also according to the stock on which the tree is worked, whether strong or weak ; and with the manner in which the tree is trained, whether "standard," "half-standard," "bush," or "cordon" ; and finally with the type of soil whether it induces strong or weak growth.

The following are the general characteristics of the chief commercial varieties :—

Apples.

Strong Growing Varieties.

Bramley Seedling	(S).
Newton Wonder	(S).
Annie Elizabeth	(U).
Beauty of Bath	(S).

Weak Growing Varieties.

Lane's Prince Albert	(S) x.
Grenadier	(U) x.
Early Victoria	(U) x.
Stirling Castle	(S) x.
Gladstone	(S) x.

Varieties intermediate between these Classes.

James Grieve	(S).
Rival	(S).
Allington Pippin	(S).
Worcester Pearmain	(U).
Lord Derby	(U).
Cox's Orange Pippin	(S).

S = Spreading.
U = Upright.

The varieties marked x are suitable for growth as "fillers."

"Bush" trees of the strong-growing varieties planted together should be 18 ft. to 24 ft. apart, and should be worked on the dwarfing, "paradise" stocks. The same varieties, worked on the strong-growing "crab" or selected "free" stocks and trained as "half-standards" should be planted 24 ft. to 30 ft. apart, whilst "standard" trees should be planted 35 ft. to 40 ft. apart.

"Bush" trees of weak-growing varieties, planted together, should be 10 ft. to 15 ft. apart, and should be worked on "crab" or selected "free" stocks. These varieties should not be grown as "standard" or "half-standard" trees as the trees do not produce sufficient wood-growth, but they are especially suitable for permanent or "filler" bush trees or for cordons.

Varieties of medium vigour, trained as "bush" trees should be 14 ft. to 18 ft. apart, if planted together. A distance of 24 ft. apart is usually sufficient for "half-standard" trees, and 30 ft. for "standard" trees of these varieties.

Strong and medium or weak-growing varieties, trained as 'bush" trees may be interplanted about 18 ft. apart, and it is a good plan to alternate upright and spreading varieties as far as possible.

Plums.

Strong-Growing Varieties.		*Weak-Growing Varieties.*	
Czar	(U).	Victoria	(S).
Monarch	(U).	River's Early Prolific	(S).
Belle de Louvain	(U).	Pershore or Yellow Egg Plum	(S).
Pond's Seedling	(U).	Purple Egg Plum	(S).
Bush	(U).	Damsons	(S).

"Half-standard" and "bush" trees of the weak-growing varieties should be planted from 14 ft. to 18 ft. apart, while similar trees of the strong-growing ones should be 18 ft. to 24 ft. apart. "Standard" trees of the weaker varieties require to be 18 ft. to 24 ft. apart, whilst 24 ft. to 30 ft. apart is sufficient for the more freely-growing varieties.

"Standard" plums normally commence bearing much more rapidly than "standard" apples, and as the life of the former is not so long as the latter, a mixed plantation of these fruits is recommended. The "quincunx" system (40 ft. square, with a tree in the centre of square), is suitable for this purpose. The apples should be at the corners of the squares and the plums in the centres.

Pears.

Pears are most profitable grown as "bush" trees worked on quince stocks. In this way a crop is obtained a few years after planting, and the fruits are finer owing to the greater attention which the trees receive. "Standard" and "half-standard" pears worked on the "wild" pear stock are not recommended, as a profitable crop is seldom obtained until about 20 years after planting.

The chief commercial varieties all make weak growth when worked on the quince stock, and their length of life is short, normally not more than 15 years; the habit of growth is upright in nearly every case. For these reasons they are exceptionally suitable for use as "fillers" on soils which are known to suit them. Pears on quince stocks are very suitable for "cordons." The spur-fruiting habit of apples is accentuated in pears and they therefore lend themselves to the spur-pruning system which is essential for "cordon-growing." "Bush" trees of all the following varieties should be planted 12 ft. square.

Conference.
Dr. Jules Guyot.
Fertility.
Durondeau.
Clapp's Favourite.

Cherries.

Morello cherries trained as "bush" trees should be planted 12 ft. square, as, although the trees are spreading, close pruning has to be carried out and large trees are not obtained.

Vigorous varieties of "Sweet" cherries, grown as "standard" trees, should be planted 40 ft. apart, whilst for the less vigorous sorts 30 ft. apart is sufficient.

Strong-Growing Varieties.	*Weak-Growing Varieties.*
River's Early Black.	Governor Wood.
Kentish Bigarreau (Amber Heart).	Elton Heart.
Napoleon Bigarreau.	Knight's Early Black.
Early Frogmore.	Kentish and Flemish (Acid Cherries).

SUGGESTED PLANTATIONS.

(*a*) **Bush Apples.**

Lane's Prince Albert (crab)
James Grieve (paradise) } 14 ft. square.

interplanted with red or black currants, or gooseberries at 7 ft. square.

(*See* Fig. 4.)

(*b*) **Bush Apples.**

Newton Wonder (paradise)
Lord Derby (paradise) } 20 ft. square

interplanted with soft fruits at 5 ft. square.

(*c*) **Bush Apples.**

Worcester Pearmain (paradise)
Allington Pippin (paradise) } 18 ft. square.

interplanted with soft fruits at 6 ft. square.

(*d*) **Bush Plums.**

Victoria
Czar } 14 ft. square.

interplanted with soft fruits at 7 ft. square.

(*e*) **Bush Pears.**

Conference (quince)
Durondeau (quince) } 12 ft. square.

interplanted with soft fruit at 6 ft. square.

(*f*) **Half-Standard Apples.**

Newton Wonder (crab)
Allington Pippin (crab) } 24 ft. square.

Bush apples, pears, plums or cob nuts can be planted in the centre of each square, and the intermediate land can then be interplanted with soft fruits at 6 ft. square.

(*See* Fig. 5.)

(*g*) **Mixed Standard Plantation.**

Bramley Seedling and
Lord Derby Apples } 40 ft. quincunx.

Bush Czar plums, interplanted among the apples at 20 ft. apart. The intermediate land planted either with Stirling Castle or Lane's Prince Albert apples ("fillers") at 10 ft. square, or with soft fruits at 5 ft.

(*See* Fig. 6.)

(*h*) **Mixed Standard Plantation.**

Kentish Bigarreau
Napoleon Bigarreau } 40 ft. square.

Czar or Belle de Louvain plums in the centre of each square. The intermediate land planted with soft fruits at 5 ft. square as long as the permanent trees are small. The plantation to be "grassed" down when 12 to 15 years old, by which time the "soft fruits" have been grubbed up.

Fig. IV

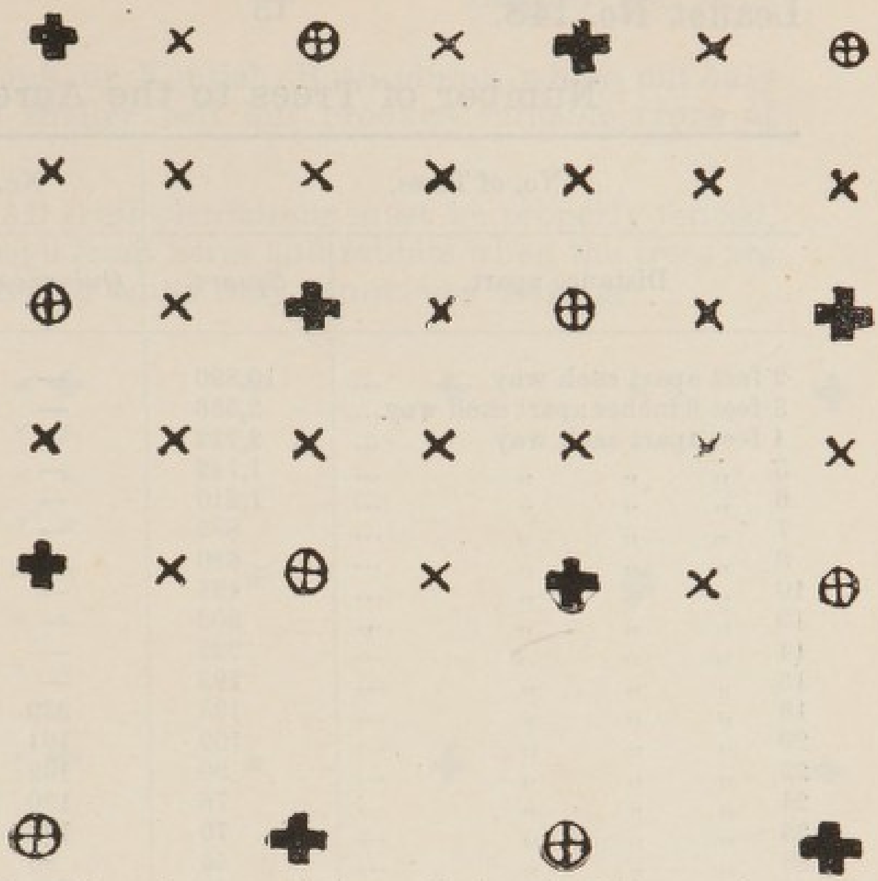


FIG. 4.—Bush Apple Plantation consisting of Lane's Prince Albert (crab stock) + and James Grieve (paradise stock) (⊕) planted alternately 14 ft. square and interplanted with soft fruits (×) 7 ft. square.

When the apples require the whole of the ground the soft fruits must be removed.

Fig. V.

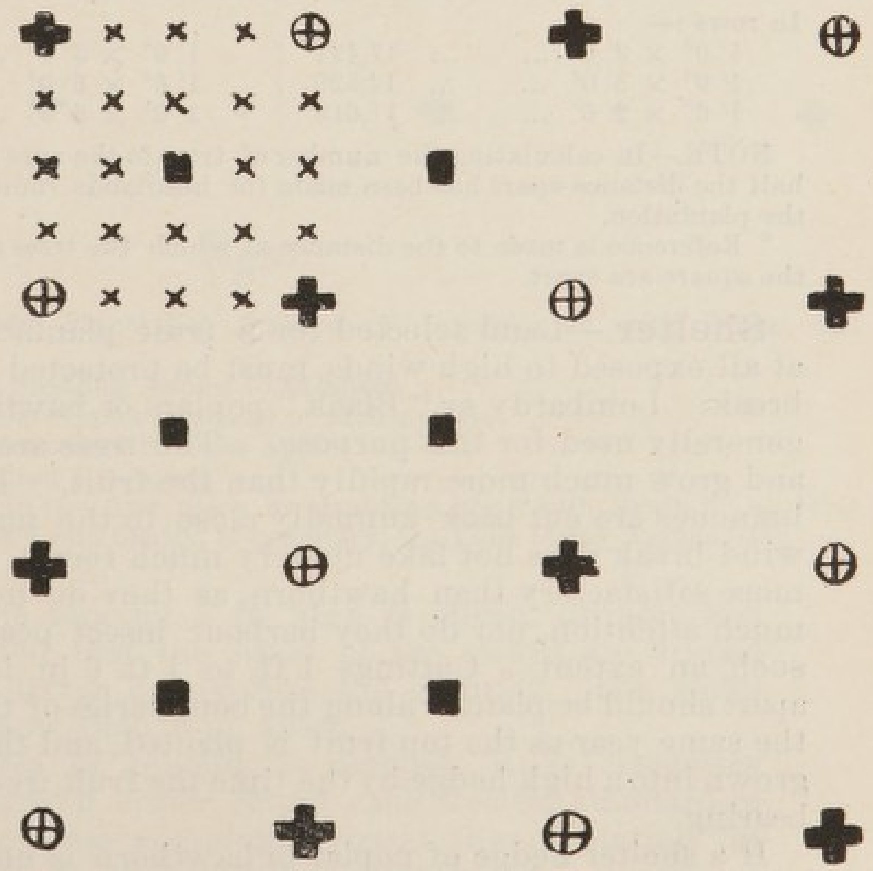


FIG. 5.—Half Standard Apple Plantation interplanted (quincunx system) with Cob or Filbert Nuts or Bush Plums.

(+) Newton Wonder (on crab) } interplanted 24 ft. square.
(⊕) Allington Pippin (on crab) }
(■) Nut or Bush Plum planted in centre of square.
(×) Soft Fruit interplanted at 6 ft. square.

Number of Trees to the Acre.

Distance apart.	No. of Trees. Square.	No. of Trees. Quincunx.*	No. of Trees. Triangular.
2 feet apart each way	10,890	—	—
3 feet 6 inches apart each way...	3,556	—	—
4 feet apart each way ...	2,722	—	—
5 " " " ...	1,742	—	—
6 " " " ...	1,210	—	—
7 " " " ...	889	—	—
8 " " " ...	680	—	—
10 " " " ...	435	—	507
12 " " " ...	302	—	348
14 " " " ...	222	—	259
15 " " " ...	193	—	223
18 " " " ...	135	239	155
20 " " " ...	109	194	126
22 " " " ...	90	162	104
24 " " " ...	76	130	87
25 " " " ...	70	124	81
28 " " " ...	55	95	65
30 " " " ...	48	81	56
32 " " " ...	42	72	49
36 " " " ...	33	53	39
40 " " " ...	27	43	31

In rows :—

1′ 0″ × 2′ 6″	17,424	1′ 6″ × 3′ 0″	9,680
1′ 0″ × 3′ 0″	14,520	1′ 6″ × 6′ 0″	4,840
1′ 6″ × 2′ 6″	11,616	2′ 0″ × 6′ 0″	3,630

NOTE.—In calculating the number of trees to the acre an allowance of half the distance apart has been made for headlands round the outside of the plantation.

* Reference is made to the distance at which the trees at the corners of the square are apart.

Shelter.—Land selected for a fruit plantation, which is at all exposed to high winds, must be protected with a wind-break. Lombardy or "Black" poplars or hawthorn are very generally used for this purpose. The trees are easily raised and grow much more rapidly than the fruit. If the lateral branches are cut back annually close to the main stem, the wind-break does not take up very much room. Poplars are more satisfactory than hawthorn, as they do not require so much attention, nor do they harbour insect pests of fruit to such an extent. Cuttings 1 ft. to 1 ft. 6 in. long and 3 ft. apart should be planted along the boundaries of the plantation the same year as the top fruit is planted, and they will have grown into a high hedge by the time the fruit trees commence bearing.

If a shelter hedge of poplar or hawthorn is not considered sufficient, the first row of fruit trees should consist of damsons, Monarch or Kentish Bush plums, which not only act as a second shelter belt but produce valuable crops of fruit.

Fencing.—All fruit plantations must be properly fenced, to prevent damage from hares and rabbits when the trees are young, and pilfering when they commence bearing.

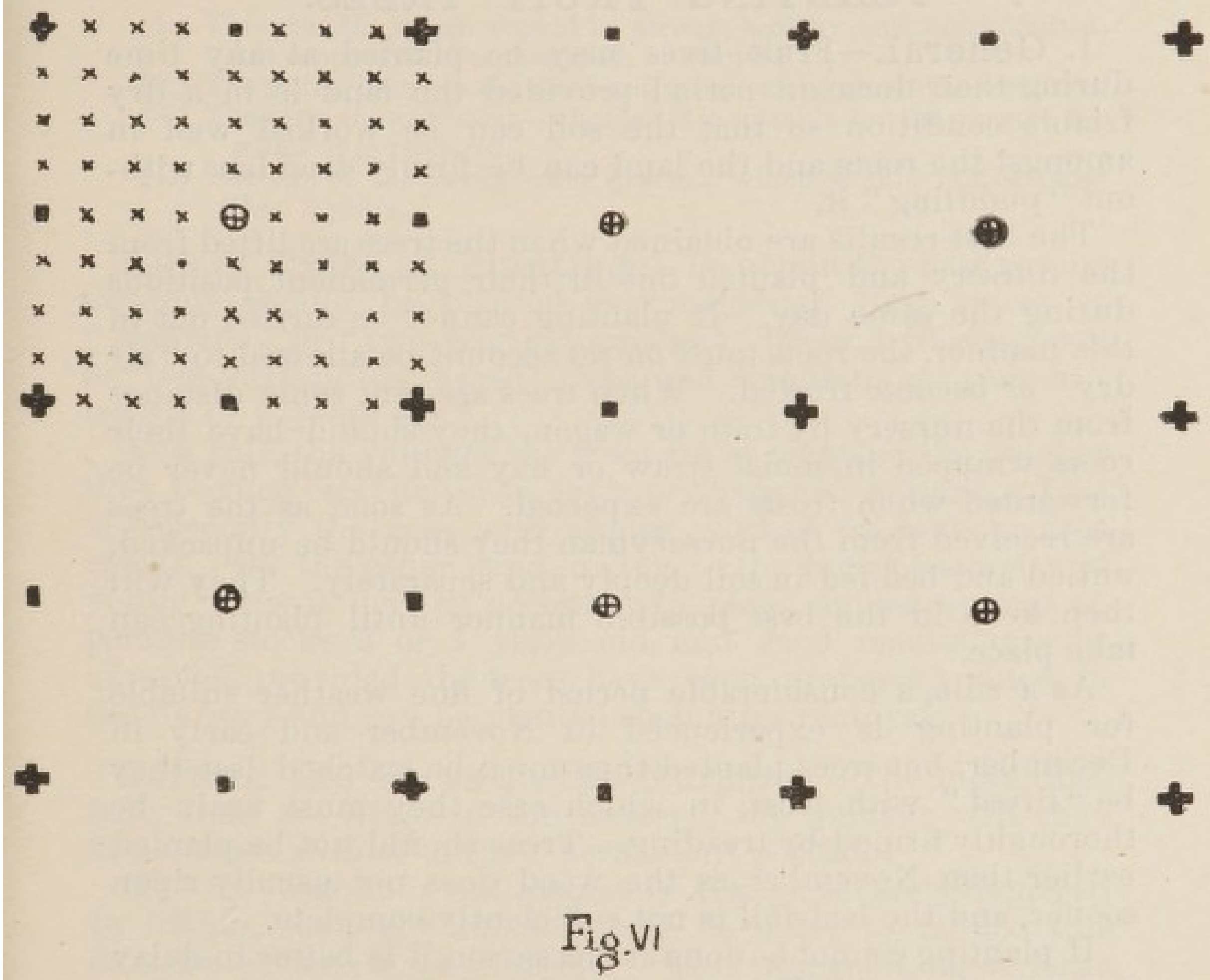


FIG. 6.—Standard Apple Plantation (quincunx) interplanted with Plums and Soft Fruit.
(+) Standard Bramley Seedling Apples 40 ft. apart.
(⊕) Standard Lord Derby Apples in centre of each square.
(■) Bush Plums interplanted 20 ft. from Apples.
(x) Soft Fruit interplanted 5 ft. apart.
Thinning is carried out in the first place by grubbing the "Soft Fruits" (x), later by removing the Plums (■), and finally, if necessary, the Lord Derby Apples (⊕).

Chestnut Spile fencing 5 ft. high is cheap, durable and effective, provided that the bases of the stakes are dipped in creosote and driven firmly into the ground. The spiles should not be more than 6 in. apart.

Whatever form of fencing is erected, it is necessary to place wire netting either round each tree for standard or half-standards, or else completely round the plantation for bush and cordons, to exclude hares and rabbits.

The netting should be 1¼ in. mesh, 3 ft. wide and 18 gauge, and, if put right round the plantation, it should be buried in the ground 3 in. to 4 in. and should be kept tight at the top by a stout straining wire. If there is no form of fencing to which the netting can be attached, stakes every 8 to 10 yards will be required.

PLANTING FRUIT TREES.

1. **General.**—Fruit trees may be planted at any time during their dormant period provided the land is in a dry friable condition so that the soil can be worked well in amongst the roots and the land can be firmly trodden without "puddling" it.

The best results are obtained when the trees are lifted from the nursery and planted out in their permanent positions during the same day. If planting cannot be carried out in this manner, the roots must on no account be allowed to "air dry" or become frosted. When trees are sent some distance from the nursery by train or wagon, they should have their roots wrapped in moist straw or hay and should never be forwarded when frosts are expected. As soon as the trees are received from the nurseryman they should be unpacked, untied and bedded in soil deeply and separately. They will then keep in the best possible manner until planting can take place.

As a rule, a considerable period of fine weather suitable for planting is experienced in November and early in December, but trees planted then must be watched lest they be "lifted" with frost, in which case they must again be thoroughly firmed by treading. Trees should not be planted earlier than November as the wood does not usually ripen sooner, and the leaf-fall is not sufficiently complete.

If planting cannot be done at this season it is better to delay the operation until February and March when another fine spell occurs. In any case planting must be completed before growth commences.

Purchase of Trees.—Young trees purchased for planting should be the best obtainable. The cost of really first-class trees is only slightly more than for rubbish, and it is not worth while risking a costly failure by purchasing the latter to save at most £5 to £10 an acre.

The majority of well-known fruit tree nurserymen are thoroughly reliable, but the following hints to intending purchasers will doubtless be found useful :—

Trees should only be purchased after first inspecting the nursery and seeing the trees in the nursery beds. June and July are the best months for this. When completing the purchase an arrangement should be made with the nurseryman that no trees are to be "bought in" to make up the order. At the same time a few trees should be marked as samples and the smallest size which will be accepted should be stipulated. Besides this, it should be made quite clear that no trees which have been badly damaged or are suffering from Apple Canker, Woolly Aphis or Silver Leaf Disease will be accepted.

When inspecting a nursery special note should be made of :—

(1.) The growth, which should be strong, healthy and short-jointed, not sappy and over-manured, or stunted.

(2.) The union between the stock and scion, which should be complete.

(3.) The type of stock used—whether it is suitable for the purpose for which it is required.

(4.) The age of the stocks when grafted, which should not be more than 2 years.

Age of Trees at Planting.—To obtain the best results Cordons should be planted as "maidens," Bush trees as "maidens" or "two-year-old-cut-back" trees, half-standards as "two-year-old-feathered" trees, and Standards as "trained" trees 3 or 4 years old.*

As a rule, the younger the trees are at planting the quicker they become established in their permanent positions. This is especially the case with apples worked on crab or free stocks. On the other hand, owing to the present scarcity of young trees it may be necessary to plant apples worked on paradise stocks 3 or 4 years old, and good results may be expected, provided the trees have been properly trained in the nursery and can be planted soon after removal.

Lifting the Trees in the Nursery.—The more carefully trees are lifted in the nursery, the quicker will they become established in their permanent position.

The root system is unfortunately always severely damaged by lifting, but every effort should be made to reduce this damage as much as possible. This depends, to a large extent, on whether the men lifting the trees are skilled or not.

Two men are required to lift the trees. Each should have a long, sharp spade. They should work on opposite sides of the tree, and after loosening the roots by inserting their

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* A "*maiden*" tree is a one-year-old tree, and consists of the growth formed during one growing season from the time the stock was budded or grafted. "Feathered Maidens" are those which have produced a number of lateral shoots during one year's growth; in comparison "clean maidens" have no lateral shoots or "feathers."

A "*Two-year-old-cut-back*" tree has two complete seasons' growth from the time the tree was budded or grafted. If a maiden had its "leader" or main shoot cut back in the winter following its formation a two-year-old-cut-back tree is obtained in the following year.

"Maiden" trees which are allowed to remain unpruned in the winter following their formation become after the second year "*Two-year-old-Feathered*" Trees.

spades as deeply as possible in a circle round the tree at a radius of 9 inches to 1 foot, they should complete the operation by inserting their spades deep down under the base of the tree and lifting it out completely. The earth can then be shaken away from the roots.

Lifting should only be carried out when the land is dry, as otherwise the root fibres are unnecessarily damaged. The trees must never be lifted until at least half their leaves have fallen.

Previous Cultivation of the Land.—Land to be planted up must be in good heart and free from all spreading weeds such as Couch (*Agropyrum repens*), Watergrass (*Agrostis vulgaris*), Creeping Sowthistle (*Sonchus arvensis*), Creeping Crowfoot (*Ranunculus repens*), and Field Convolvulus (*Convolvulus arvensis*).

The best crops to take prior to planting are either early potatoes or peas. The former is to be recommended, however, because it is essentially a cleaning crop, and ensures thorough cultivation and manuring of the land, besides which the crop is off the land in plenty of time to allow the preparations for planting to be made early.

Peas are the next best crop, but they are inclined to foul the land, and on this account early potatoes are recommended in preference.

Provided the land is in good condition, no application of manure need be made unless interplanting with strawberries, raspberries or a vegetable crop is contemplated, in which case a normal dressing of 20 tons of dung per acre should be given. As soon as this has been applied, and as early as possible in the autumn, the land should be ploughed and subsoiled.

Steam tackle is often used for this work, and is the cheapest and most efficient provided it is done carefully and in such a manner that none of the subsoil is brought to the surface.

As soon as the plantation has been planned the land can be marked out.

Marking Out.—The exact position of each tree should be marked with a packing stick, stake or "white." A builder's chain or thin wire rope with the distance apart of the trees marked with coloured wool is very useful in setting out a new plantation—a line of rope or twine should not be used, as it is easily stretched and the stakes are then placed out of alignment. Three men should mark out about 3 acres per day.

Square and Quincunx Plantations (Fig. 7).—A base line A.B. should first be marked out by squaring off one side, after making allowance for the width of the roadway or

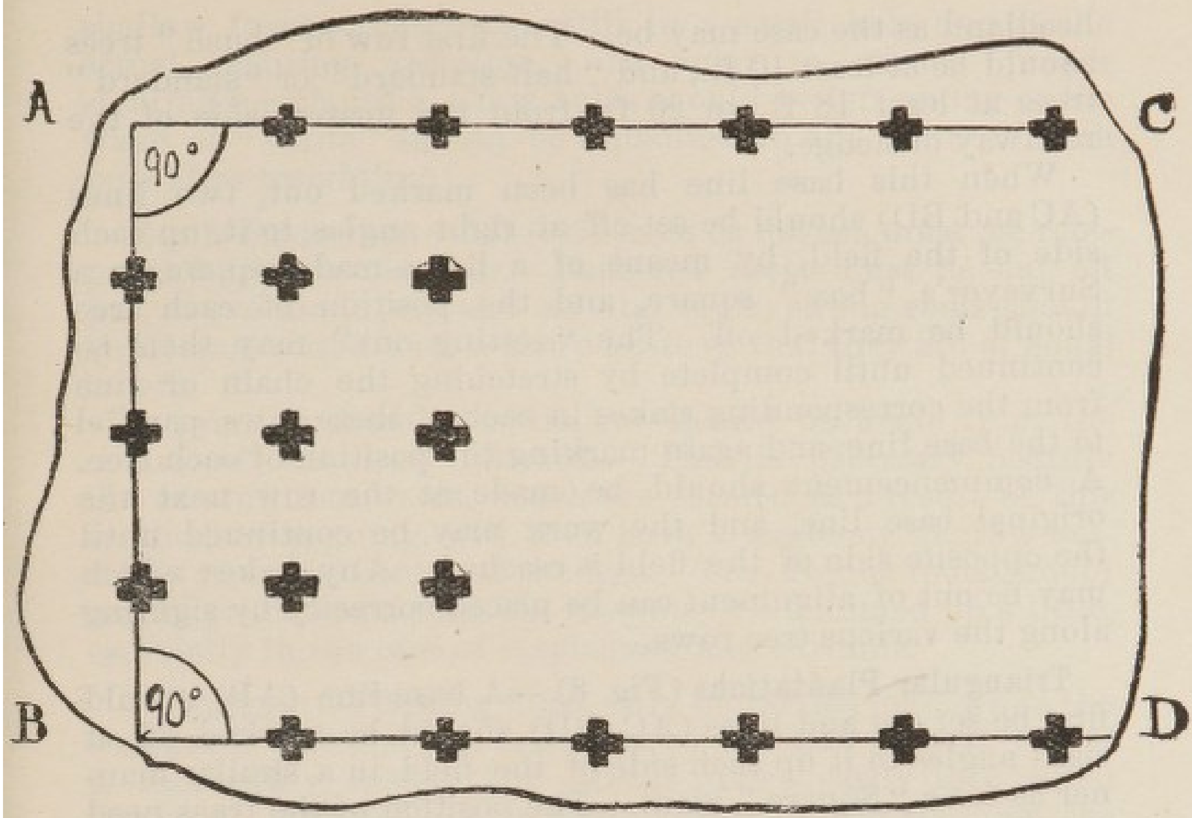

Fig. 7. Square Plant.

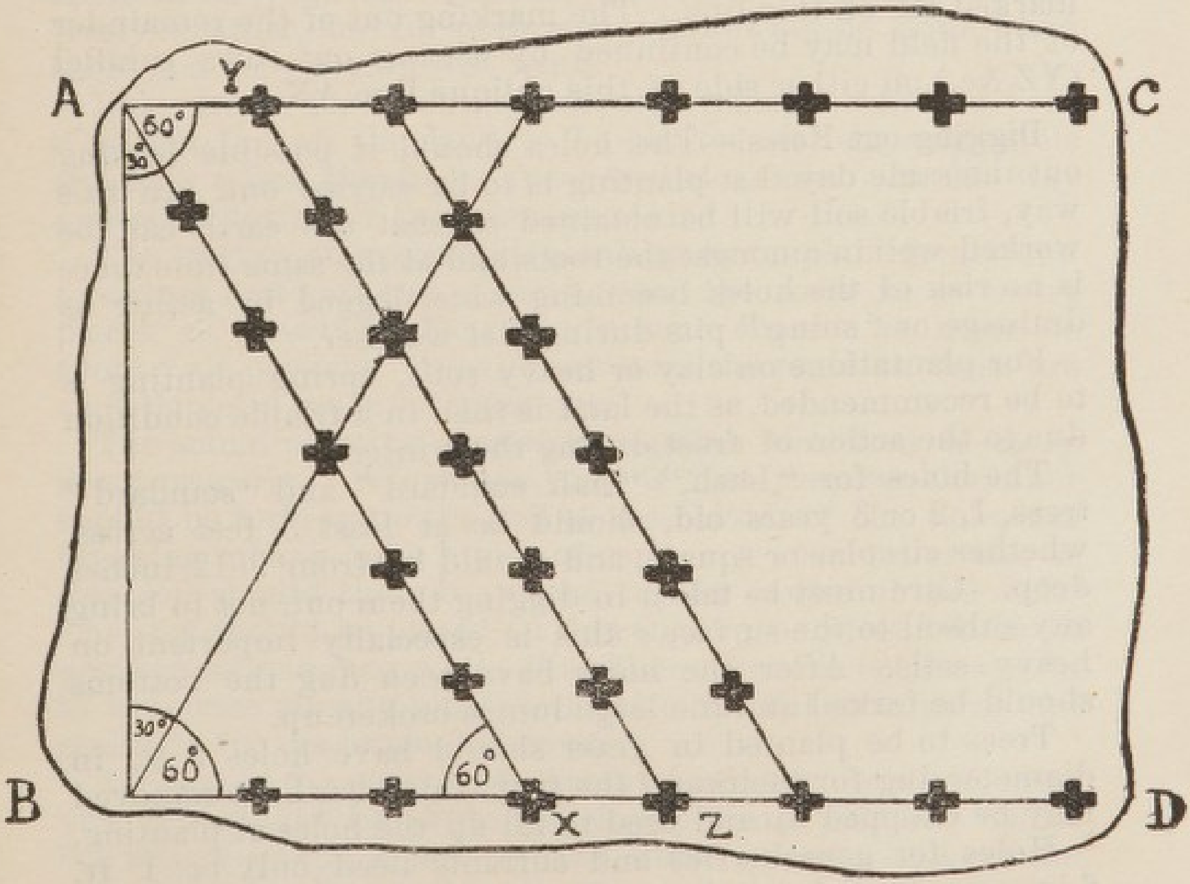

Fig. 8. Triangular Plant.

headland as the case may be. The first row of "bush" trees should be at least 10 ft., and "half-standard" or "standard" trees at least 18 ft. to 20 ft. from the nearest side of the roadway or hedge.

When this base line has been marked out, two lines (AC and BD) should be set off at right angles to it, up each side of the field, by means of a home-made square or a Surveyor's "box" square, and the position of each tree should be marked off. The "setting out" may then be continued until complete by stretching the chain or line from the corresponding stakes in each of these rows, parallel to the base line, and again marking the position of each tree. A commencement should be made at the row next the original base line, and the work may be continued until the opposite side of the field is reached. Any stakes which may be out of alignment can be placed correctly by sighting along the various tree rows.

Triangular Plantations (Fig. 8).—A base line (AB) should first be set out and lines (AC, BD) should be marked off at right angles to it up each side of the field in a similar manner as for a "Square" plant. The position of the trees need not be marked on the base line, but only on the side lines. Then by means of a box sextant or other instrument used for measuring angles a line (AX) should be set off at 30° from one end of the base line, the position of each tree being marked off on this line. The marking out of the remainder of the field may be continued by setting out rows parallel (YZ &c.) on either side of this oblique line AX.

Digging out Holes.—The holes should if possible be dug out the same day that planting is to be carried out. In this way, friable soil will be obtained so that the earth can be worked well in amongst the roots, and at the same time there is no risk of the holes becoming water-logged by acting as drainage or "sump" pits during wet weather.

For plantations on clay or heavy soils, spring planting is to be recommended, as the land is then in a friable condition due to the action of frost during the winter.

The holes for "bush," "half standard" and "standard" trees, 1, 2 or 3 years old, should be at least 3 feet across, whether circular or square, and should be from 9–12 inches deep. Care must be taken in digging them out, not to bring any subsoil to the surface; this is especially important on heavy soils. After the holes have been dug the bottoms should be forked and the large lumps broken up.

Trees to be planted in grass should have holes 5 ft. in diameter dug for them, and the turf which has been removed may be chopped up and used to fill up the holes at planting.

Holes for gooseberries and currants need only be 1 ft. 6 in. across and 1 spit deep. Raspberries can be planted in a shallow furrow, but better still in a small hole dug at the actual planting operation. In order to ensure proper sighting for planting, a few holes should be left undug or the stake or "white" should be replanted in the centre of each hole after resighting.

Root Pruning.—All fruit trees or bushes must be root-pruned prior to planting. Damaged roots must be cut off just above the injury and all the thick, strong roots should be trimmed back with a sharp knife so that they are of equal length.

In pruning these roots, the cut should be made from the centre of the tree outwards. This is necessary because the adventitious roots, which are formed as a result of this method of pruning, will then have a tendency to grow outwards from the centre of the tree. The fibrous roots should not be pruned as a rule, but they may be trimmed up a little, especially in the case of raspberries and currants.

Planting.—Planting must only be carried out when the weather is fine and the condition of the land is such that it is thoroughly friable and breaks down easily into small particles. The soil can then be worked well in amongst the fibrous roots.

As previously stated planting may be carried out either during the fine weather in the late autumn or during a fine spell in early spring. It must never be carried out during frosty weather, and for preference should not be done when there is a very drying east wind.

The trees for planting should remain "heeled" or "bedded in" on the land to be planted as long as possible and only a few should be uncovered at a time. In this way excessive drying of the roots is avoided.

The essence of successful planting is to plant firmly and to ensure that particles of earth touch the roots in as many places as possible. Every endeavour should be made to avoid "air pockets" remaining round the roots as these are very liable to cause "drying out."

The actual planting operation requires two men to carry it out properly. Whilst one man is root pruning, the other should be forking up the soil at the bottom of the hole, and breaking up any large lumps of earth. A spadeful or two of fine soil should then be placed in the centre of the hole. The tree should be placed on this slight mound and held in position by one man while the other sights it both ways on to the trees already planted or on to the stakes marking the positions for the unplanted trees.

As soon as the correct alignment has been obtained, more fine soil should be shovelled slowly round the roots whilst the tree is gently raised up and down in order to work the soil in among the small roots.

As soon as the roots are well covered, the earth must be made quite firm by treading with the feet. The remainder of the hole may then be filled in and trodden tight.

It is most important to plant the trees tightly, and if after a little while has elapsed the soil appears loose, it should again be firmed by treading.

In order to prevent loss of moisture through excessive capillary action due to "firming" the ground by treading, the topmost layer must consist of loose earth, 2 to 3 inches thick. The hole must be filled up completely, so that the level of the soil replaced round the tree is slightly higher than the normal ground level. This is absolutely necessary in order to allow for consolidation which is bound to take place as time goes on, and to prevent the ground round the tree sinking lower than the normal ground level. If excessive consolidation takes place care must be taken to fill up the hole as soon as possible, otherwise the land round the trees may become waterlogged in wet weather.

Apples on "Paradise" stocks and pears on quince stocks should always be planted so that the union between the scion and the stock is below ground level. The growth of the stock will then keep pace with the growth of the scion and adventitious roots will be sent out right up to the point of union. Should this point be neglected, the stock exerts a very much greater dwarfing effect on the scion than is required, due to the part of the stock remaining above ground level, in which case it expands very slowly. The unsightly protuberance seen in Fig. 9, is the result of not planting deep enough trees worked on dwarfing stocks. Trees worked on the strong-growing stocks should be planted at approximately the same depth as that at which they were growing when in the nursery rows.

Manuring and Cultivation of the Land after Planting.—It is often difficult to start newly-planted fruit trees growing away well the first season after planting, especially if a dry spring and summer are experienced. The lack of vigour results from the combined effect of damage to the root system during lifting, excessive drying of the roots during transit from the nursery to the plantation, and insufficient soil moisture. Every effort must be made, therefore, to conserve the soil moisture, and with this end in view the land should be "levelled" or harrowed down as soon as the dry weather sets in after planting. A soil mulch must be maintained throughout the summer, and the top few inches kept quite friable and loose. At the same time, a mulch of straw dung should be given to each tree in April, not only to prevent loss of moisture, but also to force the young tree into growth.

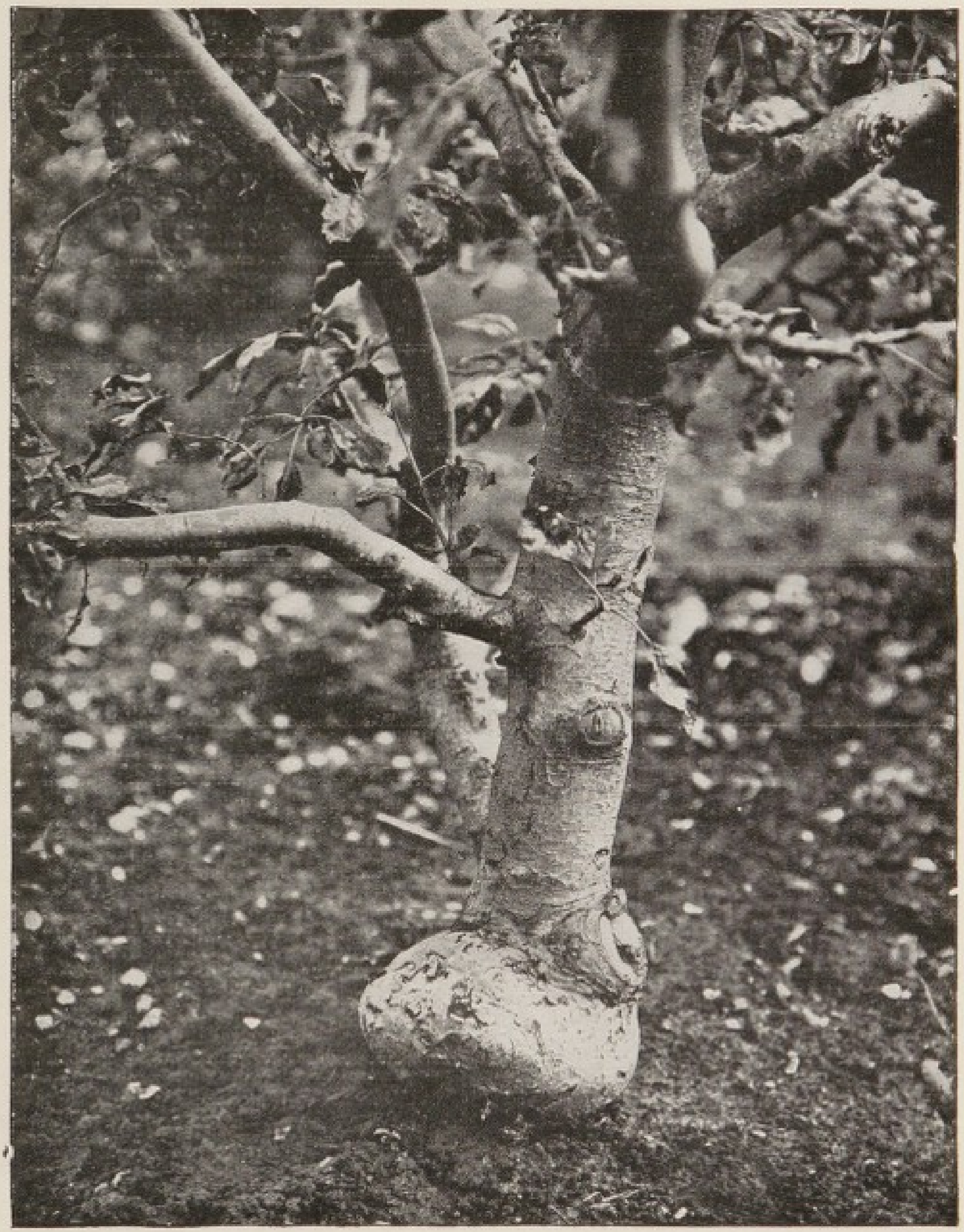

FIG. 9.—The protuberance close to the ground is the result of planting insufficiently deeply an apple tree " worked " on a Paradise stock.

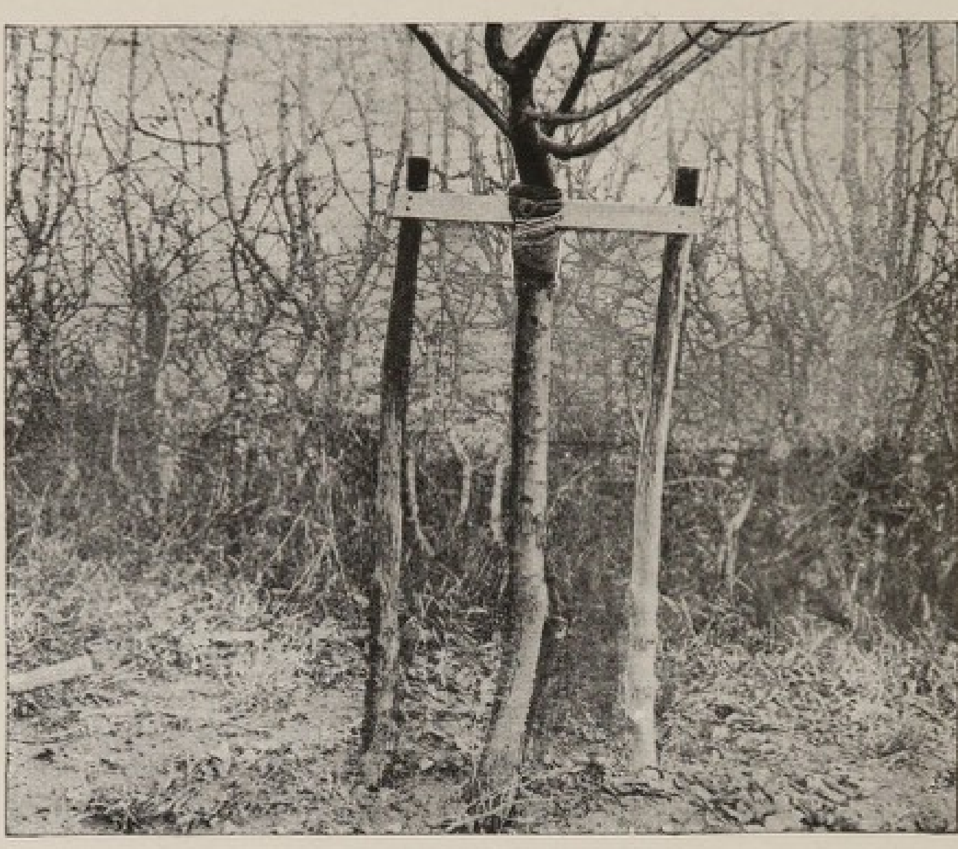

FIG. 10.—Method of Staking Half-Standard and Standard Trees.

FIG. 11.—Method of Staking Bush Trees.

Pruning after Planting.—Opinion is divided as to the advisability of pruning soon after planting or of delaying it until after the first growing season. As a general rule, if the first method is adopted it is considered best to prune in the late spring when the buds have just commenced to break so that bold wood-buds can be chosen to terminate the pruned wood.

The pruning of bush and half-standard apples from planting onwards is dealt with fully in Leaflet No. 322.

Staking.—All the trees, especially standard and half-standard, must be staked soon after planting. There are many methods adopted by growers; for "standard" and "half-standard" trees either one or two stakes are required but bush trees need only one stake.

For "standard" and "half-standard" trees, the following method is preferable as the risk of damage through the stake rubbing the lower branches can then be avoided (Fig. 10).

Stakes should be driven in on either side of the tree at a distance of about 6 to 9 inches in such a way that they will not interfere with horse cultivation. A cross-piece is then nailed to them just below the head of the tree in such a way that it does not rub the lower branches. Finally, a piece of sacking, 4 to 6 inches wide and about 2 ft. long, should be bound round the tree and tied to the cross-stake by means of coir yarn or tarred twine, the tie of the yarn being made against the cross-piece.

Another method is to replace the wooden cross-piece with a band of straw, but this is not recommended as the straw harbours insect pests and is also very liable to rot quickly, in which case the trees may break away from the stakes and become seriously damaged by rubbing.

"Bush" trees are held best with only one stake, which should be driven in obliquely about 2 ft. from the base of the tree in such a way that the top of the stake just reaches the main stem underneath the head of the tree (Fig. 11). The head of the stake should face the direction of the prevailing winds so as to give the tree as much support as possible. A strip of sacking 4 - 5 inches wide and about 2 ft. long is then wound round the tree to prevent the stake damaging it and to enable the stake and tree to be tied firmly together with coir yarn or tarred twine, the tie of the yarn being made against the stake.

All staked trees must be untied annually and the sacking unwound; the latter should then be replaced and the trees retied to the stake. If mussel scale collects on the tree under the sacking, the attacked portion should be painted with lime-sulphur (3 quarts concentrated (1.3 sp. gr.) to 10 gal. water).

The sacking and ties, if not removed annually, are very liable to damage the trees considerably by preventing the stem from swelling normally and causing a stricture. Where retying is neglected for a year or two, the heads of the trees are apt to break off just above the tie during windy weather.

London, S.W.1,
October, 1905.
Rewritten, February, 1919.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

Threshing of Barley.

Injury due to bad Threshing.

Complaints are frequently made by brewers and maltsters of the injury done to barley in the process of threshing, owing to the fact that the drum of the threshing-machine is set so close that many of the grains are cracked or broken. The presence of such injured grains greatly reduces the value of the barley for malting purposes, as the broken, bruised or skinned grains fail to germinate, and soon show signs of mould, thus leading to unsoundness in the malt and bad results in the brewery. The injury caused by over-dressing is not limited to grains which are actually broken, as grains closely nipped at one or both ends, or such as have been bruised and peeled, are equally objectionable. In fact, if by too vigorous threshing the husk of the barley is damaged, although the damage may not be apparent, irregularities in the malting, accompanied by the production of mould, are likely to result.

To prevent Injury.

(1.) When farmers commence a day's threshing they should at the outset, and repeatedly during the day, carefully examine the grain. If any signs of injury are observed the concave of the drum of the machine should be slightly opened. It is better that part of the beard should be left adhering to the grain than that any risk should be run of injuring the reputation and value of home-grown barley on account of broken and chipped grains.

In this connection, Mr. Baird, a leading maltster in Scotland, in an article on the Overdressing of Barley, which appeared in the *Transactions* of the Highland and Agricultural Society in 1902, pointed out that if in order to get all the grain out of the ear, especially when the barley is difficult to thresh, the drum and concave are set too close, there is obviously more danger of breaking and "nibbing" than when they are not so closely set.

(2.) A new machine will break the grain more than a machine which has been used for a time and in which the roughness of the beaters has been worn off. On the other hand, when a machine has been much worn, the centre of the drum and concave having had the most work, in consequence of the feeding being necessarily more in the centre than at the ends of the drum, the space between them is greater in the centre than at the two ends, and if they are set to thresh clean in the centre they will be too close at each end, and consequently damage will occur. This fault can only be remedied by putting on new drum-beaters and concave ribs.

(3.) Great attention should also be paid to regularity of feeding. The mill should be driven at an even speed, and proper care should be taken in the adjustment of the several parts of the machine.

(4.) It is not only in the drum of the threshing-machine that unnecessary damage to the kernel takes place through imperfect setting of the several parts, but also in the barley-awner or hummeler, through which the grain subsequently passes. Here, if the beaters are set too closely, and the barley is roughly handled, "nibbing" will take place.

Different varieties of barley require different treatment, so that those in charge of the threshing should make a point of constantly examining the sample, and if this is injured in any way, of ascertaining in what part of the machine the injury occurs, altering the setting until it is remedied.

(5.) As a further guide in threshing it may be added that on no account should the barley be rushed through the machine, as it is better to be content with a moderate output and a more perfectly threshed sample.

(6.) Heavy bushel-weight is no longer required by maltsters, and such barley does not command a higher price, grain of moderate weight being preferred to a sample of heavy weight. This may be emphasised by stating that barley weighing naturally from 54 lb. to 56 lb. per bushel is preferable to barley weighing 56 lb. to 58 lb. per bushel.

(7.) It is important that the machine should be thoroughly clean in all parts before commencing the day's threshing.

London, S.W.1,
August, 1905.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 150.

BOARD OF AGRICULTURE AND FISHERIES.

PEA AND BEAN BEETLES.

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1. The Pea Beetle (*Bruchus pisi*).

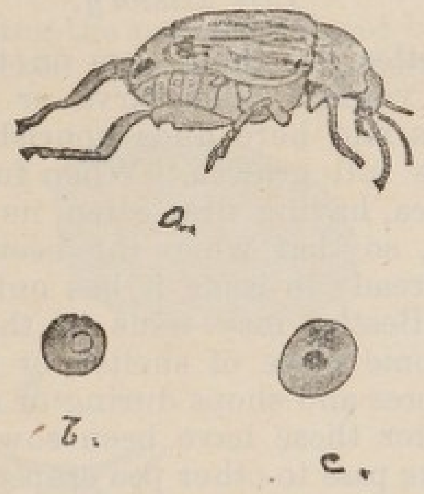

Fig. 1.—*Pea Beetle*—*a.* Beetle, × 5 (after Curtis). *b.* Infested pea showing position of beetle. *c.* Hole left in pea after exit of adult beetle.

This beetle attacks peas only, although the closely allied species, *Bruchus rufimanus*, attacks the bean in a similar manner. There are records of the adult beetle injuring the foliage of young pea plants by feeding on the leaves, but it is the larva or grub which is the real cause of the damage complained of in connection with this insect. The grubs live in the seed and the result of their work is that the seeds may not germinate, or if they germinate the plants from them may be weakly. Inferior peas imported for feeding birds, pigs, &c., are frequently very badly infested and help in adding to the numbers of the beetles and in spreading them.

Description.

The beetle (Fig. 1, *a.*) is oblong-oval in shape and black in colour, with a brownish or brown-grey pubescence. The four basal joints of the antennæ are red, as are also the shanks and tarsi of the two front pairs of legs. The thighs (femora) of the front legs are black, or almost so, whereas in the allied *B. rufimanus* the thighs of the front legs are red. The thorax is slightly narrowed in front and has a distinct white spot behind. The wing covers are rather short, so that the hinder part of the abdomen is exposed; this exposed part has a greyish-white pubescence, with dark spots, of which two large ones at the tip are marked. The hind legs are longer than the others and have the femora stout and toothed.

The larva is whitish-yellow in colour, fat and wrinkled. When newly hatched from the egg it has three pairs of small legs, which are afterwards lost. The scaly head is provided with gnawing jaws.

Life History.

The adult beetles lay their eggs on the pea pods when these are very young. The larva or grub on hatching bores into a pea and here finds nourishment sufficient to develop it to its full growth. When full grown, the larva pupates in the pea, having first eaten its way to the outer coat of the pea, so that when the beetle is mature after pupation and is ready to issue it has only to break through this thin skin. Beetles may issue in the autumn and pass the winter in some place of shelter, or they may issue in granaries and stores and shops during or after the winter, or from the peas after these have been sown. The beetles fly well and can thus pass to other pea crops.

2. The Bean Beetle (*Bruchus rufimanus*).

This beetle has habits similar to those of *B. pisi*, inasmuch as the grubs live in the seed,—in this case in the bean—where their presence is harmful because of the interference with and possible prevention of germination.

Description.

The beetle (Fig. 2, *a.*) is about one-sixth of an inch in length. Black in ground colour, with a pubescence of brown hairs, it has a great resemblance to *B. pisi*. The Bean Beetle, however, can be distinguished by the thighs of the front legs, which are red, and also by the fact that, the exposed tip of the abdomen being nearly covered with white-grey pubescence, the dark spots characteristic of *pisi* scarcely show in *rufimanus*, or may not show at all.

The larva (Fig. 2, *b.*) is whitish, fat, and wrinkled, resembling that of the Pea Beetle.

Life History.

The beetles after pairing lay their eggs on the very young pods in the field, making their way into the blossom for the purpose. Out of each egg hatches a whitish wrinkled grub which bores into a bean, nourishing itself till full-grown on the reserve matter in the seed. More than one grub may be found in a bean, two and three being very common numbers. The full-grown grub pupates in the bean, and in the spring, or earlier, the adult beetle emerges. The round hole shows the place of emergence; in beans still containing the beetle a little round patch on the outer skin of the bean marks the place where the beetle lies.

General Preventive and Remedial Measures.

(1).—Peas containing the pest should not be sown. It has been stated that attacked peas can be separated from healthy

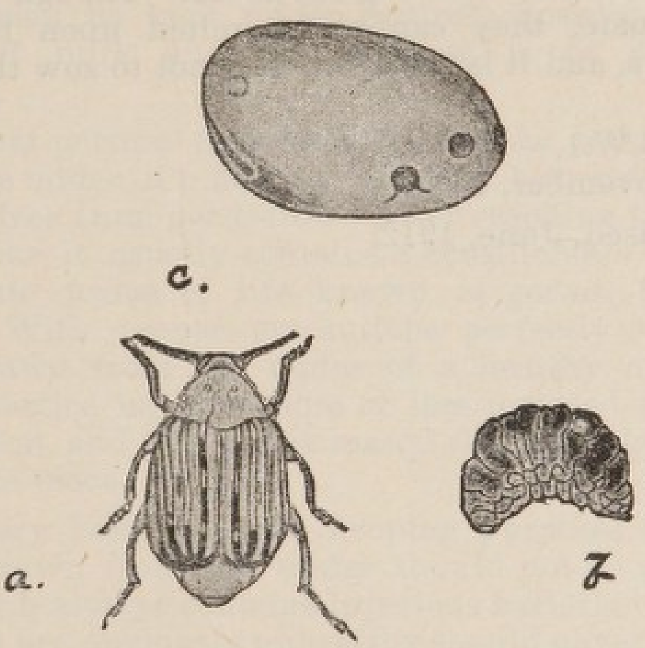

Fig. 2.—*Bean Beetle—a.* Beetle, × 5. *b.* Larva, × 5. *c.* Bean showing issuing beetle.

ones by placing the sample of peas in water, when the healthy ones will sink while the infested ones float. This statement is not wholly trustworthy. In experiments with sound and attacked peas it has been found that healthy sound peas sink at once, but that peas with holes in them from which beetles had issued, and those with the outer skin broken but with the beetle still *in situ*, might float for a short time, but ultimately they all sink. On the whole, peas with the outer skin unbroken and containing the beetle continue to float.

(2).—The best mode of killing the pest in the pea or bean is by fumigating these with bisulphide of carbon. The method is to enclose the peas (or beans) to be treated in an air-tight chamber, and then to place bisulphide of carbon in saucers or shallow dishes laid *on the top* of the peas (or beans) and allowed to remain for 48 hours at least. Two pounds of bisulphide of carbon will do for 1,000 cubic feet of air space. A very important condition is the temperature. Hinds and Turner and also Chittenden have shown in experiments with other grain-infesting beetles that a temperature of 70° to 75° F. is necessary for success. Bisulphide of carbon fumes are poisonous and easily inflammable; they should therefore not be breathed by the operator, nor should a naked light of any kind be brought near them.

(3).—If at the time of sowing live beetles are noticed in the peas, the beetles will be killed if the peas are dipped for 5 seconds into boiling water. The peas so treated may be sown after being dipped in cold water.

(4).—If infested peas and beans be placed in a closed jar or other vessel the beetles will in due course issue and will die without further harming the seeds. Though such seeds will germinate, they cannot be relied upon to produce strong plants, and it is therefore best not to sow them.

London, S.W.1,
November, 1905.
Revised, June, 1912.

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BOARD OF AGRICULTURE AND FISHERIES.

Cleanliness in the Dairy.

Milk is perhaps at once the most nourishing and the most delicate of all foods; nourishing because it supplies all the constituents necessary to support life, and delicate because in practice its character gradually changes from the moment it leaves the udder of the cow. These changes are chiefly induced by micro-organisms; and as cleanliness is the main factor by which the number and species of such organisms may be kept under control, cleanliness in the handling of milk and its products is of the utmost importance.

Except that portion first drawn from the teat, milk as it exists in the udder of a healthy cow may be considered to be practically free from germ-life. After reaching the milker's pail, however, it usually contains a considerable number of those minute forms of life known as germs, bacteria, or microbes. With proper precautions perfectly sterile milk may be drawn from the udder of a healthy cow, but in ordinary practice milk is more or less exposed to bacterial contamination, and this is the reason that souring and other changes take place.

If the very best milk for keeping purposes is required that first drawn from the udder should not be mixed with the bulk, as it always contains injurious bacteria. Milk from cows which are obviously unhealthy should never be used for human consumption, but may be given to poultry, calves, or pigs *after boiling*. Pure, clean raw milk from *healthy* cows may be considered much better for general consumption than milk which has been pasteurized or sterilized, especially when consumed while still warm.

Of the organisms which find their way into milk it may be said that they belong to the smallest forms of plant-life, which find milk to be a very suitable food and a medium in which they multiply rapidly, the increase being especially rapid when the milk stands for a time in a warm place after being drawn from the cow. There are many species of these organisms, all of which are more or less distinguishable either by their form, their habits of growth, or the effects which they produce. The products of these organisms have a peculiar chemical action upon one or more of the constituents of the milk which may affect the whole. For example, a lactic bacterium secretes a substance which acts on the milk-sugar, thereby producing lactic acid ; this acid in turn acts on the casein, forming curd. The objectionable flavours that are so frequently found in milk, butter, or cheese, are also usually due to various specific organisms.

Sources of Bacterial Contamination.

The chief sources of contamination of milk are dirt and dust on the cow, the milker, the air, the water supply, the hay, and the dairy utensils. The cow herself is one of the most fruitful sources ; not that she secretes milk containing germs, but because these germs exist on the hair which covers her body, and many of them during milking are in some way carried into the milk. A cow kept in a dirty, badly-kept or ill-ventilated byre is rarely clean ; her exterior, especially about the udder and hind-quarters, becomes more or less covered with dust and dirt, on which germs multiply, consequently increasing the number of organisms which fall into the milker's pail. The milker's hands and clothes, which in many cases are none too clean, are also fruitful, and at times dangerous, sources of infection.

The atmosphere of a cow-byre, moreover, is in too many cases confined, and consequently impure; such an atmosphere contains a large number of bacteria, which, being slightly heavier than the air, gradually settle down, and some of these are conveyed into the milk or into the utensils waiting to receive it.

Milk readily absorbs bad flavours and odours from surrounding strong-smelling substances, and proximity to anything of such a nature should be avoided.

Finally, the dairy utensils are frequently a source of contamination, either owing to improper cleaning or because they are left after cleaning in places where they are exposed to infection. Dairy utensils should, wherever possible, be perfectly tinned ; they should be as few in number as convenient; and they should be simple in construction. For example, the Danish style of milk can, with close-fitting lid which *throws off* rain water, is very much better than the ordinary English railway "churn."

Figures 1–6 illustrate the very material differences which exist between dirty and cleanly cows, pails, and byres. The plate cultures derived from the impure sources contain many more "colonies" of organisms than those derived from the cleanly sources.

Cleanliness in the Management and Housing of Cows.

Efficient ventilation is, perhaps, the first essential to a good cow-shed or byre. A properly ventilated cow-shed is

FIG. 1.—Photograph of a gelatine plate exposed for one minute in a badly ventilated cow-shed.

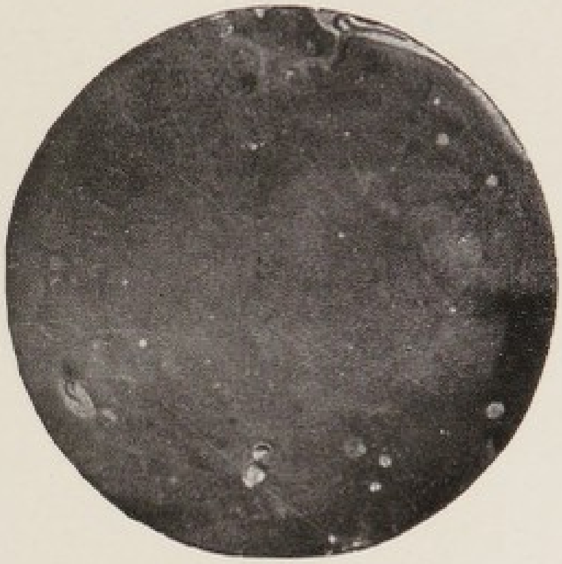

FIG. 2.—Photograph of a gelatine plate exposed for one minute in a well-ventilated cow-shed.

FIG. 3.—Gelatine plate exposed for one minute during milking under a dirty cow.

FIG. 4.—Gelatine plate exposed for one minute during milking under a clean cow.

FIG. 5.—Plate culture made from milk drawn into a dirty pail.

FIG. 6.—Plate culture made from the same quantity of milk drawn into a clean pail.

one in which fresh air is constantly supplied without causing a draught. The question of efficient ventilation and the construction of cow-houses generally is dealt with in Leaflet No. 241 (*The Construction of Cow Houses*). The walls, beams, and rafters should be regularly swept down and frequently lime-washed ; above all, cobwebs and dust should never be allowed to accumulate. The cow's bed must be kept clean at all times, and the manure and soiled bedding should be removed from the shed at least twice each day. Any manure adhering to the cow after she has been lying down should at once be removed. During the winter, when she passes most of her time in the shed, the cow should be brushed down each day *after* milking. Where this is done the bacterial contamination of the milk is sensibly decreased, *but cleaning and brushing should neither take place when milking is actually in progress nor immediately before.*

The hair on the udders and hind quarters of the cows might usefully be clipped in autumn when first taken into the stalls at night, or as they calve. Clipping the udders has been practised on one farm for thirty years, while the hind-quarters have also been clipped for several years, and the plan has been found a great aid to cleanliness. When a power clipper is used it is not so tedious a matter as may be supposed. In the case referred to about 200 cows are dealt with in this way.

The gangway and gutter behind the cows should always be kept clean, and it is important that they should be in their cleanest state at milking time. The material composing the floor of the gangway and gutter should be impervious to moisture, otherwise it may harbour organisms which, if carried into the milk, may be the cause of considerable trouble. Openings of drains from cowsheds should always be placed outside the building.

It is not desirable to confine the cows entirely in the sheds during the winter ; they should be given at least an hour in the open each day, for few things are equal as disinfectants to daylight and exercise.

Cows should on no account be allowed to consume hay or dusty fodder during the time milking is in progress, as both contain countless organisms.

Too much attention cannot be given to the drinking water. It is to be regretted that in many cases the cows have access only to a stagnant pond, into which they must wade before sufficient depth is attained to enable them to drink. When drinking, cows are apt to void excreta with results that may be imagined should such material fall into the water, as it too often does. Such a state of affairs should be remedied at once, and *ponds should be fenced in*, the water being drawn by a hand pump into a drinking trough outside the fence. Even if the droppings of cows are excluded from the drinking place, stagnant water is certain to be crowded with bacterial life, so that, apart from the risk to the cow's health, the chance of trouble with the milk is greatly increased by allowing the cows access to such a pond. There are many ways by which the bacterial life of a stagnant pond may gain access to milk, but probably the most common way is by means of the organisms carried out of the water on the exterior of the cow, and which at milking time may fall into the milk. The evil of this will be realised when it is remembered that among the bacterial life of any pond may be found, almost without exception, many organisms capable of bringing about injurious changes in milk, butter, or cheese. The ideal watering-place is a running stream of pure water so protected that cows cannot wade into it, or a trough through which such water passes. Where no such stream exists every endeavour should be made to approach the ideal as nearly as possible, and if it is necessary for the cattle to drink water that is more or less stagnant, matters should be so arranged that they can obtain what they require *without being able to stand in the water*.

It is best not to milk cows while they are dripping with rain water. This is probably a frequent source of bacterial contamination.

Dairy farmers, and especially those engaged in cheese-making, should be most careful not to allow poultry in and about the cow-sheds, or to have access to hay and straw used as food for the cattle. Droppings of poultry are a little-recognised but fruitful and frequent source of contamination. They teem with bacteria injurious to milk, and are often responsible for excessive fermentation or "sponginess" in cheese curd.

Cleanliness in Milking.

If the best is to be made of the milk after it has been drawn, it is necessary to observe the strictest cleanliness in connection with the operation.

In order to prevent contamination of the milk *everything should be at rest within the byre at milking time, that is to say, there should be no shaking of bedding or feeding of the cows.* The whole place should be clean and sweet, and quiet. Shortly before milking begins someone with a clean, rough, dry cloth should be sent to wipe each cow's udder. If any cow's udder is found to be soiled in such a manner that it cannot be cleaned in this way it should be washed. The practice of washing the udder was attended with no ill effects in the Yorkshire experiments.* After washing, the udder must be carefully dried, otherwise the cow might get cold in one or more quarters of the udder.

Each milker should thoroughly wash his or her hands and arms before commencing to milk, and particular care should be taken to see that the milker's clothes are clean and suitable for the purpose. This may be best assured by insisting that each one wears a smock or blouse which has not been too long absent from the wash-tub. All milkers and employés should be healthy and free from infectious disease.

As soon as the milk of each cow has been drawn, it should be taken outside the cow-shed and passed through a strainer, consisting of muslin resting on a fine wire gauze, and then removed to the dairy as quickly as possible. The use of thick heavy cloths for straining purposes is to be condemned, as they are liable to be very imperfectly cleansed. Numerous cases of "fishy" flavour and rapid souring in milk have been traced to the use of such cloths. Straining should take place before cooling, which should be done as soon as possible after milking, and invariably in a pure atmosphere. It is advisable to rinse the cooler with boiling water and then with pure cold water immediately before the milk is passed over it. The milk should be cooled to 50° F. It is a great mistake to allow milk to stand about in the cow-shed, as is often done, for this only serves to contaminate it further.

Milking with wet hands is an objectionable practice. The cows should be stripped of their milk thoroughly and quickly by dry-milking. Apart from the fact that no dirt is so difficult to remove from milk as that which enters in a liquid or semi-liquid form, the act of wet-milking leaves the teats covered with a film of milk on which germ-life immediately begins to multiply, and as that film of milk dries, the germs become more or less firmly attached to the teats, only to be removed and washed into the pail at the next milking. In dry-milking, it is sometimes an advantage if a little vaseline is rubbed on the milker's hands before beginning work.

Experiments* with two of the best modern milking machines showed that they were a source of great contamination, owing both to the difficulty in cleaning them and to the sucking in of air and dust when the cups fall off.

Importance of Cleanliness.

(1.) *In Dairy Utensils.*—Vessels used for the reception of milk should be absolutely unabsorbent, otherwise it is

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* *See* "Report on an Investigation as to the Contamination of Milk,' carried out on behalf of the County Boroughs of Bradford, Hull, Leeds Rotherham and Sheffield, and the Administrative Counties of the East and West Ridings of Yorkshire, 1908. Copies of this Report, price 2*s.* 6*d.*, can be obtained from the Clerk of the Council, County Hall, Beverley.

impossible to clean them thoroughly. If, for example, warm milk is put into a dry wooden vessel, the heat of the milk causes the air in the wood to expand, and so drives out a portion of it; and afterwards, as the milk and the vessel cool down, milk is sucked into the wood to replace the air previously expelled. When milk has once entered into wood it is a most difficult matter to remove all traces of it, the result being that the portion which almost invariably remains acts as a food for germ-life. To obviate this, wooden milk vessels, if used at all, should always be thoroughly saturated before being used to receive milk, by first placing them in hot, and afterwards in cold, water.

In the majority of dairy utensils tin is the surface with which the milk comes in contact. Such utensils are excellent, provided that all joints are properly made and that all parts are readily accessible for cleaning; all should be cleaned immediately after use, and on no account should milk be allowed to dry upon them. The cleansing may be best accomplished by first washing them in cold or slightly warm water, afterwards using hot water and a stiff brush, which is much better than a cloth. The utensils should finally be rinsed in boiling water. If steam is available, and the vessels can be put over a steam jet, so much the better. The hotter the final rinsing or steaming, the greater the likelihood of all forms of germ-life being killed. After cleansing, milk vessels should be left in an airy position with the mouth or opening turned downwards, but in such a manner that the air has unrestricted access. Parts which are not easily accessible should be washed with lime water occasionally.

(2.) *To the Milk Seller.*—To both wholesale and retail milk sellers all forms of germ-life are objectionable, for if they wish to retain their customers it is necessary to produce milk which not only meets the requirements of the standard of quality, but retains its freshness as long as possible. The dairy or shop should be pure and clean, and well ventilated, but protected from dust, &c., while water employed for any purpose should be quite pure. The keeping quality of milk is mainly determined by two factors: (1) the amount of germ-life contained in it; (2) the temperature at which it is kept. The latter factor is, in reality, only a part of the first, since the rapidity of the multiplication of germ-life is dependent on temperature. For this reason milk to be sold as fresh milk or milk which has to travel any distance, should invariably be run over a cooler in order to lower its temperature, and should be kept at a temperature not exceeding 50° F., ice being used if necessary.

In the retail trade all stale milk, or milk left unsold, should be kept quite apart from fresh or warm milk. All milk to be sold should be kept well stirred and the vessels kept covered. If the trade is in *warm fresh milk*, then especial care is necessary in its production and management.

During hot or dusty weather, floors and their surroundings should be sprinkled with clean cold water.

(3.) *In Butter and Cheese-making.*—It is not going too far to say that cleanliness is absolutely essential to the successful making of first-class butter and cheese. In butter-making pasteurization of milk is possible, but for the cheese-maker it is not practicable. For cheese-making, therefore, especial care is necessary in the production and handling of the milk. Unlike the milk seller, to whom all forms of bacterial life are objectionable, the maker of dairy produce has to depend on certain forms of germ-life to perform vital functions in the processes by which milk is transformed into butter or cheese. In cheese-making, milk may be compared to a field free from weeds, the cheese-maker sowing in the milk those cultures of the ferments or bacteria which he wishes to grow, and which produce the desired flavour. Butter-makers often nullify all anterior efforts to avoid contamination by washing butter in the churn with impure water, or by packing butter in bad paper or in unsuitable packages. Yet experience teaches that wherever uncleanliness exists there also will be found a large number of germs which, by their action, are almost certain to prevent the successful manufacture of dairy produce. Indeed, it not infrequently happens that, owing to the uncleanly management of the cows, uncleanly milking, or uncleanly utensils, the possibility of making the finest butter or cheese has been destroyed before the milk has even reached the dairy.

London, S.W.1,

July, 1905.

Revised, March, 1912.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 152.

BOARD OF AGRICULTURE AND FISHERIES.

Bacterial Disease of Tomatoes.

This Leaflet has been temporarily withdrawn.

BOARD OF AGRICULTURE AND FISHERIE

STORING OF TURNIPS AND MANGOLDS.

The main reason for storing roots is to protect them against damage by frost, though protection against ground game, rooks and wood pigeons, which may be very hard on roots exposed during winter, is also an important object in some districts. Not only should a good system of storage secure these ends, but it should also protect the roots against decaying and becoming too dry.

Storing of Turnips.

The more important methods of preserving turnips over winter are as follows :—

1.—In large heaps of a length and breadth depending on the quantity of roots to be stored, but not exceeding 5 ft. in depth. The sides are covered by some 12 in. of loose straw, overlaid by 4 in. of soil on the sides exposed to the prevailing winds, though 3 in. of soil will suffice on the other sides. The top of the heap is covered by 6 in. of straw kept in position by poles, branches, &c. Straw ropes are now practically unknown. Soil should not be spread on the top of the heap, as it gets washed through amongst the roots and dirties them. Nor is it required there as frost does not "strike" down.

2.—In oblong heaps, like large potato pits or clamps. The base should have a breadth of 7 ft., and on this the roots are piled, gradually contracting to the top like the roof of a house. The whole is afterwards covered by some 12 in. of (loose) straw, overlaid by 4 in. of soil on the side exposed to the prevailing wind. On the sheltered side the covering of soil need not exceed 2 in. in depth. Many farmers do not place a complete covering of soil on the sheltered side, but only a spadeful of soil on every square foot. The ridge of the heap is, in any case, left clear of soil, so that free ventilation is secured. This style of heap requires more covering in proportion to its contents than the last, but under no system ot storing are the roots better preserved.

3.—In small heaps, equally distributed over the field where the roots were grown. Each heap usually contains about 30 cwt., but in some districts, heaps containing only about half-a-ton of roots are formed, in which case, if the crop is a good one, no carting is necessary, the roots being simply thrown together by hand. The size of the heaps should be regulated by the size of the flock consuming them, the object being to provide a day's supply in each heap. Thus, with a flock of 200 sheep getting 20 lb. per head per day, about 35 cwt. would be required daily, and this would approximately represent the contents of each heap. The troughs would be moved each morning to a fresh heap, and thus the field would be evenly manured. Should the turnips in these heaps be required within a few weeks of storing, they are usually only covered by the tops, kept in position by a few spadefuls of soil, but for longer storage a covering of straw and soil is necessary. Turnips seldom go wrong in such heaps, which have the additional advantage of being quickly formed. They are specially useful for roots that are intended for consumption by sheep in spring on the land where the crop was grown.

4.—Laying two rows in one, and ploughing in, is an excellent method of storing roots on light dry land. Under this system the roots are not only well protected, but they are also placed under conditions that admit of their growing considerably if the winter is mild. The method of procedure is as follows:—The row is divided into four equal lengths, and a worker is assigned to each. An ordinary single mould-board plough opens a deep furrow close to the first row, throwing the soil outwards. The workers then proceed to lay the roots (with tops and tails attached) of the two adjoining rows into the furrow, and the plough on returning throws the earth back on the roots, leaving only the tops of the leaves exposed. Other two rows are then similarly dealt with, and so the work proceeds across the field. In spring, when required, the roots are lifted by ploughing up, dry weather being selected for the operation.

5.—If labour is scarce or work is pressing, considerable protection may be given to growing roots by merely running the double mould-board ridging plough between the rows. In this way the roots, if not very large, are fairly covered, though not so thoroughly as by the previous method.

6.—"Planting," as it is called, is practised locally in the North of England, and is regarded as the best way of preserving turnips for the use of lambing ewes. The turnips grow considerably when stored in this way, and in spring possess a well-developed top, which is considered excellent for the production of milk. A dry well-sheltered stubble field, or a grass field that it is intended to break up in spring, is selected, and in October or early in November the roots are carted to it and placed close together in a single layer in their natural position, without topping or tailing. No protection is given, except along the sides, against which a furrow is laid. The only drawback to the system is that it entails the use of a large area of ground, say 50 yards square more or less.

7.—A favourite system on the Borders, where turnips are wanted for ewes in spring, is to cart the roots, with tops and tails attached, to a grass or stubble field, on which they are laid what may be called "cart-thick," that is to say, about 2 ft. deep. By means of a strong rake or muck-hawk the roots are levelled out, care being taken to get the tops of the uppermost roots on to the surface. A furrow run round the clamp is sufficient protection. Roots stored in this way are found to be specially juicy and fresh in spring, and this system of storage has the additional advantage of being rapid and economical.

Points to be observed in Storing Turnips.—The following points should be generally observed in storing turnips :—

a.—A dry open situation should be selected on which to place the heaps. Although proximity to a wood or hedge may secure shelter from cold wind, roots often keep much worse under such circumstances than in an open exposed place.

b.—The roots should be dry and clean when carted. If topped and tailed, the operation should be conducted so as to injure the bulb as little as possible.

c.—The turnips should be well matured before storing. This is indicated by the lower leaves being yellow.

d.--It is a good plan, weather permitting, to leave the roots lying in the field, after topping and tailing, for three or four days before carting. This hardens the skin, and brings them into better condition for storing.

e.—Unless frost threatens, soil should not be put on the heaps for at least a week after the roots are carted. This permits of the circulation of air and escape of moisture.

f.—A word of warning must be uttered as to the danger of spreading finger-and-toe by means of stored turnips. Roots with any suspicion of the taint of this disease should not be consumed on tillage land, but should be carted on to permanent pasture. Further information on this subject is contained in Leaflet No. 77.

Storing of Mangolds.

Mangolds are easily damaged by frost, and consequently must be lifted and stored before other root crops. The end of October is the usual time for lifting, except in the South and West, where the process may be postponed till well into November. So long as the tops are still abundant they may afford sufficient protection against a few degrees of frost, but recurring hard frosts will do irreparable damage.

The crop is pulled by hand ; the rootlets are left untrimmed and the leaves usually twisted off. It is generally supposed that if the roots are trimmed, or the tops cut off close to the crown, "bleeding" will result and the roots will keep badly.

The practice in some parts of the country where it is customary to "top and tail" mangolds just like swedes suggests that the danger is not so great as is often supposed. When clamps are opened in spring it is common to find that roots which had been half eaten by hares or gnawed by horses have kept perfectly well.

Pitting or clamping in the field or at the homestead is the usual method of storage. Before clamping the roots may be allowed to lie in rows for a few days, or may be thrown into small heaps and covered with leaves. They should be loaded by hand (not a fork). Clamps are usually 6 to 8 ft. wide ; the roots are piled up in triangular form and covered with a layer of straw. A few days later soil from around the clamp is thrown on the straw to a depth of 5 or 6 inches to within about 2 ft. of the top, which is left clear for ventilation. After the lapse of two or three weeks, the apex of the clamp is also covered with soil.

As a rule the roots keep better if the clamp is made in an open exposed position than if it is put behind a large hedge or under the shelter of trees.

To obviate carting from the field in winter mangolds are sometimes stored at the homestead, either in clamps or in a pile 7 or 8 ft. high against a wall. This pile is covered with straw or bracken to a depth of 12 inches, and thatched so as to throw off rain.

Mangolds, properly stored, will keep safely until the following summer, and are generally reserved for use after turnips and swedes have been consumed. It is commonly believed that their use before spring is inadvisable, but the experience of many dairy farmers who rely entirely on mangolds for the whole of their autumn and winter root supply shows that if used with discretion there is little risk in early feeding. They can, if necessary, be used quite well immediately after harvesting, and where they have been damaged by frost before being pulled they should be used at once.

London, S.W.1,
August, 1905.
Revised, February, 1919.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

Foot Rot of Sheep.

There has been, and still remains, among flockmasters, shepherds and others a good deal of diversity of opinion as to whether foot-rot of sheep ever constitutes a contagious disease, *i.e.*, a disease communicable from a diseased sheep to a healthy sheep, or not.

This difference of opinion appears to be mainly due to the fact that almost any diseased condition affecting the feet of sheep, associated with lameness, is usually classed under the general and ambiguous term foot-rot, and in that way non-contagious affections of the feet of sheep, causing lameness, have supported the view of some observers that foot-rot of sheep is not a contagious disease.

Non-contagious Foot-sore.

It is important to recognise that in a flock of sheep several animals may be simultaneously lame from injury to the feet, and the disorder show no tendency to spread through the flock. Such a condition, however, is not true foot-rot although the injured feet may present ugly sores. It would be better described as foot-sore.

The non-contagious form, or foot-sore, which is due to injury to the foot, has its starting point usually in the horn itself. The horn may be decayed, broken, cut or bruised, and, through the opening in the horn, soil and filth gain an entrance and set up inflammation of the sensitive structures of the foot, from which pus is usually discharged.

Among the conditions which predispose to this form of foot-sore may be mentioned the continual grazing of sheep on low-lying marshy pastures where the grass is long, particularly during prolonged wet seasons and neglect of attention to trimming the horn, which under such adverse conditions becomes overgrown, gives an uneven treading surface, and is very liable to become soft and even decayed. Injuries may be inflicted by the animal stepping on sharp or rough objects, such as sharp stones, glass, nails, thorns, &c., and by over-trimming of the feet. They may also arise from travelling sheep for long distances on hard roads, or from anything which causes a breach in the horny foot, or bruises the sensitive foot, especially when the horn is worn or thin.

Symptoms.

The non-contagious foot-sore is the commoner condition met with, and it is not unusual to find one or more sheep in a flock affected. Although lameness may not be a marked symptom from the first, yet it is usually the first indication to the shepherd that there is anything the matter with the foot, and by this time in such cases, the lameness denotes that inflammation and suppuration have set in.

It will be observed, with perhaps rare exceptions, that in this non-contagious affection the disease has commenced at or near the under surface of the foot, and that the destructive process extends from below upwards. If pus forms and remains imprisoned within the horny box it will burrow and work its way towards the softer structures of the coronet as a way of exit, because the softer structures offer the least resistance to its progress. The foot becomes swollen round the coronet; it is hot and tender, and one or more small abscesses may appear on the coronet or heels. These abscesses burst, and discharge thick pus, which is frequently mixed with a little blood. The parts may continue to discharge pus, or they may heal up, but even when the outer wound is apparently healing and is closed by a layer of coagulated exudate on its surface, the pus may again be imprisoned, with the result that abscesses appear at other parts of the coronet. Providing there is an exit for the pus at the lower surface of the foot these secondary abscesses will not occur, since the pus, as it is formed, is continually discharged from the opening, which affords a natural drainage to the matter within the foot. If after the injury an outlet through the horn remains for the escape of pus, the case may recover in a few days without any treatment. On the other hand, if the breach in the foot is too small and does not allow the free escape of the pus, suppuration continues. Granulation tissue and new horny material are formed, and the former grows out from the sensitive parts in the form of what is commonly called proud flesh, from which a continual discharge oozes. The sore bleeds easily, and the foot becomes distorted.

Treatment.

By carefully trimming the foot, cleansing the wounds with antiseptics, applying a dressing if necessary, and removing the affected sheep to drier pastures, the flockmaster will enable many cases promptly to recover. In those cases where the injury has been aggravated by extensive suppuration the feet require careful and repeated individual attention. It will be found that although the non-contagious affection is the commoner, it usually affects only a comparatively few animals in a flock, unless they have all been subjected to like conditions. There is no evidence of the spread of contagion from sheep to sheep, and frequently only one foot is affected.

Contagious Foot-rot.

Contagious or true foot-rot of sheep is quite a different form of disease to the foot-sore already described. In this country, where the flocks enjoy freedom from such veritable plagues as foot-and-mouth disease and sheep-pox, true (contagious) foot-rot stands as one of the most serious diseases that exist among sheep generally, but it is a disease which is amenable to treatment, and can be prevented. If sheep-owners, therefore, appreciate the contagious nature of the disease and adopt effectual measures to prevent its introduction into a flock, or promptly combat it when introduced, they will be well repaid for their trouble.

Experiments have demonstrated the infective nature of the virus or poison of the disease by the application of the infected matter from diseased sheep to the feet of healthy sheep, and by the association of healthy sheep with diseased animals. The disease may affect sheep on dry or wet pastures if the infective agent be present.

It is admitted by those who are acquainted with the diseases affecting the feet of sheep that in some cases of foot-rot, especially in advanced cases, the diseased conditions may be so similar in appearance to foot-sore, that a differential diagnosis is very difficult; but by carefully considering all the circumstances, and by examining the fellow sheep, especially the more recent cases of disease, one will find that in foot-sore the trouble begins in the horn at the lower part of the foot.

Contagious foot-rot is primarily a disease affecting the soft structures of the foot. Any diseased condition of the horn itself is secondary, and is brought about by the separation of the soft from the horny structures through the agency of micro-organisms and the fluids exuded. The disease spreads from sheep to sheep, causing much lameness, loss of flesh, and even death from emaciation. If the disease appears in a flock of in-lamb ewes it is a still more serious matter, as proper treatment cannot be carried out without danger, owing to the pregnant condition of the ewes. In such instances the disease persists until the lambing season commences, and often spreads rapidly to the new-born lambs.

Apart from the adverse influence that wet seasons and damp low-lying pastures may have upon the horny structures of he feet, grit and dirt may work their way into the cleft of the foot and produce a wound. If the soil is contaminated with the virus that produces foot-rot, the disease will soon appear among the flock. It may, however, attack sheep with apparently firm horn and well trimmed feet.

Symptoms.

Lameness is usually the first symptom observed, and on examination of the affected foot a small, moist, unhealthy looking, spot-like sore will probably be found between the toes. The part is inflamed, hot and tender, and when it is manipulated the animal shows signs of pain. There is little or no appreciable swelling of the coronet at this stage. The disease rapidly extends under the horny box, and if a little pressure be brought to bear on the inside of the foot a slight dirty fœtid discharge will be observed oozing from the edge of the horn around the ulcerated spot. The discharge is never very great, but is always foul smelling; in fact the fœtid smell is often detected before any gross lesions have been discovered.

The disease progresses from above downwards, between the sensitive structures of the horn and the hoof. When the horn is pared away the diseased parts are found bathed in the fœtid discharge, and the greater portion of the foot may be involved. In some cases the disease extends from the primary seat of the disease to the more important tissues of the foot, injuring the ligaments, tendons, and even the bones.

In protracted or severe cases the foot may be greatly swollen, very tender, and hot. The upper part of the toe is widely separated and the points turn inward, giving the appearance of a club. The animal is in great pain when weight is placed on the affected limb. Abscesses form in the soft tissues of the foot and burst outwardly around the coronet, leaving angry discharging wounds. One foot is usually affected at the outset, but the disease frequently appears in two, three, or even all four feet. In the latter case the animals are unable to move about in search of food. They may be seen feeding on their knees, or lying down feeding on the grass around them. In cases associated with much pain, and where three or four feet are affected, the animals refuse to feed, rapidly lose flesh, and may develop diarrhœa. Such animals become extremely weak. They present a dejected and emaciated appearance, and may die. The various stages of the disease can be seen in one flock. Granulating tissue or proud flesh and new horn-like tissue may grow out from the wounded surfaces. In the early stages of the disease the hoof itself appears normal, but as the condition advances the horn becomes broken and decayed, and if the feet have not been attended to, the whole toe may be cast. During hot weather the condition is aggravated, and deaths are more numerous from the fact that the fœtid discharge attracts flies, and maggots subsequently develop in the wounds. An affected animal may become fly-blown on every part of the fleece which has come in contact with the discharges, and under such conditions it soon succumbs.

Prevention.

It has been said that a shepherd has no right to have foot-rot among his flock. Providing ordinary care is observed the disease should at least not get beyond control. Although the best plan to prevent the introduction of the disease is to avoid bringing suspected sheep on to clean pastures, it is not one which can always be carried out. Attention must especially be directed to fresh arrivals. In the first place it is necessary to examine any sheep which may fall lame, and any sheep which are not lame but are noticed to show wounds or sores around the hoof or over-grown horn.

1. Periodic inspection, examination and trimming of overgrown feet is a practice to be recommended, and upon the slightest indication of disease affecting the skin between the toes, the affected sheep should be isolated and treated, and the remainder put through a bath containing one of the preparations given below as cures for foot-rot.

2. In the case of sheep bought in a market, or taken to a market and brought back, or any fresh arrivals, they should whenever possible be isolated and the feet of each sheep examined. Isolation should be continued from three to four weeks, as disease might appear after an interval of two or three weeks, although the sheep appeared apparently free from disease at the time of arrival; or, as a precautionary measure after examination, the sheep should be put through one of the specially constructed shallow baths containing one of the preparations recommended below, on two or three occasions during the first week or ten days after arrival and before mixing with the other stock.

3. The shepherd should always wash and disinfect his hands after examination of the recently imported stock before attending to any of the old stock, and the same remarks apply after the examination of any individual suspected case.

4. It is advisable to afford contaminated pastures a rest from sheep until a winter's frost has intervened.

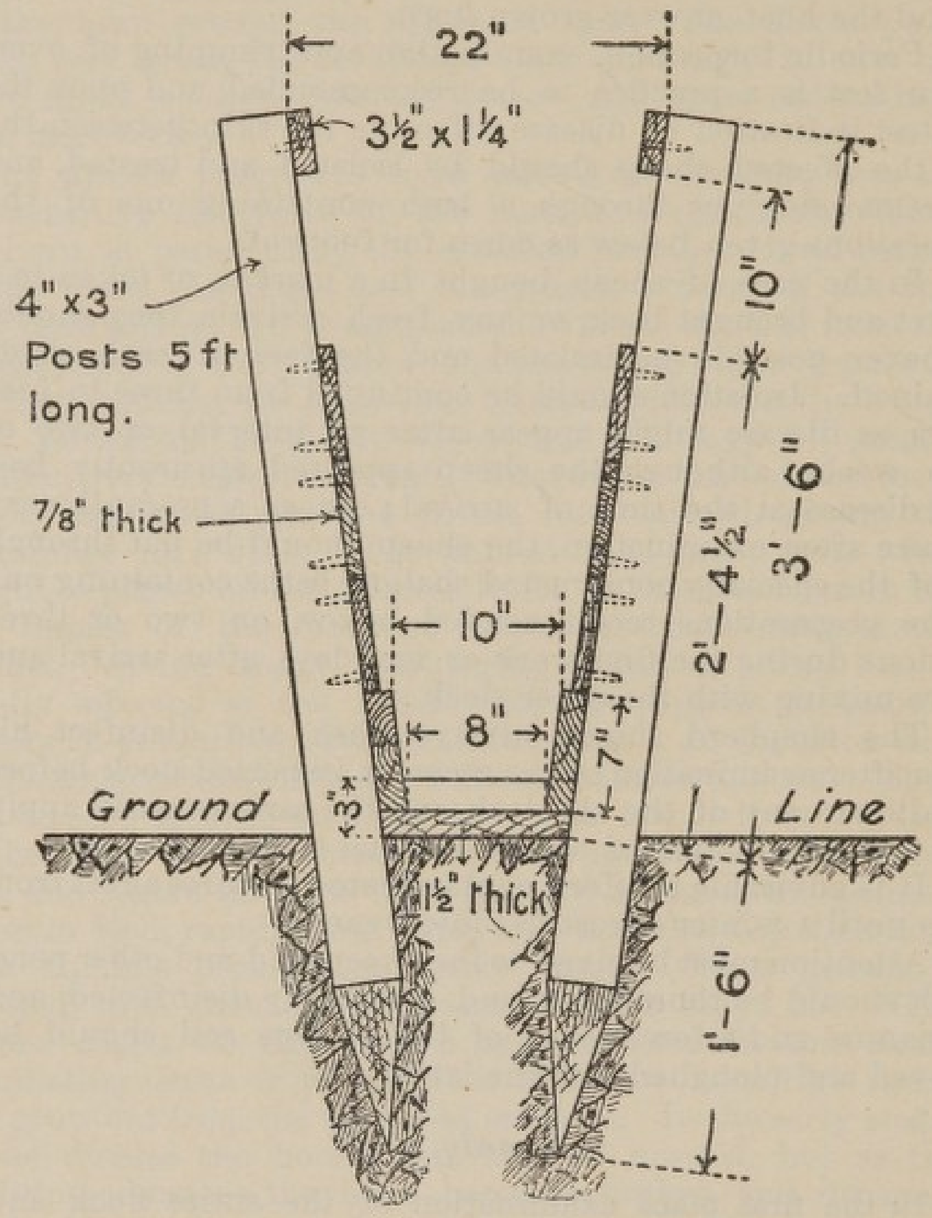
5. Attention must be given to the sheep fold and other pens, which should be thoroughly and effectually disinfected, and the manure and a few inches of the surface soil should be removed and ploughed into the land.

Remedy.

1. In the first place examination of the entire flock and separation of the healthy from the diseased animals should be carried out. The apparently healthy sheep should daily, or every second day, be put through a shallow bath or trough containing some suitable preparation, and the treatment may be advantageously continued for ten to fourteen days after the last case is detected.

2. It has been observed that a sheep may apparently recover from foot-rot without treatment, and the disease may break out again in the same sheep after an interval of several weeks. The second attack may be even worse than the first, but the animal may eventually recover without treatment, or it may die. Treatment, however, is necessary to avoid loss, and prompt measures will materially assist in arresting the spread of the disease to other members of the flock. The earlier the cases are recognised and treated, the more readily and certainly will they yield to treatment, and

aggravated and advanced cases—usually the result of neglect—should rarely occur. Everything possible should be done to prevent the disease extending into the deeper structures of



Foot-Rot Bath.—The bath, of which this is a vertical cross-section, may be made of wood or concrete, and should be about 16 ft. long. The width at the bottom should be 8 in., the sides about 7 in. high, sloping outwards, and if made of wood, boards about 1½ or 1¼ in. thick should be used. The ends should be 3 in. deep, or a little more than shown in the sketch, but deep enough to retain the solution while allowing the sheep to step over them easily. The bottom of the trough, if of wood, should have cross pieces nailed or screwed on at intervals of about a foot to prevent slipping. The floor of a concrete bath should be supplied with transverse grooves.

The sides above the trough should be nailed to posts 4 in. by 3 in. and 5 ft. long, driven firmly into the ground, 4 ft. apart. The run thus made should be wide enough to allow the sheep to walk freely through, and a width of 18 in. at 2 ft. from the ground will be found sufficient even for in-lamb ewes.

the foot, as these cannot be effectively treated without permanent damage to the foot. After thorough cleansing of the affected foot, all detached horn should be freely but carefully removed, so as to expose the affected sensitive surfaces. Skill and patience must be exercised in paring away the horn of the foot, and the operation should not be carried out in the somewhat rough and careless manner that is adopted by some shepherds. It is imperative to expose all the diseased tissue, and the more advanced and neglected the case the greater will be the labour required. The exposed diseased parts should be thoroughly cleansed with suitable remedies by washing, or by standing the patient in a bath for several minutes. All granulations or fungoid growths should be removed with the knife or snipped off with scissors.

3. It is important to remember that all removed particles of horn or other tissue should be destroyed, buried or disinfected, as such material may serve as a means of further spreading the disease.

4. Whenever the cutting has been deep or the exposed surface is extensive, a piece of clean tow, previously saturated in some antiseptic solution, should be applied, and kept in position by a properly adjusted bandage.

5. Advanced and severe cases, implicating deep structures of the foot, will require more constant attention and repeated treatment, such as cutting away as much of the diseased tissue as possible at each inspection, cleansing and disinfecting, and finally covering the parts with antiseptic powder and bandaging to keep out both soil and filth. In the case of in-lamb ewes every care should be taken in handling the ewes, and when individual treatment is deferred until after lambing, all the flock should in the meanwhile be put through the shallow bath (mentioned below) in the ordinary way at frequent intervals.

The Use of the Foot-bath.

It was noticed some years ago that the ordinary process of dipping sheep had a curative effect on foot-rot, and the good results were ascribed to the action of the poison on the cause of the disease. Arguing from this it appeared probable to the Board of Agriculture and Fisheries that beneficial results would follow the walking of affected sheep through a solution of poison just deep enough to cover the hoof. In practice this was found to be the case.

In order to test the effects of such treatment on a considerable scale the Board, early in 1904, distributed 30 baths (16 feet by 1 foot), each accompanied by 1 cwt. of copper sulphate (bluestone), amongst a corresponding number of sheep farmers in Great Britain. The instructions were to walk the sheep once a month or oftener through a 5 per cent. solution of the copper sulphate (1 lb. in 2 gallons of water), after having cleaned and dressed the hoofs in the case of a bad attack.

Reports from most of the recipients were received, and they were quite unanimous in ascribing much benefit to the use of the bath. It would appear, however, from the information to hand, that still better results (especially where it is a case of curing rather than preventing) will be got by using a 10 per cent. solution (1 lb. of copper sulphate to 1 gallon water), and, as stated above, the sheep should be put through the bath at frequent intervals.

Although the Board have only experimented with copper sulphate, they are aware that other substances are used, *e.g.*, 3 oz. arsenic, mixed with 3 oz. washing soda and boiled in 2 gallons of water; or 1 part of commercial sulphuric acid to 10 parts of water. Arsenical and other sheep-scab dips may also be used, but it is doubtful whether any substance is more effective than copper sulphate, which is comparatively safe and easy to use.

Summary of Directions for using the Foot-bath:—

a.—Bath of wood or concrete, 16 feet long and 8 inches wide (12 inches is unnecessarily wide), sides sloping out, ends 3 inches deep, provided with cross pieces or grooves to prevent slipping, side fences close boarded and to slope out so as to admit of the sheep walking easily through. (*See* Sketch, p. 6.)

b.—Solution to consist of 1 lb. copper sulphate in 1 gallon of water or, if prevention only is aimed at, half this strength will suffice. Time to be allowed for thorough solution.

c.—Copper sulphate to be bought under a guarantee of purity (98 per cent.), and if possible in the powdered state, not in large crystals.

d.—Sheep if badly affected to have their hoofs pared before being put through the bath.

e.—A day when the grass and soil are dry to be selected.

f.—Copper sulphate and most of the substances used being poisonous, a cover for the bath to prevent stock drinking the solution may be an advantage. In any case the bath must be well fenced in.

g.—If ewes with lambs at foot are treated, they should be put through very quietly so as to prevent the solution getting on to the teats, and thus into the mouths of the lambs.

h.—Sheep with long wool should also be put through very quietly, or otherwise the solution may, under certain circumstances, discolour the wool.

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BOARD OF AGRICULTURE AND FISHERIES.

Larch Canker (*Dasyscypha calycina*).*

This destructive parasite is present in greater or less quantity depending on local conditions, wherever the larch (*Larix europaea*) grows. In this country it also occurs on the Scots pine (*Pinus silvestris*), the silver fir (*Abies pectinata*), the Corsican pine (*Pinus Laricio*), the Swiss Stone pine (*P. cembra*), and the Japanese larch (*Larix leptolepis*).

The fungus is a wound-parasite ; in other words, it cannot gain an entrance into the tissues of a living tree except through a wound. The wounds ordinarily occurring in nature through which infection takes place, may be grouped under five headings :—(1) Wounds caused by wind, or by snow resting on the branches ; (2) cracks caused by late frosts ; (3) gnawing of the bark by rodents ; (4) numerous punctures made by the proboscides of the larch aphides (*Chermes laricis*), and possibly the nibbling of the bark by the fungus fairy fly, *Caecilius flavidus*† ; and (5) wounds made near the base of the stem in planting.

The general appearance of the fungus, and the injury and resin-flow following its attack, are clearly shown in the accompanying illustration.

As a broad rule, it may be stated, that when trees under ten years of age are attacked by canker, they are either killed outright, or are so deformed that if they continue to grow, they are of very little value for timber. The reason is that in the case of seedlings or very young trees, the main stem is the part usually attacked, whereas in older trees the bark of the trunk becomes so rigid that it is impervious to the punctures of aphides or to injury by late frosts ; and the only chance of infection is when branches are broken off, or more or less cracked at the point where they leave the trunk.

When a young tree is once attacked it very rarely recovers, as the mycelium spreads in the tissues and starts new wounds at some distance from the original point of infection.

Methods of Prevention.

(1.) As a safeguard against inoculation taking place through fissures in the bark caused by late spring frosts, it is

* A more detailed account of this disease, illustrated by one coloured and two other plates, appeared in the Board's *Journal* for September, 1902.
† See *Journal* of the Board of Agriculture, December, 1907, p. 551.

advisable not to form seed-beds nor plant larch in low-lying damp positions, where not only are the plants most exposed to frost, but the conditions favour the presence of the aphis.

(2.) Perhaps the larch aphis* can best be combated by spraying during winter, or when the larch is in resting condition and has not burst its buds. Paraffin emulsion should be used, and the object is to destroy the hibernating aphides. A paraffin emulsion used successfully in winter against hibernating generation on the spruce was composed of 3 lb. of soft-soap dissolved in 2 quarts of boiling water ; while this was still boiling hot, 1 pint of paraffin was added and the whole thoroughly churned. This was diluted with 5 gallons of soft water before use.

For use against the larch aphis in spring and summer a dilute paraffin emulsion would be effective.

(3.) The rank growth of grass and weeds round young trees greatly favours the development and spread of canker, by keeping the trees constantly moist.

(4.) Trees that are badly diseased should be removed and burned.

(5.) Great care should be taken not to injure the bark of young plants when lifted from the nursery, or in planting, as is often done when the turf or soil is pressed firmly round the stem by the heel of the planter.

(6.) A practice which has been generally recommended is to mix the larches with some dense-crowned species (spruce, silver fir, Douglas fir, or beech), the intention being to surround each individual larch with other species immune to the disease. Should the parasite appear on any particular tree, the chances of the spores spreading to other trees of the same species would be reduced to a minimum. Although such a system has undoubtedly proved an advantage to the larch, it has not in all cases sufficed to protect this tree against disease.

(7.) A system which promises to provide a satisfactory solution of the difficulty has for some years been practised by Mr. Munro Ferguson, of Novar, in his extensive woods in Ross-shire. Pure larch woods are planted, and when the trees are 16 to 20 years old all are removed except the soundest and most promising, of which 300 to 500 are left per acre. These trees are the picked stems of the 3,000 or 4,000 originally occupying the ground, and measure up to 51 ft. in height and 4 ins. to 8 ins. in diameter at breast-height. Stems that are sound, or fairly sound, at this stage are not likely to suffer much from disease in later life.

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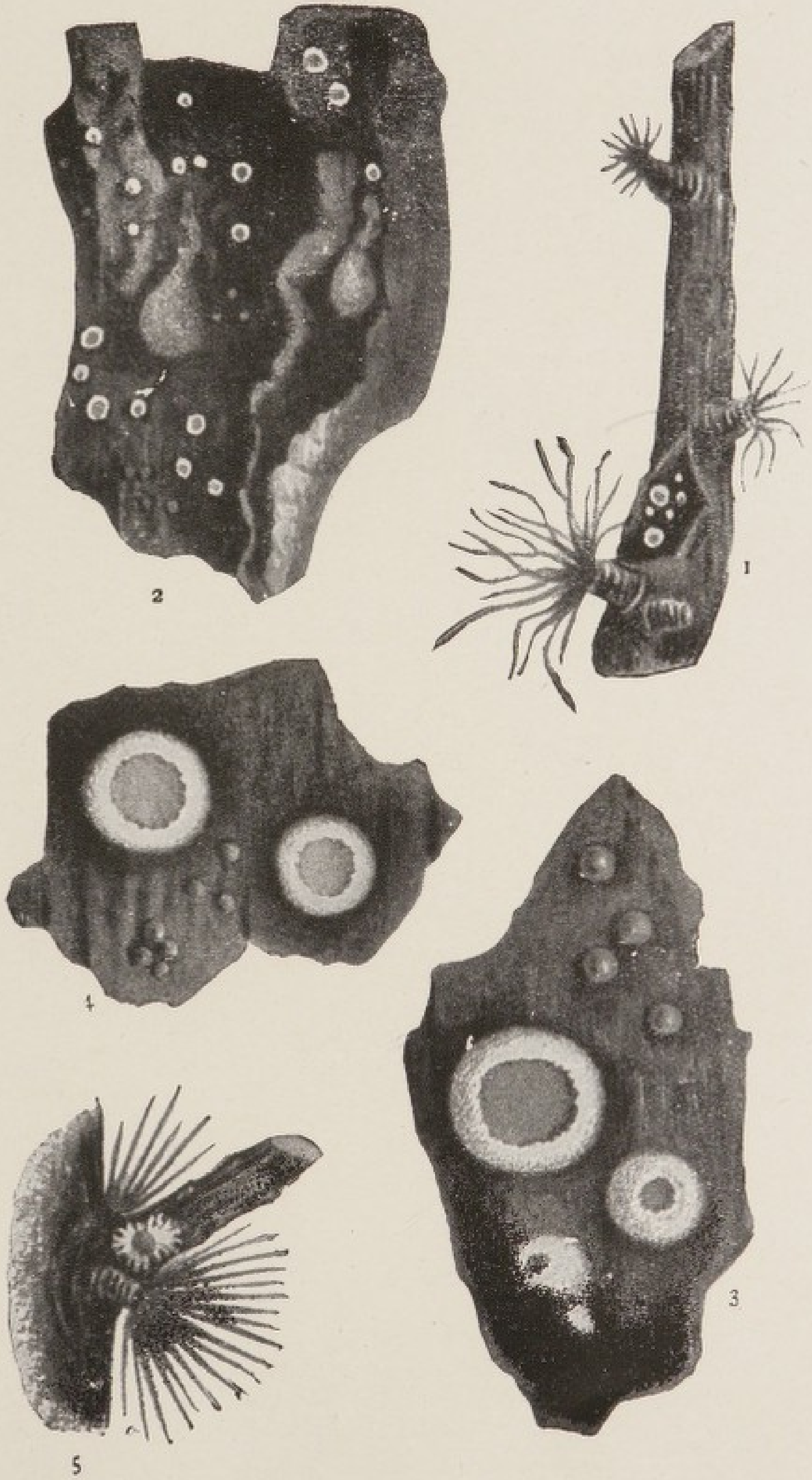
* The aphis on the larch is a stage in a life-cycle which begins on the spruce. This should be borne in mind in the treatment of aphis on the larch.



Larch and Spruce Canker.

The thinning in such a system is done as early as possible in autumn or winter, and this is followed by knocking off all the lower dead branches of the trees that are retained. The "top and lop" of the felled larches, together with the dead branches cleared off the standing stems, are collected into small heaps and burned. Without loss of time the area is then stocked with an underwood of a shade-bearing species,—e.g. *Thuja gigantea*, hemlock spruce, Sitka spruce, silver fir, Norway spruce, beech, &c. (This system is described at length in the *Journal of the Board of Agriculture* for March, 1906.)

Description of the Figures.

1. Portion of stem of a young larch, showing a small canker-wound with the fungus. Nat. size.
2. A small but characteristic canker, with the fruiting fungus present. Nat. size.
3. The two forms of fruit of the canker-fungus. Enlarged.
4. *Dasyscypha resinaria;* a fungus, forming canker on the spruce fir.
5. Portion of a larch branch showing the white flocculent tuft with a central drop of sap, which is constantly to be found near a "foundress" aphis with eggs. Spores of the canker-fungus often germinate in these drops of sap produced by the aphis, and start a canker spot.

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October, 1905.
Revised, March, 1908.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 156.

BOARD OF AGRICULTURE AND FISHERIES.

Hedgerow Timber.

Species.

At the present time the bulk of the hedgerow timber south of the Trent consists of English and Wych elm, oak, and ash. Of these the first-named is the most frequent species from Warwickshire southwards, except in certain districts which are characterised by stiff, sour clays, or by very poor or high-lying land, such as the Downs or Wolds. On clay land, or in districts which have only been cleared of natural woodland within comparatively recent times, the oak and ash are usually plentiful, while the Wych elm is abundant in Essex. These last three species also form practically the whole of the ordinary hedgerow timber in the Midlands and North of England, while sycamore also becomes more plentiful towards the North. Where other species occur, such as beech, black Italian poplar, &c., it may be taken for granted that they have been planted.

Advantages and Disadvantages.

Taking English hedgerow trees as a whole, there are three fairly distinct points of view from which they may be judged: 1st, their value as an ornamental feature of the landscape; 2nd, their importance in providing shade and shelter from hot sun, or from cold or strong winds, for men, live stock, or crops; and, 3rd, their value as a source of timber.

The ornamental features of hedgerow trees depend almost entirely upon the suitability of the soil and situation for the species grown. Shapely and well-developed trees, whatever the species may be, cannot fail to improve the landscape and render an otherwise bare or uninteresting country more or less picturesque.

The importance of hedgerow timber in providing shade and shelter is difficult to estimate with any degree of accuracy. There can be little doubt, however, that hedgerow trees act as wind-breaks and diminish the evaporation of moisture from the surface of contiguous fields. A district thickly studded with such trees, therefore, should be warmer in winter and less affected by summer drought than one practically treeless. To the dairy farmer and stock breeder, therefore, hedgerow trees should, in general, be more beneficial than harmful, though the fact is not to be overlooked that sheep suffer more from foot-rot on pastures that are much shaded. To the arable farmer, hedgerow trees are rarely of much benefit, except in the way of acting as general wind-breaks, for they cause the unequal ripening of crops by shading the ground, while their roots rob the soil in their neighbourhood and cause a reduced yield, and with fields of small acreage this may constitute a considerable loss.

Hedgerow timber in general is grown under two great disadvantages: 1st, height-growth and the formation of long straight boles are interfered with by prevailing winds, and by the absence of competition between individual trees; and, 2nd, the unrestricted development of side branches, tends to the production of coarse, knotty timber. These disadvantages are more or less common to all hedgerow trees, but they are very much greater with some species than with others. An ideal hedgerow tree may be said to be one which is little affected by the prevailing wind, retains its leading shoot until late in life when grown alone, and has no great tendency to develop large side branches near the ground. Such a species is not easy to find. Sycamore and ash stand wind well, and are not characterised by low side branches, but they are both apt to lose their leading shoot early in life and develop a short bole. Wych elm quickly loses its leading shoot, and forms a low spreading crown, and the same happens to the oak, except on a first-class oak soil, and there attention should be chiefly directed to this tree for hedgerow planting. Care should be taken to use only the sessile-flowered species, the branches of which are much less spreading than is the case with the pedunculate oak. The beech speedily kills any hedge plants over which it casts its shade, so that its use, in this connection, is practically excluded.

The English elm is probably the tree best suited for hedgerow planting over wide stretches in the Midlands and South of England. The value of the timber is not high, but taking into consideration its tall, straight, and well-shaped bole, its comparatively small crown, and the rapidity of its growth, one is certainly justified in regarding this tree as worth its standing room. An additional feature of value connected with the English elm consists in the fact that it propagates itself readily from suckers, so that a continuous succession of saplings is always coming on to take the place of felled or blown timber.

As regards soil, the same principle applies in a general way to this tree as to any other species, and poor soils are not likely to bring about satisfactory results, either in landscape effect or commercial timber. In the South of England, however, there are few soils which are not sufficiently deep and good to produce timber of fair size, though neither poor, hard gravels, nor stiff, wet clays are conducive to a rapid growth. Some of the best English elm timber is grown on the edge of the chalk districts, and in the valleys which intersect the Downs. In most districts, however, at low or moderate elevations, trees containing 300 cubic ft. of timber are frequently met with, though butts averaging 80 ft. or 100 ft. make as good a price as any. The black Italian and silver poplars possess a high-pitched crown, and are thus well adapted to grow in a hedge. The lime and Spanish chestnut, on the other hand, cast too much shade to be altogether suitable.

Establishment.

Though much of the existing hedgerow timber may be considered as having originated spontaneously, and in the case of English elm or other sucker-producing trees may require no special measures for its reproduction, the establishment of hedgerow trees on fresh ground, or in a new hedge, can only be accomplished by planting. This should be done, if possible, at the time the hedge is planted, as smaller and less expensive plants can then be used. But where it is desired to plant in an old, or established hedge, stout well-rooted trees from 6–8 ft. high should be planted about 20 to 30 ft. apart, setting them securely in the centre of the hedge by cutting a trench through the latter, and filling in with some good fresh soil. Such trees must be protected from cattle and horses for a few years, and this is more easily done when the hedge is allowed to grow untrimmed for a time, so that those animals are prevented from reaching the stems of the trees by the long shoots of the hedge.

To obtain a park-like effect, arranging the trees both singly and in groups of twos or threes is a good plan, and by thinning out later on, modifications of the original idea can be brought about if desired. It is also as well to plant fairly thickly at the outset, as it is unlikely that every tree will develop into a good specimen, even when the most careful pruning is carried out.

Management.

The subsequent management will chiefly consist in the selection or retention of suitable trees or saplings and the removal of low side branches or double leaders at an early age. In selecting the saplings at each cutting or laying of the hedge only those with straight stems and well-defined leading shoots should be considered, all others being taken out whenever the opportunity occurs. Trees with crooked stems or of stunted growth, as well as any inclined to be flat-topped early in life, should be removed as soon as they exhibit these features, or at the first periodic fall of timber which takes place, and only the best type of tree encouraged or allowed to grow to maturity. As soon as individual trees have reached a height of 30 ft. or so the pruning off of low side branches should begin, and be continued periodically until good boles are obtained, while all wide-spreading branches should be shortened back. How much of the stem may be denuded of branches will depend on species, age, and soil, but generally speaking the clear bole may be one-third to one-fourth of the height of the tree. The branches removed from the bole should be sawn or cut off neatly close to the main stem, and if more than 3 in. in diameter should be dressed with coal tar. If pruned early enough, the pole-saw or pruning chisel will usually do all that is necessary, and at little expense. Neglected until the branches are large, however, pruning becomes a costly operation and one tending to blemish the timber. Judicious pruning both improves the quality of the timber and allows sufficient light to reach the ground below to enable an ordinary hedge to be maintained in health and vigour. A good deal, however, depends on the soil and climate, a hedge being able to stand more shade where the soil and climate are good than under other circumstances.

The chief point about the treatment of hedges under trees is the method of cutting (*see also* Leaflet 147, *Fences and Hedges*). It will usually be found that when they are either allowed to grow rough for four or five years, and then cut hard back, or when cut and laid periodically, the hedges are maintained in better health and are more capable of resisting stock than when cut or trimmed annually. Annual cutting also prevents tillers and suckers from getting away, as they cannot readily be distinguished from hedge shoots, and are usually cut off. But cut as suggested above, both hedge and suckers have an equal chance, and one is not favoured at the expense of the other. Cutting the timber before it attains too great a size or age also aids in preserving the vigour of a hedge. From 80—120 years is quite old enough for elm timber when grown at a normal rate, and at that age it has not overshadowed a hedge long enough to affect its constitutional vitality, provided it has been treated on rational lines.

A word of caution must be uttered with regard to driving nails into or fixing wire to trees. It is a slovenly and objectionable practice, and greatly diminishes the value of the timber.

London, S.W.1,
November, 1905.

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Leaflet No. 157.

BOARD OF AGRICULTURE AND FISHERIES.

The Sale of Newly-Hatched Chickens.

The sale of newly-hatched chickens, or, as they are frequently termed, "day-old" chickens, is a branch of the poultry industry which is now of considerable importance. Twenty years ago it was almost unknown in this country, but the introduction of incubators and brooders has made it possible to meet the growing demand for chickens. Large and profitable businesses have been built up and in some cases many thousands of chickens are sold annually. The first consideration is the number of incubators required, as these involve considerable expenditure.

Obtaining the Eggs.

A regular supply of fertile eggs will be necessary from January to June in order to keep the incubators filled, which requires a flock of fowls or an organisation for securing reliable supplies. For a plant with a capacity equal to the production of, say, 1,000 chickens per week from February to June, or twenty weeks in all, at least 30,000 eggs will be required. Assuming an average of sixty eggs produced by each hen during that time, 600 head of stock would be needed to meet the demand. The prime necessity is for the breeding stock to be vigorous and hardy and they should be kept, therefore, on a free, open range. Eggs from hens highly bred, highly fed, or kept in confinement are found not to hatch so well artificially as those produced from breeding stock treated in a more natural manner, while the chickens produced from such eggs are less vigorous and do not travel well. A free range for the stock may, indeed, be regarded as essential.

Pure or Cross-Bred Birds.

For the attainment of success it is necessary to be able to supply chickens of the breeds required by purchasers, and the demand varies in different districts. Eggs from cross-bred birds frequently hatch out a larger percentage, and the chickens are hardier and travel better than some of the pure-breds, but the prices obtained for crosses are never so high as those for pure-bred chickens, while the cost of incubation and packing in each case is the same. For these reasons the trade is chiefly in definite breeds. Where operations are upon a smaller scale one breed only need be kept, provided an adequate demand can be secured. But in large establishments several breeds must be maintained, and these of the classes most saleable. Chicks of the heavier breeds are believed to stand travelling better than those of the lighter varieties.

Cost of Hatching and Prices obtained.

Experiments conducted upon the Reading College Poultry Farm, Theale, during 1904 and 1905, showed that, assuming the cost per egg to be one penny, and allowing for 30 per cent. of fertile eggs not hatching, but without charging anything for interest upon capital or for labour, the actual expense of producing a chicken was approximately 1¾*d.* Calculating interest and labour at the same figure, though this would be increased or decreased according to the extent of the operations, the prime cost may be reckoned at 3*s.* 6*d.* per dozen chickens at the time of hatching. To that must be added the expense of a suitable box for packing the birds and of conveyance to the nearest station, so that the actual cost may be stated as 4*s.* per dozen.

Prices vary considerably in accordance with the time of year and the class of fowls. Chickens, for instance, which are intended to be used as breeding stock command higher rates than those intended for killing or for farmyard purposes. But there is at present very little demand except for birds which are intended to be raised as breeding or laying stock. The popular varieties are largely in demand. Up to the present amateurs and smaller poultry-keepers have been the principal buyers.

The trade in selling day-old chicks to farmers is as yet in its infancy, as they have not fully realised the advantages of obtaining fresh stock in this way.

When to Despatch.

The best age at which to despatch the chickens is when they are twenty-four hours old, or as soon as they have dried off and overcome the strain of hatching. If sent away too early they would feel the change and be liable to take a chill, which would be fatal. When chicks are hatched either by the hen or by the machine, it is generally better to leave them in the place of hatching for twenty-four to thirty hours before removal to coop or brooder, and the same is largely true when they are to be sent away. But their despatch must not be too long delayed, for when once they begin to eat, the supply of food must be regular. Chicks one day old travel better than older ones. Every additional day renders them more liable to feel the effects of transportation. When sent off at the right age, in suitable boxes, they will travel long distances by land or sea quite safely, even when the journey occupies as much as thirty-six hours.

Packing and Despatching.

The packages largely used are light wooden boxes, with several ventilating holes near the top of the sides and in the lid, and fitted with a handle made of thick cord, or tied round with thick string. Another useful form of box is made of cardboard with double sides to conserve the warmth and to provide ventilation without danger of chills. For a dozen chickens a box about 14 in. by 9 in. and 9 in. high is large enough; for two dozen, 15 in. square. The floor should be thickly covered with cut chaff, among which may be scattered some coarse oatmeal, *dari*, and canary seed, and the sides, more especially the corners, lined with soft hay. The lid is better if lined either with cotton wool or with coarse flannel tacked at the edges, but loose enough to hang down in the centre. The box should be well made, and tied down, not nailed. There is much greater risk during very severe weather, more especially in cross-country journeys, when there is danger of exposure at open stations, and care should be taken to despatch the chicks by fast trains making good connections, and if possible at night. The sale of these birds takes place generally in the milder spring months, when the risk is not so great as it would be earlier in the season. Boxes should be prominently marked "Live chickens—this side up."

Treatment at Destination.

Not the least important point is the treatment of the chickens on arrival at their destination. It is to the vendor's interest to satisfy his customers by sending them hardy birds, but he has no means of controlling them when once they have left his charge, and the responsibility rests with the purchaser. There is nothing better than placing the chickens for an hour or two in a brooder heated to as near 100 degs. F. as possible, and in the absence of such an appliance, excellent results have been obtained by putting them, in a flannel-lined basket, into an oven (leaving the door open) at a temperature not higher than that named; or it will be enough if the basket is placed near the kitchen fire. They should then be given a good feed of warm steeped oatmeal or biscuit meal, and have a little warm milk to drink. If broody hens are available, the best results will be obtained by rearing the chickens under them, if they have travelled a considerable distance. One or two only should be given to a hen at first and if she takes kindly to these the remainder may be slipped under her wings. Where rearers are to be employed (and small, inexpensive appliances are now sold), these must be well warmed up, say to 100 degrees F., and the chicks placed therein. The temperature should be reduced to 95 degrees or even 90 degrees in a couple of hours. Around or in these brooders, according to the class, cut chaff should be littered, and among it scattered what is known as dry feed.* In an hour or two the chicks will begin to scratch and seek for food.

Turkey Chicks.

The same system may be adopted for the sale of day-old Turkey chicks, a branch of poultry-keeping which is capable of great development, especially by farmers. Turkeys do not respond to artificial hatching and rearing, and they should be sent in a good roomy hamper, in which a nest is made, with the hen that hatched them. The mother should have a good feed before starting on the journey.

* *See* Leaflet No. 114 (*Feeding of Poultry*).

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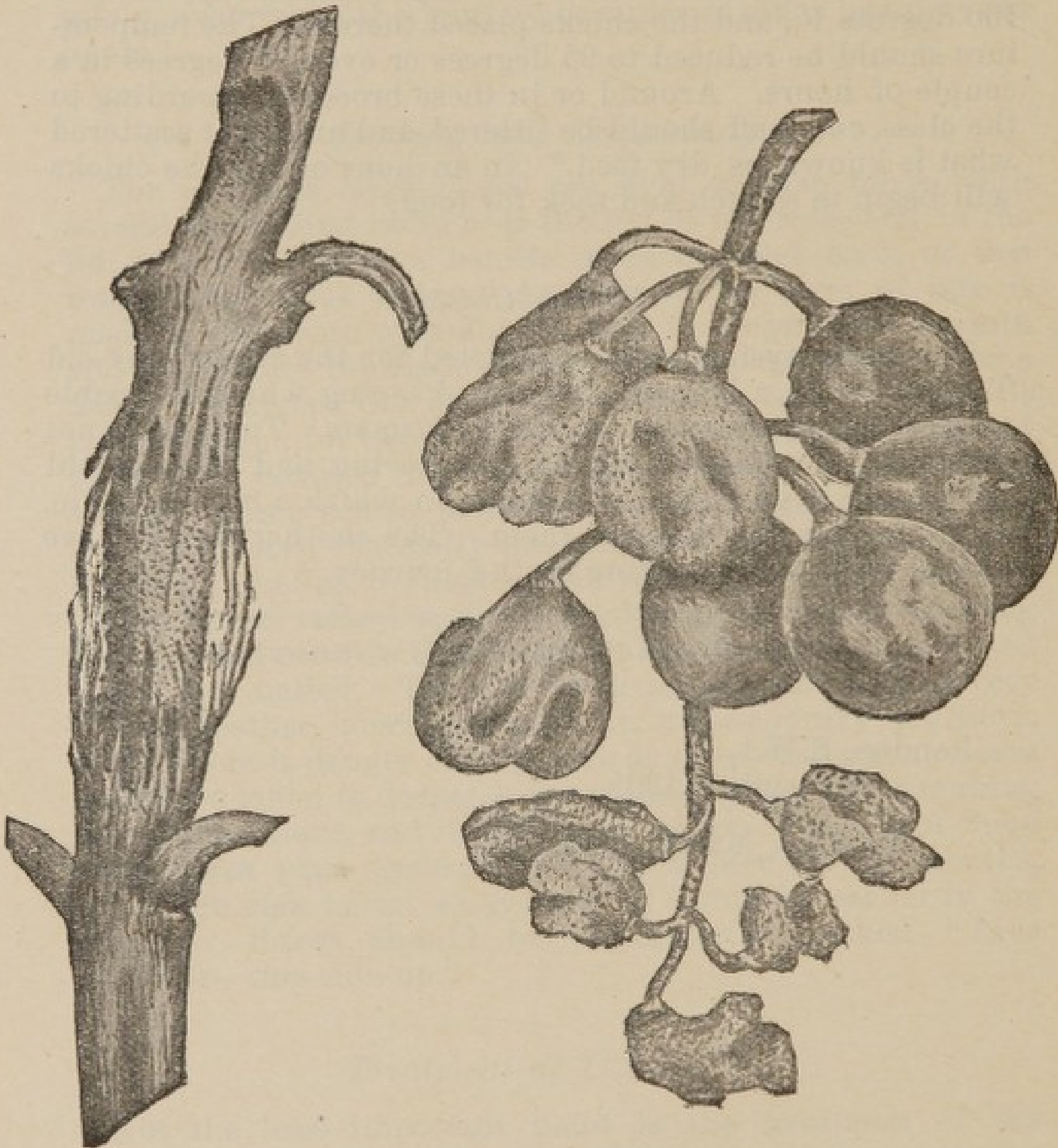
Leaflet No. 158.

BOARD OF AGRICULTURE AND FISHERIES.

White Rot of the Vine
(*Coniothyrium diplodiella* Sacc.).



Grapes and Branch attacked by "White Rot."

This disease is due to the presence of a minute parasitic fungus. On the Continent and in the United States it attacks vines growing in the open air, and during recent years has frequently been met with on vines growing under glass in this country.

Parts of the Vine attacked.

The fruit is the part most frequently attacked. and in severe cases the fungus spreads from the stalk of the bunch of fruit to the branch from which it springs. The foliage is never attacked. When once established, the disease spreads rapidly, and usually every grape on a bunch becomes diseased, owing to the numerous minute spores of the fungus being conveyed by rain, syringing, &c., from diseased to healthy berries.

Appearance of Infested Parts.

During the first stage of disease the berries become pale brown in colour, and soon commence to shrivel, but do not fall. At a later stage, when the shrivelled berries have become dry, the skin assumes a dull, silvery appearance, and is covered with minute white pimples forming the fruit of the fungus.

When the stalk of a diseased bunch is attacked, the fungus often extends to the supporting branch, where it forms slightly depressed areas, which are at first brownish in colour, but eventually become studded with the characteristic whitish pustules of the fungous fruit. The diseased patches may extend for several inches down one side, or the branch may be completely girdled by an irregular zone of diseased tissue, and, if this is the case, that portion of the branch above the injured zone soon dies. In vineyards the disease is most injurious during seasons of great humidity accompanied by warmth. Under such conditions one-quarter to one-third of the crop may be destroyed within the space of a few hours.

Remedies.

1.—The best remedy is to remove and burn all diseased bunches of fruit, and spray every part thoroughly once every five days with a rose-red solution of permanganate of potash. If the disease is of recent origin and confined to the bunches of fruit, the above treatment will suffice.

2.—If the disease has spread to the branches, its presence will be indicated by the slightly depressed, pale-coloured patches on the bark already mentioned. All such diseased branches should be cut out, as spraying will not check the disease on permanent parts of the vine, where the mycelium of the fungus spreads rapidly in the tissues.

3.—Where the disease has existed, every part of the vines, and the soil, walls, glass, &c., should be thoroughly drenched with a solution consisting of one pound of sulphate of copper dissolved in twenty-five gallons of water. This dressing should be applied during the winter before the leaf-buds begin to swell, otherwise the foliage will be destroyed.

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Leaflet No. 159.

BOARD OF AGRICULTURE AND FISHERIES.

Blindness in Barley and Oats.

Since 1897 attention has been drawn in Great Britain to a disease of the barley crop known as "blindness" or barley "stripe."

Plants attacked.

Fifty years ago, Rabenhorst, a German botanist, issued specimens of a minute fungus under the name of *Helminthosporium gramineum*, parasitic on the leaves of cultivated barley in Germany. It was noted that plants attacked by the fungus died during the flowering period.

The fungus has subsequently been recorded from other European countries as a parasite on barley, and has in many cases caused serious losses. It does not, however, appear in any instance to have assumed the proportions of an extended epidemic, but has been local and sporadic in its occurrence. During recent years the disease has become common in this country, and in some districts it is now difficult to find a barley field free from it. It is not unusual to find some twenty per cent. of the plants killed by the attacks of this fungus.

The fungus has also been observed on the leaves of wild barley (*Hordeum murinum*) in the neighbourhood of Kew.

Ravn, a Danish botanist, has recently studied the disease, and has shown that oats are subject to a similar disease, caused by a fungus very closely allied to the *Helminthosporium* of barley.

Appearance of attacked Crop.

The symptoms are characteristic and not likely to be confused with those of other disease to which the barley crop is liable. The foliage of the diseased plant, even in the seedling stage, is marked with olive-brown or purple-brown stripes and flecks. The infected plant may wither and die at this stage, but more often it appears that death does not take place until the flowering stage is reached. Then, just as the ears are pushing through the sheaths, the plant turns brown and dies off completely. Unaffected plants quickly grow above those which have become infected and consequently the presence of the disease is not readily detected unless a special search is made for it. Whilst the crop is being thrashed the blind ears of diseased plants are conspicuous amongst the straw, and often give the first indication of the losses the parasite has caused.

Methods of Prevention.

1.—The fungus is not difficult to deal with in practice. The evidence points to the fact that the death of the plant is due to infection at a very early stage of its development with spores of the fungus lurking on the grain coats. The application of any method which will destroy such spores should naturally result in a disease-free crop. Working on this assumption numbers of preventive measures have been tried, and among these may be mentioned steeping the grain before sowing either (1) in a solution of copper sulphate, or (2) in dilute formalin, or (3) in water at a temperature of 132 deg. F.

2.—Each of the foregoing methods has proved more or less satisfactory, but the best results have been secured by the use of dilute formalin. The most effective method of employing this is to make up a solution of one part of formalin in 160 of water (1 pint of the formalin in 20 gallons of water). The grain should be placed in a sack or wicker basket and steeped in the formalin solution for about five minutes, care being taken to moisten it thoroughly by lifting the sack or basket from time to time and twisting it about in the solution. Further quantities of grain may be treated with the same solution. In place of steeping in a basket a heap of grain may be sprinkled with the dilute formalin and turned repeatedly to distribute the solution thoroughly.

The cost per bushel of seed grain treated is very small, formalin costing 1*s*. 6*d*. to 2*s*. per pint, this amount, in 20 gallons of water, being sufficient for steeping about 30 bushels of seed. As the method also destroys the spores of barley smut it can be relied upon to pay for itself. In a series of experiments recently carried out the application of formalin resulted in an increase of over twenty per cent. in the crop.

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Leaflet No. 160.

BOARD OF AGRICULTURE AND FISHERIES.

The Cultivation of Lucerne (*Medicago sativa*).

Lucerne or Alfalfa, as a forage crop, was known to the ancient Greeks, Romans and Persians, and at the present day it is extensively grown in many parts of Europe and Asia as well as in the United States of America, in Canada, Australasia, and in Argentina. In all of these countries it is regarded as one of the most productive and most nutritive of crops for the provision either of green forage or of hay. In Great Britain its cultivation is confined chiefly to the South Eastern Counties, notably Essex, Kent and Suffolk. Smaller areas, however, occur throughout practically the whole of England; and it may be found in Scotland in isolated patches as far north as Caithness. The area under Lucerne in this country is insignificant in comparison with the value of the crop, and it is possible that, were its successful cultivation more generally understood, it would be much more widely grown.

Character of the Plant.—Lucerne is a perennial with a very extensive and deep root system. Where the subsoil is sufficiently open the roots will descend many feet, and thus draw upon water and food material which are beyond the reach of most farm plants. It is therefore particularly adapted to hot, dry climates, where the more shallow-rooted plants would fail to establish themselves. From the thick root-stock arises a number of erect stems reaching a height of from one to two feet, and furnished with an abundance of alternate leaves having three leaflets; flowers, generally purple in colour, and of the type of the vetch family, are produced in the angle between the stem and leaf stalk. Lucerne does not reach its full development in this country till about the third season.

Its Value to the Farmer.—It has two distinct uses on the farm. It may be included as a constituent of a "seeds" mixture for both temporary and permanent pasture and for hay, or it may be grown alone as a forage crop, fed green or made into hay or silage.

It is a highly nutritious food, being specially rich in protein, and is, therefore, a useful means of economising oilcake and supplementing roots in the winter feeding of cattle. It is readily eaten by all classes of stock, and is specially suitable for feeding to horses and milking cows. It is admirably adapted for supplementing bare pastures in dry seasons and may be fed as a perfectly good substitute for the mixture of vetches and oats so much in favour with dairy farmers in late summer and autumn. It also forms excellent forage for pigs, and might be grown more frequently in orchards or fruit plantations in strips between the rows of trees. It could either be fed off with pigs or ploughed in as green manure. Under favourable conditions it produces an enormous yield of fodder, furnishing annually from two to four cuttings, aggregating up to 20 tons or more, of green forage per acre. When grown for hay, from two to four tons per acre represents a good crop. Its permanent character and its deep rooting habit are also greatly in its favour. Under suitable conditions a "stand" may last from five to ten years in this country, and when it has to be ploughed up the soil will have become enriched with a large amount of highly nitrogenous root residue.

Soil and Climate.—Lucerne undoubtedly thrives best in dry and warm climates and where the soil is well drained, not too heavy in texture and well supplied with lime. Good crops have, however, been grown on almost all soils, from heavy clay to light gravel, and in districts with a rainfall well over 30 inches. Good drainage, plenty of lime and a thoroughly clean seed-bed, however, are essential. On heavy soils mole-drainage may often be the means of securing a satisfactory plant.

Soil Inoculation.—Like other leguminous plants, such as clover, vetches, &c., the growth of Lucerne depends normally on the presence in the soil of certain organisms which help it to collect nitrogen from the air.

These organisms do their work in nodules or growths which form on the roots of the plant, and, if they are not already present in the ground, they may be supplied by distributing broadcast and harrowing in a small quantity of soil obtained from some district where Lucerne is known to flourish. Sometimes what is known as a culture, in other words an artificial growth, of these organisms or bacteria, is applied to the land, but the former method is generally more satisfactory.

If the crop fails it may possibly be due to the absence of these organisms ; but it is more likely to be due to want of lime or to deficient drainage ; in the latter case there will be a lack of air in the soil to supply the nitrogen. Hence the necessity of well-drained and well-aired soil.

Inoculation, however, is not often necessary. Even in exceptional circumstances Lucerne, when once started, seems to possess the power of multiplying these organisms, especially if helped during the first year or two by a light dressing of soluble nitrogenous manure, either in the form of artificials or of liquid farmyard manure.

Preparing the Seed-bed.—One of the chief difficulties in connection with the growing of Lucerne in a comparatively moist climate like that of the British Isles is the tendency of grassy weeds to spread over the ground and smother out the plant. It is particularly necessary, therefore, that the soil be thoroughly cleaned before sowing and be cultivated in such a way as to induce rapid growth. A broad-bladed implement, such as the thistle plough, should be run through the soil so as to cut all tap-rooted plants before the final preparation for sowing. It is generally advisable to take Lucerne after a fallow crop, such as potatoes, or roots, that has been well manured and kept thoroughly free from weeds, or after a summer fallow or a crop of early potatoes.

Seed and Method of Sowing.—There are no well-marked differences of form or type between the varieties of Lucerne grown, but their relative productivity in this country varies to some extent according to the environment to which they have been accustomed. The best European seed is produced in Provence (France) ; seed is also imported from Turkestan, America and the Argentine. Great care should be taken to obtain good sound seed, free from dodder. The seed may be sown either alone or with a corn crop. The former method is generally to be preferred, and is invariably adopted with late summer sowings, but when a nurse crop is considered desirable or when Lucerne is intended to form part of a grass mixture, the cover crop should be an open-growing one such as barley or wheat. The most usual time for sowing is between the middle of April and the end of May, but when Lucerne is taken after a summer fallow or a crop of early potatoes it is sown in July or August.

When the crop is grown alone, from 20 to 30 lb. of seed are sown per acre, the quantity being least when the land is clean and in fine tilth. About 5 lb. less seed are required when drilled than when sown broadcast ; drills are placed from 8 to 10 inches apart. If the land is thoroughly clean, the seed may be sown broadcast ; by this means the surface of the ground is more quickly covered by the crop and weeds are effectively excluded. As a rule, however, the best results are obtained by drilling, if the spaces between the rows are kept free from weeds.

Under the best conditions, however, Lucerne alone does not form a close bottom, and it is a common practice to sow along with the Lucerne a few lb. of grasses and clovers to keep down weeds and increase the returns of the first year

The following are typical examples of such additional seedings :—

(1) 2 lb. Italian Rye-grass ;
2 ,, Red Clover.
(2) 4 lb. Italian Rye-grass ;
1 ,, White Clover.
(3) 5 lb. Cocksfoot or Timothy ;
7 ,, Meadow Fescue.
(4) 4 lb. Trefoil.

About 2 lb. Lucerne seed per acre may be included in the ordinary mixtures of grasses and clovers for pasturage.

Manuring.—The application of suitable manures in addition to increasing the yield tends to prolong the life of the plant. No hard or fast rules, however, can be laid down as to the best manures to use, for with Lucerne, more so than with most other plants, much depends on the character of the soil and climate. Generally speaking, however, phosphatic and potassic manures are most required. On clay soils about 2 or 3 cwt. of superphosphate per acre may be a sufficient annual dressing or 5 cwt. basic slag in alternate years. On light soils potash in addition to superphosphate—say ¾ cwt. sulphate or muriate of potash, when available, or blast furnace flue dust—may prove profitable, and where Lucerne has not been grown previously, and there is reason to believe that the requisite nitrogen-collecting organism is not sufficiently active, a nitrogenous manure—say ¾ cwt. nitrate of soda—might also be useful. Farmyard manure is not to be recommended generally for direct application to the crop, but it may be used fairly liberally on the preceding fallow crop. On soils not naturally rich in lime 10–20 cwt. ground lime should be applied before sowing, or 2–3 tons per acre of shell lime may be used for a preparatory crop. (See the Board's Leaflet No. 170, *Use of Lime in Agriculture* and F.P. Leaflet No. 23, *Blast Furnace Flue Dust*.)

Cultural Treatment.—It is particularly important that the plant should be kept free from weeds by horse and hand hoeing and by harrowing until it becomes thoroughly established. Thereafter, it is a good plan to stir well between the rows in the autumn. The moved soil affords some protection to the plant in winter. In some districts it is customary to run a plough, with the breast removed, between the rows in November, stirring up the soil to a depth of about 2 inches and throwing it on top of the crowns of the plants. In the early spring the plant is harrowed across and the soil distributed.

Cutting and Using the Crop.—If the seed is sown in spring without a nurse crop the plant may be forward enough to mow for hay in the year of sowing ; when sown with a nurse crop the plant should be left after harvest to make as strong a growth as possible for standing throughout the winter. In subsequent years, when made into hay, Lucerne is frequently cut twice. Cutting should take place directly the small buds are forming at the base of the stem and before the flowers open, as, when left till later, the plant loses vigour and becomes fibrous and more difficult of digestion. Early cutting induces a better aftermath and a more leafy crop. In making Lucerne hay all operations should be directed towards the preservation of the leaves, which are very liable to break off if dried too quickly. No more should be cut in one day than can be conveniently dealt with in a short time. The crop must not be left to become scorched while in the swath; but after partial drying it should be gradually cured in cocks. When a good wisp twisted in the hand does not yield any juice the Lucerne is ready to go into the stack.

When used as green fodder it should be cut fairly young and before the flowering stage is reached. It should be fed sparingly at first, and not in a wet condition, otherwise it is apt to cause "hoven" in cattle and sheep. It should never be grazed closely, nor too late in the year, as this lessens its power of resistance to winter frosts.

For directions as to the making of Lucerne into silage the Board's Leaflet No. 9 (*Ensilage*) should be consulted.

Subsequent Cropping.—After from five to seven years, when the plant begins to fail and to give place to weeds, the Lucerne should be broken up and the land prepared for a crop of another kind. As a rule only one cut is taken from the crop in its last year, and as soon as this is removed the ground is broken up and summer-fallowed in preparation for autumn-sown corn. The soil will have become greatly enriched by the growth of Lucerne, and will be capable of producing several corn crops in succession without the aid of manures. Where summer fallowing is impossible it will, as a rule, be best to follow with potatoes or oats.

It would be advisable in districts where Lucerne has not previously been tried to grow it on an experimental scale at first.

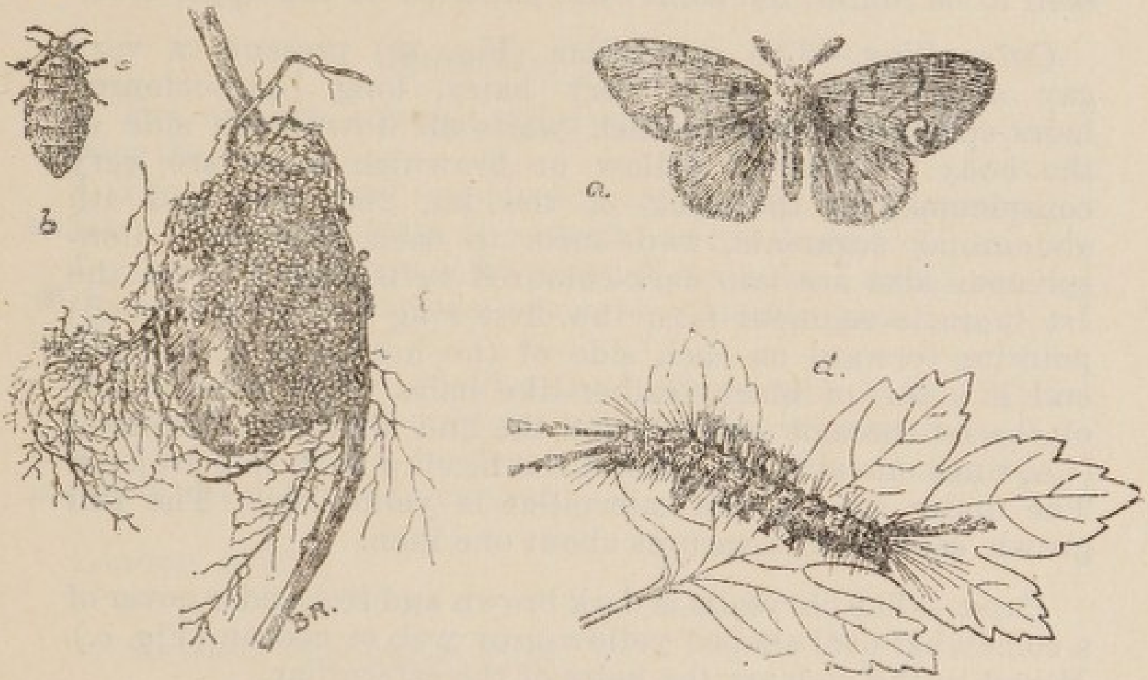
London, S.W.1.
April, 1906.

Revised, March, 1919.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

The Vapourer Moth (*Orgyia antiqua*).



VAPOURER MOTH : *a.* Male ; *b.* Female ; *c.* Cocoon, surrounded by eggs ; *d.* Caterpillar.

The caterpillars of this moth are harmful to forest trees, fruit trees, garden plants, and even to pot plants, and in some seasons are very destructive. The food plants are very numerous, and include pear, plum, apricot, sloe, hawthorn, apple, strawberry, mountain ash, rose, bilberry, laurel, mahonia, elm, willow, poplar, birch, alder, hazel, hornbeam, beech, oak, ash, lime, while there are records of severe infestation on pine and spruce. The caterpillars may be found from May to September, and the adult moths may be taken any time from the middle of July up to and including October. The Vapourer Moth is found in Europe, N. Africa, and Western Asia. It is common throughout Great Britain and Ireland and is to be found in towns as well as in the country.

Description of the Insect.

Moth.—There is a marked difference between the male and female moths. The *male* (Fig. *a.*) measures from 1 inch to $1\frac{1}{4}$ inch in expanse of wings. The body is brown: the wings are ochreous or chestnut brown, the fore-wings having dark markings. Near the hind angle of each fore-wing is a somewhat crescent-shaped clear white spot. The antennæ are double-combed. The *female* (Fig. *b.*) is yellow-grey in colour, hairy, and unable to fly, the wings being reduced to mere stumps. The antennæ are saw-like or single combed.

Egg.—The eggs (Fig. *c.*) are whitish-grey in colour and are laid in great numbers. Examined with a lens they are seen to be round, but somewhat flattened on the upper side.

Caterpillar.—The caterpillar (Fig. *d.*) presents a very gay appearance. It is very hairy, long light-coloured hairs springing from reddish warts all down each side of the body. Tufts of yellow or brownish hairs are very conspicuous on the back of the 1st, 2nd, 3rd, and 4th abdominal segments, two tufts to each segment. Conspicuous also are two dark-coloured tufts arising from the 1st thoracic segment (*i.e.*, the first ring behind the head) pointing forward on each side of the head, and at the tail end is a tuft of black feather-like hairs. From each side of the 1st thoracic segment and the 2nd abdominal segment (*i.e.*, rings one and five behind the head) a dark tuft projects. The under side of the caterpillar is yellowish. The full grown caterpillar measures about one inch.

Pupa.—The chrysalis is dark brown and lies under cover of a somewhat oval-shaped yellow-grey web or cocoon (Fig. *c.*). Mixed in the web are the hairs of the caterpillar.

Life History.

The male moths fly actively, but the females are very sluggish. On issuing from the pupa the female settles on the outside of the cocoon, and, after pairing, lays, on and all round the cocoon, eggs up to 300 or more. Some of these eggs hatch in a fortnight to three weeks, while others laid at the same time may not produce caterpillars until the following spring. From this it follows that all stages of the insect from egg to adult may be met with at the same time. Soon after hatching the young caterpillars scatter over the tree. When they are full fed they spin cocoons, which are attached to leaves, twigs, bark, or to a neighbouring post or fence. The moths emerge from the pupæ in about three weeks. Two broods in the year are possible. If the eggs that have passed through the winter hatch in the early part of May, the resulting caterpillars may become adult in time to allow for a second brood of moths by October. On the other hand there may be only one generation in the year, in which case the eggs laid by the first brood pass through the autumn and winter and hatch the following spring. Weather conditions have great influence on the production of second broods, which are usually most numerous in a hot summer. Owing to the irregularity in the hatching of the eggs and the varying extent to which a second brood is produced, there is considerable overlapping between the successive generations and larvæ may be found throughout the whole summer and early autumn.

Methods of Control.

1. The cocoons covered with eggs should be destroyed during the winter.
2. The larvæ are conspicuous and may be picked or shaken off garden plants, if spraying is not desirable.
3. Attacked plants may be sprayed with lead arsenate or with one of the various vegetable poisons now on the market.
4. The females are wingless and move very little. The species, therefore, can only spread when in the larval stage, and, if care is taken in dealing with the first attack, the insect is not difficult to control.

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Revised, September, 1914.

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Leaflet No. 162.

BOARD OF AGRICULTURE AND FISHERIES.

Grafting Fruit Trees.

Grafting or budding, though requiring some skill, is not a difficult art to learn. The best way is to obtain some practical instruction, and then, before attempting anything with growing stocks, to practise the various cuts and fittings with pieces of wood of different sizes.

To attain success in grafting the worker must employ stocks which are in just the right condition, *i.e.*, with the sap flowing freely, the grafts nicely fresh and not shrivelled, and all cuts made cleanly and fitting together exactly. It can be easily ascertained if the sap is right in the stock by cutting off the latter some little distance above the point where the graft is to be placed, making a slit in the bark and observing if it parts freely from the wood. If it will not part freely the grafts would not be likely to "take" and the operation must be postponed. It is customary to remove the grafts (scions) from the trees during January and February according to the district. After cutting, they may be neatly tied in bundles with the ends level, carefully labelled, with the name showing, and stood in deepish drills in a shaded border, with the soil made firm round the ends. They may also be kept fresh for some time by standing them in a couple of inches of water in a dish in a cool room. To make the cuts clean a very sharp knife must be used, and the smoother the cuts are made, the more quickly they heal.

The time for grafting various fruits depends very much on the earliness or otherwise of the season. The most suitable time for plums, apples and pears, is from the second week in March to the end of April. When it is not possible to undertake the operation during this period it may be carried out in May.

Preparation and Planting of Stocks.—It is generally better to purchase stocks from firms who make a speciality of them and supply the trade, than to attempt to raise them. They are very cheap—not more than thirty-five shillings per thousand if bought in quantity. If only a few dozens or scores are wanted, it is as well to obtain them from the nearest reliable nurseryman. The soil for stocks should be deeply cultivated and in good condition; soil suitable for the production of a good crop of potatoes or cabbage will be suitable for nursery "stocks." No manure should be applied where it would be under the roots, as it encourages downward rooting. The soil should be ready by the time the stocks can be obtained in early winter. When received, it is well to sort the stocks according to size, trim the roots, and shorten the heads to about two feet in length. They may then be placed with the roots in soil, to keep fresh till they can be planted.

Stocks should be planted in rows three feet apart, and one foot apart in the rows, at the same depth as they had been previously. The roots may be covered with a little soil and then manure applied to encourage lateral and surface rooting. After treading very firmly, keeping the lines quite straight, the soil may be lightly forked over just to loosen the surface. When sorting over, all stocks should be carefully examined for American blight, and, if any is found, dressed accordingly. (*See* Leaflet No. 34.) In the summer, they must be examined for aphides, and, if any are found, sprayed with a soft soap wash. (*See* Leaflet No. 104.)

If the stocks do well, they should be ready for budding in August and September following, or grafting in the spring of the next year. The smaller ones may need another year's growth.

Kinds of Stocks.—For *apples* to be grown as standards, half-standards, or espaliers, the seedling apple and seedling crab are to be recommended, and for dwarf or bush trees, the English Paradise stock; for *pears*, the seedling pear and quince respectively. *Plums* are usually budded and grafted on the seedling plum and Myrobalan plum. With many growers, however, the Myrobalan stock has become unpopular, and the Pershore or Egg plum stock is now often used in its place. *Apricots* are worked on the Myrobalan or on the Mussel and Brussels plums. For *cherries*, the Mahaleb and wild cherry are used, while for *peaches* and *nectarines*, the almond and plum are employed. A batch of stocks can readily be raised by taking up suckers from various trees, but it is a bad practice, as they are prone to future suckering.

All stone fruits do better when budded than when grafted, there being a truer junction between bud and stock than obtains with grafts, and the bulk of nursery stocks of apples and pears are also budded.

Methods of Grafting—*Whip or Tongue Grafting.*—This method (Fig. 1) is chiefly employed in the case of stocks of about half an inch to an inch in diameter. The graft is prepared by taking off a slice on one side about $1\frac{1}{2}$ to 2 in. long, the upper end of the cut being opposite a bud, and the lower end cut away to nothing. The stock should have been cut off about 4 to 6 in. from the soil. Place the graft against the stock to measure how long to make the cut on the latter, then shave off a slice of bark and wood just a little wider than the cut on the graft. This is necessary in order to make the two *inner* barks of graft and stock fit together, and the bark of the former would be thinner than that of the latter. It is between the inner bark and the wood that the union or junction is formed. The tongues in both must then be fitted together as shown and tied securely with bast or raffia and waxed over. Sometimes another small tongue is made in the stock at the bottom of the cut and the end of the graft tucked under it, as shown in Fig. 1, E, *n*.

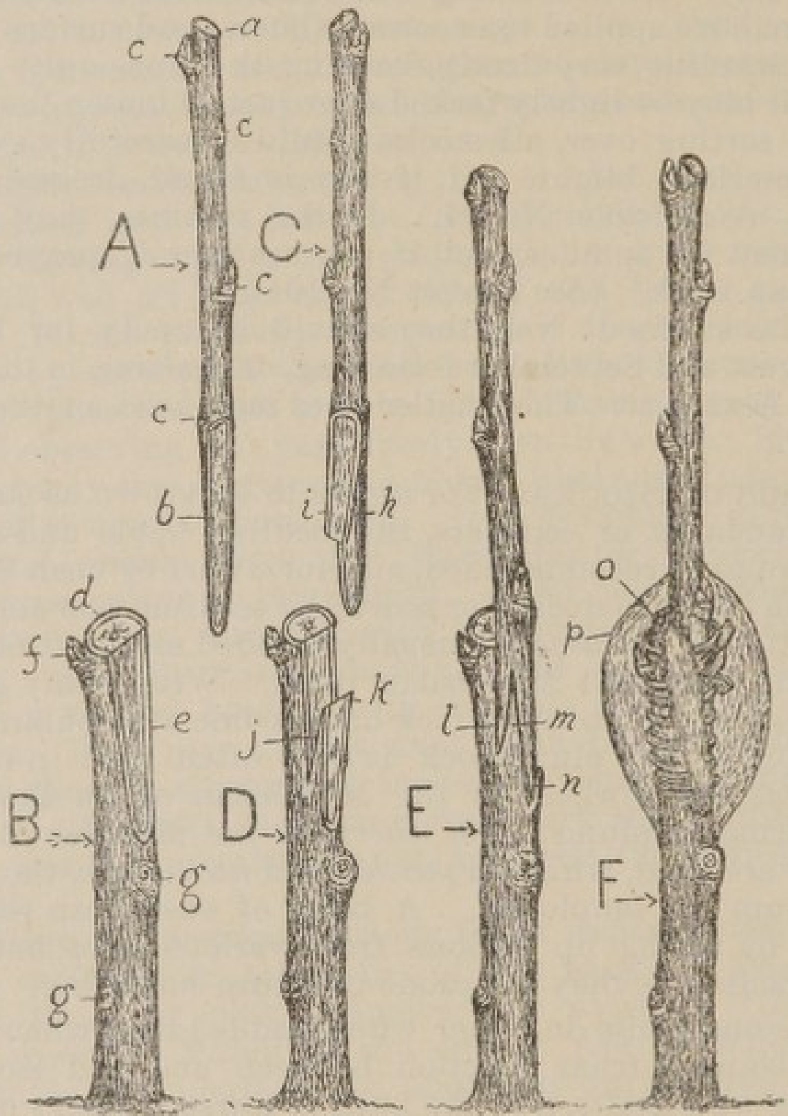


FIG. 1.—WHIP OR TONGUE GRAFTING.

A, scion or graft partly prepared : *a*, upper end cut sloping from a bud ; *b*, lower end sliced ; *c*, position of buds. B, stock partly prepared : *d*, point of severing top of stock ; *e*, sliced for fitting of graft ; *f*, bud left (if present) to attract sap ; *g*, points where growths removed. C, graft tongued : *h*, opening ; *i*, tongue. D, stock tongued : *j*, opening ; *k*, tongue. E, graft fitted properly on stock : *l*, tongue of graft ; *m*, tongue of stock ; *n*, small tongue (sometimes made and end of graft inserted in it). F, graft and stock tied and *o*, waxed ; or *p*, clayed.

Saddle Grafting.—There are various methods of saddle grafting. The first (Fig. 2) may be used in grafting stocks about three-quarters of an inch to an inch and a half in diameter. This stock is made to an acute wedge shape by cutting off a slice on each side. Another (downward) cut on each side is made through the bark and a thin slice of the wood. The graft is cut saddle-shaped as shown by making a cut on each side of the same length—about $1\frac{1}{2}$ to 2 in. Both cuts are rather thin till they reach the upper end opposite to a bud, when the knife is slipped in, and, when the second cut is made, the piece of wood drops out. The graft may now be placed in position across the wedged end of the stock, allowing the ends to go underneath the bark; then tied in and waxed. Grafts made in this way take very well and soon grow over the stocks.

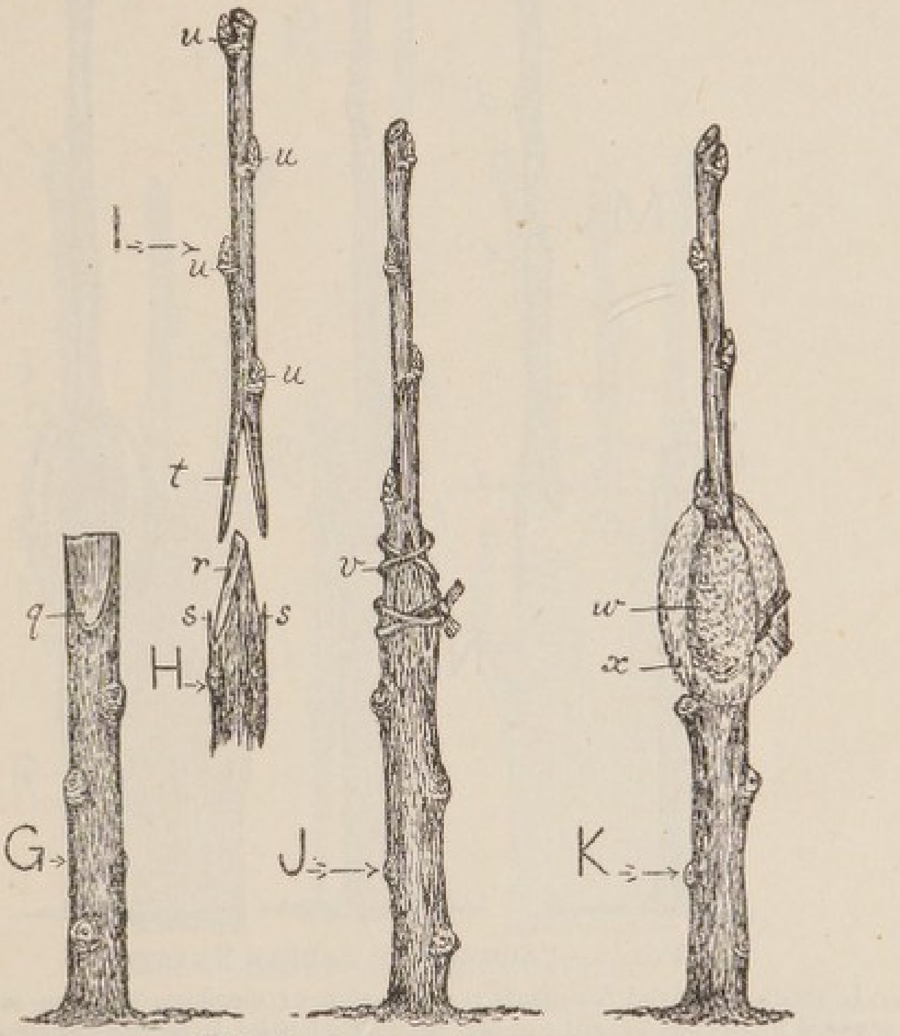


FIG. 2.—SADDLE GRAFTING.

G, stock sliced on one side to be repeated on corresponding opposite side: *q*, point of making downward cut. H, top of stock properly prepared: *r*, wedge-like form; *s*, tongues or downward cuts. I, scion or graft prepared for placing on stock: *t*, saddle-shape of lower part made by two cuts; *u*, buds. J, graft properly placed on stock, the two inner barks coinciding, at least on one side of stock: *v*, ligature securing graft to stock. K, junction of stock and graft cuts or wounds: *w*, waxed: *x*, clayed, not both

Another method is what may be termed the "Somerset" saddle (Fig. 3), as it is more practised in that county than any other. It is a better and stronger method than the last, and can be used on stocks up to an inch in thickness, Sometimes it is employed for even larger ones up to two inches thick, in which case two are put in on opposite sides.

the end of the stock being cut square instead of on the slant. In either case, making the cuts in the graft is an operation needing a good deal of skill and practice. In the method under notice the stock is prepared by a longish cut on one side only. A slit is then made in the bark on each side in just the same way as for bark or rind grafting (see below).

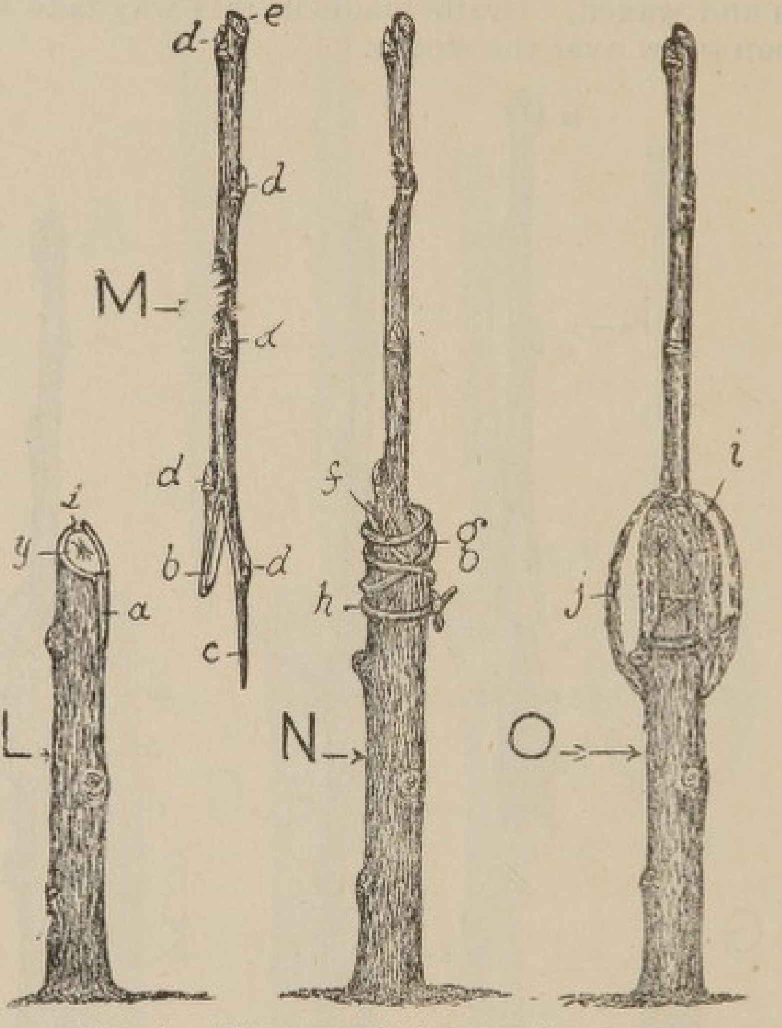


FIG. 3.—"SOMERSET" SADDLE GRAFTING.

L, stock prepared for graft: *y*, longish or slanting cut top when stem severed at proper height; *z*, slit made vertically in bark at highest point of slanting cut; *a*, slit made at lowest point of cut. M, scion or graft: *b*, short cut side of saddle; *c*, long or "strap" side of saddle; *d*, buds; *e*, top cut slanting on opposite side of bud. N, graft affixed on stock: *f*, short cut side of graft inserted under bark in slit; *g*, "strap" or long side of graft across cut of stock and under the bark on the lower side; *h*, ligature. O, junction of stock and scion wounds: *i*, waxed; *j*, clayed—one of these, not both.

If the sap is "up" the bark should part easily from the wood on giving the knife a slight twist on each side of the cuts. The first cut in the graft would be about an inch long (Fig. 3) and rather thick, or about half way through when it reaches the upper end to a bud. The other cut, to form the "strap," is double the length and thinner to allow for bending. At the upper end, when nearly opposite the first one, this cut is turned in at a more acute angle, when the wood should drop out. The short cut side is inserted under the bark on the top of the cut on the stock, the "strap" going across and under the bark on the lower side; after which the graft is tied and waxed. If the graft takes properly and the stock is not too wide, it soon grows over the cut, and in a few years completely covers it.

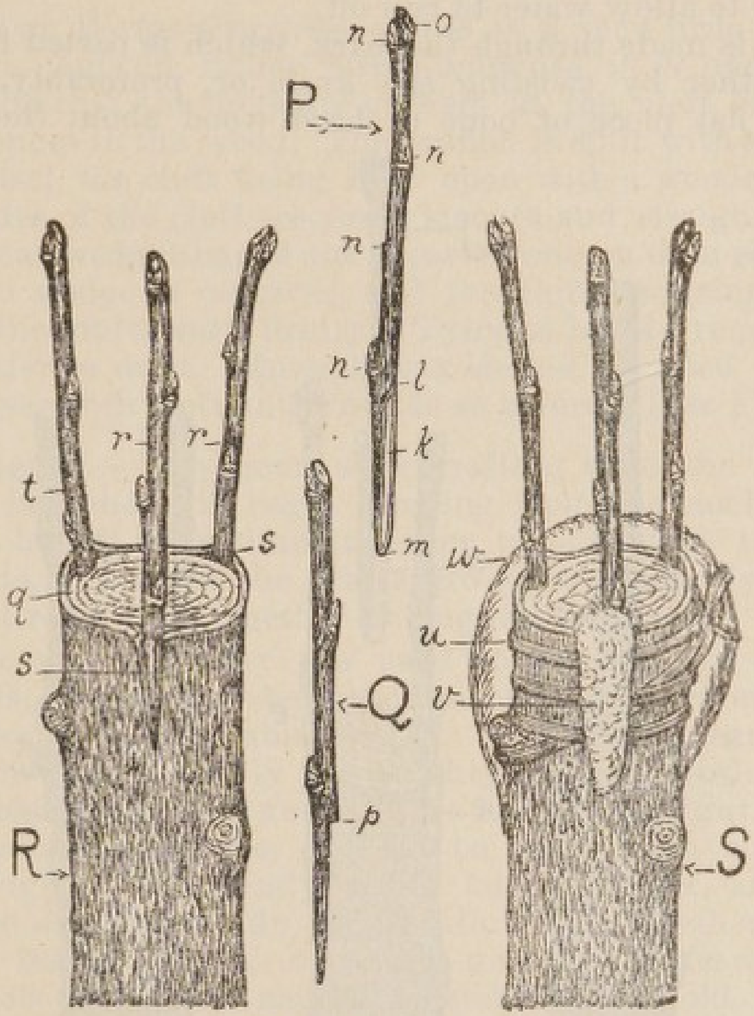


FIG. 4.—CROWN OR RIND GRAFTING.

P, scion or graft prepared by slicing: *k*, slice cut off one side opposite a bud at the upper end, *l*, and the bottom cut away to nothing, *m*; *n*, buds; *o*, top cut sloping from a bud. Q, graft prepared with a shoulder: *p*, point where cut made partly through, and with lower portion cut off to nothing forming shoulder to rest on top of stock. R, stock or limb: *q*, point where cut off; *r*, grafts with simple sliced off sides inserted in slits, *s*; *t*, graft with shoulder resting on top of stock. S, stock or limb after completing grafting: *u*, ligature; *v*, waxed over cuts or wounds, or, *w*, clayed over top of stock as well as slits.

In neither of these forms of saddle should the graft be split when preparing it, or when placed across the stock the split may extend and the graft become useless.

Scions or grafts for the foregoing methods of grafting are usually selected from well-developed one-year-old shoots, but for grafting older and larger trees as in the following methods two-year-old wood bearing wood-buds may be used in addition to stout one-year-old wood.

Crown or Rind Grafting.—This (Fig. 4) is the simplest method of all, and chiefly used on big branches of possibly oldish trees. The branches to be utilized as stocks should be sawn off some few weeks before grafting time, and a few inches higher up than where they are to be grafted, being cut off again just before the grafts are put on. If the saw cut is pared over with a knife, the bark soon heals over. If the branch is growing upright a slightly sloping cut must be made to allow water to run off.

A slit is made through the bark, which is parted from the wood either by twisting the knife or, preferably, with a smooth flat piece of bone or hard wood about the size of

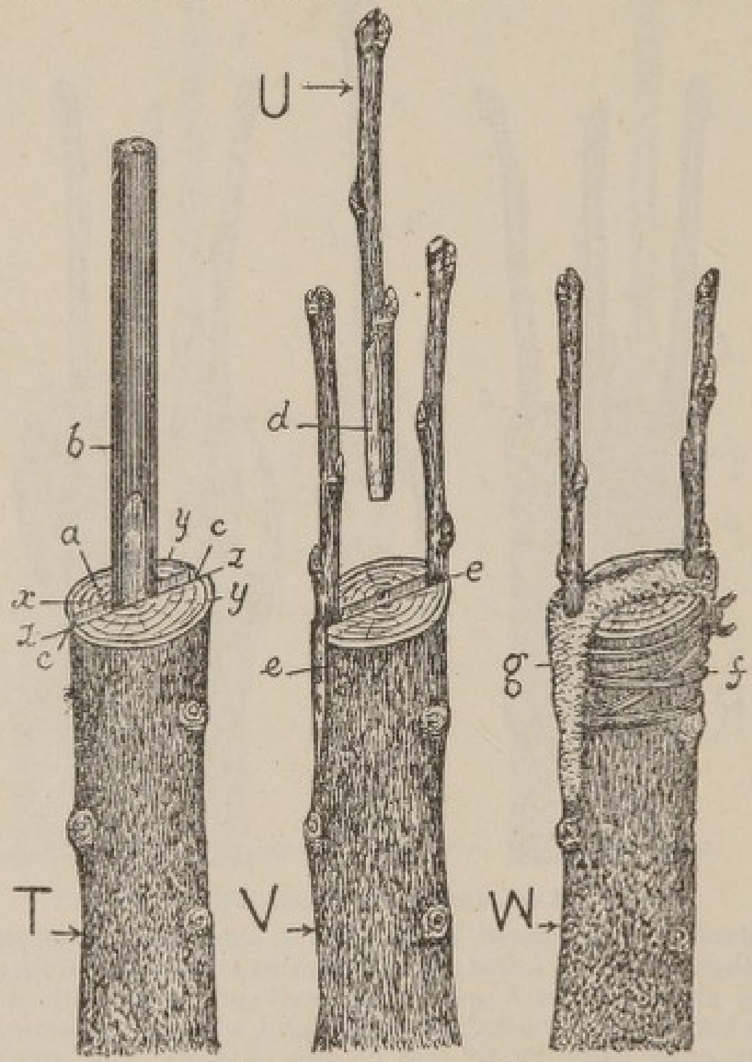


Fig. 5.—Cleft or Wedge Grafting.

T, stem or branch prepared : *x*, point where cut and edges of bark pared smooth, *y* ; *z*, point where split with hammer and chisel ; *a*, cleft kept open by iron or wooden wedge, *b* ; *c*, sides of cleft pared smooth and straight. U, scion or graft : *d*, lower end cut wedge-shaped. V, stem or branch with grafts properly inserted : *e*, inner barks entirely coinciding. W, operation completed : *f*, ligature ; *g*, waxed over cleft and wounds.

the graft. A slice about two inches long is now cut off one side of the graft, the upper end of the cut being opposite a bud and the bottom cut away to nothing; the graft is then slid between the bark and the wood. By cutting off a thin bit of bark on each side of the slit, the bark will return to its place next the wood. Several grafts may be put on in this way, each one being cut so that the leading buds point in opposite directions to grow away from each other. In all methods the grafts should be cut in such a way as to have a bud near the "collar" of the stock, which *bud*, when it grows, will assist in forming a strong union. After tying, just sufficient wax should be applied to cover and exclude air from the wounds or cuts.

Cleft or Wedge Grafting.—This is a very firm and sure method, but on rather large branches it is open to the objection that the moisture gathers in the cleft and decay commences in the wood. The branch is split with a hammer and chisel, the cleft being kept open with a wooden wedge. The sides of the cleft are pared smooth and straight, and the grafts cut wedge-shaped and inserted one on each side. The wooden wedge is removed, and the cleft, reducing in size, holds the grafts very firmly. Tying is hardly required, but it is safer to do it. Enough wax should be used to fill in and cover both cleft and wounds as before. (*See* Fig. 5.)

General.—Very soon after grafting time, the buds and young branches will begin growing from the stocks. They should be left for a time in order to encourage the sap to circulate, but when the grafts grow, be gradually reduced but not removed altogether during the first year.

Both wax and clay are used to exclude air from the wounds. Wax has been recommended throughout, as it is in many ways preferable to clay. It is much cleaner to use, and can be more easily and quickly applied, while there is not the same shelter under it for American blight. A good wax for using warm or cold can be made with equal parts by weight of Burgundy pitch, kerosene wax, and tallow (melted candles will do), or, as tallow smells rather strongly while being melted, olive oil may be preferred. The materials should be melted together in an old saucepan, and if used warm the mixture can be put on with a paint brush, or if cold with a putty knife. At the cost of not more than eighteenpence, enough can be made for several hundreds of grafts.

Clay is cheaper, but cannot always be obtained; it may be used in its natural state, according to the "temper" of the clay, or mixed with a third part of cow-dung. Cow-dung is also used alone, and also bands of hay and clay.

If the wax made as described is employed, it will remain fairly soft, and when the grafts grow well, about midsummer, if a slit is made in the raffia both wax and raffia will be pushed off by the swelling of the grafts.

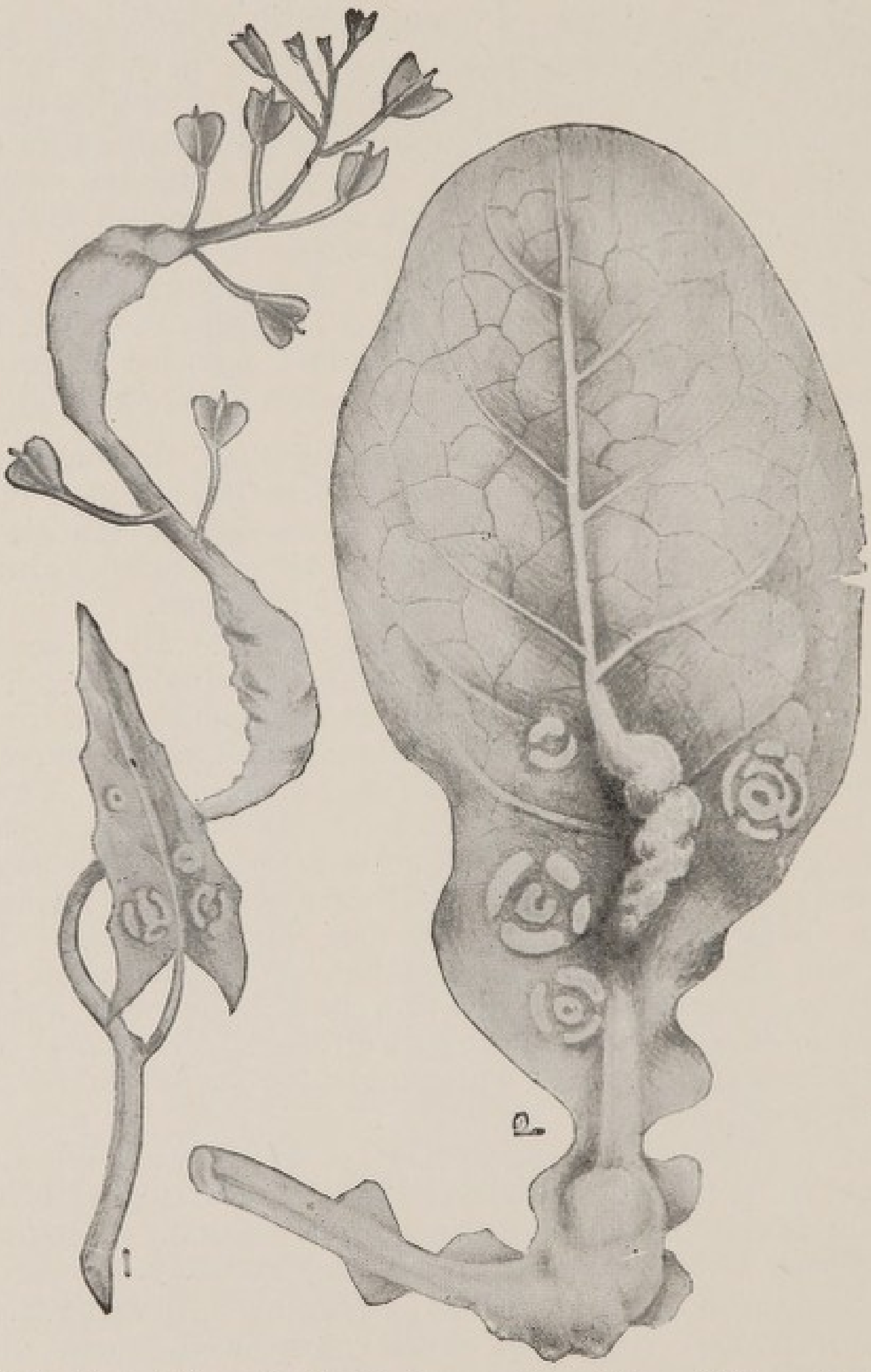
London, S.W.1,
April, 1906.

Revised, December, 1915.

Leaflet No. 163.

BOARD OF AGRICULTURE AND FISHERIES.

White Rust of Cabbages (*Cystopus candidus*, Lév.).



White Rust—(1) on Shepherd's Purse; (2) on Young Cabbage Leaf.

This destructive fungus has a world-wide distribution, and attacks many kinds of plants belonging to the cabbage family — *Cruciferæ* — both cultivated and wild. In this country the various forms of cabbage radish, and horse-radish suffer most from its presence; among wild plants the Shepherd's purse is most frequently attacked (Fig. 1).

Description.

On the leaves the fungus forms snow-white polished blotches, which are often grouped in irregular concentric rings (Fig. 2). At maturity, these white patches break up into a powdery mass and the spores are scattered by wind and rain. Infection can only take place during the seedling stage, and this can practically be prevented by selecting a fairly dry and open situation for the seed-beds, as the zoospores or infecting bodies can only perform their functions in the presence of an excess of moisture. When the stem or flower is attacked much distortion and swelling is produced, and in the swollen parts numerous resting-spores are formed, which germinate and infect seedling-plants the following season.

Prevention and Remedy.

1.—Diseased leaves should be removed the moment the fungus is observed, but the most important point to attend to is the collection and burning of all swollen and contorted stems and flowers, as it is the spores present in these swollen parts that infect seedlings in the spring.

2.—Shepherd's purse should be eradicated, as this weed is, in the majority of instances, the host and primary source of infection of cultivated plants.

London, S.W.1,
March, 1906.

Revised, February, 1913.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 164.

BOARD OF AGRICULTURE AND FISHERIES.

Potato Leaf-Curl.

The term " Curl " as applied to a malady of the potato has been in use in England for more than two centuries. It is now clear, however, that the older writers included under this term more than one specific disease ; for there are, as a matter of fact, several diseases showing as one symptom, common to them all, the curling or rolling upwards and inwards of the leaflets.

In the present leaflet the name Leaf-Curl is used in a restricted sense. It is applied to that form of disease which in Germany (where it has been responsible for very serious losses) has been called Leaf-Roll. The designation Leaf-Roll has also been used occasionally in this country, and in America, but as the name Leaf-Curl is well-known throughout Britain and is of old standing there appears to be no reason for changing it.

Although Leaf-Curl was formerly regarded as a fungus disease, it is now known that the fungi observed were secondary, and the trouble is believed to be due to a physiological weakness and not connected with any parasitic organism. The disease causes more or less reduction in the yield, and in bad cases practically no crop at all is produced.

Description of Affected Plants.—The most marked symptom of an affected plant is the curling inwards of the leaflets which gives the shoots an erect, rigid appearance (*see* illustration). The leaflets curl over towards the midrib, and at the same time the leaves assume a more or less erect attitude instead of lying somewhat horizontally as in a normal plant. Very frequently it is only the upper leaves which are curled, but at times the entire plant exhibits this phenomenon, and in bad cases the haulm is shorter than usual and the plant remains dwarf. Together with the curling of the foliage there is usually a change in colour in the affected leaves. The colour varies with the variety of potato. Most of the leaves become pink or tinged with mauve, but in some varieties a yellow hue is assumed.

Affected plants are checked in their growth, and as a result the yield is very distinctly reduced. The amount of decrease depends on the intensity of the disease. In slight attacks the tubers, though numerous, remain small. In more serious cases only a few tubers develop, and in extreme attacks no crop at all is produced. In almost all cases, the parent set fails to decay, and the new tubers which are formed tend to cluster round the base of the stems.

Distinction between Leaf-Curl and other Diseases.—A disease with which Leaf-Curl is liable to be confused in this country is the bacterial trouble known as Blackleg. In the latter there is also an inward and upward rolling of the leaflets, and a discoloration which, however, is yellow rather than pink. Blackleg, however, usually appears earlier in the season, and may be distinguished at once from Leaf-Curl by the blackening and rotting away at the base of the stem (for further details, *see* Leaflet No. 117).

* "Potato Leaf-Curl." Reproduced from a paper by Dr. A. S. Horne in "Annals of Applied Biology," Vol. I., by kind permission of the Cambridge University Press.

The symptoms presented by the somewhat uncommon *Verticillium* disease resemble still more closely those of Leaf-Curl, and accurate differentiation of the two can only be made by microscopical examination of the tissues.

Causes of the Disease.—The actual cause of Leaf-Curl is still obscure, but it is not now regarded as a disease caused by a parasitic organism. The symptoms manifested, such as stunting of the growth, curling of the leaves, and poorness of crop, clearly indicate that the functions of the plant are not proceeding normally, but the exact cause of this disturbance is still a matter of speculation. Whatever the cause, the effect is sufficiently great to affect the seed tubers, since tubers from affected plants give rise to diseased plants the following year. The disease, therefore, may be said to be inheritable, and hence great care should be exercised in the selection of seed.

Of the many causes which have been suggested, the use of over-ripe seed may first be mentioned. Such seed might be due to the result of growth in warm, dry soil, or to a sudden check due to a dry spell in July or August. This view finds some support in the fact that seed saved from the southern and drier parts of England is more subject to curl than Scotch or Irish seed.

Poor culture has also been put forward as a cause, but though it is undoubtedly correct that the disease is aggravated by poor soil and lack of moisture, these factors cannot be said to be the cause itself. It is true that the foliage of badly curled plants often partially recovers with copious summer rains, but thousands of plants showing Leaf-Curl may be seen long before dry conditions set in. Another theory which has received some support is that the stocks of certain varieties are deteriorating and that such stocks give rise to curled plants. This may or may not be correct, but the fact that Leaf-Curl often manifests itself in seedlings, or in quite new varieties appears to show that the theory does not entirely explain the case.

Yet another explanation has recently been advanced by Quanjer who believes that the disease is due to the presence of a virus which destroys certain of the conducting tissues in the shoots and leaves.

Control Measures.—1. As the disease is inheritable tubers from affected plants should not be used for seed, nor would it be wise to save seed from healthy plants if any considerable portion of the entire field or plot were affected.

2. Good seed from a northern source should be used. This is specially important in districts where Leaf-Curl has been troublesome, as although local conditions are perhaps not the direct cause of the disease, climate and soil materially affect its intensity. The best seed therefore only should be procured.

3. As freedom from Leaf-Curl cannot be determined by an external inspection of the tubers, it is most advisable if the disease is suspected to test the seed (or samples of it) by sprouting. Sets which sprout well give, as a rule, strong, healthy plants.

London, S.W.1,
April, 1906.
Re-written, July, 1918.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 165.

BOARD OF AGRICULTURE AND FISHERIES

GALL-GNATS INJURIOUS TO WILLOWS AND OSIERS.

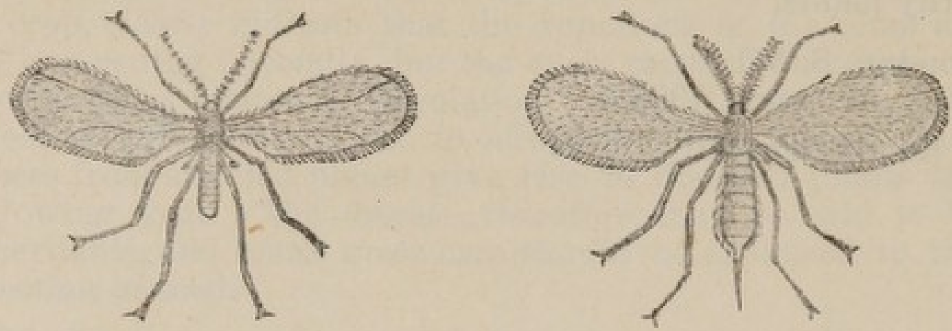


FIG. 1.—*Cecidomyia saliciperda* (magnified). Male to left, female to right. After Nitsche.

The Gall-Gnat Family, or *Cecidomyidæ*, is a family of two-winged or dipterous insects. These flies are tiny, delicate in structure, and with few nervures to the wings; their somewhat long antennæ have, typically, whorls of fine hairs at the joints; the legs are long and slender; the wings and body bear hairs which are easily rubbed off. The larvæ are small maggots, and on the lower surface of the front end of the body some have a so-called anchor-plate, or "breast bone," which may be used for leaping, for changing position, or perhaps in feeding.

The food habits of the larvæ vary considerably, but all the willow-infesting species are found in characteristic galls or malformations, the galls being on young or older twigs, at the apices of twigs, on flower buds, or on leaves.

The pupal stage is generally passed in the gall, but in some cases in the soil.

Cecidomyia (Rhabdophaga) saliciperda.

This species infests *Salix alba*, *S. fragilis*, *S. caprea*, *S. purpurea*, *S. viminalis*, and, sometimes, the White Poplar, *Populus alba*. Young twigs and also branches up to 3 or 4 inches in diameter are attacked.

Symptoms of infestation are poor leafage, swellings, and later on the rupture of the bark, which hangs down in shreds.

Description.

The *fly* (Fig. 1) measures about $\frac{1}{8}$ inch in length; its head and thorax are black, or black-brown, with black hairs; the wings are milky white, with whitish hairs.

The *eggs* are extremely minute, rounded at the ends, and orange yellow in colour.

The *larva* (Fig. 2) is rounded at both ends, or somewhat spindle-shaped, and has a well marked anchor-process.

The *pupa* is yellow, and has two small brown projections at the base of the antennæ.

Life History.

The female deposits her eggs in chains or rows on the bark. The larvæ on hatching bore into the bark (Fig. 3), and owing to their irritating presence the cambium gives rise to irregular streak-like growths, through which the larvæ make excavations or irregular galleries. Between the larval galleries the wood is normal in condition. Perhaps the activity of the cambium may serve to enclose the larvæ without marked boring on their part.

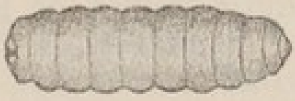


FIG 2.

FIG. 4.

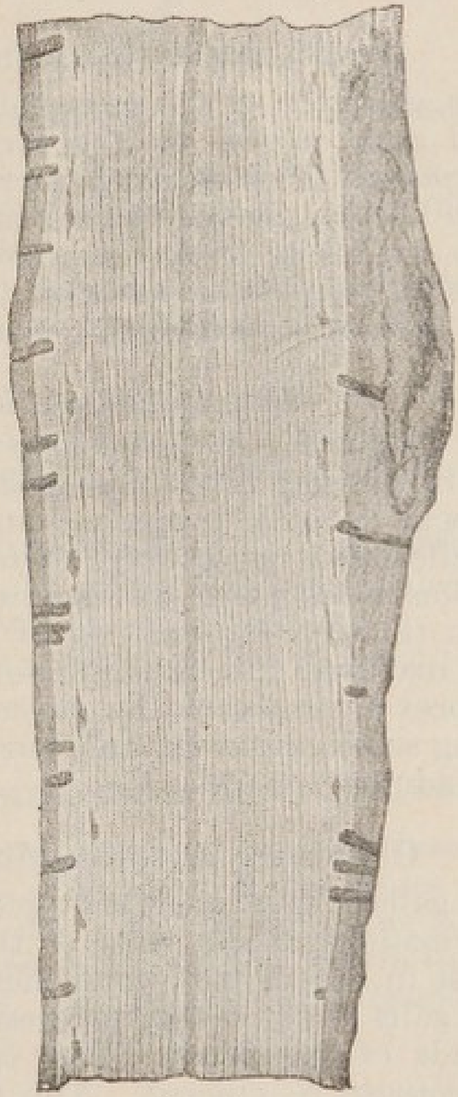


FIG. 3.

FIG. 2.—Larva of *C. saliciperda*, after preservation, greatly magnified. FIG. 3.—Longitudinal section of *Salix alba*, showing larval tunnels of *C. saliciperda*, natural size. FIG. 4.—Piece of *Salix alba* showing flight holes of adult *C. saliciperda*, natural size.

For a time the bark stretches, accommodating itself to the increased thickening, so that only spindle-shaped swellings show, but ultimately it ruptures and hangs down in shreds. Pupation takes place just under the bark, which is easily knocked through by the forehead of the pupa.

After the issue of the flies the bark may be seen riddled with small holes (Fig. 4). There is one generation in the year, the larvæ tunnelling from July till the next April, May, or June.

Preventive and Remedial Measures.

1. Cut off and burn infested shoots before the issue of the flies.

2. Cut out infested pieces and burn them.

3. Apply cart grease or some similar substance to the places attacked, and although the pupæ may occasionally push themselves through this, the flies will be entangled in the sticky material.

Cecidomyia (Rhabdophaga) salicis.

This gall-gnat is the cause of spindle-shaped or lemon-shaped galls on the one-year twigs of *S. cinerea*, *S. caprea*, *S. purpurea*, *S. aurita*, and *S. viminalis*.

Both leading and side shoots may be infested. The twigs fail to grow; they may become angled and are rendered useless for basket-making or wicker-work.

The galls are caused by an enlargement of the pith.

Description and Life History.

The *flies* are black, with two stripes of white hairs, and measure about $\frac{1}{4}$ inch in spread of wings. They deposit their eggs in little heaps, and in the many-chambered gall the yellow-red larvæ may be found, in number up to 30. Pupation takes place just below an outside skin, which is broken through for the exit of the adult gnat. Issue of adults may take place from the end of May onwards.

To prevent attack on the shoots to be formed during the ensuing season cut away and burn the galls before the flight of the adults.

Cecidomyia (Rhabdophaga) rosaria.

The galls of this insect are typical of a series, in which the malformations at the ends of the twigs hinder the normal increase in length of the branches.

The galls of *C. rosaria* are rose-shaped and are found at the ends of the shoots of *S. caprea*, *S. aurita*, *S. alba*, *S. purpurea*, *S. cinerea*. The fly is black, with greyish wings, and has silvery hairs on the thorax.

In late spring or early summer the egg is laid in the developing terminal bud, and, the internodes failing to develop, the leaves remain drawn together in a rosette.

When the other leaves fall in autumn, those of the gall remain, brown and withered looking. Pupation takes place in the gall.

Cecidomyia (Dasyneura) terminalis.

This brown-black fly is the cause of the swollen galls at the apices of the shoots of *S. fragilis* and *S. alba*.

As many as 20 to 30 larvæ may be found in the gall.

Cecidomyia (Rhabdophaga) heterobia.

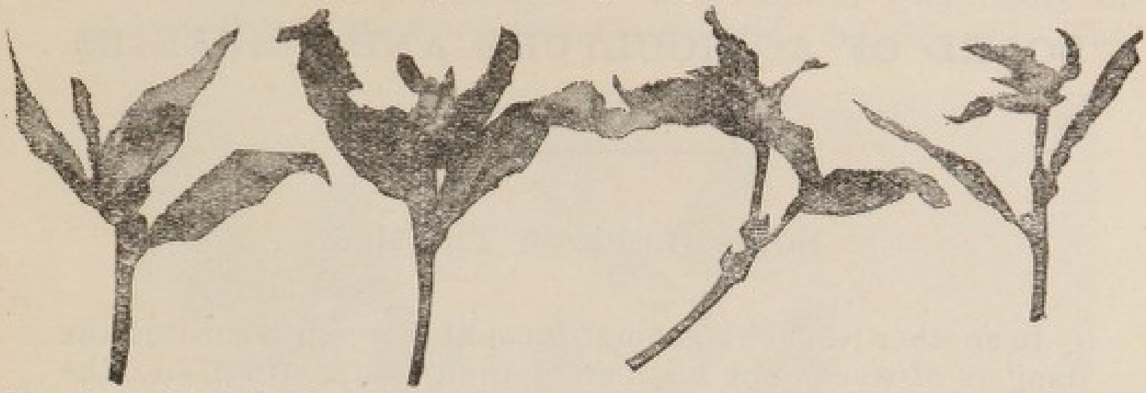


FIG. 5.—Galls of *Cecidomyia heterobia* on *Salix triandra* (two-thirds natural size)

This gall-gnat is the cause of the rosette galls (Fig. 5) at the apices of the shoots of *S. triandra* and *S. cineria*, and of the galls on the male catkins of *S. amygdalina*.

The infested catkins are deformed, while the presence of the larvæ at the apices of the shoots prevents shoot development.

This gall-gnat is dusky-brown to black in colour, with the under surface of the abdomen yellow. Pupation takes place in the gall. The damage, as in 1904, may be very great.

The varieties of osier chiefly attacked by this insect are known in the trade as Norfolks, Black Mauls or Mules, and Spaniards, these all being varieties of *S. triandra*.

The remedial measure is to cut away the galls and burn the enclosed brood.

Cecidomyia (Dasyneura) marginem-torquens.

This gall-gnat may be mentioned as a type of those that cause galls on leaves. The galls occur at the edges of the leaves, and as there may be many side by side—one larva to each gall—the leaf edges are rolled. *Salix viminalis* is a favourite host plant, but *S. fragilis* may be infested, and there is a record of attack on *S. caprea*.

London, S.W.1,
May, 1906.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 166.

BOARD OF AGRICULTURE AND FISHERIES.

Some Common Thistles.

In another leaflet* a general account is given regarding the dangers of weeds, the manner of their distribution, and the methods by which they may be suppressed. Inasmuch as certain species, however, demand special measures, it is proposed in the present leaflet to describe several of the commoner species of thistle which arrest the farmer's attention both on arable and pasture land, and to point out how they may be dealt with in a systematic manner. These pests are: (1) *The Spear Thistle*, (2) *The Welted Thistle*, (3) *The Marsh Thistle*, (4) *The Creeping Thistle*, (5) *The Stemless, Dwarf or Chalk Thistle*, (6) *The Annual Sow Thistle*, and (7) *The Perennial Sow Thistle*. The spear, marsh, creeping and stemless thistles have each hair of the down or pappus which is attached to the "seed," branched somewhat like a feather, while the hair of the down of the other three species named is simple.

All the species flower during the summer months, between July and September, but while the Annual Sow Thistle may flower in June, the Perennial Sow Thistle and the Stemless Thistle flower late, about August and September.

Description.

1.—THE SPEAR THISTLE (*Cnicus lanceolatus*, Willd.) is the strongest of the plants mentioned, and grows usually from 2½ ft. to 4 ft. high (Fig. 1). Its root is a well-developed tap-root, which descends from 9 in. to 1 ft. into the soil, and bears few lateral roots. One or two very strong adventitious roots, however, are often produced near the surface of the ground. The upright stem is stiff, and the spines on the edges of the leaves are long and stout. There are also short stiff spines on the upper surface of the leaves, and long ones on the bracts forming the involucre of the flower-head. The flower-heads are erect and comparatively few, and are placed either singly or two or three clustered together at the end of the branches. Each head is about 1 in. to 1½ in. in diameter,

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* Leaflet No. 112, Weeds and their Suppression.

with pale crimson-purple flowers (Fig. 2). The plant produces seeds freely, and these germinate very easily in two or three days when they are placed in suitable soil. The

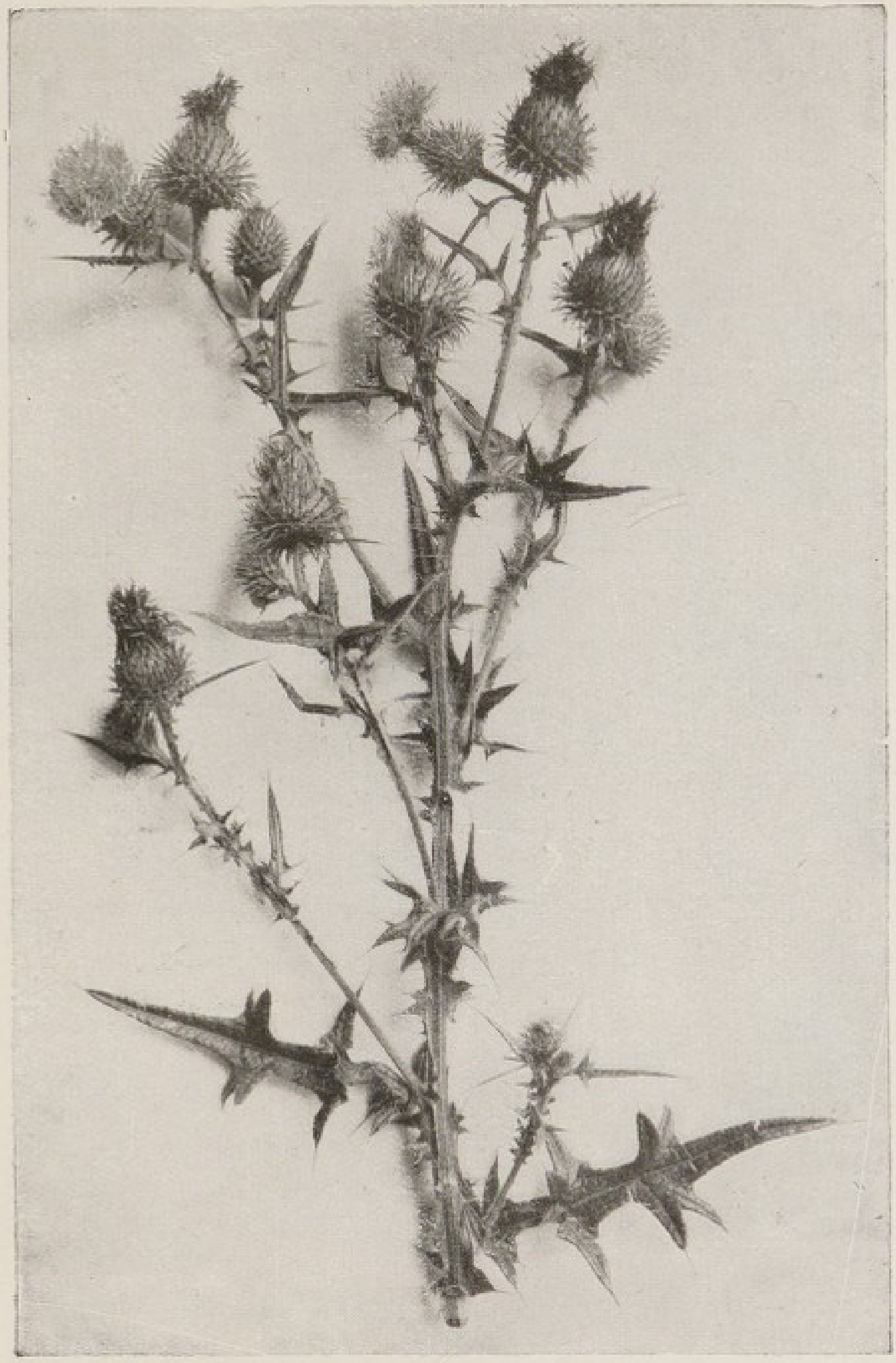


FIG. 1.—SPEAR THISTLE (*Cnicus lanceolatus*, Willd.), clearly showing its spinous character.

spear thistle as met with in the fields is usually a biennial. Seedlings have, however, been artificially flowered in one season, but such plants did not ripen seeds satisfactorily, and were destroyed by frost in the autumn. Ordinarily the plant during the first season of growth produces a compact rosette of ovate-lanceolate leaves lying close to the ground. In the second year a central stem is sent up, which branches and bears flower-heads in which seeds are produced. After the latter are ripe the plant dies. The seeds, however, are borne away from the parent plant by means of the feathery

FIG. 2.—HEAD OF SPEAR THISTLE (*Cnicus lanceolatus*, Willd.), about natural size.

down or pappus. The distance which the seed is carried is comparatively short, usually less than 30 or 40 yards rather than beyond this distance, and it varies with the state of the weather. On dry, hot days the seed separates or dries off the pappus almost as soon as it escapes from the flower-head and drops to the ground close to the plant, the pappus floating away without its load. Most of the thistle down seen floating on windy days bears no seed. The spear thistle is very common on roadsides, and in pastures and meadows on almost all kinds of soil throughout the country.

2.—THE WELTED THISTLE (*Carduus crispus*, L.) is an annual or biennial plant, not so commonly distributed as the preceding one, and it gives little trouble to the farmer. The tap-root is smaller and the stems more slender than those of

FIG. 3.—*Left:* CREEPING THISTLE (*Cnicus arvensis*, Hoffm.); *Right:* MARSH THISTLE (*Cnicus palustris*, Willd.).

the spear thistle. The stem is erect, about 1 ft. to 3 ft. high, winged, and covered with fine spines. The leaves and involucre are also covered with spines. The flower-heads (Fig. 6*d*) are roundish, clustered together at the end of the branches, and bear purplish-crimson flowers. The seeds germinate very readily, and the young plants somewhat resemble those of the spear thistle.

3.—THE MARSH THISTLE (*Cnicus palustris*, Willd.) is one of the commonest species, and is met with all through the country on damp undrained pastures and by the sides of ditches. The root-system of the plant consists of a series of fibrous roots all about the same thickness. The stem (Fig. 3) is erect and branched, somewhat slender and soft, with numerous short spines upon its wings. The whole plant is of a dull green or greenish-purple tint. The flower-heads (Fig. 6*c*) are small, about ½ in. in diameter, and bear dark purplish-crimson flowers. The involucre is practically spineless and similar in colour to the stem. The plant is a biennial. During the first season a compact rosette of leaves is formed close to the ground, from which an erect stem is sent up in the second year. The seeds are pale straw-coloured, and only germinate satisfactorily under the peculiar acid conditions of marshy, damp soil.

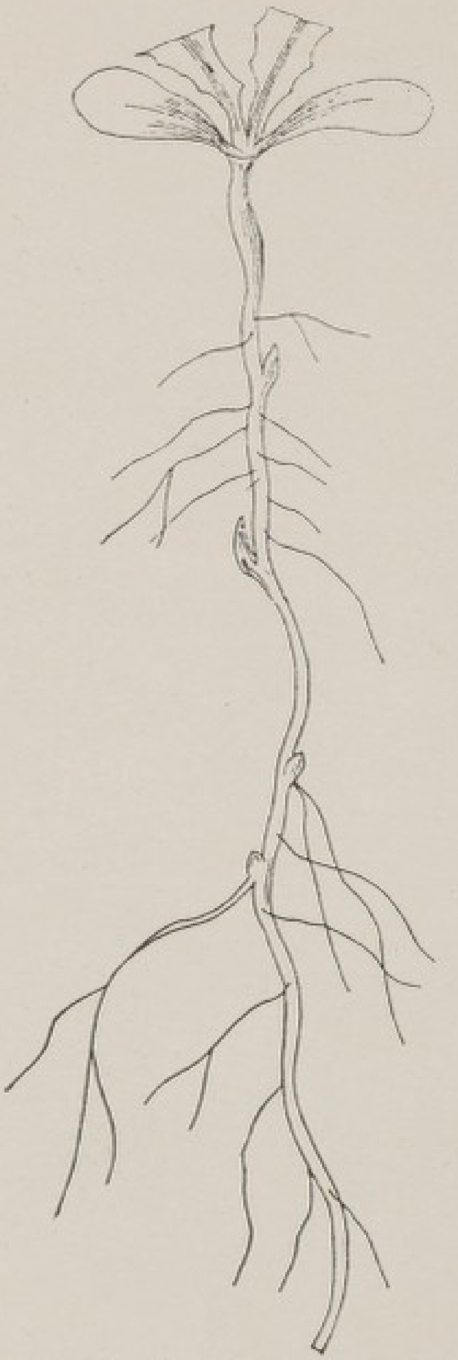
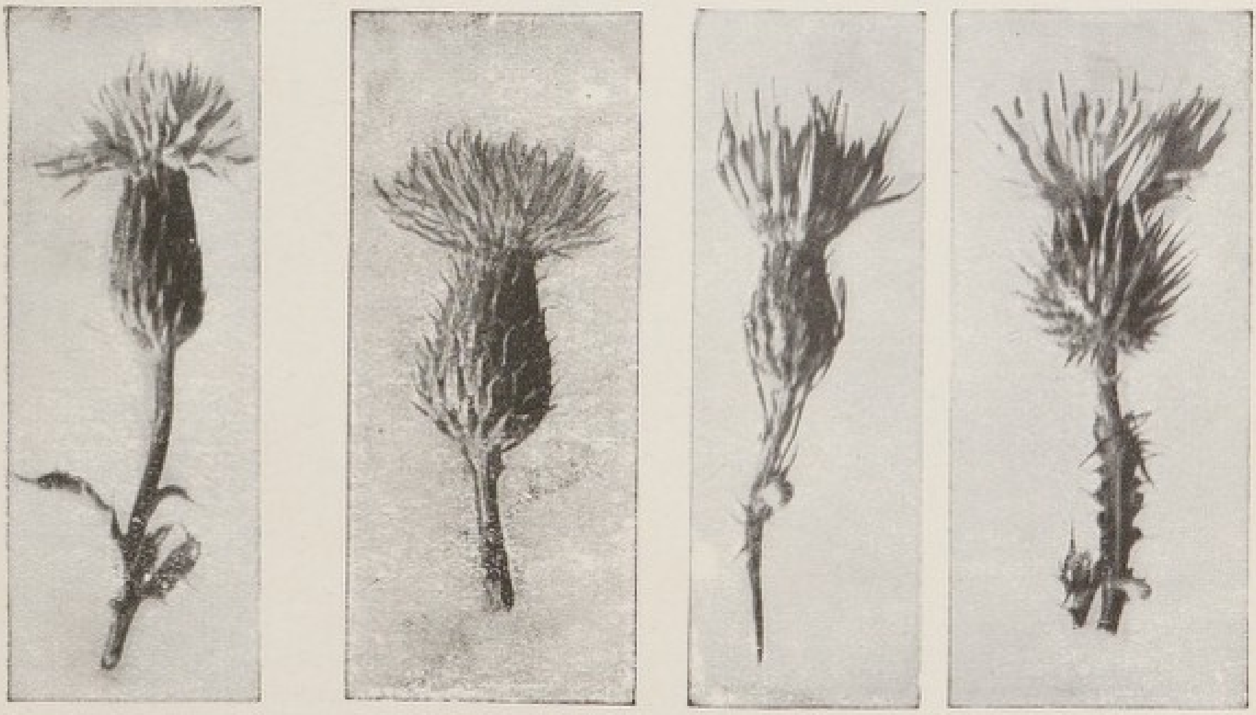


FIG. 4.—CREEPING THISTLE. Seedling 9 weeks old (slightly reduced).

4.—THE CREEPING THISTLE (*Cnicus arvensis*, Hoffm.) is the commonest and most troublesome of all thistles (Fig. 3). It grows abundantly on all sorts of arable land and pastures throughout Europe. It is a perennial plant, exhibiting many remarkable structural and biological features. The flowers have an odour very strongly resembling that of honey, and quite distinct from that of other species. In the thistles previously mentioned each flower in the head possesses anthers which bear pollen, and an ovary capable of producing seed. Moreover, in these species seed is abundantly produced in each head of flowers. The creeping thistle has, however, two distinct types of flower-head. In one of these the flowers have abortive anthers which produce no pollen, while in the other pollen-bearing anthers are present. These

Fig. 5.—Root of Creeping Thistle.



a b c d

Fig. 6.—Flower Heads of Thistles (natural size).
a.—Creeping Thistle (anthers perfect). b.—Creeping Thistle (anthers abortive).
c.—Marsh Thistle. d.—Welted Thistle.

two kinds of flower-head (Fig. 6, *a* and *b*) are always borne on separate plants, and as each individual plant is capable of spreading extensively below ground and sending up stems into the air from its underground parts, distinct colonies bearing one or other type of flower-head are sometimes met with occupying comparatively large areas. A great many farmers believe that the seed of the creeping thistle is incapable of germination. This is, however, a mistake. A

FIG. 7.—THE STEMLESS THISTLE (*Cnicus acaulis*, Willd.).

certain amount of seed is produced in both types of flower-head, but chiefly in those in which pollen is absent. The seeds germinate readily enough either in the year in which they are produced or in the following spring. The seedlings have two fleshy cotyledons, soon followed by the ordinary leaves, which do not grow in rosette form as in the other kinds of thistle. A thin tap-root descends vertically into the ground, and in a very few weeks—long before the cotyledons decay—adventitious buds are produced upon it (Fig. 4), and also upon the lateral secondary roots in great abundance. The root-system (Fig. 5) develops in all directions very extensively

FIG. 8.—ANNUAL SOW THISTLE (*Sonchus oleraceus*, L.).

both in young and old plants, and upon all parts of it buds arise which ultimately come above ground and grow into strong, leafy stems. To make matters worse from the farmers' point of view, the roots are often very deeply seated in the soil, while small broken pieces easily take root and become new plants. Though the creeping underground parts, from which the thistle gets its common name, look very much like rhizomes, they are true roots, which bear buds ; no rhizomes are produced. The stems and leaves, both of seedlings and mature plants, are very sensitive to frost. The first frosts of November and December kill off all the green parts above ground, but the buds on the roots below are uninjured, and it is from these that the plant is chiefly propagated.

5.—THE STEMLESS OR DWARF THISTLE (*Cnicus acaulis*, Willd.), sometimes termed the Chalk Thistle from its habit of growing freely in pastures over chalk, may be at once recognised by its spreading rosette or tuft of very prickly smooth leaves, its almost stemless or sessile flower-heads, and its extensively creeping rootstock (Fig. 7). It is a perennial which sometimes occurs plentifully in dry pastures over gravel and chalk in the southern and central midland counties of England. The rosettes of leaves destroy the patch of herbage which they cover.

6.—THE ANNUAL SOW THISTLE (*Sonchus oleraceus*, L.) is a weed which causes considerable trouble in arable land. It is an erect plant which may attain three feet in height, and has a tubular grooved stem, which is branched, smooth, and shiny (Fig. 8). The leaves are bright green, the lower ones being stalked and much lobed, the upper lobed, or entire and angular, and clasping the stem. The yellow flowers, which appear in summer between June and September, are borne in crowded "heads," which are smooth or slightly cottony. The fruit is attached to a simple hairy pappus, which enables it easily to be borne away and distributed by the wind ; it should be remembered that this weed is only propagated by seed. It is widely distributed on most soils, but appears to grow most freely on medium sandy and calcareous loams.

7.—THE PERENNIAL OR CORN SOW THISTLE (*Sonchus arvensis*, L.) may be at once distinguished from the Annual species in the mature stage by means of its extensively creeping rootstocks and much larger flowers. It attains 2 to 4 ft. in height ; the stem is tubular and angular and clothed with yellow sticky hairs in its upper part ; the leaves are wavy and toothed, but very variable ; and the heads of yellow flowers are rather hairy, and 1 to 2 inches in diameter. It spreads both by seed and by the creeping rootstock. The flowers open later than in the case of *S. oleraceus*, in August and September, at which time the latter species is producing seed. The Perennial Sow Thistle is a vigorous grower, occurs on all soils in arable land, and may occasion great trouble and damage. Its presence is frequently manifested in corn crops in late summer, when the large yellow flower-heads are very conspicuous.

Methods for the Extermination of Thistles.

The methods adopted for the destruction of thistles, if they are to be of any use, must take into consideration the life-history of the plant. The old rhyme which advises leaving the cutting of thistles until July is excellent so far as the spear, welted, and marsh thistles are concerned, but it is absolutely useless for the checking of the creeping thistle. In fact general advice for all kinds of thistles is valueless.

1.—*Destruction of Spear, Welted and Marsh Thistles.*—The spear, welted, and marsh thistles are all biennials and can be destroyed by the same methods. Each plant grows but two seasons, at the end of which it exhausts itself in seed production and dies. *In the case of these three thistles seeding must be prevented. This can be done by cutting with a spud below ground, or with a scythe, sickle, mowing machine or thistle-cutter above ground in late June or July,* when the plants have sent up their flowering stems, and before the flowers have opened. Cut at this time they die (as they would do in another month or two in any case) and seed is not formed. This plan effectually gets rid of plants which are in their second season of growth. Seedlings must, however, be dealt with also. These are best spudded in meadows and pastures in late autumn and in spring. At this time they are in the form of a rosette close to the ground. In cutting with the spud or similar instrument it is important to be certain that the roots of the plant are cut through below the bud part from which the leaves arise. It must also be borne in mind that in the case of the marsh thistle there are a number of roots to be severed, and the spear thistle and welted thistle often have more than one strong root. Sometimes one of the roots is cut and the other left, but this is quite useless. *To make certain of the result, the spud should be driven well below the surface of the land and the severed rosette of leaves turned upside down.* It is easily done, and requires no more time than slovenly work. Cutting at these definite times of the year, namely, in autumn and spring for the eradication of the young plants and in June or July for the destruction of the old ones so as to prevent seeding, is all that is necessary in the case of the three kinds of thistles mentioned.

2.—*Destruction of Creeping Thistle.*—The creeping thistle cannot be destroyed by the methods outlined above. Seeding must, of course, be prevented, but to wait until June or July before cutting is an excellent way of keeping this pest in a state of robust health. During the summer the plants manufacture a large amount of food-material in their leaves, and this is transferred and stored below ground in the roots and root buds. Comparatively little seed is produced, and little of the stored food is needed for it. To cut off the stems after this storage has taken place has no exhausting effect on the crop, and the mowing of this kind of thistle once or twice *late in the season* can be practised for years without diminishing its vigour. *To cope with the creeping thistle it must be cut early in the year, soon after it comes above ground, and the cutting should be repeated as frequently as possible throughout the season.* For every shoot sent above ground the thistle uses some of its stored material, and if the stems and leaves, which are the plant's machinery for making more food, are destroyed as soon as they appear, exhaustion and death certainly result. Both old and young plants must be dealt with in this way. *Faithful systematic cutting with the spud or scythe in meadows and pastures throughout two seasons, or the growth of a couple of root crops in succession where the weed is very prevalent in arable land, is a sure plan of getting rid of this most troublesome agricultural pest.*

Experiments conducted at the Harper Adam Agricultural College in 1907, 1908 and 1909, showed that the Creeping Thistle may be destroyed in three years in grass land by cutting three times in the first and second seasons (in early June, late July, and once later), and twice in the third year (in early June and late July). Cutting was found to be best done when the plants were 4 to 6 inches above ground.

In the United States it has been found that small patches of the Creeping Thistle may be destroyed by covering the plot of infested ground with large sheets of strong tarred paper, securely fastened down with pegs and large stones. Light is excluded and all vegetation beneath the paper is destroyed.

3.—*Destruction of Stemless Thistle.*—The creeping rootstock and almost stemless character of this thistle combine to make eradication extremely difficult, for it is a perennial which stores food in the same way as the Creeping Thistle. It is not tall enough to be cut with the scythe or other implement, and it sometimes occurs in such numbers that continual spudding is a most tedious and expensive operation. Spudding, however, is the only practical mechanical remedy, and should be repeated throughout the summer months. An endeavour should at the same time be made to improve the general herbage by manurial treatment, and thus crowd out the low growing thistle. Isolated patches might be dealt with by the tarred paper method mentioned above, but the bare spots would need reseeding with grass and clover seeds afterwards.

4.—*Destruction of the Annual Sow Thistle.*—As this thistle is an annual only propagated by seed, it is clear that where it occurs, either in small or large quantity, the first thing to be considered is the prevention of seeding, and to this end it is important that the plants should be cut down before the flowers appear. The cutting of the plants, moreover, should not be confined to the fields actually infested, but (as with all other species of thistles) should extend to any waste land which may be adjacent, for such land is usually a fertile source of the thousands of plants which are found in cultivated fields. Cutting off with the hoe below the surface of the soil, or pulling up by hand, is equally effective in destroying the annual sow thistle. The easiest time for hand-pulling is when rain has softened the ground, and in corn crops this is doubtless the most expedient method. The regular and thorough hoeing generally practised will keep this weed down in root crops, and the same remark applies to garden cultivation. Surface cultivation with the harrow in spring destroys thousands of the seedlings.

5.—*Destruction of the Perennial Sow Thistle.*—This species may be combated in the same way as the Creeping Thistle (*Cnicus arvensis*), as its habits are very similar, it being propagated by seed and by creeping rootstocks which store up food during the period of growth in summer. A short rotation, with thorough cultivation and the free use of the hoe in two or three successive root crops, is perhaps the most certain means of killing this pest. Badly infested land may be laid down to grass for a few years, when the weed will be crowded out. Small patches may be destroyed by the use of tarred paper, as in the case of the Creeping Thistle.

Heavy crops of lucerne, vetches and maize tend to crowd out thistles of all kinds, and where it can be grown successfully maize is especially useful, as it casts a dense shade and is thoroughly hoed.

London, S.W.1,
May, 1906.
Revised, September, 1910.

Other Leaflets on Weeds published by the Board are :—

No. 63.—The Destruction of Charlock.
No. 112.—Weeds and their Suppression.
No. 180.—Dodder.
No. 194.—Coltsfoot.
No. 222.—Meadow Saffron.
No. 226.—Broom-rape.
No. 251.—Some Common Weeds.—I.

Leaflet No. 167.

BOARD OF AGRICULTURE AND FISHERIES.

Ducks and Duck-Breeding.

In this leaflet it is proposed to deal with the chief breeds of ducks, their rearing, management, and preparation for market.

The Breeds of Ducks.—*The Aylesbury.*—The Aylesbury duck received its name in the early part of the nineteenth century owing to the fact that it was extensively bred in the Vale of Aylesbury, until recent years the chief seat of the duck-breeding industry. For nearly a century this variety has supplied ducklings to meet the demand in the early months of the year, when prices are high, and for this special trade it has practically no rival among the pure breeds of this or any other country. The chief reason for its superiority in this respect is its rapid growth. Ducklings can be produced ready for killing at seven to nine weeks old weighing four to five-and-a-half pounds. No other breed will produce the same results in so short a time, and as ducks are very heavy feeders early maturity is an important consideration. The bones in this breed are very light, and there is comparatively little offal, while the flesh is well placed and light in colour.

Adult drakes weigh about 9 lb., and ducks 8 lb., but for breeding purposes a pound less in each sex is no disadvantage, provided that the frame is large and well-developed. The ducks lay eggs of large size, but are not prolific or very early layers in the winter months.

The Rouen.—This breed possesses many useful qualities, but does not mature as early as the Aylesbury. It is much slower in development, and during the early period of growth bone rather than flesh is produced. For this reason it is not suitable for the duckling trade, but it provides larger specimens than the Aylesbury, and is chiefly kept for the autumn and winter duck trade. The flesh is excellent, very full-flavoured, and when the bird is mature very abundant; it is much darker than that of the Aylesbury, and is richer than that of any of the other domesticated breeds. The Rouen is a moderate layer of large-sized eggs, but it does not come into profit so early as the Aylesbury. Fully matured birds weigh: drakes, 10 lb., ducks, 9 lb.

The Pekin.—The Pekin breed was first introduced into Britain in 1872, direct from China, but it was not until two years later that it attracted attention among poultry-breeders.

This duck is of attractive appearance and naturally vigorous, and, though of inferior quality to the Aylesbury for table purposes, it excels this breed as a layer. Adult birds generally scale one or two pounds less in weight and do not so readily lend themselves to fattening. For crossing with the Aylesbury the Pekin is very valuable, often producing birds larger than the former breed, and quite as rapid in growth.

The Indian Runner.—Within the past thirty years a variety of duck known as "Indian Runner" has become of considerable importance to breeders. Ducks of this type have been kept in Cumberland for more than fifty years, and they are much esteemed on account of their wonderful laying powers, which are greater than those of any other race of ducks. The eggs are about the same size as hens' eggs. The birds are usually hardy. For table purposes they are small, adults weighing 3½ to 4½ lb., while ducklings would be about 2 lb. lighter; their flesh, however, is excellent. As the name indicates, they are excellent foragers.

In appearance the Indian Runner is peculiar. Combined with the long, upright body of the Pekin, it has a very fine long neck, and its head and bill are also long and fine, these points being much exaggerated in the case of exhibition specimens. The body is not so deep as in the breeds already described, much more of the leg being seen. There are three colours: the fawn, the white, and the brown and grey; the fawn variety is generally favoured, but the white is rapidly increasing in popularity. In the case of the first and last-named kinds the head, breast, back, wings, and tail of the drakes are fawn or brown and grey respectively, with white neck and sides in each case, but the ducks are pencilled.

The Muscovy.—This variety has been known for more than three centuries, and it appears at various times to have been termed the Peruvian and the Barbary duck. The breed has never become popular, firstly, because it is not pleasing in appearance, and, secondly, because it has so bad a temper that other fowls can scarcely be kept where it is. On the other hand, the birds become very tame. They cannot be kept in confinement, but must have freedom, and, being great wanderers, they sometimes remain away several days. They grow to a very large size, and drakes will often scale 12 lb. when matured. As layers they are somewhat uncertain.

The Cayuga.—Several attempts have been made to popularize the Cayuga duck, but without success, its small size and dark flesh finding little favour on our markets.

It is excellent in meat properties, the darker-coloured flesh and full flavour resembling that of the wild duck. As a layer, except where the strain has been enfeebled by close-breeding for exhibition purposes, it is exceedingly good. Crossed with a Pekin, it produces a very good table bird. The body is long and wide, with a flat back and very deep breast; the thighs are short and plump, and the legs short, strong and small; the neck is long, and the head and bill long and rather narrow; the plumage is bright metallic black; and the legs and feet are black or smoky-brown, and the bill blue-black. Adult birds weigh 6½ to 7½ lb.

Breeding.—The breeding of ducks is especially suited to those who have only a limited amount of space at their command, but it is also an industry which can be followed by the farmer. As is well known, this industry is largely developed in Buckinghamshire and Bedfordshire. Within the last few years the area has extended considerably, and success has been achieved in other parts of the country, notably where the soil is light and of a gravelly nature. As a general principle, it should be realized that the breeding stock must have access to water in which to disport themselves, the progeny being much stronger if the parents have liberty It must also be noted that the keeping of stock ducks of the larger type all the year round is not economical unless they are upon free range and are able to secure a large portion of their own food. Consequently, in the duck-breeding centres small occupiers who hatch and rear the ducklings do not keep the stock birds, but purchase eggs for hatching. This plan can be generally recommended, as it enables many to undertake the rearing of ducks who would not otherwise be able to do so, and prevents that enfeeblement of the stock which might result from continuous in-breeding.

Stock birds should not be forced.—Where ducks are to be kept as stock birds, they should be given full liberty after the first fortnight of their existence and allowed free access to water. The birds will then grow slowly as compared with those which are subjected to the forcing treatment; but they will build up a strong frame and a reserve of strength which are essential to their future work as breeding stock. Size is attained ultimately, but not with the same speed, and the birds are not fit for killing as ducklings.

Districts suitable for duck raising.—Districts which are specially suited to the raising of chickens may not be equally favourable for ducks, and those where ducklings can be reared with advantage are generally undesirable for turkeys. Market requirements must, of course, be considered, but it is useless to attempt to force production where natural influences are antagonistic. When the object is the raising of ducklings, there can be no question that valleys or well-watered plains are much better than the higher lands, and for the breeding stock the presence of sufficient water in which they can exercise themselves is important. Dry or harsh soils should be avoided; otherwise satisfactory results can hardly be expected. The greatest success is met with in valleys where the land is fairly good and natural food abounds.

Space required.—Fowls, geese, and turkeys alike are active in habit, and thrive best when they have a free range; ducks occupy a place by themselves. Whilst the older birds—the breeding stock—thrive all the better for plenty of space and for an abundance of water, the youngsters can be massed together to an extent which would be fatal to any other class of poultry. During the duckling stage, when they are fed for early development, they appear to be able to sustain forcing for a longer period than any other species of poultry, and the desire to wander is apparently dormant. Further, they appear to be less influenced by the injurious effects of tainted ground than are chickens or young turkeys. The "duckers" of the Vale of Aylesbury and surrounding districts, by cropping the land heavily when vacant, have for very many years been able to rear large numbers of ducklings upon small areas, where the birds are crowded together with no ill results. Duck farming, therefore, presents special advantages to the occupier of a small area of land, as he can raise a much larger number of birds per acre per annum than would be possible with other kinds of poultry.

Buying eggs for hatching.—Upon some of the establishments in America where duck-raising on a large scale is followed, it is customary to keep large numbers of adult birds for breeding, up to as many as 500. These are divided into flocks of about fifty, of which ten or fifteen are drakes. The drakes are by no means quarrelsome, but appear to live peaceably with each other. The capital expenditure for houses is therefore much less than with any other class of poultry. In Britain, as a rule, the duck-raisers do not keep the breeding stock, but purchase eggs for hatching from farmers and others. Such a division of labour has many advantages. Probably, however, the chief reason is that duck-raisers were originally mainly small occupiers who could not attempt to keep both breeding stock and youngsters, on account of the amount of space required for the former. It has, therefore, been found more profitable to leave the work of breeding to others and to purchase eggs, confining attention to the work from the time hatching commences. By so doing the ground can be left vacant for several months of the year, although many of the "duckers" do not trouble themselves in that direction, as the birds have no access to grass at any period of their existence. What is found to be almost a necessity with "duckers" has proved equally desirable where operations have been on a larger scale. The one point in favour of the American plan is that the race or quality of the stock can be controlled, but on all other grounds the plan adopted in this country is preferable, as the breeding stock is kept by ordinary farmers under more natural conditions, and the ducklings are hardier.

Hatching and Rearing.—*System of Hatching.*—In Britain the system of hatching has until quite recently been entirely by means of hens, artificial methods not being favourably regarded in the duck districts of Buckinghamshire and Bedfordshire. Though this feeling is not so pronounced as formerly, incubators having been used within the last few years by progressive duck-breeders, the majority still regard the natural method of hatching as alone calculated to secure success. Where the ordinary system is retained, hens—not ducks—are used for hatching, as it is recognised that ducks are unreliable and late in becoming broody, and are therefore of no use for producing early birds. Up to a few years ago it was considered doubtful whether artificial incubation would give as good results with ducklings as with chickens, but American and British breeders have since proved that duck-hatching upon a large scale by means of incubators can be made successful, and that for bringing out these birds in a wholesale fashion it is the only method which can be depended upon. Artificial incubation has proved quite reliable if a plentiful supply of fresh air is ensured and the eggs are damped daily. Formerly the great difficulty was to rear the artificially-hatched ducklings, but the process is now better understood. The period of incubation is 28 days.

Ducklings require heat for a much shorter period than do chickens; during ordinary weather a week is quite sufficient, but when the weather is severe they may be retained in heated rooms or brooders for a few days longer. They are frequently raised without any heat at all in the mild season, being simply kept in small boxes, wherein their own body heat is sufficient, but it is wise to be on the safe side if the temperature is low.

Housing.—Ducklings can bear a considerable amount of exposure after they are three weeks old; they should always have an abundance of fresh air. Many "duckers" keep them in houses built like pigsties, with an open yard in front. Another method is to enclose plots of ground, about eight to the acre, with wire-netting a foot in height. In each run is placed a small house, which may be of the simplest character. Packing-cases answer excellently for the purpose with a little alteration, the lid forming the door, and a few holes being made for ventilation, additional cases being provided as the inmates require increased accommodation. Dry and clean bedding is an important consideration during wet, cold weather. A good plan is to fix a slatted floor 6 to 8 in. from the bottom of the house; with a covering of straw this forms a comfortable bed and allows much of the damp and dirt to pass through. During the later part of the period of growth houses can be dispensed with, and the ducklings may be allowed to remain in the open day and night. Under such conditions it is sometimes necessary, during the prevalence of high winds or driving rain, to hang sacking over the netting as a means of shelter. In America more elaborate provision is made, long ranges of shedding being provided, divided inside into compartments by boards a foot high, and having small runs outside formed by wire-netting. Sheds of this description also exist in this country. Under such a system there must be a considerable waste in the manure produced and an increased danger of the runs becoming tainted. As these large houses cannot be moved, the plan of movable pens is to be preferred, and the same ground should not be used for the ducks more than once in four years if a large number is reared. The cost of removing the runs is small, and is more than compensated for by the increased crops secured owing to the fertilising properties of the manure.

Water not required for ducklings for fattening.—The absence of a pond or stream does not decrease the productiveness of ducks, but it is found that the eggs are less reliable for hatching and ducklings bred from birds kept entirely on the land are less vigorous, do not grow nearly so fast, and are more subject to disease. It is therefore desirable that birds intended for stock should be allowed access to water after they are a fortnight old. But so far as young birds for the table are concerned, they grow more rapidly if they are denied water except for drinking purposes. The great majority of English ducklings marketed during the spring and early summer have never been in water, though sometimes "duckers" allow the young birds a bath a day or two before they are killed.

Feeding.—Ducks are rather gross feeders, and the results of experiments in Great Britain as well as in America have shown that nitrogenous food is essential to ensure a plentiful supply of fertile eggs. Their natural food consists largely of slugs, worms, &c. Hence, unless there is an abundant supply of these, meat should be provided. During the breeding season old ducks should not be supplied with food of a fattening nature. The most suitable food is barley meal mixed with twice the quantity of thirds or sharps, and to this should be added some cooked lean meat. Butcher's offal, when not fatty, is excellent for the purpose. The food should be given warm and of crumbly consistency; it should be fed in troughs. Where the birds are at liberty they only require two meals per day, one early in the morning and the other about an hour before dusk. They must be supplied with water to drink, or they will not feed properly.

Ducklings.—In feeding ducklings, as great a variety of food as possible should be provided. Barley meal, cheap oatmeal, boiled rice, each with about one-fourth of fine sharps, will afford change of diet. With these should be mixed cooked lean meat or tallow greaves, unless a plentiful supply of worms is obtainable. In the duck districts tallow greaves are largely employed, but in many places carcases of animals can be obtained. Four feeds daily should be given. If the ducklings are to be reared for stock birds, the food recommended should be continued until they are fully matured. Indian meal is often used, but it is deficient in albuminoids, and should be fortified in that direction by lean meat.

Fattening.—Where the ducklings are to be killed at an early age, the system of feeding referred to above is only continued for five weeks, by which time the birds will have grown considerably. It is then changed, with the object of filling up the frame.

The final stage in the growth of ducklings intended for market is very rapid. The food which yields the best results in quality of flesh is rice properly cooked and mixed with about one-fourth its bulk of tallow greaves or meat. It is not, however, a cheap food. At this period fatty material is essential to soften the flesh. Barley meal, buckwheat meal, and Indian meal are often used instead of the rice, but they do not yield the same result. Very good results have been obtained by feeding with broken biscuits bought in large quantities from the manufacturers. In preparing the rice, one gallon should be added to four gallons of water and about four pounds of the greaves or meat. This mixture should be allowed to simmer gently until the rice has absorbed all the water, when it should be soft, yet not mushy. In order to aid digestion the birds should have a plentiful supply of coarse grit or fine gravel, without which much of the food will be lost and the ducklings will not fatten. Green food is also valuable, and almost any garden stuff is good for the purpose. The birds should be fed three times a day, the object being to encourage eating, so that quick growth may be secured. During warm weather nettles are boiled two or three times weekly and mixed with the food, using all the liquid in which these are boiled. By using rice as recommended, ducklings are produced weighing from 4 to 5½ lb. at eight to nine weeks old. Rapid growth is essential to ensure success in the duckling trade. The birds must be killed before they are nine weeks old, for there is then a change of feather, which reduces their condition, rendering them unfit for market. By the time feathering is completed they will have consumed a great deal of food and become far less profitable. The chief demand for ducklings is from February to July.

Killing and Plucking.—When sufficiently fattened the birds are starved for twenty-four hours and killed by dislocation of the neck. Plucking should take place immediately while the body is warm. If killed at the right age the feathers come out easily and cleanly. During the cooling process the birds should be placed upon a slab, breast downwards. They must not be packed until quite cold, otherwise they will deteriorate in quality. Feathers should be carefully sorted, and divided into (1) down, (2) feathers from the back and neck, and (3) wing feathers.

Where suitable markets are available duck-raising affords a profitable pursuit to small-holders, and it is equally suited to farmers who are willing and able to give the necessary time and attention to the birds, and who can obtain a supply of eggs at the right season. It is, however, an industry which entails both hard work and skill in handling large numbers of birds for several months of the year.

London, S.W.1,
June, 1906.

Revised, June, 1919.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 168.

BOARD OF AGRICULTURE AND FISHERIES.

Hints on the Formation of Permanent Pastures.

It is difficult to give precise rules for laying down land to grass; the treatment must vary greatly under different conditions. From fifteen to twenty species of plants are usually included in the mixture for permanent pastures, and it is clear, that not only will the final result depend upon the species chosen, and upon the proportions in which they were originally present, but also on the soil, the manure, the seasons, and the manner in which the pastures have been grazed.

Preparation of the Land.—Before the subject of the seeds mixture proper is considered, it will be convenient to refer briefly to some points connected with the preparation of the land. Good grass seeds are expensive, but bad grass seeds are still more so, and hence the only way in which the cost of any particular mixture may be lessened is by reducing the seed-rate. It is plain that if the number of seeds is reduced, close attention must be given to the preliminary cultivation. In the first place, it is necessary that the soil should be thoroughly cleaned, and that annual weeds, as well as couch, should be destroyed. Small and slow-growing grasses are much more readily injured by annuals than are such vigorous plants as wheat or oats. In the second place, a fine tilth and a firm surface will be necessary. If the ground is rough, a number of the seeds must perish; bare patches will thus be formed, which will subsequently extend and disfigure the pasture. If the soil is soft and open, seeds may be buried too deeply, and the "plant" will be thin. It is generally best to sow on a bare rolled surface, harrow in lightly, and then roll again at once. A further important consideration in preparing land for grass and clover plants, is the manurial condition of the soil. Although grasses are benefited by nitrogenous manures, it will seldom be desirable to apply such manures, either just before or immediately after sowing the seeds. The first effect of the manuring would be to increase the quantity of straw produced by the corn crop with which the seeds have been sown, and thus to repress rather than aid the young pasture plants. Phosphatic manures, such as basic slag or superphosphate, on the other hand, should be used liberally, and may perhaps be best applied to the preceding root crop. If the root crop has not received either of these artificial manures, one or other may be worked into the land before sowing the seeds. In dry districts and on light soils, 3–5 cwt. of superphosphate should be applied in spring, but for most soils, 4–6 cwt. of basic slag may be recommended. This manure may be applied at any time between November and March, when the soil is in suitable condition. If farmyard manure has been used freely (12–15 tons per acre) for the root crop, and if part of this crop has been consumed on the land, a potash manure may usually be dispensed with; and even where roots have been carted off, potash manures are not likely to be required before sowing, except on light gravelly, or on light peaty soils.

How to buy Grass Seeds.—The purchasers of grass seeds may broadly be divided into two classes, those who let others choose their seeds-mixture, and those who select their own. In the first class are those who have no knowledge of grasses, and who, for various reasons, are unable to give the subject personal consideration. This large class may be recommended to go to those seedsmen who have made grasses a speciality, state their requirements and leave the selection of the seeds to the merchant. The cautions which may be given to a farmer of this class are the following:—Be quite sure of your seedsman, remember that grass seeds are liable to impurities, and are frequently of low quality; further, that these defects, though easily detected by the expert, may not be within the knowledge of the ordinary trader. A merchant may be perfectly honest, but if he has not given close attention to grass seeds and their impurities he may supply unsatisfactory seeds. When quotations are asked for, the seeds of the best seedsmen may appear to be expensive, but a man who has no special knowledge must pay for the special knowledge of others, and in the case of grass seeds, this knowledge is usually well worth paying for.

The mixtures prepared by our seedsmen are compounded on the principle of sowing down a full supply of every plant which is likely to suit the soil. These mixtures usually furnish from sixteen to twenty millions of seeds per acre at a cost of 20*s*. to 40*s*. The only method of reducing the cost—which can be recommended to the farmer who is ignorant of the grasses—is to sow less seed, say 20 lb. to 30 lb. instead of the 30 lb. to 40 lb. usually put in. The seedsman recommends 30 lb. to 40 lb. for soils in "fair average condition," but if by skilful tillage and manuring the land is got into first-rate order, the quantity to be sown may safely be reduced. By sowing good seeds, and by farming well, the farmer who has no special knowlege may succeed in forming good pastures, even upon land of medium quality; but he cannot expect to obtain either the best or the most economical results, and he will seldom succeed on poor land, or upon land that has not been liberally manured. To be successful in forming pastures, the farmer must understand the special cultivation required by pasture plants, and must treat them with the same intelligence that he now bestows on corn and roots.

The Stages in a Pasture's Existence.—The hints which follow are addressed to farmers who wish to choose their own seeds, and improve on their present system of laying down land to grass. These hints are based on an article published in the *Journal* of the Board.* It was pointed out in that article, that a pasture passes through three clearly defined stages of existence, that a somewhat different type of herbage is associated with each stage, and that the management must vary with the type of herbage which may cover the soil at any given time.

The first stage of the pasture's existence lasts for from two to three years, and on almost all soils, rye-grass and red clover predominate in the herbage. The red clover soon begins to disappear, and a rapid change then sets in ; the soil appears to have become exhausted, the rye-grass gets poor and thin, and for a time the deterioration is very marked. This stage of poverty may last for from three or four years on good soil, up to ten or twenty years on poor land ; indeed, on very poor, neglected pastures, this second stage will continue indefinitely. The characteristic of the second stage is the absence of turf, so that everywhere bare soil shows through the herbage. This bareness is nearly always very marked on those pastures on which white clover does not grow freely.

On soils of fair to good quality, fertility gradually accumulates with rest, and a turf begins to form. This slowly thickens, until on fine land, after an interval of perhaps twenty to thirty years, it forms the rich velvety covering of perennial rye-grass and white clover characteristic of our best pastures ; or it may be the rougher mixture of permanent grasses, clovers, and weeds, which are common on second-rate land.

Seed-mixtures.—In the article above referred to, it was pointed out that pastures must *grow* old, and that the mere sowing down of plants in the proportion in which they are found, or desired, in old pastures, will not make a pasture

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* Journal of the Board of Agriculture, Vol. XII., October, 1905, p. 385 ; and November, 1905, p. 449.

either good or permanent. Examples were given of experimental mixtures which had failed, and also of one which had succeeded. The particular mixture which succeeded was one recommended by Mr. R. H. Elliot, of Clifton Park, which had been sown down on a poor clay soil, in one of the experiments conducted by the Cambridge University Department of Agriculture. Mr. Elliot's mixture cost about 40*s.* per acre, and, although it was successful, many farmers would consider it too expensive.

Mixture for poor Clay Soils.—The following seeds are therefore suggested for those who require a cheap mixture for sowing upon poor clay soils:—

Plant.	Weight.	Number of Seeds in Thousands.	Cost.*	
	lb.		*s.*	*d.*
Italian rye-grass	4	1,069	1	4
Perennial rye-grass	3	635	0	10
Timothy	1	1,307	0	7
Cocksfoot	2	809	2	0
Meadow fescue...	2	467	2	6
Tall fescue	½	120	0	7½
Hard fescue	1	555	0	8
Meadow foxtail	1	441	1	4
Tall oat-grass	½	62	0	7
Golden oat-grass	¼	280	0	11
Rough-stalked meadow grass ...	¾	1,626	1	1
Smooth-stalked meadow grass ...	¾	1,085	1	0
Crested dogstail	¼	210	0	4½
Perennial red clover	1½	320	1	7½
Alsyke clover	1½	1,055	1	7
White clover	2	1,434	2	6
Lucerne	1	219	1	1
Common sainfoin (unmilled) ...	5	110	1	4
Burnet	4	259	3	3
Chicory	1	284	1	3
Yarrow	⅛	417	0	6½
Total	33⅛	12,764	27	0

The reasons for recommending the foregoing mixture of seeds are:—

(1.) It is desirable to include in a mixture for a permanent pasture, all good plants that have any chance of success. Some may disappear, but if they survive

* The prices quoted are calculated on the average of price lists for the five years 1908-12. Prices are subject to considerable variation, and this mixture might sometimes be made up at a much lower cost though perhaps occasionally dearer.

all will be of use, especially in the second stage of the pasture's growth. Sainfoin and lucerne are only suitable for a southern climate, and they would not grow upon a stiff, undrained, clay soil; but if the subsoil contains an abundance of chalk, they may be recommended.

(2.) Both rye-grasses have been included, because they are quick-growing plants which cover the surface during the first two or three years. A covering is absolutely necessary on clay soils in dry districts, for if the sun gets at the soil, many of the less vigorous plants are destroyed before they have time to become established. The quantity of rye grass recommended is small, because thick seeding tends to choke out all other plants. Italian rye-grass is used mainly with a view to giving a fair bulk of produce in the first year; most of it will disappear after the first year, and will allow permanent plants room to develop.

(3.) The quantity of the larger permanent grasses is much less than is usually recommended. A careful examination of a number of recently sown pastures has shown that when rye-grass is included in the mixture it is unnecessary to sow much seed of the slower growing grasses.

(4.) Timothy and the two meadow-grasses have been used in greater quantity than other permanent grasses, because of their cheapness. When the price per million is considered, these grasses and white clover form the cheapest pasture plants. In moist seasons all four plants grow well, but in dry summers timothy and rough-stalked meadow grass are poor growers. In districts when the summer rainfall is low, the quantities of these two grasses recommended in the above mixture should be reduced by one-half.

(5.) Deep-rooted plants—burnet, chicory and yarrow—are useful in opening up the soil, admitting air, and promoting a healthy development of the roots of other plants.

The principles kept in view in preparing the above list of seeds, were three in number. Firstly, the necessity of covering the soil quickly and uniformly. Secondly, the necessity of preserving a good "plant" of white clover, which, with the assistance of suitable manures, may be made to occupy a large portion of the soil during the second stage of the pasture's existence. Thirdly, the introduction into the pasture of a large number of good plants, some of them, like cocksfoot, timothy, and meadow fescue, especially useful in the second stage, and all more or less desirable in the mixed herbage of a permanent pasture.

The seeds-mixture is based upon the observation of the behaviour of pasture plants in a limited number of experiments in the Eastern Counties. It has not been tried and tested under different conditions, and its real purpose is to suggest a mixture for the use of those who are beginning the study of pasture plants and pastures. No great importance need be attached to the exact quantities of timothy, cocksfoot, &c., recommended. The quantities of rye-grass and clover specified are the smallest quantities that could be depended upon to produce a cover, but in the other cases, the object has been to introduce a sufficient stock of each of the plants into the pasture, and they are not meant to occupy much of the surface until the third or fourth year.

As the mixture is intended for use on poor clay soils, and as such soils are generally very deficient in phosphates, it will be desirable to use basic slag liberally on the young pasture. If the roots have not received a heavy dressing of basic slag or superphosphate, then from 7–10 cwt. of basic slag should be applied to the seeds in the autumn after the corn crop has been cut; but if the land has been manured immediately before sowing seeds, the application of basic slag to the young pasture may be delayed for a year.

Mixture for Light and Medium Soils.—If a pasture on a clay soil is properly managed, white clover will cover the surface pretty uniformly about the third or fourth year after sowing, and it will often grow well on light loam soils in moist seasons; but under ordinary circumstances, white clover cannot be expected to cover nearly so large a proportion of the surface of light as of heavy soils. Chiefly for this reason, it is desirable to sow rather more grass on light soils than has been recommended in the above table, so that the place of clover may be taken by cocksfoot, the meadow grasses, hard fescue, and crested dogstail, during the second stage of the pasture's development.

For sowing down permanent pastures on light and medium soils in a district having an average rainfall of 25–30 ins., the following mixture is suggested :—

—	Percentage Composition.	Per Acre. Approximate Number of Germinating Seeds in Thousands.	Approximate Weight.	Approximate Cost.*
Top Grasses—			lb.	*s. d.*
Perennial rye-grass	10·0	1,500	7	2 1
Cocksfoot	6·6	1,000	2½	2 6
Timothy	5·0	750	½	0 3½
Italian rye-grass	3·3	500	2	0 8
Meadow foxtail	1·6	250	½	0 8
Meadow fescue	1·6	250	1	1 3
Bottom Grasses—				
Hard fescue	10·0	1,500	2¾	1 10
Rough-stalked meadow grass	10·0	1,500	¾	1 1
Smooth-stalked meadow grass	10·0	1,500	1	1 4
Crested dogstail	3·3	500	½	0 9½
Golden oat grass	1·6	250	⅕	0 8½
Leguminous Plants—				
White clover	20·0	3,000	4¼	5 5
Alsyke clover	5·0	750	1	1 1
Perennial red clover	3·3	500	2¼	2 5
Lucerne	1·6	250	1¼	1 4½
Medick	1·6	250	¾	0 6
Miscellaneous Plants—				
Yarrow	3·3	500	⅛	0 9
Chicory	1·6	250	1	1 3
Total		15,000	29⅓	26 0

It is impossible to discuss here the variations that should be made in the above mixture in different districts, but it may be pointed out that rough-stalked meadow grass is a poor plant on a hot dry soil, and that lucerne, which is particularly useful under these conditions, is not adapted for northern pastures. In the south, on soils well supplied with lime, 5–10 lb. of unmilled common sainfoin may be included in the above mixture. Unmilled sainfoin often contains burnet as an impurity, and if burnet can be purchased cheaply in this way it may also be sown with advantage.

The mixture recommended for clay soils was made up in the usual way by taking a certain number of pounds of each seed ; in the foregoing table a second method of con-

* The footnote to page 4 applies equally here.

structing the mixture is shown. The approximate number of germinating seeds to be sown has been fixed upon, and the figures in the other columns have then been calculated.

The "pound" is altogether unsuitable when dealing with seeds. Not only does the number of seeds per pound vary widely, but the number of plants produced by a pound of different samples of the same seed is liable to great fluctuation. Farmers are therefore recommended to consider "number" and not "weight" when sowing, and to aim at a certain number of plants of rye-grass, &c., not at a certain number of pounds of seed. The seed merchant should be asked to guarantee the purity and germinating power of his seeds, and then the approximate number of plants that a pound will produce can be readily ascertained. It is not intended that the farmer should attempt by exact calculation and careful weighing to sow the precise numbers given in the above table. This would of course be impossible, and even if possible the attempt would be useless; for as has already been explained, soil, season, and manuring so affect the young pasture that it usually bears no close relationship to the particular mixture used in sowing, and a few thousands of seeds more or less will make but little difference. Why then, it may be asked, should one trouble about the percentage composition of the mixture? The reason for making some attempt at precision is this:—while soil and climate affect the character of the pasture produced by any particular seeds-mixture, the final result is in part due to the influence of one plant upon another. Rye-grass will affect cocksfoot, for example, and red clover will affect white clover. In order, therefore, that we may be able to explain the final results fully, we must know approximately the composition of the seeds-mixture, and a mere record of the number of pounds sown will not help us much because of the variation in the quality of seeds. One reason why agriculturists know so little about seeds-mixtures, is that they have no experience to guide them. Some mixtures have been sown and have given good results, other mixtures have been sown and have failed. When a permanent pasture does not answer expectations, four or five years after it has been sown down, it is rarely that the causes of failure can be traced. The careful seedsman who knows the exact composition of the seeds-mixture is unable to follow its history after it passes into the hands of the farmer; the farmer who knows all about the effects of season and manure, often pays no heed to the composition of the mixture, and thus he is no more able to explain success or failure than the seedsman. Until agriculturists give more attention to the compounding of the seeds-mixture than they now do, we shall be without that practical experience which is necessary to success in this, as in all departments of farming.

Six to nine months after sowing the seeds, light soils should receive from 3 to 5 cwt. of superphosphate, and from 2 to 4 cwt. of kainit per acre; and these manures, in quantities varying with the condition of the herbage, must be repeated at intervals of from two to three years until the pasture becomes established. Nitrogenous manures may also be employed with advantage under certain conditions, but to use them successfully on pastures, a farmer must be well acquainted with their properties, and their general use is not to be recommended. A dressing of from 7 to 10 tons of farmyard manure, two or three years after sowing down a pasture, would usually prove very beneficial.

Success in the formation of a pasture depends in no small degree on the treatment of the plants in the early years of their existence. After the covering crop has been harvested the young "seeds" should be rolled with a smooth roller as soon as the implement is likely to make any impression on the ground. This will effect consolidation and promote "tillering." Further, before being depastured the plants should be allowed to make considerable growth and establish a firm and fairly deep root-hold as a precaution against winter frost, spring drought, and the risk of being uprooted by stock. At the same time, if a short-lived plant such as red clover be allowed to reach or even approach maturity in the first autumn, the chances are that by spring much of it will have died. Grazing will check this, and, at the same time, encourage branching of the grasses. In spring the seeds should again be rolled to counteract the loosening effects of the winter's frost, and thereafter laid up for an early hay crop. Judicious grazing is not an inappropriate means of starting off a young pasture, but on the whole a hay crop cut when the earlier grasses begin to flower—thus obviating undue exhaustion of the plants by the process of seed formation and at the same time securing root development—is to be preferred.

In subsequent years the object must be the formation of a close even sole of herbage, a condition that implies uniform grazing and, if need be, the mowing of the rougher portions of the field which stock may refuse to eat.

London, S.W.1,
August, 1906.
Revised, May, 1912.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

The Cultivation of Mangolds.

In Great Britain the mangold (*Beta vulgaris*) is chiefly cultivated in the southern and midland counties of England, since it requires a warm, somewhat dry, climate. The mangold grows best upon rich loams or upon such peaty soils as are found in the fens; but in a suitable climate it is not very exacting as regards soil, and good crops may be grown upon light loams or upon stiff clays. In general it succeeds better upon stiff than upon light land. Under favourable conditions the mangold crop is one of the most valuable that a farmer can grow. As a food for dairy cows, for ewes after lambing, and even for pigs and poultry, mangolds are of great value, and, as they store well, they are admirably fitted for spring and early summer use. When they are pulped, mixed with chaff, and fed in conjunction with cake and meal an excellent winter ration for milk production is obtained. The amount fed may vary widely with the season of the year and with the quantity available. For dairy cows from 50-70 lb. per head per day is an ordinary allowance while full-grown fattening cattle may receive from ¾ cwt. to 1 cwt.

The varieties commonly grown are the white-fleshed or Yellow mangolds, the yellow-fleshed, Golden or Orange mangolds, and the pink-fleshed, Red mangolds, all of these occurring in sub-varieties described according to shape, as Globe, Intermediate, Tankard and Long varieties. The mangold is essentially a food rich in sugar, nearly two-thirds of the total dry matter which averages about 12 per cent. consisting of that substance. The percentage of dry matter, however, varies considerably. Yellow Globe mangolds average about 10·5 per cent., while the Golden Globe, Golden Tankard and Long Red varieties may contain from 12·5 to 13 per cent. Small roots on the average are somewhat richer in dry matter than large ones. Certain changes take place in storing which render the roots more suitable as a food for stock, and they are therefore usually kept over winter until the early months of the year. They may, however, be fed to stock from October or November onwards—though not so suitable at this period—until the end of the following summer.

Preparing the Seed-bed.

As one of the root or fallow crops, mangolds follow a corn crop. They allow the ground to be thoroughly cultivated and cleaned, and as they are deep-rooting they materially assist in getting the land into good "heart" for the succeeding corn crop. If the land is at all foul with weeds, autumn cultivation should be directed to cleaning, after which long manure should be carted on during dry weather and the land ploughed deeply for the winter. In some cases, however, the land is laid up in ridges for the winter with dung enclosed. If desired, dung may be applied in spring, but it should then be in the "short" or rotten condition. For seeding purposes a deep, mellow tilth is required, and to this end spring cultivation takes the form of ploughing, scuffling or cultivating, and harrowing, all perennial weeds being as far as possible removed. The aim should be to prepare a fine seed bed ; but care must be taken not to over-dry the soil. If the soil is clean, it is desirable to prepare the ridges a fortnight or more before sowing the seed. When the land has been ridged in late autumn or winter the ridges are slightly harrowed down, at seed time or a little before, and artificial manure distributed. The ridges are then made up again with a ridging plough. If dung is to be applied in spring (1) the land may be ridged, and the dung spread, after which the ridges are split back, or (2) when sowing is to take place on the flat the dung may be ploughed in by the ordinary plough. Applications of dung in spring are, however, inadvisable in dry districts, and where mangolds are sown on the flat, it should be ploughed in during the previous autumn or winter.

Manuring.

Mangolds are much influenced in yield by the character of the manuring.

As in the case of most crops so in this : the manuring may be conducted along three main lines. The grower may depend on farmyard manure alone, or on artificials alone, or on a combination of both, according to the particular circumstances of the farm. If farmyard manure is abundant and of good quality, it may be most profitable to rely on it alone. On a farm where much straw is sold, or where the dung is chiefly used on the wheat or meadows, the mangold crop must be chiefly treated with artificials. But in the majority of cases the natural fertilizer is not so abundant, or of such high quality, as to be alone depended on, nor, on the other hand, is it so scarce as to be altogether ignored, and the result is that the mangold crop receives dung supplemented by artificials.

During the past fifteen years or so a large number of manurial experiments have been conducted on the manuring of this crop by agricultural colleges and societies, and although from the results thus obtained it is possible to draw conclusion which can be applied with confidence to average conditions, every farmer should himself determine the manurial requirements of his land by means of some simple and well-conceived field experiments.

The Use of Farmyard Manure Alone.—If land is in good "heart," and especially if it is the custom to top-dress the other crops in the rotation, it is often possible to grow a full crop of mangolds by using about 20 tons of dung without any addition of artificials. As a rule, however, it will pay better to use less dung for this crop, and to employ the surplus on some other crop of the farm, supplementing the dung by means of some artificial dressing.

The Use of Artificial Manure Alone.—Although large crops of mangolds can be grown without any farmyard manure, the use of artificials alone would be justifiable only under very exceptional circumstances. It might be warranted on outlying fields, or on farms favourably situated for the sale of straw, but in any case the crop succeeding the mangolds (unless it were barley) would seldom give a satisfactory yield without the direct use on it of a considerable amount of artificials. Speaking generally, if artificials are alone depended on for the mangolds they should be ample in amount and should contain all of the three important substances: nitrogen, phosphates, and potash. Of these, most attention should be given to the nitrogen, the bulk of which should be derived from nitrate of soda. This manure, in the great majority of cases, acts much better than sulphate of ammonia on mangolds. It is only in districts where the rainfall is heavy that the latter manure may replace the nitrate with advantage. Organic nitrogen, in the form of rape dust, blood meal, fish meal, dissolved bones, &c., often acts well in the absence of dung, and if these manures can be obtained at a reasonable price they may form a proportion of the mixture, especially on the lighter classes of soil. Without dung nitrate of soda may be used up to 3 cwt. per acre, though 2 cwt. will usually suffice, or half of this dressing may be replaced by a corresponding outlay on one or other or several of the manures just mentioned.

In the majority of cases superphosphate will furnish the most suitable form of phosphoric acid, 5 or 6 cwt. per acre being as much as will usually prove profitable. Basic slag does not generally prove a satisfactory substitute for superphosphate for use on this crop, at least when applied at the time of sowing the seed, though 3 or 4 cwt. per acre put on in early spring may, on heavy land, replace 2 or 3 cwt. of superphosphate. Dissolved bones, as has already been indicated, may to some extent be used, but bone meal is not to be recommended.

Potash has often proved to be the constituent that determines the success of this crop, and every farmer should take steps to ascertain its effect on his mangolds. Of the three forms generally available—kainit, sulphate of potash, and muriate or chloride of potash—the preference is generally to be given to the first on account of the common salt which it contains ; 5 cwt. per acre would be a suitable dressing in the absence of dung. Much has been written about the effects of common salt on the mangold crop, and there can be no doubt that in the absence of kainit its use, at the rate of 3 to 4 cwt. per acre, will often be found to pay, especially on the lighter classes of land.

The Use of Dung Supplemented by Artificials.—This is the usual and best combination in which to supply fertilizing materials to the mangold crop. The amount of dung which should be used per acre must depend chiefly on the aggregate amount at the farmer's disposal. Speaking generally and having regard to practical convenience, 10 tons per acre may be taken as the minimum, while little is to be gained by exceeding 18 tons. Of the supplementary artificials nitrate of soda is by far the most important, and 1 to 1½ cwt. per acre may be put as the normal allowance. Phosphates are of less importance, and 2 to 4 cwt. per acre of superphosphate will usually suffice. Although dung holds much potash, the addition of this substance in the form of 2 or 3 cwt. of kainit will usually prove profitable, and it should not be omitted unless previous experience has shown it to be unnecessary. Here, as where artificials alone are used, salt may be given at the rate of 2 or 3 cwt. per acre.

In some parts of the country it is the custom to top-dress the mangold crop during June or July with ½ to 1½ cwt. per acre of nitrate of soda, and the practice may be recommended if the crop appears to require assistance. Where this course is followed some reduction should take place in the amount put on at the time of sowing the seed.

As regards the manuring of mangolds see a *Special Report on the Manuring of Mangolds*, which can be obtained, post free, on application.

Seed and Sowing.

Mangold "seeds" as they occur in commerce consist of one to three true seeds embedded in a woody capsule, and this explains why several plants come up in a group, rendering careful thinning so necessary. The germinating capacity of mangold "seed" should be not less than 120 while it may be 180 or over.

Mangolds are usually sown between the beginning of April and the middle of May. Except in those districts which are exposed to late frosts, or in which mangolds are liable to "bolt," the earlier in April the sowing is done, the better are the prospects of the crop. Three to 6 or 10 pounds of "seed" are sown per acre, according to the method adopted, the quantity being least when dibbled. In most cases sowing on the ridge is to be recommended, but in dry districts or on light soils the "flat" system is preferable. Seed may be sown on the ridge by means of small drills covering two ridges at a time, with rollers before and behind the drill coulters, while on the flat an ordinary corn drill is employed. For small areas dibbling may be resorted to. The rows are usually from 26 ins. to 29 ins. apart when mangolds are sown upon the ridge, and from 22 ins. to 26 ins. apart when sown on the flat. It should be remembered that unnecessarily wide ridges mean a reduction in yield, and that the width should therefore be such as will just allow of after-cultivation being conveniently carried out. In dibbling, 1 ft. apart in the rows is about the distance for sowing, two or three "seeds" being placed in each hole. Mangold seed should not be sown deeper than ½ to 1 in. A roller should follow the drill when seed is drilled on the flat, and as a firm seed bed is necessary ridges should be rolled after sowing if the soil is at all loose or open.

Subsequent Treatment.

As soon as the young plants are well up the horse-hoe should be set to work, and all weeds kept down between the rows by repeating the hoeing until the widespreading leaves or the growth of the roots would render further treatment in this way harmful. Hand-hoeing also should be sufficiently frequent to keep down weeds between the plants in the rows. "Singling" commences as soon as the plants are well established, and usually from six weeks to two months after sowing. The plants are left 9 to 12 ins. apart, the lesser distance when the rows are over 2 ft. apart. Since several plants may grow from one "seed," some skill is necessary to carry out this operation in an efficient manner.

Top-dressing the crop once with nitrate of soda is frequently practised when the crop is about two months old (*see* p. 4), or two half-dressings may be given at a few weeks interval. A portion of the common salt may also be given as a top-dressing where this fertilizer is employed.

Pulling and Storing.

Pulling.—Harvesting of the mangold crop takes place during October or early November after yellowing of the leaves. The quantity to be lifted may vary from 15 to 50 tons per acre; from 20 to 30 tons is an ordinary crop. Mangolds are pulled up by hand, the leaves are *twisted off* to minimise "bleeding," and the roots are then thrown into heaps and covered with the removed leaves.

Storing.—Being very liable to injury by frost, mangolds must be carefully covered. They may be stored in large quantities in pits or clamps. In the system usually adopted the roots are first arranged in a long triangular "clamp" about 6 ft. wide at the base. This "clamp" is then covered thinly with straw or bracken, which in turn is covered with 9 inches of soil dug from all round the clamp. The ridge layer of soil is best put on a week or so later in order to permit complete ventilation. Stored in such a manner mangolds will remain in excellent condition throughout the winter, during which time the roots will "ripen."

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Copies of this leaflet may be obtained, free of charge, and post free, on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

The Use of Lime in Agriculture.

The practice of liming or chalking the soil is one of the oldest and most widely-spread operations of British agriculture ; unfortunately for many districts, it is a custom that is perhaps less observed at the present time than at any other period since farming became an organised industry. Until about forty years ago lime was much more extensively used in agricultural practice than it is to-day.

The fertility of many farms to-day is undoubtedly due to the liming and chalking that was done by the farmers of the eighteenth and earlier centuries : they, indeed, built up the soil, and it is through their labours that it remains in profitable cultivation at the present time. Owing to the very large amounts of lime and chalk which were then applied, it has been possible for later generations to live upon the capital thus accumulated and dispense with any expenditure of their own in this direction. This spending process cannot continue indefinitely, for natural causes—*e.g.*, the percolation of rainwater—are also steadily removing the lime in the surface soil ; for example, the Rothamsted soil, which at the beginning of the nineteeth century must have contained something like a hundred tons of chalk per acre, has now less than fifty tons.

Many other soils which started with a much smaller initial stock are beginning to run dangerously short, and in various parts of the country there is evidence with light as well as heavy soils, that a return to the practice of liming or chalking is essential if the fertility of the soil is to be maintained.

There are several reasons why the practice of liming has fallen so much into disuse. In the main it may be said to be due to (1) increased cost of labour : (2) the increased use of artificial manures : and (3) the reduction in value of farm produce.

It should be recognised, however, that soils may reach a state when manures cannot give a satisfactory return unless preceded or accompanied by an application of lime, chalk or similar materials.

The Functions of Lime.

Lime often fulfils such a number of functions in the soil that it has come to be regarded as a soil improver. Its presence tends to govern the efficacy of true fertilisers to such an extent that, as for instance in the case of dressings of sulphate of ammonia, it becomes inseparably connected with the action of the fertiliser itself. It has several direct uses, all of which are of great importance to the farmer. These may be given as follows :—

(1.)—Lime improves the nature of clay soil, making it more open and friable. Drainage goes on more readily, while the land is warmer and is more easily worked to a good tilth. It is difficult to exaggerate the value of this action of lime on the heavier soils ; it is thus frequently possible to secure a seed bed when the unlimed land is still too wet to work. Even after the crop is in, much unlimed land remains so persistently wet in winter and bakes so badly in summer that the crops often suffer in consequence. The character of the crop may depend as much upon securing a good tilth as upon manuring.

When the amount of lime in *clay* soils falls to below 0·5 per cent. it is highly probable that an application of lime would result in an improvement of the texture of the soil and allow of easier working.

(2.)—Lime is an essential plant food, and unless it is present in fair quantity soils cannot produce good crops.

(3.)—The insoluble reserves of nitrogenous material in the soil are brought into action and rendered available by the presence of lime. In many soils a similar though less marked improvement in the supply of available potash is probably effected, while indirectly the lime may be expected to facilitate the supply of phosphates from organic matter.

(4.)—The crops usually cultivated on the farm vary greatly in their dependence on liberal supplies of lime in the soil ; leguminous crops in general, and clover and sainfoin in particular, respond markedly to its presence. Turnips, swedes and barley also require ample supplies, but potatoes and oats can do with less : indeed, in some cases it may not be profitable to apply lime for potatoes, quite apart from the tendency of caustic lime to induce scab on the tubers.

The use of lime is often advocated as a preventive measure against clover sickness, while its value in reducing "finger and toe" disease* in turnips is a well-established fact. The use of either burnt lime or carbonate of lime is the best means of preventing or eradicating this disease, but gas lime is not, as a rule, suitable for the purpose.

(5.)—By removing soil acidity, lime has a beneficial effect on the development of those bacteria which convert the organic matter of the soil into soluble plant food. In the absence of lime the decay of organic matter is incomplete, as is often seen on grass-land. This results in the formation of peaty matter, acid in character, which is not only resistant, but also detrimental, to bacterial action. The processes which normally tend to enrich the soil in nitrogen and to supply nitrates to plants are adversely affected, and the soil becomes infertile.

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* See Leaflet No. 77 "Finger-and-Toe Disease in Turnips."

(6.)—By virtue of its caustic properties, quicklime is often used as an insecticide, and may be employed as a means of partially sterilising or correcting "sick" soils.

The Causes and Rate of Loss of Lime from the Soil.

Passing reference has already been made to the depletion of lime in the soil owing to percolation. As water sinks through the soil it becomes charged with carbonic acid gas, and exerts a considerable action in dissolving any lime which may be contained therein. Some of this lime eventually finds its way into the drains and rivers, and is the cause of much of the hard water which occurs in limestone and chalk districts. From this cause alone the losses of lime from the soil are often quite considerable, and may range from ¼ to ½ ton of carbonate of lime per acre yearly The extent to which this action takes place is further affected by the use of certain fertilisers. In this connection some results obtained at Rothamsted may be summarized as follows :—

(1.)—Superphosphate, sulphate of potash, kainit, and kindred manures do not increase the loss to any appreciable extent.

(2.)—Farmyard manure and probably all organic manures diminish the loss of carbonate of lime.

(3.)—Nitrate of soda also diminishes the loss.

(4.)—Sulphate of ammonia increases the loss, removing nearly its own weight of carbonate of lime. This action is frequently sufficiently potent to render the soil infertile.

Lime sinks in the soil of grass-land from purely mechanical reasons. In arable land this sinking is less marked, but the lime is subject to a greater wastage by solution in the rain water draining through the soil.

Since lime is an essential plant food, it enters into the composition of all crops, and the removal of these either directly, or indirectly through the agency of stock, leads to a still further depletion of the soil's reserves.

Hence it is essential with most soils that, if the fertility of the soil is to be maintained, these losses should be made good by regular applications of lime or limestone. Even in the case of soils immediately overlying chalk or limestone rock, it is often found that the reserves of free lime have been so much reduced as to warrant an application of lime.

Duration of the Effects of Lime.

Unlike that of the common nitrogenous fertilisers, the action of lime is not confined to the first season following its application, but often persists for a number of years. Much depends, of course, on the need of the soil for lime and the quanti y of lime applied, but experience has shown that as a result of applications of from one to two tons of burnt lime per acre, an improvement in the soil conditions may be expected to continue for a period of at least eight years.

The Classes of Lime.

Those materials, containing lime, which are of any agricultural importance may be divided into two classes. The first includes all the materials in which the lime is in a free state such as burnt (or quick) lime and slaked lime, and also those where the lime is in the form of carbonate as in chalk, limestone and marl. The second class is composed of substances in which the lime is in a "fixed" state, that is, already in combination with a strong acid, as in bones, mineral phosphates and gypsum, or in manures, such as superphosphate and dissolved bones, where there is an excess of acid.

The first class possesses value for neutralizing acidity in the soil while for this purpose the second class is valueless.

What is necessary for the soil is not merely the chemical substance lime, but a base, *i.e.*, something capable of combining with the acids which are naturally or artificially produced in the soil.

It must, therefore, be understood that only freshly burnt lime (quicklime), slaked lime, chalk, limestone, marl, and, to a less extent, basic slag, contain "lime" in the farmer's sense, *i.e.* in the form of a base capable of neutralizing acids; in bones, in superphosphate, and in gypsum the lime is combined with acids, and is no longer capable of acting as a base.

Common Forms of Lime.

Lump Quicklime and Slaked Lime.—The most common form in which lime is purchased by farmers is that known as burnt lime, lime shells, quicklime or caustic lime. It is obtained by burning either chalk or limestone in a lime-kiln. Quicklime when exposed to the atmosphere or applied to the soil, becomes slaked and reverts to the state of carbonate of lime in which it existed before it was "burnt" in the kiln. The superiority of burnt lime over chalk or limestone for application to the soil lies partly in the fact that it falls naturally into a fine state of division, some of it also passing into solution, so that it is more easily disseminated throughout the soil and acts with greater rapidity and in smaller quantities.

The method most frequently adopted in applying quicklime is to put it on the land in small heaps and allow it to slake naturally or to slake it with water from a water-cart. It may then be spread with a shovel and harrowed in at once. The former course is open to certain objections especially in rainy weather. Too much moisture is apt to be absorbed by part of the heap, with the result that the lime becomes pasty and afterwards reverts into hard lumps of carbonate of lime. Where the slaking process has been efficiently carried out the resulting lime is often sufficiently finely divided to allow of its being spread from a manure distributor.

Good samples of pure burnt lime should show 90 per cent and upwards of calcium oxide.

Present prices of lump quicklime range from 15*s.* to 30*s.* per ton f.o.r., but, although the costs of production vary according to proximity to coalfields and other factors, the farmer should be on his guard against the demand of a price approaching the higher limit. In certain districts the opinion is commonly held that lime containing considerable quantities of magnesia is inferior in value.

Ground Lime.—This consists of burnt lime (quicklime) which has been ground to a powder. It should be similar in quality to lump quicklime, but is often impure and contains less lime than the latter.

As quicklime readily slakes when applied to the soil there is no need for the lime to be ground very finely, and any attempt to achieve this involves unnecessary cost of grinding. The additional cost of grinding best lump lime ought not to exceed 2*s.* to 5*s.* per ton, but owing to the fact that ground lime is often produced from small burnt lime it is sometimes possible to obtain ground lime at a price little more than that of best lump lime. Some samples placed on the market are distinctly inferior owing to exposure during the grinding process and to the inclusion of cinders with the lime.

These two products are more concentrated forms of lime than are limestone and chalk. Roughly speaking, one ton of burnt lime supplies the same amount of "lime" as $1\frac{3}{4}$ tons of limestone or chalk, and thus has an obvious advantage in decreased cost both of railway transit and of distribution.

Ground Limestone.—This is now coming into more general use and consists of unburnt limestone ground to a fine powder. Compared with burnt lime its action in the destruction of vegetable matter in the soil is less rapid, and it is doubtful whether it will exercise the same influence in coagulating clay. On the other hand, the general effect is similar to that of burnt lime, and it has a number of advantages. It is not harmful in large doses and is a more convenient form to handle and to apply. It can be uniformly distributed in one operation, and there is no irritating effect upon the eyes and nose. Should unsuitable weather occur it can be held over until better conditions prevail, and, if necessary, it may be stored for use the following season without fear of deterioration or destruction of bags.

It has been found that when limestone (or chalk) is ground so that the product is capable of passing through a 10-mesh sieve (that is to say, a sieve having 100 meshes to the square inch), and contains the whole of the fine material produced in grinding, the increases in crop on acid soils are equal to those obtained by the use of chemically equivalent quantities of burnt or slaked lime. For general purposes it should be remembered that $1\frac{3}{4}$ tons of ground limestone (carbonate of lime or chalk) are equal to 1 ton of best burnt lime. Farmers are recommended to consider the use of ground limestone when it conforms to the above standard and can be obtained at a reasonable price.

Chalk.—This substance is really a soft limestone, and when the flints are removed is usually a very pure form of carbonate of lime. When fairly pure it will contain about half its weight of lime. The application of large quantities of chalk (from 20 to 30 tons or more per acre) to agricultural land was formerly a general practice in some parts of the country. In recent years, however, this method of applying lime has been largely discontinued, but it is still practised in some districts, especially in the southern counties. The chalk is dug out of the pits in late autumn and spread over the land before it becomes dry. No attempt is made to break up the lumps, as the winter frosts and a harrowing in the spring will reduce them to a sufficiently fine state of division.

The price of chalk as quarried is generally about 4*s.* to 5*s.* per ton free on rail, but in this state it may contain a considerable amount of water.

Ground Chalk.—In order to permit of the more economical use of chalk by the application of smaller and more frequent dressings, various firms have recently placed very finely ground chalk on the market. On account of the high water content of the material as it is quarried, the chalk has to be subjected to a preliminary drying process which adds appreciably to the cost of production. Against this, the cost of grinding is less than that incurred in pulverising limestone, and there ought therefore to be little difference in the price of these two forms of carbonate. The general advantages and limitations mentioned in connection with ground limestone apply also to ground chalk.

The prevailing prices of ground limestone and ground chalk vary from 12*s.* to 25*s.* per ton f.o.r.

On the basis of the actual lime supplied per ton and the prices at which burnt lime can be obtained (15*s.* to 30*s.*) the value of ground limestone and chalk may be calculated at from 8*s.* 6*d.* to 17*s.* per ton. Some allowance should, however, be made for the increased cost of reducing the material to a fine state of division, but it should be remembered that the transit charges are proportionately greater than in the case of burnt lime.

Gas Lime.—This form of lime is a by-product in the manufacture of coal gas, for which lime is employed as a purifying agent. It consists of slaked lime more or less saturated with compounds of sulphur; it is liable to considerable variation in composition, and often has but little basic property left in it. Owing to the presence of certain poisonous compounds it should be used with care. Good results have been obtained in some cases with fresh gas lime, but it must be applied in early winter and be very well spread. It is unprofitable to use it at considerable distances from a town, or where high railway rates prevail.

Basic Slag.—Basic slag is a by-product in the manufacture of steel, and is very largely employed as a phosphatic manure. It usually contains about 45 per cent. of lime, some of which is available as a base capable of neutralizing acids in the soil, though probably not more than 2 to 5 per cent. is in the form of "free" or "caustic" lime. The fact that some of the lime present is available for counteracting acidity in the soil renders basic slag of very considerable value on soils deficient in lime. For further information as to the use of basic slag reference should be made to Leaflet No. 267.

Other Sources of Lime.—In addition to the common forms of lime already referred to, waste lime products are often to be obtained from certain industrial processes.

Considerable quantities of *waste carbonate of lime* are produced in soap works, paper works, bleach works, etc. Its chief constituent is carbonate of lime in a very fine state of division, together with small quantities of caustic lime, caustic soda, and carbonate of soda, all of which are useful for reducing soil acidity. In the fresh condition this waste lime contains from 30–40 per cent. of water and can frequently be had at a nominal price. It is, however, difficult to handle or to transport by rail, but when spread on the land it dries out rapidly and falls down to a fine powder.

The value of such material as a source of agricultural lime has not been sufficiently recognised in the past, although numerous trials have shown it to be quite as effective a remedy for "finger-and-toe" as other forms of lime. Its use might well be greatly extended, especially if arrangements could be made for drying it at the works. After drying it may contain from 60–90 per cent. of carbonate of lime. Generally speaking, $2\frac{1}{2}$–3 tons of wet, or $1\frac{3}{4}$–2 tons of dry waste lime would be equal to 1 ton of good burnt lime.

Lime is also obtained as a by-product in the manufacture of acetylene gas from calcium carbide. In this case the by-product is chiefly in the form of slaked lime containing from 30 to 40 per cent. of water; when dried it usually contains 60 per cent. or more of quicklime. This form of lime, however, must be used with caution. Fresh samples frequently contain impurities likely to be poisonous to plant life, and in no case should the residue be applied before these impurities have been rendered innocuous by exposure to the weather. After weathering, the lime may be applied as a substitute for quicklime. It is best applied to fallow ground during the winter; trials on a small scale should be made before any growing crop is dressed with the residue.

Among other kinds of waste lime which may be used, when available, are "small" lime or screenings (the residue when lime shells are sold) and small chalk, which is sometimes obtainable at a comparatively cheap rate from manufacturers of lime.

None of the miscellaneous forms of lime mentioned should be bought except after analysis, or at a very low price.

Indications of the Need of Lime.

Some general idea as to whether a soil requires liming may be obtained from observation in the field. In the case of grass land lack of lime eventually results in the absence of clovers from the herbage; there is often an excess growth of bent grasses and accumulation of dead matter.

The presence, particularly in excess, of such weeds as Sheep's Sorrel, Dother or Sour Dock (*Rumex Acetosella, L.*), Spurrey, Beggar-weed, Sand-weed, or Yarr (*Spergula arvensis, L.*), Corn Marigold or Yellow Ox-eye (*Chrysanthemum segetum, L.*), Bracken (*Pteris aquilina, L.*), Gorse (*Ulex europaeus, L.*), Heaths (*Erica* spp.) and Ling (*Calluna vulgaris*, Salisb.), is regarded as one of the best indications of the need of lime, a judicious application of which is almost certain to result in a considerable reduction of these plants. Lime has also proved useful in reducing Yorkshire Fog (*Holcus lanatus, L.*), Bent Grasses (*Agrostis* spp.), Wavy Hair Grass (*Aira flexuosa, L.*), and various Mosses. (*See* Figs. 1–4.)

On arable land the presence of "finger-and-toe" disease in turnips, &c., the repeated failure of the clover crop (clover-sickness), the occurrence of such weeds as spurrey on light land and sorrel on heavy land, are the best guides as to the requirements of the soil. In such cases there is also a general lack of response to treatment with fertilisers.

Quantities to Apply.

Since lime is used for many purposes the proper quantity to apply varies widely. Of recent years it has become common practice to apply dressings of about 10 cwt. to 1 ton per acre of burnt or ground lime or 1 to 2 tons per acre of carbonate once in four to five years, but these quantities are, as a rule, only sufficient to maintain the soil in a neutral or "sweet" condition. In those cases where the soil is definitely acid the early applications should be such as will bring the soil into a neutral condition in order

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Description of Figs. 1–4.

FIG. 1.—Spurrey (*Spergula arvensis, L.*); FIG. 2.—Bent Grass (*Agrostis vulgaris*, With.); FIG. 3.—Sheep's Sorrel (*Rumex Acetosella, L.*). FIG. 4.—Corn Marigold (*Chrysanthemum segetum, L.*). All about one-half natural size.

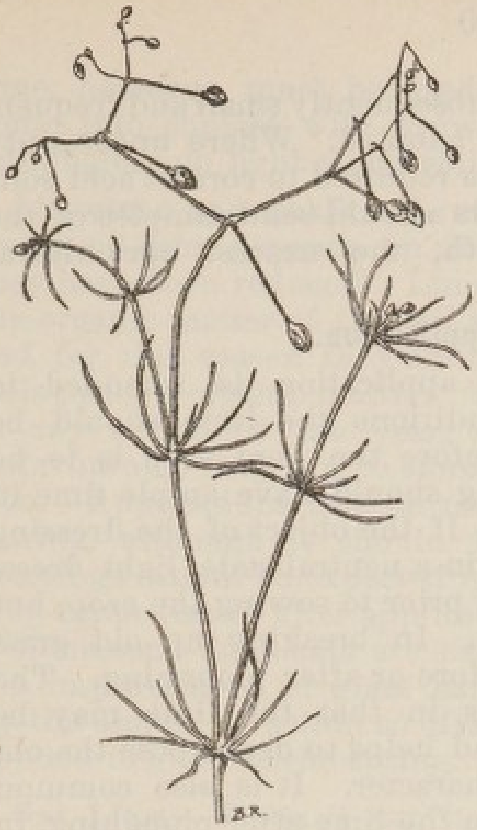


FIG. 1

FIG. 2.

FIG. 3.

FIG. 4.

(For a description of these figures see page 8.)

to secure maximum fertility; subsequently small and frequent dressings as above may be adopted. Where uncertainty exists as to the amount of lime required to correct acid soils it is recommended that farmers should send samples of the soil to, or communicate with, the nearest agricultural Advisory Authorities.

Time of Application.

Arable Land.—Where the application is intended to remove any existing acid conditions the lime should be applied as long as possible before the next crop is to be sown in order that the dressing should have ample time in which to complete its action. If the object of the dressing is merely to maintain the soil in a neutral state, light dressings may be made immediately prior to sowing the crop, but must be harrowed in at once. In breaking up old grass land, lime may be applied before or after ploughing. The former has certain advantages in that the lime may be applied earlier in the season and helps to decompose the old turf, which is often acid in character. It is also common practice to spread and harrow in the lime after ploughing, in order that it may be retained in the upper layers of the soil.

Grass Land.—The remarks as to application on arable land also apply to grass land, with the reservation that if burnt lime be used, the dressing should be made, wherever possible, in autumn or early winter, if a reduction of the first crop is to be avoided.

Form of Lime to Apply.

Burnt Lime compared with Carbonate.—The choice between the use of quicklime (lump or ground) and carbonate (as powdered chalk or limestone) can only be decided on the merits of each individual case. Not only the initial price and composition, but also the cost of transit, cartage and distribution should be considered. It should be remembered that it requires about 1¾ tons of carbonate to supply as much "lime" as 1 ton of good burnt lime.

Burnt or Quick Lime.—In general this form of lime is more suitable for arable than grass land, and is particularly useful in the treatment of heavy clays and peaty land. On account of its caustic properties it is a cheap and efficient insecticide, and for intensive cultivation may be used to obtain the same results as are induced by steaming or heating the soil. Burnt lime exerts a direct chemical action on the organic matter in all soils, and tends therefore to give a return when the soil is neutral or where the application is more than sufficient to neutralise the soil. Burnt lime has often marked effects in the treatment of old grass land where it is essential to destroy the worthless growth of mat grass in order to allow the finer herbage to obtain a hold. Burnt lime, however, must be used with caution, and should not come into contact with growing crops nor be used indiscriminately on light sandy soils.

Limestone and Chalk.—As stated above, the value of these forms of lime depends on the degree of fineness to which they have been reduced. Limestone and chalk do not attack the organic matter of the soil so severely as does burnt lime, and for this reason they are to be preferred for light sandy soils poor in organic matter. They can be applied to the soil at any season of the year, or if weather conditions are unfavourable they can be stored without suffering deterioration. Applications can be made up to or after the time of sowing, although it should be borne in mind that late dressings cannot be expected to exert their full action on the crop immediately after application.

Limestone and chalk are also somewhat more suitable for the improvement of grass land, as their use is not attended by the scorching action so often caused by burnt lime when applied to grass in the spring.

Gas Lime.—When it can be obtained at a low price, gas lime can often be profitably employed for improving old grass land where it is necessary to destroy much of the existing rank herbage. Although the turnip crop is sometimes increased, gas lime is not so suitable for combating "finger-and-toe" disease as are quicklime and carbonate. On most soils the oat crop, which follows, will be considerably benefited. The usual dressings range from 2 to 4 tons per acre applied in autumn or early winter.

London, S.W.1,
April, 1907
Revised, April, 1918.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 171.

BOARD OF AGRICULTURE AND FISHERIES.

Rhizoctonia Diseases.

A disease due to the fungus *Rhizoctonia violacea*, Tul. was recognised and described nearly two hundred years ago as the cause of serious injury to the saffron industry in France. It was at that time also noted that the disease attacked the roots of many other kinds of plants, both wild and cultivated. From this period it has not only continued its ravages, but has attacked in turn almost every new plant introduced to cultivation. It does not, however, attack cereals.

Plants Attacked.

In this country *Rhizoctonia* has a special predilection for lucerne; clover, parsnips, carrots, beet, mangold, seakale, and potatoes sometimes also suffer severely, and most frequently when they follow lucerne, which appears to attract the stray mycelium of the fungus present in the soil. The mycelium increases enormously in quantity on the root of this plant, and a large stock remains in the soil in a vigorous condition ready to attack any suitable host. If the following crop happens to be a cereal, which the fungus cannot feed upon, it attacks weeds of various kinds, and thus tides over the period until a crop suitable to its requirements is planted, when a fresh stock of mycelium is again left in the soil.

Description and Appearance of Plants Infested.

The disease is readily recognised by the bright colour of the mycelium of the fungus, which varies from rose, with a tinge of purple, to a deep brownish purple when old. The mycelium at first spreads as a delicate, much-branched network over the surface of the root or tuber, and finally forms dense patches, or covers the entire surface with a compact felt (see fig. 1). As a rule the fungus confines its attacks to underground parts of the plant, but when the weather is continuously damp and dull the mycelium sometimes extends up the stem, and even passes on to the leaves and fruit.

The first sign of disease is the drooping and yellowing of the foliage; the presence of violet mycelium on the surface of a carefully removed root proves the fact.

Sources of Infection.

So far as is at present known, the fungus does not form fruit, its only mode of reproduction being vegetative by means of mycelium.

The way in which the fungus spreads in the soil and keeps its hold can readily be seen. When a root or tuber has become superficially coated with a felt of mycelium, sclerotia or concentrated masses of mycelium of two distinct kinds of structure, and having different uses, are formed. Some sclerotia are of considerable size, varying from that of a pea to a hazel nut ; these become free from the root when fully formed, and remain in the soil as centres of future infection. Other sclerotia, rarely exceeding the size of an ordinary pin's head, are usually produced in considerable numbers under the felt of mycelium, and in close contact with the root or tuber, to which they remain firmly attached, and are removed along with it. If such infected roots or tubers are eaten by some animal, the minute, compact sclerotia are not injured by passing through the digestive system, and are in this way often transported to new localities. In like manner new districts are often infected by means of minute sclerotia attached to potato tubers, carrots, &c. In some instances beans and peas are attacked while yet in the pod, and minute sclerotia are formed in the skin of the seed.

The disease usually spreads from a point of infection equally on every side, the mycelium gradually spreading through the soil from diseased to healthy plants.

Injury Caused by the Disease.

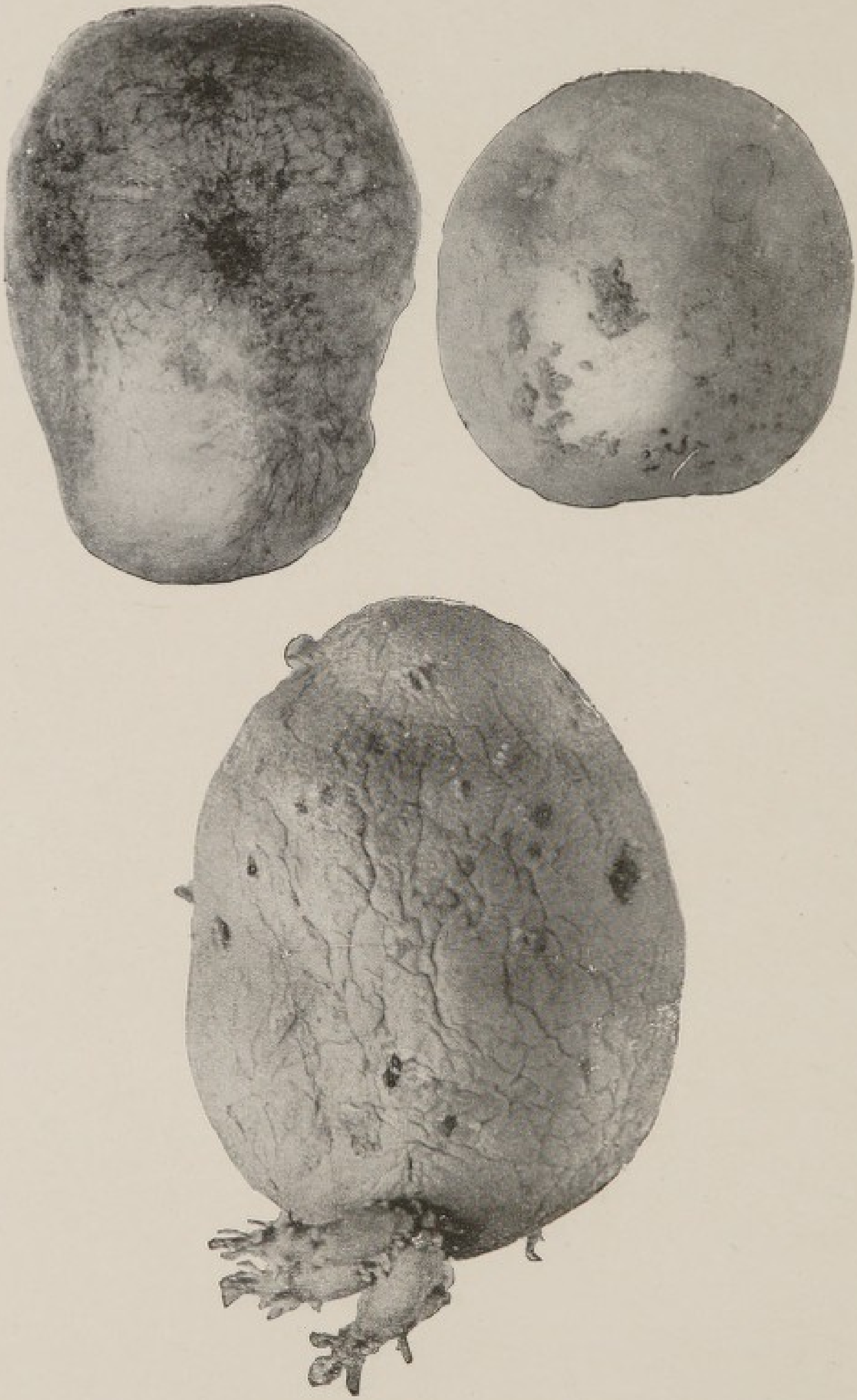
The amount of injury caused by the fungus varies to a great extent on different plants. In the case of *beet* and *carrots*, the mycelium soon enters the fleshy root and destroys it. In *lucerne* and *clover* the active rootlets are killed. In *potatoes*, mycelial strands originating from the small sclerotia described above penetrate the skin, and ramify abundantly in the internal tissues, causing a rot which soon reduces the tuber to a pulp.

Preventive and Remedial Measures.

1.—Good drainage and the prevention of sourness of the soil are essential features in combating the disease. Liming is of value in preventing acidity of the soil.

2.—Weeds should be rigorously suppressed, for they furnish the main supply of food for the fungus when a cereal crop is present.

3.—Care must be taken not to introduce the disease by means of small sclerotia adhering to seeds or tubers.



DESCRIPTION OF FIGURES.

FIG. 1.—*Rhizoctonia violacea.*—The illustration shows the brownish purple mycelium, which occurs in patches and radiating strands over the surface of the tubers. Mycelium also enters the flesh, and destroys the tissues.

FIG. 2.—*Rhizoctonia solani.*—The sclerotia, which in this species are entirely superficial and apparently cause little or no injury, are seen as conspicuous blackish bodies. They can be scraped off the tuber without difficulty.

FIG. 3—Later stage of *R. solani.*

4.—Seed obtained from dry, high-lying districts should be selected.

5.—Diseased plants should be removed and burned, and the soil treated with a disinfectant before being re-planted. In the case of seakale, the best results have been obtained by treating the soil some days before planting with a solution of carbolic acid (1 oz. to a gallon of water). The seakale not only came up free from disease, but actually appeared to be stimulated in growth. Good results have also been obtained by the use of corrosive sublimate solution (1 oz. to every 8 gallons of water).

6.—Before planting, seed potatoes should be steeped for 2 hours in a solution, consisting of 1 pint of commercial formalin (= 40 per cent. formaldehyde) in 36 gallons of water.

Potatoes are also attacked by another species of *Rhizoctonia*, *R. solani*, Kühn. The tubers are found covered with small black bodies, or sclerotia, of irregular shape, connected only by fine threads of mycelium which are not visible to the naked eye (see figs. 2 & 3). These bodies can be easily scraped off, leaving very little scar, and do not appear to cause much injury beyond rendering the tubers unsightly. In America, however, it seems that the fungus may cause serious losses by attacking the young sprouts.

R. solani has been stated to be the underground, sterile state of the Potato Collar fungus, *Hypochnus solani*, Prill et Del. The latter forms a very thin, greyish, or fawn coloured film round the base of living potato haulms, but the mycelium is entirely superficial, and does not appear in this country to cause any injury.

The treatment recommended for *R. violacea* is applicable also to this disease.

London, S.W.1,
May, 1906.
Rewritten, August, 1913.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 172.

BOARD OF AGRICULTURE AND FISHERIES.

Bare Fallows.

Historical.

The practice of taking a bare fallow as a preparation for wheat was at one time almost a universal custom in farming. It was said to have been introduced into these islands by the Romans, and in mediæval times the usual rotation appears to have consisted of wheat, barley, fallow, with beans instead of barley on the stronger lands. In Scotland, where up to the eighteenth century it was the custom to grow corn crops repeatedly and then let the land lie in grass for a few years, the introduction of a bare summer's fallow, after the ley was broken up and before the wheat was sown, was one of the earliest improvements in the traditional system of farming. The thorough cleaning which the land received, and the marked improvement in the tilth which was effected, were strong arguments in favour of the practice; furthermore, experience amply demonstrated that better crops of wheat could be secured after a bare fallow than after a previous corn crop or a recently ploughed lea. The early theorists concluded that some fertilizing principles were absorbed from the atmosphere during the summer's exposure to sun and air, and, indeed, it became patent that the more thoroughly the soil was stirred and pulverized by the cultivations the greater was the benefit resulting from the fallow.

But towards the close of the eighteenth century the custom had begun to decline; green crops, and turnips in particular, had become part of the routine of farming, and the Norfolk husbandry, with its four-course system of turnips, barley, clover, wheat, was spreading from the Eastern Counties all over Great Britain.

The more advanced farmers perceived the importance of keeping the land under crop; by growing turnips it was possible to obtain all the advantages, in the shape of the cultivation and the stirring of the soil, which result from a bare fallow; at the same time, food was provided for the stock, and a much better kind of dung was made than when the straw was merely trampled down to get it into a state fit to go back upon the land. The writings of Arthur Young, who was Secretary to the then Board of Agriculture, in the early years of the nineteenth century, were unceasingly directed against bare fallows; and his influence, combined with the numerous enclosures and the high prices prevailing during the Napoleonic wars, did much for the spread of turnip culture. The strong lands and the clays were still the difficulty; on them it was often a costly and even an impossible operation to secure a good plant of turnips, but it became more and more a mark of careless farming to rest content with a bare fallow. Mecchi showed that the strongest Essex clays could be made to grow turnips, and with the spread of mangel cultivation it became possible to put even the most stubborn soils in the South and East of England under roots. The bare fallow still survived as an occasional operation once in seven or eight years, and many clay-land farmers maintained that it was a profitable operation, the benefit of which was felt for several years. Latterly, with the fall in corn prices and diminished rents, the acreage under bare fallow has again showed a tendency to increase. For instance, in Essex the bare fallow in 1866 amounted to 11·4 per cent. of the land under corn; in 1904 it was 16 per cent.; in Suffolk the bare fallow has actually increased, despite the diminution in the area of arable land, rising from 25,000 acres in 1866 to 30,400 acres in 1904.

Beneficial Effects of Bare Fallows.

A bare fallow may exert a beneficial effect on the land in three ways:—

1.—*By cleaning the land of weeds;*

2.—*By improving the texture of the soil; and*

3.—*By increasing its fertility.*

1.—A bare fallow is generally taken after a stubble crop the prime object being to get as many weed seeds as possible to germinate. A first ploughing in autumn will be followed by a cross-ploughing in the spring and two other ploughings in the summer. Sometimes the first ploughing is left until the spring corn has been sown, and is followed by two or even four ploughings during the summer. The harrow is used after each ploughing to collect the weeds, and many farmers roll the land to reduce the clods and promote the germination of the weeds. But on many soils it is desirable to avoid getting too fine a tilth, lest heavy rains cause the land to run together and the surface to set to a hard crust, To this danger the heavy loams and clays with an admixture of fine sand are more liable than the clays proper.

The continued cultivations and repeated draggings will rid the land of couch; at the same time annual weeds are germinated, and destroyed by the next ploughing.

2.—It may be said, however, that with reasonable farming land should never get so foul as to require a bare fallow to clean it, and it is found among the clay-land farmers that their chief justification for a bare fallow lies in the great improvement in the texture of the soil that results. A clay soil is in the main composed of very fine particles, and the finer the particles are the "heavier" and the more tenacious is the clay. Coarse-grained material like sand does not bind together when dry, but the more fine-grained it becomes the more sticky will it be when wet, and the firmer will it set when dry. To a certain extent these very fine particles in an ordinary clay soil are loosely bound together into little groups which behave like single larger particles. If, however, the clay is knocked about when it is wet the groups are broken up into their constituent fine particles, thus increasing both its holding power for water and its tendency to dry to a hard clod. This is seen to the fullest extent when clay is deliberately "puddled," in which state the particles making up the clay are all separate and able to move independently. Exposure to the weather, on the contrary, freezings and thawings, alternate dryings and wettings, unite the particles again and lighten the texture of the soil. With the best of management the texture of heavy clay land tends to deteriorate under cultivation, and the rest it gets by lying under grass for a year or two, or from a summer's fallow, is necessary from time to time to get the soil back into a good working condition. The improvement persists for three or four years and forms the main reason for taking a bare fallow nowadays; for good crops, particularly of roots, depend more on the tilth of the seed-bed than on any other single factor in farming.

3.—Many have been the theories as to whether land gains or loses fertility through a summer's fallow. Thaer, who was an authority about the beginning of the eighteenth century, wrote: "There is no doubt that the fallow absorbs or attracts the fertilizing properties of the atmosphere." Arthur Young, on the contrary, with his aversion to bare fallows, wrote about the same time: "The quantity of gas or vapour that is hourly exhaling from a fallow field after rain or every fresh ploughing is improvidently lost, and argues a want of economy that is truly reprehensible." But experience was against Arthur Young; the practical farmer knew that cultivation by itself made the land better able to support a crop; this was the basis of Jethro Tull's horse-hoeing husbandry and of the Lois-Weedon system of alternate husbandry. Anybody, again, who visits an experimental farm, where the plots are separated by paths, will recognise the "fallow effect" in the increased vigour of the outside rows bordering the bare soil. An explanation, however, was not possible until the discovery of nitrification some twenty years ago and the investigations which have been made into the conditions favouring the process.

All soils contain considerable residues of nitrogenous material which cannot reach the plant until they have been oxidized by various bacteria in the soil and so converted into nitrates. A summer's fallow provides just the conditions favourable to nitrification—warmth, aeration, the stirring of the soil, and the greater amount of moisture which results from the absence of a crop to dry the soil.

Gain of water by fallowing.—It is easy to ascertain that the fallowing results in a great gain of water to the soil; for example, at Rothamsted in 1904, halves of certain plots were fallowed while the other halves carried wheat. The soil was sampled in mid-September, after harvest, with the following results :—

—	Percentage of water in fine soil.	
	Cropped.	Fallow.
1st depth of nine inches	17·4	17·2
2nd " "	18·8	20·0
3rd " "	20·1	22·3
4th " "	20·9	23·1

or down to the depth of 3 ft. an average gain of 1·35 per cent. of water, equivalent to 3·1 in. of rain. In a climate like that of Great Britain this extra water is a matter of little or no moment, since the land becomes saturated repeatedly by the winter rainfall, but in more arid countries it often makes all the difference to the crop. In parts of California, for example, it is only possible to take a crop like wheat every other year without irrigation, the bare fallow in the intermediate years being necessary to collect the rain for a full yield.

Accumulation of nitrates.—The chief gain, however, from a summer fallow lies in the way the nitrates are made and stored up in the soil for the benefit of the ensuing crop. The Rothamsted experiments illustrate the increase thus produced, for there one plot grows wheat every year without manure, and the second is divided into two portions, one of which is fallowed while the other is cropped every alternate year. The yield is as follows :—

—	Wheat every year.		Wheat after fallow.	
	Grain.	Straw.	Grain.	Straw.
	Bushels.	Cwt.	Bushels.	Cwt.
Average crop per acre per annum, 1856–1902 ...	12·7	10·0	17·1	14·2

This shows a considerable gain for fallowing, but it must be remembered that the land in the second case is only cropped every other year, hence the production per acre under cultivation is only half as much, or 8½ bushels per acre per annum.

The benefit of fallowing depends upon the formation of nitrates during the summer and their retention for the next crop, but heavy rain during the winter may wash them entirely away and leave the land no richer. This is plainly seen if the results given above are divided into two groups according as the autumnal rainfall, September to December inclusive, is above or below the average :—

——	16 seasons of less than average rainfall.	16 seasons of more than average rainfall.
Rainfall (Sept.—Dec.)	8·88 in.	13·66 in.
Percolation through 60 in. soil ...	4·03 in.	8·92 in.
Total produce (wheat after wheat) ...	1,810 lb.	1,627 lb.
Total produce (wheat after fallow)...	2,743 lb.	1,757 lb.
Percentage increase due to fallow ...	51·5	7·9

Thus when followed by a dry autumn, the fallowing produces an increase of more than 50 per cent. in the ensuing crop, whereas if the winter be wet the increase due to fallowing is little or nothing.

It therefore follows that summer fallowing is only likely to be of direct benefit to the next crop where the climate is dry and no great amount of percolation takes place through the soil in the winter. It is, on the whole, more likely to result in a permanent loss of fertility, and can only be justified on those heavy soils which need an occasional rest to maintain their condition and restore a good tilth.

Clover Crop v. *Bare Fallow*.—Another of the Rothamsted experiments illustrates how much may be gained by a clover crop in place of a bare fallow. One of the fields is farmed under a four-course rotation—swedes, barley, clover or fallow, wheat ; one half of the plots growing clover and the other fallowed before the wheat. The better the clover the better the ensuing wheat, and if we compare the succeeding crops after a good clover year its benefits are very marked :—

——	Clover Hay.	Wheat.	Swedes.	Barley.
	Cwt.	Bushels.	Tons.	Bushels.
Clover plot	76·7	39·5	19·4	36·3
Fallow plot	—	32·5	19·0	28·3

Although nearly four tons of clover hay were removed, the residues, roots and stubble, were sufficient to increase the wheat crop by 21 per cent.; the root crop, which came next, by 2 per cent., although the same manure was put on both crops; and finally the barley, three years after, by 28 per cent.

Conclusion.

From all these results it will be seen that a bare fallow can never be a directly profitable operation and has no justification on free-working land. But with strong clays in dry climates, as for example over much of the East and South-East of England, it may often be necessary to clean the land and restore its friable texture; on such soils also there is least likelihood of loss through the washing out of the reserves of nitrogen which have been rendered available by the process. Bare fallowing may in such a case be useful.

London, S.W.1,
May, 1906.

Leaflet No. 173.

BOARD OF AGRICULTURE AND FISHERIES.

Potato Growing.*

The Potato as a War Crop.—Of the crops, other than cereals, which exercise an important influence on the course of the war, the Potato is the chief; indeed, in some ways the potato may be said to be the most important of all crops, for without it Germany could not have carried the war into the fourth year.

With the single exception of sugar beet, more human food per acre can be produced by the potato than by any other of our common cultivated plants, and whereas the sugar beet must go through a process of manufacture, and sugar, when produced, can only be employed as a relatively small component of a mixed diet, the potato may be used direct as a principal article of food diet. At the present time, *e.g.*, the potato forms from one-third to one-fourth of the diet of the German civilian population.

The war uses of this crop have long been recognised in Germany, and the country grew a very much larger quantity of potatoes than was needed for the supply of the people. The crop was employed in stock feeding, all classes of stock, especially pigs, receiving potatoes as part of their regular winter food; to a less extent the crop was used in distilling, starch manufacture and in the preparation of dried potatoes. After the outbreak of war there was a great shrinkage in the German supplies of cereals, and human food was secured by reducing live stock and providing more potatoes (especially in 1915 and during the present winter) for direct consumption.

In illustration of the important position taken by the potato among German food crops it may be stated that, before the war, while the average 100 acres of British cultivated land included less than 2 acres of potatoes, the average 100 acres of German cultivated land included 10 acres under this crop.

Further in illustration of the quantity of human food produced by the potato the following figures may be given. The figures show the number of persons who could be supported for a year on the produce of 100 acres of the crops named. The crops are assumed to be average British crops.

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* Further information on Potato growing will be found in Leaflet No. 296 (*Potato Growing in Allotments and Small Gardens*); Food Production Leaflet No. 11 (*Hints on Purchasing Seed Potatoes*).

In the case of potatoes two sets of figures are given showing the results if the crop were fed to people, as it chiefly is in Britain, or if fed half to people and half to pigs, as in Germany before the war. It is, in all cases, assumed that the foods form part of a properly blended diet.

100 acres potatoes support	420	persons.
50 acres potatoes used direct support 210 persons; 50 acres potatoes fed to pigs support 45 persons	255	"
100 acres Wheat used direct support*	230	"
100 acres Barley used direct support*	180	"
100 acres Oats used direct support* ...	155	"
100 acres medium Grass, producing beef	15	"

There has been a disposition in the past to underrate the dietetic value of the potato, and while admitting that it was a useful cheap food, to regard its nourishing properties as low. Those who have remarked the results produced by potatoes when used in combination with oatmeal by the Scottish or Irish peasantry have been sceptical as to the popular reputation of the tuber, and recent scientific work has shown that the nitrogenous constituents of the potato have, in fact, a much higher dietetic value than has hitherto been supposed.

In public lectures given under the auspices of the German Council of Agriculture in Berlin in 1917, great claims were advanced on behalf of the potato as an article of diet, and as a substitute for butcher's meat; but no experimental evidence in support of these claims was given, and it would be as unwise to exaggerate the food value of the potato as hitherto it has been to underrate it.

The disadvantages of the potato as a war crop are that it is bulky and calls for extra transport just when the railways are busiest; that it does not keep well after April, and that when there has been much disease in the growing crop there is a heavy wastage even earlier in the year. To some extent, too, the crop is an uncertain one, but this is now much less the case than formerly owing to the number of varieties in cultivation. The 1916 crop was the only bad failure in recent years, and even in that season many districts grew quite satisfactory crops.

On balance, having regard to the ease of cultivation, the very high yield of human food produced, the quality of the potato as fodder for live stock if not required by man, its value as a cleaning crop, its suitability for planting on newly broken grass land (especially on land too rich for corn growing), its usefulness for small fields in thickly populated

* Offals fed to cattle.

districts or near villages where sparrows would do great damage to grain, and the fact that a good crop may be secured in most parts of the country even if planted as late in the season as the beginning of May, the potato must be regarded as the most valuable of all our Spring crops and, indeed, a close second to Autumn sown wheat.

The sowing of Autumn wheat for the harvest of 1918 has been finished; every effort must, therefore, be made to secure the largest possible acreage of the second best crop—potatoes.

Cultivation.

As a farm crop potatoes are grown to a greater or less extent on practically all kinds of soil except heavy clays or on wet undrained land, but deep rich sandy loams, such as the Red soil of East Lothian, or well drained alluvial silts, such as the "Warp" lands of Yorkshire and Lincolnshire, are best adapted for the crop. Fen or peaty soils if well drained are also suitable, though the quality of tubers produced on such land is not quite so good. Like carrots and rye, potatoes can be grown on the very lightest sands, and on such soils the quality of the tubers is usually high and the cost of cultivation is comparatively small. There is no fixed rule as to the position potatoes should occupy in the rotation. In special cases, *e.g.*, the early potato districts of Ayrshire and Cornwall, they are grown on the same land year after year, autumn catch crops such as broccoli, rape or Italian ryegrass being the only change given. In other cases, *e.g.*, the Fen districts or on the red soil of Dunbar, they may be taken every three years, but in ordinary cases they occupy part of the root "break" and usually follow a corn crop. It may, however, be pointed out that potatoes do exceptionally well after a temporary ley or old grass, and where conditions are suitable, potatoes should be taken on at least part of any area of good grass land which is to be broken up for 1918. After really good grass the land is usually in too high condition to grow corn satisfactorily, and with proper cultivation the decaying sod provides ideal conditions for potatoes.

Under any circumstances potatoes demand a deep friable tilth, though a very fine condition of soil is not essential. So long as the seed is well covered there are good opportunities for working the soil after the potatoes have been planted, and in fact within limits the more thorough the cultivation after planting the better. When potatoes follow a corn crop the cultivation is similar to that for an ordinary root crop and should begin with an autumn cleaning followed by a deep winter ploughing, with suitable cultivation in spring to secure the necessary tilth. The cultivation of leys or old grass in preparation for potatoes is not so common, and as an extension of this practice is most desirable, mention may be made of the various ways found satisfactory.

In the case of a temporary ley, one, two or three years old, or an exceptionally well grazed old pasture, there is no special difficulty. As a rule the land is ploughed quite shallow in autumn and left until early spring, when a deep cross ploughing is given, a skim coulter being used to turn the sod to the bottom of the furrow.

If farmyard manure is to be given it is best applied on the grass before the first ploughing. If it is left to be applied in the rows they will have to be made so deep that a good deal of the turf will be brought to the surface, and cause trouble in the subsequent cultivation.

In specially favourable conditions, as in the case of a deep uniform sand or light loam, one deep ploughing with a digging plough fitted with a good skim coulter may be sufficient. A better practice, however, is the "double ploughing" adopted on the deep alluvial soils of Lincolnshire and other districts, even where the grass is really old and not merely the comparatively loose, open turf of a temporary ley. Two ploughs follow each other ; one takes off the sod to a depth of 3 in. or 4 in., turning it into the bottom of the deep furrow previously left by the second plough. This in turn throws the soil to a further depth of 8 in. or 9 in. on to the top of the shallow furrow, which is thus effectually buried and is not brought to the surface by any subsequent cultivation.

Where such a method cannot be adopted, owing either to the roughness of the sod or the shallowness of the soil, the preparation for potatoes presents more difficulties. Under such conditions a disc harrow is a most useful aid at all stages. In some cases the sod may be thoroughly cut up by repeated disc harrowings before it is ploughed, and if the work has been well done a deep ploughing will be all that is required to prepare for the usual spring cultivation. Where a particularly thick tough sod is encountered the land should be ploughed shallow in early autumn and heavily rolled immediately afterwards. During winter the sod should be torn to pieces as thoroughly as possible by repeated harrowings, disc-harrowings and whatever other operations are found to have the desired effect. Having achieved the object in view, a deep ploughing should be given, and it is desirable to complete this in time to allow the raw soil to mellow and weather before planting-time. In the first ploughing of such land a disc coulter will be found almost indispensable, as the rough sod drives in front of an ordinary coulter, accumulates under the beam and either forces the plough out of the ground or slips on one side in a mass which the plough cannot cover.

Taking everything into account it is best to aim at getting the land into such a state that it can be ridged and the potatoes planted in rows, but good results are sometimes obtained by dibbling potatoes on land ploughed just as it would be for corn, or, in the case of land ploughed early, by planting the tubers in the bottom of every third furrow at the time of the second ploughing in spring. In such circumstances the tubers should be placed under the shoulder of the previous furrow slice so as to escape damage by the feet of the furrow horse. On a small scale the lazy bed system may be useful, particularly where the drainage is not good, though it is not advisable to attempt to grow potatoes at all on a really badly drained soil.

The advantage of having potatoes in drills is particularly marked in the case of foul soils. Given good weather conditions, much can be done to clean the land before the young shoots appear. The usual process consists in harrowing down the ridges with either "saddleback" or chain harrows, scuffling or grubbing between the rows and then earthing up with a ridging plough. This series of operations is repeated as often as thought desirable until the potatoes are just appearing at the surface, and the result is not only suppression of weeds at a comparatively small cost but the reduction of the soil to a fine uniform tilth even if it was in a rather rough condition when the crop was planted. If good seed of a strong vigorous variety has been selected and the manuring is adequate, further cleaning will soon be impossible and unnecessary, as no crop in general cultivation is so well able to smother out weeds of all kinds as a really good crop of potatoes.

Manuring.

Probably no crop grown on the farm receives more manure than the potato crop. Though, in most cases, the plant responds readily to liberal manuring, it is doubtful if it is a greedier feeder than other "fallow" crops. It should be borne in mind that the largest possible crop is not always the most profitable, and that an excess of manurial ingredients over the requirements of the crop may lead to considerable waste.

Dung alone.—In manuring potatoes a certain amount of dung is always beneficial except possibly when the crop is taken after really good grass. It may be applied at different periods of the year. In the drier districts autumn or winter applications are to be preferred ; elsewhere spring applications generally give the best results. A dressing of 20 tons of dung per acre is not uncommon, and with this alone good crops may often be obtained. It frequently happens, however, that the foliage is encouraged at the expense of the tubers, especially when nitrogenous artificials are also applied, and actually heavier and more profitable crops can be grown by using half the above quantity of dung with artificials. If the land is in very poor condition, 20 tons of dung may prove more profitable than 10, but in most cases the former quantity of good manure is too large to be applied with profit.

Dung supplemented with Artificials.—The most common system of manuring potatoes is to apply a moderate dressing of dung—say about 10 tons per acre—and supplement it with artificials.

The following mixture of artificials per acre may be recommended as a safe and reliable one under most circumstances, and no farmer should use artificials in greater quantity along with 10 tons of dung until he has thoroughly satisfied himself by experiment that it can be done with profit :—

1 cwt. sulphate of ammonia.
2 to 3 cwt. superphosphate.
1 cwt. sulphate of potash, or equivalent quantities of blast furnace flue-dust,* if available.

This mixture will contain 4 to 5 per cent. of nitrogen (equal to 5 to 6 per cent. of ammonia), 13 to 15·6 per cent. of soluble phosphates and 10 to 12·5 per cent. of potash.

Under present conditions from 1 to 1½ cwt. of sulphate of ammonia and 3 to 4 cwt. of superphosphate may be used in place of the normal dressing stated above. If the full allowance of superphosphate is not obtainable a smaller quantity should be supplemented with steamed bone flour or ground mineral phosphate ; or 4 to 5 cwt. per acre of a highly-soluble slag may constitute the sole phosphatic dressing.

In the case of early potatoes with a comparatively short period of growth 1½ cwt. of sulphate of ammonia may be given in addition to the phosphatic manure mentioned above.

The Effect of Artificials when no Dung is applied.—Though dung is generally regarded as essential in the manuring of potatoes, very good and highly profitable crops can be grown without it.

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* *See* Food Production Leaflet No. 23, *Blast Furnace Flue-Dust as a Potash Manure.* For the present potash is scarce and very expensive, and the quantities indicated above should only be used (even if available) in cases in which the grower has proved that full supplies of potash are essential for his crop. In other cases half the quantity should be used.

The following mixture of artificials per acre may generally be depended upon to produce as big a crop of potatoes as 10 tons of dung :—

2 cwt. sulphate of ammonia.

5 cwt. superphosphate.

2 cwt. sulphate of potash, or equivalent quantities of blast furnace flue dust, if available.

The mixture will contain 4·4 per cent. of nitrogen (equal to 5·3 per cent. of ammonia), 14·4 per cent. of soluble phosphates, and 11·1 per cent. of potash.

As before, if the full allowance of superphosphate cannot be given, as much as possible of this manure should be used, and the deficiency made up with either steamed bone flour or ground mineral phosphate ; or 6 cwt. of highly-soluble basic slag may be the sole phosphatic dressing. (Sulphate of ammonia should not be mixed with basic slag or mineral phosphate.)

Dung, when readily obtainable, will doubtless prove more economical than the above mixture of artificials, but there are times—*e.g.*, after grass—when such a mixture alone will give quite as profitable returns as 10 tons of dung.

Sulphate of Ammonia v. Nitrate of Soda.—When used with dung there is generally little to choose between these two sources of nitrogen in regard to the yield of the crop, but when no dung is used the results are mostly in favour of sulphate of ammonia. It is possible that in the absence of direct supplies of potash nitrate of soda may give the better results.

Calcium Cyanamide and Nitrate of Lime.—Experiment has shown that in some cases these fertilizers are about equal in value, nitrogen for nitrogen, to sulphate of ammonia.

Different Potash Manures.—Sulphate of potash will, in most cases, give the best results, but there is so little to choose between the sulphate and the muriate that a farmer should be guided by their respective unit prices at the time of purchasing.

Both these forms have proved superior to kainit. There is an idea prevalent amongst farmers that kainit, owing to its attractive power for moisture, is superior to the other forms on sandy or light soils, especially in a dry season. This, however, does not appear to have been borne out by experiment.

In view of the small stocks of these manures at present available in this country the supplies of potash required will have to be obtained as far as possible from other sources. On rich loams, on the heavier classes of soils generally, and in the fens, potash manures will not be greatly needed if an average dressing of farmyard manure or (in certain districts close to the sea) seaweed can be applied. One ton of farmyard manure or 12 to 13 cwt. of seaweed contains on an average about as much potash as 1 cwt. of kainit. Even when supplies of farmyard manure are available, however, the lighter classes of soils are often greatly benefited by a small quantity of potash in the form of artificial manure. Limited quantities of a potash manure obtained from the flue dust of blast furnaces are now on the market, and should be reserved for potatoes on such light soil as are known to respond to potash manure. Potash may also be purchased in the form of Peruvian guano, many samples of which contain from 2 to 3 per cent. Assuming a sample to contain 8 to 9 per cent. of nitrogen, 25 to 30 per cent. of phosphates and 3 per cent. of potash, 4 cwt. per acre would give approximately the same amount of potash as 1 cwt. of kainit and, where dung is applied, an ample amount of nitrogen and phosphates.

Selection and Treatment of Seed.

In the cultivation of potatoes the importance of good "seed" cannot be over emphasized.

With all crops the proper selection of seed is essential to success, but in growing potatoes it is of prime importance. The variety, origin and treatment of the seed often have a greater influence than methods of cultivation, manuring, &c., and neglect to pay proper attention to these points may nullify the care, labour and money expended on cultivation and manuring.

Choice of Variety.—Potatoes vary greatly as regards cropping capacity, cooking quality, disease resisting power and earliness. Care should be taken to select varieties which suit the conditions under which they are to be grown, and the purpose for which they are intended. The number of varieties in cultivation is large, and as old sorts gradually lose vigour they are continually being replaced by new. It is impossible to mention more than a few of the well-known varieties, but from these a selection might be made to suit almost any conditions or market. It is perhaps necessary to add that the same variety is often sold under several different names. In the following notes the best known varieties of each type or group is mentioned.

First Earlies.—*May Queen* and *Duke of York* are two favourite varieties for garden cultivation. They are very early and of good quality, but their cropping power is rather low, and, under present conditions, the area devoted to them should not be great. Some varieties of main crop potatoes keep quite well until the end of June, and heavier cropping earlies than those mentioned above are ready for lifting after that time.

Ninety-fold is a heavy cropping variety, and is grown largely for marketing purposes, though the tubers are rather watery, and readily suffer from handling. It is fairly early, and should be lifted in good time, as it is very susceptible to ordinary potato disease.

Epicure on a field scale is grown more extensively perhaps than any other early variety. It produces heavy crops, is reasonably early, and a large proportion of the tubers, even when lifted early, are of marketable size. It resists potato disease well, but should, as a rule, be marketed in good time, as the tubers if left to mature are apt to become rough and coarse, and are not then readily disposed of. In some markets a round potato is almost unsaleable, and in such cases either Ninety-fold or Eclipse, or Sharpe's Express, should be grown in preference to Epicure.

Sharpe's Express is a little later than Epicure, but is a good cropper, and the kidney-shaped tubers are of excellent quality. If lifted too early a large proportion of the crop will be small, but where extreme earliness is not required the variety can be recommended.

Eclipse is one of the heaviest cropping early varieties, and has fair quality and disease-resisting power. It is a little doubtful whether it should be classed as a first or second early, but at the present time when weight of crop should not be sacrificed to extreme earliness it should occupy ground devoted to first earlies rather than to later varieties.

None of the varieties mentioned above is immune to Wart Disease. The only well known early variety which can be grown on land infected with this disease is Edzell Blue, an old dark-skinned variety of excellent quality.

Second Earlies.—*British Queen* has in recent years become so susceptible to attacks of potato disease that it has lost favour to a great extent, but it is still the most important second early in cultivation. For combination of cropping power and cooking quality it cannot be beaten, but the crop should be lifted comparatively early to avoid loss by disease.

Great Scot, a white round variety, produces very heavy crops and as it is resistant to Wart Disease it has assumed an important position in recent years. Owing to the limited supply of seed and the necessity of providing for the needs of infected areas, it is not recommended for general cultivation this year. It is important to bear in mind the fact that while Great Scot is not affected by Wart Disease it is not immune from ordinary potato disease. On this account it should be lifted comparatively early.

King George V, like Great Scot, is resistant to Wart Disease, and practically all the available seed will be required for growth in infected areas. It resists ordinary potato disease well but is usually considered to be of inferior cooking quality.

Royal Kidney has the advantage over British Queen in that it resists potato disease extremely well and is also a good cropper, but the cooking quality is poor.

Mid-Season or Early Main Crop Varieties.—*King Edward*, *Evergood* and other varieties are sometimes regarded as second earlies, sometimes as later varieties, but it is perhaps better to class them separately. *King Edward* is a well known oval potato with pink patches. It produces heavy crops of good quality when grown on deep rich and rather moist land, but is apt to be disappointing under dry conditions. It is not resistant to potato disease and should be lifted comparatively early, though the tubers if properly stored keep very well.

Evergood is a heavy cropping variety almost entirely resistant to potato disease, but the tubers are of such low quality that the variety can only be recommended for sale in markets where quality is a secondary consideration, or under conditions where resistance to disease is all-important.

Main Crop or Late Varieties.—*Arran Chief* is a comparatively new variety which has done well in recent years. The crop produced is as a rule heavy and the tubers, though apt to be rather rough and ill-shaped, are of excellent cooking quality. It is not particularly resistant to potato disease but is better in this respect than Up-to-Date, which it is now largely replacing. The tubers are round and, as in the case of many round varieties, are sometimes hollow.

President is a favourite in some districts where resistance to disease is of great importance. The quality is very fair and provided that fresh seed is obtained the crops are almost invariably heavy, but this variety is particularly subject to leaf curl, and to be on the safe side seed fresh from Scotland or the North of Ireland should be purchased every year.

Up-to-Date, with which may be included a large number of similar varieties, such as Dalhousie, Factor, Dalmeny Beauty, was until a few years ago by far the most important main crop variety. In recent years, however, it has become so subject to potato disease that the area devoted to it is being rapidly reduced. Where disease does not occur it is still strongly recommended ; the quality is excellent and the yield good.

Langworthy, Golden Wonder and What's Wanted belong to an old class of potatoes grown largely on account of their high quality. Both tubers and crops are apt to be small unless conditions are very favourable, and the varieties now are noteworthy mainly because they resist Wart Disease.

Irish Queen is a round, deep-eyed, pink-skinned variety which also resists Wart Disease, and may be relied on to produce fair crops which will keep well.

Lochar and *Templar* are two new varieties resistant to Wart Disease. The supply of seed is not great, and will practically all be required for planting in infected areas.

Wart Disease.

Where Wart Disease has occurred, only those varieties proved experimentally to be resistant to the disease should be planted and a licence must be obtained from the Food Production Department, 72, Victoria Street, London, S.W.1.

In trials recently conducted at Ormskirk on land badly infected with Wart Disease, Epicure, King Edward, Arran Chief, and Up-to-Date produced, on the average, 2 tons 7 cwt. of sound tubers and 4 tons 2 cwt. of warted tubers per acre, while King George, Great Scot, Golden Wonder, Lochar and Templar produced over 11 tons per acre of sound tubers and no warted tubers.

It is evident, therefore, that when immune varieties are planted, excellent crops of sound tubers can be obtained from badly infected land, but that only disaster can result from planting varieties susceptible to this disease.

Change of Seed.

Too much stress can hardly be laid on the importance of securing new seed from a district known by previous experience to give a good change. For most districts in England and Wales, seed from Scotland or the North of Ireland give the best results, and, as a rule, the farther north the district from which the seed is obtained the better the results, but the altitude of the farm on which the seed was grown has an important effect. For instance, in tests carried out in North Wales, seed grown at 900 feet above sea level in Midlothian produced slightly heavier crops than seed grown at about sea level in Aberdeenshire or Sutherland. On the other hand, seed from similar elevations in Sutherland, Aberdeenshire, and Forfarshire, produced crops of 16 tons 16 cwt., 14 tons 19 cwt., and 14 tons 8 cwt. respectively.

Farmers in hill districts might with advantage bear the effect of altitude in mind with a view to developing a trade in seed potatoes with growers on low ground.

Results of experiments which have clearly shown the advantages of obtaining fresh seed could be quoted almost indefinitely, and the extensive trade in seed potatoes from Scotland and the North of Ireland is clear evidence of the importance attached by potato growers to the effect of a change, but the following cases typical of many others may be mentioned.

In North Wales, at fourteen farms, new seed from the North of Ireland was tested against "once grown" seed and against seed grown at least two years on the farm. In all cases the variety was the same—Up-to-Date. The average crops from the three classes of seed were as follows :—

	Marketable.		Small.		Diseased.		Total.	
	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.
New Seed	10	16	1	13	0	12	13	1
Once-grown Seed...	9	0	1	3	0	18	11	1
Twice-grown Seed	7	13	1	4	0	16	9	13

These results show clearly the usual effects of a change of seed. The new seed gives a more vigorous crop, which resists disease better than that grown from old seed; the total crop is much greater, but the average size of the tubers is rather less than in the crop grown from old seed.

In the southern counties it is always advisable to change seed after the second year, and, in some localities, every year, especially after a hot, dry summer. Garforth experiments have shown also that as far north as Yorkshire it may be profitable to change the seed after the *second* year. Crops of British Queen and Conquest, grown for three years in succession on the farm, produced, on the average, 2 tons 1 cwt. *less* than crops of the same varieties grown only two years, and included many more diseased tubers.

It may be pointed out that new seed should be obtained as early in spring as possible, before sprouting has commenced, so that the damage which sprouted potatoes suffer in course of bagging and transit may be avoided.

Storing of Seed.

During recent years different methods of storing seed have been tested, and it has been found possible by introducing suitable systems of storage to produce considerable increases in crop.

Boxing in Autumn.—According to this method, which has been largely adopted for some years by the growers of early potatoes, seed-size tubers are placed in the autumn in shallow boxes containing no soil or other material, and stored throughout the winter in tiers in a cool, well-ventilated and well-lighted shed. No artificial heat need be used, except in frosty weather, when a small paraffin stove or large lamp should be placed in the shed to keep the temperature above freezing point. From time to time the order of the boxes in the tiers should be reversed so as to ensure an equal amount of light to all the potatoes. This treatment leads to the "greening" of the tubers and the development of short, sturdy green sprouts, which do not break off during planting, and the crop gets an "early start." Further, experiments conducted at Kew showed that "greened" tubers lose only about one-sixth as much in weight during the season as those not "greened," and are therefore firmer; while "greening" will to a great extent check the ravages of winter rot. The method, however, involves a good deal of labour at a time when work presses, and, further, accommodation for boxes is often lacking on farms at this season of the year.

Boxing in Winter or Early Spring.—Second early or late varieties may be clamped or "pied" straightway in autumn and transferred to boxes in winter or early spring, whenever weather conditions are suitable and men can be spared for the work.

In some cases quite as good crops have been grown from seed stored in this way as in the former, but in general it is less satisfactory to box in winter and early spring than in the autumn.

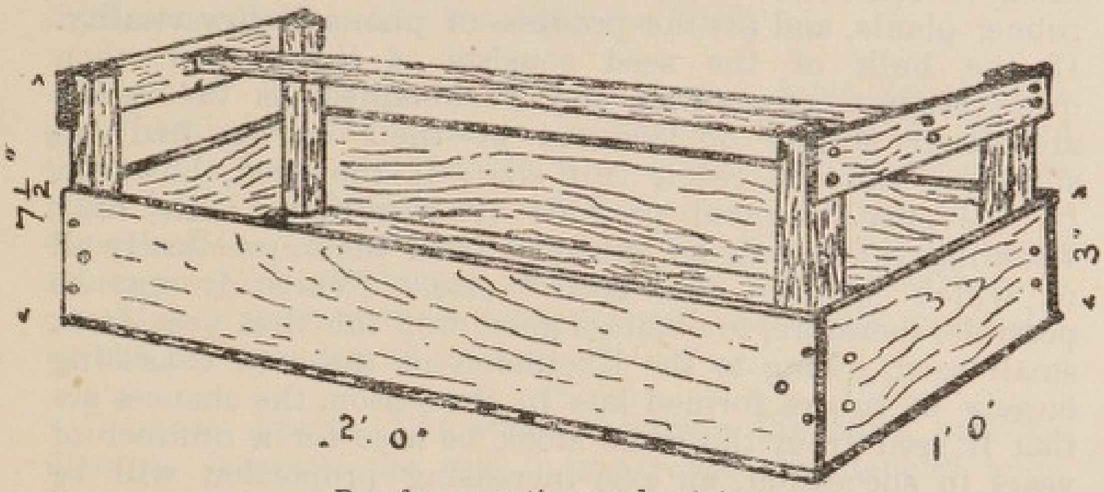
A very convenient box is that illustrated on p. 14. It holds from 16 to 20 lb. of seed, and from 100 to 120 boxes will be required per acre. Before the war the boxes cost 4*d.* to 5*d.* each, and as they last for several years the annual cost per acre was not great.

Pieing in Autumn and Planting direct from the Pie.—Both of the methods just described have proved superior to the ordinary one of planting direct from the pie. Even with late varieties, if the potatoes taken direct from the clamp are planted so late that sprouting has taken place before planting time, the results with boxed seed will almost invariably be better. In a Yorkshire experiment carried out in 1903 with Up-to-Date, an advantage of two tons per acre followed the use of boxed seed. In 1904, five varieties (second early and late) showed an advantage of 33 cwt. per acre in favour of boxed seed. In 1905, an average increase of one ton per acre was produced at Garforth by seven varieties when boxed seed was used.

In each year these results were obtained from Scotch seed, introduced into Yorkshire in the previous season, and, as might have been expected, excellent crops were obtained without any special treatment. Even with such seed, however, boxing resulted in a profitable increase.

In each of the above trials the potatoes were planted in May. Further experiments appear to show that the advantages of boxing are not so great in districts where planting is possible about the end of March or the beginning of April.

Where large areas of potatoes are planted it is difficult to provide sufficient boxes for the seed, or accommodation for



Box for sprouting seed potatoes.

the boxes, but it should at least be possible to box the earlier varieties. If it be found impracticable or unnecessary to box the seed of late or maincrop varieties, which do not sprout in the pies to the same extent as the early varieties, it is perhaps better to spread the seed some time in early spring in a thin layer on the floor of a dry, well-lighted shed, than to leave it in the pie till planting time.

The free admission of light is important. It has the effect of producing a slow, sturdy growth of sprouts which are much less liable to be knocked off at planting time than the pale, elongated sprouts produced in the dark.

In addition to minimizing the damage to sprouts, early removal of the seed from pies is beneficial for another reason. Rotting frequently takes place in the pie, sometimes to a serious extent, and sprouts which have come into contact with rotten tubers are often considerably damaged, and not infrequently killed. Rotting may be checked by dusting the tubers freely with quicklime before pieing. Lime used in the "quick" form readily becomes detached from the tubers in spring, leaving them clean and dry. Slaked lime should not be used, as it adheres to the tubers in a pasty condition, and on drying becomes firmly attached to them. Sprinkling the tubers with powdered sulphur at the rate of 2 lb. per ton of tubers also holds winter rot in check.*

Small compared with Large Seed.—In many parts of the country it is the practice to plant small tubers, *e.g.*, those

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* See also Leaflet No. 193, *Dry Rot of Potatoes.*

which will pass through a $1\frac{5}{8}$ in. riddle but not through a $1\frac{1}{4}$ in. riddle, all the bigger ones being sold for cooking purposes. Other growers prefer large seed and have their seed dressed through a 2 in. or even a $2\frac{1}{4}$ in. riddle. In discussing their cropping capabilities, two kinds of small potatoes must be considered : (1) the late-formed tubers of strong, robust plants, and (2) the produce of plants of low vitality. If the bulk of the seed consists of the former, then quite satisfactory returns may be obtained, as the tubers are small simply on account of their having had insufficient time to reach full size ; if the seed, however, be the small, stunted produce of weakling plants, only weakling tubers can be expected from them, practically all of which will be of "seed" size. Whilst it may be possible, therefore, to obtain a good crop the first year from small seed, owing to the likelihood of the seed consisting largely of tubers formed late in the season, the chances are that if seed from the same stock be used for a number of years in succession, an ever-increasing proportion will be the produce of weakling tubers, with the result that the returns will become more and more unsatisfactory.

Experiments have shown that tubers about the size of a hen's egg generally prove the most profitable for planting purposes, but when supplies of seed are scarce and dear there need usually be no hesitation in planting somewhat smaller tubers provided they are the produce of a uniformly vigorous crop, or have been grown in a cool, northern climate.

Whole compared with Cut Seed.—Should the supply of whole seed run short, the deficiency may be made good by cutting large tubers. In this case the weight planted per acre may be considerably greater than when seed-size potatoes are planted whole, but, on the other hand, the produce will generally contain a less proportion of "small" tubers than the produce of whole seed. Planting should be done directly after cutting, and the sets covered in with as little delay as possible. Exposure even during the dinner hour may be sufficient materially to reduce the yield from cut sets. If for any reason it is impossible to plant immediately after cutting, the cut surface should be dusted with quicklime.

Planting.

Time of Planting.—Potatoes should be planted in spring, as soon as a good tilth can be obtained. April is generally a suitable month, but planting is sometimes possible towards the end of March, while good returns are not infrequently obtained from seed planted in May. When, however, no special precautions—such as boxing—are taken to preserve the first sprouts, it is advisable to plant the potatoes so that they shall, as far as possible, make their first growth in the soil. A good covering of soil will protect the sets from frost, even when planted as early as the end of March, but as soon as the weather becomes fairly mild, part of the covering should be removed by harrowing, as weak and spindling sprouts result if they have to push their way through a considerable thickness of soil before reaching the light.

Depth of Planting.—As to the proper depth to plant, a great deal depends upon the character of the soil. Where the soil is loose and friable it is possibly advantageous to plant fairly deeply. When dung is applied in the row the danger of the sets being covered too much is minimized, but when potatoes are planted without dung in the row there is considerable risk of their being covered too deeply, especially on the heavier class of soils.

Distance Apart.—The width between the rows, and the distance between the sets in the rows, also depend upon local conditions, but in general 26 inches between the rows and 15 inches between the sets will prove satisfactory. On the other hand, on some soils and in some localities 12 inches between the sets has yielded a better crop.

In the case of First Early varieties the distance between the rows may be 20 to 24 inches, and between the sets in the row, 10–12 inches.

Spraying.

The object of spraying potatoes is to reduce the loss caused by the ordinary potato disease or blight (*Phytophthora infestans*),* and at the outset it must be made clear that the extent of the damage done by this disease cannot be measured simply by the proportion of tubers found to be diseased when the potatoes are lifted. The disease first makes its appearance on the leaves, usually about the end of July or beginning of August, and if the variety grown is not one which resists the disease, and if other conditions are suitable—particularly if the weather is moist and warm—the whole of the haulms may be killed off in a few weeks, with the result that, instead of growth extending well into October, no addition to the weight of tubers takes place, after say the beginning of September. The result of this is that the weight of crop is less than it would otherwise have been, and the proportion of small tubers is large. Whether the proportion of diseased tubers is large or not will depend very much on the weather after the potatoes have been

* *See also* Leaflet No. 23, *Potato Disease ("Blight") and its Prevention.*

attacked. If the weather continues to be wet, a large proportion of the tubers will be diseased when lifted. If, on the other hand, September and October are dry and hot, the proportion of diseased tubers may be small, but none the less, owing to the reduction of the crop, serious loss may have been caused. Put briefly, it may be said that under certain conditions potato disease may have caused very serious damage even though hardly a diseased tuber is found when the potatoes are harvested.

It need hardly be said that climate has a good deal to do with the occurrence of the disease, and, particularly in the moist and mild western districts of England and Wales, the annual loss caused is very great.

The effect of spraying has been thoroughly tested during the last sixteen years in North Wales and the following average results of experiments conducted at ninety-one centres in North Wales in the years 1901–1915 may be quoted :—

—	Average Weight of Potatoes per Acre.			
	Marketable.	Small.	Diseased.	Total.
	T. C.	C.	C.	T. C.
Sprayed	10 6	18	11	11 15
Unsprayed	8 12	21	15	10 8

The figures show clearly the effect of spraying. The proportion of diseased tubers is less where spraying has been done than in the untreated crop, but probably the difference between the proportion of diseased in the two sets of figures is less than many people would expect. If, however, the weights of marketable potatoes are considered, the full results of the spraying are evident. The spraying has prolonged the growth, and thus resulted in a much greater crop of marketable potatoes, the average increase being 1 ton 14 cwt. per acre.

Consideration of the effects of the disease, as briefly indicated above, shows that it is quite possible for spraying to have proved successful, even though there are almost as many diseased tubers in the sprayed crop as in the unsprayed crop.

Time to Lift Potatoes.

It is highly important that potatoes should be lifted as soon as they are ripe. It has been demonstrated repeatedly that, if attention is given to this point, comparatively healthy crops can be obtained even from those varieties which are generally regarded as being very liable to disease.

Formation of the Pit.

The general principles on which a pit or pie or clamp is made are practically the same throughout the country. The method of covering however, varies considerably, but the following may be safely recommended. The usual roof-shaped pie is covered with a layer of straw about 6 in. thick. A plank about 1 ft. broad and from 8 to 10 ft. long is then placed along the top or ridge of the pie, and the sides to the edges of the plank are covered with an inch or two of soil. The plank is then moved along and another length is covered with soil. In this way the top of the pie is kept free from soil, thus providing for ventilation. It may be necessary to add more soil to the sides later in the year, but the top is left untouched except, perhaps, in a time of severe frost, when a covering of potato haulm is put over the straw. Potato haulm should not be used for this purpose, however, unless the crop from which it was derived was quite free from disease.

Diseases of the Potato.

The potato crop is subject to several fungus diseases which may cause serious loss both in yield and quality of the produce. A number of these diseases are dealt with in certain of the Board's Leaflets, as follows :—No. 23 (*Potato Disease*); No. 105 (*Wart Disease of Potatoes*); No. 117 (*Black Leg or Potato Stem Rot*); No. 137 (*Varieties of Scab in Potatoes*); No. 164 (*Potato Leaf Curl*); No. 171 (*Rhizoctonia Diseases*); No. 193 (*Winter Rot of Potatoes*); No. 242 (*Bacteriosis of the Potato and Tomato*).

London, S.W.1,
October, 1906.
Revised, February, 1918.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

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Leaflet No. 174.

BOARD OF AGRICULTURE AND FISHERIES.

Tree Root-rot (*Armillaria mellea*, Vahl.).

This destructive parasite, also known as Collar Rot and *Agaricus melleus*, is one of the most abundant and widely distributed of British "toadstools." In addition to attacking nearly all kinds of orchard and other broad-leaved trees, it is parasitic upon European and some introduced conifers.

Description.

The fungus, in common with many other kinds, grows in dense clusters round the roots of living trees, also round dead stumps. In some instances it appears to grow directly from the ground, but careful examination in such cases shows that the mycelium springs from buried wood, roots, &c. It is distinguished by the dingy honey-yellow coloured cap being covered, more especially towards the centre, with small, darker scales; the stem is coloured like the cap and has a frill or ring near the top; when young this frill extends from the stem to the edge of the cap and conceals the gills, which are whitish. Myriads of spores are produced, which form a snow-white powder on whatever they fall. These spores are distributed by wind, game, mice, &c., and aid greatly, but not solely, in spreading the disease.

Indications of Disease.

Usually the first indication of disease is the drooping and yellowing of the foliage. When this symptom manifests itself, the presence of a thin, firm, white sheet of mycelium, situated between the bark and the wood at the collar, or on the main root-branches, clearly indicates *A. mellea* as the cause of the mischief. This felted white mycelium often extends up the trunk between the bark and the wood for several feet, and changes gradually into blackish cord-like strands of mycelium, called rhizomorphs, which continue to grow upwards between the wood and the bark as the latter becomes dry and separates from the wood. These cord-like rhizomorphs become variously branched, and anastomose to form an irregular black network, so frequently met with on removing the bark from a dead trunk, indicating the cause of its death. Black rhizomorphs may also be found surrounding the root-branches. In fact, these first infect the tree by penetrating the bark of the root and giving origin to the white mycelium.

Prevention and Remedy.

1.—When the leaves of a tree droop and turn yellow owing to the presence of the fungus, curative measures are hopeless, as the mycelium has by this time completely girdled the trunk. Nevertheless, it is very important at this period to adopt measures against an extension of the disease. When a tree has been killed the black rhizomorphs surrounding its root extend in all directions about three or

I.—Cluster of Armillaria mellea. II.—Rhizomorph on Root.

four inches below the surface of the ground in search of living roots of a fresh tree. When such are encountered, the tips of the rhizomorphs pierce the bark and give origin to the white mycelium, which eventually kills the tree. These underground rhizomorphs travel for an unlimited distance in the ground, and, unless checked, constitute a continual source of danger to trees surrounding the one attacked.

When a tree is attacked a portion of the bark at the collar should be removed, and if the white mycelium is found to have passed up the trunk the case is hopeless, and the wisest course is to cut down the tree, and remove as much as possible of the root, which should be burned. The roots should not be used for ornamenting, as when this is done, dense masses of toadstools appear in due course, and the underground rhizomorphs spread on every side.

2.—If the mycelium has not entered the trunk, but is confined to certain branches of the root, these should be removed, and as much as possible of the root exposed, and covered with a mixture of equal quantities of quicklime and powdered sulphur. This mixture should also be placed round the base of the trunk before the soil is filled in.

3.—Whether a diseased tree has been removed, or treated in the hope of recovery, a trench about eight inches deep and six inches wide should be made all round the site of the tree, at a distance well outside the spread of the branches. The object of the trench is to intercept the spreading rhizomorphs. If in a situation where an open trench can be allowed to remain, this is all that is required to be done. If the position is such that an open trench would be objectionable, planks about six inches deep, well coated with gas-tar, may be let into the ground instead, and will answer the same purpose. In making the trench it is important that the soil removed be spread over the ground enclosed by the trench.

4.—When the toadstools appear at the base of a trunk, they should be collected and buried ; crushing them underfoot is worse than useless, as this only aids in the dispersal of the spores.

5.—Great care should be taken not to injure the base of the trunk or exposed roots, as the spores can only enter the tree through a wound. The grass-mower is responsible for many wounds, through which this and various other fungi parasitic on trees first gain an entrance.

London, S.W.1,

July, 1906.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

The Use of Waste Organic Substances as Manures.*

There are several ways in which a manure may be beneficial, but in general most manures serve one or more of four purposes, which are :—

1.—*To increase the supply of available plant food either directly, or indirectly through their solvent action on the soil.*

2.—*To improve the mechanical condition of the soil.*

3.—*To hold up water in the soil and so ensure a constant supply to the plant.*

4.—*To favour the growth and work of micro-organisms on whose activity the productiveness of the soil to a certain extent depends.*

Value of Organic Manures.

Mineral substances, with the exception of lime and basic slag, chiefly serve one function—they supply plant food. Organic substances, however, such as dung and the products described below, act beneficially in all the directions enumerated above. They furnish plant food, although the proportions are not well balanced, and somewhere in the rotation the proper mineral substances must be added if the best results are to be obtained. They have a marked effect on the mechanical condition of the soil: a heavy soil is lightened by their mere presence and also as a result of their decay; and a light soil is improved by the cementing action of the humus to which they give rise. Without organic matter it is difficult to secure a good tilth.

One of the most valuable properties of organic manures, and one in which they far surpass artificials, is their power of holding water. The water supply in many soils is insufficient for securing maximum crops; the manuring and cultivation adopted would give much better results

* Other Leaflets dealing with Manuring of Farm and Garden Crops are No. 72 (*Purchase of Artificial Manures*); No. 93 (*Farmyard Manure*); No. 170 (*The Use of Lime*); No. 254 (*Use of Seaweed as Manure*); and No. 314 (*The Manurial Value of Shoddy*). Also Food Production Leaflets Nos. 15 (*The Use of Sulphate of Ammonia as Manure*); No. 23 (*Blast Furnace Flue Dust as a Potash Manure*); No. 24 (*Compound Manures*); No. 27 (*Potash Supplies during the War*); and No. 33 (*Fertilisers for Farm Crops in* 1918).

if more water were present, provided, of course, it had no depressing effect on the soil temperature and air supply. This question will probably assume even greater importance as the necessities of the towns compel them to sink more and deeper wells in the country. Already in many districts the water level appears to be lower than it was ; shallow wells are in consequence left dry and have to be deepened, and the supply available for the fields promises to be still further curtailed. Proper cultivation and the application of organic manures are satisfactory ways of conserving the water supply.

Organic matter is not indispensable ; crops can be grown on an experimental scale without it. But the advantages due to its presence are well recognised, and it should be replaced as it disappears from the soil in consequence of bacterial and other actions. The farmer uses dung, and the manure manufacturer frequently puts organic matter into his compound fertilizers.*

There are a number of waste products, used at present only in special branches of farming, some of which deserve a more extensive trial, particularly by market gardeners, who are finding it increasingly difficult to obtain adequate supplies of dung at a moderate price. This leaflet deals with certain substances used in the hop gardens of Kent and Surrey, but there is no fundamental reason why their use should be restricted solely to hops, and some of them have been applied with great advantage to other crops. Nor is their use confined to a particular type of soil ; they are generally applied to light chalky or sandy land, but this is by no means essential.

There are, however, certain drawbacks with regard to purchasing. The supply is somewhat irregular, and bulks are often not uniform ; it is difficult to draw a representative sample for analysis, and dealers often decline to give any guarantee as to composition. Competition from other quarters may force up prices too high, while difficulties attendant on sanitary regulations may have a similar effect, or they may act in precisely the opposite direction. There is no uniformity of price ; indeed, prices vary in neighbouring districts in an apparently haphazard way. Little information is obtainable as to the relative manurial value of the various substances ; the usual pot experiments are not quite satisfactory, because sufficient account can hardly be taken of the power to hold up water. It seems certain, however, that,

* An Order, dated 4th June, 1918, has been issued by the Ministry of Munitions in consultation with the Food Production Department, fixing the Maximum Prices to be charged for Compound Manures on the basis of the value per unit of nitrogen, phosphates and potash contained in them.

provided the mechanical condition is satisfactory, these substances have considerable fertilising value.

The substances dealt with fall into four groups :—

1.—*Residues from animal carcasses*: Dried blood, feathers, greaves, hair waste, hoofs and horns, rabbit waste, slaughter-house refuse.

2.—*Residues from manufactures* : Damaged cakes, shoddies, tannery waste.

3.—*Residues from towns* : Destructor refuse, sewage sludges.

4.—*Seaweed, vegetable refuse, bracken, &c.*

1.—*Residues from Animal Carcasses.*

Dried Blood.—This is an excellent fertilizer, and it is used by some manufacturers for their mixed manures. Owing, however, to the shortage of feeding stuffs it is now being used for the manufacture of poultry food, &c., and little or none is available as a fertilizer.

Feathers and Feather Waste.—Excellent results are obtained in some hop gardens by using about 20 to 25 cwt. of feathers per acre, and the limited supply (amounting probably to only a few hundred tons a year) is rather keenly sought after. Large feathers are slow in action, the shafts especially taking a long time to decay; a sample containing many of them is not as valuable as one composed mainly of small, more easily decomposable feathers. The nitrogen obtained is usually a little over 8·24 per cent.

Greaves.—This is the refuse or sediment left in making tallow or soap grease. Clean samples, derived from butchers' fat and the trimmings of joints, are used as food for dogs, pheasants, and poultry ; lower grades, obtained in melting down grease from other sources, are available as manure, and have been effectively used on hops, fruit, wheat and other crops. The composition varies, and the fluctuation in price is considerable, but it is not difficult to fix a maximum value for a particular sample, because of the close relationship between greaves and meat guano. The latter article consists of well-dried and finely ground greaves mixed with bone meal ; as a manure it is superior to ordinary roughly ground greaves.

Hair (Calf Hair, Hair Waste).—This yields about 9·9 per cent. of nitrogen, but it does not easily decompose in the soil. As a rule the mechanical condition is very bad ; the hair is matted in lumps which resist all ordinary farm appliances and absolutely refuse to break down. They may be in the soil for an indefinite time without perceptibly diminishing. Calf hair has been known to remain for two years in a hop garden and at the end of that time still yield 9·9 per cent. of nitrogen when brought to the laboratory.

Having regard to its unsatisfactory mechanical condition, hair must be valued at less than feathers and much less than meat guano. At the same time, if it could be supplied in a finely divided state it would be more valuable.

Hoofs and Horns.—The value of these is regulated mainly by their fineness; high grade samples of horn shavings and finely-ground horns yielding 12·3 to 14 per cent. of nitrogen are largely used by market gardeners. Other grades yield about 9·9 per cent. of nitrogen, and 20 to 25 per cent. of phosphate. They contain some bone. The demand has gone up enormously during the last few years. On the other hand, *whole* hoofs and horns and materials like trotter scutch (consisting of hair, hoof, and bone), sometimes bought by farmers, are of little value until they have been finely ground.

Rabbit Flick (Rabbit Waste).—This consists of the ears, feet, tail, and various other external portions of rabbits. The mechanical condition is usually very fair, but if the substance could be broken up a little more its value would be increased. It yields from 9·9 to 12·3 per cent. of nitrogen. A certain amount of phosphate is invariably present. Rabbit waste is regarded by many practical men as quite a useful fertilizer, the only drawback being that the supply is rather restricted.

Slaughter-House Refuse, Viscera, &c.—The proper way to utilize slaughter-house refuse is to convert it into meat meal or guano, in which form it can easily be carried about without interference from sanitary authorities. Where those who contract to clean out cattle markets have the refuse removed in barges it finds its way to waterside farms. It is worth about the same price as town stable manure.

Fish Waste.—Fish waste varies considerably in composition according to the relative amounts of dry matter and water present. The percentages of nitrogen and phosphates increase as the percentage of water decreases, and the farmer in estimating the value of this material should be guided by its water content. Fish waste may be used either directly or mixed with soil in the proportion of five parts by weight of soil to one part of fish.

East Kent farmers are very fond of waste fish as a manure and the loads of sprats and of "five fingers" occasionally obtainable are disposed of without difficulty.

Its use is not confined to hops; it has been applied with great advantage to mangolds. It may be applied in the same way as farmyard manure in autumn or spring at the rate of 1 ton per acre in preparation of land for potatoes, turnips or mangolds. Owing to its particularly penetrating and unpleasant odour it is, as a rule, only available in districts directly connected with the sea.

Fish guano has not been dealt with in this leaflet, because it is now no longer a waste substance, but a definite manufactured manure.

2.—*Residues from Manufactures.*

Damaged Cakes.—Damaged cakes, or meals or cakes unsuitable for feeding purposes, are occasionally offered to farmers as manure, and where it is possible to have them finely ground they are very useful substances. Rape meal really belongs to this category, and in view of its uniformity may be taken as the standard in fixing a maximum price.

In Kent and Surrey (and no doubt elsewhere also) the price of a unit of nitrogen derived from rape dust is about 20 per cent. higher than that of nitrogen from fish guano, which in turn is somewhat higher than that from meat guano. There is no obvious reason for supposing that the actual value as manure differs to this extent, and it is desirable that the matter should be settled by properly conducted trials.

Among the samples known to have been used as manure are several Bombay cotton cakes yielding 3 to 4·5 per cent. of nitrogen, and 0·2 to 4 per cent. of phosphate ; also certain compound cakes, falling within the same limits of composition, which had in some way got mixed with excessive quantities of sand.

Shoddy.—This has long been used as manure. Writing a century ago about woollen rags, Young says in his "Farmers' Calendar": "They hold moisture, and are adapted for dry, "gravelly, and chalky soils, and succeed in dry seasons better "than most manures, but they do little good on wet soils." Six to ten cwt. per acre were ploughed in three months before sowing wheat and barley ; one ton per acre was dug nto hop gardens.

Woollen rags are now too valuable to be applied direct to land ; they usually go first to the manufacturer to be torn up, shredded, and again made into cloth, only the portions which cannot be utilized in this process being available as manure. Considerable admixtures of dirt, cotton, and occasionally oil, may be present, but the mechanical condition, as a result of the shredding, is excellent.

Shoddies may conveniently be divided into three classes :—

(1.) *High grade*, yielding 12·3 to 13·2 per cent. of nitrogen, or, in the case of silk waste, 14 per cent. ; the samples are clean and pure, and often highly coloured. This class includes carpet waste, and high quality cloth clippings. The supply is somewhat limited, manure manufacturers taking a considerable quantity.

(2.) *Medium grade*, yielding 4·9 to 7·4 per cent. of nitrogen. The samples show considerable variation, and it is often difficult to obtain any guarantee as to their quality. This class includes wool combings, wool waste, flock dust, and the poorer qualities of cloth clippings. The supply is larger and prices are lower than for the higher grade, but samples are not always sold on the basis of their composition.

These shoddies are widely used in hop gardens, and with such good results that they deserve a wider trial. They have been occasionally used with good effect on other crops, and are not so slow acting as has sometimes been stated.

(3.) *Low grade*, yielding about 2·5 per cent. of nitrogen.

Refuse from Tanneries.—Leather dust, yielding about 3·5 per cent. of nitrogen, used occasionally to be offered to farmers, but the recorded experiments show that it has little or no manurial value.

Of late years the method of preparation has improved, and a product is now obtainable at a relatively low price yielding 5 to 6 per cent. of nitrogen and in a very finely ground condition. There is nothing to show that the material possesses any value as a fertiliser. There is reason to fear that it is sometimes used to increase the nitrogen percentage of poor mixed manures.

Thin soft leather scraps from glove factories are considered to be distinctly valuable in the Pershore and Evesham district. They are applied when setting out cabbages, etc., and have a good physical effect in addition to any chemical change they may undergo ; they are also used as manure for plum trees on heavy ground. The supply is restricted, and the demand considerable, so that prices sometimes run high.

Other tannery wastes are stated to be used by manufacturers and farmers. Some of them doubtless have distinct manurial value.

3.—*Residues from Towns.*

Destructor Refuse.—This substance does not appear to have any greater value on the land than coal ashes of equal fineness. Its action is chiefly mechanical.

Sewage Sludges.—Numerous attempts have been made to utilize the sludges deposited during sewage purification, and it has been found, especially with those containing lime, that they have some manurial value. Their action, however, is very slow, and they appear to be best adapted for slow-growing crops and moist climates. The possibilities are by no means exhausted and important developments may be looked for in the future. At the present time, however, sludges and sludge products should only be purchased and utilized under expert guidance.

4.—*Seaweed, Vegetable Refuse, Bracken, &c.*

In addition to the residues mentioned above, and, in the absence of a plentiful supply of dung, it is desirable to draw attention at the present time to the value of seaweed and vegetable refuse, particularly as sources of potash. If these materials were systematically collected and utilised for potatoes and other crops to which the application of potash in some form is essential, they might do much to render the deficiency of artificial potash manures less keenly felt.

Seaweed.—All who have access to seaweed should collect it in quantity. Broad weed may be used direct as manure. Grassy weed and tangle should be dried and burnt where-ever possible. A ton of fresh weed should yield 20 to 30 lb. of potash (enough, for example, to manure from a quarter to half an acre of potatoes). For general information as to the use of seaweed as manure reference should be made to Leaflet No. 254.

Hedge-trimmings, &c.—Inland gardeners may obtain small quantities of potash by burning weeds, prunings, hedge-clippings, brushwood and vegetable refuse generally. The proportion of potash present in the ash resulting from the burning of the materials mentioned naturally varies widely, but as a rule it falls very little short of that contained in an equal weight of kainit. Experiments carried out at Rothamsted have shown that the ash of the waste material removed in the course of hedging and ditching may contain from 10 to 13 per cent. and the ash of burnt cavings 11 per cent. of potash. The potash is in a very soluble form and speedily washes out if the ashes are exposed to rain.

Bracken.—Bracken ash may usefully be employed as a source of potash if the necessary labour can be spared for cutting and burning the plants. The results of a series of experiments recently conducted at different centres show that young shoots collected in May or early June may yield about 20 lb. potash per acre; the full-grown plant collected in July or August, 200 lb. or more. If the fronds are large

—5 feet or 6 feet—and the bracken dense in growth, a ton of ash may be expected from about 4 acres of ground; and valuing the potash at, say, 10*s.* per unit, the ash should be worth £15–£20 per ton, provided it were collected in perfect condition and not washed by rain.

Banana Refuse.—Attention may also be drawn to the value of banana refuse as a source of potash. The stems, which weigh on an average about 5 lb. each, may contain up to 60 per cent. of potash, and when conditions permit of a more normal importation of bananas into this country*, a considerable amount of potash might be obtained from this source. Unfortunately a large proportion of the bunches are sent to the fruiterers whole and it is doubtful whether any potash which could be recovered from the stems of these would repay the cost of collection. At the same time large numbers of stems are bound to collect in markets and at the shops of wholesale dealers, and, where this is the case, the labour involved in burning the material and sacking the ash might be profitably employed. Consignments of bananas condemned at the ports might also be utilised. Fruiterers who own market gardens might with advantage utilise the stems for their own land.

In burning these waste materials it should be carefully borne in mind that if the ashes are exposed to rain a large proportion of potash will be washed out. Wherever possible the ashes should be removed directly they have cooled down, and stored in a dry place until required for use.

London, S.W.1,
July, 1906.
Revised, August, 1918.

* Some 7,000,000 bunches were imported annually before the War.

Copies of this Leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

Poultry Fattening.

Fattening is an unnatural and artificial process, which can only be carried on for a limited period. The length of this period is fixed by the health of the bird, for no bird will bear more than a certain amount of close confinement combined with heavy feeding. Under the present system about three weeks has been found to be the most suitable period, but some birds are not able to bear the treatment as long as this.

Selection of Birds.

Class of Bird Suitable for Fattening.—All birds are not ready for the fattening pens at a given age. This is largely on account of variation in size, which is dependent upon such circumstances as breed, date of hatching, previous feeding, weather, &c.

If the bird has been well fed from the start, much less fattening is required, and it is usually large enough to enter the fattening pens earlier than is the case with a sparsely-fed bird, which has only had sufficient food to develop a good frame without much covering. In this connection it is well to note that a bird fed entirely on grain is unlikely to be as forward as a bird fed on grain combined with soft food. Experiment has proved that ground grain is not only more freely eaten, but tends to put on more flesh than does whole grain, while it promotes more rapid growth.

All breeds of poultry can be fattened, but some lay on flesh far more rapidly and to a greater extent than others. The non-sitting varieties, in other words the layers, generally make the poorest table birds. Good layers are very active in habit, their surplus food and energy are utilized in egg production, and their activity keeps them lean. They are usually more developed behind than in the breast parts, whereas the good table bird is generally more ample in front. The breast of the ideal table bird, judged from the side, should be somewhat of the shape of a parallelogram with rounded corners. It should have a long, deep, broad, nicely-rounded breast, the bone of which is long and straight. It should be small or soft boned, with white skin and legs.

Unsuitable Birds.—Certain birds are unsuitable for fattening purposes. All those intended for the fattening pens must be in a fair state of health, or they will not stand the strain. Very wild birds will not fatten well. Feather-eaters must on no account be placed in the pens with other birds, as they would worry them by continually picking at their feathers, and thus retard the growth of the whole pen. Fighters must also be excluded.

Suitable Breeds.—Superlative excellence both for laying and for table use cannot be expected in one and the same bird, and hence it is best to employ special breeds for table purposes if they are intended for the market.

Amongst pure breeds Dorkings, Sussex, Old English Game, Faverolles, Malines, Orpingtons, Langshans, Plymouth Rocks, and Wyandottes may all be used as table fowls. Of these, the first seven named have white flesh.

Suitable cross-breeds are Old English Game—Dorking; Indian Game—Dorking; Faverolles—Buff Orpington; and Indian Game—Buff Orpington, and it is to this class of birds that attention is particularly directed. Sussex, Faverolles, Buff and White Orpingtons, and Malines, among pure breeds, and Old English Game—Dorking and Faverolles—Buff Orpington among crosses, are quick in growth and suitable for spring and summer chickens. The others are better adapted for the production of winter supplies.

As a pure breed the Sussex is greatly esteemed. Old English Game are best crossed with another breed, such as the Dorking. The Heathfield fatteners prefer Sussex, and next to that Brahma or Plymouth Rock crosses. Indian Game—Dorking crosses are only suitable for winter sale, when they often scale up to 10 lb. and more. Old English Game—Dorkings reach 7 to 8 lb.; Langshans, 10 lb.; Orpingtons, 7 lb. and over; Plymouth Rocks and Wyandottes, 7 to 8 lb. These weights, however, apply to birds in the autumn and winter. Faverolles are greatly favoured by the French, and they make capital table birds either pure or crossed with the Buff or White Orpington. The chickens come early to maturity.

It has been pointed out that the non-sitters, such as the Leghorns, make the poorest birds for meat; but if they are crossed, say with a Houdan, a fair bird for the home table can be produced.

Best Age for Fattening.—Birds on a free range are usually more forward for their age than those hatched and reared in confined runs, so that while from three to four months is the usual age at which a bird is ready to be fattened, size is the best guide.

An important point to remember is that at a certain age, varying with each case, a bird is in a condition to return a maximum amount of profit. It is important, not only to know just when a bird is ready to be placed in the fattening pens, but to be able to determine exactly when each bird, in turn, reaches its highest state of perfection, after which no more food should be given it. It should be fasted for 24 to 36 hours, and then killed at once. Experience alone can enable one to decide the proper time at which to cease fattening. The loss to a fattener on hundreds of birds kept a few days beyond their time would be very great. There is, moreover, a double loss, for if kept beyond a certain time, not only is a bird consuming unnecessary food, which costs money, but in addition it actually loses weight. The cost of labour and the space it is occupying have also to be considered.

Buildings and Pens.

Where sheds are specially erected it is better that they should be medium in height and built on the span-roof principle, allowing for only one tier of pens. This ensures better ventilation.

Where barns or sheds are utilized for fattening purposes, the pens are sometimes placed in tiers one above the other, allowing room in front of each row for the food trough, so that starting about 3 feet from the ground, each row of pens comes nearer to the wall than that immediately below it. The fewer the number of tiers the better the ventilation, and, where space permits that arrangement, one row only is to be preferred.

The pens should be 20 inches high, 20 inches wide, and 7 feet 6 inches long. These are divided into three sections, each of which is then capable of holding five or six birds. They are usually made of a framework composed of any sort of stout wood—1-inch batten does well—the whole of the rest of the structure being composed of wooden rods. The rods are placed 1½ inches apart all over, except on the front, where they are about 2 inches. Batten used throughout has been found very serviceable.

The floors of pens in the Heathfield district are made of strips of wood about 1 inch wide on the top and 1 inch in depth, narrowing to ½ inch at the bottom to enable the manure to drop through more easily. Battens with the lower edges planed away do very well, whereas the material mentioned above has to be specially procured.

The rooms or sheds in which the birds are penned must be kept scrupulously clean by frequent lime-washing and the daily removal of all manure and stale food. The ventilation must be very free, but draughts should be avoided.

Troughs.—Troughs in the Heathfield district are very often cut out of a solid piece of wood; but two pieces of board placed at right angles so as to form a broad V, and then closed at each end, answer the purpose. Troughs may be held in position by hooks and eyes where there are several tiers, as each trough, except that in the lowest tier, rests on the roof of the pen beneath. In the case of the lowest tier, two projecting pieces of wood, cut on the upper side to fit the trough, will answer the latter purpose. At Heathfield they are hung by loose cords. The troughs should be kept scrupulously clean, being scalded and scrubbed twice a week, while no stale food should be allowed to remain in them.

Temperature.—Experiment has proved that the best temperature at which to keep birds, so as to secure the greatest possible increase of flesh, is 60° Fahr.; but temperature will vary according to the season, and should be regulated by ventilation, no artificial heat being employed. If the birds are kept in an overheated, overcrowded, stuffy shed, they will not fatten at all satisfactorily. On the other hand, if the sheds are draughty and cold in winter time, a good deal of the food is employed in replacing heat unnecessarily wasted. This would not be the case if a proper system of ventilation and adequate protection from cold were provided.

Single Pens Undesirable.—Birds do not fatten well if confined singly, as they are apt to fret and lose flesh. When several are penned together they thrive much better, for the sight of other birds eating causes each one to strive to obtain its share. This proves a healthy stimulus to the appetite, and far more is eaten than would be the case were the birds penned singly.

Gain in Weight.

Experiments have been undertaken from time to time to determine the weight gained during the fattening period. There may sometimes be a loss during the first few days, as birds do not always take to the new state of things. If, however, weight is lost during the first week, it is usually more than compensated by the gain made in the second week.

During the first week there may be a slight loss in weight, or a gain varying up to, say, 10 oz. The greatest gain is nearly always made in the second week, and may be anything up to 1½ lb. During the third week the gain is not nearly so great, but may be as much as ½ lb. Very few birds can stand more than three weeks' fattening, and if kept for four weeks they will probably lose weight, or gain very little in the last seven days, possibly only 1½ to 2 oz. It is therefore inadvisable to prolong the process beyond a period of three weeks. The gain in weight over the whole time varies from about $1\frac{1}{2}$ lb. to $2\frac{3}{4}$ lb.

Feeding.

The best plan, and the one most frequently adopted, is to feed the birds from the troughs for about ten days, after which they should be crammed by machine for the remainder of the three weeks. Some fatteners cram for a week only, but a good deal depends on the birds. Those sold after the trough-feeding period without being crammed are usually described as half-fattened.

Number of Meals.—When fed from the troughs two meals a day should be given, the food being left until the birds are thoroughly satisfied, after which it should be cleared away and they should be left to digest their meal and drowse until the next.

Consistency of Food.—The consistency of the food during the trough-feeding period should be that of stiffish paste or porridge. A test of correct consistency is to take a handful and squeeze it. It should then pass through the fist in a thick stream that will support its own weight to the height of about an inch or so before falling over; the bird when eating it should be unable to drag lumps into the cage. If this is possible, it is a sign that the food is made too thick. If the food is too thin the bird will be unable to lift and swallow it properly.

Cramming.

There are three methods of cramming—by machine, by funnel, and by hand.

The Cramming Machine.—The method of cramming by machine is almost invariably adopted by English fatteners.

The cramming machines in general use have a round reservoir at the top which contains enough food for 100 to 150 birds. This is connected with a pump cylinder, the piston-rod of which is operated by a lever worked by the foot of the person using the machine. There is a nozzle, to which is attached a piece of rubber tubing, and through this the food passes into the bird's crop when the lever is pressed down by the foot. Immediately the lever is released, the piston is forced by a spring to return to its original position, during which operation sufficient food passes down from the food reservoir into the cylinder, in readiness for the next feed.

The mode of operation is as follows:—The bird should be lifted carefully from the cage and placed under one arm, being held firmly but gently against the body of the operator; this obviates all struggling. The head of the bird is now taken in the hand of the same arm, so that the comb lies in the palm, and the mouth is opened with one finger, which holds down the tongue. The tube is then inserted. Immediately that is done, the head is passed over to the other hand and, the neck being stretched out, it is drawn by the head *towards the machine*, until the tube has passed down into the crop. On depressing the lever, the food passes into the bird's crop. One hand, during this operation, should hold the crop, where the end of the tube can be felt, and gauge carefully the amount of food received and required, which will vary according to the size of the crop. When sufficient food has been forced in, the foot is removed from the lever, and the bird released. Care should be taken to remove the foot *before* releasing the bird.

The consistency of the food should be that of thick cream. Care should be taken to hold the tongue well down when passing the tube into the bird's throat, and to straighten the neck, or accidents may occur.

The Funnel Method of Cramming.—The second method is by means of a funnel. The spout of this funnel is usually about 6 inches long, ½ inch in diameter, and made very smooth to avoid injury to the bird's gullet, whilst the outlet should be on the slant. The operation is as follows :—The funnel is inserted so that it passes down into the bird's crop, and then with a ladle the food is poured into the mouth of the funnel until the crop is felt to be full.

The consistency of food for funnel-feeding should be about that of thin cream. This is a much quicker system than that of hand-cramming.

Cramming by Hand.—The hand method consists in making boluses of food and forcing them down the bird's throat. In this operation the bird is gripped between the knees. The head is held in the left hand, while the mouth of the bird is opened by the forefinger, which holds down the tongue. The bolus, which should be about ⅝ in. thick, and about 1 in. long, is then dipped into a bowl of milk, and pressed by the forefinger down the throat. The bird's neck should then be drawn well up, so as to make an easy passage for the bolus, which is pressed gently down into the crop by running the forefinger and thumb of the right hand behind the bolus outside the gullet. The full meal usually consists of about ten to twelve boluses, but judgment should be exercised as to the amount required. The hand process is said to produce absolutely the finest results, owing no doubt to the fact that a more concentrated meal can be given than by the machine or the funnel methods, but although practised on some farms, the process is too tedious to recommend itself to the large majority of fatteners.

Food to be Used.

The best results in this country appear to have been produced by the use of Sussex ground oats, or pure ground oats, mutton fat, and milk, usually skim milk or butter-milk Barley meal, buckwheat meal, fine wheat meal, and boiled and mashed potatoes, may also usefully be employed for fattening purposes.

One of the best foods is ground oats; with the addition of mutton fat and milk this makes a perfect fattening mixture. The combination of fat and milk is found greatly to improve the quality of the meat produced.

The poultry food known as Sussex ground oats is not pure, but contains a certain admixture of barley, which enables the grinding process to be carried out more thoroughly owing to the dryness of the barley. The Russian oat is generally used, as it contains less moisture than the English. It is the fineness of the meal that is supposed to produce such excellent results, owing to the ease with which it can be digested.

The mutton fat used is clarified and then stored away in barrels. If small quantities only are being dealt with, it can be placed to cool in pails. Mutton trimmings, which can be obtained from butchers, are suitable for this purpose; and where large quantities are used they may be bought cheaply. The birds are usually given the fat when the actual cramming commences, and, beginning with a small amount, are worked up to about ½ oz. per bird per diem. The fat should be melted down and then mixed in with the meal.

The milk is allowed to become sour before being used, as in this state it is believed to prevent sickness, to take the place of green food, and to aid digestion. Butter-milk is also very valuable.

If whole milk is used, less fat is required, but whole milk is too costly where fattening is being carried out for trade purposes. Where milk is unobtainable, molasses has also been tried, whilst sugar has been used by some. It is believed, however, that no other food is equal to the combination of ground oats, sour milk, and mutton fat.

The following mixtures are sometimes used in place of ground oats :—

1. Two parts of buckwheat meal, one part of maize meal, two parts of ground oats, mixed with soured skim milk or butter-milk.

2. A mixture of toppings, barley meal, and ground oats in equal parts, with milk as in 1.

3. Buckwheat meal, middlings, and ground oats in equal parts, with milk as in 1.

Maize meal is useful if mixed with other meals, but unfortunately, it creates a yellow greasy fat. Potatoes are useful for trough-feeding also, and the addition of a little vegetable charcoal is desirable. The charcoal should be broken up to the size of peas and scattered in the troughs prior to one of the daily meals.

Fasting.—A most important point to remember is that on being first placed in the fattening pens all birds must be fasted for at least 24 hours. If this is not done some birds may refuse to eat. Fasting stimulates the appetite and induces the birds to commence feeding, after which little difficulty will arise.

Killing.—Birds should also be fasted 24 to 36 hours before they are killed. The best method of killing is by dislocation of the neck, and plucking should take place while the body is warm. The birds should then be shaped and allowed several hours to cool before they are packed and despatched.

Cost of Fattening.—The cost of fattening will naturally vary. A farmer who has his own skim milk or butter-milk, &c., will fatten chickens more cheaply than the man who has to buy everything. It was estimated, however, that before the War the cost of fattening a bird for three weeks was about 5*d.* for food alone. Where outside labour was employed the total cost was probably about 8*d.* per bird. The present cost will be higher in proportion to the increased cost of feeding stuffs and of labour.

Whitehall Place, London, S.W.1,
December, 1906.
Revised, October, 1916.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1.

Leaflet No. 177.

BOARD OF AGRICULTURE AND FISHERIES.

Precautions against Accidents caused by Farm Machinery.

Several cases in which serious accidents have occurred owing to the insufficient fencing of farm machinery and to the improper use of steam engines and boilers have been brought to the notice of the Board, and they desire to urge upon farmers and others the necessity for taking stringent precautions against such accidents.

Fencing Farm Machinery.

In the case of certain classes of farm machinery, namely, threshing and chaff-cutting machines worked by any motive power other than manual labour, Parliament has made special provisions requiring the machines to be so constructed as to secure the safety of the person feeding the machine, and it is the duty of farmers to see that these necessary requirements are fully complied with so as to prevent the injuries and loss of life which may otherwise occur.

The main provisions of the Threshing Machines Act, 1878, and the Chaff-Cutting Machines (Accidents) Act, 1897, are given below.

Threshing Machines Act, 1878.—This Act, which does not apply to Scotland or Ireland, provides that the drum and feeding mouth of every threshing machine, worked by steam or by any motive power other than manual labour, shall at all times when working be kept sufficiently and securely fenced, so far as is reasonably practicable and consistent with the due and efficient working of the machine.

Chaff-Cutting Machines (Accidents) Act, 1897.—This Act requires that so far as is reasonably practicable and consistent with the due and efficient working of the machine, the feeding mouth or box of every chaff-cutting machine worked by motive power other than manual labour shall be so constructed, or fitted with such apparatus or contrivance, as to prevent the hand or arm of the person feeding the

machine from being drawn between the rollers to the knives, and that the fly-wheel and knives shall be kept sufficiently and securely fenced at all times during working.

A penalty of £5 may be imposed for non-compliance with these Acts, and provision is made for enabling constables to enter premises for the purpose of seeing whether the Acts are complied with.

Other Machinery.

With regard to other machinery used in farming, there are no statutory provisions of general application. In some cases, *i.e.*, where the premises on which the machinery is used constitute a factory within the meaning of the Factory Act by reason of articles being manufactured there by way of trade, &c., the provisions of that Act as to the fencing of machinery, &c., will apply ; ordinarily, however, farm machinery, being used solely for estate purposes, or ordinary farming, and not in the manufacture or adaptation of any article for sale, does not come under the provisions of the Factory Act.

The importance, however, of securing the safety of the men working the machines, and also of safeguarding other persons against the risk of accident, will be obvious to all, and the Board would urge all farmers to take special precautions in this direction.

All shafting, whether vertical, horizontal, or oblique, which is not more than seven feet from the ground or floor, should be fenced by metal or wooden coverings. This should also be done with belting.

Gearing and cog-wheels should also be covered with a wire cage or some similar protection, while fly-wheels, water-wheels, and other parts of the machinery should be securely fenced.

Prevention of Boiler Explosions.

There is reason to believe that in agricultural districts considerable ignorance prevails with regard to the precautions which are necessary for the safe working of steam engines and boilers.

Every year serious explosions from these engines and boilers occur, through which there is loss of life or injury to persons, and frequently damage to property.

To ensure safety in the working of engines and boilers it is necessary that they should be regularly examined by a thoroughly competent person who is able to detect defects, and to fix a safe working pressure for the boiler.

The best method of securing this is to insure the engine and boiler with a reliable boiler insurance company who will undertake the periodical inspections, and will advise on all necessary repairs and on the precautions to be followed in working the boiler.

The person who is placed in charge of the boiler should understand the danger of tampering with any of the safety fittings.

It should also be remembered that under the Boiler Explosions Acts, the Board of Trade order inquiries into all explosions from boilers, and in cases where they consider it necessary, public formal investigations are held.

The Courts holding these investigations have power to censure any party who is held to blame in connection with the explosion, and to order him to pay the whole or part of the costs of the inquiry. This power is very frequently exercised.

Most of the serious explosions which have occurred from agricultural boilers have arisen through the working of old or second-hand boilers which have not been properly inspected and tested for some time previously; or through the safety valve being weighted or screwed down so that the boiler was worked at a much higher pressure than it could withstand.

Steam engines and boilers used for generating steam should be thoroughly examined by an insurance company's engineer or other competent person at least once in every fourteen months.

London, S.W.1,
November, 1906.
Revised, July, 1911.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 178.

BOARD OF AGRICULTURE AND FISHERIES.

Onion Mildew (*Peronospora Schleideni*, Ung.).

Description.—This well-known disease, due to the fungus named *Peronospora Schleideni*, occurs practically wherever the onion is cultivated. It usually appears first about the end of June, and shows as pale spots or blotches on the leaves. These spots, which occur mostly in the upper part of the leaf, gradually increase in size and merge into one another, and may soon cover the whole leaf, causing it to wither up. If the spots be examined they will be found to be covered with a greyish white powder, which later changes in colour to a dingy violet. The powder consists of the spores of the fungus and is best seen early in the day before the dew has dried. The spores are produced in great profusion and infect neighbouring plants. In contrast to the smooth surface possessed by a healthy leaf, the pale blotches caused by the mildew will be found to be rough to the touch, a character which at once serves to distinguish mildew from injury due to other agencies. During the later phases of the attack black spots often develop on the mildewed areas and the whole of the affected portion may turn black. This is not due to the mildew fungus itself, but to a black mould named *Macrosporium parasiticum* which often follows it. The presence, therefore, of the black mould on a bed of onions in late summer is usually a sign that the crop had suffered from mildew earlier in the season.

Life-History of the Fungus.—Unlike the true mildews, where the mycelium is external, the onion mildew fungus possesses internal mycelium, which lives inside the leaf and only produces external filaments when about to fruit. In this respect it resembles the potato blight fungus, to which it is in fact closely allied. Microscopic examination of a diseased spot shows that the leaf is densely permeated with mycelium and that the spores are produced on very minute branched threads, which emerge through the stomata (or breathing pores) and thus form a furry layer on the surface of the leaf. It is this furry layer which accounts for the rough feel of the mildewed spots when handled. A second form of the spore, the resting spore, is produced *inside* the decaying leaves. These provide for the reappearance of the disease the following season, and, by falling down to the ground with the dead leaves, thoroughly infect the soil. If buried they retain their vitality for several years, but when brought to the surface they germinate, and if onions happen to be present they bring about their infection.

Damage caused by Mildew.—The extent of the injury caused by mildew depends very largely upon the nature of the weather. If a dry spell sets in, especially if accompanied by drying winds, spore-production will be checked and the disease will not spread; but if the weather is damp and muggy spore-production recommences, and, the conditions being highly suitable for infection, the disease spreads rapidly.

The fungus itself does not attack the bulbs, but is confined to the leaves, and the damage resulting from the loss of the foliage is manifested in the small size of the bulbs, or in bad cases in the almost total loss of crop. If the plants are attacked early and the foliage severely crippled the growth of the bulb is largely arrested, but in certain cases secondary growth takes place, and if this escapes the mildew good bulbs may still be obtained. If the attack is slight or appears only late in the season little harm is done; a bad attack in autumn, however, seriously interferes with ripening.

Control Measures.—1. Much may be done by means of good cultivation to keep the plants free from mildew. The grower should aim at promoting robust, steady growth by deep digging, complete manuring, and constant hoeing.

2. The mildew may be kept in check by spraying or by dusting with a dry powder fungicide, but to be successful this treatment must be commenced early. For spraying purposes Bordeaux or Burgundy mixtures may be used, of the strength recommended for potato disease.* The spraying should be begun about the end of June or the beginning of July, and if damp, cloudy weather prevails it should be repeated at intervals of ten days. It is best applied early in the morning.

3. On account of the smooth surface of the onion leaf the spraying mixture does not adhere well to the surface, and some

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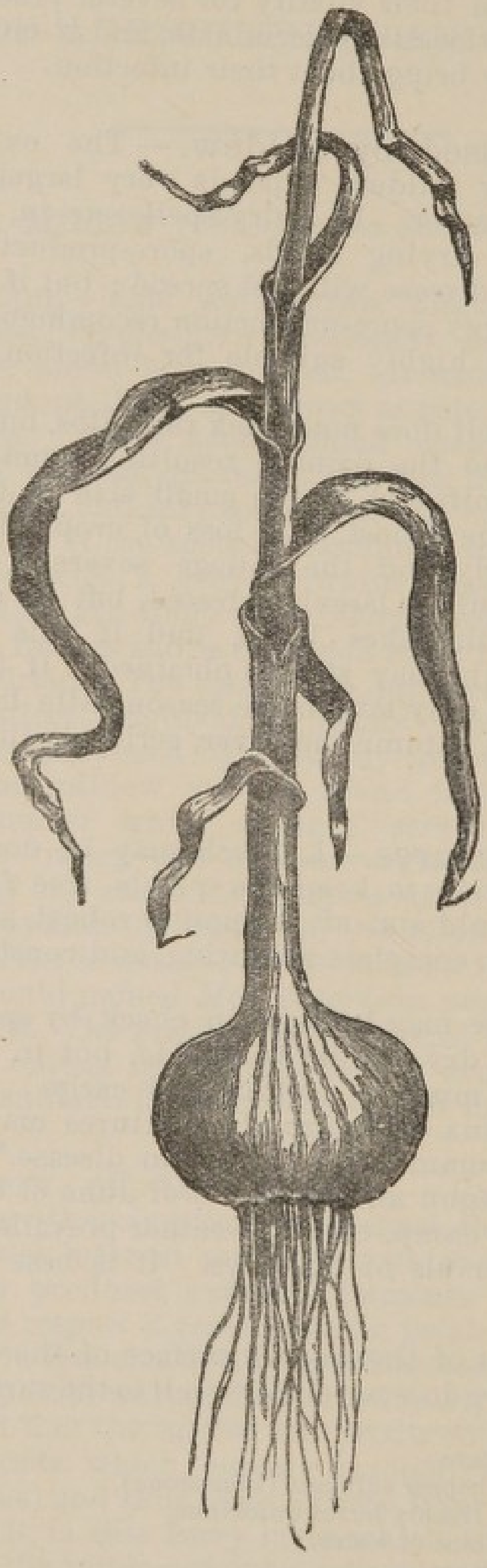
* *Bordeaux Mixture—*
4 lb. copper sulphate (blue-stone),
2 lb. freshly burnt quicklime,
40 gallons of water.

Burgundy Mixture—
4 lb. copper sulphate,
5 lb. washing soda,
40 gallons of water.

For details of the preparation of these mixtures *see* Leaflet No. 23.



ONION ATTACKED BY MILDEW (*Peronospora Schleideni* Ung.)

growers prefer dusting with a dry powder. This should be applied when the plants are wet with dew. The following substances yield satisfactory results :—Flowers of sulphur, black sulphur, or a mixture of powdered lime and sulphur (one part of lime to two of sulphur). The powder may be applied by means of a sulphurator or bellows, or by some such improvised apparatus as an old disinfectant tin.

4. As a rule the disease spreads in the first instance from one or more centres, particularly in the case of autumn-sown onions. Individual plants may frequently be found stunted in growth and badly infected with mildew. It is specially important to remove and burn these before the disease spreads from them to other plants. After their removal the remaining plants should be sprayed.

5. Although onion mildew spreads by wind-borne spores, it should be remembered that the new attack each season is due primarily to the resting spores present in the soil. In order to destroy these spores it is essential that, as far as practicable, every trace of diseased tops should be collected and burned, and not thrown on the manure heap or into the piggery. It is most important also not to plant on soil where badly diseased plants have previously existed, as a certain number of resting spores inevitably reach the ground and become buried, and these retain their vitality for several seasons.

London, S.W.1,
October, 1906.
Revised, June, 1919.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 179.

BOARD OF AGRICULTURE AND FISHERIES.

The Making of Soft and Cream Cheeses and Clotted Cream.

Hard or pressed cheeses have for many generations been manufactured in this country and are well known everywhere, but until comparatively recent years little has been heard concerning another type of cheese, properly called *soft cheese*.

No country has been so successful in the manufacture of soft cheeses as France, whence nearly all the delicate and refined varieties are obtained. To a certain extent the climate may be responsible for the great success of French cheese-makers, but given favourable conditions as to climate and locality such as prevail in many districts of England, and the presence in the dairies of the necessary moulds and bacteria, there is no reason why really good soft cheeses should not be made in Great Britain. It has, in fact, been proved that cheeses can be made equal in all respects to the best French produce, especially in the south Midlands and the south and west of England, districts which possess a moderately equable climate very similar to the soft cheese-making districts of France.

The production of soft cheese is especially to be recommended to small farmers and to others situated near populous centres or watering-places.

Necessary Accommodation.—The chief obstacle in the way of the successful development of the soft cheese industry lies in the difficulty of controlling the ripening so as to make the produce uniform. Even in the localities where these cheeses are made in France the quality may vary greatly; hence it is necessary for the prospective cheese-maker to acquaint himself with the conditions desirable, the various rooms required, and the temperature at which each should be maintained.

In general, three rooms are necessary: (1) a *making room*, in which the milk is coagulated, drained, and formed into cheeses; (2) a *drying room*, where the cheeses undergo the first stages of ripening; and (3) a *ripening room* (or *cellar*), kept at a low temperature, in which the cheeses undergo the final process of ripening and refinement. The temperature, moistness of the atmosphere, and ventilation differ in each of these rooms, and unless the maker is fully acquainted with the conditions which should prevail in each, his attempts at manufacture are likely to fail.

Fortunately, however, it is not difficult to adapt to the purpose of soft cheese making the buildings usually found on small homesteads. The *making room* need not be large, but should be provided with means for artificial heating so that the apartment can be kept at a constant temperature. The *drying room* should be in such a position and so constructed that the temperature and ventilation can be regulated at will. Thorough ventilation with means of controlling it is absolutely necessary in the drying room. The final *ripening room* should be moist, and not subject to any great variations in temperature.

General Description of Soft Cheeses.—The varieties of soft cheeses most popular are the Camembert and Brie. The Pont l'Évêque cheese is also well known, but though it is usually considered a soft cheese, the mode of manufacture and ripening differs somewhat from that of the true type of soft cheese, the ripening not being due so much to mould growth as to the action of enzymes.

Makers are advised to specialise in one variety of cheese only, as each variety described below requires a different degree of temperature, moisture, &c., in the different stages of manufacture.

As generally understood, soft cheeses are small, non-pressed, and quickly ripened, and are frequently so soft as to be spread like butter upon bread. Usually they are made from perfectly sweet milk, and development of acidity takes place in the milk after the rennet has been added, or in the curd whilst draining and before the application of salt. On the other hand, with the hard or pressed type of cheese, the milk is partially soured or ripened before the addition of rennet, and all the acidity necessary for securing the correct type of cheese is developed before the curd is salted or placed in the hoops or forms in which it is pressed.

Soft cheeses—though each variety may be made in a special manner—all agree in one particular, namely, that the whey is never fully drained from them. The coagulated milk, or "curd," is usually ladled into forms or metal hoops, and allowed to drain naturally. The cheeses are not subjected to heat or pressure, and consequently contain a much larger amount of water at the beginning of the ripening stage than do hard cheeses. As a consequence of this soft and moist condition they afford favourable conditions for the growth of various micro-organisms, and enzyme action occurs more readily than in the pressed or hard varieties of cheese.

The action of the fermentation agents ripens the cheeses rapidly and develops high flavours, as in the Camembert, Brie, and other varieties. Certain moulds which form readily upon the surface of these cheeses play an all-important part in the ripening process.

These moulds are aerobic, and consequently the ripening takes place from the surface to the interior. The breaking-down or ripening of the curd is due in most cases to the production of unorganised ferments or enzymes, but the flavour, texture, and appearance of the curd are different for different varieties of cheese, and depend largely upon the methods of treating the curd, the quality of the milk, and the conditions in the ripening rooms.

From the foregoing remarks it will be gathered that the ripening of soft cheeses is due to the presence of certain moulds and bacteria, and that the maker cannot produce a Camembert or Brie cheese of correct texture or flavour unless he is able to grow upon the surface certain types of moulds. In the ripening of the cheeses the mycelium (or "roots") of these moulds penetrates to a short distance into the surface of the cheese and produces enzymes, or proteid digestive materials which gradually bring about changes of a digestive nature in the raw curd, this action being equivalent to ripening. In the true type of ripened soft cheese, such as Camembert, the ripening proceeds from the surface towards the centre. Beginning at the outside there appears a change of the hard raw curd into a softer buttery material, and if the cheeses are properly made this slowly extends to the centre, and in from three to five weeks the ripening process will be complete.

For the luxuriant propagation of the desired moulds it is necessary that the curd should at the outset be distinctly acid. Unless the curd is sufficiently acid or sour at the time of salting, the mould will never afterwards grow properly, but if the making room is kept at a sufficiently high temperature during the draining process, the cheeses are certain to attain to this condition before the application of salt, which to a great extent stops the further development of acidity. The acidity should, however, be allowed to develop naturally. If starters of lactic-acid bacteria are used in soft cheese making—as in cheddar-making—the development of acidity will be too rapid during the first stages and the curd will drain quickly, becoming hard and dry, and will not contain sufficient moisture for the growth of the desired moulds. The only ripening material admissible in the manufacture of soft cheeses is a mixture of a little of the ripe cheese—which contains the spores of the moulds or fungi—with water or sweet whey, and this is introduced into the milk before renneting. (The preparation of this form of starter or inoculating material is dealt with on p. 5.)

Camembert Cheese.—The Camembert is a French variety of cheese, and in its native country is usually made from whole milk of a quality similar to that given by Shorthorns. Often, however, separated or perfectly sweet skimmed milk is mixed with the new in the proportion of 1 to 5. This cheese is usually made from September to May. During the hotter summer months its manufacture is attended by greater difficulty, and on that account it is advised that attention during that period should be paid to the making of a soft cheese of a fresh or unripened type. These cheeses are small—about 4½ ins. wide and 1¼ ins. thick—and weigh from 10 to 13 oz. About 5½ gallons of mixed new and skim milk are required for each dozen cheeses.

The milk is received uncooled direct from the cow. Milk that has been cooled does not make good Camembert cheeses. If separated milk is added, it should be perfectly sweet and fresh, and free from froth. The milk is strained into wooden tubs provided with close-fitting lids; tubs of a correct size hold six gallons each. Metal vessels should not be used, or the outside portion of the curd will get chilled, and this chilled and soft curd causes irregularity in the cheeses afterwards. A six-gallon setting tub will hold sufficient milk to make two dozen cheeses if the two-curd system, which is the best, be employed. The cheeses are sometimes finished at one operation, but the two-curd system is preferable—half of the curd being filled into the moulds in the evening, and the other half the following morning.*

The milk is usually renneted at a temperature of from 80° to 82° F., and ½ c.c. of rennet of a standard brand per gallon of milk is added so as to produce perfect coagulation in from 2 to 2½ hours. The rennet should be mixed with six times its volume of water and be thoroughly stirred into the milk.

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* The two-curd system is considered preferable for the following reasons :—If made of two curds the cheeses drain better, and there is less loss through oozing of the curd from the forms or hoops. There is also no need to wait for the curd to settle and chill before the hoop is completely filled. If the moulds are altogether filled at one operation the lower portion of the curd is subject to too much pressure, and irregularity in the moisture content of the cheese will ensue. Another most important point in favour of the two-curd system lies in the application of salt. It is necessary to salt these cheeses twice with an interval of six or eight hours between each salting. If the cheeses are made in two operations the lower or older portion is turned up and salted first, and by the time the salt has dissolved the newer surface will be ready to be salted and it will then be almost identical as regards age, acidity, etc., with the first-made curd, whereas if the cheese has been made of one curd only and an interval allowed between the salting of the two surfaces—which, if the salting is to be properly accomplished, is absolutely necessary—then it follows that the top and bottom will differ in acidity and one side of the cheese will ripen differently from the other. In cheeses made of one curd only it is often found that the later salted side fails to mould and ripen at all, because it has been too sour and draining has proceeded too far.

The milk is stirred gently and carefully at first to prevent the rising of the cream. If the cream be allowed to rise during coagulation it will show in streaks in the body of the cheese, and any of the creamy substance appearing on the surface of the cheese will fail to grow mould satisfactorily.

To introduce the proper moulds and ferments into the cheeses, and into the dairy where soft cheeses have not previously been made, it is advisable to inoculate the milk with what is termed a "starter," which is added before renneting.*

The curd when ready is ladled out into forms or hoops of metal $4\frac{1}{2}$ ins. in diameter and $4\frac{1}{2}$ ins. high. These hoops rest upon straw mats placed on an inclined and grooved draining-table, made in such a form that the whey readily drains away.

The ladle used should have a sharp cutting edge and go easily into the hoops. Before ladling out the curd it is well to pour a little warm water into each hoop, as this produces a better face upon the cheeses. The cheeses are then left overnight, twenty-four of the half-cheeses having been made from $5\frac{1}{2}$ gallons of milk used. By morning they will have drained to about two-thirds of their original dimensions. In the morning a similar quantity of milk is taken and treated as described, but before ladling out the morning's curd the surface of the first portion of the cheese should be carefully broken up with a wooden spatula to admit of the two curds joining properly ; unless this be done, the cheese is liable to break in halves. In ladling out the morning's or second half of the curd, it is important that the last slices be placed upon the surface of the cheese in an unbroken condition ; to ensure this a little curd with which to finish the cheeses should be placed on one side at the outset.

The cheeses are now left to drain in a temperature of not less than 65° F., and when the two curds are approximately thirty-six and twenty-four hours old they should be more than half-way down the hoop and firm enough to admit of turning. The turning of the cheeses is rather a delicate operation, and requires much practice before it can be skilfully performed. The maker, deftly putting his left hand under the cheese without removing the hoop, inverts the whole,

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* This culture of the desired ferments, etc., is made as follows :—Take a small portion of curd, say $\frac{1}{2}$ oz., from just below the crust of a really good half-ripe Camembert. Macerate this piece of curd and add it to half a pint of distilled water or sweet whey at a temperature of about 80° F. Stir occasionally until the curd has thoroughly dissolved and then strain into the milk from which the cheese will be made. Stir the milk for a while so that the ferments get properly distributed before the addition of rennet. This inoculation of the milk should be repeated for a few days or until the cheese rooms and utensils get thoroughly permeated with the ripening ferments. Afterwards if conditions are favourable the mould will make its appearance upon the cheeses naturally.

steadying the cheese meanwhile with his right hand and placing it face downwards upon a fresh straw mat. The upturned surface of the cheese should present an unbroken grooved appearance due to the straw upon which it has been resting. Sometimes the cheeses settle too rapidly. This is due to the milk being out of condition—a little sour, perhaps, or the making room may have been kept at too high a temperature. At other times the cheeses fail to drain or settle sufficiently ; when this is the case the temperature has usually been too low at renneting, or the temperature of the room may have been too low. Cheeses which drain slowly are usually fermented and spongy ; the excess of moisture encourages abnormal fermentation. Such cheeses are never good. They are nearly always slimy on the outside, and a slimy cheese will never mould or ripen properly.

The salting of the cheese takes place when the curd has shrunk a little from the sides of the hoops, and the upper and older surface is salted first with fine dry salt spread evenly, about ½ oz. being used for each cheese. After thus salting the upper face only, the cheeses are left for six to eight hours in the hoops, when the second salting takes place. The hoops are removed, and the cheeses turned and held on the palm of the left hand, salt being applied to the new upper surface and to the sides, the latter being well rubbed with salt. The cheeses should then be placed on latticed shelves in the making room and turned twice daily. When they begin to show the growth of a fine white, rather pilose or hairy mould, evenly distributed, they are removed to the drying room. Up to this stage all the processes hav e been carried out in the making room.

The drying room is an apartment with preferably a northern aspect, and so constructed as regards ventilation that currents of air can be directed upon the cheeses in all directions. Provision is made for artificial heating, and the ventilating slides and windows are so constructed that they can be opened and shut at will. The room should be kept at a temperature of from 54° to 56° F., and not be too dry. If the conditions are favourable the Camembert mould will grow rapidly, and in course of time blue tints will appear upon the extremities of the white mould, and the cheeses generally will assume a greyish-blue appearance. When this point is reached the cheeses must be removed to the cellar or cave. The object in bringing the cheeses into the first ripening or drying room is to get a fairly dry surface, and also to facilitate the development of the fungi which exercise such an important part in the ripening process.

During the time the cheeses are in the drying room a great deal of attention and observation is necessary on the part of the maker. If the moulds do not grow freely or the cheeses shrink, then the atmosphere is too dry. If, on the other hand, the cheeses get greasy or points of dark green or black appear, then the temperature is either too low or the atmosphere too damp. In the drying room the latticed shelves should run down the middle and not be placed against the wall, and the cheeses are first placed on the top shelves and gradually lowered as they ripen, and new cheeses are brought in.

At the stage when the cheeses are removed to the cellar or ripening room they should feel soft and springy to the touch. The atmosphere of the cellar should be fairly damp and still, and little ventilation is required. The temperature should be maintained at about 50° F., and the cheeses should be turned daily. The shelves upon which the cheeses rest are covered with wheat straw, which is occasionally changed.

On removing the cheeses to the lower temperature of the cellar the growth of the moulds is greatly reduced, and largely ceases. The outsides assume a reddish-brown appearance, and the cheeses get a little sticky and glairy on the surface. This is an indication that the cheeses are ripe and ready for sale, for at this stage certain compounds are formed which give characteristic flavours to this type of cheese. If kept too long they will rapidly deteriorate and liquefy, and become unpalatable.

The cheeses are usually packed in lots of six and wrapped in straw, or they may be placed in the familiar wooden chip boxes and sent to market when about three-fourths ripe.

The mould growth on Camembert cheese is of the greatest importance, and if the colour appears in any different sequence to that described, then the cheeses will be inferior.

At first the cheeses should be covered with a pure white rather pilose mould, forming a layer of about one-eighth of an inch thick over the whole surface of the cheese. With ripening, the spores of the mould gradually change in colour to greyish-blue. This change becomes complete in about three weeks from the time of making, and no further mould-growth seems to take place afterwards. Finally, the mould breaks down and the brown-reddish condition of the surface appears, and at this stage the cheeses are considered ripe. In a well-made cheese, cut through the middle when ripe, the softening of the curd will extend to the centre, whereas a cheese badly made will show a layer of hard sour curd in the centre, while the outside portions will be in an almost liquid state.

Brie.—The Brie cheese is a very popular variety in France. It is softer and more creamy in texture than the Camembert, resembling a good cream cheese, but of different flavour.

It is larger than the Camembert, but the ripening process is similar, and it owes its distinctive flavour and qualities to the action of moulds which grow upon its surface. In the matter of curing rooms and method of manufacture, the requirements are very similar to those of the Camembert, though the temperatures at which the various rooms are kept vary somewhat.

The aim of the maker is to obtain a cheese which will ripen rapidly and regularly. The first point is chiefly a matter of manipulation, while the second depends upon the growth and development of certain types of moulds and ferments. In order that a cheese may ripen quickly, it must contain an excess of moisture and be non-coherent; to ensure this condition a slow coagulation of the milk is necessary, and this means the employment of a very small quantity of rennet (¼ cc. per gallon) and the use of sweet milk.

The milk is usually brought direct from the cowsheds while retaining its animal heat, and the rennet is added at a temperature of from 82° to 86° F. About 14 lb. of milk are required to produce a cheese of standard size, and coagulation should be complete in about four hours.

When the curd is ready to be ladled out it should be shorter or less tough than in the case of the Camembert, and should have shrunk a little in the cheese-tub, to the extent at least that whey appears upon the surface. The hoops or cheese-moulds are usually 10½ ins. in diameter by about 4 ins. in height, and the ladle for scooping out the curd is similar in shape to the old-fashioned cream-skimming dishes in use in many dairies. The moulds are laid singly upon straw mats resting upon boards, and the curd is placed in them in horizontal thin slices.

The best cheeses are made of two curds, as described in the manufacture of Camembert. When the two curds have sunk just below the rim of the lower mould, the upper ring is removed, the cheese is covered with a clean straw mat and a board, and reversed.

The cheese is again turned at the end of three or four hours, clean mats being used at each turning. It is important that the mats be crossed at turning so that the marks of the straws show in cross section and in order that air can more readily reach the under surface. When the cheese is firm enough to admit of the hoop being removed, it is salted with fine dry salt, which should be spread very evenly over the whole upper surface. After the first salting the cheese is left for from eight to ten hours, and then turned on to a round osier mat termed a *clayette*. It is then again salted upon the now upper surface and the sides, and removed to a drying room which is kept at a temperature of from 63° to 65° F., where the shelves are so placed that gentle currents of air can be admitted over the surface of the cheeses. When placed in this drying room the cheese is solid and rather firm, but friable and very acid.

In the course of a day or two, if the cheese has been properly made, there should appear upon the surface a white fungus mycelium which grows rapidly in a warm and fairly moist atmosphere. With the best cheeses a reddish mould succeeds the white mould, though with many of the coarser cheeses a blue mould succeeds the white. The latter, though common, are not the true type, a cheese growing a red mould being always superior in quality.

When this red mould is well established on the cheeses, they are removed to the cellar or cave, where ripening is completed. If the cheeses are to be kept for any length of time they should be placed in a very cool dry cellar at an early stage in the ripening process.

It will be gathered that the method of manufacture of Brie is somewhat different from that of Camembert. The object of the maker is to conserve more moisture in the curd and to ripen in a shorter period. Hence coagulation of the milk is slower, and the temperature of the making room is lower. These two factors tend to slow and incomplete drainage during the first stages. After being properly formed and salted, the cheeses are placed in the second ripening room at a higher temperature, and this room is kept more moist than would be the case with Camembert. This tends to rapid growth of the moulds and quick ripening, and a soft texture in the cheese. In the cellar the temperature will vary, depending in a great measure on the period at which the maker wishes to dispose of the cheese.

The cheeses when ripe are usually cut up into diamond-shaped pieces, and sold in boxes of the same shape.

Pont l'Evêque.—The cheese known as the Pont l'Evêque has acquired a considerable reputation in England, and though usually designated a soft cheese, it is of a type entirely different from the Camembert and Brie.

The ripening of this cheese is not dependent to any great extent upon the growth of moulds, but is probably largely due to the action of the enzymes contained in the rennet used.

The cheeses are usually oval in shape, measuring $1\frac{1}{4}$ ins. in thickness, and weighing about 1 lb. each. When ripe they present a brownish-red exterior, are pliant and yielding to the touch, and the peculiar flavour somewhat resembles that of a very fine soft Edam cheese, though more sweet to the taste.

In the manufacture of this cheese it is important to start with absolutely sweet milk. Milk at all acid or to which a lactic acid starter has been added is altogether unsuitable for the manufacture of Pont l'Evêque. Acidity during the first stages of manufacture causes the cheeses to become hard, dry, and valueless.

The Pont l'Evêque cheese is somewhat difficult to manufacture. The various mechanical processes are simple enough, but much depends on the ability of the maker to determine when the curd is ready to hoop. It may be said that very few English makers are really able to determine the exact stage at which to hoop the curd. If at this stage the curd is too hard and dry, the cheeses will drain inordinately and become hard ; whereas if the curd is too moist or has been chilled, the cheeses will contain an excess of moisture, and in the course of a few days will spread out into an unshapely mass in the curing room and become quite unpalatable.

The cheeses are rendered more difficult of successful manufacture by the very fact that acidity of the curd during the earlier stages is not admissible.

The method of manufacturing Pont l'Évêque is as follows : —About 50 lb. (for six cheeses) of perfectly fresh new milk should be strained into a wooden tub of 6 gallons capacity. If the milk has fallen to below 90° F., then it should be raised to this temperature or a little higher before rennet is added.

The usual setting temperature is from 90° to 94° F., and rennet of a good standard brand is added at the rate of one dram (mixed with six drams of water) to each 20 lb. or 2 gallons of milk. Many makers add a quart of boiling water to each 5 gallons of milk before putting in the rennet. This is good practice, as it tends to the production of a soft cheese. It will be observed that the proportion of rennet used is comparatively large, and this is necessary if the cheeses are to ripen properly, for, as already stated, the ripening is largely due to the enzymes contained in the rennet.

After the addition of rennet the milk is stirred carefully at intervals for four or five minutes, and then covered up and kept as warm as possible. In from thirty to forty minutes coagulation will be firm and complete. At this stage the curd is cut vertically with a long knife into one-inch square sections, which are then cut diagonally across. This cutting is done to ensure rapid drainage of the whey from the curd, and should be carefully and thoroughly performed. A sharp-edged skimming dish or flat scoop is now inserted about three-fourths of an inch deep, thus cutting the curd horizontally. and the curd is ladled out into warm straining cloths thrown over wooden forms resting on a draining-table. This operation should be done quickly and carefully, as it is necessary to keep up the temperature. When all the curd has been ladled out, the corners of the cloth should be brought together but not tied. The curd will drain more quickly if spread out in a thin layer, and the temperature can be kept up by the use of warm dry cloths spread over the surface. The cloths should be opened out and the curd moved at intervals, drainage being assisted in every way without injuring the quality of the curd.

If the curd has been properly handled, drainage should be complete in about thirty minutes, and the curd should then weigh about one-third of the original volume of milk. At this stage the curd is partly broken up with the fingers and carefully placed in the little metal hoops or moulds which rest in pairs upon straw mats spread over boards. The curd is taken in the fingers and pressed closely and firmly against the sides and bottom of the hoops so as to secure a smooth surface, and great care is necessary to finish the cheeses so that they present a close unbroken exterior. As soon as the moulds are filled they are turned in pairs upon other dry straw mats and boards, and this turning is repeated six or eight times during the first hour. The object of the cheese-maker should be to secure a close tight surface, as unless the surface is close the cheeses will lose moisture by excessive drainage and be spoiled.

The temperature of the making room should be kept at 65° or 68° F., and the cheeses should be ready to salt in from twelve to sixteen hours after the milk was renneted. The proper stage at which to salt is when the cheeses smell yeasty and are a little greasy upon the outside. Rapid digestive changes occur in these cheeses, and a knowledge of the exact stage at which to salt is important. In salting, the cheeses are lightly covered all over with salt, a little extra being added on the upper surface. Later they are turned and again salted in a similar manner.

The cheeses are kept in the making room for about three days, and are then taken to the curing cellar, which is kept at 58° to 60° F. They are laid on latticed shelves covered with wheat straw, and are occasionally washed with weak brine to prevent the formation of mould.

When the ripening process has proceeded for sixteen or eighteen days, the cheeses are packed together in layers of three to conserve moisture, and occasionly their position is reversed in order to secure uniform ripening. The period of ripening usually extends to five or six weeks, and when the cheeses are ripe they should be soft, but not creamy. A good cheese will show a slight bulging of the sides, and when cut should be uniformly ripe throughout. In this respect it differs from the Camembert and Brie, which ripen gradually from the outside towards the centre.

When ripe the cheeses are packed singly in suitable chip boxes. When properly made they are excellent, and are not so perishable as many other soft cheeses.

Gervais.—This is a popular variety of French cheese, made from a mixture of whole milk and thin cream, in the proportion of two to one. The Gervais is a small cheese, measuring about $2\frac{3}{4}$ in. high by $1\frac{3}{4}$ in. in diameter, and may be consumed either fresh or when some days old. The shapes for this variety of cheese consist of 12 small moulds fixed on one base. To produce 12 cheeses two quarts of warm new milk and one quart of cream should be mixed together by constantly stirring for at least 10 minutes. The temperature of the mixture should then be regulated to 60-65° F., and 1 c.c. of rennet (diluted with a little cold water) should be added. Provision should be made to keep the temperature uniform until coagulation is complete, this being in about 12 hours, when the curd may be ladled into a draining cloth of a suitable degree of coarseness and hung up to drain as in the case of cream cheese. When sufficiently firm it should be salted preparatory to moulding. The moulds should be lined with strips of blotting-paper, a special variety of which is made for this kind of cheese, and then set on a straw mat placed on a board. The moulds should be carefully filled with the curd by means of a bone knife. The curd should be left in the moulds for a short time until the cheeses have become fairly set, when the moulds may be removed. The cheeses may be placed in light boxes of beech wood for sending by post or rail. Though Gervais cheese is chiefly eaten fresh, it keeps well for several days after removal from the moulds, and some prefer it at this riper stage.

Cream Cheeses.—Cream cheeses are extensively manufactured in England during the summer months, but almost every dairy has its own particular method, and no really serious attempt appears to have been made to put upon the market cheeses of uniform quality and flavour.

In flavour the produce of different dairies varies widely, no two dairies being alike, and the flavour of the greater portion of the cheeses made is not good. Many makers appear to think that any sort of cream is good enough with which to make cream cheeses, but this is a mistake. If the cheeses are properly made with the best cream, no more profitable branch of dairying exists than the manufacture of cream cheeses.

Cream intended for cheese-making should be perfectly fresh and sweet to commence with, and any ripening necessary should be undertaken before the cream is placed to drain. The old method of draining the cream by hanging up in a bag or cloth for two or more days is a mistake, as by the time the cream has drained sufficiently it has assumed a bad flavour, which is reproduced in the cheese. In judging the cream-cheese classes at shows it is found that the flavour is at fault in 90 per cent. of the exhibits, and this is almost always due to the protracted period of drainage.

In general, two varieties of cream cheeses are manufactured—the one known as double-cream, from cream containing about 50 per cent. of fat, and the other from thin cream which is thickened with rennet before drainage takes place.

If it is required to make the sweet variety of cream cheese, the cream is drained after standing twelve hours, but if a certain amount of ripening is desired, then a small quantity of starter (usually about half a pint to each gallon) is strained into the cream immediately the temperature has been reduced to 60° F.

This starter may be either a pure culture of lactic acid bacteria, such as is used by most cheese-makers, or it may be a little clean soured milk.

Double-Cream Cheese.—A really good method of making double-cream cheese may be described as follows :—

The cream is taken off thick, and if pasteurised will be so much the better. It is then cooled in cold running water till the temperature is down below 60° F., and is allowed to stand at this temperature for twelve hours.*

The cream is drained in fine linen or longcloth spread over a wooden form, and this form is provided with a loose board which can be weighted when necessary to press out the superfluous moisture.

The cream should be put to drain on a level slate or marble slab or table, and if it has been properly treated only skim milk should exude.

A form large enough to drain one gallon of cream at a time (for 32 $\frac{1}{4}$-lb. cheeses) will be 18 ins. long, 14 ins. wide, and 4 ins. deep. The pressing board should be $1\frac{1}{2}$ ins. thick, and made of sycamore or canary wood. The fine cloth is thrown over the form and pressed down to the level of the table, and the cream then poured in to the depth of 1 or $1\frac{1}{2}$ ins., covering the whole inner area of the form. The edges of the cloth are now turned over and neatly adjusted so as to cover the whole surface of the cream, the board is placed on, and left for half an hour with a 7 lb. weight on it. Drainage must be gentle at first, or the pores of the cloth get filled with cream. The cloth should be opened out once or twice during the first

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* Thick cream cooled over a refrigerator does not make good cheese the product tending to be coarse and open in texture. The proper method is to cool the cream in pails in cold running water. An interval of twelve hours between separation and drainage is necessary, as this develops the flavour and assists in after-drainage.

hour and the sides scraped down, when the cream should be re-weighted with a 14-lb. weight. If the cream is thick and has been properly cooled and prepared before drainage, it should be ready to mould in three or four hours from the time it was put to drain. It will have drained sufficiently when the curd weighs at the rate of 16 oz. to each pint of cream used. A small tinned-copper mould holding ¼ or ½ lb. is used, and, lined on the inside with a strip of parchment, it is placed in the centre of the muslin or paper wrapper and the cheese filled in with a wooden knife ; on removal of the mould the muslin or paper is wrapped round the cheese.

The cheeses are sold fresh or ripened, but it must always be remembered that cheeses made from fresh cream are perishable, and will not retain a nice sweet flavour for more than two or three days. Those who have a quick sale for their produce may venture to manufacture their cheeses from sweet cream, but if the cheeses are to be kept for any length of time, then the cream should be slightly soured before drainage.

It is, however, essential that the starter be of the right flavour, or the quality of the cheese will suffer. On no account should the cream be allowed to sour naturally, as by the time the cream has become sour the flavour will have suffered otherwise. Natural souring can be hastened by keeping the cream at a higher temperature, but such a procedure results in a greasy cheese, which rapidly becomes rancid. If it is necessary to salt the cheeses, the salt should be added to the cream, about 1 oz. to each gallon of cream usually being sufficient.

Single-Cream Cheese.—A very good cream cheese of poorer quality, but having more of a cheesy flavour, can be manufactured from cream containing from 25 to 30 per cent. of fat. Many persons prefer this type of cream cheese. About 24 ¼-lb. cheeses are made from one gallon of such cream. In this case the cream must be cooled to 65° F., and three or four drops of rennet per gallon, together with a little starter, should be added immediately the cream is cooled, when the whole is left for eight or twelve hours before draining. If necessary, salt may be added to the cream at the same time as the rennet. With a cream that has been coagulated, it is necessary to use a ladle with which to lift out the curd into the cloth. The methods of draining, preparation and moulding are the same as those already described for double-cream cheese.

The single-cream cheeses can be sold at a lower price, as they contain a fair proportion of casein.

Cheeses of whatever quality will always be of uniform condition and flavour if made as described. The essentials necessary for the production of prime quality cream cheeses are :—(*a*) A sweet cream carefully cooled and prepared, and ripened at a low temperature ; (*b*) the addition of salt to the cream and not to the finished curd ; (*c*) the use of fine *dry* cloths in which to drain off the superfluous moisture ; (*d*) to have the cream spread out in a layer of not more than 1 or 1½ ins. deep in the draining form ; (*e*) slight pressure during the first stages, increasing gradually to not more than 14 lb.

Neatly printed wrappers should also be used, and if the cheeses are sold wholesale they should be packed in wood pulp boxes holding half a dozen each. It must always be remembered that cream cheeses are particularly liable to become tainted, and hence care should be taken to have all cloths clean and draining forms and boxes made of materials that will not taint the cheeses.

Clotted or Scalded Cream.—Though originally confined to the counties of Cornwall and Devon, the manufacture of clotted cream is now carried out most successfully in practically all counties. In addition to its having gained a great reputation as a luxury, it is now largely recommended by the medical profession as an excellent fatty food, and is displacing to some extent the use of cod liver oil amongst invalids. Clotted cream is very rich, containing from 50 per cent. to over 60 per cent. of fat, and this fat is of a more digestible kind than any other, being present in the cream in a finely emulsified condition. In the preparation of clotted cream it is desirable to use rich milk, such as is produced from the Channel Island breeds of cattle, but this is not essential, and the evening's milk from Shorthorn cows will produce very good cream indeed. In Devon and Cornwall clotted cream is largely made from the milk of Devon cattle, which are admirably suited for the purpose. Crosses with Channel Island cattle are also commonly employed.

A recent investigation has shown that the addition of a small quantity of water to the milk before setting the pans, a practice resorted to by some makers of clotted cream, does not meet with the results claimed for it, and is not essential for the production of the best quality cream.

Clotted cream is prepared as follows :—

1. Whole milk, warm from the cow, is carefully strained into setting pans. The pans most suitable for the purpose hold about six to eight quarts of milk, and measure 15 in. across the top, 7 in. in depth, and 11 in. across the bottom ; they are similar to ordinary "shallow pans" but are somewhat deeper.

2. The pans of milk are left undisturbed in a cool dairy for the cream to rise. In summer, twelve hours or less is the time allowed, but in winter twenty-four hours is usual.

3. The pans should now be removed and scalded, great care being taken not to shake them and so disturb the cream on the surface. Scalding is carried out by placing the pans on a hot-water stove, and allowing steam to play under them until they have attained a temperature of 175° to 185° F. in not less than twenty minutes, when they are removed, and allowed to cool naturally in a cellar or other cold position. The scalding should not be done too quickly, otherwise the characteristic scald flavour is not produced and the cream is rendered greasy. The heating may be carried out by placing the pans on a kitchen range or hob, but the hot-water method is preferable.

4. When the scalded milk and cream are cold the cream may be taken off in a thick clotted condition, and is ready for sale. In summer it is especially advisable to cool the pans as quickly as possible after scalding, as this ensures extra keeping properties.

The cream is generally sold by the pound. One pound of cream may be obtained from $1\frac{1}{2}$ gallons or less of Jersey milk; whereas nearly 2 gallons of Shorthorn milk may be required to produce the same quantity.

London, S.W.1,
October, 1906.

Revised, March, 1919.

Leaflet No. 180.

BOARD OF AGRICULTURE AND FISHERIES.

Dodder.

The question to what extent the various species of dodder are harmful to agricultural crops is one which is of considerable interest to the farming community. In 1905 as much as 11 per cent. of the clover seed samples examined by the Botanist to the Royal Agricultural Society were condemned owing to the presence of dodder seeds, while two samples of red clover contained no less than 6 per cent. Dodder was found in 26·9 per cent. of the 1,370 samples of red clover tested at the Official Seed Testing Station in the season 1917–18; whilst 80 per cent. of the Chilian samples actually contained the seeds of this parasite, several samples containing no less than 3 to 5 per cent. by weight of the seed. Biffen, in 1912, recorded dodder in 65 per cent. of the samples of alsike clover and in about 30 per cent. of the samples of white clover then tested. Some information, therefore, on the several species of dodder, the methods by which they are spread, and the best means by which they may be suppressed or avoided, may be of value to agriculturists and seed merchants alike.

Over one hundred species of dodder are known to science, and of these several occur in Britain. Dodder is botanically included in the order *Convolvulaceæ* under the genus *Cuscuta*. The dodder plant is an annual, growing from seed either self-sown or sown with other seed, and it is parasitic on plants of a higher order, germination, however, taking place in the soil.

Description of Dodder Seeds.—The seeds of most species of dodder are very small—usually much smaller than the seed of red clover—roundish, and angled. It may be stated that they are generally smaller than the seeds of the plants on which they are parasitic. Exception must be made, however, in the case of large American dodder, *C. Gronovii*, the seed of which is much larger than that of most species. The seeds of *C. Trifolii* are roundish, about $\frac{1}{25}$ inch in diameter, dull in appearance, and grey, brown, olive-brown, or yellowish-brown in colour. In the case of *C. Epithymum* the seed is round-oval in shape, and yellowish-brown in colour.

Dodder seeds can soon be recognised with a little practice, but cannot be certainly identified without the aid of a pocket-lens, or a slightly enlarging microscope.

Life History.—The embryo of the dodder seed is simple and thread-like, and coiled spirally round the fleshy albumen, while the radicle is thickened. The seeds seem to germinate best during damp seasons. At a suitable temperature they will germinate in five to eight days. When a seed germinates the thread-like coil unwinds gradually, the radicle end taking root in the soil, the remainder meanwhile lengthening, and, when it reaches a suitable host, commencing to twine itself round the stem, to which it attaches itself firmly by means of the suckers or haustoria. (Should the thread-like stems fail to reach a suitable host plant, they die.)

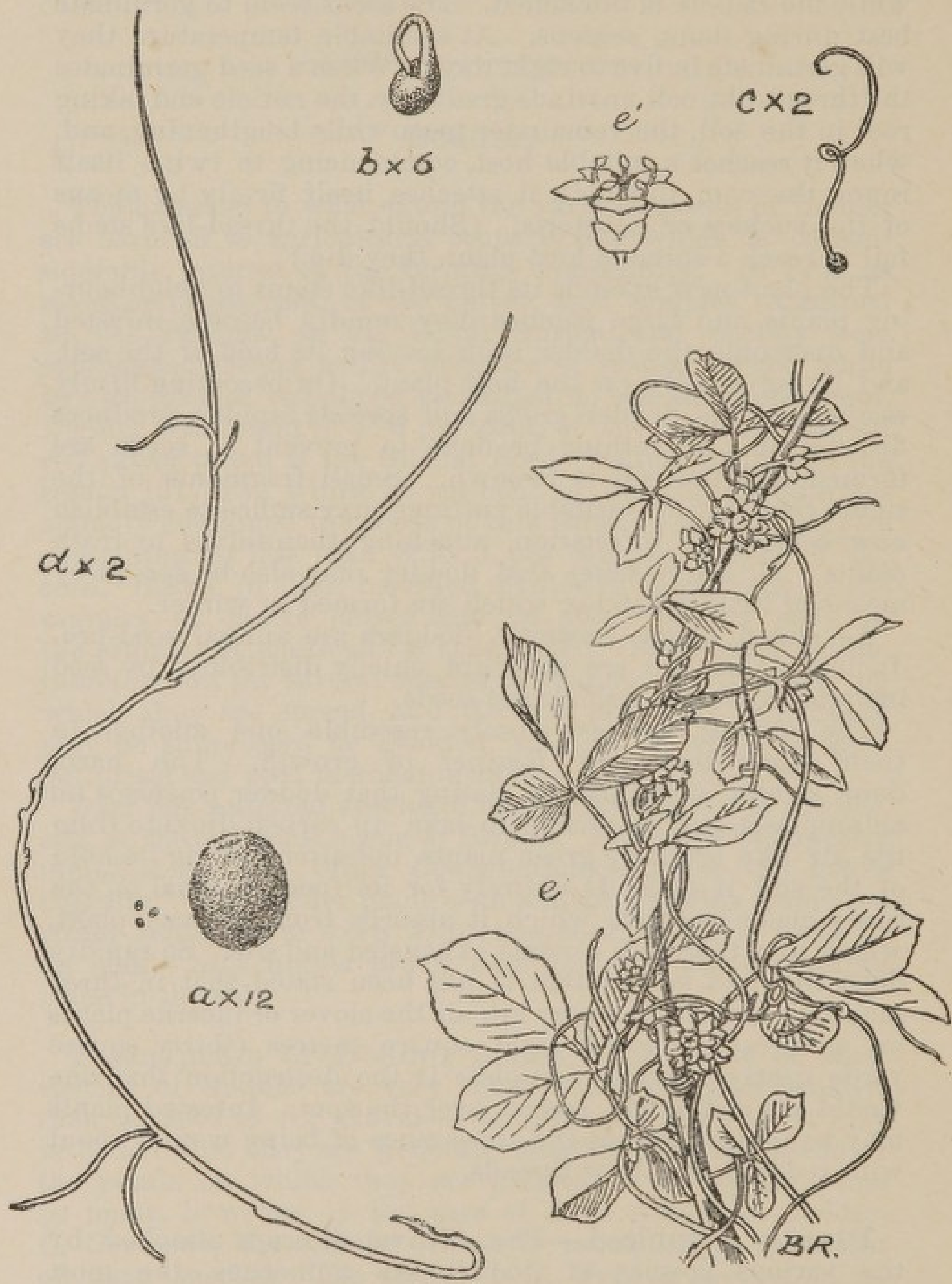
The plant now extends its thread-like stems to neighbouring plants, and large patches may rapidly become infested and overcome, the dodder soon leaving its hold of the soil, and living wholly on the host plant. On becoming firmly established the dodder grows and spreads rapidly, produces flowers, and, if nothing be done to prevent it, seeds are formed and the soil is re-sown. Small fragments of the stems, constituting veritable cuttings, may suffice to establish new centres of infestation, attaching themselves to fresh plants. M. Marre states that dodder may also be spread by means of little tubercles, which are formed in winter.

As stated above, however, dodders are annual seed-producing plants, and are no doubt chiefly distributed by seed included amongst agricultural seeds.

The various species closely resemble one another in their life-history and manner of growth. The harm done is best explained by stating that dodder possesses no chloroplasts, and is unable to take up carbon dioxide from the air like ordinary green plants, but after leaving its hold of the soil it depends entirely for its food material on the ready-made products which it absorbs from its host plant, which may therefore become exhausted and die. So rapidly does the pest spread that it has been stated that in three months a single plant may kill all the clover or lucerne plants on an area of twenty-eight square metres (thirty square yards nearly), and so complete is the destruction that one would say a fire had passed over the spot. Infested plants may be said to present the appearance of being wound about with reddish or yellow threads.

Plants Attacked.—The cultivated crops attacked by the various species of dodder are numerous, the most important, however, being red clover and lucerne.

C. Trifolii.—This variety is that which is most commonly found on clover and lucerne in Great Britain. According to Frank, however, it has been found on vetches, lupins, potatoes, beet, carrots, fennel, aniseed; not infrequently the wild species *C. Epithymum*, of which *C. Trifolii* is



CLOVER DODDER (*Cuscuta Trifolii*, Bab.) : *a*, Seed, natural size, and × 12 ; *b* germinating seed, × 6 ; *c*, young seedling ; *d*, further stage of seedling ; *e*, flowering plant on lucerne ; *e′*, enlarged flower.

sometimes considered a variety, is found in meadows and pastures, on heaths, &c. M. Marre cites also *Lotus corniculatus*, lavender and other labiates, St. John's wort, species of heaths, *Achillea Millefolium*, and even (according to Prillieux) such graminaceous plants as ryegrass, as having been noticed attacked by this species. He observes, however, that very probably in some cases the dodder is merely entwined round the plants, and not attached to them by means of its suckers. *C. Epithymum* is also found on furze, thyme, and ling.

C. europaea.—In Britain, this species is found on vetches, nettles, &c. In France, it is recorded as living on hops, hemp, vetches, potatoes, the vine, acacia, poplar, aconite, and other plants.

C. Epilinum.—Known as flax dodder; this species chiefly attacks flax, but on the Continent it is found also on hemp and *Camelina*.

C. Gronovii.—Besides attacking lucerne, and without doubt other leguminous plants, it is stated to infest chicory, potatoes, and beet.

C. monogyna infests vines and some other plants; and *C. racemosa* var. *chiliana* not only develops on lucerne but on various other leguminous plants.

Prevention and Remedy.—1. As it is so harmful when once established, it is very important that dodder should not be allowed to obtain a footing on clean farms. In order to help the farmer and to prevent his using clover seeds containing dodder, it has been made obligatory under the terms of the Testing of Seeds Order that when dodder is present in samples of seed offered for sale a declaration shall be made to that effect; provided that it is present to an extent greater than one seed in 4 oz. in the case of red clover, crimson clover and lucerne, and than one seed in 2 oz. in the case of alsike and white clover.

2. In the case of all seeds the purchaser will be well-advised to submit samples to the Seed Testing Station for a report as to the presence or otherwise of dodder, and not to assume that, because dodder may not have been declared, it is therefore not present in a sample.

3. Where dodder is found infesting a crop, however small the patch, steps should at once be taken to destroy it. This may best be done by digging up the infested plants and burning the whole, *in situ*, by covering the area 6 to 9 inches thick with long chaff, sprinkling it with paraffin, and then firing it. It is wise not to remove the infested plants for burning, as small pieces left on the field or dropped in fresh places may only serve to spread the pest. It is better to lose

completely a small area of the crop by burning than to take risks and possibly have a much more serious infestation another year, especially since dodder seed may lie dormant in the soil for five or six years.

4. An infested field should not be allowed for a few years to carry a clover, lucerne, or other leguminous crop.

5. Thaer recommends that the infested spot be surrounded by a small trench at a suitable distance from the outermost threads of dodder, the soil removed from the trench being thrown on the infested spot. This method, or burning with straw, he considers to be better than the employment of corrosive substances, sulphate of iron, large quantities of superphosphate, or the refuse liquor from the manufacture of sulphate of ammonia, all of which work certain destruction to dodder. Such substances, however, ruin the soil for one or more years after use.

6. Tearing out the dodder with a rake is to be condemned, as it only serves to spread the pest.

7. Infested clover or lucerne should not be fed to stock, as the seeds may pass through the alimentary canal unaffected, and Frank mentions a case in which a field was actually infected by means of manure from young cattle, which had been fed on rape and linseed cake containing dodder seed the germinating capacity of which had not been destroyed.

8. Frank suggests that substances which will smother the dodder may be effectually employed, such as a layer three inches deep of chaff, tan or gypsum, covered with an inch or so of fine soil and saturated with liquid manure or sprinkled with powdered quicklime in winter. The clover will generally break through such coverings, but the dodder will be unable to do so.

9. In cases where the infestation extends to the larger part of the crop, it is perhaps better to plough the whole under before seeds are formed.

10. Spraying with a solution of sulphate of iron has proved successful in Germany. In August, 1906, a plot of red clover on which *Cuscuta arvensis* (an American species) had developed luxuriantly was sprayed with an 18 per cent. solution of sulphate of iron. The clover became so black that one might have thought it was ruined. After a short time, however, it sprouted again, and grew at least as well as the portion which was left unsprayed. The latter was ultimately still more checked in its growth by the spreading dodder. The dodder entirely disappeared from the sprayed plot, though it afterwards made its appearance to a small extent in consequence of fresh infection from the adjacent plot.

In 1905, however, infested clover did not recover after the application of an 18 per cent. solution, and Dr. Hiltner thinks it unnecessary to exceed a strength of 15 per cent. The spraying must be done with a sprayer, so that the liquid falls with some force on the ground. An application with a watering-can did not prove successful.

NOTE.—Clover seeds are imported into Great Britain from nearly all parts of the world, particularly from Chile, Canada, the United States, France, Italy, and, before the War, very largely from Germany, Austria, and Russia. Generally speaking seed from the United States is remarkably free from dodder, whilst that from Canada is also relatively free. Red clover from Chile usually contains more or less dodder, whilst that from the Continent of Europe is often contaminated. This is also the case with alsike and white clover obtained from Europe and sometimes with English-grown samples of these seeds.

Lucerne is chiefly imported from France and the United States, but in much larger quantities from the former. The plant, too, from French seed is altogether superior to the American. Lucerne from these countries hardly ever contains dodder.

The Testing of Samples at the Official Seed Testing Station at the Food Production Department of the Board.—Samples should be addressed to:—

THE DIRECTOR GENERAL,
Seed Testing Station,
Food Production Department,
72, Victoria Street,
London, S.W. 1.

The size of the samples should not be less than 4 oz. for red clover, crimson clover and lucerne, and 2 oz. for alsike and white clover.

A fee of *3d.* per sample should be sent.

Special envelopes may be obtained free of charge at the above address. (*See* also Food Production Leaflet No. 47, *Testing of Seeds Order, 1918.*)

London, S.W.1,
January, 1907.

Revised, May, 1919.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 181.

BOARD OF AGRICULTURE AND FISHERIES.

Cleansing of Water Courses.

The attention of the Board has been drawn to the damage stated to be caused by the neglect of certain occupiers of land to keep clean the channels of water-courses and streams running through their land. It has been suggested that the law which deals with this subject is very little known, and the Board consider that it will be useful to publish, in the form of a leaflet, a short summary of the legal position.

For mere omission a man is not, generally speaking, answerable by law; and accordingly, at common law, the occupier of land through which a water-course runs is not, as a rule, under any obligation to neighbours whose lands drain into that water-course to prevent or remove any obstruction of the outfall due to merely natural causes (such as silting up of the channel or growth of weeds), and not caused by any action on his part, though, in exceptional cases, *e.g.*, under an inclosure award, such an obligation may sometimes exist.

A statutory remedy is, however, provided by the Land Drainage Act, 1847 (10 & 11 Vict. c. 38), and it appears to be applicable irrespective of any existing legal obligation on the part of the occupier of the land; but the statutory duty imposed by this Act arises only on notice given by the person injured, and the Act does not create any statutory liability in damages for the injury caused by the occupier's neglect.

Section 14 of the Act enacts that where, by the neglect of any occupier to maintain or join in maintaining the banks, or to cleanse and scour or join in cleansing and scouring the channels of existing drains, streams, or water-courses lying in or bounding the lands of such occupier, injury is caused to any other land, the proprietor or occupier of any land so injured may serve a notice on the neglecting occupier requiring him to maintain the banks or cleanse or scour the channels in question. If he neglects so to do, the occupier of the land injured may, after one calendar month from the service of the notice, carry out the necessary work. The cost of the same or a just proportion thereof is to be paid by the neglecting occupier, and payment may be enforced by an order of justices.

Section 15 provides that, unless the drain, stream or water-course to be cleansed bounds or immediately adjoins the land of the occupier injured by the neglect, a justices' warrant to enter on the defaulter's land in order to carry out the necessary works must be obtained. This warrant is to be granted if the justices are satisfied that the injury has been caused by the neglect of the occupier whose land is to be entered.

The effect of these provisions was discussed in the case of *Finch* v. *Bannister* (L.R. 1908–2 K.B. 441; 77 L.J.K.B. 718; 99 L.T. 228) where it was held that they are confined to injury done to the land itself, and that they did not apply where the injury complained of was injury to a mill.

London, S.W.1,
December, 1906.
Revised, August, 1909.

(This leaflet does not apply to Scotland.)

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 182.

BOARD OF AGRICULTURE AND FISHERIES.

Crimson Clover (*Trifolium incarnatum*).

While there are several species of plants belonging to the genus *Trifolium* the generic name is commonly applied to Italian or Crimson Clover, the term "Trifolium" being used among seed merchants at Mark Lane and in country markets, and also among the farming community.

Crimson Clover was introduced into this country as a field crop early in the nineteenth century, but previous to its introduction for such a purpose it was highly valued as an ornamental and showy border plant.

Owing to its peculiar climatic requirements Crimson Clover is most successfully grown in the Southern counties of England, where it is usually cultivated as a catch crop. It is an erect-growing annual from one to two feet high, and its habit of growth, hairy appearance, and bright crimson, oblong flower-heads are sufficient to distinguish it from all other species of the same genus.

In districts and soils suited to its growth, farmers seldom omit to lay down a certain breadth of Trifolium. The inducement to do so is apparent when one takes note of the economy of its cultivation and the rapidity of its growth, resulting in an early bite for stock, or in a crop which can be cut for horses and cattle at a period when green food is scarce.

The maximum yield of Trifolium is only obtained on warm, loamy, and gravelly soils. On colder land and in later districts it is sown much less frequently, as autumn rains and winter frosts prevent anything like successful results. As soon as the corn crop is removed, the cultivation for this clover should be immediately taken in hand. The preparation for the reception of the seed merely consists in working the surface with heavy drag harrows, so that the necessary tilth for covering the seed may be obtained without loosening the soil to too great a depth. The seeds are sown on the scarified surface, harrowed with seed harrows, and firmly rolled in. It is absolutely essential to its successful growth that the seed should be sown on a firm and solid bottom. If failure results it is more often than not caused by lack of firmness, and even on soils of a rather heavy nature, when ploughing is resorted to, the growth is not quite so successful as when the harrow only is employed.

When sown in August as described, at the rate of 15 to 25 lb. of seed per acre, crimson clover grows rapidly, becomes well established and firmly rooted, so as readily to withstand the severity of the winter, and will yield a large crop, to be cut or fed off in the following May or June. The exact quantity of seed to be sown is somewhat dependent on whether the conditions for successful growth are favourable or otherwise. The larger quantity would of necessity have to be used should the conditions of climate or soil be adverse. If a time may be stated during which this useful plant should be sown, it might be given as ranging from the first week in August until about the 10th September, and, as a general rule, the earlier the better.

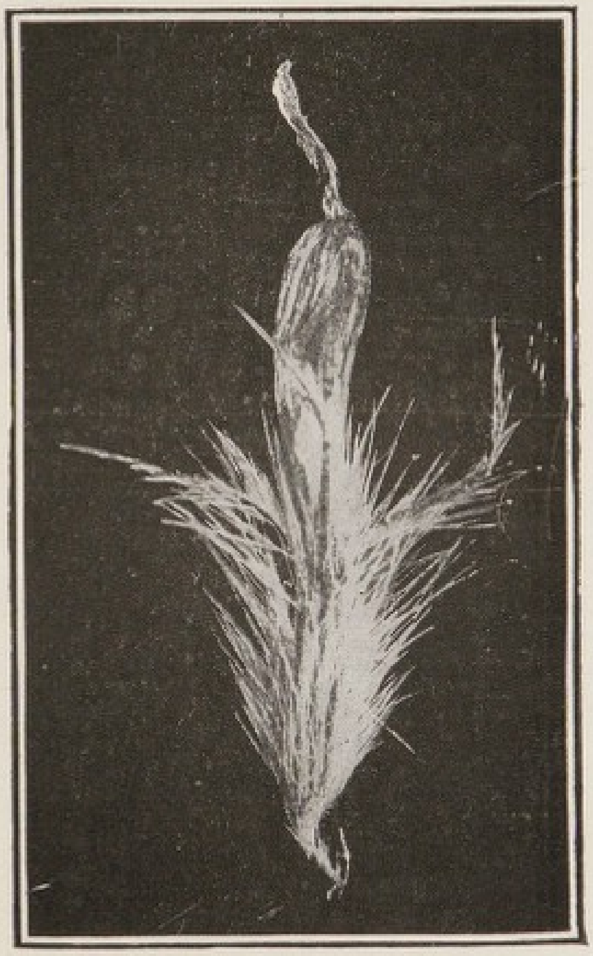


FIG. 1.—FLORET OF CRIMSON CLOVER (magnified five diameters).

There are, at least, three varieties of Trifolium in commerce: early, medium, and late, as well as the white-flowered variety. They are all useful plants. In practice, it is usually desirable to sow a certain breadth of each; and, though sown at the same time, these varieties come into use at different times in the spring, thus producing a useful succession of food. When the ordinary clovers are seriously affected by the drought of summer, or weakened or killed by severe winter frosts, the bare spots may be successfully renovated by sowing a few pounds of Trifolium.

As a hay crop Trifolium is not successful, for it is usually more stemmy than leafy; but if it is to be made into hay it should be cut directly the flower-heads appear, for, as the

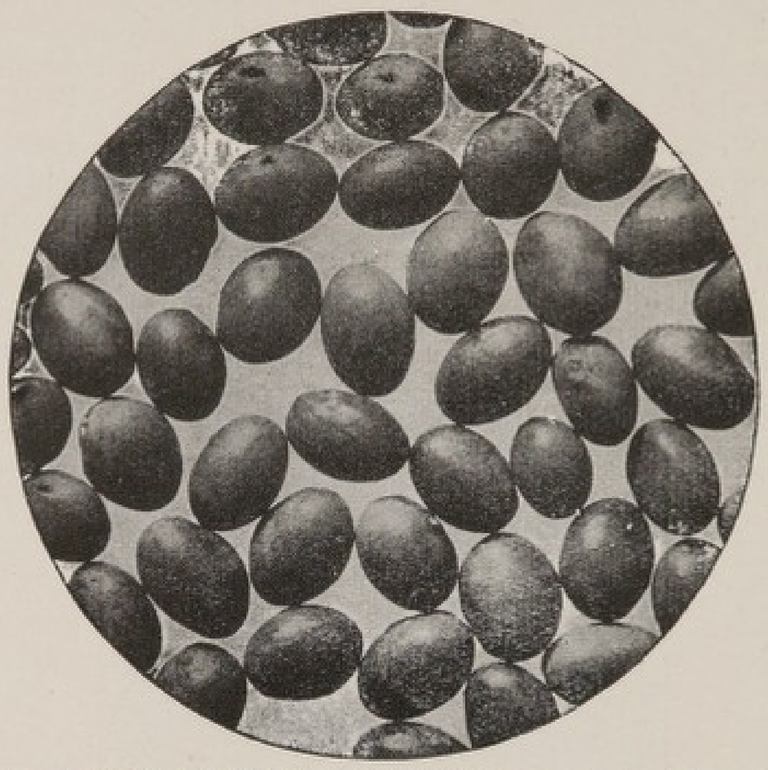


FIG. 2.—SEED OF CRIMSON CLOVER (magnified five diameters).

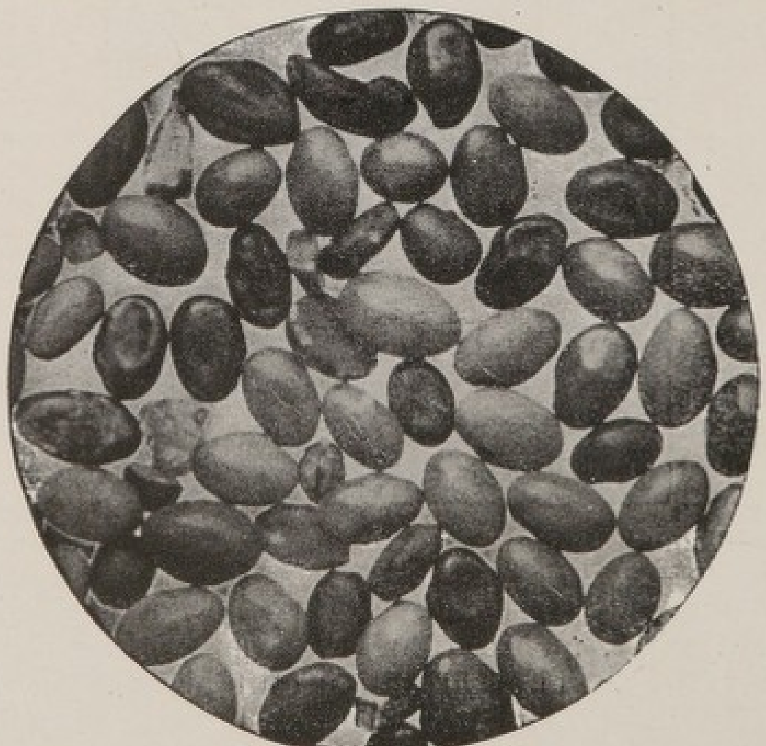


FIG. 3.—LOW-GRADE SAMPLE OF CRIMSON CLOVER SEED (magnified five diameters).

plant reaches maturity, the stem gets tough and woody, and serious danger to live stock consuming it may be apprehended.

Some idea of the danger following the feeding of mature Trifolium may be gathered by closely observing Fig. 1, which illustrates a single mature floret, five times life size. The whole of the flower-head from which the floret was taken was a little over three inches long, and its extreme hairiness can be imagined, as it contained 172 florets similar to that figured.

Hair balls removed from the intestines of sheep and horses have, by causing an obstruction, resulted in the death of the animal concerned, and have been found to be due to feeding with mature Trifolium. The hair balls have the appearance of a lump of smooth dried clay, but they are extremely light, and, when closely examined, are found to be composed of minute hairs. These hairs, when viewed under the microscope, prove to be identical with the hairs of the mature flower-head of Trifolium. They are serrated or barbed, and in consequence of the movement of the food in the stomach, become felted and form balls.

Crimson Clover, therefore, should never be fed to stock after the crop has ceased flowering, while the straw of Crimson Clover, raised and thrashed as a seed crop, should never be employed as a fodder.

Description of Seed.

The seeds of *Trifolium incarnatum* are quite distinct, both in colour, size, and shape, from other species of closely related *Leguminosæ*. Seeds recently harvested and in good condition are of a yellowish colour, somewhat tinged with red, or varying from a light to a reddish yellow, oval or elliptical in shape, and when fresh and new are bright and polished, with a smooth surface, and very much larger than the seeds of Red Clover. In the micro-photograph of a group of the seeds of Crimson Clover the uniformity of shape and size of grain in a good sample is well shown (Fig. 2). A very poor, low quality sample is also illustrated (Fig. 3), where the great variation in the colour and uniformity of the seeds is noticeable. Good commercial seed should be at least 95 per cent. pure, and there is no difficulty in obtaining seed having a purity of 98 per cent. The germinating capacity of fresh new seed of good quality rarely falls below 90 to 95 per cent.

The seed of White Trifolium, although larger than the red, is less uniform, both in shape and size. It is very easily recognised by its shape and colour, for, instead of being yellow tinged with red, it is of a bright cream white. In many samples the lack of lustre, combined with darkening of colour, is, in a great measure, sufficient evidence that advancing age has robbed the once living and robust germ of its vitality.

Impurities found in Trifolium Seed.

Some of the impurities found in Trifolium samples are shown magnified to the same scale, viz., five diameters in each case. Those illustrated are two species of Crane's-bill

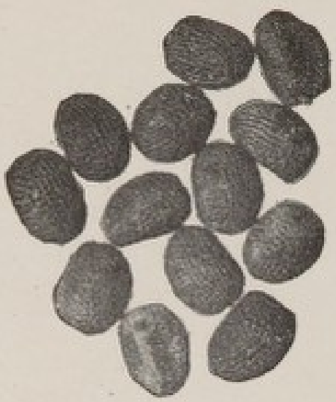


FIG. 4.—GERANIUM DISSECTUM.

FIG. 5.—GERANIUM MOLLE.

FIG. 6.—GERANIUM MOLLE (without husk).

FIG. 7.—FIELD MADDER.

FIG. 8.—CORN GROMWELL.

FIG. 9.—CURLED DOCK.

WEED SEEDS FOUND IN IMPURE SAMPLES OF TRIFOLIUM SEED (all magnified five diameters).

(*Geranium dissectum* and *Geranium molle*) (Figs. 4, 5, and 6), Field Madder (*Sherardia arvensis*) (Fig. 7), Corn Gromwell (*Lithospermum arvense*) (Fig. 8), and Curled Dock (*Rumex crispus*) (Fig. 9).

Samples of Trifolium seed that lack lustre usually contain a considerable proportion of immature grains, and, in consequence, the germinating energy is weak, the total vitality being below the standard of good marketable seed.

London, S.W.1,

November, 1906.

Revised, December, 1911.

Copies of this leaflet may be obtained, free of charge, and post free, on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 183.

BOARD OF AGRICULTURE AND FISHERIES.

Sycamore Leaf Blotch (*Rhytisma acerinum*, Fries.).

Rhytisma acerinum ON SYCAMORE.

The conspicuous black spots, resembling blotches of pitch, which are so common on living leaves of the sycamore and maple, are probably familiar to everyone, although not always associated with the work of a parasitic fungus. These blotches, however, are due to the fungus *Rhytisma acerinum*, Fries., the damage done by which is not generally recognised.

Description and Life History.

Towards the end of June, small yellowish patches appear on infected leaves; these patches increase in size until they are half an inch or more in diameter, and gradually darken in colour, until finally they become almost jet-black, with a border of dingy yellow. The substance of a fully-formed patch is much thicker than that of the leaf proper, owing to a crust formed by the fungus. The surface of the patch is wrinkled or corrugated, and, during the summer, produces myriads of very minute spore-like bodies, the function of which is unknown. They have not been seen to germinate, and seem incapable of causing infection. During the following spring, after the dead leaves have been lying on the ground throughout the winter, spores of another kind are produced in the substance of the black patches. These spores escape into the air through gaping cracks, and if they happen to alight on suitable young leaves, infection follows.

A second fungus, *Rhytisma punctatum*, Fries., also forms large black blotches on living leaves of sycamore and maple; it is distinguished by the black patch not being continuous, but composed of numerous minute distinct black spots, crowded together on a yellowish groundwork. The two species of fungi are not infrequently present on the same leaf.

Damage Done.

When the disease is present, almost every leaf on the tree is usually infected, and consequently a considerable amount of leaf surface is prevented from doing its work; and, in addition, diseased leaves fall early in the season. As the disease, unless checked, continues from year to year, the tree becomes enfeebled through lack of food, and then becomes an easy prey to a yet more destructive parasite, the Coral Spot fungus, *Nectria cinnabarina* (*See* Leaflet No. 115, Coral Spot Disease), which almost invariably follows an epidemic of leaf blotch.

Prevention.

The method for preventing a continuance of this disease is both simple and effective. As already stated, the young leaves are infected in spring by floating spores which escape at that season from dead leaves which have been lying on the ground during the winter. If all such dead leaves are collected and burned directly they fall in the autumn, or at latest before the young leaves unfold in the spring, the disease will be arrested.

London, S.W.1,
August, 1907.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 184.

BOARD OF AGRICULTURE AND FISHERIES.

RED, WHITE, AND ALSIKE CLOVERS.

Red Clover (*Trifolium pratense*).

Two leaflets already issued* deal with Lucerne and Crimson Clover or Trifolium, and in the present leaflet it is proposed to give some account of three further leguminous crops which are of very great value to farmers. The differences between the seeds and the impurities found in samples of the different species are also given, as being of considerable importance.

Red clover takes high rank among fodder plants, not only on account of the quantity but also of the quality of its produce. It is, perhaps, the most common and widely distributed of all the clovers. Several varieties are indigenous to this country, but only the two which are commonly sold as red clover and cow grass will be discussed here.

Red clover is largely used in alternate husbandry ; in the south of England it is chiefly grown as a pure crop, while in the north and also in moister districts of the country it is largely sown with Italian rye grass for a one year's ley, or with a mixture of grasses for a two or three years' ley. When used alone, about 14 lbs. of seed are usually sown, and in mixtures various proportions are employed, the smaller quantities being used for leys of longer duration. It grows freely upon practically all soils except those which are either very wet or very dry, but thrives best and for longer periods upon rich, deep, heavy loams, particularly when these contain a fair supply of lime. It yields the heaviest crop during the first year but on suitable soils continues to grow a second or even a third year. Remunerative crops cannot be grown frequently upon the same land ; usually four years, and often a much longer period, must elapse after a red clover crop, whether grown as a pure crop or in a mixture, before the soil is capable of again yielding a good crop of it. Land which is thus unable to produce clover is said to be *clover-sick*. On such land a good plant of clover may often be obtained, but during the period from October to March most of the plants disappear. This is probably not always due to the same direct cause ; it may frequently be due to infection of the ground with the fungus *Sclerotinia trifoliorum*, to Eelworm (*Tylenchus devastatrix*), or to a joint attack of both.

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* Leaflets No. 160 (*The Cultivation of Lucerne*), and No. 182 (*Crimson Clover*).

Cow grass, or perennial red clover (*Trifolium pratense perenne*), sometimes also called Single Cut Cow Grass or Late Flowering Red Clover, is mainly used for permanent pasture* or leys of extended duration, and differs from the first-named clover in its degree of permanence and in being a single-cut crop. When grown side by side, the difference between the two crops is most striking at harvest time ; the aftermath of red clover is then making some headway towards a second or seed crop, while the cow grass is only coming into flower, and, after cutting, produces little or no aftermath or second crop. For this reason the high price of cow grass seed need never occasion surprise.

Description of the Seeds.

There appears to be no real difference between the seeds of red clover and cow grass, so that the description of one seed answers equally well for the other.

The seeds of red clover differ from all other clovers in commerce in form, colour, and size, and it is easy for the analyst or expert to know at a glance that he is dealing with red clover, but when he is required to determine whether a particular sample is or is not of English growth, a great difficulty presents itself, and, under certain conditions, it is almost, if not quite, impossible to determine the origin. If seeds are examined in bulk, however, before they are cleaned, the presence of certain weed seeds may indicate that the sample has had its origin in England, America, or Northern or Southern Europe.

The seeds of red clover (Plate I.) are somewhat oval in shape, and in a general way slightly three-angled, the radicle of the embryo projecting prominently on one side, the colour varying even in high-class samples from light or deepish purple at the broad end shading down to a yellow or greyish-yellow at the narrow end. The evidence of immaturity, and perchance of a weakened or deficient germination, is recognized by means of the number of single-seeded seed pods and by the somewhat indefinable shade of yellowish-green which the seeds exhibit. Any sample that contains a goodly number of red or brownish coloured shrivelled-looking seeds should be avoided, as they are either browned by age or by unfavourable weather conditions during harvest.

The farmer, in handling a sample preparatory to purchase, may insensibly, as it were, form a definite opinion in several ways sufficient to give him a direct and practical hold upon the quality and market value of the sample. With care, and a certain amount of experience, he can be fairly certain whether the seed is genuine or otherwise. If the colour is good, fresh and bright, the seeds are likely to be new and of

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* *See* Leaflet No. 168 (*Hints on the Formation of Permanent Pastures.*)

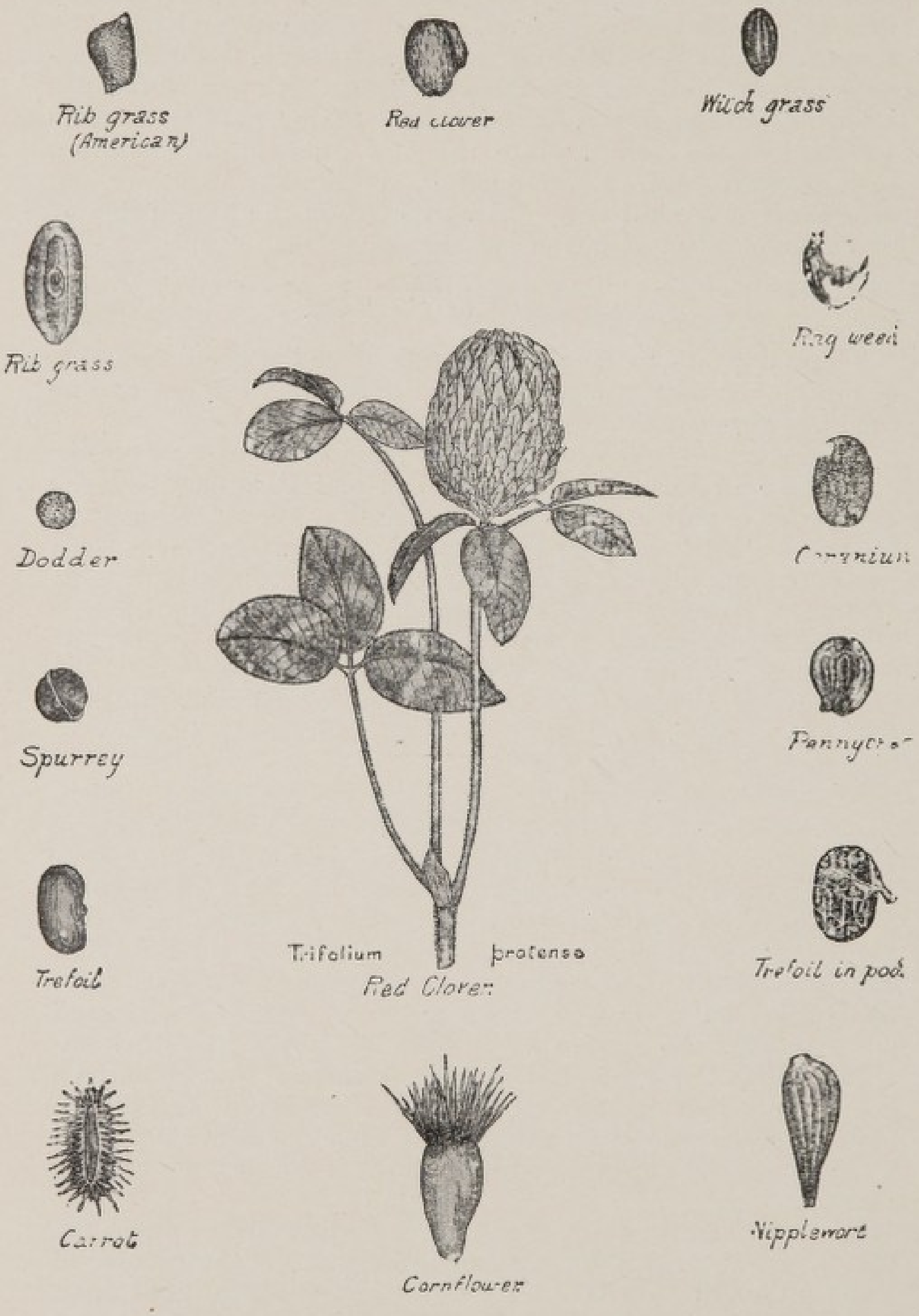

PLATE I.—WEED SEEDS COMMONLY FOUND IN SAMPLES OF RED CLOVER SEED.

(Each seed drawn to scale and magnified six diameters.)

last season's crop. The seeds must also be large and bold, and fairly uniform in size throughout the bulk, free, or comparatively so, from noxious weeds, and entirely free from the seeds of the parasitic plant Dodder.*

The purity examination of all the seed he sows is of vital importance to the farmer, meaning perhaps to him the difference between a robust, healthy crop, and a weak, straggling, diseased one. If unable to analyse the sample himself, it would be better to expend the necessary small sum required for such an examination by an expert than to risk the possible introduction of weeds and disease into his fields that years of toil may fail to eradicate.

Although the farmer from his own knowledge and experience may be perfectly satisfied from the appearance of the sample of clover he intends to purchase that it is genuine or true to name, and absolutely pure, yet that is not all. If the seeds fail to respond to the germinating test and produce living healthy plants, the purchase is a failure, and the seeds dear at any price. In this connection it is desirable to take advantage of the system adopted by seedsmen of guaranteeing the purity, genuineness and percentage of germination of seeds.

Weed Seeds found in Samples of Red Clover.

In Plate I., showing the clover seeds and the impurities commonly found in samples of clover, each seed is drawn to scale and magnified six diameters. In genuine American seed a certain number of weed seeds are invariably found, and these, as already indicated, help to determine its origin. The following are shown in the plate :—Rag weed (*Ambrosia artemisefolia*), rib grass (*Plantago major*, var., *Americana*), witch grass (*Panicum capillare*), and, in addition to these, the seeds common to English or European samples, such as ordinary rib grass (*Plantago lanceolata*), spurrey (*Spergula arvensis*), trefoil (*Medicago lupulina*), carrot (*Daucus Carota*), cornflower (*Centaurea Cyanus*), nipplewort (*Lapsana communis*), penny cress (*Thlaspi arvense*), geranium (*Geranium dissectum*), dodder (*Cuscuta trifolii*). Of all the impurities found in red clover, dodder is the one most to be dreaded. Clover seed of any kind containing the seed of dodder should never be purchased, however tempting may be the appearance of the sample or the price at which it is offered.

White Clover (*Trifolium repens*).

White clover is also called Dutch clover, a name given because it was first collected and cultivated as a seed crop in Holland and thence exported to other countries. It is indi-

* *See* Leaflet No. 180 (*Dodder*).

genous throughout Europe, but it was not until about the beginning of the eighteenth century that it was sown as a field crop in this country. It differs from red and Alsike clovers, inasmuch as its habit of growth is low and widely creeping, but it is similarly provided with a well-developed tap-root, which enables it to persist and hold its own during a dry scorching summer, while at the same time its prostrate, creeping stems, which give off adventitious rootlets at the nodes, feed mainly, if not entirely, in the upper layers of soil. It may be largely owing to this peculiar rooting habit that white clover can withstand the English climate and is very much less susceptible to climatic changes than red clover. The power of accommodating itself to a great variety of soils and situations may, perhaps, be due to the same cause.

The roots of white clover, in common with other clovers, possess an advantage over other plants in that they have the power under certain conditions—even when grown in soils destitute of nitrogen—of manufacturing albuminoid substances. Hellriegel was the first to discover the true significance of the warts or nodules on the roots of the Leguminosæ, and he ascertained that the nodules contained innumerable nitrogen-fixing bacteria engaged in manufacturing the elementary nitrogen of the air into compounds, which are employed by the host-plant in building up the necessary albuminoid substance.

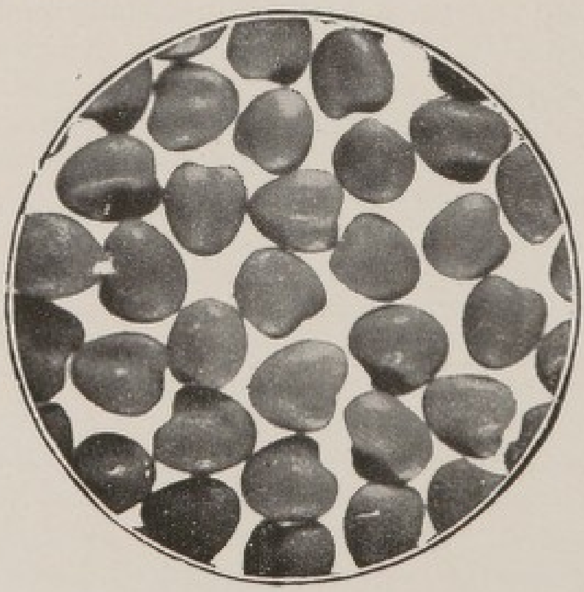

FIG. 1.—WHITE CLOVER (plump, uniform sample, magnified seven diameters).

White clover is found in abundance in all the best pasture land in the country, helping materially, in conjunction with some of the finer grasses, to form a close-bottomed grazing turf of high quality; it is also considered essential and especially valuable on pasture land intended for sheep grazing. In many districts two varieties may be recognized

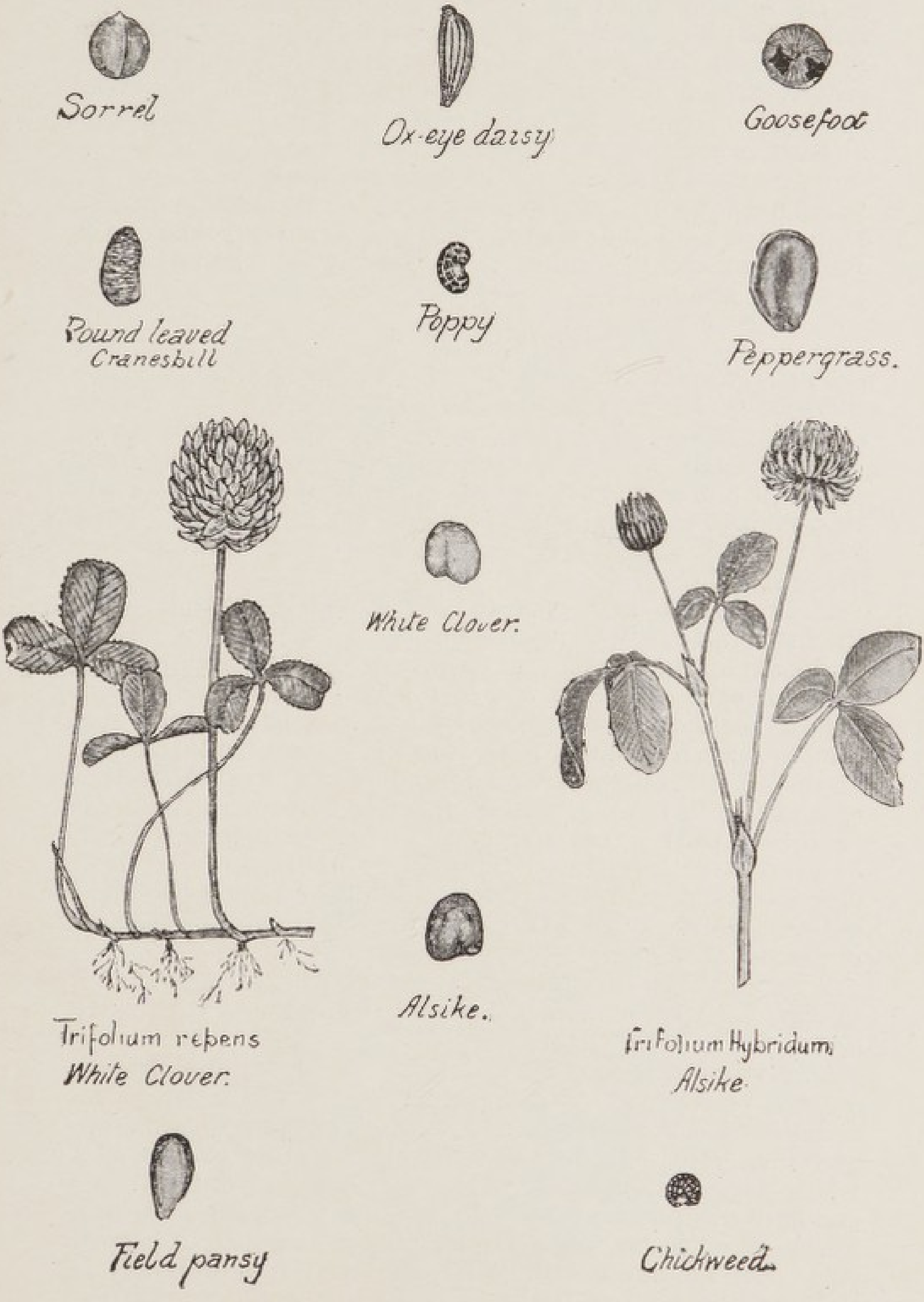

Plate II.—Seeds commonly found in Samples of White and Alsike Clover Seed.

(Each seed drawn to scale and magnified six diameters.)

growing in the fields : one, the ordinary white clover of commerce, characterized by its more robust habit of growth, the other a smaller-foliaged variety indigenous to the soil.

The seeds of this wild white clover have been in considerable demand of recent years. From experiments carried out at Cockle Park it was shown that, unlike the ordinary white clover, which does not produce lasting plants, the wild variety is evidently perennial. Its seeds go farther, and it appears to be immune from clover sickness.

White clover seed should be used in all seed mixtures for permanent pasture* and in leys of temporary duration ; when they are to remain down for more than one year, though the yield is small, it is much more permanent than either red clover or Alsike.

White Clover Seed.

The seeds of white clover are somewhat similar in shape to those of Alsike (*see* Figs. 1 and 3, and Plate II.), though slightly smaller. They are heart-shaped in appearance, and in new fresh seed the bright sulphur or orange-yellow colour is a characteristic feature. Seeds, which are reddish-brown, broken, thin, weevil-eaten, or imperfectly developed, are a fairly common feature of medium or low grade samples.

It is possible, as a rule, to estimate fairly accurately the intrinsic value as well as the commercial worth of a sample by its appearance alone. If the seeds in bulk are uniformly of a fair even size, fresh and of a bright yellow colour, with only an occasional brownish seed, it may be assumed that the seeds are new and at least of average germinating power ; on the other hand, seeds which fail to respond to the germinating test have, in all probability, suffered from the weather conditions during the later period of ripening and harvest, or are old or immature. The colour of some of the seeds may have changed from a yellow to a dark red or brown ; the greenish-yellow tinge in others is direct evidence of the lack of perfect development.

A good sample of white clover should at the least have a purity of 96 per cent., and the standard of top-price quality should be 98 or 99 per cent.

The progressive farmer should never, under any circumstances, be satisfied by the germinating test alone, for to the uninitiated it is entirely misleading. Though a report as to germinating capacity is comparatively high, the sample as a whole may be of third or fourth rate quality ; one-third or one-half the purchase may be rubbish or, what is worse, living weed seeds, as it is the pure and apparently good seeds only that are tested. The combined test of purity as well as germination is the only key or guide to the real cultural worth of any sample.

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* *See* Leaflet No. 168 (*Hints on the Formation of Permanent Pastures*).

Weed Seeds found in Samples of White Clover.

Apart from the use of comparatively worthless low quality seed, white clover is rarely or never adulterated, perhaps with the exception that, when the seed is scarce and prices rule high, an admixture of suckling clover is sometimes used, and, unless the sample is closely scrutinized, it is not readily seen, as the seeds are similar in colour. When examined, however, under a low-power lens, the difference between the seeds is easily recognized, the seed of suckling clover being somewhat cylindrical in shape and very shiny (Fig. 2), while the white clover is heart-shaped (Fig. 1).

Some of the weed seeds (*see* Plate II.) common both to white clover and Alsike are here represented magnified six diameters :—Sheep's sorrel (*Rumex Acetosella*), round-leaved Cranesbill (*Geranium molle*), Ox-eye daisy (*Chrysanthemum Leucanthemum*), Goose-foot (*Chenopodium album*), Poppy (*Papaver Rhœus*), Field pansy (*Viola tricolor*), Chickweed (*Cerastium triviale*), Pepper grass (*Lepidium virginicum*), the last being fairly common in American seeds. Ordinary rib grass, as illustrated in Plate I., is also found in more or less abundance in many samples of white clover and Alsike. The seeds of dodder are rarely found in white clover. The seed of the weed *Trifolium parviflorum* is sometimes offered as white clover. The seeds so far resemble one another that a purchaser might easily be deceived unless a careful comparative examination is made. It seems desirable, therefore, that large quantities of white clover seed should only be purchased on a warranty and after examination by an expert.

Fig. 2.—Suckling Clover (sometimes used to adulterate white clover ; magnified seven diameters).

Alsike (*Trifolium hybridum*).

Alsike clover derives its common name from the fact that though indigenous to Southern Europe it was first introduced into this country from the village of Alsike, in Sweden, about seventy years ago. The specific name of *hybridum* was given to it by Linnæus, who regarded it as a cross between red and white clover.

The colour of the flower-head—the outer florets of which are tipped with purple or pink—imparts to the plant the appearance of an intermediate form between red and white, no doubt giving rise to the supposition that it is a cross, but on this point opinions are divided, and it is now more generally believed to be a distinct species.

Alsike clover is truly perennial in character and useful for both temporary and permanent pasture.* It attains its maximum yield on moist loams and clays, and is favoured rather than otherwise by wet seasons. Of all clovers it is the only one suitable for irrigation. Owing to its surface-rooting habit the yield on light dry land is correspondingly meagre ; on land suitable to its development it is more permanent than red clover, and superior to white clover by its upstanding leafy growth, which enhances both the quantity and quality of the hay crop. In pasture land the tread of cattle affects its growth but slightly, if at all, and after depasturing, new shoots quickly spring into growth. It stands heat and cold, and on "clover-sick" land, which is unfavourable to a healthy crop, it is indispensable as a substitute for red clover.

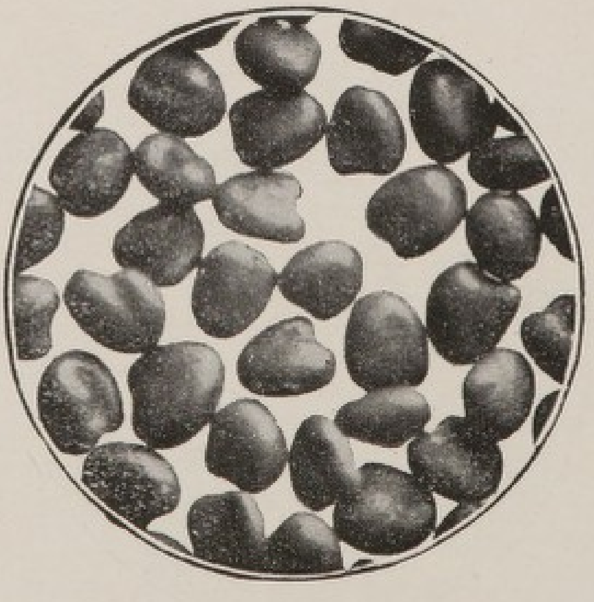

FIG. 3.—ALSIKE CLOVER (good sample ; magnified seven diameters).

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* *See* Leaflet No. 168 (*Hints on the Formation of Permanent Pastures*).

Alsike Clover Seed.

The seeds of Alsike, like white clover, are heart-shaped, and in good samples should be plump and uniform. The colour is very variable in different samples, and even in the same sample there may be dark green, yellowish-green, and pale green seeds; alternate shades of light and dark green in many cases give the seeds a somewhat marbled appearance, which is characteristic of many samples. The variations are largely due to the maturity or the ripeness of individual seeds, yellowish-green indicating immaturity, while brown or reddish-brown indicates advancing age or weather influence about or during harvest time.

Weed Seeds found in Samples of Alsike Clover.

The seeds of Alsike (Fig. 3) contain in most instances the impurities common to white clover, perhaps with the striking exception that while dodder is but seldom found in white clover, it is not unusual in Alsike. Samples of Alsike containing dodder very frequently exhibit a peculiar sickly greenish hue, and this leads one to think that the development of the seed has been interfered with by the ravages of the parasite which has robbed the plant of its food. Lightish green, immature samples of Alsike, therefore, should be closely scrutinized for dodder seeds.

Unless the presence of a high percentage of weeds and other rubbish is regarded as adulteration, it cannot be said that Alsike is often adulterated. But it sometimes contains a considerable proportion of the seed of timothy, white clover, suckling clover, and trefoil. The purity and germination of good samples should be similar to that of white clover.

London, S.W.1,
January, 1907.
Revised, February, 1913.

Copies of this leaflet may be obtained, free of charge, and post free, on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

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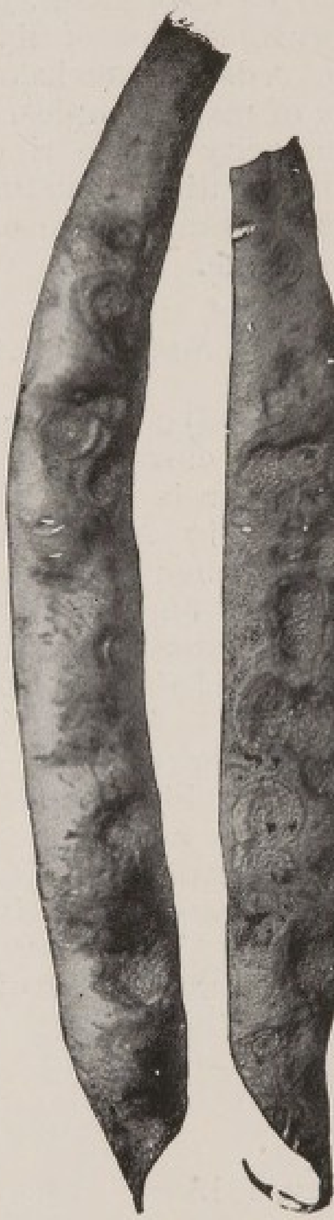
Leaflet No. 185.

BOARD OF AGRICULTURE AND FISHERIES.

Bean Pod Canker (*Colletotrichum lindemuthianum*, Briozi).



BEAN PODS, SHOWING CANKER.

The pods of scarlet runners and French beans suffer most in this country from the attacks of this parasite. In America it is said to be parasitic on the living rind of cucumbers, vegetable marrows, water-melons and musk-melons.

On the pods the first indication of the disease is the appearance of small, scattered, dark-coloured specks surrounded by a reddish line. These spots gradually increase in size, and often run into each other, forming irregularly-shaped patches which become sunk below the general level of the surface. In due course the sunken brown patches become more or less covered with a thin whitish crust, consisting of a dense mass of spores or reproductive bodies of the fungus. When mature these spores are carried by rain, insects, &c., and infect neighbouring plants.

Pods that are attacked when quite young frequently become variously bent and contorted. The parasite often passes quite through the pod and attacks the beans. If such infected beans are used for seed the crop shows the disease at an early stage of growth, and is killed before the flowering season is reached.

Although the appearance of the disease on the pods is accepted as the first evidence of its existence by the gardener, it nevertheless usually appears first on the stem, where it forms brownish sunken patches. If such patches are confined to one side of the stem the plant is not killed outright, and the injury may escape notice; on the other hand, when a diseased patch girdles the stem, the portion above the wound withers and dies. In some instances the leaves are also attacked, and the diseased portions soon become dry and drop out, leaving irregular holes usually attributed to the ravages of insects.

As a rule the pods are infected by spores produced on the stem or leaves, and consequently much depends on dealing with the disease on its first appearance.

Preventive Measures.

Bordeaux mixture of half the normal strength* should be used until the pods are set, after which a solution of liver of sulphur—one ounce dissolved in four gallons of water—should take its place. Even this fungicide should be discontinued when the pods are about half-grown.

* To make normal strength Bordeaux mixture:—(1) Dissolve 12 lb. of sulphate of copper (bluestone) in a tub of cold water; (2) slake 8 lb. of lime in another vessel; finally, mix the contents of the two vessels in a wooden tub by stirring thoroughly, and make up to 100 gallons. To make this half the normal strength double the quantity of water must be used. Exact instructions for making Bordeaux mixture are detailed in Leaflet No. 23, *Potato Disease (Blight), and its Prevention.*

London, S.W.1,
November, 1906.
Revised, July, 1912.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 186.

BOARD OF AGRICULTURE AND FISHERIES.

The Large Larch Sawfly.

(*Nematus Erichsoni*).

The importance of a careful outlook by the sylviculturist and the arboriculturist in order to observe whether there seems to be any increase above the normal of a special insect, receives once more strong support in the recent ravages of larch, by the caterpillars of the large larch sawfly over a large area in Cumberland. There are in Great Britain native species of forest insects which once and again on the Continent or elsewhere have been the cause of immense loss, and yet in Britain have never attracted attention by any serious damage, or, indeed, by any damage at all. There is always, however, the possibility of trees being damaged by such species, and the danger will grow with the increased area that may be put under forest crops, and with the massing together of great numbers of the trees of one species.

Nematus Erichsoni is not a very common insect in Britain or in Europe generally. It is not even mentioned by name in the literature of wood or forest injury in Britain, and it is almost passed over in the Continental forest literature as of little forest importance. The increase, however, of this insect in the last three years over a considerable area in Cumberland, and the damage there done by its larvæ, is a matter of great importance, and may, unless careful outlook be kept, have grave results elsewhere. It were a pity, after the loss and discouragement caused by the larch canker fungus,* if a second scourge in the shape of this sawfly enemy should follow. British foresters should be on the alert against this possibility.

Previous History of Nematus Erichsoni.

In the forest literature of the Continent there are references to the larvæ of the large larch sawfly as having been the cause of damage to larch in the Harz Mountains,

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* See Leaflet No. 155) *Larch Canker*).

in Holland and in Denmark. The references are chiefly antecedent to 1840; the most recent is from Denmark, in 1902. The insect has been recorded in Western Europe, from Sweden in the north to as far south as France.

As regards Britain, Cameron* writes: "*Nematus Erichsoni* does not appear to be a common species."

In the United States of America this sawfly has been catalogued as one of the most destructive forest insects, the larvæ, in the North-Eastern States, having at different times defoliated the larch.

Defoliation of Larch in England.

During the summer of 1906 the caterpillars of *N. Erichsoni* were at work in very large numbers over a considerable area in Cumberland. The trees cover the mountain up to an elevation of 1,600 feet. Part of the area is made up of pure larch, which suffered more than another portion of the wood where the larch is mixed with oak and a few other broad-leaved species. The attack was first observed in 1904; it was more serious with the spread of the insect in 1905; and again in the summer of 1906 great damage was done. Caterpillars were sent to the Board of Agriculture and Fisheries for determination and report in August of 1906, and a visit to the affected district followed.

The area worst infested was a wood somewhat conical in shape, and hence exposed to all points of the compass, the largest part, however, facing south. The age of the trees attacked varied from twenty years to seventy years and over, and the fact of tall trees being attacked adds greatly to the difficulty of satisfactorily combating the caterpillars and the adult sawflies. When the area was inspected in the last week of August, the brown and withered appearance of many of the trees attested the severity of the infestation. At some hundreds of yards distance, looking up at the wood, the eye could easily pick out the defoliated trees. Some of them were practically in their winter condition, devoid of leaves. Others which had been defoliated in July had by mid-August started to produce new leaves, so that on inspection at the end of August such larches appeared as they normally do in April or May, with the dwarf shoots bearing tufts or clusters of partly grown leaves (Fig. 8).

Some seventy-year old larches felled at the end of July and the beginning of August were infested with thousands of the sawfly caterpillars. These caterpillars, many of them dislodged by the fall of the trees, made their way to the trees standing near and attempted to ascend them, the bases of the trunks of several hawthorns, for example, being hidden by

* "A Monograph of the British Phylophagous Hymenoptera," Vol. II., p. 7, 1885.

their numbers. The caterpillars, numerous and easy to find on the trees up to the third week of August, were by the fourth week, in the great majority of cases, full fed, and had left the trees and made their way into the moss and litter on the ground below, in order to make their cocoons.

Altogether in the neighbourhood referred to an area of over 300 acres was attacked. Examination of other larch woods near by, and of isolated larches here and there at a greater distance, showed that there were still uninfested places, although there was great danger of infection.

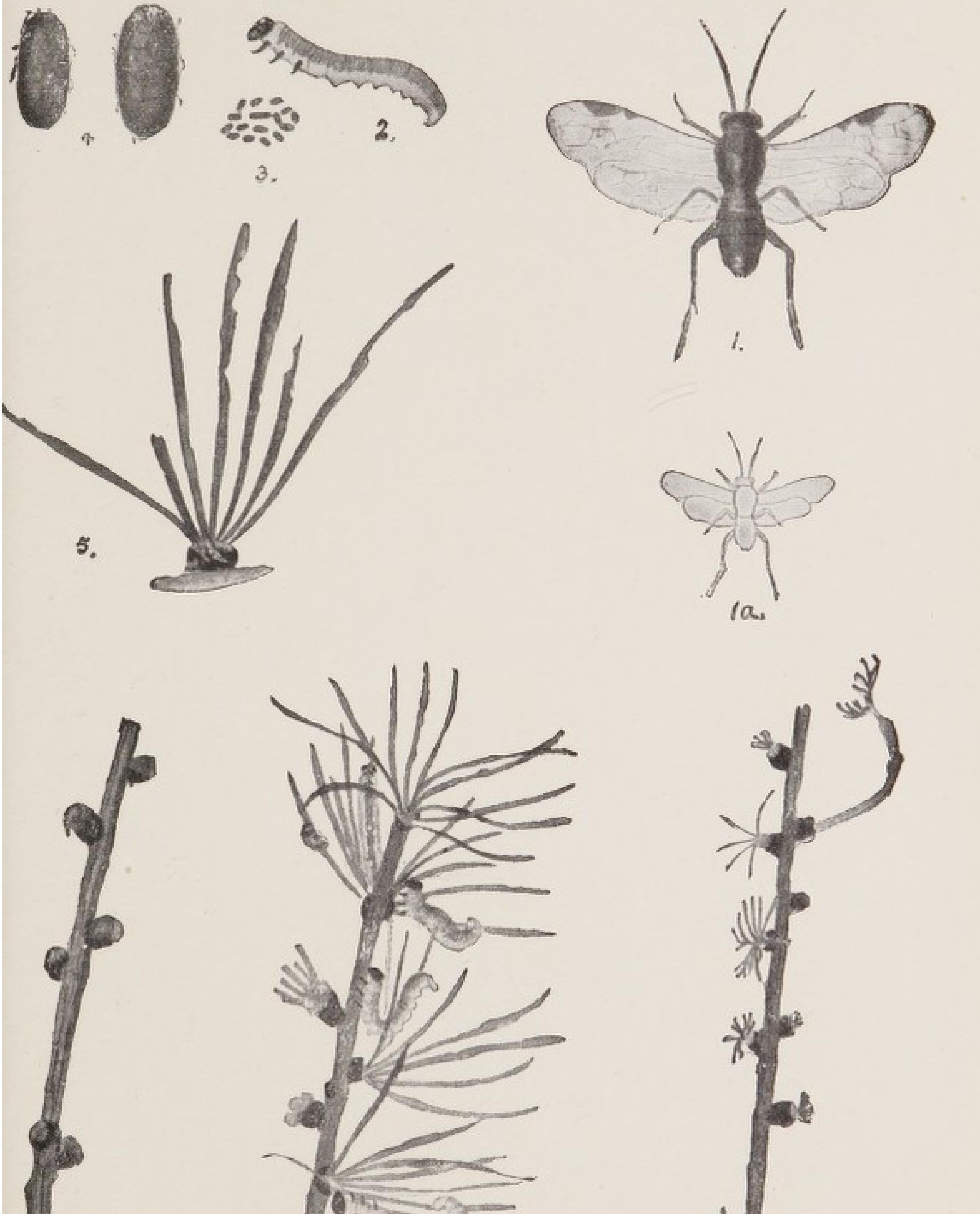
Position of Nematus Erichsoni in the Insect World.

The large larch sawfly belongs to the Order Hymenoptera and to the family *Tenthredinidæ*, or sawflies. The sawflies are so called from the fact that the ovipositor of the female is modified, typically, to form a sawing apparatus, by which openings are made in leaf or twig for the reception of the eggs. The two saws are side by side on the under surface at the hind end of the sawfly. The adult sawflies do not attract much notice, but if examined it will be seen that they do not have the narrow waist characteristic of the wasps but that the base of the abdomen is broadly joined to the thorax. The adults, in nearly every case, are harmless, save that, of course, they lay the eggs. The larvæ are very characteristic: they are caterpillars, which, with one or two exceptions, have more than sixteen legs. In the great majority of cases they feed exposed; a few, however, live in galls, or mine or burrow in plant tissue. Dr. Sharp reckons that nearly 400 species have been found in Britain, and amongst these are species troublesome in gardens, and to fruit, and in agriculture. Six or seven genera contain species of importance in forestry, of which *Lophyrus* (see Leaflet 103), *Lyda*, and *Nematus* are the most important.

The species of the genus *Nematus* that have relation to forestry affect, amongst broad-leaved species, the willow chiefly. The interesting, and sometimes injurious, caterpillars of *Nematus septentrionalis*, besides feeding on willow, attack also the leaves of birch, hazel, alder, and mountain ash. On the larch, besides *Nematus Erichsoni*, the large larch sawfly, *Nematus laricis*, the small larch sawfly, also occurs.

Description of Nematus Erichsoni.

Adult.—The adult sawfly (Figs. 1 and 1*a*) measures up to $\frac{3}{8}$ inch, or a little over, in length, and in spread of wings just less than an inch. The ground colour is black. The head and thorax are black; the first joint of the abdomen is black; then follow joints coloured red; the end of the abdomen again being black. The mouth parts, the two front pairs of legs,



THE LARGE LARCH SAWFLY (*Nematus Erichsoni*)

(For description of figures, *see* p. 7).

except at the part next to the thorax, and the upper parts of the femora of the hind legs, are reddish or reddish-yellow. The tibiæ are yellowish or pale in the upper parts. The antennæ are nine-jointed and somewhat thick, and taper towards the apex. With a lens the head and thorax are seen to be sparsely and finely pubescent, and the thorax is markedly punctured. The wings are glassy and slightly clouded below the stigma.

Egg.—The egg is longish oval, and measures just over a millimetre in length. It is white in colour.

Larva.—The full-grown caterpillar (Fig. 2) measures three-quarters of an inch, or a little over, in length. It has a round black hairy head, with a single ocellus (simple eye) on each side. On the upper surface, all down the back, the colour is grey-green; the sides are lighter; the under surface is yellowish-green. If a lens is used, transverse rows of minute warts with spines will be seen on the abdominal segments. The spiracles along each side are brown. The legs number twenty, viz., three pairs of thoracic legs, which are black, and seven pairs of abdominal legs, which have the colour of the underside of the body. The head is followed by twelve segments or joints—1, 2 and 3 are thoracic joints, and each bears a pair of legs; 4 to 12 inclusive, are abdominal joints; 4 has no legs; 5, 6, 7, 8, 9 and 10 have each a pair of legs; 11 has no legs; and 12, the last joint, carries a pair of legs.

Packard* describes the caterpillar as moulting three times, and so distinguishes four stages of larva. On hatching, the head is very large and dusky green, not black; neither are the thoracic legs black; the body is uniformly pale green. After the first moult the head and thoracic legs are black; the body is wrinkled, but no warts show. After the second moult the upper surface is grey-green, and the transverse rows of warts appear. The caterpillar attains its full size after the third moult. The moulted skins can be seen wound round, or attached to, the leaves (Fig. 7).

Excrement.—The castings (excrement) of the caterpillar are longish, cylindrical, and somewhat square cut at the ends (Fig. 3). The castings observed on the ground will afford a hint as to the presence of the larvæ. So numerous were the caterpillars in some parts of the attacked area in Cumberland that in July their excrement falling on leaves below suggested the patter of rain drops.

Cocoon.—The cocoon (Fig. 4), strong and leathery, or parchment-like, is dark brown in colour; it is cylindrical in shape, with rounded ends; the inside is smooth, the outside shows a raised network pattern. The size may be taken on the average as between $\frac{3}{8}$ inch and $\frac{1}{2}$ inch.

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* Fifth Report of the United States Entomological Commission; "Forest Insects," 1890.

The following tables may assist in making certain the determination of the large larch sawfly.

Moth Caterpillars.	Sawfly Caterpillars.
Head somewhat hollowed out, not markedly globular.	Head globular.
A group of ocelli on each side of the head.	One ocellus on each side of the head.
Hooklets on the abdominal legs.	No hooklets on the abdominal legs.
Legs 16 in number or less.	Legs more than 16.
The Geometer moth caterpillars, of which at least three species feed on larch, have a less number of legs than 16. The caterpillars of the larch mining moth (this was quite common in Cumberland, and is often a serious enemy of the larch) mine into the needles, causing the upper half to shrivel up; these caterpillars are very minute, and make cases for themselves in hollowed out parts of the needles.	Genus *Lophyrus*. *e.g.*, the pine sawflies, not found on larch. The caterpillars have 22 legs. Genus *Nematus*. The caterpillars have 20 legs.

The Large Larch Sawfly. *Nematus Erichsoni.*	The Small Larch Sawfly. *Nematus laricis.*
Adult 10 mm. in length, and with red on the abdomen.	Adult 6 mm. in length and quite black.
Thorax prominently and thickly punctured.	Thorax not prominently punctured, and may be quite smooth.
The eggs are laid on the young shoots.	The eggs are laid on the buds.
Caterpillar measures up to 22 mm. and is grey-green on the back, lighter on the sides.	Caterpillar measures up to 15 mm., and is grass-green or greenish-brown.
Head of caterpillar black.	Head of caterpillar brown.
Caterpillars feed till the end of August.	Caterpillars full grown in July.
The caterpillar eats especially the leaf clusters or tufts.	The caterpillar eats more commonly the single leaves on the shoot of the current year.

Life History and Habits of the Large Larch Sawfly.

The caterpillars winter under cover of the cocoons, and pupate, generally speaking, in May or June, according to the conditions. The adults probably issue in June. The eggs are laid, in one or two rows, on the youngest larch shoots, and in slits in the bark made by the saws of the females. Packard saw the eggs laid at the bases of the young leaves. (It will be recalled that on the new shoot or shoot of the current year in the larch the leaves are not in clusters but are arranged singly.) The presence of the eggs may cause the shoots to curl somewhat, and on occasion the leaf at whose base an egg had been laid, dies. As the embryo develops the slit in the shoot gapes a little, and through the oval hole the caterpillar creeps on hatching. The caterpillars may begin by gnawing the single leaves on the young shoot, but they soon pass to the clusters of needles on the dwarf shoots. Single leaves may be eaten so that the edges appear serrated, or the clusters of leaves may be half eaten or quite destroyed so that only stumps are left (Figs. 5 and 6).

In the young condition the caterpillars may be found in clusters. They assume various positions, arranged with the tail end curled round the shoot; or like a mark of interrogation, or the letter S; or (a characteristic attitude) with the hind half of the body turned upwards and over the front half (Fig. 7). On being handled, the caterpillars wriggle violently, rolling themselves about in a fashion similar to surface caterpillars, ultimately lying on their side with their body forming a circle, the tail end touching the head.

The larvæ are to be found at work during the summer, and most numerously in July and the first fortnight of August. By the end of August most have left the trees. Some, however, do not complete their growth till September. The full fed caterpillars leave the trees and pass into the moss or litter or the soil below, and in such shelter places spin the cocoon in which they pass the winter. They lie somewhat bent in the cocoon until the late spring or summer of the next year, when they turn to pupæ, the adults issuing in due course.

There is no evidence so far that there are two generations in the year, and yet the caterpillars seem to attain full size in a comparatively short time.

Age of Trees attacked.

Infestation in the larches in Cumberland was upon trees of from twenty to seventy years of age. The records elsewhere show that young plants of ten years of age may be attacked, but attack has been reported more frequently on older and taller trees. The fact that the caterpillars work on well-grown trees, and, it seems, characteristically at the crown first, greatly increases the difficulty of fighting them.

Preventive and Remedial Measures.

1.—Against the adults scarcely anything can be done effectively. They lay high up, well out of reach, so that the placing here and there of tarred boards standing erect and with the tar frequently replenished, which is practised sometimes against sawflies that lay on young plants, cannot be tried with hope of success.

2.—If young trees chance to be affected with the caterpillars, these, especially when small and, it may be, in clusters, should be squeezed in a gloved hand or rubbed off the shoots into a small hamper; or badly infested shoots could be snipped off or cut through and dropped into the hamper. The contents of the hamper should then be emptied on a slow-burning fire. This measure, practised against the pine sawfly, will often be impracticable against the caterpillars of the large larch sawfly, feeding as these do, out of reach.

3.—Jarring the trees to shake down larvæ would meet with most success on a dull day or early in the morning, when the caterpillars are cold and sluggish.

4.—Where the caterpillars are out of reach and the trees attacked are isolated, or where the infestation is limited, the trees should be sprayed with (*a*) fresh white hellebore, 2½ lb. being mixed with 10 gallons of water, the mixture to be kept agitated while spraying ; or (*b*) Paris Green in the form of paste, 1 lb. to 150 gallons of water ; or (*c*) lead arsenate, made by dissolving 1 oz. of arsenate of soda in a little water, then dissolving 3 oz. acetate of lead in a little water, finally mixing the two solutions. This mixture should then be made up to 10 gallons by the addition of water.

5.—When infested trees are felled the dislodged caterpillars should be destroyed.

6.—A certain amount of help is rendered by Nature. Birds may take the caterpillars : in the Cumberland wood referred to rooks and jackdaws were seen to be feeding on the caterpillars during July. Parasitic ichneumon flies are active enemies of the caterpillars.

7.—The cocoon stage comes within reach of practicable treatment if the infested area be not too wide. The litter and surface soil below attacked trees could be ploughed in deeply so as to bury the cocoons, or in a prescribed area boys could be employed to collect them, or the soil and litter and moss could be collected together in little heaps. If quicklime were placed on these heaps and water sprinkled over them the heat engendered would kill the enclosed caterpillars. Swine, useful in some insect infestations against pupæ in the soil, are not here of value as they refuse to eat the cocoons.

A fuller account of *Nematus Erichsoni*, with a coloured plate, was published in the *Journal of the Board of Agriculture* for October, 1906.

Description of Figures :—Fig. 1, *Nematus Erichsoni* (magnified) ; Fig. 1*a*, *Nematus Erichsoni* (natural size) ; Fig. 2, Larva ; Fig. 3, Excrement of larva ; Fig. 4, Two cocoons, each magnified 1½ times ; Fig. 5, Some injured leaves magnified ; Fig. 6, Larch twig defoliated by the larvæ ; Fig. 7, Larvæ on twig of larch : on one of the needles a moulted skin is seen ; Fig. 8, Larch twig, drawn in September, that had been defoliated and was then putting out new leaves. Figs. 1 and 1*a* are after Packard ; all the others are drawn from nature.

London, S.W.1,
February, 1907.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

The Selection and Milking of Dairy Cattle.

The importance of obtaining really first-class dairy stock has long been recognised by practical men, and the degree of perfection which has been reached in the production of excellent types is well seen in the existing breeds of dairy cattle. In selecting cattle for dairy purposes the farmer should give special attention to the particular object for which the milk is to be produced.

1. When milk-selling is the object, the farmer will strive to obtain a large *volume* of milk, the quality of which will meet the requirements of the Sale of Milk Regulations.

2. Should the object be butter production, the richness of the milk in *fat* is an important consideration.

3. For cheese-making *a large yield of rich milk* is required. In the production of uniformly high-class cheese, good quality of the milk is imperative.

Suitable Breeds.—Breeds which are suitable for special purposes are mentioned on p. 2. Most milk-sellers desire to find cows—either pure or cross-bred—that will give an ample yield of milk of good quality. In purchasing animals, care should be taken to ascertain the ancestry both of the sire and of the dam. The animal that will yield eight hundred to a thousand or more gallons of milk a year is a most valuable asset; especially is this the case if the milk is of a quality well above the limit prescribed by the Sale of Milk Regulations, for at times, when it is realizing a low price, it may be kept at home and manufactured into either butter or cheese. Cows that will yield the quantity of milk specified may be bred or bought, but the average quantity of milk yielded per cow throughout the country is much lower than it should be. Cows yielding large quantities of milk frequently cost little, if any more, for keep and labour than those yielding small quantities, while the returns obtained are sufficient to make the difference between a substantial profit and a heavy loss. Another point to be taken into consideration in selecting an animal for the dairy is the inherent capability of a cow, after her milking days are finished, to put on flesh and be saleable as beef. Dual-purpose cattle, or those that will milk well but may be readily converted into good beef, and that will produce calves which will develop into good feeding beasts, are much to be desired; but there is a difficulty in finding any breed which combines in the highest degree the best milking and feeding qualities. Shorthorns, Red Polls and South Devons, as well as the little Dexters are, however, of considerable value from this point of view. Probably the carefully-bred Dairy Shorthorn is the nearest approach to an ideal dual-purpose cow.

Before discussing the special characteristics of the dairy cow, the suitability of the leading dairy breeds for certain districts and purposes may be pointed out:—

Suitable for Good Land.	Suitable for Exposed Country.	Specially Adapted for Milk-selling.	Most Suitable for Butter-making.
Dairy Shorthorns.	Welsh.	Dairy Shorthorns.	Jerseys.
Lincoln Reds.	Ayrshires.	South Devons.	Guernseys.
British Friesians.	Kerries.	British Friesians.	South Devons.
South Devons.	Dexters.	Lincoln Reds.	
Jerseys.		Welsh.	
Guernseys.		Ayrshires.	
Red Polls.		Red Polls.	
		Kerries.	

For cheese-making, Shorthorns, Ayrshires, Devons, and Welsh are most in demand. Where, as is sometimes the case with the heavy milking breeds, the morning milk has a tendency to contain a low percentage of butter-fat, especially when milked at unequal intervals, an addition of about 10 per cent. of milk from Channel Islands cows will help to raise the general quality of the milk and to maintain the required amount of fat.

Points of Dairy Cattle.—The special points to be considered in the purchase and judging of dairy cattle are:—(1) General appearance denoting constitution and milking qualities, and that conformity to type which is noticeable in all well-bred animals; (2) Shape and capacity of the udder, and size of milk veins and teats; (3) General indications of suitability for dairy purposes.

1. **General Appearance.**—The ideal dairy cow, no matter of what breed, should be wedge-shaped, the side lines tapering from the hind quarters toward the neck. The head should be fine, and the eyes rather prominent; the neck and throat clean; the horns small and not coarse. The dewlap, if any, should be thin and not fleshy. The shoulders should be light and oblique, with rather pronounced withers free from flesh, while the back should be lean. The hips should be placed wide apart and level with the back; the

rump long and wide, with a fine tail well set on, reaching down to the hocks, and carrying a good switch. The thighs should be long and lean, and the flanks thin; the hocks wide apart and set square, with plenty of room allowed for the udder. The abdomen should be capacious. In comparison with a "beef" animal a typical dairy cow will often appear flat-sided, but "depth" of body which denotes constitution will make up for this apparent defect.

If the cow is one of the Channel Islands breeds, the hoof should be small, and bright in colour, the skin "mellow," soft, and "creamy," and the horns "crumpled," clean and bright, well set on, yellow at the base and black towards the tip.

2. **Shape of Udder, &c.**—The udder or bag should extend well forward,—the fore teats in some cows will be found in a vertical line with the hip bone. The udder should be full and capacious but not fleshy, silky to the touch, flat underneath and well rounded behind, each quarter being sound and the teats easy to draw. The teats should be evenly placed, squarely set on, and of a useful size for milking.

The milk veins should be large, prominent, and branched.

3. **General Indications of Suitability for Dairy Purposes.**—"Touch," which is best judged by taking hold of a portion of the skin and flesh behind the last rib, should be 'mellow," the skin loose and rather thin, and of a slightly oily nature, and the hair soft and velvety. Ears which are fine, well fringed with hair, and of a deep yellow colour inside, are, in the case of the Channel Islands breeds, usually regarded as certain indications of good quality and colour of milk and of butter. The horns should show no coarseness, and the head should be spare about the jaw and generally present an alert but placid appearance. Points indicating quality and colour of milk are much more apparent in Channel Islands cattle than in other breeds. As regards constitution, a deep chest gives plenty of room for lung development, whilst wide and open nostrils commonly show good lung capacity. The ribs immediately behind the shoulder, if round and deep, make a big heart girth, whilst ribs wide apart give the cow the appearance of strength and solidity. Generally speaking, a good cow possesses a loosely-knit frame.

The size, shape and feel of the udder and the general appearance of a cow afford indications of her suitability for dairy purposes, but the most important qualification of a dairy cow—*i.e.*, her probable milk yield—cannot be ascertained with any degree of accuracy by inspection alone. The only reliable guide for this purpose is an authenticated record of the amount of milk which she has yielded during a past year or years.

Reference to the importance of keeping records of milk yields will be found in the last two paragraphs of this leaflet.

MILKING.—Much has been said and written on the subject of a pure milk supply, the chief responsibility for which rests with the owners of cows. It is the duty of those engaged in the production and sale of milk to see that all cows are in good health, and fed in such a manner as to produce wholesome milk. It is essential that the milk from any cow which is not in perfect health should not be mixed with the general supply of the herd. The milk from any cow continually ailing should not even be given to pigs or poultry unless previously boiled, as there is always danger of the transmission of disease. In every herd of cows there are animals which will suffer from ailments of a temporary character. Such cases should be given immediate attention, and their milk for the time should not be mixed with the rest.

Cleanliness.—Cleanliness is one of the most important items in connection with all dairy work, and no amount of skill in the dairy will counteract ill-treatment of cows and lack of cleanliness in milking. Every cow should be kept well groomed, and the udder and off flank especially carefully rubbed over with a rough damp cloth before milking is commenced. Milkers should wear clean garments and wash their hands with soap and hot water prior to commencing operations.

Cows frequently get very dirty in the byres owing to lack of stall partitions and the bad construction of the standings. The latter are commonly too long, and the mangers are placed too high, so that when the cows lie down, they have to draw back and lie in their manure. The cure for this is to have proper stalls for not more than two cows, to place the mangers on the ground and shorten the standings to the length of the cows, putting a gutter of moderate depth behind them. The animals will then lie down with their heads over the mangers, and the manure will drop into the gutter. The expense of making these alterations is not necessarily great, and the saving of labour in the lessened cleaning the cows require, to say nothing of the improved condition of the milk, will soon repay the outlay. The grooming of the cows will be reduced to a minimum, and the udder and flanks will not have to be washed so frequently, since these parts should be nearly as clean as the rest of the animal.

Method of Milking.—The use of any organ of the animal body undoubtedly promotes its development, and this particularly applies to the udder, for the process of milking, if carried out thoroughly, increases the milking capacity. To secure the greatest development of the udder, it is necessary that the milking should be carried out very completely, and no milk should be left behind at the end of each operation. There are two special reasons for withdrawing all the milk that can be obtained from the udder: firstly, to develop and increase the milking powers; secondly, to obtain the richest portions yielded during the whole of the milking, namely, the "strippings," which contain from 8 to 10 per cent. of fat, while milk of average quality contains only 3·7 per cent. of fat. Failure to withdraw all the milk from the udder at the time of milking is the commonest cause of cows drying off too soon.

The question as to which teats should be milked together is a debateable one. A good delivery of the milk to the pail may be got by grasping a near fore and an off hind teat, and then reversing the order. In the majority of cows, however, the hind teats yield the most milk, and, if one hand is being used to milk a fore and the other a hind teat, the operation is not usually completed simultaneously. By taking, say, the two fore teats, and then the two hind teats, a more equal flow of milk is obtained, and this is, on the whole, the best method of milking.

Hard Milkers.—Cases are sometimes met with in which cows are very difficult to milk, being termed "hard milkers." Cows are frequently so at their first calving, but usually improve with milking or suckling a calf. Occasionally cows may have become difficult to milk owing to the milker having for a lengthened period adopted a severe method of milking, such as the streak method, the result being that persons accustomed to the more gentle procedure would find difficulty in milking such animals.

Wet or Dry Milking.—Milking is performed with either wet or dry hands. In the former case the hands are commonly moistened by drawing on to them a few streams of milk, but, as shown in Leaflet No. 151 (*Cleanliness in the Dairy*), this method is objectionable in practice and should not be adopted. The dry method is the more cleanly, and if the hands are washed before milking, moistening with milk will not be necessary. In cases where the teats have become tender the use of vaseline is recommended.

Essentials of Good Milking.—The essentials of good milking are that it should be performed, (1) Quietly: that is to say, the milk should be withdrawn in a manner that will cause no discomfort to the cow; (2) Quickly: if performed quickly more milk is obtained, for rapid milking appears to be beneficial in increasing the flow. A comparison of the results obtained by good and inferior milkers makes this point very clear. A good milker is able to milk from seven to ten cows in an hour, the common indication of good milking being the production of plenty of froth or "head" upon the milk in the pail. (3) Thoroughly : the last milk, being the richest, should always be withdrawn.

In the milkers' contest held at the London Dairy Show, in which no competitor is allowed to milk his own or his employer's cows, the following are the points upon which competitors are judged :—(1) Manner of approaching the animal, and style of work, 20 points; (2) Cleanliness, 10 points ; (3) Clean stripping, 10 points ; Total, 40 points.

Most cows get accustomed to the milking process, and expect it to be carried out at certain fixed times, but much depends upon the milker. Roughness on the part of the milker should not be tolerated. Women are on the whole better milkers than men.

Times of Milking.—The common practice is to milk twice in twenty-four hours, and the more equally the time is divided the more uniform will be the quality of the milk produced. For example, if milking takes place at six o'clock in the morning, the next milking time should be as near six in the afternoon as possible. This is easily recommended, but it must be admitted that it is often difficult to carry out in practice, especially in the case of those farmers who supply warm milk for consumption in towns. The demand in towns is for milk to be delivered before breakfast, and again in time for tea, and this usually means starting milking at from 4 to 6 o'clock in the morning, and again at 2 p.m. This results in intervals of about fifteen hours and nine hours respectively, and as a consequence it frequently happens that the milk yielded at the morning milking is inferior in quality to the evening milk. Perhaps on most farms, however, where milk is sent away by train, milking in the afternoon could be conveniently postponed to 4 or 5, thus giving a more equal division of the time.

Cows like to be fed and milked at regular times. If milking is delayed they frequently become uneasy, and the irregularity may cause considerable diminution of the amount of milk obtained. Cows which are left too long without milking get very distended udders, and may suffer considerable pain. Very heavy milkers have sometimes to be milked three times instead of twice a day, to relieve the pressure on the udder. Over-stocking, or allowing the udder to become unduly distended with milk by failing to milk a cow before sending her to market, is not only a common but a cruel and dangerous practice. It may lead to inflammation of the udder, and often results in the loss of one or more quarters, while it may prove fatal to the cow.

Kicking during Milking.—When heifers are badly trained or ill-treated they may develop the habit of kicking during milking time. When they first calve heifers are often very sensitive when being milked, and unless they are kindly treated, may subsequently prove a great nuisance. Kind treatment in the early days is likely to prevent kicking, but some cows can only be milked when an appliance is used to prevent them from kicking. Two methods commonly employed are strapping the legs together with a heavy strap, or strapping one leg to the stall, but neither should be employed unless absolutely necessary.

GENERAL.—Drying Off.—Some cows continue in milk from the birth of one calf until the next is due, but though the continuous production of milk is valuable to the dairyman, the cow, unless allowed some period of rest between each calf, suffers very considerably from the strain : poorer calves are likely to be produced, and the milking powers may be impaired. Whilst the majority of cows do not milk for more than nine months at a time, many good dairy cows only dry off for a month or so previous to calving. It is desirable that a resting period of six or eight weeks should be allowed to each cow before calving. Drying off can be effected by milking less frequently, milking once every other day, then every third day, or even less frequently than this, according to the condition of the udder, until so little milk is secreted that it is unnecessary to withdraw it.

Importance of Milk Records and Milk Testing.—It is desirable that those who are anxious to improve their dairy stock by weeding out unprofitable milkers should weigh the milk of each cow morning and evening, and note the yield in a book specially kept for the purpose. Or, if this cannot be done, each cow's milk should be weighed morning and evening on the same day every week and the weight multiplied by seven at the end of the milking period. This would give the approximate total. The daily record, however, is to be preferred. In conjunction with the record of the weight of milk yielded by each cow, at least an occasional test for the amount of butter-fat present should be made.* It is further highly desirable that the cost of the feeding ration be known. The usefulness of records, showing both the quantity and quality of milk of individual cows yielded per annum, and its cost of production, cannot be overestimated. The value of the increased milk yield of the herd year after year, consequent on the judicious weeding out of inferior animals and the economies which may be effected as a result of knowing the cost of milk production, well repay the small additional expense of the work entailed in keeping such records.

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* *See* Leaflet No. 146 (*The Value of Records of the Milk Yield of Cows*).

With a view to encouraging the keeping of authenticated records under supervision, the Board of Agriculture make grants to Milk Recording Societies which are formed and operate under prescribed Regulations, and they publish annually a Register of Dairy Cows whose yields have been certified under their scheme to have amounted to 8,000 lb. or over during a year, or to have averaged 6,500 lb. over two consecutive years. Full particulars of the Board's Milk Recording Scheme are given in Form L4, copies of which can be obtained free of charge on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W.1.

London, S.W.1,
September, 1907.

Revised, November, 1918.

The following leaflets on Dairying have also been issued :—

146. The Value of Records of the Milk Yield of Cows.
151. Cleanliness in the Dairy.
192. Farm Butter-making.
231. Cheese-making for Small Holders.
235. Organisation of the Milk Supply.
241. The Construction of Cow Houses.
266. Ropy Milk.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

Fumigation with Hydrocyanic Acid Gas.

Although fumigation with hydrocyanic acid gas when carried out by a careless operator is admittedly somewhat dangerous, yet if reasonable precautions are taken all risks can be practically eliminated, and the value of the gas as an insecticide in certain cases is so great that it is worth the trouble and care which are involved.

The following notes indicate the general methods which are employed, but within the scope of a leaflet it is impossible to enter into every detail, and those who make use of the treatment must, to some extent, adapt it to their own particular requirements.

Nature and Uses of Hydrocyanic Acid Gas.—Hydrocyanic acid gas is a colourless, highly poisonous gas and is sometimes known as prussic acid gas. It is exceedingly deadly to most forms of animal life, notably to insects, and in certain circumstances to plants as well. Plants, however, under favourable conditions are able to withstand doses which would be fatal to insects, and it is therefore possible so to arrange the quantities of gas used that the insect pests are killed while the plants remain unhurt.

Since hydrocyanic acid at normal temperature is a gas, it must be used in a closed space, and in this country the treatment is almost confined to glass houses. In America and elsewhere trees (chiefly *Citrus*) growing in the open are fumigated after covering them with a portable tent, but this form of treatment is hardly likely to be of service in the British Isles.

Hydrocyanic acid gas is also used in granaries for dealing with the pests of stored grain.

The chief pests in this country against which the gas is usually employed are those which cannot easily be dealt with by any other form of treatment. Such pests are the Greenhouse White Fly (*Aleurodes vaporariorum*), Mealy Bugs (*Dactylopius* sp.) and other Scale insects which infest greenhouse plants, though of course it would be equally satisfactory in the case of Thrips or Aphides, which are more often controlled by a nicotine fumigant. Hydrocyanic acid gas should also be used for cleaning large parcels of nursery stock from such pests as the Woolly Aphis and Scale Insects. If persons receiving woody plants from foreign countries were to fumigate their stock on arrival, the risk of introducing dangerous foreign pests into this country would be much reduced.

Materials needed.—When sodium cyanide is treated with an acid, such as sulphuric acid, hydrocyanic acid gas is produced, and this reaction is usually employed for fumigating plants. Potassium cyanide was formerly used, but has now been replaced by sodium cyanide. The sodium cyanide should be of the quality known as "130 per cent.," and the sulphuric acid of a specific gravity of not less than 1·83. The former may be obtained ready weighed out from horticultural chemists. Pure sulphuric acid is better than commercial acid for delicate plants, and in the case of the most delicate plants the use of phosphoric acid* (66 per cent. of a specific gravity of 1·5 or over) has been advised. In addition to the above chemicals, water, a glass ounce measure such as is used for photography, and one or more earthenware jars, in accordance with the size of the house, are required.

The proportions in which the materials are used are as follows:—For every 1 oz. of sodium cyanide, 2 oz. of sulphuric acid and 8 oz. of water should be allowed, or if phosphoric acid be used, 1 oz. of this acid and 4 oz. of water. In a small house one jar will be sufficient, but in larger houses it is preferable to use several jars in order to distribute the gas more evenly. One jar may then be allowed to every 6,000–8,000 cubic feet of space in the house.

Doses required.†—It is impossible to give the maximum dose which every kind of greenhouse plant will bear without injury, but the following suggestions may be taken as a rough guide :—

Nature of Plant.	Amount of materials for each 1,000 cubic feet of space.		
	Sodium Cyanide.	*Sulphuric Acid.*	*Water.*
Dormant vines and other fruit trees when dormant.	2 oz.	4 oz.	16 oz.
Palms	$\frac{1}{4}$–$\frac{1}{2}$ oz.	$\frac{1}{2}$–1 oz.	2–4 oz.
Tomatoes	$\frac{1}{8}$–$\frac{1}{4}$ oz.	$\frac{1}{4}$–$\frac{1}{2}$ oz.	1–2 oz.
Delicate plants generally	$\frac{1}{8}$ oz.	$\frac{1}{4}$ oz.	1 oz.

The nature of the pest by which the plant may be attacked is not indicated in the above table as naturally it is not practicable to use a stronger dose than the plants will stand. Mealy Bugs on vines and White Fly on tomatoes will, however, be killed by the doses suggested above. Insects which are easily killed, such as Aphides, will succumb to as small a dose as $\frac{1}{8}$ oz. of sodium cyanide to every 1,000 cubic feet.

Insect eggs and some pupæ are resistant to hydrocyanic acid gas and it may be necessary to fumigate two or three times if the pest reappears, in order to eradicate it.

In cases of doubt—as, for instance, in mixed houses—it is wiser to begin with a very small dose and regulate subsequent treatment in accordance with the effects.

Method of Fumigating.—The plants in the house to be fumigated should be rather dry and the temperature not above 60° or below 40° F. The house should be rendered as air-tight as possible by making sure that the lights close properly, and further, arrangement should be made for opening the lights from the outside. Fumigation should not

* Sargent, Edwards, *Gardener's Chronicle*, LVI., p. 65.

† Much information on this subject may be obtained from the paper in the *Gardener's Chronicle* mentioned above, and from Bull. 513 of the U.S. Dept. of Agriculture.

be started until after dark. The method is as follows :—The bowls with the proper amount of water in them are distributed at intervals on the floor of the house. The measured quantity of sulphuric acid is then poured into each. The acid *must always* be poured into the water and *not* the water into the acid. The weighed quantities of cyanide are then dropped into the bowls, and it is best to arrange a simple apparatus so that the cyanide can be dropped into the acid from outside the house by releasing a string. In no circumstances should the operator remain in the house after the cyanide is in the acid. The door should be tightly closed and, if possible, locked ; and every precaution must be taken to see that no one enters while fumigation is in progress. Fumigation may be allowed to continue for two hours or, especially in the case of very weak doses, until the following morning. The house must in any case be opened up and ventilated before sunrise. It is of course most important that no one should enter the house until it has been well aired. In the case of very delicate plants it is best, when possible, to keep the house somewhat shaded during the day after fumigation. Damage to foliage most frequently occurs when the atmosphere or plants in a house are too damp. Strong sunlight the day after the work is carried out is then specially liable to cause scorching. In order to make sure that the gas is distributed evenly throughout the house the use of fans (or " punkahs ") worked from outside by means of a string is sometimes advised.

Precautions.—(1) Sodium cyanide is a deadly poison and must not be left about, but should be kept under lock and key.

(2) Hydrocyanic acid gas must not in any circumstances be breathed.

(3) The acid must be poured into the water and not the water into the acid.

(4) The materials must be accurately weighed or measured.

(5) Fumigation must not be carried out in daylight or in houses where the atmosphere or plants are moist.

(6) In the case of plants in leaf it is better to fumigate two or three times using a small dose rather than to attempt to kill all the pests by one strong dose.

Calculation of Cubic Contents of a House.—For an ordinary " lean-to " house (Fig. 1) add the height to eaves (AB) in feet to the height to ridge (CD) in feet and divide by 2. Multiply this result by the width of the house (BD) in feet, and then multiply this result by the length of the house in feet. In the example (Fig. 1) AB (= 5 feet) added to CD (= 12 feet) amounts to 17 feet. Half of this is $8\frac{1}{2}$ feet. The width of the house BD (= 15 feet) multiplied by this result ($15 \times 8\frac{1}{2}$) comes to $127\frac{1}{2}$ feet. Supposing the house is 100 feet long, the cubic contents would be $127\frac{1}{2} \times 100$, amounting to 12,750 cubic feet.

Exactly the same process applies to an " even-span " house (Fig. 2), the height to the eaves in feet (5 in the example figured) added to height to ridge in feet (10) amounts to 15

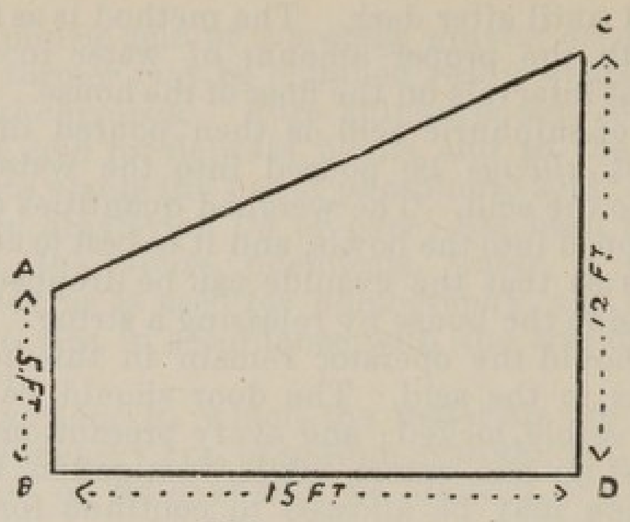

FIG. 1.

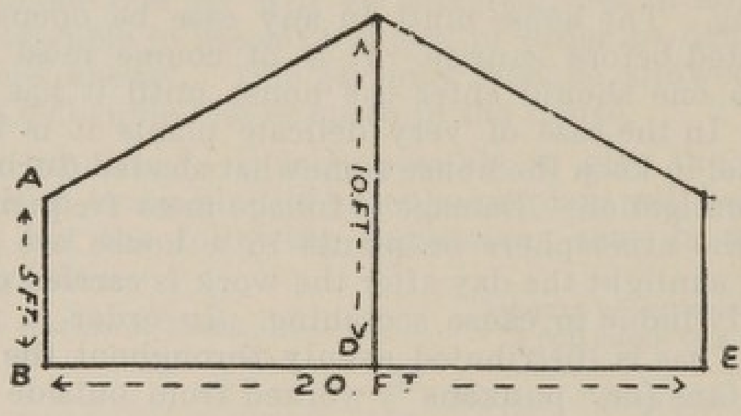

FIG. 2.

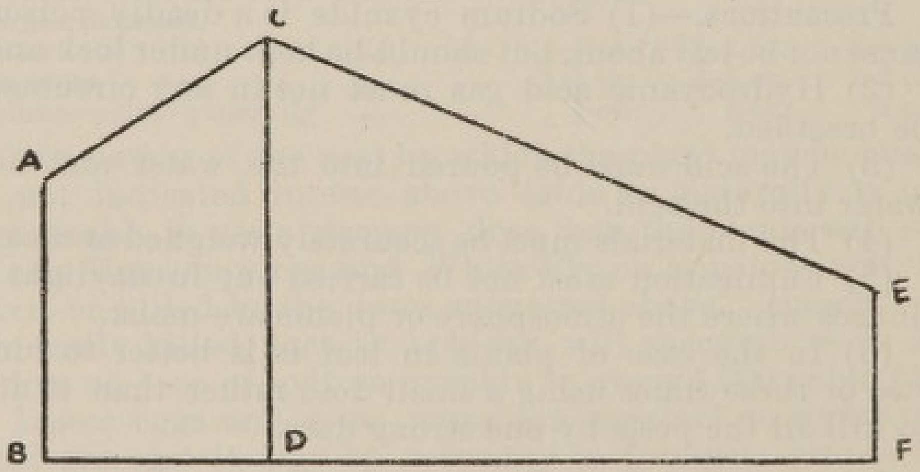

FIG. 3.

feet. Half this is $7\frac{1}{2}$ feet. This result multiplied by the *whole* width of the house (20 feet) amounts to $20 \times 7\frac{1}{2} = 150$. Again supposing the house to be 100 feet long the cubic contents would be 150 multiplied by 100, amounting to 15,000 cubic feet.

In a "three-quarter span" house (Fig. 3) each span is calculated separately as for a "lean-to" and the results added together.

London, S.W.1,
January, 1908.
Re-written, June, 1918.

BOARD OF AGRICULTURE AND FISHERIES.

Insurance of Farming Stock against Fire.

Among the various risks to which the crops, produce, and live stock of the farm are exposed, that of destruction by fire is not the least, but it is fortunately one of the few risks against which farmers are able to protect themselves by insurance.

The advantages of fire insurance are well-known and generally recognised, and no farmer should be deterred, by the small annual expenditure involved, from securing himself against loss from this cause.

The terms and conditions on which fire insurances in *England and Wales* are effected by all the principal insurance companies are practically identical, having been settled by a committee representative of about fifty of the leading companies in this country. As some of these conditions, which are of importance to the insured, are not perhaps always understood, the Board believe it will be useful to summarize some of the principal points.

The loss or damage to property caused by its own spontaneous fermentation or heating is not covered by a fire policy.

Special Condition of Average.

Agricultural Produce.—In policies of insurance effected on agricultural produce, including growing crops, fruit, wool, cider, cheese, together with manures, artificial and other food for cattle, a special condition of "average," is generally inserted in the following terms :—

"When a sum insured is declared to be subject to the special condition of average, then if such sum shall at the breaking out of a fire be less than three-fourths of the value of the property insured in that amount, then the insured shall be considered as being his own insurer for the difference between the sum insured and the full value of the property insured at the time of the fire, and shall bear a rateable share of the loss accordingly.'

The effect of this condition is as follows :—Suppose the sum insured be £300, and the value of all the agricultural produce insured over the entire farm (together with any other property insured with the agricultural produce in one amount) at the time of the fire to be not more than £400, the clause will not take effect, the sum insured being equal to three-fourths of the full value of the property, and the whole amount of loss up to £300 will be paid; but if the sum insured be £300 as before, and the value £600, the "average" condition will come into operation, the sum insured being less than three-fourths of the value of all the property on which such sum is insured, and the office would therefore only pay one-half the amount of loss, whether that half be £300 or any smaller sum, the insured being his own insurer for the difference and bearing a rateable share of the loss accordingly.

Implements, &c.—In many policies "implements and utensils of husbandry and dead farming stock" are included in one sum with "agricultural produce," and the special "average" clause then applies to the whole amount. They can be insured separately if desired, in which case the "average" clause does not apply to them.

Growing Crops.—In the absence of any provision to the contrary in the policy, agricultural produce also includes growing crops, and insurers should be careful to bear this in mind, as in a recent case of the destruction by fire of hay and straw in the stack it was claimed by the company, and decided in their favour, that the insurance included growing crops, and that, consequently, under the operation of the special "average" condition it was necessary, in order to obtain payment to the full value insured, that these crops, together with the whole of the other produce, should have been insured to at least three-fourths of their value.

Property not included in Policies on Agricultural Produce.—Policies on agricultural produce are usually expressly stated not to include :—

1. Hops and grain in any oast or kiln, while fire-heat is being used therein, or in any building adjoining any such oast or kiln, and not separated therefrom by a perfect stone or brick wall ; nor barley under process of malting.

2. The contents of any building in which hemp or flax is scutched or dressed, or in which screening of grain by power is done, or in which timber is sawn by machinery, nor the contents of any building adjoining another building, and not separated therefrom by a perfect party-wall of brick or stone, in which any of such processes may be performed.

3. Tanks and vessels (with the material contained therein) for dipping hop-poles, nor farming property within fifty yards of any such tanks or vessels, or within fifty yards of any line of railway, and the value of this property therefore need not be taken into consideration.

All or any of these properties may be insured, if desired, under separate items, and at special rates.

It is desirable to consult the insurance company before introducing any steam boiler, gas or oil engine, with a view of obtaining the benefit of their advice as to the best means of minimising the fire risk.

Farmers, therefore, in order to obtain the full benefit of a policy of insurance as regards agricultural produce against risk of fire throughout the year, must insure for not less than three-fourths of the full value of the agricultural produce, immediately after harvest, which may be assumed to be the period when the property on the farm is at its maximum value. *The point to be borne in mind is* that if, on the occurrence of a fire, the sum assured on the whole of the property under the heading of "agricultural produce" is less than three-fourths of its value, then the company will not be liable to pay the full amount of the loss, even though it be less than the amount insured, but only a rateable proportion, as explained above.

Rates of Insurance.

Agricultural Produce.—The insurance of agricultural produce (including growing crops, implements, &c., which are allowed to be insured in one amount), is usually undertaken, subject to the special condition of average, at a minimum charge of 7*s.* 6*d.* per cent. per annum, or for any shorter period.

Roots.—Roots not stored in buildings may be insured under a separate item at a minimum rate of 2*s.* 6*d.* per cent. per annum, or any shorter period, subject to the special condition of "average." If not separately insured the ordinary minimum rate of 7*s.* 6*d.* applies.

Proximity to a Railway.—Some companies require agricultural produce, including growing crops, within fifty or 100 yards of a railway line to be separately insured at a higher rate.

Under the Railway Fires Act, 1905, railway companies are responsible for fire damage they may cause to pasturage land or agricultural crops, which are not led or stacked, also for damage to fencing. Claims under the Act are limited to £100. Where negligence on their part can be shewn, railway companies are responsible in the case of any kind of property for damage which may be caused by them.

Wool.—Wool is included with other agricultural produce, but it may also be insured separately in farm buildings for a year or for any shorter period, usually at a rate of 3*s.* per cent., subject to the above-stated special condition of average.

Hops.—Hops not undergoing any process of drying are included in the item "agricultural produce," but hops in farm buildings (including hop oasts and stowages communicating therewith, provided that no fire be lighted therein during the currency of the policy) may also be insured for any period not exceeding three months at a rate of usually about 2*s.* 6*d* per cent. Provided such insurance be limited to any specified single building, the policy may be granted without any "average" condition. Hops in oasts and stowages communicating therewith, whilst undergoing any process of drying, may be separately insured at rates varying from 4*s.* to 7*s.* 6*d.* per cent. per annum, or for any shorter period, according to the construction of the buildings and the method of drying employed.

Other Items Separately Insured.—Insurances are also granted on roots not stored in buildings; on growing crops, by separate items; on agricultural produce in any specified single building or range of buildings directly communicating; and on any specified stack, in each case without the "average" clause being applied.

Implements and Utensils of Husbandry.

Some companies expressly exclude machines worked by steam, gas, oil, electric, water, or wind power, unless the same be specially mentioned as insured. Farmers possessing machinery worked by power are advised, therefore, to insure it as a separate and distinct item. N.B.—The use of a steam threshing machine is allowed without extra charge.

Live Stock.

In the case of the insurance of animals on the farm against fire or lightning, the policies of the leading companies provide that if live stock is insured in one item, then in case of loss no animal is to be deemed of greater value than £40; if horses or cattle are respectively insured in items by themselves, then the limit of value payable in case of loss on each horse, or on each head of cattle so insured, may be raised to £100, but in that case horses and cattle so insured must be excluded from the general insurance on live stock.

If it is desired to insure any horse, bull, ox, or cow for more than £100, or any other animal for more than £40, such horse, bull, ox, cow, or other animal must be specifically described and insured by itself for a stated sum.

Live stock insurance is not subject to "average," that is to say, the farmer can insure his stock for any amount, and not necessarily the full value or any fixed proportion thereof. The insurance covers deaths by lightning. The rate is usually 3*s.* per cent. per annum or for any shorter period. It is desirable to telegraph to the insurance company in the event of loss by lightning.

Policies on farm live stock may be extended to cover, without "average," live stock whilst grazing on any land which is not included in the specified farm, or in any other farm in the insured's occupation.

An insurance applying to a farm may be extended to cover agricultural produce, farming stock, live stock, implements and-or utensils in transit on any road within twenty miles of the insured's farm without being made subject to any condition of "average" other than that, if any, which would be applicable to such property if covered whilst on the farm only.

Where rates are mentioned in this leaflet they are minimum rates.

N.B.—In *Scotland* the practice differs from that in England and Wales in the following respects :—

(1.) *Growing Crops* (p. 2).—In every policy covering agricultural produce in Scotland a clause is inserted stating whether roots not stored in buildings, and growing crops are, or are not, included in the term "agricultural produce."

(2.) *Rates of Insurance on Agricultural Produce* (p. 3).—In Scotland the minimum charge is 10*s*. per cent. per annum, or for any shorter period.

(3). *Wool* may in Scotland be included with other agricultural produce, but it may also be insured separately as follows :—(*a*) If the insurance be limited to one specified building subject to the special condition of "average" mentioned above. (*b*) If the insurance extends to two or more buildings, subject to the *pro rata* or ordinary condition of "average" given below. In each case the minimum rate is 5*s*. per cent. per annum, or for any shorter period.

(4.) *Stock* (*other than Wool*) is subject to the special condition of average whether covered in single specified buildings or under insurances extending over two or more buildings or places on the farm.

Ordinary Condition of Average.—The *pro rata* or ordinary condition of average is in the following terms :—"Whenever a sum is declared to be subject to 'average,' if the property covered thereby at the breaking out of any fire be collectively of greater value than such sum insured, then the insured shall be considered his own insurer for the difference, and shall bear a rateable share of the loss accordingly." For example : If property insured subject to "average" is insured for £500, but at the date of a fire is worth double that amount, the insurer will only be able to recover one-half of the damage, whatever be the amount of such damage.

London, S.W.1,

January, 1907.

Revised, July, 1912.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1 Letters of application so addressed need not be stamped.

Leaflet No. 190.

BOARD OF AGRICULTURE AND FISHERIES.

Dogs Act, 1906.

(6 Edw. 7, Ch. 32.)

This Leaflet has been withdrawn.

BOARD OF AGRICULTURE AND FISHERIES.

Cross-Breeding for Mutton in the North of England.

South of England buyers often visit the great autumn sheep auctions of the North, in order to purchase cross-bred lambs and draft cross-bred ewes. Some information as to the manner in which these cross-bred sheep are produced may, therefore, be of value to farmers and others who are interested in the production of first-class mutton.

The greater part of the mutton produced in the four northern counties of England is cross-bred, and the same may be said of that fed in the South of Scotland. The chief reasons for the method of breeding prevailing in these districts are to be found in the mountainous character of the country, the long and often severe winters, and the special suitability of the climate for turnip-growing.

Mountain Breeds.

All the crosses met with in the North of England have their foundation in the mountain breeds : the Cheviot, on the low and verdant Border hills ; the Black-faced mountain sheep (Scotch Black-face), on the higher hills of Scotland, and on the Pennine chain and its spurs running into Northumberland, Cumberland, Durham, and Westmorland ; the Herdwick, on the poor mountain land of Cumberland and Westmorland ; and the Limestone fell sheep of Westmorland.

Of these the Herdwick is the hardiest—possibly the hardiest sheep in existence—and able to get its living throughout the winter on the scanty herbage of the fells, so long as the ground is not covered with frozen snow. Closely following the Herdwick for hardiness are the Black-faced mountain and the Limestone sheep. Without these sheep very little fell farming would be possible, and there would be no means of profitably turning to account the mountain herbage in these districts. But they are small sheep, coarse in the wool, slow in maturing, and too wandering in habit to settle down quietly to feed in small fields and folds ; consequently, as distinct breeds, they are not profitable for stocking tillage farms, which are comparatively highly rented, and on which the production of rapidly-maturing lamb and mutton is aimed at and quick returns are expected. On the other hand, all three breeds are renowned for the large proportion of lean meat in the carcass, and for the sweet and fine-grained quality of their flesh.

The Cheviot has a fleece of fine quality, and is a much tamer sheep than those just described. It is very compactly made, and yields mutton of the highest quality. Of the pure mountain breeds it is certainly the best adapted for fattening on the lowland farms, though it is small in size.

First Crosses.

When these mountain sheep are crossed with any of the large-sized quick-growing breeds, they produce lambs of excellent quality, quickly maturing, and very profitable, either for the butcher or for breeding from as cross-bred ewes.

Border-Leicester—Cheviot cross.—For the first cross the Border-Leicester ram is the one most in favour for use on these mountain ewes in Scotland and the North of England. Like all sheep of the long-woolled breeds—Border-Leicester, Leicester, Lincoln, and Cotswold—it carries far too great a proportion of fat in its carcass; but it is a large, early-maturing sheep, with excellent fleece, and begets good-backed lambs that both grow and fatten rapidly. It has also the important recommendation of having a narrow head, which is inherited by the lambs, and so the difficulty to the small mountain ewes of lambing large lambs is not materially increased by its use as a sire. Where rams of the Down breeds are used, lambing difficulties and losses may occur, owing to the large heads of the lambs.

South country farmers frequently raise the objection to the Border-Leicester—Cheviot cross that the flesh is "sappy" and does not keep well, but this is probably through associating this half-bred white-faced sheep with the pure Leicester and other white-faced breeds that carry so much fat. As a matter of fact the Cheviot so satisfactorily corrects the inferior quality of the flesh of the Border-Leicester as to make the cross one of the best mutton carcasses.

The ewes of this cross are handsome, compact sheep, of good size, with fleeces of the best quality: they inherit the good milking qualities of the Cheviot, are free yeaners—generally bringing twin lambs if in good condition at tupping time—and easily fatten while suckling a pair of lambs. Very large numbers of half-bred lambs and draft ewes of this cross are sold annually at the autumn store sheep sales of Scotland, a large proportion of them coming across the Border, the lambs for winter fattening and the ewes for early lamb-breeding.

Border-Leicester—Black-face cross.—The Border-Leicester—Black-face cross prevails in the adjacent districts of

Cumberland and Westmorland, of which the market town of Penrith is the centre. Some thousands of these "Grey-faced" lambs and draft ewes, as they are locally named, are sold in the Penrith Auction Mart every autumn. These sheep are not so compact in make as the half-bred white-face just described, nor do they carry wool of such good quality ; but for good feeding qualities and high-class mutton, with plenty of lean, they would be difficult to beat. The ewes have the excellent milking qualities of the Black-face, and mostly drop couples. Early lambs of this cross, having a little colour in their faces, take the market well.

Border-Leicester—Herdwick cross.—For high-lying tillage farms, the Border-Leicester—Herdwick cross sheep are excellent ; their mutton is of the very best, they are hardy and good sized and thrive well, but the ewes are not so prolific as those of the other two crosses, while the fleece is coarser.

Wensleydale—Black-face cross.—A very favourite first cross along the adjacent Westmorland and Yorkshire borders is that of the Wensleydale—Black-face. Sheep of this cross also go by the name of "Grey-faced." The lambs are rapid growers, and the mutton is of high repute, but they fatten more easily when nearly full-grown than as young lambs ; they are therefore better adapted for the mutton market than the lamb market. The Border-Leicester sire certainly scores over the Wensleydale as a producer of fat lambs ; but the latter has a special value as a sire for a second cross.

Second Crosses.

Coming now to the second cross, the Border-Leicester ram has not much advantage over the rams of other large breeds in the matter of begetting lambs that come easier to the birth ; for the first-cross ewes above described are large and roomy enough to give birth quite naturally to fairly large-headed and wide-shouldered lambs. Rams of the following breeds are used on these half-bred ewes :—Border-Leicester, Oxford Down, Wensleydale, Shropshire Down, Leicester, Lincoln, and Suffolk Down. The first-named was at first much more largely used than all the others put together ; but the Oxford Down, especially for white-faced cross ewes, is coming rapidly into favour, as may be gathered from the large and increasing numbers sent in recent years to the great ram sales of the North, at Kelso and elsewhere. The plump, dark-faced, close-coated lambs of this Oxford—Border-Leicester—Cheviot cross are great favourites with the butchers, and carry more lean than lambs produced by the use of the Border-Leicester ram a second time ; and even on the grey-faced ewes, except when fat lambs are required, the Wensleydale ram is to be preferred to the Border-Leicester.

In fact, the heaviest cross-bred sheep produced in Cumberland and Westmorland are those of the Wensleydale—Border-Leicester—Black-faced breed. For several years in succession at the Penrith Christmas Fat Stock Show the 1st prize pen of shearling wethers were thus bred. These sheep have averaged 230 lb. live weight, and have realised 84*s*. each.

A common practice on the higher arable lands of the Border district is to cross the half-bred ewe with a half-bred ram, bred on identical lines. Fattened during the winter, the lambs of this cross produce carcasses of solid lean mutton in much favour with the butcher.

At the Cumberland and Westmorland Farm School, the ewes used have been (1) Border-Leicester—Cheviot, (2) Border-Leicester—Black-face, and (3) Wensleydale—Black-face; and the rams Border-Leicester, Oxford Down, and Wensleydale. In the matter of fecundity, the average number of fat lambs actually marketed from the three classes of ewes for six years was 1·7 for each ewe, or about 34 lambs to every 20 ewes—the number born was, of course, higher than this. The ewes have always been in good condition when the rams have been put to them. Of the three kinds, the Border-Leicester—Cheviot have dropped the largest number of lambs, often more than were desired in the way of triplets; and the Wensleydale—Black-face the smallest number, though the difference has not been great. The lambing period has practically been the month of March.

Lambs from Border-Leicester—Cheviot ewes by an Oxford Down ram have been found to mature quickly. This allows the dams to be sold off fat earlier than the other ewes, thereby realizing better prices, and costing less to keep.

Lambs from similar ewes crossed by a Wensleydale ram showed a growing rather than a fattening tendency in the very early stages, so that they had to be kept longer before they were fat, and in consequence reached heavier weights.

For fat lambs a Border-Leicester ram is generally preferable to a Wensleydale, while for rapidly-growing stores the Wensleydale is to be preferred; and there will be more lean flesh in those sired by the latter. Lambs from Border-Leicester—Black-face ewes by a Border-Leicester tup have, in certain cases, done remarkably well.

During the past two seasons two other cross-bred ewes have been used with the Oxford Down ram, viz., the Lonk-Wensleydale, obtained from the York and Lancashire Border; and Herdwick—Border-Leicester, from Mid-Cumberland. The former, though fine-looking sheep, proved inferior milkers, and consequently poor nurses for early fat lambs. The latter milked well and supplied the market with particularly good-looking and well-conditioned lambs.

General.

It will be observed that rams of two of the most early-maturing English breeds of sheep have been omitted from the above list, viz., the Hampshire Down and Cotswold. The former has been tried, but is said not to do well in the North, one of the objections being the closeness of the fleece, which is believed to hold the wet too long for the rainy climate of Cumberland and Westmorland. Its high percentage of lean flesh would be a valuable contribution to the qualities of lambs from Leicester cross ewes. The Cotswold would not in the same way improve the quality of the flesh.

The pure breeds of sheep kept in the four northern counties of England and the Border counties of Scotland are the mountain breeds named above, together with Border-Leicesters, and a few excellent flocks of Oxford Downs, and Wensleydales for the production of rams.

Draft Ewes.—The breeders of mountain sheep generally sell their draft ewes to the lowland farmer after three lambings to be mated in good time with a Border-Leicester ram for the fourth lambing. These ewes are then sold fat off good pasture as soon after the lambs are sold or weaned as their condition will allow. The earliest of these first-cross lambs may be sold as fat lambs, and the remainder may be fattened off on turnips as prime hogg (teg) mutton, or wintered well on grass and fattened later for the following summer's mutton market. But the best of the cross-bred ewe lambs are reared for breeding purposes. The wether lambs of the pure mountain breeds are allowed to take their time to grow and fatten on their native fells and do not come into the mutton market except as shearlings or two-shear sheep. A Herdwick two-shear fat wether is by some considered to be the acme of mutton production for quality and flavour.

The system of cross-breeding described in this leaflet may perhaps be found worthy of more extensive application by breeders in other parts of the country, especially in the mountainous and upland districts of England and Wales.

London, S.W.1,

February, 1907.

Revised, September, 1909.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 192.

BOARD OF AGRICULTURE AND FISHERIES.

Farm Butter-making.

In the following pages it is proposed to consider when and how butter should be made on the farm.

It is generally agreed that under present conditions it is not advisable to make butter, as margarine provides an almost perfect substitute. Milk should in all possible circumstances be made into cheese or despatched to towns for direct consumption. There are, however, cases in which other methods of utilising milk cannot readily be adopted, as, for instance, where the rearing of calves on farms very remote from a railway station or market is largely practised, or where cheese-making facilities do not exist. Under certain other conditions it may be advisable to make butter, especially in districts where difficulty is at present experienced in obtaining either butter or margarine through ordinary trade channels.

In such circumstances butter-making may give quite satisfactory results, provided that cattle of the right type are secured and properly managed, that the land, water-supply and buildings are suitable, that the separated milk can be profitably utilised either for stock feeding or for commercial purposes, and above all that really good and absolutely uniform butter is produced so that a steady demand at relatively high prices can be secured.

Although the profits on butter-making are probably better now than in pre-war days, the financial results, even with butter exceeding a summer price of 2*s.* per lb., are not comparable with either cheese-making or milk-selling, and from a national standpoint butter should only be made regularly when it is found impossible to sell the milk for direct consumption or to make it into cheese which can be stored and used as a substitute for meat.

Quantity of Milk needed to produce 1 lb. of Butter.—The quantity of milk required to produce 1 lb. of butter not only varies considerably with the breed, but also largely depends on the individuality of the cow. It may be said, however, that it will usually lie within the following limits :—

Shorthorns, Lincoln Reds, Welsh, Red Polls, Ayrshires	One lb. of butter from 24 to 32 lb. of milk.
South Devons, Kerries, Dexters	One lb. of butter from 20 to 27 lb. of milk.
Jerseys, Guernseys	One lb. of butter from 16 to 24 lb. of milk.

The proportion of butter to milk is therefore highest in the Channel Islands breeds ; moreover, the fat globules in their milk are larger than in that of other breeds, and on this account the cream is more easily separated. It is therefore clear that under favourable climatic conditions the

Channel Islands cattle or their crosses* are the most suitable for farms on which butter-making is carried on. At the same time other questions, such as yield of milk, suitability of calves for rearing, and value of draft cows have to be taken into account, but even if these considerations render the use of the Channel Islands type of cattle inadvisable, it is sometimes found desirable to include a small number of them in a herd of Shorthorns or other breeds to improve the colour of the butter, and to increase the richness of the milk.

The Dairy.

Buildings.—There are advantages on the score of sanitation in having the dairy away from, rather than attached to, the house or homestead. In either case the building should comprise : (1) A cream-ripening room, where the temperature can be to some extent controlled ; (2) The dairy proper, where the churning is done : the best dairies have a northern aspect, double walls, and a cement or asphalt floor, and are provided with plenty of light and ventilation ; and (3) A scullery or covered yard where provision is made for hot and cold water.

Water Supply.—An ample supply of pure cold water is one of the most important factors in successful butter-making. Any contamination means disaster so far as the production of good keeping butter is concerned.†

Utensils.—The following list comprises those articles which are generally used in the dairy :—

A churn, size according to the amount of cream.
A butter worker.
A hair sieve.
Butter boards.
Two pairs of Scotch hands.
Butter scoop.
Floating thermometer.
Cream squeegee.
Light steel pails of 12 quart capacity.
One gauged pail.
Set of scales and weights.
Set of measures varying in size from 1 quart to ¼ pint capacity.
Straining cloths.
Butter muslin.
Grease-proof butter paper.
Dry salt.
Set of brushes.
Small railway milk churn for separated milk.

In the Cream-Ripening Room.

Enamelled cream pails.
Earthenware glazed crocks for cream ripening.
Shallow setting pans.
An acidimeter for ascertaining when cream is ripe and ready for churning.
Wall and floating thermometers.
Heating stove. Chip boxes.

In the Scullery.

Hand or power separator.
Steel milk pails.
Railway milk churns.
Milk strainer.
Hot and cold water supply.
Floor squeegee, mop and brushes.

Other appliances, which will be found most useful when any considerable quantity of milk has to be dealt with, are a cooler, having a cooling capacity of 120 gallons of milk per hour, which can be used for cooling both cream and separated milk ; a box refrigerator to harden the butter after making,

* *See also* Leaflet No. 187 (*Selection and Milking of Dairy Cattle*).
† *See* Leaflet No. 151 (*Cleanliness in the Dairy*).

and in which to store it till sold; a Gerber, Babcock, or other milk tester; and a dairy herd register for recording the yield of each cow by weight.* In practically all cases the most economical method for the removal of cream is the use of the hand or power separator.

Preparation of Utensils.—The churn, butter worker, Scotch hands, &c., should be prepared for use in the following manner:—(1) Scald with boiling water, ventilating the churn immediately it is set in motion, and scrub all utensils with a suitable brush; (2) Rinse with cold water and drain it off; (3) Rub the inside of the churn with salt, also the worker; (4) Rinse again with cold water, leaving some on the worker and some in the churn, until the cream is ready to be put in. Wrap a wet butter muslin round the roller of the worker and place another damp cloth over the butter board until ready for use. (5) Before working the butter on the worker drain off all superfluous water, as the worker should only be sufficiently damp to prevent the butter from sticking to it. In very hot weather it is sometimes advisable to prepare the utensils several hours before they are required in order that they may have time to cool.

Separation of Cream from Milk.—Butter fat in milk is in the form of small globules, the size of which, as already indicated, varies considerably according to breed and also to the period of lactation. The cream may be readily separated from the rest of the milk either by allowing the milk to stand, when the fat being lighter rises to the surface and may be skimmed off as cream, or by a mechanical separator in which advantage is taken of the same principle. A separator possesses many advantages over the old system of "setting" milk, among the chief of which are the following:—

(1.) More butter is obtained.
(2.) The separated milk is fresh and sweet.
(3.) Less accommodation and labour are required in the dairy.
(4.) The cream obtained is perfectly fresh and sweet, and if pasteurised can be easily controlled by the use of a starter as described later.
(5.) The thickness of the cream can be regulated.

These advantages far outweigh the initial cost of the machine and the labour involved in operating it. It is now generally admitted that where butter-making is carried on all the year round a separator is necessary if the most satisfactory results are to be obtained.

Butter can be produced by churning sour or sweet cream or whole milk; except in one or two localities, however, where the butter-milk is specially valued, whole milk is now seldom used for the purpose.

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* *See* Leaflet No. 146 (*The Value of Records of the Milk Yield of Cows*)

Cream Ripening and its Preparation for Churning.—Sweet cream butter is made from fresh cream. The churning of fresh cream, however, involves a greater loss of fat in the butter-milk than in the case of ripened cream, and fresh cream should not be used unless an increase in price proportional to the loss sustained can be commanded.

Cream ripening may be brought about in two ways:—(1) by natural means; (2) by the aid of "starters."

(1.) *Natural Ripening.*—The natural method is to allow the cream to stand for two, three or four days, according to the weather, in a pure atmosphere at a temperature of 56 to 66 deg. F. Two days in summer and three or four in winter will be sufficient as a rule. The finest butter cannot be produced from over-ripened cream, or from cream that in winter has been collected over too long a period. During ripening cream should be stirred several times a day and the receptacle containing it covered over with a muslin cloth, when souring or acidifying will take place naturally. The percentage of lactic acid present in the cream when ripe should be about 0·5 per cent., and the cream should be smooth and velvety, and possess a clean acid flavour.

If required, ripening may be promoted by adding butter-milk at the rate of about half a pint to each gallon of cream. Great care must be taken, however, that the butter-milk used comes only from a churning of really well-flavoured butter.

(2.) *Starters.*—So long as all goes well with "natural ripening" nothing further may be required. It not infrequently happens, however, that the butter produced from naturally-ripened cream is inferior in quality. In such cases it is advisable to pasteurize each lot of fresh cream by heating it to 150 deg. F., and to ripen by the aid of a *special ferment* or "starter." The method by which this "artificial" system of ripening is carried out is as follows:—

(*a*) The special ferment having been procured from a Dairy Institute or from some reliable firm, one or two pints of separated milk should be heated to 150 deg. F. for 20 minutes, and then gradually cooled to 70 deg. F. The purchased ferment should then be added (in the proportion directed by the makers) and well stirred in, and the whole should stand in a clean, well-ventilated room at about 60 deg. F. to allow the milk to thicken. Thickening should occur in about 24 hours.

(*b*) Next morning another lot of separated milk (one to two gallons in accordance with the requirements of the dairy) should be taken, and after heating and cooling as directed in (*a*), from a quarter to one pint of the thickened milk (*a*) should be added, well stirred in, covered, and left for a further period of 24 hours.

(c) The following morning the "starter" should be ready for use, and a portion of it may be added to the pasteurized cream, the amount varying according to the length of time the cream is required to stand before churning.

(d) The starter should be renewed daily in summer and at least three times a week in winter, by following the directions given under (b).

These special ferments after a time lose some of their vitality, and when this is observed to be the case a new supply should be obtained.

Working Temperatures.—Different lots of cream of varying ages should not be mixed just before churning. Twelve hours at least should elapse from the time of the last addition of fresh cream to a ripened lot before churning takes place. No arbitrary statement can be made as regards the temperature of the cream, as this must depend on the method of feeding the stock as well as on other factors. The average temperature, however, at which cream may be churned is perhaps 57 deg. F., but a much lower temperature is required in summer than in winter. In summer it may vary from 52–56 deg. F., and in winter from 56–62 deg. F. or thereabouts.

The following table of temperatures will illustrate approximately what is desirable :—

When the Temperature of the Air in the Dairy is :—	The Temperature at which Cream should be churned is :—
Deg. F.	Deg. F.
62	53
60	54
58	55
56	56
54	57
52	58
50	59
48	60

It is advisable to use the thermometer frequently at different stages of the work and to record the temperatures under the following headings, so that information may be obtained for future guidance :—

(a) The Temperature of the Dairy, which will govern
(b) The Temperature of the Churn, and
(c) The Temperature of the Cream.
(d) The Temperature at "Breaking" stage, which will regulate
(e) The Temperature of the Breaking Water and
(f) The Temperature of the Washing Water, and also
(g) The Temperature of the Brine.

When the temperature at which to churn has been decided, the cream may be warmed by standing the pail containing it in hot water not above 120 deg. F., or it may be cooled by standing the pail in water at a lower temperature than the cream. In either case care should be taken to stir the cream during the process. Where ice is not available well water may be used, but if this is not cold enough then brine can be made to reduce the temperature.

If the cream is too thick it should be thinned down to the right consistency with cold water; cream for churning should run freely from the Scotch hand and through the straining cloth without squeezing. It is important to stir the cream while adding the water and to avoid making it too thin.

Churning.—The cream should be strained into the churn, which should not be more than half filled. The churn should be turned slowly at first, and frequently ventilated, and then turned more rapidly until the speed of the churn is about 55 revolutions a minute. The time taken in producing butter varies considerably, and depends upon the kind of churn used, on the temperature, the ripeness and thickness of the cream, the length of the period of lactation of the cows. Generally speaking, the butter should "come" in twenty to forty minutes. Churning should cease as soon as the butter "breaks," that is, as soon as the cream is changed into the form of fine grains of butter. This stage is indicated by a partial clearing of the glass window in the lid, and by the dull thud of the "broken" cream falling inside the churn. If doubt is entertained as to whether this stage has been reached, the churn may be opened and the condition of the contents observed.

Should the cream become "sleepy," water should be added to thin it down and regulate its temperature. Cream usually gets into the "sleepy" condition after about 25 to 30 minutes churning if it becomes so at all. In most cases the addition of a little water at from 65 to 75 deg. F., will cause the butter to come quickly and without any bad result, as when the butter comes the subsequent washing with water, cooler than the butter-milk, will rectify any harm that may have been done in making the grain soft.

When the butter comes, a quart or so of cold breaking water should be added for each gallon of cream in the churn, and then churning continued until the butter grains are of the required size. The best size is, on the average, about that of mustard seed. In no case should the butter be churned into lumps, or casein will be enclosed, and as it is impossible to wash this out, the keeping qualities of the butter will be greatly impaired. The butter-milk should be drawn off through the hand sieve over which a piece of muslin has been tied.

Washing and Salting.—The temperature both of the washing water and of the butter inside the churn should be taken at this stage. To harden the grain the temperature of the water should be reduced; to soften the grain the temperature should be raised a few degrees. In the latter case, however, great care must be taken or the butter may be churned into lumps.

Two washings are usually sufficient to get rid of most of the casein. Brine is made by dissolving salt at the rate of 1 to 2 lb. in each gallon of water. The butter grains are usually allowed to soak in the brine for about twenty minutes, although a much shorter time is perhaps equally effective so far as salting is concerned. Complete immersion of the butter is necessary. The butter should be removed by means of a scoop and sieve from the brine to the butter-worker.

When salt butter is made, dry salting is the method usually adopted. The salt used should be fine, dry and clean, and added to the butter grains on their removal from the churn to the butter worker before the roller is brought into use. In order to obtain mild salt butter ¼ oz. of salt per 1 lb. of butter may be used, while for medium salt butter ½ oz. of salt will be required. In all cases of dry salting the working of the butter should not be completed in one operation. Time must be allowed for the salt to dissolve, otherwise "streakiness" may result. For this reason the butter when about half worked should be allowed to stand for 30 minutes in a cool place.

Working.—The butter grains having been removed from the churn to the worker by means of the perforated wooden scoop, working may be commenced. The object of "working" is to get rid of the moisture, by means of pressure, with as little injury to the grain as possible. Great care is needed in the operation, for well-churned butter is frequently spoiled by the rough and clumsy use of the roller at this stage. The law permits a maximum of 16 per cent. of water in butter, but this quantity would be considered excessive in most farm-made samples. The amount of water present in well made butter is usually no more than 12½ per cent.

Making Up and Marketing Butter.—Scotch hands are employed in making up the butter into various shapes, such as bricks, rolls and fancy forms. A pound print of a useful packing size measures about 4½ inches by 2½ inches by 2½ inches. A neatly made block of butter with square ends and printed with some fancy design which gives it an attractive appearance obtains an enhanced price. After butter is made up it should be put in a cool place for a short time to allow it to harden before packing. Chip or card boxes, which can be bought very cheaply, are useful for packing purposes. The butter should be wrapped in grease-proof paper before being inserted in the box.

Potting Butter for Winter Use.—Butter that is to be potted down should be made from slightly ripened cream. One oz. of dry salt must be added to each pound, and the butter very thoroughly worked, in order to get it as dry as possible. The butter is packed in thoroughly cleaned glazed crocks, and must be well consolidated. After being well pressed down it should be covered with a thick layer of salt, or, better still, with brine. A piece of parchment paper should be tied tightly over the crock, which should then be stored in a cool dry place. Butter so treated will keep for several months. On removal it should be soaked for some time in water of about 65 deg. F., re-worked, and then made up. In re-working it should be sprinkled with cold water, to freshen it and reduce the saltness.

Judging Butter.—The scale of points used in judging butter varies considerably, but the following may be accepted as a useful one :—

General appearance, including neatness of make-up and finish, 15 ; colour, 5 ; texture, 20 ; freedom from moisture, and, where butter is salted, evenness of salting, 20 ; flavour, 30 ; aroma, 10. Total, 100 points.

Washing Up.—All utensils should be well washed first with cold water, then with warm water to remove grease, and afterwards scalded. The churn when sealed must be ventilated after each revolution, the rubber band should be removed from the lid and the ventilator taken to pieces occasionally and the parts carefully cleaned. The butter worker sometimes becomes sticky, making the rolling of the butter difficult and unsatisfactory. As a remedy the wooden parts should be washed with soda, or scrubbed with finely-ground lime. If the wood becomes rough through wear, the worker should be taken to pieces and the wood carefully planed along the grain.

London, S.W.1,
August, 1907.
Revised, February, 1918,

Note.—Other leaflets which may usefully be read in connection with the present leaflet, are the following :—No. 151 (*Cleanliness in the Dairy*); No. 231 (*Cheese-Making for Small-Holders*) ; No. 323 (*The Profitable Utilisation of Surplus Milk*) ; and Special Leaflet No. 75 (*The Manufacture of Cheese in Co-operative Dairies*). Any leaflet can be obtained free on application to the Board (3, St. James's Square, London, S.W.1). Letters of application need not be stamped.

Leaflet No. 193.

BOARD OF AGRICULTURE AND FISHERIES.

Dry Rot of Potatoes (*Fusarium caeruleum*).

DRY ROT (*Fusarium caeruleum*).—Potato tuber suffering from Dry Rot showing the white spore-bearing pustules of the fungus and the shrivelled flesh of the tuber.

The Board are indebted to the courtesy of the Royal Dublin Society for permission to reproduce this illustration.

All growers of potatoes are probably more or less familiar with this disease and with the serious losses to which it sometimes gives rise. The disease, which is caused by a parasitic fungus belonging to the genus Fusarium,* attacks the tubers during storage and causes their decay. It does not attack the potatoes while they are still in the ground, nor is it known to produce a "wilt" or more or less gradual death of the haulm, as is the case with diseases caused by certain allied species of Fusarium in America.

Description.—In the initial stages of attack Dry Rot appears as a superficial patch that is darker in hue than the surrounding skin and somewhat sunken. As the diseased area increases it becomes corrugated or wrinkled in irregularly concentric rings and shrinks considerably (*see* figure).

* The species causing Potato Dry Rot in the British Isles is now regarded as being *F. caeruleum* and not *F. solani* as was formerly supposed. The name *Nectria solani*, which has been much used in the past, is erroneous. It should be understood that other species of Fusarium occur on potato tubers, but these are saprophytic and quite distinct from *F. caeruleum*.

Pustules of the fungus then begin to burst out through the skin whilst the internal tissue of the potato becomes, as the disease proceeds, brown and shrunken, leaving hollow cavities inside, or cavities filled with fluffy mycelium.

The pustules are white and downy in appearance ; though they become pink if developed in a good light. If the soft white or pink exterior be rubbed away the base of the pustule is found to be bluish. The blue colour is also sometimes well seen in the mycelium of the fungus which flourishes in the internal cavities. A microscope shows that the pustules bear a dense mass of spores. These spores are long and colourless, more or less sickle shaped, and divided by cross walls into a varying number of cells, usually four.

In bad cases the rot continues until the potato becomes hard, dry, and quite light in weight. If the attack commences very late or makes but slow progress the tubers survive till planting time and commence to sprout. Such tubers if planted generally die and produce no plants at all, but they may grow and develop small though healthy plants. Failure of planted seed tubers (especially in early varieties) to produce plants is frequently due to the Dry Rot disease.

The disease is very widespread and the fungus is probably present in all soils in which potatoes are grown.

Causes leading to Attack.—Dry Rot may start at any point on the tuber, and is not particularly associated with the "heel" or stem end of it. It most frequently starts from a wound, a broken surface offering an ideal place of entrance for the fungus. Wounds, however, are not essential for infection, for it has been proved that potatoes with unbroken skins can also be attacked. In such cases the disease usually starts at an eye or a lenticel (breathing pore). The wounds through which the fungus so frequently enters may be caused in various ways, but seed potatoes that have been rubbed against each other in a sack or have otherwise been roughly handled or bruised are often found to become badly attacked after some weeks in storage. The breaking off of sprouts affords another easy means of infection. The maturity of the tuber has a considerable influence on its susceptibility to infection ; the more mature the tuber is and the nearer it is to the time of sprouting the more easily it becomes infected. As a consequence the disease is usually most prevalent in the early months of the year, and seldom causes serious trouble before December.

Susceptibility of Varieties.—Varieties vary considerably in their susceptibility to Dry Rot. Early sorts suffer more than late varieties, and certain varieties such as May Queen, Ninety-fold, Reading Russett, and Duke of York, are particularly susceptible. Others, such as Epicure, are fairly resistant, though probably none are absolutely immune.

Control.—1. As soon as Dry Rot appears in the store the tubers should be gone over and all affected ones removed. This process should be repeated as frequently as practicable.

2. Potatoes that are but slightly affected may be fed to pigs or chickens, but only if previously thoroughly cooked. Badly diseased potatoes should be burned. Cutting out the diseased portions and treating with sulphur or lime does not check the disease.

3. Potatoes attacked by Dry Rot should never be used for seed. Sets cut from potatoes affected with Dry Rot or even from sound tubers which have been in contact with diseased ones, frequently develop the disease through spores lighting on the freshly cut surface, and loss of crop ensues.

4. When digging potatoes much more care than is often bestowed should be exercised to avoid mechanical injury to the tubers. This is particularly necessary if the tubers are to be kept for seed purposes and if they are of thin-skinned varieties. When planting sprouted potatoes care should be taken not to injure or break off the sprouts.

5. Where Dry Rot is anticipated great care should be exercised as to storage. All tubers which are affected with any kind of disease should be removed before storing. The storage place should be well ventilated and cool.

6. Where the disease is very bad and re-appears each year it is advisable that the storage boxes and the walls of the cellar or loft should be disinfected or washed down with a 2 per cent. solution of copper sulphate.

London, S.W.1,
August, 1907.
Re-written, January, 1918.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

Coltsfoot. (*Tussilago Farfara*, L.)

One of the common weeds about which farmers make frequent enquiry is coltsfoot or foal's foot (*Tussilago Farfara*, L.), as it is sometimes called.

Description.

The flowers of the plant are among the earliest to bloom in spring, being generally seen in February and March. The stalks bearing them usually grow from four to ten inches high, and are clothed with small scale-like leaves (Fig. 1).

At first the flower heads droop, but when they open out they are erect. At night or in dull weather they close up, but expand in bright sunshine. Each head consists of yellow flowers arranged on the same plan as those in a daisy, having a central collection of small florets—the "disk" florets—and an outer rim of "ray" florets. The "disk" florets, which occupy the central parts of the flower head, are about thirty in number. Each has a small tubular corolla with five regular divisions or segments. Stamens which bear pollen are present, and there is also a thickish, blunt stigma attached to the ovary below. Although stamens and pistil occur together in them, these flowers rarely, or never, bear fertile seeds. Honey is produced by the flowers, and flies, bees, and other insects pay visits to them for it.

The outermost "ray" florets, of which there are from 200 to 300 in each head, are irregular, with a narrow strap-shaped extension of the corolla. They are female only, having no stamens and therefore no pollen. The stigma, which is divided at the top, projects a short distance from the tube of the corolla. It is protruded, and ready for the reception of the fertilizing pollen before the central florets of the same flower head are open, so that fertilization, if it is effected at all, is brought about by pollen which has been transferred to it by insects from older distinct flower heads.

Cross-fertilization is the rule, and fertile seeds arise in the ovaries of the "ray" florets. Each ripened fruit or "seed" is a thin elongated structure, orange-red in colour, and bears at its apex a bunch of white fluffy hairs or down called the pappus, just as in thistle "seeds." The leaves, when fully developed, are generally from four to eight inches across, roundish or heart shaped, downy beneath and with a few marginal teeth. In shape they somewhat resemble the sole of a colt's foot, hence the name of the plant (Fig. 2).

Life History.

The "seeds" are carried about by the wind, and thus freely disseminated.

They only germinate readily under shady conditions in loose, damp soil, or on ground covered with herbage, between the leaves of which the seeds ultimately find their way when they settle. In dry situations or on smoothly-pressed soil they germinate very irregularly or not at all.


FIG. 1.—COLTSFOOT BEFORE LEAVES APPEAR.

The seedlings are remarkably small, with two very narrow cotyledons. After a week or two the first broad, somewhat heart-shaped leaf appears (Fig. 4). Coltsfoot is a perennial weed and flowering does not take place during the first season.

The blooming of the first flowers and the distribution of the seeds occur very commonly before the leaves of the plant are sent above ground, a peculiar feature which it is essential to emphasize. The flower heads come up singly or three or four together from an underground root-stock; after they have been developed some time the leaves begin to appear. These arise from underground buds of the root-stock, distinct from those out of which the flower heads arise (Figs. 1, 2 and 3).

The rootstock branches below the surface of the ground and extends to very considerable depths. It has been traced vertically downward in stiff clay to a depth of three or four feet (Fig. 2). Coltsfoot is commonly confined to stiff, damp soils, and more especially to those containing lime or marl, although it is sometimes met where lime is not abundant.

Prevention and Remedy.

1. Very frequently no attempt is made to get rid of this pest until its conspicuous broad leaves become an eyesore to the farmer. It is, however, essential to check seeding, and the plant should be spudded or hoed out while in

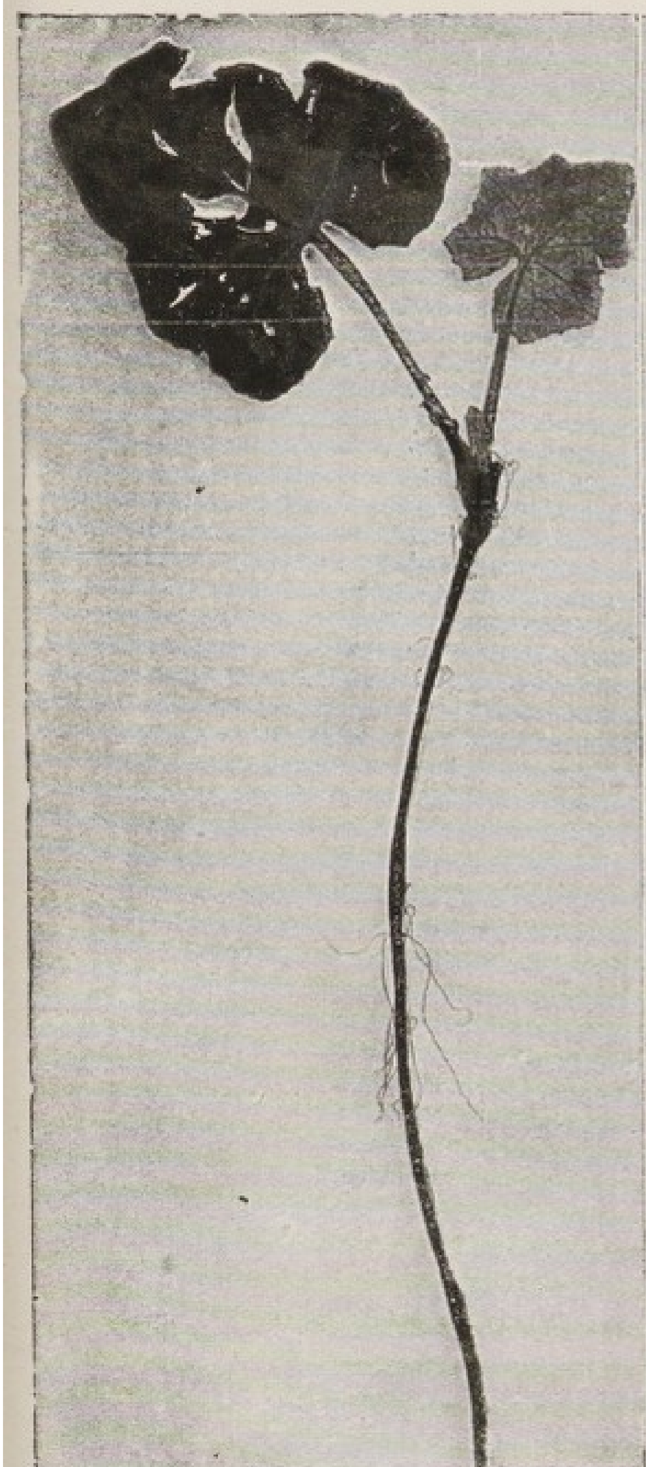

FIG. 2.—LEAVES AND RHIZOME OF COLTSFOOT.

FIG. 3.—COLTSFOOT PLANT JUST AFTER "SEEDING."

flower. If properly done many of the leaf-buds on the root-stock just below the surface of the soil are damaged, weakened, or destroyed at the same time.

2. Repeated spudding or hoeing of the leaves must be practised early in the season, and also later in the year, as recommended at pp. 10–11 of Leaflet No. 166 (*Some Common Thistles*) for creeping thistle. This practice will have the effect of exhausting the plant and is especially necessary where it is established on arable fields.

3. Wherever possible the ground should be dried by

FIG. 4.—COLTSFOOT SEEDLINGS.
SIX DAYS TO THREE WEEKS OLD (Natural size).

well-placed drains. The plant does not succeed except where the soil is stiff and retentive of moisture.

4. Coltsfoot grows best, and is especially adapted to thrive, in situations where the leaves have free, unrestricted exposure to sunlight. Hence it succeeds on poor soils where other plants are checked, the absence of competition favouring its access to light. On arable land kept free from other weeds it luxuriates especially.

5. In pastures and meadows it can be gradually destroyed by the application of manures of a nitrogenous character—farmyard manure, nitrate of soda, and similar materials—which encourage grass and other tall-growing herbage.

6. Deep ploughing and cultivating, with removal of the root-stocks, in the hotter periods of summer does much to destroy it.

7. Amelioration of the soil by the application of lime, sand, ashes, and long dung will tend to render its eradication more easy.

The damage done by weeds generally is fully described in Leaflet No. 112 (*Weeds and their Suppression*).

London, S.W.1, June, 1907.

Revised, August, 1913.

BOARD OF AGRICULTURE AND FISHERIES.

American Gooseberry Mildew (*Sphaerotheca mors-uvae*, Berk.).

The disease known as American Gooseberry Mildew, *Sphaerotheca mors-uvae*, is of a very serious character. It has greatly increased the cost of the cultivation of gooseberries in the countries in which it has appeared, and in some cases it has rendered gooseberry-growing impossible.

This fungus is much more injurious to gooseberry bushes than the allied European Gooseberry Mildew, *Microsphaera grossulariae*, Lev. (Leaflet No. 52), as it not only attacks the leaves, but also extends to the shoots and fruit, stunting the latter and rendering it unsaleable.*

In this leaflet there is given (1) such a description of the fungus as will aid fruit-growers to recognise the disease should their gooseberry bushes be found to be attacked, (2) precautions to be observed by gooseberry growers, and (3) instructions for the treatment of infected bushes.

Description of the Fungus.

There are two well marked stages in the life of this fungus: in the first stage it is white; in the second stage it is brown. The white stage always comes first, but the brown is more easily seen and is often the first to attract attention. The white form of the mildew, usually called the summer stage, may appear at any time between April and November, while the brown stage, known as the winter stage, may be seen from June onwards. During the winter months the brown colour gradually changes to grey. While in the white stage the mildew produces vast numbers of minute spores. (The spores of fungi correspond to the seeds of higher plants.) These spores are carried about in various ways, and if they fall on the opening buds or young fruit of a gooseberry bush they may begin to grow at once. In this way in warm and moist weather the mildew may spread very rapidly; but fortunately for fruit growers it does not always spread rapidly. The young shoots are the parts attacked, and the mildew is always worst on young, vigorous, growing bushes, and especially on "suckers." The summer spores though numerous are short-lived, and in cool, dry weather, or hot, dry weather they seem to be incapable of doing much mischief.

If gooseberry mildew were to depend on the short-lived summer spores it could not exist throughout the winter; very soon, therefore, a second kind of spore begins to form. This spore is known as the winter or resting spore. The

* Occasionally the English mildew assumes a virulent form and attacks the fruit.

fungus is thus more difficult to check than an ordinary weed, which produces only one kind of seed, and the difficulty is increased by the character of the winter fruits inside of which the spores are found.

Before forming winter spores the mildew changes colour and assumes a deep brown tint, so that badly affected twigs look as if they had been smeared with chocolate. If infected twigs are thereafter examined with a magnifying glass minute black dots called winter fruits will be seen (*see* Fig. 5). Each winter fruit consists of a strong case, inside which are eight spores. The case protects the delicate spores throughout the winter and does not open until spring growth begins. From the course which the disease runs in this country, it would appear that the fruits begin to liberate the resting spores early in April, but that the majority burst in June or July. Some winter fruits remain attached to the infected twigs throughout the winter, but the greater number fall off and lie in the soil. Most of them burst and release the infectious spores in the following summer, but there is reason to believe that they may lie dormant for about eighteen months, and infect the bushes in the second year.

Conditions under which Disease occurs.

American Gooseberry Mildew attacks soft, quick-growing shoots; thus suckers, and the shoots produced in warm moist weather are much more liable to infection than firm slow-growing shoots. This explains a feature of the disease which often puzzles growers. When a new district is attacked, the first plantations to suffer are those which have been highly manured and carefully managed. The large, quick-growing bushes produced by such treatment are found to be much more liable to attack than the poor plants in a neglected garden.

Some varieties of gooseberry are naturally more vigorous than others, and thus produce more young wood in the late summer and autumn; these varieties are found to be most affected by mildew. For example, the quick-growing varieties "Keepsake," "White Lion," and "Crown Bob" contract disease to a greater extent than the slow-growing varieties "Whitesmith," "Careless" and "Long Swan." Apart from the rate of growth and the nature of the new shoots produced, varieties do not seem to have any special capacity for resisting disease. Thus "Golden Drop" and "Whinham's Industry" are not so liable to attacks on the young wood as most other varieties, but the berries, which happen to have a soft skin, are more apt to suffer from mildew than those of any other kind. In most varieties disease does not appear to be able to attack the berries after they are half grown, but in "Golden Drop" full-grown berries may suffer. Ripe berries of any variety are liable to attack. In the case of "Keepsake" the berries are fairly immune, while hairy berries of all varieties appear to suffer much more than smooth ones.

Deep, porous soils produce tall, vigorous plants, while shallow or stiff soils produce small bushes, so that disease is more troublesome on the former than on the latter class of soil. When, associated with deep porous soils, there is an abundance of moisture, as in the silty soils of the Wisbech district, the conditions are specially favourable for the spread of mildew. In gardens in all affected districts variations in the depth of the soil, and in the amount of moisture, account for the unequal distribution of disease throughout infected plantations.

Precautions to be observed by Growers.

Although there are many infected gardens in certain districts, and although infection may doubtless be conveyed by wind, birds, insects and other means which are outside a grower's control, it does not follow that it is useless to take precautions against infection. Even in Worcestershire, where the disease has longest been known to exist, by far the greater number of gardens are free, and of those infected a comparatively small number are badly attacked.

Again, as has already been stated, the disease does not always spread rapidly, and in many of the cases in which it has suddenly appeared all over a plantation there has been reason to suspect that the plantation had been affected for some time without attracting attention. On the other hand, in many of the cases in which the mildew has been discovered early and prompt action has been taken, disease has not spread throughout the plantation.

When the disease is neglected and allowed to spread all over a garden, the cost of treating it is heavy, and in many of the worst cases it pays the owner better to grub up the plantation than to attempt to cure the affected bushes. This is especially the case when the fruit has been badly attacked. But the bushes should never be destroyed while affected with the white stage of disease, unless previously sprayed thoroughly, as disease may be spread by this means. It is quite clear, therefore, that it is worth a fruit-grower's while to take precautions to prevent infection, and to prevent disease from spreading if his garden should unfortunately become infected.

Fruit-growers are recommended to observe the following precautions :—

(1) Plants should not be purchased from nurserymen or dealers unless a guarantee is given that they are free from American Gooseberry Mildew. Young bushes should be cut back before being planted and the prunings burned. It is illegal to move gooseberry or currant bushes from Kent, Cambridgeshire, parts of Norfolk, Lincolnshire, Huntingdonshire and Worcestershire without a licence, and purchasers

of bushes from those districts must sign an undertaking to observe the conditions imposed before a licence can be granted.

(2) So many cases have been found in which disease has begun on bushes close to the packing sheds or other places near which "empties" have been stored, that baskets, barrels, sacks, &c., which may recently have been in a diseased garden should be treated with suspicion. Empties sent by salesmen for carrying fruit of any kind to market should not be taken direct into gooseberry plantations. They should first be disinfected. Baskets may be disinfected by dipping them in boiling water or in a solution of 1 lb. of bluestone (copper sulphate) to 20 gallons of water; sacks may be scalded. Even if disinfected, packages should not be taken into fruit-plantations until actually required. As already stated, the summer spores of mildew do not live long, and every day's delay in bringing baskets near gooseberry bushes makes the risk of infection less. (*See also* page 8.)

(3) Labourers who have been working in a garden in which the disease exists in its summer stage, should not be set to work in a clean gooseberry plantation for a week at least, unless means have been taken to disinfect their clothing. If possible, affected plantations should be left until last.

(4) Growers should make a practice of searching their plantations for traces of disease at frequent intervals, especially in the months of June, July, August and September. Young leaves which are attacked generally curl upwards and show a white under-surface covered with mildew. Pickers should be told to report at once any cases of mould on the berries. As indicated above, outbreaks of disease in plantations in which mildew has not previously appeared are very often found near packing sheds, so that special care should be taken in examining bushes near the places where gooseberries, plums, &c. have been got ready for market.

(5) As disease may appear at any time between April and November, fruit-growers should keep on their premises a few pounds of liver of sulphur. This substance when freshly made up, as explained below, is the best spraying material for summer use. A good quality should be procurable at 6d. per lb. It must be kept in an air-tight tin or a corked bottle, for if exposed to the air it quickly loses its value. A spraying pump should also be kept in readiness. The common knapsack sprayer costing about 35*s.* would serve for ordinary plantations, or a hand-pump of the syringe pattern costing 7*s.* 6*d.* to 15*s.* might be used in small private gardens.

Treatment of a first Outbreak.

Assuming that a watchful fruit-grower discovers the disease as soon as it gets into his plantation, he should at once remove and destroy the affected berries or shoots; they

AMERICAN GOOSEBERRY MILDEW (*Sphaerotheca mors-uvae*).

Fig. 1. Early or "summer" stage on leaf (nat. size); Fig. 2. Early or "summer" stage on young shoot (nat. size); Fig. 3. Diseased berries on previous year's shoot with unaffected leaves (nat. size); Fig. 4. Affected leaves and shoot, showing "chocolate" or second stage on the latter (nat. size); Fig. 5. Grey or "winter" stage, showing winter fruits or perithecia as black dots (enlarged).

Fig. 6. A branch from a gooseberry bush showing berries badly attacked by American Gooseberry Mildew.

may be collected in an iron bucket containing a little paraffin and burned, or dipped into a "steep" made by dissolving 1 lb. of liver of sulphur or 1 lb. of bluestone in 10 gallons of water. A spraying mixture should then be made up of 1 lb. of liver of sulphur to 32 gallons of water, and the affected bush and surrounding bushes should be thoroughly sprayed. Those who do not possess a spraying pump should thoroughly soak the bushes by means of an ordinary syringe, or a watering can. If many twigs or berries are covered with mildew when the disease is first observed, the bushes should be sprayed *before* the diseased material is removed.

In recent years experiments with lime sulphur wash indicate that this substance is more effective than liver of sulphur, and lasts much longer. Unfortunately it causes some varieties of bushes to shed their leaves and should therefore be used with caution, and a few bushes should be tested for this purpose before a large area is sprayed.

In treating American Gooseberry Mildew the first essential for success is prompt action. Since the spread of the infection may be very rapid, it is recommended that where very little mildew is to be seen, it should be cut off and destroyed immediately. The shoots removed must not be carried through the plantation. They may be destroyed as indicated above. When many twigs have become diseased there is much danger of spreading the mildew while working among the bushes, and the bushes should therefore first be sprayed. The spray will destroy much of the mildew, and the risk run by working among the bushes will be greatly reduced.

On any bush upon which mildew has been seen, and also on the bushes in contact with the diseased plant, there will probably be a number of recently infected twigs, which will bear no visible traces of disease. Thorough spraying will do much good, but as it is very difficult to ensure that the spray wets every part of a bush the safest plan is to prune carefully all the infested and suspected bushes so as to remove all young wood that may be infected; but this pruning should not take place until all likelihood of further growth has passed.

In the above recommendations it is assumed that spraying materials are at hand; should this not be the case a bucket containing paraffin should be procured, and all diseased material should be removed, dipped in paraffin and burned at once. It is better to risk the danger of spreading infection by working among unsprayed bushes than to delay for a day the work of destroying diseased twigs.

It must be clearly understood, however, that the above advice refers to slight outbreaks affecting a few bushes which could be dealt with single-handed by a careful man. It would be most unsafe to turn a number of labourers into an affected plantation to root-up and burn bushes suffering from disease in the summer stage until the plantation has been disinfected by spraying.

As soon as the fruit grower has dealt with the diseased bushes he should spray the whole of his gooseberries and currants with liver of sulphur, and repeat the dressing in a week. The spray for general use should be made up of 1 lb. of liver of sulphur to 32 gallons of water. A stronger spray, say 1 lb. of liver of sulphur to 24 gallons of water may safely be used after July. It has been found that the spray wets the mildew and sticks better if soft soap is added to the wash at the rate of 1–2 lb. for 32 gallons of water.

If there is no fruit on the bushes Bordeaux mixture is better than liver of sulphur. A convenient formula for fruit-growers who usually make Bordeaux mixture in a paraffin cask is 4 : 4 : 40, *i.e.*, 4 lb. of freshly burned lime and 4 lb. of bluestone (copper sulphate) to 40 gallons of water. To make Bordeaux mixture, 4 lb. of lime should be weighed out, moistened and allowed to slake; when the lumps have fallen to powder the lime should be stirred up in 2 to 3 gallons of water to make "milk of lime," and then strained through a piece of coarse sacking into the cask, which should then be filled with water to within 5 or 6 inches of the top. The whole should be stirred for a few minutes and then the lime should be allowed to settle for half-an-hour. The 4 lb. of copper sulphate should next be dissolved in from half a gallon to a gallon of boiling water (this must be done in an earthenware or wooden vessel) and poured into the cask. The mixture should be stirred gently, but not so as to disturb the sediment at the bottom of the cask. The Bordeaux mixture is then ready and should be used while fresh.

Treatment of Diseased Plantation.

By adopting the line of treatment indicated above, the chances of stamping out the disease are good, but if from neglect or any other cause a garden has become generally infected with disease a different procedure will be required.

It is impossible to say what is the best course to adopt in any particular garden, for once the disease has become widespread the treatment, to be successful, must vary according to the time of year, the weather, and the condition of the bushes. In general terms, however, it may be said that the grower's object must be to check the spread of the disease as much as is practicable while it is in its summer stage, and to cure it when it has passed into the winter stage. For advice in dealing with bad outbreaks the grower is recommended to consult one of the Inspectors of the Board or of the Local Authority. Inspectors are always glad to assist growers, and all advice is free.

Two methods may be adopted in treating the summer stage, (1) Spraying, and (2) Removal of the diseased tips.

The first remedy is the best in the early part of the season, up to about the end of July, while the second is the more effective from the middle of August onwards.

There is no doubt that a spray of liver of sulphur checks the disease if the spray soaks the mildew and dries upon it, but unfortunately it is difficult to ensure that the somewhat greasy surfaces of mildewed twigs are soaked with spray, and even when the twigs have been wetted a fall of rain frequently washes off the spray before it has had time to dry. In practice, therefore, it is found that spraying, to be successful, must be frequent. Regular spraying is of special importance when the mildew appears early in the season, when young bushes in nurseries are attacked, and when disease breaks out in a new district. In all cases in which neighbouring plantations are endangered by the presence of mildew, spraying must be resorted to.

As soon as active growth stops, growers should begin to remove and burn every twig showing disease. This is a valuable means of checking the spread of mildew in the early autumn. If begun too soon, however, bushes throw out many fresh shoots, and the soft tips so produced are very liable to infection. After the middle of August the buds would seldom "break," and in the case of old bushes growing on poor dry soil the removal of the tips may safely begin early in July. All diseased tips must in any case be removed by a date specified in the notices served under the Board's American Gooseberry Mildew Order, and the sooner this can be done the better for the grower himself.

On diseased twigs in the early autumn mildew is found in both the summer and winter stages. Twigs showing the summer stage are highly infectious, and if they are removed many adjacent bushes will be saved from disease; further, the summer stage soon changes into the winter stage, so that even if the grower does not remove the diseased wood in August he will be forced to do so a month or two later. He has therefore little to gain and much to lose by delaying the removal of the tips of gooseberry shoots affected by the summer stage of the disease.

As regards twigs suffering from disease in the winter stage there is also a good reason for their early removal, for the winter fruits begin to drop off the bushes and to infect the soil a few weeks after they are formed. If, for example, mildew attacks a crop in the middle of July, the winter fruits may begin to drop off by the end of August. The only chance the grower has of curing a bad attack of mildew is to destroy the winter fruits, and if he wishes to do so he must begin pruning in good time. It is true that a number of winter fruits remain attached to the wood, so that by pruning, even as late as February, he is *reducing the risk of a severe attack* in the following summer; but if he does not begin his work *early* so as to prevent the winter fruits dropping into the soil, it is very unlikely that he will effect *a cure*; the chances are that he will have the whole of the work to do over again in the following summer. As indicated above the winter fruits may lie in the soil for more than a year, so that if a grower by pruning too late has once allowed the winter fruits to fall he is liable to re-infection for two years, and perhaps longer. The ultimate and only sure remedy where a plantation has been badly attacked is early pruning for a series of three or four years.

Fruit-growers are busy during the early autumn months and labour is difficult to obtain, but in view of the dangers entailed by delay, strenuous efforts should be made to remove diseased tips in August and September. In any case the suckers which grow in an affected plantation must be pulled up and destroyed, as suckers are very liable to contract disease. Growers forming new plantations might with advantage plant "one-legged" bushes, the "eyes" of which have been rubbed off.

Nitrogenous manures should not be used too freely, as by encouraging rapid, "soft" growth, they may render the bushes more liable to disease.

Diseased tips should not be allowed to fall on the ground, but should be thrown into iron buckets, or baskets lined with sacking, as soon as they have been pruned off the bushes. As a further precaution against re-infection, the soil of gooseberry plantations should be dug over in winter and the surface buried as deeply as possible.

NOTE.—American Gooseberry Mildew is a scheduled disease under the Destructive Insects and Pests Acts, 1877 and 1907. Every person who has on his premises any gooseberry or currant bushes which have been or are affected with the disease, or are suspected of being affected, is obliged to report the fact to the Board of Agriculture and Fisheries, or to the Local Authority for the district, or to one of the Inspectors of the Board or of the Local Authority. The penalty for the neglect to report is £10. Full information is given in the American Gooseberry Mildew Order of 1911.

The American Gooseberry Mildew (Fruit) Order of 1912 makes it illegal to sell or offer for sale any gooseberries affected with this mildew. Growers should, therefore, exercise the utmost care in destroying all affected berries before sending their fruit to market, since the consignment of such berries renders them liable, on conviction, to a fine of £10. Copies of both Orders can be obtained free on application to the Board of Agriculture and Fisheries.

London, S.W.1,
May, 1907.
Revised, June, 1914.

Leaflet No. 196.

BOARD OF AGRICULTURE AND FISHERIES.

Fertilisers and Feeding Stuffs Act, 1906.

[6 Edw. 7. Ch. 27.]

This Leaflet has been temporarily withdrawn.

Leaflet No. 197.

BOARD OF AGRICULTURE AND FISHERIES.

Agricultural Education and Research in England and Wales.*

AGRICULTURAL EDUCATION.

The Board make grants in aid of the higher agricultural education provided at Universities, and at University and Agricultural Colleges in England and Wales.

In addition, most of the counties of England and Wales provide agricultural education of a less advanced character, either through a permanent staff of instructors or through instructors attached to one of the Colleges referred to above. In many cases both systems are adopted. The Board also make grants in respect of this work.

Briefly, the agricultural education which is now available consists of courses at various colleges extending over three or four years and leading up to a degree or diploma; shorter courses at the same institutions; short courses varying from a few weeks to several months at farm schools and similar institutions; courses of ten days or a fortnight in dairying at migratory dairy schools which visit a number of different centres each season; and courses of day or evening lectures, accompanied in many cases by practical instruction in agriculture, poultry-keeping, bee-keeping, farriery, horticulture and manual processes. Most County Councils offer a number of scholarships, tenable at agricultural institutions or courses, to students resident in the county.

A number of counties carry out field experiments or demonstrations, and have fruit-growing stations, demonstration gardens or trial allotments.

It is not possible within the limits of this leaflet to give particulars of the activities of each County, but a short account of the work of each Collegiate Institution and Farm School is given below. Persons wishing to obtain further particulars should apply to the Secretary or Principal of the Collegiate Institution in question, or for any particular County to the Education Secretary or Agricultural Organiser† at the County Council Offices.

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* Owing to present conditions the arrangements at the Institutions mentioned in this Leaflet are liable to alteration. The intending student is, therefore, advised to communicate with the appropriate Authority as regards any course of instruction which he may desire to follow.

† A list of agricultural organisers will be found in Leaflet No. 279.

Universities and University Colleges.

1. *University College of Wales, Aberystwyth.*—The degree course extends over three academic years after matriculation, the fees being £17 per annum including tuition and laboratory fees. The agricultural diploma course also extends over three years, but students are required to attend during the winter and spring terms only, and to spend twenty-four weeks in each of the first two years of their course on an approved farm. The fees are £10 2*s.* 6*d.* for the two terms.

There are also short courses for farmers, intended to provide technical instruction for those who have already some experience of practical agriculture. Part I. extends over eight weeks, for which the fee is £4; Part II. lasts for eleven weeks, and the fee is £5; Part III. is of a more advanced character, and extends over the winter and spring terms of the subsequent year, the fee being £10 2*s.* 6*d.*

The course for the College diploma in dairying extends over two sessions (six terms), the fee being £14 5*s.* per session; the certificate course lasts for one session, and the fee is £14 5*s.* for the course. Further instruction in practical dairying may be obtained during the summer months at a fee of 10*s.* per week. An elementary course in practical dairying extending over four weeks is held in May, June and July in each year, the fee being £3. The advanced course in practical dairying extends over ten weeks during the months of July, August and September in each year, and is open to those who have done satisfactory work in the elementary course or its equivalent. It includes practical instruction in butter-making and cheese-making with elementary lectures on the theory of dairying. The fee for the course is £7 10*s.*

2. *University College of North Wales, Bangor.*—The College prepares students for the B.Sc. degree (three years' residence after matriculation), the fee for which is approximately £17 per session. The diploma course comprises three winters (October to March), leaving the summers free for practical work on farms. The fee is eleven guineas for each winter. There is a special course of ten weeks during the autumn term for those who find it impossible to attend for longer periods, and for this course a fee of £5 15*s.* 6*d.* is charged.

The College farm is situated at Aber, 5 miles from Bangor. In area it covers 675 acres, more than one-third being arable and pasture land of fair quality and the remainder an upland sheep walk. An important feature of the work at the farm is the breeding and feeding of cattle, sheep and horses. The stock kept consists of 90 head of cattle, 1,600 sheep and lambs, and 18 horses. Short-course students reside in the village of Aber.

An experimental area for forestry is available at Chirk, covering 50 acres. The B.Sc. degree may be taken after three years' study, and a diploma in forestry is also obtainable.

3. *Cambridge University.* — The University grants a diploma in agriculture to those candidates who pass the requisite scientific and practical examinations. The University has also instituted a Special Examination in Agricultural Science for the ordinary B.A. degree. To obtain this B.A. degree the student must pass the Previous Examination, Parts I. and II., and the Special Examination in Agriculture Science, together with the Preliminary Scientific or another Special Examination. The examination for the degree is held twice a year, and the fee is £3. Students of agriculture are expected to reside in Cambridge during nine terms (three years), and are advised to attend at the University farm during part of the Long Vacation, when special classes are given.

The School of Agriculture is provided with a farm of 230 acres for teaching and experimental purposes. Local experiments are also carried out with crops and stock at a number of stations in the Eastern Counties.

Candidates for the diploma in forestry must have passed a recognised examination in Elementary Science and have attended a course of practical work for six months in an approved forest. They must also pass the diploma examination in forestry and allied subjects, courses of instruction in which are given in the University.

The revision of the degrees in agriculture and forestry is now under consideration (1919).

4. *University of Leeds.*—The complete course extends over three winters, but students may take a one or a two winters' course. This leaves the spring and summer free to be devoted to practical work. The fee for the winter course is £10. There is also a summer course from April to June, the fee for which is £5. In the degree course, students are required to pass the matriculation and intermediate examinations as for the ordinary science degree, and do not enter the agricultural department until they begin to work for the final examination. The latter period of study extends over two years. The fee for the degree course is £27 a year. During the two final years students are required to spend at least six months on the Manor Farm, Garforth, where each student must conduct an experiment on some agricultural subject, and present a report on the same. The farm at Garforth extends to 312 acres, and affords means of instruction in general farming and dairying.

5. *Armstrong College, Newcastle-upon-Tyne.*—The course for the degree of B.Sc. in agriculture (University of

Durham) covers three years of three terms each, and that for the diploma three years of two winter terms only. Special short courses of six weeks are given in the Michaelmas term for farmers and foresters. Students can also attend for a specially arranged one-winter course in agriculture, for single terms, or for special subjects. In connection with the Officers' University Training Corps a special six months' course in agricultural subjects is provided, and arrangements are made for placing such officers on suitable farms for practical training. The tuition fees vary from £6 for one term and £10 for the winter course to £20 a year for the degree course.

The Northumberland County Council Experimental Station at Cockle Park, which is worked in connection with the College, extends to 460 acres, and affords opportunities for practical instruction and experimental research.

In Durham the County Council have made arrangements with the college for the conduct of research work in dairying on a farm of nearly 600 acres, where about 60 milch cows are kept.

For instruction in forestry, there are experimental plantations and tree nurseries at Cockle Park, while by an arrangement with H.M. Commissioners of Woods and Forests the Chopwell Woods, comprising 900 acres, have been placed under the control of the College.

6. *University of Oxford.*—Candidates for the degree of B.A. in the School of Agriculture and Forestry are required to pass a preliminary examination in certain subjects, after which they have the choice between agriculture and forestry in the Final School. If the candidate elects to take agriculture he must pass an examination in the Principles of Farm Management, and also in two of the following three subjects :—(*a*) Estate Management (including Agricultural Law and Land Agency) ; (*b*) Economics of Agriculture ; (*c*) The History of the Development of Agriculture. Should the candidate decide on forestry for the final examination he must pass in the following subjects :—The Economics of Forestry and Forest Policy, Silviculture, Forest Protection, Forest Utilization, Forest Mensuration, Forest Management, Forest Valuation and Finance. In the final examination the degree is conferred "with distinction" in the case of candidates of sufficient merit. The fee for the preliminary examination is £2 ; while for the final examination the fee is £4.

The course for the diploma in agriculture and rural economy extends over two years and in most cases entrants for the examination are required to take the full course, the only exceptions being those members of the University who have kept by residence all the terms necessary for the B.A. degree. Candidates are required to have attended an approved course in elementary chemistry before taking the examination. The examinations are held annually and a fee of £2 is charged.

The instruction for the diploma in forestry is conducted on lines similar to those for the degree in forestry. No minimum length of residence is prescribed, but it usually takes not less than six terms—including a practical course extending to six months (unless specially reduced by the Delegates for Forestry)—in order to qualify for the diploma. The practical course is taken during the vacations. The fees for the examinations are £2 for each of the two parts; the first part deals with subjects auxiliary to forestry and the second part with forestry proper. In the final examination candidates can obtain a simple "pass" or "distinction."

7. *University College, Reading.*—Separate instruction at this College is given in agriculture, dairying, and horticulture.

The degree course in agriculture extends over three years and the diploma course over two years; there is also a six months' course for the certificate. The fee for the degree and diploma courses is £24 per session of three terms, and for the certificate course £16 for two terms. In the case of students residing in contributing counties these fees are reduced to £18 and £12 respectively.

In dairying, two regular courses are provided, one extending over two years for the diploma, and one of one year (October to September) for the certificate. The fee per session of three terms for the diploma course is £24 and for the certificate £30 (including the charges for practical work at the British Dairy Institute), reduced in the case of county students to £18 and £24 respectively. There are also short courses of 6 months and 3 months in dairying, for which fees of £16 and £10 respectively are charged.

The courses in horticulture include lectures and laboratory work in the College and practical work in the College gardens and orchard. There are two principal courses of instruction, one for the diploma in horticulture extending over two years of forty weeks each, and one for the certificate extending over one year. The fee for these courses is £24 for a session of forty weeks, with a reduced fee of £18 to students from contributing counties.

Facilities are afforded for practical instruction in all these subjects. The College Farm at Shinfield, two miles from Reading, comprises about 150 acres; 7½ acres consist of copse or wood, and 11 acres have been laid out as a fruit station, the remainder being permanent pasture and arable land in equal proportions. Instruction is given here regularly in the afternoons, and students are encouraged to assist in the farm work. In addition to about 30 acres of land at Shinfield used for the cultivation of fruit and vegetables, the College gardens, 4 acres in extent and consisting of fruit plantations and vegetable and flower gardens, are available for instruction in horticulture. There are a large number of pits and frames, and 15 glass houses. The buildings of the British Dairy Institute, which are on the College site, are available for practical dairy work.

8. *South-Eastern Agricultural College, Wye, Kent.*—The agricultural instruction at this College, which is a School of the University of London, is arranged in three courses:—(1) The London University B.Sc. course, extending over four years, including matriculation; (2) the diploma course, extending over three years; and (3) the certificate course (agriculture and commercial fruit-growing) of two years. The mornings are allotted to lectures and laboratory work, and the afternoons are occupied by various practical classes on the farm, the fruit and hop plantations, the dairy, poultry-yard, &c. Lectures are given in the evening.

The inclusive fee for board and tuition is £120 a year; for tuition only, £70 a year; and for a limited number of students resident in Kent and Surrey £60 a year, including board and lodging, or, for tuition only, £15 per annum.

The College farms consist of about 460 acres, of which 260 are arable and the remainder pasture, gardens, buildings, &c. The sheep kept are chiefly pure-bred Romney Marsh and Southdowns; there is a herd of Shorthorns, as well as Aberdeen-Angus, Galloways, Red-Polls, Herefords, Sussex, and other breeds. Four breeds of pigs are also kept, and representatives of the three principal breeds of farm-horses are used on the farms. The hop garden is devoted entirely to the raising and testing of new varieties and other experimental purposes, and covers about 3 acres. Commercial fruit-growing receives special attention, and instruction is also given in market-gardening, 16½ acres being devoted to horticulture. A series of demonstration plantations and a nursery for forest trees are being established to enable practical instruction in forestry to be given.

Agricultural Colleges.

9. *Midland Agricultural and Dairy College, Kingston, Derby.*—Instruction is provided in agriculture, dairying and poultry-keeping.

The certificate course in agriculture commences in October and covers, at the present time, 22 to 24 weeks. The course is open to male and female students and is designed to give sound practical instruction to those who intend to become farmers. Practical instruction is also provided on the College farms and arrangements can be made for this branch alone. The diploma course in agriculture has been temporarily suspended but will be reopened when the full facilities which are provided at the new College buildings are available.

In dairying, there is the diploma course and also short courses of six weeks' duration. The latter are held contінously throughout the year. The diploma course in dairying extends over a period of nine months and is a complete training in theory and practice. Students attending this course qualify for the Teachers' Diploma of the College, and the National Diploma in Dairying.

Special courses of instruction in poultry-keeping, qualifying for the College certificate, commence each 12 weeks. These courses comprise systematic lectures and up-to-date instruction in practical methods.

The fees for instruction vary from 15*s.* to 20*s.* per week in the dairy and poultry courses, whilst in the agriculture course the tuition fee is 10*s.* per week. Board fees are 17*s.* per week in the case of females and 19*s.* in the case of males. Students resident in the contributing Counties (Derbyshire, Leicestershire, Lindsey division of Lincolnshire, Notts and Rutland) receive special treatment in regard to instruction fees.

The College has two farms, one of 176 acres at Kingston, where the dairy department is situated, and the other at Sutton Bonington, near Kegworth station. New buildings have been erected on the Sutton Bonington farm.

Field trials and other forms of experimental work are regularly carried out and the results published.

10. *Harper-Adams Agricultural College, Newport, Salop.*—The College provides three courses of instruction. The diploma course, extending over three years, is of an advanced nature. The course can be completed in two years where evidence of previous scientific training is produced. The certificate course, extending over two years, is of a less advanced character, and is intended for those who wish to farm at home or in the Colonies. A special course of one year is provided for those who are unable to spend a longer time at a College and includes a practical course in agriculture and applied subjects. In this course students can specialise in poultry, horticulture, or dairy work. Arrangements are made for students who wish to spend the whole time in one department to take lectures in the principal subjects and to spend the rest of the time at practical work

In this way, students can spend six to twelve months in poultry, horticulture, or dairy work. The fees are £12 10*s.* for tuition and £45 for board and residence per session of three terms for students from Shropshire and Staffordshire, and £22 10*s.* and £51 15*s.* for those from other counties.

The College is a residential institution and only senior students are accepted as non-resident. The farm surrounds the College and is 303 acres in extent, of which 146 acres are grass and 157 acres are arable. There are two homesteads of a complete character. The stock includes a herd of pedigree Shorthorns, pedigree pigs and Welsh sheep. A considerable acreage is devoted to corn growing, and a large number of experiments in connection with grain and root crops and on grass land are carried out for the benefit of farmers who pay periodical visits to the College farm. The College has about five acres under fruit and vegetables and also about three acres under forest trees.

A special branch of the College is the Poultry Department, extending over 11 acres, in which particular attention is given to breeding stock and egg-laying trials.

A portion of the College Farm is set aside to demonstrate the possibilities of intensive dairy farming.

11. *Horticultural College, Swanley, Kent.*—This College aims chiefly at giving a thoroughly systematic training to women who wish to become fruit-growers, market-gardeners, colonists, teachers and lecturers in horticulture.

The courses include (1) the diploma course, two years resident and a third year spent in practical horticulture ; and (2) the certificate courses—of which there are three—(*a*) general horticulture, a course following the lines of the diploma course but with modified scientific instruction ; (*b*) the small-holders' course, comprising one year in horticulture, half a year in farm work and half a year in domestic economy ; and (*c*) landscape architecture, two years resident and one year spent in practical horticulture. The landscape course is specially suited to educated women who have already had gardening experience.

A course in commercial horticulture specially devoted to fruit and vegetable growing is now added to the curriculum. This course can be taken independently of other courses by women who already have experience in horticulture. The fees are from £90 a year of about 36 weeks, for board, lodging and tuition, or £50 a year for tuition only. Extra charges are made for poultry-keeping, bee keeping and dairy work at the rate of £3 3*s.* to £5 5*s.* per course.

Short courses of from five to ten weeks are given in dairying, poultry-keeping, farm work, domestic economy and general horticulture. The fees are at the rate of from £28 10s. for 10 weeks.

The College stands in 52 acres of land. There are 16 large market houses, also plant houses and conservatory, 25 acres of fruit plantation, 4 of market land, a French garden, kitchen garden and pleasure grounds.

Special Institutions.

12. *British Dairy Institute, Reading.*—The British Dairy Institute is under the management of a committee representing the British Dairy Farmers' Association and University College, Reading. It contains large milk-receiving, butter-making, and milk-testing rooms, four cheese-making rooms, and seven rooms for ripening cheese, and is equipped with the best modern apparatus for the manufacture of dairy produce. The instruction given is both practical and theoretical, and is arranged to suit the requirements of those who need either elementary or advanced dairy instruction. The fees for all subjects are £1 per week, £10 for three months and £18 for six months, the latter fee being reduced to £16 for the special six months' course from March to September. The fee for practical and theoretical instruction in buttermaking only is 10*s.* per week. The Institute is open throughout the year, except during the winter vacation of eight weeks, and certain shorter intervals. For longer courses of instruction in dairying see under *University College, Reading*, above.

13. *Harris Institute, Preston.*—The object of the instruction given at this institute is to prepare young men and women for the work of a farmer's life by enabling them to study the principles which underlie farming operations. The full course, which prepares students for the National Diploma, extends over three winter sessions of twenty-six weeks each, while there is a special short course covering one session.

Students from the administrative county of Lancaster who are the children of farmers receive their education free ; for other county students a charge of £3 3*s.* per session is made. Allowances and scholarships are also awarded. The fee for students from other counties is £6 6*s.* per session. A diploma in agriculture, as well as a certificate, is awarded, and students are also prepared for the National Diploma.

14. *Royal Horticultural Society's School, Wisley, Surrey.*—The instruction consists of a two years' course in the principles and operations of horticulture, and is designed to lay a good foundation in practical fruit, vegetable, and flower growing. The garden affords full opportunities for practice in all kinds of garden work, and the course is designed so that all students take their full share in it. The laboratory course covers the main scientific principles underlying good garden practice.

The course leads up to the School diploma, and the fee for the full course is £5 5*s*., students finding their own board and lodging. The School is open to men students only.

Farm Schools, Fixed Dairy Schools, and similar Institutions.

Carnarvon County Council: Madryn Farm School.—Madryn Farm School is situated five miles from Pwllheli, and contains accommodation for resident teaching staff and 30 students, together with a large lecture room, library and reading room, laboratories, and museum. The land attached to the Castle for Farm and School purposes extends to a total area of 118 acres.

The courses of instruction are as follows :—

(1.) Two Courses in Dairying and Poultry Farming for young women. These courses are held during the summer and last from four to ten weeks.

(2.) Vacation Courses for elementary school teachers, including a course in practical gardening at Easter and a course embracing horticulture, nature-study, elementary science, poultry farming and bee-keeping in August.

(3.) Winter Agricultural Course for Farmers. This course commences at the end of October and lasts for about five months. The syllabus provides for instruction in subjects connected with agriculture and dairying, land surveying, and farm account keeping.

The fees for students from the County of Carnarvon are 15*s*. weekly, and for other students 20*s*. weekly for board, residence, and instruction. Day students are admitted at a charge of 2*s*. 6*d*. weekly for tuition only. The fee for teachers attending the Summer School is £1 5*s*. weekly for Carnarvonshire teachers and £1 10*s*. for others.

Cheshire County Council: The Worleston Dairy Institute.—This institute provides accommodation for 20 female students, and instruction is given in dairy work, particularly in the making of Cheshire cheese. Four courses are held in the year, each extending over 11 weeks. A farm of 180 acres (all grass land except 20 acres), on which a herd of dairy cows is kept, is attached to the Institute. The County Council has also a farm of 210 acres, of which about 50 acres are arable, at Henhull Hall, near Nantwich. The milk produced at this farm is taken daily to the Dairy Institute, Worleston, for making into cheese and butter. The fees at the Dairy Institute, including board, for Cheshire students, are 15*s*. per week, and for students from outside the county 30*s*. per week. The County Council offers a number of scholarships tenable at the Institute.

Cumberland and Westmorland County Councils: Farm School, Newton Rigg, Penrith.—The farm at Newton Rigg comprises 130 acres of good land, 47 of which are arable. Scientific and practical instruction in agriculture is provided for pupils of both sexes, special attention being given to dairy farming (particularly in respect of cheese-making), poultry rearing, and fruit growing. Courses of eight weeks each for female pupils are held from April to October, and of sixteen weeks for male pupils from November to March. The fee for resident pupils from the two counties is 10*s*. a week for board, lodging, and tuition; for pupils from other counties £1 per week. Day pupils residing in the neighbourhood of the farm may be admitted at a reduced fee, for tuition only, of 2*s*. 6*d*. per week. This school was extended in 1914 and now has accommodation for twenty resident pupils.

Denbighshire and Flintshire County Councils: Lleweni Hall Dairy School.—A fixed dairy school is maintained in co-operation with the University College of North Wales, at Lleweni Hall, near Denbigh, where instruction is given in butter-making, hard and soft cheese-making and the general theory of dairy work.

Durham County Council: Sherburn Hall Dairy School.—A three months' course in Dairying and Poultry-keeping is held in the spring for holders of County Council Scholarships. Courses of instruction for paying students are arranged at other periods of the year. The County Poultry Station is attached to this institution, which also forms the headquarters of the County Migratory Dairy and Poultry Schools.

Essex County Council: East Anglian Institute of Agriculture, Chelmsford.—A course in agriculture, consisting of two terms of ten weeks each, is held during the winter months, instruction being given in soils, manures, farm crops, land surveying, farm accounts and live stock. For residents in the county of Essex a weekly fee of 2*s*. 6*d*. is charged; students from contributing counties pay £12 for 20 weeks, while other students pay £1 per week.

The Dairy School is open practically all the year round. A long course of about 3 months is held in the summer, and short courses of about 6 weeks each in the winter. Residents in the county of Essex pay no fee; students from contributing counties pay 10*s*. per week or £5 for 12 weeks, while other students pay £1 per week or £10 for 12 weeks.

There is a one-year course in horticulture, comprising three seasonal terms of three weeks each, and one of four weeks. Residents in the county of Essex pay no fee; students from contributing counties pay 10*s*. per week, while other students pay 15*s*. per week. There is also a gardening class for teachers, who are nominated by the Education Committee, and instruction is free.

Gloucester County Council: Central Dairy School, Gloucester.—During the war this school was closed temporarily, the Instructress giving itinerary instruction in cheese making in the county; but under normal conditions six weeks' courses in butter and cheese making are provided during the summer months.

Hampshire County Council: Farm Institute, Sparsholt, Winchester.—At this school provision is made for training lads and young men in winter and women in summer. The subjects comprise mainly practical work in agriculture, dairying, horticulture, poultry-keeping, and farm carpentry, with class teaching on the principles underlying the practice. Special attention is given to hard cheese making during the summer term. The school year begins in October and consists of a winter term of 24 weeks' duration, followed by a spring and summer term of 15 weeks. Pupils from Hampshire connected with the land pay 10*s.* per week for board and tuition, and other Hampshire pupils 15*s.* per week. Pupils from outside the county pay £1 5*s.* per week. For day pupils the tuition fees are 5*s.* per month for those connected with farming and 10*s.* per month for all others from Hampshire. External students pay £1 a month. A farm of 250 acres is attached to the Institute.

Hereford County Council: A ten weeks' course is given in this county at a fixed centre. Work in the classroom is supplemented by practical work in the field.

Lancashire County Council: The County Council Farm, Hutton, Lancs.—On this farm are located the permanent Dairy, Poultry and Horticultural Schools. The farm is 302 acres in extent, 60 acres of which are arable. Eight acres are covered by the Horticultural Station and eight by the Poultry Department. The stock consists of about 150 head of shorthorn dairy cattle, 40 pigs, 5 horses and 1,000 to 2,000 head of poultry. Courses of instruction are held for female students each year in—*Dairying* (four Junior Courses of nine weeks' duration; one Senior Course of fourteen weeks' duration; and one Diploma Course of forty weeks' duration); *Poultry-keeping* (similar courses which, however, cannot be taken simultaneously with a course of dairying); and *Horticulture* (one course which covers a period of twelve months).

Special arrangements are made in all sections for shorter periods of instruction if desired. Certificates and diplomas are awarded. Residents in the administrative county are admitted on very easy terms; external students are charged 30*s.* per week for complete courses in the above subjects, including board, lodging and tuition. All students reside in a new and commodious hostel. Candidates are prepared for the National Diploma in Dairying

Monmouthshire County Council: Agricultural Institution, Usk.—The farm is 293 acres in extent and is run as a typical mixed farm. Experiments in connection with the improvement of grass land and variety trials are carried out. Instruction is given in general agriculture, dairying and horticulture. At the present time only a limited number of students can be accommodated.

Norfolk County Council: Ingham Horticultural Institute.—This Institute is intended in the first instance for the instruction of disabled ex-service men. Pending the provision of suitable accommodation on the farm, students are being lodged in a neighbouring village. The syllabus provides for a year's course of instruction in practical and theoretical horticulture (including market-gardening and fruit-growing), pig-, poultry- and rabbit-keeping, and carpentry. Each student will work an acre strip of land under the supervision of the head gardener. The farm is about 80 acres in size.

Salop County Council: Shropshire Technical School for Girls, Radbrook, Shrewsbury.—Instruction is given in various branches of domestic science, and in dairy work and poultry keeping. The fees for the latter are 30*s.* per week inclusive of board and residence. The course lasts about ten weeks.

Somerset County Council: County Cheese School.—The school is stationed at a farm each year from the beginning of April to the end of September or October for Cheddar cheese-making and usually two or three weeks longer for Caerphilly cheese-making. During this time the whole of the milk, usually from a dairy of from 50 to 70 cows, is made into cheese by the students under the direction of the instructress. Students attend for from one to four weeks and the fees are £1 per week, including board and lodging, for residents in Somerset, and higher fees, amounting to £5 5*s.* for four weeks, for non-residents. The instruction is given under practical farming conditions.

Worcester County Council: Droitwich Experimental Garden.—This experimental garden, which is maintained by the county, has an area of about 6 acres. Numerous experiments in fruit and vegetable cultivation are conducted. Teachers are trained for teaching school gardening, and ladies are trained as gardeners. An annual report on the experiments is issued and the garden is open to visitors, of whom a large number attend annually. Instruction and demonstrations in pruning, &c., are given in the garden.

Yorkshire County Council: The Dairy School, Garforth, Leeds.—This is maintained by the three Ridings of Yorkshire on the farm which is worked in connection with the University of Leeds. Three courses of six weeks' duration are usually held during the summer. The fee for the course is £8, including board and lodging in the hostel.

Institutions for Women.

Women attend courses of study at the majority of the institutions described above. A few institutions are devoted entirely to women, viz., the Horticultural College, Swanley, Kent (page 8), the Horticultural College, Studley, Warwickshire, the Worleston Dairy Institute (page 10), and the Shropshire Technical School for Girls at Radbrook (page 13). The following agricultural institutions are also attended by women for courses either in agriculture, horticulture, dairying or poultry-keeping:—University College and British Dairy Institute, Reading (pages 5 and 9); Midland Agricultural and Dairy College, Kingston, Derby (page 6); Harper Adams Agricultural College (page 7); and Harris Institute, Preston (page 9). The Farm Schools and Dairy Schools described on pages 10–13 also provide special courses for women students. For full information as to the facilities available for women at any of the above-mentioned institutions application should be made to the Principal.

AGRICULTURAL RESEARCH.

In the case of research, funds have been allocated from the Development Fund for the purpose of aiding research into certain definite groups of subjects, the object aimed at being the concentration at one institution, or at institutions working in combination, of the scientific work in each group.

The institutions and the subjects selected are as follows:—

Subject.	Name of Institution.
Plant Physiology	Imperial College of Science, South Kensington, London, S.W.7.
„ Breeding	Cambridge University.
„ Pathology	Rothamsted Experimental Station, Harpenden, Herts.
„ Nutrition and Soil Problems.	Rothamsted Experimental Station, Harpenden, Herts.
Fruit Growing, including the practical treatment of plant diseases.	The National Fruit and Cider Institute (Bristol University).
Animal Nutrition	Cambridge University.
„ Pathology	Royal Veterinary College, Camden Town, London, N.W.1.
„ „	Board's Veterinary Laboratory, Addlestone, Weybridge.
Dairying	University College, Reading.
Agricultural Zoology, with special reference to Helminthology.	Birmingham University.
Economics of Agriculture...	Oxford University.

Grants are also made to the South-Eastern Agricultural College, Wye, in aid of a Fruit Research Station, to Leeds University for Research in Animal Nutrition, to Oxford and Cambridge Universities for Research in Bee Disease, to Cambridge University for Research in the Breeding of Small Animals, and to the Nursery and Market Gardens Industries Development Society, Waltham Cross, for Research in Glasshouse Culture of Crops.

A sum of money has also been allotted to provide assistance in respect of special investigations for which provision is not otherwise made. A number of such investigations are in progress at various institutions throughout the country.

ADVISORY WORK IN AGRICULTURE.

Another direction in which agricultural education and research is being developed is in the supply of technical advice to farmers and the investigation of local problems. A grant has been made to enable the Agricultural Departments of Universities and Agricultural Colleges to supplement the advice usually given by members of the County Agricultural Staff.

Many enquiries on agricultural subjects, especially those likely to be made by small-holders and others, as regards dairying, poultry-keeping, and gardening, can quite well be dealt with by the County Staff, but difficulties frequently arise which demand not merely skill and experience in agriculture, but special scientific knowledge and training.

It is the duty of the staffs of the Institutions aided by this grant to devote themselves to the investigation of such local problems, while they also form a link between the Research Institutions and the farmer.

The Institutions selected up to the present, and the areas in which the services of the staffs are available, are as follows :—

Institution.	Area.
Cambridge University ...	Bedford, Cambridge, Essex, Herts, Hunts, Lincs. (Kesteven), Lincs. (Holland), Norfolk, Northampton, Suffolk.
Bristol University	Gloucester, Hereford, Somerset, Wiltshire, Worcester.
Reading University College	Berkshire, Bucks, Dorset, Hants, Middlesex, Oxford
Bangor University College	Anglesey, Carnarvon, Denbigh, Flint.

Institution.	Area.
Aberystwyth University College.	Brecknock, Cardigan, Carmarthen, Merioneth, Monmouth, Montgomery, Pembroke, Radnor.
Newcastle, Armstrong College.	Cumberland, Durham, Northumberland, Westmorland.
Leeds University	Yorkshire.
South-Eastern Agricultural College, Wye.	Kent, Surrey, Sussex.
Midland Agricultural and Dairy College.	Derby, Leicester, Lincoln (Lindsey), Nottingham, Rutland.

Persons desirous of obtaining advice on difficult agricultural questions should communicate with the Advisory Officer at the Institution for the area in which they reside. In counties in which there is a County Agricultural Organiser agriculturists should communicate with that officer in cases in which the assistance required does not appear to be of a scientific or specially difficult nature. Further information as to the facilities for the provision of advice for farmers will be found in the separate leaflet on the subject, No. 279.

London, S.W.1.
Revised, May, 1919.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 198.

BOARD OF AGRICULTURE AND FISHERIES.

Rearing and Marketing of Geese.

Under suitable conditions, and in comparatively small flocks, geese are as profitable as any other class of poutlry. Since they require a wide range for grazing purposes, they are only suited for farmers and commoners who have open lands and rough grazings at their disposal. Owing to their grazing habit, however, many farmers, especially those living in highly cultivated districts, will have nothing to do with them. The objections usually advanced are that four-legged stock will not graze after them, and that they are destructive to the herbage of the pasture. These objections, however, do not appear to be well-founded, and have usually arisen from attempts to keep the geese in small fields or too numerously in association with other stock. Horses, cattle, and sheep have all been found to graze freely after geese, but owing to the semi-liquid excreta of the geese it would be well to allow the pasture a few days in which to freshen after the geese have been removed. A few hours rain will wash the excreta into the soil. There are many open land districts where geese might be reared in considerable numbers without fear of injury to the pastures.

With regard to the supposed destruction of herbage, the structure of a goose's bill undoubtedly enables it to crop grass very closely. On the other hand geese will search for and greedily devour the root of the buttercup, a weed which is undesirable for other stock. This habit should commend geese to dairy farmers, in whose pastures the buttercup is frequently unduly abundant.

THE DEMAND FOR GEESE.—With certain exceptions it is not desirable to keep large numbers of geese, the ordinary demand being limited and variable. In many, perhaps most, localities a moderate number will nearly always find a remunerative sale as goslings, and the birds may, without undue risk, be sent off the grass to London and other great centres of population during the season. The distinctive goose market at Michaelmas has practically ceased to exist; there is still a demand at that time of year, but it is not materially greater than that which now prevails during earlier months. Where stubbles are available the flock should be driven out to feed there daily as long as anything remains to be gleaned. In many cases it is advisable to market geese straight off the stubbles rather than carry them on for the Christmas market.

A complaint often made against the goose is that it is too large for ordinary households. In southern Europe what is known as the Roman Goose is chiefly kept, producing in September and October fine fleshed birds weighing 8 to 10 lb. each, at which weight geese are generally in their best condition naturally without special feeding.

BREEDS.—In England and Wales the breeds usually kept are the Embden and the Toulouse, or a cross between the two. Here and there tufted geese are found denoting a cross with the Chinese goose; these are prolific layers and quick in growth.

The Embden has white plumage, flesh-coloured bill, orange shanks, a square, deep-set body, and a tall upstanding carriage. The average weight for an adult gander is 20 lb., and for a goose 18 lb., but much greater weights are attained, especially when fattened off.

The Toulouse is of a dark grey colour on the upper part and a lighter shade on the breast, which gradually merges into the white of the under part; the bill is of a red flesh colour and the legs orange-red; the body is full and compact, with a convex back. The weight is generally greater than that of the Embden.

The Canada Goose, which is extensively bred in America, thrives better than the Embden or Toulouse on marshy land, and is preferred by many on account of its delicate flavour. Its colouring of brown-grey, white and black, being very effective, it is in demand—to a limited extent —for the stocking of ornamental waters.

The Roman Goose referred to above is very precocious, rapid in growth, and an excellent layer. It carries a large quantity of excellent meat in relation to its size, and weighs, when fully grown, from 12 lb. to 14 lb.

BREEDING.—Geese will continue to produce eggs profitably until an advanced age, and instances are known of geese nineteen years old which still continued to lay an average of fifty-five eggs each per year. For hatching purposes the eggs of mature birds are much more reliable than those of young stock: the risk of infertility is reduced, and the vigour and hardiness of the goslings increased. Rearing, therefore, is easier, and the profit more assured. The breeding stock should be in the proportion of one gander to three geese; the geese will commence to lay in February or not later than early March, sometimes producing (if not permitted to sit) from fifty to sixty eggs in a season. An ordinary hen will cover four goose eggs, while ten is a suitable number for a goose. The period of incubation is thirty days; it often extends beyond this, and though it is not advisable to disturb the mother or interfere with nature if it can be avoided, a little assistance may sometimes be given with advantage if hatching is overdue and a gosling appears to be experiencing difficulty in emerging from the shell.

Stock birds may be housed in a roomy, well-littered shed with a wire-netting front. The geese should have access to water for swimming in order to assure fertility in the eggs. When the laying season approaches, a rough nest, provided with an ordinary nest egg, should be made in a convenient place. If this is not done the eggs may be dropped near the water. Stock birds should usually have a small allowance of soft food in the early morning, and a little corn when they return from the fields at night.

REARING AND MARKETING.—When hatched the goslings should be cooped out with the hens that have hatched them, in the same manner as chickens. They thrive best upon a diet consisting largely of green food, which after the first few days they should be able to obtain for themselves. At first they may be fed on table scraps, sharps, or good meal, mixed with a good proportion of well-chopped dandelion leaves. By the end of the first week they will have made considerable progress as graziers, and their rations will consequently not require increasing in the same proportion as those of other growing stock. By about the tenth day they will be able to do without any brooding, if accommodated in comfortable quarters, and the hens may be turned out and brought into condition for laying again. To be profitable it is essential that geese should be fed chiefly on natural food, and after they are six to eight weeks old, the birds should find practically all their food, except during a dry, hot summer. Their range should not be restricted, and although swimming water is not a necessity where the soil is of a generous nature, in certain circumstances they will do better if allowed access to ditches and streams.

In addition to the grass, two moderate meals of a soft mixture, which may consist of barley meal, middlings, a small proportion of brewers' grains, and a little linseed cake (ground, soaked, and well mixed in), should be given daily. Goslings thus treated should be in good killing condition before they are three months old.

It will often be found profitable to fatten birds for the Christmas market, commencing 3 to 4 weeks before they are to be marketed. The practice frequently adopted is to confine the birds in a clean, dry, and airy shed on a bedding of straw, only allowing light at intervals for feeding. It is, however, equally satisfactory, and probably more economical, to allow a fair amount of liberty during the period ; the liberal supply of fattening food prevents the birds from becoming too active.

Two meals a day are sufficient, and if confined a plentiful supply of green food should be given in addition. Steeped oats are the best food for producing the best quality birds; barley may be used alternatively. It is more economical, however, if small quantities of millers' offals, barley meal, and maize and gluten meals mixed with boiled potatoes or swedes are substituted for grain for one feed daily.

The restrictions on the use of cereals for poultry do not affect the feeding of geese to any extent as wheat and rice, which are not economical foods, are now the only cereals prohibited.

KILLING AND PREPARING.—Geese should be fasted before killing. Dislocation of the neck is, perhaps, the better method of killing, as it has the great advantage of being cleanly, but in the case of large birds, or where there is a doubt as to the strength of the wrist, it should not be attempted. The alternative method is (1) to pinion or lock the wings over the back to prevent unnecessary struggling, (2) to tie the legs and hang the bird up by them, (3) to stun the bird by a sharp blow on the back of the head, and (4) immediately to sever the jugular vein by means of a sharp penknife thrust through the neck behind the lower jaw. The usual preparation for shop or market consists in rough plucking, and pressing until cold. A Leaflet (No. 201) on the Marketing of Poultry has been issued, and contains information on the various markets throughout the country.

London, S.W.1,
September, 1907.
Revised, April, 1919.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 199.

BOARD OF AGRICULTURE AND FISHERIES.

A Pine Disease (*Diplodia pinea*, Kickx.).

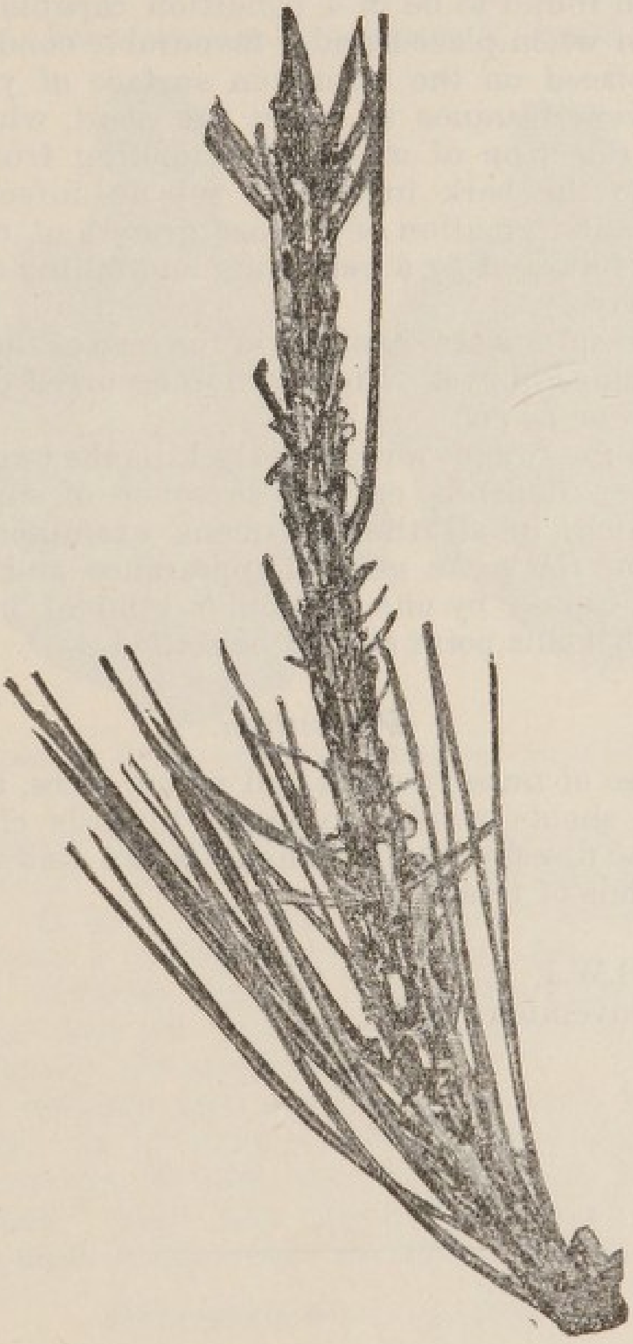
Diseased shoots of pine have been sent to Kew for investigation on several occasions, and from widely separated districts during past years; but until March, 1906, no definite statement could be given as to the primary cause of the disease, owing to the unsuitable condition of the earlier specimens received. The reasons for this will be obvious, when the development of the fungus causing the injury is explained.

Description and Life History.

The disease is confined to terminal shoots, and is recognised by the yellowing and subsequent shedding of the leaves, followed by the death of the shoot, which dies back for a distance of 6 to 10 ins. These dead shoots are persistent, and, commencing with the year following infection, furnish a crop of fungus spores each season, which, in turn, infect other shoots.

Diplodia pinea, Kickx., the fungus causing the injury, is a wound parasite, that is, its spores on germination cannot enter through an unbroken surface into the living tissues of its host-plant, but only through a wound made by some other agent. In every diseased shoot examined the presence of one or more slight wounds penetrating the cortex is indicated by a slight incrustation of resin surrounding the injured spot. It is through these injured points that the fungus gains an entrance into the living tissues. When once established, the mycelium extends rapidly towards the tip of the shoot, soon choking up the vessels and arresting the food supply intended for the growing point of the shoot. The mycelium of the fungus does not extend in the shoot for more than one or two inches below the point of infection, and the length of a dead shoot consequently depends on the distance of the wound below the apex of the shoot.

Experiments conducted at Kew show that, within two months after infection, the leaves become yellow and begin to twist. This is due to desiccation, and at the expiration of four months all the leaves have fallen, and the shoot is dead.



Shoot of Weymouth Pine (*Pinus Strobus*), killed by *Diplodia pinea*, Kickx.

In many other species of *Diplodia* fruit is not produced on the host-plant until the year following infection, and this condition of things appears to prevail in the fungus under consideration. The fruit condition is indicated by the presence of numerous blackish warts protruding through minute cracks in the dead bark.

Three-year-old plants of Weymouth pine (*Pinus Strobus*, L.), Scots pine (*Pinus sylvestris*, L.), Spruce (*Picea excelsa*, L.), Silver Fir (*Abies pectinat*, DC.) and Larch (*Larixa europaea* DC.) were infected. Spores obtained from material supplied by Professor Somerville were used, these spores having been found to be in a condition capable of vigorous germination when placed under favourable conditions.

Spores placed on the unbroken surface of young shoots failed in every instance to infect the plant, whereas spores placed on the drop of moisture extending from a minute puncture in the bark invariably set up infection, which resulted in the formation of a dense growth of mycelium in the tissues, followed by a yellowing and falling of the leaves, as stated above.

Positive results were obtained in the case of the two species of *Pinus* named above. No infection occurred on species of *Picea*, *Abies* or *Larix*.

Although the fungus undoubtedly kills the twigs it infects, yet its entry depends on the presence of some previous wound, which, in all the specimens examined, was very small, and of the same general appearance, and was, in all probability, caused by one particular kind of insect. It is important that this point should be settled.

Prevention.

In the case of nursery stock and young trees, the removal of all dead shoots would do much towards checking the spread of the disease, as the fungus is not known to occur on other kinds of trees.

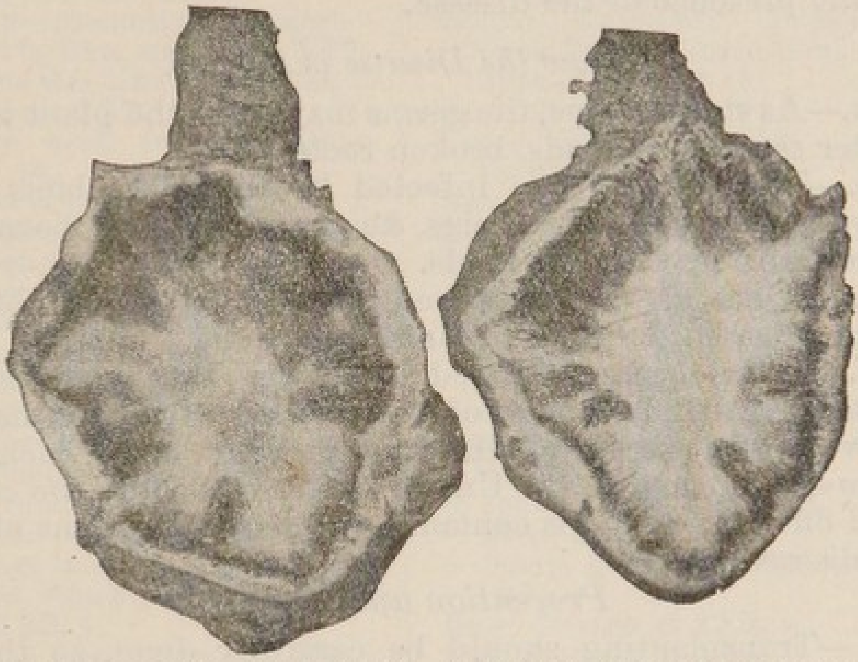
London, S.W.1,
November, 1907.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

Black Rot of Cabbages, Turnips, &c.

(*Pseudomonas campestris*, E. Smith.)



CROSS SECTION OF CABBAGE STEM, SHEWING BLACKENED VASCULAR BUNDLES.

This disease is very prevalent in the United States, and during recent years has occurred in various European countries. It is of bacterial origin and causes the plant to rot and form a pulpy fœtid-smelling mass. Cauliflowers, cabbages, Brussels sprouts, radishes, white and swede turnips, in fact all cultivated plants belonging to the Crucifer family, are attacked.

In this country rape appears to be most susceptible to the disease. In an extensive trial plot of various kinds of cabbages, savoys, Brussels sprouts, &c., those that contained rape "blood" were first attacked, whereas those strains without a taint of rape were the last to succumb.

Description and Life History.

The lower leaves are usually infected first, the germs entering the substance of the leaf through minute openings (water stomata) situated along the margin, or through wounds caused by the punctures of insects, &c. In cases where the soil is infected the germs may gain an entrance to the plant through broken roots at the time of transplanting. When the bacteria are once inside the leaf they multiply rapidly and are confined to the veins, from whence they pass down the leaf-stalk into the stem. From the stem they quickly pass into the stalks of other leaves, so that within a short time every leaf is infected. As the bacteria travel along the veins and the vascular bundles of the leaf-stalks and stem a dark-brown or blackish substance is deposited, which causes the veins to show up as a black network; the vascular bundles of the leaf-stalk and the stem also appear as black points or a blackened ring when cut across. The presence of this blackening of the veins is a certain indication of the presence of the disease.

How the Disease is Spread.

a.—As stated above, the germs may enter the plant through water stomata, wounds, broken roots, &c.

b.—The soil may be infected by diseased plants which have been fed to cattle, pigs, &c., or which have been otherwise transferred to the fields.

c.—It has also been proved that the germs are conveyed from diseased to healthy plants by insects.

d.—It has been considered by growers that the disease can be transmitted by means of the seed, and this idea has been proved to be correct by Harding, Steward and Prucha, who have shown that, in the United States, much of the cabbage seed offered for sale is contaminated with the germs of black rot disease.

Prevention and Remedy.

1.—Transplanting should be carefully done, so that the roots are injured as little as possible.

2.—Infected plants should neither be buried nor used as food for cattle or pigs, but should be promptly removed and burned, or infection of the land will follow sooner or later.

3.—Rotation of crops is advisable, cereals, potatoes, and legumes not being attacked.

4.—The following precautionary measure may also be suggested. Seed can be disinfected before sowing by soaking it for 15 minutes in a solution consisting of one part of corrosive sublimate in 1,000 parts of water, or in a solution of 1 lb. of formalin in 30 gallons of water. It is hardly to be expected that this treatment will prevent either leaf or root infection in infected soils, but it may be safely relied upon to prevent all danger from infected seed. It will not injure the germinating power of the seed.

London, S.W.1,
August, 1907.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

GENERAL INDEX.

Figures in large type (e.g. **197**) *indicate the number of the Leaflet, and those in small type (e.g.* 2) *the page of the Leaflet. Generic and specific names are given in italics. Insecticides, fungicides, &c., are given in a separate index.*

SPECIAL INDEX.

This index refers to insecticides, fungicides, &c.