Leaflets. Nos. 1 to 100 / Board of Agriculture and Fisheries.

Contributors

Great Britain. Board of Agriculture and Fisheries.

Publication/Creation

London : Printed for H.M.S.O. by Darling, 1919.

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BOARD OF AGRICULTURE AND FISHERIES.

LEAFLETS

(Nos. 1 to 100).

SEVENTEENTH EDITION.

WITH INDEX.

LONDON:
PRINTED UNDER THE AUTHORITY OF HIS MAJESTY'S STATIONERY OFFICE,
BY DARLING & 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.

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First issued, July, 1904,	...	*1,500 copies.*
Second Edition, November, 1904,	...	*1,500 copies.*
Third Edition, January, 1905,	...	*2,000 copies.*
Fourth Edition, April, 1905,	...	*3,000 copies.*
Fifth Edition, July, 1905, ...	...	*3,000 copies.*
Sixth Edition, April, 1906, ...	...	*5,000 copies.*
Seventh Edition, December, 1908,	...	*15,000 copies.*
Eighth Edition, June, 1910,	...	*5,000 copies.*
Ninth Edition, April, 1911, ...	...	*7,500 copies.*
Tenth Edition, August, 1912,	...	*10,000 copies.*
Eleventh Edition, December, 1913, ...		*5,000 copies.*
Twelfth Edition, December, 1915, ...		*5,000 copies.*
Thirteenth Edition, October, 1916, ...		*5,000 copies*
Fourteenth Edition, May, 1917,	...	*5,000 copies.*
Fifteenth Edition, January, 1918,...		*7,500 copies.*
Sixteenth Edition, December, 1918,...		*10,000 copies.*
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London, S.W.1,
September, 1919.

(24846—16.) Wt. P. 749—82. 10000. 10/19. D & S. G. 17/18. A 2

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BOARD OF AGRICULTURE AND FISHERIES.

Black Currant Mite.

Fig. 1. Black Currant Shoots : right attacked by bud mites, left normal.*

The disease known as "big bud" in Black Currants, caused by the Black Currant Mite, was first recorded in these islands in the year 1869, but according to Miss Ormerod it had been responsible for losses in the district of Blantyre, N.B., for 20 years previously. Similarly Theobald† states that about the same period it was known to the Maidstone growers. The original home of the mite, however, is uncertain. It has now spread throughout Great Britain and Ireland and occurs in most of the countries of Western Europe. It has also been introduced into Canada.

It has been scheduled by the Department of Agriculture for Ireland, where attempts are being made to stamp it out, but this end does not yet appear to have been attained.

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* Reproduced from "*Insect Pests of Fruit*," by permission of Professor F. V. Theobald.

† *Insect Pests of Fruit*, p. 232.

The Black Currant Mite is undoubtedly the most serious animal pest of the Black Currant, and its attacks have caused a marked reduction in the area devoted to this fruit. In spite of much careful research by numerous investigators, no really satisfactory methods of control have yet been discovered, and there is need for still further investigation. It is only necessary in this leaflet to describe the nature of the attack and to indicate the lines of the treatment which have given the more hopeful results.

Plants Attacked—Nature of Injury.

The plant which suffers most seriously from the mite is the Black Currant, but Red and White Currants and the Gooseberry are also attacked. Owing to the difficulty in carrying out the necessary experiments it does not appear to have been proved that the mites can pass from one species of host plant to another, but it is highly probable that they can do so. The point is obviously one of great practical importance.

The nature of the injury in the case of the chief host plants is briefly as follows :—

Black Currant.—The developing buds are attacked and swell until they are almost globular in shape and are about twice the size of the normal buds—thus giving rise to the term "big bud." Buds, if slightly attacked, may produce small stunted and crumpled leaves, but as a rule they dry up and die in early summer.

The natural result of this loss of buds is a progressive decrease in the crop which may ultimately fail altogether. In the case of certain old bushes, however, it has been noticed that the number of "big buds" produced each year has increased up to a certain point but subsequently has remained stationary, and in spite of the attack a small crop is always obtained. Notes on the resistance to the disease shown by some varieties or individual bushes of black currants will be found in the section on Methods of Control. Owing to the fact that the extent of this resistance is so variable, no list of resistant varieties is given. Young bushes frequently appear to resist attack for 4 or 5 years but subsequently break down, and a variety should not be judged until it has been tried for a considerable period.

Red Currant.—Theobald* states that "the mites produced a dense growth of buds, every here and there, which were found to be teeming with them. At the same time the shoots bearing the attacked buds were abnormally swollen, many twice the thickness of normal ones."

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* Theobald, *Insect Pests of Fruit*, p. 241.

Gooseberry.—In the case of the gooseberry the noticeable features of the attack concern the young shoot, soft tender leaves, and to some extent the fruit blossom. The mites cause a marked blistering and, according to Miss Taylor,* "after a bad attack the whole leaf surface, the veins and the petiole become covered with succulent outgrowths." "Leaves so attacked are considerably under the normal size and the main stem itself is reduced in length. The leaf colour is yellow green and the tree has a generally unhealthy colour." Obvious injury only occurs early in the season—later, when the leaves and shoots harden, no further damage is done and the later-formed leaves are normal in size.

The reason for the difference in the form of attack on the three plants would seem to lie in the nature of the buds. The black currant bud is somewhat loosely made, and hence the mites can penetrate to the centre. In the red currant and gooseberry the buds are tightly compressed and the mites cannot work their way far in.†

Description and Life History.

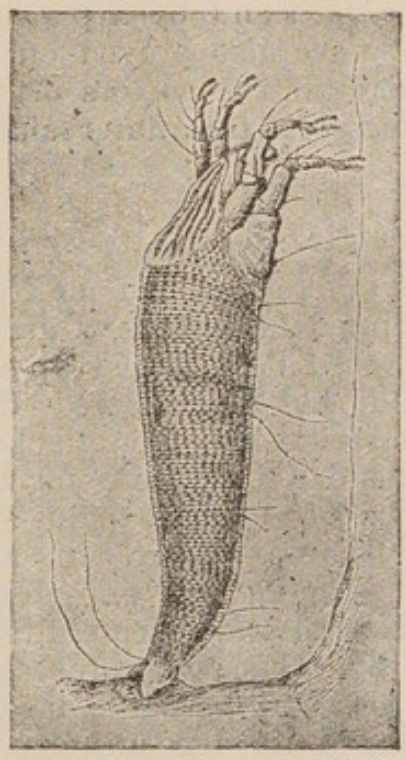

Fig. 2. Black Currant Mite (much magnified) erecting itself upon its terminal suckers (after E. J. Lewis).

The general appearance of the mite when highly magnified is shown by Fig. 2, but the animal is only about $\frac{1}{100}$ inch in length, and if a big bud is cut open, the mites are hardly discernible to the naked eye; even through a pocket lens they appear only as minute white specks.

From July throughout autumn and winter and until March the mites live mainly inside the buds, where eggs are laid and fresh generations are produced. During a period covering roughly the months of March, April, May and June the diseased buds either dry up and die, or produce distorted foliage, and the mites are forced to migrate to fresh quarters. When weather conditions are favourable—that is to say, on sunny days with some wind‡—the mites crawl out of the buds and stand erect on the

* Taylor, *Journal of Agricultural Science*, VI, p. 131.
† Taylor, *loc. cit.*, p. 133.
‡ Taylor *loc. cit.*, p. 121, *et seq.*

outside of the bud. They then either "jump" or are blown off by the wind, which is capable of carrying them, probably, for a considerable distance. The mites may also migrate by clinging on to insects which settle on the affected bushes, and may travel for short distances on the twigs by crawling. Naturally in this process of migration, in which chance plays so large a part, very many of the mites can never reach an appropriate food plant, but so enormous is the number of mites produced—Miss Taylor calculates that under favourable conditions 1,000 mites may leave one bud in an hour—that sufficient reach fresh currants to carry on the attack in spite of all losses. After migration, but before the new buds are large enough to enter, the mites live at the bases of the leaf stalks, between the developing buds and the stem and among the young leaves at the growing points of the shoots. When the buds are sufficiently large, that is to say about July, the mites enter into them and reproduce, causing the well-known "big buds."

Natural Enemies.

Black Currant Mites are attacked by the larva of a minute parasitic insect (*Tetrastichus eriophyes*) and by a parasitic fungus (*Botrytis eriophyes*). They are also preyed on by other mites and insects. The reproductive powers of the mite, however, appear more than sufficient to counterbalance all losses in this manner.

Methods of Control.

1. As has already been stated there are no entirely successful measures for combating the Black Currant Mite, and badly affected bushes should be grubbed up and burnt. In replanting it should be remembered that adjacent red currants and gooseberries may be attacked, and it is, therefore, better to choose a fresh site for the young bushes. It should hardly be necessary to point out that stock showing big buds should never, in any circumstances, be purchased or planted, but experience shows that this error is still sometimes committed. Similarly, cuttings should never be taken from diseased bushes, unless they are required for some special purpose, in which case they should be dipped for ten minutes in water heated to a temperature of 115° F., a treatment which appears to kill the mite in all its stages.*

With reference to the different varieties of Black Currant, certain forms have been claimed to be immune, but further evidence is required as to this supposed immunity, which too often breaks down. It is often observed, however, that

* Spencer Pickering and F. V. Theobald. *Fruit Trees and their Enemies, with a Spraying Calendar*, p. 81.

in a plantation where several varieties are grown some are more subject to attack than others, while occasionally almost free bushes are found in close proximity to plants badly diseased. There is undoubtedly much variation in the powers of resistance shown both by different varieties and by different individuals in each variety, and the establishment of a highly resistant race does not seem impossible.

2. In gardens, attacked buds should be destroyed as soon as they can be detected so as to kill the mites before the period of migration. In commercial orchards, if many of the bushes are affected, it may prove impracticable to collect "big buds," but when the mite first appears in a previously clean plantation the twigs carrying diseased buds should be removed and burnt. If only one or two bushes show signs of attack it is better to remove and burn the whole bush. It might be thought that in the case of a bad attack cutting the bushes to the ground would prove a complete cure, but this has not proved to be the case, though it is not known how the fresh shoots become infested. Success has been claimed, however, for certain systems which are based on drastic pruning of this nature. The bushes are planted much more closely than usual, and then either (1) every alternate bush is annually cut to the ground or (2) the whole of the old wood is removed immediately after the fruit has been gathered.

3. Some growers appear to have obtained considerable success by applying dry or "wet" sprays," while others have reported a complete failure. Treatments of this nature are open to the objection that the mites are only affected by them when on migration, and, as the migratory period extends over three months, it is necessary to spray or dust several times.

The dry spray treatment, originally suggested by Collinge,* is, perhaps, in more general use than the wet spray. It consists in dusting the bushes four times at intervals of a fortnight, beginning at the end of March. The material first advised was a mixture of 1 part finely ground quick lime and 2 parts flowers of sulphur. Owing to the fact that this mixture is likely to "burn" badly, it was modified, and it is now suggested that the first dressing should contain only 1 part of quick lime and 4 parts of sulphur, the second, 1 part of quick lime and 8 parts of sulphur, and the last two dressings, sulphur alone. Burning is also avoided by using slaked lime instead of quick lime, about equal quantities of lime and sulphur being allowed. The powder should be

* Collinge, *A Manual of Injurious Insects*, pp. 240, 241.

applied when the bushes are damp, and it is best distributed by means of one of the machines made for the purpose.

The spray fluids used against Black Currant Mite usually contain a high proportion of soft soap with the addition in most cases of sulphur. The following formula* appears to have given good results on one large plantation :—

Soft soap	25 lb.
Sulphur (Flowers of)	2 „
Water	25 gallons.

Applications are made at intervals of a week or even less during the migratory season, but the treatment can hardly be considered as commercially practicable.

4. No suggestions are made for the control of the Black Currant Mite on other host plants. The attacks either appear to be rare or, more probably, are overlooked.

London, S.W.1,
April, 1894.
Re-written, February, 1917.

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* Collinge, *loc. cit.*, p. 238.

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.

Vine, Plum, Hop, and Raspberry Weevils.

The weevils included under the above heading comprise (1) the Black, or Vine Weevil (*Otiorhynchus sulcatus*, Fab.), (2) the Clay-coloured, or Raspberry Weevil (*Otiorhynchus picipes*, Fab.), (3), the Red-legged, or Plum Weevil (*Otiorhynchus tenebricosus*, Herbst.), and (4) the Ivy and Hop Weevil (*Liophlæus nubilus*, Fab.). Other species do damage, but the four named are the most abundant.

These weevils frequently do much harm to many plants and trees, among which may be noted vines, mangolds, peas, beans, young turnips, strawberries, raspberries, plums, cherries, peach and nectarine trees, and ferns and flowers of various kinds in pots and borders, in greenhouses or in the open air. In 1894 the first two of these weevils were unusually troublesome; the hot dry summer of 1893 appeared to be very favourable for their increase. Every year, however, there is more or less complaint. Hop plants are sometimes seriously injured by them, mainly, however, by the clay-coloured species (*O. picipes*), and the ivy and hop weevil (*L. nubilus*), though occasionally the dark-coloured species (*O. sulcatus*) is found on these plants. The hop bines flag, their heads droop just after they are tied to the poles, and they have deep punctures here and there. In some cases these punctures are so deep that the bines are nearly cut in two. In the same way the tender shoots of vines are punctured by the vine weevil.

Besides the damage done to hop plants through the leading shoots of the bines being cut off or so weakened as to be practically useless, the "hills," or plant centres, are much injured by the grubs, or larvæ, which feed upon them during the late autumn and winter. This injury has in many cases been attributed to wireworms. The roots are especially damaged by the grubs of *O. picipes*, which burrow into them and soon cause decay.

Strawberry growers often experience loss from these beetles in the adult stage, but more particularly from the grubs or larvæ. The grubs burrow into, and feed on, the roots and crowns of the plants from September until March, and after April the weevils pierce the shoots and runners.

Gardeners who find such plants as dracænas, cinerarias, cyclamens, primulas, spiræs, sedums, and others, withering or dying in greenhouses and borders, should search among the roots for the white grubs of the weevils. If the young succulent shoots of vines are found to be pierced and nearly severed, it is certain that there are weevils in the soil near the vine stems, and action should be taken against them. Sometimes roots and underground stems are tunnelled by the grubs of *O. sulcatus*.

Peach, nectarine, apple and pear trees are frequently injured by weevils, which bite the shoots and cause the sap to escape just when it is required for the development of the fruit.

The Black, or Vine Weevil.

(*Otiorhynchus sulcatus*, Fab.)

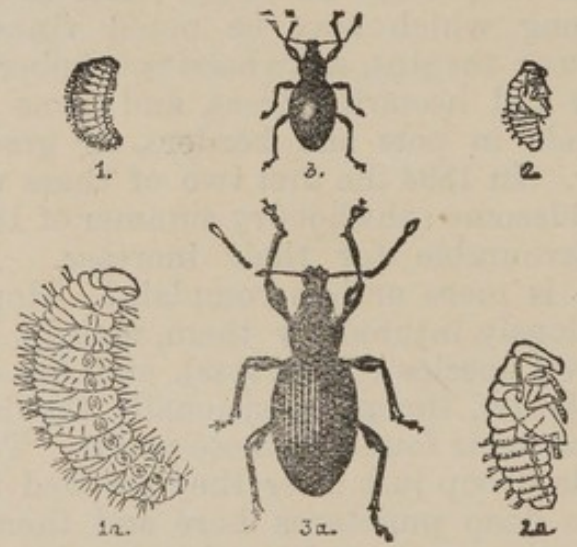

FIG. 1.

Larva 1, 1*a* ; pupa 2, 2*a* ; weevil, 3, 3*a* ; natural size and magnified.

Description.—This weevil is termed *sulcatus* because of the broad, deep furrow on its short rostrum. It is about two-fifths of an inch long, black, with greyish hairs upon the head and thorax, has reddish antennæ with clubbed apices, and dark coloured legs. The elytra have somewhat deep furrows with a few yellow hairs. No wings are present.

The legless larva is creamy white, and bears many brownish hairs ; the jaws are yellow-brown ; it lies curved in the manner shown in the figure. The pupa is yellowish-white in colour., and is covered with reddish hairs ; it is not enclosed in a cocoon.

Life History.—Eggs are laid in the summer, and the grubs, or larvæ, are found, from the early autumn until March, in the earth near to, and among, the roots of plants. The pupal stage is assumed in the early spring, and according to Taschenberg lasts 14 days. The pupa is found at a depth of from 2½ to 4 inches in the earth. When the weevil emerges, it at once attacks the plants near it, feeding only at night. When disturbed, it feigns death, and remains immovable for a long time. It is tenacious of life, and in its weevil state disregards heat, cold, and the most pungent odours.

The Clay-coloured, or Raspberry Weevil.

(*Otiorhynchus picipes*, Fab.)

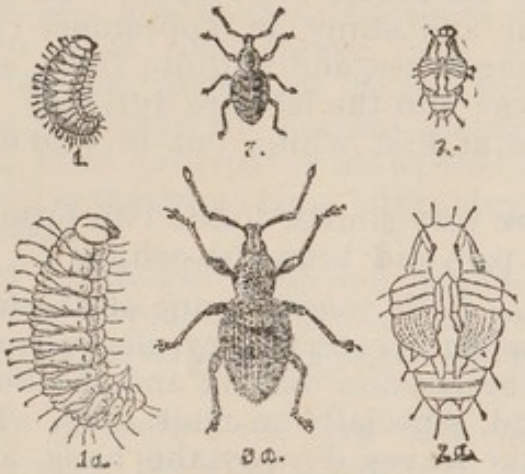

FIG. 2.

Larva, 1, 1*a*; pupa, 2, 2*a*; weevil 3, 3*a*; natural size and magnified.

Description.—The clay-coloured, or raspberry, weevil varies from one-fourth to a little under one-third of an inch in length. Its head and thorax are of a pitchy colour, and the elytra somewhat brown, but these are thickly covered with light-coloured scales, which make the weevil of the colour of clay, so that it is almost impossible to detect it in clayey soils. These scales, seen under the microscope, appear like beautiful mosaic or tessellated work. The weevil is rather ovate in form, and has dark-red or pitchy-red legs, as Schönherr describes them, with pitchy 12-jointed antennæ furnished with clubs. The femoral teeth, as Schönherr notes, are very indistinct, and in many cases imperceptible. There are long bristles upon the rostrum, and rows of short bristles down the furrowed elytra. This insect has no wings, and is a night feeder.

The legless larva is white or yellowish white in colour, is thickly covered with hair, and has a brown head.

Life History.—The life history resembles that of *O. Sulcatus.* Eggs are laid in the ground and the larvæ feed on roots throughout the summer and autumn until the spring, when they change to whitish pupæ with black eyes.

This species is sometimes harmful in young plantations, the adult weevils ringing the shoots. Examples of roses affected in this way have been sent to the Board. The adult weevil is also most destructive to buds, raspberry and cherry suffering most.

The Plum, or Red Legged Weevil.

(*Otiorhynchus tenebricosus*, Herbst.)

Description.—In length the plum weevil, so-called because of its apparent partiality for plum foliage, varies considerably; the usual size is about half an-inch long, but small specimens may be found two-fifths of an inch long. It is black in colour and shiny in appearance; the wing-cases bear lines of punctures, and in quite fresh specimens some ashy-grey scales; and the legs are dull red.

The eggs are at first white, but in two days become jet black.

The larvæ are very similar to the two former species.

The pupa is pale and brownish-white.

Life History.—This weevil is one of the most destructive to the plum, raspberry, strawberry, cherry, apricot, nectarine, and peach in the London district and the South and South-East of England, especially on chalk soils. The beetles strip the shoots of the leaves, destroy the buds, and even attack the bark, while their larvæ devour the rootlets and roots of the strawberry, &c. during the winter. Like the two species already mentioned, the plum weevil is mainly nocturnal in habits. The eggs are laid just under the ground; they hatch in August and September, and the larvæ remain feeding upon strawberry and other roots until the following March or April. The pupa is found in an earthen cell, and, as a rule, about 2½ inches beneath the surface of the ground, where it remains from fourteen to twenty-one days. This weevil is apparently double brooded.

A closely related species (*O. fuscipes*, Walton), also works in a very similar way.

The Ivy and Hop Weevil.

(*Liophlæus nubilus*, Fab.)

Description.—The weevil varies considerably in size; small males occur only one-third of an inch in length, while some females are as much as three-fifths of an inch long. In colour it is black, densely covered with ashy-brown

scales ; the wing-cases bear small tessellated spots and punctured lines ; and the legs are dark, and rather hairy.

Life History.—Several reports of the damage caused to hops by this weevil have been received from growers in Kent. This weevil lives in hedges, on various young trees and on ivy and other plants. It damages hops by biting the bine, especially attacking the tender shoots. Like the other *Otiorhynchi* it works at night, hiding between the bine and the pole or in the hearth of the "hills" during the day. It frequently becomes covered with the earth, in which it hides. Nothing seems to be known of its life history.

Preventive and Remedial Measures.

As the weevils described above feed upon many trees and plants, it will be found that they often come from hedgerows round fields cropped with hops, peas, beans, mangolds, turnips, or fruit bushes, and gradually infest these crops. In some hop gardens in Kent they spread from rows of poplars planted as shelters, or "lews," for the hop plants. In others they came from raspberry and currant plantations near. As they cannot fly, their progress is slow, and they should be prevented by active measures from advancing in fields where they are discovered.

1.—They may be caught upon hop plants and raspberry plants by holding tarred boards near the ground at night, aud tapping the poles or stakes so that the insects fall into the tar.

2.—Some hop planters send men with lanterns to pick them from the hop bines at night. In this way many weevils may be caught.

3.—They would be disturbed by prong-hoeing close round the plants, and hoeing in lime and soot mixed together. A constant moving of the soil with nidgetts, horse-hoes, and hand-hoes, would tend to check the progress of the weevils in the case of hops, mangolds, peas, beans, and turnips.

4.—In infested hop-land and fruit-land, where the plants are permanent, besides constant hoeings and the application of caustic materials in May and June, when the weevils are active, the soil immediately round the plant centres and bushes should be treated in the autumn with lime and soot, or earth, sand, sawdust, or ashes saturated with paraffin oil at the rate of from four to five pints to a bushel.

5.—In strawberry fields it is most difficult to cope with these insects, but when infested fields are grubbed up they should uot be replanted with strawberries for two or three years.

6.—Strawberry plants in gardens that have become infested wtih weevils should be examined closely in late autumn, and the grubs picked out from the roots as far as possible.

7.—In regard to strawberries, one point of importance to notice is that the beetles seek shelter beneath which to deposit their eggs, and this is readily found under the straw or grass put between the rows to keep the fruit from the earth. In all cases the straw should therefore be put on as late as possible, and cleared away as soon as the fruit is gathered.

8.—With regard to vines in houses, the weevils may be shaken at night on to tarred boards, or cloths spread under the vines, or they may be picked off them. The treatment must be repeated.

9.—Where peach, nectarine, and other wall fruit trees are attacked, the walls should be kept free from holes, and often whitewashed; the base of the wall should be thickly tarred, and ash and tar spread along the foot of the wall. The tarred boards may also be used at night, or the weevils may be picked off by hand. Sacking or bands of hay can be used as traps; the weevils take shelter in them.

10.—The roots of plants in pots should be freed from the grubs, and if there is an attack on flowers in borders their roots and the soil near them should be examined and the grubs picked out.

11.—Naphthalene or one of the naphthalene preparations on the market may be used against the grubs with advantage.

Natural Enemies.

These weevils, although not materially checked by them, have several natural enemies. Amongst the most important are the so-called sand wasps, or *Odyneri*. These wasp-like insects provision their nests with the adult weevils, which they kill or paralyse with their sting, and upon these the wasp larvæ feed when hatched. One species (*Odynerus parietinus*) has frequently been observed carrying off the smaller of these weevils, and another hymenopteron (*Cerceris arenaria*) often does the same.

Blackbirds and thrushes also devour them.

London, S.W.1,
June, 1894.

Revised, April, 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.

Flea Beetles.

Introduction.—All who have grown turnips, cabbages and similar crops will be only too familiar with the pests which pass under the names Flea Beetles, Turnip Flea or Turnip Fly: in the aggregate the damage which is caused by these insects must be enormous. Moreover, turnips and plants of the cabbage tribe are not the only crops attacked, for there are many species of Flea Beetles with different habits, and at times mangolds, barley, hops, and even potatoes, may suffer greatly. This leaflet, however, deals mainly with the species which attack turnips, other plants of the cabbage tribe, and mangolds. Flea Beetles occur throughout the United Kingdom and in fact are known as pests in practically every country in the world, though the species found abroad are not of course in all cases the same as those known in Britain.

Nature of Damage.—The chief damage is done when the adult beetles attack the first two leaves of the crop as they appear through the soil, eating them away and often destroying the seedlings completely. Damage is also done when the plants are in the "rough leaf," but it is less serious, and as a rule the crop is then able to grow away from the attack, though in an unfavourable season the check may cause appreciable loss. Unfortunately the beetles are most active and appear most numerous in dry, hot weather, just when the crop is standing still or growing slowly, and under such conditions it is not uncommon to find two or even three sowings cleared off entirely. Turnips and swedes perhaps suffer most, but rape and mustard are almost as liable to attack, while all vegetables of the cabbage tribe may be destroyed while in the seed bed. Mangolds are not so often damaged, possibly because they are less affected by drought, or are grown on soil which naturally retains moisture better, but at times (as, for instance, in 1918) they may suffer equally with swedes and turnips.

Description and Life-History. — The two most common Flea Beetles (*Phyllotreta undulata*, Fig. 1, and *P. nemorum*) are minute (one-tenth of an inch long) black beetles with a yellow stripe down each wing-case (elytron) but in company with them are often found Flea Beetles which are quite black (*Phyllotreta consobrina*, etc.), metallic blue (*P. cruciferæ*), or brassy black (*Plectroscelis concinna*, Fig. 2). The last named is the one which is chiefly responsible for the damage to mangolds (and hops).

On account of their small size Flea Beetles are not very conspicuous, though their presence is always obvious enough from the characteristic damage to the leaves. On the slightest disturbance they jump like a flea and soon become hidden among small lumps and clods of earth, where they are easily overlooked.

It is impossible to give a full account of the habits of all the common species of Flea Beetle; in most cases there is still room for investigation, but it may first be mentioned that practically all spend the winter as adult beetles hidden under bark on trees, in hedge bottoms, heaps of refuse, stacks, etc. Thousands, for instance, may be found in the bottom of a hay-stack which has been put up near a turnip field. In the spring the beetles come out and at first feed on any plants of the cabbage family which may be available—horse-radish, rape and turnip when kept for seed, charlock, and many other weeds. On warm days the beetles fly freely and probably for considerable distances, for as soon as the turnips, swedes or cabbages appear above the ground the beetles collect on them, feeding on the seed leaves.

During June, July and August, eggs are laid and after this there appear to be differences in the habits of the various species. According to a recent investigator*, in the case of the Larger Striped Flea Beetle (*P. nemorum*) and probably of the Lesser Striped Flea Beetle (*P. undulata*) also, the eggs are laid on the soil near the plants, though many other writers state that the eggs are laid on the leaves. In the case of the first-named beetle (*P. nemorum*) the larvæ on hatching crawl up and mine into the leaves, while in the case of the latter the larvæ burrow down and feed on the roots, though they may perhaps also attack the upper parts of the plant. In either case the larvæ when full-fed crawl into the soil, pupate, and after some ten days or more turn into the adult beetles which make their way out of the soil and start feeding on the turnips, etc. The length of time spent in the egg, larval and pupal stages appears to be from six to ten weeks.

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* Taylor, *Entomologist*, Vol. 51, p. 83.

FIG. 1. *Phyllotreta undulata*, Kutz.

FIG 2. *Plectroscelis concinna*, Marsh

FLEA BEETLES.

The adult beetles live from the latter half of summer through the winter and on until July or even August of the following year, when their place is taken by beetles of the next generation.

Methods of Control. (1.)—In the first place everything possible should be done to reduce the numbers of the pest by clearing out and burning the rubbish from hedge bottoms, dykes, &c. All farm refuse should be burnt when it cannot be worked into a properly made compost heap.

(2.) An increase in charlock will be accompanied by an increase in the numbers of Flea Beetles, and this alone would be sufficient reason for dealing with it either by spraying or hand pulling.

(3.) Obviously the object at which to aim is a rapid growth on the part of the young plant. This may largely depend on the weather, but nevertheless a fine tilth free from clods combined with suitable manuring will at all events go far to help the plant through the dangerous period.

(4.) It is often claimed that dressing the seed with paraffin, or preferably turpentine, is of great value in avoiding an attack. A dessertspoonful of turpentine is said to be sufficient for 7 lb. of seed.

(5.) When an attack is in progress there are various measures which may be employed. The oldest is to dust the plants with fine soil by hoeing or by driving sheep through the field. Basic slag dusted along the rows when the dew is still on the plants is also said to have proved effective.

(6.) Various devices have been used for catching the beetles and undoubtedly they can be useful. They all work on the principle of disturbing the beetles, causing them to jump, when they are caught on tarred boards or sacks. There is no standard pattern for these machines as they are made up from any material which may be available on the farm. A very simple form, for instance, consists of two old bicycle or perambulator wheels joined together by an axle from which hangs a fringe of material—old bags, for instance—about two to three feet wide and the length of the axle. A pair of handles is also attached to the axle. The bags are then well tarred or covered with grease-banding material to within about six inches of the ground, and the whole apparatus is *pushed* (not pulled) by a boy up and down the field. The tarred side hangs downward and sweeps over the plants, causing the beetles to jump up and stick to the tar. Much depends on keeping the tar fresh and doing the work well.

More efficient machines than this can easily be made on the principle of that illustrated below (Fig.3) for use on garden crops. This trap was invented by Professor Lefroy and was tested at the Royal Horticultural Society's Gardens at Wisley, where it was found most effective.

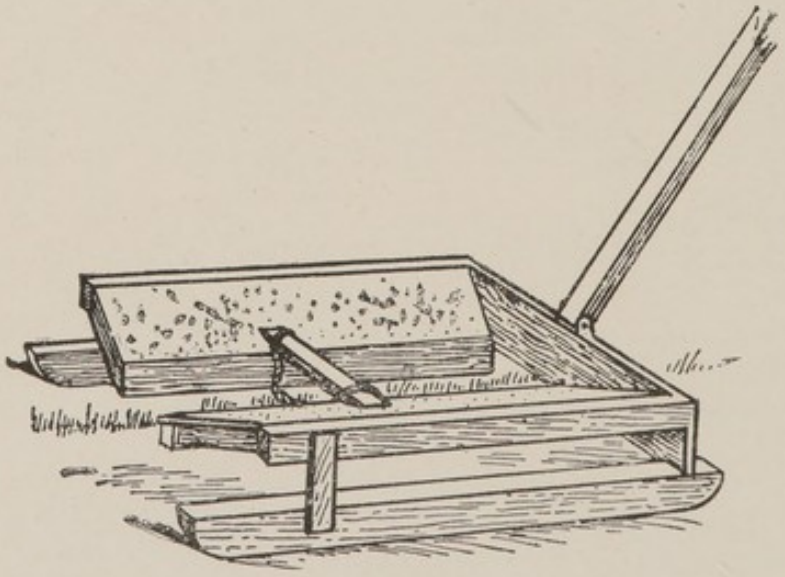

FIG. 3.—Flea Beetle Trap.

The apparatus consists of a framework, on runners (or small wheels), made to carry two pieces of thin board 20 inches long by 5 inches wide, placed side by side but with the outer edge higher than the inner edge, *i.e.*, sloping outwards and upwards, and with a clear space of 4 inches

between the inner edges. These two sloping boards must be connected just before the middle by a cross-bar, and behind by a back board. A loop of cord is tied to the cross-bar so that it barely touches the ground, and when in use the surface of the sloping boards, the cross-bar and the back board, must be coated with some sticky substance such as tar or grease-banding material.

The trap is pushed along the rows of turnips, mangolds, etc., in such a position that the loop of cord brushes the young plants. The beetles are thus disturbed and, leaping up, alight and are caught upon the sticky boards. It is necessary to renew the sticky surface occasionally during the process of the work.

(7.) Spraying is also well worth testing, as in America and Canada both lead arsenate and paraffin emulsion are said to have given quite satisfactory results, while many writers in this country record good results with paraffin alone. Potato sprayers are now available on many farms and allotments, and there is no excuse for allowing crops to be eaten off without making an effort to save them. The following are formulæ for making paraffin emulsion and lead arsenate washes. It is suggested that the former should first be tried.

(*a.*) Paraffin Emulsion.

Paraffin	...	...	...	2 pints.
Soft Soap	...	...	...	1 lb.
Water	...	...	...	10 gallons.

Dissolve the soft soap in about a gallon of boiling water, remove the soap solution from near the fire and while still hot add the paraffin. Churn the mixture very thoroughly by syringing it back into itself, add soft water to make 10 gallons, and before using make sure that there is no free paraffin floating on the surface.

(*b.*) Lead Arsenate Wash.

Lead arsenate paste			...	1 lb.
Water	...	...	...	20-25 gallons.

Mix the lead arsenate paste with a little of the water to the consistency of thin cream and then add the rest of the water.

(8.) Dusting with insecticide powders can also be effective. Powdered naphthalene was recently tested on a seed bed of cabbages which was being badly attacked, 1 oz. of powdered

naphthalene being allowed to each row—about 30 ft. long by 2½-3 in. wide. No further damage was done. Pyrethrum powder should also prove useful, and the old remedies, soot and lime, scattered on the plants when damp can be employed when no other remedies are available.

London, S.W.1,
July, 1895.
Revised March, 1919.

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BOARD OF AGRICULTURE AND FISHERIES.

Winter Moths.

FIG. 1.

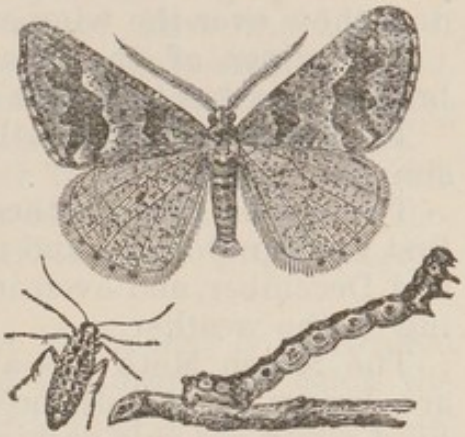

FIG. 2.

Fig. 1. Winter Moth (*Cheimatobia brumata*). Fig. 2. Mottled Umber Moth and Caterpillar (*Hibernia defoliaria*). Male Moth, winged; Female Moth, wingless. All natural size.

There are several moths whose wingless females crawl up the stems of fruit and forest trees in the autumn and early winter and spring and deposit eggs in the interstices of the bark of the twigs and branches. From these eggs caterpillars are hatched in the spring which bore into buds and eat the foliage, the blossoms, and young green shoots and, in conditions favourable to their development, cause much injury to the fruit crop. Among these moths the Winter Moth (*Cheimatobia brumata*) (Fig. 1), the Mottled Umber, or Great Winter Moth (*Hibernia defoliaria*) (Fig. 2), and the March Moth (*Anisopteryx aescularia*), are the principal offenders. In some seasons, especially when the rapid growth of leaves and flower trusses is arrested by spells of cold weather, great mischief is caused by the caterpillars of these and other moths, the females of which are wingless. Sometimes the trees are left as bare as in winter, and are, as a result, seriously injured for another season. The caterpillars attack apple, plum, damson, cherry, filbert and cob-nut trees, and also currant and gooseberry bushes. They are occasionally harmful in woods, feeding on the hazel, maple, hornbeam, lime, oak, hawthorn and blackthorn.

Description and Life-History.—About the second week of October, the two Winter Moths come from chrysalids in the ground, under and near the trees that were infested with caterpillars in the preceding summer, and the wingless females crawl up the trees for the purpose of egg-laying.

The Moths.—The male of the Winter Moth measures 1 to 1¼ inches in spread of fore-wings. These are grey-brown in colour with darker wavy lines. The hind wings are pale grey and are without markings.

The female moth has the wings so small that flight is impossible. The abdomen of the female is large and the legs long.

The Mottled Umber is about twice as large as the Winter Moth. The male has the fore-wings pale brown or brown-yellow, each with two dark bands. The hind wings are paler and have a brown spot near their middle. Small dots show over the wing surface.

The wings of the female are practically abortive; the brown body has two dark spots on every segment.

The antennæ of the male are combed, those of the female simple.

The moths of both these species begin to appear in the first week in October, and may be seen throughout November and December, and even in January and February—depending on the weather.

The March Moth has a brownish head. The fore-wings are brown or yellow-brown with transverse bands; the hind wings are pale greyish-white with a darker zig-zag line running across them. The moth measures about three-eighths of an inch in length and up to 1½ inches in spread of wings. The female is wingless, brownish-yellow, and has a pencil or tuft of hairs at the hind end.

The March Moths appear typically, as the name indicates, in March, but they may be found earlier.

The Eggs.—The eggs of the Winter Moth are very small, cylindrical, and at first of a light green colour, afterwards becoming red. They are placed in small groups, usually at the base of buds and on pruned surfaces, but also on the larger branches and on the trunk, the latter specially when the trees are banded. From 150 to 200 eggs are laid by one female.

The Mottled Umber Moth lays larger, rather rusty coloured, long eggs, and more in quantity (as many as 400), placing them in lines, or small groups, according to circumstances.

The eggs of the March Moth are laid round the twigs in bands or rows, and embedded in the down or hairs from the hind tuft of the female.

The Caterpillars.—From the eggs the caterpillars come in the early spring, usually about the middle of March, and, as it appears, just before the buds begin to burst. The Winter Moth caterpillars are at first grey, with dark heads, and so small that it is difficult to see them. Later on they become greenish, with white stripes and brown heads, and are finally rather yellow. When full grown they are about three-quarters of an inch long. They, as well as those of the Mottled Umber and March Moths, are called "loopers," or "measurers," on account of the position they assume when moving. They have six true legs, and only two pairs of prolegs, one pair of these being at the hind end of the body, so that they can be easily distinguished from caterpillars of moths of other families. These larvæ eat bud, leaf, blossom, and fruit, and spin the blossom heads, and also the leaves, together, and live under their protection. When food fails, or when they are fully fed,—from May to June—they let themselves down by silken threads to the ground, in which they bury themselves

The caterpillar of the Mottled Umber Moth is chestnut brown above, yellowish on the sides and underneath, with a wavy dark stripe on each side of the brown. It is much larger than the Winter Moth caterpillar, being 1¼ inches in length (Fig. 2). These caterpillars, too, have the habit of letting themselves fall from the twigs, to hang by a silken thread. When the period of pupation arrives the caterpillar descends to the ground and changes to a chrysalis just below the surface.

The caterpillar of the March Moth is yellowish green, with a darker green line down the back edged with yellow ; there are pale yellowish lines at the sides. The pupal stage is passed in the ground.

Methods of Control.—Winter Moths may be controlled either by grease banding the trees in autumn to catch the wingless females as they ascend the trunks or by spraying the foliage in spring to kill the larvæ. The former method is most in use and will be found effective in the case of standard trees where the bands can be placed from 3 to 5 feet above the ground. When the bands are placed low down, which is inevitable in the case of bush trees, a number of the moths usually find their way over the bands. How they do so is not altogether clear, but there seems no doubt that the male moths are able to carry the females for a short distance when pairing. Moreover in the case of bush trees the process of banding is somewhat troublesome and spraying is usually the better method to employ.

Where trees are often attacked by larvæ of the "Bud Moth" (*Hedya ocellana*) or of other moths with winged females banding may be neglected since it is possible to control both these larvæ and those of the winter moths by means of an arsenical spray in spring.

Grease Banding.—The bands should be placed on the trees at the beginning of October and should be kept in a "tacky" condition until April. Winter Moths appear between October and January, but the majority are caught in November and early December. March Moths emerge in February and March, while during the latter month and in April the eggs of the Winter Moth hatch. Since some of the latter are likely to have been laid on the trunk of the tree below the band, the young larvæ must be prevented from ascending.

Various compositions for use in banding are on the market and growers will learn by experience which are best suited to their requirements. In general they fall into two classes, (1) those of an oily nature, (2) those which are sticky, like bird lime. The former are usually cheaper to buy but must be renewed about three times during the season, while the latter are more expensive, but one application should be sufficient. Greasy compositions must never be applied directly to the bark of the tree or erious injury may be caused. This warning also applies to many of the "sticky" compounds, though it is said that some of the latter are harmless. Unless the grower has

definite information as regards the particular compound he is about to use, it is wise to protect the bark by means of a paper band. Exceptions to this rule are old trees with a very uneven surface, since in these cases the paper band would not fit sufficiently closely to prevent the moths from crawling underneath.

A stout, grease-proof paper is usually used for banding purposes and it should be noted that good paper, though more expensive than bad paper, is the more economical in the end, since it will retain the grease in good condition for much longer.

The paper band should be from 7 to 9 in. wide and should be firmly tied round the tree 3 to 5 ft. from the ground, by two pieces of string, each string being an inch or two from the edge of the paper. The best methods of applying the composition to the band naturally vary with the class of substance used, but, in general, it should cover from 3 to 6 in. of the band and should be so applied as to form horizontal ridges rather than a uniform smooth surface, since it will then remain sticky for a longer period. Compounds which are thin and liable to run should be applied mainly to the upper part of the band so as to prevent the drops from running off on to the bark. A good material will retain its sticky qualities for many months, though it may be necessary to scrape the bands occasionally to expose a fresh surface to the air. The bands should be examined periodically to find whether they are still sufficiently "tacky" to fulfil their object, and a fresh coating of composition must be put on if necessary.

Spraying.—Lead arsenate has been found most satisfactory for this purpose. It is usually obtained in the paste form, 4 to 5 lb. of paste being added to 100 gallons of water. The spray should be applied as soon as the leaves begin to appear, and, if necessary, a second application may be made after the fruit has set, but in no case should lead arsenate be used on open blossom owing to the danger of poisoning bees. A nozzle giving a fine, misty spray is most suitable, and the foliage should not be drenched so that the liquid drops off the tips of the leaves. Lead arsenate may be used in conjunction with either Bordeaux mixture or lime sulphur if it is necessary to deal also with fungus diseases—as for instance Apple Scab (*see* Leaflet No. 131) or Brown Rot (*see* Leaflet No. 86).

London, S.W.1,
September, 1895.
Revised, August, 1918.

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BOARD OF AGRICULTURE AND FISHERIES

Mangold Fly (*Pegomyia betae*, Curtis).

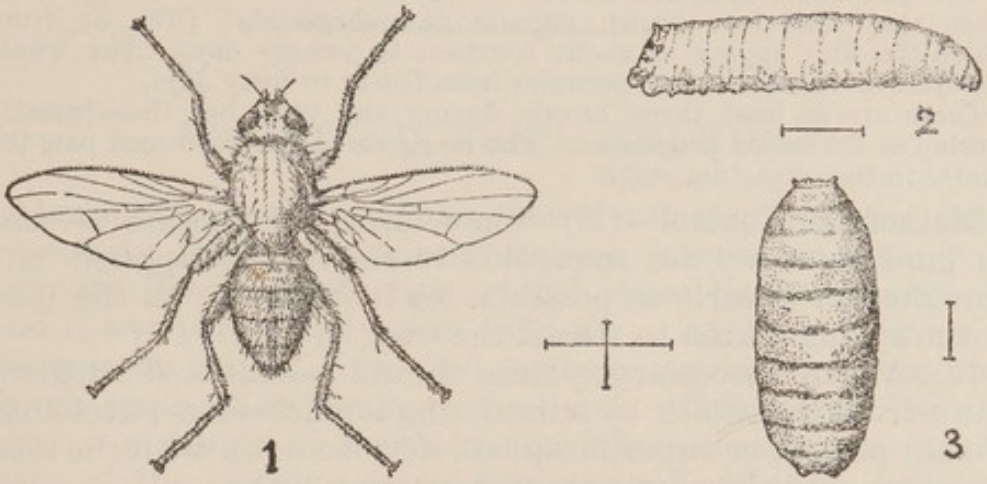

FIG. 1.—*Pegomyia betae*, Female. FIG. 2.—Larva. FIG. 3.—Puparium, the figures magnified, the actual size being indicated by lines on the right of Figs. 1 and 3 and beneath Fig. 2.

The Mangold Fly as an enemy of sugar beet, mangolds and spinach is well known throughout Europe and N. America. In the British Isles it chiefly attacks the mangolds, but various other plants such as Henbane, Belladonna, and Goosefoot also serve as food-plants for the larvae. It is seldom a serious pest to the root crops except when it attacks the plants at an early stage of their growth—especially when weather conditions are against rapid growth—but even later attacks, by lowering the vitality of the plants, reduce the weight of the crop. The fly is much more numerous in some years than in others; at times its numbers may be so reduced owing to unknown factors that it becomes comparatively harmless.

Nature of Injury.—After the mangold plants have been singled and begin to show growth they sometimes suddenly droop and present a withered appearance. Upon examination pale blotches, like blisters, will be found upon the leaves caused by the maggots of the fly feeding upon the tissues between the upper and lower skins of the leaf. These discoloured patches become brown and withered, and when the attack is severe and weather conditions unfavourable small plants may be killed outright.

Description and Life-History.—The fly (Fig. 1) is about the size and shape of the common house fly. It is brownish-grey and bristly, the abdomen is a paler brown and usually a fine dark dorsal line can be traced down the middle. The legs are extensively yellow.

This fly appears in the spring and the female lays her eggs singly or in groups of two, three, or four—rarely more—upon the under surface of the leaves of the young mangold plant. The eggs are elongate oval, and pure white. From these eggs the creamy-white legless larvae hatch in

about five days and immediately bore their way through the skin into the central leaf tissue in which they mine, thereby producing the blisters in the leaves. When full-fed the larvae (Fig. 2) are about one-third of an inch long, pointed at the head end, squarely blunt and bearing minute tubercles at the tail. After feeding for about ten to fifteen days the larvae quit the leaves and burrow about two inches into the ground, when they turn into brown puparia or "chrysalids" (Fig. 3), from which the flies appear in about fourteen to twenty days. The whole life-cycle of the insect thus occupies from thirty to forty days.

There are at least three broods during the year, but these greatly overlap as the season progresses. The maggots of the last brood pass the winter in the puparium stage.

Methods of Control—(1.) When farmyard manure is used on land intended for mangolds it should be applied and ploughed in as early as possible, for its presence on the land in the spring is said to attract the flies.

(2.) Where necessary, plants should be assisted to grow away from the attack by stimulating top dressings ; dressings of salt, potash, or superphosphate may be sown with the seed to ensure a healthy growth of the young plant.

(3.) Though perhaps not commercially worth while for large areas, spraying the plants in order to prevent the flies from laying their eggs or to kill the young maggots, is effective if carried out sufficiently early, and repeated during the critical period of the plant's growth. Good results are said to have been obtained from the use of a 5 to 7 per cent. solution of barium chloride,* and with a paraffin and nicotine emulsion, for which the following formula might be tried :—

Soft Soap	1 lb.
Paraffin	1 pint.
Nicotine (95 per cent.) ...	$\frac{3}{4}$ oz.
Water	10 gall.

Dissolve the soft soap in 1–2 gallons of boiling water. Emulsify the paraffin in the hot soft-soap solution by taking up the paraffin in a garden syringe, a syringeful at a time, and squirting it violently into the soap solution. Dilute to 10 gallons by the addition of 8–9 gallons of water as required. Add the nicotine and stir well before using.

(4.) Where a mangold crop has been badly attacked by the fly, the following crop should preferably be a spring-sown one, in order that by suitable cultivation during the winter the pupae of the flies buried in the earth may be exposed to the attacks of birds and to the effects of greater variations in temperature.

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* Vassiliev, E. M. Report on the work of the Experimental Entomological Station of the All-Russian Society of Sugar Refiners in 1913. Kiev, 1914.

London, S.W.1,
January, 1898.
Re-written September, 1918.

BOARD OF AGRICULTURE AND FISHERIES.

VOLES AND THEIR ENEMIES.*

Among the vermin whose excessive multiplication, under especially favourable circumstances, results in injury to farmers, the field vole has several times been conspicuous, and it was particularly so in 1892, when it inflicted extensive damage on young grass and herbage, on hill grazings and rough pastures in southern Scotland. This animal has also proved a source of much loss on other occasions in various parts of the country, as in Essex and Kent three hundred years ago, in Gloucester and Hampshire early last century, and again in Scotland in 1875-6.

The animal which caused so much mischief on many hill farms in the southern uplands of Scotland in 1892, although often spoken of as a mouse, is technically known as the short-tailed field vole (*Microtus*, formerly *Arvicola*, *agrestis*) (PLATE I.). Two species of the genus *Microtus* inhabit this country, viz., the water rat (*M. amphibius*) and the field vole (*M. agrestis*). The red or bank vole (*Evotomys glareolus*) belongs to another genus.

All three voles are distinguished from the true mice (genus *Mus*) (PLATE II.) by their stouter body, thicker head, blunt muzzle, small ears, and the tail shorter than the body, whence they are often called short-tailed mice. Their molars, or back teeth, have flat crowns, with transverse ridges of enamel, adapted for grinding the vegetable matter on which they feed, whereas in true mice they are covered with points or tubercles suitable for an omnivorous diet.

The Short-Tailed Field Vole (*Microtus agrestis*).

This vole is at all seasons an inhabitant of our pastures, and may be found at all heights, from the sea level to near the summits of our highest hills; its favourite haunts, however, are low-lying moist grass lands and damp plantations, especially when young. In such spots, and more frequently in the former, these animals live in communities,

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* The illustrations of birds, together with the notes on which this leaflet is based, have been taken from the Report of the Departmental Committee on Field Voles (Scotland), C. 6943.

forming numerous burrows at a considerable depth, each pair having their own dwelling in which they bring up their young, and deposit their store of winter food. All around, their tortuous runs are seen on or near the surface, indicating where they have been foraging.

The characteristics of the field vole (PLATE IV.) are a blunt rounded muzzle, short ears, and a short hairy tail. These features distinguish it from the true field mouse, or long-tailed field mouse (PLATE IV.), which has a pointed muzzle, prominent ears, and a long naked tail.

The field vole usually produces three or four litters a year, each consisting of from four to eight young ; in some seasons, however, it is even more prolific, the breeding season being prolonged from February to November, and the litters containing as many as ten young.

Its diet is principally herbivorous, consisting of grass, the roots of young broad-leaved trees and conifers, and the tender bark of trees and shrubs. It particularly affects the delicate white stems of grass but in times of scarcity nothing green comes amiss to it. Insects and worms are also eaten ; in connection with the destruction of Larch by the caterpillars of the Large Larch Sawfly this vole has been found destroying the cocoons and eating the caterpillars.

The Water Vole or Water Rat (*M. amphibius*).

The water vole devours the stems of grain, grasses, &c., growing near water, and also barks the exposed roots and bases of stems of shrubs and trees, osier beds for example being sometimes much harmed. The water vole also damages the banks of rivers, canals, and dykes. It lives along the borders of streams or almost any piece of water, also in damp meadows, and tunnels long passages into the soil. It is blackish-brown on the back, while the belly is greyish-brown or black. Its length is 6 inches. The water rat differs from the common brown or Norway rat in having a rounded muzzle, short ears, and a short hairy tail.

The Bank Vole (*Evotomys glareolus*).

This vole occurs chiefly in and around forests and woods, being especially fond of sheltered banks, ivy-clad tree stumps, and the exposed roots in banks. Not infrequently it does considerable damage to trees. It climbs to the height of ten feet or more, and eats out the terminal and lateral buds, its action resulting in the formation of misshapen stems. The bank vole is brownish-red with a pure white breast, belly, and feet ; the ears are longer than in the field vole, coming well above the fur. It varies in length from 3½ to 4 inches, while its tail reaches 1¾ inches. It is not difficult to catch by means of traps baited with cheese.

Natural Enemies of Voles.

Most of the animals described as preying upon the field vole are likewise natural enemies of mice and rats. Thus weasels, stoats, foxes, rooks, crows, ravens, sea-gulls, kestrels, owls, and buzzards are all known to prey upon these vermin.

*Short-Eared Owl.**—This bird (*Otus brachyotus*) is one of the greatest and most effective enemies of the field vole. It is distributed over almost every part of the globe, and is a normal winter immigrant to these islands, appearing simultaneously with the woodcock (whence it is popularly known as the "woodcock" owl) and usually departing in spring. Nests in ordinary seasons are of comparatively rare occurrence in Great Britain, but on occasions when there has been a multiplication of their favourite food, the vole, these owls (PLATE I.) have not only arrived in unusual numbers, but have remained and bred all over the affected district, laying from 8 to 13 eggs, and rearing more than one brood. Professor Newton, however, in his edition of Yarrell's "British Birds," mentions seven as an unusual number of eggs, and five seems a general clutch.

The short-eared owl differs from most other owls in that it hunts in daylight—hence one of its names "Hawk" owl—so that its beneficial operations can be observed, but the nocturnal species are no less beneficial to farmers in destroying small rodents, and it would be difficult to condemn too severely the foolish and cruel action of those who encourage or allow the destruction of this useful and beautiful family of birds.

The Kestrel.†—Next, and hardly inferior in merit, as a check upon voles and mice, comes the kestrel (*Falco tinnunculus*) (PLATE II.), and it is to be deplored that popular ignorance as to its food and habits is even greater than that which prevails in regard to owls. This bird, although possessing the long wings and dark eyes characteristic of a true falcon, is known to gamekeepers as "a hawk," and its death warrant is a standing order in some preserves, though here again there has been great improvement, and the destruction of the kestrel is forbidden on many estates. The food of this bird is known to consist chiefly of voles mice, and insects.

It is one of the peculiarities of the *Falconidæ* that their plumage varies according to their age and sex; in the southern counties of Scotland the sparrow-hawk (PLATE III.), which does not prey on mice, is generally known as the "blue hawk," and the kestrel as the "brown" or "red"

* *See also* Leaflet No. 42 (*Short-Eared Owl*).
† *See also* Leaflet No. 40 (*Kestrel or Wind-hover*).

hawk. But an immature male sparrow-hawk has reddish-brown plumage, and an adult male kestrel has a bluish-grey head and back. The Kestrel is also characterised by its habit of poising or hovering, so that for many minutes its position in the air is practically stationary.

Other Birds.—Buzzards and *ravens* destroy voles and mice, and are too heavy on the wing to do much injury to game. *Rooks* and *crows* have also been known to dig up the nests of voles and mice, and to devour the young. Certain species of *sea-gulls* have also been observed to prey on voles.

*Stoats and Weasels.**—These little animals are among the deadliest and most persevering enemies of small rodents. They kill far more than they can devour, apparently out of sheer blood-thirstiness. In woodlands and on low ground they undoubtedly do much harm to game, especially the stoat (PLATE V.), which may be easily distinguished from the weasel (known in Scotland as the "whittret," PLATE V.) by its greater size and by the black tuft on the end of the tail, which is retained at all seasons of the year, even in winter, when the rest of the body becomes wholly or partially white.

It is, perhaps, hardly reasonable to expect that stoats should be allowed to multiply in game-coverts, or in the vicinity of pheasant coops, but the Board have no hesitation in recommending that weasels, which are persistent mouse-hunters, and do little damage to game, should not be molested, at least in moorlands and hill pastures, where they can do little harm and much good.

The natural enemies of the vole may be divided into two classes: (1) those which destroy voles and are harmless to sheep, crops, and game, and (2) those which, though preying on voles, are so harmful in other ways as to have less claim to preservation:—

1. *Vole-killers, harmless, or nearly so, to sheep, crops, and game:* Owls of all sorts, buzzards, kestrels, and the smaller sea-gulls.
2. *Vole-killers, harmful in other ways:* Stoats, weasels, ravens, carrion and hooded crows, rooks, and great black-backed gulls.

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* STOAT. *Putorius ermineus*, formerly *Mustela erminea*.—Locally known as Weasel, Stoat, Clubster, Lobster, and Ermine (in winter). General colour, brown above, white beneath. Tail longer than in Weasel, and with a black tip at all seasons, even in winter, when the fur becomes white or partially so. Average length of head and body, 9 to 10½ ins.; tail 4½ to 6 ins. Preys on mice, voles, rats, rabbits, leverets, and young game-birds.

WEASEL. *Putorius nivalis*, formerly *Mustela vulgaris*.—Locally known as Whittret, Cane, and Mouse-hunt. Average length of head and body, 7 to 8¾ ins.; tail, 2 to 2½ ins. Colour, reddish-brown above, white beneath; tail brown. Does not turn white in winter. A persistent enemy to rats, mice, and voles. It also takes rabbits and leverets

Strict injunctions should be given by landowners that the birds mentioned in the first class should not be destroyed. Their presence in full numbers, though inadequate to avert an outbreak of voles, would undoubtedly tend to mitigate it, and, as has been proved in the case of the short-eared owl, they have the faculty of multiplying abnormally in presence of an unusual supply of food. They are, at all events, most useful allies to man in combating attacks of ground vermin.

The use of the pole-trap is illegal.

Protective Measures.

With reference to the steps which may be taken by occupiers to protect themselves in the earlier stages of an outbreak, it is of great importance that early information be given to the local organizations, farmers' clubs, or agricultural societies, and to all interested, of the first signs of any exceptional multiplication of voles. Systematic and concerted attempts should then at once be adopted to stamp out the plague throughout the affected district. The most effective measures appear to be the periodical and timely burning of grass or heather, followed by active pursuit of the vermin by men with wooden spades and dogs. Where plantations of limited extent are attacked, pit-falls, wider at the bottom than at the top, and about 18 inches deep, have been found efficacious in trapping many voles.

London, S.W.1,
July, 1893.
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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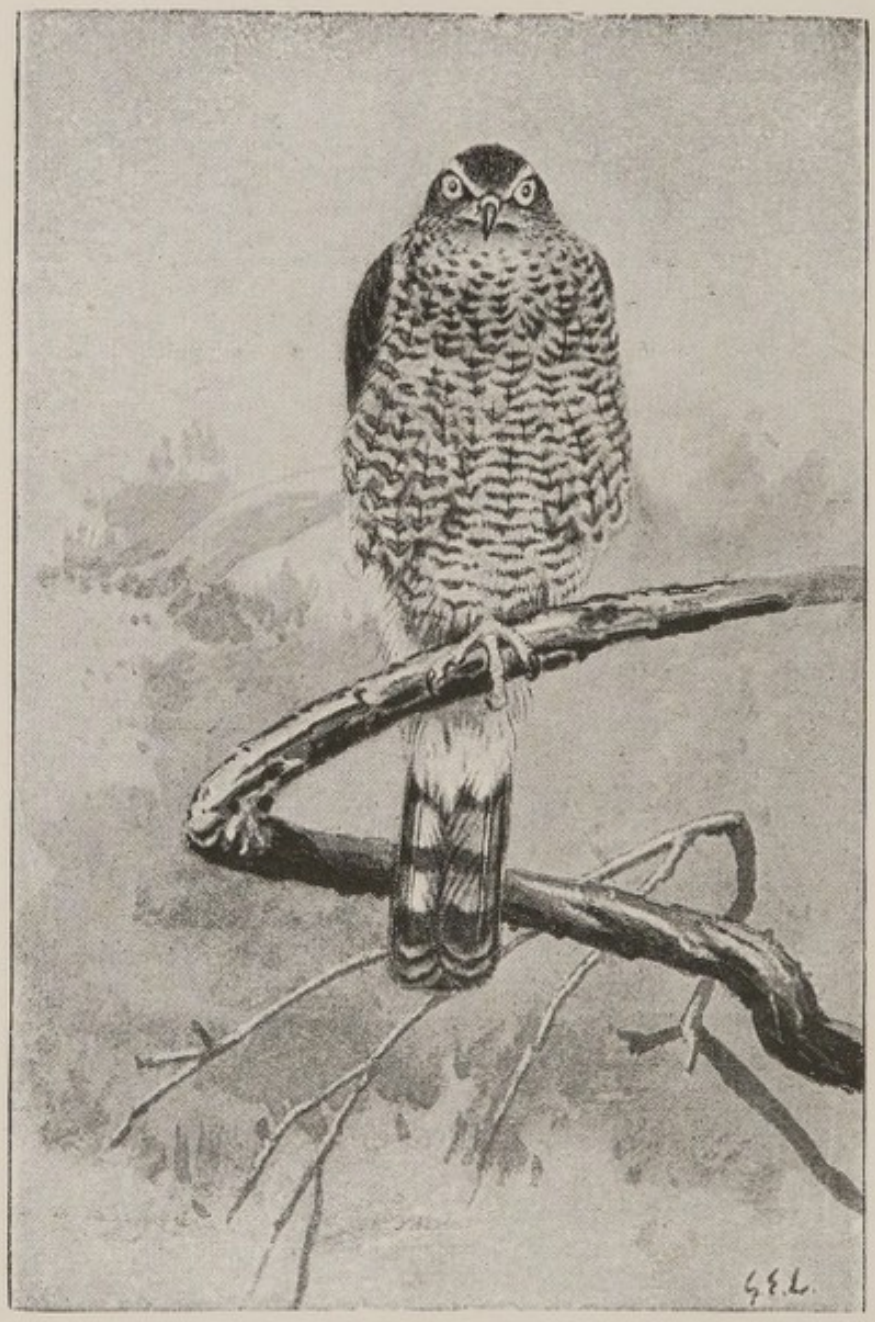
Plate I.

SHORT-EARED OWL. *Otus brachyotus.*—Migratory, living much on the ground, and of diurnal habits. General colour, yellowish-brown above, variegated with spots, streaks, and cross-bars of a darker colour ; pale beneath. Eyes yellow. (The eyes of the White or Barn Owl and the Brown or Tawny Owl are black.) Appears usually in October (whence called Woodcock Owl) and remains until April. A few remain to breed annually in suitable situations. Preys largely on mice and voles.

Plate II.

KESTREL or WINDHOVER. *Falco tinnunculus.*—Locally known as the Brown or Red Hawk. A long-winged, dark-eyed Hawk, with reddish-brown back and bluish-grey head and tail when adult. Preys upon mice, voles, beetles, grasshoppers, small birds, and occasionally young game-birds. Easily recognised on the wing by its habit of hovering over the fields.

Plate III.



SPARROWHAWK. *Accipiter nisus.*—Locally known as the "Round-wing" or "Blue Hawk."—A short-winged yellow-eyed Hawk with long-barred tail. Mottled brown above when young, brownish-grey when adult. White beneath, with transverse bars on breast and flanks. Preys upon small birds, black-birds, thrushes, pigeons, and young game-birds. Does not hover like the Kestrel.

Plate IV.

SHORT-TAILED VOLE. *Microtus*, formerly *Arvicola*, *agrestis* (nat. size).—Locally known as Field Vole, or Grass Mouse, and Meadow Mouse. Colour, reddish-brown above, paler beneath. Average length of head and body, 4 ins.; tail, 1 in. External distinguishing characters: short rounded muzzle; short ears, almost buried in the fur; short hairy tail.

LONG-TAILED FIELD MOUSE. *Mus sylvaticus*.—Colour, sandy-brown above, white beneath. Average length of head and body, 4¼ ins.; tail, 4 ins. External distinguishing characters: long pointed muzzle, prominent naked ears, and long naked tail.

PLATE V

Above: WEASEL (*Putorius nivalis*, formerly *Mustela vulgaris*) × ½ (*see* p. 4).
Below: STOAT (*Putorius erminea*, formerly *Mustela erminea*) × ½ (*see* p. 4).

BOARD OF AGRICULTURE AND FISHERIES.

Autumn Catch Crops and Fodder Supply.

The Board of Agriculture and Fisheries believe that it may be useful to direct the attention of farmers and others to special and catch crops, which, in the event of an early harvest, may, under favourable conditions, prove of utility in providing green food for stock in the succeeding autumn winter, and spring in districts where severe and prolonged drought has seriously diminished the ordinary hay and fodder crops of the season.

The policy of resorting to one or other of these catch crops must in every case be determined by the varying local circumstances of soil and climate, and cannot be made the subject of general recommendation.

It cannot be too strongly emphasized that more attention might usefully be given to green fodder and catch crops as a provision against possible drought and hot summers. Such crops need never be wasted ; when not absolutely required for fodder in the green state they can almost invariably be ensiled and held in reserve for winter use.

Rye, if sown by the middle or end of July, might afford good food for stock early in the autumn, or it might be mown for hay if the land were strong and in good heart. It would furnish very early food for stock in the spring, or it could be made into silage. Rye in the early stages of its growth should be top-dressed freely with nitrate of soda.

Oats put in in July would give food for soiling or cutting in the autumn. The crop might also be made into hay, and it is equally useful for converting into silage.

Trifolium incarnatum on suitable soils and under favourable conditions, in its three varieties, early, medium, and late, may be largely sown in proper proportions to follow in succession in cutting. It may be sown on stubble directly the cereal is off, while it might also take the place of red and other spring-sown clovers that have failed.

Italian Rye Grass sown very thickly in July or August, would under favourable conditions yield some good food in the autumn, and again in the following spring. This crop provides good fodder for dairy stock. It may be sown after vetches or grain crops from July to September, but will require a heavy manuring of nitrate of soda or other nitrogenous fertiliser.

Trifolium pratense, or Red Clover, when sown by the first or second week in July, either alone or with Italian rye-grass, might with sufficient moisture yield a good crop in the autumn. It should be simply brushed or rubbed in, or harrowed in by a chain harrow, followed by a roller. Nitrate of soda and superphosphate may be used as manures. This clover can only be mown once, but it affords excellent seed throughout the late summer and autumn after its crop of hay.

A mixture of *rapid growing Grasses and Clovers*, such as red clover and Italian rye grass, with the addition of cocks-foot, trefoil, and alsike, should, with the necessary moisture, yield a good crop by the end of September, or in October, when sown by July.

Brank, or Buckwheat, may in some instances be grown with advantage, where climate and soil permit. It grows rapidly, may be sown up to the end of July, and suits poor dry light soils.

White Mustard grows very rapidly, and may be sown where turnips and mangolds have failed, or upon stubble. If plenty of seed be used, and some phosphatic manure be applied to the stubble, there should be good sheep food in six weeks or less, but this crop does not stand a hard winter. A peck of seed per acre, sown as late as the end of August, will yield good food by the end of November.

Rape, in the form of Giant Rape, may be drilled in the old drills where mangolds and swedes have failed, or on freshly ploughed stubbles. In a favourable season there might be time to single it and get a good crop, or it might be left unhoed.

Dwarf or ordinary rape may be sown broadcast in July and August on land where crops have failed, and should be harrowed in. On stubbles it may be sown broadcast with 3 or 4 cwt. of superphosphate per acre, and will furnish good food for the spring.

Thousand-headed Kale, when drilled in July or August, well manured, and afterwards singled, will under favourable conditions supply a valuable and very bulky food for both sheep and cows in early spring from February onwards. If kale plants are available time would be saved by their being transplanted where other crops have failed.

Thousand-headed Kale has, in many districts, taken the place of rape, as it yields a heavier crop.

Kohl-rabi may be put in up to the end of July where turnips and mangolds have failed, and where turnips could not be again sown, but in most districts the season would be too much advanced for a large crop to be looked for.

Vetches, sown after an early cereal crop, where the stubble has been broken up either by a plough, grubber, or harrow, might afford much food, even in the late autumn, on well-farmed land. The seed should be sown with oats, wheat, beans, or rye to support the vetches.

Winter Oats and Barley, if put in before the end of July, may furnish a fair yield of food for soiling or ensilage. If the weather is unfavourable to quick growth these crops will still furnish excellent food for stock in the spring.

Pea Haulm, if made into hay, should form a useful addition to the stock of fodder for winter feeding.

Hop Bines may also be made into hay. For this the finer bines, which are often trained on cocoanut fibre strings, may be specially used, but care must be taken to pull out all strings so that they are not eaten by cattle. In making hop bines into hay the bines must be got together directly they are "hayed," and not left till the end of hop-picking. It will pay to take up the bine-hay when ready ; the neglect to take this precaution is the probable cause of the hop-bine hay frequently turning out poor.

Late Swedes, Turnips, &c.—Where mangolds and swedes have failed to come up, it would not be too late up to the end of July to run in the same drills, either with or without manure, some of the late and hardy varieties of swedes and turnips, six weeks turnip, or the grey stone turnip. There are several varieties of turnips which might be sown late in this way which would produce considerable quantities of keep, and stand the winter, even where sown broadcast, and some of them may be sown upon stubbles, after an early harvest, when they would have nearly three months to grow in.

Brewers' Grains will form a useful addition to rations of straw for stock in the absence of hay.

Clover Leys (Old Leys), instead of being ploughed up in the autumn, after a hot, dry summer, may often be left down for another year in cases where the plant is at all good.

*Ensilage.**

The process of preservation by ensilage, either in pit or in stack, is applicable to all kinds of green food, such as *Clover*, *Vetches*, *Rye*, *Oats*, *Wheat*, *Peas* and *Beans*.

Silage may be either sweet or sour, according to the pressure employed. In sweet silage the material is allowed to heat to a higher temperature than in the other form.

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* *See* also Leaflet No. 9 (*Ensilage*).

Sorghum Saccharatum, drilled or dibbled in not later than the second week of July would, in a hot summer, yield a bulky crop suitable for ensilage. If, however, the late summer should prove cold or wet, the crop is unlikely to prove successful.

Maize, or Indian corn,* will yield a crop large enough for ensilage when sown up to the end of July in the southern counties. When sown late the seed should be previously soaked to ensure rapid germination.

Great care must be taken in converting maize or sorghum into silage, as both are apt to become mouldy.

Refuse herbage.—Rough herbage on the outside of fields, by the sides of hedges and roads, &c., should be mown and put into silos with any brushings of meadows and pastures.

Coarse Hop Bines may be chopped while green and put into the silo, care being taken to remove all cocoa-nut fibre strings.

Aftermath.—Pastures and meadows not wanted for stock may be treated in July and August with nitrate of soda, and would yield herbage, if not for hay, at any rate for ensilage late in the autumn.

Fern or Bracken may be made into hay, or put into the silo.

The green shoots of *Gorse* or *Whin* may be made use of for spring food in districts where these are available.

In the special circumstances of an abnormally hot season it may be also expedient with the view of providing sufficient supplies of fodder, to use straw for the feeding of stock, wherever practicable, and to substitute for bedding, such materials as fern or bracken, moss litter, and rushes.

London, S.W.1,
July, 1893.
Revised, August, 1911.

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* *See* also Leaflet No. 73 (*Cultivation of Maize for Fodder*).

This Leaflet is not at present (September, 1919) issued separately.

BOARD OF AGRICULTURE AND FISHERIES.

Assessments to Local Rates.

The Board of Agriculture and Fisheries have, on more than one occasion, found it useful to circulate a memorandum, prepared by the Local Government Board, directing the attention of occupiers of land in England and Wales (outside London) to the principles upon which assessments should be made to the poor rates and other local rates, and explaining the steps which may be taken, where an assessment is objected to, to obtain a reduction of the amount on the ground that their premises have been valued at too high a figure, or the valuation maintained at a level above the actual value.

It has been thought desirable to incorporate in that memorandum, in addition to the primary subjects dealt with, a reference to the bearing of the Agricultural Rates Act, 1896, whereby special and important provisions relating to the assessment of agricultural land have been enacted. The Act was originally made to operate for a period of five years commencing 1st April, 1897, but it has been continued in force from time to time and is now in operation until the 31st March, 1915. The Board would also draw the attention of owners and occupiers of land to Sections IV. and V. of the memorandum, concerning the rating of woodlands and plantations, and of sporting and fishing rights.

MEMORANDUM.

Outside London the basis for the assessment of the poor rate, and practically of every other local rate levied under the general law, is, where the Union Assessment Acts are in force, the valuation list made under those Acts. The only places in England and Wales, outside London, where the Union Assessment Acts are not in force are a few large town parishes under local Acts.

I.—*As to the Poor Rate.*

Where the Union Assessment Acts are in force, the poor rate is assessed upon the net annual, or rateable, value of premises, as entered in the valuation list. The rateable value is arrived at by making certain deductions from the gross estimated rental of the premises which is the rent at which the property might reasonably be expected to let from year to year, if the tenant paid all usual tenant's rates and taxes, and tithe rentcharge, if any. It is not necessarily the same as the rent actually paid for the property. By the Tithe Act, 1891, the liability for the payment of tithe rentcharge was imposed on the owner of the land subject to the tithe rentcharge, but it would seem that the gross estimated rental of the land is still to be calculated upon the assumption that the tithe rentcharge will be paid by the tenant of the land. The amount of the tithe rentcharge payable upon any lands, if not within the tenant's knowledge, may be ascertained by an inspection of the tithe apportionment deposited in the parish.

The deductions to be made from the gross estimated rental in order to arrive at the rateable value, are the probable average annual cost of the repairs and insurance, and any other expenses that may be necessary to maintain the property in a state to command a rent equal to the gross estimated rental.

If a person considers that his assessment to the poor rate is too high, he should, in the first place, give notice to the assessment committee and, desirably, to the overseers also, that he objects to the valuation list on which the rate is based. The notice must be in writing, and must specify the grounds of the objection. It may be served on the assessment committee by being left at the office of the clerk to the guardians, or sent by post addressed to the committee at such clerk's office, or delivered personally to the clerk of the assessment committee (usually the clerk to the guardians) or at his usual place of abode.

A day will be appointed by the assessment committee for the hearing of the objection, and on such hearing the committee have full power to call for and amend the valuation list. If they do amend it, they must give notice of the amendment to the overseers, who are thereupon to alter the poor rate current at the date of the notice of objection ; so that, if on the hearing of an objection made by a farmer or other person the assessment committee reduce the assessment, the objector will only be called upon to pay on the reduced amount the rate current at the time when he made his objection. The reduction will take effect also as regards any rate made subsequently.

Supposing that the objector fails to obtain from the committee the relief to which he considers himself entitled, the only course open to him is to appeal against the poor rate to the next practicable special or quarter sessions. He cannot appeal against the rate unless he has first objected to the valuation list in the manner above referred to, and has failed to obtain relief from the assessment committee. An appeal to special sessions can only be made on a question of value, and does not lie where the dispute is as to the liability of a hereditament to be rated.

If the objector appeals against the poor rate he must give 21 days' notice in writing previous to the holding of the sessions to which the appeal is to be made, of his intention to appeal, and the grounds thereof, to the assessment committee. Notice is also required to be given to the overseers, and in some cases to the parish council, or to the town or urban district council. The objector should take legal advice as to the precise procedure in conducting such an appeal.

The justices, on the hearing of an appeal against the poor rate, are empowered to amend the rate by altering the sum therein charged on any person, or in any other manner which may be necessary for giving such relief as they think just; and in certain cases they may quash the rate. If the rate is amended, the valuation list must be altered by the assessment committee in conformity with the amendment made by the justices.

If the decision of the justices in special sessions is against the appellant, he may carry the appeal to quarter sessions. But in the vast majority of instances in which persons who have been over-assessed take action in order to get their assessment reduced, no appeal against the poor rate is necessary: the relief desired is obtained by the simple process of objection to the valuation list before the assessment committee.

With respect to places outside London in which the Union Assessment Acts are not in force, it may be stated generally that, subject to the provisions of any local Act, the procedure for obtaining a reduction of assessment is by appeal against the poor rate to special or quarter sessions.

II.—*As to Rates other than the Poor Rate.*

The principal rates other than the poor rate which are levied under the general law, are the borough rate, the general district rate, the lighting rate, separate rates to meet contributions required by the county council, and separate rates levied for sanitary purposes in rural districts.

When the whole parish is liable to county contributions or to the borough rate, the sum required is usually paid out of the poor rate. Where only part of the parish is liable, a separate rate is levied in such part in the same manner as the poor rate, and the same observation applies to sums required for the expenses of burial boards. All these rates are based practically on the valuation list; and it would seem that if the assessment committee amend the valuation list after hearing an objection to the list, any of these other rates should be correspondingly amended without any formal appeal against the rate.

As regards the general district rate levied by an urban authority, it was held in the case of *Sheffield Waterworks Co.* v. *Sheffield Corporation* (1885) (55 L. J. M. C. 40; 54 L. T. 179), that where, subsequently to the making and demand of a general district rate, the valuation list upon which the rate was based was amended by the assessment committee by the reduction of the assessment of particular premises, sufficient cause was shown for non-payment of so much of the rate as corresponded to the reduction in rateable value made by the committee, although there had been no appeal against the general district rate.

The urban authority are empowered to reduce the sum at which any person has been assessed in the general district rate, if he has been over-rated, *i.e.*, if he has been assessed on a higher rateable value than that entered in the valuation list in respect of his property.

If a person assessed in any of the above rates considers that he is over-rated, and is unable, in any other way, to obtain the relief to which he considers himself entitled, he may appeal against the rate.

An appeal against a general district rate lies to the next court of quarter sessions held not less than 21 days after the demand of the rate. Fourteen days' notice of the appeal must be given to the urban authority, and the notice must state the ground of appeal.

In the case of separate rates levied by overseers to meet expenses of rural district councils, the same appeal lies to special or quarter sessions, as in the case of the poor rate.

Any separate borough rate, and any separate rate to meet contributions required by a county council, may also be appealed against in like manner as a poor rate.

Appeals against rates levied under the Lighting and Watching Act, 1833, may be made to quarter sessions, and are subject to the same provisions as appeals against poor rates.

III.—*Reduced Assessments in respect of Land not occupied by Buildings.*

1. Occupiers of land used as arable, meadow, or pasture ground only, or as woodlands, allotments, orchards, market gardens, or nursery grounds, are assessable to a general district rate in an urban district in respect of such land, in the proportion of one-fourth part only of the rateable value according to the valuation list; and in the case of a separate rate for special sanitary expenses in a rural district they are, according to circumstances, either to be assessed in respect of one-fourth part only of the rateable value of the land, or are to pay in respect of it one-fourth part only of the rate in the pound payable in respect of houses and other property.

Occupiers of houses, buildings, and property (other than land) are required to pay, in respect of their assessment to a lighting rate under the Lighting and Watching Act, a sum in the pound three times greater than that paid by occupiers of land. This has been held to mean that if the rate on houses &c. is 6*d.* in the pound, occupiers of land should pay only 2*d.* in the pound.

Failure, in rating such occupiers, to allow the partial exemption for which the Acts provide, would be a good ground of appeal against any of the three rates above-mentioned.

2. In the case of rates which before the Agricultural Rates Act, 1896, came into operation were payable by an occupier of agricultural land in full, or in the proportion of more than half, such occupier is liable, so long as the Act continues in force, to pay one-half only of the rate in the pound payable on buildings and other hereditaments. This partial exemption does not, however, apply to rates assessed under any commission of sewers or in respect of any drainage, wall, embankment, or other work for the benefit of the land. The expression "agricultural land" means any land used as arable, meadow, or pasture ground only, cottage gardens exceeding one-quarter of an acre, market gardens, nursery grounds, orchards, or allotments, but does not include land occupied together with a house as a park, gardens other than as aforesaid, pleasure grounds, or any land kept or preserved mainly or exclusively for purposes of sport or recreation or land used as a racecourse. "Cottage" in this definition means a house occupied as a dwelling by a person of the labouring classes.

The rateable value of agricultural land is required to be stated separately from that of buildings or other hereditaments in the valuation list. The power of the assessment committee to amend the list, on objection being made, in the manner previously explained on page 2, is not affected by the carrying out of this requirement.

IV.—*Rating of Woods and Plantations.*

Poor Rate.—The Poor Relief Act of Elizabeth made an occupier of saleable underwoods liable to assessment to the poor rate. The underwood itself was rated, not the land upon which it grew. But by Section 14 of the Rating Act, 1874, so much of the Statute of Elizabeth as related to the taxation of an occupier of saleable underwoods was repealed, and by Section 3 of the Act, the Statute of Elizabeth, and the Acts amending the same, were extended to land used for a plantation or a wood or for the growth of saleable underwood, and not subject to any right of common.

Under this enactment it is the land, and not the timber, underwood, or other produce of the land, which is made the subject of assessment. It would seem that if land used as a plantation or a wood, or for the growth of saleable underwood, is subject to common rights, it is exempt from the poor rate and other local rates.

The method of estimating the gross estimated rental and rateable value of such woodlands is prescribed by Section 4 of the Act, and is as follows :—

(a) If the land is used only for a plantation or a wood, the value shall be estimated as if the land, instead of being a plantation or a wood, were let and occupied in its natural and unimproved state :

(b) If the land is used for the growth of saleable underwood, the value shall be estimated as if the land were let for that purpose :

(c) If the land is used both for a plantation or a wood and for the growth of saleable underwood, the value shall be estimated either as if the land were used only for a plantation or a wood, or as if the land were used only for the growth of the saleable underwood growing thereon, as the assessment committee may determine.

Land of the kind described in paragraph (a) should be assessed as if it were divested of timber or wood of any description, and its value determined without taking into account any improvement which has been made, or of which the land might be capable. In connection with the matter reference may be made to the case of the *Earl of Westmorland* v. *Southwark and Oundle* ((1877), 36 L.T. 108 ; 41 J.P. 231), in which it was decided that in ascertaining the rateable value of a plantation or wood as "land let and occupied in its natural and unimproved state" it was not admissible to base the estimate upon the rent which a hypothetical tenant would give after money had been laid out in grubbing up woods, in draining and fencing, and in making roads. In the case of *Eyton* v. *Mold Churchwardens and Overseers* ((1880), 6 Q.B.D. 13), it washeld that the value of a right of sporting over land might properly be included in estimating the rateable value of a plantation or wood as land in its natural and unimproved state.

Woodlands are not agricultural land within the meaning of the Agricultural Rates Act, 1896, and an occupier of woodlands is liable to pay the full amount in the pound of any poor rate assessed upon him in respect of such property.

Other Local Rates.—By Section 10 of the Rating Act, 1874, any hereditament made rateable to the poor rate under that Act became subject to all other local rates leviable upon property rateable to the relief of the poor. Woodlands are thus rateable to the general district rate, and the separate rate for special sanitary expenses, and to any lighting rate levied in a rural parish under the Lighting and Watching Act, 1833. Information as to the abatements allowed to occupiers of woodlands in paying the general district rate or special sanitary rate has already been given in Section III. (1).

V.—*Rights of Sporting and Fishing.*

Under the old Statute (43 Elizabeth, c. 2) the sporting right was in no case separately rated, although, where the occupier of land retained the right of sporting or let it to another person, the value of the right formed an element in estimating the value of the land to the occupier (*Reg.* v. *Battle* (1866), L.R. 2 Q.B. 8).

Where the right is not severed from the occupation of the land (*i.e.*, where the owner retains both the land and the right, or lets them both to one tenant) the value of the sporting rights is still included in the valuation of the land ; but in any other case the right must be dealt with in the manner directed by Section 6 of the Rating Act, 1874.

Sub-section (1) of that section provides that where any right of sporting is severed from the occupation of the land, and is not let, and the owner of such right receives rent for the land, the right shall not be separately valued or rated, but the gross and rateable value of the land shall be estimated as if the right were not severed ; and if the rateable value is increased by reason of its being so estimated the occupier of the land may (unless he has specifically contracted to pay such rate in the event of an increase) deduct from his rent such portions of any poor or other local rate as is paid by him in respect of such increase.

The direction in Section 6 (1) is that the value of the land shall be estimated *as if the right were not severed.* It would appear, therefore, that in dealing with the right as an element of value, it ought not to be estimated upon any such consideration as that of the rent which a third person might be found to give for it, but according to its worth, if any,

to the occupier of the land, upon the supposition that the right is not severed, or, in other words, that he himself is entitled to exercise the right without the power of making a profit by letting it.

The effect, therefore, of this provision is to place those lands which are let by an owner, with a reservation of the right of sporting, on the same footing in relation to rateability as the lands which he himself occupies, retaining the right to the game upon them.

The preceding remarks are mainly directed to those cases where the right of sporting is severed from the occupation of the land, but is retained by the owner. Where, however, the right is let to a person other than the occupier of the land, it is rateable as a separate hereditament, and either the owner or the lessee of the right may be rated, as the occupier of the right of sporting, under Section 6 (2) of the Act of 1874. The ordinary rules of law for determining the gross estimated rental and rateable value of other kinds of property will apply.

Subject to the provisions of Section 6, the owner of any right of sporting, when severed from the occupation of the land, may be rated as the occupier of the right, under Sub-section (3) of the section. But where the owner receives rent for the land he could not be rated under Sub-section (3) as the occupier of the right, because this case is dealt with by Sub-section (1) of the section.

For the purposes of the section the owner of the right is, (1) the person entitled to exercise the right if the right is not let, (2) if let, the person who is entitled to receive the rent for the same.

The poor rate, general district rate, special sanitary rate, and other local rates are payable in full upon sporting rights when severed from the occupation of the land over which they are exercised and separately assessed.

The observations relative to the right of sporting are equally applicable to the assessment of the right of fishing.

London, S.W.1,
August, 1893.

Revised, February, 1914.

BOARD OF AGRICULTURE AND FISHERIES.

ENSILAGE.

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ENSILAGE is the process by which green fodder is preserved in a "silo"; green fodder so preserved is known as "silage."

I.—ADVANTAGES OF ENSILAGE.—1. Ensilage is a means of preserving green fodder in a succulent state for winter feeding.

2. Ensilage is independent of weather, and is therefore safer than haymaking in wet seasons.

3. On heavy clay lands or on light soils in dry districts, where roots are precarious, there is almost a certainty of obtaining a silage crop.

4. Ensilage is cheaper than root growing on soils and in districts not adapted to roots.

5. If the silage crop is sown in early spring, or, preferably in autumn, it can be got off in time for turnips or rape to be taken, or for a bastard fallow.

6. The usual silage mixture of oats and vetches is a useful cleaning crop. Stubble land, therefore, which in the ordinary course would be bare-fallowed, may safely be sown with oats and vetches, after which cleaning may be completed in time for autumn corn by means of a bastard fallow.

7. Stock fed on silage made from leguminous crops, *i.e.*, clover, lucerne, sainfoin and vetches, will require less oilcake than stock fed on roots; moreover, such crops tend to increase the fertility of the land.

8. Ensilage will enable poor heavy land now in grass to be brought under tillage, cleaned and improved.

9. The labour involved in feeding silage is very much less than that in feeding roots.

II.—**MATERIALS SUITABLE FOR SILAGE.**—Meadow grass, Italian rye-grass, grass and clover mixtures, maize, lucerne, clover, trifolium, sainfoin, vetches, and any other green fodder crops that can be spared from the immediate requirements of the farm stock may be made into silage. Hay aftermath, top-dressed if necessary with quick-acting manures, might also be converted into silage, especially when weather conditions are apt to render the saving of a second hay crop difficult or impossible.

1. **Vetches and Oats.**—A favourite mixture consists of 2 bushels of vetches and 1 bushel of oats per acre. To keep the vetches from lodging, and to facilitate cutting, ½ bushel of beans may be substituted for ½ bushel of vetches. If sown in autumn, preferably the last week in September or the first half of October, these generally yield heavier crops, by 2 to 4 tons per acre, than if sown in spring.

(*a*) *How to plant.*—The preparation of the ground, provided it is not too foul, is a simple matter. Tares do not like a deep seed-bed, and the land should therefore be ploughed shallow ; if a few beans are to be planted, they should be ploughed in at this time, both to protect them from birds, and also to let them get a start of the tares, by which they are otherwise apt to be smothered. About a week afterwards the seed-bed is completed and the rest of the seed is sown by the methods usually adopted for autumn corn.

(*b*) *How to manure.*—The manuring of the crop should be directed chiefly to stimulating the growth of the leguminous crops. If the land is in fair condition 4 to 5 cwt. of basic slag is all that is required upon heavy land, or 2 to 3 cwt. of superphosphate with 2 cwt. of kainit (when available) or its equivalent,* on light soils deficient in potash ; these manures should be applied in autumn at seed time. If the land is poor a dressing of dung in autumn or ¾ cwt. nitrate of soda or sulphate of ammonia in spring should be given.

(*c*) *When to cut.*—As a rule vetch mixture for silage should be cut when the oats are in the milk stage and the vetch seeds begin to dent. Certain other crops, such as clover aftermath and maize, should be allowed to stand as late as the weather will permit.

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* The quantities of blast furnace flue-dust equal to 1 cwt. kainit are grade 1, 4½ cwt. ; grade 1a, 3 cwt. ; grade 2, 2 cwt. ; grade 3, 1 cwt. *See* Food Production Leaflet No. 23, *Blast Furnace Flue-Dust.*

2. **Maize.**—In America by far the most important silage crop is maize, but the manufacture of silage from maize has not been very successful in this country owing apparently to the lesser degree of maturity reached by the plant. This, however, can be largely overcome by mixing dry material with the maize in the chaffing machine. To facilitate packing maize should be chaffed in pieces of about one inch in length. (See also Leaflet No. 73, *The Cultivation of Maize for Fodder*.)

3. **Other Materials.**—

(*a*) *General.*—All classes of herbage upon farms may, if necessary, be utilised for silage, even nettles and other weeds having been successfully employed. The margins of fields and the sides of hedges and other waste places may be brushed and the material so obtained ensiled. The leaves and young shoots of most hardwood trees may also be utilised. If the material is too coarse for actual silage it will be useful for topping up the silos, stacks, or clamps. Coarse grass in meadows, pastures, and under trees in orchards and elsewhere, which stock frequently reject, may be made into passable silage. Hop bines may be ensiled directly the hops have been picked, before the sap has disappeared.

(*b*) *Bracken.*—Though there are no recent investigations, it is stated that, if cut when young and juicy, bracken makes excellent silage which is highly relished by stock even when they will not touch it in the green state.

(*c*) Mustard, rape and other cruciferous crops have generally been found to produce unsatisfactory silage.

III.—KINDS OF SILAGE.—Silage is of two kinds, sweet and sour. The difference depends on the temperature reached during fermentation. If air is excluded the temperature remains comparatively low ; more air will cause a higher temperature. The exclusion of air is more complete when the material is damp, and when it is ensiled quickly or is tightly pressed. The result is then "sour," the thermometer not rising over about 120° Fahr. In the case of "sweet" silage the thermometer may rise as high as 160° Fahr., but seldom above. There is no danger of silage firing, as the system does not admit sufficient air to ensure combustion. Too high a temperature, however, causes a waste of feeding material.

The results of feeding trials and chemical analyses show that there is no marked difference in the feeding of sweet

and sour silage. The sweet variety, however, has a less powerful smell, and on that account is to be preferred in the feeding of milch cows.

IV.—METHODS OF MAKING SILAGE.—Silage may be made inexpensively in stacks or clamps; at a comparatively slight cost in pits or in ordinary buildings altered to suit the purpose; or at a greater initial expense in a specially designed structure, such as the tower stave or concrete silo so popular in America. Although the details of the various methods of making silage differ somewhat, the main features are the same in all. The chief essential is compression, to exclude air, and this object is usually best attained by using fresh material, by tight packing, and by careful covering.

1. Stack Silage.—For stack silage the material is used whole. The method is thus inexpensive, and is useful for preserving surplus fodder. The crop should be cut to leave a fairly high stubble, so facilitating drying and turning. When the swathes have become dry on the upper surface, they are turned over with a swathe turner, and thereafter the crop is at once taken to the stack. If the stack is built in the field a horse sweep may be used for collecting; if built at the homestead a hay bogey or rick shifter will be found convenient for removal.

Stacking.—The stack is usually built in circular form with a base diameter of from 18 to 24 ft. A layer of waste material is laid on the ground to form the base of the stack. The outer edge of the stack is made to slope slightly inwards from the base, and when a height of about 15 ft. has been reached, and the stack has settled, the outer edge is trimmed off with a sharp hay-knife—starting at a height of about 12 ft. from the ground—the portion trimmed off being placed on top of the stack. This trimming off is done to minimise the waste at the outside.

The stack should be built as high as possible, and, generally speaking, when using an ordinary horse fork, this will mean about 15 ft. high when the stack has settled down. In order to allow time for the stack to settle, and with a view to controlling the temperature, it will be found a great convenience to build two stacks at the same time. Where there is only sufficient material for one stack of the above dimensions, two smaller stacks should be made, or the operations may be proceeded with at intervals of several days.

Weighting of the Stack.—The silage stack should be finished off about 4 ft. higher in the centre than on the outside. In a few days the centre will have sunk nearly level with the outside. The stack may then be finally topped off as before described. Soil to a depth of 9 in. or 12 in. should be placed on the top of the waste layer. If the

stack is built on a piece of grass land, the turves may be cut all round the stack and be placed grass side down on the outer edge of the stack to act as a coping.

A considerable amount of labour is expended in covering the stack with soil, but saving may be effected in various ways. In the first place hand digging of the soil may be avoided by drawing a cultivator or disc harrow round and round the stack, until sufficient material has been obtained, whilst the soil may be raised to the top of the stack by fitting a box on to the haulage rope of the horse fork. As the stack settles down, cracks will appear in the layer of soil. These should be closed with a hand rake, using the back of a spade to smooth off.

2. **Clamps.**—Clamps are useful in the absence of a silo, when silage must be made immediately. They are best made on slightly sloping ground and should be oblong in shape. The carts should be drawn on and over the heap precisely as in the case of a manure clamp, and tipped where material is required to fill up. They must be drawn as closely to the sides as possible so as to give pressure there. When the middle has risen too high for further carting the sloping ends should be cut off, and the sides should be trimmed, the material being thrown on to the clamp, levelled, and firmly trodden in. The whole should be covered with a layer of rough herbage, bracken, or leaves, and be closed in with earth, to a thickness of 10 inches.

3. **Pits.**—Old chalk pits or gravel pits, so numerous in some districts, form servicable receptacles for silage. The sides should be lined with boards, and the space between should be filled in to keep the silo air-tight. The boards should rise above the surface of the ground to prevent rain draining into the silo. Instead of boards, concrete may be used. The carts should be led over the mass of green material, which must be finally left in a somewhat conical form, and covered with earth to a depth of from 10 to 12 inches.

Where earth is used as a covering for silage stacks or clamps occasional inspection is necessary, as the earth sinks with the silage, and cracks are sometimes formed. These cracks should be filled up.

Clamps and pits are distinctly useful in cases where no large expenditure can be incurred, or where they are employed (as, for instance, in adverse seasons) for the purpose of saving fodder that would otherwise be wasted. Their use, like that of stacks, is justifiable as a war-time substitute for the more expensive method.

4. **Adapted Out-buildings. etc.**—In adapted out-buildings. pits, etc., there should be as few corners as possible, as these are difficult to fill properly.

5. **The Modern Silo.**—Modern silos are constructed with very tall airtight walls, generally circular in section, and in which the necessary pressure is obtained automatically over the greater part of the heap by the weight of the material above. Such silos are often 30 to 35 feet in height, and generally vary between 12 and 18 ft. in diameter. They are best built of reinforced concrete, or reinforced brickwork. Silos so constructed may be sunk for a short distance in the ground; too great a depth is not advisable owing to the greater difficulty of emptying.

(*a*) *Construction, Capacity, Cost, etc.*—The following particulars as to construction, capacity, cost, etc., of silos are taken from a leaflet issued in May, 1918, by the Food Production Department of the Board (F.P. 253/S.1).

Two sizes of silo have been provided for :—

Size 100 { 15 ft. diameter × 30 ft. high.
Capacity 5,300 cubic ft. or nearly 200 cubic yards.
Holding say about 100 tons of silage.

Size 50 { 12 ft. diameter × 24 ft. high.
Capacity 2,710 cubic ft. or about 100 cubic yards.
Holding say about 50 tons of silage.

Each size can be constructed either in reinforced brickwork, style "B," or in reinforced concrete, style "C." Thus for reference purposes a silo built in brick 15 ft. diameter × 30 ft. high would be described as a "100B" silo, and one of 12 ft. diameter × 24 ft. high made of concrete would be styled a "50C" silo.

Each silo takes the form of a hollow round tower covered with a wooden roof in which ventilation is provided. It is fitted with a large door at the top through which it is filled. There are also a number of smaller doors (arranged one above the other up the side of the silo) which are used in succession as the level of the contained silage sinks, for its delivery when required for feeding. Provision is made for suitable drainage and for steps by which the doors can be reached from the ground. These silos are intended to be filled with unchaffed crops by means of the ordinary elevator with horse gear such as is to be found on many farms. There is nothing, however, in their construction to prevent farmers from adopting the American system of chaffing the crop and blowing it into the silto if they prefer this method of filling, and have, or can obtain, the necessary plant consisting of engine, chaff cutter and blower.

In order to obtain an approximate idea of the cost of a particular silo, it may be assumed that in situations where there are no special local difficulties, and where good clean sand and ballast are readily obtainable, a concrete silo of size 100C will cost at the present time roughly £310, and one of size 50C roughly £210.

Where bricks are more easily obtained than ballast, "B Type" silos will probably be preferred, costing roughly £340 for size 100B, and £235 for size 50B. In each case it is assumed that the purchaser will himself cart the materials to the site.

The estimated weights for each type are as follows :—

100B.	100C.	50B.	50C.
140 tons ...	102 tons ...	95 tons ...	70 tons.

To save labour the silos should be built close to the cattle sheds, and, if possible, should deliver straight into them. It is very necessary that there should be a good road and ample space around the base of the silo on the side from which filling operations are to take place.

APPROXIMATE ACREAGE REQUIRED TO FILL STANDARD SILOS.

Crops for Silage.	*Silo "size 100." Acres.*	*Silo "size 50." Acres.*
Maize	6	3
Oats and vetches	9½	4¾
Lucerne (2 cuts)	9½	4¾
Red clover and rye-grass ...	13	6½
Red clover	15	7½
Meadow grass	17	8½
Sainfoin...	12	6

(*b*) *Filling.*—Green fodder is usually chaffed before it is put into the silo ; chaffed material packs more tightly, but where chaffing is not possible the crop may be ensiled in the long condition by means of the ordinary stack elevator. In filling the silo it is important to keep the surface uniformly level. In the case of chaffed material the weight of the green fodder above is sufficient to ensure adequate pressure, but with long material some extra treading is desirable.

Two or three days after filling has begun a settling process (due to fermentation) begins, and the material in the silo sinks. Some prefer to fill the silo at once and let the material settle, and complete the filling two or three weeks later. In this case the top of the first filling is generally spoilt.

Another plan is to complete the filling in about 10 days, allowing two or three days between each instalment. If the work of the farm admits it, this plan is preferable. When the silo is finally filled great care should be taken to protect the surface of the material from air; the best plan is to "seal" the silo with chaffed rubbish, moistened if necessary, rather than to use valuable fodder for the top layer.

(*c*) *Danger of Suffocation.*—It is important to remember that, whilst fermentation is proceeding for two or three weeks after filling, a heavy, suffocating gas (carbonic acid gas) is produced, which may cause the suffocation of anyone who incautiously enters the silo. If the doors in the side of the silo at the level of the silage are left open, there well be no danger of suffocation. Nor is there any danger after heating has finished.

V. FEEDING SILAGE. 1. **General.**—The feeding value of silage varies greatly according to the crop from which it has been made, its condition when cut, and other considerations. Generally speaking its feeding properties will be similar to those of the original crop, but it will contain rather a larger percentage of dry matter and be rather less digestible. It is sometimes suggested that any sort of forage material when converted into silage becomes good food, and that indigestible material becomes digestible, but these suggestions are incorrect.

Silage may be fed to nearly all classes of stock, cattle, sheep and horses, but it is especially suited to dairy cattle and horned stock, except that it is considered unwise to give more than 15 lb. per head per day to stock bulls.

Though good food for cattle, oat and tare silage must not be regarded as a complete food; it is too bulky, whether fed together with roots and hay or by itself, to satisfy completely the requirements of dairy cows or fattening cattle, though it may be sufficient for dry cows or store stock. Cows in full milk will need some concentrated food in addition to silage and roots or hay, though on account of the comparatively high percentage of protein in silage the ration need not contain nearly so high a proportion of this constituent as it should if the cattle were fed on roots instead of silage.

2. **Suggested Rations.**—For cows no hard and fast rules can be laid down, but the two following rations are suggested for average dairy cows weighing about 10 cwt. and yielding 2 gallons of milk :—

Ration I.—Oat and tare silage, 20 lb.; mangolds, 56 lb.; straw chaff, 8 lb.; bran, 3 lb.; cake and meal, 5 lb.

Ration II.—Oat and tare silage, 50 lb.; meadow hay, 7 lb.; cake and meal, 5 lb.

For fattening cattle between 2½ and 3 years old a ration containing 28 lb. oat and tare silage, 84 lb. mangolds, 10 lb. oat straw, and 4 lb. mixed linseed and coconut cake, has given good results.

For store cattle, about 15 months old, a ration containing about 35 lb. oat and tare silage, 8 lb. straw chaff, 2 lb. mixed cake, has proved successful and kept the stock growing well.

3. General Observations.—The labour involved in feeding silage is very much less than that of feeding roots; not only do the cattle require a very much smaller weight of food (since the silage is comparatively dry), but the labour of preparing the food consists only in getting it out of the silo. If in fattening a bunch of cattle in winter half the roots are replaced by silage, a man can feed roughly half as many more bullocks in the same time. If all the roots are replaced by silage it will be necessary to supply the cattle with water.

Mouldy silage, or silage that has been exposed to the air for more than a day, should never be fed to stock. When once a silo has been broken into, feeding should continue regularly. The silage should be fed evenly off the top all over.

VI. LITERATURE.—The following papers have appeared in recent years in the *Journal of the Board of Agriculture*:—

March, 1916, G. Jaques: Silage as Food for Stock.
June, 1916, A. W. Oldershaw: Silage made from Oats and Tares as a Food for Milking Cows.
July, 1916, A. Amos and A. W. Oldershaw: A Preliminary Inquiry into the Cost of Production of Silage in East Anglia.
September, 1916, T. Wibberley: Sweet Stack Silage.
February, 1917, A. W. Oldershaw: Observations on Silage.
May, 1917, A. Amos: Some Problems in the Growth of Silage Crops.
December, 1917: Ensilage.
March, 1918: Improvised Methods of Making Silage.
May, 1918: Supply of Silos by the Food Production Department.
An Article on "Modern Ensilage Practice," by A. W. Oldershaw appeared in the *Transactions of the Highland and Agricultural Society of Scotland*, 1917.
The following bulletins of the U.S.A. Department of Agriculture may also be consulted:—
Farmers' Bulletin No. 825, 1917: Pit Silos.
" " " 578, 1914: Making and Feeding Silos.

London, S.W.1,
August, 1893.
Revised, August, 1918.

Leaflet No. 10.

BOARD OF AGRICULTURE AND FISHERIES.

Wireworms.

Wireworms are perhaps the most common and also the most widely distributed of all root feeding agricultural pests. They occur in practically every situation and in all classes of soil, and attack nearly every kind of crop. The loss to be attributed to them each year is very considerable, but their attacks are not epidemic and it is seldom possible to point out any district or year as being specially remarkable for their abundance. Because of their universal presence, there is a tendency to attribute all injury below ground to "wireworms," with the result that much confusion has arisen and the term "wireworm" is often applied to a number of distinct pests.

True wireworms are the larvae or young of certain species of "click-beetle," and since they are easily distinguishable from other insect pests, confusion ought never to arise. An account of the features which distinguish the wireworm from other pests is given below.

In spite of the fact that wireworms are both abundant and troublesome much yet remains to be discovered with regard to the best methods of controlling their attacks. Statements in general are so contradictory that it is impossible to give authoritative advice until an extensive series of experiments has been carried out under modern conditions.

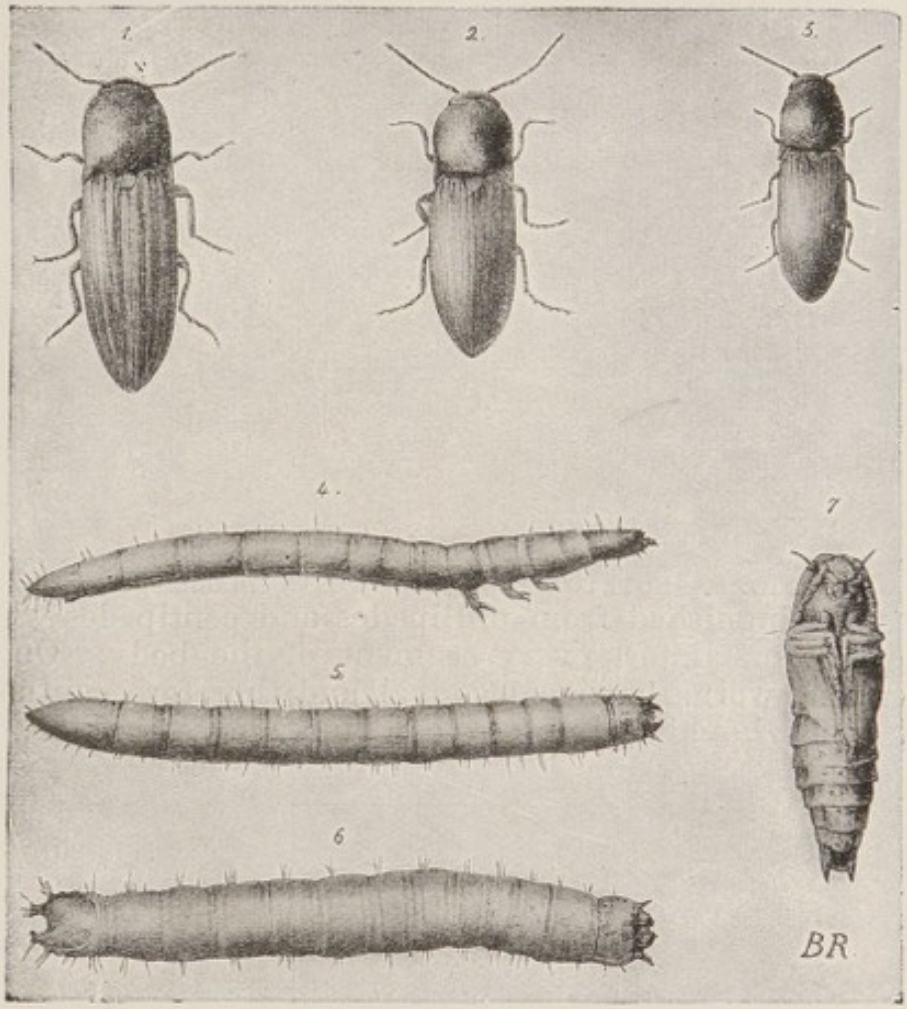
Description.

Beetle.—Adult wireworms are beetles belonging to the family *Elateridae*, usually known as "click-beetles" or "skip-jacks." The characteristic appearance of the members of this family is clearly shown by Figs. 1, 2, and 3, and a general description is, therefore, superfluous. Like most beetles they possess two pairs of wings of which the front pair or "elytra" are horny and serve as a cover for the hind pair, which are the chief organs of flight.

The terms "click-beetle" or "skip-jack" have been given on account of the faculty of bending the front part of the body (head and prothorax) away from the remainder and then straightening it again with a sharp click. By this means the beetles are able to jump a short distance vertically into the air, and to right themselves if placed on their backs, a position in which they would otherwise be somewhat helpless.

There are a large number of species of click-beetle in Britain, and, though they are much alike in form, they vary greatly in size, and their colour ranges from red and green to black. The majority, however, are harmless and there

are only a few species which are important pests; these are all dull brown or black insects. The chief offenders belong to the genera *Agriotes* and *Athous*, but wireworms of



FIGS. 1, 2, 3.—CLICK BEETLES (Adult Wireworms). Three times nat. size. Fig. 1—*Agriotes lineatus*. Fig. 2—*Agriotes obscurus*. Fig. 3—*Agriotes sputator*.

FIGS. 4, 5, 6.—WIREWORMS. Three times natural size. Fig. 4—*Agriotes* wireworm (side view). Fig. 5—*Agriotes* wireworm (upper surface). Fig. 6—*Athous* wireworm (upper surface).

FIG. 7.—WIREWORM PUPA. Three times natural size.

other genera—*e.g.*, *Lacon* and *Adrastus*—are sometimes troublesome.

Larvae.—The larvae of click-beetles are the true wireworms. They are more or less elongate, worm-like insects, yellowish-brown or brown in colour, with a very hard skin which is usually highly polished. The head is darker than the body and is armed with powerful jaws. The three segments behind the head each carry a pair of legs, but the remaining segments are legless. The commonest species, those of the genera *Agriotes* and *Athous*, are shown in Figs. 4, 5, 6, 9. Wireworms may be distinguished from the other pests and animals with which they are most often

confused, by the presence and number of the legs. Wireworms have only three pairs of legs and can therefore be

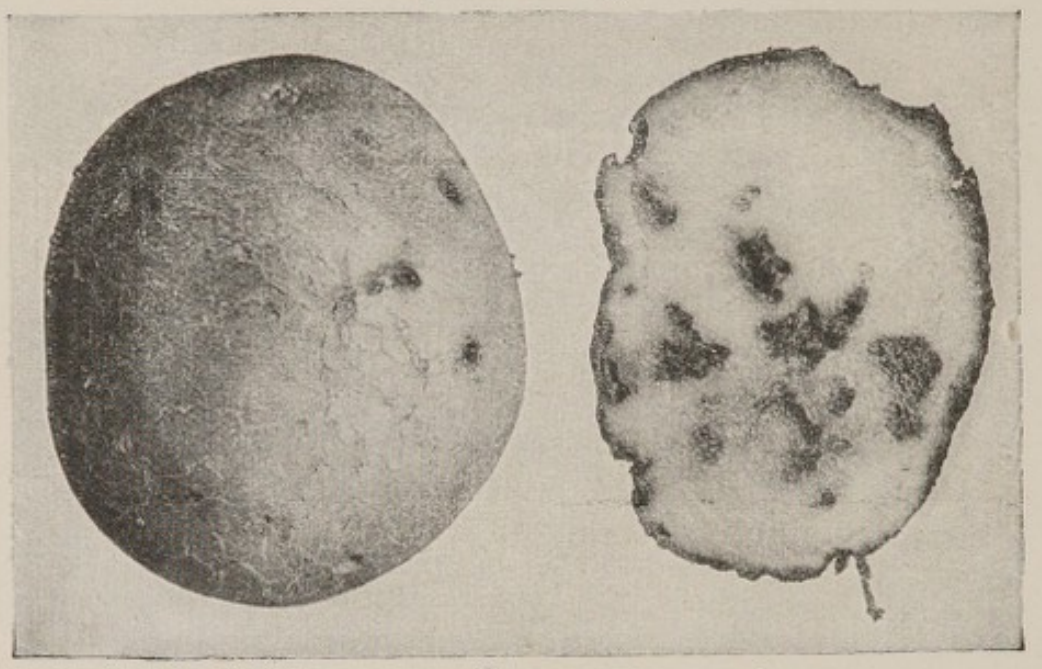


FIG. 8.—POTATOES. To show wireworm damage.

easily distinguished from millipedes and centipedes which have legs on almost every segment of the body. On the other hand worms have no legs at all and, therefore, confusion with them should be impossible. The same feature, *i.e.*, the

FIG. 9.—WIREWORMS. Natural size to show general appearance.

absence of legs, will also serve to distinguish certain fly "maggots" which otherwise somewhat resemble wireworms.

Pupa.—The general appearance of a wireworm pupa is shown by Fig. 7. It is white in colour and differs from the larva in being very soft and easily injured. Wireworm pupæ are seldom seen and, owing to the time of year at which they occur, are not likely to be noticed in the ordinary cultivation of the land.

Eggs.—The eggs of *Agriotes* are milky white, opaque and nearly spherical, though slightly longer than broad. In size they are rather more than $\frac{1}{30}$ inch long, but vary slightly according to the species and also individually.*

* From a description by Mr. Rymer Roberts, of Rothamsted.

Life History.*

The eggs of Agriotes are laid in June and July beneath the surface of the soil in which the female beetle burrows for the purpose. Eggs may be found singly or in clusters of various numbers. The young larvae emerge about a month after the eggs are laid and at once burrow into the soil. They are at first white and semi-transparent, but as they grow older their colour becomes more and more yellow. In length newly hatched *A. obscurus* are less than $\frac{1}{8}$ inch. while young *A. sputator* are slightly smaller. Growth appears to be slow at first, and the first moult does not take place before the following June. Probably the larvae in their first stage feed principally on decayed vegetable matter in the soil, but there is some evidence that they also eat the living roots of plants. At the end of their first year's life when they have grown to the length of $\frac{1}{4}$ inch they have begun to feed freely on the roots and underground stems of all kinds of plants and these appear to form the greater part of their food for the remainder of their larval existence. (Wireworms are, however, in part carnivorous and attack both each other and many other animals which they meet in the soil.)

The exact period which the insect spends as a wireworm is not known, but at least in the case of *A. obscurus*, it is believed to be five years. When the larvae are ready for pupation, which takes place during the latter half of summer, they burrow down below the surface soil and hollow out a small cell in the ground. The depth of the cell below the surface varies with the situation and nature of the soil, but it is seldom less than 6 inches deep and is more often from 8–12 inches. The object of descending seems to be to obtain a soil which is damp and of such a nature that the cell may be formed in it without risk of its subsequently falling in and pressing on the pupa. The depth is also of advantage in that predaceous insects are to a great extent avoided.

After a period of 3 or 4 weeks the beetle emerges from the pupa, but according to many authorities it still remains underground until the following spring, unless it is previously disturbed by cultivation. This, however, is only partially correct, for both *Agriotes lineatus* and *A. sputator* frequently leave their cells without being disturbed in any way and may be found during the winter in tufts of grass, hedge bottoms or refuse of dykes. *Agriotes obscurus* seems more often to remain below ground and the same is probably the case with the *Athous*.

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* The Board are indebted to Mr. Rymer Roberts, of the Rothamsted Experimental Station, for permission to make use of his unpublished notes on the biology of wireworms, and also to Messrs. Chittenden, Theobald, and Warburton for notes and suggestions.

In the adult state click-beetles of both genera may be found in the spring and summer crawling actively about or flying in the sunshine. They appear to feed to a certain extent on various leaves and, though they are not recorded as doing any damage in this country, this knowledge has been made use of in trapping them in order to reduce the numbers of the succeeding generation.

Nature of Damage and Economic Importance.

It is useless to give any list of plants attacked since it would include the majority of cultivated plants, while the nature of the damage in almost every case consists in the destruction of the roots or underground portions of the plant. Certain crops, such as beans (both Broad and Horse Beans) and clover, seem less liable to attack than others, while white mustard and rape are usually, but not invariably, immune. There appear to be no records of damage being done to Linseed even when grown on badly infested land, but this crop is subject to the attacks of "leather-jackets" (Crane Fly larvae). Grass land is often infested with wireworms, but it is usually able to support them without suffering appreciable loss.

In the case of cereals the damage is done when the crop is young, usually in the spring and early summer. Five or six consecutive plants in a row die and the stems below ground are found to have been eaten away. A further search usually reveals the wireworm at the roots of the next living plant and, if undisturbed, it will burrow along from plant to plant killing each as it goes. There seems to be no record in this country of an attack on the seed as is so often the case with the maize crop in America.

In the case of potatoes, Fig. 8, the set is sometimes riddled by wireworms, and the crop may also be damaged in the same way, in some cases to such an extent as to be unsaleable. Besides the common *Agriotes*, wireworms of the genus *Athous* are often found in potatoes.

A special form of injury is shown by tomatoes and beans. The wireworms attack the plant near the surface of the soil and then burrow up inside the stem for some inches above the surface of the ground—an unusual method of attack for an insect which lives in the soil.

As regards the general distribution of wireworms and the conditions favouring an attack, it has already been mentioned that they are always present in great numbers throughout the country, and from the fact that they live for five years it is evident that there may be five generation in the soil at the same time. They do not increase suddenly however and so form a definite epidemic as, for instance, in the case of the Diamond-back Moth (*Plutella maculipennis*) (*see* Leaflet No. 22). The types of vegetation which are usually most

infested by wireworms are rough grass land, partly derelict, or weedy land, and it is when such lands are brought back into cultivation that a wireworm attack is most to be feared. Well cultivated land, however, is always infested to a certain extent, especially after "seeds" or grass lea.

Natural Enemies.

Both wireworms and click-beetles are eaten by various birds and animals. Wireworms are also parasitised by minute insects of the Order *Hymenoptera* and are also killed by one of the forms of fungus known as *Isaria*. It is impossible to estimate the extent to which these natural enemies assist in controlling the pest, but it is evident that they are incapable of checking it sufficiently under normal conditions.

Methods of Control.

Agriculture.—The chief object to be aimed at under agricultural conditions is to keep the pest continually in check by suitable cultivation, for it is seldom possible to apply chemical insecticides to large areas of land. Experience shows that an attack is most to be feared after grass, leys, or when land has become foul. In order to reduce the wireworms as much as possible the best time to break up such land is in the latter half of summer—in the case of meadow land directly after the hay crop has been carted so as to make a bastard fallow. This course is specially to be recommended, since it not only checks the wireworm but also deals with the leather-jacket, which in some seasons is almost as bad a pest.

If the land cannot be ploughed until winter or spring the turf should be broken up—for instance, by disc harrows—and then well buried. The greatest importance must be attached to the thorough consolidation of the land, which, in many cases, is only attainable after the turf has been well broken up. A deep, firm seed-bed will often enable the subsequent crop to withstand a wireworm attack.

With regard to crops to be grown on infested land, it has already been mentioned that beans, peas, mustard and rape, and possibly buckwheat, are less susceptible to injury than cereals, while recorded attacks on flax are very rare. Such crops as mustard or rape are specially useful on land which cannot be prepared in time for more valuable crops, as they may be sown very late, and should form such a thick cover that the growth of weeds will be checked. It is often supposed that mustard has some effect on wireworm, apart from causing starvation, and in spite of statements to the contrary this possibility cannot be neglected, for wireworms are most difficult to starve, and yet a mustard crop is sometimes effective in cleaning infested land. If a relatively

immune crop cannot be grown, potatoes may be taken on land which is somewhat infested, but if the wireworms are really numerous the risk to the crop is great. Corn crops perhaps suffer most of all, and this is specially the case when they are "standing still." A top dressing of sulphate of ammonia on autumn sown crops or the same manure put in with the seed in the case of spring sown crops will help the plant to grow away. Attention may again be drawn to the importance of consolidating the land by means of the roll.

With regard to "remedies" involving the use of insecticides, it is impossible at present to recommend any with confidence. They have not given consistent results and probably failures have been considerably more numerous than successes. If used they should not be allowed to take the place of the proper preparation and cultivation of infested land. Gas lime if fairly fresh applied at the rate of 4 tons to the acre seems to have been effective and salt in heavy dressings—5–10 cwt. per acre—is sometimes recommended on light soils but its value is doubtful. If either gas lime or salt (in heavy dressings) is used, it should be applied as long before the crop is sown as possible. Fragments of rape cake or rape dust have been found by some to be very attractive to the pest, but here again the results of trials have been discordant and the verdict must at present be "not proven." There are various proprietary soil insecticides which are said to eradicate wireworms, but it is naturally impossible to discuss these claims in detail. The only advice which need be given here is to the effect that either a heavy dressing should be applied or the treatment be avoided altogether. A light dressing is likely to prove both a waste of money and of labour.

In general, thorough cultivation and clean farming keep wireworms more or less in check but it is impossible to eradicate them entirely.

Horticulture.—The remarks above as to the preparation of agricultural land apply equally to horticultural land, but it is even more advisable to spare no pains in the eradication of wireworms before the main crops are planted. Wherever it is possible an immune crop should be taken before land, especially grass land, is divided into allotments and gardens; the time spent in doing this will not be wasted.

The application of soil insecticides is more often possible under horticultural conditions than in agriculture, owing to the greater intrinsic value of each plant, but, apart from the proprietary compounds, there are few chemicals which are within the means of the average grower. These proprietary compounds usually depend for their action either on naphthalene or on substances of carbolic acid and creosote types. The former are somewhat less

fatal to insect life but have the advantage of being harmless to plants, while the latter are more deadly but can only be used as a rule on land which need not be planted for a time. Attention may be drawn again to the advice as to the application of sufficient dressings. Never less than the amount suggested by the maker should be used. If it is not desired to use a proprietary compound, experiments may be made in the use of naphthalene alone. This substance in the crude or semi-refined form can be obtained at prices ranging from 5*s.* to 10*s.* 6*d.* per cwt.* and may be obtained from gas works or makers of insecticides. The naphthalene in powder at the rate of from 1–2 oz. per sq. yard, should be worked into the soil as thoroughly as possible, and its effects seem to be much greater if the application is followed by a heavy rainfall or drenching by artificial means. Naphthalene appears to be harmless to plants, though it is said to retard the germination of seeds to some extent if present in any quantity. Carbon bisulphide or carbon bisulphide emulsion may be used with success under special circumstances as for instance for "disinfecting" heaps of grass turves, &c., rotting down to make potting soil, but they depend too much on suitable soil conditions for general application. The use of gas lime and salt has been mentioned in the previous section.

If the land is not badly infested or if soil insecticides are considered unsatisfactory, wireworms may be either trapped or dealt with by poisoned baits. In the former case pieces of potatoes, beet or carrot are spitted on short sticks and then buried in the ground. The stick enables the "trap" to be lifted and any wireworms attacking it can be destroyed. If it is desired to poison the wireworms, the slices of root, or preferably small pieces of rape cake, may be dipped in a mixture of paris green in water (1 oz. in 2 gallons) and then buried. Opinions differ as to the readiness with which the insects attack these poisoned baits but they are said to have been most effective—specially where wireworms are attacking such plants as hops or tomatoes.

The adult beetles may also be trapped in the spring and summer by means of small heaps of cut clover, sainfoin, or broken rape cake, covered with a tile or board. If desired these traps may be made poisonous with paris green to avoid the necessity of visiting them and removing the beetles, but in this case the covering must be sufficient to prevent animals from eating the poisoned bait.

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* These quotations were obtained before the outbreak of war. Subsequently both prices and supplies have been irregular.

London, S.W.1,
December, 1894.
Revised, July, 1918.

Not only the grubs, but also the perfect insects of the two common species of Crane Fly (*Tipula oleracea* and *T. paludosa*) are so much alike that only an expert can distinguish them with certainty. They agree with each other, and differ from all other Crane Flies, in having clear wings without any (even faint) spots, clouds, or streaks, except for a narrow brownish streak along the front margin, or costa followed by a more or less distinct whitish streak. In the male, the body ends abruptly and is slightly swollen at the tip; in the female, the body ends in a pointed "ovipositor." The females of both species are rather less than an inch in length with a wing expanse of two inches in *T. oleracea* as against 1½ in. in *T. paludosa*.

Control in Grasslands.—(1.) The flies prefer to lay their eggs in long grass or where there is good covering; close cropping during the late summer and early autumn is therefore beneficial.

(2.) Any method of disturbing the surface, such as bush-harrowing, when, or shortly after the flies have laid their eggs, or rolling at the time the flies are about to emerge from the pupa-cases is to be recommended.

(3.) As a soil insecticide in the case of "leather jacket" attacks, naphthalene is worth a trial. Naphthalene is a by-product in gas making and may sometimes be obtained very cheaply at a local gas works. In a partially refined form—the condition in which it is to be preferred for application to grassland—it is usually on sale at large gas works and insecticide makers at prices varying from 7*s.* 6*d.* to 17*s.* per cwt., in accordance with the degree of refinement and state of the market at the time. It should be applied broadcast at the rate of about 2 cwt. per acre (on golf courses it has been used at as high a rate as 5½ cwt. per acre) to affected patches in the fields in autumn or spring during showery weather, the effect being largely dependent on a fall of rain soon after the application.

(4.) As the grubs cannot stand continued immersion in water, the flooding of low-lying meadows during the winter probably kills large numbers in their favourite breeding places.

Control in Arable Land.—(1.) "Leather Jackets" are most troublesome to crops following grass or clover leys, but their attacks may be largely avoided if the land is broken in July or early August, care being taken to leave the herbage well covered. Both grass and leys intended to be broken should be kept as closely grazed as possible. Grass ploughed in autumn for a spring crop may be dressed with gas-lime (3–4 tons per acre) previous to breaking, in order to destroy the grubs. After the land is broken it is most important to obtain thorough consolidation and a good tilth; these alone will enable crops to withstand attacks which would otherwise cause serious damage.

(2.) When a corn crop is being attacked the field should be given a double harrowing followed by rolling with a heavy Cambridge roller, so as to break down the burrows made by the grubs and consolidate the ground round the roots of the plants. If the land is in poor heart a top dressing of nitrate of soda at the rate of 1–2 cwt. per acre may be given previous to harrowing.

(3.) Oats that do not "tiller" freely appear to have distinctly less power of recovering from an attack than some of the older free tillering varieties, but the production of a vigorous young plant is of primary importance, and this can often be obtained by a suitable change of seed and the use of a variety suited to the district.

(4.) When drilled crops such as turnips, mangolds, or potatoes are attacked, the best plan is to hoe diligently by horse and hand. In this way many of the grubs are destroyed or exposed to the attacks of birds.

(5.) Rooks, starlings, peewits, pheasants and other birds devour the grubs in a wholesale manner. Starlings are especially useful when they congregate after the breeding season. Pheasants killed in the winter have been found to have hundreds of larvæ in their crops.

Control in Gardens.—(1.) These pests should be numerous only in gardens which have been recently converted from grass or waste land, or where the grass and weeds have been abundant the previous summer. In the first case, the breaking of the land in summer is advisable; leather jackets will be avoided, wireworms greatly reduced in number, and the land can be thoroughly cleaned before the first crop is sown. In the case of a weedy garden the remedy is obvious.

(2.) When an attack is taking place continued hoeing is the best remedy.

(3.) It is well to remember that from early summer onwards the grubs pupate and a second crop may often be undamaged after the first has been destroyed.

(4.) Where the grubs are numerous an application of semi-refined naphthalene (*see* p. 3) at the rate of 2–2½ oz. per sq. yard is worthy of a trial. The naphthalene should be worked into the soil, after which a thorough watering is advisable. It seldom does any harm to growing plants but should not be used on seed beds which are just about to be sown as it may retard germination.

(5.) Sods of turf buried in the ground will attract the grubs. These can subsequently be dug up and the grubs destroyed or given to fowls.

London, S.W.1,
July, 1894.
Revised, April, 1919.

Copies of this leaflet may be obtained free and post free on application.

Leaflet No. 12.

BOARD OF AGRICULTURE AND FISHERIES.

The Gooseberry Sawfly (*Nematus ribesii*, Curtis).

FIG. 1.

Figures 1 and 2. Larva in the two last stages.
3. The Cocoon. 4. The Fly.

The Gooseberry Sawfly is a common and destructive pest in most parts of the British Isles. It also occurs in many European countries, in the United States and in Canada, being thought to have reached the two latter countries in soil adhering to the roots of imported gooseberry or currant bushes.

Plants Attacked and Nature of Damage.—The Gooseberry Sawfly occurs most frequently on the gooseberry, but it also attacks red currants, and (more rarely) black currants. The injury is due to the sawfly caterpillars, which devour the leaves, and in a bad attack strip the bushes completely, with the result that the season's crop may be lost, and the bushes so weakened that they can produce little fruit during the following year. A characteristic feature of the pest is that it increases steadily whenever it is neglected. Too frequently no notice is taken of an attack on one or two bushes when the pest could easily be controlled, and the following year, or even later in the same season, it is found that the whole plantation is attacked, with the consequence that much trouble must be taken and expense incurred in destroying the caterpillars.

Description and Life History.—The adult sawflies first appear in April or May. The female is about one-third of an inch in length, with clear transparent wings, and the body black and yellow in front and yellowish-orange behind.

The male is similar, but the upper part of the body behind the wings is black and the size somewhat smaller. Eggs are laid by the female on the gooseberry leaves, usually a large number being laid on one leaf (*see* fig. 5); they are fixed into shallow slits in the surface of the leaf, but are fairly conspicuous. In about a week the caterpillars, which at first are pale green, slightly speckled with black, are hatched from the eggs, and for some days feed together in a colony, first eating the surface of the leaf and then nibbling holes. As they grow older they spread all over the bush, eating the whole of the leaf. They are then sage-green in colour, with

FIG. 5.—Eggs of Gooseberry Sawfly on leaf, natural size. Some 60 eggs were found on this leaf.

a black head and numerous black spots. When full-grown, about four weeks after they have hatched, the caterpillars lose the black spots and are pale green, almost orange behind the head (which is now green) and near the "tail." At this stage they leave the bushes and make oval brown cocoons in the soil, from which, in the summer, the adults emerge in from 10–21 days. There are usually three broods of sawflies in the course of the season, and if the weather is very favourable (dry and warm) there may even be four. In consequence the pest may increase in numbers enormously by the close of the summer. There is considerable overlapping in the various broods, so that flies, eggs and larvæ of

all sizes may be found on the bushes at the same time. The cocoons of the last brood of larvæ remain in the soil during the winter, and produce flies the following spring.

Gooseberry Sawfly caterpillars are sometimes confused with those of the Magpie Moth, but it is easy to separate them, since Magpie larvæ are black and white with some yellow at the sides, and are, therefore, very different from the speckled green sawfly caterpillars.

In addition to the species here described, other species of sawfly larvæ are also found on gooseberries, but from the growers' point of view it is unnecessary to distinguish them.

Natural Enemies.—Several species of ichneumon fly have been recorded as parasites on the caterpillars of the Gooseberry Sawfly, but the latter do not appear to suffer from them to an appreciable extent. As a whole, natural enemies do not exercise a sufficient check on the sawfly, and artificial measures of control are often necessary.

Methods of Control.—Attention is again drawn to the advisability of dealing with small attacks. Otherwise it is almost certain that serious trouble will follow.

(1.) Hand-picking is the simplest method in the case of a few bushes, but it must be done before the colonies of young larvæ have scattered over the bush. Some prefer to pick the leaves on which eggs have been laid.

(2.) Spraying is thoroughly effective against this pest; the chief difficulty lies in the fact that the best washes are poisonous. Lead arsenate may be used in the case of an early attack where it can be applied before the gooseberries have flowered, and also after the fruit has been gathered. Hellebore, when fresh, and nicotine, are also effective, and though poisonous do not retain their poisonous qualities for long. They may therefore be used with safety if an interval of three weeks be allowed between the dates of spraying and picking. Pyrethrum, which must be fresh, may be tried where a non-poisonous insecticide is needed, and there are also certain proprietary insecticides now on the market which are quite satisfactory and can be recommended for small gardens.

(3.) *Formulæ:*—

A.	Lead arsenate paste	½ lb.
	Water	10 gallons.
B.	Hellebore powder	2 lb.
	Water	10 gallons.
C.	Pyrethrum powder	2 lb.
	Water	10 gallons.
D.	Nicotine 98–99 per cent. ...	¾ oz.
	Soft Soap	½–1 lb.
	Water	10 gallons.

In mixing lead arsenate it is best to work up the paste into a thin cream with a little water, subsequently adding the remainder.

Sprays B. and C. are improved by the addition of ½–1 lb of soft soap to each 10 gallons, and when being used they should be kept well shaken up. Half a pound of soap will be enough in the case of B., C. and D. unless the water is hard, when the full quantity may be allowed.

London, S.W.1,
October, 1893.

Re-written, August, 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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BOARD OF AGRICULTURE AND FISHERIES.

Acorn Poisoning.

The Board of Agriculture and Fisheries consider it desirable to warn stockowners who are accustomed to turn cattle into parks, or on to commons, or other places where acorns are plentiful, that there is considerable risk of injurious effects arising from the consumption of large quantities of acorns, which, in cases of dearth of herbage, are certain to be eaten with avidity.

In the years 1868, 1870, 1884, and 1900, which were remarkable for a large yield of acorns after a long, dry, and hot summer, serious losses among young cattle occurred from outbreaks of what is known as the acorn disease, or acorn poisoning. In many districts, notably in Middlesex, Kent, Hertfordshire, Warwickshire, Lincolnshire, Northamptonshire, Wiltshire, Gloucestershire, Devonshire, the New Forest, Sussex, Surrey, Suffolk, Norfolk, and Derbyshire, extensive outbreaks of the disease occurred. Young cattle up to two years old suffered most severely. Milch cows and cattle over three years old were seldom affected. Sheep and pigs appeared to be unsusceptible to the poisonous action of the seeds, and only two or three cases of the disease were reported in these animals, while entire herds of young cattle were attacked and a large proportion of them succumbed.

Acorn poisoning is not quite distinct from what appears to be indigestion due to eating an excessive quantity of acorns. This accidental disorder may occur in ordinary seasons when animals are first allowed access to pasture where acorns abound. Acorn disease may be accompanied by progressive wasting, entire loss of appetite, constipation followed by diarrhœa, discharge of an excessive quantity of pale urine, sore places inside the mouth, discharge from the nostrils, and also from the eyes, which are always sunken and thus give to the animal a peculiar haggard expression. No fever is present from first to last, but, on the contrary, the temperature is commonly below the normal standard.

On post-mortem examination it is frequently noticed that all traces of the acorns have disappeared. The morbid changes are an inflammatory condition of the stomach and bowels.

There is no specific remedy, but purgatives and demulcents are useful; professional advice should be sought. Prevention is comparatively easy when the risk is realised,

For absolute security cattle must be kept from the pastures while acorns are falling. The danger will be materially lessened by collecting the acorns from the pastures, but this device does not prevent a considerable consumption of the nuts which fall during the night. If swine are allowed access to pastures on which acorns fall they will devour large numbers, on which they will thrive well, and, at the same time, proportionately reduce the quantity within the reach of cattle. It has also been suggested that when cattle are allowed access to acorns only during the daytime, they should be supplied with a liberal allowance of food before they are turned out.

London, S.W.1,
September, 1893.

Revised, October, 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.

The Raspberry Moth (*Lampronia rubiella*, Bjerk.).

Moth and Caterpillar, both magnified ; the lines show the natural size.

The Raspberry Moth, also known in the caterpillar stage as the Red Raspberry Grub, occurs throughout England and Scotland, sometimes causing considerable losses both in commercial plantations and private gardens. Next to the Raspberry Beetle (*Byturus tomentosus*) it is perhaps the most serious insect enemy of raspberries in Great Britain. Abroad it is widely distributed on the Continent and appears to be specially harmful in Holland.

Nature of Injury.—If an infested plantation be examined towards the end of April or early in May it will be found that many of the young shoots, particularly those towards the tops of the canes, have withered or died owing to the fact that the inside of each attacked shoot has been eaten away. Inside the tunnel in the shoot is usually found a small red caterpillar or, later, a brown chrysalis. The damage is, therefore, very characteristic and when a large proportion of the shoots are attacked, great loss of crop may occur, since each injured shoot dies without producing flowers. The only pest with which the larva of the Raspberry Moth is sometimes confused is that of another small moth (*Aspis udmanniana L.*) which may be known as the Blackberry Leaf Spinner. This pest sometimes feeds on raspberries, the leaves of which it ties up into a large bundle. The caterpillar is brown or chocolate coloured and feeds within the bundle of leaves ; it never burrows into the shoots and may be recognised both by its habits and colour.

Description and Life-History. — The Raspberry Moth is a small insect with a wing expanse of from $\frac{1}{4}$–$\frac{3}{8}$ inch. In colour the wings are dark purplish brown, often with a satin-like sheen and with several conspicuous yellow spots. The moths appear at the end of May and in June and lay their eggs in the raspberry flowers. In about a week young caterpillars, whitish in colour, are hatched from the eggs and burrow into the receptacle (or plug) of the fruit in which they feed, but during this period they do practically no damage, and in fact it is difficult to tell which fruits have been attacked. When the fruits begin to ripen the caterpillars leave them and crawl about searching for places in which to make cocoons. These cocoons are about one-tenth of an inch in diameter and are placed sometimes in cracks or crevices in the canes or supporting stakes, sometimes among the soil or rubbish round the stools. The young caterpillars spend the winter in the cocoons and then, early in April, leave them and crawl up the canes to the shoots into which they burrow. Each caterpillar then feeds within a shoot for four to six weeks, and during this time it becomes bright pink in colour, with a blackish head and plate on the first segment. When mature it changes to a brown chrysalis, usually within the burrow in the shoot, and three or four weeks later the moth appears.

(1) **Methods of Control.**—After an attack every effort should be made to clean all rubbish from the stools, carting it, and also old canes, a short distance from the plantation, where the whole should be burnt if possible. Old cracked stakes should be renewed and the soil forked or hoed right up to the stools.

(2) There appear to have been few experiments in spraying in this country but the following trials should certainly be made.

(*a*) Spray the canes, the soil round the stools and all stakes during the winter with paraffin emulsion (or miscible oil) at winter strength, the object being to soak the cocoons and kill the larvæ inside.

(*b*) At the end of March spray the canes, soil round the stools and stakes heavily with lime-wash as used for apple and plum trees. At this period the larvæ will be preparing to leave their cocoons and the object in spraying is to cover the canes, stakes and soil round the stools with a coating of lime which will prevent the larvæ reaching the buds.

(*c*) At the beginning of April spray the young shoots with lead arsenate using a strong mixture. In Russia, Paris green and lime used in this manner ave been found quite effective and might also

be tested here. The object in this case is to cover the shoots with a poisonous coating so that the larvæ must eat the poison and be killed while entering the shoots.

(3) In plantations which are so badly affected that little crop is obtained, a radical cure may be attempted by cutting back all young canes in the spring to within six or eight inches of the ground exactly as if a new plantation had been made. No flowers will then be produced and in consequence the moths will have nowhere to lay their eggs and there will be no fruit in which the young larvæ could feed. The following year the plantation should be almost free of the pest.

(4) In small gardens it is quite possible to keep the pest well in check by picking off the shoots as soon as they begin to wither in the spring, destroying the pink grub inside.

(5) Spray Formulæ.—

(a) *Paraffin Emulsion, winter strength.*

Paraffin Oil	1 gallon.
Soft Soap	1½–2 lb.
Water	10 gallons.

Dissolve the soft soap in about a gallon of boiling water, remove the solution from near the fire and, while still hot, add the paraffin. Churn the mixture very thoroughly by syringing it back into itself. When required for use add soft water to make 10 gallons and mix again thoroughly so as to make sure that there is no free paraffin floating on the surface.

(b) *Lime Wash.*

Best Quicklime...	10–15 lb.
Water	10 gallons.

Obtain only best stone quicklime and store carefully to prevent it from air-slaking. Builder's lime, which is often partially air-slaked, should not be used.

Slake the lime with a little water, and when slaked into a fine powder, add the remainder of the water, stirring vigorously the whole time. Strain carefully before filling the spraying machine and keep the lime-wash well agitated throughout the application.

(c) *Lead Arsenate.*

Lead Arsenate paste	1 lb.
Water	15 gallons.

In mixing lead arsenate it is best to work up the paste first into a thin cream with a little water, subsequently adding the remainder.

(d) *Paris Green.*

Paris Green paste	...	...	1 oz.
Quicklime	...	...	1 lb.
Water ...	...	...	10 gallons.

Slake the lime to a cream with a little water and make it up to nearly 10 gallons with water. Then work up the Paris green with a little water and add it to the mixture of lime and water, stirring well before use. The quantity of lime used has been increased considerably above the normal in order that a better coating over the shoots may be obtained.

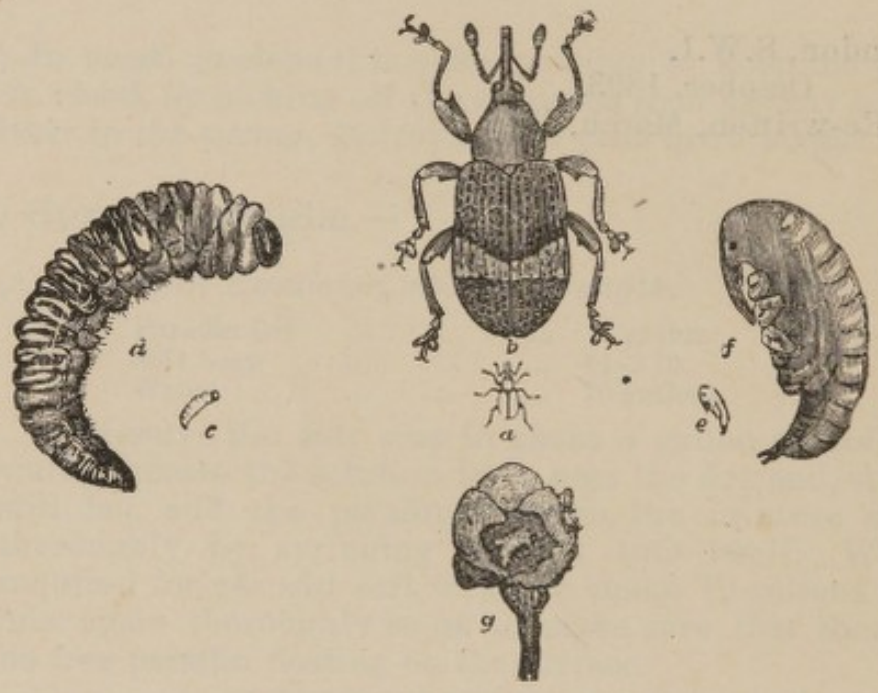
London, S.W.1,
October, 1893.
Re-written, March, 1919.

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. 15.

BOARD OF AGRICULTURE AND FISHERIES.

The Apple Blossom Weevil (*Anthonomus pomorum*, L.).



a, Weevil, nat. size; *b*, magnified. *c*, Larva, nat. size; *d*, magnified. *e*, Pupa, nat. size; *f*, magnified. *g*, Larva in blossom bud.

The Apple Blossom Weevil occurs in most counties in England and Wales, and is recorded from Scotland and Ireland. It is specially prevalent from the midlands south ward, being a serious pest in the Evesham district, in Cambridgeshire, Kent, and in the southern and south-western counties. Abroad the insect is well known in most European countries, in some of which—as, for instance, France—it has proved even more destructive than in the British Isles, and indeed has caused such damage that growers have been forced to take co-operative action for its destruction.

The Apple Blossom Weevil is notoriously difficult to control owing to the fact that it is little amenable to treatment by spraying, but there are certain general measures which serve to check its numbers to some extent.

Nature of Injury.—If an apple orchard be examined at the close of the blooming period it will often be noticed that certain of the blossoms have failed to expand, the petals having died and become brown in colour without falling off. Such blossoms are usually known as "capped blossom," and a further examination will show that underneath the brown petals is a small yellowish grub (or later a pupa), which has eaten away the base of the flower and so prevented all further growth. Blossoms so attacked ultimately die and fall off. In bad cases a high proportion of the flowers in an orchard may be damaged in this manner, with the result that the crop is almost entirely lost.

Description and Life-History.—The adult beetle is a small insect about ¼ in. in length with a long rostrum or "trunk." In colour it is black or brownish, dotted with fine grey hair, and across the wing-cases (elytra), which appear to form the "back" of the insect, is a light-coloured, greyish or yellowish mark. This mark is more or less in the form of a V, and is very characteristic of the insect (fig. *b*). The adult weevils appear in spring and crawl or fly to the apple trees, on which they may often be found in numbers during the period preceding the opening of the blossom. Eggs are laid as follows:—The female weevil bores a hole into the unopened bud, lays an egg in the hole and then pushes it down with her trunk, afterwards sealing up the hole with saliva. Only one egg is laid in each blossom, and a single female can probably lay 50 eggs or more. If the weather happens to be such that the apple blossom expands very rapidly, the flowers may open before or about the time when the egg hatches, in which case the insect dies. As a rule, however, the grub appears first and prevents the petals from expanding. The larva grows rapidly and in a fortnight is full grown. It is then a pale yellowish grub with a brown head (fig. *d*.) and lies in the cavity of the capped blossom in the curved position usual to weevil larvæ. The bloom by then is practically dead and the larva turns to a pupa (fig. *f*). About a week or ten days afterwards the pupa casts its skin and becomes an adult weevil, the insect remaining a short time within the blossom and then eating its way out through a hole in the side. These weevils may be found upon the apple trees for some time after their emergence, but they gradually disappear and by the autumn they have all found their way to winter quarters—as, for instance, under rough bark on the trees, beneath stones or rubbish on the ground, or in dead leaves, hedge cuttings, etc. They remain there during the winter, and in the following spring come out again and return to the apple trees, when a fresh generation is produced.

Natural Enemies.—The Apple Blossom Weevil is eaten by birds such as tits, and is also destroyed by insect parasites. The larva of the ichneumon *Pimpla pomorum* feeds on the larva and pupa of the weevil in the capped blossom, and in this way very many are destroyed. Dr. Imms, of the Manchester Department of Agricultural Entomology, has shown that in an orchard in Cambridgeshire over 25 per cent. of the weevils are killed by this ichneumon.

Methods of Control.—From the above account of the life-history it will be clear that the Apple Blossom Weevil is at no time really susceptible to those measures usually employed against orchard pests. The insect when young is protected within the "capped blossom;" when adult it appears to feed little—or at all events, not in such a manner as to make a lead arsenate spray of much use. It spends the winter in various places, always well concealed, and winter treatment cannot be wholly effective.

(1.) Nevertheless, in most orchards something, and in many, much, can be done in winter. In the first place, if the trees are mossy and the trunks encrusted with loose bark many weevils will hibernate on the trees and a winter wash, or later a lime wash, will destroy many of them. The burning of all rubbish and the cleaning of hedge bottoms and ditches will also be helpful, as will the cultivation of the ground underneath the trees.

(2.) In France it has been found practicable to reduce the numbers of the beetles by shaking them off the trees just before they lay their eggs. A large sheet is spread under the tree which is shaken or tapped with a stick, and the beetles which fall down are tipped into a pail containing a little paraffin.

(3.) In small orchards or where the trees are young it is worth collecting the capped blossom by hand before the beetles emerge.

(4.) In connection with this hand picking, the possibility of increasing the number of ichneumon parasites is worth consideration. If the collected "capped blossom" be placed in the orchard in a box with a muslin cover of a certain mesh (about $\frac{1}{32}$ inch) the weevils will be imprisoned while the ichneumons will be able to escape. It has already been pointed out that the ichneumon is an efficient enemy of the weevil, destroying 25 per cent., and if capped blossoms could be collected over a wide area and the ichneumons released, this percentage might be considerably increased. In France results obtained by this method are said to have been distinctly hopeful.

(5.) When the weevils are seeking winter quarters something may be done to trap them. Bands of hay or corrugated card tied round the trees in July, as for Codling Moth, will also trap blossom weevils. The bands are burnt in winter and both pests killed.

(6.) Apart from winter washing, no spray has yet been proved to be of much use and spraying should only be tried experimentally.

London, S.W.1,
October, 1893.
Revised, September, 1905.
Re-written, May, 1918.

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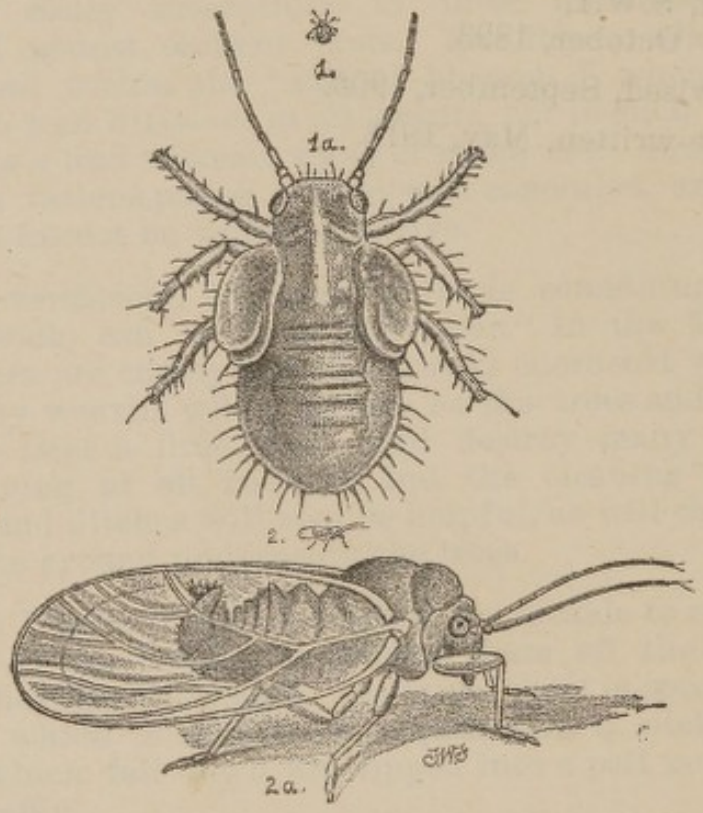
Leaflet No. 16.

BOARD OF AGRICULTURE AND FISHERIES.

The Apple Sucker.



1, larva, nat. size. 1*a*, larva after third moult, much magnified. 2, perfect insect, nat. size. 2*a*, much magnified.

The Apple Sucker is a widespread and abundant insect and is usually regarded as one of the most harmful pests of the apple, both in the British Isles and on the continent of Europe. It has not, however, been recorded from America, Australia, New Zealand, or South Africa.

Nature of Injury.—Apple Suckers belong to the same Order of insects as Aphides and Capsid bugs, which obtain their food by sucking up the sap of plants through minute holes, or punctures, so causing the injury or death of the parts attacked—especially when the latter are in a young growing state.

In the case of the Apple Sucker, the most serious damage is done to the flower buds and flowers. The insects when

quite young attack the flower buds and later the stems of the blossoms, draining away the sap, with the result that the buds may die unopened, or if they expand, fail to set fruit. In the latter case the trusses of bloom often remain on the tree, dead and brown as if damaged by frost. This is the most characteristic sign of attack. Damage is also done to the developing leaf buds and leaves, the latter being sometimes deformed, stunted, and rendered light in colour. After the blooming period and when the leaves have reached their full development, further injury is not obvious; but, nevertheless, it seems likely that the trees may be weakened by the attacks of the sucker to the prejudice of the succeeding crop. Certain varieties of apple, such as Bramley's Seedling, appear to suffer less than others, and, in fact, in most varieties there is considerable variation in the precise amount of injury, trusses of bloom noted as being infested sometimes developing a full crop.

Description and Life History.—The eggs of the Apple Sucker are minute, oval, and creamy white in colour, with a small projection at one end and a longer projection at the other, the latter passing into the bark and holding the egg in position. They are laid mainly on the fruit spurs, and to a less extent at the base of the leaf buds and on the twigs generally. The eggs hatch from the end of March to the end of April, varying with the season and also with the variety of apple on which they are laid, those on early leafing varieties hatching first. The newly-hatched suckers —small, rather flat, yellow insects—crawl in between the leaf folds and later into the trusses, puncturing them and feeding on the sap. The young suckers grow rapidly, and before long excrete from the hind end of their bodies a small, whitish globule or drop, and later long waxy threads which are usually very conspicuous, being sometimes white, sometimes blue, and iridescent. By this time the suckers have become bright green in colour, and rudiments of wings can be seen. (Fig. 1 *a*.) In the succeeding moults the wing rudiments become more conspicuous, and finally, four to six weeks from the date of hatching, the adult winged suckers appear. (Fig. 2 *a*.)

The adult suckers live on the apple trees throughout the summer, but do not lay eggs until the autumn. In September, egg-laying begins, and may continue until November, when the adults die. The eggs then remain until the following spring, when they give rise to a further generation.

Methods of Control.—There are three methods of dealing with the Apple Sucker, the first two being those usually employed.

(1.) The trees are sprayed with lime-wash about the time when the buds begin to swell ; if necessary the spraying may be continued until within about a week of the bursting of the blossom. It is sometimes thought that late lime-washing may injure the young leaves and blossom buds, but the injury, if it occurs, is unimportant, and the results as regards insects are more satisfactory than when the work is done too early. The lime-wash forms a coating over the twigs, which tends to seal up the eggs just when they are about to hatch, and also to kill any young suckers which may already have appeared. The work must, therefore, be done thoroughly, so that the twigs and branches are well coated with lime. The following is a formula for making lime-wash :—

Best Quick Lime (in lumps) ...	10–15 lb.
Water	10 gal.

Only the best stone quick lime should be used ; ordinary builder's lime is often impure and partially air slaked. In making the wash a small quantity of water should first be poured into the lime to slake it ; the remainder of the water should then be added, and after a thorough stirring, the wash should be carefully strained into the machine.

(2.) The trees are sprayed with a contact insecticide shortly before the blossoms open, a nozzle with a rather coarse jet being used for the purpose, so as to get a driving spray. Occasionally, the newly-hatched suckers may be found somewhat earlier in large numbers on the unexpanded leaf buds, and in this case they are specially amenable to treatment by spraying. The best contact insecticide is nicotine and soap, which also deals with Aphides, Capsid bugs and young caterpillars. The following formula has proved satisfactory :—

Nicotine (98–99 per cent.)	¾ oz.
Soft Soap	½ lb.–1 lb.
Water	10 gal.

The soft soap is first dissolved in a little hot water, and the solution is added to the remainder of the water. Finally, the nicotine* is poured in, and after stirring the wash is ready for use. Sufficient soap is needed to make the mixture lather well. With soft water ½ lb. will be sufficient. An emulsion containing creosote oil has been recommended as an efficient insecticide for the control of Sucker. In practice, however, it has at times caused such severe injury to the foliage that its use cannot be advised without further investigation.

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* Nicotine, especially when undiluted is very poisonous, and must, therefore, be used with care.

(3.) It has been pointed out that the suckers do not lay eggs until the autumn. It may therefore be possible, in the case of early varieties of Apple, to kill the great majority after the apples have been picked, and before eggs have been laid. At this date injury to the leaves is not of great importance and any contact insecticide, as, for instance, a paraffin or creosote emulsion, will answer the purpose.

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Theobald.—" Insect Pests of Fruit," p. 153.

Petherbridge.—*Journal of the Board of Agriculture*, 1915, Vol. XXI., p. 915, " Spraying for Apple Sucker and Plum Aphis."

Awati.—*Annals of Applied Biology*, 1915, Vol. I., p. 247.

Petherbridge.—*Annals of Applied Biology*, 1916, Vol. II. p. 230, " Spraying for Apple Sucker."

Lees.—*Annals of Applied Biology*, 1916, Vol. II., p. 251, " Some Observations on the Egg of Psylla Mali."

London, S.W. 1,
December, 1893.
Re-written, March, 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. 17.

BOARD OF AGRICULTURE AND FISHERIES.

Preservation of Commons.

The Board of Agriculture call attention to the recent Act of Parliament amending the law relating to Commons, with a view to their better preservation and in connection with previous enactments.

By the Law of Commons Amendment Act, 1893, lately passed, it is enacted that an inclosure or approvement o any part of a Common purporting to be made unde t hef Statute of Merton and the Statute of Westminster the second, or either of such statutes, shall not be valid unless it is made with the consent of the Board of Agriculture, who in giving or withholding their consent are to have regard to the same considerations, and are if necessary to hold the same inquiries, as are directed by the Commons Act, 1876, to be taken into consideration and held by the Board before forming an opinion whether an application under the Inclosure Acts shall be acceded to or not.

By the 6th section of the Copyhold Act, 1887, the lords of manors were forbidden to make grants of land not previously of copyhold tenure to any person to hold by copy of court roll or by any tenure of a customary nature without the previous consent of the Land Commissioners (now the Board of Agriculture), who in giving or withholding their consent were to have regard to the same considerations as are to be taken into account by them on giving or withholding their consent to any inclosure of common lands.

By the 31st section of the Commons Act, 1876, it is provided that any person intending to inclose or approve a Common, or part of a Common, otherwise than under the provisions of the Act, shall give notice to all persons claiming any legal right in such Common or part of a Common by publishing at least three months beforehand a statement of his intention to make such inclosure, for three successive times, and in two or more of the principal local newspapers in the county, town, or district in which the Common or part of a Common proposed to be inclosed is situate.

It follows from the above enactments that an inclosure of part of a Common, whether purportihg to be made under the Statutes of Merton and Westminster the second, or

either of them, by way of approvement on the ground of sufficient pasture being left for the commoners, or under copyhold grant founded on a custom of the manor, cannot now be legally made without the consent of the Board of Agriculture, who in giving or withholding their consent are to have regard as well to the benefit of the neighbourhood as to private interests; and that any person intending to make such an inclosure should publish notice of his intention in the local newspapers.

London, S.W.1,
December, 1893.

This leaflet is no longer issued separately.

BOARD OF AGRICULTURE AND FISHERIES.

FERTILISERS AND FEEDING STUFFS REGULATIONS.

The Fertilisers and Feeding Stuffs (General) Regulations, 1906. Dated December 27, 1906.*

The Board of Agriculture and Fisheries, in pursuance of the provisions of the Fertilisers and Feeding Stuffs Act, 1906, hereby make the following Regulations :—

Commencement.

1. These Regulations shall take effect on the 1st day of January, 1907, and remain in force until altered or revoked by the Board of Agriculture and Fisheries.

Definitions.

2. In these Regulations :—

"The Act" means the Fertilisers and Feeding Stuffs Act, 1906.

"Purchaser" and "seller" include their respective agents.

"Fertiliser" means any article used for fertilising the soil.

"Feeding stuff" means any article used as food for cattle (as defined by the Act, *i.e.*, bulls, cows, oxen, heifers, calves, sheep, goats, swine, or horses) or poultry.

Other expressions have the same respective meaning as in the Act.

Forms of Certificate of Agricultural Analyst (*s.* 3 (4) (*b*)).

3. The certificate of an Agricultural Analyst, in the case of a sample which has been divided into parts as in the Act provided, shall be in such one of the Forms A and B set forth in the schedule hereto as may be applicable to the case, with such variations as the circumstances require.

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* No. 944 of 1906.

Analyst's Report.

4. Every Agricultural Analyst shall, as soon as may be after the 31st day of March, the 30th day of June, the 30th day of September, and the 31st day of December in each year, report to the Board of Agriculture and Fisheries the results of all analyses made by him under section 3 (4) (*b*) of the Act during the three calendar months ending on such dates respectively; and he shall also forthwith report to the said Board the result of any such analysis in any case in which any provision of the Act appears to him to have been infringed.

Citric Acid Solvent (*s.* 10 (1)).

5. (*This Regulation has been revoked by the Fertilisers and Feeding Stuffs* (*General*) *Regulations*, 1908, *and is therefore omitted.* See *p.* 13.)

Revocation.

6. The Fertilisers and Feeding Stuffs Regulations, 1897, are hereby revoked as from the time at which these Regulations take effect.

Short Title.

7. These Regulations may be cited as the Fertilisers and Feeding Stuffs (General) Regulations, 1906.

In witness whereof the Board of Agriculture and Fisheries have hereunto set their official seal, this twenty-seventh day of December, one thousand nine hundred and six.

(L.S.) T. H. ELLIOTT,
Secretary.

THE SCHEDULE.

FORM A.

Certificate for Fertiliser.

I, the undersigned, Agricultural Analyst for the (1) in pursuance of the provisions of the Fertilisers and Feeding Stuffs Act, 1906, hereby certify that I received on the day of 19 , from (2) two parts of a sample of (3) for analysis; which parts were duly sealed and fastened up and marked (4) , and were accompanied by the annexed (5) (copy of an) invoice, and also by the annexed (5) circular and advertisement,

(1) Here insert the name of the county, borough, or district.
(2) Here insert the name of the person delivering the sample, and if so "by post."
(3) Here insert the name of the article as stated on the invoice.
(4) Here insert the distinguishing mark on the sample.
(5) The invoice or copy invoice, and any circular or advertisement given to the Analyst, will be initialed by the Analyst for purposes of identification and annexed to this certificate.

and that at the request of (6) , I have analysed one of the said parts and declare the result of my analysis to be as follows :—

I am of opinion that the said part contained the following percentages :—

(7) Nitrogen ... ... per cent.

(8) Phosphates { Soluble ... ... ,,
Insoluble ... ... ,,

(9) Potash ... ... ,,

(10)

As witness my hand this day of , 19 .

[*Name and Address of Analyst.*]

(6) Here insert name of the person requesting the analysis.

(7) The analyst may, in his discretion, add a statement of the amount of ammonia to which the amount of nitrogen stated in the certificate is equivalent.

(8) The phosphates in both cases to be given in terms of tribasic phosphate of lime, and in accordance with the definitions of "soluble" and "insoluble" contained in s. 10 (1) of the Act.

(9) The potash to be given in terms of potassium oxide, K_2O.

(10) Here state :—

(*a*) The percentages of chemical and other ingredients present, when any statement of such percentages is contained in the invoice, or in any accompanying circular or advertisement descriptive of the article.

(*b*.) In what respect, if any, the invoice or the description of the article contained in any such circular or advertisement, is false in any material particular to the prejudice of the purchaser.

FORM B.

Certificate for Feeding Stuff.

I, the undersigned, Agricultural Analyst for the (1) , in pursuance of the provisions of the Fertilisers and Feeding Stuffs Act, 1906, hereby certify that I received on the day of , 19 , from (2) two parts of a sample of (3) for analysis, which parts were duly sealed and fastened up and marked (4) and were accompanied by the annexed (5) (copy of an) invoice, and also by the annexed (5) circular and advertisement and that at the request of (6) , I have analysed one of the said parts and declare the result of my analysis to be as follows :—

I am of opinion that the said part contained the following percentages :—

Oil ... ... per cent.

Albuminoids ... ... ,,

(7)

and that (8)

As witness my hand this day of 19 .

[*Name and Address of Analyst.*]

(1) Here insert name of county, borough, or district.

(2) Here insert name of person delivering sample, and if so "by post."

(3) Here insert the name of article as stated on the invoice.

(4) Here insert the distinguishing mark on the sample.

(5) The invoice, or copy invoice, and any circular or advertisement given to the Analyst, will be initialed by the Analyst for purposes of identification and annexed to this certificate.

(6) Here insert name of the person requesting the analysis.

(7) The percentages of nutritive and other ingredients present, when any statement of such percentages is contained in the invoice, or in any accompanying circular or advertisement descriptive of the article.

(8) Here state, as the case may be :—

(*a*.) Whether the composition of the article agrees with the statements contained in the invoice, and with the name or description under which the article is sold, so far as the same implies that it is prepared from one particular substance or seed only, or from two or more particular substances or seeds only ; and, if not, in what respect.

(*b*.) In what respect, if any, the invoice or description of the article contained in any such circular or advertisement, is false in any material particular to the prejudice of the purchaser.

(*c*.) Whether the article is suitable for feeding purposes for cattle (as defined by the Act), or for poultry, as the case may be ; and, if not, in what respect.

(*d*.) Whether the article contains any ingredient deleterious to cattle (as defined by the Act) or to poultry, as the case may be, or any ingredient worthless for feeding purposes and not disclosed in the invoice ; and, if so, whether, in either case, to an extent materially prejudicial to the purchaser.

(*e*.) Where separate samples are taken of the portion of a feeding stuff which is mouldy, sour, or otherwise unsuitable for feeding purposes, and also of the residue of the feeding stuff, state the estimated proportion of the unsuitable feeding stuff in the certificate relating to the unsuitable portion

The Fertilisers and Feeding Stuffs (Sampling, &c.) Regulations, 1906. Dated December 27, 1906.*

The Board of Agriculture and Fisheries, in pursuance of the provisions of the Fertilisers and Feeding Stuffs Act, 1906, hereby make the following Regulations :—

Commencement.

1 These Regulations shall take effect on the 1st day of January, 1907, and remain in force until altered or revoked by the Board of Agriculture and Fisheries.

Definitions.

2. In these Regulations :—

"The Act," means the Fertilisers and Feeding Stuffs Act, 1906.

"Purchaser" and "seller" include their respective agents.

"Fertiliser" means any article used for fertilising the soil.

"Feeding stuff" means any article used as food for cattle (as defined by the Act, *i.e.*, bulls, cows, oxen, heifers, calves, sheep, goats, swine, or horses) or poultry.

Other expressions have the same respective meanings as in the Act.

Appointment of Agent.

3. The purchaser of a fertiliser or feeding stuff may, for the purposes of the Act, appoint an agent, in the form set forth in the schedule hereto, or in a form to the like effect.

Invoice, &c., to be Sent to Analyst.

4. Where a sample is, or parts of a sample are, under section 3 of the Act, sent for analysis to the Chief Analyst or to an Agricultural Analyst, there shall be sent with the sample or parts the invoice (if any) relating to the article from which the sample was taken, or a copy of the invoice or of such part thereof as is hereinafter prescribed, and also any circular or advertisement, or a copy thereof, of the seller descriptive of such article which the purchaser may wish the analyst to consider in making his analysis and giving his certificate.

Prescribed Part of Invoice (*s.* 3 (7)).

5. Where a copy of an invoice is sent to the Chief Analyst or to an Agricultural Analyst in pursuance of the Act

* No. 945 of 1906.

there may be omitted from such copy the name and address of, and any other matter which would identify or disclose, the seller of the article to which the invoice relates. The prescribed part of the invoice shall be the whole thereof except such name, address, and other matter as aforesaid.

Sampling.

6. Where, for the purposes of the Act, a sample is required to be taken in the prescribed manner, or in accordance with regulations made under the Act, the following provisions shall apply :—

(*a.*) The person taking the sample shall give to the seller at least three days' notice in writing of his intention to take the sample, with particulars as to the place, day, and hour of sampling. If the seller does not attend, the sample shall be taken in the presence of a witness.

(*b.*) The sample shall be taken in the following manner :—

In the case of a fertiliser—

(i.) When the fertiliser is delivered in bags or other packages, a number of bags or packages shall be selected as follows, viz. :—

Not less than 2 bags or packages where the quantity of the whole consignment does not exceed 1 ton.

Not less than 3 bags or packages where the quantity of the whole consignment exceeds 1 ton and does not exceed 2 tons.

Not less than 4 bags or packages where the quantity of the whole consignment exceeds 2 tons and does not exceed 3 tons ;

and, where the quantity exceeds 3 tons, one additional bag or package for every additional ton or part of a ton ; provided that in no case need more than 10 bags or packages be selected. The selection shall be made from different parts of the whole consignment.

(ii.) The selected bags or packages shall be emptied separately on a clean and dry floor, worked up with a spade, and one spadeful from each set aside. The spadefuls so set aside shall then be thoroughly mixed together and any lumps broken up by the hand or spade. From this mixture a sample, from about 2 lb. to 4 lb. in weight, shall be taken.

(iii.) When the fertiliser is delivered in bulk, a like number of portions, according to the quantity

of the whole consignment, shall be taken from different parts of the whole consignment and thoroughly mixed together on a clean and dry floor, and a sample, from about 2 lb. to 4 lb. in weight, shall be taken from the mixture.

(iv.) When the fertiliser consists of bulky material, uneven in character and likely to get matted together, such as shoddy, wool refuse, hair, &c., portions are to be taken from the selected bags or packages, or from different parts of the fertiliser if in bulk, the matted portions torn up, and all the portions thoroughly mixed together. The sample shall be taken from the mixture and shall be not less than 3 lb. in weight.

(v.) As an alternative method, where neither the seller nor the buyer signifies objection thereto, the sample of a fertiliser delivered in bags or other packages may be taken by a sampling pale or spear or pipe or tube, which shall not be less than twenty-four inches in length, and two inches in diameter. The sampling instrument shall be pressed into the mouth of the bag or package so as to pass through the entire depth of the contents or to the extreme length of the sampling instrument. The several quantities thus taken from the selected bags or packages, which shall be at least double the number of bags or packages required to be selected under paragraph (i), shall be thoroughly mixed together and a sample, from about 2 lb. to 4 lb. in weight, shall be taken from the mixture.

In the case of a feeding stuff—

(vi.) When the feeding stuff is in the state of grain or meal, it shall be sampled in the same manner as prescribed for fertilisers. When the feeding stuff is in the state of cake, a number of cakes shall be selected, from different parts of the whole consignment, as follows :—

Not less than 5 cakes where the quantity of the consignment does not exceed 2 tons.

Not less than 10 cakes where the quantity exceeds 2 tons and does not exceed 5 tons.

Not less than 15 cakes where the quantity exceeds 5 tons and does not exceed 50 tons.

Not less than 25 cakes where the quantity exceeds 50 tons.

(vii.) The selected cakes shall either be passed through a cake-breaker or be broken into small pieces such as could be passed through a 1½ inch

sieve. The broken cakes or the pieces shall be thoroughly mixed, and from the mixture a sample, not less than 6 lb. in weight, shall be taken.

(viii.) As an alternative method, three strips shall be taken across the middle of each selected cake; and each of the three parts, into which (under Regulation 7) a sample is to be divided, shall contain one strip of each selected cake.

(ix.) Where, on delivery of the consignment, any appreciable portion of the feeding stuff is found to be mouldy, sour, or otherwise unsuitable for feeding purposes, separate samples are to be taken of the unsuitable portion and of the residue of the feeding stuff respectively; and, in the case of unsuitable cakes, the sample may consist of several large pieces fairly representative thereof. An estimate shall be made by the person taking the sample as to the proportion of the feeding stuff unsuitable for feeding purposes and shall be communicated in writing by him to the Analyst.

(x.) When the feeding stuff is in a fluid or semi-fluid condition, three packages shall be selected, and, after the contents have been well stirred or shaken, a portion shall immediately be taken from each. The several portions shall then be thoroughly mixed together in a clean vessel, and from the mixture a sample, from about 2 lb. to 4 lb. in weight, shall be taken.

In the case of both fertilisers and feeding stuffs:—

(xi.) Where the quantity of the whole consignment does not exceed 2 cwt., the sample may consist of such a portion of the consignment as is fairly representative of the whole, and the sample shall be of such a quantity that each of the parts, into which (under Regulation 7) it is to be divided, will be sufficient to enable a proper analysis to be made thereof.

(*c.*) General directions as to sampling:—

(xii.) In every case the sampling shall be done as quickly as is possible consistently with due care, and the material shall not be allowed to be exposed any longer than is absolutely necessary.

(xiii.) Each of the parts, into which (under Regulation 7) the sample is to be divided, shall be packed in a dry, clean bottle, or jar, or (except in the case of a fertiliser) in a dry clean tin, or

in some other suitable manner, so that the original composition of the fertiliser or feeding stuff may be preserved.

(xiv.) Each of the said parts of the sample shall be so packed and secured that it cannot be tampered with, and shall be sealed and initialed by the person taking the sample. It may also be sealed by the purchaser and the seller, if present, and so desiring. If the seller does not attend, the witness shall initial it. It shall be marked with the name of the article, the date and the place of the sampling, and with some distinguishing number, in such a manner that the particulars so marked can be seen without breaking the seal or seals.

(xv.) Where a sample is taken in the presence of, and sealed by, the seller as well as the purchaser, it shall be deemed, as between the purchaser and the seller, to have been taken in accordance with these Regulations.

Division of Sample, &c.

7. Where a sample has been taken, under s. 3 of the Act, with a view to the institution of any civil or criminal proceeding, the person taking the sample shall divide it into three parts, as nearly as possible equal, and shall cause each part to be marked, sealed, and fastened up, and shall forthwith deliver or send by post two parts to the Agricultural Analyst and one part to the seller.

Short Title.

8. These Regulations may be cited as the Fertilisers and Feeding Stuffs (Sampling, &c.) Regulations, 1906.

In witness whereof the Board of Agriculture and Fisheries have hereunto set their Official Seal this twenty-seventh day of December, one thousand nine hundred and six.

(L.S.) T. H. ELLIOTT,

Secretary.

THE SCHEDULE.

FORM.

Appointment by Purchaser of Agent for the purposes of the Fertilisers and Feeding Stuffs Act, 1906.

I, *A.B.*, of hereby appoint *C.D.*, of *or* the Secretary for the time being of the Association [*or as the case may be*] to do on my behalf all things necessary for the purpose of obtaining an analysis under the Fertilisers and Feeding Stuffs Act, 1906, of the fertiliser *or* feeding stuff bought by me under an invoice, a copy of which is annexed.

The Fertilisers and Feeding Stuffs (Limits of Error) Regulations, 1910. Dated January 25, 1910.*

The Board of Agriculture and Fisheries, in pursuance of the provisions of the Fertilisers and Feeding Stuffs Act, 1906, hereby make the following Regulations :—

Commencement.

1. These Regulations shall take effect on the 1st day of March, 1910, and remain in force until altered or revoked by the Board of Agriculture and Fisheries.

Definitions.

2. In these Regulations—

"The Act" means the Fertilisers and Feeding Stuffs Act, 1906.

"Purchaser" and "seller" include their respective agents.

"Fertiliser" means any article sold for use as a fertiliser of the soil, which has been subjected to any artificial process in the United Kingdom or imported from abroad.

"Feeding stuff" means any article sold for use as food for cattle (as defined by the Act, *i.e.*, bulls, cows, oxen, heifers, calves, sheep, goats, swine, or horses) or poultry, which has been artificially prepared otherwise than by being mixed, broken, ground, or chopped.

Other expressions have the same respective meanings as in the Act.

* No. 90 of 1910.

Limits of Error.

3. For the purposes of the provisions of Section 1 of the Act, concerning the effect, as a warranty, of the statements made in the invoice of a fertiliser or of a feeding stuff (as above defined in Regulation 2) respecting the percentages of nitrogen, phosphates, and potash contained in the fertiliser, or of oil and albuminoids contained in the feeding stuff, the limits of error shall be as set forth in the Schedules hereto.

Short Title.

4. These Regulations may be cited as the Fertilisers and Feeding Stuffs (Limits of Error) Regulations, 1910, and the Fertilisers and Feeding Stuffs (Limits of Error) Regulations, 1906, are hereby revoked as from the time at which these Regulations take effect.

In witness whereof the Board of Agriculture and Fisheries have hereunto set their official seal, this twenty-fifth day of January, nineteen hundred and ten.

(L.S.) T. H. ELLIOTT,
Secretary.

FIRST SCHEDULE.

FERTILISERS.

Note.—In this Schedule the figures relating to Limits of Error represent percentages of the whole bulk.

Example of Application of Schedule.—In the case of a Bone Compound, if the percentages stated in the invoice are, soluble phosphates, 20; insoluble phosphates, 8; nitrogen, 1; then the warranty implied under s. 1 (1) of the Act will be that the fertiliser contains:—soluble phosphates, 19 to 21 per cent.; insoluble phosphates, 7 to 9 per cent.; nitrogen, ·7 to 1·3 per cent.

Description of Fertiliser	Limits of Error.			
	Soluble Phosphates.	Insoluble Phosphates.	Nitrogen.	Potash.
1. Superphosphate	1	—	—	—
2. Dissolved Bones (Vitriolized or Vitriolated) made from Bones (whether raw or steamed or boiled) and Acid only:—				
(I) When the total of the percentages of Phosphates (soluble and insoluble) stated in the invoice amounts to 32 or more, then—				
(*a*) If the excess of the actual percentage of insoluble Phosphates over that stated in the invoice is 3 or more	4	—	·3	—

Description of Fertiliser.	Limits of Error.			
	Soluble Phosphates.	Insoluble Phosphates.	Nitrogen.	Potash.
(*b*) If such excess is not less than 2, but is less than 3	3	—	·3	—
(*c*) If such excess is not less than 1, but is less than 2	2	—	·3	—
(II.) In all other cases	1	1	·3	—
3. Bone Compounds	1	1	·3	—
4. Compound Manures (other than Bone Compounds, but including Dissolved or Equalised Guano):—				
(*a*) If the respective percentages of Nitrogen and Potash stated in the invoice do not exceed 4	1	1	·3	·3
(*b*) If such respective percentages exceed 4 ...	1	1	·5	·5
5. Sulphate of Ammonia	—	—	·5	—
6. Nitrate of Soda	—	—	·5	—
7. Ground Hoofs and Horns	—	—	·5	—
8. Dried Blood	—	—	·5	—
9. Fish Guano and Meat Meal	—	2	·5	—
10. All Cakes and Meals (other than Bone or Meat Meal)	—	—	·5	—
11. Ground Bones and Bone Meal	—	2	·5	—
12. Basic Slag and Basic Superphosphate	2*	2	—	—
13. Shoddy, Wool, and Hair Waste	—	—	1	—
14. Kainit and other Potash Salts :—				
(*a*) Where the percentage of Potash stated in the invoice does not exceed 15	—	—	—	1
(*b*) Where such percentage exceeds 15	—	—	—	2
15. Nitrate of Potash	—	—	·5	2
16. Peruvian and other natural Imported Guanos :—				
(*a*) Where the percentage of insoluble phosphate stated in the invoice does not exceed 30	—	3	—	·5
(*b*) Where such percentage of insoluble phosphate exceeds 30	—	5	—	·5
(*c*) Where the percentage of Nitrogen stated in the invoice does not exceed 3.	—	—	·5	·5
(*d*) Where such percentage of Nitrogen exceeds 3 and does not exceed 5	—	—	·75	·5
(*e*) Where such percentage of Nitrogen exceeds 5	—	—	1	·5

* That is, soluble in a solution of Citric Acid of the prescribed strength.

SECOND SCHEDULE.

Feeding Stuffs.

Note.—In this Schedule the percentage of albuminoids is to be taken as the percentage of nitrogen (other than nitrogen present as ammoniacal or nitric nitrogen) multiplied by 6·25.

Example of Application of Schedule.—In the case of a linseed cake, if the percentages stated in the invoice are, oil, 10 ; albuminoids, 30 ; then the warranty implied under s. 1 (2) of the Act will be that the linseed cake contains :—oil, 8·75 to 11·25 per cent.; albuminoids, 26·25 to 33·75 per cent.

Description of Feeding Stuff.	Limits of Error.
Decorticated Cotton Cake Undecorticated Cotton Cake Earth Nut or Ground Nut Cake Palm Kernel or Palm Nut Cake Cocoanut Cake Niger Seed Cake Sesame Seed Cake Sunflower Seed Cake Hemp Seed Cake Kurdee or Safflower Cake Compound Cakes Compound Meals	One-tenth of the percentage of oil and one-tenth of the percentage of albuminoids stated in the invoice.
Linseed Cake Rape Cake Soya Bean Cake Maize Products	One-eighth of the percentage of oil and one-eighth of the percentage of albuminoids stated in the invoice.
All other feeding stuffs (as above defined in Regulation 2) not otherwise specified in this Schedule	One-fifth of the percentage of oil and one-fifth of the percentage of albuminoids stated in the invoice.

Note.—The term "Cake" includes ground cake and meal from which oil has been removed by any process

The Fertilisers and Feeding Stuffs (General) Regulations, 1907. Dated September 18, 1907.*

The Board of Agriculture and Fisheries, in pursuance of the provisions of the Fertilisers and Feeding Stuffs Act, 1906, hereby make the following Regulations :—

Regulation as to the Analyst to whom Samples are to be sent.

1. Where under the Fertilisers and Feeding Stuffs Act, 1906, any person desires that a sample shall be analysed by the agricultural analyst, the sample or parts of the sample, as the case may be, shall be sent to such agricultural analyst as is hereby prescribed, that is to say :—

(1) if the sample is taken in a county, or in a county borough or a burgh of which the council have appointed or concurred in appointing an agricultural analyst, then to the analyst appointed for the county or borough or burgh ;

* No. 752 of 1907.

(2) if the sample is taken in a county borough of which the council have not appointed or concurred in appointing an agricultural analyst, then to the analyst appointed for the county in which for the purposes of the Local Government Act, 1888, the borough is deemed to be situate ; and

(3) if the sample is taken in a burgh of which the council have not appointed or concurred in appointing an agricultural analyst, then to the analyst appointed for the county within which the burgh is situated or with which it has the longest common boundary.

Commencement.

2. These Regulations shall take effect on the 1st day of January, 1908, and remain in force until altered or revoked by the Board of Agriculture and Fisheries.

Short Title.

3. These Regulations may be cited as the Fertilisers and Feeding Stuffs (General) Regulations, 1907.

In witness whereof the Board of Agriculture and Fisheries have hereunto set their official seal, this eighteenth day of September, one thousand nine hundred and seven.

(L.S.) T. H. ELLIOTT,
Secretary.

The Fertilisers and Feeding Stuffs (General) Regulations, 1908. Dated November 8, 1908.*

The Board of Agriculture and Fisheries, in pursuance of the provisions of the Fertilisers and Feeding Stuffs Act, 1906, hereby make the following Regulations :—

Commencement.

1. These Regulations shall take effect on the first day of January, 1909, and remain in force until altered or revoked by the Board of Agriculture and Fisheries.

Definition.

2. In these Regulations, "fertiliser" means any article used for fertilising the soil.

Citric Acid Solvent (*s.* 10 (1)).

3. When in an invoice relating to a fertiliser a certain percentage of the fertiliser is stated to be phosphate soluble in citric acid, this shall be taken to mean that it is capable

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* No. 963 of 1908.

of being dissolved to the extent of such percentage when 5 grams of the fertiliser and 500 cubic centimetres of water containing 10 grams of pure crystallised citric acid, or alternatively when 5 grams of the fertiliser, moistened with 5 cubic centimetres of alcohol or methylated spirit, and 495 cubic centimetres of water containing 10 grams of pure crystallised citric acid, are continuously agitated during 30 minutes in a stoppered flask or bottle of about 1 litre capacity fitted into a mechanical shaking apparatus.

Revocation.

4. Regulation No. 5 of the Fertilisers and Feeding Stuffs (General) Regulations, 1906, is hereby revoked.

Short Title.

5. These Regulations may be cited as the Fertilisers and Feeding Stuffs (General) Regulations, 1908.

In witness whereof the Board of Agriculture and Fisheries have hereunto set their official seal, this ninth day of November, nineteen hundred and eight.

(L.S.) T. H. MIDDLETON,
Assistant Secretary.

The Fertilisers and Feeding Stuffs (Methods of Analysis) Regulations, 1908. Dated November 9, 1908.*

The Board of Agriculture and Fisheries, in pursuance of the provisions of the Fertilisers and Feeding Stuffs Act, 1906, hereby make the following Regulations :—

Commencement.

1. These Regulations shall take effect on the first day of January, 1909, and remain in force until altered or revoked by the Board of Agriculture and Fisheries.

Definitions.

2. In these Regulations—

"The Act" means the Fertilisers and Feeding Stuffs Act, 1906.

"Fertiliser" means any article used for fertilising the soil.

"Feeding stuff" means any article used as food for cattle (as defined by the Act, *i.e.*, bulls, cows, oxen, heifers, calves, sheep, goats, swine, or horses) or poultry.

Other expressions have the same respective meanings as in the Act.

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* No. 964 of 1908.

Methods of Analysis of Fertilisers.

3. The methods of analysis of a fertiliser for the purposes of the Act shall be as follows :—

(*i.*) *Preparation of the sample for analysis.*

(*a*) In the case of powdered fertilisers in a dry, or moderately dry, condition, the sample shall be passed through a sieve with perforations about one millimetre in diameter.

Adventitious materials which cannot be conveniently crushed, *e.g.*, fragments of metal in basic slag, shall be removed and allowed for.

(*b*) Other substances which are dry enough to powder but which are not in a fine condition shall be pulverised until the sample passes through a sieve with perforations about one millimetre in diameter.

(*c*) Wool, hair, hoof, shoddy, and similar substances, shall be pulled apart and cut until in a fine condition ; or, if dry, they may be passed through a shredding machine.

(*d*) Moist fertilisers which do not admit of being passed through a sieve shall be thoroughly mixed by the most suitable means.

(*e*) In the case of horn. shoddy, and other substances which gain or lose water during the process of pulverising, the proportion of water shall be estimated in the coarse and in the powdered condition respectively, and the results of the analysis of the powdered sample shall be calculated to the water content of the original coarse substance.

(*f*) Crystalline or saline materials, such as sulphate of ammonia, nitrate of soda, or potash salts, may be prepared by being well mixed and rapidly ground in a stoneware mortar, the portion finally reserved for analysis being especially finely ground.

(*g*) When the sample has been passed through the sieve and thoroughly mixed, or, if not passed through the sieve, has been thoroughly mixed, a part of it not being less than 100 grams shall be placed in a stoppered bottle, and from this the portions for analysis shall be weighed.

(*ii.*) *Determination of moisture* (*loss on drying*).

A weighed quantity of the sample shall be dried at 100° C.

(*iii.*) *Determination of nitrogen.*

The presence or absence of nitrates must first be ascertained.

(*a*) *Nitrogen in absence of nitrates.*

(*α*) A weighed portion of the sample shall be transferred to a Kjeldahl digestion flask; 10 grams of potassium sulphate and 25 cubic centimetres of concentrated sulphuric acid shall be added, and the flask shall be heated until a clear liquid, colourless, or of light straw colour, is obtained. The operation may be accelerated by the addition of a small crystal of copper sulphate or a globule of mercury to the liquid in the digestion flask.

(*β*) The quantity of ammonia shall be determined by distillation into standard acid after liberation with alkali, and, where mercury has been used, with the addition also of sodium or potassium sulphide solution.

(*b*) *Nitrogen when nitrates are present.*

(*α*) A weighed portion of the sample shall be transferred to a Kjeldahl digestion flask; 30 cubic centimetres of concentrated sulphuric acid, containing 1 gram of salicylic acid, shall be added, and the flask shall be shaken so as to mix its contents without delay. The shaking shall be continued at intervals during ten minutes, the flask being kept cool, and then 5 grams of sodium thiosulphate and 10 grams of potassium sulphate shall be added. The flask shall be heated until the contents are colourless or nearly so. Copper sulphate or mercury may be used as above described in paragraph (*iii.*) (*a*) (*α*).

(*β*) The quantity of ammonia shall be determined as above prescribed in paragraph (*iii.*) (*a*) (*β*).

(*c*) *Nitrogen in form of ammonium salts.*

A weighed portion of the sample shall be transferred to a distillation flask, and the quantity of ammonia shall be determined as above prescribed in paragraph (*iii.*) (*a*) (*β*).

(*d*) *Nitrogen in nitrates in the absence of ammonium salts and of organic nitrogen.*

One gram of the sample shall be placed in a half-litre Erlenmeyer flask with 50 cubic centimetres of water; 10 grams of reduced iron and 20 cubic centimetres of sulphuric acid of 1·35 specific gravity shall be added. The flask shall be closed with a rubber stopper provided with a thistle tube, the head of which shall be half filled with glass beads. The liquid shall be boiled for five minutes, and the flask shall then be removed from the flame, any liquid that may have accumulated among the beads being rinsed back with water into the flask The solution shall be boiled for three minutes more

and the beads again washed with a little water. The quantity of ammonia shall then be determined as above prescribed in paragraph (*iii.*) (*a*) (*β*).

In cases in which the proportion of nitrates is small a larger quantity of the sample shall be taken.

(*e*) *Control experiment in determination of nitrogen.*

The materials used in any of the methods described under this paragraph (*iii.*) shall be examined as to their freedom from nitrogen by means of a control experiment carried out under similar conditions with the same quantities of the reagents which have been employed in the actual analysis, in the case of (*a*) one gram of pure sugar being used in place of the weighed portion of the sample. The quantity of standard acid used in the control experiment shall be deducted from the total quantity of acid found to have been neutralised in the distillation of the sample.

(*iv.*) *Determination of phosphates.*

(*a*) *Phosphates soluble in water.*

In the case of superphosphates, dissolved bones and similar substances, 20 grams of the sample shall be continuously agitated for 30 minutes in a litre flask with 800 cubic centimetres of water. The flask shall then be filled to the mark, and again shaken, and the contents shall be filtered. 50 cubic centimetres of the filtrate shall be boiled with 20 cubic centimetres of concentrated nitric acid, and the phosphoric acid shall be determined by the molybdate method prescribed below in paragraph (*iv.*) (*d*).

In the case of fertilisers in which the proportion of phosphates soluble in water is small, a larger quantity of the filtrate prepared as above shall be taken.

(*b*) *Phosphates soluble in the prescribed citric acid solution.*

5 grams of the sample shall be transferred to a stoppered bottle of about 1 litre capacity ; 10 grams of pure crystallised citric acid shall be dissolved in water, the volume shall be made up to 500 cubic centimetres, and the solution shall be added to the weighed portion of the sample in the bottle. To lessen the possibility of caking, the portion of the sample in the bottle may be moistened with 5 cubic centimetres of alcohol or methylated spirit before the citric acid solution is added ; and in that case the volume of the citric acid solution shall be 495 cubic centimetres instead of 500 cubic centimetres. The bottle shall be at once fitted into a

mechanical shaking apparatus and shall be continuously agitated during 30 minutes. The solution shall then be filtered through a large "folded" filter, the whole of the liquid being poured on the paper at once. If not clear, the filtrate shall be again poured through the same paper.

50 cubic centimetres of the filtrate shall be taken and the phosphoric acid shall be determined by the molybdate method prescribed below in paragraph (iv.) (*d*).

(*c*) *Total phosphoric acid.*

A weighed portion of the sample, in which portion, if necessary, the organic matter has been destroyed by ignition and the silica removed by appropriate means, shall be dissolved in nitric acid and boiled, the solution being made up to a definite bulk. The phosphoric acid shall be determined in an aliquot part of the solution by the molybdate method prescribed below in paragraph (iv.) (*d*).

(*d*) *Molybdate method.*

To the solution, which should preferably contain from 0·1 to 0·2 gram of phosphoric oxide (P_2O_5), obtained as above described in paragraphs (iv.) (*a*), (*b*) or (*c*), 100 to 150 cubic centimetres of molybdic acid solution prepared as described below, or an excess of such solution, *i.e.*, more than is sufficient to precipitate all the phosphoric oxide present in the solution, shall be added, and the vessel containing the solution shall be placed in a water bath maintained at 70° C., for 15 minutes, or until the solution has reached 70° C. It shall then be taken out of the bath and allowed to cool, and the solution shall be filtered, the phospho-molybdate precipitate being washed several times by decantation and finally on the paper with one per cent. nitric acid solution. The filtrate and washings shall be mixed with more molybdic acid solution and allowed to stand for some time in a warm place in order to ascertain that the whole of the phosphoric oxide has been precipitated.

The phospho-molybdate precipitate shall be dissolved in cold 2 per cent. ammonia solution, prepared as described below, and about 100 cubic centimetres of the ammonia solution shall be used for the solution and washings. 15 to 20 cubic centimetres of magnesia mixture prepared as described below, or an excess of such mixture, *i.e.*, more than sufficient to precipitate all the phosphoric oxide present, shall then be added drop by drop, with constant stirring. After standing at least 2 hours with occasional stirring, the precipitate shall be filtered off, washed with 2 per cent. ammonia solution,

dried, and finally weighed as magnesium pyrophosphate. The filtrate and washings shall be tested by the addition of more magnesia mixture.

(*e*) *Preparation of Molybdic acid solution.*

The molybdic acid solution shall be prepared as follows :—

125 grams of molybdic acid and 100 cubic centimetres of water shall be placed in a litre flask, and the molybdic acid shall be dissolved by the addition, while the flask is shaken, of 300 cubic centimetres of 8 per cent. ammonia solution, prepared as described below. 400 grams of ammonium nitrate shall be added, the solution shall be made up to the mark with water, and the whole added to 1 litre of nitric acid (Sp. Gr. 1·19). The solution shall be maintained at about 35° C. for 24 hours and then filtered.

(*f*) *Preparation of Magnesia mixture.*

The magnesia mixture shall be prepared as follows:—

110 grams of crystallised magnesium chloride and 140 grams of ammonium chloride shall be dissolved in 1,300 cubic centimetres of water. This solution shall be mixed with 700 cubic centimetres of 8 per cent. ammonia solution, and the whole shall be allowed to stand for not less than three days and shall be then filtered.

(*g*) *Preparation of the Ammonia solutions.*

The 8 per cent. ammonia solution shall be prepared as follows :—

One volume of ammonia solution of Sp. Gr. 0·880 shall be mixed with three volumes of water. This solution shall then be adjusted by the addition thereto of more strong ammonia solution or water as required until the specific gravity of the solution is 0·967.

The 2 per cent. ammonia solution shall be prepared as follows :—

One volume of 8 per cent. ammonia solution shall be mixed with three volumes of water.

(*v.*) *Determination of Potash.*

(This paragraph has been amended by the Fertilisers and Feeding Stuffs (Methods of Analysis) Regulations, 1918, and is therefore omitted. *See* p. 22.)

Methods of Analysis of Feeding Stuffs.

4. The methods of analysis of a feeding stuff for the purposes of the Act shall be as follows :—

(*i.*) *Preparation of the Sample.*

(*a*) If the sample is already in a fine condition, *e.g.*, a meal, it shall be thoroughly mixed, and a portion for the determination of the moisture shall be at once taken.

(*b*) If the sample is not in a fine condition, *e.g.*, a cake, it shall be carefully pulverised until the whole passes through a sieve with perforations from 2 to 3 millimetres in diameter. It shall then be thoroughly mixed, and a portion for the determination of the moisture shall be at once taken.

(*c*) From the sample thus prepared, a portion not less than 100 grams in weight shall be taken and further powdered if necessary and passed through a sieve with perforations of about one millimetre in diameter.

(*d*) If the original sample is appreciably damp, or if for any reason the operations of pulverisation and mixing are likely to result in loss or gain of moisture, the moisture shall be determined in this portion, as well as in the sample prepared as in paragraph (i.) (*b*), in order that the results of the analysis may be corrected to correspond with the sample in its original condition as regards moisture.

(*e*) Materials which cannot be conveniently pulverised or passed through a sieve shall be thoroughly mixed and sampled by the most suitable means.

(*f*) The prepared portion of the sample shall be placed in a stoppered bottle and from it the portions for analysis shall be weighed.

(*ii.*) *Determination of Moisture* (*loss on drying*).

A weighed quantity of the sample shall be dried at 100° C.

(*iii.*) *Determination of Oil.*

(*a*) A weighed quantity of the sample shall be placed in a Soxhlet thimble, which shall then be placed in the Soxhlet extraction tube and extracted with washed, re-distilled ether. At the end of 3 to 4 hours the thimble shall be removed from the Soxhlet tube, dried, and its contents finely ground in a small mortar previously rinsed with ether. The substance shall then be returned to the thimble, the mortar being washed out with ether, and the extraction continued for another hour.

After evaporation of the solvent the oil shall be dried at 100° C. and weighed. The oil shall be re-dissolved in ether and any undissolved matter shall be weighed and deducted.

(*b*) In the case of samples containing saccharine matter, *e.g.*, sugar meals, the weighed portion in the Soxhlet thimble shall be washed twice with water, and then dried, previous to the extraction.

(*iv.*) *Determination of Albuminoids.*

The percentage of albuminoids shall be ascertained by multiplying the percentage of nitrogen by 6·25.

The determination of nitrogen shall be as follows :—

A weighed portion of the sample shall be transferred to a Kjeldahl digestion flask ; 10 grams of potassium sulphate and 25 cubic centimetres of concentrated sulphuric acid shall be added, and the flask heated until a clear liquid, colourless or of light straw colour is obtained. The operation may be accelerated by the addition of a small crystal of copper sulphate or a globule of mercury to the liquid in the digestion flask.

The quantity of ammonia shall be determined by distillation into standard acid after liberation with alkali, and, where mercury has been used, with the addition also of sodium or potassium sulphide solution.

The materials used shall be examined as to their freedom from nitrogen by means of a control experiment carried out under similar conditions with the same quantities of the re-agents which have been employed in the actual analysis, one gram of pure sugar being used in place of the weighed portion of the sample. The quantity of standard acid used in this control experiment shall be deducted from the total quantity of acid found to have been neutralised in the distillation of the sample.

Use of Prescribed Weights.

5. In calculating the results of analyses the atomic weights adopted by the International Committee on Atomic Weights shall be employed.

Forms of Certificates.

6. Every certificate which is affected by Regulation No. 3 of the Fertilisers and Feeding Stuffs (General) Regulations, 1906, and these Regulations, and which is dated on or after the first day of January, 1909, shall contain the following words :—

"The analysis was made in accordance with the Fertilisers "and Feeding Stuffs (Methods of Analysis) Regulations, "1908."

Short Title.

7. These Regulations may be cited as the Fertilisers and Feeding Stuffs (Methods of Analysis) Regulations, 1908.

In Witness whereof the Board of Agriculture and Fisheries have hereunto set their official seal, this ninth day of November, nineteen hundred and eight.

(L.S.) T. H. MIDDLETON,
Assistant Secretary.

The Fertilisers and Feeding Stuffs (Methods of Analysis) Regulations, 1918. Dated June 14, 1918.*

The Board of Agriculture and Fisheries, in pursuance of the provisions of the Fertilisers and Feeding Stuffs Act, 1906, hereby make the following Regulations:—

1. The Fertilisers and Feeding Stuffs (Methods of Analysis) Regulations, 1908, are hereby amended by the substitution for paragraph (V) of Regulation 3 of the following paragraph:—

(V) *Determination of Potash.*

(*a*) *Muriate of Potash free from Sulphates.*

A weighed portion of the sample (about 5 grams in the case of concentrated muriate of potash or 10 grams in the case of low-grade muriate) shall be dissolved in water, the solution shall be filtered if necessary and made up to 500 cubic centimetres. The potash shall be determined in 50 cubic centimetres of the solution either by the platinum chloride method, or by the perchloric acid method, prescribed below in clauses (*e*) and (*f*) of this paragraph.

(*b*) *Salts of Potash containing Sulphates.*

A weighed portion of the sample (about 5 grams in the case of concentrated sulphate of potash or 10 grams in the case of kainit or other low-grade sorts) shall be boiled with 20 cubic centimetres of hydrochloric acid and 300 cubic centimetres of water in a half-litre flask. Barium chloride solution shall be cautiously added, drop by drop, to the boiling solution until the sulphuric acid is completely precipitated. Any slight excess of barium shall be removed by the addition of the least possible

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* No. 659 of 1918.

excess of dilute sulphuric acid. The liquid (without filtration) shall be cooled, made up to 500 cubic centimetres and filtered. 50 cubic centimetres of the filtrate shall be taken and evaporated to dryness, and shall then be moistened with concentrated hydrochloric acid, again evaporated to dryness, treated with a little dilute hydrochloric acid and filtered if necessary. The potash shall be determined in the filtrate either by the platinum chloride method, or by the perchloric acid method, prescribed below in clauses (*e*) and (*f*) of this paragraph. If the solution contains phosphates, iron, manganese, or other substances that would interfere with the determination of potash, the method prescribed in clause (*c*) of this paragraph is to be used instead of the method prescribed in clause (*b*).

(*c*) *Potash in Flue-Dust.*

10 grams of the sample shall be gently ignited in order to char organic matter, if present, and shall then be boiled with 300 cubic centimetres of water. 10 cubic centimetres of concentrated hydrochloric acid shall be added slowly so as not to check the boiling, which is to be continued for a further 10 minutes after the addition of the last portions of acid. The liquid shall be filtered into a half-litre flask and raised to the boiling point; and to the boiling liquid powdered barium hydroxide is to be added until there is slight excess. The liquid shall then be cooled, made up to 500 cubic centimetres and filtered. Of the filtrate, 250 cubic centimetres shall be treated with ammonia solution and excess of ammonium carbonate, and, while boiling, with a little powdered ammonium oxalate. It shall then be cooled, made to 500 cubic centimetres and filtered. Of the filtrate, 50 cubic centimetres or 100 cubic centimetres, according to the amount of potash expected, shall be evaporated in a porcelain dish to dryness. If desired, nitric acid may be added during the evaporation after free ammonia has been driven off. The residue is to be heated gently over a low flame until all ammonium salts are expelled, the temperature being carefully kept below that of low redness. The residue shall be moistened with concentrated hydrochloric acid, evaporated to dryness, treated with dilute hydrochloric acid, filtered, and the potash determined in the filtrate either by the platinum chloride method or by the perchloric acid method, prescribed below in clauses (*e*) and (*f*) of this paragraph.

(*d*) *Potash in Guanos and Mixed Fertilisers.*

10 grams of the sample shall be gently ignited in order to char organic matter, if present, and shall then be heated for 10 minutes with 10 cubic centimetres of

concentrated hydrochloric acid, and finally boiled with 300 cubic centimetres of water. The liquid shall be filtered into a half-litre flask, raised to the boiling point, and a slight excess of powdered barium hydroxide shall be added. The contents of the flask shall be cooled, made up to 500 cubic centimetres and filtered. Of the filtrate 250 cubic centimetres shall be treated with ammonia solution and excess of ammonium carbonate, and then, while boiling, with a little powdered ammonium oxalate, cooled, made up to 500 cubic centimetres and filtered. Of the filtrate, 100 cubic centimetres are to be evaporated in a porcelain dish to dryness. If desired, nitric acid may be added during the evaporation after free ammonia has been driven off. The residue is to be heated gently over a low flame, till all ammonium salts are expelled, the temperature being carefully kept below that of low redness. The residue shall be moistened with concentrated hydrochloric acid, evaporated to dryness, treated with dilute hydrochloric acid and filtered. The potash shall be determined in the filtrate either by the platinum chloride method, or by the perchloric acid method, prescribed below in clauses (*e*) and (*f*) of this paragraph.

(*e*) *Platinum Chloride Method.*

To the solution obtained as above described in clauses (*a*), (*b*), (*c*) or (*d*) of this paragraph a few drops of hydrochloric acid shall be added, if none is present, and also 10 or 20 cubic centimetres (according to whether the portion weighed was 5 grams or 10 grams) of a solution of platinum chloride containing 10 grams of platinum per 100 cubic centimetres. After evaporation to a syrupy consistency on a waterbath, the contents of the basin shall be allowed to cool and shall then be treated with alcohol of specific gravity 0·864, being washed by decantation until the alcohol is colourless. The washings shall be passed through a weighed or counterpoised filter paper, on which the precipitate shall be finally collected, washed with alcohol as above, dried at 100° C. and weighed.

The precipitate is to be regarded as $K_2Pt\ Cl_6$, and is to be calculated to its equivalent as K_2O.

(*f*) *Perchloric Acid Method.*

To the solution obtained as above described in clauses (*a*), (*b*), (*c*) or (*d*) of this paragraph and placed in a small glass or porcelain basin, 7 cubic centimetres, or 12 cubic centimetres (according to whether the portion weighed was 5 grams or 10 grams) of a 20 per cent. solution of perchloric acid (specific gravity 1·125) shall

be added. The basin shall be placed on a hot plate or sand bath and the contents evaporated until white fumes are copiously evolved. The precipitate shall be re-dissolved in hot water, a few drops of perchloric acid solution added, and the whole concentrated again to the fuming stage. After cooling, the residue in the basin shall be thoroughly stirred with 20 cubic centimetres of alcohol of specific gravity (0.816 to 0.812 (95 to 96 per cent. of alcohol by volume). The precipitate shall be allowed to settle, and the clear liquid shall be poured through a weighed or counterpoised filter paper, or through a gooch crucible, draining the precipitate as completely as possible from the liquid before adding the washing solution. The precipitate shall be washed by decantation with alcohol (as above) saturated with potassium perchlorate at the temperature at which it is used, pouring the washings through the paper or gooch crucible on which the whole of the precipitate is finally collected, dried at 100° C., and weighed.

The precipitate is to be regarded as $KClO_4$, and is to be calculated to its equivalent as K_2O.

Saving as to Analysis under Existing Regulations.

2. Nothing herein contained shall affect an analysis made before the commencement of these Regulations or the validity of any certificate of an analysis so made or any legal proceedings in respect of any sample to which any such analysis or certificate relates.

Commencement.

3. These Regulations shall take effect on the fourteenth day of June, 1918, and remain in force until altered or revoked by the Board of Agriculture and Fisheries.

Extent.

4. These Regulations shall extend to England and Wales.

Short Title.

5, These Regulations may be cited as the Fertiliser and Feeding Stuffs (Methods of Analysis) Regulations, 1918.

In witness whereof the Board of Agriculture and Fisheries have hereunto set their Official Seal this fourteenth day of June, One thousand nine hundred and eighteen.

(L.S.) A. D. HALL,
Secretary.

London, S.W.1,
January, 1907.
Revised, July, 1918.

BOARD OF AGRICULTURE AND FISHERIES.

The Pea and Bean Weevils (*Sitones lineatus*, and *S. crinitus*).

The Striped Pea and Bean Weevil (*Sitones lineatus*). 1. Natural size. 2. Magnified.

Plants Attacked.

Peas and beans are very subject to attacks by the Pea and Bean Weevils, but the injury is frequently attributed to sparrows and slugs, because the weevils are not by any means easily seen, and readily fall to the ground when alarmed. The weevils eat the leaves and young shoots of the pea and bean plants, and the larvæ devour their roots. They are often troublesome in market gardens and allotment grounds as well as in the fields, and in some years an extensive reduction in the crops of peas and beans has resulted from their attacks. They have also been known to attack sweet peas in gardens. *Sitones* seriously injure red clover in its early stages, and their small white maggots, or larvæ, also spoil "second cuts" of clover by eating the roots of the plants and stopping their growth. Trifolium, too, suffers considerably, particularly in its early stage of growth, from the attacks of these weevils, although the injury is generally attributed to slugs and other insects. Reports of damage to lucerne have also been received, and one species attacks tares.

Description of the Beetles.

The commonest species is the Striped Pea Weevil (*S. lineatus.*) This is from one-fourth to one-fifth of an inch in length. Its ground colour is dark, but the body

is covered with greyish scales, which in some specimens are of a slightly greenish-grey shade. There are three lines of this grey, or grey-green, hue on the thorax, and many lines, lighter and darker alternately, on the wing cases. Some specimens are of a uniform colour. The antennæ are of a dull red colour, very slender, with club-like terminations. The legs are ferruginous, and the male has the anterior tibiæ curved and armed with a small hook. On the under surface the beetles are clay-coloured or dull grey, so that when they fall on their backs to the earth they can scarcely be detected.

Although not so abundant as the Striped Pea Weevil, the Spotted Pea Weevil (*S. crinitus*) also does much harm. It is smaller than *S. lineatus*, more of a grey or reddish colour, fresh specimens having almost a coppery sheen and with more or less distinct dark patches on the elytra. The bases of the legs are dark, the other portions dull red. Like the former it may be found almost uniform in colour, sometimes ochraceous grey, and may easily be known by its spotted elytra and by its often chalky appearance. It is somewhat local, and is particularly prevalent in the London district and on the South Coast. *S. crinitus* is very partial to tares.

Another species, *S. hispidulus*, is also common on clover in sandy districts, in some localities taking the place of *S. lineatus*. This weevil is black, covered with fuscous-brown scales, the thorax with three paler lines, the elytra with small black patches and stiff grey bristles; the eyes are flat, not prominent as in *S. crinitus*. In the South of England another species (*S. humeralis*) also occurs in numbers on trefoils. It resembles the previous weevil, but instead of erect bristles on the wing cases has a pale patch on each side of them. It has apparently a similar life-history to the Striped Pea Weevil.

Life-History.

The beetles lay their eggs either upon or just beneath the soil close to the roots of their food plants. The eggs hatch into small, white, footless, wrinkled grubs, with brown heads and biting jaws. These grubs feed on the roots of peas, beans, clover, sainfoin, and lucerne. When full-grown the larvæ are about one-fourth of an inch in length and pupate in an earthen cell. The pupæ lie in this cell—which is not lined with silk—at a depth of about two inches below the surface of the ground. At first the pupa is pale creamy-white; later the eyes become black and the proboscis-sheath darkens. The adult beetles hibernate in great numbers in stacks, and even, it is said, in stubble, but chiefly in hedgerows and similar places. These hibernators

appear early in spring, attack the young peas and beans as soon as they appear above ground, and lay eggs on or near the roots. From these eggs larvæ appear, which from the end of May to the middle of June reach maturity and produce a summer brood of the beetles. A large number of these lay eggs which hatch into larvæ in the autumn; these live on the roots of clover, lucerne, &c., and feed there all the winter, doing considerable harm. The winter larvæ mature in May and appear as adult beetles in June. In some cases they have been known to come from the pupal condition as early as March. Thus the *Sitones lineatus* may live in one of two ways during the winter, either by hibernating in the adult form, or by feeding, in the larval stage, on the roots of clover, &c. The larvæ bore channels along the main roots of the plant and also seem to feed on the nodular growths found in the roots of leguminous plants.

The beetles are very active on the wing early in the year, especially on warm days, but they may also be found on damp, foggy days well into autumn. In spring time they have frequently been noticed in numbers with the Bean Beetles (*Bruchus rufimanus*), on the blossoms of the gorse, and also on broom. The beetles eat out notches in the leaves of the young peas and beans and so interfere with the growth of the plant; in severe infestation the leaves may be eaten to the midribs. Warm, dry weather and a rough tilth, especially the latter, favour these pests. When the weather is cold, the beetles shelter beneath clods, &c., and in dry weather even enter cracks in the ground. The habit of feigning death, so common amongst the weevils, is well shown in these species. As soon as the observer approaches them they fall to the ground on their backs, and lie as if dead until the danger appears to be past.

Methods of Prevention and Remedies.

1.—*Garden Cultivation.*—As unbroken clods of earth provide the beetle with shelter, every effort should be made to obtain a good tilth.

Lime, soot, or lime and soot mixed, may be distributed over the plants, the application to be made, if possible, after a heavy dew or rain. Finely powdered guano has also been used in this way. An observer found that by covering rows of peas with fine earth the beetles were kept in check, and Theobald recommends that this treatment should precede the application of lime and soot. Powdered naphthalene and the various commercial soil insecticides are also worthy of trial against this pest.

Spraying has been found beneficial, both arsenical washes and weak paraffin emulsions being used for this purpose. Some difficulty has been experienced, however, in distributing the arsenical washes with sufficient uniformity over the leaves of the plants.

2.—*Field Cultivation.*—A crop which is vigorous can often withstand an attack, as it will produce more foliage than the beetles can devour. Suitable cultivation in conjunction with liberal manuring therefore tends to prevent serious damage.

Since the larvæ of *Sitones* feed at the roots of clover, trifolium, lucerne and other leguminous crops, peas or beans planted on land adjacent to such crops are often liable to attack.

The recommendations as to lime and soot given in the preceding section for garden cultivation apply equally to field cultivation.

Insecticides other than soot and lime appear to have been little used against this insect, but where the grower has the necessary appliances they might certainly be tried.

The beetles hibernate in heaps of rubbish, at the bottoms of rank, overgrown hedgerows and in rough dyke sides. If all rubbish is burnt and hedgerows or dykes are well kept, this pest and many others which winter in the same way will be greatly checked.

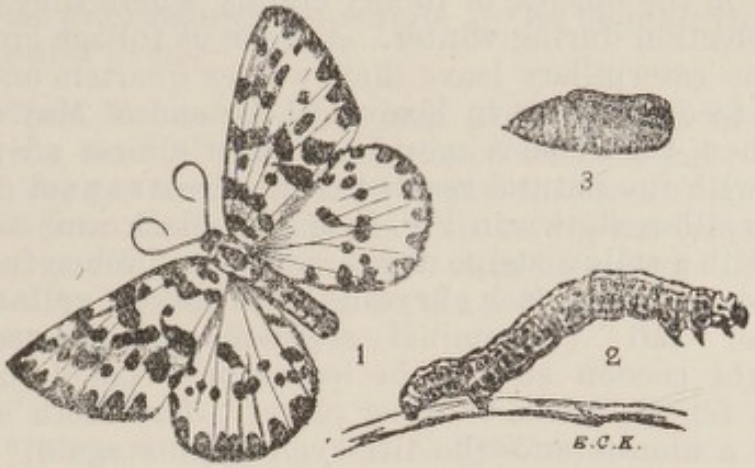
London, S.W.1,
May, 1895.

Revised, August, 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.

BOARD OF AGRICULTURE AND FISHERIES.

The Magpie Moth.



1, Moth ; 2, Caterpillar ; 3, Cocoon. All natural size

The Magpie Moth, also known as the Currant Moth, is a well-known enemy of gooseberries and currants, to which it may do considerable damage if allowed to breed unchecked. Fortunately, it is not really difficult to control and, therefore, with reasonable care, it need never be allowed to cause a serious loss of crop. As in the case of another abundant gooseberry pest—the Gooseberry Sawfly—the great thing is to deal with the attack in its early stages, before, and not after, the damage has been done. The Magpie Moth occurs—and attacks may therefore be expected—throughout the British Isles, in town and industrial areas as well as in the open country. Abroad, the moth is recorded as a pest in Central and Northern Europe, and its range extends across Asia to Japan.

Plants Attacked and Nature of Damage.—The caterpillars of the Magpie Moth feed on currant and gooseberry, plum, sloe, apricot, nut, laurel (*Prunus laurocerasus*), spindle (*Euonymus*), and probably other plants, but damage of importance is usually confined to currants, gooseberries, and occasionally apricots. The pest is perhaps more often harmful in confined gardens than in large orchards. The injury, which consists in the destruction of foliage by the caterpillars, begins as soon as the leaves appear and continues until June, the bushes in a bad attack being completely stripped. This naturally weakens the trees, and may cause a loss of crop for one or two years.

Description and Life History.—The Magpie Moth is the well-known black, white and yellow insect shown in Fig. 1.

It appears in July and August and lays eggs, singly or in small groups, on the leaves of gooseberries, currants, etc. In about a fortnight minute blackish caterpillars are hatched from the eggs and feed on the foliage, growing slowly, until the autumn, when, while still small, they go into winter quarters sheltered among the dead leaves of their food-plant, in moss and lichen growing on the bushes, or in any cranny where they may get some protection during winter. As soon as foliage appears in spring the caterpillars leave their winter quarters and again begin to feed, growing in size until the end of May or early June, when the bushes may have been almost stripped of foliage, with the natural result that the fruit cannot develop. The caterpillar, shown in Fig. 2, is then black and white in colour, with a yellow stripe down each side. When full-fed it turns into a shining black chrysalis, with narrow yellow bands round the "tail" (abdominal) segments, and is suspended in a slight cocoon among the leaves or twigs of the food-plant, on fences, walls, or other places. The moth emerges in about a month and the life-cycle begins again. Rarely there is a partial second brood, a few caterpillars feeding up rapidly and producing moths in autumn, but this second brood is never sufficiently numerous to do any damage.

It is important to distinguish between true Magpie Moth caterpillars and those of the Gooseberry Sawfly, since after an attack of the former no damage will again occur until the following season, while in the case of the latter damage must be expected at intervals throughout the summer unless preventive measures are taken. Gooseberry Sawfly caterpillars may be recognised by the fact that they are *green, more or less speckled with black*, and so are very different from the *black, white and yellow* Magpie caterpillars.

Methods of Control.—(1) *Spraying.*—Magpie caterpillars are easily killed by means of lead arsenate, but a difficulty arises from the fact that this insecticide is very poisonous and cannot be used when the gooseberries are fruiting. Lead arsenate spray should, therefore, be applied either (1) just before the flowering period, or (2) at the end of August to kill the young caterpillars. The time available for the work during the first period is very short, as it is necessary to wait until as much foliage as possible has been produced, while, on the other hand, spraying must cease before bees have begun to visit the flowers. It is possible that a second application of lead arsenate might be given directly after the flowers have set, but the berries swell so rapidly that there would be a risk of poisoning the fruit unless the work was carried out rapidly and with discrimination.

If spraying be deferred until the end of summer, the nozzle should be directed as much as possible on to the undersides of the leaves.

When an attack has not become apparent until it is too late to use lead arsenate, then hellebore (which loses its poisonous properties rapidly) may be used within three weeks of the time when the fruit is to be gathered. Pyrethrum, which must be fresh, is non-poisonous, and may be applied at any time. There are also various non-poisonous proprietary compounds to be bought from most horticultural firms.

(2) *Other Measures.*—In small gardens with only a few bushes, the caterpillars can be picked off by hand.

Since the young caterpillars spend the winter among the dead leaves on the ground it is well to dig the leaves deeply into the ground after an attack has occurred. A coat of powdered quicklime applied to the soil under the bushes is also reported to be effective.

(3) *Formulæ.*

A. Lead arsenate paste* ½ lb. Water ... ... 10 gallons.	C. Pyrethrum powder... 2 lb. Water ... ... 10 gallons
B. Hellebore powder*... 2 lb. Water ... ... 10 gallons.	

In mixing lead arsenate it is best to work up the paste into a thin cream with a little water, subsequently adding the remainder.

Sprays B. and C. are improved by the addition of ½ lb.–1 lb. of soft soap to each 10 gallons, and when being used, they should be kept well shaken up. Half-a-pound of soap will be enough unless the water is hard, when the full quantity may be allowed.

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* Lead arsenate and Hellebore are poisonous to man and animals. They should be kept under lock and key, and special tubs should be reserved for mixing the spray fluid.

London, S.W.1,
October, 1895.
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.

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Leaflet No. 21.

BOARD OF AGRICULTURE AND FISHERIES.

Warble Flies (*Hypoderma bovis*, De Geer and *H. lineata*, Villiers).

Fig 1

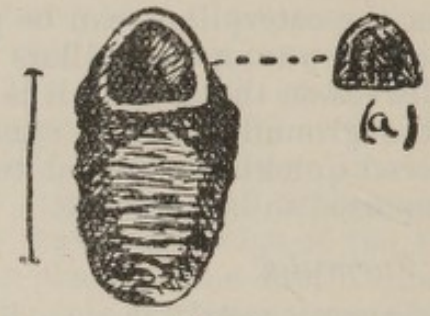

Fig. 3.

Fig. 2

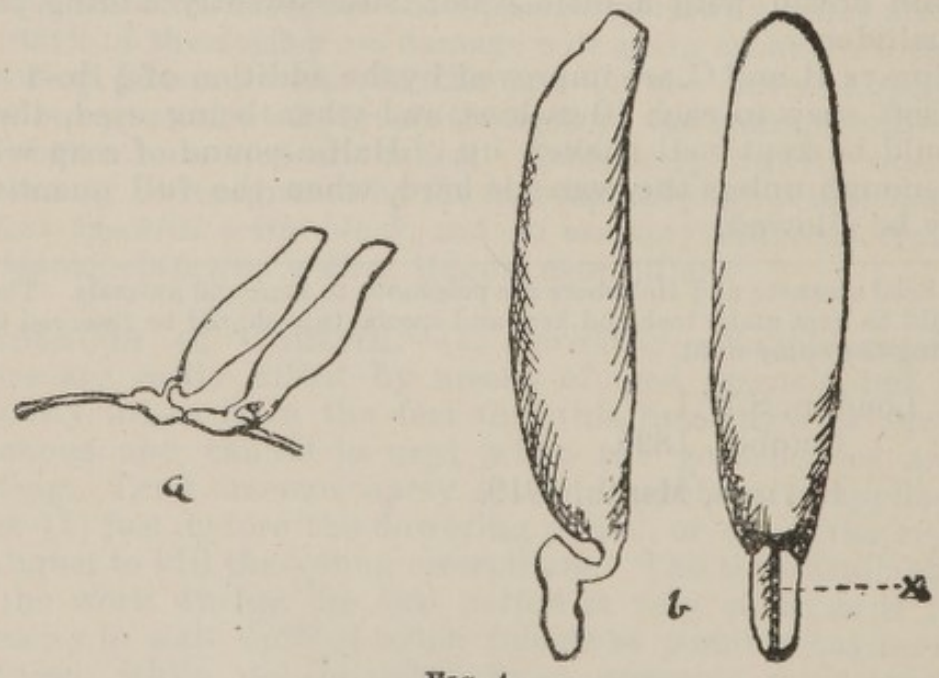

Fig. 4.

Fig. 1. Adult fly, *H. bovis*. Fig. 2. Puparium of *H. bovis*. Fig. 3. Puparium of *H. lineata*, shewing 'lid' (*a*). Fig. 4. *a*. Eggs of *Hypoderma lineata* on hair, magnified. *b*. Eggs still further magnified; x, clasper.

The Ox Warble Flies are a serious pest in Great Britain. They cause enormous losses in ruining hides for tanning purposes, in spoiling the appearance of the beef, and in damage to cattle by their being frightened and "stampeding" when the female fly approaches them to lay her eggs. These

losses are not confined to Great Britain, but are equally great on the Continent of Europe, and in the United States of America and in Canada. At present these flies have not become established in South Africa or Australia.

Nature of Damage.—The damage caused by these pests is due both to the adult flies and to their larvae, or "bots." The flies, especially *H. bovis*, when on the wing and on the look-out for a host on which to deposit their eggs, frighten the stock and may cause loss to "in calf" cows by making them stampede about the fields. The galloping about is also bad for milch cows and fattening stores. The maggots or "bots" living beneath the skin are a source of irritation to the cattle, while the perforations in the hides may ruin them for tanning purposes.* The parasites also cause loss to the butcher, who often finds the flesh beneath the "warbled" areas so altered by the inflammation set up that the beef in that region is spoilt. This so-called "licked beef" has a straw-coloured, jelly-like appearance in a newly slaughtered carcass, but turns to a dirty green in a few hours.

Description and Life-History.†—The eggs are of peculiar shape (Fig. 4) and about one-twelfth of an inch long, with a "clasper" at the base, by which the egg is attached to the hair of the animal. In the case of *H. bovis* the eggs are attached singly near the base of a hair, but in *H. lineata* they are attached in a row of seven or more halfway up a hair. They are laid by the female fly chiefly on the hind legs of the animal attacked and usually just below the heel joint or hock, more rarely on the flanks, and apparently never on the back. The presence of *H. bovis* (which is generally the more common species) for the purpose of egg-laying appears to frighten the animals far more than does *H. lineata*.

The young larvae hatch in about 4 or 5 days and at once enter the skin close to where the eggs were laid. After wandering for some time through the tissues of the animal attacked, the larvae make their way to the gullet, or œsophagus, to rest for a time in the subcutaneous coating of that organ; subsequently they migrate to the back of the animal, where, from January onwards they may be found in swellings just beneath the skin. At this stage they produce considerable irritation, and the swelling soon becomes perforated by a hole in its summit. When full-fed, the maggot emerges out of the swelling or "warble" and falls to the ground. It then enters the pupal stage which may take place either on or in the ground or under some stone, etc.

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* *See* also Leaflet No. 246 (*Prevention of Damage to Hides, Skins and Wool*)

† Carpenter, Hewitt and Kerry-Redin. *Journal of Depart. of Agric. Tech. Instruct., Ireland*, Vol. XV., 1914, pp. 105–132.

lying upon the ground. The puparium, or pupa-case is formed by the "bot's" old skin, which hardens and gradually becomes almost black in colour. In from three to five weeks in the case of *H. lineata*, and five to eight weeks in the case of *H. bovis*, the fly escapes by pushing off a cap at the end of the pupa-case.

The flies appear in Great Britain from the middle of May until September, *H. lineata* being the first to appear. They fly only in hot bright weather, and are most active during the hottest part of the day. It is said that they are so susceptible to temperature that they will not fly into the shade or over water. They produce a low audible hum when flying, which appears to be recognised by animals as a sign of danger and causes them to stampede and seek shelter. In appearance the flies somewhat resemble bees, being about half-an-inch in length and banded and marked with differently coloured hair.

Prevention and Treatment.—1. It is very desirable to arrange that stock shall have plenty of shelter during hot weather, either the natural shelter of trees, or artificial shelter formed by rough lodges or sheds.

2. The proximity of shallow water which the stock can enter at will is also useful as a means of warding off the pest.

3. The best means of treatment, and the only one by which these pests are likely to be kept under control, is the destruction of the grubs after removal from the warbles on the backs of the cattle. The skin should be made pliable by washing with a salt solution composed of ½ lb. salt to 3 gallons of water, after which any well-developed "bot" can be squeezed out and destroyed. Where several bots are removed from a small area of skin, it is advisable to apply carbolic oil. The removal should begin early in May and be continued during June, July and August.

London, S.W.1.,
September, 1894.

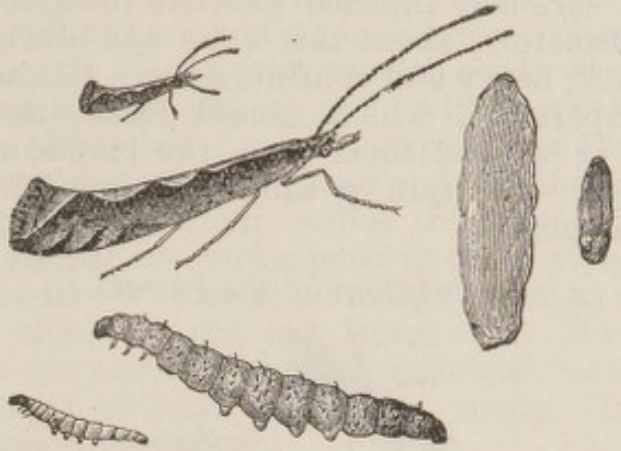
Re-written February, 1919.

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.

The Diamond-back Moth (*Plutella maculipennis*, Curtis).

FIG. 1.



The moth and caterpillar, natural size, and magnified. The cocoon, natural size, and magnified.

The caterpillars of this pretty little moth have in some seasons caused considerable injury to turnips, swedes, cabbages, kale, and other plants of the group *Brassica*. The caterpillars congregate upon the leaves, on their under surfaces for the most part, and soon devour every particle of their soft tissues, so that either the plants are killed outright or they are so much injured that the crop is materially reduced. A field of turnips or swedes badly infested with these caterpillars has a most peculiar and ghastly appearance, especially when the sun shines upon the riddled and whitened leaves.

This insect has been noticeably injurious to the turnip crop in Great Britain in 1837, 1851, 1883, and 1888. In 1891, however, there was a most serious attack both in England and Scotland, principally in the eastern counties, from Kent to Aberdeenshire. There were attacks in many other parts of Great Britain in 1891, but not nearly of the same gravity and extent as in the eastern districts, where whole fields of turnips, swedes, rape, and cabbage were completely ruined by the hordes of caterpillars infesting their leaves. Cabbages particularly were sadly affected by these pests; they swarmed between the leaves covering the "hearts," and soon caused them to rot. In 1901 also the caterpillars did much damage from July onwards.

The first notes of alarm with regard to the grave infestation of 1891 were heard about the beginning of July, and by the middle of that month great anxiety was felt by many farmers as to the fate of their turnip and cabbage crops, for the caterpillars were clearing everything before them with startling rapidity. On account of their increasing ravages the Board of Agriculture made an exhaustive inquiry into the circumstances and extent of the attack, and instituted a series of special experiments as to the value of various remedial measures which were conducted in different parts of the most seriously infested districts towards the end of July.* Fortunately, about that time and during the first part of August, heavy and continuous rain fell, accompanied by low temperature, which caused fatal disease in the caterpillars, or washed them from the plants, and checked their progress. The rain at the same time stimulated the growth of the plants.

Description of the Insect.

FIG. 2.

Moth flying, natural size; Moths resting, natural size; Caterpillar and cocoon, natural size.

The Diamond-back Moth belongs to the family *Plutellidæ* of the extensive group of moths known as *Tineina*. It has been wrongly known for years as *Plutella cruciferarum*, Zeller, but Curtis had previously described it in 1831 under the name *maculipennis*. It is from five lines to half an inch long when resting with folded wings, as shown in two of the figures. The wings when expanded have a breadth of nearly two-thirds of an inch. The prevailing colour is light brown shaded with grey, with the "diamond" marks plainly visible upon the back when the moth is at rest. The hind edge or margin of each fore-wing has three white marks, and these, on the margins of the wings being brought together when the moth is at rest, form the diamond marks. In this position of rest the peculiar tilt of the wings at their ends, forming a kind of tuft, is a notable characteristic. In

* Special Report on the Attack of the Diamond-back Moth Caterpillar, 1891.

some specimens the grey or ashy grey shades prevail over the brown. The under surface of the body is of a grey or pale grey hue.

The fore wings, shown expanded in Figure 2, are greyish brown with dark spots. Along the inner margin of the fore wings there is a border of light colour. The narrow hinder wings are more silvery-grey and have long fringes. The moth has greyish legs, and long slender antennæ of a white colour.

The egg is white or yellowish white, cylindrical, and marked with elaborate and most delicate tracery.

The caterpillars are half an inch long. They have 16 feet and are green in colour, with greyish heads when full grown, but in their early life are grey with dark heads. Their bodies are somewhat "spindleshaped," as Curtis puts it: that is, they taper off at the head and tail ends. Upon some of the segments of their bodies there are a few bristles.

The chrysalids are enwrapped in creamy yellow cocoons, of a fine net-like texture more or less open at each end, one end being closed by the cast larval skin. Stripped of the cocoon the chrysalis is white or yellowish white, with dark marks upon it, at least, in its latest stages. In the earlier stages the colour is darker.

Life History.

In the spring the first brood of moths comes from the chrysalids which have wintered upon the stalks and dead leaves of weeds, such as Charlock, Hedge Mustard, Jack-by-the-Hedge, and similar plants, upon *Cheiranthus* or wall-flower, especially the common variety, which grows freely upon cliffs by the sea, and also upon the Prickly Saltwort, *Salsola Kali*, a common seashore plant. The chrysalids, snugly packed in silken cocoons represented in the figures, are also found on dead stalks and rubbish near the food plants of the caterpillar. When the first brood of moths appears, the females lay eggs upon the under sides of the leaves of wild cruciferous plants, and on the leaves of such cultivated varieties of them as are then growing. There is no reliable record as to the time when the caterpillar comes from the egg, but the caterpillar stage lasts from 20 to 28 days, and the chrysalis stage of the first broods about 15 days.

Curtis and some other authorities hold that there are more than two broods, or generations, of this insect if the weather is favourable; this was demonstrated in 1891, and it may be concluded that there are two and more broods in a season if the conditions of climate are suitable. Food supply is only a secondary condition affecting the multiplication of these insects, as there are so many plants upon which the larvæ may be supported; for instance, all kinds of turnips, all kinds of cabbage, broccoli, Brussels sprouts, kale, rape,

mustard, wild mustard, radishes, horse radish, stocks, wall-flowers, rockets, penny cress, shepherd's purse, scurvy grass, and wall mustard, all of which are crucifers, and on saltwort, which belongs to the Chenopodiaceae.

Remedies and Methods of Prevention.

1.—From the experiences of 1891, and as the result of many experiments carried out then, dressing the infested plants with soot and lime mixed together appears to be the best remedy.

This should be put on by means of a distributing machine, at the rate of from two to six bushels per acre, the proportions being one part of lime to three parts of soot. This pungent substance should be distributed with regularity and force over, through, and under the leaves, and upon the bodies of the caterpillars.

2.—Sprayings with pungent substances, such as carbolic acid and paraffin, applied with a distributing machine in the smallest quantities, or paraffin emulsion in larger quantities, have been found to be efficacious in some degree, but not so effectual as soot and lime.

3.—Soot and sulphur, in the proportions of one bushel of soot to three or four pounds of sulphur, put on at the rate of from two to four bushels per acre by a distributing machine, have been found useful in some cases.

4.—Broadcasting soot and lime, or soot and sulphur, upon infested plants checks the caterpillars to some extent. This must be done when the dew is upon the plants, and much larger quantities are required per acre than when a distributing machine is used. It is, however, not very satisfactory, as the mixture does not go under the leaves, where the caterpillars are.

5.—Horse hoes with branches of birch, green broom, furze, or any elastic boughs, fastened to their sides, may be drawn between the rows advantageously, so as to brush the plants and dislodge the caterpillars upon them. Another horse hoe should follow at once to bury or crush the dislodged caterpillars.

6.—When plants are found to be infested, nitrate of soda, guano, or other forcing manures should be applied to stimulate growth.

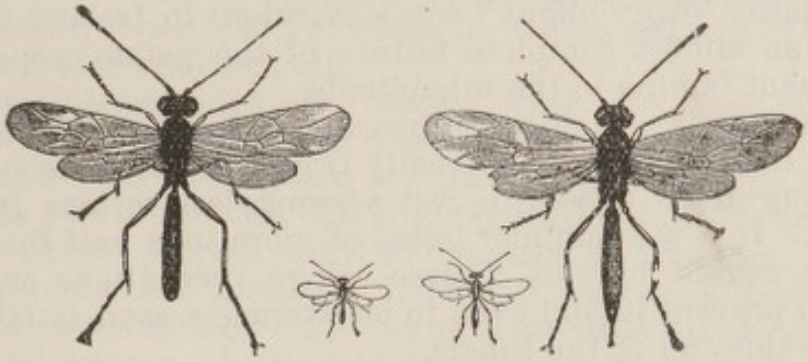
7.—After an attack of this insect it is most desirable to brush hedge sides and hedge rows, ditches, and other places harbouring weeds, in the early spring, as it has been noticed that the attack has often been commenced in corners and other parts of fields bounded by hedge rows, and has spread over the fields. Many of the moths may be often seen around cruciferous weeds on the hedge sides. Charlock is a favourite resort of these insects.

Natural Enemies.

In 1891 it was noticed that many of the caterpillars of the Diamond-back moth were attacked by parasites and destroyed by other insects.

Foremost among these was a species of the *Ichneumonidæ* called *Limneria gracilis*, Gravenhorst.

FIG 3.



Limneria gracilis, Gravenhorst: Male and Female Flies, natural size and magnified.

The female fly places an egg in the body of the caterpillar. upon which the larva from this egg feeds. The late Mr. Stainton, writing in August 1891, concerning the great number of the parasites that were in evidence, said: "Probably the parasites of the Diamond-back moth will this "year be developed in such numbers that the moth will be "almost annihilated in 1892."

It was noticed in 1891 that various kinds of birds were effective enemies of the caterpillars of this moth. Among these were rooks, starlings, peewits, golden plovers, and sea-gulls, and it was stated that where small birds had been exterminated the damage was worse. This is one more reason for endeavouring to preserve harmless and useful birds.

London, S.W.1,
June, 1894.

Revised, July, 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. 23.

BOARD OF AGRICULTURE AND FISHERIES.

POTATO DISEASE ("BLIGHT") AND ITS PREVENTION.

HISTORY OF THE DISEASE.—The common potato disease known as "blight" or "late blight" is caused by a minute (microscopic) form of vegetable life—the parasitic fungus *Phytophthora infestans*. It was first noticed in Europe and America about 1840, and by 1845 it had become widespread. In the latter year "blight" was so virulent in Ireland that it caused an almost complete failure of the potato crop, with consequent famine to the inhabitants.

Since that time the disease has always been present in the British Isles, varying in intensity from year to year: more disastrous in its effects in wet seasons, less serious in dry seasons. In a wet summer losses of more than half the crop may be caused by this disease where precautions are not taken to prevent it, and even in an average season it takes a considerable toll of the tubers.

SYMPTOMS.—The first sign of the disease visible to the naked eye is the appearance on the leaves of dark brown or blackish spots of irregular size and shape, on the under surface of which a delicate white mould may be seen especially round the margin of the diseased areas. If weather conditions favour the "fungus" the dark-coloured patches spread rapidly and the whole of the foliage, and sometimes the stems also, soon become blackened.

Potato plants badly attacked by "blight" give off a very distinct and disagreeable smell. In wet, muggy weather the whitish mould, which is the most characteristic sign of the disease, may grow out from the upper as well as from the under surface of the leaves. The minute threads of which the whitish mould consists, branch like microscopic trees and produce innumerable, pear-shaped outgrowths, the spores or "seeds" of the fungus. The spores, becoming detached from the thread-like stalks which bear them, are carried by currents of air and spread the disease to any healthy potato leaves on which they happen to alight. Each spore falling on a leaf, growing into and spreading through it, gives rise to a discoloured patch. After the fungus has fed on the food substances in the leaf, its threads grow out from the leaf into the air, especially from the under surface, and form the whitish mould already described. The period from the time of infection to the production of a new crop of spores is only a few hours, or at the most days, hence the extreme rapidity with which the disease may spread. If dry weather intervenes after a bad attack of "blight," the affected leaves shrivel and subsequently fall off, leaving the haulm bare.

If the weather is wet after the haulm has been attacked, the tubers soon begin to be affected. Infection of the tubers is brought about by spores which, liberated from the surface of the leaf, are washed down into the soil. The first signs of disease in the tubers are discoloured, rusty patches just visible through the skin, but more evident when the skin is scraped away. At first only a small part of the tuber may be attacked, but the disease may spread rapidly until half or more of the tuber is affected. Blighted tubers may also become secondarily infected with bacteria and other micro-organisms, when a soft rot sets in, which reduces the tubers to the consistency of pulp.

The re-appearance of "blight" year after year is mainly due to the fact that each year a certain number of tubers infected with the disease are planted as "seed." This in turn is due to the fact that slightly infected tubers are easily overlooked. Herein lies the advantage of "boxing" tubers, for if boxed the diseased tubers may very often be detected by the fact that they either do not sprout at all or bear poor, weakly sprouts. Such sets should not be planted. When small quantities of "boxed" potatoes are to be planted, it is advisable to cut across the tubers at planting time and to observe whether the flesh shows hollow spaces or black or brown spots. Any such tubers should be regarded as suspect and should not be planted. To prevent any possible damage from cutting, the cut surface may be rubbed in dry plaster of Paris, powdered lime, sulphur, or charcoal dust. Under suitable weather conditions during the early part of the summer, some of the slightly diseased tubers, that escaped detection at the time of planting, may give rise to one or more diseased shoots which come above ground and on which spores develop, thus providing the starting point for an epidemic. Potato "blight" develops its spores and hence spreads most rapidly under moist conditions, such as are provided by warm, muggy days following heavy rain.

Infection may perhaps also proceed from diseased tubers which have been left in the ground after digging, or which have lain about near clamps during the winter. No satisfactory evidence is yet forthcoming that the disease persists during the winter in a dormant condition in the soil.

THE PREVENTION OF "BLIGHT" BY SPRAYING.—The object of spraying potatoes is to prevent the outbreak and spread of "blight," and in order to do this it is necessary to use a substance which, whilst not harmful to the potato plant, prevents the fungus which causes "blight" from penetrating into the tissues of the leaves. The substance, if it is to be effective, must not only have this property but also must be capable of adhering firmly to the leaf.

A solution of copper sulphate, if used alone, though it would destroy the blight fungus, would also injure the

foliage. When, however, copper sulphate is combined with lime or washing soda, a fungicide is obtained which is both harmless to the potato foliage and destructive to the fungus. The use of Bordeaux mixture (copper sulphate combined with lime) and Burgundy mixture (copper sulphate combined with washing soda) has been common for many years in the vineyards of France and other countries. These substances have also been used largely and for many years for the purpose of preventing "blight" in potatoes, and it has been shown that the more effectively the foliage is covered with either of these mixtures, the more thoroughly is an outbreak of "blight" prevented.

By the use of Bordeaux or Burgundy mixture, the spores of the fungus are prevented from germinating and producing threads which grow into the tissues of the leaf, and hence the haulm, instead of withering, as it does when attacked by "blight," remains healthy and green; the crop is therefore increased, and the tubers remain free from "blight."

In practice, however, no matter how carefully spraying may be done, it is not possible to cover the foliage so completely as to prevent all chance of infection. Even so spraying when well done assists very materially in preventing the successive and rapid infections already described, and hence in limiting the extent of the disease both in the haulm and in the tubers.

It is important to realise that spraying is to be regarded as a means of prevention rather than as a cure, for when this is realised it becomes apparent first, that spraying must be done in good time, and second, that if heavy rains have washed the spraying material from the leaves, the operation of spraying must be repeated. This is the more important because in wet seasons the fungus finds conditions favourable for its rapid multiplication, so that if wet weather follows the spraying it is doubly important to repeat the operation, and even to spray a third time. Some of the most successful large growers of potatoes no longer rely on spraying only once or twice, but make a practice of spraying as often as weather conditions make repetition of spraying necessary.

In short, spraying must not be regarded as an infallible preventive of "blight." It is not. **Spraying should rather be regarded as a measure of insurance:** as a means of enabling the plant to tide over a time during which it is specially liable to infection, and if by reason of spraying this dangerous time is successfully passed, the work of tuber-formation goes on instead of being checked, as would be the case if the disease got a hold on the plant. Hence the yield is increased, and the proportion of sound tubers is larger than would be obtained from a crop the tops of which have been attacked by disease.

Later on, if the disease declares itself in the tops when tuber formation is approaching completion, and when, owing to the large growth of the haulm, spraying is no longer possible, removal of the tops will help to prevent the fungus from infecting the tubers in the ground.

The accumulated evidence of many years justifies the conclusion that the cost of insurance by spraying in an average season is amply repaid by the greater yield of healthy tubers.

It may be of interest to mention briefly the views held by scientific men as to the way in which Bordeaux mixture acts. One is that the carbon-dioxide in the air acts upon Bordeaux mixture in such a way as to bring about the gradual liberation of small amounts of soluble copper, which substance, though present at any given time in very small quantities, is sufficient to kill the spores of the blight fungus. Another view is that the spores falling upon the film of Bordeaux mixture excrete a substance which acts upon the mixture, and brings about the liberation of soluble copper. By absorbing this, the fungus brings about its own death by poisoning. The action of Burgundy mixture is probably identical with that of Bordeaux mixture.

Opinions differ as to the relative value of Bordeaux and Burgundy mixtures; there is, however, no doubt that both are efficient fungicides. Where freshly-burnt stone-lime of good quality is to be obtained the use of Bordeaux mixture is to be recommended; but if good lime is not readily obtainable, Burgundy mixture should be used.

INSTRUCTIONS FOR MAKING BURGUNDY MIXTURE.—The mixture should be carefully made, otherwise injury to the foliage may result. It is essential that all the soluble copper be precipitated by the addition of sufficient soda. Whilst adding the soda to the solution of copper sulphate the mixture must be vigorously stirred. The precipitate formed by the mingling of these two substances should be flocculent and remain in suspension for a considerable time.

The method of making Burgundy mixture is as follows:—

For Spraying One-third of an Acre (*say* 50 *rods*).

(1) Dissolve 4 lb. of sulphate of copper in five gallons of water in a barrel,* capable of holding 40 gallons, then make up to 35 gallons.

(2) Dissolve in another vessel in five gallons of water 5 lb. of washing soda (previously broken up into small pieces if necessary).

(3) When the soda is *completely* dissolved, add (2) to (1), stirring vigorously meanwhile.

N.B.—(Both copper sulphate and soda should be of fully 98 per cent. purity.)

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* Iron or zinc vessels must not be used.

Where smaller areas are to be sprayed, barrels, capable of holding 10 gallons may be used ; in that case, the quantities of copper sulphate and soda given above should be reduced each to ¼, namely, 1 lb. of sulphate of copper and 1¼ lb. of washing soda.

Burgundy mixture should be bright blue in colour, and should not settle for a considerable time. Experience has shown that the precipitate remains longer in suspension and adheres better to the foliage when the mixture is made up in the above manner than when the soda is added to a concentrated solution of copper sulphate. The fungicide should be used in a *fresh state* and in no case should it be applied more than ten hours after it has been made.

Both copper sulphate and washing soda dissolve slowly in cold water. The preparation of the solutions may be hastened by dissolving the copper sulphate and soda each in a gallon or so of hot water and making up the quantities indicated above by the addition of cold water ; but before the solutions are mixed with one another they should be allowed to become cold. In order to save time, the copper sulphate and soda may be dissolved beforehand, but after the one is added the mixture should be used with as little delay as possible.

Sulphate of copper is poisonous, therefore the vessels in which the copper compounds have been prepared should not be used for the preparation of food.

The above formula gives what is known as 1 per cent. Burgundy mixture, *i.e.*, 1 per cent. of copper sulphate is used in its preparation. The use of Burgundy mixture of double this strength, *i.e.*, 2 per cent., is sometimes advocated, but results indicate that there is little to be gained by the application of the stronger fluid. The Irish Department of Agriculture has for a number of years carried out trials as to the relative merits of 1 and 2 per cent. Burgundy mixture. For the five years 1911–1915 the average yield per acre sprayed with the 1 per cent. mixture was 12·24 tons as against 12·25 with the 2 per cent. strength, the weights of *healthy* tubers being respectively 11·72 and 11·84 tons. In some years the 1 per cent. mixture gave better results than the other. Although the average yield during the five years was fractionally better when the 2 per cent. mixture was used, there is not sufficient difference to justify the use of the stronger fluid, especially at a time when copper sulphate is much increased in price. In particularly wet districts, however, it may be advisable to use the 2 per cent. mixture. During 1917 good results were generally obtained with the weaker solution.

INSTRUCTIONS FOR MAKING BORDEAUX MIXTURE.—This mixture should be made up in the following proportions :—

Copper Sulphate	... 4 lb.
Quick Lime (freshly burnt lumps)	... 2 lb.
Water	... 40 gallons.

The copper sulphate should be dissolved in 35 gallons of water in a barrel. The lime should be placed in a separate vessel and slaked *slowly*. This is best done by adding only the amount of water which the lime can absorb. After the lime is thoroughly slaked, more water should be added gradually, stirring all the time, to make up to five gallons. It should then be strained through a fine sieve and added to the solution of sulphate of copper, the contents of the barrel being vigorously stirred during the mixing. The above formula is for a 1 per cent. Bordeaux mixture, and to make the stronger, 2 per cent. solution, double the quantities of copper sulphate and lime are required to the same amount of water. There is, however, little to choose, as regards fungicidal power, between a 1 and a 2 per cent. mixture.

APPLICATION OF THE SPRAYING MIXTURE : KNAPSACK SPRAYING MACHINES.—For small areas Burgundy and Bordeaux mixtures are best applied by means of a knapsack machine, which must be provided with a nozzle that throws a fine misty spray. The person spraying should aim at covering the under surface as well as the upper surface of the leaves, as both sides are liable to infection. It is a mistake to apply too much fluid. On no account should the plants be "washed." All that is required is that, after spraying, the thinnest possible covering of the fungicide should be spread evenly on the leaves ; this is best done by maintaining a high pressure in the spraying machine.

For the first spraying, about 120 gallons of the fungicide per acre or $\frac{3}{4}$ gallon per rod, pole or perch should be used, and for the second spraying, about 160 gallons per acre or one gallon per rod, pole or perch.

If a knapsack machine is not available, a syringe fitted with a nozzle which throws a mist-like spray may be used on small plots. Large fields of potatoes on the other hand should be sprayed by a horse-drawn machine. All spraying machines should be kept in good condition by oiling frequently the important working parts, and by careful washing out after use.

DATES FOR SPRAYING.—It is important to remember that the first spraying should be done before the disease appears, but in view of variations in the time of appearance of "blight" in different years and in different parts of the country, it is obvious that the dates for spraying must vary

with the season and the district. Thus, potatoes in the south-western counties should be sprayed earlier than those in the east and north. The condition of the haulm must also be taken into account, it being difficult and sometimes impossible to spray effectively when the haulm is far advanced in growth. When possible, the spraying should be done as soon as dry weather sets in after the first wet spell occurring at or about the dates given below. The best results are obtained when spraying is done during dry weather. It is better, however, to spray even when light rain is falling than to delay the operation too long in expectation of dry weather. Spraying should in no case be done in very wet weather, and if heavy rain falls before the spraying fluid has dried on the foliage, thereby washing off much of it, a further application should be given as soon as conditions permit. Spraying should be carried out preferably in the early morning or evening, and not when a hot sun is shining.

In an average season an approximation to the following dates for the first spraying of second early and main crop potatoes will probably be satisfactory.

Cornwall	June 15th—end of June.
Devon	*N.B.*—Spraying should be done the last week of May for early varieties in the Penzance district and the first week of June in other forward districts of Cornwall, Devon, and the Isle of Wight.
Dorset	
Isle of Wight and Hampshire ...	
Somerset	
S.W. Wales ...	
Glamorganshire ...	July 1st—July 8th.
Gloucestershire ...	
Monmouthshire ...	
Sussex	
N.W. Wales ...	
Wiltshire	
Berkshire	July 8th—July 15th.
Herefordshire ...	
Kent	
Oxfordshire ...	
Surrey	
Worcestershire ...	
Remainder of the country.	July 15th—July 31st.

(In the north-eastern counties spraying should usually be deferred until the last week of July.)

The second spraying should generally be done about three weeks after the first. It will serve to cover the new foliage and to protect more completely that already sprayed. In the south-west of England it will often be found advisable to spray a third time, and this applies also to other districts in wet seasons when heavy rains are frequent.

Even when blight has broken out and the potatoes have not previously been sprayed, it is not too late to spray ; for by so doing the rate of spread of the disease will be checked

and the damage to the crop reduced, though the protection from disease will usually be less complete than when spraying was done earlier.

There is some difference of opinion as to whether second earlies as well as main crop varieties should be sprayed. Where the disease is apt to appear early and to be specially virulent, as in the western half of the country, it is certainly advisable to spray second earlies, but where the foliage of these varieties is on the point of ripening before the disease appears, it is not worth while to spray them. Second earlies, which are planted late or which are to be lifted late, should, of course, be sprayed.

In the Penzance district it may also be necessary to spray first early varieties, as in adverse seasons serious outbreaks of disease are apt to occur even in first earlies. In other parts of the country the haulm of early varieties may be affected by blight, but it is generally held not to be worth while to spray them, as the crop will usually be lifted before the disease affects the tubers, but it should not be forgotten that the disease developed on first earlies may spread from them to second earlies or main crop potatoes growing in their neighbourhood. First earlies, which have been planted late or which for any other reason are to remain in the ground some time after the appearance of disease, should be sprayed.

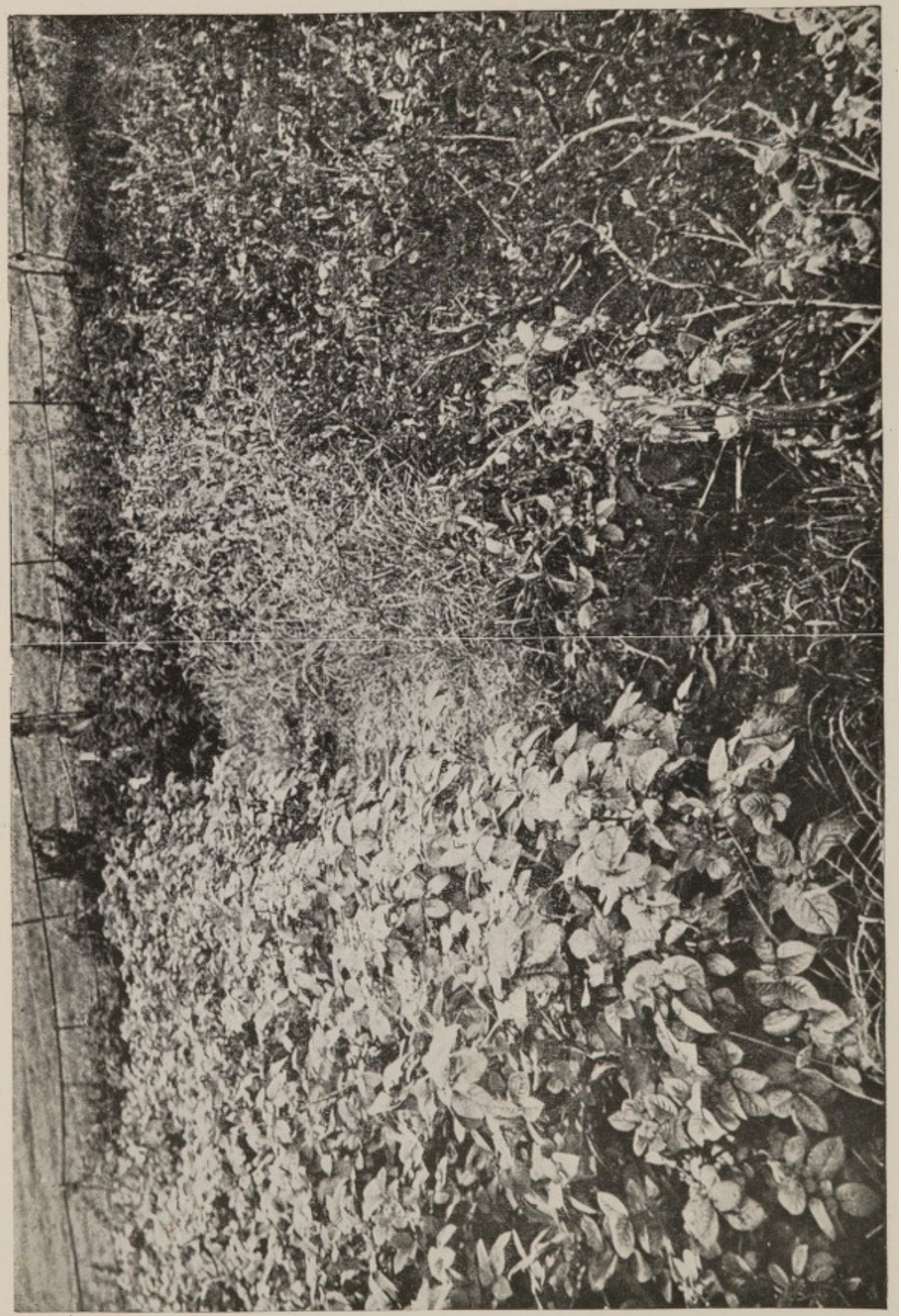
THE ADVANTAGES AND DISADVANTAGES OF SPRAYING.—The advantages derived from spraying have already been described. They are :—

(1) Prevention or delay of outbreak of the disease.
(2) Reduction of the virulence of the attack,

leading to

(3) An increased yield and a smaller amount of disease in the tubers.

As has already been stated, potato spraying has been practised for many years both abroad and in the British Isles, and the results of spraying show an overwhelming preponderance of evidence in favour of this operation. In the same way an analysis of the reports received during 1917 shows that in the large majority of cases spraying produced beneficial results. A striking example of protection from disease conferred by spraying is given in Fig. 3. In some cases, however, the reports state that spraying was either useless or actually harmful. Of these adverse results it is possible to show that some were due to inexperience in spraying. Sometimes the spraying material, instead of being used immediately whilst it was fresh, was allowed to stand too long before use. In other cases the directions for making the spraying fluid were not followed, and sometimes the spraying was not done until the



haulm had already made very considerable growth or until after disease had appeared, owing to the earliness of the season and to machines and chemicals being delivered late.

When, however, every allowance is made for these remediable defects in methods of spraying, the fact remains that in a certain number of cases competent observers reached the conclusion that spraying was not beneficial. It is, therefore, important to endeavour to ascertain what are the causes leading to the remarkable fact that, although in the majority of cases spraying resulted in marked benefit to the crop, in some cases it failed to produce this result.

Before considering this question it may be worth while to refer briefly to certain opinions adverse to spraying which are undoubtedly groundless.

Bees and Spraying.—It is claimed sometimes that spraying is poisonous to bees. There is no ground for this statement. Many varieties of potatoes fail to flower; others drop their flowers before the blossoms open. Among those that do flower, not a few varieties bear blossoms the stamens of which do not burst, and hence produce no free pollen which insects might gather in lieu of nectar. Neither do bees visit potato flowers in any considerable numbers, nor, if they did, would the small amount of fungicide deposited in the flower be likely to injure these insects.

Keeping-quality and Spraying.—Another baseless statement frequently made is that spraying spoils the keeping qualities of potatoes. The opposite is the truth, for, as already mentioned, the tubers of sprayed potatoes are less liable to disease than are those of unsprayed potatoes, and diseased tubers are apt to rot in store.

Cooking-quality and Spraying.—Again, it is sometimes asserted that sprayed potatoes turn black on cooking; spraying has no influence on the colour which cooked potatoes assume. The blackening is a peculiarity due to the fact that certain varieties of potatoes sometimes contain a chemical substance which when exposed to the air is oxidised and forms a black pigment.

Spraying and Seed Tubers.—Yet another objection is that seed taken from sprayed potatoes is unsatisfactory. Here also the objection has no basis in fact. Indeed, wherever disease has appeared, seed from sprayed potatoes is likely to be less diseased and hence to be better than seed from unsprayed potatoes. Moreover, it is a well-established fact that the best seed is obtained from *immature* tubers, and one of the effects of spraying is to prolong the growth of the haulm, and hence to delay the maturing of the crop.

Spraying and Risk of Poisoning Other Food Plants.—Another of these minor objections may be mentioned. It is

often stated that when potatoes are inter-cropped there is a risk of food plants being poisoned. In the case of ordinary inter-crops of the cabbage tribe the danger is negligible ; at the time of spraying the plants are not far advanced ; the rains subsequent to spraying will gradually wash away any deposit which may be on the leaves, and the copper, if any, which remains will be confined to the outer leaves which are not used. At the same time it may be said that every precaution should be taken before these plants are prepared for food. If no copper is to be seen on them, no danger is to be feared. In the case of food plants which are used in the raw state, however, as, for example, lettuce, there is an element of danger, and such crops should not be used for inter-cropping with potatoes.

Spraying and Ripening of the Crop.—Turning now to the more weighty objections which are raised, the first that deserves attention is the statement that the ripening of the crop is delayed owing to the haulm remaining green for a longer time. The statement is correct. The copper sulphate used in spraying exercises a preserving influence on the haulm, and in some seasons, with the latest varieties, this might possibly be a disadvantage ; on the other hand, in the majority of cases and seasons the extension of the growing period means an increase in the yield, and is therefore a decided advantage rather than a disadvantage.

Spraying and Injury to Foliage.—A certain number of complaints from inexperienced growers take the form that after spraying the lower yellow leaves fall off. This is no disadvantage ; the yellowing leaves indicate by their colour that they are already moribund and their fall is no loss to the plant.

The most serious objection which has been brought against spraying is that it may lead to scorching and falling off of the leaves. There is evidence that this result occurred during the past season, but the cases of scorching or partial defoliation were comparatively rare.

An examination of the records indicates that the scorching and other damage to the foliage, where it occurred, took place under one or other of the following conditions :—

(1) In potatoes growing under bad conditions, of cultivation, as, for example, in insufficiently drained, shallow, or light soils.

(2) Where mistakes were made in making up the mixture, particularly by using wrong proportions of the ingredients.

(3) In cases in which frost occurred after spraying had been done ; for example, in 1917, where spraying was done in June in northern districts late frosts occurred after the date on which spraying was done. It appears to have been undoubtedly the case that sprayed foliage suffered more severely than unsprayed. The explanation is obscure, but it should be noted, and those who grow potatoes in exposed districts will be well advised to delay spraying until the danger of late frosts is past. It may

be mentioned also, that in some places on the north-east coast potatoes sprayed during the day were "scorched" the same night by the inopportune occurrence of a cold sea-fog.

(4) Lack of success in spraying was also traced to the fact that the sprayed plants had previously been attacked by aphis. There is no doubt but that plants so attacked suffer considerable damage from spraying, nor is this remarkable when it is remembered that the aphides made innumerable punctures in the leaves, and hence the spraying material on such leaves has ready means of access to the delicate internal tissues of the plant. It therefore follows that if it has been impossible to protect the plants from the attacks of aphides, they should not be sprayed with Burgundy or Bordeaux mixture. It is possible that in such cases a "dry" spray might be found beneficial. It is noteworthy that in 1917 aphides were quite exceptionally prevalent upon potato foliage—especially in the Midlands,—and that no such attack had been seen on potatoes for many seasons.

(5) Lastly, it appears to be an undoubted fact that potato crops grown in the neighbourhood of factories and in an atmosphere containing acid fumes may be adversely affected by spraying. The reason for this is not clear. It may be due to some chemical change brought about by the action of the acid fumes on the spray mixture. On the other hand it has been suggested that the potato foliage in many of these situations is less vigorous than when it is growing in clearer air and hence is less able to resist the penetration into its tissues of the poisonous ingredients of the spray fluid. Possibly it may be proved that a "dry" spray will produce the advantages of spraying without the disadvantages. This, however, must not be taken as a recommendation of "dry" spraying, for although various substances in powdered form have been used in different parts of the country, and although the results are said to have been beneficial, the experience at the disposal of the Board is not sufficient at present to enable them to make a general recommendation on the subject.

Of the serious objections which have been raised, the first two are remediable: by ensuring better cultivation and by making up the spray fluid accurately, the damage may be prevented.

The third objection, damage by frost after spraying, can only be prevented by delaying spraying until risk of frost is over.

The last-mentioned cases of potatoes affected by aphis and of potatoes grown in a fume-laden atmosphere are serious, and must be taken into consideration by those who are contemplating spraying.

In concluding this summary of objections, it is important to point out that, as described in some detail later on, the potato is subject to many diseases, of which "blight," although in many ways the most important, is only one. Now it cannot be too strongly insisted upon that spraying is a preventive of "blight," and not of other potato diseases.

In this connection it may be mentioned that during the past year the disease known as "Blackleg" was common in certain districts of the country. This disease is already in

the seed when it is planted. It is due to a bacterium, and not to the fungus which causes "blight." Spraying is useless to prevent it, and in not a few instances when the advanced symptoms of "blackleg" appeared, viz., blackening of the lower part of the stem and dying of the leaves, it was assumed erroneously that the disease was "blight," and that spraying was therefore useless.

OTHER MEANS OF REDUCING THE DAMAGE CAUSED BY "BLIGHT."—The outbreak of an attack of "blight," like that of any other disease caused by living germs, depends first, on the presence of the organism causing the disease, and second, on the power of that organism to gain an entrance to and grow into the tissues of the plant.

The most certain method of preventing this disease would be to cultivate varieties which resist its attack. In the case of certain other diseases, as, for example, wart disease (black scab) of potatoes, immune varieties have been discovered, and are now in general use in infected areas. By planting these immune varieties the grower is able to secure a heavy crop and to be sure that the crop will not suffer from wart disease. It must, however, be clearly understood that a variety which is immune from one disease, as, for example, wart disease, is not necessarily immune from another, and in point of fact the varieties immune from wart disease show all degrees of susceptibility to "blight." Unfortunately, the grower is not able at present to plant varieties immune from "blight," for although the Irish Department of Agriculture has discovered that certain varieties of potatoes, *e.g.*, Champion II. and Shamrock, are either immune from or highly resistant to "blight," these varieties are often deficient in some important character, such as quality, cropping power, or appearance. Little can be said about the relative susceptibility to "blight" of the many varieties of potatoes grown on a large scale, because the degree of susceptibility depends largely upon the particular stock of the variety and upon the locality in which it is grown. In the absence, therefore, of varieties which are immune from "blight," and at the same time are profitable commercially, the potato grower for the present must rely on other means of prevention.

Before describing the means of reducing the danger of loss by "blight" other than by spraying, it will be useful to point out that, as every good cultivator knows, an outbreak of disease depends not only on the presence of the agent causing the disease, but also on the healthiness of the plant. It therefore follows that the grower has at his hand the means not, it is true, of preventing entirely but of reducing the risks and severity of an outbreak of disease. These means are :—

(1) Choice of clean and vigorous seed (sets).
(2) Good methods of cultivation.

(1) **Choice of Seed.**—The two most important points to be borne in mind in choosing and planting seed (sets) are :—

(*a*) The selection of a good stock of a good variety suitable to the soil ; and

(*b*) Care in securing that diseased sets are not planted.

(*a*) *Selections of a Good Stock.*—It is a well-known fact that if seed tubers are taken from plants grown in some parts of England, especially on the light soils of the South, the plants which that seed produces are lacking in vigour, and whether they suffer from disease or not, give an inferior yield. On the other hand, it is equally well known that if Scotch or Irish seed—that is, seed obtained from the good potato-growing districts in Scotland or the North of Ireland—is used, the plants are vigorous and the yield is high.

Similarly, seed from "once-grown" Scotch or Irish potatoes —that is, the produce of seed raised in Scotland and Ireland and grown for one year in England—also gives strong plants and good yields, provided that the plants were grown in one of the good potato districts as, for example, Lincolnshire, parts of Cambridgeshire, or Yorkshire.

Inasmuch as it is good common sense that the healthier the plant the less likely it is to suffer from disease, it follows that Scotch or Irish seed, or "once-grown" seed from Scotland or Ireland, would be less likely to suffer from disease than would plants raised from own-saved seed. Therefore, unless a grower has absolute proof, from long experience, that his own raised seed gives higher yields of healthy tubers he should plant only Scotch or Irish seed. As an example of an actual test of the yields from Scotch or Irish, as compared with English seed, the following figures, taken from the report of a trial carried out by the Royal Horticultural Society at Wisley, Surrey, may be given :—

	English Seed.	*Scotch Seed.*	*Irish Seed.*
	lb.	lb.	lb.
Yields of 20 sets of Edward VII....	63	71	—
" " " Arran Chief ...	48	76	76
" " " " " " ...	61	78	—
" " " Golden Wonder	51	78	—
" " " White City ...	57	77	—

It is also a well-established fact that immature tubers make better sets than well-matured tubers, and therefore it is good practice where home-grown seed is to be used for planting, to lift the more vigorous plants before the haulm has completely died down and to use the tubers of these plants for seed. Tubers to be used for seed purposes should be greened by exposure to the light for several days, whereas those which are to be used for food should be stored as soon as dry. (*See* Leaflet No. 299, *The Storage of Potatoes and Other Vegetables for Winter Use.*)

The best sets are obtained from tubers about the size of a hen's egg and weighing about 2 oz. Larger sets give a slightly increased yield but are not economical owing to the greater weight required for planting. Where only large tubers are available for seed purposes, they should be cut into several pieces and the cut surfaces rubbed in dry plaster of Paris and the pieces boxed. Lime is sometimes recommended but plaster of Paris gives better results. In cutting tubers it should be remembered that sets taken from the heel end give poorer plants than those taken from the rose end, and hence the cuts should be such as to secure several pieces each of from 1½ to 2 oz. in weight from the rose end of the potato, recollecting that each piece must have at least one eye.

(*b*) *Selection of Clean Seed.*—Growers who cultivate small breadths of potatoes can do much to prevent "blight" by taking care to plant seed which is free from disease. In order to ensure this, potatoes, even those of the main crop, should be boxed and sprouted. For this purpose the sets should be put in boxes of convenient size, either the ordinary potato-sprouting boxes or, failing those, any convenient shallow, wooden or wicker receptacles, stored in a dry, frost-proof place and exposed as fully as possible to the light. By this means sturdy shoots are obtained which are less likely to be broken at planting time than are the weaker or spindly shoots produced when tubers are sprouted in the dark. If, however, it is not possible to sprout boxed seed in the light the seed should none the less be boxed and sprouted, for even though the sprouting is done in the dark the yield is higher than from unsprouted sets. With care in planting, injury to the sprouts may be prevented. The sets should be placed in the boxes in single layers with the rose end (*i.e.*, the end with most eyes) uppermost.

The sets should be put to sprout at least three weeks, and preferably five or even more, before planting. If this is done the sprouts should be from half an inch to an inch long at planting time, and such sets when planted give yields larger than those from unsprouted sets by as much as 28 lb to the square rod. Another advantage of boxing is that it enables the grower to reject diseased and poor sets.

When planting the sets, two sprouts only should be left, as it has been shown that thereby the best results are obtained.

Those tubers which do not sprout at all or which give only thin and weak shoots should not be planted. Moreover, if the tubers belong to a variety which does not suffer by being cut, they may be cut at planting time by slicing off a portion of the heel end, and any tubers which show signs of disease, hollow spaces, or brown or black patches in the flesh, should be rejected.

Steeping the sets in a fungicide before planting is of no use as a means of preventing "blight."

(2.) **Methods of Cultivation.**—(*a*) *Planting Distances.*—Next only in importance to the choice of good seed as a means of reducing the risks from "blight" is the practice of good methods of cultivation. Among these methods, sufficient space between the rows and between the plants must have consideration. The width of the rows and the distance from plant to plant naturally vary according to the soil and variety but, from the point of view of preventing the rapid spread of "blight," it is certain that wide planting is advantageous, and many good growers recommend a distance of 3 feet between the rows and 15 to 18 inches from plant to plant. It is true that closer planting will at times give a larger yield on certain soils, but it also increases the risk of disease.

(*b*) *Earthing up.*—By earthing up the plants thoroughly the risk of infection of the growing tubers is reduced, and wherever possible it is recommended that the earthing up should be done in two stages. If the development of the haulm is not too advanced the second earthing up should be deferred until shortly before the time at which disease is likely to make its appearance in the particular neighbourhood. (*See* pp. 7–8.)

(*c*) *Manures.*—The potato is a crop which grows well even though the ground is only lightly treated with farmyard manure. It responds well to artificial manures. A good system of manuring consists in the application just before the time of planting of a mixture of superphosphate of lime (5 parts) and sulphate of ammonia (3 parts) at the rate of 3–4 oz. to the square yard. If sulphate of ammonia is applied after the shoots have come above the ground, it should be mixed with soil so that the growing plant does not come in contact with it. The addition of a small quantity (1 oz. to the yard run) of wood ashes as a dressing to the soil before the sets are planted is also to be recommended; for the potash combined in the ashes helps to produce vigorous growth.

(*d*) *Treatment of Diseased Haulm.*—If blight appears to a serious extent in the foliage at a time when it is too late to spray, it is advisable to pull or cut off the haulm before the majority of the spores fall to the soil—main crop tubers being left for a time to ripen naturally in the ground, for by so doing the risk of the tubers becoming infected is reduced. The potatoes should be dug as soon as their skins have set, because after this takes place there is a likelihood of their growing out, particularly if wet weather intervenes. The haulm should be burnt as soon as possible, and in no case should it be allowed to lie on the ridges.

(*e*) *Lifting and Storing.*—(*See* Leaflet No. 299, *Storage of Potatoes and other Vegetables for Winter Use.*)

ARRANGEMENTS FOR POTATO SPRAYING DURING 1918.—For 1918 the distribution of knapsack spraying machines and chemicals will be left in the hands of manufacturers and retailers.

Knapsack Spraying Machines.—The trade has arranged to manufacture certain types of knapsack spraying machines which, while retaining the distinctive marks of individual firms, will be made to a specification issued by the Food Production Department. The manufacturers have undertaken to supply these machines at a fixed price.

It is essential that all those who are not already provided with knapsack spraying machines shall place their orders without delay so that the machines will be delivered early in the season.

Chemicals.—The price of copper sulphate in 1918 will be controlled in such a way that purchasers ordering for early delivery will have a distinct advantage over those who defer their orders.

There will probably be a shortage of soda crystals (washing soda) in the coming season, hence it is *absolutely essential* that early steps shall be taken to secure the necessary supply for spraying purposes.

Lectures and Demonstrations.—With the object of spreading knowledge on the subject of Potato Blight and of providing instruction in spraying during the latter part of the winter and spring, a staff of lecturers has been appointed whose services will be available to Local Societies on application to the Food Production Department. These officers will give lectures, illustrated by lantern slides and drawings, on Potato Blight and its prevention. The services of these lecturers will be available also to assist Local Authorities and Allotment Societies in organising the spraying of the potato crop during 1918.

OTHER IMPORTANT DISEASES OF THE POTATO AND THEIR SYMPTOMS.

Wart Disease or Black Scab (*see* Leaflet No. 105).—Affected tubers show irregular outgrowths which look like dirty pieces of cauliflower or the whole tuber may be similarly transformed. This is the most serious disease of the tubers, and its presence must be notified to the Board of Agriculture and Fisheries. The disease is caused by the fungus *Synchytrium endobioticum*. *Immune varieties* must be grown in land infected with Wart disease.

Black-leg or Black-stalk Rot (*see* Leaflet No. 117).—The foliage becomes yellowish, and the base of the haulm turns black and subsequently becomes rotten, after which the plant dies down completely; the

tubers also may be affected. This disease—which is most prevalent during June and July—is caused by a bacterium.

No remedy is known. The disease passes from the seed into the growing plant. Tubers from plants affected with this disease should not be used for seed.

"Rust."—This is the popular name of a disease especially prevalent in the west of England and characterised by rusty and enfeebled foliage. It is largely due to the use of poor seed, and when dry weather prevails early in the season, the crop is frequently crippled.

Rusty foliage and a stunted habit of growth are sometimes associated with a disease of the haulm caused by the fungus *Verticillium albo-atrum*. Change of seed and care in seed selection should ensure the crop against attack by "Rust."

Leaf-curl (*see* Leaflet No. 164).—As the name implies, plants thus affected have curled leaves and are often stunted in growth. Plants seriously affected by leaf-curl often give little or no yield. No remedy is known, but if good seed is used the disease is not likely to prove troublesome. Sprouting prior to planting is helpful for, as a rule, sets which produce strong sprouts will grow into sturdy, fruitful plants.

Corky Scab (*see* Leaflet No. 232).—Affected tubers are only partly deformed, the seat of infection by the parasite *Spongospora subterranea* being characterised by the presence of loose, corky *débris* which does not usually penetrate deeply into the tuber.

Common Potato Scab (*see* Leaflet No. 137).—This scab is exceedingly common, but as it is purely superficial and does not affect the quality of the tubers it can generally be ignored, though badly scabbed potatoes should not be used for seed.

Dry Rot (*see* Leaflet No. 193).—This disease, which leads to shrivelling and collapse of the tubers attacks them mainly in storage. It is caused by the fungus *Fusarium caeruleum*. (For best methods of storage *see* Leaflet No. 299.)

Caterpillar Injury.—During 1917 the caterpillar of the Rosy Rustic moth, *Hydroecia micacea* frequently attacked potato haulm, penetrating the stem and eating the inner tissues, thus causing the haulm when nearly full grown to collapse. Ordinarily the caterpillars feed upon coarse weeds, and the breaking up and cultivation of land which had lain derelict for many years and had been the home of the insects destroyed their natural food, so that the caterpillars were driven to the potatoes. Proper soil cultivation will prevent insect hibernation, so that no future trouble to any extent need be feared by good gardeners.

London, S.W 1,
July, 1894.
Re-written, May, 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.

The Ribbon-Footed Corn-Fly (*Chlorops tæniopus*, Mg.).

The larvæ, or maggots, of the Ribbon-Footed Corn-Fly, which is sometimes termed the "Gout Fly," in some seasons cause an immense amount of harm to wheat and barley plants. In 1893, particularly, the injury it occasioned to the barley crop was most serious, mainly because the plants were kept in a backward condition by the extreme drought, so that they could not grow away from the attack of the larvæ within them. Many hundreds of acres of barley were fed off with sheep, as the plants were so injured that they could not possibly recover and yield a crop. In many cases the yield of infested fields was next to nothing, the plants being stunted and distorted, as shown in Fig. 5, and the ears were unable to emerge from the sheathing leaves.

Symptoms of Attack, and Damage done.

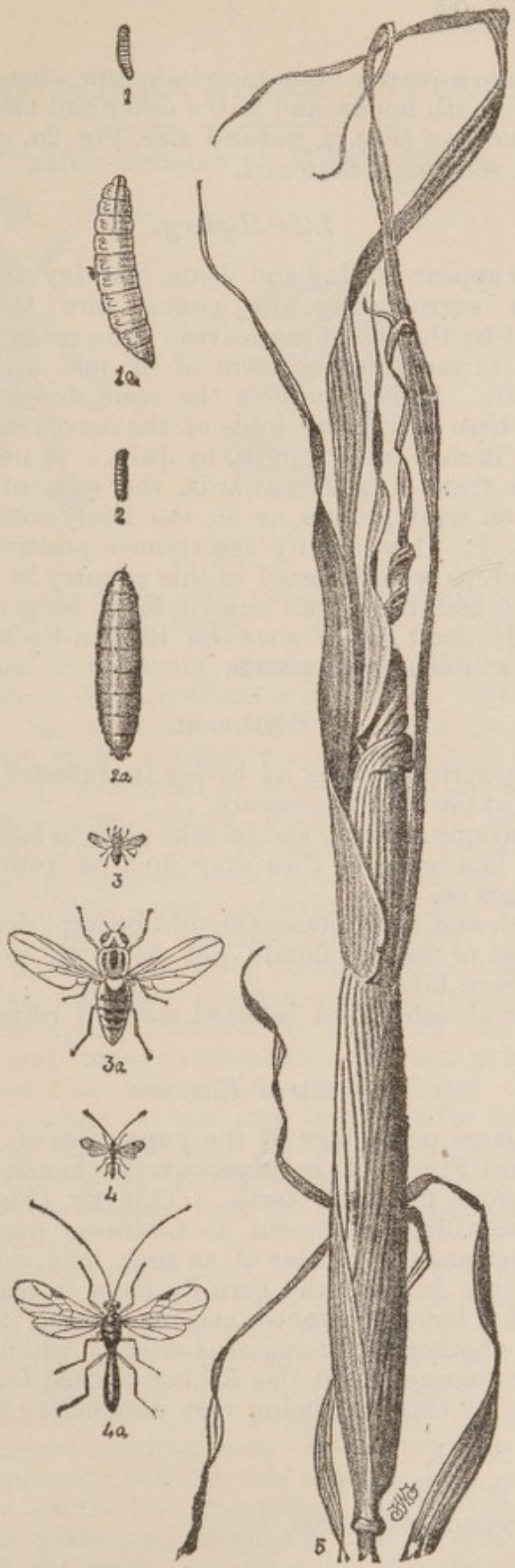
In plants infested by the larvæ the ear is eaten away at its base, and the stem is channelled to the first node or joint below the ear. The ear is checked in its growth and fails to push out through the surrounding leaves, the shoot showing a characteristic gouty or distended appearance. When climatic conditions are favourable and forcing manure is applied, the infested ear can escape from the sheathing leaves and produce some grain, but in a season such as 1893 was, this does not take place. Although only one larva may have been present in the stem, if the environment has been unfavourable for growth the whole ear may be spoiled.

Description.

The fly is very small, being only about one-sixth of an inch long (Fig. 3, natural size, Fig. 3*a*, magnified) and one quarter of an inch in spread of wings. The head is yellow, with a black triangle on its upper surface; the antennæ are black; the thorax is yellow, with three prominent longitudinal black stripes on its upper surface; and the abdomen is yellow, with dark-brown transverse markings or stripes. The eyes are large and green. The male is rather smaller than the female, and of a light yellow hue, the female being of a somewhat greener colour; the hind end of the male is rounded, that of the female pointed.

The eggs are elongate oval, and greenish white in colour; they have a longitudinal groove on one side.

The larva (Fig. 1, natural size, Fig. 1*a*, magnified) is legless; it is white in colour, becoming slightly yellow in time. It is



Chlorops tæniopus.—Figs. 1 and 1*a*, larva; figs. 2 and 2*a*, puparium figs. 3 and 3*a*, the fly. Figs. 4 and 4*a*, *Cælinius niger*. All nat. size and mag. Fig. 5, stunted and distorted barley.

from a fifth to a quarter of an inch in length when full grown; it has two mouth hooks, and at the other end two spiracles.

The puparium (Fig. 2, natural size, Fig. 2*a*, magnified) is brown and somewhat flattened.

Life History.

The flies appear in May and June, and lay their eggs on the leaves surrounding the young ears that are still surrounded by the sheathing leaves. The maggot on hatching passes inwards to the stem at or just below the ear. Here it feeds. It then tunnels the stem down to the first node, and here or in the folds of the leaves encircling the spoiled ear it changes to a pupa, by July. A new brood of flies issues from August onwards, the eggs of these flies being laid on wild grasses, or on the lately-sown wheat or winter barley. It was only ascertained positively in 1890 that these crops were infested in this country in the autumn, although it had been well known for a long time that in Germany, Holland, and France the Ribbon-Footed Corn Fly passes the winter in corn plants.

Treatment.

1.—Early spring sowing of barley in infested districts is an important preventive measure.

2.—In autumn, sowing should take place as late as possible, so that the late brood of flies may find no young plants to lay their eggs on.

3.—Couch and other grasses should be kept down.

4.—Wheat or barley should not be sown close to fields that have been infested.

5.—After thrashing an infested crop all refuse should be burnt.

Natural Enemies.

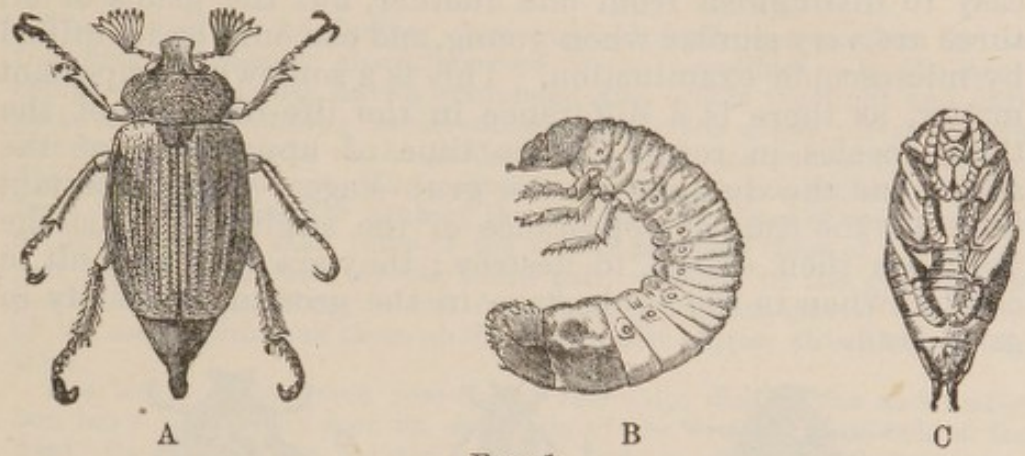
From a large percentage of the pupa-cases of the Ribbon-Footed Corn-Fly kept in glass-covered boxes, a parasitic hymenopterous fly came forth. This fly (Fig. 4 natural size, 4*a* magnified) is known as *Cælinius niger*, a pretty brown insect about a quarter of an inch long, with brilliant wings. In the body of the corn-fly larva it places an egg, from which a larva is hatched, and feeds upon its host.

There is another fly, *Pteromalus micans*, which is parasitic in a similar manner upon the Ribbon-Footed Corn-Fly, and is described by Curtis as being very destructive to it.

London, S.W.1,
August, 1893.
Revised, May, 1908.

BOARD OF AGRICULTURE AND FISHERIES.

Chafer-beetles *or* White-grubs.



A B C

FIG. 1.

The Large Cockchafer (*Melolontha vulgaris*).
A. Perfect insect; B. Larva; C. Pupa. All natural size.

Distribution and Plants attacked.—In the majority of districts in Great Britain "Chafer-grubs" or "White-grubs" are more or less abundant. The damage they do in the larval or grub state is often very serious, but is perhaps more frequently attributed to the work of the wire-worm. Not only do these insects cause loss to the farmer, gardener, and forester by damaging the roots of plants when in the grub stage, but much harm is also done by them when they appear as adult beetles. The beetles feed on the leaves of various forest trees, occasionally quite stripping them of their foliage, particularly broad-leaved species, although conifers are also attacked. Fruit trees are occasionally attacked by them, as also are grass, corn, peas, and many vegetables. It has usually been supposed that this loss is due to the Large Cockchafer (*Melolontha vulgaris*), but this large chafer is no more abundant and harmful than two smaller species known as the Garden-chafer, Bracken-clock or Coch-y-bonddu (*Phyllopertha horticola*), and the Summer-chafer (*Rhizotrogus solstitialis*).

These insects are much more abundant and destructive in France, Germany, and other parts of Europe than in Great Britain; but as during the past ten years they have very materially increased in this country, farmers and gardeners should guard against them wherever possible. The grubs feed on almost any roots, but are particularly prone to attack those of grass and seedling trees. Young oaks and pine-trees often suffer severely both in this country and on the Continent. The grubs bite the roots, thereby checking the growth of the plants and frequently killing them outright. In grass-land, the grass may often be seen dying from the ravages of these pests. Rooks are very fond of white grubs, and are attracted to the fields to feed on them; these

useful birds are often unjustly accused of injuring the grass plants, whereas they are really feeding on the chafer-grubs which destroy the grass. The beetles are perfectly easy to distinguish from one another, but the grubs of all three are very similar when young, and can only be identified by microscopic examination. This is a somewhat important matter, as there is a difference in the life-histories of the three species in regard to the time of appearance of the adults and the duration of the grub stage. It is important to notice the time of appearance of the adult beetles, as the pests are then easiest to destroy; they are very difficult to combat when in the grub stage in the ground, especially in grass-land.

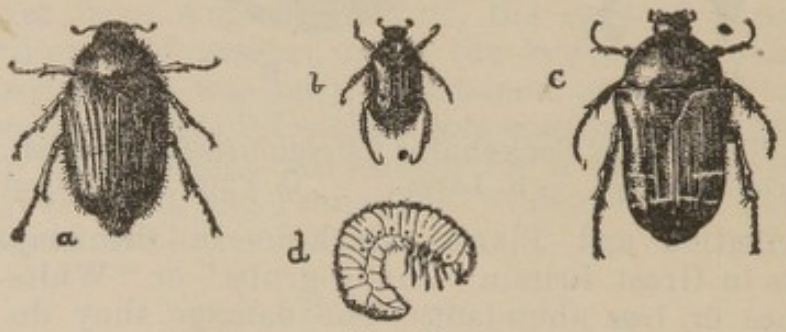


FIG. 2.

a. The Summer-chafer (*Rhizotrogus solstitialis*). *b*. The Garden-chafer (*Phyllopertha horticola*). *c*. The Green Rose-chafer (*Cetonia aurata*). *d*. Larva of the Garden-chafer. All natural size.

Description.—(1) The *Large-chafer*, usually called the *Cockchafer* (Fig. 1 — A, B, C), is often an inch in length, with head and front portion of the body black, the wing cases (elytra) being reddish-brown, hairy, and with five raised lines on each; along each side of the abdomen are five white triangular marks. The abdomen ends in a prolongation, downwardly curved, and not covered by the elytra. The end joints of the antennæ form a kind of club, made up in the male of seven, and in the female of six, leaves.

(2) The *Summer-chafer* (Fig. 2—*a*) is somewhat smaller, being about two-thirds of an inch long, of a general reddish-brown or yellowish colour, the colour varying. The wing covers have each four raised lines. Fresh specimens are distinctly hairy, and the club at the end of the antennæ has three leaves, both in the male and the female.

(3) The *Garden-chafer* (Fig. 2—*b*, *d*) varies from one-fourth to one-half of an inch long, the front part of the body is of a metallic greenish colour, and the wing cases of a reddish-brown hue; the male is very hairy.

(4) A fourth species of chafer is *Cetonia aurata*, the *Green Rose-chafer* (Fig. 2—*c*). This beetle measures two-thirds of an inch in length, and is golden green above; the wing covers are marked with white specks and streaks.

The garden-chafer appears in June and July, and the summer-chafer about the same time, whilst the large or cockchafer usually occurs in May and June, as also does the green rose-chafer. There are slight differences in the times of flight according to weather conditions.

The grubs are thick, fleshy, and dirty-white, the tail end of the body being swollen and darker in colour; the head is large and brown, the mouth being armed with strong mandibles, which vary somewhat in each of the three species figured above; there are also three pairs of jointed legs on the front of the body. These white grubs lie with their bodies bent, and, although sluggish when taken out of the soil, are comparatively active when in it In habits and external appearance the larvæ are very

similar, but when full-grown there is a marked difference in size ; the grubs of the cockchafer and the green rose-chafer reach one-and-a-half inches in length and are thicker in proportion than those of the garden-chafer and the summer-chafer, which, when full-grown, are distinctly smaller.

The grubs can be further distinguished from one another by the following microscopic characters seen in the mandibles :—In the large-chafer the mandibles have a granulated area where the light and dark parts of the jaws unite ; in the summer-chafer the whole surface is very minutely granulated ; in the garden-chafer there is a pale oval area with file-like ridges across it. The cockchafer grub can be further distinguished from the garden-chafer grub by the fact that the claws of its front pair of legs are longer than those of the second pair, and those of the second pair longer than those of the third pair, whereas in the grub of the garden-chafer the claws of the front pair of legs are shorter than those of the second pair, and those of the second pair shorter than those of the third.

The larva of the green rose-chafer resembles that of the cockchafer, but has a large rusty spot on each side of the first segment behind the head ; its feet, too, are pointed, and the body is covered with transverse rows of short hairs.

Life-histories.—*The Cockchafer.*—The female burrows into the earth and lays her eggs, 12 to 30 at each laying, and near one another, and up to 70 in all. After five to six weeks the larva hatches out. No great damage is done till the second summer, when the grubs gnaw the roots of grass and agricultural plants and seedling trees, the feeding being continued during a third and a fourth summer, when the grub becomes a pupa in the soil, but the beetle does not appear above ground for egg-laying till the next May, *i.e.*, a new generation of beetles may, in our climate, be expected every four years. The cockchafer flies towards night, resting sluggishly during the day on trees.

The Summer-chafer has a similar life-history, but the grubs are more destructive to agricultural plants than to young trees. The beetles rest in the daytime and fly in the evening. They sometimes appear in thousands. There is no complete agreement as to the length of the life-cycle, but very probably it can be completed in one year. The swarming of the adults lasts for only a few weeks, and may, under similar weather conditions, be expected at the same time in the next year.

The Garden-chafer.—This beetle flies in the bright sunshine, and often in great swarms. The mature beetles strip trees of their leaves, and are destructive to turnips, peas, and garden plants—*e.g.*, roses. Young fruits are also attacked. There is one generation during the year.

The grubs of both the garden chafer and summer chafer are very harmful to grass land—especially perhaps to dry hill pastures—and it is often noticed that certain well-defined areas in the fields are subject to attack for two or more years in succession. Such areas can first be detected by the soft spongy nature of the turf, which becomes apparent when it is trodden on. Subsequently, much of the grass dies, and brown patches appear.

The Green Rose-chafer also flies in the daytime in bright summer weather, resting sluggishly during dull days. The adults are harmful to leafage and especially to flowers—*e.g.*, strawberry and other rosaceous plants, turnips, &c.—the stamens of flowers being destroyed by the biting off of the anthers. The eggs are laid in the ground. in rich garden soil ; the grubs have also been taken from the rotting wood of tree stumps. Pupation takes place under cover of a cocoon of earth, the exterior of which is rough. Two or more years may be required to complete the life-cycle.

In certain years these beetles are noticed to be more abundant than usual. These " chafer-years " are fairly regular, occurring every fifth year so far as the large-chafer is concerned but the appearance of the garden-chafer and summer-chafer in large numbers is much more irregular. It has been noticed that these insects are somewhat local although widely distributed, certain fields being attacked time after time while neighbouring fields are quite free from infestation.

Methods of Control.—1. Chafer grubs are susceptible to naphthalene and to insecticides containing this substance.

In the case of attacks on grass land naphthalene may be applied broadcast to the affected areas at about the rate of 2 cwt. per acre. The dressing may be given in either autumn or spring, and is most effective when followed by rain, which carries the insecticide into the soil.

Naphthalene is a by-product in gas-making and can sometimes be obtained cheaply in a crude or semi-refined form from a neighbouring gasworks. It may also be obtained through manufacturers of insecticides, etc. Under present circumstances it is of little use quoting prices, but it may be mentioned that quotations have recently ranged from 4*s.* 6*d.* per cwt. at the works for a somewhat crude naphthalene to 17*s.* 6*d.* per cwt. for a more refined sample.

2. When the grubs are working at the roots of raspberry canes, strawberries, etc., one of the above insecticides may be worked into the soil between the rows near the roots.

3. If infested grass land is being converted into arable, poultry turned on the land when it is ploughed will greatly reduce the numbers of the grubs. Pigs also have been found equally effective.

4. In the case of new allotments in which the large grubs of the cockchafer are discovered it should prove possible to control the insects sufficiently by hand picking when the land is dug.

5. It is said that trapping the larvæ has also been resorted to with marked success. For this purpose, pieces of turf from eight to twelve inches broad and six to eight inches thick are laid, with the grass downward, on the surface of the ground. The larvæ collect beneath the turf. Heaps of turf, humus, dung, etc., may also be employed as larval traps.

6. When the beetles of the garden chafer are attacking fruit trees a lead arsenate spray (lead arsenate paste 1 lb., water 25 gallons) is worth trial, and in the case of a few trees it may prove possible to collect the beetles by jarring the branches over a sheet The latter method is practised on the Continent for the control of all chafer beetles.

7. The rook, starling, green plover, and the black-headed and common gulls should be encouraged, as they devour large numbers of white and other grubs. The two birds last mentioned often occur far inland, and may be seen following the plough and greedily picking up any larvæ that are thrown up. Moles also hunt in the ground for the grubs. The adult chafers are eaten in large numbers by owls, night-jars and bats.

London, S.W.1,
April, 1896.
Revised, June, 1918.

Leaflet No. 26.
(*Revised.*)

BOARD OF AGRICULTURE AND FISHERIES.

Tenant Farmers, Income Tax, and Accounts.*

INCOME TAX.

(1.) **Assessment.**—Farming profits are charged under Schedule B of the Income Tax Acts *unless* the farmer specially requests to be charged under Schedule D (*see* paragraph 11).

Under Schedule B farming profits are reckoned as equal to twice the full rent of the farm; thus, if a farmer pays a rent of £100, his profits will be assessed at £200. If, however, any cottages are included with the farm, the rental value of the cottages will be deducted from the rent in arriving at the assessment.

(2.) **Exemption and Abatements.**—If the total income of the farmer and his wife does not exceed £130, he will be exempt from Income Tax. If, therefore, a farmer's total rent does not exceed £65 a year, and neither he nor his wife has any other source of income whatever, he will be exempt.

If the total income of the farmer and his wife does not exceed £700, he can claim certain allowances from the assessment, and he is then charged tax only on the balance, if any, left after deducting such allowances. These allowances are as follows :—

An abatement of £120 where the total income exceeds £130 but does not exceed £400.

An abatement of £100 where the total income exceeds £400 but does not exceed £600.

An abatement of £70 where the total income exceeds £600 but does not exceed £700.

(*See* Example 1 on page 9.)

(3.) **Allowance for Wife or "Housekeeper" :—**

(i) If the total income of the farmer and his wife does not exceed £800 a year he can claim an allowance of £50 in respect of his wife ;

(ii) If the farmer is unmarried and his total income does not exceed £800 per annum, and he proves that he has living with him and maintained at his own expense either his mother (being a widow or living apart from her husband) or some other

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***NOTE.—A detailed memorandum dealing with appeals against assessments and with the case of those who farm their own land can be obtained on application to the Board.**

female relative, for the purpose of having the charge and care of any brother or sister of his, being a child in respect of whom relief is given under paragraph (4), he can claim an allowance of £50 ;

(iii) If the farmer is a widower and his total income from all sources does not exceed £800 a year, and he proves that he has a female relative* of his, or of his deceased wife, resident with him in the capacity of a housekeeper, or for the purpose of having the charge and care of any child in respect of whom relief is given under paragraph (4), he can claim an allowance of £50.

(4.) **Allowances for Children and Dependents.**—If the total income of the farmer and his wife does not exceed £800 a year he can claim :—

(i) £40 in respect of one child† who is under the age of 16 on the first day of the year of assessment, namely, April 6, or who, being over the age of 16 on that day, is proved to be receiving full-time instruction at any university, college, school or other educational establishment ;

(ii) £25 in respect of each additional child who falls within the description in (i) ;

(iii) £25 in respect of any other person whose income from all sources does not exceed £25 a year, and whom the farmer maintains at his own expense, provided that such person is a relative* of his or his wife and is incapacitated by old age or infirmity from maintaining himself or herself.

If the total income of the farmer and his wife exceeds £800 but does not exceed £1,000 and he has three or more children falling within the description in paragraph (4) (i) he can claim :—

(iv) £40 in respect of one such child ;

(v) £25 in respect of each additional child in excess of three.

(5.) **Life Assurance.**—A farmer may claim from his assessment a deduction of the premium paid by him in respect of any life insurance policy on the life of himself or of his wife. *This allowance may be claimed no matter what may*

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*In this connection "relative" includes any person of whom the farmer had the custody and whom he maintained at his own expense while that person was under the age of 16.

† Stepchildren and (under certain conditions) adopted children are within the scope of the allowance.

be the amount of the farmer's income, except that the total allowance is not to exceed :—

(1) one-sixth of his income ;
(2) seven per cent. of the capital sum assured at death ;
(3) £100 in respect of payments for securing benefits other than a capital sum at death (*e.g.*, an annuity).

Note.—As regards assurances made after 22nd June, 1916, the allowance will not be made at any greater rate than 3*s.* in the £. (*See* Examples on pages 9 and 10.)

(6.) **Form of Claim to Allowances.**—In order to obtain the allowances to which he is entitled, the farmer must fill up a form of claim (obtainable from the local Collector or Inspector of Taxes) showing *particulars of his own and his wife's income from every source whatsoever.* For instance, particulars of interest received for money on deposit at the bank, income from Government loans, dividends on shares, rents of property owned, etc., must all be entered on the form.

In the case of a claim for life assurance it will be necessary for the farmer to produce the receipts for the premiums paid.

(7.) **Appeal if Profits fall short of Assessment.**—If at the end of his farming year a farmer finds that the profits actually made by him fall short of the assessment under Schedule B, he can claim to have the assessment reduced to the amount of such profits. He should write without delay to the Inspector of Taxes quoting the name of the parish and the assessment number on the Collector's Demand Note, and requesting that the assessment upon him may be reduced. He will receive a form of account from the Inspector on which to enter particulars from his books, but if he has already made out accounts in some other form he may enclose a copy of those accounts instead of filling up the official form.

The printed form of account for use in making an appeal is given at the end of this leaflet on pages 13–15.

(8.) **Dates to which Accounts may be made up.**—Although the Income Tax year ends on 5th April a farmer is not bound to make up his accounts to that date, but may submit accounts made up to the date which he has usually adopted for balancing his books. Thus, in an appeal against an assessment in respect of the year ending 5th April, 1920 accounts may be presented made up to Michaelmas, 1919, Christmas, 1919, Lady Day, 1920, or any other date within the year ending 5th April, 1920 to which the farmer makes up his books.

(9.) **Consultation with Inspector of Taxes.**—If the farmer has any difficulty in the preparation of the account, he should see the Inspector of Taxes, explain the difficulty, and obtain his advice.

It will generally be found possible for the farmer and the Inspector of Taxes to arrive at a settlement. Where, however, this is not possible, the farmer will be given the opportunity of appealing personally to the Income Tax Commissioners for the district.

(10.) **Appeal where no Account Books kept.**—Where a farmer wishes to appeal but has kept no proper books of account, he will obviously have much greater difficulty in proving what amount of profit he has made. He should, however, prepare from his bills, bank books, receipts, etc., the best statement he can, and then see the Inspector of Taxes in order to lay the matter before him. If the Inspector feels able to recommend the Commissioners to reduce the assessment to an amount with which the farmer agrees, no further action will be necessary; but otherwise the farmer will have the opportunity of attending before the Commissioners to state his case.

(11) **Assessment under Schedule D.**—As mentioned in paragraph (1), a farmer can, if he chooses, be assessed under Schedule D instead of under Schedule B, in which case he will be charged on the average profits he has made in the three years preceding the year of assessment. For example—if the farmer's profits for the year to Michaelmas, 1916, were £230, to Michaelmas, 1917, £320, and to Michaelmas, 1918, £260, his assessment under Schedule D for the year ending 5th April, 1920, would be £270, as follows:—

Year to Michaelmas, 1916		£230
" " 1917		320
" " 1918		260
	3)	810
Average		£270

A request to be assessed under Schedule D must be sent to the Inspector of Taxes *not later than 5th June* in any year, and the farmer will then receive a form of return upon which to declare his profits on the basis of the average of the three preceding years, and to claim any allowances in respect of abatement, wife, children and life assurance to which he may be entitled.

(12.) **Assessment by Special Commissioners.**—Assessments under Schedule D are made in the ordinary course by the Income Tax Commissioners for the District; but, if the farmer so desires, he may elect to be assessed by the Special Commissioners in London. A space for making this request will be found on the form of return.

(13.) **Appeal against Schedule D Assessment.**—If the farmer finds it necessary to appeal against the assessment, he must give notice to the Inspector of Taxes within twenty-one days from the date of the notice of assessment, and should submit signed accounts for the three years preceding the year of assessment. Remarks relating to accounts for the purpose of appeal against the Schedule B assessment apply also to accounts in connection with appeals under Schedule D.

(14.) **Appeal against Schedule D Assessment at End of Year.**—If at the end of the year a farmer assessed under Schedule D finds that his total actual income from all sources is less by more than 10 per cent. than the amount upon which he has been assessed and charged, he is entitled to claim repayment of tax on the excess of the assessed income over the actual income. For instance, suppose that, in the case referred to in paragraph 11, the farmer's sole source of income other than that derived from his farm consisted of £10 interest on War Loan, and that his actual profit for the year to Michaelmas, 1919, was £240. His total actual income for the year would thus be £250 (£240 plus £10) as against the assessed income of £280 (£270 plus £10). As this is a reduction of more than 10 per cent. the farmer would be able to claim to have his Schedule D assessment reduced from £270 to £240.

Even though his total income for the year of assessment has not diminished by more than 10 per cent. if the farmer can show that his profits during the year of assessment have diminished owing to causes attributable directly or indirectly to the war, he can claim to have his assessment altered by bringing the actual profits for the year of assessment into the three years' average in substitution for those of the earliest year in the original average. For example, suppose that a farmer is assessed for the year ending 5th April, 1920, on £640, as follows :—

Year to Michaelmas,	1916	...	...	£590
,, ,,	1917	...	...	700
,, ,,	1918	...	...	630
				3) 1920
	Average	...	...	£640

and that his other income consists of £300 interest on Bank Deposit and War Stock. If, owing to the war, his actual profits for the year to Michaelmas, 1919, diminished to £560, he could claim to have his Schedule D assessment reduced from £640 to £630, as follows :—

Year to Michaelmas,	1917	...	...	£700
,, ,,	1918	...	...	630
,, ,,	1919	...	...	560
				3) 1890
	Average	...	...	630

Farmers' Accounts.

(15.) **Importance of keeping books.**—Every farmer should keep accounts which will enable him to show at the end of each farming year what his profits have been.

(16.) These accounts may be kept in the simplest possible form provided that they give the following particulars :—

(1) The value of the live stock, implements, corn, hay, straw, and other produce ; seeds, manures, and other stores, at the beginning of the year ; and again at the end of the year.

(2) The payment made during the year for rent, rates, purchases of stock, feeding-stuffs, manures, wages, and other outgoings incurred in carrying on the farm.

(3) The receipts during the year from the sale of stock, corn, or other farm produce, together with an estimate of the value of the farm produce (meat, poultry, eggs, &c.) consumed by the farmer and his family.

(4) The farm debts owing to and by the farmer at the beginning of the year and at the end of the year.

The value of stock, &c., and the debts owing *to* the farmer at the beginning of the year, together with the year's expenditure, will form the debit side of the account after deducting the debts owing *by* the farmer at the beginning of the year.

The value of the stock, &c., and of the debts owing *to* the farmer at the end of the year, together with the year's receipts, will form the credit side of the account after deducting the debts owing *by* the farmer at the end of the year.

The excess of the credit side over the debit side will give the year's profit.

(17.) **The Simplest Form of Bookkeeping.**—The following instructions have been drawn up for the benefit of those farmers who have not hitherto kept accounts but now wish to do so on a simple plan. More elaborate accounts, designed to analyse a farmer's costs and to indicate the varying degrees of profit of his various farming operations, can with advantage be kept, and the following system of accounts is intended only for those who wish to keep books in the simplest possible form.

(18.) **Valuation of Stock necessary.**—The farmer should start his account-keeping by making a valuation of all his live stock and dead stock at the commencement of his farming year. He can value each item on any reasonable basis, such as the price of the day or cost price provided that he adopts exactly the same method of valuing each item,

both at the beginning and end of the year. In practice, items of dead stock which he has bought are best valued at cost. Live stock and crops produced on the farm are most easily valued at market price less, say, 5 per cent. for cost of marketing, whilst implements, &c., should be valued at cost less a reasonable depreciation based on the length of life of the article.

For example, he can value his ploughs or his binder at cost price less a reasonable rate of depreciation. Assuming a binder costs £40 and is expected to last ten years. At the end of the first year the farmer can value it at £40 less £4 (being one year's wear out of the ten years' life). At the end of the second year he must value it at £40 less £8, and so on.

As to live stock, suppose he has 40 bullocks on his farm, it is clear that he cannot value them at cost unless he can take each bullock, or lot of bullocks, separately, ascertain the original cost, and find from very clearly kept cost accounts how much it has cost him to feed them, house them, and provide labour to look after them, and how much of the rent, rates, and other farm expenses ought to be added as part of the cost of keeping them. A farmer who is only keeping the simple cash account here outlined will, therefore, probably find it necessary to value his bullocks at market price, less 5 per cent. Similarly, with regard to his corn and any other produce, the basis of market price, less 5 per cent., could be adopted.

Any *purchased* corn, seeds, feeding stuffs, &c., he will of course, value at cost price.

In valuing working horses, and milch cows, flock ewes, and other breeding stock, the farmer will not be expected to write them up in value, simply on account of fluctuations in market prices.

Each item of the valuation should be entered separately in a book kept for the purpose.

(19.) **Tillages, &c.**—Properly speaking, the valuation at the beginning and end of the year should include, besides live and dead stock, the value of tillages, growing crops, unexhausted manures, &c. In the great majority of cases farmers do not have such a valuation made except on coming into or going out of a farm, nor do they attempt to make a valuation for themselves. The Income Tax Authorities are, therefore, prepared to accept an account that does not contain the valuation of tillages, growing crops, unexhausted manures, &c., provided that the farmer is in a position to certify either that the value of the tillages, &c., at the beginning of the year did not differ materially from the value at the end of the year, or that there has been an increase or decrease, particulars of which he is able to

give. A declaration regarding this valuation appears in Abstract "C" of the form of account printed at the end of this leaflet (page 14).

(20.) **The Cash Book.**—The principal account book which it is necessary for a farmer to keep is a cash book. If the cash book is one with wide pages ruled in columns so that each item can be entered under its proper heading, there will be no difficulty in making a total which will show the year's receipts and expenditure in classified form. By this means the trouble of picking out the whole year's items at the end of the year is avoided and the accounts can easily be made up.

A suggested set of columns for the cash book is shown on page 11, the headings of which have been arranged in order that the farmer may be able to give at the end of the year totals for the various headings of expenditure and receipt indicated in the account printed at the end of this leaflet on page 13. Other headings will suggest themselves to the farmer to suit the particular nature of his farming operations.

(21.) **Statement of Debts owing to and by the Farmer.**—In addition to keeping a cash book, it will be necessary for the farmer to draw up at the beginning and end of the year a statement of the farm debts owing to him and by him. This statement can readily be made up from his unpaid farming bills and from the record he keeps of debts which are owing to him.

(22.) **Wages Book.**—A wages book should also be kept, in which should be entered week by week the wages paid to each person employed on the farm.

Note.—The farmer can also charge in his accounts, in respect of the keep of employees who are boarded by him, the difference between their actual money wages and the wages they would receive if not boarded. This must not include the value of a rent-free cottage, since the full rent and rates of this will already be charged in the farm account as part of the farm rent and rates.

(23.) **Petty Cash Book.**—Where there are daily cash receipts from small sales of milk, butter, eggs, &c., it is desirable to keep a petty cash book, in which these accounts can be entered as received. The total of this book for the week can then be transferred into the principal cash book.

(24.) **Prompt Entry of Receipts and Payments essential.**—The whole success of this system of accounts will depend upon the prompt entry of all payments and receipts immediately they occur. Once the book-keeping is allowed to get into arrear it becomes a considerable task to bring the books up

to date, whereas, if the entries are made daily or weekly, as the case may require, a farmer should be able to keep his books at a very small expenditure of time.

(25.) **Profit and Loss Account**—At the end of the farming year a total should be made of each column in the cash book and in the wages book. This will be rendered a very simple matter if a total is made each *month*, and then carried forward. As soon as the columns have been totalled the farmer will be able to strike his balance of profit in the manner indicated in paragraph (16).

(26.) **Further information on any of the points mentioned in this leaflet may be obtained from the Inspector of Taxes for the District, who will help any farmer who wishes to claim relief from, or in payment of, Income Tax.**

Examples.

(1.) Rent £200, includes farm and 5 cottages. The cottages are assessed at £4 each. Farmer and his wife have no other income. Three children living, under 16 years of age. Wife's mother, incapacitated, 62 years of age, lives with them and has no income. Farmer pays £20 a year premium on an assurance policy for £700 on his own life. Policy taken out in 1896.

Schedule B assessment will be—

£200—£20, *i.e.*, 5 cottages at £4 each = £180 × 2 = ...		£360
Abatement	£120	
Allowance for—		
Wife	50	
3 children	90	
Wife's mother	25	
Life assurance premium... ...	20	
	——	305
Net assessment		£55

At 2*s.* 3*d.* in £. Tax £6 3*s.* 9*d.*, payable £3 1*s.* 10*d.* on 1st January and £3 1*s.* 11*d.* on 1st July.

(2.) Rent £600, including 6 cottages assessed at £6 each. Farmer has £1,000 War Loan, and his wife has £500 War Loan and also an income of £120 a year from dividends taxed by deduction. Farmer has 6 children under 16, and pays £25 a year premium on a life assurance policy of £800 on his own life and £20 a year on a policy of £700 on the life of his wife.

Schedule B assessment will be—

£600—£36, *i.e.*, 6 cottages at £6 each = £564 × 2 = £1,128.

The total income of the farmer and his wife is therefore—

Schedule B assessment	£1,128
Farmer's War Loan interest	50
Wife's „ „	25
Wife's taxed dividends	120
	£1,323

The rate of tax applicable to a total income of £1,323 is 3*s.* 9*d.* in the £ on the earned income and 4*s.* 6*d.* in the £ on the unearned income.

The farmer is not entitled to any allowance for wife or children because his total income is over £1,000 a year.

His assessments will be—

Schedule B		£1,128
Less Life assurance self ...	£25	
„ „ wife ...	20	
	——	45
		£1,083

At 3*s.* 9*d.* in the £, Tax £203 1*s.* 3*d.*, payable £101 10*s.* 7*d.* on 1st January and £101 10*s.* 8*d.* on 1st July.

He will also be assessed, under Schedule D in respect of the untaxed War Loan interest, £75 at 4*s.* 6*d.* — tax £16 17*s.* 6*d.*

This is all payable on 1st January. But, as his wife's dividends of £120 will be taxed by deduction of 6*s.* in the £, there will be a refund due of 1*s.* 6*d.* in the £ on these, since tax is payable at 4*s.* 6*d.* in the £ on this unearned income—the rate applicable to the total income of £1,323. This refund of 1*s.* 6*d.* on £120 amounts to £9, and will be deducted from the £16 17*s.* 6*d.* payable on 1st January, so that only £7 17*s.* 6*d.* will be collected.

London, S.W.1,
November, 1894.
Re-written, October, 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.

[OVER

PAYMENTS.

| Date. | To whom paid. | Classification of sums paid. | | |

INCOME TAX. SCHEDULE B.

Year 19 .

For use of Inspector.

Parish _____

Asst. No. _____

Name of farmer _____

Postal address _____

PARTICULARS OF THE FARM TO WHICH THE APPEAL RELATES.

Parish of _____ Name of farm _____

Assessment No.	Owner.	Acreage.				Full amount of the Rent payable.		Amount of any Rent remitted by the Landlord for the year to which the Appeal relates.		Annual Value charged under Schedule A. where the Occupier is also the Owner.	
		Arable.		Pasture.							
		a.	r.	a.	r.	£	s.	£	s.	£	s

Note 1.—A farmer lodging an appeal may present his accounts made up to the date at which his accounts are usually balanced.

If full accounts have been properly made up, it will be unnecessary to complete this form, provided a certified copy of the farming account and (where available) the last two Balance Sheets are forwarded, and any other information required by the Commissioners is furnished on application.

Note 2.—This account is provided to meet the case of a farmer who keeps only a cash account of his transactions. This necessitates the closing entries on each side of the account, regarding the farm debts owing to him and by him at the beginning and end of the year.

Note 3.—The farmer can charge in his accounts, in respect of the keep of employees who are boarded by him, the difference between their actual money wages and the wages they would receive if not boarded. This must not include the value of a rent-free cottage since the full rent and rates of this will already be charged in the farm account as part of the farm rent and rates.

Note 4.—The profits on dealings in horses, &c., are assessable under Schedule D, and *if* a separate return of such profits has been made under this head the amount should not be entered again in this account; the expenses incurred in earning such profits should similarly be excluded from the expenditure side of the account.

Dr. ACCOUNT FOR THE YEAR ENDING 19 . *Cr.*

	£	s.	d.		£	s.	d.
Value of live stock at beginning of year (*see* Abstract A)				Sales of live stock during the year ...			
Value of dead stock at beginning of year (*see* Abstract B)				Sales of dead stock during the year ...			
Value of Tillages, unexhausted manures and growing crops at beginning of year, if a valuation has been made (*see* Abstract C)				Sales of Poultry, Eggs, Milk, Butter and other dairy produce			
Purchases of live stock during year ...				Machinery, implements, horse or other labour hired out...			
Purchases of dead stock during year ...				Taking in stock to keep, service fees, etc. Profit on dealing in horses, cattle, etc. (in respect of those not already included in farm purchases or sales, *see* Note 4)			
Rent				Sundry receipts—such as rent of land, cottages, sporting rights, etc., sublet, premiums of pupils, sales of implements, tools, old materials, rabbits, etc., sold			
Hire of grazing, etc.				Sums recovered or recoverable from landlord (opposite)			
Rates and Taxes (excluding Income and Property Tax)				Sums recovered or recoverable under insurance contracts			
Wages and National Health Insurance ...				Value of produce, etc., consumed by farmer and his household, and by farm hands boarded in (*see* Abstract D) ...			
Employers' Liability Insurance and Insurance of buildings, stock, crops, etc. ...				Value of live stock at end of year (*see* Abstract A)			
Hire of threshing machinery, steam ploughs or other machinery, and hire of horses				Value of dead stock at end of year (*see* Abstract B)			
Repairs to machinery, implements, tools, harness, etc.				Value of tillages, unexhausted manures and growing crops at end of year, if a valuation has been made (*see* Abstract C)			
Blacksmith, veterinary surgeon, and medicines...				*Add*—			
Tradesmen's bills recoverable from landlord (*see* opposite)				Farm debts owing to me at end of year			
Valuers', Auditors' or Accountants' fees ...				*Deduct*—			
Other farming expenses, viz.—				Farm debts owing by me at end of year			
Add—							
Farm debts owing to me at beginning of year							
Deduct—							
Farm debts owing by me at beginning of year							

Abstract A.

—	Number.	Value of Stock at beginning of year. £	s.	d.	Number.	Value of Stock at end of year. £	s.	d.
LIVESTOCK ACCOUNT.								
Working horses								
Dairy cows								
Ewe flock...								
Other horses								
„ cattle								
„ sheep								
Pigs								
Poultry								
Any other livestock ...								

Abstract B.

DEAD STOCK ACCOUNT.								
Implements and machinery.								
Loose tools								
Hay...								
Straw								
Corn								
Seeds								
Feeding stuffs, cake, &c.								
Roots								
Potatoes								
Manures, chalk, lime, soot &c.								
Fuel, peat, &c.								
Wool, hides, &c.								
Other stock								

Abstract C.

VALUATION OF TILLAGES, UNEXHAUSTED MANURES AND GROWING CROPS AT BEGINNING AND END OF YEAR.

Form of Declaration.

I hereby declare that the value of the tillages, unexhausted manures and growing crops

* is shown in these accounts as actually valued by_____ at the beginning and end of the year,

* at the beginning of the year did not differ materially from the value at the end of the year,

* showed an increase or decrease at the end of the year as shown on the accompanying sheet.

*Signature*_____

*Date*_____

* Strike out the inappropriate lines

Abstract D.

Number of persons resident at farm (excluding farm hands)	Number of farm hands boarded in ... ...

Farm Produce consumed by Family, &c.

	£	s.	d.
Farm stock killed for home consumption, viz.—			
Pigs			
Lambs			
Other stock (give particulars)			
Estimated weekly value of own farm produce, &c., consumed by family (including produce provided free to farm hands boarded in), viz.—			
Poultry			
Eggs			
Milk and Cream			
Butter			
Flour or meal from home-grown corn...			
Wood			
Coal			
Per week			
Equals per annum ...			
Estimated value of carting, hauling, &c., done for house			
Proportion of wages, if any, already charged in farm account for farm hands, servants or grooms, partly engaged in garden or housework or attending to horses used other than for farm purposes			
Estimated value of keep of_____horses wholly or partly used for other than farm work, included in farm account			
Any other private expenses charged in farm account, viz.:—			
Total			

I hereby declare that all the particulars given in these accounts are true and correct to the best of my knowledge and belief, and that they disclose a complete account of my farming business for the period stated

*Signature*_____

*Date*_____

Leaflet No. 27.

BOARD OF AGRICULTURE AND FISHERIES.

Remission of Tithe Rentcharge.

The Board of Agriculture desire to draw the attention of owners of lands used for agricultural purposes to the statutory provision for the remission of tithe rentcharge that is made by section 8 of the Tithe Act, 1891, whereby a remission of such part of the tithe rentcharge on agricultural lands as exceeds two-thirds of the assessment of the lands under Schedule B. of the Income Tax may be obtained under the conditions laid down.

The section provides as follows:—"Where a sum is "claimed on account of tithe rentcharge issuing out of "any lands, and the County Court is satisfied that, if "the sum claimed is paid, the total amount paid on "account of the tithe rentcharge for the period of twelve "months next preceding the day on which the sum claimed "became payable, will exceed two-thirds of the annual "value of the lands as ascertained and entered in the "assessment for the purpose of Schedule B. to the Income "Tax Act, 1853, or as certified as hereinafter mentioned, the "Court shall order the remission of so much, whether the "whole or part of the sum claimed, as is equal to the "excess, and the amount so ordered to be remitted shall "not be recoverable; and if the Court is satisfied that "neither such remission, nor the liability thereto, has "been taken into account in estimating the rateable value of "the tithe rentcharge, the Court may remit such amount of "any then current rate assessed on the owner of the tithe "rentcharge as appears to the Court to be proportionate to "the amount of the remission of tithe rentcharge."

It is to be noted, however, that by sub-section 8, remission is confined to rentcharge on lands used solely for agricultural or pastoral purposes or for the growth of timber or underwood. And where lands were at the commutation the subject of a special apportionment, that is, where the tithe rentcharge in respect of a larger area was, by the desire of the landowner, specially apportioned on a smaller area, so that the smaller area bears a greater proportion of rentcharge than it would otherwise have borne, remission is not to be granted unless the Court is satisfied that the applicant would have been entitled to remission if no special apportionment had been made (section 8, sub-section 6).

The basis of any remission being the annual value for the purpose of assessment under Schedule B. of the Income Tax, it is obvious that, where there is reason to think the provision will apply, attention should first be directed to seeing that the lands are correctly assessed under Schedule B.

If the lands out of which any tithe rentcharge issues are assessed under Schedule B. with other lands, the surveyor of taxes for the parish is, on application of either owner or occupier, to divide the annual value stated in the assessment between the lands out of which the tithe rentcharge issues and the other lands, and give notice of the annual value, as so determined, to the applicant and the tithe owner ; and either of these parties, if dissatisfied, can appeal to the General Commissioners of Income Tax for the division in which the lands are assessed, who will finally determine the proper division of the annual value (section 8, sub-sections 2 and 3).

If in any case the annual value is not ascertained and entered in the assessment under Schedule B., the General Commissioners of Income Tax for the division are, on application of either owner or occupier, to ascertain the annual value for the purpose of Schedule B., and inform the applicant (section 8, sub section 4).

On payment of 1*s*., the Commissioners of Taxes are to give a certificate of the annual value of any lands for the purposes of section 8. It is important that this certificate should be obtained, since, under Rule 32 of the Tithe Rentcharge Recovery Rules, 1891, its production at the hearing before the County Court appears to be necessary for obtaining remission.

The procedure in the County Court is available only when a tithe owner has given the Registrar of the Court notice of his intention to apply to the Court for the recovery of his tithe rentcharge. Notice of the application is served on the owner of the lands, and if he desires to obtain remission he must, at least five clear days before the hearing, give the Registrar notice of his intention to apply for a remission, and in such notice state whether more than one tithe rentcharge issues out of the lands—*e.g.*, the application may be for rectorial tithe rentcharge, and the land may also be subject to vicarial tithe rentcharge. If there is any such other rentcharge, the owner of it receives notice of the application, so that both rentcharges may be dealt with by the Court at the same hearing.

The procedure in these cases is regulated by the Tithe Rentcharge Recovery Rules, 1891, in the Appendix to which is a form of notice of intention to apply for remission.

These provisions do not apply to rentcharges under The Extraordinary Tithe Redemption Act, 1886.

The Tithe Act, 1891 (price 1½*d.*), and the Rules thereunder, may be obtained from H.M. Stationery Office, Imperial House, Kingsway, London, W.C.2.

It may be added that where there is doubt as to the amount of tithe rentcharge charged on any lands, information can be obtained by any person on sending to the Board an Ordnance Survey Map with the lands clearly marked thereon, and on payment of a search charge, which usually amounts to two shillings. If extracts from the tithe apportionment are required there is a further small charge, the amount of which can be ascertained on application to the Board.

Copies of forms and memoranda relating to the re-apportionment and redemption of tithe rentcharges may be obtained free of charge on application to the Board.

London, S.W.1,
December, 1894.

Revised, December, 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.

Anthrax.

Anthrax is a contagious disease caused by a microbe *Bacillus anthracis*. Human beings and all animals are liable to become infected. The disease, which shows itself suddenly, chiefly attacks cattle, pigs, and sheep, but horses are not uncommonly affected. It is often very quickly fatal, usually within forty-eight hours of illness showing itself, but in the United Kingdom it does not often spread with rapidity from animal to animal, though it may affect a number of swine at the same time if they have been fed on flesh affected with anthrax.

Symptoms.

Where an animal is attacked with anthrax its inclination is to separate itself from its companions. It stands almost immovable, with head depressed, and usually at the later stages of the disease declines every kind of food. If carefully watched, rigors, or shivers, will be seen to pass over the body ; there may be swellings (around the throat—especially in horses and pigs) which are extremely hot to the touch, the eyes have a fixed and staring look, and, if carefully examined, a small quantity of blood may sometimes be found trickling from the nose, or upon the voided fæces of the living animal. Death follows as a rule very rapidly after these symptoms are observed. Cattle are most frequently attacked by this disease.

Post Mortem appearances of the Disease.

Where an animal dies of anthrax there is generally, though not always, to be found almost directly after death a slight oozing of blood from the nostrils or some other of the external openings of the body. The carcass is swollen. The muscles may be infiltrated with blood at certain points. The lungs and glands are congested. The spleen is very much enlarged ; it is softer and darker than normal, and its substance usually resembles tar.

In most parts of this country the enlargement of the spleen in cattle is of great diagnostic importance, but in those districts where Red-water exists, enlargement of the spleen may be due to this disease and not to anthrax. In such a case, however, the spleen substance has not the same fluid, tarry, appearance. In horses and pigs, and much less frequently in cattle, the spleen may be of normal size,

although the animal has died of anthrax. The flesh is dangerous to animals and human beings.

Difficulty of recognising the Disease.

One of the greatest of the difficulties which present themselves in dealing with this disease is that the symptoms during life are not such as to lead a person who is unacquainted with anthrax to suspect the presence of the disease. Moreover, the death of the animal attacked often occurs when the owner or attendant is absent. It frequently happens that an animal which has sickened is killed, or that the carcass of an animal dead of anthrax is cut up, and the blood, which is the main source of danger, is freely spilt about the premises or on the soil. The disease is in this indirect manner spread to other animals, and in some cases the persons who have handled the carcass contract it. In every case of sudden and unaccountable death amongst stock the owner of the animal should await a skilled opinion before disposing of the carcass.

Anthrax or Suspected Anthrax to be Reported.

Every person in Great Britain having or having had in his possession or under his charge an animal (that is, a ruminating animal, pig, horse, ass, mule or dog) affected with or suspected of anthrax, is required by law to give notice of the fact with all practicable speed to the Police. Failure to give such notice renders a person liable to a fine of £20, and in certain circumstances to a month's imprisonment with hard labour.

It is the duty of the Local Authority under the Diseases of Animals Acts on receiving such notice to institute inquiries, and to make proper provision for the disposal of the carcass of any animal suspected of anthrax, and for the disinfection of the premises upon which disease has existed or is suspected to have existed. The Inspector of the Local Authority is also required to give information to the Medical Officer of Health.

Precautions to be taken.

An owner of animals can do much to assist in preventing the spread of the disease amongst his stock, and it is clearly to his own interests that he should do so.

A sick animal should on no account be killed, but should be carefully isolated from all other animals. Should there be the slightest suspicion of Anthrax being present, the matter must, as before mentioned, be reported to the Police.

and in the event of such an animal dying before the arrival of the veterinary surgeon employed by the Local Authority, the carcass must not be dragged along the ground, but should be allowed to remain where it is, until the examination has taken place. It is essential that *the carcass of the animal should not be cut or opened*, and steps should be taken to prevent the escape of blood or of excretions which may contain blood. Any such blood should at once be destroyed and also any drops of blood which may have escaped from the carcass to the floor of the shed or to the soil, inasmuch as every drop of blood of an animal which has died of Anthrax contains large numbers of the bacilli which cause the disease, and from these very resistent spores may form. For the purpose of destroying the bacilli contained within the infected blood a strong solution of carbolic acid should be used, and all the external openings should be plugged with hay saturated with the same solution.

Under the Anthrax Order of 1910, which came into operation on the 1st January, 1911, various provisions are required to be observed in connection with cases, or suspected cases, of Anthrax, and it is advisable therefore that stock-owners, butchers, and other persons dealing with animals should make themselves fully acquainted with these provisions, as any failure to observe them may render the offender liable to legal proceedings. The following provisions may, however, be quoted here.

Under the Order, the occupier of any premises on which there is a diseased or suspected animal or carcass must—

(i.) prevent access of animals or fowls to the diseased or suspected animal or carcass, or to any part of the premises which has been exposed to infection of disease from the animal or carcass ; and

(ii.) detain on the premises any diseased or suspected animal thereon and any other head of cattle, or sheep, or goat, or swine which has been in the same shed, stable, building, yard or field with the diseased or suspected animal or carcass.

The occupier is also required to disinfect as soon as possible with chloride of lime any place where the carcass of a diseased or suspected animal has lain or where its blood has escaped.

A diseased or suspected carcass must not be buried or destroyed otherwise than by the Local Authority, or be removed from the farm or premises upon which the animal died or was slaughtered except by the Local Authority.

Animals with which a suspected animal has been in association should be carefully watched, and isolation at once adopted in the case of the appearance of symptoms similar to those of the suspected animal. Such precautions are particularly necessary in the case of milch cows affected

or suspected of being affected. The milk of these cows may contain anthrax bacilli, and so be the means of infecting human beings. Article 11 of the Anthrax Order prescribes that the milk produced by any diseased or suspected cow or goat shall not be mixed with other milk, and that all milk affected by that Article shall forthwith be boiled or otherwise sterilised, and any utensil in which such milk is placed before being so treated shall be thoroughly cleansed with boiling water before any other milk is placed therein.

General Observations.

It is important that it should be widely known that anthrax is due solely to the introduction of the minute germs or spores of anthrax into the blood of an animal or of man. The disease may therefore be introduced by any medium capable of conveying these germs or spores. Feeding stuffs brought on to a farm, or manures made from animal substances, may be vehicles of infection. If a stream becomes contaminated, as has been found to be the case where certain industries involving the use of the hides, hair, &c., of animals are carried on, the spores may be carried to the farm by the water. The spores of anthrax develop into bacilli which find their way into the circulation of an animal through a cut or abrasion.

Where infection has once been introduced upon a farm it has frequently been continued by the ignorance or carelessness of individuals, and in some cases farms have become permanently infected with anthrax.

It is a common practice amongst owners of stock to slaughter their cattle as soon as they present symptoms of serious illness, in order that the carcass and hide may be utilized. Where, as is not uncommonly the case, the sudden illness is due to the presence of anthrax, the greatest mischief is done by such a practice. The blood of the diseased animal is distributed on the ground, or it may be on the floors of the cattle shed or upon the mangers, or is carried on the boots of the attendants to other parts of the farm or premises. The bacilli contained within the blood of a diseased animal will, when exposed to the air, multiply and produce spores which may become the means of infecting other animals at short or long intervals. Many cases have come under the notice of the Board from time to time of persons having contracted anthrax whilst engaged in slaughtering animals, or in dressing or otherwise handling the carcasses of animals.

On the other hand the bacilli of anthrax die *if kept within the intact carcass* of an infected animal; no spores are formed; and experience has shown that, where the pre-

cautions recommended above have been scrupulously adhered to, the disease frequently ceases after the death of one animal on the farm.

Preventive Inoculation.

The Pasteur method of preventive inoculation has rendered great service in preserving stock on badly infected farms in various parts of the world. The method consists of injecting the animals with fixed doses of attenuated cultures of the *Bacillus anthracis*. Two injections at intervals of 12 days are performed. For the first injection a very attenuated culture is used (first vaccin), and for the second one employs a less attenuated culture (second vaccin). The immunity is established about 12–15 days after the second vaccin has been injected. In cattle it lasts about a year, and should be repeated after this period unless the ground has become purified. The great majority of cattle operated on show little more than a temporary indisposition with passing fever after the injection, which may be assumed to indicate a mild attack of anthrax. Occasionally, however, an inoculated animal may die of the disease as the result of the injection, and for this reason the animals while undergoing the process of immunization should be kept in a special paddock, or better still, in sheds which can be disinfected in the event of an accident taking place. The operation should only be attempted by skilled persons, who will know the best way to prevent an accident, and guard against its consequences should it occur.

Since the operation is not altogether unattended by the possibility of loss, and since it incurs a certain amount of expense, one has to consider under what circumstances it will be worth while undertaking it. It will be obvious that on farms registering only one death annually it will hardly be called for and that it would be folly to adopt it on clean farms.

It results from observations on several millions of cattle in various parts of the world that accidents occur in about 0·5 per cent. of the inoculated cattle taken all round, and that the operation may be expected to reduce the death rate from anthrax on infected farms to about 1 per cent. or slightly under.

If a stockowner finds that his annual losses from anthrax amount to 2 per cent. he will possibly find it profitable to have recourse to preventive inoculation.

It should be understood, however, that since the number of animals dying of anthrax in one year will vary, and since the inoculation must be repeated annually, the estimation of annual losses must be based on two or three years' casualties.

A certain degree of temporary immunity can also be almost immediately conferred by injecting a dose of anthrax serum, and the injection produces no accidents. Where animals have been exposed to the risk of what might be called gross infection (for example, when a carcass has been carelessly dealt with on a pasture) it is advisable to inject them immediately with serum, and remove them to another field.

Farmers invited to assist Public Authorities.

Stockowners are, therefore, earnestly invited to co-operate with the public authorities,

(*a*) By reporting every case of sudden and unexplained illness or death, especially amongst cattle, to the Police;

(*b*) By isolating an ailing animal, and by protecting any suspected carcass from persons or animals pending the arrival of the veterinary surgeon employed by the Local Authority;

(*c*) By giving every facility to the officers of the public authorities in carrying out the precautionary measures enjoined by the Anthrax Order; and

(*d*) By affording such officers every assistance in their power in tracing the origin of the outbreak.

They are further strongly recommended to give positive orders to their servants that *under no circumstances is an ailing beast to be killed by them, or its carcass opened, where the cause of sickness or death is unexplained.*

The Board have prepared a short notice (A 357/A) dealing with the principal points above set out, suitable for posting up in byres or sheds. Copies can be obtained gratis and post free on application to the Board.

London, S.W.1,
September, 1893.
Revised, January, 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.

BOARD OF AGRICULTURE AND FISHERIES.

Swine Fever.

Swine fever is a contagious disease. It is caused by a living and infective agent which is so small that it cannot be seen by the highest powers of the microscope. That it is a living agent is proved by the fact that if liquid containing infective material be passed through a fine bacteriological filter a very small amount of the filtrate will produce the disease in a pig into which it has been injected, and the infecting agent will increase in its system to such a degree as to provide enough material to infect an infinite number of other pigs.

Animals which suffer from the Disease.

The pig is the only animal which suffers from swine fever, but within certain limits, which are not very wide, some pigs are more resistant to infection than others. As a general rule it may be said that young swine are less resistant than older animals, and that they suffer more severely when attacked by the disease. It must not be assumed, however, that older pigs do not take swine fever. They very frequently do, and in some outbreaks the mortality amongst the breeding stock is nearly as high as in the young pigs.

Incubation Period.

In every contagious disease there is an interval between the time of infection and the appearance of the symptoms of the disease; this is called the incubation period. During this period the infecting agent is growing in the system of the animal and producing poisonous substances and alterations of tissue, which eventually give rise to the symptoms. In swine fever the incubation period is usually about five days, but it should not be expected that in every case infected animals will be distinctly ill in this time. Some of them may not show outward symptoms until about ten days after infection, but, notwithstanding this, if their temperature be taken with a thermometer, it will be found to be higher than usual.

Symptoms.

The affected animals show marked want of appetite, and it is said that "they do not come up to the trough." They shiver, and bury themselves in the dry litter, or if there is no litter, they may lie up in one corner of the sty. Sometimes they vomit at the commencement of the disease. If the temperature be taken it will be found to register from 104° to 107° Fahrenheit. There may, or may not be, a purple rash on the skin of the ears, belly, and hock; diarrhœa is generally present. The animals gradually get weaker, and when made to move, they stagger about the sties in a drunken fashion; finally, they become unconscious, and die.

The duration of the disease varies considerably, but pigs seldom die under ten days after natural infection. More commonly they die from an acute attack of the disease after fifteen days. A considerable number, however, may live for thirty days, and in some cases pigs affected with swine fever may live as long as eighty days.

A noticeable symptom in the more chronic form of disease is great thirst, and the pigs may often be seen and heard sucking up the drainage from the floor of a wet sty. They are also inclined to eat all kinds of filth in preference to the ordinary food—generally displaying a morbid appetite. Another noticeable symptom of swine fever in the chronic form is swelling of the joints.

The symptoms vary in degree according to the activity of the infecting agent. In some outbreaks, for example, outward symptoms amount to very little more than an appearance of unthriftiness in a number of the pigs. The fact that deaths may not occur in such cases often misleads the owner regarding the true nature of the trouble, which may be hidden by symptoms of inflammation of the lungs (pneumonia) giving rise to breathlessness and panting. The appearance of pneumonia in several pigs may, in fact, be the first important indication of the existence of swine fever. In other cases pneumonia may attack, and carry off, animals which are recovering from mild attacks of swine fever. There is no disease of swine except swine fever in Great Britain, which as a general rule gives rise to so many deaths at short intervals, or to continued unthriftiness amongst a number of swine. Taking one outbreak with another the average death-rate is very high. It may even amount to 100 per cent. of the pigs on the premises.

Pig owners should suspect swine fever under the following circumstances:—(1) When a number of pigs are dying; (2) when a number of pigs are sick or unthrifty; (3) when periodic deaths are taking place, even if the other

pigs appear healthy; (4) when large numbers of deaths are taking place in sucking or newly weaned pigs, even if the older ones appear to be healthy; (5) when a number of pigs are sick or dying with symptoms of inflammation of the lungs, diarrhœa, or what may appear to be acute swine erysipelas ("Diamonds"); (6) the fact of suspicious symptoms appearing first in pigs which have been recently purchased, or in those which have been off the premises to a market, and have been brought back, should increase the suspicion. Careful inquiry, however, into the circumstances in connection with a number of outbreaks shows that the fact of no new pigs having been brought on to the premises for some months does not of itself justify a definite opinion that an outbreak of disease is not swine fever.

Post Mortem Appearances.

The carcases of pigs which have died of swine fever may or may not be emaciated, and purple patches may be present on the skin of the ears, belly and hocks. In the acute cases characterized by death after a short period of illness, redness of the lymphatic glands is observed, there are signs of inflammation on the inner lining (mucous membrane) of the intestines, while the membrane is often dotted over with innumerable small red blood spots. These spots (hæmorrhages), however, are not peculiar to the very acute forms, but may also be seen in the more chronic cases. In the latter cases one finds a deposit in the form of a yellowish membrane on the inner surface of the intestines. The most typical lesion is the swine fever ulcer, which is most commonly found in the large bowel about the junction of the end of the small bowel (ileum), and blind gut (cæcum), but swine fever ulcers may also be found much more rarely in the throat, on the tongue, and on the skin. In examining the intestines of sick animals which have been killed for purposes of diagnosis, it must be borne in mind that it does not follow that the disease is not swine fever because the typical ulceration and deposit are not found. The experimental inquiries conducted by the Board have shown that many animals may have a slight attack of swine-fever and recover in a little more than ten days. If cases of this description be examined in the stage of fever, nothing more may be found in the bowel than slight redness or surface sores on the folds of the mucous membrane. The most common form of ulcer is about the size of a three-penny piece. Its edges are circular, and raised above the membrane. Its centre is soft and either yellow or black in colour. Congestion of the mucous membrane of the bowel should always be looked upon with suspicion, and particularly if it is combined with inflammatory symptoms in the lungs.

The Infective Material and how Infection Spreads.

The blood of pigs suffering from swine fever contains a large amount of the infective agent, and as the blood flows through all the organs and tissues, they also contain it. All the discharges contain the infective agent to a greater or less extent, and the intestines showing ulcers are particularly dangerous. Healthy pigs acquire the disease by mixing with affected pigs. The latter through their excretions infect the troughs or the ground and litter, and the healthy animals are infected by swallowing, or licking up, contaminated material. Infected material can be carried on the boots and clothes of attendants or castrators to neighbouring establishments, but it is mainly by affected pigs in life that the disease is spread from one part of the country to another. In this connection what has already been indicated might be repeated here with advantage :—(1) Unthrifty pigs may have swine fever without showing definite symptoms of the disease, and may be moved to other premises in the belief that they are suffering from some trifling and non-contagious disease ; (2) some pigs may have apparently recovered from swine fever, although they are suffering from the disease in a very chronic form, and such pigs may be infective to others for a period of as long as eighty days or even more. In the majority of cases, however, such pigs show a certain amount of unthriftiness, and very frequently they are stunted.

Prevention.

It may be stated at the outset that the more sanitary the condition of the premises (*see* Leaflet No. 121—*Construction of Pigsties*) the better will be the chance of preventing swine fever, once it is introduced, from spreading rapidly through the pigs in different sties. For those who buy pigs in markets, however, or who are dependent on other people in any way for their supplies, it must not be thought that the possession of sanitary premises is a safeguard against the introduction of the disease. Precautionary measures may be tabulated as follows :—

(1.)—Pigs which have been recently purchased, or which have been off the premises to a market and brought back again, should be kept isolated from the others for about a month, and carefully watched ; the same rule applies to sows which have been to the boar and to pigs which have recently been cut by a practising castrator.

(2.) In the event of suspicious symptoms of swine fever appearing in pigs on any part of the premises, pigs therein should, if possible, be kept rigidly isolated from the others, and have separate attendants who should wear special boots

and overalls while going about the sties. If, however, the existence of disease is confirmed by the Board, and the owner agrees to adopt the serum treatment (*see* later), it may be considered advisable to mix the ailing pigs with the healthy after the latter have received a protective dose of serum.

(3.)—If there are rats on the premises, an effort should be made to reduce their numbers (*see* Leaflet No. 244, *The Destruction of Rats*). This is advisable, not because rats suffer from swine fever, but because it is possible that they may convey infected material from one sty to another.

(4.) Serum treatment is now known to be very valuable in saving the lives of pigs on infected premises, provided owners report at an early stage, and the veterinary inspector of the Board has the opportunity of applying the treatment to those pigs which are not in the grip of swine fever at the time of his visit. Treatment by serum is dealt with in a special "NOTICE TO OWNERS OF PIGS—A. $\frac{28}{a}$", which is issued with this Leaflet, and veterinary inspectors of the Board when dealing with outbreaks have been instructed to supply owners with further information on the subject should it be required.

NOTE.—Swine-fever is a disease scheduled under the Diseases of Animals Act, 1894, and the existence or suspected existence of the disease must be notified to the police in accordance with the provisions of the Swine Fever Order of 1908. Copies of this Order can be obtained free of charge on application to the Board.

London, S.W.1,
January, 1896.
Re-written, April, 1916.
Revised, July, 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. 30.

BOARD OF AGRICULTURE AND FISHERIES.

The Codling Moth (*Carpocapsa pomonella, L.*).

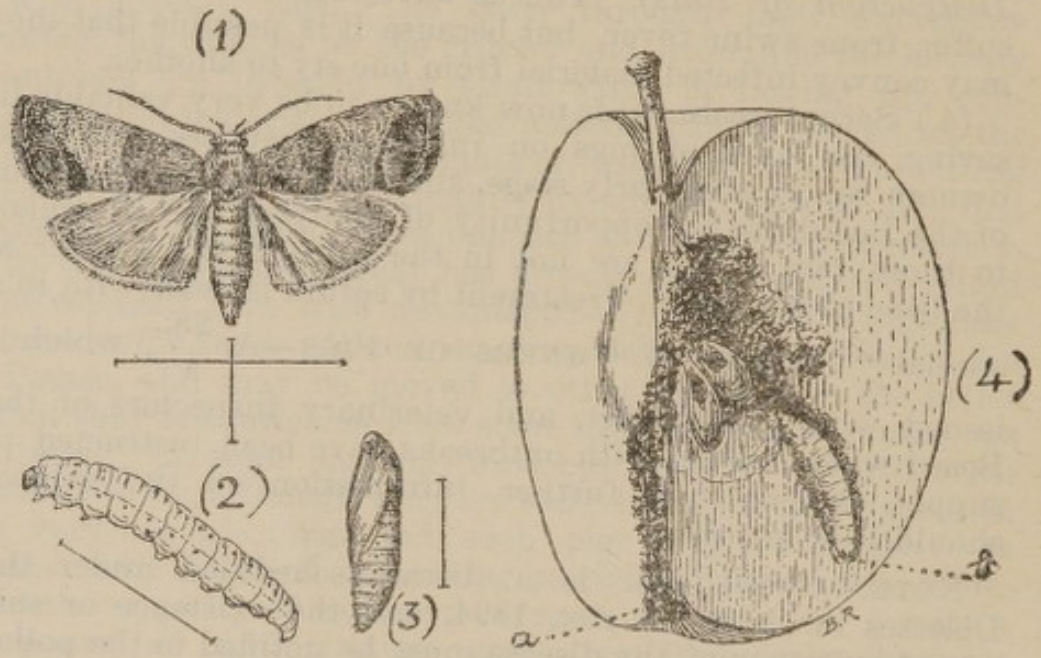


FIG. 1.—Codling Moth, enlarged. Lines showing natural size.
" 2.—Larva of ditto " " " " "
" 3.—Pupa of ditto " " " " "
" 4.—Section of apple showing work of larva, which has entered at the eye, passed up the core by the burrow *a*, and is leaving the fruit at side at the point shown by letter *b*.

The Codling Moth is probably the most notorious of all apple pests and is to be found in almost every country in which apples are grown. The damage is caused by the larva which burrows into the fruit and so produces the worm-eaten or maggoty apple which must be familiar to everybody.

It must be noted, however, that there is a further pest, the Apple Sawfly (*Hoplocampa testudinea*), the larvae of which damage the apples in much the same way as those of the Codling Moth, and it is very necessary to distinguish between the two, since the methods of control in the case of the Codling Moth are quite useless when employed against the Sawfly. An account of the Sawfly will be found in Leaflet 205, but the chief distinguishing features are also given below in the sections "Description and Life History of Insect" and "Nature of Damage."

Description and Life History of Insect.

The Codling Moth measures from $\frac{1}{2}$–$\frac{3}{4}$ inch in spread of wings and $\frac{1}{3}$ inch from head to tail (tip of abdomen). The fore-wings are dark grey with numerous waved brown lines giving the appearance of watered silk. Near the end (outer margin) of the wings is a brown patch which in certain lights has a coppery metallic lustre, the most characteristic feature of the moth. The hind wings are greyish brown, often with a coppery tinge.

Codling Moths emerge from the pupae towards the end of May and may be found for a period of about three weeks. They fly at dusk and spend the day at rest on the trunk, branches or leaves of the apple trees, but are very difficult to detect.

The female, after pairing, lays her eggs singly on the young fruit, and on the leaves, or twigs. The eggs are small —$\frac{1}{25}$ inch in diameter—oval and very flat, appearing, in fact. more like small shining scales than the eggs of an insect. After a period of 10 days or longer, according to the weather, the young larva leaves the egg and crawls away until it reaches the "eye" (or calyx) of the apple, through which, in the great majority of cases, it gnaws a hole into the interior. As an exception the larva may enter the apple at some other point, but in this case it is usually where two apples press together or where one is in contact with a leaf. Having penetrated into the apple, the larva attacks chiefly the core and the neighbouring flesh, burrowing down the centre to the pips, which are also eaten.

After a period of three weeks to one month the larva is full fed. It then measures from $\frac{1}{2}$–$\frac{3}{4}$ inch in length and is pinkish or creamy white in colour with a brown head. It has three pairs of true legs and five pairs of "sucker" legs, including the clasper-like pair at the "tail." There are therefore 8 pairs in all, and this feature will serve to distinguish it from the Apple Sawfly larva, which has 10 pairs altogether. In general appearance the two larvae are different, Sawfly larvae being often dead white and rather plump, while the Codling larvae are to some extent coloured and more slender, but these features are not constant and cannot be relied on.

On becoming full fed the Codling larva burrows its way out through the side of the apple, which may still be hanging on the tree or may have dropped to the ground. In either case the larva crawls away in search of some shelter in which to spend the winter and for this purpose it often chooses a crack or crevice in the bark of the apple tree, though it may conceal itself in a dead leaf or in any other rubbish near-by. Having chosen its position, it spins a silk cocoon in which it remains as a larva until the following

spring, when it changes into a yellowish brown pupa. Very occasionally the larva pupates in the summer and emerges as a moth in August, but this second brood is rare in Britain, though it becomes normal in the warmer climates of America. When moths of a second brood are produced they give rise to larvae which attack the apples in the same way as the first brood, though they often enter the fruit through the side instead of through the eye. As in the case of the first brood they spin cocoons in which to pass the winter, pupating the following spring and producing moths in due course.

Plants attacked and Nature of Injury.

The attacks of the Codling Moth are not confined to the apple. Pears at times suffer rather severely and the fruits of the quince, walnut and of various wild species of Pyrus may also be damaged, though as regards these plants the pest is of little importance.

In the case of the apple, Codling Moth injury may usually be distinguished from that due to Apple Sawfly by the fact that the larva has entered through the eye and has confined itself mainly to the neighbourhood of the core, finally passing out by a burrow to the side. The Sawfly larva, on the other hand, usually both enters and leaves the apples by holes at the side (as opposed to the eye), while instead of attacking mainly the core region, it eats out a large irregular cavity in the flesh. In the case of sawfly attack the decay produced is more rapid and the apple seldom attains any size, usually falling in June or July.

Distribution and Economic Importance.

The Codling Moth is an insect which has been able to adapt itself to practically every climate in which its chief host plant, the apple, can be grown, and since it is easily carried in infected fruit, it has now spread throughout the apple-growing regions of the world. It appears to have been known to the ancient Romans, and has certainly been long resident in Europe.

In Great Britain the insect is abundant in England and Wales, and occurs in Scotland and Ireland. Descriptions of its life history were made in the 18th century, and it is probably an old inhabitant of these islands, though its numbers have perhaps been reinforced by the introduction of larvae in infested consignments of apples from abroad.

In Europe—that is to say, in countries in which it has long been resident—it is always a troublesome pest, but its attacks seldom attain the proportions which have marked its spread through America and Australia.

In the latter country, the moth has been made the subject of special legislation with apparently good results. It is impossible to give any estimate of damage done in Britain by the Codling Moth, since confusion so frequently occurs between the Moth and the Sawfly. Further, the Codling Moth is most numerous in old orchards and gardens attached to houses, where little attention is paid to its ravages. In large commercial orchards it does not seem to be such a serious pest as is sometimes supposed, and this is explained by the facts, (1) that trees in modern orchards are kept very clean, (2) that spraying is carried out if necessary, (3) that there is usually only one brood in the year. In America, where the annual loss from the Codling Moth has been estimated at no less than £4,000,000, it is the occurrence of more than one brood in the season which makes it such a dangerous enemy.

There are several insect parasites of the Codling Moth, and birds also devour great numbers of the hibernating larvae, but it does not appear that these natural enemies are alone capable of keeping the pest in check and recourse must therefore be had to artificial measures of control.

Methods of Control.

A.—*In Orchards where spraying can be practised.*

(1.) If the trees are covered with moss and loose bark they should be cleaned by means of an alkaline winter wash (*see* Leaflet No. 70, *Treatment of Neglected Orchards*). This will destroy some of the larvae, and will reduce the number of cracks and crevices in which they can spin their cocoons.

(2.) The trees should be sprayed with lead arsenate just after the petals have fallen. It will be found that there is a period of from 7–14 days during which the calyx cup, subsequently the eye of the apple, is open, while later it closes. The object in spraying is to force the arsenate into the calyx cup, where it is retained after the calyx closes, with the result that any Codling larva which attempts to burrow through the "eye" of the apple is poisoned. It is useless therefore to spray too late, when the calyx cup is closed, for then the poison cannot reach the point at which it will be needed, but it is also necessary to wait until the blossom has completely fallen to avoid poisoning the bees. A nozzle giving a fine spray is usually used and the spray should be directed as much as possible on to the trusses of bloom. 1 lb. of lead arsenate paste should be allowed to every 20–25 gallons of water, or the water may be replaced by a similar quantity of Bordeaux Mixture or Lime Sulphur, if it is desired to control fungus diseases as well. The lead

arsenate spray in addition to checking the Codling Moth will also destroy any leaf-eating caterpillars, such as those of Winter Moths, which may be present.

B.—*In orchards where spraying is impossible.*

(1.) The trees may be banded in June with old frayed sacking, folded paper or ropes of hay. If possible, two bands 4–6 inches wide should be used on each tree, one just below the junction of the branches with the trunk and the other a few inches from the surface of the ground. The upper band will catch those larvae which crawl down the branches, while the lower will arrest those which fall from the tree and crawl back to the trunk. A single band is fairly effective and may be placed at any convenient height on the trunk, which must be cleaned as far as possible (see section 3 below). The bands should not be made "sticky" for the larvae on leaving the fruit are likely to make their cocoons in the folds of the sacking or in the hay, and the bands must therefore be burnt in the autumn after the apples have been gathered.

(2.) All fallen fruit should be picked up and disposed of in such a way as to kill any larvae inside. Attacked apples should be separated from the others when they are picked, and if unfit for cooking should be given to the pigs or otherwise dealt with so as to destroy any larvae which they may contain.

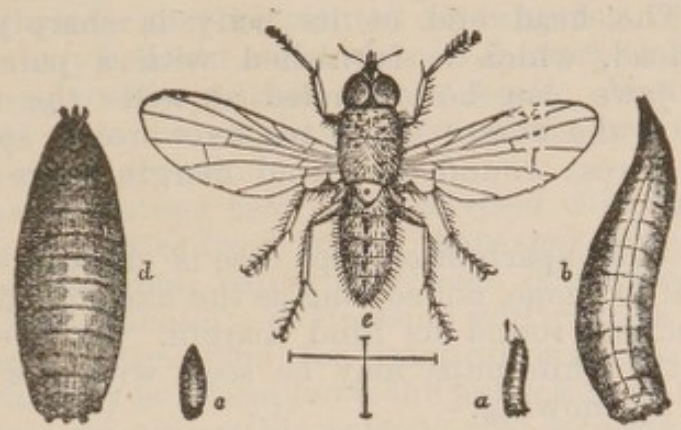
(3.) All rubbish near the trees should be cleared away and burnt. Without spraying it is often possible to clean the trees somewhat by pruning out all dead wood and scraping off loose bark and moss.

London, S.W.1,
June, 1896.
Revised, 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 Onion Fly (*Phorbia cepetorum* Meade=*Hylemyia antiqua* Meigen).



a and *b*, Larva, natural size and magnified ; *c* and *d*, Pupa, natural size and magnified ; *e*, Fly magnified ; lines showing wing expanse and length of body.

The Onion Fly is widely distributed throughout the country and causes serious injuries to the onion crop both in market gardens and on farms where onions are extensively cultivated. It is also a source of great trouble to onion growers in Canada, in the United States, and on the Continent of Europe.

Appearance of Infested Plants.—In many cases the first indications of the infestation are that the longest or first leaves of the onion plants become yellow, and afterwards whitish ; if these leaves are pulled, they easily break away from the stem, and subsequently the other leaves also turn yellow and decay. In other cases the outer, or lower, leaves of the plant are seen to be lying on the ground, still green, while the leaves remaining upright and green feel soft and flabby.

If infested plants be examined, it will generally be noticed that very young plants are nearly eaten through, just above the swelling bulbs, by the maggots of the fly. In older plants with large bulbs maggots of all ages and sizes may be found within the bulbs.

Onion plants attacked when young are often killed, while larger bulbs become decayed and useless for human consumption.

Description.—*Adult Flies.*—Onion flies in general shape and appearance somewhat resemble house flies. In colour they are grey, with four, often indistinct, brownish stripes on the thorax between the wings, and a series of dark triangular marks on the abdomen. The two sexes much resemble each other, but in the female the eyes are widely separated on the upper part of the head, and the dark markings are less evident.

Eggs.—The eggs are white, oval in shape, and measure about $\frac{1}{20}$ in. in length. They can easily be seen without a glass.

Maggot.—The maggot, when full grown, is nearly one-third of an inch in length, and is of a dull dirty white colour. The head end of its body is sharply pointed, and the head, which is furnished with a pair of black hook-like jaws, can be extended at will; the tail end is blunt, and in the centre there are two brown spiracles or breathing pores; round the hind margin there are eight projections.

Pupa.—The puparium or pupa case is chestnut-brown in colour, oval in shape, not so long as the maggot, and has the same projections round its hind margin. On opening this puparium the white pupa may be seen with the wings of the future fly showing.

Life History.—The flies first appear in spring and early summer and lay their eggs on the young leaves or necks of the onions or on the soil near by. From four to eight eggs are usually found near each plant, but larger numbers are noted not infrequently, possibly as the result of visits by more than one fly. In about a week the eggs produce maggots which burrow down into the plants and feed on the developing bulbs. In from two to three weeks the maggots are full fed and turn to pupae either in the decayed onion or in the surrounding earth. These pupae during the summer months produce adult flies in from ten to twenty days, but insects which become pupae in the autumn remain in that stage until the following spring. The rate of development from egg to adult varies considerably, in accordance with weather conditions, food supply, etc., and maggots of different sizes and probably of different broods may be found together in the same bulb. It would appear that in this climate there are usually three broods in the year and that the majority of the insects spend the winter in the pupal stage. The habit of passing the winter as a pupa, however, is not invariable, since, even in the cold climate of Canada, larvae have been noted in December, while in the warmer regions of the United States it is said that the insects hibernate as adult flies.

Methods of Control.—The onion fly is a most difficult insect to control. Attacked plants should, of course, be burnt as soon as possible in order to avoid the production of further broods; in removing badly decayed plants care is needed or many larvae or pupae will be left in the surrounding soil. After a crop has been attacked it is obvious that the following year onions, if grown at all, should be sown as far away from the infested land as possible. In any case land intended for onions should be cultivated (in the case of gardens, deeply dug or trenched) in October or November, and left in a rough state during the winter. Apart from

general measures of this nature, certain other treatments have given fair results—notably in the case of garden cultivation.

I. Any measures which will bring the plants forward early in the season will reduce the injury done by the fly. To this end young immature bulbs which have been stored through the winter may be planted out in spring, or, alternatively, seeds may be sown under glass in January or February, and the young onions pricked out in April. Manures such as nitrate of soda or sulphate of ammonia are useful in stimulating rapid growth.

II. Various dressings have been advised with the objects of preventing the flies from laying their eggs and of killing small larvae (maggots) before they have penetrated far into the bulb. Unfortunately, no dressing will remain effective for any length of time, and, for practical purposes, the most which can usually be attempted is the protection of the plants during their most vulnerable period—that is to say, for three or four weeks after the date on which they first appear above the ground. During this period three or four applications at intervals of a week should prove sufficient. As to the nature of the dressings, those best known in this country are paraffin emulsion, paraffin and sand, soot, or soot and lime. It would appear, however, that carbolic acid emulsion, hellebore and pyrethrum, as used in Canada and the United States of America, are more effective.* Formulae for making these dressings are given in paragraph V below. The liquids are applied to the plants and the soil around them either by means of a spraying machine with a coarse jet, or a watering can with a narrow spout.

III. Experiments† in America appear to show that the female flies are strongly attracted by a mixture of treacle ("molasses") and water. Poisoned syrup is, therefore, sprayed on the plants, or is exposed among them in tins or pans, to kill the flies before they have laid their eggs. If a trial is given to the treatment in this country, it is suggested that the poisoned syrup should be exposed in tins or pans, since at the period when the onions most need protection there would be little leaf surface to hold a spray. In Canada it is advised that "excelsior" wood packing, sometimes known as "wood wool," be placed in the tins to make it easier for the flies to reach the poison; every care must, of course, be taken in using the syrup, which is poisonous to man and domestic animals as well as to insects. A formula for making it is given in paragraph V.

IV. There appear to be no mechanical measures for protecting the onions comparable with the card discs in use against cabbage fly. Miss Ormerod, however, records‡ success by growing the onions in a trench and earthing them up as they grew, so as to keep the bulbs covered.

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* Gibson & Treherne, Bull. 12. Canadian Dept. of Agriculture.
† Severin. Canadian Entomologist. Vol. 46, p. 312.
‡ Ormerod. Manual of Injurious Insects, p. 159.

V. *Formulae.*

Paraffin Emulsion—

Paraffin	1 pint.
Soft soap	1 lb.
Water (soft)	10 gallons.

Dissolve the soap in 1 gallon of boiling water. Add the paraffin and churn the mixture thoroughly by spraying it back into itself with a hand syringe. When required for use, add the remaining 9 gallons of water and again stir the emulsion thoroughly.

Carbolic Acid Emulsion—*

Crude carbolic acid	1 pint.
Hard soap	½ lb.
Water	1 gallon.

Dissolve the soap in 1 gallon of boiling water and then add the carbolic acid and boil again for 5 minutes, stirring thoroughly. This mixture forms a concentrated carbolic emulsion which, for use, must be diluted at the rate of 1 part of the emulsion to 35 parts of water.

Hellebore or Pyrethrum—*

Hellebore (white) powder ... ... *or* Pyrethrum powder	2 oz.
Water	1 gallon.

In either case it is essential that the powders should be fresh, since they deteriorate rapidly on exposure to the air. It is said that they are more easily mixed if they are first worked up with a small quantity of warm water, after which more water is added to make up to 1 gallon

Poisoned Syrup†—

Sodium arsenite	¼ oz.
Treacle (molasses)	¼ pint.
Water	1 gallon.

Dissolve the sodium arsenite in a little boiling water ; add more water to make one gallon and finally mix in the treacle. Dark coloured strongly smelling treacle should be used. If more convenient it is probable that ½–1 lb. of Barbadoes sugar would do equally well.

London, S.W.1,
July, 1896.

Revised, December, 1918.

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* Gibson & Treherne. Bull. 12. Canadian Dept. of Agriculture.
† Severin. Canadian Entomologist. Vol. 46, p. 312.

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BOARD OF AGRICULTURE AND FISHERIES.

Foul Brood or Bee Pest.

Description.

Foul brood or Bee pest, a disease known all through the centuries, is a most terrible scourge of apiculture. It spreads so rapidly by contagion in a single season, that, unless precautions are taken, a whole neighbourhood may become affected, and the chances of successful bee-keeping therein will be seriously imperilled, if not utterly destroyed.

Two forms of foul brood have long been recognised as existing in Europe, a virulent or strong smelling, and an odourless form. A third type has recently been added ; this is called *Sour brood*, and it has usually been found associated with the strong smelling type. In the first two forms of foul brood, microscopic rod-shaped bacilli are present ; these bacilli increase by cross-division, and have, under certain conditions, the power of forming spores. It is important to note that bacilli are present in the earlier stages of the disease, but in the later stages, when the brood has become rotten and coffee-coloured, or has dried up to a scale, the bacilli produce spores and then perish. These spores represent the seeds of the evil ; they are a resting resistant stage tiding the bacterium over unfavourable conditions, and are capable on the return of favourable conditions of food, temperature, &c., of giving rise to the growing form of the bacillus.

The spores are endowed with wonderful vitality. Freezing, carbolic acid, thymol, salicylic acid, beta naphthol, perchloride of mercury, as well as creolin, lysol, eucalyptus and naphthalene, which evaporate at the ordinary temperature of the hive, prevent the growth of the bacilli, but have much less action on the spores. In 5 per cent. carbolic acid the spores persisted two months ; the spores also resisted the boiling temperature of water for 15 minutes. From this it will be seen how great is the difficulty in curing foul brood unless the disease is attacked in its earliest conditions.

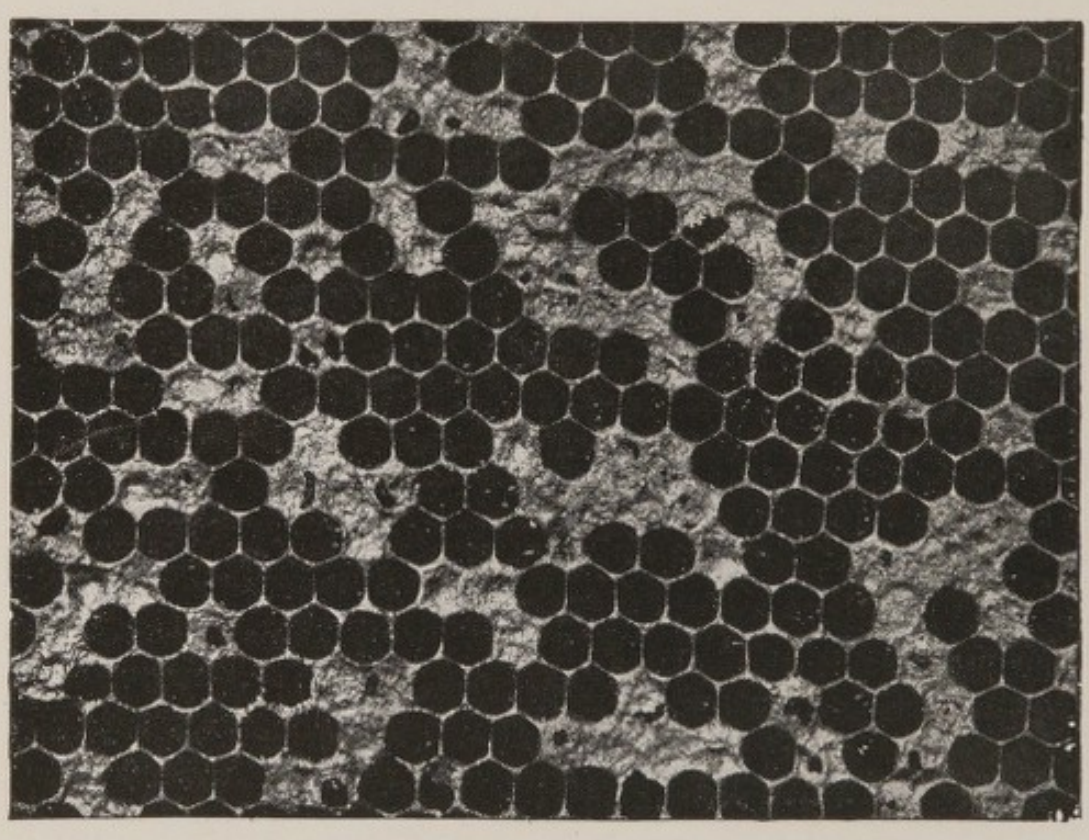
In "sour brood" a non-spore bearing organism is found.

Symptoms.

When stocks are found to be weak and are working languidly, with little desire to fly, and swarming little, foul brood may be suspected. If it is present, an examination of the combs will show some cells (many or few) containing dying or dead larvæ, and others with their covers sunken or perforated (*see illustrations*), the cells of healthy brood being usually compact, and the grubs plump and of a pearly whiteness. When healthy, the young larvæ, pearly white in colour, lie curled up in crescent shape at the bottom of the cells. On the other hand, if diseased, the symptoms vary according to the presence of the three

micro-organisms, so that the different forms of foul brood can be recognised.

When a colony is attacked by the *strong smelling* foul brood (*Bacillus alvei*, Cheshire & Cheyne), the larva begins to move unnaturally and loses its characteristic plumpness, assumes a flabby appearance and lies at the base or lower side of the cell. The colour changes to pale yellow, then to brown, and when the larva begins to decompose the mass becomes paplike or gluey, and shows slight ropiness. The difference in the decomposed larva depends on the proportion of "sour brood" associated with this form of foul brood.

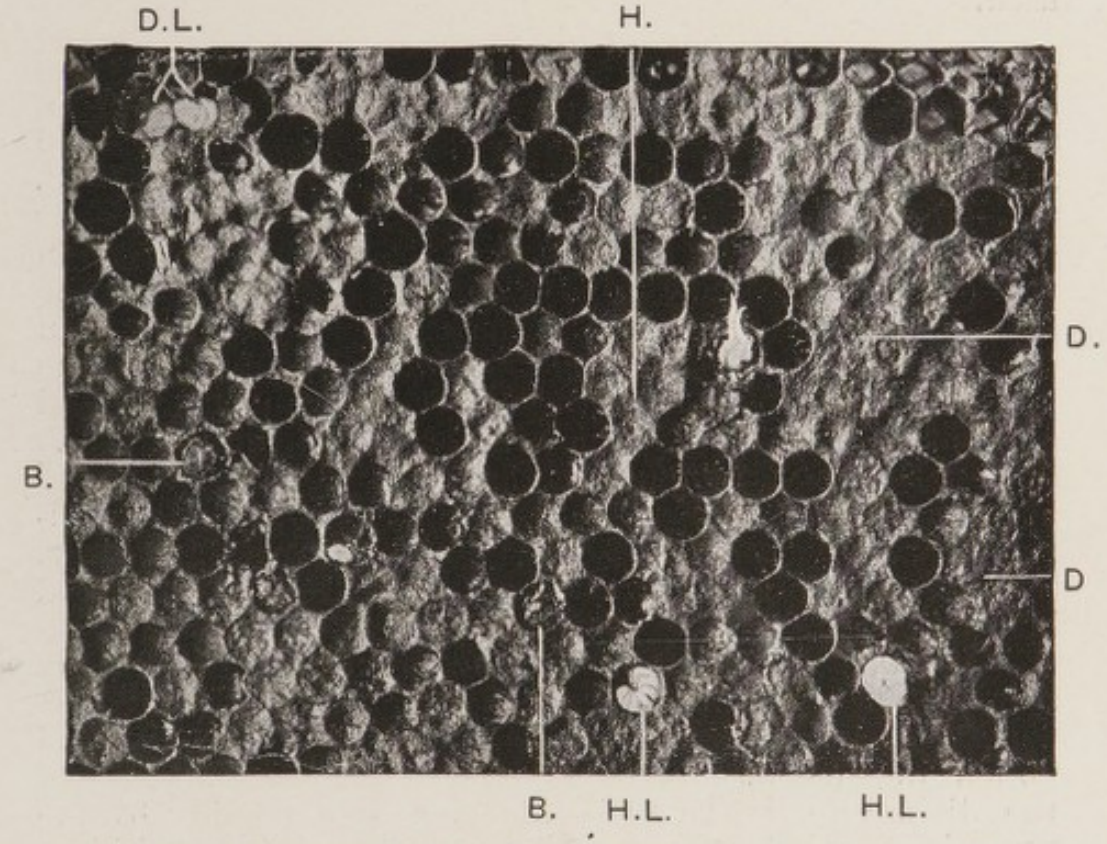


[*From a photograph lent by the Department of Agriculture and Technical Instruction for Ireland.*]

Fig. 1. Portion of a comb affected by foul brood in an advanced stage. The empty cells are those from which healthy brood has been produced, or which have been occupied by diseased larvæ, the remains of which are not discernible in the print. All the capped cells bear the appearance of being diseased. This is indicated by the sunken cappings of the cells, and the numerous perforations in the cappings.

If the former predominates the mass is paplike, and if the reverse is the case the decomposed larva is of a gluey and slightly ropy consistency. In every case a most disagreeable stench, resembling bad glue, is emitted, and in an advanced stage of the disease the foul odour may frequently be detected at a considerable distance from the hive. The foul mass in the end dries up in the cells and leaves only a *smooth* dark brown scale adhering to the lower side of the cell, and this scale is difficult to remove.

In the *odourless* foul brood (*B. Burri*, Burri ; *B. Brandenburgiensis*, Maasen ; *B. larvæ*, White) the progress of the disease is much slower, as the larvæ are usually affected at a later stage, just before or after the brood is sealed. The diseased larva lies extended on the bottom side of the cell, and soon assumes a brown colour. The decomposed mass is odourless, and on inserting a piece of stick into one of the cells, it will have adhering to it on withdrawal a ropy coffee-coloured mass, which can be drawn out in a fine thread before it breaks. The dried scale, which is dark brown and *rough*, sticks to the lower side of the cell. The cappings of the affected cells are also very much more depressed, darker, and perforated with irregular holes.



[*From a photograph lent by the Department of Agriculture and Technical Instruction for Ireland.*]

Fig. 2. Portion of comb affected by foul brood, in a less advanced stage than *Fig.* 1. The raised cappings indicate that there is a good deal of healthy brood, but the presence of diseased brood all over the comb is indicated by the sunken cappings.

H. A group of healthy cells ; other healthy cells being observable all over the comb.

D. Two groups of diseased cells of which there are many more.

B. Healthy bees emerging from their cells.

H.L. Healthy larvæ.

D.L. Diseased larvæ. Note that these larvæ are not lying like the healthy larvæ.

In *sour brood* (*B. Güntheri*, Burri ; *Streptococcus apis*, Maasen) the larva is attacked while still curled up, and when it dies it changes to a greyish colour, then to yellow, and there is a strong acid odour resembling vinegar. The

remains are easily drawn out of the cell without rupturing the chitin covering. Sour brood is seldom found by itself, but is usually associated with the strong-smelling form of foul brood.

It should be noted that "chilled brood" must not be mistaken, as it very frequently is, for foul brood. The dead larvæ of "chilled brood" turn first grey, and afterwards become nearly black, whereas in foul brood the larvæ turn at first pale yellow and then brown, except in "sour brood," when they turn from grey to yellow. The larvæ in "chilled brood" are also generally removed by the bees, which seldom attempt to carry away larvæ which have died from disease, unless disinfectants to arrest decomposition are used.

Sources of Infection.

Experience has plainly shown that with foul brood—as in all epidemic diseases—the weak, sickly, and badly nourished are specially liable to attack, and become centres of infection.

1.—A diseased stock becomes too weak to defend its stores; robbers from healthy neighbouring colonies then probably steal the honey, and in doing so carry away the seeds of disease and death, which are thus spread, until all the hives of a neighbourhood may be fatally affected. The bees do not seem to have the power to clean out the foul cells, which consequently spread infection within the hive.

2.—Another very important point is that the bee-keeper may himself be the means of spreading the pest by indiscriminately manipulating, first diseased, and then healthy hives, without taking proper precautions to disinfect himself and his appliances.

3.—Combs which have contained foul brood retain the spores. The queen lays eggs in the cells and the workers deposit their honey and pollen in them. The honey and pollen in this way become vehicles for the transport of the disease to the larvæ in the process of feeding by the nurse bees. Under no consideration should infected hives or combs be exposed to the visits of bees. Carelessness in this respect may work immense mischief to neighbouring stocks and apiaries.

Prevention and Remedies.

1.—The hives should be placed in suitable positions, and be kept clean, well ventilated, and weather-proof.

2.—In endeavouring to get rid of foul brood, efforts must be made to raise to a high standard the lowered vitality of the bees, which first enables the germs of the disease to develop. Strong stocks only, with young and prolific queens should be kept, while good wholesome food, and freedom from dampness are also important.

3.—When the bee-keeper has been in contact with diseased stocks, his clothes, appliances, and hands must be washed with carbolic soap, and other articles disinfected by spraying with a solution of one ounce Calvert's No. 5 carbolic acid in 12 ounces of water.

4.—It was formerly thought that honey was the only source of infection, and that if bees were starved until they had got rid of the honey carried by them from the diseased hive, a cure would be effected. It is now known that the starvation method often fails when it is not supplemented by disinfection of hives, etc.

5.—When the disease is discovered in a weak colony, the destruction of bees, combs, frames, and quilts, together with a thorough disinfection of the hive, is by far the best course to pursue. The spores are then destroyed, and the source of infection removed.

6.—If an affected colony be still strong, the bees may be preserved by making an artificial swarm which should then be placed in a straw skep and fed on syrup to which three grains of naphthol beta have been added to every pound of cane sugar used, the naphthol beta being dissolved in alcohol and added to the syrup while still warm.

The infected frames, combs, and quilts should then be burned, and the hive roasted, cleaned, and well painted. When the smell of the paint has disappeared, the hive will be ready for use. The bees must be confined to the skep for 48 hours, by which time all the honey they may have taken with them will have been consumed, and such of the bees as are diseased will have died.

NOTE.—It may be added that in the case of mild attacks disinfection or fumigation is sometimes resorted to, formalin being the chief agent used. In attempting such remedial measures, however, or remedial measures of the nature described above, it would be desirable, wherever such help can be procured, to seek the advice of an expert.

London, S.W.1,
July, 1896.

Revised, June, 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. 33.

BOARD OF AGRICULTURE AND FISHERIES.

Surface Caterpillars or Cutworms.

Cutworms or Surface Caterpillars are terms applied to the larvæ of a number of different species of moth which frequently cause a great deal of damage to cultivated plants, both in Britain and in almost every other country in the world.

In Britain the most harmful kinds are the caterpillars of the Turnip Moth (*Agrotis segetum*), the Heart-and-Dart Moth (*Agrotis exclamationis*) and the Yellow Underwing Moth (*Agrotis pronuba*), but there are many others, mostly belonging to the same family, which might be included with equal justice. In this leaflet it is only possible to give a general description of the more characteristic habits of the group.

Nature of Injury.—The damage caused by Cutworms varies considerably and can best be described in connection with the habits of the pests. Cutworms, as a rule, spend the day in the surface layers of the soil or hidden under leaves, thick grass or stones. At night they come out and feed, sometimes on the leaves of plants, but more often on their stems, both above and below ground, and are specially fond of the thick, fleshy parts of such crops as mangolds, turnips and potatoes. They also bite through the stems of plants at, or just below, the ground level, cutting them off one after another, and from this habit they have been given the name "Cutworms." Since the caterpillars are often of the same colour as the soil on, or in which they live, they are not easily seen, and damage may continue for some time before the nature of the pest is realised. An examination of the crop after dark, when the caterpillars are feeding, is perhaps the simplest way of discovering their presence.

It would be difficult to give a list of all the crops attacked, but the following are some of the most important :—

Wheat and other autumn-sown cereals at times suffer considerably during the winter, the caterpillars feeding whenever the weather is mild, eating away the stems and leaves.

Potatoes are attacked in the field, the tubers being gnawed and hollowed out (Fig. 7). *Mangolds and turnips* are also eaten out in the same way, small plants being bitten right through. while large roots are hollowed out, leaves as well as roots being sometimes attacked.

Many vegetable crops are damaged and the pests are also harmful to young forest trees in the nursery, biting through or barking the stems below ground.

Damage by Cutworms may occur at most times of the year, except in late spring and the first half of summer, when the insects are present either as chrysalides or moths and are incapable of causing any injury.

Description and Life History.—The general appearance of the moths of the three species of Cutworms mentioned is shown in the figures. The Turnip Moth (Figs. 1 and 2) has the front pair of wings greyish brown with darker markings—in some individuals quite black—with the hind pair of wings pearly white. The Heart-and-Dart Moth (Figs. 5 and 6) has brown fore wings with brown and black markings, and the hind wings in the male are pearly white; in the female brownish. The Large Yellow Underwing (Fig. 3) has the fore wings brown, sometimes extensively mottled with brownish black, and the hind wings orange yellow with a black border. The caterpillars—the "Cutworms"—of the Turnip Moth (Fig. 4) and of the Heart-and-Dart Moth are much alike.* They are dirty grey in colour, sometimes tinged with chestnut brown, and have rows of blackish dots along their sides with faint traces of stripes passing down the body from head to tail.

Apart from other Cutworms these caterpillars are not likely to be confused with any other pest except perhaps with Leather Jackets (Daddy Longlegs grub)† from which they may be distinguished by the fact that they possess legs whereas Leather Jackets do not.

The caterpillar of the Large Yellow Underwing Moth varies greatly, the ground colour ranging from reddish brown to grey or even greenish. There is a light coloured stripe down each side with more or less conspicuous black marks just above it. The upper part of the caterpillar is always darker than the under parts. No general description, however, can give much idea of this caterpillar.

The life-histories of all these insects are more or less the same. The adult moths appear from the beginning of June until the end of July, the Turnip Moth being the earliest species, and the Yellow Underwing the latest, though all may be found together. Eggs are laid on the leaves or stems of many common weeds and cultivated plants, and produce caterpillars 10 to 14 days afterwards. In a warm season a certain number of these caterpillars feed rapidly, and change into chrysalides at the end of July or in August, producing another brood of moths in August or September. The remainder of the caterpillars, usually the majority, feed more slowly and continue feeding whenever the weather is suitable throughout the autumn and winter. The September

* In the Heart-and-Dart caterpillar the spiracles are quite black and are larger than the spots before and behind. In the Turnip Moth caterpillar the spiracles are dusky and are smaller than the adjacent spots.

† *See* Leaflet No. 11.

FIG. 1—Male.

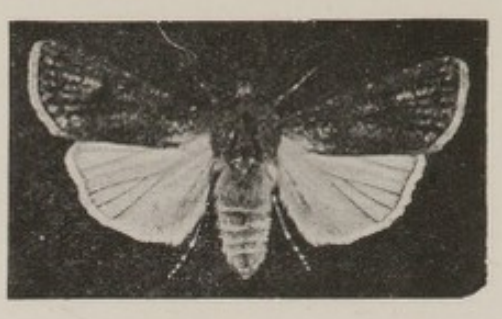


FIG. 2.—Female.

Agrotis segetum.

FIG. 3.—*Agrotis pronuba.* Male.

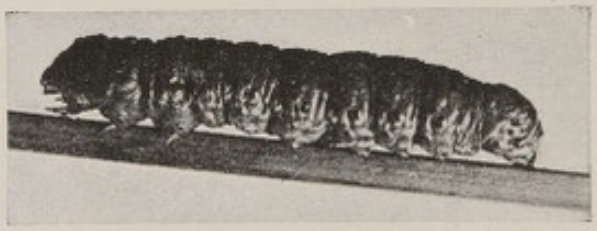


FIG. 4.—*Agrotis segetum.* Larva.

FIG. 5.—Male.

FIG. 6.—Female.

Agrotis exclamationis.

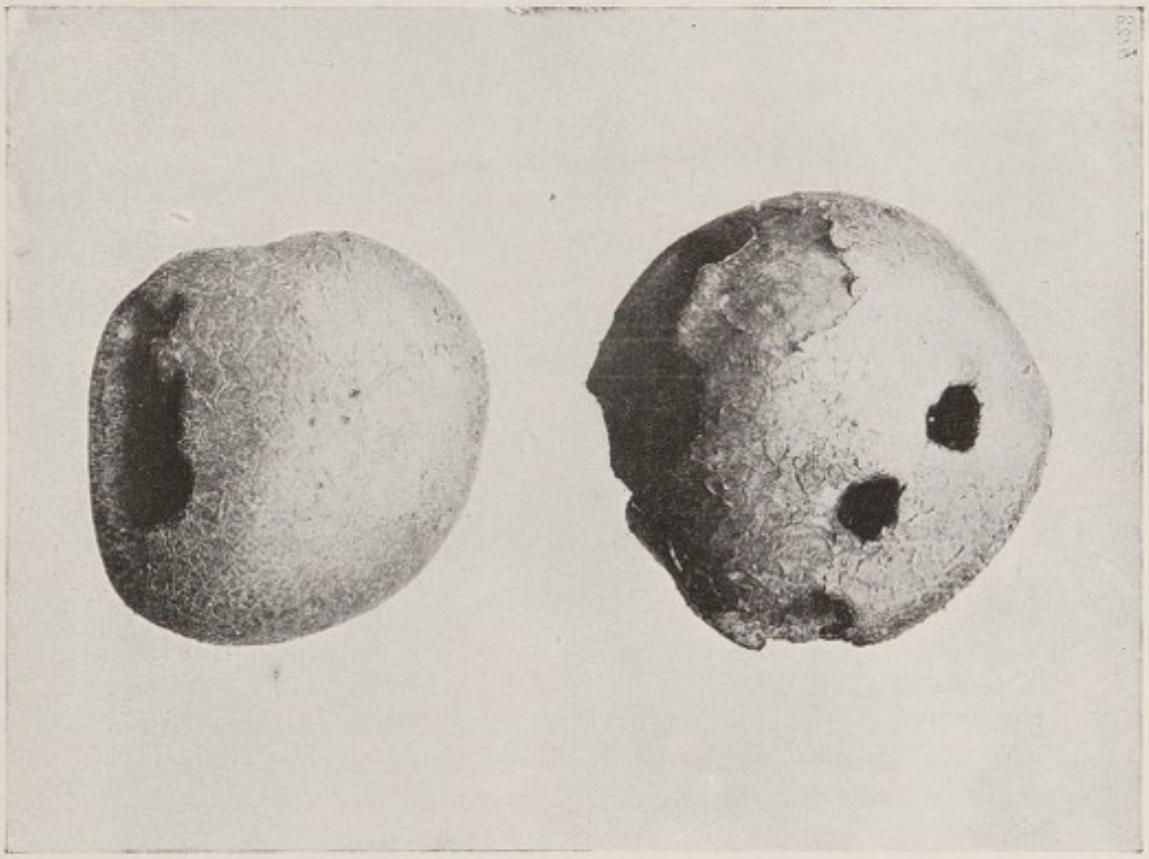


FIG. 7.—Potatoes damaged by Cutworms

moths also lay eggs hatching into caterpillars which feed through the autumn and winter, reinforcing the army of caterpillars derived from the first brood. From February to April the caterpillars are full-fed, and turn to brown chrysalides in the soil. They remain in this stage until the beginning of June, when moths are produced, and the life-cycle begins again.

Methods of Control.—(1.) Cutworms are specially likely to be troublesome on foul, weedy land. Fallows, for instance, after being cleaned from such weeds as couch may still produce a crop of annual weeds which, if not destroyed, are attractive to the moths when egg-laying. Potatoes again which are not free from weeds are likely to be attacked.

(2.) Grass land required for wheat sowing the following autumn should be broken as early as possible—preferably by the beginning of July. This will avoid attacks both by Cutworms and Leather Jackets and may well compensate for the loss of a small crop of hay.

(3.) When crops of potatoes or mangolds have been badly attacked it is not wise to sow winter wheat.

(4.) When an attack is in progress hoeing or harrowing is of some value, disturbing the Cutworms, injuring some and exposing the others to the attacks of birds.

(5.) When young root crops are being attacked above ground, the plants may be sprayed with lead arsenate (1 lb. lead arsenate paste to 25 gallons water). Provided the plants are *small* so that the greater part of the root has yet to be made, there will be no risk of poisoning stock when the roots are finally eaten.

(6.) In market gardens and allotments hand-picking is often the most simple method of dealing with the pests, which can be scraped out of the soil near the plants last attacked by means of a blunt knife or pointed stick. They may also be collected at night when they are feeding or crawling about on the surface of the soil.

(7.) Cabbages, etc., which are planted out from a seed bed may be protected by folding a strip of paper from two to three inches wide round the stems so that rather more than half this collar is below the ground. The paper will unfold or decay as the stems increase in size.

(8.) In Canada and the United States where control of Cutworms is a serious problem, poisoning is the treatment which has proved most successful. and it is worth a trial in this country. A poisoned bait made of bran mixed with Paris Green and moistened with water, to which a little treacle, sugar or salt is added, is sown broadcast over the attacked field in the evening. The amount of bait required per acre is given as from 10 lb. to 50 lb., and it is said that when sown so thinly there is no danger to poultry or other

birds. To avoid touching the poisoned mixture with the hands it is sometimes placed in a sack, into the mouth of which a large "tin" tube is tied, so that the mixture can be freely shaken out. The following formula is said to have given good results :—

Bran	50 lb.
Paris Green	½ lb.
Sugar (or salt)	½ lb.
Water	2 gallons.

The sugar (or salt) is first dissolved in the water, which is then used to moisten the bran, which should then be damp, but not wet. The Paris Green is worked into the mixture, stirring well.

Lead arsenate could probably be substituted for Paris Green at about the rate of 2 lb. of lead arsenate paste to every ½ lb. of Paris Green given in the formula. In this case the paste should be worked up with the water and sugar and the mixture added to the bran.

The principle of poisoning may also be made use of as follows. Bundles of cut clover or other "green stuff" are sprayed or dipped in a poisonous mixture, and then distributed about the attacked field. A poison for spraying the bundles may be mixed as follows :—

Lead arsenate paste...	½ lb.
Water...	10 gallons.

The addition of a little treacle or sugar (when available for this purpose) would probably make this more attractive.

CAUTION.—Paris Green and lead arsenate are very poisonous, and must be used with care. When in powder form the dust must not be breathed when the mixtures are being made up. A handkerchief tied over the mouth and nose will tend to prevent this.

London, S.W.1,
July, 1896.
Re-written, June, 1918.

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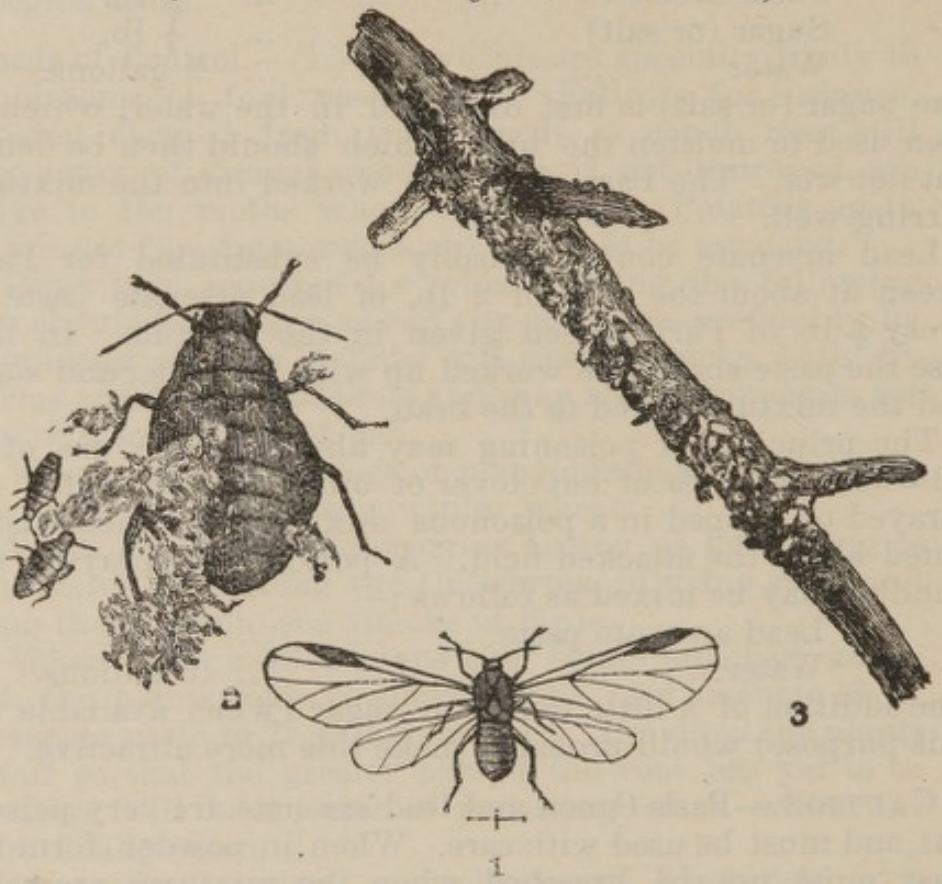
Leaflet No. 34.

BOARD OF AGRICULTURE AND FISHERIES.

The Woolly Aphis.

(*Schizoneura lanigera*, Hausmann.)



1. Winged female, magnified; and line showing natural size. 2. Wingless viviparous female, magnified.* 3. Apple twig, covered by woolly aphides.

Distribution. — This insect is always more or less abundant in old and neglected orchards and apple plantations where no attention is given to pruning or to keeping the trees free from moss, lichens, &c. Unfortunately it is also sometimes seen in orchards recently planted owing to nursery stock being frequently sent out with aphis on the plants. Indeed, although dispersal by the agency of wind is not unimportant, by far the most common way for the pest to be distributed is on infested nursery stock. Not only has the woolly aphis been carried from orchard to orchard in Britain in this way, but also from country to country, until it is now found in every part of the world where apples are grown. It has been stated that this aphis, although termed the American Blight, was originally a European insect, but it is doubtful whether its country of origin has yet been conclusively settled.

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* Figure 2 is reproduced, with permission, from Mr. G. B. Buckton's "British Aphides."

Injury caused.—All varieties of apple in this country are subject to the ravages of woolly aphis, but perhaps the old Ribston Pippin suffers most of all. The Blenheim Orange, Cox's Orange Pippin, and Lord Suffield also suffer severely. Varieties having a soft bark are most affected. Certain experiments conducted in Victoria and elsewhere show that in the case of apples grafted on Majetin and Northern Spy stocks the roots are free from attack.

Infestation may be on the main trunk, on the branches, on the fruit, or *on the roots*; in very bad attacks the leaves are also infested. The fact that the woolly aphis lives below ground on the roots should be carefully noted, as the above-ground parts, though cleared of the insect, may, unless treatment has been extended to the root-infesting forms, receive a new infection as a result of migration from below. That this migration from the roots actually takes place may easily be proved by grease banding the trees, when the aphides may be caught in large numbers as they ascend the trunks.

The woolly aphis feeds, like all aphides, by puncturing the epidermal tissue and then draining away the sap by means of its proboscis. Not only is the tree weakened, but swellings or galls result which later on crack, an appearance being produced (fig. 4) resembling the lesions caused by the canker-fungus. Sheltered in the canker-like cracks, the aphides are more difficult to reach by treatment. The wounds produced by the aphis are also said to serve as points of entry for the true canker fungus (*Nectria ditissima*). (*See* Leaflet No. 56.)

Description and Life History.—The woolly aphis may readily be recognised in an orchard by the masses of white woolly substance formed by the larvæ and females which are sheltering in the crevices of the bark. The woolly substance arises as an excretion from glands in the backs of both the young and mature females. It may often be seen hanging in festoons from the trees. Parts of this "wool" get blown off and are carried by the wind, often for some little distance, and in this material young *Schizoneuræ* may be carried.

Various forms of the woolly aphis are found in the course of the year's cycle:—wingless females that produce live young; winged females that are also viviparous; and males without wings, which pair with wingless egg-laying females.

The wingless viviparous females are oval in shape and purplish-brown in colour. Numerous white threads pass from their backs. Their antennæ and legs are very short, and in colour are dark reddish-brown to black. Such wingless viviparous females may be found all the year round. They give rise to great numbers of young (so-called lice) which are at first of a dull yellowish colour but later become purple

brown. It is the woolly material secreted by these that gives rise to the festoons mentioned above. These lice on becoming adult produce live young in turn, and a number of such generations can be produced in the summer.

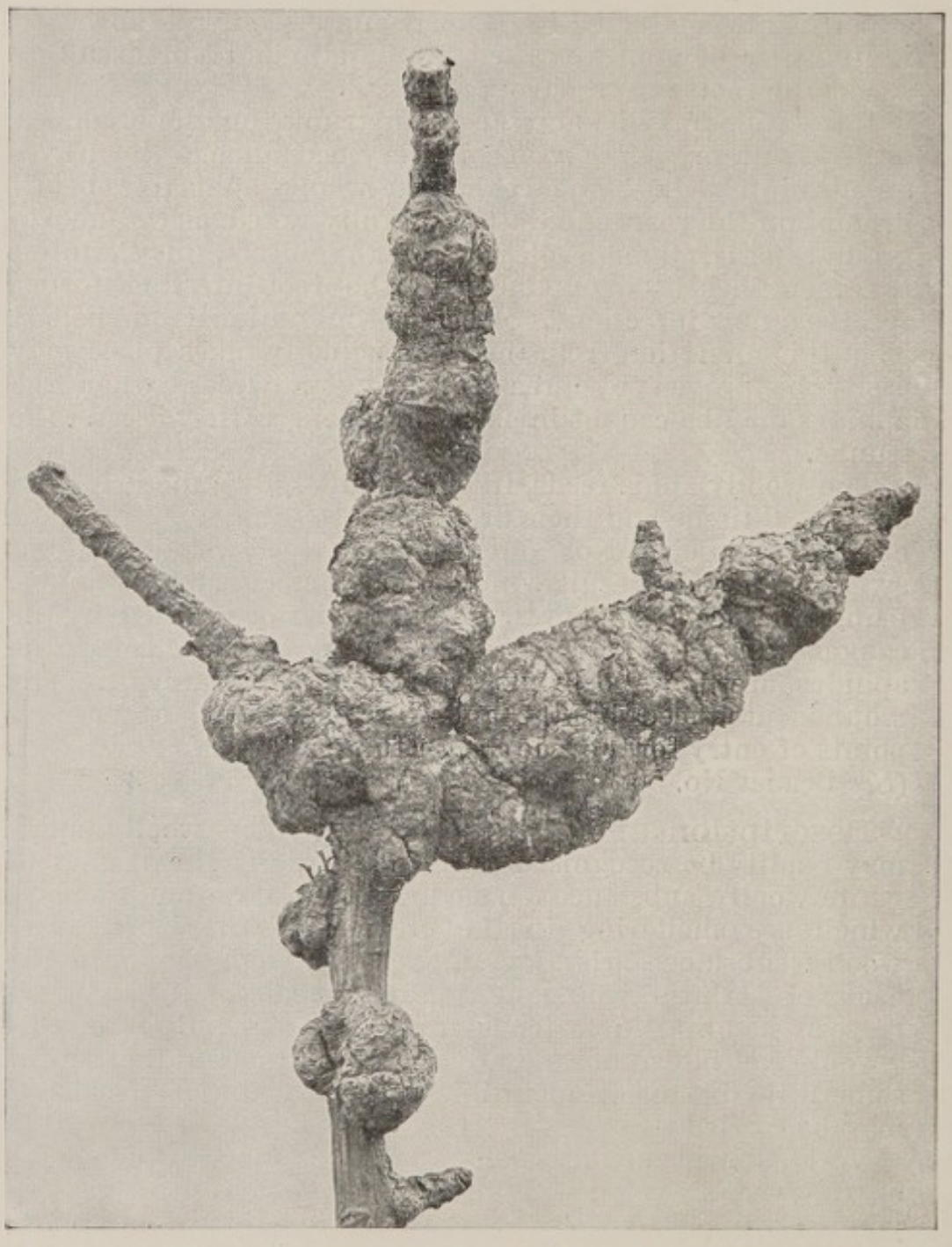

FIG. 4.—Apple twig showing canker-like galls produced by Woolly Aphis attacks (slightly less than natural size).

The wingless viviparous females may, however, give rise, between June and late October, to winged viviparous females, the exact function of which has not yet been discovered. Patch* appears to have shown conclusively

* Bull. 203. Agric. Exp. Station of Maine.

that in America these winged females, which there occur commonly, migrate to elm trees, where they give rise to wingless males and wingless egg-laying females. The eggs laid by the latter in the crevices of the bark of the elm remain over the winter, and in the spring produce wingless forms from which arise aphides which attack and curl the elm leaves. Subsequently the elm leaf form produces winged individuals which migrate back to the apple.

In this country there is as yet no direct evidence that the woolly aphis of the apple migrates to elm, but it is of interest to note that Theobald* has discovered a woolly aphis which curls elm leaves and which produces a winged form indistinguishable from the winged form found on apple. No males or egg-laying females of this aphid have yet been discovered in this country and its relation—if any—to the apple woolly aphis is still unknown. It is, of course, quite distinct from the usual species of *Schizoneura* (*S. ulni* or *fodiens*) which attacks elm and currant in Britain.

On the apple in this country the woolly aphis produces winged forms only occasionally, while wingless males and females, which lay winter eggs, are known on apple trees, but are exceedingly rare. The usual method of passing the winter is as a wingless viviparous form which hides in cracks in the bark, in the canker-like wounds, or in the galls on roots. There appears to be a migration of individuals from the portions of the tree above ground to the roots at the approach of winter and a return migration from below to the branches in the spring.

Natural Enemies.—There are not many natural enemies that do much good in checking the increase of this pest. Possibly the woolly excretions and oily globules that surround the insect protect it from the various foes which attack unprotected plant-lice.

The larvæ of Lady-birds (*Coccinellidæ*) devour them, as also do the adult Lady-birds. Larvæ of several species of Hover Flies (*Syrphidæ*) also feed upon them, but not to the same extent as upon other plant-lice. Lace Wing Flies and Ichneumon Flies are seldom found attacking them. Small dipterous larvæ of the genus *Pipiza* feed on the subterranean form. Perhaps the Tits (*Paridæ*) (*See* Leaflet No. 43) do most good in keeping down this pest. These little birds, especially the Blue Tit, do inestimable good by devouring woolly aphis and other pests all the year round, and should be protected in every orchard.

* An account of this observation has not yet been published, but Mr. Theobald kindly allows a reference to be made to it. He finds the Elm form common all over Britain—the top of the young shoots being extensively curled. Winged forms appear in June and July and fly away from the Elms.

Methods of Prevention and Remedies.—(1.) Woolly aphis is especially prevalent in neglected orchards where the trees are close together and where their trunks are covered with lichens and moss. To clean the trees and destroy the hibernating females a winter wash should be used. This may be the simple alkaline wash composed of caustic soda, 2–2½ lb., and water, 10 gallons, or it may be one of the more efficient Woburn washes (*See* Leaflet No. 70). Lime or lime sulphur winter washes have also been found useful, but they are naturally less effective than the more caustic fluids.

(2.) Any portion of a tree which has been wounded, as, for instance, by pruning, is specially liable to an attack by woolly aphis. If large branches have been removed the cut surface should always be dressed, Stockholm tar being an excellent dressing for this purpose.

(3.) Methylated spirit brushed well into the affected portions of trunk or branches is the most successful treatment for young trees or when an attack first manifests itself in an orchard. Owing to the rapidity with which methylated spirit evaporates and its consequent expense, paraffin or petrol is sometimes substituted for the spirit, but where the trees are young and the bark thin, this may lead to injury. A wide range of compounds containing linseed oil, Stockholm tar, shellac and other substances have also been invented for brushing on to the affected portions of the trees. In all cases, however, success depends on the thoroughness with which the treatment is carried out.

(4.) For a summer spray nicotine and soft soap, dilute paraffin emulsion, or quassia and soft soap have all been recommended. If used they must be applied with force and the affected parts thoroughly drenched owing to the necessity of penetrating the woolly material before the insects themselves are reached.

(5.) To prevent the introduction of the aphis, great care should be taken to see that all young stock is clean before planting. If any traces of either the root or the aerial forms are seen, the trees should be returned to the nurseryman to be disinfected before being planted. All nursery stock can be fumigated with hydrocyanic-acid gas (*see* Leaflet No. 188), and thus thoroughly cleared of woolly aphis before planting.

(6.) Where the root form is committing havoc, the best plan is to use bisulphide of carbon. This should be injected by means of a special injector into the soil in four places about two feet away from the trunk of the apple tree at a depth of about 6 inches. For each of the 4 injections one fluid ounce of bisulphide of carbon is sufficient in the case of a good sized tree. It should be injected into the soil so

as not to come into actual contact with a root. The liquid would harm the root, but the vapour is harmless. The injections should be made before April at a time when the soil is dry.

This plan should be followed when any white wool or rough lumps are seen on the roots of trees that seem to be in an unhealthy state. On exposing the roots the signs of woolly aphis can easily be observed and the remedy should then be applied around the trees.

It must be remembered that both hydrocyanic-acid gas and bisulphide of carbon are very poisonous ; and that the latter substance is highly inflammable, and should not be brought near a light—the operator should not even be smoking.

(7.) In Australia two varieties of apples are said to be proof against the action of the woolly aphis by reason of their bark being hard and their tissues close, thus resisting the action of the beaks of the insects. These are the Northern Spy, an American apple, and the Majetin, a Norfolk (England) variety. Apples in Australia are now always worked upon these stocks. Mr. French, Government Entomologist of Victoria, says, "Before the advent of these excellent blight-proof stocks, the Majetin and the Northern Spy, it was exceedingly difficult to find in most orchards an apple tree that was clean or in perfect health. Now, with a little care and attention, the fruit grower, as a rule, may snap his fingers at the American Blight."

London, S.W.1.
October, 1896.
Revised, May, 1919.

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BOARD OF AGRICULTURE AND FISHERIES.

The Celery Fly (*Acidia heraclei*, Linné)

1. Fly magnified. 2. Larva magnified. 3. Pupa, natural size. Lines show natural size of Fly and Larva.

The Celery Fly (*Acidia heraclei*, formerly known as *Tephritis onopordinis*) is a well-known pest in the British Isles and the continent of Europe generally. The larvæ mine in the leaves of celery and parsnips and are frequently the cause of a great reduction in the value of the crop. The attack may commence in April or early in May, and last, in mild seasons, until as late as the beginning of December.

Nature of Injury.—The larvæ live upon the juicy substance between the upper and lower skins of the leaf, making blister-like patches, which are at first pale but later become brown; the leaf soon contracts, and after a short period shrivels up and becomes utterly valueless to the plant. In consequence of the loss of the leaves, the celery stalks and stems cannot grow and fill out properly, while in bad attacks the plant is killed or the celery is small, green, and of a bitter flavour.

Parsnips suffer in the same way, and when badly attacked the roots are small and generally of a bad shape.

Description.—The fly (Fig. 1) is only about one-eighth of an inch in length, with a wing expanse of nearly half an inch. It is tawny brown in colour, with the under part of the body lighter coloured. The wings are iridescent, with oblique brownish or rust-coloured bands and transparent spots. The eyes are deep green in colour, and the legs dark yellow, clothed with short black hairs. When the fly is sitting or running upon the plants its wings are held in an upright position and frequently waved up and down.

The larva (Fig. 2) has no legs; it is white or very light green in colour, with the dark line of the gut visible through the skin. In shape it is rather stout, pointed at the head and squared off at the tail, where there are two black tubercles.

The puparium (Fig. 3) is oval, of a light yellow colour, much wrinkled, and about one-eighth of an inch in length.

Life History.—Many eggs are laid by one female fly, the underside of a leaf usually being chosen and each egg placed singly within the tissues of the leaf, just beneath the skin or cuticle. The eggs hatch in about six days, and the young larvæ at once bury themselves in the leaf tissues and form mines within them. In about 14 days the larva changes to a pupa inside a pupa-case or puparium, either remaining in the leaf or falling to the ground. The fly hatches out in a few days, and there are several broods or generations in the course of the summer. The last generation remain in the puparium stage in the earth and also on pieces of leaf and stalk throughout the winter, the fly appearing the following April.

Methods of Control.—1. When possible it is wise to avoid growing successive crops of celery in close proximity to each other.

2. Theobald* advises the protection of the seedling plants during sunny weather by means of muslin screens. The young seedlings are often attacked by the first brood of the fly before they are planted out, but, if protected at this stage, they usually escape subsequently.

3. When a few leaves only in a bed are noticed to be attacked they should be picked off and burnt.

4. A mixture of three parts soot and one part lime dusted upon the leaves from April onwards is reported to be of service in preventing the female fly from laying her eggs. Success is said also to have been obtained by the use of deterrent sprays, which, however, must be applied frequently from the time when the plants are in the seedling stage. They are of no use for killing the larvæ within the mines. Paraffin emulsion has been recommended as a good deterrent, and a suitable formula will be sent on application to the Board.

5. It is desirable to force rapid leaf-growth where there is a bad attack. Applications of nitrate of soda mixed with a little agricultural salt, and frequent and heavy watering will effect this.

6. Theobald* records excellent results in killing the larvæ obtained by spraying infested celery with a solution

* Theobald. Journal South Eastern Agricultural College, Wye, Kent, 1913, pp, 296, 297.

containing one part nicotine (98 per cent.) in 200 parts water with sufficient soap to make a lather. This formula, however, requires about 8 oz. nicotine to make 10 gallons of spray fluid and would be too expensive to have a wide application. A trial might be given to a more dilute solution such as:—nicotine (98 per cent.) 1 oz., soft soap ½ lb. and water 10 gallons.

7. Directly any celery or parsnips have been dug, every particle of foliage and stem should be collected and burnt. If it is merely put in bulk upon compost heaps, or mixens, not in active fermentation, it is most probable that the puparia will be carried out with manure for celery or parsnips, or other crops grown near, and the flies will issue in due course. In cases where the foliage and stem cannot be conveniently burnt they should be buried deeply.

8. After an infested crop has been removed it is likely that pupæ will be left in the surface layers of the soil, and it is possible that by digging in the surface layers deeply some of the flies may be prevented from emerging during the following season. It must be noted, however, that in the case of some other species of flies burying the pupæ has not prevented the subsequent emergence of the adults and its value in the case of the Celery Fly remains to be proved.

London, S.W.1,
March, 1897.
Re-written, March, 1918.
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 Cultivation of Basket Willows.

A large area of the low-lying land of the river valleys of this country is too wet in character to admit of being treated as tillage, or of being used as pasture except during the drier months of the year. This land could probably be more profitably devoted to willow cultivation than to the growing of any other crop.

Basket willows will not thrive on land which is water-logged for long periods, but floods are beneficial provided an adequate drainage system exists for the rapid removal of excess water.

Soil.—From the large number of cultivated willows varieties may be selected which will thrive on any class of soil except peat. Rich heavy loam soils, with substrata of clay, are most suitable, but lighter soils prove satisfactory when other fertility factors are present. If willows are grown on peat the quality of rods produced is too poor, and the life duration of the plants too short, to admit of profitable cultivation.

Preparation of the Land.—The objects to be attained are :—

1. The removal of weeds ;
2. Pulverisation and the loosening of the top 10 inches (at least) of soil, so that the cuttings may be inserted to a suitable depth.

In the past the usual method of preparing the soil was by means of the spade.

Double-spit digging, or trenching, whereby the underspit becomes the surface soil (the turf layer being buried, grass side downwards, beneath it), is the most effective method of treatment, because the soil is thus deeply worked and can be kept clear of weeds for the first two years at small cost and to the great advantage of the young plants. Single-spit digging, or bastard trenching, to a depth of 10 inches, care being taken to invert the sod, has been found to be satisfactory.

In some cases land can only be prepared by means of the spade, and the only objections to this practice as a general method are the heavy expenses thus incurred, and, with the labour usually available, the slow rate at which the work is performed.

Land may be prepared by means of the plough. Four or six horses are sometimes needed to turn a furrow slice completely in one operation, but a more efficient method of using this power might be to adopt the method of double ploughing, whereby the turf turned by one plough becomes buried under the lower slice turned by the other.

It is probable that where the land is sufficiently firm, steam ploughs would do satisfactory work.

In places where rushes and other deeply-rooted perennial plants abound, the land would need to be fallowed during the summer preceding the planting season.

Drainage.—A ready outflow for surplus water should be secured by scouring the neighbouring permanent watercourses. From these, open drains should be cut across the land in such directions as to secure effectual drainage of the soil and the least interference with later cultivation operations. Pipe drains may often be advantageously laid, especially at outlets.

Choice of Varieties.—About forty varieties of Basket Willows are grown commercially in this country, and many of them might be advantageously discarded. Although wide differences exist, the varieties may be readily grouped according to their appearance and economic value. Such grouping generally agrees with their botanical classification.

HARD RODS OR FINE TOPS (*Salix triandra*).—This type includes varieties possessing characters most desired by the makers of the best quality baskets, as well as varieties of little value. They find greatest use as one-year-old rods. The chief varieties are :—Black Maul, Black German, French, Italians, Dutch, Stonerods, Whissenders, Long Bud, Newkind, Mottled Spaniards, Champion and Glibskin.

SOFT RODS OR FULL TOPS—OSIERS PROPER (*Salix viminalis*).—Compared with the *triandra* varieties the rods are longer, thicker, less tough, less pliable, and of poorer working quality ; the yield is greater, but the value per equal weight is less. The rods are specially suitable as staking for the framework for heavy basketry, and for the making of various kinds of baskets where *triandra* rods would be less suitable and unnecessarily expensive. The chief varieties are :—Longskin, Brown Merrins, and various "Osiers," frequently distinguished in name and character by the colour of the bark in winter.

BITTER WILLOWS (*Salix purpurea*).—The rods of this species differ from those of the preceding species in being bitter, tougher, more supple, more finely tapering, freer from side shoots, and, in the chief varieties, shorter. They are unsuitable for conversion into "White," and as "Buff" are

pale in colour. The rods are unexcelled in the making of the fine quality of small basketry. The chief varieties cultivated are :—Old Dicks or Red Buds ; Light Dicks, Dark Dicks, and Kecks.

BLACK TOPS (*Salix hippophaefolia*) is a variety of good quality suitable for cultivation on sewage farms, because its dense foliage checks the growth of weeds.

"BELGIAN RED" AND "GOLDEN WILLOW" (*Salix alba*) are widely grown and are used as "Green" by market gardeners and nurserymen for tying purposes.

A prospective grower, in selecting varieties for planting, should have in mind :—

(1) the varieties best suited to his land ;
(2) the local supply and the kind of rods locally required ;
(3) varieties of good quality which would command a wider market ; and
(4) the condition (Green, White, Buff) in which he ultimately intends to market his crop.

Cuttings or Sets.—Cuttings or sets are obtained by cutting either one-year-old or two-year-old rods in lengths of from 12 to 16 inches. The best cuttings are taken from young healthy heads. All the plants in the same bed should be of the same variety, because difficulties arise when willows are mixed, and the value of such crops is depreciated.

Distance apart.—The distance apart at which planting is done depends upon :—

(1) *Variety.*—Many varieties differ greatly in their yields and in the size of the crowns which they develop. Consequently the spacing should be in accordance with the amount of growth made.
(2) *The Methods of Cultivation* to be employed during the lifetime of the crop. The rows should be sufficiently wide to allow a horse to walk without stepping on the heads when horse hoeing is intended, but closer planting is possible when the ground is to be worked by hand.

In general, from 18,000 to 30,000 cuttings are required to plant one statute acre. The following distances apart are given for guidance, and from these the exact number of cuttings needed can be calculated :—

For varieties of	*S. viminalis*,	22–26 inches	by	16–18 inches.
„ „	*S. triandra*,	20–24 „		12–16 „
„ „	*S. purpurea*,	20–24 „		10–12 „

These areas for individual plants should be maintained as nearly as possible in cases where "planting on the square" is adopted, *i.e.* where equal distances between adjacent

rows and adjacent plants in the same row are maintained. This system enables hoeing to be performed in two directions, but can only be adopted advantageously in cases where the size and shape of the fields permit, and open drains are not essential. It is better to err on the side of too close than too wide planting, because the yield is increased, the closer foliage acts as a greater check on the growth of weeds, and the rods are straighter at the butts.

Planting.—This operation may be carried out at any convenient time between the months of November and March. The land should be harrowed and the cuttings inserted so that not more than 2 inches remain above the ground after the soil has been firmly pressed round them. Protection for the hand is afforded by the use of a leather pad. In order to facilitate cleaning, tillage, &c., it is important that adjacent rows should be equidistant throughout their lengths. This may be achieved (*a*) by means of a planting chain or long line, (*b*) by means of markers attached to the framework of a horse-drawn wheeled implement. During the growing season the land should be kept clear of weeds and the surface layer of soil retained in a pulverised condition by hoeing, both by hand and by horse hoe.

Cutting the Crop.—The crop may be cut after the first leaf-fall, and before the second season's growth commences, or may be deferred until after the second season's growth has been completed. Special knives are used for the purpose. These should be kept sharp and the rods should be cut close to the stem in this and in all subsequent years. Thus, well-shaped heads are developed close to the surface of the ground, whereby cutting is facilitated, a sufficient distance between plants is maintained for cultivation operations, and the chances of the plant becoming a host for injurious insects and fungi are diminished. The cut rods are tied in bundles and removed from the ground.

Later Treatment of the Growing Crop.—Willow holts should be kept clean and fully planted. If allowed to become infested with weeds, a reduction in yield and quality follows, the life of the holt is considerably shortened, and the expenses incurred in cutting and sorting are increased.

Weeds may be removed by shallow digging and by horse and hand hoeing. The most efficient method of dealing with weeds is that practised by the Mawdsley (Lancashire) willow growers. Before growth commences, a ridging plough fitted with a stout broadshare, working to depth of 2 to 3 in., is drawn along the intervals between the rows. Weeds are thus cut and the upturned layer of soil placed alongside the heads of the plants. After completion of the operation the land resembles a ridged-up potato field. The

soil becomes dried and tempered, and is easily drawn back to its original position by means of scufflers. Weeds growing in the rows are removed by hand hoeing.

Full-length rods (full sets) are inserted in the spaces where plants have failed to grow.

Preparation of the Rods for Sale.—Rods may be sold as "Green," "Brown," "Buff," or "White." The freshly-cut crop "**Green**" may be allowed partially to dry in stook in the field. The bundles are afterwards stacked in a well-roofed shed or in the open air. When drying is completed the rods are known as "**Brown.**" If rain water gains entrance to stored rods it rapidly causes serious damage, so that stacks in the open should be well covered and thatched. In coverting "Green" to matured "Brown" 50 per cent. loss in weight occurs.

"**Buff**" rods are prepared by removing the bark from either "Green" or "Brown" rods after they have been boiled in water for from two to five hours. They are then dried and intensified in colour by exposing them to sunlight. A buffing plant consists of a tank of approximately the following dimensions :—9 ft. long, 2 ft. 9 in. wide, and 2 ft. 6 in. deep. Iron boilers set with bricks, with a furnace beneath and a flue communicating with a chimney, are in common use, but in some places the bottom plate only consists of iron. The sides and ends are constructed of wood 2½ to 3 inches thick, and are bolted or bracketed to the plate. The joints are tongued and grooved, and the tank is made water-tight by means of red lead. A suitable boiler forcing steam through closed coiled pipes within the tank might work with greater efficiency. The boiling tank should be erected in a shed of suitable size or a special room should be provided to give weather protection to the peelers.

The peeled rods are spread out in rows in a field, being supported in an inclined position by a series of lightly constructed temporary fences and allowed to remain until dry and the desired intensity of colour has been reached. The partially-dried rods are placed under cover, graded according to length, and when thoroughly dry are tied in bundles and stored. The storage room should be weather proof, dry, and well ventilated. Serious damage will occur, owing to the development of moulds, if buffed rods are stored closely when in a damp condition and when dry rods are stored in a damp place. About 75 per cent. loss in weight occurs in converting "Green" to "Buff."

"**White**" rods are prepared by removing the bark from "Green" rods. This operation is carried out in spring directly after the flow of sap has released the bark throughout its length from the underlying wood. At this stage the

rods are cut from the heads and at once peeled by means of a "*break.*" The essential parts of a break are a pair of straight upright iron rods suitably mounted on a stand and working in contact along their inner edges by means of springs. Sufficient pressure is exerted during the passage of a willow rod between the jaws to break the bark on opposite sides. The bark is then removed by hand. Breaks differ in design, but the working principle is the same in all.

The period during which any variety may be "peeled from the head" is about 10 days, but the peeling period can be extended until July by adopting the following methods:—(1) By growing several varieties which arrive at the proper peeling condition in succession; (2) by Couching; (3) by Pieing; (4) by Pitting.

Couching.—Spring cut rods, in the condition for being peeled, are tied in bundles, a layer of which is placed on the ground, the tops being directed the same way. A similar layer, reversed in direction, is placed on top with the butts at about the centre of the length of the lower layer. This order of arrangement of layers is continued until the stack is about six courses high. By thus directing all the tops outwards the rods do not suffer damage by becoming overheated. Drying is prevented by the addition of a liberal quantity of water and by covering the stack lightly with old peelings.

Pieing.—The bundles are arranged one layer thick in a sloping position on the ground, the tops of one row well overlapping the butts of the row immediately in front. The pie is then loosely covered with old peelings and kept moist by being watered when required.

Pitting.—Rods cut in March or earlier are tied in bundles and rested on their butts in dykes or specially constructed rectangular flat-bottomed ponds through which flow a slow and continuous stream of water 4 to 8 in. in depth. In spring roots are formed and growth commences. Under this treatment rods remain in a satisfactory condition for peeling until August. Rods are peeled for "White" in the following order:—(*a*) From the Head; (*b*) from the Couch; (*c*) from the Pie; (*d*) from the Pit.

The freshly-peeled rods are dried in the open as in Buffing, graded according to length, tied in bundles, and finally stacked in dry quarters.

Cost of Growing and Returns obtained.—The wide variations in the value of land as determined by such such factors as position, condition previous to preparation, state of fertility, the amount of labour available for cultivation, and the present abnormally high value of willows, do not permit at the present time of a comprehensive reliable

statement being made to meet all cases. The following summaries taken from the Board's publication on the Cultivation of Osiers and Willows (1913)* will serve as a guide :—

FIRST YEAR.

Expenditure.		*Receipts.*	
Preliminary expenses of ploughing.	£4 0 0		
Cuttings	15 0 0		
Planting	1 5 0	2 tons "Green" at £4 2 6	£8 5 0
Rent and Rates ...	1 15 0		
Labour and other expenses.	4 15 0		
Total ...	£26 15 0		£8 5 0 per acre.

SECOND YEAR.

Total expenses ...	£7 5 0	4 tons "Green" at £4 10 0	£18 0 0 per acre.

THIRD YEAR.

Total expenses ...	£7 5 0	6 tons "Green" at £4 10 0	£27 0 0 per acre.
Total for the three years	£41 5 0		£53 5 0 per acre.

The expenses and returns differ much according to circumstances, but willow growers regard the crop as satisfactory when the total expenditure for the first three years is covered by the receipts for the same period.

It is more profitable to the grower to dispose of his crop either as "White" or "Buff" rather than as "Green," as the following table shows :—

Green.	*White.*	*Balance in favour.*
3 tons worth £15.	Converted to 1 ton worth £24, at cost of £4 (= total of £19).	£5
Green.	*Buff.*	
3 tons worth £15.	Converted to 1 ton worth £23, at cost of £5 (= total of £20).	£3

The duration of a willow bed depends upon the suitability of the land and on the amount of care bestowed upon the crop. Suitable land will continue to yield satisfactory crops for 25 years, and occasionally for a longer period.

During the life of the crop the annual returns vary greatly, owing to damage which may arise from frost, storms, ground game, insects and fungi, adverse growing seasons, and to economic factors, but for a series of years on such land as should be used for the purpose, few other cultivated crops yield more satisfactory profits to the grower.

* Now out of print.

There are prospects that willow growing will be profitable for many years to come, because :—

1. The supply of home-grown rods will continue to fail to satisfy basket-makers' requirements owing to the permanently dilapidated condition into which established beds have fallen, both at home and on the continent.
2. Little new ground has been planted since the outbreak of war.
3. Basket-making as a national industry may be expected to grow, since it affords suitable employment for many partially-disabled ex-service men.
4. An export trade in certain varieties can be developed.

Security of Tenure.—As a large amount of capital is sunk in establishing the crop, the tenant of a holding held on the usual yearly tenancy should not embark on the work except with the previous written consent of the landlord to the improvement, which, under the Agricultural Holdings Act, 1908, is necessary to enable the tenant to claim compensation from the landlord on the determination of the tenancy.

Literature.—Further information on the cultivation of willows can be obtained from the following publications :—

A Lancashire Willow Farm, *W. Dallimore* (Bulletin Royal Botanic Gardens, Kew, No. 9, 1908).

The Duke's Osier Bed by the River Thames between Kew and Richmond, *B. V. Ramaiengar* (Quarterly Journal of Forestry, April, 1907).

Willows and their Cultivation, *E. J. Baillie* (Journal Royal Agricultural Society, 1894).

Cultivation of Osiers as a Means of Utilising Boggy Land, *W. J. Cochrane* (Transactions of the Highland and Agricultural Society of Scotland, 1893).

The Cultivation of Willows, *W. P. Ellmore* (London : J. M. Dent, 1919, 4*s*. net).

La Culture de l'Osier, *F. Lesourd* (Paris : Librairie Agricole de la Maison Rustique).

Willows : their Growth, Use and Importance (U.S. Department of Agriculture, Bulletin No. 316, 1915).

Basket Willow Culture (U.S. Department of Agriculture, Farmers Bulletin No. 662, 1914).

London, S.W.1,
May, 1893.

Re-written, 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.

Rabies.

The Board of Agriculture consider it desirable to give further publicity to the following paragraphs on the subject of Rabies, which have been extracted from the report of the Departmental Committee appointed by the Board to inquire into and report upon the working of the laws relating to Dogs.

The Committee report as follows :—

Rabies.

We have concluded from the terms of our reference and from the composition of the Committee that it was not intended that we should re-open the pathological question of the origin and nature of rabies, and throughout our inquiry we have acted on the assumption that the conclusion of the Select Committee of the House of Lords of 1887 was correct. That Committee reported "that it is practically "proved that subcutaneous inoculation with the virus of "rabies is the only ascertained means of imparting the "disease, and in order to check it every effort should be "made to prevent the dissemination of that infective "substance." We have, therefore, limited our inquiry to the examination of the efficacy of the existing system of dealing with rabies, and to the consideration of the means which may be taken by legislation or administration to make that system more effective.

Prior to the passing of the Dogs Act of 1871 (34 & 35 Vict. c. 56) the Acts of Parliament which dealt with the muzzling of dogs, and the disposal of rabid dogs, were mainly of a local character.

The Act of 1871, which is still in force, and applies to the United Kingdom, empowers the police to seize savage or dangerous dogs not under proper control, and authorises certain local authorities to impose restrictions on dogs not under proper control where a rabid or suspected dog is found within their respective districts.

In 1886 the Privy Council were empowered by the Contagious Diseases (Animals) Act of that year (49 & 50 Vict. c. 32 s. 8) to extend the definition of animals for the purposes of the Contagious Diseases (Animals) Acts, so that those Acts should comprise for all or any of the purposes of those Acts any kind of four-footed beasts, in addition to the animals mentioned therein. On the 16th September of that year the Privy Council issued the Rabies Order of 1886. A copy of this Order, which came into force on the 1st October 1886, is printed in the Appendix to the Committee's report, but it may be stated shortly that notification of rabies was made compulsory, that the necessary powers were conferred upon the local authorities to deal with cases of disease thus notified, and that those authorities were empowered to make regulations with regard to muzzling, the keeping of dogs under proper control, the seizure and disposal of stray or unmuzzled dogs, and the prohibition or regulation of dog shows.

This Order was re-enacted, with certain amendments of the powers conferred upon local authorities, by the Rabies Order of 1887, which took effect as from the 28th February, 1887.

Local Authorities availed themselves of the powers conferred by these Orders, but not to any considerable extent.

In 1889 the Board of Agriculture was formed, and under the Board of Agriculture Act, 1889 (52 & 53 Vict. c. 30), the powers of the Privy Council under the Contagious Diseases (Animals) Acts were transferred to the new Department. The Board were at the same time empowered to make orders for the muzzling of dogs and the seizure, detention, and disposal of stray and unmuzzled dogs.

On the 9th July, 1889, the Privy Council passed an Order which came into force on the 1st August, providing for the muzzling of dogs in the City of London and the Metropolitan Police districts, and later in the year this Order was repeated by the Board of Agriculture, and extended so as to comprise the counties of Cheshire, Lancashire, and the West Riding, and the whole of the counties of Essex, Hertford, Kent, London, Middlesex, and Surrey, with the boroughs locally situated therein. The new Order took effect from the 1st January, 1890.

From time to time the Board made Orders extending the Rabies (Muzzling of Dogs) Order of 1889 to other districts, or, where the position with regard to disease had improved, granting an exemption from muzzling in favour of dogs wearing a collar. In 1892, however, the amount of rabies in the country had so considerably diminished that the Board passed Orders, as from the 1st November, 1892, revoking all

former Orders, and again empowering local authorities to make regulations as to muzzling, and at the same time imposing upon them the specific duty of seizing and disposing of all stray dogs found within their respective districts.

In 1894 the Contagious Diseases (Animals) Acts were consolidated under the title of the Diseases of Animals Act, 1894 (57 & 58 Vict. c. 57), and the Board of Agriculture re-issued the Rabies Order of 1892, with certain modifications, under the title of the Rabies Order of 1895.

It will be seen from the foregoing statement that recent experience with regard to rabies divided itself into two distinct periods. From 1889 to 1892 muzzling regulations were imposed by a central authority over wide areas, embracing the districts of numerous local authorities, whilst in the period from 1893 to the present time it has been practically left to local authorities to decide, each for themselves, whether or not muzzling regulations should be imposed.

A comparison of the two systems is of the first importance in the consideration of the lines upon which the law is hereafter to be administered, and the facts which such a comparison elicit are fortunately so striking as to leave no room for doubt as to the relative values of local and central control in this matter.

In the four years during which muzzling regulations made by the Board of Agriculture were in force the number of cases of rabies in dogs reported was as follows :—

In 1889	there were	312	cases.
„ 1890	„	129	„
„ 1891	„	79	„
„ 1892	„	38	„

Since the issue of the Rabies Order of 1892, and the practical relegation to local authorities of the duty of making muzzling orders, the disease has shown a very marked increase ; the number of cases reported has been as follows :—

In 1893	there were	93	cases.
„ 1894	„	248	„
„ 1895	„	672	„

In 1895, owing to the great prevalence of disease, muzzling regulations were more generally enforced by local authorities, and in 1896 there were, in the 49 weeks ended the 5th December, 422 cases reported as compared with 649 in the corresponding period in the preceding year.

Rabies in London has followed very much the same course as in the case of the country as a whole.

Muzzling regulations were in force in the county of London from August 1889 to October 1892. They were then withdrawn, but they were reimposed in February 1896. The number of reported cases was as follows :—

In	1889	there were	123 cases.
„	1890	„	32 „
„	1891	„	13 „
„	1892	„	3 „
„	1893	„	8 „
„	1894	„	12 „
„	1895	„	46 „

Since the re-imposition of the muzzle in February 1896, the number of cases for each month, up to and including November, has been February, 22 ; March, 21 ; April, 10 ; May, 11 ; June, 11 ; July, 11 ; August, 2 ; September, 1 ; October, 4 ; and November, 2.

It will be seen that the general results of the imposition of a muzzling order in London correspond with the results derived from the whole country, and we have reason to believe that the figures for every other area over which muzzling has been applied would teach the same lessons.

The number of deaths from hydrophobia in England and Wales in the same period presents similar features, and was as follows :—

In	1889	there were	30 deaths registered.
„	1890	„	8 „
„	1891	„	7 „
„	1892	„	6 „
„	1893	„	4 „
„	1894	„	13 „
„	1895	„	20 „

These statistics appear to us to fully confirm the views expressed in their evidence by the Chief Veterinary Officer and the Principal of the Animals Division of the Board of Agriculture, and to justify the conclusion, at which we have arrived, that muzzling is not only an efficient, but the only means which is now practicable, for the extermination of rabies, but that the powers of muzzling as exercised since 1892 by local authorities, acting in complete independence of one another, are inadequate to eradicate rabies, and only result in temporary and local checks to its spread. As the Principal of the Animals Division of the Board of Agriculture stated in his evidence : "The disease will continue to "rise and fall in waves unless it is altogether eradicated," and "so long as the public look upon it with indifference "the disease will rise : so soon as they begin to be at all "alarmed, then the necessary steps will be taken to decrease "it."

The futility of the system which has been in operation since 1892 largely accounts, in our opinion, for its unpopularity. It produces the maximum of local irritation with the minimum of general and permanent good. Surrey naturally grumbles at the retention of a muzzling order within its limits, when Berkshire, co-terminous with it, is permitting its dogs to go unmuzzled, even although an outbreak of rabies may have occurred much closer to the Berkshire boundary than are a very large number of the dogs required by Surrey to be muzzled.

The state of things in Lancashire and the West Riding of Yorkshire is still more striking. In each of these counties the county area is studded with borough islands, Lancashire being governed in this matter by no fewer than 34 separate local authorities, and the West Riding by 16. Each one of these separate local authorities imposes or remits muzzling orders according to its own pleasure and convenience, often without regard to the action of neighbouring authorities or to the general weal of any large tract of country.

On the other hand, the Board of Agriculture, under the law as it stands, have the power and the machinery necessary to enforce muzzling in a general and systematic way, and experience has shown that by the exercise of the functions vested in them as a central authority, the suppression of cattle plague, foot-and-mouth disease, and pleuro-pneumonia has been obtained.

We think, therefore, that the time has come and that the circumstances are opportune for the Board of Agriculture to make a determined and systematic attempt to stamp out rabies.

This will not, in our opinion, involve universal muzzling, inasmuch as there are districts where rabies has never appeared.

What is necessary is that the Board of Agriculture should have regard to the country as a whole and should impose muzzling over considerable areas, irrespective of the boundaries of boroughs and counties, that the Board should impose it, in fact, where it is really required and leave the rest of the country free. We believe that much of the feeling against the present capricious and ineffective system of partial and uncertain muzzling will not show itself against the operation of a centralised system carried out on well-considered lines and effectively producing the result which all desire to see achieved, viz., the suppression of rabies.

We confidently hope that our proposal will achieve this result, and that it will then become unnecessary again to resort to a measure, the inconvenience of which we fully recognise, but which we now recommend as the one practical means to a much desired end.

The complete report [C. 8320.] of the Departmental Committee on Laws relating to Dogs, can be purchased (price 2*d.*), either directly or through any Bookseller, from H.M. Stationery Office, Imperial House, Kingsway, London, W.C.2, and 28, Abingdon Street, London, S.W.1; 37, Peter Street, Manchester; 1, St. Andrew's Crescent, Cardiff; 23, Forth Street, Edinburgh; and also from E. Ponsonby, 116, Grafton Street, Dublin.

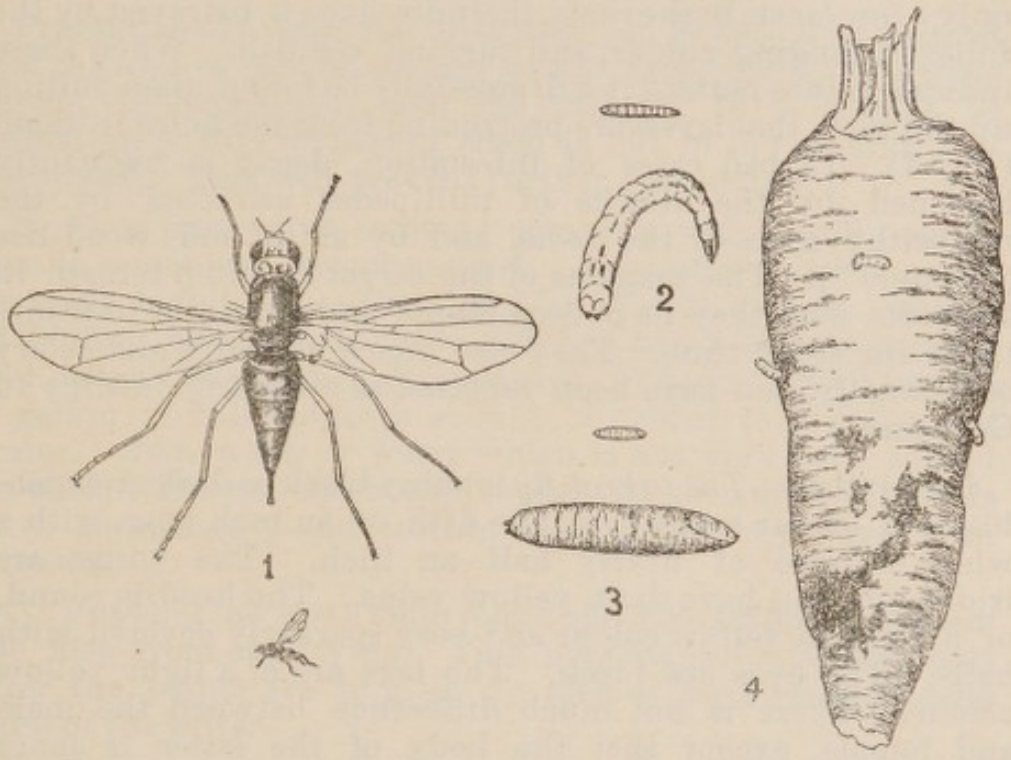
London, S.W.1,
March, 1897.

(Last para. revised, December, 1918).

This leaflet is no longer issued separately.

BOARD OF AGRICULTURE AND FISHERIES.

The Carrot Fly (*Psila rosæ*, Fab.).



1. Fly, natural size and magnified; 2. Larva, natural size and magnified; 3. Pupa, natural size and magnified; 4. Infested carrot showing "rust" spots.

Carrots are frequently much injured by the larvæ or maggots of this fly, which bore into and feed upon the carrot roots, living upon them and causing them to become brown or "rusty," and finally rotten. In some cases of early attack the growth of the small roots is entirely checked. Carrots grown by market gardeners and market-garden farmers for "bunching," or pulling early, are not often materially injured, as the fly does not, as a rule, attack them until the end of May, though the latest of these early roots are sometimes disfigured and their value depreciated because of the rusty spots made by the maggot. Those that are dug late for storing, either for human or for cattle food, however, are very frequently seriously damaged; they rot in the clamps and stores, and are rendered unsaleable by reason of the rust marks upon them. It has been noticed that the carrot fly is more injurious in dry seasons, when the growth of the

roots is not so luxuriant and rapid as when moisture is plentiful. The rain also closes the soil, and this may in some degree hinder the fly from laying eggs, the female making use of cracks in the earth for this purpose.

Carrots badly attacked by this insect sometimes have deep cracks in the roots in which the larvæ are found. These frequently extend to the centre of the roots and cause them to rot. The tops become pale in colour and wither away, and in the early stages of the attack, when as yet there are only a few larvæ in the roots, their presence is betrayed by the foliage changing colour, and turning reddish. When these indications are noticed it will generally be found upon pulling up the roots that larvæ are protruding from the holes in them (Fig. 4). In bad cases of infestation, decay is frequently hastened by the attacks of millipedes attracted by the unhealthy state of the roots, and by slugs and wood-lice ("Slaters"). The maggots of the carrot fly often remain in the roots after they have been stored and continue to injure them for some time. They also attack parsnips and celery occasionally, and have been reported as attacking turnips in Germany.

Description.—*The carrot fly* is shiny black or dark greenish-black in colour and about one-fifth of an inch long, with a wing expanse of nearly half an inch. The wings are iridescent, and have dark yellow veins. The head is round, of a reddish yellow colour and very sparingly covered with hairs. The eyes are black. The legs are of a light yellow colour. There is not much difference between the male and female, except that the body of the latter is more pointed than that of the male, and is furnished with a long retractile ovipositor or egg-laying tube.

The maggot is without legs, yellowish in colour, and nearly a quarter of an inch long. It has no distinct head, but its fore-end tapers to a point, in which there are two claw-like hooks for biting and boring. The hind end is blunt and bears two small black points close together.

The puparium, or pupa-case, is light brown in colour.

Life History.—The flies appear in spring, and may be seen upon the lower leaves of trees and bushes, especially near brooks and streams. When the carrot roots are well established the flies lay eggs upon them just below the surface of the ground. All authorities agree that the eggs are laid below the surface of the soil, but none have actually observed how deeply below the surface. It is believed that it is only just below and that the maggot when hatched goes down instinctively to the lower part of the carrot, as the root is there softer and more easily penetrated. When it has gained an entry the maggot works upwards and makes

passages, with frequent holes to the outside. When young, the maggots especially attack the outer parts of the carrot. When full fed they leave the root for pupation in the soil.

There are several generations during the summer. Kühn and Ormerod state that the series of changes is accomplished in between three and four weeks, but in parts of Great Britain it very often takes five weeks. The last generations for the most part remain in the soil in the chrysalis stage.

Preventive and Remedial Measures.—1. When it is noticed that the tops of carrots change colour prematurely, the roots should be examined, and the infested parts should be forked up so that no part of them is left in the ground, and destroyed. This will prevent further infestation.

2. As a preventive measure spraying with paraffin emulsion is sometimes recommended. A paraffin emulsion may be made as follows :—Dissolve 1 lb. of soft soap in 1 gallon of boiling water, and, while still hot, add 1 pint of paraffin and churn the mixture thoroughly. When required for use 1 gallon of this mixture should be added to 9 gallons of water. Rain water or water which is not very hard should be used. The carrots should be sprayed soon after the seeds have germinated, and immediately after they have been thinned.

3. Pressing the earth close round the stems tends to prevent the flies from egg laying. This may be done immediately after the plants are singled, by men or boys treading both sides of the rows.

4. Heavy watering of the crop after thinning tends to consolidate the soil, and so ward off attack.

5. Sand or ashes, impregnated with paraffin or carbolic acid, may be scattered round the plants at singling time to keep the flies from them. The main object must be to prevent the flies from laying eggs on the carrots, and for this purpose offensive substances, such as soot, earth, ashes or sand, sprinkled with carbolic acid, might be applied as soon as the plants are well established. Theobald has reported some benefit from broadcasting over the plants after thinning a mixture of fine soil and washing soda in the proportions of 1 part of finely crushed washing soda to 10 parts of soil.

6. It is a matter of common observation that carrots that have sprung up singly on paths or the like, from seed accidentally dropped, are seldom attacked. Apparently the operation of thinning is, in many instances, the predisposing cause of attack, and this has led some growers to sow the seed very thinly, and so to avoid the artificial thinning of the crop.

7. After an infested carrot crop has been removed, garden land should be trenched but fields should be very deeply

ploughed. A good dressing of finely powdered gas lime should be applied before the land is dug or ploughed in the ordinary way. The interval between the planting of two carrot crops on the same land should be made as long as possible.

8. Where carrots have been stored in earth, measures should be taken so that any puparia, or maggots which have left the carrots to pupate, may be destroyed.

9. In localities where the attack of the fly is very prevalent a supply of carrots can usually be maintained, (*a*) by sowing such early varieties as French Forcing in a sheltered position as soon as the soil and weather permit in February or March, for early use, and (*b*) by deferring the main crop sowing until mid-July, choosing the Early Horn variety, which will grow sufficiently large for storing for winter use.

London, S.W.1,
April, 1897.

Revised, May, 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.

Assessments to Land Tax.

The Board of Agriculture and Fisheries consider it desirable to give publicity to the following Memorandum, prepared under the authority of the Board of Inland Revenue, directing the attention of owners of land and other persons to the method by which assessments to land tax are now made, and to the procedure to be followed in cases where persons who may think themselves over-rated to the tax desire to make an appeal.

Memorandum as to Land Tax in England and Wales.

1. The land tax is an apportioned tax. It is not charged at the same rate in the pound over the whole country, but each parish is liable to contribute a fixed annual quota. The parochial quotas were fixed permanently and made perpetual by the Land Tax Perpetuation Act, 1798, but subject to redemption.

2. The land tax quota payable is required by law to be raised in each parish by a new assessment yearly and from year to year at an equal rate on the annual value of all lands and tenements, etc., which have not been exonerated from land tax (Land Tax Redemption Act, 1802, section 180). Such lands and tenements are to be charged "with as much equality and indifference as is possible by a pound rate" (Land Tax Act, 1797, section 4).

3. Formerly the maximum rate of land tax chargeable was 4*s*. in the pound (Land Tax Redemption Act, 1802, section 180). Now, by the provisions of the Finance Act, 1896, section 31, the amount assessed may not exceed the amount which would be produced by a rate of 1*s*. in the pound on the "annual value." For the purposes of that section "annual value" is the annual value as assessed under Schedule A. in the Income Tax Act, 1842, and if an assessment so made on a parish is insufficient to raise the amount of the parish quota the difference has to be written off as irrecoverable.

4. The assessment of the land tax rests exclusively with the Land Tax Commissioners for each division, and any complaint against a land tax assessment on the ground of

inequality or incorrectness must be by way of appeal to them. Notices as to when appeals will be heard are annually fixed early in the financial year to the church door in each parish. The collectors of land tax are required, upon the application of any person who may think himself over-rated, to permit such person, or his proper representative, to inspect the duplicates of assessment at all reasonable times in the day, without payment of fee. Every person intending to appeal is required to give notice of his intention in writing to one or more of the assessors. Appeals once heard and determined by the Commissioners are final.

5. If an owner in possession of the rents and profits of any lands, etc., in any financial year before payment of the land tax assessed on such lands, etc., produces to the collector of land tax a certificate from the surveyor of taxes—(1) that he has been allowed in that year a total exemption from income tax by reason of his income not exceeding £160, the land tax assessed on such lands, etc., will not be collected—or (2) that he has been allowed in that year an abatement of income tax by reason of his income not exceeding £400, one-half of the land tax assessed on such lands, etc., will not be collected.

6. Any person having an estate or interest in lands and tenements (except tenants at rack rent, or holding under the Crown) may contract for the redemption of the land tax charged thereon. By the Finance Act, 1896, the consideration for the redemption has been fixed at thirty times the amount of the tax.

7. Information as to redemption may be obtained from the clerk to the Commissioners of Taxes for the division in which the land tax desired to be redeemed is assessed, or (by letter) from the Registrar of Land Tax, Inland Revenue Office, Somerset House, London, W.C.2.

No fee is payable by a redemptioner for such information.

London, S.W.1,
June, 1897.

Revised, May, 1899.

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 Kestrel or Wind-hover (*Falco tinnunculus*, L.).

The beautiful and valuable bird known as the Kestrel or Wind-hover is often wantonly killed either for the sake of shooting at "something wild," and the pleasure of seeing it stuffed and set in a glass case, or because of an exaggerated idea on the part of gamekeepers that it is a systematic destroyer of young partridges and pheasants, grouse, hares, and rabbits.

The wholesale destruction of such birds as the Kestrel is frequently a main cause of abnormal and sudden attacks upon crops by animals and insects. In favourable conditions of climate and other circumstances, and in the absence of the checks provided by nature against their undue increase, certain animals multiply exceedingly and do infinite harm, as was exemplified by the serious injury occasioned to grassland in parts of Scotland by voles in 1892. Insects also appear more frequently and in larger numbers in these later days owing in some degree to the destruction of certain birds, their natural destroyers.

In his *History of British Birds*, Yarrell says, "Mice form the principal part of the food of the Kestrel," and there is no doubt that small rodents (*e.g.*, mice, field voles and young rats) are favourite food ; while young moles may be taken and also frogs. The Kestrel also feeds on beetles (*e.g.*, cockchafers), on grasshoppers, and on insect larvæ,—a Kestrel has been found containing as many as 178 wireworms. When it cannot get mice it will occasionally take very young birds, as pheasants, partridges, and grouse, but practically all observers agree that it preys chiefly upon mice and insects, a statement borne out by examinations and dissections of the castings or pellets thrown up by the bird. In the report of the Departmental Committee, appointed by the Board of Agriculture to inquire into a plague of field voles in Scotland in 1892, it is stated that the food of the Kestrel is known to consist almost exclusively of mice, grasshoppers, and coleopterous insects.

Keepers do not always discriminate between hawk and hawk, and because some other hawks, as the Sparrow-hawk, for instance, take young game birds, it is often erroneously concluded that the Kestrel is equally an offender in this respect. In the report referred to above, it is observed, in connection with the question of the Kestrel's habits, that it

is rare to find people able to distinguish between one kind of hawk and another. Few of the witnesses who gave evidence before the Departmental Committee were able to describe hawks otherwise than as red, blue, brown, or yellow, and it was often found impossible to make out what species they intended to indicate.

The identification of the Kestrel is easy on account of its practice of hovering in the air, without motion, for a long time; it is further distinguished by its chestnut colour and its long pointed wings. Its graceful flight is different from the rapid dashes of the Sparrow-hawk. It is about fifteen inches from head to tail, the female being slightly smaller.

The colour of the Kestrel is reddish-brown to pale-chestnut, with small black or bluish-black bars or spots on the back, according to sex, the male having spots, the female bars. The under parts are buff, streaked and spotted with black. The head, neck, the lower back, and tail are bluish-grey in the male. The tail is edged with white below a broad black band, while in the case of the female there are several dark bands on the tail. The beak is blue, except the base (cere), which is yellow, as also are the legs and feet. Old females often partially assume the appearance of the male.

The Kestrel seldom, if ever, builds a nest, but makes use of the old nest of a crow, rook, magpie, or similar bird, or else lays its eggs in cavities in cliffs, quarries, chalk-pits, hollow trees, or buildings. It has now and then been known to lay eggs on the ground. The eggs are usually laid in the latter half of April, and vary from four to six in number. They are yellowish-white mottled with deep brownish-red patches. During their first year the young resemble the female, but are a little lighter in colour.

There is testimony from many writers as to the value of the Kestrel to the agriculturist as a mouse destroyer, notably from Charles Waterton and White of Selborne. Amongst continental authorities Ritzema Bos speaks of the great usefulness of the Kestrel to cultivators in Germany; and in France, according to Brocchi, it is also highly valued.

London, S.W.1,
August, 1897.
Revised, May, 1908.

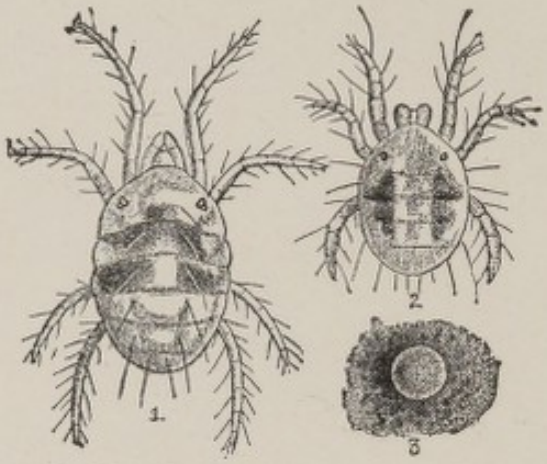
Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1 Letters of application so addressed need not be stamped.

THE KESTREL OR WIND-HOVER (*Falco tinnunculus*).

Leaflet No. 41.

BOARD OF AGRICULTURE AND FISHERIES.

Red Spiders (*Tetranychus*, *Bryobia*, and *Tenuipalpus*).



1, A full-grown Red Spider. 2, Immature mite, with six legs.
3, Egg. Each figure about 26 times natural size.

One of the families of Mites, the *Tetranychidæ*, sometimes known as Red Spiders or Spinning Mites (many of the species can spin silken threads) contains three genera troublesome to plants, viz., the genera *Tetranychus*, *Bryobia*, and *Tenuipalpus*. These may be thus distinguished :—

Tetranychus has a somewhat pear-shaped body, which is half as long again as broad, the front pair of legs being longer than the body.

Bryobia has the two front legs not only longer than the body but distinctly longer than its other legs.

Tenuipalpus has short heavy legs.

The damage is in all cases due to the piercing of the plant tissues by the sharp mandibles.

A species of red spider (*Tetranychus althææ*) sometimes causes serious injury in hop plantations. In bad cases the leaves fall off, the burr or blossom does not develop into cones, and, in some instances, the plants are completely shrivelled up. In most seasons, at least in those in which rainfall and temperature are normal, a few spinning mites can be found upon the large leaves of the hop plants, especially where the soil is shallow.

Life History.

The spinning mite of the hop plant passes the winter in the perfect state under stones and clods, in the bark of trees, and in the clefts and under the dried rind of hop poles. It is not noticed, at all events in numbers or as actively injurious, unless there is at least normal summer-heat

and it only multiplies in a dangerous degree when the day and night temperatures are abnormally high. In such circumstances the increase in its numbers and the rapid spread of its destructive influence are remarkable.

The comparatively large eggs are pellucid white at first and finally become slightly dark-coloured. They are globular, and are placed in the space between the ribs of the leaves. A close inspection with a microscope will show that they are kept in this position by means of fine threads stretched from side to side. A female *Tetranychus* may lay more than 100 eggs, and by a week and a half the larvæ from these may be adult.

The mites emerge from the eggs in five or six days, and at once begin to suck the juices of the leaves. At first they are pale greenish-yellow in colour, with dark patches on both sides of the body; they become more tinged with yellowish-red later, and some very light brown specimens have been found, whereas in other cases they are seen to be of a distinctly red colour. Red Spiders in different stages of development may be found at the same time.

In the earlier stages of their existence the mites have only three pairs of legs, but when full grown they have four pairs. The head is provided with a stout pair of mandibles with hooked ends for biting into the tissues of the leaf, and the mouth has a sucking apparatus which is inserted into the tissues. On the under side of the mite, towards the end of the abdomen, there is a conical nipple, from which the threads of the web are drawn out and guided by the motions of the mite and by the action of the minute claws and hairs of the legs.

A badly infested leaf has its under side completely covered with a dense web of fine silk, in which eggs are found in abundance as well as numbers of mites of all sizes sucking up the juices of the leaf. The leaf becomes yellow and mottled, and, as a rule, finally falls off, when the mites escape on to the earth. Mites left on the leaves upon the hop plant retire into the cracks and under the rind of the poles; they have great power of locomotion, and travel very rapidly quite independently of their webs.

Several complaints have reached the Board of attacks of Red Spiders on apple trees characterised by a rustiness of the leaves. *Tetranychus tiliarum* on Lime and *T. lintearius* on Whin have also been reported as troublesome.

Red Spiders are also very harmful under glass. They form one of the most serious pests in green-houses and vineries (*Tetranychus telarius*); melons and cucumbers are also attacked (*T. cucumeris*). Theobald has recorded *T. anauniensis* on sweet scented lemon. The different species can be identified only by specialists. They have, however, very similar habits and may be killed by the same wash.

The Red Spiders of fruit trees belong to two genera, *Bryobia* and *Tenuipalpus*. The former are most destructive, *e.g.* the *Bryobia*, on the Gooseberry and Currant. A common species (*B. prætiosa*) is found on ivy. These mites have very long front legs and spin but a scanty webbing. The eggs may be found on the bushes all the winter, as also may those of the *Tenuipalpus*. When present in numbers the mites soon cause the leaves to become unhealthy and fall off.

The colour of the *Bryobia* is variable like that of the Red Spider on hops, but is usually of reddish shade, darkened at the sides. The *Bryobia* mites are active from March onwards and may lay eggs in April, May and June. The eggs are shiny red and are placed in the axils of twigs and between the remains of old bud-scales. While eggs laid early hatch soon, eggs laid late may remain on the trees right through the rest of the summer and winter. The Red Spiders of the other genus, *Tenuipalpus*, live in a similar way, but their work is not so evident. This genus receives its name from the small and slender palpi which end in short bristles. The colour of these mites is red.

Methods of Control.

1.—It is most difficult, in fact it may be said to be almost impossible, to prevent mites from getting on hops and fruit trees. They are most agile in movement, and travel rapidly. Hop plants on wire and string seem equally liable to attack, as the mites crawl up the bines. The application of caustic substances close round hop hills is ineffectual. It is also almost impossible to get at the mites in the cracks of the poles and posts of hop gardens. When a drought commences in June and there is a probability of its continuance, it would be useful immediately to syringe with cold water hop and other plants upon which the mites are seen. Water alone put on with force can be distinctly helpful. Paraffin jelly, water and liver of sulphur, and paraffin emulsion applied before the webs are made or before they are plentiful and thick are also useful. To be effectual, syringing must be done early, vigorously, and abundantly. When the webs are well established, even the most drastic syringing is often unsuccessful.

Species of *Bryobia* forming but a scanty webbing are more easily killed.

2.—Good results have been obtained by spraying with paraffin jelly and water. The formula given is :—Boil 8 lb. of soft soap with 5 gallons of paraffin, adding, when boiling, 1 pint of cold water. Stir thoroughly, and allow to cool into a jelly. Owing to the danger of fire the operation should be performed with great caution and always out of doors, and it is better to buy the jelly ready made. For use

as a spray fluid dissolve 10 lb. of jelly in 40 gallons of water.

3.—Liver of sulphur (sulphide of potassium) at a strength of from 3 oz.–5 oz. dissolved in 10 gallons of water is now used against Red Spiders. To each 10 gallons ½ lb. soft soap may also be added. It has not, however, been found effective on apple trees, and it is difficult to reach the Spiders on plants that are hairy or woolly.

4.—Bulletin No. 117 of the United States Department of Agriculture advises the use of flour paste as a spray against Red Spiders. For this purpose 1 lb. of flour is made into a "batter" with water and is then mixed with 1 gallon of water. The mixture is heated until a clear paste is formed. 8 gallons of flour paste are used in 100 gallons of water for spraying purposes.

5.—For vines, cucumbers, melons, &c., the liver of sulphur can be used mixed with quassia wash.

6.—Sulphur mixed with water and painted on the hot-water pipes is often employed in conservatories. When sulphur is used in this way care must be taken to maintain a proper degree of moisture in the greenhouse or the plants may be damaged. Special apparatus is now sold for sulphur fumigation and its use reduces the risk of injury to the foliage. Apart from the danger of this treatment if the atmosphere of the house be dry, one of the great causes of the prevalence and multiplication of Red Spider is over-heating and over-dryness, and where forcing is practised and the temperature is therefore high, the question of moisture should be attended to.

7.—Under glass, fumigation with tobacco is a common and usually a fairly effective remedy.

London, S.W.1,
April, 1898.
Revised, August, 1915.

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Leaflet No. 42.

BOARD OF AGRICULTURE AND FISHERIES.

The Short-Eared Owl (*Asio accipitrinus*, Paalls).

THE SHORT-EARED OWL.

Otus brachyotus (*Strix brachyotus*).

The Short-Eared Owl is from 14 to 15 inches in height. The female is rather larger than the male. The head, back, and wings are lightish brown, with darker brown patches upon them. The wing feathers have an edging of light buff or fawn colour, and the under surface of the body is of this colour with blackish markings upon the breast. The

legs are pale buff and the toes black. The beak is also black, and the ears, as well as the tufts of feathers on the head, are brown. The eggs are creamy white in colour, and about $1\frac{3}{4}$ inches long by $1\frac{1}{4}$ inches in breadth. They are deposited on the ground in a nest scooped out of the earth and lined with a little dry grass or moss. The nest is made generally in tufts of heather or furze, or on the top of a clump of sedge or reeds in fen districts. Nests have been occasionally found in the Kentish marshes on little hillocks covered with rushes. From six to eight eggs are generally laid, but, as was shown by evidence before the Committee cited below, as many as 13 eggs have been found in a nest. Seebohm, in his "Far Countries of North America," quotes Richardson to the effect that this species of owl lays as many as 10 to 12 eggs.

This Owl differs somewhat in its habits from other owls found in Great Britain, which live in thick woods and plantations, or in barns, churches, and ruins, and seldom leave their retreats during the day. The haunts of the Short-Eared Owl are heath and moorland, marshes, furzy downs, meadows, turnip fields and open places, principally in the north of England and Scotland, though it is found occasionally in many English counties. It flies in the daytime as well as at night. Its food consists of mice, voles, rats, small birds, fish, reptiles, large insects, and occasionally bats. Prentis, in his *Birds of Rainham* (Kent), says that the Short-Eared Owl is not uncommon, and comes in the autumn. It visits the marshes, where it is safe, nearly every year. When partridge shooting, sportsmen have met with these owls in Kentish turnip-fields. On one occasion a pair nested and succeeded in hatching their young on an island marsh which had been lying idle throughout the winter and spring. But this owl, being migratory, does not, as a rule, breed in Great Britain; it leaves this country at the beginning of the spring for many other countries, so that, to use Seebohm's words, outside our islands its range is almost cosmopolitan. It is found in such different latitudes as the Sandwich Isles and Greenland. Sometimes, however, as ornithologists relate, its nest is found in this country, especially in districts where there has been an extraordinary supply of its favourite food—mice, voles, or rats. In Gloucestershire, for example, when there was a great plague of mice in the Forest of Dean, Short-Eared Owls were attracted there in large numbers and materially assisted in destroying the intruders. The birds also proved markedly useful during the last severe plague of voles in the south of Scotland.

The Departmental Committee, appointed in 1892 by the Board of Agriculture to inquire into a plague of field voles in the south of Scotland, say in their report, "This bird (*i.e.*, the Short-Eared Owl), which is distributed over almost

every part of the globe, is a normal winter migrant to these islands, appearing simultaneously with the woodcock (whence it is popularly known as the 'woodcock owl') and usually departing in spring. Nests in ordinary seasons are of comparatively rare occurrence in Great Britain, but in consequence of the vast multiplication of their favourite food, the vole, these owls have not only arrived in unusual numbers but have remained and bred freely all over the district affected, laying from 8 to 13 eggs (though Newton in his edition of Yarrell's 'British Birds' mentions seven as an unusual number) and rearing more than one brood. The shepherd on Crooked-Stone, near Crawford, has counted 14 nests on his ground."

The Committee were of opinion that it would be difficult to condemn too severely the foolish and cruel action of those who allow or encourage the destruction of this useful and beautiful bird, and it was with much satisfaction that they were able to record that many land owners and game preservers had become convinced in late years that owls of all sorts are not only harmless to game, but most beneficial to agriculturists, and had issued orders for their preservation. Seebohm also writes strongly: "Too often, however, the poor harmless owl is shot down by the thoughtless farmers, or ignorant gamekeepers, who foolishly imagine they are ridding the domains of a pest, although in reality they are taking the life of one of their most valuable friends."

The Short-Eared Owl is much appreciated in Germany, where it is called the "moor," "fen," and "meadow" owl. It occasionally breeds in Germany as in England, while it also breeds, but not extensively, in certain Southern Departments of France.

London, S.W.1,
August, 1897.

Revised, November, 1911.

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BOARD OF AGRICULTURE AND FISHERIES.

Titmice (*Paridæ*).

THE GREAT TITMOUSE (*Parus major*).

All the titmice are more or less active hunters of insects, for which they are constantly on the watch, and no inhabitants of the insect world come amiss to them as food. They are especially useful in the destruction of many crop pests, which they devour in all stages. During the winter they clear off enormous quantities of eggs which have been deposited by insects of various kinds in or near buds, and in the clefts of the bark or rind of trees. At this season the titmice may be seen frequently running up and down the trunks, stems, and branches, or hanging head downwards from the smaller branches and twigs, prying anxiously into each crevice and fold of the rind, in search of eggs, hibernating larvæ, or perfect insects. Their sight is so keen that they can detect such small eggs as those of the Winter Moth, and they have been seen actively devouring the minute red eggs of the mite *Bryobia* upon the stems and branches of gooseberry bushes and damson trees.

It is sometimes alleged that the tits, like the sparrows, wantonly pick out the buds of trees and shrubs; but this accusation is wrong, and based upon insufficient investigation

of the circumstances, as titmice only attack buds that are diseased.

The Crested Tit (*Parus cristatus*).

The Crested Tit is a pretty little bird, but it is very scarce and decreasing in numbers, forests in the north or north-east of Scotland being its chief and almost only habitat in Britain. It can be recognised by the feathers of the head being prolonged into a crest, black in colour but edged with white, and by the black streak which runs backwards from each eye and then round the cheeks. The crest of the female is not so conspicuous. Nesting takes place in May ; eight eggs are laid, white in colour and spotted with red. The Crested Tit feeds on insects and weed seeds, and should be carefully preserved.

The Coal Tit (*Parus ater*).

Living as it does chiefly amongst pine and birch woods, often far from houses, the Coal Tit is not so well known as the Great Tit and the Blue Tit. It is, however, as great a destroyer of insects as the other members of the same family, and should be rigorously preserved. It is found throughout the British Isles.

The Coal Tit is rather more than four inches long. Its general colour is bluish grey, with a dull white breast, and it may be distinguished from the Marsh Tit, which it somewhat resembles in colour and size, by a large white patch on the back of the neck and by the two white bars on the wings. It usually makes its nest in holes in trees ; but it occasionally nests in burrows and holes in the earth made by rabbits and other animals. The eggs are white, spotted with red-brown.

The Marsh Tit (*Parus palustris*).

This Tit is occasionally seen in gardens and orchards, principally in the winter, but its chief habitations are low-lying meadows and damp situations, where it nests in holes in old willow-trees and other trees, pollards, and stumps, very close to the ground. After *Parus cristatus* it is the least common of the Tits. Like the other British Tits it is insectivorous, though Yarrell states that it is also partial to the seeds of the thistle. The young keep together for some time after they are fledged

According to Seebohm it may be seen in almost every conceivable position searching for insects on the buds at the end of a branch. It is slightly smaller than the Coal Tit, its head is bluish black, the sides of the neck are white, the under part of the body is light brown while the upper part is olive-brown, of varying shades. The 5 to 8 eggs are greyish white speckled with brown.

The Great Tit (*Parus major*).

Two of the tits are especially useful to agriculture, because they are not only more numerous than the other members of the family, but they live near human habitations, and are found in every garden and orchard. The first place in point of size may be given to the Great Tit, which is a voracious devourer of insects of all kinds and in all stages. It is indefatigable in search of food, and may often be observed climbing the trunks of trees, or hanging suspended from the under surfaces of branches while examining every cavity, leaf, or bud that is likely to afford shelter to any of its numerous insect-prey. These tits have been observed in numbers upon and under oak trees, pecking to pieces the galls for the sake of the insects within. Late in the autumn, small seeds and fruit form part of its diet, but its young are fed entirely on small caterpillars and grubs. Apart from the courage displayed by the Great Tit in defence of its young it has been seen to attack and kill other small birds.

The Great Tit, called also the Ox-eye, is a beautiful bird about six inches long, and usually builds its nest in holes in walls, trees, decayed posts, and similar places. Six, seven, or eight is the average number of eggs, which are white, sometimes a faint yellow, and spotted with red. The head and throat of the Great Tit are glossy black, with a white patch under each eye. The back is olive, or ashy green, and the body underneath is greenish yellow with a broad stripe of black down its entire length.

The Blue Tit (*Parus cæruleus*).

This elegantly feathered little bird is the most useful of all the tribe of tits. It is about four-and-a-half inches in length, and happily, distributed generally throughout the country. The wings and tail of this species are blue, the breast and belly sulphur-yellow, the back yellowish green, and the side of the head white with a blue band running across it from the beak to the nape. Its nest of moss, hair, and feathers is built in holes in trees, walls, or gate posts, and sometimes in pumps, letter boxes, and other extraordinary places. The eggs are six to nine in number, and are white, spotted with light red. Insects appear to be the principal objects of its search during the summer. Naturalists who have watched these birds saw nothing but small grubs and caterpillars brought to the young ones from apple trees near. In the winter this tit feeds upon seeds, eggs and pupæ of insects, and anything it can pick up.

The Long Tailed Tit (*Aegithalus vagans*).

This tit, which is abundant in the southern and south-western counties of England, but not so common in the

north, is also beneficial. It is about four-and-a-half inches long, and builds a most elaborate nest, shaped like a bottle, from which this bird is known familiarly in some localities as the "Bottle Tit." The nest, which is built in thick bushes or dense shrubs, has a very small hole in the upper part of the side. The eggs vary in number from ten to sixteen and are white with faint red spots. It is stated that this bird is more decidedly insectivorous even than the other species of tits. Brocchi maintains that it feeds entirely on insects in France, and that it and all the species of tits have a right to the protection of agriculturists, to whom they render important services. He estimates the annual consumption of each of these birds at nearly 200,000 insects in the form of eggs and larvæ, and remarks that when they attack the buds of fruit trees, an offence with which they are sometimes charged, it is certain that there are insects or mites within ahese buds.

The head, breast and neck of the Long Tailed Tit are whitish, with black bands or stripes. The back is black, mixed with rose colour, and the wings and the very long tail are black edged with white.

THE BLUE TIT (*Parus cæruleus*).

There is no doubt that the Great and Blue Tits occasionally damage apples and pears by pecking holes in the base; and it is believed that this may occur even when no insects are in the fruit. This destructive habit can easily be

checked by growing rows of sunflowers in and around the orchards. The Tits feed greedily on the seed, and are thus kept away from the fruit; and at the same time they are attracted to the orchards where they do much good in checking insect depredations. In a case where the Blue Tit damaged the pear crop by perching above the stalk of the nearly ripe fruit and pecking it, so causing the pears to fall, protection was afforded by the use of small shields of cardboard. The pears were large and valuable and were being grown on bushes; cardboard shields were cut two inches square, with a hole in the centre and a slit on one side so that they could be fitted round the stalk of the pear. The Great Tit also attacks nuts; but the good it does in devouring the nut maggot outweighs the harm it now and again does to the sound nuts.

So beneficial in every sense are the Tits that everything possible should be done to encourage their increase. In winter, during severe weather, they should be supplied with some food, *e.g.*, fat, acorns, or beech nuts. Where old trees and walls are abundant the Great and Blue Tits usually find ample opportunities for nesting, but under other circumstances, the birds may be rare or altogether absent, owing to their inability to find nesting places. In such a case much may be done by fixing up rough boxes in suitable places, care being taken (*a*) that they are placed beyond the reach of cats, (*b*) that they are as inconspicuous as possible, and (*c*) that the entrance hole is not large enough to admit sparrows. It must be said, however, that Tits do not take nearly so readily to artificial nesting places as some other birds, notably Starlings.

London, S.W.1,
August, 1897.
Revised, 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.

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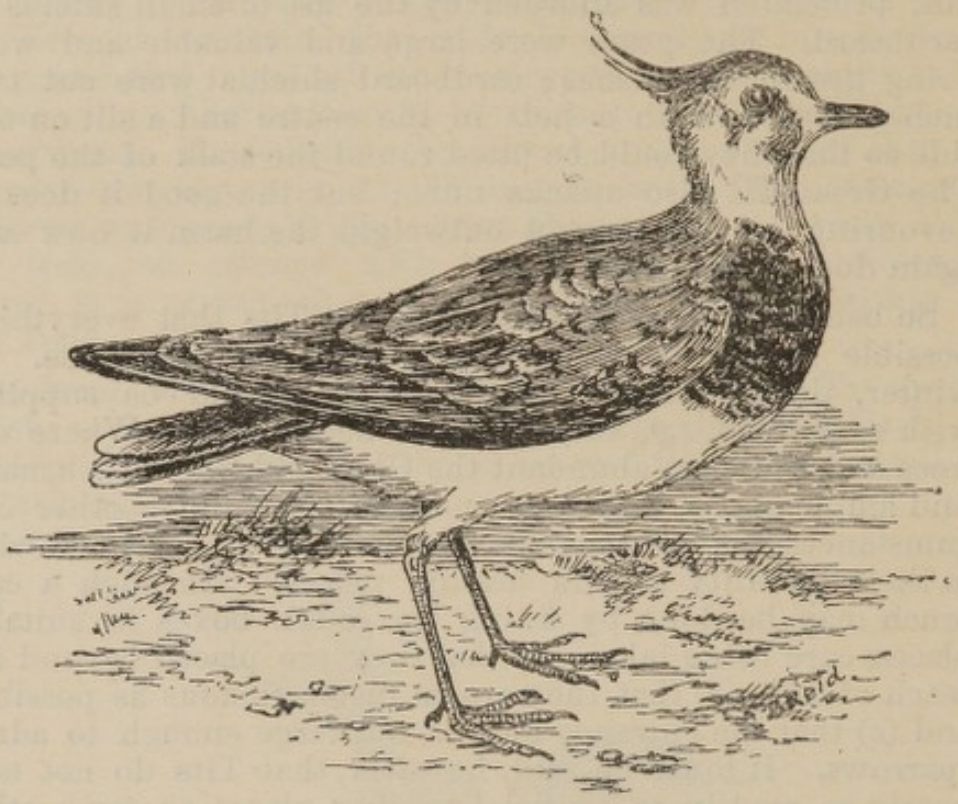
Leaflet No. 44.

BOARD OF AGRICULTURE AND FISHERIES.

The Lapwing, Green Plover or Peewit.

*Vanellus vanellus (Linn.).**



The lapwing or peewit (otherwise called the green plover) is a handsome and conspicuous bird, well-known to most persons in the country from its characteristic manner of flight and its cry. It is to be found in every county, during the breeding season in pairs or small gatherings, and in autumn or winter in large flocks, the numbers of which are swelled by migration from the Continent of Europe.

In summer the crown of the head and the long spur-like crest of the full-grown bird are greenish black, the back and upper surface of the wings glossy dark green shot with purple and copper-colour, the sides of the neck whitish, the throat and chest black, the lower part of the breast and the belly white, the upper and under tail coverts cinnamon-red, the wing-quills black, and the feathers of the tail white with a broad black band near the end. In winter the throat becomes white and the head black-brown. The bird measures about a foot in length.

The lapwing breeds in marshes, moors, meadows and fallows. Nesting begins towards the end of March. The nest is merely a shallow hole or depression in the surface of

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* Known also as *Vanellus cristatus* or *V. vulgaris.*

the ground, either in grass land or arable, sometimes with a few bits of dried grass, bents, or rushes at the bottom. The eggs are olive-coloured, with black-brown blotches, broad at the large end, and rather sharply tapering. They are usually four in number. The eggs are very keenly sought after for the table, and high prices are paid for them, especially in the early part of the season. Lapwings are protected between 1st March and 1st August throughout Great Britain by the Wild Birds Protection Act of 1880. In almost all counties of England and Scotland the eggs are protected (by the application of the Wild Birds Protection Act of 1894) after the 15th April. In a few counties in England the protection of the second sitting only is aimed at by prohibiting the taking of plovers' eggs after the 20th April or the 1st May. A table of the dates at which the eggs are protected by County and Borough Orders is appended.

The lapwing does no damage to crops, and is exceedingly useful to the farmer. It devours snails, slugs, wireworms, beetles and the larvae of insects such as the crane-fly, turnip moth and yellow underwing, which prey upon the roots of grass, turnips and cereals. It is also of benefit to sheep-owners by eating the water-snail, which harbours the immature form of the liver-fluke, which produces liver-rot in sheep.

The persistent collection of eggs for the market interferes with the natural increase of the lapwing, and with its useful work in keeping down mischievous insects. Large numbers of the birds are netted and shot in the autumn and winter and sent to market from the Eastern Counties and from parts of Ireland. There is some evidence that the numbers of the bird have been considerably diminished by these causes in some districts of England; and that wireworms have increased in such localities. In the interests of agriculture the eggs of this bird should be protected in all counties, and its destruction energetically discouraged.

Protection for Plovers' Eggs.

County Orders.

County.	Date of Order.	Protection afforded.
Anglesey	14th February 1912 ...	After April 1st.
Carnarvon	2nd September 1905 ...	After April 30th.
Chester	29th January 1912 ...	After May 1st.
*Cumberland	20th June 1911	All the year.
Derby	1st February 1911 ...	After April 15th.
Dorset	7th November 1913 ...	After April 15th.
*Gloucester	17th October 1910 ...	All the year (for 5 years).
Hertford (within M.P.D.)	10th August 1910 ...	All the year.
Kent (within M.P.D.) ...	12th August 1912 ...	All the year.

Protection for Plovers' Eggs.

County Orders—*continued.*

County.	Date of Order.	Protection afforded.
*Lancaster...	1st September 1911 ...	After April 20th.
London	17th July 1909	All the year.
Middlesex	5th December 1911 ...	All the year.
*Northumberland ...	27th November 1911 ...	After May 1st.
Salop	31st March 1913	After April 15th.
Southampton	31st October 1913 ...	After April 30th.
Stafford	21st December 1910 ...	After April 7th.
East Suffolk	22nd February 1912 ...	After April 20th.
*Westmorland	22nd September 1913 ...	All the year.
Wilts	7th July 1904	After April 15th.
Worcester...	19th November 1908 ...	Before April 15th
Yorks (North Riding) ...	15th January 1912 ...	After April 15th.
Yorks (West Riding) ...	18th January 1910 ...	After April 14th.

Borough Orders.

Borough.	Date of Order.	Protection afforded.
Barnsley	17th November 1913 ...	After April 14th.
Bournmouth	18th August 1900 ...	After April 30th.
Bristol	5th July 1902	All the year.
Croydon	6th July 1898	All the year.
Halifax	29th June 1910	After April 14th.
*Newport	8th March 1911	All the year.
Portsmouth	6th May 1901	After April 30th.
*Rochdale	23rd August 1913 ...	After April 20th.
Southampton	18th August 1900 ...	After April 30th.
Stockport...	25th February 1914 ...	After May 1st.
*Tynemouth	21st February 1914 ...	All the year.
Walsall	17th September 1912 ...	After April 7th.
Warrington	30th May 1904	After May 1st.

* The bird is also protected throughout the year.

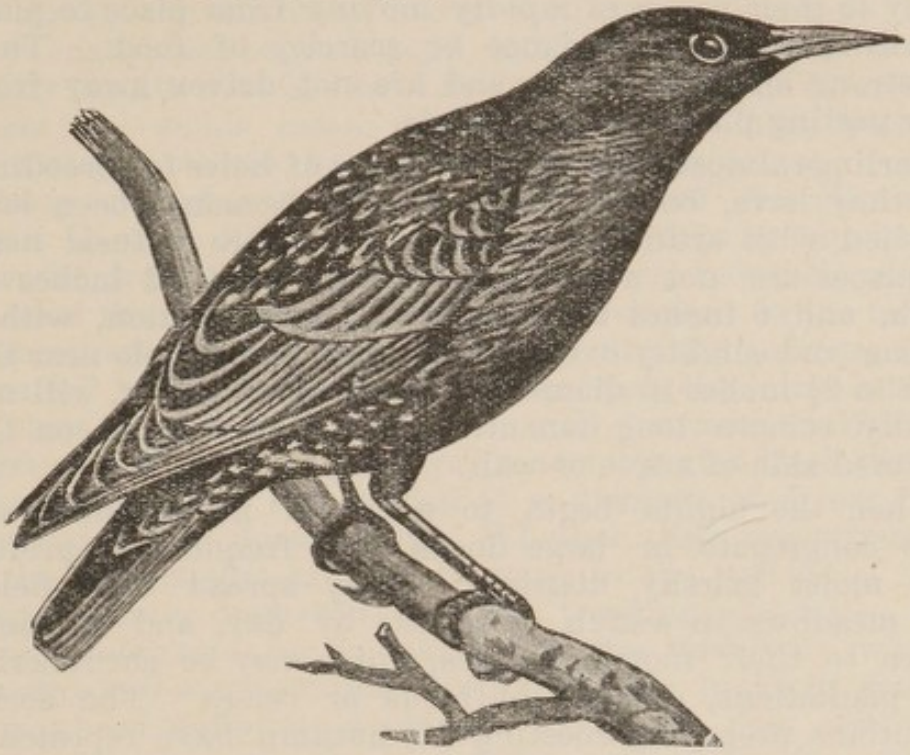
The Bird, but not its Eggs, is protected throughout the County Borough of South Shields (Order of 11th November 1897). Devonshire has an extension of the close time for the Lapwing, 1 February—31 August, both inclusive.

London, S.W.1,
August, 1897.
Revised, March, 1915.

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 Starling (*Sturnus vulgaris*).



The starling is so well and widely known throughout Great Britain and Ireland as hardly to need description. It is nearly 8½ inches in length. The beak of the adult male is yellow; the head, neck, and back, and all of the under part of the body are glossy black, with metallic purple or green tints; the feathers on the upper parts are tipped with buff or dead gold colour; and the wings are greyish black with a fringe of reddish brown; the legs and feet are red-brown. In the adult female the colour is similar, but not so glossy and lustrous as in the male, and the body is more spotted. The young birds are unspotted, uniform ash-brown above, and clouded with white on the under surface. In the autumn the adults are somewhat lighter in colour, and lose the metallic lustre in some degree.

Pairing takes place early in the year, depending on the weather, and eggs are generally found in the first weeks of April. The starling builds without much care or art, in holes almost anywhere—in trees, eaves of buildings, church towers, caves, clefts, and rocks. It has also been observed to build openly in creeping plants against a wall, and in the thicker and uppermost branches of the spruce fir, the nest being placed close to the stem. In most cases, twigs, straw, hay, grass, moss, or wool are used to line the nest, but sometimes scarcely any lining is supplied. Four to seven eggs are laid (5 or 6 on the average), these being pale blue in colour tinged with green, and very slightly more than an

inch long. There are often two broods in the season, and eggs are found from early April until the end of June.

Starlings have increased very markedly of late years. This is due partly to the protection which they enjoy, and partly to their power of rapidly moving from place to place according to the abundance or scarcity of food. They are strong and bold birds, and are not driven away from their nesting places by other birds.

Starlings almost invariably make use of holes for breeding, and they have, both in Belgium and Germany, been long supplied with artificial nesting-boxes where natural nesting-places are not available. A box 10 to 12 inches in depth, and 6 inches by 6 inches in cross section, with a sloping and slightly overhanging roof, and a hole near the top 2 to 2¼ inches in diameter, with a perch below, will not usually remain long tenantless. It is best fixed on the sheltered side of a tree or wall.

When the nights begin to get cold in autumn starlings congregate in large flocks, and frequent by preference moist marshy districts. They spread over fields and meadows in search of insects by day, and at night return to their roosting places, which may be shrubberies and plantations, or beds of reeds or osiers. The aerial evolutions preceding roosting in autumn have repeatedly excited the admiration of observers. According to Seebohm a large flock of starlings will divide into several parts as the night approaches, each going to a separate roosting place. He adds: "Starlings often congregate with rooks and jackdaws in the autumn on the pastures, and later in the year with redwings. When alarmed, the starlings, as if to a bird obeying a commander's voice, fly off in a compact mass, and if the danger soon passes, they will wheel and return again in the greatest order."

In hard weather, and when food is scarce, the starlings migrate to parts of the country where frost is not so intense, but they ultimately return to their native places, and the same pairs occupy their accustomed nests.

Food of Starlings.—*Insect Food.*—The starling is of much benefit to agriculturists, as its food consists principally of worms, snails, and insects in their different stages. It is especially useful in clearing off chafer larvæ, and other larvæ of the same habits, in meadows and pastures, and surface caterpillars in turnip and mangold fields. The destructive larvæ of the Antler moth, the Diamond Back moth, the Silvery Y moth, and of other moths, as well as those of the Daddy Longlegs, and of the Click Beetle (known as wire-worms), are also eagerly devoured by this bird. In the late autumn and winter when the starlings congregate in flocks they clear whole fields of injurious insects in larval or pupal form.

Theobald and McGowan* found the starling's chief food to consist of injurious insects and mollusca. The principal harmful insects eaten were leather jackets, click beetles, wireworms, earwigs and weevils (pea, bean, clover and tare); the chief injurious mollusca taken were the hairy snail, the banded snail and the strawberry snail. Similar results were obtained by Leigh* as regards injurious insects and snails eaten, caterpillars of the large yellow underwing moth also being recorded in many cases.

Sheep regard starlings as their natural friends, and permit them to alight on their backs to take out the keds, ticks, etc., from their wool. Some farmers, however, maintain that the droppings which starlings deposit on the backs of sheep attract flies, and that sheep are not infrequently "struck" by maggots exactly on the spot (the loins) where the birds most usually settle. In early summer it will often be found that cattle on pastures are accompanied by starlings, each animal being surrounded at a distance of a few feet by about half a dozen birds. Whether these are attracted by the worms that are apt to come to the surface of the ground when disturbed by the treading of cattle, or are on the look-out for the maggots of the warble fly, which in spring and early summer drop from the backs of cattle, has not been definitely made out. Starlings may often be seen accompanying rooks in meadows and fields in a joint search for insects. In the summer a pair of starlings may often be seen in meadows and fields near their nesting place, surrounded by five or six young ones, busily engaged in hunting for insects. Broods frequently keep together until the autumn, when they join the flocks congregated for the winter.

In the breeding season the quantity of insects consumed by starlings is enormous. A single starling has been seen to carry food to its young, from a grass paddock 100 yards distant from the nest, as many as eighteen times in fifteen minutes. In another case, between May 30th and June 8th, 1908, for 17 hours a pair of starlings were observed as they brought food to their three nestlings.† During that time (representing approximately the hours of one day during which food was collected) 169 journeys were made to the nest by the parent birds. The food brought to the young was approximately as follows :—269 insects of the injurious group (very many large caterpillars), four insects of the useful group, two of the indifferent group, 30 earthworms, 14 slugs and snails, one centipede, one wood louse, two harvest spiders, 23 lots of bread, 19 lots of garbage (?), and 10

* "Reports on the Food of the Rook, Starling and Chaffinch" (*Supp. Jour. Bd. Agric.*, May, 1916).

† "The Food of some British Birds," R. Newstead, M.Sc. (*Supp. Jour. Bd. Agric.*, Dec., 1908).

lots of unidentified insects. These figures represent but a small portion of the food actually brought in during the days of observation. It is clear, therefore, that starlings, when feeding their young, destroy an enormous quantity of harmful insects.

Vegetable Food.—The birds have been seen at work in the field pulling up and devouring the sprouting grain.

Corn crops when just appearing above the ground often sufferconsiderably from the attacks of starlings which gather upon them in enormous flocks and are most difficult to scare away. Many complaints are also received of the depredations of starlings, not only in the cherry orchards, but in apple and pear orchards and in connection with other fruit.

In the above mentioned investigations by Theobald, McGowan and Leigh grain (wheat, oats and barley) was found quite often in opened starlings, but only in October, November and December in any quantity according to the first two investigations. Small numbers of the seeds of most of the common weeds were also found, as well as clover, moss, grass and miscellaneous herbage. The investigations recorded hardly any fruit.

Summary.—On the one hand :—

1. The starling feeds principally on worms, snails, chafer larvæ, and beetles, wireworms, surface caterpillars, larvæ of daddy longlegs, and many other harmful insects.

2. The starling is entirely useful on newly ploughed land, and in meadows and pastures.

On the other hand :—

The bird devours or spoils cherries, apples, and pears and other fruit to a certain extent, whilst it is destructive to newly sown corn crops.

There is no doubt that starlings do much harm in the manner mentioned above. On the whole, however, the information at present collected goes to show that, in view of their great partiality for insect food, starlings are, from the forest standpoint, entirely useful, whilst in agriculture and gardening their usefulness outweighs the harm done.

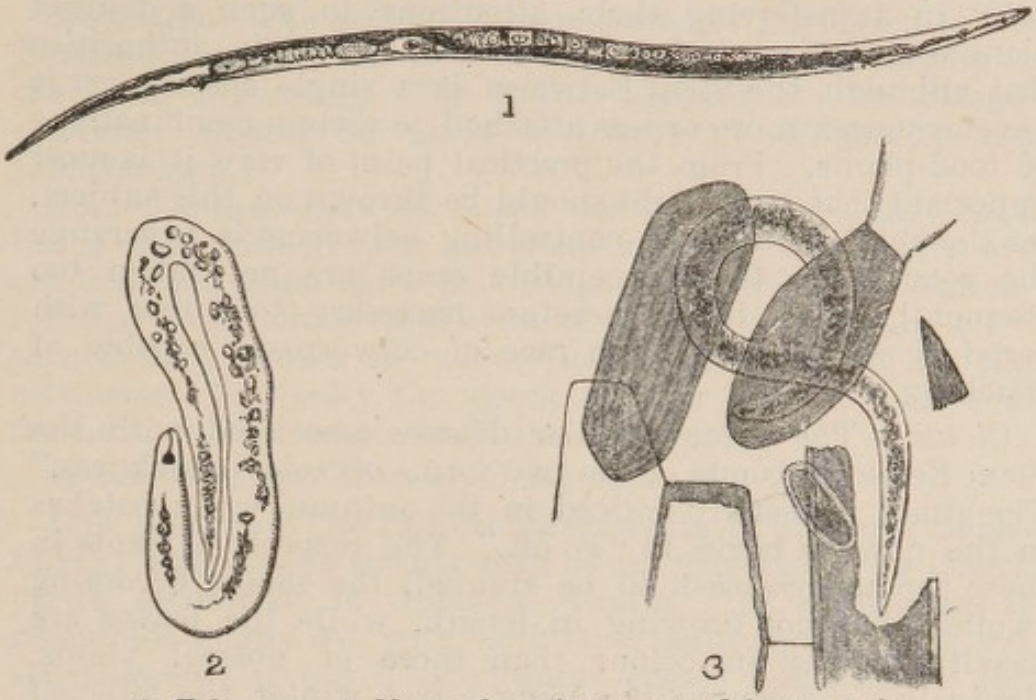
In the case of such a bird as the starling, which subsists on a mixed diet, it is important to guard against extreme opinions as to the good or harm of which it is capable. Its extermination would probably prove a serious calamity, but on the other hand its unlimited increase—with the resulting difficulties as regards its food supply in winter—may also be undesirable. The measure of protection which should be afforded to the starling in any district cannot therefore be decided once and for all, but must always be determined by the numbers of starlings at the time.

London, S.W.1,
October, 1897.

Revised, September, 1917.

BOARD OF AGRICULTURE AND FISHERIES.

The Stem Eelworm (*Tylenchus devastatrix*).



1. Eelworm. 2. Young form just emerged from egg.*
3. Eelworm and egg in plant tissues.
(1 much magnified, 2 and 3 more highly magnified.)

The Stem Eelworm (*Tylenchus devastatrix*, Kühn) is a common pest throughout the country, and year by year is responsible for serious losses both to crops grown on the farm and in the market garden, while it is also very destructive to certain flowers and ornamental plants. It must be noted, however, that the term "eelworm" is often applied to forms of crop failure which have no connection whatever with eelworms, and there is a tendency to attribute to these pests all damage of a mysterious nature. Eelworms are very minute animals, almost invisible to the naked eye, making it difficult for a grower to diagnose an attack with certainty. The difficulty is increased by the fact that all kinds of eelworm are not harmful and also that true eelworm attack is often found in combination with the attacks of other pests. It is therefore suggested that in all cases in which loss due to eelworm is suspected, specimens of the affected plants should be submitted to an expert for examination.

Plants Attacked and Nature of Injury.—Stem Eelworms —or rather animals indistinguishable in form from the Stem Eelworm—have now been found attacking a very large number of different plants. There is still, however, some

* These figures are reproduced from *L'Anguillule de la Tige*, by courteous permission of Dr. Ritzema Bos.

uncertainty as to the extent to which eelworms living on one crop are capable of adapting themselves to a different crop from that on which they have been living. For instance, it seems possible that eelworms which for many generations have lived exclusively on clover may find considerable difficulty in transferring their attentions to such a distinct plant as the oat, and the view is held by certain authorities that although the Stem Eelworm is a single species, yet it develops races more or less attached to certain combinations of food-plants. From the practical point of view it is most important that more light should be thrown on this subject, for the chief method of controlling eelworms is to arrange the rotation so that susceptible crops are not taken too frequently, and it is therefore necessary to know with certainty which crops each race of eelworms is capable of attacking.

Clover.—The most familiar disease associated with the Stem Eelworm is one of the two forms of "clover sickness." The attack is usually noticed in the autumn when patches in the new lea begin to "go off." The respective plants in these patches are seen to be stunted, the shoots becoming swollen, but not growing in length, while the leaves are usually lighter in colour than those of normal plants. Gradually, and especially during a wet winter, the affected patches spread, and as the diseased plants usually die, become bare of clover. This form of clover sickness is quite different from the form caused by the fungus *Sclerotinia* (*see* Leaflet No. 271) and is to be distinguished by the swelling and thickening of the shoots combined with the stunted growth which are characteristic of the eelworm.

Oats.—In this country the oat is the chief cereal which suffers from the Stem Eelworm—though Frit fly attack is so often ascribed to eelworms, that it is difficult to say how serious the losses usually are. The chief sign of attack is that the base of the plant swells and becomes "tulip rooted"; the leaves also are often twisted and pale in colour, while the whole plant is generally stunted and fails to produce a crop. Plants attacked by Frit fly are also stunted, but the facts that the central shoots have been definitely eaten away, and that small white grubs are present, will usually distinguish them from plants attacked by eelworms. Not seldom both eelworm and Frit fly attacks occur in the same crop. In addition to oats, wheat and rye are also attacked, but more especially abroad, where great damage is sometimes caused to the rye.

Onions.—Onions may be seriously damaged by the Stem Eelworm. The young plant develops swollen and twisted leaves, and the upper part of the stem becomes unduly

thickened, the tissues being soft and flabby. This condition is sometimes known as "bloaty." Attacked plants rot and die, never producing a crop unless the infection has taken place very late, when decay takes place in the store.

Daffodils.—The serious disease formerly attributed to the fungus *Fusarium* has now been shown to be due largely to the Stem Eelworm. For a full account of the disease reference should be made to papers by Welsford* and Ramsbotham.†

Some of the signs of attack are as follows :—Attacked bulbs start into growth abnormally early. The leaves are crinkled and often show pale stripes. A section through an infested bulb shows that certain of the bulb scales have turned dark brown in colour, having been killed by the eelworms. Gradually the attack spreads from one scale to the next, and the whole bulb dies and rots.

Hyacinths suffer from a similar form of attack.

Life History.—The full-grown eelworm (*Tylenchus devastatrix*) is about one twenty-fifth of an inch long. Its length varies somewhat in different plants. In appearance it resembles a tiny eel, with both ends pointed, the hind end specially so. It has a sharp spear-shaped point within the gullet (seen under a high magnification), which serves to pierce the tissues of plants and to extract their juices. The eggs are oval, and sometimes oblong in shape, as shown in the figure, and are found in the tissues of the host-plants, together with partly grown and fully developed eelworms. When the young worms come from the eggs, they are about one-seventh of the size of the adult eelworm, and resemble them in outward appearance, though their internal parts differ somewhat. The young form undergoes several changes or moults, before it becomes a perfect eelworm. When the tissues of the host-plant decay and dry up, the eelworms and the young forms either fall to the ground and enter it, or the eggs and young worms remain in the decaying and dead parts, and become dried up with them. Eggs containing the embryo worm can be kept dry for six months without losing their power of hatching, and young worms have the power of resuming animation and active life after they have remained in a perfectly dry condition, in dead tissues or in dry soil, for between two and three years. It is apparent that this faculty enormously increases the chances of the distribution and spread of this nematode, which may be carried in various ways into fields and gardens in this dried-up state.

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* *Annals of Applied Biology*, Vol. IV., p. 36.

† *Gardener's Chronicle*, 19 May, 1917, p. 207 ; 26 May, 1917, p. 217 ; and 2 June, 1917, p. 226.

Methods of Control.—(1.) Eelworms are exceedingly difficult to control, and prevention should be the object rather than cure. On farms which suffer from eelworm sickness of clover a long interval should be allowed between successive clover crops. In order to overcome the difficulty as regards rotation which this entails, leguminous crops less liable to attack should be taken. Amos,* by growing the crops on badly infested soil, came to the conclusion that Sainfoin, Peas, Beans and Vetches (except Kidney Vetch) do not suffer from eelworm, while White Clover and Trefoil are rarely attacked and Crimson Clover suffers slightly—the case of Lucerne being regarded as doubtful. Certain of these plants, *e.g.*, Beans, have been recorded by other workers as being injured, but it is probable that they may be relatively immune from the race of eelworm usually found on Red and White Clovers, and there is therefore a choice of crops to replace the latter in the rotation.

(2.) In the case of both Clover and Oats vigorous growth tends to overcome a slight attack and this may be induced by applications of such manures as ammonium sulphate and nitrate of soda. Potassic manures—such as potassium sulphate—have given good results both in the case of oats and clover, and it appears that they may have some definite action on the eelworm. When these manures become available they should be tested on eelworm-infested land.

(3.) Little can be done when onions are attacked, and it is necessary to avoid growing onions for several years on land which has become infested.

(4.) Affected daffodils should be removed as soon as it is apparent that they are diseased. When a bulb in a row fails to appear in the spring it should be dug up before it has time to decay. At present it is not possible to recommend treatment for affected bulbs; an investigation on the whole subject is in progress at the Royal Horticultural Society's Gardens at Wisley.

(5.) Refuse from attacked crops should be burnt or otherwise destroyed before it has time to rot. In no circumstances should such refuse be thrown on the manure or waste heap, as this would in all probability lead to a fresh attack.

London, S.W.1,
April, 1898.

Re-written, January, 1918.

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* *Journal of the Farmers' Club*, May, 1916, p. 61.

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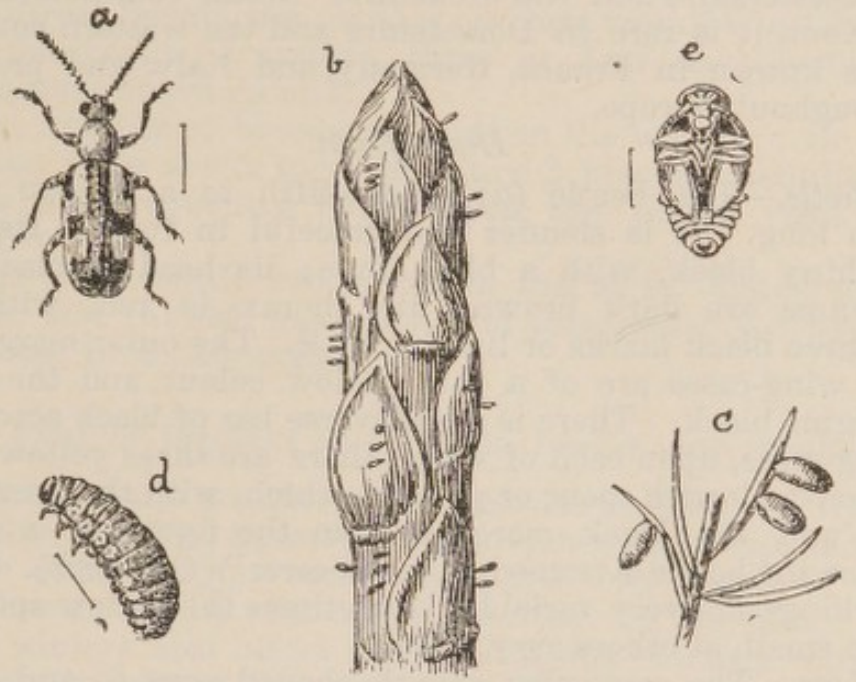
BOARD OF AGRICULTURE AND FISHERIES.

The Asparagus Beetle (*Crioceris asparagi*).



a. Beetle enlarged, with line showing nat. size ; *b*. eggs on shoot (nat. size) ; *c*. eggs on foliage enlarged ; *d*. larva, and *e*. pupa enlarged, with lines showing nat. size.

Damage done.

This beetle now and then does harm to asparagus, especially in beds which have been established from one to three years, by eating and disfiguring the heads as they are formed, but chiefly at a later date by attacking the stems, which they particularly relish. In the larval and adult stages the insects bite the tender asparagus heads, making brown patches upon them ; the adults defile the heads with masses of the sticky eggs ; the heads get covered with a brown-black sticky fluid emitted by the larvæ ; and thus the appearance of the plants is spoilt for the market. Later on the beetles and larvæ eat the large round seeds, to which they are very partial. Plants may be completely denuded of their foliage by a succession of broods of larvæ. The adult beetles now and then gnaw the shoots underground, and cause them to become bent and woody.

Distribution.

The Asparagus Beetle is locally common in the southern and eastern parts of England, but is rarely found in the northern districts. Canon Fowler, in his Coleoptera of the British Isles, states that he does not know of a record from any locality farther north than South Derbyshire. Enquiries made in 1899 failed to show its presence in the North of England or in Scotland. It is fairly widely distributed around London, and has been recorded as doing damage in Gloucestershire and Warwickshire. While common in parts of Kent, it is rare in Dorsetshire and the western counties. It is known in France, Germany, and Italy, and probably throughout Europe.

Description.

Beetle.—The beetle (*a*) is one-fifth to a quarter of an inch long. It is slender and graceful in form. Its body is shiny black, with a blue tinge; its head is black; its antennæ are dark brown; its thorax is red, with two or three black marks or lines upon it. The outer margins of the wing-cases are of a pale yellow colour, and the inner margins black. There is a transverse bar of black across the wing-cases, upon each of which there are three yellowish or lemon-yellowish spots, or patches, which, with the transverse bar and the black margins, form the figure of a cross; hence the beetle is termed "Cross-bearer" (*Crioceris*). These markings are very variable; sometimes the yellow spots are very small, at others very large.

Eggs.—The somewhat spindle-shaped eggs (*b* and *c*) are brown to dusky greenish-brown, and oval, being glued by their ends to the plants, usually in rows of three to five. Frequently, however, they are placed singly, and occasionally in rows up to eight in number. They are usually covered with a thin gummy coat, and are about one-sixteenth of an inch long.

Larva.—When full-fed the larva (*d*) is from two-fifths to nearly half an inch in length; in colour it varies very much from dirty greenish-grey to dull slate, some grubs being almost yellow; the skin is wrinkled, and the head is black. Each of the first three segments is provided with a pair of jointed feet; the tail segment bears a distinct proleg; and the remaining segments are each provided with a pair of fleshy tubercles.

Pupa.—The pupa (*e*) is pale yellowish in colour.

Life History.

Eggs are laid from June onwards, first upon the heads and shoots, and later upon the feathery foliage of the asparagus plants. The eggs hatch in from 5 to 7 days (Chittenden, writing of America, says 3 to 8 days), and the larvæ at once begin to feed on the asparagus. The larvæ

hold very firmly to the plant by their tubercles and anal proleg. Probably in the course of their growth they moult three times. The larva is full grown in 10 to 13 days, and pupation takes place just under the surface of the soil, in a cocoon formed of frothy saliva which hardens into a case of parchment-like consistency. The cocoon is dull yellow in colour, and grains of earth cover it externally. Lintner says that instead of going into the soil some larvæ "merely conceal themselves beneath dead leaves and other material on the surface."

In Great Britain the pupal stage lasts from 14 to 20 days, but the beetle is mature three or four days before its appearance above ground.

The number of broods depends on the weather ; in some seasons there are 3, in others only 2 broods. Adults and larvæ are frequently found upon the plants right into October.

The adult beetle hibernates in the earth, under stones, sticks, and rubbish generally, and also under the bark of trees and in hollow stalks.

Effect of Weather on the Eggs, Larvæ, and Adults.

During warm weather the beetles breed more rapidly ; in hot, dry weather, however, many eggs shrivel up, and the larvæ often fail to reach maturity, a long period of such weather materially affecting the increase of the pest. Very cold winters also affect the hibernating beetles, numbers apparently being killed, particularly if warm and cold spells of weather alternate.

An Allied Species.

A closely-related species—the Twelve-spotted Asparagus Beetle (*Crioceris duodecim-punctata*, Linn.), is also found on asparagus in Europe and America, the larvæ living on the foliage and in the berries. In colour it is orange-red, each wing-case having six round black spots. It is apparently very rare, if not extinct, in Great Britain. As it is more troublesome than the common Asparagus Beetle a look-out should be kept for it by growers in this country.

Natural Enemies.

A few natural enemies help to keep down an excess of this beetle. The most important is the Two-spotted Lady Bird (*Adalia bipunctata*), whose larvæ ("niggers") devour the eggs of the beetle. The adults have also been observed to eat them. Larvæ of the Lace Wing Flies (*Chrysopidæ*)—very ravenous Green Fly eaters—also attack the larvæ of the Asparagus Beetle.

Methods of Prevention, and Remedies.

1.—In the first stages of this attack, that is, when the beetles are feeding upon the juicy parts of the heads of the asparagus as they are formed, they are difficult to deal with, though at this period they do considerable harm by making the heads brown and spotty. It is desirable to leave a few heads uncut in every bed where there is infestation, as traps for the beetles, which get up the feathery shoots and branches during the day for pairing and the deposition of eggs. In the course of eight or nine days these plants should be cut off close to the ground, and burnt. Another set of heads should be allowed to run to shoots, which should also be similarly disposed of. In America a method among prominent growers is to cut down all asparagus plants in early spring so as to force the parent beetles to lay their eggs upon new shoots, which are then cut every few days before the eggs have time to hatch.

2.—Beds of young asparagus plants are most liable to this attack in the first year or two, when only the strongest heads are cut for market, as the beetles like the succulent shoots of young plants. It would seriously injure the stocks in *newly-made* infested beds to cut off their shoots. In such cases, it would be better to handpick the beds, killing the grubs and eggs between the fingers.

3.—Very finely powdered lime dusted on infested plants would also be efficacious, as it would adhere to the slimy bodies of the larvæ. The lime should be applied as soon as the larvæ are noticed, and the application repeated at intervals.

4.—In extensive beds the remedies to be employed are liming and trapping, as indicated above, by letting some heads grow into shoots and burning them.

5.—Syringing can be adopted in gardens. Where asparagus is grown upon a large scale this process is more difficult, as the plants are not always set in rows, but it may be effected by means of knapsack spraying machines. Paraffin emulsion, consisting of two gallons of paraffin oil, and half a pound of soft soap dissolved in a gallon of soft water, may be used for spraying purposes. The soap should be boiled, and while boiling the paraffin should be poured into it and churned up with the soap until it is thoroughly incorporated. The mixture should then be diluted with fifteen to twenty gallons of soft water.

6.—Paris green is also a valuable remedy against these and other insects which feed upon foliage. It may be used at the rate of one pound of Blundell's Paris green to 200 gallons of water. This mixture can also be put on in a very fine spray. The mixture must be kept constantly stirred. *As this is poisonous, it should not be used till the asparagus has all been cut.*

Spraying should be carried out before the foliage has become thick and strong. It may be necessary to repeat this operation, and it would be effective against both beetles and larvæ.

7.—The asparagus may be sprayed with arsenate of lead, made by dissolving 1 oz. pure arsenate of soda in a little water, dissolving 3 oz. acetate of lead also in a little water, and pouring both into 10 or 12 gallons of soft water, finally stirring in 1 lb. of treacle.

8.—Poultry and ducks do not seem to eat asparagus, but they readily devour grubs; a few kept in the gardens, especially ducks, would probably do much good.

9.—It would be desirable to examine the roots of asparagus obtained for making new beds, as the pupæ or beetles may be conveyed in these. In the United States infestation is extended partly in this way.

London, S.W.1,
May, 1898.

Revised 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.

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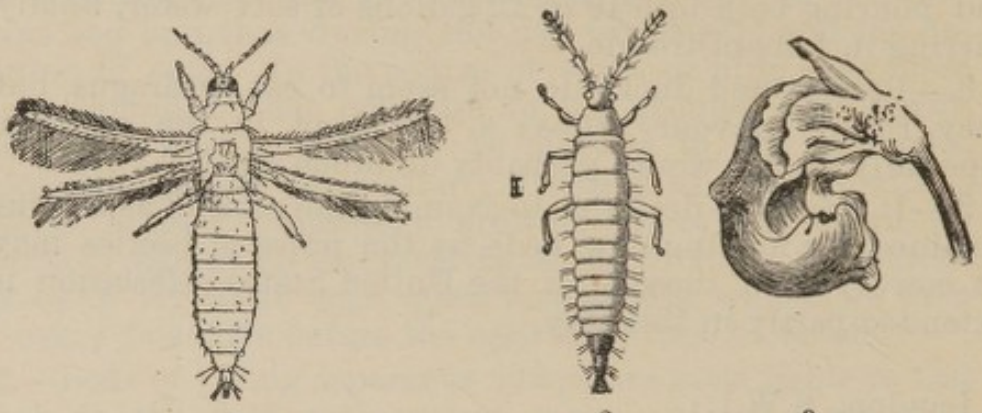
Leaflet No. 48.

BOARD OF AGRICULTURE AND FISHERIES.

Pea and Bean Thrips, or Black Fly

(*Frankliniella robusta*, Uzel).



1. 2. 3.

Fig. 1. Adult Pea Thrips.* Fig. 2. Larval Pea Thrips.*
3. Distorted pod.

The small insects known as Thrips, Black Fly, or Thunder Fly, are extremely abundant in this country, and may be responsible for considerable damage to cultivated plants. Species are known which attack cereal crops, others damage fruit, and there are several which are injurious to plants grown under glass. The insect dealt with in the present leaflet, *Frankliniella robusta*, was formerly known to science as *Thrips pisivora*. It has been recorded as harmful to peas and beans for many years, but its life history has only recently been worked out, and there is little doubt that in the past several species have been confused under one name. The group, as a whole, has been insufficiently studied, and much still remains to be discovered before our knowledge of these insects in relation to practical agriculture can be considered as satisfactory.

Description of Insect.

The adult insects of the pea Thrips cannot be distinguished from other species of Thrips without entering into minute features only to be observed under the microscope. They are small black insects about $\frac{1}{15}$ inch in length, elongate in form and tapering towards both head and tail, the latter appearing to be sharply pointed. They have four wings each consisting of a narrow membrane surrounded by a broad fringe

* Fig. 1 is from a drawing kindly supplied by Mr. C. B. Williams, who has investigated the life history of the Pea Thrips.

of hairs, which give the insects sufficient expanse of wing to enable them to fly or drift for long distances. The general appearance of the adult pea thrips is shown by figure 1. The young pea thrips are somewhat like the adult in form but have no wings ; they are bright orange in colour with a conspicuous black tip to the abdomen (*see* figure 2), the latter feature serving to distinguish them from most other species likely to be found in peas and beans.

Distribution in Great Britain.

The pea thrips is distributed over the whole of England and is recorded from Ireland. The districts where most damage is done, however, are chiefly in the south and east of England, though records have been received occasionally from as far north as Cheshire.

Life History.

The eggs of the pea thrips are laid in June. They are minute, kidney-shaped and are imbedded in the tissues of the stamen sheaths, young pods and, rarely, in the petals of the pea or bean flower. After about nine days they hatch and the small orange coloured young feed on the petals, stamens, and inner parts of the flower, and later on the pods. Their method of feeding is peculiar and consists in scraping away the surface tissues of the plant and then sucking up the liquid and minute fragments from the wound. After feeding for three or four weeks the thrips leave their food plant and descend into the earth, where they remain quiescent for the rest of the summer, through the autumn and winter until the spring when they pass through two stages, which together may be likened to the pupal stage of many other insects. These two intermediate stages last about one month and the insects then become mature winged thrips which leave the soil in May and June and go in search of pea or bean flowers on which to lay their eggs. The males emerge earlier than the females and are at first quite common, but before much damage is visible they have mostly disappeared and only females can then be found.

Plants Attacked and Nature of Injury.

The pea thrips here described is only known with certainty to attack the ordinary eating pea and the broad bean or varieties of these plants. In the case of attacks on scarlet runner beans it is not known which species is responsible and it may possibly be one of which the life history is still unknown. The damage done by the pea thrips is two-fold. In the first

place the flower may be so injured that no further development takes place, and secondly when a damaged pod develops it has a curious silvery or shining appearance, more or less mottled with brown. Some distortion may also occur, but the appearance of the pod is the most characteristic feature of an attack. In this country injury to the haulms does not seem to be common, but it is known in Sweden and may frequently pass unnoticed here.

Treatment.

Where an attack is in progress it is difficult to suggest any remedy. The insects are well protected by the flower of the pea or bean and it is considered unlikely that any treatment by means of spraying would be effective. Since the immature thrips pass the winter under ground, fields affected during the summer should be ploughed deeply and, if possible, should receive a dressing of lime in the following winter. In gardens this dressing of lime might be replaced by one of the well known naphthalene or other soil fumigants. It is obviously unwise to grow peas or beans on land adjacent to that which has been attacked during the previous year. The burning of the old pea sticks, previously recommended, is of no avail against this insect.

London, S.W.1,
June, 1898.
Re-written, August, 1914.

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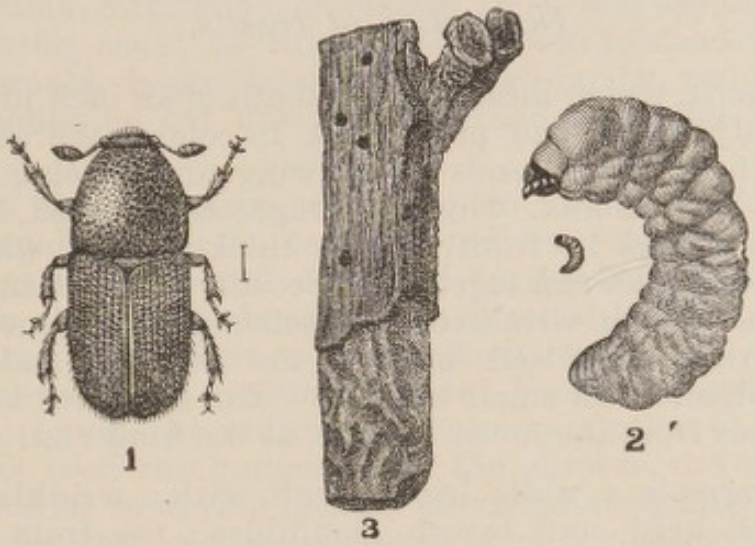
BOARD OF AGRICULTURE AND FISHERIES.

The Fruit Tree Beetle (*Scolytus rugulosus*, Ratzeburg).



1. Beetle magnified ; line showing natural length.
2. Larva, natural size, and much magnified.
3. Piece of Apple branch, showing holes in bark made by the beetle and channels made in the wood.

There have been numerous complaints of damage to fruit trees which on investigation has proved to be due to *Scolytus rugulosus*, the adults and the larvæ of which make tunnels, typically between the wood and the bark. The main stem may be infested, as well as the thicker branches and smaller twigs. If the part attacked has thick bark then the tunnels may be more in the bark than on the wood, but thin-barked branches are commonly attacked, and in such places the tunnels are cut sharply into the outermost youngest wood. The "mother galleries" run in the longitudinal direction and the "larval galleries" are more or less at right angles to these.

Scolytus rugulosus very willingly attacks sickly trees; the larvæ have been frequently found at work in the tips of shoots of trees injured by frost or other weather influences, as well as near knots and scars from canker or knife cuts. The beetle, however, also attacks healthy trees, and if in overwhelming numbers may kill them.

Trees attacked.—The Fruit Tree Beetle attacks apple, pear, plum, cherry, apricot, nectarine, peach, quince, bird-cherry, hawthorn, and mountain-ash.

Signs of Infestation.—External signs of infestation are, the withering and dying of the leaves, exudation of gum from such trees as cherry and plum, the dying away of the ends of twigs and smaller branches, loosening of the bark, the tiny entrance holes which may be obscured by exuded sap, and later the flight holes in the bark through which the new adults have issued.

Description of Insects.

The beetle, which measures one-tenth of an inch in length, is slightly shiny, and pitch-black in colour, the antennae, shanks, feet, and the ends of the wing-covers being reddish brown. The thorax, which is longer than broad, is somewhat narrowed in front and is thickly beset with deep punctures which run together, especially in front and at the sides, and give a wrinkled or puckered appearance. The wing-covers, narrowed behind, are striated and finely puckered, and bear small bristles. The abdomen is arched and slopes from the lower surface, at the hind end.

The larva is a white legless grub, with a wrinkled body, yellowish head, and brown mandibles; the front part of the body is thicker than the hind part.

The pupa is white.

Life History.

The adult beetles bore into the bark, and the female tunnels a gallery in the longitudinal direction, laying eggs right and left, and close together, as she goes along. The length of this "mother gallery" varies from half-an-inch to just over an inch. The larvæ on hatching eat out galleries more or less at right angles to the mother gallery; the regularity of the larval galleries varies according to the number of larvæ present, irregularity being more pronounced if the larvæ are overcrowded. Where there is room, and the branch attacked is thick enough, the larval galleries are regular; only at the top and bottom of the mother gallery the larval galleries bend round to run somewhat in the longitudinal direction. When full grown the larva gnaws out a bed, typically in the outermost wood and here pupation takes place.

There may be such overlapping in the generations that all stages—larva, pupa, and adult—may be found at the same time. The earliest beetles begin working towards the end of April and in May, and a brood from the eggs laid by these may begin to issue towards the end of June. From the earliest laid eggs of the June beetles new adults may appear in the autumn.

Treatment.

1.—Pruned branches should not be left in heaps to act as centres for breeding.

2.—Infested branches should be cut off and burned by the beginning of June before the new brood has escaped. Badly infested trees should be cut down and burned.

3.—In orchards, plantations, and gardens where there is considerable infestation, worthless trees that are unfruitful or decaying could be ringed and allowed to stand as traps; beetles would choose these for their egg-laying, and the trap trees should be cut down and burned with the enclosed brood.

4.—In the literature referring to *S. destructor* it is recommended that the trees should have applied to them dressings which would deter the beetles from boring. As, however, the thinner branches are attacked by this beetle the whole tree would need to be so treated, and where the trees are numerous such treatment would be scarcely practicable. Soft soap with the addition of a strong solution of washing soda has been recommended for the purpose, the coating of this material on drying being a preventative against the boring of the beetles; lime-sulphur in spring has been recommended for the same purpose.

The beetle is destructive to fruit trees in the United States and several European countries. In the United States several parasites (*Chalcididae*) help to keep the beetle in check; one of these has been identified as *Chiropachys colon* and another was probably *Pteromalus maculatus*. From some Scolytus larvæ sent to the Board of Agriculture and kept in suitable conditions, at least two species of *Chalcididae* appeared.

London, S.W.1,
June, 1898.

Revised, July, 1908.

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Leaflet No. 50.

BOARD OF AGRICULTURE AND FISHERIES.

Water Wagtails, or "Dish-washers."

(*Motacillæ.*)

There are five species of Wagtails found in this country. Of these only three are fairly common—the Pied Wagtail (*Motacilla lugubris*, Temminck), the Grey Wagtail (*Motacilla melanope*, Pallas), and the Yellow Wagtail (*Motacilla raii*, Bonaparte). The other two, the White Wagtail (*Motacilla alba*, L.) and the Blue-headed Wagtail (*Motacilla flava*, L.), are comparatively rare in Great Britain. Few species of birds are more useful—within the limits of their numbers—than Wagtails, because their food is for the most part of a "soft" character, comprising insects of all kinds and in all stages, and small snails and slugs. The seeds of weed plants may be taken when insect food is scarce. For this reason alone, apart from their beauty and their harmlessness to crops, they and their eggs deserve to be protected. They did not figure in the original schedules of the Wild Birds' Protection Act of 1880; but in several counties in England, Wales, and Scotland some of the species were added to the schedule later.

The Pied Wagtail.

Distribution.—The Pied Wagtail (*Motacilla lugubris*) is perhaps the most common of the Wagtails. It migrates from the more northern to the southern parts of the kingdom in the autumn, some of the birds leaving this country for the winter. Flocks of Pied Wagtails have been noticed in Kent and Sussex near the coast in September, evidently bound for foreign climes. These return again very early in the spring, but there are always Pied Wagtails to be seen throughout the winter in this country, except in the more northern regions.

Description and Nesting Habits.—The male of this species of Wagtail is rather more than 7 inches in length, and the female is slightly over 6 inches long, from beak to tip of tail. The body is black above, while the breast, belly, and parts under the tail are white (*see* Plate). There are also white feathers on the margins of the wings and tail, but the legs and beak are black. The throat is black in summer but becomes white in winter.

Breeding begins in the spring, and there are often two broods in the season. The nest is constructed of moss, dried grass, bents, and fine roots, and lined with wool, feathers, and other soft materials. From four to six eggs are laid, of which the ground colour is bluish white, with brownish or purple-brown specks.

Food Habits.—The Pied Wagtail may generally be seen in meadows, pastures and fields where cattle and sheep are

grazing, busily engaged in catching the insects attracted by these animals. Gilbert White says: "Wagtails run round cattle, availing themselves of the flies that settle on their legs, and probably finding worms and larvæ roused by the trampling of their feet." "Interest," he adds, "makes strange friendships." This bird is also seen near ponds, streams and rivers, and in marshes and flooded meadows, taking the insects found there. If Pied Wagtails are watched, it will be seen that they are never still, but are continually hunting for insects of all descriptions: beetles, flies, moths, and aphides, as well as millipedes, snails and slugs. They also diligently follow the plough in search of food, and doubtless then account for large numbers of insect pests.

The Grey Wagtail.

Distribution.—This species is not so abundant as the Pied Wagtail. It is of more solitary habits, and is found chiefly in the mountainous and hilly districts of England and Scotland. It frequently breeds, however, in Devon, Dorset, Somerset, and Wilts, and in localities generally where there are streams and brooks, and plenty of water; but less frequently in the south-eastern districts. It is fairly common in Ireland. It migrates to the more southern counties in the autumn.

Description and Nesting Habits.—The Grey Wagtail (*Motacilla melanope*) is not quite so large as the Pied Wagtail. In colour it is blue-grey or slate, with a line of white above the eyes. In summer it has a black chin and throat; the breast, belly and underside of the tail are yellow; the beak and feet are black. Yellow is such a prominent colour in the Grey Wagtail that its name scarcely seems appropriate, and it is, on this account, apt to be confused with the species described below.

It builds early in the spring, generally in banks, a nest lined with hair, much like that of the Pied Wagtail, and lays five eggs as a rule, though sometimes as many as seven have been seen. The eggs are of a creamy white colour, speckled with light brown blotches, and marked with a few black hair streaks.

Food Habits.—Like the Pied Wagtail, this species subsists almost entirely upon insects, and may be seen, especially near brooks and other water-courses and in marshes, busily hunting for its food. It is addicted also to small fresh-water molluscs, and this predilection doubtless enables it to do good service to sheep farmers and breeders by destroying quantities of the snail known as *Limnæa truncatula*, which is the host of that scourge of flocks, the liver-fluke (*Distoma hepaticum*, L.). Species of *Limnæa* have been found in the crops of all the three Wagtails commonly met with. It was not actually ascertained that the snails were *Limnæa truncatula*, but there can be no doubt that

if these birds feed upon one species of *Limnæa*, they would also feed upon *Limnæa truncatula*, a small thin-shelled snail coming from water-courses and wet ditches to marsh pastures and low-lying grass-land.

The Yellow Wagtail.

Distribution.—The Yellow Wagtail is not a winter resident in this country, but appears in April, and leaves in

THE PIED WAGTAIL (*Motacilla lugubris*).

September and October. It may, however, occasionally remain later, and the Board were informed in December, 1904, that Yellow Wagtails had been observed in two places

near Paignton (Devon), on Dec. 6th of that year. The species is distributed throughout England generally, but is not common in Scotland, except in the more southern counties, whilst in Ireland it is rarely seen. On the first arrival of the immigrants they are found in marshes and grass land, but soon pair and go to the cultivated fields.

Description and Nesting Habits.—The Yellow Wagtail (*Motacilla raii*), as its name implies, is mainly of a yellow or canary colour. The upper parts of the bird are olive, or greenish yellow, and the lower parts more of a canary yellow. The plumage of the female is not so bright as that of the male; the bill and feet are black. In length it is about 6½ inches. The nest, usually placed on the ground in grass or tufts, and occasionally on a bank, is composed of dried bents and fine roots, with dried grass and wool, or hair, or even fine roots, for a lining. Nests are sometimes found upon ploughed land. Two broods are sometimes produced in a season. From four to six eggs are laid; they are greyish-white, mottled with clay-brown, with a few black hair streaks.

Food Habits.—In cultivated fields this species may be seen hunting for insects and following the plough with assiduity, swallowing millipedes, wireworms, and other insects as they are turned up. Breeding begins early, and after the young are hatched, the birds move off to meadows, marshes, and pastures, where they follow cattle and sheep for the insects around them, and may be seen busily hunting for all kinds of insects, upon which they live. Like all the Wagtails or Dish-washers, they are constantly found near water-courses, ponds, and marshy places. There is no doubt that this Wagtail, like its congeners, devours the snail-hosts of the liver-fluke.

From this short account of Wagtails it will be seen that these birds are of very great economic value, and should everywhere be carefully protected.

London, S.W.1,
October, 1898.

Revised, August, 1911.

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Leaflet No. 51.

BOARD OF AGRICULTURE AND FISHERIES.

The Barn Owl (*Strix flammea*, Linn.).

The Barn, White, Screech, or Church Owl, as it has been variously called, is beyond question a most useful bird, and yet it has been much persecuted.

The destruction of this bird has been due to a variety of reasons : to superstition (associated with the bird's being a night flier and having a noiseless flight and a weird cry) ; to faulty observation and ignorance of its true food habits ; to the price obtainable for its eggs ; to the demand for the bird by bird-stuffers ; and to the use of its plumage for decorative purposes.

There is some ground for the belief that even with game-keepers the Barn Owl is not so ruthlessly destroyed as formerly, the statement that the chief food of the owl consisted of game birds having been disproved. The Barn Owl (like other birds of prey) has the habit of disgorging by way of the mouth indigestible particles, in the form of pellets, and by examination of these one can determine on what the bird has been feeding. Dissection and examination by competent and unprejudiced observers of numbers of the disgorged pellets, has proved that fur and not feather is the chief food.

Description.

The Barn Owl has the characteristic curved beak and strong talons of a bird of prey. The colour varies in different specimens ; the upper parts of the adult may be tawny-buff, mottled with grey and white and brown, and the under surface whitish. The upper side may, however, be more grey than brown, and the under side yellowish with greyish or blackish spots.

The face is white and the bill yellow. Round the eyes and beak the feathers show a heart-shaped pattern. The legs are long and covered with downy feathers. No tufts are present on the head, such as characterise the Long Eared and the Short Eared Owls. The female is rather larger than the male, the length being about 14 inches.

Favourite places for egg-laying are buildings, such as church towers, ruins, or barns, but holes in rocks, and hollow trees in woods are also used. Dovecotes may also be frequented, the owls living on the whole peacefully with the

pigeons. No actual nest is made. The eggs are white, and the number laid may be up to six or seven. Incubation begins, however, after, say, two have been laid, other eggs being laid at different periods during incubations, so that it is possible to find in the nesting place unhatched eggs and young of different ages.

The Barn Owl has a wide distribution.

Mode of Life and Food Habits.

During the day the owl stands motionless and asleep in its shelter-place, but at nightfall it sallies out with its stealthy noiseless flight and patrols its beat in the search for food. With its large eyes forwardly directed, the owl's sense of sight during flight is very keen (it cannot, however, see in perfect darkness), but it is equalled if not excelled by its sense of hearing. The ears are covered by folds of skin which are bent forwards during flight. The soft loose plumage enables the bird to fly along noiselessly so that the prey is not alarmed, while the slightest sound or motion of the prey is heard in the stillness by the owl. The cry of the owl is a weird screech or shriek, and both old birds and owlets make a noise resembling snoring.

The food of the Barn Owl consists chiefly of mice and voles, but rats may be taken and also bats; the larger insects are taken on occasion and even various small birds, but the percentage of these last is small; the Barn Owl has been known also to take surface-swimming fish.

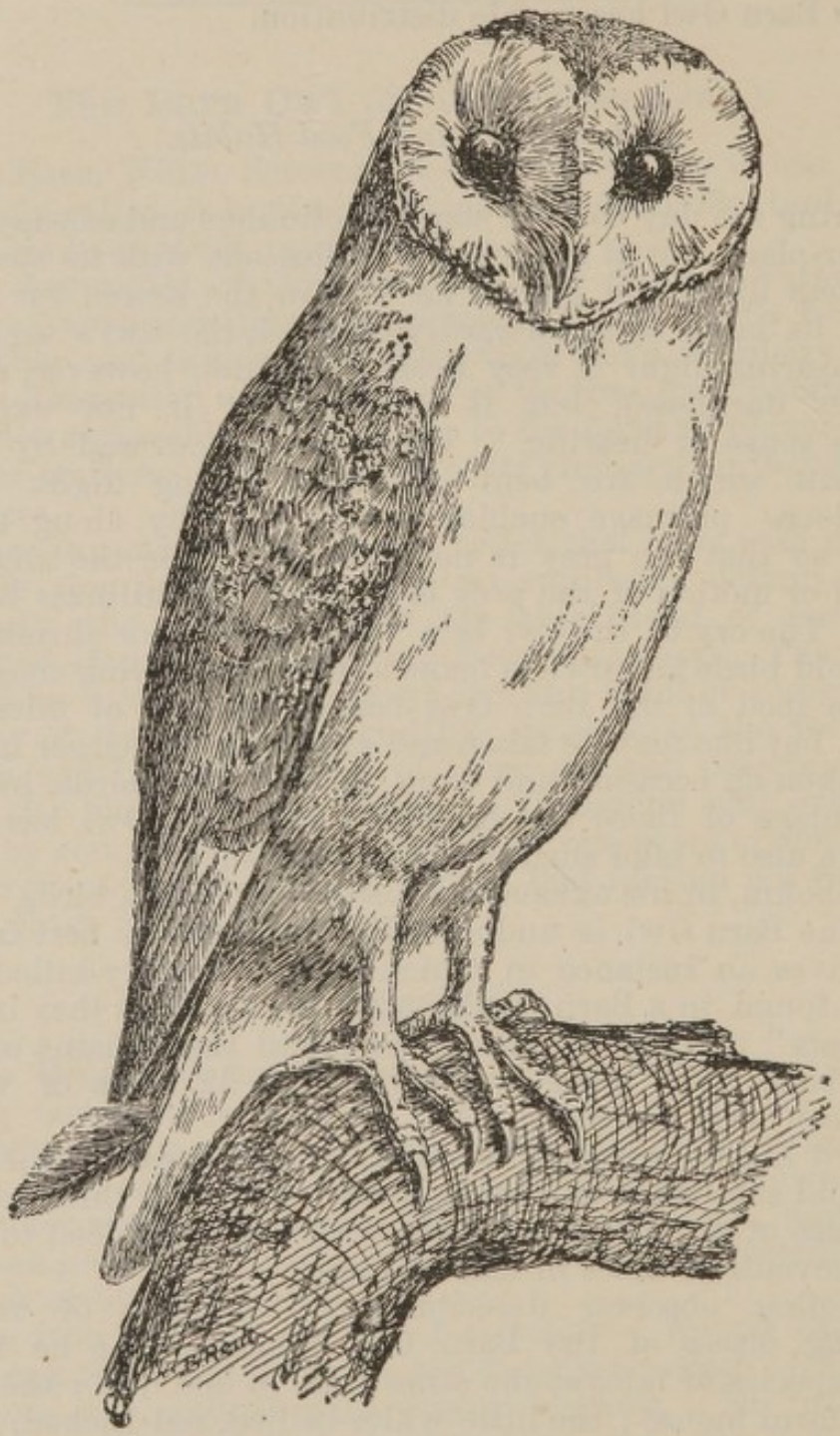
Seebohm, in his exhaustive history of British birds, holds that the Barn Owl is undoubtedly the farmer's best friend. He gives an instance in which twenty freshly-killed rats were found in a Barn Owl's nest. He also says that in 700 "pellets" of this owl there were found the remains of sixteen bats, 2,513 mice, one mole, and 22 birds of which nineteen were sparrows.

Lord Lilford writes of a half-grown owl eating nine mice in rapid succession and being hungry again in three hours; and also of an old pair of owls which brought food to their nest seventeen times in half-an-hour.

Another observer describing the contents of various nesting places of the Barn Owl remarks that he found four species of mice at the same time in one nest: the common farm mouse; the little white-bellied, red-backed, short-bodied, harvest mouse; the large, thick-coated, full-headed, short-tailed grass mouse; and the long, sandy, long-tailed long-eared field mouse.

The Barn Owl will take young hand-reared game birds, but this can easily be prevented by keeping them in their coops at night; naturally hatched ones are safe under the mother's wings at night.

In the Report of the Departmental Committee of the Board of Agriculture on Field Voles in 1893 it is stated that white and brown owls prey upon these pests, which caused much mischief on hill farms in Scotland; and in



THE BARN OWL (*Strix flammea*).

their two schedules of the natural enemies of the vole the Committee place in the first category of "Vole-killers, harmless or nearly so to sheep, crops, and game," owls of all sorts, buzzards, kestrels, and the smaller seagulls.

In view of the unanimity of evidence as to the great utility of the Barn Owl, from witnesses who have carefully studied its habits, the necessity for the careful preservation of this valuable bird cannot be too strongly urged upon the whole rural community.

The White or Barn Owl is included in the Schedule of the Wild Birds' Protection Act, 1880, which provides that any person taking or killing an Owl during the close season is liable to a penalty of £1. The close season is generally from the 1st March to the 31st July; but in some counties it lasts from the 1st February to the 31st August. The eggs of the Barn Owl are protected in a large number of counties.

London, S.W.1,
October, 1898.
Revised, April, 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. 52.

BOARD OF AGRICULTURE AND FISHERIES.

The European Gooseberry Mildew.

(*Microsphaera grossulariae*, Lév.)

The gooseberry plant is attacked by two distinct mildews, termed respectively the European Gooseberry Mildew and the American Gooseberry Mildew. The former, caused by the fungus *Microsphaera grossulariae*, is the only one dealt with in the present leaflet. The latter, caused by an entirely different fungus, is a very much more serious pest and will be found described in Leaflet No. 195.

The two mildews, though somewhat similar in certain stages, can with a little experience usually be distinguished even with the naked eye. The European Gooseberry Mildew occurs on the upper side of the leaves in the form of a very delicate white mould or mildew. In the early stages it is coated with a distinctly mealy substance. As is the case with all true mildews the *mycelium* (spawn) is quite superficial, although, in order to obtain the nourishment it requires, the fungus sends down minute suckers into the cells of the attacked leaf. The white mealy substance consists of masses of spores. These spores are termed *conidia* or "summer spores," and, being carried by insects or being blown about by the wind, bring about the infection of other leaves. As a rule the mildew is confined to the upper surface of the leaf, but occasionally it is found on the under surface and also on the berries.

Later in the season the fungus produces a second form of fruit. These consist of minute spherical spore-cases (*perithecia*) which contain the "winter spores" or "resting spores." They occur on the mildewed patches and appear first as yellow specks just visible to the naked eye, but ultimately become black. In autumn the spore-cases either fall off the leaves or fall to the ground with the leaves. They remain dormant during the whole winter. In spring the spores are liberated and shot out into the air. They are blown by the wind on to the new leaves just unfolding and infection results. The delicate white mould soon appears and a crop of summer spores follows in a few days. From these "primary" infections, new or "secondary" infections take place and thus in favourable weather the mildew spreads rapidly.

European Gooseberry Mildew may occur as early as May and it lasts throughout the season. It is widely distributed and as a rule causes but little damage; it is mostly found under heavy shade and on old bushes. When the attack is severe the leaves die, and fall off early in the season; the fruit as a result is checked in its growth and remains small. If a severe attack follows for several seasons in succession

the bushes become stunted and may even be killed. Red Currants are also occasionally attacked by European Gooseberry Mildew.

The most obvious differences between the present disease and the American Gooseberry Mildew may be summed up as follows. Whereas in the European Gooseberry Mildew the fungus occurs as a very delicate mould or mildew on the leaves, the American Mildew forms a dense white woolly mould which, though found on the leaves, attacks chiefly the shoots and berries. As the growth of the American Mildew continues the white stage gives place to a light brown woolly phase and finally to a thin dark-brown felted mat, which is very conspicuous on the berries and shoots. This condition is never found in European Gooseberry Mildew, where the mildew always remains thin and scanty. The resting-spore fruits, moreover, are in the European Mildew found exposed on the leaves, whereas in the American Mildew they are embedded in the felt on the shoots and berries. Occasionally the two mildews are found on the same plant.

Control Measures.

European Gooseberry Mildew can be controlled by spraying. If the amount present is small it will hardly be necessary to resort to this treatment, but if the attack is severe, or if from previous experience a bad outbreak of mildew may be expected, it will be advisable to spray occasionally with lime sulphur. The first application should be given early in May and at the rate of 1 part lime sulphur to 60 parts water.

The ground under diseased bushes should be dug over in winter in order to bury the winter spores, and if only a few bushes are grown the additional precaution may be taken of collecting and burning in autumn the dead and fallen diseased leaves.

London, S.W.1,
October, 1898.

Re-written, October, 1917.

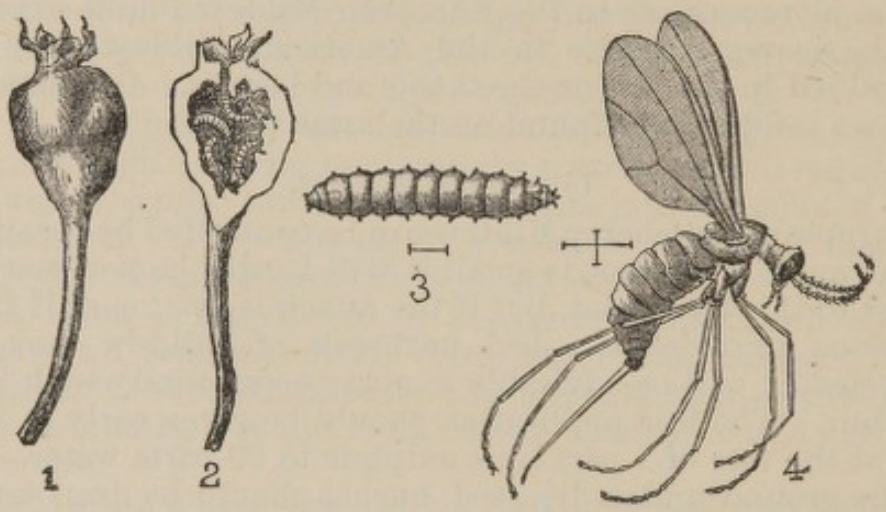
Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 53.

BOARD OF AGRICULTURE AND FISHERIES.

The Pear Midge.

(*Diplosis pyrivora.*)



1. Pear stunted and malformed by the larvæ within it. 2. Section of pear with larvæ. 3. Larva, much magnified. 4. Female fly, much magnified. Lines show natural length of fly and larva.

The pear midge causes serious losses in pear orchards by its attacks on the young fruit. Some pear growers, seeing the young pears falling fast in June when they are about the size of marbles, used to believe that this result was due to an unhealthy condition of the tree, or to influences of the weather, but they now recognise that it is more often due to the insidious attack of the tiny pear midge, the presence of which is far more common than is usually believed.

It would appear that early pears, and those that blossom early, are most liable to infestation by this insect. Williams' Bon Chrétien is notoriously subject to it, and in America, where the pear midge is very prevalent and most destructive, the Bartlett pear (identical with Williams' Bon Chrétien) and the Lawrence are the varieties chiefly attacked. Beurré de l'Assomption, earlier than Williams' Bon Chrétien, is also frequently seriously affected. Pitmaston Duchesse, Marie Louise, Jargonelle, Souvenir du Congrès, all early,

and like the Bon Chrétien in many respects, are also especially liable to be infested. Infestation has been noticed on later pears, as Josephine de Malines and Catillac, but in a much less degree than on earlier varieties.

Professor Riley, writing in 1885, considered that the insect had been imported from Europe, as until it was found in 1880 upon a certain farm near Meriden, in Connecticut, no insect of similar habits was found in the United States.

This is probably the same insect as that termed *Cecidomyia nigra* by Meigen. Schmidberger first described the habits of this insect in 1831. He says: "The species of gall-midges found by me in the pears are evidently the *Cecidomyia nigra*, because the description which Meigen gives of the black gall-midge completely agrees with this. I retain Meigen's name, and call it the black gall-midge." Riley, however, suggested that the name of *Diplosis pyrivora* would be suitable, and this has been adopted by entomologists, as it is not certain that Meigen's species is the same.

It is not known how long the pear midge has been at work in this country. It was first mentioned more than twenty-five years ago, and there is every reason to believe that it had been present here long before this, for its action upon pears, closely resembling, as it does, that of weather and other natural causes, might easily have been mistaken for these, especially as there were then comparatively few trained observers. It is certainly on the increase in many parts of the country, causing a heavy annual loss, and unless checked will cripple the cultivation of this fruit.

Description.

The fly is nearly one-tenth of an inch long, with an expanse of wings of nearly one-fifth of an inch. Its slender body is blackish-grey to black in colour, with pale yellowish and white hairs; its antennæ, with twenty-six joints in the male, are dark brown and very long; its legs are also very long, and yellowish brown. The wings are grey with dusky hairs, and a few dull yellowish ones at the base. The female is slightly longer than the male, having antennæ with fourteen joints, and an exceedingly long ovipositor for the purpose of depositing her eggs in the calyces of the blossoms of the pears. In colour the female is dusky grey, always paler than the male.

The larvæ are footless, yellowish-white in colour, and are composed of fourteen segments, with a brown head, bearing two nipple-like, two-jointed antennæ; on the underside near the head end is a long brown process slightly furcate at the tip—the anchor process or breast bone. When mature the larvæ reach one-seventh to one-sixth of an inch in length.

The pupa is about one-tenth of an inch in length, black above, and yellowish-brown beneath.

The eggs are longish, and transparent white, a number being laid in a single flower.

Life History.

The perfect midge appears in April, about the time the blossoms commence to show signs of the white petals, and continues on the wing until about the second week in May. The exact time varies from year to year and in different localities to some slight extent, The females lay their eggs both in the unopened and the expanded blossoms by means of the long egg-laying tube. When the blossom is unopened they pierce the petals and deposit the eggs on the antlers, usually in little heaps. When the blossoms are expanded they push the egg-tube deep into the pistil or ovary. In from four to six days the eggs hatch and the young maggots make their way into the developing fruit. By the first week in June some of the maggots are fully grown and commence to leave the fruit; the majority may be mature by the end of the second week, or towards the end of June the pears may still contain the maggots. Some are, however, unable to escape owing to the pears not splitting or decaying so rapidly, and thus remain on the trees longer. The majority of the maggots leave the pears, either by a cleft on the fruit or by some decayed patch. The fruit may or may not fall with the maggots in it; as a rule the larvæ escape when the pears are on the trees, but some correspondents mention the ground being covered with small fruit laden with midge larvæ. The maggots, in common with others of the genus *Diplosis*, have the power of skipping. When they leave the fruit on the trees they move to the other surface, bend their bodies and make a spring on to the ground. At times this jumping habit is very marked. As many as forty larvæ have been counted in a single pear, but fifteen to twenty seems to be about the normal number. In some pears picked at random from infested material the following numbers were found :— 16, 21, 28, 15, 19, 15, 17, 23. On reaching the ground the larvæ bury themselves under the soil, usually about an inch and a-half from the surface. Professor Lintner observed them to go as deep as two and a-half inches in America. At the end of about two weeks they have completed little papery cocoons of a dirty creamy silk, which become more or less covered with fine grains of earth. The cocoons are one-tenth of an inch long. Many of the maggots may remain as such until the end of winter and pupate in the early spring; others seem to pupate in a few weeks after entering the soil. If the larvæ cannot escape from the pear as sometimes happens, they remain in it (as larvæ) for some time, until it decays on the ground.

When the larvæ first attack the fruitlets their presence cannot be detected ; later they form small dark tunnels, and by degrees they hollow out all the pear, which becomes internally a blackened mass of pulp and excreta.

Appearance of Infested Fruit.

About two weeks after the attack has commenced the fruitlets begin to swell abnormally. The diseased fruit always grows much more rapidly than the sound. By degrees the fruitlets become deformed, some rounded, others bulged out at the sides and much distorted. On cutting them open they will be found to contain the larvæ. Internal examination should always be made, as sometimes pears become deformed from other causes.

Preventive Measures.

1.—In gardens the best remedy is hand-picking where dwarf trees are attacked, but in large orchards this is not possible.

2.—Mr. Fletcher, entomologist to the Canadian Government, suggested that when trees are persistently badly attacked and the fruit not likely to come to maturity, a heavy spraying with arsenites or sulphate of copper should be given so as to kill the fruit ; the larvæ would thus all be starved to death by having their food destroyed.

3.—Skimming off two inches of the surface soil beneath the trees in winter and burning it, replacing it afterwards as is done in gooseberry sawfly attack, would be sure to do good, but on a large scale probably could not be carried out. Certainly it is advisable to cultivate the ground beneath the trees, instead of having the land under grass.

4.—At present no detailed experiments have been carried out with spraying, but it is possible that by spraying with paraffin emulsion as soon as the blossoms show the first white petals, and at the same time giving the ground a good drenching with the emulsion beneath the trees, the pest might be deterred from egg laying and many killed in the soil. This would have to be done at the time when the flies are appearing from the soil. The emulsion for the ground should of course be stronger than that applied to the tree.

5.—The use of kainit has proved serviceable in America. Dr. Smith, who has made careful experiments with the pear midge, has found that kainit spread under the trees has been most effectual in killing the larvæ. He recommends that the ground under the trees should be dressed with kainit at the rate of a ton to the acre and mentions an instance of an orchard so treated having practically escaped infestation, while in an adjoining orchard not treated he failed to find a single fruitlet not containing larvæ. In New Brunswick

kainit has also been used with success in orchards at the rate of half a ton to the acre. In Great Britain some experiments (Journal S.E. Agri. Coll., No. 7., p. 27) have shown that kainit at the rate of 5 cwt. to the acre killed the larvæ if applied just about the time the larvæ fall from the fruit, though a Herefordshire grower who employed this method in his orchards got negative results. It is certainly advisable for growers to give kainit a fair trial at the rate of half a ton to the acre, a quantity that may be safely used, where the orchards are down with grass or not cultivated with strawberries or vegetables. To be successful the kainit must be spread very evenly, and be applied just before or when the larvæ are falling, as it has the greatest effect on the larvæ before they become enshrouded in their silken cocoons.

6.—Gas lime has been used but is not successful; its coarse nature enables many of the grubs to escape its effects, but possibly, if finely powdered and spread evenly, it might have a similar effect to kainit.

London, S.W.1,
October, 1898.
Revised, July, 1905.

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BOARD OF AGRICULTURE AND FISHERIES.

The Spotted Flycatcher (*Muscicapa grisola*, Linn.).

The spotted Flycatcher, known also in some districts as the "Beam bird" because it sometimes builds its nest on beams in outbuildings, is, as its name signifies, a devourer of insects. It is also known in Northamptonshire as the "Cobweb," and in Kent as the "Cherry sucker." It is a fairly common bird in England and some parts of Ireland, but is not so frequently met with in Scotland. This bird winters in Africa, and of our summer birds appears late, arriving in this country about the beginning of May, Gilbert White dating its arrival between May 10th and May 30th, although Markwick in his calendar gives the dates between the 25th of April and May 22nd. Other naturalists say that it generally appears when the oak is in leaf, which means that the date of its arrival in May depends upon whether the season is backward or forward. Selby says it seldom makes its appearance before the latter part of May, or until the woods are in complete foliage, when the particular insects that compose its food are in full vigour and maturity. Howard Saunders states that it has been observed exceptionally in our eastern counties as early as April 23rd. In Gilbert White's calendar the bird is recorded as departing from these shores between September 6th and September 29th, and these dates agree pretty closely with those given by Markwick and other observers.

Description and Habits.

The spotted Flycatcher is not quite six inches in length from head to tail. The head and back of the bird are of a chestnut-brown colour, while the wings and tail are of a darker brown; the breast and the under parts vary from greyish-white to greyish-brown; the legs and bill are dark brown. On either side, at the base of the bill, there are numerous hair-like pointed projections, or short bristles, which are peculiar to a few species of insectivorous birds, and serve to prevent insects from getting on the bill. The female is slightly smaller than the male, but almost identical in colour.

The spotted Flycatcher constructs its nest of stems of grass, horsehair, moss, lichens, and wool, lining it with feathers, common spots chosen being a hole in a wall or tree, the fork of a tree, beams in outhouses, ledges of rocks, fruit trees nailed to walls, and the stumps of trees. It returns to its old nesting haunts and often avails itself of

the old nests of other birds. The eggs are usually five in number, varying in colour from pale green to bluish-white, mottled with rust-coloured and purple spots. There appear to be two broods in the year.

Food of the Spotted Flycatcher.

The spotted Flycatcher frequents orchards, gardens, plantations and woods, and the banks of streams. It feeds exclusively upon insects, though it has been accused of eating fruit by those who have seen it near cherries and raspberries when in search of insects attracted by ripening fruit. Yarrell states that no remains of fruit were found in the stomachs of Flycatchers which had been suspected of taking fruit, and killed. Selby also observes that he has not been able to verify the alleged fondness of this bird for cherries, and he is inclined to believe that the Garden Warbler, sometimes called the greater Pettichaps (*Sylvia hortensis*) has in most cases been mistaken for the Flycatcher. The Garden Warbler does eat fruit, but there is not the least evidence of the spotted Flycatcher touching cherries or any other fruit, as it is sometimes supposed to do in Kent.

The spotted Flycatcher may often be seen either taking a short sharp flight in search of insects, or, perched on a rail, gate, or branch, making frequent swoops at passing insects and returning to its coign of vantage. Sometimes it half jumps, half flutters, from the ground and snaps up flies, gnats, and other insects within easy reach. It takes all kinds of insects: butterflies, moths, flies, sawflies, beetles, and aphides. During August when the air is thick with aphides coming in swarms from the hop gardens, the Flycatchers appear to be perpetually in motion from their eagerness to devour the winged hosts. Macgillivray says that the food of this bird consists exclusively of insects of various kinds. He gives a description of the feeding of their young by a pair of Flycatchers. The parent birds brought food to the nest five hundred and thirty-seven times during the course of a day. "Their motions," Macgillivray says, "were so uncommonly rapid that I could not for a single moment keep my eye off the nest. By short jerks they usually caught the winged insects. It is impossible to give the precise number of flies that might have been consumed by this brood, as they sometimes brought them one large fly, at other times two, three, four, five, and even more flies of different sizes."

Owing to its extraordinary insectivorous propensities and its perfect harmlessness, this little bird and its eggs ought to be carefully protected, and the birds encouraged to increase in numbers.

London, S.W.1,
January, 1899.
Revised, April, 1908.

THE SPOTTED FLYCATCHER.

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 Swallow.

(*Hirundo rustica.*)

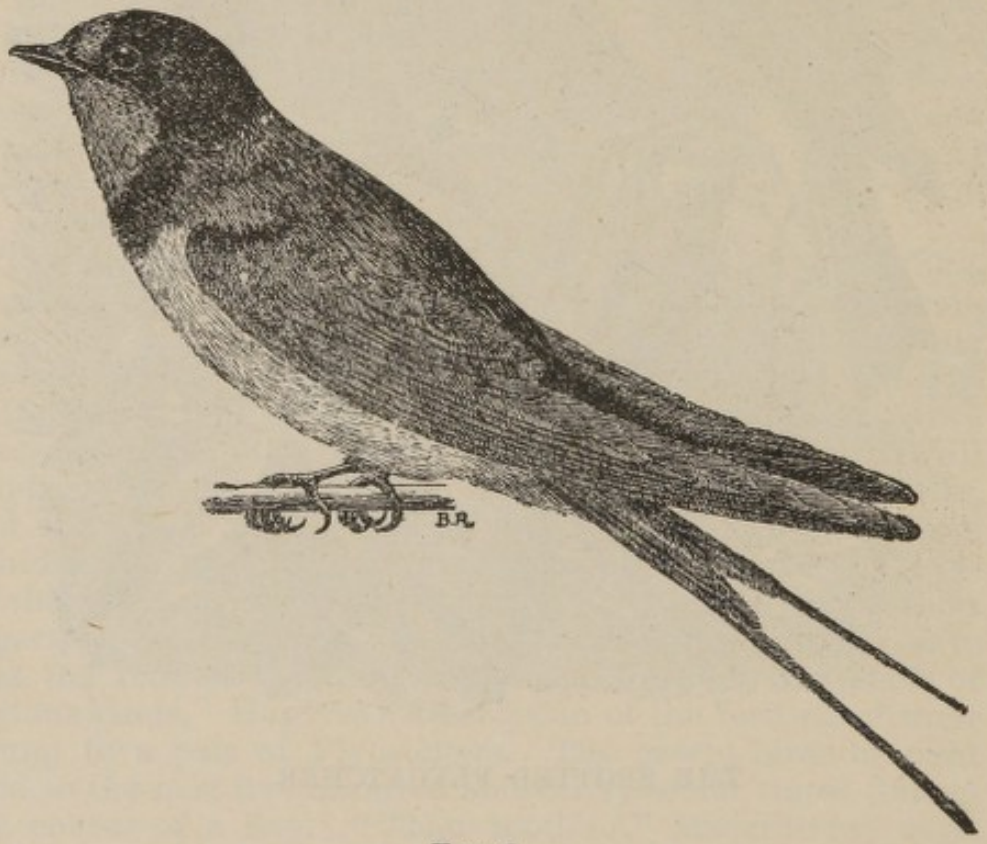

FIG. 1.

Male Swallow. (⅔rds natural size.)

This bird is sometimes called the "Chimney" Swallow, sometimes the "Barn" Swallow. Macgillivray says that the former name is not quite correct, as the Swallow rarely builds in chimneys. He distinguishes it from the Martin (*Chelidon urbica*) by calling the first the "Red-fronted," and the Martin the "White-rumped."

There is considerable confusion between the Swallow and the Martin, and this is accentuated by the similarity in their

habits and their appearance in this country at about the same time. They may be distinguished thus :—

Swallow.	Martin.
Forehead and throat chestnut-brown.	
Upper surface steel blue, including the rump.	Upper surface steel blue except the rump which is white.
Lower surface dusky reddish-white. (The female has lower surface whiter.)	Lower surface white.
Tail markedly forked, with a large white spot on the inner web of all except the middle pair of rectrices. (The female with outer feathers of tail shorter.)	Tail not so markedly forked, uniform in colour. Wings shorter.
Feet and toes not feathered.	Feathers on feet and toes.
Eggs white, speckled with brown or dark red spots.	Eggs pure white.
Nest open at the top.	Nest with a small hole only, for entrance.

The Sand-Martin is smaller than either of these two birds, and its upper surface is brown or mouse-coloured.

The Swallow, the Martin, and their ally the Sand-Martin (*Cotile riparia*), are of great benefit from an economic point of view, as insect-destroyers. They live solely upon insects, which they catch mainly when on the wing, though they may often be seen taking them from the surface of the water, and sometimes from the ground. Swallows take insects of many kinds, although probably their commonest food consists of the various species of two-winged flies. When the large species of *Tipulidæ*, such as *Tipula paludosa*, and other "Daddy Longlegs" or "Crane flies," come from the pupal form towards the end of the summer, and fly heavily over the fields, pastures, and lawns, they are eagerly seized by the Swallows, which fly low to secure them. Swallows have been observed destroying quantities of the "hop flies," or aphides (*Phorodon humuli*), as they leave the hop gardens for their winter quarters on the neighbouring plum and damson trees, from which they come again in the early spring and go to the hop plants. The migrations of these insects afford a fine harvest for Swallows, but unfortunately the latter are now so reduced in numbers that their influence in keeping down "hop flies" is much less effective than formerly. It is said by some observers that the regular

recurrence of hop aphis attacks, known as "blights," year after year, and their alarmingly increasing intensity are due to the absence of Swallows. This increase is, however, more probably due to the plan of planting prunes in the alleys.

In the Swallow (*Hirundo rustica*) the plumage of the head, neck and upperparts, including the wings and tail, is glossy steel-blue, with the forehead and throat chestnut; the rest of the underparts is whitish-buff; and all the tail-feathers except the middle pair have a large oval mirror of white on the inner web. The bill is black and the feet brown, or brownish-black. It is about seven inches from the head to the tail, and its wing expanse is fourteen inches. There is but little difference in the appearance of the sexes; the tail of the female is, however, shorter than that of the male, whilst the underparts are whiter and there is less black on the breast.

This bird appears in our country, as a rule, about the beginning of April, reaching the North of Scotland about the middle of May. Its nest is composed of mud or dirt mixed with bits of straw or dried grass and hair, and is lined with fine grasses and feathers. It is not covered like the Martin's nest, and is placed under the eaves of barns and other buildings, on the beams and joists of out-houses, under gateways, and beneath the arches of bridges. The eggs, of which four or five are usually laid, are white, speckled with brown or dark red and lilac spots. Normally there are two broods. The young of the first brood generally fly towards the end of June, and the second at the end of August.

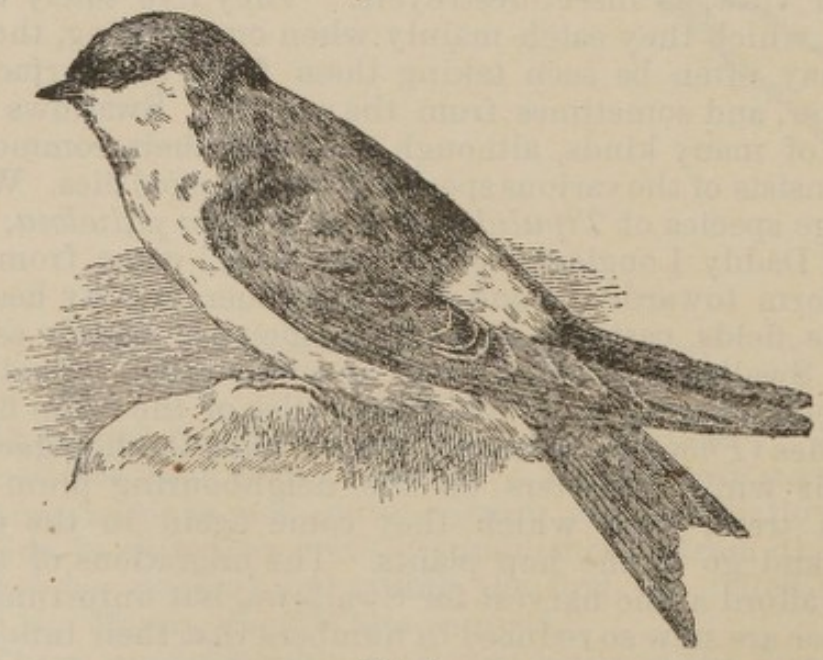

FIG. 2.

The Martin. (⅔rds natural size.)

About September the birds congregate and betake themselves at night to trees, telegraph wires, &c., to prepare for their long flight to warmer regions in Africa, where they pass the winter. All the Swallows do not leave in the first flight. The young birds may go first and the old birds later, the last flight taking place at the end of September or even in October.

The continued decrease in the numbers of Swallows and Martins is a serious loss to agriculture. It seems that there are two reasons for this diminution, one being the slaughter of the birds in the south of Europe, both for food and for purposes of millinery; the other reason being the disturbance to which they are subjected by the ubiquitous Sparrow, whose numbers have largely increased in late years. The places where Swallows have been accustomed to build are occupied by Sparrows, whose pugnacity and overbearing spirit will not allow any other birds to come near them.

The Swallow is not included in the schedule to the Wild Birds Protection Act of 1880; but a special close time has been prescribed for its protection in certain counties, and its eggs are also protected in several counties.

London, S.W.1,
January, 1899.
Revised, July, 1912.

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Leaflet No. 56.

BOARD OF AGRICULTURE AND FISHERIES.

Apple Canker (*Nectria ditissima*).

Apple Canker is one of the most destructive diseases with which fruit growers have to contend. It is a serious menace to fruit trees on the continent of Europe, whilst in England it has ruined many a plantation and placed certain kinds of apples very largely outside the pale of commercial cultivation. Though the term "canker" is often applied to various open wounds where the bark is swollen and rugged, the true apple canker, as understood in Britain, is a specific disease, and is caused by the minute fungus *Nectria ditissima*. The same fungus also causes canker in the pear, though the disease is not so frequent in this tree as in the apple.

Description.—The general appearance of apple canker will be recognised from the figures accompanying this leaflet. Fig. 1 represents an early stage of the disease, Fig. 2 one which is far advanced. The wounds may occur anywhere on the branches, but are found most frequently at a node or at the junction of a small branch with a larger one.

The commencement of the canker-wound and the various stages which follow may readily be observed if a diseased tree is studied with a little care. The young stages will be seen as small depressed areas, which gradually break away from the surrounding part of the shoot and are somewhat darker in hue. Such areas very frequently, but not invariably, originate around a dead twig (Fig. 1), and are caused by the activity of the fungus which has gained an entrance to the tissues. This small damaged area increases in size and usually becomes more or less elongated in outline. The tissue in the central portion dies and gradually decays, so that the damaged area assumes the form of an open wound surrounded in later stages by rugged bark. Such wounds, termed "canker" by gardeners, are found in many plants and may be produced by a variety of causes. In the apple, canker is due to the fungus *Nectria ditissima*, although, as explained below, the injury caused by Woolly Aphis is often very similar in appearance, and in fact the two pests are not infrequently found together and aid each other in the damage they cause. One of the most marked features of apple canker is the presence of more or less regular concentric rings around the wound, and it may frequently be recognised by these even in the absence of the fruits of the fungus.

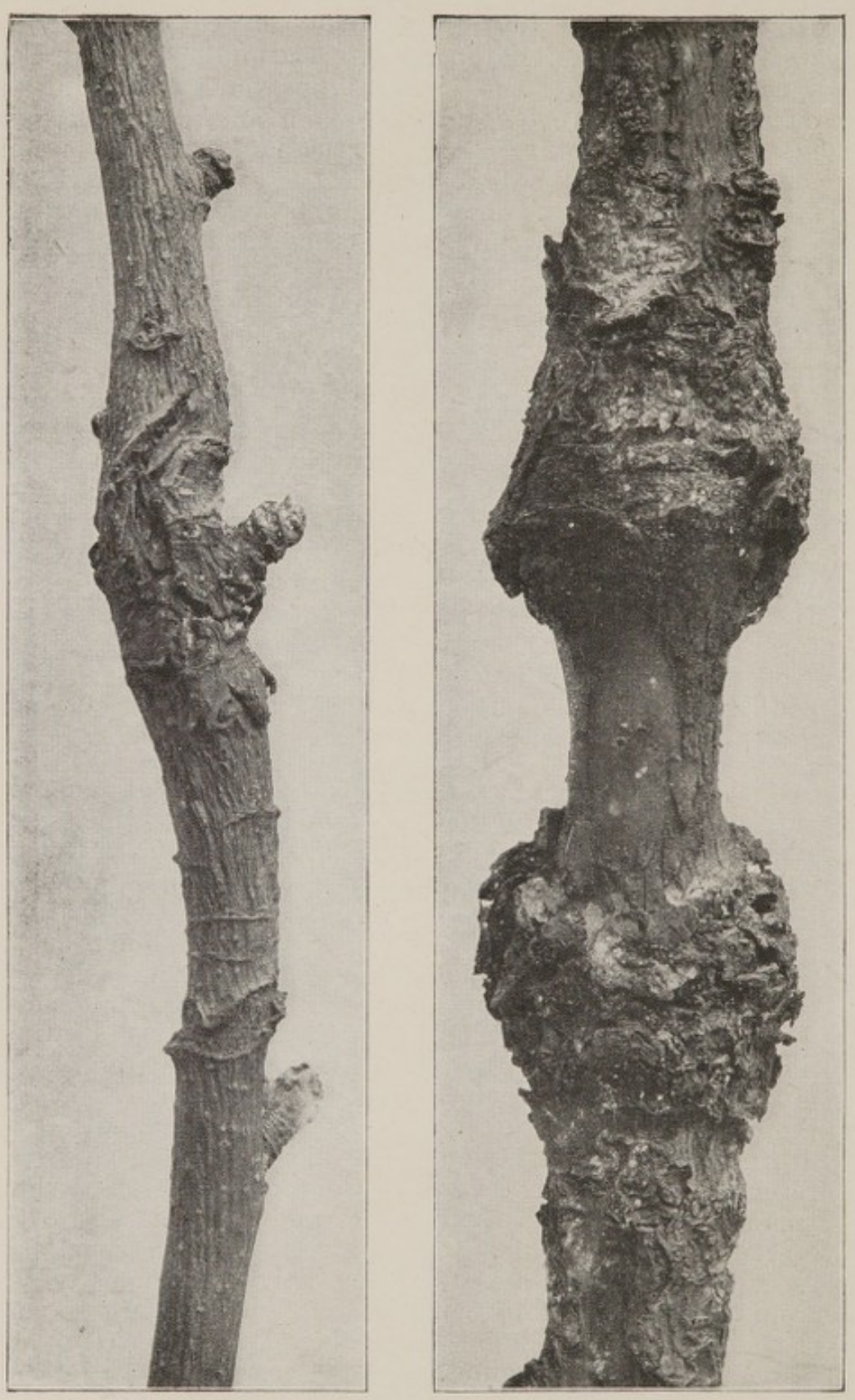
As the disease progresses the wound enlarges and a mass of swollen tissue, due to the repeated formation of callus by

the branch, arises around it. The subsequent behaviour varies under different circumstances and with different varieties of apple. In many cases the wound is confined to one side of the branch and the branch continues to live for many years. In other cases the parasite rings, that is completely encircles, the branch or shoot, as shown in Fig. 2, and causes its death. Provided the branch is not ringed the sap continues to flow, and such branches remain alive and may even grow and yield heavy crops of small fruit.

The fruiting bodies of the fungus, by which alone the disease can be identified with absolute certainty, are minute and occur especially in autumn and spring. Those formed in spring and early summer are perhaps the most conspicuous and best known. They occur on various parts of the wound and consist of round, rather tough bodies (perithecia), deep crimson in colour and about the size of a poppy seed. Large numbers of two-celled spores are liberated from these fruit-bodies and are conveyed by rain, wind, insects, &c., to other trees, and thus spread the disease. In late summer and autumn the fungus develops another form of fruit, which show as white or pale pink, very minute spots on the rough bark around the wound. The fruiting bodies bear masses of sickle-shaped spores (conidia) and these also serve to spread the disease.

Causes Leading to Attack.—The canker fungus gains entrance to a tree by means of wounds or small injuries, and apart from these the fungus spores are not able to infect the branches. The wounds may be large, such as those caused by hailstones, careless pruning, &c., but minute injuries, as, for instance, cracks in the bark, provide just as efficient means of entry. Other wounds which may frequently lead to canker are frost-cracks and the breaking off of young shoots due to careless picking or pruning. Probably one of the most frequent methods by which the fungus gains admittance is through injuries caused by Woolly Aphis. The soft, swollen tissue produced by the aphis is very apt to become cracked during the winter, and it is probable that when the aphis returns the following season to the wounded areas, Nectria spores are attached to their bodies and introduced into the cracks with the aphis. The aphis attack may usually be recognised by the masses of white, woolly substance excreted from their bodies and by which they are surrounded, although, as stated above, both aphis and canker are not infrequently present in the same wound.

Influence of the Soil.—Although the presence of wounds is essential for successful infection by the fungus, there are two other factors intimately concerned with the prevalence of disease. Chief amongst these is the question of location and



APPLE CANKER.

FIG. 1.—Young branch of Apple with a small canker present on the right-hand side. The commencement of the wound is at the base of short side shoot.

FIG. 2.—Older branch. The fungus here has not only destroyed the tissues on one side of the branch, but has completely encircled and killed it.

soil. Canker is always worse on a low site and a clay subsoil, so much so that it is impossible in such positions to grow certain varieties of apples successfully (*e.g.*, Lord Suffield, and Cox's Orange Pippin). The effect of damp, heavy soil is to cause rank growth, which is probably more readily injured by the fungus and more liable to be cracked by severe frost. Although a hill slope and more open soil are desirable much good may be done, where a bad subsoil is present, by careful drainage and by the encouragement of surface rooting. With improved conditions affected trees will sometimes grow out of canker, and by careful pruning, clean, healthy trees may be produced.

Susceptibility of Varieties.—Another factor of great importance is the nature of the variety, some sorts being exceedingly liable to the disease, whilst others are more resistant. Varieties such as Lord Suffield and Cox's Orange Pippin are so prone to attack that they are liable to canker even on good soil, whilst Bramley's Seedling is resistant and will often remain free even when grown on heavy land. The following varieties are amongst those which are most subject to attack :—

Cox's Orange Pippin.
Dumelow's Seedling (Wellington).
Ecklinville Seedling.
Lady Henniker.
Lord Derby.
Lord Suffield.
Peasgood's Nonsuch.
Pott's Seedling.
Ribston Pippin.
Stirling Castle.
Warner's King.
White Transparent.
Worcester Pearmain.

Amongst the varieties less susceptible may be mentioned :—

Annie Elizabeth.
Beauty of Kent.
Blenheim Orange.
Bismarck.
Bramley's Seedling.
James Grieve.
Lane's Prince Albert.
Mr. Gladstone.
Newton Wonder.

Control.—1. Old and badly-diseased trees should be cut down and burned. An exception to this rule may be made if, as occasionally happens, the trees are bearing well.

2. In the case of trees not so badly diseased, cankered shoots and badly-cankered boughs should be cut out. If a sharp look-out be kept for the commencement of the canker, affected branches may be removed without much loss of symmetry to the tree.

3. In the case of large boughs the canker-patch can sometimes be cut out with a sharp knife or chisel. If care be taken to cut down well into sound wood, and to protect the exposed surface, the wound may completely heal over, and the bough may thus be saved.

4. All cut surfaces should be covered by a protective substance, such as coal-tar, Stockholm tar, paint, white lead, painters' knotting, styptic, or grafting wax. If nothing

better is procurable the surface may be luted with clay. Rubbing earth over the surface, a frequent custom, should not be practised.

5. In certain cases, especially where the variety is very susceptible, the tree may be cut back and top-grafted with a more resistant variety, such as Bramley's Seedling. This practice is extensively adopted by commercial growers and often pays well.

6. Woolly Aphis, which not only itself injures the tree, but frequently also introduces canker, should be kept down. Instructions as to this pest will be found in Leaflet No. 34.

7. Apples are more liable to canker in heavy subsoils and in damp situations. Where a wet, heavy soil is present an effort should be made to drain it. In the case of young trees growing down into an unsuitable soil, the trees should be root pruned, and surface-rooting encouraged. On exceptionally heavy and stiff land trees may sometimes be planted on the surface and earthed up.

8. When planting a new garden or orchard, varieties resistant to canker, and those which have been found to do well in the locality, should be chosen.

9. Spraying is practically useless, but in order to reduce liability to infection all general sanitary measures should be adopted, and diseased shoots and prunings should be promptly burnt.

London, S.W.1,
August, 1899.
Re-written, February, 1918.

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BOARD OF AGRICULTURE AND FISHERIES.

External Parasites of Poultry.

The parasitic infestation of poultry causes far more loss than most breeders imagine. Birds are rarely examined, and the cause of their poor condition is not ascertained or even considered. The evil is allowed to spread unmolested, in many instances it spreads with great rapidity, and a general weak and unhealthy condition results. Insects and mites are the chief external parasites of poultry.

These parasites are most injurious to young chicks and "brood" hens. The persistent loss of chicks, and the failure of hens to bring off their young, are often due to the irritation caused by the presence of parasites upon their bodies—enemies that are frequently unsuspected. The insect and mite pests weaken the constitution and may predispose to other maladies. Parasites on the young birds stunt their growth. What is termed "Scaly-leg" is due to a parasite—a mite. Another species of mite at the roots of the quills is sometimes the cause of birds plucking their feathers.

There are three distinct groups of insect and mite pests upon fowls, namely :—(1.) Fleas (*Pulicidæ*) ; (2.) Biting or Bird Lice (*Mallophaga*) ; and (3.) Mites (*Acarina*). The two former only are true insects, having the six insect legs ; the *Acarina* have four pairs of legs when adult and are quite distinct from true insects. The fleas and some of the worst mites are armed with a piercing and sucking mouth ; the bird lice or *Mallophaga* have biting mouths. The pests with piercing mouths weaken the birds not only by causing irritation but by actual robbing of blood. The biting lice, on the other hand, generally only cause itching and severe irritation, which keep the birds in constant unrest ; it is not impossible, however, that on occasion they may draw blood. Most birds have each their distinct parasites, each species of louse only flourishing on a particular species of bird ; duck lice, for instance, cannot live permanently upon fowls, and *vice versâ*.

Different species also seem partial to particular parts of the bird's body. The favourite positions seem to be the head, neck, rump, and under the wings. Some of these parasites live permanently on their hosts (lice and some mites), whilst others (fleas and some mites) go to and fro. Some mites live entirely upon, and even under, the skin, deep amongst the feathers and at their roots ; some lice live like "ticks," with their head against the skin and their body erect ; whilst a single genus (*Lipeurus*) (Fig. 4) lives between the barbs of the feathers. All these parasites are encouraged by dirt and uncleanly conditions.

1. Fleas (*Pulicidæ*).

The fleas, which are true insects, belong to the order of flies (*Diptera*). They feed upon the blood. Only one species lives upon the fowl, namely, the Hen flea (*Pulex gallinæ*). This flea is abundant in dirty fowl runs, and especially in the nests where straw is used. The adult flea is dark in colour, and, as in all fleas, is devoid of wings. The fleas are provided with very sharp piercing mouths. They are not noticed on the birds, because they generally attack them at night; then, however, they do much harm, causing constant irritation and loss of blood, and depriving them of rest.

Life-history of the Hen Flea.—The female flea lays her eggs (nits) chiefly in the nests amongst dust and dirt and in the crevices of the walls and floor. These nits give rise to pearly white maggots, with brown horny heads; the maggots can often be found in the bottom of the nests amongst the dust (Fig. 1). These larvæ are mature in two or three weeks,

FIG. 1. Larva of hen flea (greatly enlarged).

FIG. 2. Pupa of hen flea (greatly enlarged).

when they reach about one-sixth of an inch in length. In warm weather they may be full fed in even ten days. They then spin a pale cocoon amongst the dirt, in which they pupate. The pupa (Fig. 2) is at first pale brown, then dark chestnut brown. In this condition the flea remains ten to twenty-one days, when the pupa hatches into the adult. Hen fleas breed all the year round, but chiefly in warm weather. It is well to remember that, whenever there are dark and dirty hen roosts, there are sure to be numbers of fleas.

For *Prevention and Treatment*, see p. 4.

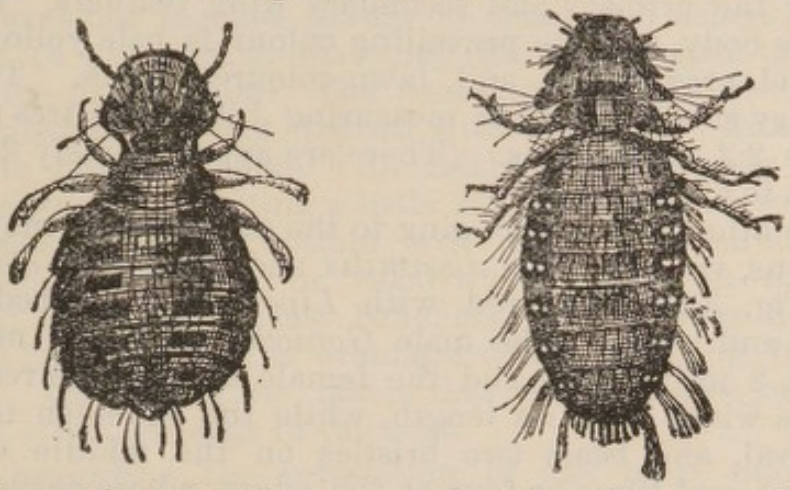
2. Biting Lice (*Mallophaga*).

The bird lice belong to the group *Mallophaga*, quite distinct from human lice (*Pediculidæ*) and from lice of the genus *Hæmatopinus*, &c. The *Mallophaga* have not a piercing and sucking mouth, but their mouth is fitted for biting and cutting. They subsist upon the productions of the skin and fragments of feathers. They cause violent itching, and bite sharply, and must produce considerable pain when present in large numbers, as they too frequently are. The feathers, especially the saddle hackles, generally show notched edges with lice infestation. Eight distinct species of lice attack fowls. The presence of these lice is generally ascribed to too uniform or insufficient nutrition, and also to damp, dark,

and dirty runs, especially those badly ventilated. Food either when uniform or insufficient, has no effect upon their presence. Dark damp places, however, when dirty, are sure to harbour all these pests, especially when badly

FIG. 3.

Two Species of Fowl Lice.



Fowl louse (*Goniocotes hologaster*) (greatly enlarged).

Fowl louse (*Menopon pallidum*) (greatly enlarged).

ventilated. It is also said that breed affects their presence, but observation tends to show that all breeds are more or less subjected to infestation. In every case they set up severe irritation and inflammation of the skin, which often leads to stunted growth, and even death. Lice and other parasites flourish on unhealthy birds.

Life-history of Biting Lice.—All the lice breed fairly rapidly. The eggs or nits are laid upon the down feathers

FIG. 4.

Fowl louse (*Lipeurus variabilis*) (greatly enlarged).

as a rule; they are often beautifully sculptured objects, oval in form. In about six to ten days they hatch into small, pale, active lice, which at once commence to irritate the birds. The adults are occasionally found in the nests. Before reaching the full-grown state these lice moult their skin ten or twelve times, there being little difference in each stage, except the gradual darkening of the markings.

Menopon pallidum (see Fig. 3) is the most troublesome of the fowl lice, and it runs with great nimbleness among the feathers. The head in front is somewhat angular and somewhat crescent-shaped. The temples are rounded and bear four bristles and a few hairs. The abdomen is oval and

elongated, and each segment carries a series of bristles. In colour this pest is pale yellow, with bright fawn spots on the abdomen. *M. pallidum* has been kept alive for months upon fresh feathers, when the quill epidermis especially was consumed.

Lipeurus variabilis (see Fig. 4) may be found in considerable numbers among the feathers of the fowl, especially among the primary and secondary wing feathers. It has a narrow body, and the prevailing colour is pale yellow, with dark-coloured bands and fawn-coloured spots. The lice are very small, the male measuring 1·9 millimetres and the female 2·2 millimetres. (There are approximately 25 millimetres to an inch.)

Two other forms belonging to the same section may infest chickens, viz., *Goniodes dissimilis* and *Goniocotes hologaster* (see Fig. 3). Compared with *Lipeurus*, their bodies are flatter and wider. The male *Goniodes dissimilis* measures almost 2 millimetres and the female 2½ millimetres. The head is wider than its length, while the abdomen is broad and oval, and bears two bristles on the middle of each segment, and three or four at the edges, where curved spots also occur. The general colour is whitish, the spots being darker, with fawn-coloured bands. *Goniocotes hologaster* is much smaller than *G. dissimilis*, the male being ·9 millimetres and the female 1·3 millimetres in length. The head is as wide as it is long, and it is broadest just behind the antennæ. This insect is of a yellowish colour which darkens at the thorax, and it has brownish black bands.

Prevention and Treatment of Fleas and Lice.

1.—Infestation is always worse in dirty and neglected runs and roosts, which are a standing danger to more cleanly neighbours. Cleanliness and freedom will always put fleas and lice under a disadvantage, and not only should the nests, walls, and floor be kept clean and sweet, but also the ceilings and perches. To suppress these pests the houses should be cleaned down at least twice a year with a wash made of hot lime and soft soap, the ceilings, walls, and nests receiving a good coating; the wash should be fairly liquid so that it may run into every crack and crevice.* Early spring and autumn are the times for these applications. The perches are best treated with boiling water and soft soap, or with an emulsion of kerosene. As an additional means of prevention, solutions of commercial disinfectants made up to double the strength recommended for ordinary domestic use may be applied, by means of a watering can fitted with a fine rose, or by means of a garden syringe, to the inside of the house, the woodwork of

* To every gallon of lime-wash add ¼ lb. of soft soap, previously dissolved in boiling water.

the runs and to the dust-bath. Such treatment may be carried out weekly, or at longer intervals. It is important that houses should be well built, with as few cracks and crevices as possible, for the pests congregate in such harbours and may escape from any wash used

2.—Special attention should be paid to the nests, and these should be frequently cleansed and changed. Neither nest-boxes nor perches should be fixed, and relays of each should be at hand, so that they can be changed to ensure complete disinfection. The nest-boxes should be now and then cleaned out, and dressed with hot lime. Either dusting the prepared nests with fresh Persian insect powder (*Pyrethrum*) or putting a little sawdust or sand soaked in naphthalene at the bottom will have the desired effect. Pine-wood shavings, or wood-wool, placed in the nests instead of straw is most beneficial. No lice or fleas will live in it, owing to the aromatic odour given off from the wood. Care must be taken that the remedies employed do not affect the eggs in the nest.

3.—Regarding the infestation of the birds themselves, white precipitate seldom fails. The heads and necks of young chicks should be early dressed very sparingly, and this treatment should be repeated when necessary. White precipitate is a strong irritant poison, and needs the greatest care in its use, especially in the case of young chicks. It is best obtained as an ointment from the chemists. Hens selected for sitting should have a small quantity of this ointment rubbed in under the vent, head, and sides, and then be well dusted with fresh insect powder (*Pyrethrum*). Sitting hens are greatly tortured by parasites, and their young are often lost by neglect of these simple precautions. Dust-baths are the natural remedy for lice and mites, and fowls should never be kept without them. Sand and road dust, mixed with a small quantity of paraffin, will generally keep the birds free from vermin. In place of paraffin *Pyrethrum* powder may be used with the dust. Some poultry keepers find that when paraffin is added the birds avoid the dust-bath.

The supposed connection between "Gapes" and "Lice."—It has been stated that there is a connection between lice and the nematode worm, *Syngamus trachealis* (the "red-worm" of gamekeepers), that produces "gapes" in fowls and pheasants, and the one is thought to give rise to the other in some mysterious way. It may here be stated, therefore, that there is no life-history connection whatever between lice and "gapes." The life-history of that destructive scourge, the gape-worm,* has been clearly traced, and it is known that no intermediate host is required for its development.

* *See* Leaflet No. 58 (*The Nematode or Round Worm Diseases of Poultry.*)

3. Mites (*Acarina*).

Mites are very minute creatures, and they bear four pairs of legs when adult. Some live on the birds *at night*, as the red hen-mite (*Dermanyssus avium* or *gallinæ*) (Fig. 5); others are permanent parasites, *e.g.*, Itch mites or *Sarcoptes*, living at the base of the feathers,

FIG. 5.

Dermanyssus avium and ovum (greatly enlarged).

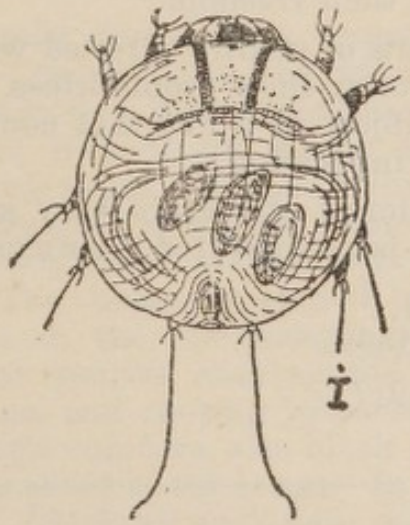
and popularly called "Depluming scabies" (Fig. 6) or, living under the skin, forming scabby growths, such as are seen on fowls' legs (*Sarcoptes mutans*). These skin mites, which are armed with a pricking mouth with which they torment the birds, especially at night, cause loss of condition, hinder sitting, and create loss in other ways.

The Red Fowl Mite (*Dermanyssus avium*).—The common red fowl mite is a very injurious form. It is a very minute creature and is yellowish white to dark red in colour, according to the amount of blood it contains, drawn from the birds. The mites are found in abundance in pigeon-houses and poultry-roosts, while they often attack cage birds. Both sexes are armed with a sharp rostrum, but the female is most bloodthirsty. They feed upon the birds only at night, and hide away in cracks and crevices in the nests, perches, floors, walls, and ceilings during the day. Brood hens are worried, and young birds become anæmic and may die. Numerous colonies can be found in the nests, especially in straw nests, with countless eggs and young forms, and quantities of cast skins. They are most prolific, and can also remain for months without any live host to feed on; hence the removal of the birds from the runs is useless as a remedy. The eggs hatch rapidly, and the young are at first silvery white, with six legs. They moult their skin a number of times, the cast skins forming a whitish or silvery powder often seen on the perches, and as the mites grow older they become darker in colour. Light and air are distasteful to them; damp, dark, and badly-ventilated places are where they flourish best. Breeding is especially rapid in spring and summer. The red fowl mite is often unobserved, owing to its strict nocturnal habits, and hence

the cause of the fowls keeping backward, and even dying, is not understood. When looking dejected and emaciated, birds should be examined at night, and if mites are found cleansing treatment should be at once resorted to as regards the houses and perches ; some paraffin in the cleansing wash is excellent for the perches. If bisulphide of carbon is used for fumigating the houses, fumigation must be repeated, as the eggs escape. Transmission to man and other animals (*e.g.*, horse, dog, cat), is not unusual, but, although the mites for a time cause severe irritation, they will not remain for any length of time, and readily yield to treatment. Hens should not be permitted to roost in stables and sheds where other animals are kept.

FEATHER-EATING OR DEPLUMING SCABIES.—Feather-eating in poultry is often due to a minute parasitic mite (*Sarcoptes laevis*) at the roots of the feathers. It is generally supposed to be due to a "vicious habit," numerous absurd theories, such as idleness and thirst, having been put forward to account for it. There are two kinds of feather-eating, viz. "self-feather-eating" and the plucking of other birds' feathers The former is chiefly due to the mites living upon and irritating the roots of the quills. The form on the fowl makes its appearance about April, and is most prevalent in spring and summer. Beginning at the rump, the disease may spread to other parts, the head and neck often being badly affected. The mites can be easily found amongst the white powdery matter at the base of the quill. The fowls pluck out the feathers to get rid of the irritation

FIG. 6.



Sarcoptes laevis. Egg-bearing female (greatly enlarged).

caused by the mites at their base. Besides the loss of feathers the suffering birds become thin, and fall off in egg-laying. Lice, also, are partly accountable for feather-plucking. The birds in picking at the mites and lice pull out the feathers.

Prevention and Remedies.—As the mite disease is contagious, isolation of the affected bird is the first step, especially if it be a cock. The mites readily yield to treatment with oil of cloves rubbed into the infected area. A mixture of one part of creosote to 20 of lard or vaseline is s ill more successful. Another measure is to wet the base of the feathers with soapy water, and then dust the birds with fresh *Pyrethrum.*

SCALY LEG.—This well-known disease is also due to a mite (*Sarcoptes mutans*). This complaint is a serious matter and very prevalent. The scales of the legs and feet become raised and separated, and a chalk-like excretion accumulates between and over them. Rough lumpy crusts are formed, and under these and the scales the mites live and breed. The disease is slightly contagious, and may pass to other birds than fowls. Infected birds are lame, they have a difficulty in perching, and they fall off in condition.

Prevention and Remedies.—Isolation of diseased birds is most essential. Removal of the crusts without causing bleeding, and then the application of a mixture of creosote (one part) and lard (20 parts), will be found sufficient. The legs should be previously bathed in hot water in order to soften the crusts. A mixture of equal parts of flowers of sulphur and vaseline rubbed into the limb also cures this complaint. In every case the limb, some days after treatment, should be well cleaned with hot water and soft soap. It is most important than any new stock should be examined, especially cocks, and if any signs of parasites are seen they should be cleared off before the birds are given their freedom.

NOTE.—If exhibits of poultry intested with parasites were prohibited by poultry-show committees, it would force attention to the subject in a way that could not fail greatly to reduce parasitic infestation.

The pests mentioned above are very small, and a good lens or microscope is required for their examination.

London, S.W.1,
August, 1899.

Revised, June. 1917.

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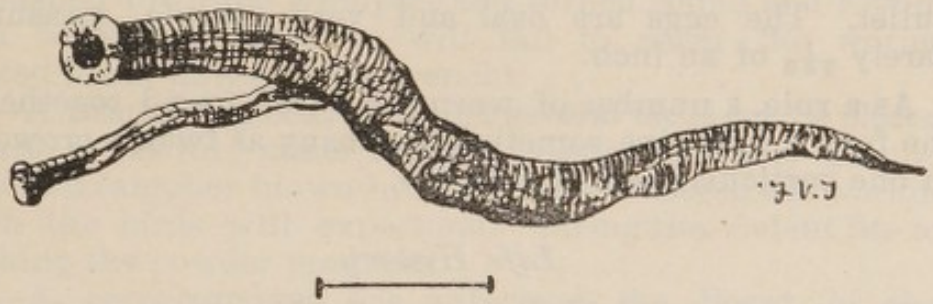
BOARD OF AGRICULTURE AND FISHERIES.

The Nematode or Round Worm Diseases of Poultry.

The Nematode worms are characterised by the rounded and generally thread-like character of the body. The sexes are separate. Some are free-living in the open, but the majority are parasitic either on plants (*e.g.*, eelworms), or on animals. Of the round worms parasitic in poultry the two worst genera are *Syngamus* and *Heterakis*.

I. The Gape-worm (*Syngamus trachealis*).



The Gape Worm (*Syngamus trachealis*), male and female (mag., line showing natural size of female).

Gapes is a disease caused by a nematode or round-worm which takes up its abode in the windpipe and sometimes in the bronchial tubes. It is scientifically named *Syngamus trachealis*. The Gape-worm is also known as the Red-worm and Forked-worm. Not only fowls and turkeys, but pheasants, partridges, sparrows, linnets, starlings, rooks, martins, swifts, and green woodpeckers are also invaded by this parasite. The disease is caused by the worms taking up their abode in the air-passages, attaching themselves by their circular mouths, sucking the blood, irritating the lining membrane, and causing inflammation. These pests, if present in large numbers, also block up the windpipe and stop the passage of air to the lungs. In either case the birds may succumb. Chickens up to four weeks old are the most susceptible.

The Gape-worm is nearly always found in copulâ inside the host, the small male worm being permanently attached to the female towards her head end, and the two worms making a fork; hence the name of Forked-worm. The smaller branch of the fork is the male.

It is chiefly in chicks and turkey poults that gapes causes the greatest mortality, although old birds are sometimes attacked. The birds contract the disease by picking up eggs or embryos from infected ground or polluted water; probably also in eating earthworms that have swallowed the eggs of the Gape-worm. That wild birds play some part in the dissemination of gapes is also extremely probable.

The *symptoms* of gapes are a curious listless gaping of the mouth, a wheezing cough and stretching forward of the neck, a ruffling of the feathers, and a drooping of the wings, while there is frequently an appearance of frothy saliva in the mouth and sometimes in the nostrils.

Description.

The Gape-worm is reddish in colour, often bright red. The male measures up to one-fifth of an inch in length and the female up to four-fifths of an inch. The mouth is circular or bell-shaped, and at its base are six horny lancets or processes surrounding the opening that leads into the gullet. The eggs are oval and very minute, measuring barely $\frac{1}{250}$ of an inch.

As a rule, a number of worms may be found together in the fowl's windpipe, sometimes as many as twenty crowding in one particular part of the tube.

Life History.

The eggs are not laid, but when the female worms become mature and full of eggs they and the attached males are coughed up by the bird. These worms, coughed out, lie about on the ground, and they may be picked up by the birds and eaten, and the eggs liberated; or, lying on the ground or in water, they sooner or later burst. Thus the eggs and embryos are scattered, and the poultry run becomes infested. The eggs hatch—in damp places especially—into tiny white embryo worms, and both eggs and embryos, being picked up by a chick, are capable of directly developing into the adult Gape-worm.

Experiments have shown that birds fed with ova and embryos of *S. trachealis* will develop gapes, and thus no second host, such as we find in the tapeworms, is necessary. Although a second host is not necessary, numbers of the eggs and embryos are swallowed by earthworms, and doubtless fowls may contract gapes when eating these worms, which thus act as carriers of the disease.

Treatment.

1.—Houses, coops, and hatching boxes should be thoroughly cleansed, being treated with hot lime-wash.

2.—Water vessels should be kept scrupulously clean and only pure water given to the birds. The drinking troughs are best cleansed by being put in boiling water and well scalded.

3.—Any bird showing signs of the disease should be isolated.

4.—Chicks should not be kept with the stock birds. Fresh breeding ground should be used if possible every year. The worst outbreaks are always on overstocked land.

5.—If the birds are kept in small runs, the runs should be disinfected either with gas-lime, or with hot powdered lime, or by watering with a 1 per cent. solution of sulphuric acid.

6.—It is most essential that all chicks which die from gapes should be burnt rather than buried.

7.—Local treatment of the throat with a feather soaked in carbolic oil, turpentine, &c. is specially meant for cases where the upper air passages are blocked with plugs of worms. Such treatment must be carefully applied. The worms may also be partly removed from the windpipe by means of a feather, dipped in oil of cloves or eucalyptus oil, pushed down the windpipe and turned round and round. Such treatment, however, will fail to reach the worms situated lower down in the bronchi.

8.—A fumigating box, in which several birds can be placed at once, is useful; either *Camlin powder* or finely ground chalk and camphor blown into the box will loosen the worms, which the birds will expectorate during the violent fits of coughing the powder produces.

9.—A correspondent has informed the Board of the following remedy as having proved very effective in cases of gapes in poultry :—"A brick is placed on the fire till nearly red hot. It is then taken out, put at the bottom of a large sized pail and a small quantity of ordinary carbolic oil poured on it. The chickens which require treatment should be previously placed in an old basket, which is placed on the mouth of the pail, but not touching the brick. The fumes from the oil rise and pass through the interstices of the basket, and are kept from escaping too fast by a cloth which is thrown over the basket. The chicks are kept here until nearly suffocated, and then immediately placed in the open air. The birds treated were unwell for a day or two, but the treatment was so effective that only in a few cases had it to be repeated."

Fumigation with sulphurous acid or chlorine would probably prove superior in its effects to fumigation with carbolic acid, which is very poisonous to the system as well as having a local effect.

II. White Intestinal Worms.

Death is not frequent from intestinal worms, yet weakness is very often caused by two Nematode worms, *Heterakis*

papillosa and *Heterakis inflexa*. These worms are found in different parts of the small intestine, often in considerable numbers. Sometimes they interfere with the passage of food by forming a plug and blocking up the alimentary canal.

Birds infested with them are usually ravenous and yet keep losing condition.

Description.

Both worms are white or yellowish white. *Heterakis papillosa* resembles a small pin without the head, the body thinning out at both ends. The male measures ¼ to ½ inch in length, and under the microscope shows at the hind end two projections or spicules. The female measures ⅜ths to ⅝ths of an inch in length and has the hind end of the body distinctly more drawn out than in the male.

Heterakis inflexa is a somewhat larger worm and is not found straight but with body twisted or curled. The male measures from 1¼ inch to 3 inches, and the female from 2¼ inches to 4 inches.

Life History.

The worms are adult in the bird's intestines; and here the eggs are laid. The eggs are passed to the outside, and these or the young embryos reach the bird again in dirty water or from the ground.

Treatment.

1.—Diseased birds should be isolated.

2.—The worm can easily be expelled by a dose of Thymol; one grain made up in a dough pill may be administered morning and night.

3.—Similar good results have sometimes been obtained by the use of one to three grains of Santonine, given in the same way, the one grain for chicks.

London, S.W.1,
October, 1899.
Revised, April, 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.

Improvement of Land Acts.

(England and Wales.)

The Improvement of Land Acts, 1864 and 1899, enable owners of land with the sanction of the Board of Agriculture and Fisheries to borrow money for agricultural and other improvements and to charge the cost of the works upon the lands improved. The maximum period over which such rentcharges may extend is 40 years, but it must not be assumed that the full term will always be allowed. The period in each case will be determined by the Board, regard being had to the character and probable duration of the improvement.

Upon a landowner applying to the Board for a charge under these Acts, the Board cause the land proposed to be improved to be inspected by their Inspector, upon whose report, if satisfactory, they sanction the proposed improvement by a Provisional Order, and until such Order has been issued the works should not be commenced. When the works have been completed and passed by the Inspector, the Board issue their Absolute Order, charging the lands improved with the cost of the works and any reasonable expenses incident to the application, the amount of the charge being repayable by equal half-yearly instalments of principal and interest extending over the period for which the charge was sanctioned.

The Board have no public funds at their disposal from which advances can be made to landowners for carrying out improvements.

The Lands Improvement Company of 1, Great George Street, Westminster, is authorised by special Acts of Parliament to advance money for the execution of certain improvements, and by a resolution duly passed under the Improvement of Land Act, 1899, these have been extended so as to comprise any improvement authorised by the Improvement of Land Act, 1864, or an enactment amending it.

The various improvements which may be the subject of a charge under the Acts are as follows :—

1. Drainage, including the straightening, widening, or deepening of drains, streams, and watercourses.
2. Irrigation ; warping.
   The provision of drains, pipes, and machinery for supply and distribution of sewage as manure.

4. Embanking or weiring from a river or lake, or from the sea or a tidal water.
5. The erection of groynes, sea-walls, and defences against water.
6. Inclosing; straightening of fences; re-division of fields.
7. Reclamation; dry warping.
8. The making of farm roads, private roads, and roads or streets in villages or towns.
9. Clearing; trenching; planting.
10. The erection of cottages for labourers, farm servants and artisans, employed on the land or not, and of dwellings available for the working classes.
11. The erection of farm houses, offices, and outbuildings and other buildings for farm purposes.
12. The erection of saw-mills, scutch-mills, and other mills, water-wheels, engine-houses, and kilns, which will increase the value of the land for agricultural purposes, or as woodland or otherwise.
13. The construction of reservoirs, tanks, conduits, water-courses, pipes, wells, ponds, shafts, dams, weirs, sluices, and other works and machinery for supply and distribution of water for agricultural, manufacturing, or other purposes, or for domestic or other consumption.
14. The making of tramways, railways, canals, and docks.
15. The erection of jetties, piers, and landing-places on rivers, lakes, the sea or tidal waters, for facilitating transport of persons, and of agricultural stock and produce, and of manure and other things required for agricultural purposes, and of minerals and of things required for mining purposes.
16. The construction of markets and market-places.
17. The laying out and construction of streets, roads, paths, squares, gardens, or other open spaces, for the use, gratuitously or on payment, of the public or of individuals, or for dedication to the public, the same being necessary or proper in connection with the conversion of land into building land.
18. The making of sewers, drains, water-courses, pipes, fencing, paving, bricks, tiles, and other works necessary or proper in connection with any of the objects aforesaid.
19. The sinking of trial pits for mines, and other preliminary works necessary or proper in connection with the development of mines.
20. The construction of bridges.
21. Making any additions to, or alterations in, buildings reasonably necessary or proper to enable the same to be let.

22. The erection of buildings in substitution for buildings within an Urban District taken by a Local or other Public Authority or for buildings taken under compulsory powers.
23. The reconstruction, enlargement, or improvement, of any of the works referred to above.

The erection or improvements of a Mansion House may also be the subject of an improvement charge, but in general the charge will be subject to the provisions of the Limited Owners Residences Acts, 1870 and 1871.

Improvement charges can also be obtained for certain assessments in respect of public works, such as drainage and street improvements, and for subscriptions for stock or shares of a Railway, Canal, or Water Company whose works will improve the land comprised in the charge.

London, S.W.1,
April, 1912.

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Leaflet No. 60.

BOARD OF AGRICULTURE AND FISHERIES.

Goat Moth (*Cossus ligniperda*) and Wood Leopard Moth (*Zeuzera æsculi*).

The Goat Moth.

Trees attacked.

The caterpillars of this moth bore galleries in the stems of many species of broad-leaved trees, *e.g.*, willow, poplar, walnut, birch, elm, beech, lime, sycamore, ash, and various fruit trees. The softer woods are more commonly infested.

The caterpillars are large and a great number may be found at work in the same tree; the wood, on this account, is so tunnelled and honeycombed as to be rendered useless for technical purposes.

Indications of Infestation.

(*a.*) The little heaps of excrement and frass thrown by the feeding caterpillars from their galleries to the outside.

(*b.*) The odour of the caterpillars (the walls of the galleries in the wood also smell), the odour being that of the acid distilled from wood; by some the odour has been compared to that of the goat.

Isolated trees, or those in an avenue or at the edge of a wood, are chosen by the females for their egg laying in preference to trees in close forest, though the latter are sometimes attacked.

Description.

Moth.—The goat moth, which flies at night, is large and plump. The female measures 1½ inches or more in length, and over 3 inches in spread of wing; the male is somewhat smaller. The head is small and the eyes large; the proboscis and antennæ are short. The antennæ of the male are distinctly comb-like, whilst those of the female are saw-like. The fore wings are pale-brown mottled with ashy-grey, and have numerous irregular black streaks and marks; the hind wings are darker greyish-brown. The thorax is densely hairy, brown and grey in front, and with a blackish band across it behind. The large heavy abdomen is grey with whitish rings.

Caterpillar.—The caterpillar is somewhat flattened, and hence the galleries are oval in shape. When young the caterpillar is dull pink, but as it grows the upper surface becomes dark red or purple, the sides and under-surface being yellowish flesh-coloured. The head is black; the segment behind the head bears a dark shield, and the segments have fine bristle-like hairs. The full-grown caterpillar may measure about 4 inches in length.

Pupa.—Pupation takes place in the burrow in the stem, near to the outside, the chrysalis being surrounded by a cocoon covered by wood chips and sawdust. Sometimes the caterpillar leaves the tree and pupates in the soil, in which case the cocoon consists chiefly of particles of soil.

Life History.

The moths fly in June and July; the eggs are laid in little heaps in cracks and crevices in the bark generally very low down, but sometimes up to the height of a man. The caterpillars on hatching feed at first below the bark, but later they gnaw irregular ascending galleries in the wood. In cases of overcrowding (and more than 100 caterpillars have been taken from one stem) some of the caterpillars may leave the tree and bore into another. When full grown the caterpillar pupates, and the pupation stage lasts about a month or on occasion somewhat longer. Before the emergence of the moth the pupa pushes its way partly out of the burrow in the tree, and the empty pupal skin may be seen projecting after the emergence of the moth. The cocoon has been found projecting from the soil of a garden near an infested balsam poplar.

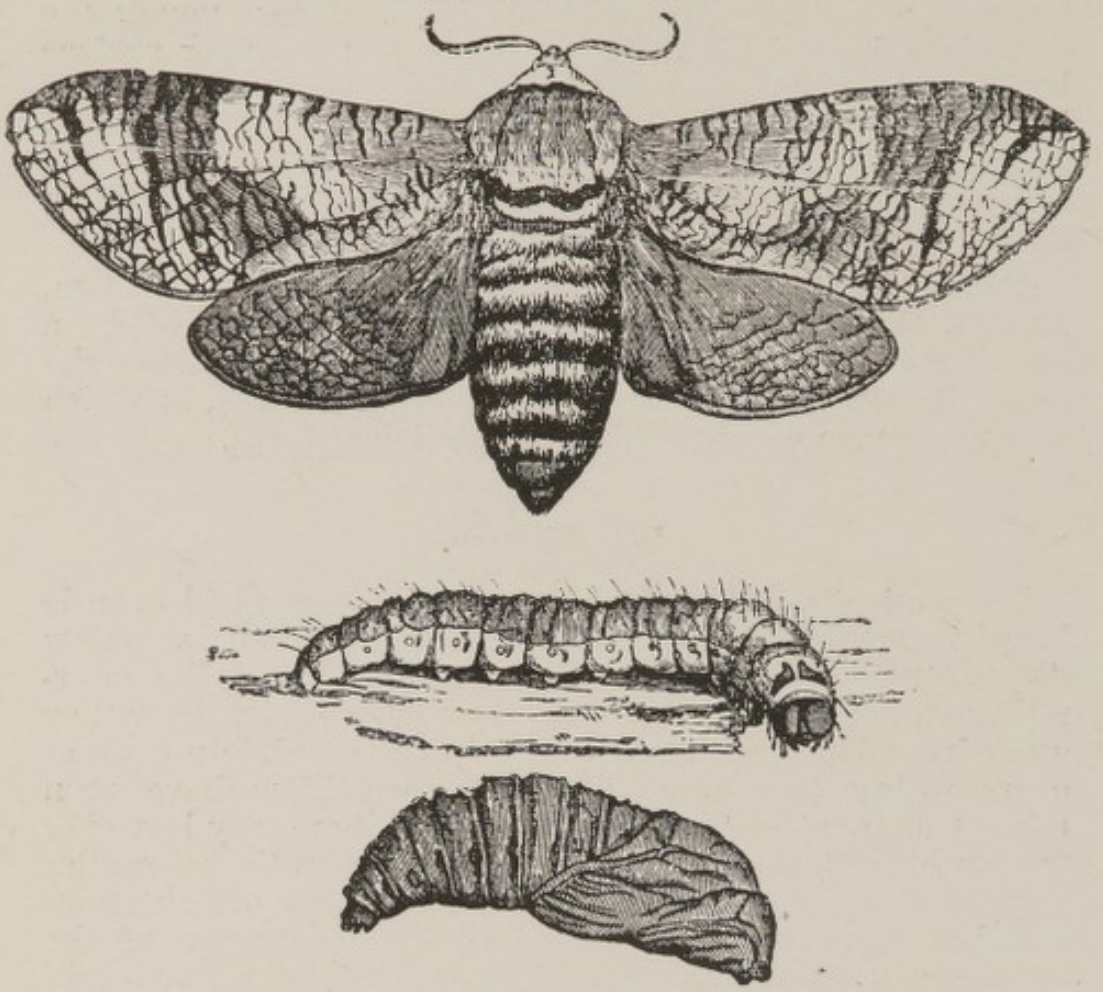
The life cycle appears to vary in length. A period of two years is given by some authorities but the majority consider that it extends to three years and that under exceptional conditions it may last for four or even five years.

Methods of Control.

(1.) Trees which are badly attacked and are of no great value should be cut down and the larvæ destroyed.

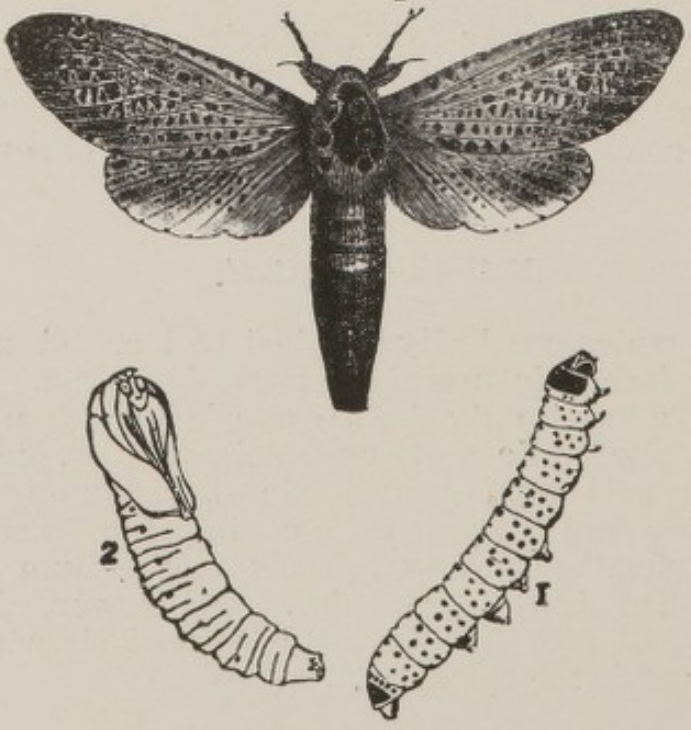
(2.) When a tree is only slightly attacked or when it is of special value for shade or ornamental purposes, one of the following methods may be employed :—(*a.*) Small quantities of carbon bisulphide may be injected into the holes in the trunk. (*b.*) Small pieces of potassium or sodium cyanide may be pushed into these holes. Whichever poison is used the holes must be thoroughly blocked with clay immediately after the operation.

The Goat Moth.



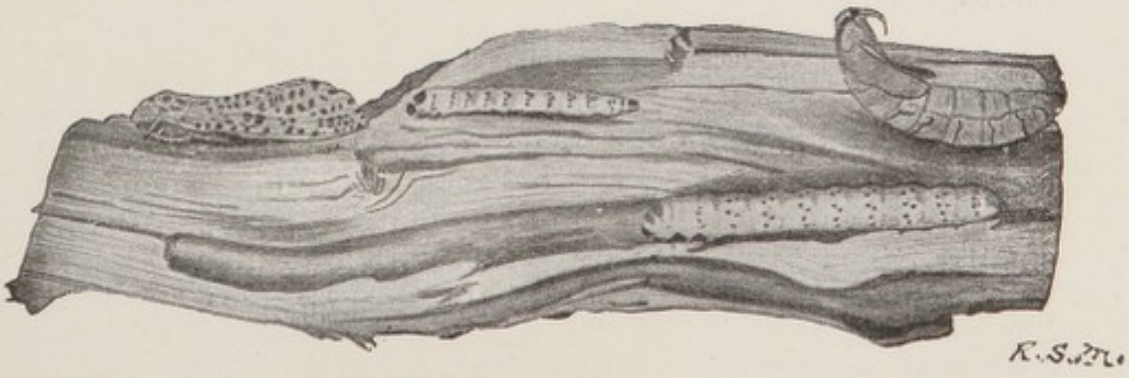
Goat Moth, larva, and pupa, all natural size.
The larva is not fully grown.

The Wood Leopard Moth.



Male Wood Leopard Moth; 1. Caterpillar, 2. Chrysalis,
all natural size.

Portion of Ash Tree with larva of Goat Moth *in situ*.
From an illustration by Mr. W. E. Collinge, M.Sc. Birmingham University.



The Wood Leopard Moth.—Figure showing young caterpillar, well grown caterpillar, pupa case, moth at rest, and a larval gallery.

Injections of carbolic acid, paraffin, or a solution of nicotine are also said to have succeeded in certain cases, but either carbon bisulphide or one of the cyanides will be found most effective. The latter substances must however be treated with care, as carbon bisulphide is exceedingly inflammable while the cyanides are virulent poisons.

(3.) As a preventive against the egg-laying of the moth the trunk of the tree, up to a height of eight feet, may be painted with a mixture of clay, lime and soft soap or clay and cow dung. The mixture should also cover any exposed roots at the base of the trunk and should be applied during the month of May. This measure is mainly of service in parks and gardens where a few trees are affected and it is desired to take every precaution to prevent the insect from spreading.

The Wood Leopard Moth.

Trees attacked.

Like the Goat Moth, this pest has importance both for the forester and the fruit-grower. The caterpillars of *Zeuzera æsculi* feed in the stem and branches of a number of broad-leaved trees, *e.g.*, lilac, lime, sycamore, birch, beech, oak, sweet chestnut, ash, willow, poplar, and such fruit trees as apple, pear, and cherry, where they may cause considerable harm. The horse chestnut, from which the scientific name of the moth is derived, is not so frequently attacked as other trees. In the case of this insect, the caterpillars are not found many together in an attacked stem, but generally singly. The presence of the caterpillar may be betrayed by its copious out-throw of frass and wood-coloured excrement. The moth is frequently found in the Metropolitan districts, and sometimes causes considerable destruction to trees and shrubs in the public parks and private gardens of the metropolis.

Description.

Moth.—The moth, which is named "Leopard" on account of its spotted wings, measures between 2 and 3 inches in expanse of wings in the case of the female, the males being smaller. The fore wings are white, with a number of black or blue-black spots. The hind wings are similarly marked, but the spots are fainter. The thorax is white, with 6 large dark spots arranged in pairs, and a smaller spot between the hindmost pair.

Caterpillar.—The full-grown caterpillar may measure 2 inches in length. It is white or yellow-white in colour with black spots; the head is dark, the joint behind the head bearing a black shield or plate, whilst a black plate is also present on the last segment.

Pupa.—The pupa is brown and may be found at first just below the place of exit, and later, after the emergence of the moth, it may be seen projecting from the tunnel in the infested tree.

Life History.

The moths lay their eggs singly on stems and branches late in June or July, and the caterpillar on hatching gnaws at first irregularly below the bark. After wintering, the caterpillar bores into the wood, and the gallery or tunnel, running in the long axis of the infested stem, is round and regular and may reach 8 inches in length. The life cycle is said to be either two or three years. The caterpillars have been known to leave their first feeding place and attack younger and fresher growths.

Methods of Control.

(1.) When the trunk of a tree is badly attacked it should be cut down and burnt. Branches which are dying should be cut back until the end of the burrow is reached. If the larva has not been found during this process the cut portions must be split and the larva killed.

(2.) In the case of branches and stems which are slightly attacked or which it is desired to save, a pointed wire may be pushed down the burrows to kill the larva, or the methods suggested against the goat moth, section 2, may be employed. The fumes of burning sulphur or tobacco forced into the holes by means of a pair of bee bellows have also been found effective.

London, S.W.1,
October, 1899.
Revised, October, 1914.

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Leaflet No. 61.

BOARD OF AGRICULTURE AND FISHERIES.

Sheep-Scab.

Sheep-Scab may be described as a parasitic rather than as a purely contagious disease, affecting the woolly parts of the body, and due to the presence on the skin of a species of mite or acarus known scientifically as *Dermatodectes ovis*, or *Psoroptes communis*.

Symptoms of Attack.—One of the first symptoms apparent in a sheep that has contracted scab is restlessness combined with a desire to bite the affected part, or to rub against posts, fences, hurdles, or even other members of the flock. This restlessness is the result of the irritation produced by the mites pricking the skin of the sheep in their endeavour to obtain food. The constant biting and rubbing of the sheep to allay the irritation causes injury to the skin, which is followed by an exudation of lymph, and the formation of crusts or scabs, under the edge of which the parasites and their ova are to be found.

As the mites increase in number they move from the scabs to the more healthy parts of the skin and thus extend the area of the diseased parts.

The injury to the skin is followed by shedding of the wool, and the fleece becomes broken and tufted, or matted together, giving the animal a ragged appearance. Even where the wool does not detach itself from the skin, it assumes a dead-white bleached appearance.

When a sheep is found to present the above symptoms the owner should at once examine the animal, and, if he has any doubt as to the nature of the disease, he should report to the Local Authorities in order that the Veterinary Inspector may examine and report whether the itching and rubbing are due to the presence of the sheep-scab mite, or to other causes.

The simplest method of examining a piece of wool or crust taken from a sheep suspected of scab is to spread it out upon a dark surface, and place it in the sun or any other warm position. If it be a case of scab the mites will be seen as small opaque specks moving about on the wool or perhaps on the surface beneath it. These moving objects should then be examined with a pocket lens or with a microscope of low power, when the parasites and their eggs will present a characteristic appearance.

The parasites and their eggs are usually abundant at the margin of crusts or scabs on the surface of the skin, and if a small portion of the crust and wool, after being softened in a mixture composed of glycerine and a solution of potash or soda, is teased out and placed upon a microscope slide there will often be found, in cases of scab, whole mites or portions of the detached legs, and eggs mixed up with the fibres of the wool and fatty matter.

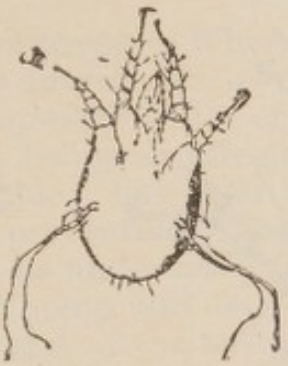


FIGURE 1.

An immature Sheep-Scab Mite much magnified.

The parasites of sheep-scab may be seen by the naked eye, but examination is greatly facilitated by the use of a pocket lens, or a low-power microscope. Now that the decisions of the Veterinary Inspectors of Local Authorities in Great Britain are followed by serious consequences to the owners if sheep are certified to be affected with scab, it is most important that no errors should be made in diagnosis. It therefore becomes necessary that all enquiries into reported outbreaks should be conducted on the above lines and with due care, because, unless the particular mite can be discovered, the existence of the disease may be questioned.

Description.—*The mature acarus* or mite that causes scab in sheep measures $\frac{1}{40}$ to $\frac{1}{50}$ of an inch (·52 — ·62 mm.) in length, the female (Fig. 2) being somewhat larger than the male (Fig. 3). Both male and female are provided with four pairs of legs. Each foot of the first three pairs of legs of the male is furnished with a sucker-disc ; but in the case of the female this disc on the third pair of feet is replaced by long hairs.

The egg is about $\frac{1}{125}$ of an inch (·2 mm.) long.

The immature mites or larvæ (Figure 1) have only three pairs of legs.

Parasites very similar in form and size are also found on the horse, dog and other animals, producing the disease commonly called mange, but these other mange mites do not produce scab in sheep. It may therefore be accepted that where sheep become affected with sheep-scab they must have previously been in contact with diseased sheep, or with fences, posts, hurdles, or other objects against which diseased animals have rubbed.

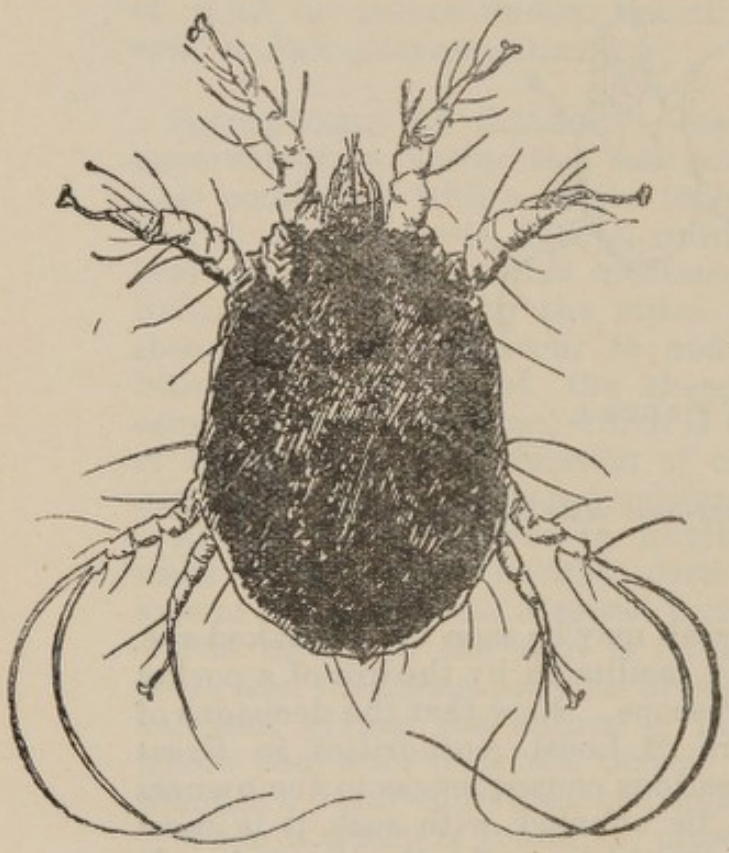


FIGURE 2.

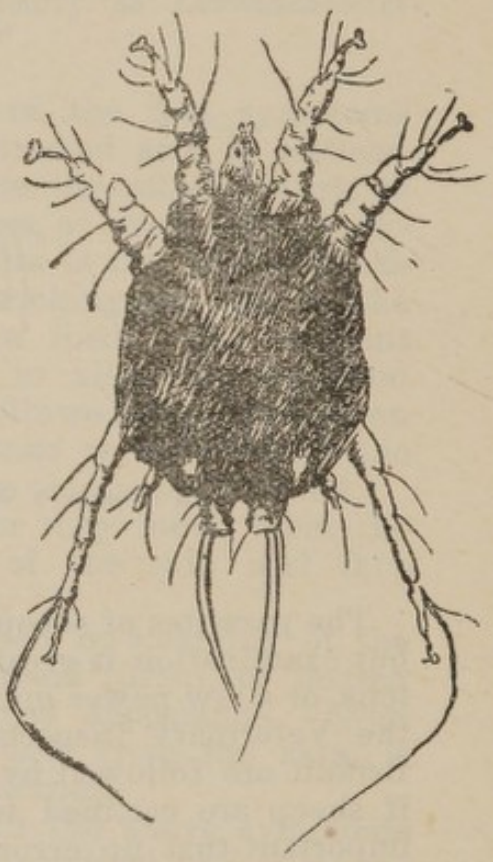


FIGURE 3.

Sheep-Scab Mites (*Psoroptes communis*). Figure 2, Female × 65. Figure 3, Male with copulatory suckers extended, × 65.

Life History.—Since the life history of the sheep-scab parasite has a very important practical bearing upon that part of the Sheep-Scab Order of 1905 which deals with the dipping of sheep, it should be explained that after the parasite has been transferred from the diseased to the healthy sheep the female lays its eggs and dies. These eggs under favourable circumstances are hatched in about seven days, and the young female parasites, after passing through the various stages of their development, arrive at maturity in about two weeks, when they, in their turn, proceed to lay eggs.

In all instances where sheep exhibit manifest evidence of scab, there are present not only living parasites but also eggs which may be newly laid, or are on the point of hatching. While therefore one dipping, properly conducted, will have the effect of killing the living mites and destroying some of the eggs, it is absolutely necessary, if a perfect cure is to be established, to have recourse to a second dipping, which should be carried out not later than the 10th day following the first dipping. If the dipping has been done with proper materials, two dippings will generally suffice, but if any doubt exists, a third dipping should be undertaken after a similar interval.

Preventive Measures.—Where sheep-scab exists, or is suspected, it is the duty of the owner of the sheep, under Article 1 of the Sheep-Scab Order of 1905, to give notice of the fact of the sheep being so affected or suspected to the nearest police constable; but even in the absence of any suspicion of disease preventive measures against sheep-scab may with advantage be undertaken periodically.

Needless to say, dipping will only be effective if proper materials are used, and if the operation is carried out in a thorough manner. The substances most commonly employed to kill the scab-mite are preparations of white arsenic, carbolic acid, tobacco juice, or sulphur. Some flock-masters compound home-made dips, but most rely upon one or other of the many patent dips that are now upon the market.

In pursuance of the recommendation contained in paragraph 34 of the Departmental Committee's Report* [Cd. 2,258] on Sheep-Dipping, the Board have incorporated in the second Schedule of the † Sheep-Scab Order of 1905 particulars as to the composition of three preparations which have been proved by experiment to be suitable for use as sheep-dips without detriment to the fleece of the animal dipped, and, if properly employed, to be effective against sheep-scab,—as follows :—

Prescriptions for Sheep-Dips approved by the Board for Sheep-Scab.

(Quantities for 100 gallons of bath.)

1. Lime and Sulphur.

Mix 25 lb. of flowers of sulphur with 12½ lb. of good quick-lime. Grind the mixture with water until a smooth cream without lumps is obtained. Transfer this to a boiler capable of boiling 20 gallons, bring the volume of the cream to 20 gallons by the addition of water, boil and

* This is a Parliamentary publication, and can be obtained, through any bookseller, from H.M. Stationery Office, Imperial House, Kingsway, London, W.C.2, at the price of 3*d*. The volume of Evidence is numbered Cd. 2,259, price 2*s*. 4*d*.

† A copy of the Order can be obtained on application to the Board.

stir during half an hour. The liquid should now be of a dark red colour; if yellowish, continue the boiling until the dark red colour is obtained, keeping the volume at 20 gallons. After the liquid has cooled, decant it from any small quantity of insoluble residue, and make up the volume to 100 gallons with water.

2. Carbolic Acid and Soft Soap.

Dissolve 5 lb. of good soft soap, with gentle warming, in 3 quarts of liquid carbolic acid (containing not less than 97 per cent. of real tar acid). Mix the liquid with enough water to make 100 gallons.

3. Tobacco and Sulphur.

Steep 35 lb. of finely-ground tobacco (offal tobacco) in 21 gallons of water for four days. Strain off the liquid, and remove the last portions of the extract by pressing the residual tobacco. Mix the whole extract, and to it add 10 lb. of flowers of sulphur. Stir the mixture well to secure an even admixture, and make up the total bulk to 100 gallons with water.

NOTE.—The period of immersion in these dips should not be less than a minute.

Although the Board have not included in the above-mentioned schedule any preparation containing arsenic, it is not to be assumed from this omission that the Board do not concur in the view that the arsenic dips are thoroughly effective against sheep-scab. The possible danger to human beings attendant upon the preparation of such dips renders it advisable, however, that they should be compounded by qualified persons only.

The Board recognise that there are a large number of sheep-dips on sale which may be regarded as equally effective against sheep-scab, but it must be borne in mind that in order to comply with the provisions of the Sheep-Scab Order, and the various Sheep-Dipping Orders, the dip used must be an "efficient sheep-dip," that is, one approved by the Board for sheep-scab, or purporting to be so approved. (Over 400 preparations have been so approved.)

Where approved preparations are employed the amount of dilution should be no greater than that stated on the label on the package in which the dip is contained, and the instructions issued by the manufacturer as to the period of immersion should be carefully observed. The dip bath should at all times be of sufficient volume to secure the complete immersion of the sheep.

Sheep dips approved by the Board are required to contain sufficient of one constituent to make the dip effective for the cure of sheep-scab at the strength approved. It is, therefore, inadvisable to make up the dip-bath by mixing two or more dips containing different ingredients, even in cases where each dip has been approved for use by itself. For instance, to mix carbolic and arsenic dips may result in destroying the efficacy of both ingredients, and even the mixing of dips

containing the same ingredients may result in the bath being below standard. In some cases also, the use of mixed dips may injure the sheep.

Of the two forms of bath—hand and swimming—the latter is greatly to be preferred. The advantages of the swimming bath are: (1) The sheep, being in a natural position, may be completely immersed, even in a poisonous solution, with comparatively little danger; (2) sheep in lamb may be dipped with much less risk; (3) the motion of swimming allows no portion of the fleece to escape contact with the solution; (4) the work is more easily and therefore more effectively performed; (5) a larger number of sheep can be dipped in a given time and with fewer operators. Different forms of bath are described in Leaflet No. 145 (*Sheep Dipping*), and in the *Journal of the Board of Agriculture* for July, 1908.

On pastoral hills, or where the boundary fences are defective, it is difficult, if not impossible, to prevent a certain amount of mixing between sheep belonging to adjacent owners, and it is no easy matter to avoid the risk of attack. On commons the danger of contamination of the flock is still greater. With ordinary precautions, however, scab should be difficult of introduction to a well-fenced farm. These precautions consist in using reasonable care in the purchase of sheep, and in making a point of never bringing fresh sheep on to the ground without first twice dipping them at an interval of not more than 10 days. If sheep are exposed at a market, without effecting a sale, the animals should be similarly dipped before they are returned to their grazings or are mixed with other sheep. These are safe precautions under any circumstances, and especially so in scab-infected districts.

NOTE.—From time to time the attention of the Board is directed to the pollution of watercourses arising from the improper disposal of the dipping material after sheep-dipping has been done. Flock-masters should bear in mind that this residue is necessarily highly injurious to fish and animal life generally when a poisonous dip has been used, and they should, therefore, always be careful to dispose of it in such a way as to avoid any possibility of its finding its way into streams, ponds, or other waters.

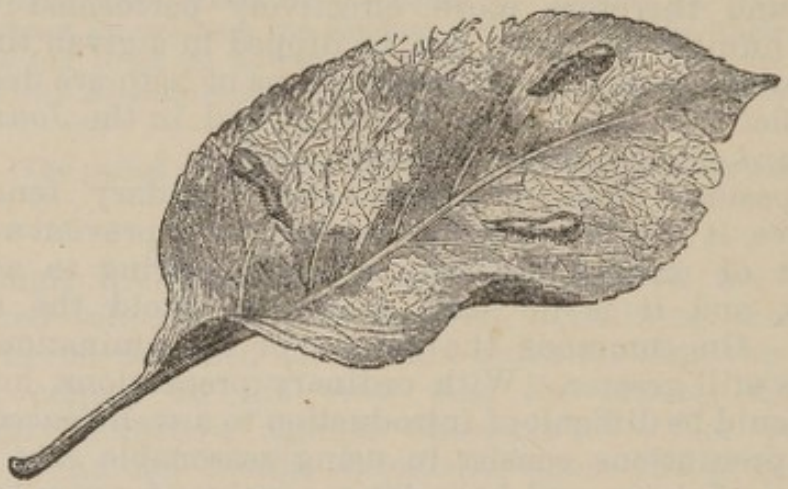
London, S.W.1,
November, 1918.
Revised, April, 1919.

Leaflet No. 62.

BOARD OF AGRICULTURE AND FISHERIES.

The Pear and Cherry Sawfly.

(*Eriocampa limacina*, Cameron.)



Slugworms (Larvæ of *Eriocampa limacina*) upon a leaf.

The extremely repulsive larva of this sawfly is frequently most destructive to pear and cherry trees. It also infests apple, plum, damson and peach trees, and is occasionally seen upon oak, birch, and other forest trees, as well as on some species of thorns. In the dry seasons of 1899 and 1901, cases occurred where nearly all the leaves fell from pear trees in consequence of the continuous attacks of larvæ of this insect. The larvæ are sometimes termed "slug-worms" or "snegs."

The adult sawfly is harmless—although by it the eggs are laid—but the larva or slugworm eats away the upper epidermis of the leaf and destroys the soft tissue or parenchyma between the veins; the veins and the lower epidermis are left intact. To begin with, the leaf is eaten in patches here and there, but ultimately every particle of green is devoured. Severe infestation entirely prevents the production of fruit and even a slight attack has a marked effect on the crop of pears, which cannot come to perfection if the foliage is injured.

This insect does much harm to pear and cherry trees in America. As early as 1797, according to Harris, the larvæ caused great injury. "Small trees," he says, "were covered

with them, and their foliage entirely destroyed, and even the air, by passing through the trees, became charged with a disagreeable and sickening odour given out by these slimy creatures." This has also been noticed in England. In California the pest is often very troublesome, especially to pear trees. Professor Saunders states that in 1874 *Eriocampa limacina* was unusually abundant in Ontario, in many cases destroying the foliage so thoroughly that the trees looked as if they had been scorched by fire. This insect was at one time called *Selandria cerasi* in America. It is also well known in France and Germany.

Description.

Sawfly.—The adult sawfly is a quarter of an inch in length, and has a wing expanse of about half an inch. Its body is blackish; its wings are dusky, but they are slightly paler at the tip; its legs are also dark. The eggs are white in colour, oval in shape and yellowish.

Larva.—The larva is at first white, but in a day or two a dark green slime exudes from and covers its body. This exudation is evidently designed to protect the insect from parasites, and from the influences of the weather, to which it is fully exposed upon the upper surface of the leaf. The larva is particularly ugly at this period of its life, being slimy and dark green or almost black, the under part of the body paler; its head and fore part of the body are much broader than the hinder part, which tapers towards the end. At this stage the larva very much resembles a malformed slug or a tadpole. It has seven pairs of "sucker" feet on its abdomen, three pairs of distinct feet upon the thorax, and a pair of very rudimentary "sucker" feet at the end of its body. But with all these feet it moves very slowly, being slug-like in its movements. When it is full grown it is close upon half an inch in length, and, then, after a month or more, it loses its slug-like appearance and slime, and appears as an orange yellow or buff coloured caterpillar.

Life History.

The adults usually make their appearance early in June, but sometimes in May. The female soon proceeds to make an irregular oval slit in the leaf with the aid of her peculiar saw-like apparatus, which resembles that of the gooseberry sawfly (*Nematus ribesii*) and many other sawflies. In this slit an egg is deposited; this can be easily seen on the leaf, as a slight, round spot is formed, in the centre of which there is a transparent skin or film covering the whitish egg. The number of eggs upon one leaf often amounts to twenty or even more, but as a rule

only a small number of larvæ are seen upon a leaf. The egg is laid from the under surface of the leaf, or it may be on the upper surface.

The larva hatches out in from seven to twelve days, and emerges from the upper surface of the leaf. It feeds voraciously, and when full grown it passes into the soil and becomes a pupa under cover of a cocoon covered externally with particles of soil. There are two or three broods in the year. The pupa stage lasts two weeks during the summer. The larvæ are found upon the leaves of fruit trees even as late as October. Winter is passed in the cocoon shape.

Preventive and Remedial Measures.

1.—As it is clear that the pupæ of this sawfly are in the earth immediately under the fruit trees upon which the larvæ have been feeding, it is desirable to dig the ground all round the trees in the early spring, and to hoe it with pronged hoes so that the earth may be broken up finely. Quicklime should then be put on and hoed in.

2.—In gardens, after the digging and hoeing, it would be useful to beat down the earth in the spring with a shovel in order to prevent the flies from coming up.

3.—Soot and lime should be scattered evenly and in moderate quantity under the trees in autumn, as it has an injurious effect upon the larvæ when they fall to the ground.

4.—In the late autumn or winter, poultry might be penned round trees that have been severely attacked in gardens and orchards.

5.—The removal and burning in winter of the surface soil below such trees has been proved a useful measure.

6.—The caterpillars can be poisoned by a spray of—

(*a*) Hellebore wash.—1 oz. of fresh hellebore, 3 gallons of water, 2 oz. of flour. This must be constantly stirred.

(*b*) Arsenate of lead.—This should be obtained in the paste form, the proportion recommended for use being 2 lb. to 50 gallons of water or two even teaspoonfuls to a gallon of water, the whole being thoroughly mixed.

(*c*) Paris Green has been used as a remedy for these slug-worms. It poisons their food, and is used extensively in the United States for attacks of the sawfly larvæ and many other insects. It should be obtained in the form of paste and be applied in the proportion of 1 lb. of Paris Green to 200 gallons of water,

carefully mixed and distributed over the leaves as evenly as possible. The paste can be much more easily mixed with water than the powder, which is so fine that the least breath of air blows it over the face and clothes of those who use it.

These washes are poisonous, so must not be used on ripe or ripening fruit for four weeks before it is gathered.

These remedies would be applicable to pear, apple, plum, and damson trees. It would be more difficult to apply them to cherry trees, as the fruit is often nearly ripe when the attack of the insect is first noted. After the cherries are picked the trees should be dressed to prevent the larvæ from devouring the foliage and weakening the trees for the next season.

7. Dusting over the leaves with dry powdered hellebore or a mixture of soot and lime.

Heat and drought are, without doubt, favourable to the multiplication and destructive activity of this insect, while cool, showery weather interferes not only with the hatching of the eggs, but also with the growth and health of the larvæ. It is generally found that the larvæ do not cause serious harm in wet seasons.

London, S.W.1,
January, 1900.
Revised, March, 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. 63.

BOARD OF AGRICULTURE AND FISHERIES.

Destruction of Charlock.

This weed, which is common in cultivated fields throughout the whole of Great Britain, is known under a variety of names, such as karlock, yellows, yellow weed, skelloch runches, wild mustard (*Brassica Sinapis* Vis., *B. Sinapistrum* Boiss., *Sinapis arvensis* L.). In the early stages of growth it closely resembles the turnip, to which it is very nearly related. As in the case of other plants of the same family, charlock seed contains a large amount of oil, and this is at least partly accountable for the persistent vitality often exhibited by this seed. Land that has been under grass for many years may thus, when broken up, show an abundant growth of this weed, and the same state of things not unfrequently attends extra deep cultivation, and the consequent disturbance of dormant seeds.

Charlock is undoubtedly one of the most troublesome weeds with which the farmer of arable land has to contend. In corn crops its growth is often so rank that the yield of grain is seriously reduced. In root and bean crops the weed can be more easily dealt with ; but here also it often proves very injurious, and especially so when the conditions of the weather, or scarcity of labour, prevent its timely eradication. As a rule, it is not conspicuous amongst rotation grasses or clover, and it is practically absent from permanent grass land.

Injury caused by Charlock.—The injury induced by charlock is partly direct and partly indirect. It competes with crops for light and air : that is to say, it overgrows more or less completely, and smothers, other plants with which it is associated. It also robs crops of a part of their nutriment, and prevents their deriving full benefit from the moisture of the soil. In other ways also—though more indirectly—this weed may be the cause of much loss. The turnip "fly," for instance, would be unable to exist in early summer, when the cultivated crops on which it preys are, for the most part, absent from our fields, did it not find weeds like charlock to supply it with food ; and similarly the turnip-gall weevil is often found in the roots of charlock. Then again, the microscopic fungus that causes finger-and-toe finds a congenial habitat in the roots of this plant, which may thus do much to carry the disease over the years that separate two turnip crops.

Control Measures.—*Root Crops.*—In the case of root crops reasonable attention in the matter of horse and hand hoeing may usually be depended on to keep charlock in check.

Corn Crops.—Autumn sown crops, are not, as a rule, infested with charlock. It is when it is present in quantity in spring corn crops that charlock is most troublesome. Various expedients have been tried with the view of curtailing the development of the weed. If the field be harrowed, and the sowing of the grain be somewhat delayed, a large proportion of the charlock seed will be induced to germinate, and the resulting seedlings may be destroyed by harrowing. Hand and horse hoeing may be practised—providing the corn has been drilled, and has not been sown down with grass or clover seeds. At a later stage of growth the flower heads may be more or less effectively knocked off by means of a special machine, the use of which diminishes the formation of seed. but does little to mitigate injury to the corn crop immediately concerned.

Spraying of Charlock in Corn Crops.—In 1897 attention was called to the possibility of getting rid of charlock in corn crops by means of the application of certain solutions which, it was contended, could destroy the weed without injuring the cereal. The reason for this "selective power" of such solutions is said to lie in the fact that the leaves of charlock, being rough and horizontally disposed, catch and retain the poison, whereas the leaves of cereals, being erect and smooth, allow liquids to run off, and so escape injury. During the past twenty years this method of dealing with the pest has been extensively tested in Great Britain, and the results have been highly successful. The substances chiefly tried have been copper sulphate and iron sulphate, and good results have been got with both. Although the former costs much more than the latter, the solution of iron sulphate must be used so much stronger than the other that the difference in the cost of material is less per acre than would at first sight appear. Moreover, copper sulphate deteriorates less by keeping, is more easily manipulated, and does less injury to the clothes of the workmen.

Experience indicates that good results will, as a rule, be got by dressing an acre with 40 gallons of a 4 per cent. solution of copper sulphate, or with a similar quantity of a 15 per cent. solution of iron sulphate. To make the former, 16 lb. of copper sulphate should be dissolved in 40 gallons of soft water; while, in the latter case, 60 lb. of iron sulphate are required in a similar quantity of water. Somewhat better results will be got by dressing an acre with 16 lb. of copper sulphate dissolved in 60 gallons of water—thus making a $2\frac{2}{3}$ per cent. solution—but although this entails no extra outlay for material, it implies an increased expenditure on account of labour. Then, again, in place of applying 40 gallons per acre of a 4 per cent. solution at a single operation, better results are sometimes obtained by applying 30 to 40

gallons per acre of a 2 per cent. solution at a somewhat early stage of the growth of the weed, and a similar quantity ten days or a fortnight later. As compared with a single dressing this involves no extra expenditure on material, but it entails more labour, since about twice as much solution

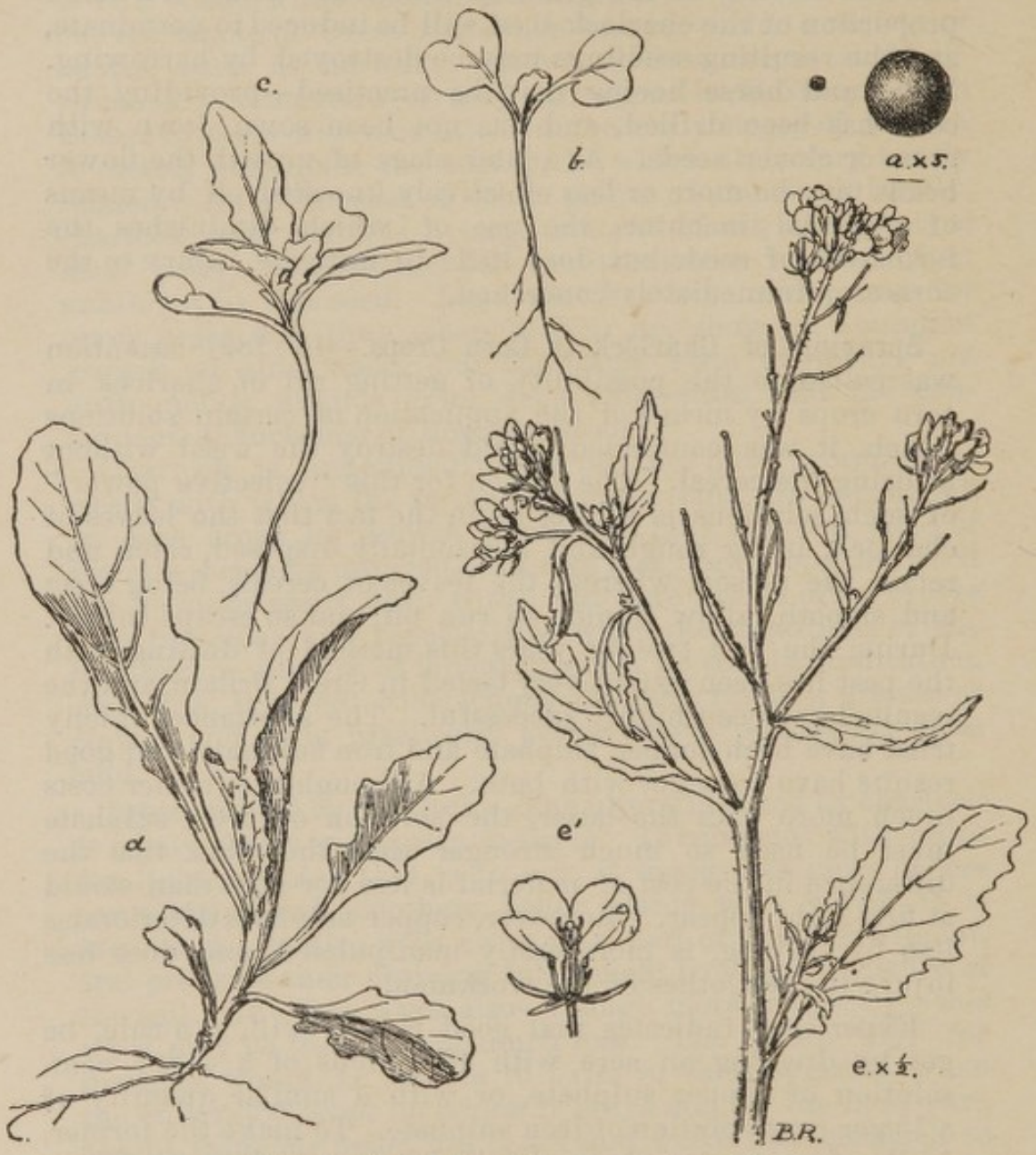


FIG. 1.—CHARLOCK (*Sinapis arvensis*, L.).

a, Seed, nat. size and × 5; *b*, cotyledon stage of seedling × 1; *c*, second stage of seedling × 1; *d*, third stage of seedling × 1; *e*, flowering and fruiting portion × ½; *é*, flower × 1.

must be applied, and the crop suffers more from mechanical injury. Good results have occasionally been got with weaker solutions and with smaller quantities than those indicated, but on the whole those recommended above have proved most effective.

In all cases there should be sufficient liquid to wet the plant thoroughly. This is more difficult late in the season when growth of both weed and corn is advanced, though the weed is more easily killed when in full flower than at any other stage.

The quantities indicated have been found to do no permanent harm to cereals, beans or peas, or to clover or grass occupying the ground along with the corn crop.

A convenient method of procedure is to have two 40-gallon barrels in use, so that while the contents of one are being distributed, the other may be used for the preparation of a fresh quantity of solution.

It may be noted that certain weeds closely allied to common charlock—especially wild radish, or white charlock, and smooth-leaved charlock—are not unfrequently met with, and these do not readily yield to treatment. Other weeds such as docks and thistles are more or less crippled, without being destroyed by the solution.

To obtain the best results it is necessary to attend to the following points :—

1. The weed should be sprayed either before it exceeds three inches in height or else when in full flower. Spraying is not, as a rule, so effective in the intermediate stages,
2. The solution must be made with clean and, if possible, soft water, and the vessels used in this process should be of wood.
3. The material, especially copper sulphate. should be bought under a guarantee of purity of 98 per cent. It should be obtained powdered, not in crystals, as solution is then more certain and more rapid.
4. The solution must be applied by means of a machine that generates a fine spray under air pressure. The equipment necessary is simple and inexpensive, consisting of a spray bar with nozzles, a hand-pump and a barrel, all of which may be fitted on an ordinary farm cart. The spray bar is also suitable for attaching to a horse-drawn potato sprayer. The requisite outfit, capable of spraying from 12 to 20 acres a day, may be purchased direct from makers, or in some cases hired from County Agricultural Executive Committees.
5. Rain immediately after spraying will interfere with success, and the calmer the weather the more evenly and effectively is the solution distributed. The spray should be applied as early as possible in the day.

London, S.W.1, March, 1900.
Re-issued June, 1905.
Revised, August, 1918.

Leaflet No. 64.

BOARD OF AGRICULTURE AND FISHERIES.

White Root Rot.

(*Rosellinia necatrix*, Prillieux and Delacroix.)

The destruction of fruit trees due to rotting of the root, caused by fungi, is very prevalent, and has been recorded from every part of the world where such trees are cultivated. Wild trees such as cherries, crabs, bullace, &c., growing in woods and hedgerows are also attacked, and in some instances it has been proved that the disease has passed from these trees to cultivated plants.

Although the disease named above has been mostly observed on fruit trees belonging to the order *Rosaceae* (apple, pear, cherry, plum), it is by no means confined to them. In Germany it has been met with on the roots of vines, fruit-trees, potatoes, beans, beet, young maples, oaks, beeches, pines and spruces. It also attacks and destroys very many kinds of weeds, and as it is thus able to obtain food from the living roots of such a varied assortment of plants, the fungus, when once introduced into a district, spreads with great rapidity in every direction, travelling from root to root. As the fungus remains entirely underground during its progress, the true cause of the disease is in many instances not suspected.

The earliest indication of the disease is the withering of the leaves; in the case of annual plants this is followed by the drooping of the stem, after which the plant quickly dies. If the root is examined at this stage it will be found to be covered with a white fluffy coating of fungus spawn or mycelium. This mycelium does not appear able to obtain food from a dead root, but white strands spread in all directions in the soil in search of other living roots.

When the root of a fruit tree is attacked, the end is not so sudden, but quite as certain, if proper treatment is delayed. During the first year of attack the wilted foliage falls early in the season, resulting in imperfectly matured wood.

1. A diseased root showing mycelium ascending the trunk under the bark.
2. Fruit of fungus on portion of a dead root.

During the second season there is usually a profusion of blossom with only a scanty development of foliage, which again withers and falls to the ground quite early in the season. The fruit does not set, and the whole tree presents a distinctly sickly appearance. In the third year of disease the tree usually dies.

If the soil is carefully removed from the root of a diseased tree, patches of variable size of a snow-white mycelium will be observed on its main root branches, and if the tree has been diseased for some time, white strands of mycelium will be found spreading in all directions in the soil, which has a strong mouldy smell.

If the bark of the lower part of such a diseased stem is removed, these flakes of mycelium will be found between the bark and the wood, and spreading up the trunk from the diseased root.

Two or three kinds of fungi, in addition to the one named above, cause root-rot; the general appearance of the disease and the treatment are the same for all.

During the early stage of the disease the mycelium is snow-white, eventually becoming grey in colour, especially where it grows round the collar of the trunk, or on portions of roots exposed to the light.

Various simple forms of fungus fruit are produced by the fungus while the tree it is attacking is yet alive, but it is only after the tree is dead and its wood thoroughly dry and decayed that the highest form of fungus fruit, consisting of dense clusters of minute, black, bead-like bodies, is produced.

Methods of Control.

If withering of the leaves suggests root-rot, an examination of the root should be made at once; if white mycelium is found, as much of the root as possible should be carefully exposed, and the branches covered with powdered sulphur; some of this substance should also be mixed with the soil used for filling in, which should be fresh and free from mycelium, and not the old infected soil removed from the root.

In order to prevent the underground spread of mycelium to adjoining healthy plants, diseased trees or portions of a diseased orchard should be isolated by digging a narrow trench about eighteen inches deep round the infected part.

The removed soil should be thrown on to the diseased area inside the trench. Dead or badly diseased trees should be taken up and burned, special care being taken to extract the roots.

As stagnant water in the soil favours the disease, good drainage is requisite.

Weeds of all kinds should be kept down, and if the disease is noticed amongst wild trees, blackthorn, bullace, cherry, &c., the trees should be isolated, removed and burned.

Infected soil should not be used for at least a year. It should be dressed with quick-lime or gas-lime and repeatedly forked over and exposed to the air as much as possible. It is most important to remove any fragments of roots observed during the process, as these might otherwise form fresh centres of infection.

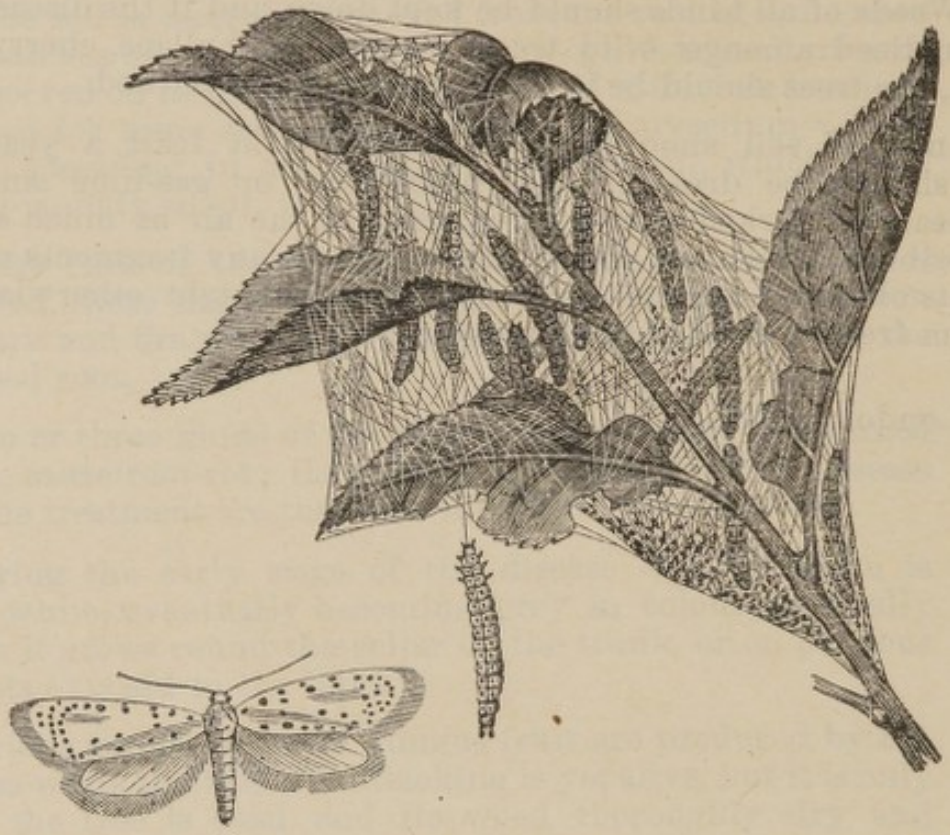
London, S.W.1,
August, 1900.
Revised, June, 1915.

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. 65.

BOARD OF AGRICULTURE AND FISHERIES.

The Small Ermine Moths (Genus *Hyponomeuta*).



H. padella, L.

Moth, twice natural size; larvæ and web about natural size.

The name "Small Ermine Moths" is given to a group of little moths which are often of considerable importance to the fruit grower. They are present in almost every orchard or garden throughout the country, and where no steps are taken to keep their numbers in check, are capable of doing very serious damage. Outside the British Isles Small Ermines are known as pests in practically every European country and also in Japan. Recently one of the more harmful species has been introduced into the United States of America, where efforts are being made to stamp it out.

There are several species of Small Ermine Moth in this country, but this leaflet is chiefly concerned with one or more, which for the present may be dealt with under the name *Hyponomeuta padella* L. and will include forms often referred to in literature as *H. malinella* Z. and *H. variabilis* Z. It is doubtful whether the true *H. malinella* has proved injurious in this country, though it is said to occur on crab

apple. A further species, *H. evonymella* (*cognatella* Hb.), may also receive brief mention as it is sometimes most injurious to spindle (*Evonymus*) hedges.

Plants attacked and Nature of Injury.—The Small Ermine (*H. padella*) is most harmful to apple trees and hawthorn hedges, but it also attacks pear, plum, cherry, mountain ash, and other allied plants. The injury consists in the destruction of the leaves by the Ermine caterpillars, which in a bad attack may completely defoliate the tree or hedge, leaving only bare twigs and a few shrivelled brown leaves spun together by a dense web of silk. The damage is at its worst in July, apples usually falling from the trees when still young, and although new leaves are produced before the end of the season, the trees are seriously weakened and the chances of obtaining a crop the following year are much reduced. The injury to hawthorn hedges (and also to Evonymus hedges by *H. evonymella*) is similar, and although there is no loss of fruit, the leafless hedges in summer are very unsightly, and if the attack occurs for two or more years in succession portions of the hedge are likely to die out.

Description and Life-History.—Small Ermine Moths are about one-third of an inch in length and about three-quarters of an inch in spread of wings. In colour the fore wings are white or grey with a number of black dots, and the hind wings are of a uniform grey. The moths appear at the end of July and in August and lay their eggs on the twigs or small branches of the apple or hawthorn. The eggs are flat and are laid many together in small scale-like masses, each egg being firmly cemented to the next. These egg-masses are so slightly raised above the surface of the twig and are so nearly of the same colour that they are not easily detected. In September minute caterpillars are hatched from the eggs, but during the winter remain under the egg shells which form a protection over them. In the early spring they crawl out and bore into the buds and later mine into the growing leaves. As the foliage develops they feed on the surface of the leaves, spinning two or three together to form a nest.

Towards the end of May and in June the work of the caterpillars becomes more evident, and colonies may be found living in large webs spun between the leaves and twigs, the leaves being eaten and fresh leaves drawn in to serve as food. Gradually the whole branch or even the whole tree may become enveloped in a dirty ragged web, and practically every leaf may be devoured. Each web appears to be full of little black caterpillars which wriggle rapidly backwards and forwards, and if disturbed often fall down suspended by a silken thread.

When nearly full grown the caterpillars measure about half an inch in length and are dusky grey in colour with black spots.

In July the caterpillars are full grown and spin cocoons, often many together, in which they turn into chrysalides. The moths appear some three weeks after, and the life-cycle begins again.

The above account of the life-history refers in the main to the Ermines on apple, hawthorn, plum, &c., but there are one or two curious points which are worthy of mention. In the first place the cocoons of the apple-fed caterpillars are formed of dense white silk, and are often spun together in definite rows. On the other hand the chrysalides of the hawthorn-feeders are suspended almost at random in the webs and are enclosed in very slight and flimsy cocoons which hardly serve to hide the chrysalides. Secondly, the apple-feeders produce a high proportion of moths with white fore wings, while those from hawthorn are either white or grey—more often, perhaps, the latter colour.

The facts are somewhat suggestive of the presence of two distinct forms, and it is important from the practical point of view that the matter should be decided. If there is only a single species, then the grower who wishes to clear his orchard should treat any surrounding hawthorn hedges as well as his apples. If, on the other hand, there are two species, a severe infestation on the hedges need not necessarily be regarded as a danger to the apples.

The Evonymus feeder in its life-history does not differ widely from that just described, but the insect is quite distinct, and indeed never feeds on either apple or hawthorn. The moths always have pure white fore wings with very conspicuous black spots, and are somewhat larger than those of the apple-feeding species.

Natural Enemies—Ermine Moths are attacked by a number of species of Ichneumon Fly, such as *Angitia majalis* Grav., and *Herpestomus brunneicornis* Grav., the larvæ of which feed inside the Ermine caterpillars. They are also devoured by starlings and probably by other birds.

1. **Methods of Control.**—The most satisfactory treatment is to spray the affected trees or hedges with lead arsenate (1 lb. lead arsenate paste in 25 gallons of water) soon after the blossom is over. The object is to cover the leaves with a fine spray of lead arsenate which will sooner or later be eaten by the caterpillars, and will poison them. It is useless to wait until serious damage is apparent, for then not only has considerable loss of fruit and foliage already occurred, but also the dense web prevents the spray from reaching those leaves which are left. Provided the webs are still small, however, and there is much clean foliage, it is still

worth applying the spray, to prevent further injury. It is not certain how early the spraying can be done, but it is probable that many of the caterpillars will be destroyed even if the lead arsenate is put on just before the blossom opens. In no circumstances should the spray be applied to open blossoms.

Lead arsenate is poisonous to man, and must therefore be used with care.

2. It is possible—though it does not appear to have been proved—that a winter wash would destroy the young larvæ under the egg scales. In addition to the caustic washes given in the Board's Leaflet No. 70 (*The Treatment of Neglected Orchards*), paraffin emulsions and miscible oils are worth a trial. Miscible oils must be bought from a manufacturer, and be diluted in accordance with his instructions.

A paraffin emulsion for winter use may be made as follows :—

Paraffin	1 gallon.
Soft soap	1½–2 lb.
Water	10 gallons.

Dissolve the soap in boiling water, using up to 2 lb. if the water is at all hard. Remove from the fire, and while still very hot add the paraffin and mix thoroughly by syringing the liquid back into itself with a hand syringe. Thorough mixing is important if a good emulsion is to be obtained.

Any of the above winter washes should be sprayed on to the trees so as to wet thoroughly the twigs and branches.

London, S.W.1,
August, 1900.
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.

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Leaflet No. 66.

BOARD OF AGRICULTURE AND FISHERIES.

Fowl Cholera.

Fowl cholera is a contagious disease of birds due to the bacillus of fowl cholera, which frequently appears on the Continent of Europe and in America, and is by no means rare in Great Britain.

Birds Susceptible.

The disease may attack fowls, turkeys, geese, ducks, guinea-fowl, pigeons, pheasants, partridges, and some of the smaller wild birds. It is also communicable to rabbits by inoculation.

The Microbe.

Fowl cholera is caused by a minute ovoid bacillus, which is found in the blood, organs, and intestinal contents of birds suffering from the disease. The bacillus does not form spores ; it is easily destroyed by disinfectants, and it gradually loses its virulence on exposure to air.

Methods of Infection.

Birds are infected by eating food-stuffs, or drinking water, which have been soiled by the excrement of infected birds.

The disease may be brought into a flock by newly purchased birds, by birds returning from poultry shows, by dealer's crates, and by birds which have recently occupied dealer's crates, or by utensils soiled by affected birds, or by wild birds which are susceptible to the disease. The infective excretions may also be carried on the boots of people who have visited affected flocks.

There is reason to believe that birds which have recovered from fowl cholera may remain infective to others for a considerable time.

Symptoms.

The disease has a short incubative period (eight hours to three days) and the mortality is high. In the most acute cases the onset of the disease is so sudden that symptoms of illness are often not observed, and the birds are found dead, In less acute cases there is loss of appetite and great thirst, erection of the feathers, drooping of the head, wings and tail, swaying gait, quick breathing, and great depression.

Diarrhœa is a most noticeable symptom. The evacuations are frequent, watery, white or yellow at first, becoming green and fœtid as the disease progresses. The feathers round the anus become matted together. A whitish discharge flows from the eyes, nose, and mouth. The comb and wattles at first are paler than normal, but later they become of a livid colour. This form lasts two or three days, when the birds usually die in a state of stupor, or in convulsions. The death-rate among affected birds may be from 80 to 90 per cent. Towards the end of an outbreak milder cases occur, and a greater number of recoveries takes place. Birds which recover acquire a certain amount of immunity to this disease, and, if they thrive, are valuable for re-stocking purposes.

Post-mortem Appearances.

In acute cases the only lesions visible to the naked eye will be found in the intestinal tract. The intestinal contents are watery, whitish in colour, but sometimes blood-stained. In the intestinal wall, and particularly on the mucous membrane, bloody patches are seen. There are alsc areas of congestion, ranging in colour from red to purple and black. The mucous membrane is destroyed in places and patches of yellow exudate may be observed. The liver and spleen are usually engorged, and in some cases the lungs are consolidated.

Preventive Measures.

1.—An endeavour should be made to prevent the introduction of the disease by isolating all newly purchased birds and birds returning from poultry shows for fourteen days, unless there is some guarantee that they have not been in contact with infection.

2.—Crates, utensils, etc., which have been used for suspected birds should be disinfected.

3.—If any attendants have been in contact with diseased birds, their hands, clothes and boots should be disinfected before they go near healthy birds.

4.—If the disease appears, all suspected or affected birds should be isolated, and the healthy ones should be moved to fresh ground.

5.—The houses, nest boxes, utensils, and the parts of the runs contaminated by the affected birds, should be thoroughly cleansed, and disinfected with 5 per cent. of carbolic acid in water, or with a 2 per cent. solution of commercial sulphuric acid in water. The houses should then be lime-washed, using a wash in which ¼ lb. of carbolic acid has been mixed with each gallon of wash.

As it is impossible to disinfect fowl runs thoroughly, it is not safe to re-stock infected runs with fowls, turkeys, geese, ducks, or guinea-fowl for two months after the disappearance of the disease.

6.—Dead birds and their excreta should be burnt, or buried deeply, and covered with lime.

A protective serum is sometimes used on the Continent, but it is expensive and its value is doubtful.

London, S.W.1,
May, 1908.
Re-written, 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.

BOARD OF AGRICULTURE AND FISHERIES.

Favus or White Comb in Poultry.

While many fungi cause disease in plants some give rise to disease in animals. Ringworm and Favus are two such diseases, the disease-causing fungi consisting of extremely delicate threads which prey on the live tissue of the host.

The disease Favus in the fowl is due to a parasitic fungus, *Lophophyton gallinæ*, which is distinct from that causing favus in mammals. This fungus attacks the comb and wattles of birds, and spreads from the naked parts of the head to parts covered by feathers, *e.g.*, the neck, and the parts in the neighbourhood of the vent. At times the breast and more often the rump may be attacked. In some cases one side only of the neck may be affected, this side becoming quite denuded of feathers, whilst the other shows no signs of the disease. As a rule, however, it is the comb that suffers first and most from the attack. Favus may spread to man, rabbits, and mice, but dogs and rats are unaffected when inoculated. The disease is rarer in Great Britain on man than it used to be, and is almost exclusively confined to the poorer classes living under dirty and insanitary conditions.

Favus is very destructive in poultry-yards, and, being highly contagious, often spreads with great rapidity. A single diseased cock soon contaminates the whole run, and several outbreaks have been traced to a new male bird from an affected yard.

Nearly all breeds seem equally susceptible, but the disease does not appear to have occurred in Indian Game; it is said that fowls of Cochin China descent are most liable to it.

Symptoms.—The first signs of an attack of favus are small, pale, irregular, cup-like spots on the comb or wattles, generally appearing on the comb first. These spots grow together, and sooner or later form a confluent covering of a dirty yellowish-grey substance, which is often arranged in concentric layers. These crusts grow thicker. When they are present on the comb or wattles only there may be a complete and rapid disappearance of the malady; but when the feathered areas become invaded the disease is more persistent and may end fatally unless treatment is resorted to. The feathers become erect, dry, and somewhat brittle, and fall off. The naked skin is then seen to be covered with dull yellowish grey crusts, showing here and there somewhat funnel-shaped depressions from which the feathers have fallen. The affected birds exhale a mouldy odour. The fungus may

easily be observed by scraping the diseased surface or the skin under the crusts, and examining the material obtained under a microscope. It will then be seen to consist of a number of fine threads (the mycelium). To examine the fungus, the scraping from the skin and crusts should be put on a slide, and then moistened with distilled water and a little acetic acid.

As the disease can be transmitted to man care should be taken by poultry keepers in handling diseased fowls, especially if they have any exposed cuts or wounds.

Treatment.—1.—The treatment consists in bathing the invaded parts with warm water and soft soap, and then applying some ointment to destroy the parasite. Nitrate of silver well rubbed into the comb and wattles has been found of great benefit. A correspondent of the Board of Agriculture and Fisheries recommends an ointment of 5 per cent. of nitrate of silver in soft paraffin (vaseline) for the purpose. Red oxide of mercury one part, to lard eight parts, has proved an excellent remedy if used persistently for several days.

2.—Before applying the ointment the diseased parts should be carefully fomented, and all the crusts removed as far as possible with a blunt knife.

3.—One cannot be too careful in examining a fresh bird before turning it into the run. If any signs of "favus" are noticed the bird should be kept apart from the others.

4.—Should the disease appear, infected birds must be isolated, or they may spread the disease. They should be treated at once, as when the parasite reaches the feathered tracts it is much more difficult to eradicate.

London, S.W.1,
March, 1901.
Revised, July, 1915.

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BOARD OF AGRICULTURE AND FISHERIES.

Currant and Gooseberry Aphides.

Currant and gooseberry bushes are often considerably damaged by Aphides or Plant Lice. In some districts bushes may be quite ruined; the leaves turn brown and shrivel up and the fruit falls off. Long spells of dry, warm weather are very favourable to the development of the insects. As Aphides are usually more or less prevalent on the bushes and, as favouring natural conditions may result in their increase to overwhelming numbers, attempts should be made, especially in autumn and in spring, to destroy them.

An interesting feature in the life-history of these Aphides is that only part of their life is passed on the currant and gooseberry bushes. At certain times of the year they migrate to plants of other Natural Orders, returning as winged individuals in autumn or the next spring. All the species affecting the currant and gooseberry feed above ground except one found on the currant which feeds on the roots.

The bushes are affected in various ways. The leaves may show marked blisters, green, yellow, and red in colour, under cover of which the insects feed. The leaves curl up and hang down and form rosettes and the attacked shoots remain short and become bent and hidden by rolled up curled leaves. The fruit fails or falls away owing to the destruction of the leaves.

Theobald writes of nine species found on the genus *Ribes;* of these five may be mentioned here.

Aphis grossulariae, Kalt.—This species is characterised by the antennæ being shorter than the body, by the honey tubes being short, thick and pale-coloured, and by the presence on the abdomen of blunt tubercles.

A. grossulariae is found on the currant and gooseberry from May onwards. Later it leaves these plants to fly to other host species, but the complete year's round of life is still in doubt. On the currant and gooseberry this Aphis attacks the leaves and the young wood. The leaves get crowded together and overlap, and the Aphides are thus sheltered from any spray applied too late.

Rhopalosiphum ribis, Buckton.—The wingless females are green, mottled with darker green; the legs, honey tubes and antennæ are pale green, and the eyes are red. The body measures about $\frac{1}{10}$ inch in length. The winged females are yellowish-green with dark head and antennæ; the thorax is dark with a yellow band in front; and the abdomen is bright yellowish green with dark spots and patches on the sides and back. The honey tubes are yellow and are swollen towards the apex, the legs are ochreous, with the joints and feet black.

Winter is passed on the currant and gooseberry in the egg stage. The eggs hatch and from April onwards the wingless females are found on the under surface of the leaves which show the green, yellow, and red blisters. The winged individuals appear in summer and fly to the lettuce; they have also been found on nipplewort, sow-thistle, and guelder-rose. The return to the currant and gooseberry takes place in autumn.

Myzus ribis, Linn.—The wingless female is shiny, yellowish-green, with dark green mottlings; there are small knobbed hairs in front; the honey tubes are pale green and the eyes bright red. The antennæ are long and thin, and are pale in colour, while their third joint bears six knobbed hairs.

The winged female is bright green with pale olive head; the thorax is brown; the abdomen has irregular transverse bands and dark lateral spots; knobbed hairs are present at the base of the antennæ and on the abdomen.

This species is found on the currant and gooseberry from May to July. It gives rise to blisters on the leaf, as with the previous species, and it often causes the leaves at the apex of the shoots to curl. Winged females migrate in late summer but details are lacking.

Macrosiphum lactucæ, Schrank.—The mark of the genus macrosiphum is long antennæ springing from well-marked tubercles on the forehead. This species found on red and black currants migrates to the lettuce and other composites at mid summer and returns to the currant in the autumn.

Prevention and Treatment.

When Aphides are present on the bushes it is most important to spray early in the year, directly the insects are seen, and before the blisters form and the leaves curl over and overlap. Species that return to the currants and gooseberry in the autumn should be sprayed before they lay their eggs. The burning of prunings will destroy the eggs. Various sprays of service against Aphides are mentioned in Leaflet No. 104. Aphides have natural enemies in the parasitic *Hymenoptera* and in the grubs of the ladybird and the larvæ of the hover-flies.

The Currant Root and Elm Leaf Aphis.

Schizoneura Ulmi, Linn.—This species has no honey tubes on the abdomen. In the summer it is found on the elm where it causes a very marked curling of the leaves. Winged individuals in late summer and autumn leave the elm and distribute themselves over a number of different species of plants, amongst which are the currant and gooseberry. The migrants infest the roots and are then covered by a woolly material like that of the Woolly Aphis of the apple. This species appears in Buckton's monograph as *Schizoneura fodiens*; it has been recently recorded by Theobald in England and Carpenter in Ireland. A migration back to the elm takes place sometimes in the same autumn, but more commonly in the next spring.

Treatment.

There is no remedy which has yet proved satisfactory. Soil fumigants such as a naphthalene preparation (vaporite, &c.) and carbon bisulphide have been recommended and where there is reason to expect a fresh infestation from badly affected elms in the neighbourhood the former compound may be used as a preventive.

London, S.W.1,
Rewritten, September, 1913.

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Leaflet No. 69.

BOARD OF AGRICULTURE AND FISHERIES.

TENT CATERPILLARS.

The Lackey Moth (*Clisiocampa neustria*, Linn.) *and* the Brown Tail Moth (*Euproctis chrysorrhœa*, Linn.).

Two species of so-called "Tent Caterpillars" are frequently found on various fruit trees, especially on the apple, plum, and pear. By far the commonest and most destructive of the "Tent Caterpillars" is the Lackey Moth Caterpillar (*Clisiocampa neustria*). In some parts of England, however, notably certain districts in Kent, the somewhat local Brown-Tail Moth (*Euproctis chrysorrhœa*) did some years ago great damage in apple and plum orchards. The caterpillars of both moths are called "Tent Caterpillars" on account of their forming tent-like nests of silk on the trees.

I.—The Lackey Moth.

Distribution, and Trees attacked.—The Lackey Moth is widely distributed over the south, west, and middle of England. There are numerous records from the East side, *e.g.*, from Norfolk, Suffolk and Essex. It does not occur further north than York, where it is usually rare. Always more or less prevalent in the south, at certain times it occurs in greater abundance, and apple and pear orchards are sometimes stripped of every vestige of foliage by the caterpillars. It is abundant in France, where there are laws compelling growers to cut off and destroy the "tents" formed by the larvæ. The Lackey larvæ feed not only on Rosaceous fruit trees but also on hawthorn, oak, elm, and many other trees and shrubs.

Description.

The moth is very variable in colour and size, and measures up to an inch and a quarter in expanse of wings in the male, and an inch and a half in the female. The fore wings are a rusty reddish-brown, yellowish-brown, ochreous or brick-dust red, with two pale or dusky-brown transverse lines across them, the space between the two bars being often more deeply coloured than the rest of the wing; the hind wings are the same tint as the fore, but often a little paler; the thorax and abdomen are densely scaly. The adult may be taken on the wing at dusk in July and August, and even as late as September.

The eggs are deposited in autumn in rings that surround the smaller shoots of the fruit trees, each ring containing

from forty to over two hundred eggs. These remain unhatched on the trees all the winter, and, being greyish-brown in colour, are readily seen by a careful observer on the dark ground-colour of the twigs.

The caterpillars are almost black at first, and more or less hairy.

They become brilliantly-coloured as they grow, being bluish-grey, with two black spots on the segment next the head, and two also on the bluish-grey head; there are three orange-red stripes along each side, and between the two lowest of these is a broad blue stripe with little black specks, these brilliant lines being separated by black and black spotted with blue, and a white stripe down the back with a narrow black line on each side; the whole larva is covered with rather rusty hairs, darker above than at the sides. When full-grown the caterpillar reaches two inches in length.

Life History.

The eggs hatch about the end of April, and the young larvæ soon commence to form a fine web, enclosing a few leaves, and beneath this little tent of silk they continue to feed in communities for some time. As they grow the silken house is enlarged, until in some large colonies it may reach nearly a foot in length. At first the larvæ feed entirely under the tent, but as they grow they spread out over the trees, and eat off the leafage and blossom, returning to the web at night and in wet weather. On warm days they may often be found in batches, several lying parallel with one another, either on the outside of the tent or along the branches. They are somewhat timid, and fall to the ground on the tree being shaken, but soon crawl back to the foliage again. From the middle of June to the end of July they reach maturity, and spin a delicate loose white cocoon, the silk being mixed with a yellowish powder and numerous hairs of the larvæ. The cases are formed amongst the leaves, on the bark, amongst grass below the trees, on walls, fences, &c.; always above ground. The larva changes in this cocoon to a dark-brown pupa, from which the moth emerges in from two to three weeks.

II.—The Brown-Tail Moth.

Distribution, and Trees attacked.—According to Stainton the Brown-Tail Moth is local, and not to be found everywhere. Where it does occur, however, it is often very abundant. It has been recorded from Lytham, Epping, Teignmouth, Lewes, Lymington, Stowmarket, Black Park, Chesham, Dorking, Newhaven, Bisterne, Bristol, Norwich, and many other places, though it may not occur there now. It has also been recorded from Scotland.

THE LACKEY MOTH.

(A) Tent and caterpillars. (B) Male moth. (C) Egg-ring (natural size)
(D) Pupa (natural size).

The female lays her eggs on the under surface of the leaves of the oak, elm, beech, willow, rowan, black-thorn, white-thorn, apple, plum, and sometimes pear.

Description.

The female moth has pure white forewings, with a faint black spot ; hind wings pure white. *The male* has similar fore and hind wings, white head, thorax and abdomen, the apex of the latter having a golden brown tuft. In length the wing expanse varies between an inch and a quarter and an inch and three quarters. The moth is a night flyer, resting during the day on walls, leaves, lamps, &c., and is then very sluggish, falling down as if dead when its resting place is shaken.

The eggs are round, and as many as two hundred and fifty may be counted in each batch ; the egg masses have a brown colour. Each patch of eggs is covered over by hair from the female's tail and completely hidden.

The caterpillars are at first very small, of a blackish or dirty yellow appearance, with a black head and four rows of black dots and numerous hairs. In the spring of the next year they moult and assume a deep brown appearance with reddish-brown hairs, a row of white spots on each side, a narrow double broken line of red alone on the dorsum, black between, and with two prominent bright red tubercles on the back of the eleventh and twelfth segments, depressed in the centre ; these tubercles can be elevated or depressed by the larvæ at will.

The finely barbed brittle hairs of the caterpillars cause a severe skin rash.

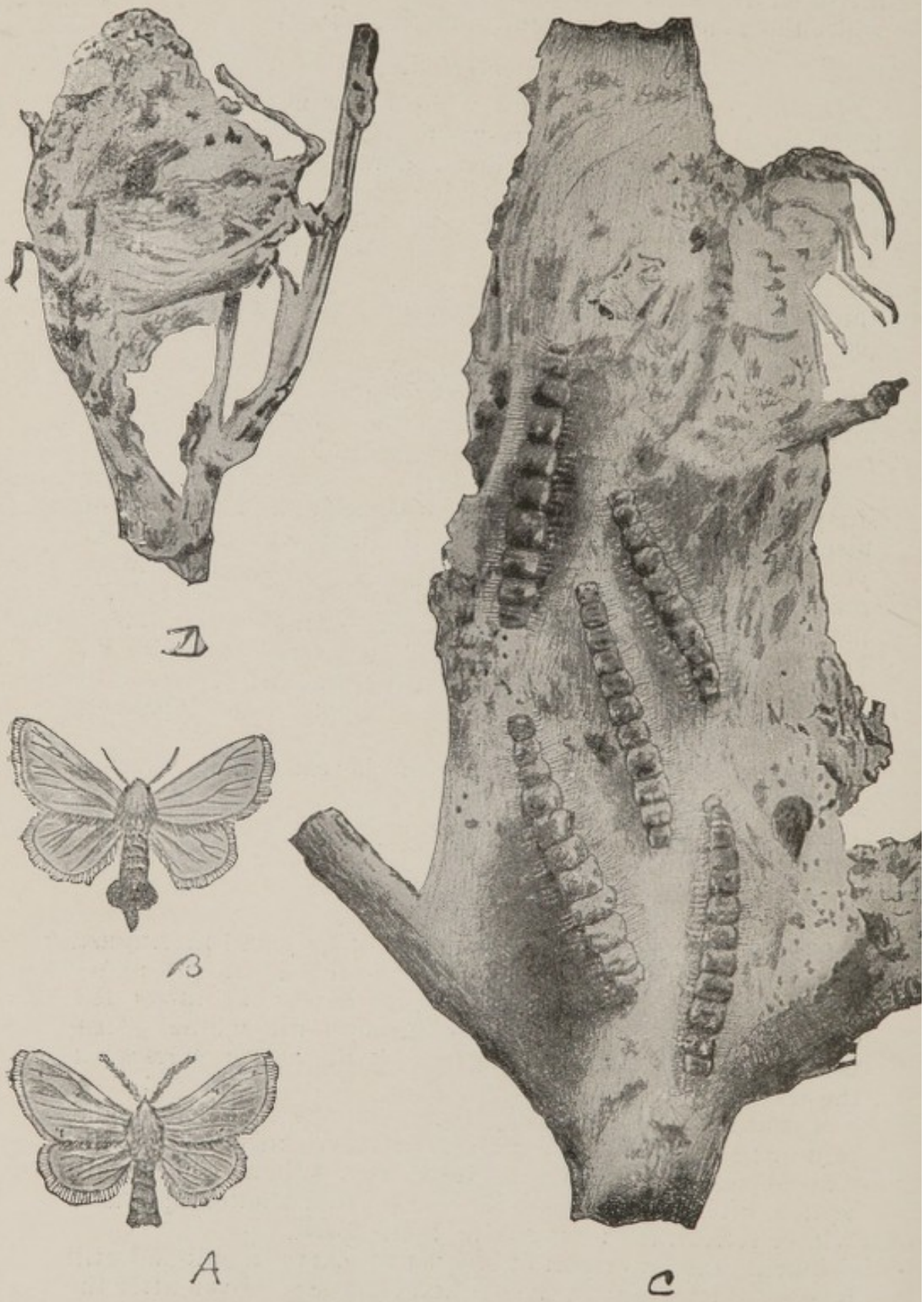
The pupæ are deep brown in colour, and are enclosed in a loose web of silk.

Life History.

The moth appears towards the end of July and in August, and is typically a night flier. Eggs are laid on the under surface of the leaves. The larvæ hatch out about the beginning of August, and live through the winter. The larvæ on hatching feed in clusters on the upper surface of the leaves.

Towards September they commence to make a regular tent or nest, attaching a number of leaves together by silk. The leaves are lined and covered with silk, and all firmly united. This nest is used as a nocturnal shelter and as a winter retreat, the tents having then closed.

During the latter part of August the larvæ moult and still feed on as long as the leaves contain any sap. Even after the leaves have fallen it is not unusual to see the larvæ on a sunny warm day basking in the sun outside the tent. As the weather becomes cold, they become dormant and remain in their



THE BROWN TAIL MOTH.

(A) Male moth. (B) Female moth. (C) Summer tent and larvæ.
(D) Winter tent of larvæ.

dwelling. In the spring of the next year they recommence feeding on the leaves as they open, and wander freely over the trees. Very frequently the colony divides, two nests being made, and sometimes even a third is formed. Early in May they moult again, assuming the appearance described above. After this moult they spread out over the fruit trees, forsaking their nests, and then devour the foliage very ravenously.

From the end of June to the beginning of July they spin their cocoons often at the ends of the branches. A number of cocoons may be found under a common web. From these cocoons the moths issue in the latter part of July and August.

Prevention and Treatment.

1.—After an attack of Lackey Moths the orchards should be gone over in the winter and all egg-bands collected and burnt. On large trees this is not possible, but where it can be done, it is a rule that should always be followed.

The small tents of the Brown Tail should also be looked for during the winter and cut off and burnt. Any tents left should also be collected and destroyed in the early summer either on a dull wet day or during the evening, when the caterpillars are at home. The tents of the Lackey should also be collected during summer. As the larvæ readily fall when shaken, care should be taken to hold boards or a sheet beneath the tents which are being cut off.

2.—A great deal of damage will be saved by spraying as soon as the attack is noticed, especially when the tents cannot be reached by hand. For this purpose arsenical washes should be used, *e.g.*, Arsenate of Lead.

Natural Enemies.—There are several Ichneumon species which parasitise the larvæ and pupæ of the Lackey Moth and the Brown Tail Moth.

Being hairy, these larvæ are avoided by birds, so that little help is given by the latter when the pests are causing harm in the orchard. The cuckoo, however, devours hairy caterpillars.

London, S.W.1,
July, 1901.
Revised, May, 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. 70.
BOARD OF AGRICULTURE AND FISHERIES.

The Treatment of Neglected Orchards.

The state of dilapidation and neglect of thousands of acres of orchards in England and Wales is deplorable. It is to the interest both of the owner and the State to ensure that this condition of things shall be remedied, for whereas the great scarcity of British-grown fruit experienced during the season of 1918 was in the main due to causes beyond the growers' control, it was aggravated by the neglected condition of many of the orchards in this country. It is, therefore, the duty of every fruit grower to give the most careful attention to his plantations and orchards, so that by obtaining larger yields of fruit of better quality he may contribute towards meeting the future demand, and help to make this country more self-supporting in this connection.

The causes of the unprofitableness of orchards are many. Some are beyond remedy, but others are preventable.

Speaking generally, it is only waste of time and money to endeavour to restore plantations and orchards which have become unprofitable owing to old age, or because of severe damage to the trees (due to insufficient protection from stock, careless staking, or grease-banding without paper.)

It is, however, possible to restore quickly to fruitfulness plantations and orchards which have become unfruitful through overcrowding, or through neglect to control insect and fungus pests such as Woolly Aphis, Canker and Brown Rot.

Orchards suffering from lack of pruning and proper cultivation may also be quickly restored.

Even when plantations are unremunerative because they consist of varieties which are unsuited to the locality or are of poor market quality, much may be done to bring them into a fruitful condition by top grafting.

It will be readily understood that, although the results of renovation may become apparent even in the following season, yet as a general rule careful treatment may be required for several years before a neglected or otherwise unfruitful plantation is brought into full bearing.

The renovation of a neglected plantation or orchard may be divided into two sets of operations:—(1) cleaning the trees and controlling insect and fungus pests by winter-washing and summer spraying; (2) thinning overcrowded plantations by judicious pruning, top-grafting, manuring and general cultivation.

WINTER WASHING OF FRUIT TREES.—Winter washing of neglected fruit trees removes moss and lichens and at the same time it reduces the numbers of such pests as the woolly aphis, mussel scale, codling moth, and blossom weevil, which spend the winter on the trunks or branches, under loose scales of bark, or among the moss and lichen.

The term "winter wash" is often applied to several more or less distinct classes of spray fluid, which may be used alone or in some cases in combination with each other. Four classes of washes are in common use, their characteristic features being as follows :—

1. *Strongly Caustic Fluids*, of which the chief active ingredient is caustic soda. The efficiency of these washes, however, is increased when they are used in conjunction with those of Class 4.
2. *Lime Washes*, which in their simplest form are made from lime and water alone. Their action is essentially that of a cover wash, that is to say, they leave a deposit or covering layer over the surface of the trunk and branches, and so tend to imprison either insects or their eggs. They also have a definite cleansing effect.
3. *Lime-sulphur Washes*, made by boiling together lime and sulphur. They are much less corrosive than washes of Class 1, but have a specific action in the case of certain insect pests, and when used as summer washes are useful fungicides. They are sometimes used in combination with washes of Class 2.
4. *Paraffin Emulsions* and miscible oils which, when used alone, destroy some definite pests, *e.g.*, scale insects. They have slight cleansing properties also.

Washes of Class 1, or combinations of Classes 1 and 4, are the most satisfactory for the purpose of dealing with trees which are in a thoroughly bad condition. They should not, however, be used every year, for if too frequently applied they may do damage. In many cases, washes of Class 2 or Class 3 will be sufficient to check any growth of lichens or moss.

Winter washing with caustic washes (Class 1) is carried out between November and February, and as regards insect pests, either early or late applications give good results. Spraying should not be started before the leaves are off the trees, nor, under any circumstances, should it be continued after the buds have begun to swell in the spring. The main branches and trunk of each tree should be thoroughly wetted and the liquid driven into every crack and cranny ; *a nozzle giving a fine or misty spray must, therefore, be avoided.* Every care must be taken to prevent the caustic fluid from touching the skin or clothes, and those engaged in spraying should be protected by suitable overalls, gloves, &c. The work should of course be done in fairly still weather.

Lime-sulphur Washes (Class 3) at winter strength may also be used during the same period and in the same manner. *Lime Washes* (Class 2) are usually applied in early spring just before the buds break, but they may be used much later, almost until the bursting of the blossom, without ill effect ; in fact, as regards insect pests, the later applications give the best results.

In spraying with these washes care should be taken to cover every part of the tree-trunk, branches, and twigs. *It is not sufficient to spray the main trunk only.*

Formulæ.—*Caustic Washes* (Class 1).—Directions for making caustic washes are given below. The first is a plain caustic wash which, though less efficient than a caustic paraffin emulsion, is useful and easily made.

(1.) Caustic soda (98 per cent.) ... 2 to 2½ lb.
Water ... ... 10 gallons.

The caustic soda (in powdered form) is dissolved in the water and the solution is ready for use.

The second is a caustic paraffin emulsion based on the well-known Woburn formula. Directions for making caustic paraffin emulsions containing copper sulphate or soap may be required under special circumstances and can be obtained on application to the Board:—

(2) Caustic soda (98 per cent.) ... 2 lb.
Iron sulphate ... ... ⅓ lb.
Quicklime ... ... ¼ lb.
Paraffin ... ... 5 pints.
Water ... ... 9 to 10 gallons.

The iron sulphate is dissolved in about 9 gallons of water. The lime is next slaked and a little more water added to make "milk of lime." The "milk" is strained through a piece of sacking or a fine sieve into the iron sulphate solution. The paraffin is then added and the fluid thoroughly mixed by churning it by means of a hand syringe. (The liquid is drawn up into the syringe and then sprayed back again.) Finally the caustic soda is dissolved and the whole fluid is made up with water to 10 gallons.

NOTE.—The oil known as solar distillate is recommended in the original formula, but the ordinary paraffin used for lighting purposes answers sufficiently well and is more easily obtained. In making any caustic wash the caustic soda should not be added until just before the spray is to be applied, or the spray fluid will lose some of its caustic properties.

It is advisable not to allow live stock in grass orchards for a week or two after spraying.

Lime Washes (Class 2):—

Best quicklime ... ... 10–20 lb.
Water ... ... 10 gallons.

Only the best fresh quicklime (purity 98 per cent.) should be used. Builders' lime often contains impurities, is partially air slaked, and should be avoided. In making the wash, sufficient water should be poured on to cover the lime while it is slaking, and the remainder of the water should then be added, stirring vigorously. The resulting lime wash should be carefully strained before it is put into the spraying machine.

Lime-sulphur Washes (Class 3):—

Lime-sulphur (1·3 sp. gr.) ... 1 gallon.
Water ... ... 14 gallons.

The concentrated solution is bought ready made and is added to the water. This wash should not be used in a copper machine.

OVER-CROWDING.—Close planting is often the cause of a considerable reduction in the fruit crop. As soon as there is the slightest sign of over-crowding, alternate trees should first be cut-in hard annually, and later, after several years have elapsed, grubbed up to give the permanent trees sufficient room for growth.

If thinning in this manner is not carried out, the whole plantation gradually becomes unproductive, because the trees grow into each other and fruit is only produced on the top branches, instead of throughout the trees. At the same time, normal lateral extension is prevented and the head of the tree is forced up to a great height in search of light and air. Picking the fruit then becomes a matter of great difficulty.

Plantations and orchards which have become badly overcrowded in this manner should receive very drastic treatment and nothing less than the removal of alternate trees will be of permanent use.

PRUNING.—Although established standard trees require comparatively little winter pruning, the neglect of this operation is one of the chief causes of unprofitableness in many orchards and plantations. Standard trees are not dwarfed or forced into rapid fruiting in the same way as cordon, bush and half-standard trees, but are allowed to extend at their normal rate. The system of spur- and leader-pruning, so essential for success, with the latter forms of tree, is consequently replaced by a simple system of slight regulation or thinning of the heads of the trees.

This thinning consists of removing all crossing branches or strong growths (water-sprouts) arising from the centre of the tree. The head then remains well balanced, can be effectively sprayed, and sunlight and air can penetrate to all parts of the tree even in summer, so that the fruit colours and the wood ripens satisfactorily.

When pruning standard trees in this way all dead or diseased wood must be removed; in apples, branches attacked by Canker (*Nectria ditissima*) must be removed, and in plums those attacked by Brown Rot (*Monilia* Sp.) or Silver Leaf Disease (*Stereum purpureum*). In the case of Silver-Leaf the branch must be cut back to a point where no brown stain in the wood can be found.

If winter pruning has been neglected for several years very careful treatment is required for successful renovation. The heads of such trees are usually nothing more than "thickets" and therefore contain practically no fruiting wood except on the outside of the tree.

Apples in this state, especially when they are varieties of poor market quality and provided they are not too old (under 25 years), should be top-grafted with a suitable strong-growing variety; but pears, plums and cherries (because they frequently succumb from top-grafting), and apples which are not very badly overcrowded, should be very carefully thinned in the manner already described. This thinning must be extended over several years, otherwise so much wood has to be removed that the tree receives a very severe check and death may ensue.

Plums and cherries which have grown to a great height as the result of close planting, and the fruit of which cannot be picked satisfactorily, should have the central upward-

growing main branches cut back to a reasonable height, leaving as many lateral branches as possible. A new head will then form below this height.

Large branches should be removed by means of the saw, and the cut should be made as close to the main branch or stem as possible (the position of the cut should be through the "crutch" or angle made with the main branch.) The cut surface should be pared smooth with a knife, and if labour can be spared painted with Stockholm Tar, Shellac or a white paint consisting of white lead and boiled oil.

MANURING.—One of the most common causes of unfruitfulness, and the most difficult to deal with is insufficient manuring. This is generally found in grass orchards, and is not nearly so common in cultivated plantations, especially if the trees are intercropped with soft fruits or vegetables, since the latter usually receive dressings of manure.

Poverty-stricken trees present a well marked appearance; the leaves are of a light yellow colour, very little annual growth is made, and the bark of the trunk and branches has an "unkind", hide-bound appearance. In the case of trees planted on grass insufficient manure and the injurious effect of the grass, are jointly responsible for this condition.

Grass, even when properly grazed and manured, is known to have a very deleterious effect on young trees, but on older trees, s pecially on strong land, it often tends to check excessive growth and to cause heavy fruiting, provided that the herbage is maintained in good condition.

Grass Orchards.—Trees planted on grass must be manured through the herbage. The grower must remember that his aim is to produce fruit, and that the grass is a secondary crop which must be managed so that the trees are benefited and not adversely affected.

Young trees (up to 10 years old) should have the grass removed in a circle about 5 ft. in diameter from their base, so that the effect of the grass is minimized and growth is maintained. Occasionally during this period—whenever there is the slightest sign of leaf-yellowing—a dressing of dung should be spread round the trees. Even so the trees will never become as profitable as they should be unless the turf is maintained in the very best condition.

The turf should consist chiefly of fine grasses, and of white or other small clovers. Strong rank grasses, such as Cocksfoot and Timothy, should not be too abundant, as they have a stunting effect on the trees.

The grass must always be kept closely grazed, preferably with cake or meal-fed sheep, and must never be allowed to get so long and rank that it has to be cut with a scythe or mower. A crop of hay must not be taken, otherwise the trees will suffer for a number of years afterwards.

It is a good plan to turn pigs, which are being meal-fed, into the orchard during the late summer and winter once every four or five years, and to allow them to tear up the turf.

In the early spring, before it can dry out, the land should be levelled and well harrowed.

Besides grazing, a dressing of Basic Slag at the rate of 5 to 10 cwt. per acre gives good results on heavy soils and should be applied every four or five years. Ground Lime in dressings of 4 or 5 cwt., applied at similar intervals between dressings of Basic Slag, also has a good effect. The improved condition of the pasture alone will more than cover the cost of the manure, not including the benefit to the trees.

At the same time, brush or chain harrowing and rolling must be carried out annually, in the early spring, to break down worm and mole casts and to tear out moss.

If the orchard presents the characteristic appearance of starvation and the pasture is poor, either (1) pigs should be turned in to root up the turf, the grass then being treated in the manner already mentioned ; or, (2) better still, the grass should be ploughed up and cultivated for two or three years by intercropping with vegetables or roots, dressings of dung being given whenever intercropping is practised. At the end of three or four years the land should again be laid down to grass. An excellent mixture for heavy lands where orcharding is mainly practised, and costing about £3 per acre, is as follows :—

Seed Mixture suitable for sowing a Grass Orchard.

Cocksfoot	6lb.
Timothy Grass	2lb.
Crested Dogstail	1lb.
Perennial Rye-grass	11lb.
Rough-Stalked Meadow-grass	2lb.
Alsike	2lb.
Perennial Red Clover	2lb.
White Clover	3lb.
or	
Wild White Clover...	1lb.
	30lb.

The turf should be maintained in good condition, in the manner already indicated.

As soon as the trees commence to crop heavily, they should receive a good dressing of dung spread round in a circle corresponding to the spread of the branches. In many districts this dressing is given as a mulch in late spring as soon as the flowers have set. It then has a tonic effect and helps the tree to carry a heavy crop to maturity ; in other districts a similar dressing is given in the autumn. If the trees are in a healthy condition and are growing strongly but are not fruiting heavily, these dressings of dung should be withheld

Cultivated Plantations.—Trees grown on cultivated land which show signs of starvation usually have a yellow leaf-colour and make poor growth, and it is probable that the scorching or browning of the edges of the leaves, so general on apples on Paradise Stocks and growing on poor soils, is largely due to lack of humus.

Bulky or slow-acting nitrogenous manures (dung* for preference, otherwise shoddy, wool waste, hair waste, night soil, or hoof and horn) are the best remedies, and if inter-cropping is carried out these dressings should be balanced with applications of phosphates and potash, but generally speaking phosphates and potash are not regarded as limiting factors from the manurial point of view as regards fruit, and there is therefore little need to give the trees special dressings, if no other crops are grown on the land.

Quick-acting nitrogenous manures, such as Nitrate of Soda or Sulphate of Ammonia, are seldom required by fruit trees. These manures cause rapid succulent growth which cannot be maintained throughout the season and the resulting check is bad. Wherever trees are stunted through lack of nitrogen it is, however, advisable to give a small dressing (one or two handfuls) to each tree just sufficient to induce strong growth, provided an application of a bulky slow-acting manure has also been given.

TOP-GRAFTING.—Apples, not more than 25 years old, which are unprofitable either owing to bad attacks of Woolly Aphis, Brown Rot or Canker, or because they are not suitable for the locality, or are of poor market quality and provided they have sound bodies and main branches, should always be top-grafted. A strong-growing variety of known value should be used, and Bramley's Seedling and Newton Wonder are generally most suitable for this purpose. In special cases Worcester Pearmain, Grenadier and Allington Pippin may be used provided the tree to be grafted has plenty of vigour.

Top-grafted apples usually commence bearing quickly and crop heavily, and the fruit, as a general rule, has a high colour. Full particulars of the methods of top-grafting will be found in Leaflet No. 162. "Rind" and "crown" grafting is recommended and is better than the "cleft" or "wedge" method. From a commercial point of view the following varieties generally pay for top-grafting and should only be retained if they crop well and produce clean fruit. The reason they are generally unprofitable is stated briefly in each case.

Devonshire Quarrenden ...	Fruit small, very subject to apple scab and canker.
Lady Henniker	Does not crop well.
Mere de Ménage	Subject to canker.
Ribston Pippin	Crops poorly, very subject to apple scab and canker. Does not top-graft well.
Warner's King	Cankers badly.
New Hawthornden... ...	Very subject to apple canker and scab.
Duchess of Oldenburgh ...	Sells badly.
Ecklinville	Very subject to apple scab and canker.
Emperor Alexander... ...	Crops very badly.
Gascoigne's Scarlet Seedling	Very subject to apple scab and canker

* Normal dressings per acre are as follows :—dung, 10 to 20 tons ; shoddy, wool waste and hair waste, 20 to 30 cwt. ; night soil, 10 to 20 tons ; hoof and horn, 10 cwt. ; superphosphate of lime, 2 to 4 cwt. ; flue dust (for potash) about 5 cwt. (5½ to 9¾ per cent. potash).

Golden Noble	... ...	Cankers very badly.
Golden Knob...	... ...	Fruit very small, sells badly.
Lord Suffield...	... ...	Cankers very badly, does not top-graft well.
Pott's Seedling	... ...	Cankers very badly.
Red June Eating	... ...	Does not sell well owing to its poor colour.
Wellington ...	... ...	Cankers very badly.
Colonel Vaughan	... ...	Fruit too small.
Keswick Codling	... ...	Fruit too small, cankers badly.
Northern Greening ...	...	Fruit too small.
Winter Queening	... ...	Fruit too small. Subject to apple scab.

RE-PLANTING.—Although the planting of young trees in old orchards is not a practice to be recommended if fresh land can be obtained, growers are frequently obliged to fill up gaps owing to a clause in their lease or agreement.

If the orchard is composed almost entirely of old trees likely to die in the course of a few years, young trees planted as the vacancies arise should be placed so that they are between the positions which were occupied by the old trees.

Where gaps are to be filled in comparatively young orchards, there is not generally the same choice of position, since the existing trees will last for many more years and the area for replanting is therefore restricted.

In any case, however, it will be well if each new tree can be planted in such a way that it will not occupy the same spot as its predecessor; and in such instances the planting may be done in the usual manner.

Where, on the other hand, a new tree will occupy the same ground as the old, the soil should be specially prepared. The roots of the old tree should be removed as completely as possible, in order that no decaying wood may be left in the soil, and a circular hole, at least six feet in diameter and from 1½ to 2½ feet in depth, should be dug and left open to atmospheric influences as long as possible before the tree is planted. The soil may also be sweetened and freed as far as possible from insect and fungus pests by a dressing of quicklime. If fresh soil can be obtained to substitute for that dug out, the newly-planted tree will have a better chance of flourishing. On grass land the grass should not be allowed to grow within 5 feet of it for the first few years after planting.

London, S.W.1,
November, 1901.
Re-written, December, 1918.

BOARD OF AGRICULTURE AND FISHERIES.

The Colorado Beetle.

(*Leptinotarsa* (*Doryphora*) *decemlineata*, Say.)

This beetle, a member of the family *Chrysomelidae*, was first known in the west of the United States, and has now spread over the United States and Canada. In its native home it was known to feed on wild plants of the natural order *Solanaceae*, the family to which the potato, tomato and tobacco belong. About 1850, having found its way to the cultivated plants of settlers in the west, it began to travel eastwards. By 1859 it had reached Nebraska, and by 1865 it had crossed the Mississippi. It had passed north into Ontario by 1870, and in 1874 it had reached the Atlantic. Later it obtained a partial footing in England and the Continent of Europe, but prompt preventive and remedial measures removed the danger.

Food Plants.

The principal food of this beetle is the cultivated
and it derives its economic importance from its destructive effect on this crop. The tomato is also attacked, and other plants on which the beetle has been known to feed are the thorn-apple, henbane, tobacco, belladonna, petunia, various poppies, pigweed (*Amaranthus retroflexus*), hedge mustard (*Sisymbrium officinale*), oats, smart-weed (*Polygonum hydropiper*), red currant, various thistles, goosefoot (*Chenopodium hybridum*), thorough-wort (*Eupatorium perfoliatum*), and mullein.

Grasses and other weeds have been known to harbour the larvæ. In some allotments at Tilbury Docks, where an isolated colony of these beetles was found and destroyed in 1901, the larvæ were observed feeding on woody nightshade (*Solanum dulcamara*), cabbage and thistles, while in one case the eggs were found on the sow thistle (*Sonchus*).

Harm Done.

Both the adults and the larvæ are destructive. The adult beetles destroy young plants just coming through the soil, eating them, it may be, to the ground. Beetles and grubs defoliate older plants. Where potatoes are not altogether destroyed, tubers may be produced, but they are likely to be small and poor in quality.

Description of Insect.

Adult.—The adult beetle is about one-third of an inch in width, and a little under half an inch in length. In colour it is yellow, with five longitudinal black lines on each wing-cover; the head has a triangular black spot; and the thorax bears dark spots and a more or less irregular V-shaped mark in the middle.

Egg.—The eggs are elongate-oval in form and orange in colour. They resemble those of some of the Lady-birds (*Coccinellidae*), but are much larger than those of any of our antive species.

Larvæ.—The young, soft-bodied larvæ are of a dull red or red-brown colour, and bear some resemblance to the larvæ of Lady-birds. As they grow they become paler in colour varying from a dull brickdust-red to an almost orange hue, with the head, legs and posterior part of the first segment black. They also bear two rows of black tubercle-like spots along each side, the upper row being the larger and composed of seven spots. As the larvæ mature the body becomes somewhat swollen and more or less arched, the apex terminating in a kind of sucker, the upper part of the two apical segments being black. The full-grown larvæ are rather more than half an inch long when extended.

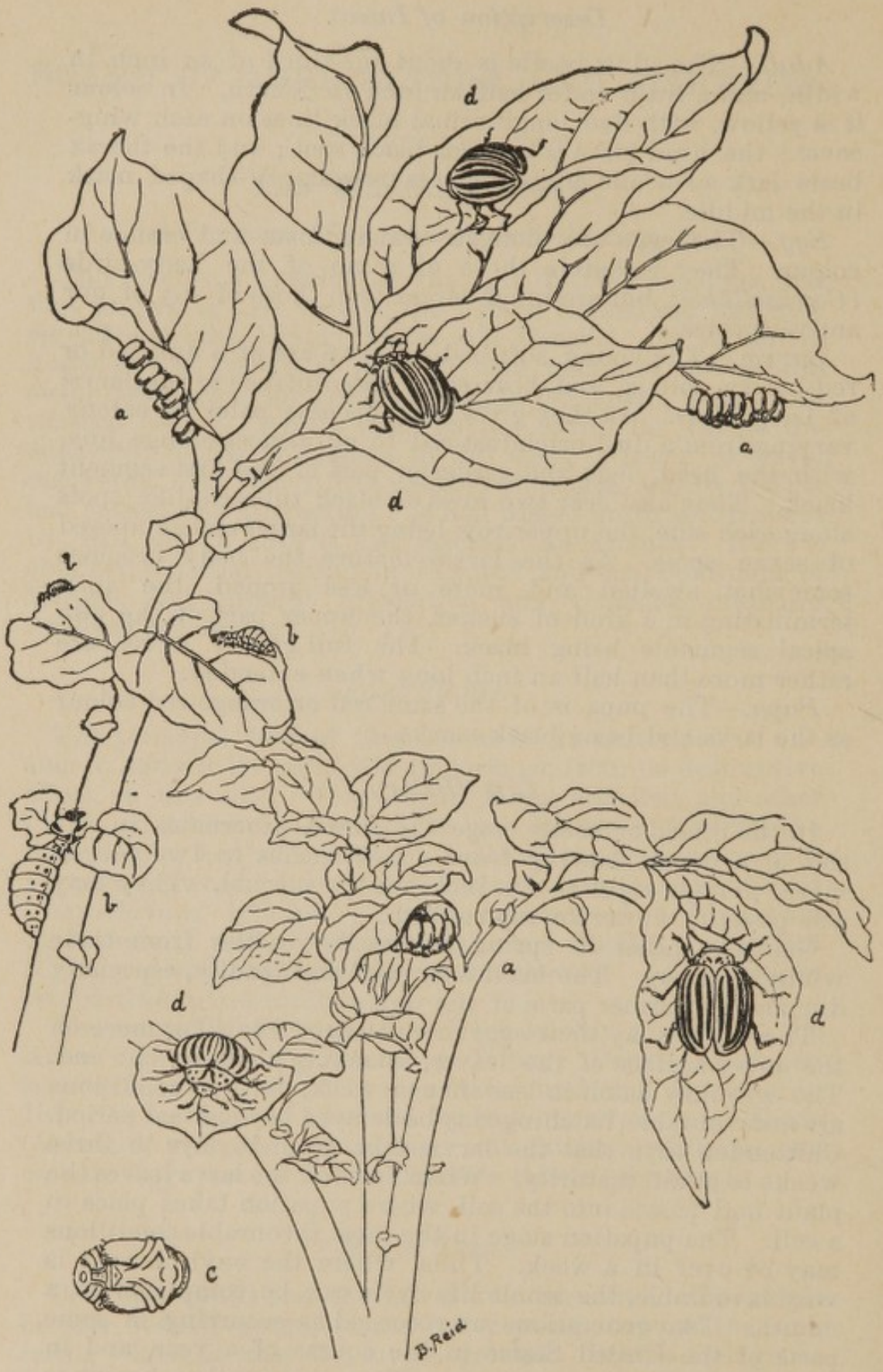
Pupa.—The pupa is of the same red or orange-red colour as the larva and bears black marks.

Life History.

In the imago or beetle stage the insect hibernates in the soil at a depth varying from a few inches to two feet or more, though eight to ten inches is the normal. They may also pass the winter among rubbish.

Genial weather in spring brings the beetles from their winter quarters. The beetles fly well and readily, especially during the warmer parts of the day.

The females lay their eggs in clusters of 9 to 40 or more on the under surface of the leaves, attaching them by one end. The eggs may hatch in less than a week, but, if conditions are unfavourable, hatching may be delayed beyond that period. Chittenden says that the larvæ take from 16 days to three weeks to attain maturity. When full-fed the larva leaves the plant and passes into the soil, where pupation takes place in a cell. The pupation stage in the most favourable conditions may be over in a week. Thus, where the environment is very favourable, the whole life cycle can be completed in a month. Two generations are recorded as occurring in some parts of the United States in the course of a year, and in other parts three generations. When the weather begins to turn cold in the autumn, the beetles bury themselves in the earth for hibernation.



COLORADO BEETLE (*Leptinotarsa* (*Doryphora*) *decemlineata*).
a. Eggs; *b*. Larvæ; *c*. Pupa; *d*. Beetles.

Natural Enemies.

A great number of natural enemies tend to check the Colorado beetle in America. Birds, especially the Rose-breasted Grosbeak (*Guiraca ludoviciana*), feed upon both larvæ and adults. Both ducks and chickens, but especially the former, devour the larvæ.

In America the toad (*Bufo Americana*) gorges itself with the grubs, and our British species would probably also greedily devour them.

The insect enemies recorded by Riley are very numerous; they are chiefly predatory beetles and blood-sucking bugs or *Hemiptera-heteroptera*. Strange to say, no members of the *Hymenoptera*, the order that contains so many parasites, are actually parasitic on the Colorado beetle; a single species of wasp (*Polistes rubiginosus*), however, occasionally provisions its nest with the larvæ.

Theobald, when examining the allotments at Tilbury, noticed the large Seven-spotted Lady-bird (*Coccinella septempunctata*) in considerable numbers both in the adult and larval stages. The larvæ were seen in one instance devouring the eggs of the Colorado beetle, and, when placed in a box with some, to eat them ravenously. Thus in the short space of time in which this potato pest existed in this country it found one natural enemy which, on account of its ravenous nature, would very materially check its increase. A single female Colorado beetle, however, is said to be capable of producing from 500 to 1,000 eggs.

Treatment.

In America an infestation is controlled by jarring the beetles off the plants into vessels containing paraffin. This method is very useful, as a large number of beetles are frequently to be found feeding together on the same plant. The pest is chiefly combated, however, by the use of arsenical sprays, arsenate of lead and Paris green both proving very effective.

The pest has appeared from time to time in Great Britain, but has always been exterminated. It was made the subject of legislation in 1877 by the Destructive Insects Act, and is included among the insects scheduled under the Destructive Insects and Pests Order of 1908. This Order requires the occupier of any premises on which the insect is discovered to notify the fact to the Board with particulars of the time and place of discovery, under a penalty not exceeding ten pounds. It also renders it illegal to sell or expose or offer for sale, without the written permission of the Board, any live specimen of the Colorado Beetle. Copies of the Order may be obtained on application.

London, S.W.1,
March, 1902.
Revised, February, 1910.

Leaflet No. 72.

BOARD OF AGRICULTURE AND FISHERIES.

The Purchase of Artificial Manures.

In spite of their almost universal use, artificial manures are often so little understood that a few suggestions as to their purchase should be of interest and value.

Generally speaking, manures are applied to land to supply crops with what may be termed food materials. It is true that many organic manures, such as rape cake, dried blood, guano, and, above all, farmyard manure, are extremely valuable in improving the physical character (texture, workability, water holding power, &c.) of soils, and cannot be valued merely as suppliers of plant food. It is, however, very seldom that purchased artificial manures are used in such quantities as to have an appreciable effect upon the physical character of the soil, and in ordinary cases their action in this direction may be regarded as too small to be valued separately, though it may be kept in mind.

Regarding artificial manures merely as supplying plant "food," it may be said that of all the materials taken by plants from the soil it is only necessary to apply three in the form of manure (a fourth substance, lime, is required by most soils, but not so much as a plant food as on account of its action on the soil. *See* Leaflet 170.) These three materials, usually referred to as nitrogen, phosphates, and potash, are therefore the only ingredients valued in artificial manures, and, other things being equal, the value of a manure is determined entirely by the amount of these substances which it contains.

Some manures contain only one of the three ingredients, *e.g.*, nitrate of soda, nitrate of lime, sulphate of ammonia and calcium cyanamide contain only nitrogen; superphosphate, precipitated phosphate, and basic slag contain only phosphates; and blast furnace flue dust, kainit, sulphate of potash, and muriate of potash contain only potash. Other manures hold two substances that are valued, as in the case of bones and fish meal, which furnish both nitrogen and phosphates, or saltpetre (very seldom used, however, as a manure), which supplies both nitrogen and potash. Excluding "mixed" or "compound" manures, only one class of so-called artificial manure, namely, Peruvian or other similar guano, contains an important amount of all three substances.

It has been stated above that only nitrogen, phosphates, and potash are valued in artificial manures, for they are the useful constituents on which the crop depends. For this reason, and in order that in other ways there shall be no ambiguity of expression, the Fertilisers and Feeding Stuffs Act, 1906, provides that *in an invoice the actual percentages of nitrogen, soluble phosphates, insoluble phosphates, and potash in any manure must be stated as such*, and not as ammonia, phosphoric acid, sulphate of potash, &c. Partly from custom, and partly for other reasons, the invoice is sometimes illegally made to show the amount of the last-named constituents present in the manure sold, and farmers and others in considering an invoice should be careful to notice whether the percentages of the manurial constituents relate to nitrogen or ammonia, phosphates or phosphoric acid, potash or sulphate of potash.

In trade circulars, price lists, and text books the use of the terms ammonia, phosphoric acid, sulphate of potash, &c., is still common, and it is therefore well to be familiar with the method of converting them to the terms required by the law. The common relationships are explained below under the headings *Nitrogen*, *Phosphates*, and *Potash*.

Nitrogen.

The relationship between nitrogen and ammonia need occasion no difficulty or uncertainty; 17 lb. of ammonia always contain 14 lb. of nitrogen, or, what is the same thing, 14 lb. of nitrogen are the equivalent of 17 lb. of ammonia. If, therefore, a sample of, say "Corn Manure," were said to contain 4·5 per cent. of ammonia, this would be the same as saying that it contained 3·7 per cent. of nitrogen. The figure may be made to look still more attractive by being stated as sulphate of ammonia, but this also raises no difficulty, for 66 lb. of this substance contain 14 lb. of nitrogen or 17 lb. of ammonia. The figures therefore mean one and the same thing, whether they are stated as 3·7 per cent. of nitrogen, or 4·5 per cent. of ammonia, or 17·4 per cent. of sulphate of ammonia. Yet a manure merchant, who failed to effect many sales for a fertiliser, of ever so high-sounding a name, on a statement of 1 per cent. of nitrogen or 1·2 per cent. of ammonia, might be more successful with a certain class of buyer if he entered the nitrogen as equal to 4·7 per cent. of sulphate of ammonia, though the three figures all represent the same fact.

Phosphates.

Phosphates in a manure may be in either an insoluble or a soluble condition, and as the value in the two cases is widely different, the two forms must be separately mentioned in an analysis of manure. It is usual to give the percentage

of "phosphate of lime" soluble or insoluble as the case may be. Occasionally, but not often, the percentage of "phosphoric acid" only is quoted. This should cause no difficulty to the purchaser if it is remembered that 142 lb. of phosphoric acid always form 310 lb. of phosphate of lime. If, therefore, in a manure the percentage of phosphoric acid is quoted, multiplying by 2·2 gives the percentage of phosphate of lime to which this is equal.

Thus if the analysis of a manure shows it to contain 12 per cent. of phosphoric acid, it is equivalent to saying that it contains 26·4 per cent. of phosphates. Similarly 30 per cent. of phosphates is equal to nearly 14 per cent. of phosphoric acid.

Potash.

Potash usually exists in manure in the two forms of sulphate of potash and muriate or chloride of potash. It takes 94·2 lb. of pure potash to form 174·2 lb. of pure sulphate of potash, whereas the same amount of potash will form only 149·2 lb. of the pure muriate or chloride of potash.

Occasionally, instead of giving the amount of potash, an analysis shows the percentage of sulphate of potash. To obtain from this the percentage of potash divide by 1·85. Thus if a sample of kainit is said to contain 23·1 per cent. of sulphate of potash this means that it contains 12·5 per cent. of potash.

Just as a buyer may sometimes be led into purchasing a manure through its nitrogen being illegally expressed as sulphate of ammonia, so may the contents of potash be made to look more attractive by being stated as sulphate of potash.

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*The rules for approximately converting the various terms into their equivalents may be summarised thus :—

To convert	ammonia	into terms of	nitrogen	divide	by	1·2
"	"	sulphate of ammonia	"	"	"	nitrogen	"	"	4·7
"	"	phosphate of lime	"	"	"	phosphoric acid	"	"	2·2
"	"	sulphate of potash	"	"	"	potash	"	"	1·85
"	"	muriate of potash	"	"	"	potash	"	"	1·58

The Comparative Value of Nitrogen, Phosphates and Potash in different forms.

As explained above, the first thing that determines the value of an artificial manure is the percentage of the different manurial ingredients which it contains, but it

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* While this and the foregoing is given for the information of farmers and others it must again be emphasised that under the provisions of the Fertilisers and Feeding Stuffs Act, 1906, the analysis which must be given in an invoice shall state the percentages of nitrogen, soluble phosphates, insoluble phosphates and potash as such, and not as ammonia, sulphate of ammonia, &c. Any case where such percentages are not clearly stated should be reported at once to the Board.

must be remembered that nitrogen, phosphates, and potash may each exist in different forms which vary a good deal in efficiency and rapidity of action and consequently in value. Thus, it is quite possible for a manure to contain fairly high percentages of the three substances and yet be worth very little, owing to the extreme slowness with which the ingredients will become available for the use of the plant.

Nitrogen is mainly taken up by plants in the form of nitrate, so that nitrate of soda and nitrate of lime can be used by crops at once, and, on account of the rapidity and certainty of action, these forms, if properly used, generally give the greatest return in weight of crop for a given quantity of nitrogen supplied. In the case of other manures the nitrogen is not as a rule taken up directly but is first changed by the action of bacteria in the soil to the nitrate condition. This makes them slower in action than the nitrates of soda or lime, and while in many circumstances this is an advantage, there is always a certain amount of loss in the process of change to nitrates. Roughly speaking it may be said that the amount of this loss varies according to the amount of change necessary, and the slowness of action of the manure. If properly used, more of the nitrogen is recovered in the crop when a quickly acting manure is applied than when a slowly acting one is used. It need hardly be said that the amount of change necessary and the rapidity of action vary greatly according to the manure, *e.g.*, sulphate of ammonia and calcium cyanamide change fairly quickly and are only slightly less rapid in their action than nitrate of soda, while such manures as dried blood, rape cake, guano, &c., are also fairly quick in action. In the case of shoddy or even coarsely ground raw bones, however, some of the nitrogen may remain unchanged and be quite useless, as far as crops are concerned, for years after the manure has been applied to the soil.

Phosphates, as already seen, can be divided into two classes—soluble and insoluble.* The different forms of soluble phosphates are the same in character, action and value, but there is considerable variation in the value of the different forms of insoluble phosphates. These are all insoluble in pure water, but to varying extents become soluble in the soil, and in order roughly to compare their value the method generally adopted is to find what proportion is soluble in a weak solution of citric acid in

* NOTE.—The terms soluble and insoluble as used in this leaflet mean soluble and insoluble in pure water. The Fertilisers and Feeding Stuffs Act, 1906, and the Regulations made under it, admit the use of the terms "insoluble phosphates" and "soluble phosphates" in relation to phosphates treated with a 2 per cent. solution of citric acid. But the fact that a solution of citric acid has been employed in making the analysis must be stated in the invoice. If nothing is said, "soluble" and "insoluble" always mean soluble or insoluble in pure water.

a given time. This citric acid soluble phosphate must not be confused with the water soluble phosphate of superphosphate or dissolved bones. The main difference between the two is the rapidity of action of the latter due to its being more quickly distributed through the soil. After it has been in the soil a short time it "reverts" to a condition which, though not necessarily the same, is in effect similar to that of the citric acid soluble phosphate of "insoluble" manures.

It is probable that the phosphate insoluble in the standard solution of citric acid has no immediate fertilising value, and will become only very gradually available for the use of crops. Therefore, in valuing manures such as basic slag and compound manures, it is desirable to ascertain the proportion of the "insoluble" phosphate which is soluble in the citric acid solution.

To a great extent the value of phosphatic manures is determined by the fineness of grinding. Thus in a raw undegreased bone meal, which cannot be ground really finely, less than half of the phosphate may be soluble in the 2 per cent. solution of citric acid, while in steamed bone flour, very finely ground, the same phosphate may be soluble to the extent of three quarters or more in the 2 per cent. solution.

Apart from this, however, phosphates in different manures are of different nature and value. Thus, as a rule, about four-fifths of the phosphate in Bessemer basic slag is soluble in the citric acid solution, a higher proportion than in average bone manures, while only one-fifth of that in mineral phosphate (the raw material from which superphosphate is made) is soluble in the citric acid solution and for ordinary purposes is less effective and less valuable.

Potash in all the commonly used manures—kainit, muriate and sulphate of potash—is soluble, and probably equally effective in the different forms. From time to time, however, there have been attempts to put on the market ground minerals and rocks containing potash in the form of double silicates—almost entirely insoluble and extremely slow in action. In these forms potash is certainly far less effective and less valuable than the potash in the soluble manures.

As some of the above statements are not in agreement with popular opinion as evidenced by the market prices of the various forms of manure, it is necessary to point out that in many cases too much attention is paid to prejudice and custom, and too little to the subject from a practical and commercial standpoint. Perhaps the most common tendency is to attach too high a value to slowly acting manures the maximum effect of which is not produced for, it may be, years after application. No doubt the use of such is often desirable to assist in improving the "condition" of land—though generally speaking the best plan of doing this is by such

systems of manuring as dunging, feeding crops off with sheep and ploughing in of green crops—but when they are used, it should be remembered that the slowness of action actually detracts from their intrinsic value instead of adding to it. This is apart from risk of loss and possibility of such occurrences as expiration of tenancy or changes in the system of farming. Just as £100 due in six years, or even six months, is not worth £100 to-day, so 100 lb. of nitrogen or phosphate which will not become effective till the more or less remote future is less valuable than the same quantity which can be brought into action this season.

It is also a radical mistake to suppose that the risk of loss of nitrogen (there is little fear of loss of phosphates or potash, no matter in what form applied) is necessarily greater in a quickly acting manure than in a slowly acting one. Of course this may be so if the former is supplied to unsuitable crops or at the wrong time of year, but a farmer who understands their action is able to obtain an almost maximum return from them. The slowly acting manures are safer for an inexperienced man, but no matter how they are used, a considerable proportion of the nitrogen will be lost.

"Condition" of Manures.

Too much importance cannot be attached to the necessity of having manures evenly distributed through the soil to which they are applied. Unless the manure is in a fine powdery condition it is almost impossible to secure this. Even in the case of a readily soluble manure which disappears into the soil almost as soon as it is applied, there is very little spreading *sideways* of solutions in the soil—practically all natural motion in a soil is up and down. The importance of this may be judged by the following illustration. If a manure is being applied at the rate of 5 cwt. per acre, 1 square foot receives only one-fifth of an ounce. With many manures this would be represented by a very small lump, which at most would not manure more than 1 square inch, or less than one hundredth of the area for which it is intended. Even after allowing for the slight mixing with the soil brought about by splitting drills or by harrowing, it is clear that if there is even a fair proportion of lumps—which are very often rather large—only a fraction of the ground is being manured at the rate intended, to say nothing of the actual poisoning of the spots on which the lumps fall.

Other things being equal, preference should certainly be given to a manure in a finely divided condition, and a little trouble and expense in keeping it fine and dry, and in applying it evenly, will be well repaid.

The Chief Artificial Manures.

The purely Nitrogenous Manures.—The most important of the nitrogenous manures are nitrate of soda and sulphate of ammonia, others in less general use being nitrate of lime, calcium cyanamide, rape dust, blood meal, and shoddy.

Nitrate of soda and sulphate of ammonia are apt to be lumpy, and the farmer should therefore attend carefully to the mechanical condition. Nothing should be applied that will not pass a ¼-inch riddle. Lumps larger than this will often kill plants with which they may come into contact. Nitrate of lime has great power of absorbing moisture from the air, and much loss may occur in storing for any period over a month unless care be taken to keep it properly protected from the atmosphere—as in air-tight casks. Calcium cyanamide, on the other hand, can be stored for a reasonable time under ordinary conditions without danger or sensible loss of its fertilizing properties.

Nitrate of soda is generally offered on the basis of 95 per cent. of purity (= 15·6 per cent. of nitrogen), while commercial sulphate of ammonia usually contains 97 per cent. of the pure article (= 20·6 per cent. of nitrogen). Nitrate of lime should contain about 13 per cent. of nitrogen; while calcium cyanamide contains from 15 to 20·3 per cent. of nitrogen, and 18 per cent. is usually guaranteed. Sulphate of ammonia is thus usually the most highly concentrated of the four manures.

The purely Phosphatic Manures.—Of the purely phosphatic manures, superphosphate and basic slag are the most important.

Basic slag generally leaves little to be desired as regards mechanical condition, provided the grinding be fine enough (80 per cent. through a No. 100 sieve—that is, 100 wires per linear inch, or 10,000 apertures per square inch—should be the minimum requirement). Superphosphate is sometimes almost as dry and mealy as slag, but in other cases it is lumpy and sticky. Samples of the latter character should be avoided.

Superphosphate contains from 25 to 38 per cent. of soluble phosphate, from 28 to 30 per cent. being a very usual quantity. Basic slag also varies in quality, most of the slag now available ranging from 18 to 30 per cent. total phosphates. Basic slag of lower quality is also met with.

Steamed bone flour, though it usually contains a little over 1 per cent. of nitrogen, is regarded as practically a purely phosphatic manure. It generally contains from about 60 to 70 per cent. of phosphate of lime, and should be in an extremely fine dry condition, which makes it valuable

for including in mixtures which would otherwise tend to "set" or become pasty. Of late years it has been almost the only form of bones cheap enough for use in ordinary farm practice. It is more rapid in its action than raw bone meal, and though most of the nitrogen originally in the bones is removed with the gelatine, &c., in the steaming process, this is an advantage rather than otherwise, as the nitrogen can be more cheaply supplied from other sources, while the process makes fine grinding possible. "Boiled" bones have not been so thoroughly treated as steamed bones, and contain a little more nitrogen.

The Nitrogenous-Phosphatic Manures.—The most important of this class of manures are bone meal, dissolved bones, fish meal, guano, &c.

Bone meal should be very fine and free from grease. Any particles $\frac{1}{10}$ of an inch or upwards in size become available very slowly. It should contain about 50 per cent. of phosphates, and 4 or 5 per cent. of nitrogen.

Dissolved bones lose in value through being damp and lumpy; they can, however, be bought as dry and almost as fine as superphosphate. They usually contain 32–34 per cent. of total phosphates (of which more than half should be soluble) and fully 3 per cent. of nitrogen.

In recent years this class of manure has generally been too expensive for use except in limited quantities for special cases, though occasionally samples at fairly reasonable rates come on the market.

Potash Manures.—Genuine kainit contains about 12½ per cent. of potash, and in addition over 30 per cent. of common salt. Where, therefore, a farmer needs to use the latter substance, in addition to potash, he may find it to his advantage to employ kainit.

Sulphate of potash is offered in various degrees of purity, containing from 25 to over 50 per cent. of potash. Muriate or chloride of potash often contains over 50 per cent. of potash.

Potash manures are apt to be lumpy, and if they are stored long they may become so hard as to be almost unmanageable. Poor mechanical condition is here quite as undesirable as in the case of other manures.

Valuation of Manures.

The necessity of having some means of valuing artificial manures is obvious. The market prices of manures fluctuate in accordance with ordinary laws of supply and demand, and some manures, either on account of their particular suitability for some special crop or for other reasons, are higher in price than is justified by their real value for

ordinary purposes. It is possible, therefore, for anyone possessing the slight knowledge required, to save money by selecting the most economical forms of manure, and, furthermore, to protect himself against fraud in buying mixed or special manures.

It has been explained that, other things being equal, the value of an artificial manure is fixed by the amount of nitrogen, soluble phosphates, insoluble phosphates, and potash it contains. These amounts are always stated as numbers per cent., and as prices are, in farm practice, always quoted per ton, a simple system of valuation is possible. Some illustrations of the method are given below, *but it must be understood that the prices quoted for the different manures are given only as examples, and are not necessarily the prices ruling at the date of this reprint.*

Taking first manures supplying only one of the four ingredients mentioned :—

A farmer may ascertain, by obtaining quotations, that he can have nitrate of soda containing 15 per cent. of nitrogen delivered at his station for, say, £12 10*s*. 0*d*. per ton. In this case the cost to him of *one* per cent. of nitrogen is £12 10*s*. 0*d*. divided by 15, or 16*s*. 8*d*. Similarly he may find that sulphate of ammonia, containing 20 per cent. of nitrogen, will cost him £14 16*s*. 0*d*. per ton. Dividing the price by the number per cent. we obtain 14*s*. 10*d*., which is the cost of one per cent. of nitrogen as supplied in sulphate of ammonia.

Thus, tne nitrogen that he could obtain for 14*s*. 10*d*. in sulphate of ammonia would cost 16*s*. 8*d*. in nitrate of soda—at the prices taken, sulphate of ammonia would therefore be the cheaper source of nitrogen.

In the same way, if he can buy nitrate of lime containing 12·75 per cent. of nitrogen at £11 5*s*. 0*d*. a ton, and calcium cyanamide containing 18 per cent. of nitrogen at £12 0*s*. 0*d*. a ton, the price of one per cent. of nitrogen, or the price per unit,* is 17*s*. 8*d*. in the former and 13*s*. 4*d*. in the latter.

If all the four forms are equally suitable for the purpose for which the manure is intended, then, clearly, calcium cyanamide would be the cheapest form of nitrogen, and nitrate of lime the dearest at the prices named. It should be noted, however, that these prices are merely taken for purpose of illustration, and will vary not only from year to year but in different districts.

* The term "unit" (one per cent. of a ton) is much used in buying and selling manures.

Again, a farmer who knows the price he will have to pay for different grades of superphosphate can decide which is the better value, as, assuming they are in equally good condition, the one that gives the lowest price per one per cent. of soluble phosphate is the cheapest.

For instance, a sample "26 per cent. soluble" at, say, £2 17*s.* 0*d.* a ton is dearer than one "35 per cent. soluble" at £3 9*s.* 0*d.* a ton, as one per cent. of soluble phosphate in the former costs 2*s.* 2*d.*, while in the latter one per cent. is obtained for 2*s.* 0*d.*

In just the same way we can compare different grades of basic slag, or compare the cost of insoluble phosphate in basic slag with that in, say, steamed bone flour—though in the latter case allowance must be made for the small amount of nitrogen present.

Potash presents no greater difficulty; kainit containing 12 per cent. of potash at £3 0*s.* 0*d.* a ton gives a unit price of £3 0*s.* 0*d.* ÷ 12 = 5*s.* Sulphate of potash containing 48 per cent. of potash (*see* page 3) at £12 11*s.* 0*d.* gives a unit price of £12 11*s.* 0*d.* ÷ 48 = 5*s.* 3*d.* Muriate of potash containing 50 per cent. of potash (*see* page 3) at £10 18*s.* 0*d.* gives a unit price of £10 18*s.* 0*d.* ÷ 50 = 4*s.* 4*d.*

Clearly, at these prices muriate of potash is the cheapest of the three sources of potash, while sulphate of potash is the dearest.

The system can, however, be used not only to compare the value of manures of the same kind, but to determine roughly whether a manure containing more than one of the four manurial ingredients is worth what is asked for it. If a farmer has worked out for his own use the prices of various manures, as suggested above, he should have a very good idea as to what nitrogen or phosphates or potash cost him at his station at any particular time. Thus, assuming that the prices and qualities taken above for purposes of illustration apply to some particular case, he knows that on the open market nitrogen does not cost him more than 17*s.* 8*d.* per one per cent., and he is justified in assuming that he ought not to pay more than 17*s.* 8*d.* for it in a manure for ordinary purposes. In the same way the maximum price he is justified in paying for soluble phosphate would be about 2*s.* 2*d.* per one per cent.; for insoluble phosphate, about 1*s.* 6*d.* (assuming that steamed bone flour, say, one per cent. nitrogen and 60 per cent. phosphate, costs £5 5*s.* 0*d.* a ton); and for potash 5*s.* 3*d.*

If, then, he is offered a manure containing any or all of the four ingredients, he can estimate what is its highest value

to him ; just as if he had a mixture of so many quarters each of wheat, barley, oats, and peas, he could find the value of the whole mixture if he knew the value per quarter of each of the four kinds of grain.

A few examples may be given by way of illustration :—

A sample of Peruvian guano containing 8·4 per cent. of nitrogen, 28·7 per cent. insoluble phosphate of lime, and 2·85 per cent. of potash is offered—what is its value ?

				s.	d.		£	s.	d.
8·4	% of nitrogen	at	...	17	8	=	7	8	5
28·7	% of phosphate*	„	...	1	6	=	2	3	1
2·85	% of potash	„	...	5	3	=	0	15	0
	Total value of manure per ton					=	10	6	6

in addition to which an allowance must be made for the cost of mixing disintegrating and rebagging, and for loss of weight.

Again, a turnip manure containing 3 per cent. of nitrogen, 18 per cent. of soluble phosphate, 12 per cent. of insoluble phosphate and 4 per cent. of potash is offered :—

			s.	d.		£	s.	d.
3 %	nitrogen	at	17	8	=	2	13	0
18 %	soluble phosphate ...	„	2	2	=	1	19	0
12 %	insoluble phosphate...	„	1	6	=	0	18	0
4 %	potash...	„	5	3	=	1	1	0
	Total value of manure ...					£6	11	0

plus allowance for mixing, &c.

In the same way manures of any kind can be valued, and it should be clearly understood that the value obtained in this way is the maximum value. That is, it assumes that the nitrogen, phosphate and potash are in available forms, and that of the available forms the most expensive have been selected for illustration. For instance, if instead of taking the costs of nitrogen and potash from those in nitrate of lime and sulphate of potash, the price had been taken from calcium cyanamide and muriate of potash the calculation of the value of the turnip manure mentioned above would show not £6 11*s.* 0*d.* but £5 14*s.* 0*d.* If, as is possible, some at least of the nitrogen or phosphate were in the form of shoddy, ground feathers or leather, the value would be still less.†

* Unless specially stated to be soluble, phosphate of lime refers to insoluble phosphate

† *See* Leaflet 270.

It is not desired to emphasize this part of the question too strongly, for, as already explained, the value of a manure also depends on such questions as special suitability for the soil, crop and general conditions for which it is intended, on the availability of the ingredients it contains, and on such points as condition and convenience for general use. While, however, these must all be taken into account, arithmetical valuation is absolutely necessary as a safeguard.

London, S.W.1,
April, 1902.

Revised, June, 1914.
Amended, 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. 73.

BOARD OF AGRICULTURE AND FISHERIES.

Cultivation of Maize for Fodder.

This crop has now been grown on a small scale in certain parts of England for about 20 years, having been definitely introduced into Britain as a regular crop about the year 1886. Its usefulness in dry summers and the reports of the success of the crop in Canada and the United States, have been the means of securing for it a largely increased amount of attention in this country.

Maize, when grown for fodder, does not demand a better climate than many districts of England are able to offer, while as regards soil-requirements and expenses of cultivation it compares favourably with most of our fodder crops.

Situation and Soil.

Taking an average of seasons it is doubtful if the cultivation of maize is likely to prove of advantage north of the English Midlands. In the Southern and South Eastern Counties, however, where a low rainfall, and frequently recurring periods of drought, make the growth of roots rather uncertain, maize offers the opportunity of securing a large bulk of succulent material that may, to a considerable extent, replace the common fodder crops.

While this crop may be grown on a variety of soils (sand, clay, and fen-land) it is found to give its best return on a deep loam.

Tillage and Manuring.

The land should be ploughed early so as to secure a good tilth, and in spring the ground should be cleaned, and generally prepared as for roots.

Ten or twelve tons of farmyard manure, ploughed in in autumn or winter, supplemented, when the crop is above ground, by 1–2 cwt. of nitrate of soda, would be sufficient manuring. In the absence of farmyard manure artificials alone may be employed, the dressing per acre consisting of 1 cwt. sulphate of ammonia, 3 cwt. superphosphate, and, on light soil, 3 cwt. kainit, applied before sowing; a month later 1–2 cwt. nitrate of soda should be given as a top dressing.

Seed, Sowing and After-Cultivation.

Seed.—Certain varieties of maize are specially adapted for fodder purposes, and in purchasing seed maize attention should be paid to this point. It is found, however, that satisfactory results are obtained in this country from the use of the ordinary flat white maize sold for feeding purposes, provided care be taken to ascertain by experiment that its germinating capacity is satisfactory, say 90 per cent. or upwards. It is of the utmost importance that such a test should be carried out, as owing to heating much commercial maize is incapable of germination.

The best results, on the other hand, are undoubtedly obtained by the use of specially selected seed.

Sowing.—The seed may be sown from the middle of May till the middle of June, though, in the case of May sowings, the young plants run considerable risk of injury from late frosts.

The seed may be sown in a variety of ways, *e.g.*, by hand-dibbling, by means of a bean drill, &c., the best results being attained by placing the rows not closer than 16 inches, and by burying the seed to a depth of about 2½ to 3 inches. A plan that is followed with success is to deposit the seed in the bottom of every second furrow, as is often done in the case of beans. It may be mentioned that in America it is the custom to make the distance between the rows greater than in this country, say 2½ to 3 feet. The quantity of seed varies between 1½ and 2½ bushels per acre. Heavy rolling after sowing is recommended by several of the best growers.

Protection from Rooks.—Great trouble arises, in many cases, from the attack of rooks, which search for the sprouting grain with much persistency. It is frequently absolutely necessary that means be taken to keep these birds off, and this is best done by "stringing" the field before the sowers leave it. If this operation be delayed, and the rooks discover that maize is in the ground, it is extremely difficult subsequently to keep them off. Tarring the seed before sowing, as a method of prevention, is also practised with fair success.

Cultivation.—When the young plants appear above ground horse and hand hoeing must be attended to, as in the case of other drilled crops; but when once fairly established maize, being a rank-growing plant—reaching, as it does, a height of 5 to 8 feet—will largely suppress weeds.

Yield and Composition.

The yield of green fodder varies considerably according to locality, soil and season, but may be given as varying from 15 tons on poor soils or in a bad season, to 35 tons on

good soil in a good season. As an average, 20 to 25 tons may be expected on good land. The great value of the crop is evident when it is remembered that 20 tons per acre of a good food stuff may be obtained in less than four months after sowing the seed, even in seasons when grass runs short. It is not too much to say that no other crop commonly cultivated gives so much fodder in so short a time.

The feeding value of maize depends very much on the season, but is always high. In many respects maize can be more nearly compared with grass than with any other British crop. It is characteristically deficient in protein and in mineral matter, and therefore a large crop does not exhaust the soil as much as might be supposed. The following table shows the average percentage composition of green maize (at Wye College) at the end of September and in early October, in good, bad and intermediate seasons respectively, with pasture grass for comparison :—

Year.	Dry Matter.	Ether Extract.*	"Protein" (Nitrogen × 6·25).	Nitrogen Free Extract.*	Fibre.	Ash.	Sugar.
Good Seasons.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
1901	21·9	0·85	1·9	13·6	4·25	1·3	—
1905	18·7	0·52	2·04	9·88	5·30	0·98	1·0
Bad Season.							
1903	13·35	0·16	1·81	6·70	3·83	0·79	1·5
Intermediate Seasons.							
1904	15·00	0·66	1·59	8·06	3·74	0·95	0·80
1906	15·09	0·22	1·58	8·39	3·93	0·97	—
Pasture grass...	23·3	0·9	4·0†	10·9	5·2	2·3	—

Utilization.

Soiling.—The crop may be utilized as green fodder at any time when well grown, but in a favourable season it grows so rapidly during July and August that to cut during these months would entail considerable loss. At the same time it is very useful for scattering on bare pastures in August and September, and is particularly relished by all kinds of farm stock, and is almost as valuable for pigs as for cattle. A plan occasionally adopted on light soils in East Kent is to run sheep on the growing crop, ploughing in the stalks remaining after the sheep have cleared all they will. If maize is not required as a green fodder in September, it may be made into hay or silage.

* The "ether extract" is often called "oil" and the "nitrogen free extract" called "soluble carbohydrates."

† 1·1 of this is non-protein. *Vide* "Warington, Chemistry of the Farm," p.1 30,

Ensilage.—In America the main value of the crop is due to the opportunity it provides, through the agency of ensilage, of securing a supply of nutritious succulent material for use in the winter and spring months. In this country also maize is invaluable for this purpose.

The quality of the silage that maize produces is excelled by that of no other crop. If maize be utilized in this way it should stand till it is as mature as it is likely to become in this country, though it must be got off the fields before the occurrence of autumn frosts, which fatally injure maize. Generally speaking the latter half of September is the best time to make maize silage, which may be produced in stacks, draw-heaps, silos, pits, &c. (For general information in regard to ensilage, see Leaflet No. 9.) The practice of several farmers is to utilize as much of the crop as possible in a green condition, and, about the middle of September, to make what remains into silage. From investigations carried out at Wye College* it appears that the changes which take place in making maize silage are very complex. Although there seems to be no reason why the silage should not be fed to stock soon after it is first made, it is probably more economical and certainly more usual to keep it until February or well into spring, when roots are running short. By that time the fermentative changes are complete, the composition being very constant and showing far less fluctuation than that of the original maize. The following table shows the average composition of maize silage (at Wye College), compared with mangolds :—

Year (date of filling Silo).	Dry Matter.	Ether Extract.	"Protein" (Nitrogen × 6·25).	Nitrogen Free Extract.	Fibre.	Ash.	Sugar.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
1902	12·10	0·16	1·33	5·08	4·66	0·98	Nil.
1903	12·20	0·10	1·35	5·67	4·13	0·95	,,
1904	13·79	0·83	1·65	5·15	5·06	1·10	,,
1905	13·56	0·56	1·63	5·38	5·06	0·93	,,
1906	13·32	0·29	1·30	5·61	5·20	0·92	,,
Average ...	12·99	0·39	1·45	5·38	4·82	0·98	,,
Mangolds ...	12·5	0·1	1·1	9·6	0·8	0·9	7·5

Notwithstanding its inferiority to mangolds, maize silage is quite a useful food, readily eaten by bullocks, and, with certain exceptions, by dairy stock, when they have become accustomed to it. With proper care, too, the milk is not tainted.

* *See* Maize as a Fodder and Silage Crop, *Journal of the Board of Agriculture*, April, 1907, p. 14.

During the process of ensilage, there is considerable loss of weight, and in the Wye College experiments referred to the loss in dry matter was not less than 29 per cent., and even rose to 47·6 per cent., the soluble carbohydrates suffering most and the fibre least. Experience shows that mature maize suffers less in the silo than immature, and that loss can be somewhat reduced by rigidly excluding air, and by selecting varieties of maize which can be relied upon to give large and more mature crops containing 20 per cent. of dry matter without an undue amount of fibre. Maize silage, however, is hardly likely to compete seriously with roots or mangolds.

A good sample of maize silage is of a greenish brown colour, and emits an aroma almost indistinguishable from that of strong tobacco.

General Summary.

Large crops of maize can be produced in many districts, especially in the southern counties, Herts and Essex, and in parts of Cheshire and Norfolk.

The composition somewhat resembles that of grass; it depends on the season, and is least satisfactory in cold, wet seasons when the crop is small, and most satisfactory in hot, dry ones when the crop is large.

All classes of stock take to maize, and it is well worth a trial where succulent fodder is wanted during September. It is especially valuable for dairy cows, encouraging a large flow of milk.

Maize can be converted in silage, which is quite a useful food, though inferior to roots and mangolds. In the process of manufacture the loss of dry matter has been found to vary between 30 and 40 per cent., the loss falling mainly on the soluble carbohydrates and least on the fibre. Except when mangolds are unusually costly, it hardly appears worth while growing maize solely for the production of silage.

London, S.W.1,
March, 1902.
Revised, August, 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. 74.

BOARD OF AGRICULTURE AND FISHERIES.

The Composition and Properties of Concentrated Feeding Stuffs.

(This Leaflet has been withdrawn.)

BOARD OF AGRICULTURE AND FISHERIES.

Root-knot Disease in Cucumbers and Tomatoes.

Cucumbers and tomatoes are often affected by a disease induced by the Root-knot Eelworm (*Heterodera radicicola*, Greeff.).

The first symptom of attack is a drooping and yellowing of the foliage, followed by the stem becoming limp, and a collapse of the entire plant.

The finer branches of the root are more or less studded with swollen portions or "knots," varying in size up to one quarter of an inch across; knots of larger size are also often present on the thicker branches of the root (*see illustration on page* 2).

Microscopic examination shows the presence of numerous eelworms in the knots. In these knots the females lay their eggs.

The eggs hatch into tiny eelworms. The young eelworms leave the swellings or knots and pass into the soil to seek fresh plants or places for attack; they bore into the roots. The young worms are $\frac{1}{75}$th of an inch in length. As a result of the boring and the presence of the worms the galls or swellings or "knots" are produced. In the course of their development in the knots the eelworms gradually increase in diameter, the females becoming permanently rounded or pear-shaped. The males swell at first, but they regain and then retain their worm-like elongated form.

Prevention and Remedy.

1.—To destroy these eelworms the soil must be thoroughly saturated three times, at intervals of a fortnight, with a solution of one part of cresylic, or "liquid carbolic" acid in forty parts of water.

2.—Russell and Petherbridge found that *Heterodera radicicola* and other species of eelworms were killed by heating the soil to a temperature of 140° F. Sterilisation of the soil by exposure for about one hour to a temperature of 200° F. is, however, recommended. Infested soil may

Roots of (A) Cucumber, (B) Tomato, attacked by Root-knot Eelworm.

therefore, be partially sterilized and again used for growing cucumbers and tomatoes. Information as to experiments in the partial sterilisation of soil for glasshouse work is given in the *Journal of the Board of Agriculture*, January, 1912, and January, 1913.

3.—Successful experiments have been performed in America showing that the eggs, the young and the adult stages of Heterodera are all destroyed if the soil is allowed to freeze.

Similar results have been obtained by allowing the soil to become thoroughly dry.

Flooding for about 25 days has been also found effective.

4.—A very important and somewhat discouraging fact to bear in mind is that a very large number of plants in addition to the cucumber, marrow and tomato, have been recorded as host plants for *Heterodera radicicola*. Among them are cultivated cruciferous plants, red and crimson clover, black medick, peas and beans, lettuce, potatoes, beet, some grasses, some rosaceous and other fruit plants, and such weeds as the dandelion and the rib-grasses or plantains. The practical import of this on the possibilities of spread of the pest is evident.

5.—In experiments conducted at Kew against another species of eelworm infesting clover it was found that the eelworms were destroyed by treating the diseased plants with sulphate of potash, the quantity used in the experiments being equal to 4 cwt. to the acre.

6—The plants ruined by this eelworm should not be allowed to remain, or be just thrown on the manure heap, but should be burnt.

London, S.W.1,
November, 1902.

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.

Cucumber and Melon Leaf Blotch.

(*Cercospora Melonis*, Cke.)

This fungus, although first observed and described as a new species so recently as 1896, has spread with remarkable rapidity, and at the present moment is the most destructive parasite with which the cultivator of cucumbers and melons has to contend. In several instances growers report an annual loss of £2,000, whereas others have had to abandon the cultivation of these plants owing to the repeated destruction of their entire stock, in places where the fungus has secured a firm foothold.

The foliage is the part first attacked. At a later stage the fruit often also suffers. The first indication of the presence of the disease is the appearance of a few small, scattered, pale green spots on the upper surface of the leaf. The spots gradually increase in size and also in number, and often run together, gradually passing through grey to a brownish or ochreous colour. If at this stage the upper surface of a diseased spot be examined with a pocket-lens, it will be seen to be covered with delicate upright brown threads, each bearing a conidium at its tip. This represents the fruiting portion of the fungus, the mycelium or hyphae being buried in the substance of the leaf.

The minute conidia or reproductive bodies are carried from diseased to healthy leaves by currents of air, insects, clothing, &c., or by spraying, and if the leaf surface is moist such conidia germinate and the germ-tubes enter the tissues of the leaf directly.

Very frequently a leaf becomes quite dry and crumbles to the ground within twenty-four hours of the first infection. Such dead fallen leaves are much more responsible for the rapid spread of the epidemic than are the conidia which pass directly from one leaf to another.

When the dry fragments of a diseased leaf fall on damp earth, the mycelium present in the tissues quickly commences growth and forms an exceedingly delicate cobweb-like mycelium which runs on the surface of the soil and produces myriads of very minute conidia, which are dispersed

by currents of air, and infect the leaves in a manner similar to that of the larger conidia borne on the leaves.

The mycelium in the soil originating from diseased fallen leaves continues to extend and produce conidia so long as the requisite conditions as to moisture and temperature are present. When these conditions fail, the mycelium passes into a resting condition, but readily assumes renewed activity when stimulated by returning moisture and heat. By this means the fungus survives from one season to another in the soil, and the disease is almost certain to recur year after year in a house that is once infected, unless the soil is thoroughly sterilised.

It is important to remember that the disease under consideration can only assume the proportions of a destructive epidemic when attacking plants grown under glass, and where a high temperature and an excess of moisture are present. Such conditions, accompanied by a deficiency of light, result in the production of "soft" foliage, and it is only such soft foliage that the fungus can attack. Experiments carried out at Kew prove that the fungus cannot inoculate leaves that have developed under "lights," or in the open air. Plants that are badly diseased, if removed to the open air produce new foliage, which remain perfectly healthy.

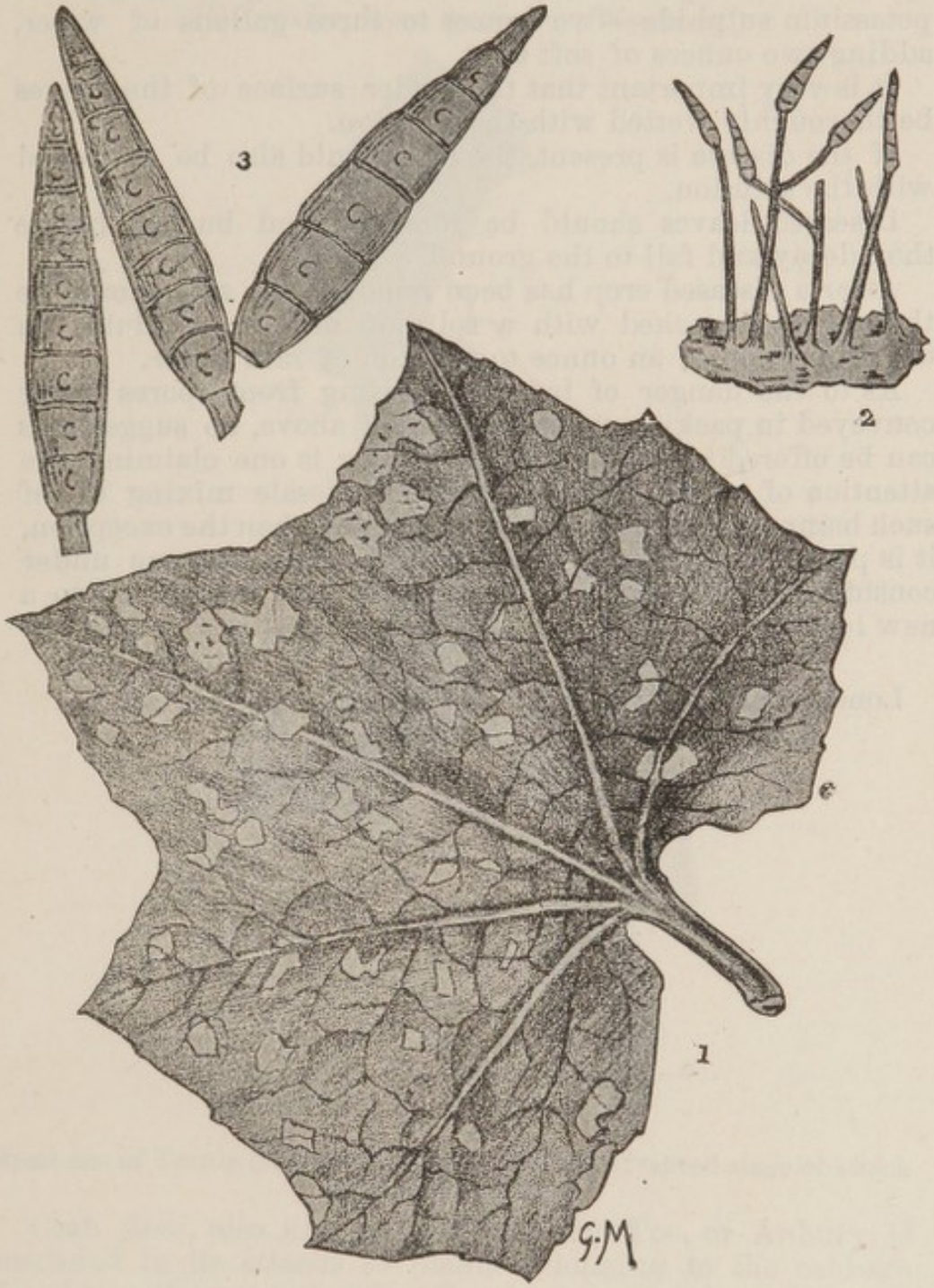
The disease is entirely an artificial creation, rendered possible by the rushing mode of cultivation followed.

The seed remains perfectly free from disease, hence there is no fear of its introduction from this source, and its sudden appearance in a new locality remained inexplicable until indicated by the following incident:—An establishment in Hertfordshire sending consignments of cucumbers to Covent Garden Market remained free from the disease until the commencement of the present season, when on one occasion some empty "flats" or packing boxes that had contained cucumbers, sent from a place where the disease was known to be rampant, were by mistake returned from Covent Garden to the Herts establishment, where from that date the disease appeared and is now practically beyond control.

To test the possibility of this means of introducing the disease, an empty box that had contained diseased cucumber leaves sent to Kew for determination, was placed over a young vegetable marrow plant that was growing under glass; within three days every leaf was destroyed by the disease. Another marrow plant growing in the open and subjected to similar treatment did not contract the disease.

Preventive Measures.

If the foliage is fairly hard the disease cannot assume the dimensions of an epidemic. and even if it appears it can be



Description of the Figures.

1 Cucumber leaf shewing the disease in an early stage of development, Natural size.

2. Portion of a diseased patch of leaf shewing the fruiting condition of the fungus. Magn. 40.

3. Ripe Conidia. Magn. 400.

kept well in hand by spraying. To accomplish this end a fair supply of air should be admitted so that the atmosphere is not constantly saturated with moisture. It is wise to spray in anticipation of the disease, using a solution of potassium sulphide—two ounces to three gallons of water, adding two ounces of soft soap.

It is very important that the under surface of the leaves be thoroughly wetted with the solution.

If the disease is present, the soil should also be drenched with the solution.

Diseased leaves should be removed and burned before they decay and fall to the ground.

After a diseased crop has been removed the soil should be thoroughly drenched with a solution of "Jeyes' Fluid," in the proportion of an ounce to a gallon of rain water.

As to the danger of infection arising from spores being conveyed in packing cases as recorded above, no suggestions can be offered ; nevertheless the matter is one claiming the attention of cultivators, and as the wholesale mixing up of such hampers appears to be the rule rather than the exception, it is probable that many diseases other than the one under consideration have by this means been first introduced to a new locality.

London, S.W.1,
October, 1902.

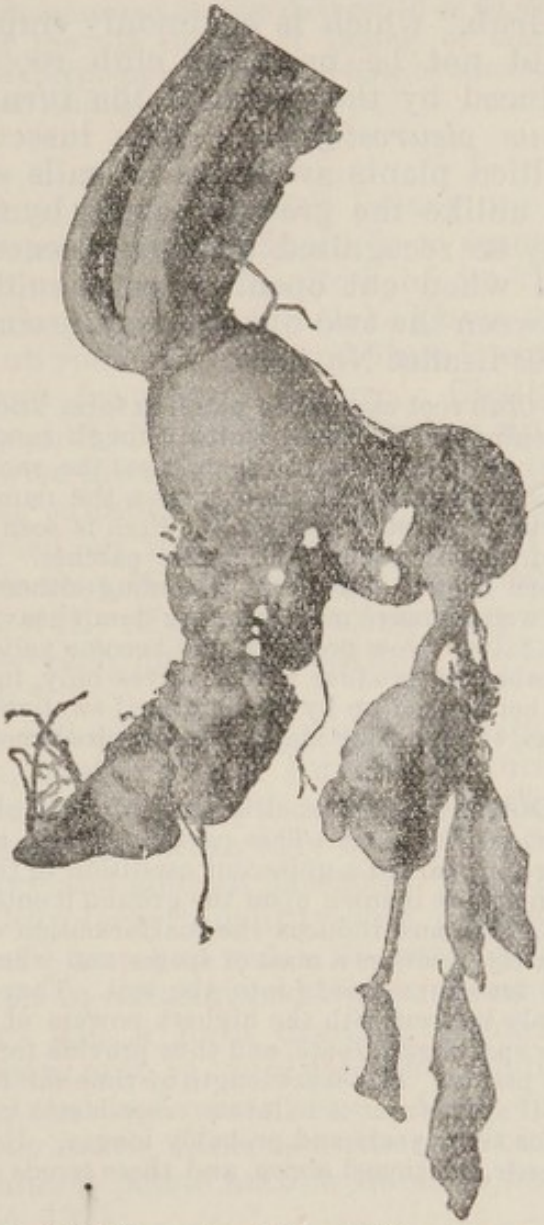
Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 77.

BOARD OF AGRICULTURE AND FISHERIES.

Finger-and-Toe in Turnips.

(*Plasmodiophora brassicæ*, Woronin.)



Specimen of Turnip (slightly reduced in size) in advanced stage of attack by Finger-and-Toe.*

Club Root, also known as Finger-and-Toe, or Anbury, is confined in its attacks to plants belonging to the cabbage family, or the natural order *Cruciferæ*, which includes such crops as turnip, swede, kohl rabi, cabbage, broccoli, kale, rape, radish, and mustard. It also attacks the weeds of that order, for example, charlock, shepherd's purse, and hedge mustard. Cauliflowers and brussels-sprouts are specially liable to club root. White turnips are more severely attacked than yellow, and yellow turnips more so than swedes, but though some plants are more resistant than others, none

* From a photograph lent by the Northumberland Education Committee.

have yet proved to be immune. Amongst garden plants, wallflowers, candytuft and stocks frequently suffer. The disease is common and often very destructive ; the measures of control therefore should be known by every farmer, gardener and allotment holder.

The term "Grub," which is commonly employed in some districts, should not be used for club root, but for the swellings produced by the grubs of the turnip gall-weevil (*Ceuthorhynchus pleurostigma*). This insect produces on cabbage and allied plants swellings or galls at the base of the stems, not unlike the growths caused by finger-and-toe, but which may be recognised by the presence of the grub inside the gall when cut open. Care should be taken to distinguish between the two diseases, as the control methods are different (*see* Leaflet No. 303).

Description.—Club root causes the plant to form knob-like swellings or irregular thickenings of the roots, which, though small to begin with, may reach the size of a man's fist. In some cases the roots become extraordinarily distorted and many fingered, hence the name finger-and-toe. If the affected portions are cut through, the flesh is seen to be solid and of a greyish colour, mottled with dull white patches. After a time the diseased tissues turn brown and decay, becoming either dry or powdery on a dry soil, or a wet offensive mass when in damp heavy ground.

Attacked plants fail to grow properly, and become yellow and stunted. Cauliflowers and cabbages produce a few leaves only, instead of a good head, their energy being used up by the deformed swollen roots. Affected turnips and swedes, though they may form fair-sized roots, decay rapidly in autumn.

Cause of the Disease.—Club root is caused by one of the slime fungi named *Plasmodiophora Brassicæ*. This parasite, which is very minute, is capable of existing for years in a quiescent condition in the soil, but when a crop which it can attack is sown upon the ground it enters the fine roots, multiplies in the tissues, and induces the malformation described above. The fungus ultimately produces a mass of spores, and when the roots decay the spores are set free in myriads into the soil. They are exceedingly minute, and can only be seen with the highest powers of the microscope. Sooner or later the spores germinate, and thus provide for the infection of future cruciferous plants. The exact length of time the fungus is capable of living in the soil apart from cruciferous crops is not known, but it can certainly persist for three years and probably longer. It can also lurk in the cruciferous weeds mentioned above, and these weeds allow it to carry on still longer.

Methods of Spreading.—By means of the spores in the soil, club root is very easily spread from one part of the ground to the other, and the presence of a few infected plants may, unless energetic measures be taken, lead to the infection of a whole garden or farm. Although the spores are not wind borne, as in potato disease, they are easily transported during the ordinary routine of garden and farm operations. In gardens the disease may, for instance, be carried into clean soil through pieces of diseased roots being thrown about, by sweepings of paths, or by contaminated soil adhering to spades and forks, or to the wheels of the barrow, or boots of the worker. On the farm much new infection takes place through stock feeding on diseased roots, carrying the disease on their feet when transferred to fresh ground. The plough and other implements scatter infected soil, and clods of earth attached to carts and horses' hoofs carry infection to other parts. Contaminated manure also spreads the disease, and many a new outbreak may be traced to the refuse from infected turnips in storage being thrown on to the manure heap or scattered on the land.

Conditions favouring the Disease.—The parasite does not flourish in chalky soils, or those well supplied with lime, but an acid or sour condition greatly increases its growth and prevalence. The only certain antidote is the application of lime, and soils thoroughly infected with the parasite may, by repeated applications of this substance, be rendered clean, provided proper precautions are taken against re-infection. The fact that club root has much increased during the past 50 or 60 years is largely due to the neglect of the old custom of liming or marling, and to the increasing use of superphosphate and sulphate of ammonia, both of which tend to promote soil acidity.

Control.—

Liming.—Lime may be applied in any one of the various forms, but the main object should be to secure it in a finely divided condition in order to allow of its thorough incorporation with the soil. Freshly slaked lime is very effective in reducing club root; and ground lime is equally good, but more costly, and frequently impure. Chalk may be used with advantage, but should be well broken up and applied at not less than twice the rate necessary for burnt or slaked lime. Gas lime is less suitable for checking club root and if used should be spread on the surface of the soil in autumn or early winter, so that it may become weathered before being dug in. The full effects of liming may not be evident during the first year, but they continue for some years after the application.*

In gardens and allotments, where the soil is a light or medium loam, freshly slaked lime finely broken should be applied at the rate of about ½ to 1 lb. per sq. yd., or 14 to 28 lb. per rod, but these quantities may be increased by half where the soil is heavy and sour in character. Ground lime may be given in slightly larger quantity, and crushed chalk at the rate of at least ½ cwt. per rod. In each case the dressing should be given in autumn and dug in immediately. If the disease is very bad, a light dressing should be given the following season, and in any case the application of lime should be repeated in 5 years' time. Care should be taken not to apply too much lime, as with an excess of this substance the common potato scab is liable to become prevalent (*see* Leaflet No. 137).

In the case of farms, swedes and turnips suffer most, and here it is best to apply the lime as soon as the diseased crop is lifted, so that it may become thoroughly incorporated in the soil before the next turnip crop comes round in the rotation. If slaked lime is used 1–1½ tons per acre will suffice in slight attacks. In bad cases 3–4 tons may be necessary. It must be well broken up and evenly spread. Somewhat heavier dressings should be given if ground lime is used, and double the amount if chalk only is available.

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* The use of waste carbonate of lime, such as may be obtained from soap works, bleach works, paper works, etc., has been attended with good results and such material should be given a trial wherever it can be purchased at a low price. Further details as to liming will be found in Leaflet No. 170.

Other Preventive Measures.—(1.) As it is chiefly during the seedling stage that the plants are infected the seed beds must, at all costs, be kept clean and well limed. Great care must also be exercised when planting ; all plants showing swellings on the roots should be rejected and carefully collected and burned.

(2.) All decayed refuse from clubbed crops should be burned, and on no account should such refuse be put on the manure heap. In gardens and allotments the risk of infection through the agencies alluded to on page 3 should be guarded against, e.g., contaminated bags, implements, etc., also sweepings and clods of earth or shifting the soil from one part of the garden to another. Plants affected by club root should be pulled up and burned before the diseased portion decays in the soil.

(3.) In the case of feeding stock, diseased roots should, if practicable, not be used unless they have been well boiled. If this is impossible, care should be taken that the disease is not spread through the manure becoming contaminated, or by the feet of sheep and cattle. Sheep should be penned, preferably only on ground already infected, or the roots may be spread out on a paddock or field of permanent pasture where no injury will follow. Contaminated dung should be used only for permanent pasture or on land where no cruciferous crops will be grown.

(4.) A proper rotation must be given. As the disease remains in the soil for three years or longer, cruciferous crops should not be grown for at least that period. After a bad attack, or where liming has not had time to be entirely successful, it may be advisable to replace the turnip crop in the rotation by potatoes or mangels, or any other non-cruciferous plant.

(5.) All cruciferous weeds, such as shepherd's purse, hedge mustard, and charlock must be kept down. The last named, which has often been responsible for carrying on club root in farms, must be vigorously dealt with (*see* Leaflet No. 63).

(6.) Sour wet soil is particularly liable to bad attacks ; drainage therefore should be carried out, and poached, trampled parts of a field put in good order. Any hard pan preventing free escape of water should be broken.

(7.) With regard to manures, where club root is troublesome, bone meal, steamed bone flour, or basic slag should be used instead of superphosphate or dissolved bones, and nitrate of soda instead of sulphate of ammonia, though if lime is applied regularly all manures may safely be used.

London, S.W.1.
October, 1902.
Re-written, February, 1918.

BOARD OF AGRICULTURE AND FISHERIES.

Tuberculosis of Poultry.

Tuberculosis is one of the most common diseases of fowls, turkeys, pheasants and other birds. It is a frequent cause of loss to poultry owners in some parts of this country. It has been spoken of as "liver disease," but is only one of *several* liver diseases. Avian tuberculosis is world-wide in its distribution.

Symptoms.

Affected fowls become anaemic, thin, emaciated, and they lose weight. Their appetite is impaired, and erratic feeding is noticeable. The comb and wattles and mucous membranes become pale, and there is usually persistent diarrhœa. As a result of extreme emaciation, which is the most noticeable symptom, the bones become very prominent.

Post-mortem Appearances.

The flesh is scanty and the muscles pallid. The liver is dotted all over with small pale spots, or larger patches of a white, grey or yellow colour. The spleen is usually enlarged and beset with small or large tubercles. The intestines and the lymphatic glands of the mesenteries may be also the seats of tubercular deposits. Tubercles may likewise occur on the skin. There are very rarely small tubercles in the lungs.

Cause.

The exciting cause of the disease is a bacillus which may be considered a variety of the bacillus of mammalian tuberculosis. It gains entrance with the food, fouled by means of the droppings of affected birds.

Prevention and Remedy.

1.—The most frequent source of infection is the poultry-house or yard, which receives the droppings of the affected birds, these droppings containing bacilli. Damp, dirt, and absence of sunlight greatly favour the spread of the disease. It is necessary that there should be good ventilation and strict cleanliness in the runs and sheds.

2.—All diseased birds should be killed and buried in lime. The house where they have been should receive several applications of disinfectant, and the tainted run should be dug over and heavily dressed with quick-lime.

3.—Many months should elapse before birds are put back in old quarters that have been cleaned. It is best to clear off old stock where this disease breaks out, and make a fresh start with new stock later. Strong and healthy birds should be carefully selected and put into a new house and run, and if any show indications of disease, they should be removed at once and the house disinfected with chloride of lime ($\frac{1}{4}$ lb. to 1 gallon of water). In this way a disease-free stock may be obtained, and until this is accomplished all that can be done is to observe all possible sanitary precautions.

NOTE.—Until April, 1908, this leaflet was known as *Liver Disease of Poultry*.

The subject of tuberculosis in farm stock generally is dealt with in Leaflet No. 277.

London, S.W.1,
January, 1903.
Revised, November, 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 Principles of Feeding Farm Stock.

The Principles of Nutrition.

Foodstuffs are composed of a variety of ingredients of which the ones considered valuable for feeding purposes are commonly grouped under the headings Albuminoids (or Proteins), Amides, Oils (or Fats), Ash, Crude Fibre, and Soluble Carbohydrates.

Digestion.—Before food can be of any use to the animal, it must undergo the process commonly referred to as digestion. This is a complex series of changes, partly mechanical and partly chemical. The object of the mechanical changes (mastication, &c.), is to reduce the food to a fine pulp, in which state it is most readily mixed with and acted upon by the chemical digestive forces. The chief of these chemical forces are ferments (or enzymes) contained in the digestive juices (saliva, gastric juice, pancreatic juice, bile, &c.), which are mixed with the food in the mouth, stomach and intestines of the animal.

The action of these juices is to change as large a portion as possible of the different constituents of the food into soluble forms, which then pass directly or indirectly into the blood, and are made to serve the various requirements of the animal. The matters absorbed from the food in this way are said to be digested, whilst the residue which resists the digestive forces—the undigested matter—is eventually ejected from the body in the solid excrement or dung.

It is obvious, therefore, that only the digestible portion of foodstuffs can have any direct feeding value, and hence the value to the animal of a foodstuff is determined primarily, not so much by its total content of albuminoids, oil, &c., as by the proportion of these present in digestible form. Although the indigestible matter cannot supply nutriment to the animal, it may influence the efficiency of digestion in other ways, *e.g.*, by increasing the bulk of the food up to the proportion that is best suited to the capacity of the stomach and bowels of the particular animal.

Furthermore, it is certain that an animal will derive more benefit from a ration which is palatable than from one containing the same amount of digestible food in an unpalatable form. Therefore, certain pleasant-smelling, or appetising substances that are present in small quantities in many foodstuffs (*e.g.*, in hay, roots, malt coombs, treacle), although they have little direct nutritive value, add so greatly to the aroma and palatability of these foods that they are commonly accredited with an appreciable beneficial influence upon the utilisation of the food by the animal—especially in the case of milk-production.

These indirect effects of indigestible matter and of "stimulants" are, however, so vague and incapable of measurement that it is safest to regard them as insignificant in comparison with the direct value of the digested nutrients.

The following table gives an indication of the proportions of the different nutrients present in average samples of the commoner feeding-stuffs, together with the "starch equivalent"* of 100 lb. of each feeding-stuff :—

Composition of Feeding Stuffs.

—	Total Dry Matter.	Percentage of Constituents.							Starch Equivalent per 100 lb.
		Total.				Digestible.			
		Albuminoids.	Oil.	Carbo-hydrates.	Fibre.	Albuminoids.	Oil.	Carbo-hydrates and Fibre.	
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	lb
Cottonseed Cake—									
Decorticated	91	41	9	26	8	34	8½	20	71
Undecorticated, Egyptian ...	88	23	5½	33	21	16½	5¼	23	43
,, Bombay ...	88	20	4¾	35	22	14	4¼	24	40
Linseed Cake	89	30	10	35	8	25	9½	31	75
Coconut Cake	90	21	9	42	12	16	8½	43	78
Palm Kernel Cake	89	19	7	46	13	15	6½	42	72
Palm Kernel Meal (extracted)	89	18	2	48	16	14½	2	45	63
Groundnut Cake—									
Decorticated	90	47	7	26	5	42	6½	22	75
Undecorticated	90	30	7	23	24	27	6½	23	55
Soya Bean Cake	88	43	6	29	4	34	5½	23	68
Soya Bean Meal (extracted) ...	88	45	1½	32	5	36	1¾	24	61
Soya Beans	89	36	17	26	5	28½	15½	20	82
Linseed	91	23	36	23	6	17	34	21	119
Fish Meal	87	56	5	—	—	47	4	—	53
Dried Yeast	92	48	1	34	1	43	¾	31	73
Maize Gluten Meal	90	38	4	45	2	33	3½	42	77
Maize Gluten Feed	90	24	3	56	4	19	2½	53	72
Maize Germ Meal	89	13	12	56	4	9	11	51	80
Wheat Middlings	88	15	3½	62	5	12	3	56	74
Wheat Sharps	88	15	4½	57	8	11	3½	50	58
Wheat Bran (coarse)	87	14	4	56	9	10	3	45	47
Malt Culms or Coombs ...	90	24	1½	48	11	12	1	41	41
Brewers' Grains dried ...	91	20	6	43	17	13½	5½	34	50
,, ,, wet (fresh) ...	24	5¼	1½	12	5	3¾	1¼	10	14

* This term needs some explanation. It is the result of a method of valuation adopted by the German Agricultural Chemist Kellner at the conclusion of exhaustive investigations into the relative feeding value of albuminoids, fat, &c., in food. It simply means the value of a food or ration in terms of starch, *e.g.*, the starch equivalent of Decorticated Cotton Cake is stated to be 71, that is, for feeding purposes, 100 lb. of the cake are equivalent to 71 lb. of starch.

	Total Dry Matter.	Percentage of Constituents.							Starch Equivalent per 100 lb.
		Total.				Digestible.			
		Albuminoids.	Oil.	Carbo-hydrates.	Fibre.	Albuminoids.	Oil.	Carbo-hydrates and Fibre.	
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	lb.
Rice Meal	91	13	13	50	7	7	1	42	72
Locust Bean Meal	86	6	1½	70	6	3½	1	70	73
Treacle or Molasses	78	10	—	60	—	—	—	55	48
Wheat	87	12	2	69	2	9	1¼	65	73
Barley	86	10	2	67	5	7	1⅜	64	74
Oats	87	12	6	55	10	9	5¼	45	63
Maize	89	10½	5	70	2	7	4½	68	84
Beans	86	25	1½	48	7	19	1¼	48	67
Peas	86	23	1½	54	6	17	1	53	70
Meadow Hay	86	9	2½	43	25	5	1	42	34
"Seeds" Hay	86	12	2½	40	25	6½	1½	40	35
Straw—Wheat	86	2	1¼	37	41	¼	—	34	12
,, Barley...	86	3¾	1¼	38	39	¾	½	39	18
,, Oat	86	3	2¾	41	34	¾	1	36	19
,, Bean	86	5	1	30	46	2¼	½	39	16
,, Pea	86	9	1½	33	36	3½	¾	32	16
Mangolds	12	1¼	¼	9	1	1/10	1/10	9	7
Swedes	11½	1¼	¼	8	1½	¼	1/10	8	7
Turnips	9½	1	¼	6	1	¼	1/10	6	6
Cabbage	15	2½	¾	7	2	1½	½	7	9
Carrots	13	1¼	¼	9½	1½	½	1/10	10	9
Sugar Beet	25	1¼	¼	20	2	¼	1/10	20	15
Potatoes...	25	2	¼	21	1	1/10	1/10	19	19

Functions of Digested Food.—The varied functions that the digested food is required to fulfil in the animal may be summarised briefly as follows :—

(a) *Supply of Heat.*

The temperature of a healthy animal's body does not fluctuate to more than a very slight extent. The heat required to maintain the temperature is provided from the food.

(b) *Supply of Energy to maintain Vital Processes.*

Even in the case of an animal completely at rest, a certain amount of energy is needed for the performance of the internal work of the body (*e.g.*, for maintaining the movements of the heart, lungs, &c.), and for the labour involved in the mastication and transmission of the food through the digestive system. This supply of energy is obtained from the food.

(c) *Supply of Materials to make good the normal wear and tear of the Body.*

All vital activity involves the destruction of various ingredients of the body, and the material so lost must be replaced from the food if the live weight and health of the animal are to be maintained.

The foregoing requirements are fundamental, and hold good for all classes of animals. In many cases, however, there are still further requirements that the food must meet, viz. :—

(d) *Supply of Material necessary for the support of any productive activity of the Animal.*

In all cases where the animal is either producing new substance (*e.g.*, growth, in the case of young animals ; fat, milk, wool, &c.), or is expending muscular energy upon the performance of external work, this extra demand can only be provided for by the supply of correspondingly increased amounts of digestible nutrients.

Maintenance and Production Requirements of Animals.—The requirements summarised in (*a*), (*b*), and (*c*) may be referred to as the "maintenance requirements." A ration which simply satisfies these requirements may be described as a "maintenance ration." It represents the minimum supply of food upon which the animal, when completely at rest, can sustain a normal existence without losing weight. Among animals of the same class it will be roughly proportional to the live-weight of the animal.

Any food supplied in excess of the maintenance requirements is available for the productive purposes outlined under (*d*), and may therefore be described as the "production ration," or the productive part of the total ration.

It is important in the case of full grown animals to keep in mind the distinction between maintenance and production ; thus the maintenance requirements of a cow remain practically the same whether she yields two gallons or four gallons of milk daily. It is the production requirements that are halved when the milk flow is halved, not the total requirements, so that a heavy yielding cow makes more economical use of her food than a low yielding one.

Functions of the Various Ingredients of Foods.—The various ingredients (albuminoids, oils, &c.) of foods are not of equal value to the animal for the discharge of the requirements summarised above. Functions which involve the production of albuminoids in the body, such as the production of muscular tissue (lean meat), hair, skin, &c., or of the albuminoids present in the various body fluids and secretions—including milk—can only be discharged by

albuminoids in the food. For these purposes oils and carbohydrates are valueless. Every ration, for any class of stock, must therefore contain a certain amount of digestible albuminoids, the minimum amount requisite varying according to the class and age of stock.

For all other purposes digestible albuminoids, oils, and carbohydrates are, to a great extent, mutually replaceable, though they are not equally valuable. Thus, for the production of heat in the animal (and in general for maintenance purposes) one pound of digested oil goes as far as 2¼ lb. of digested carbohydrates (starch or sugar), or nearly 2 lb of digested albuminoids. For the production of animal fat, or for the performance of mechanical labour the relative values of digestible oil and carbohydrates are much the same as for heat-production, but the albuminoids are for these purposes slightly inferior, or at most equal, to carbohydrates.

The digestible fibre of foods is practically equal to the more easily dissolved carbohydrates for the production of heat in the body ; for the production of fat, however, its value is largely dependent upon its condition. The more thoroughly it is reduced to a soft, easily masticated condition before feeding, the more nearly will it equal carbohydrates.

The Compounding of Rations.

Consideration of the Food Requirements of different Classes of Stock.—The chief difference in the food requirements of the various classes of stock lies in their relative powers of digesting and utilising coarse, fibrous foods such as hay and straw. Such foodstuffs are dealt with most effectively by the ruminant animals (cattle and sheep). Pigs cannot deal effectively with any but the softest types of fibre, such as are met with in juicy, green food ; whilst horses occupy an intermediate position in this respect.

Feeding Young Animals.—The growth of young animals is essentially a rapid production of muscle and bone, and the prime consideration in making up the food ration must be to ensure a sufficiently liberal supply of digestible albuminoids and of the bone-forming mineral ingredients (lime and phosphates). Further, any food given during the early months of the young animal's life must be, like milk, easily digested.

The quantity of food required by the young animal increases, of course, with growth, but not at the same rate. The amount of growth produced by a given quantity of food steadily diminishes as growth progresses.

Fattening Adult Animals.—The fattening of full-grown animals is mainly a process of converting food into body-fat, very little albuminoid matter being contained in the fattening

increase. The additional food required in excess of the maintenance ration (*i.e.*, the ration required to keep the animals in "store" condition) may therefore consist largely of digestible oil, carbo-hydrates, and fibre, though a certain minimum weight of digestible albuminoids is necessary.

Animals that are in poor, lean condition at the commencement of fattening should receive a more liberal supply of albuminoids for a few weeks than those which start in fair condition, in order to ensure that the fleshy tissues shall be fully developed and made capable of storing up large quantities of fat.

In order to obtain the best results in fattening, it is necessary that the activities of the animal shall be confined as far as possible to the consumption of food. Facilities for exercise should therefore be restricted, and such provision made for the comfort of the animal as will allow of its resting contentedly almost continuously. Good housing, an abundant supply of litter, freedom from disturbance, and strict adherence to a time table, so that feeding, removal of manure, &c., are carried out at the same time and in the same order day after day, contribute very largely to success in fattening stock.

Milk-Yielding Animals.—The milk of all classes of farm animals contains considerable proportions of albuminoids, fats, and carbohydrates. These materials are manufactured by the animal from ingredients of the body, which obviously must be replaced by feeding if the "condition" of the animal is to be maintained.

The production of milk-fat and milk-sugar can be sustained by supplying oil and carbohydrates in the food, but only albuminoids will serve for the production of the albuminoids of the milk.

The effect of food on the yield and composition of milk demands notice. Up to a point, which varies greatly in different animals of the same class, any food given in excess of the minimum necessary for "maintenance" is utilised for purposes of milk-production. When the food-supply is steadily increased, however, the point referred to is reached sooner or later, beyond which there is an increasing tendency for additional food to promote fattening rather than to increase the flow of milk.

The percentage composition of the milk yielded by a particular animal is largely independent of the nature of the food supplied. Provided that the ration is such that it maintains the milk-yield and general "condition" of the animal, the composition of the milk can in general be but little affected by change of food. Little reliance can be placed, therefore, upon the claims advanced on behalf of certain foods, that they exercise a specific influence upon the composition of the milk.

An exception ought perhaps to be made of the case of very watery foods, such as turnips or brewers' grains, in view of the widespread opinion of farmers and cowkeepers that the quality of cow's milk can be appreciably lowered by the use of such foods. This view has received as yet but little support from experimental investigation, and as a rule the amount of water supplied in the food can vary greatly without affecting the percentage of water in the milk.

General Considerations in the Compounding of Rations.—In devising rations for stock, the following general considerations have to be taken into account :—

1. The ration should be suitable in weight and composition for the class of stock to which it is to be fed, and compatible with the particular system of cropping practised on the farm.
2. The ration must be adapted in bulk to the capacity of the digestive organs of the animals for which it is intended.
3. The foods composing the ration must all be suitable for the class of stock to be fed. It is well known that certain foods are not suitable for all classes of stock ; for instance, cotton cake for very young stock or for pigs ; on the other hand certain foodstuffs have special merits for particular classes of stock.
4. Any foodstuff which might detrimentally affect the quality of the finished product should be avoided as far as possible.
5. The ration must be palatable and acceptable to the stock.

Feeding Dairy Cows.

The following points of general application should be borne in mind in connection with the feeding of dairy cows :—

(1) The diet should not be monotonous ; occasional changes of food during a long winter are advantageous, but these changes should be effected gradually.

(2) Swedes, turnips, cabbage, rape, kohl rabi, mangolds, carrots, and parsnips all afford suitable green or succulent winter food for cows. For practical purposes these foods are much alike in nutritive qualities, though parsnips, carrots, and moderate-sized mangolds are rather superior to the rest. Cabbages, carrots, and mangolds are probably the best where first-rate butter is desired, care being taken, in the case of cabbage, to remove the dead and bruised leaves before feeding. Potatoes, either raw or steamed, are a suitable food for cows ; they are much richer in carbohydrates than the other foods named. Raw potatoes should not be given near calving-time.

(3) A mixture of two or more concentrated foods is usually more serviceable and more economical than one foodstuff alone. In selecting the concentrated foods, due regard must be had to their possible influence upon the flavour of the milk, or more particularly the flavour, appearance, and texture of the butter. The following foodstuffs, if used

liberally, have a softening tendency upon the butter-fat :— rice-meal, maize, oats, wheat bran. On the other hand, a hardening influence is exercised by beans, peas, cotton cakes and meals, and coconut cake. These effects are only appreciable when the foodstuffs in question are used liberally, and may be avoided by using appropriate mixtures of foods from each class. Musty, mouldy, or otherwise damaged food should be avoided as far as possible, or objectionable taints may easily be imparted to the milk. Good pasturage stands unrivalled as a food for the production of the best flavour in both milk and butter, carrots are probably the best of the root crops in this connection, oats the best of the cereal grains, and rice-meal or maize germ meal the best of the cereal offals.

(4) The water-supply should be adequate and of good quality.

(5) Cows should either be allowed access to rock-salt, or salt should be mixed with the food (about 1 oz. per head per day).

(6) Cow-houses should be kept at a temperature of about 56° to 58° F. The ventilation should be ample, but not such as to give rise to cold draughts. It is better for the general health of the cows that the byre shall be cool and well ventilated rather than warm at the expense of ventilation. The milk-yield will not suffer unless the cows experience actual discomfort from exposure to chilly draughts.

Winter Rations for Dairy Cows.—The basis of nearly all rations for dairy cows is formed of roots (mangolds, swedes, cabbages, &c.) or silage and fodder (hay and straw). The complete ration should be modified to suit special circumstances such as the supply and value of the hay, straw, roots, and corn available, and the prices of the various concentrated feeding-stuffs that are suitable for the purposes of the ration.

Roots.—A great range may be allowed with respect to the quantity of roots given. Up to 70 lb. a day may be an economical allowance if roots are plentiful, but it is doubtful if this should be exceeded. Where silage is used in place of roots, up to 50 or 60 lb. per day may be given. When wet grains can be had readily they may be used both in winter and summer in moderate quantities, say, up to about 20 lb. per day, and may to a considerable extent take the place of roots.

In town cowsheds, roots, as a rule, are used only in small quantity, if at all, on account of the expense. To keep the cows' relish for their food keen, so that they may be fit for the butcher as soon as they become dry, it is the custom to chaff some portion of the hay, scald or steam it, and mix it with the meal or bran, and thus allow the cows two moist

meals between the dry ones. Where roots are consumed this is not necessary.

Hay and Straw.—The allowance of fodder per day may range between 14 and 25 lb. and of this not more than half need be hay. Experiments show that when hay is fed in quantities of 20 lb. or more the cost of the ration is out of all proportion to the return obtained in milk.

When milk records are kept the farmer should endeavour to group his cows and feed the concentrated foods according to milk yield. A milk record is valuable not only as a guide in breeding and as a means of detecting the poor milker, but it is also the first step in a rational system of feeding. A saving of 1*d.* per gallon in the cost of feeding will amount to £60 in the six winter months with a herd of 40 cows averaging 2 gallons per head per day, a very handsome return on the small extra expenditure involved in labour and outlay.

A cow weighing about 11 cwt.—say a Shorthorn of average size—and giving two gallons (20 lb.) of milk per day, will require a ration per day of about 12 lb. starch-equivalent, including 2 lb. of digestible albuminoids. For cows giving more (or less) than two gallons of milk, the allowance of concentrated foods should be increased (or reduced) at the rate of about 2 to 3 lb. for each gallon of milk. As a rule, the amount of any one oil-cake or similar meal included in a ration should not exceed 4 or 5 lb., or 3 to 4 lb. where butter is made.

For each hundredweight live-weight above (or below) 11 cwt. the ration should be increased (or decreased) by about 2 lb. of hay or 3 lb. of straw, or such amount of other foods as will supply about 0·1 lb. digestible albuminoids and 0·7 lb. starch-equivalent.

Summer Feeding of Dairy Cows.—The feeding of cows in summer depends largely upon the character of the season and the quality of the pastures. Good pasture will supply all the needs of even the heaviest milkers up to about the middle of July in an average season. From this point onwards, however, the grass becomes increasingly deficient in albuminoids, more fibrous and less digestible, so that it requires supplementing with an allowance of concentrated, easily digested food. This should be one of the more highly nitrogenous foods, such as decorticated cotton cake, gluten meal, soya cake, decorticated groundnut cake, dried yeast, or linseed cake.

Commencing with 1 lb. a day in July, the cake should be increased gradually on ordinary pasture to about 3 lb. by the end of August. For cows that have calved in winter and early spring, and by this time are naturally going off their milking, this addition of cake is unnecessary, though it might benefit the land; neither is it necessary when cows

are put on aftermath full of clover. On the other hand, the addition of some food like decorticated cotton cake, is necessary for all summer and autumn calving cows soon after they have calved. Some pastures produce very soft butter in June, and an addition of 1 lb. of decorticated cotton cake, though not otherwise required, would have the effect of much improving the consistency of the butter.

Fattening Rations for Adult Cattle.

The rations of fattening cattle are usually composed mainly of roots, oat straw, hay, and an allowance of cake or meals which is periodically increased as fattening progresses. On suitable rations the live weight should increase at an average rate of about 2 lb. per head per day, this rate being, indeed, often exceeded by good animals. Assuming that the ration includes not less than about 14 lb. of coarse fodder, the rate of increase mentioned will require for a bullock weighing 1,000 lb. (say 9 cwt.) the daily supply of about 28 lb. dry matter with a starch-equivalent of 13 lb., including 1·6 lb. of digestible true albuminoids (or 1·9 lb of digestible crude albuminoids). The amount of digestible oil included in the ration should be about ¾ lb., and the digestible carbohydrates will then be about 16 lb.

In barley-growing districts, barley straw would probably take the place of oat straw in these rations; the former not being so nutritious, as a rule, some allowance can be made by increasing slightly the quantity of meal used. In the rapid fattening of cattle for the fat market it is more necessary to resort to chaffing, scalding, and mixing of foods, especially in regard to hay and straw if fed together in the same ration, than in feeding cows for milk; the craving for food is keener in the latter than in the former, and fattening cattle are found to eat straw that has been chaffed, mixed with pulped roots, and allowed to lie a day before being eaten, or chaff scalded and mixed with meal of some kind, and a sprinkle of treacle, more readily than straw in the long dry state. Cattle spices or condiments are often used for the same purpose, but should be given sparingly and only when other means of stimulating the appetite have failed.

Young Cattle.

The rearing of calves is dealt with fully in Leaflet No. 142, and need not be dealt with here.

Sheep.

The needs for the maintenance of life and the production of wool in the case of full-grown sheep will be satisfied by a daily ration supplying (per 1,000 lb. live-weight) about 1 to 1·2 lb. digestible albuminoids and 8½ to 9 lb. starch-equivalent.

Ewes.—In Scotland and over a large portion of the north and west of England, ewes wintering on grass require no more than a rack of hay; they sometimes get mangolds and turnip-tops thrown out to them, or are run over the root land, after the roots have been pulled and carted off, to clean up small ones and stray leaves. As soon as they lamb they require, in order to keep up their milk supply and flesh, a ration with an albuminoid ratio of about 1 to 5 or 6, and containing about 2 lb. of digestible true albuminoids per ewe per week. This is generally provided in the first three months of the year by means of swedes or mangolds, in addition to pasturage, pea straw, or mixed hay and straw chaff (oat or barley) and peas, linseed cake, oats, bran, &c.

When the ewes and lambs are put on a good spring pasture they no longer require trough feeding; but should they be inclined to scour it would be well to continue oats for a while. As the ewe's milk diminishes the lambs should be kept progressing after July with an allowance of concentrated food. When ewes or lambs are placed on clover aftermath they fatten without other food.

In the case of the various "Down" breeds of sheep in the south of England, lambing usually takes place in January and February. After lambing the ewes and lambs are folded on roots, and the ewes are allowed about 1 to 1½ lb. of sainfoin or meadow hay per day, and about the same quantity of concentrated food, consisting, say, of linseed cake, peas and pollards, or dried grains and oats. During the spring months the sheep are folded on rye, trifolium and rape, with an allowance of mangolds. In summer the food will be vetches and rye grass, and in autumn rape, with a run each day on old leys. As the lambs become independent of milk, the allowance of concentrated food to the ewes is gradually dropped. Dried grains are an excellent food for ewes, and an admixture of malt dust with hay chaff not only supplies extra nourishment, but also renders the chaff more palatable.

Fattening Sheep.—The following points should be considered in the successful fattening of sheep: (1) a mixture of two or more concentrated foods is better than one concentrated food alone; excellent mixtures can be made from linseed cake, decorticated cotton cake, dried grains and maize; (2) the allowance of cake and corn should be gradually increased as the fattening process continues, commencing with, say, 2 lb. per head per week, and finishing with, say, 6 to 10 lb. according to the size of the sheep; (3) a monotonous diet should be avoided as much as possible; (4) the greater the amount of bulky food consumed, the more rapid and economical will the fattening process be.

Hoggets (tegs) are extensively fattened during the winter on turnips or swedes, and experience has shown that the

fattening is done much more economically, and with fewer losses by death, when dry foods are given in gradually increasing quantities with the roots, and the roots are cut and measured out to the sheep. Cakes and grain should be well broken or bruised.

Young sheep fattening for the butcher usually consume from 100 to 160 lb. of roots or green food, such as cabbages or rape, per head per week, and from 3 to 8 lb. of hay, or hay and straw. The consumption of concentrated food varies from 2 to 10 lb. per head per week, being on the average about 5 lb.

Where sheep are growing rapidly, and at the same time putting on flesh—such as is the case with ram lambs to be sold for service at about eight months old—there must be plenty of variety in the diet, and the trough food must be rich in flesh-forming material. A good mixture for this purpose is linseed cake and peas, with or without malt coombs.

In certain parts of Scotland sheep are regularly fattened without the addition of hay or straw to the ordinary diet of turnips and cake, &c. The high quality of the roots grown in these districts largely accounts for the success of this system. Where there is a good market for hay, a modification of the system could be followed in other parts of the country by substituting dried grains for a portion of the hay, or by giving dried grains and straw chaff instead of hay.

The growth of wool will not be affected by the feeding so long as the live weight of the animal is maintained. Liberal feeding may give a heavier fleece, but the difference will be due more to increased deposition of wool-fat than to extra growth of wool fibre.

Pigs.

The essential features to bear in mind in feeding pigs are their relatively low powers of dealing with fibrous food-stuffs and their high powers of converting easily digested food-stuffs into meat. For these reasons pigs are fed almost exclusively upon milk, dairy wastes, potatoes, and meals. No animal responds more liberally to generous treatment in the matter of food-supply.

For the first three weeks the young pigs will be entirely dependent upon the mother's milk, but this should afterwards be supplemented with gradually increasing quantities of skim or separated milk, together with a little meal given in three feeds. The young pigs must not, however, be permitted to share the sow's food, or serious digestive troubles may be occasioned.

The safest single dry food for pigs for a few weeks both before and after weaning (also for sows suckling their young) is the class of wheat milling offal known commonly as

"sharps." This should be of the very best quality. The more concentrated meals (barley, maize, peas, &c.) should only be introduced gradually, when the pigs are two to four months old, or stomach troubles may result. The best addition to the meals is skim milk, then separated milk, butter-milk and whey. These should be given at first in small quantities, and afterwards increased up to the amount desired.

Compared with whey, separated milk and butter-milk are both rich in flesh-forming constitutents (albuminoids). A mixture of whey and maize meal would be quite unsuitable unless fortified by, say, bean or pea meal.

Attention must be given to the supply of lime and phosphates in the food of growing pigs. As a rule the milk and meals supply all the phosphate required, but there is often a deficiency of lime. This can be made good by small additions of precipitated chalk, increased gradually up to $\frac{1}{4}$ or $\frac{1}{2}$ oz. per day.

The meal is scalded in bulk and mixed with separated milk, whey or water, as the case may be, at the time of serving. The pigs are fed three times a day with as much as they will "clean up" each time.

With regard to the quantity of food required, young pigs of three or four months old will consume about $3\frac{3}{4}$ lb. of dry food per 100 lb. live weight per day. This quantity of dry food would be supplied by one gallon of separated milk and about 3 lb. of meal.

After pigs have attained the age of about five months the feeding is of a more forcing nature, and the amount of exercise restricted. From this time the fattening process continues till the animals are slaughtered at the age of eight or nine months. The quantity of food required is represented by about $3\frac{1}{4}$ lb. of dry feeding substance per 100 lb. live weight per day, and in order to produce a fair proportion of lean flesh the diet should have an albuminoid ratio not wider than about 1 to 6. The allowance of meal should be gradually increased, and the food should be given of thicker consistency as the fattening proceeds. A pig of 160 to 180 lb. live-weight will require about 6 lb. of meal per day, or its equivalent in meal and dairy refuse.

In the spring and summer a moderate supply of green food (clover, vetches, cabbage, &c.) is very advantageous. In winter a supply of turnips, swedes, mangolds, cabbage, &c., will serve the same purpose. The potatoes should always be well boiled or steamed, but this treatment is not necessary with the other succulent foods mentioned.

Well-fed pigs slaughtered at eight or nine months old will usually yield 75 to 80 per cent. of carcass.

It is considered that a pig thriving well should yield about 1 lb. of dressed meat for 5 lb. of meal consumed.

In London and the South of England fattened pigs weighing when dead from 60 to 120 lb. ("jointers," "porkers," or "porket pigs") find the readiest sale at best prices. Such pigs are fattened as they grow, and are ready for sale when about sixteen to eighteen weeks old. This is undoubtedly the most profitable system where the fattened porkers can be readily disposed of at fair prices, since the cost of production of any form of meat, other things being equal, steadily increases with advancing age.

In many parts of the country the most saleable pig is one weighing about 160 lb. dead weight, giving a side of bacon of about 60 lb. in weight. This should be attained when the animal is about eight months old. The pigs are weaned at from six weeks to two months, and for the next three months are kept in rapidly-growing store condition. They should be given cooked potatoes, roots, or vegetables of some sort every day, and in addition should receive a thin wash comprising a fair proportion of albuminoids. Salty refuse from any source must on no account be given to pigs.

Pigsties should be kept clean, warm and dry, as the pig is very susceptible to cold or damp.

A brood sow will largely provide herself with food if allowed the run of a grass-field, but it is advisable, especially during the last month of gestation, to add some concentrated food such as maize, peas, or beans that have been soaked in water for at least twenty-four hours. Bulky food should, however, be avoided. After farrowing she will require a liberal supply of nutritious food, which may consist of sharps, maize, boiled potatoes and skim milk.

Horses.

In feeding horses it is essential to remember that, compared with cattle, the horse has a very small stomach, which acts most efficiently when about two-thirds full. The horse is thus not well adapted for dealing with bulky food, and should receive its food at regular short intervals.

The ration of the working horse must hence contain a large proportion of concentrated foods, the most suitable being oats, barley, maize, beans, and peas. A ration composed exclusively of concentrated foods will not prove satisfactory, but must be blended with a certain amount of bulky food. This should consist of hay or good straw.

It is economical to chaff hay for horses, as they frequently waste it by littering when supplied long in the rack, though possibly a horse given to bolting food would chew it better in the long state. In general, however, if the greater part of the hay is chaffed and mixed with the grain food, a thorough mastication of the latter will be ensured, the mastication will be effected more rapidly, and waste of hay

will be reduced to a minimum. Long hay may be placed in the racks for consumption during the night. If both hay and straw are fed they should be given mixed in the chaffed condition. The proportion of hay and straw in a horse's ration should be regulated by the demands made upon it for work. During busy times, when horses are working long hours at heavy work, the diet should be of a concentrated character, as horses do not derive the same amount of nourishment from bulky foods that cattle do. In the neighbourhood of London, where farm horses are frequently engaged almost continuously in carting hay and straw to market, it is not unusual to allow as much as 25 lb. per head per day of oats, with only a small quantity of hay chaff.

Of the grain foods, none is superior to oats, and for the more valuable horses they are commonly regarded as indispensable. Barley and maize may be used in moderate quantities with safety if blended with oats, beans, or peas. They are more suited, however, for horses working at a slow pace than for those doing fast work.

Beans are favoured for horses that are called upon for sudden exertion or prolonged heavy work. All corn should be crushed or bruised. Sugar also seems to be an energy-producing food of the first rank as well as a suitable flavouring agent, and may be conveniently supplied in the form of one or other of the various sugar feeds.

All the hay and grain used must be in thoroughly good condition.

Carrots, swedes, and mangolds are much relished by horses ; they are very suitable for idle horses, but to those in work they should not be given in quantities greater than about 8 or 10 lb. a day.

A heavy farm-horse at ordinary work will require a ration supplying about 25 to 30 lb. total dry matter, with a starch-equivalent of about 14 or 15 lb., including about $1\frac{3}{4}$ lb. digestible albuminoids.

The following is probably the simplest example of a daily ration for a farm horse :—20 lb. hay, 12 lb. oats.

As a rule, however, a simple diet like this is not the most serviceable. Occasional changes of food are advantageous. With a more complex diet the animals will be found to thrive better, and in many cases also the expense is reduced.

A mixture of maize and beans in the proportion of $2\frac{3}{4}$ of the former to 1 of the latter gives about the same albuminoid ratio as oats, and it will be found that 15 lb. of the maize-beans mixture affords the equivalent amount of nourishment to 19 lb. of oats.

Farm horses fed on oat straw and oats alone—the plan followed in many northern and western districts during the short days of winter—require a very variable quantity of oats, depending upon the character of the straw, which in

some localities has a high nutritive value, whilst in others its quality is very low. In any case the oat straw is given *ad libitum*, and the quantity of oats required to supplement it will vary from 14 to 24 lb. according to the quality of the straw, the quality of the oats, the size of the horse, and the character of the work to be done.

Mares with Foals.—Mares suckling foals find all the nourishment they require in an early summer pasture. The foal when weaned (about five months old) should get a little trough food, consisting of ½ lb. oats, and ¼ lb. linseed cake, a day. It would probably be wintered out on the pastures in the day time, but in most parts of the country it will be desirable to house the foal at night in a shed or well-aired loose-box.

During severe weather it should be fed twice or three times daily, and, in any case, when brought in at night it should be supplied with a rack of hay and one of the following trough mixtures :—(1) 1 lb. of oats and ½ lb. linseed cake, or (2) ½ lb. oats, ½ lb. bran, and ½ lb. crushed beans. The oats should be crushed or bruised.

Bruised oats, bran, cut hay and pulped turnips moistened with treacle and water, make an excellent mixture. A hot mash of bran, beans and hay also gives good results.

Except in very bad weather, foals are much better running out during the day than kept in confinement, not so much because of the food they find as for the exercise, which is so essential for the normal development of the body and limbs.

During the autumn of its third year the colt may be gradually introduced to light work, say about three half-days a week, and during the following winter it may be fully broken in to the heavier work of the farm. On no account, however, must the young horse be overworked, or irreparable damage may be done to the slowly hardening framework of its body.

London, S.W.1,
February, 1903.
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. 80.

BOARD OF AGRICULTURE AND FISHERIES.

The Use of Artificial Manures.

This Leaflet has been temporarily withdrawn.

Leaflet No. 81.

BOARD OF AGRICULTURE AND FISHERIES.

A Substitute for Dishorning.

It is well known that polled or dishorned cattle can be managed and fattened with greater facility than horned animals, and that, where a consignment consists solely of hornless cattle, the animals can be conveyed by sea or land with less danger of sustaining injury while in transit. The opinion of Irish salesmen and feeders of experience in the cattle trade, who were consulted by the Department of Agriculture and Technical Instruction for Ireland, is to the effect that Irish stores for export, when horned, require more space in railway waggons, on board ships, and in the market place ; that they receive more injury in transit ; and that they are worth from 10*s.* to 15*s.* per head less than hornless cattle.

The practice of dishorning cattle, by sawing off or otherwise entirely removing the horns after they are partly or fully grown, appears to inflict great pain upon the animals, and may even be the cause of death ; and the Board therefore desire to call the attention of breeders and stock-owners to a method of preventing the growth of the horns by the application of caustic potash to the horn-buds of young calves. If performed in the manner set out below, and with proper regard to the precautions which follow, the operation is comparatively painless, and can be done quickly and with ease :—

Clip the hair from the top of the horn when the calf is from two to five days old. Slightly moisten the end of a stick of caustic potash with water (or moisten the top of the horn-bud) and rub the tip of each horn firmly with the potash for about a quarter of a minute, or until a slight impression has been made on the centre of the horn. The horns should be treated in this way from two to four times at intervals of five minutes. If, during the interval of five minutes after one or more applications, a little blood appears in the centre of the horn it will then only be necessary to give another very slight rubbing with the potash.

The following directions should be carefully observed :—

1.—The operation is best performed when the calf is under five days old, and should not be attempted after the ninth day.

2.—Caustic potash can be obtained from any chemist in the form of a white stick. When not in use, it should be kept in a stoppered glass bottle in a dry place, as it rapidly deteriorates when exposed to the air.

3.—One man should hold the calf while an assistant uses the caustic.

4.—A piece of tinfoil or brown paper should be rolled round the end of the stick of caustic potash which is held by the fingers, so as not to injure the hand of the operator.

5.—The stick should not be moistened too much, or the caustic may spread to the skin around the horn and destroy the flesh. For the same reason, the calf should be kept from getting wet for some days after the operation.

6.—Care should be taken to rub on the centre of the horn, and not round the side of it.

Note.—Caustic potash is *poisonous*, and must therefore be kept in a safe place.

London, S.W.1,
February, 1903.

Revised, April, 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. 82.

BOARD OF AGRICULTURE AND FISHERIES.

Preparation of Wool for Market.

In view of the great competition in the trade in wool, it is important that flock-masters and others should pay close attention to the conditions under which wool is produced, and to the cleanliness and packing of fleeces before sending them to market. The following suggestions bearing on these points have been drawn up in consultation with the Bradford Chamber of Commerce.

Washing and Shearing of Sheep.

In districts where tub-washing is not adopted, the sheep should be washed without any artificial assistance, that is to say, in cold water without any soap except the natural soap which exudes from the skin in sufficient quantity at the shearing period. All dung should be removed from the fleece before washing, as the manure not only discolours the water but damages the fleece. A good free "swim" affords the best washing; and the softer the water employed the better will be the results.

After washing, the sheep should be kept on grass until shearing takes place. The interval between the two operations should not exceed 10 or 12 days, as otherwise the wool resumes its normal greasy condition. Care should also be taken not to clip the sheep or wind the fleeces while wet, as this takes away the "liveliness" from the fibre and causes the wool to rot.

Shearing is best done on a clean floor or in the open on a rick cloth, and any chaff, straw, and other foreign matter which might get into the wool should be carefully removed before commencing operations. Failure to observe this precaution may cost the dealer and manufacturer much more than flockmasters think, as it is often impossible to rid the wool of this extraneous matter without the use of chemicals which are in themselves harmful to it.

When the fleece is wound, no earth or dung should be left on, or be allowed to get in whilst winding. No burs, seeds, locks, tailings, skin wool, black or cots should be wrapped up inside fleeces; neither should greasy wool be wrapped up inside washed fleeces. Locks and broken wool should be packed separately.

The Branding of Sheep.

The practice of branding sheep should be conducted with care, as indicated in Leaflet No. 246, p. 4, for tar and paint

marks have to be clipped off, so reducing the value of the fleece. A large quantity of wool used for manufacturing purposes, however, does not undergo the process of sorting, and thus it frequently happens that, in spite of efforts to remove marks, some of them pass into the finished goods, thereby causing considerable damage and loss. Even when the wool is sorted and trimmed it is very difficult entirely to eliminate the marks.

As tar and paint are not dissolved in any process of wool-washing, flock-masters should endeavour, in cases where their use cannot be avoided, to improve the methods of applying them, either by making use of smaller marks or by adopting means to prevent the tar or paint from running or being smeared. If practicable, marking on the ear or face is much to be preferred.

Methods of Tying Fleeces.

The fleeces should be rolled on a clean wooden table, and tied up with bands made by twisting a portion of the fleece itself. It is not necessary for these bands to be tightly twisted, the object being merely to keep one fleece separate from another. Most farmers tie up their fleeces with wool bands, and have done so for generations, except in a few western and southern counties. In the latter the use of string (and frequently the worst kind of string, such as reaper or binder twine) is not uncommon. String composed of vegetable matter, such as hemp, jute, &c., ought not to be used. The most careful manipulation by the manufacturer often fails to detect small pieces of string, which do not make their appearance until the cloth is dyed, because vegetable matter will not take the dyes used for wool. Dress goods and cloths are often damaged in this way to a very considerable extent. The use of string is unprofitable to all the parties concerned. The amount of damage done is a very serious matter to the manufacturer, and the district from which such wool comes suffers in reputation.

Storage of Wool.

Wool should be stored until sold in a dry granary or room, piled clear of all walls, carefully covered to keep out dust, and if possible protected from rats and mice. No grain should be near the wool, as it is often carried into the pile by vermin.

Dips.

In the selection of dips, care should be taken to use only those that do not permanently stain the wool, and any that discolour the wool should not be employed. Dipping should not take place for some months before shearing.

The results of experiments arranged by the Departmental Committee, appointed by the Board of Agriculture and Fisheries in April, 1903, to investigate and report upon the dipping and treatment of Sheep, go to show that tar acid (carbolic) dips, and tobacco and arsenical dips, with or without sulphur, when skilfully prepared, leave the wool in a nice condition. Fleeces so treated were placed in the first class by the Bradford Conditioning House, as not having deteriorated in value as a result of the dip. Pitch oil, spirits of tar, and crude tar products lowered the commercial value of the fleece by 5 to 10 per cent.

NOTE.—Other Leaflets which should be consulted in connection with the treatment of wool are :—No. 61 (*Sheep Scab*); No. 126 (*Sheep Maggot Fly*); No. 145 (*Sheep Dipping*); and No. 246 (*Prevention of Damage to Hides, Skins, and Wool*).

London, S.W.1,

April, 1903.

Revised, April, 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.

Preservation of Eggs.

The supply of eggs upon our markets is very irregular. During the spring and early summer months eggs are plentiful. As a consequence prices fall considerably. On the other hand, in the autumn and winter, new-laid eggs are scarce and command twice, and sometimes thrice, as much as those produced in spring and summer. Even the cheaper grades of foreign eggs, most of which are preserved, or "pickled," realise more than the new-laid egg in the spring.

One advantage in preserving eggs on a commercial scale is that the withdrawal of surplus supplies in the cheap season tends to the steadying of the prices obtained by producers. Simple methods of preservation may also usefully be resorted to as a means of regulating the domestic supply. Those who keep a few hens to supply their own household should be careful in spring and summer to preserve eggs for winter use.

Some private persons who preserve their own eggs with care find that the eggs have a good flavour in almost any form—boiled, fried, or poached.

The following are the methods of preserving eggs which, up to the present, have yielded the best results :—

Lime Water.

An egg pickle, composed of lime, salt, cream of tartar, and water, was patented upwards of a hundred years ago, and a modification of this preparation is still used extensively both at home and abroad. The pickle as now generally employed is made by mixing four parts by measure of finely slaked lime with twenty parts of cold water, and afterwards adding one part of salt. This solution should be prepared by mixing the lime and the water a week before it is to be used, and stirring well together daily, adding the salt on the fourth or fifth day. The eggs should be placed in vats, barrels, or crocks, and the cleared solution poured over them, care being taken to avoid adding any of the lime sediment, otherwise there is danger of the solution becoming a solid mass. Where large quantities are preserved it is more economical to place them in cement tanks, each holding 60,000 to 80,000. The vessel should not be filled with eggs, but two or three inches of solution should rest above the top layer. A little fresh solution should be added occasionally, in order

to provide for evaporation. An egg preserved by this method can be easily recognised by the roughness of the shell. When the egg is boiled the shell will crack, a result due to the effect of the lime upon the outer covering, causing it to be hard and brittle. Preserved eggs are not recommended for boiling but, if it is desired to use them in this way, the cracking may generally be prevented by pricking the broad end with a needle immediately before the egg is boiled.

Waterglass.

Waterglass is a strong solution of silicate of soda in water varying in specific gravity, according to the amount of silicate dissolved. The strongest solution usually found in commerce has a specific gravity of 1·7 and contains approximately equal parts by weight of sodium silicate and water. A ready means of ascertaining whether the waterglass is uniform in different supplies would be to weigh a measured ounce of the waterglass. One ounce by measure of the concentrated solution of specific gravity 1·7 should weigh 1·7 oz., or nearly $1\frac{3}{4}$ oz.; if it weighs less than this it contains less silicate, and more of the waterglass should, therefore, be used in making the dilute solution.

In preparing the waterglass for use, five or ten times its bulk of clean boiling water should be added to the concentrated solution, according to its strength. The preparation should be quite cold before it is used. Experiments in America have shown that a 3 per cent. solution (*i.e.*, 3 parts by measure of the concentrated solution to 97 parts of water) yields as good results as that generally recommended, namely 10 per cent. A 5 per cent. solution may be used with safety, and with this strength there is less danger of giving the eggs an objectionable flavour than with the stronger solution. When the waterglass is added to the water the two must be very carefully and thoroughly mixed. The eggs may be dipped in the waterglass and dried off, leaving a film on the shell, and then stored upon shelves, or they may be kept in the liquid until sold or used. The latter method is to be preferred. When taken out of the solution they are sticky, and before packing should be washed and dried.

It has been shown* that the changes in eggs preserved in waterglass take place very gradually; at one year old they are hardly noticeable, at two years they are distinct, but not so distinct as at three or four years old. Eggs which had been preserved for about six months tasted and smelt like well-kept eggs a few days old, but as these eggs were a few days old when placed in the waterglass, it did not seem that they were appreciably changed. At three or

* Hendrick, *Journal of Agricultural Science*, January, 1907.

four years old the white became pink in colour and very liquid, but even at four years old the eggs had no unpleasant taste or smell, and the white coagulated in the usual manner in cooking. Practically no change was observed in the composition of the eggs, even after lengthened immersion.

Cold Storage.

The methods already described are equally suitable for large and small quantities, and may be adopted either by the farmer or by the trader. Cold storage, on the other hand, in order to be profitable, must be carried out upon a large scale, and is consequently not available for small producers unless they have a cold storage plant for other purposes. In America this system is extensively employed, and large plants have been specially erected for the business. Eggs require to be unpacked and laid upon shelves or in trays, and kept at an even temperature, not falling below 33 degrees Fahrenheit, with a free circulation of absolutely sweet air. No other products should be kept in the same room, otherwise the eggs may be affected. By this method, provided that the eggs are new laid when placed in storage, they can be kept for many months in good condition, but great care is necessary in removing them for use, as a too sudden change of temperature causes rapid deterioration. In all cases they require to be used very speedily on removal from the cool chamber, and the evidence obtained in this and other countries shows that such eggs will keep for a much shorter period after they are taken out of the chamber, than if preserved in solutions of lime or waterglass as described above.

General Suggestions.

1.—Eggs for preservation should be treated as soon as possible after they are laid, but not until they have been cooled. If the egg is not absolutely fresh when placed in the preserving medium the final result cannot be entirely satisfactory. An egg twenty-four hours old is superior to one a week old.

2.—Eggs should not be stored in a warm place before preservation, and where limewater or waterglass is used the preparation should be quite cold before the eggs are placed in the solution.

3.—Eggs from hens fed chiefly upon grain, and with full liberty, are likely to keep better than those laid by fowls in confined runs.

4.—The general experience has been that infertile eggs keep in good condition longer than those which contain a living germ. Probably this is less apparent when eggs are preserved at a low temperature.

5.—When eggs are preserved in waterglass or limewater the vessels containing them should be stored in a cool place, at a temperature of not less than 33 degrees Fahrenheit, nor more than 45 degrees. A cool, well-ventilated cellar is excellent for this purpose. Exposure to a higher temperature, even for a few hours, will cause deterioration in spite of the preservative.

6.—Eggs may be stored in large or small quantities, and may be allowed to remain in the pickle for six months. Wooden, cement, or galvanized iron vessels should be employed.

7.—Eggs should be carefully tested before they are preserved, and again prior to sale. For this purpose a well-constructed candling lamp is to be preferred ; but a piece of black cardboard, 8 inches square, with an oval hole in the centre rather smaller than an ordinary egg, can be used. Each egg should be placed against the hole, and held between a strong light and the eye, so that the condition of the contents can be observed. In the final test all eggs of which the contents are opaque or which show spots or black shadows should be rejected.

8.—The best months for preserving are March, April, May, and June. It has been found in many cases that summer eggs do not keep nearly so well as those laid before the hot weather.

9.—Preserved eggs should be sold under that name, and not as "new-laid," "breakfast," or "fresh" eggs.

London, S.W.1,
March, 1903.
Revised, August, 1917.

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BOARD OF AGRICULTURE AND FISHERIES.

The House-Sparrow (*Passer domesticus*, L.).

The house-sparrow is so well known that a detailed description of it is unnecessary. In almost all parts of Europe where grain is grown this bird is, unfortunately, far too common. It has been introduced into New Zealand, Australia, and North America, and in these countries has increased to such an extent that it has become as serious a pest to the farmer and gardener as in Great Britain.

While no one wishes to exterminate the sparrow, it is generally agreed that any good it may do in destroying harmful insects is so greatly outweighed by the damage done to crops that a reduction in its numbers is as necessary as in the case of rats, or of any other destructive pest.

Food Habits.

Hundreds of examinations of the contents of the crops of sparrows have been made in this country and abroad, and it has been shown that from 75 to 80 per cent. of the food of adult birds throughout the whole year consists of cultivated grain of some sort. A farmer in the neighbourhood of a town or village where the bird has been unmolested has this fact forcibly brought home to him by the great diminution in his crops. In such districts, the profitable cultivation of cereals becomes well-nigh impossible.

The sparrow does most damage during the few weeks before harvest. At this time thousands of adult birds and the young birds of the season desert the village and farm homesteads for the fields, and live almost entirely upon the ripening grain. Later they live mainly round human habitations, taking grain from the stacks and poultry yards.

Sparrows not only destroy grain crops, but also do much damage to garden produce. They apparently take a delight in stripping gooseberry and red currant bushes of their buds; tearing in pieces various brightly coloured flowers, such as crocuses, primroses, and violets; destroying the blossoms and young fruits of the gooseberry; eating the young shoots of carnations in winter; and pulling up rows of newly-sown peas in spring and summer.

Ricks and thatch are damaged by them, and rain-water pipes are frequently blocked by their nests.

It may reasonably be asked if nothing can be said in favour of the sparrow. Examination of young birds in the nest, and those recently fledged, has shown that they feed partially upon caterpillars, beetles, crane-flies, aphides, and

other insects. The proportion of their food consisting of insects is, however, not more than 50 or 60 per cent., and then only for a short period of their early life. It must also be remembered that the sparrow drives away swallows, house-martins, and other purely insect-feeding birds, which would do most of the useful work carried on by the sparrow if they were undisturbed.

Nesting Habits.

The nest of the house-sparrow is placed in all sorts of situations: in trees and shrubs, in holes in hayricks, thatch, walls and trees, in rain-water pipes, under the eaves of houses, in ivy-clad walls, and in the nests of the house-martin and swallow. It is rarely found more than a mile or so from human dwellings, and is usually made of straw, hay, or dried grasses, more or less in the form of an oval ball with an opening into it at the side. Five or six eggs are laid, of a bluish-white ground colour, blotched or speckled with brownish or blackish markings which vary very considerably.

Each pair of birds may rear two or three broods during the summer, and this accounts for the rapidity of increase when the birds are unmolested in districts where food is plentiful.

Methods for reducing the Number of Sparrows.

Any attempt to reduce the numbers of sparrows must be thorough and must embrace the whole of the district infested. It is of little use to kill the sparrows in one locality, if they are allowed to multiply in surrounding parishes. Not only should sparrows be destroyed round villages and hamlets, but on every isolated farm in the neighbourhood. Sparrows left to multiply on one or two farms in a district soon spread over the neighbouring areas. The particular methods for lessening the number of sparrows are very numerous.

a.—Eggs and nests may be destroyed in the breeding season.

b.—Various forms of nets may be employed on dark nights to catch the sparrows as they are disturbed from ricks, hedges, or ivy-clad houses where they roost.

c.—Shooting with small shot during winter is useful.

In all cases care should be exercised to prevent other birds suffering along with sparrows.

d.—As individual private effort can have but a slight effect, the work of lessening the sparrow plague in a district is best carried out by the formation of a Sparrow Club.

Sparrow Clubs.

The object to be attained by a Sparrow Club should be made clearly known to all who join it. Anything like indiscriminate destruction of small birds in general should be avoided, the object being merely to reduce the numbers of the house-sparrow. Every encouragement should be given to the protection of other small birds.

Very frequently it is found that rats can be dealt with at the same time as sparrows.

The following are suggested as model rules, which can be amended or curtailed according to the requirements of the district :—

Rule 1. The name of the club shall be "The.....and District Sparrow [and Rat] Club," and includes the parishes of... .....

Rule 2. Occupiers of land shall pay a minimum subscription of ½*d.* per acre ; labourers and working members 1*s.* per annum.

Rule 3. Private residents, shopkeepers, and tradesmen shall be invited to co-operate and become honorary members, who shall subscribe 2*s.* 6*d.* per annum.

Rule 4. House-sparrows [and rats] only shall be destroyed.

Rule 5. Old sparrows shall be paid for on production at the rate of 3*d.* per dozen ; young sparrows 2*d.* per dozen ; and sparrows' eggs 1*d.* per dozen ; [rats at the rate of 6*d.* per dozen]. Sparrows and their eggs [and rats] can be collected by members during the off season and handed in to the secretary or collector appointed for the purpose. These will be paid for and count towards the total for the month of October following.

Rule 6. Sparrows and their eggs [and rats] must be taken in the parishes mentioned in Rule 1. Any member infringing this rule shall be disqualified from taking any prize.

Rule 7. Members found smoking in stackyards or on any premises whilst catching sparrows [or rats] or loading shot-guns with ordinary paper instead of stout wads, shall be disqualified for all prizes.

Rule 8. Three monthly cash prizes, value 3*s.*, 2*s.*, and 1*s.*, shall be offered for competition amongst members securing during each month, October to March inclusive, the greatest number of sparrows [and rats]. *No member shall be qualified to take a monthly prize unless he has handed in a minimum of 50 sparrows [or 25 rats].*

Rule 9. Working members shall hand in some sparrows [or rats] each month during the season, October to March, to qualify for the monthly prizes.

Rule 10. No member shall take more than two 1st or three 2nd prizes during the season, or a total sum of 6*s.* in prizes.

Rule 11. Monthly meetings shall be held at..... on the.....of each month, October to March inclusive, for receiving from the secretary an account of the number of sparrows [and rats] taken, paying out monthly accounts and prizes, and discussing any business in connection with the club.

If such clubs could be instituted and their work carried out systematically for three or four seasons throughout the country, there would be a great improvement in increased crops on farms and gardens, while martins and other insect-feeding species of birds would have a better chance to increase.

The Hedge-Sparrow.

It may perhaps be advisable to note that the hedge-sparrow (*Accentor modularis*, L.) is in no way related to the house-sparrow, the former being a very useful bird, which should be protected, since its diet consists almost entirely of insects. It has a soft narrow beak quite unlike that of the house-sparrow, which is hard and specially adapted for eating seeds. The nest of the hedge-sparrow also, is quite different from that of the house-sparrow, being open, and composed of plants, roots, and moss, lined with hair or wool, while the eggs are blue in colour.

The Tree-Sparrow.

The only bird likely to be mistaken for the house-sparrow is its near relative the tree-sparrow (*Passer montanus*, L.). The latter is a much rarer and more locally distributed species, somewhat smaller in size, with two white bars across its wings instead of one as in the house-sparrow. The male house-sparrow has a white patch on its cheek or side of its head; in the tree-sparrow the white cheek has a black triangular patch on it. The tree-sparrow is of little importance compared with the house-sparrow.

London, S.W.1,
April, 1903.
Revised, January, 1916.

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BOARD OF AGRICULTURE AND FISHERIES.

Haymaking.

The details of this operation vary considerably in different parts of the country. In the North and West of England and in Scotland, the rainfall is heavier, and the air more humid, than in the South and East, with the result that in the drier districts hay can be brought into a condition to carry with an amount of labour that would be quite insufficient in other circumstances. The crops too, in the drier districts are usually comparatively light, so that they "make" with little handling. The details of haymaking are also influenced by the character of the crop—whether from old meadows, or new leys; whether containing much or little clover; and whether from a large or small area—a large area demanding the use of machines that would be quite out of place on a few acres.

In general, however, the principles of haymaking are the same. The objects are to cut the crop at the time when its quality and quantity are at about their maximum, to handle it with the least expenditure of labour, and to "save" it with the smallest loss of nutritive constituents.

Time to Cut.

The best time to cut is when the bulk of the grasses are in flower, that is to say, when the anthers or pollen sacs are protruding from between the chaff scales. At this time the weight of herbage is nearly at its maximum, while the greatest yield of digestible nutrients will also be obtained at or about this stage. From this point onwards the stems become harder and less digestible, and the seeds form rapidly, the riper they become the greater being the waste during the subsequent processes of haymaking.

Before fertilisation has taken place most of the nutrient materials are distributed throughout the leaves and stems, but when the seeds begin to form there is a rapid transference of the more valuable nutrient materials to the developing seeds, so that if the latter are subsequently

knocked out of the hay the loss of nutritive substances is quite out of proportion to the loss of weight.

If the ley be a new one, and the grass chiefly consists of a single species, say ryegrass, it is not difficult to determine the time to cut. On old grass-land, however, which carries a great variety of plants, some species may be fully ripe before others have come into flower. Meadow Foxtail, Sweet Vernal, Cocksfoot, and the Rough- and Smooth-stalked Meadow Grasses may be ripe, and have shed much of their seed, by the time such a grass as Timothy has commenced to flower. It is therefore impossible to catch all plants exactly at the right time, but the hay harvest should be started on a field where early grasses are most abundant, or where, owing to thin soil or a south exposure, maturity is most advanced. Then, again, there are some plants, like Cocksfoot, which become hard and unpalatable sooner than others, and, where these predominate, cutting may take place before the flower heads are well out of the sheath.

A little loss in weight owing to an early start is usually more than counterbalanced by the superior feeding properties of the crop, and by the greater quantity and better quality of the aftermath. If a second crop of hay is contemplated, the advantages of starting early with the cutting of the first crop are specially emphasised.

Manner of Cutting.

In the case of meadow hay the crop can hardly be cut too close to the ground, but with rotation hay it is found that red clover produces more aftermath if the first crop has not been cut too close, and, especially so, if very sunny weather occurs when the crown of the root has recently been exposed. It is contended that red clover is most permanent, and the aftermath is better, when the crop is cut by the scythe than where the mowing machine is employed. This result has been ascribed to the cut surface made by the scythe being somewhat oblique and so running off the rain, whereas the cut of the machine is horizontal and allows the rain to enter and to rot the root, but it is probable that the greater length of the stubble generally left by the scythe is the true cause.

"Making" the Hay.

It need hardly be pointed out that the weather is the determining factor in "making" hay, but as a general principle the less hay is turned and knocked about the better Every time it is moved it suffers loss through the shedding

of seed, and the separation of the fine leaves, and especially clover leaves. These two portions, the seed and fine leaves, are the most valuable part of the crop, and every effort should be made to preserve them. Further, the more hay is moved the more are the stems and leaves of the plants bruised and broken, and should rain subsequently intervene a relatively large amount of the nutritive constituents will be washed out of the crop.

Every farmer strives to get his hay beyond the washing influence of rain as soon as possible. Rain water may dissolve and remove more than ten per cent. of the dry matter of hay, and what is thus removed may represent quite twenty per cent. of the feeding value.

In the drier districts of England hay is generally raked into windrows straight from the swath, and put directly into the stack, but in other districts it must be turned, cocked, and often piked, or put into field "tramp-ricks" before it is fit to stack. If the weather admits of the crop being stacked or ricked straight from the swath the minimum of loss will occur, combined with greatest economy of labour; but if this cannot be done, and if wet weather threatens, it is a great advantage to put the crop, even if not in first rate condition, into small cocks, which, when the weather is dry, may be shaken up, and afterwards carted. Half an inch of rain means some 50 tons of water per acre, and if the crop be equally spread over the ground it is, of course, subjected to the whole of the washing influence of this quantity of water; but if it be put into cocks that occupy only one-tenth of the area it follows that the hay will be affected by only one-tenth of the rainfall, that is to say by 5 instead of 50 tons of water.

Not only does water actually wash out much of the soluble and most valuable of the constituents of hay, but it also removes the aroma, and leaves the crop much less appetising as food for stock. The colour, too, suffers, and with it the selling value.

In the stack the hay should be consolidated as thoroughly as possible, and this is secured by spreading it evenly, and by careful trampling. The object is to exclude air as much as possible, and so to keep fermentation within proper limits. If this is secured, and previous drying has been satisfactory, the produce will be of a good colour; green, in the north and west, where the natural sap is largely eliminated by handling in the field, and brown, in the south, where the sap is more conserved. If the crop is loosely stacked, air enters too freely, excessive fermentation takes place, and the resulting produce, being partially carbonised, will be very dark in colour and of low value. A light crop, or a crop consisting of fine grasses, packs more easily in the stack, and requires less trampling, than a strong "stemmy" crop into which air enters more freely.

The foregoing notes refer mainly to the making of meadow hay. Many other crops, however, are utilised for hay making, *e.g.*, clover, ryegrass, and mixtures of these, timothy, lucerne, sainfoin, &c. Even a corn crop, particularly if it has become laid early, may be cut green and made into hay. Each of these crops requires some modification in handling. Ryegrass and timothy dry comparatively easily and quickly, while clover is much more difficult to "make." Lucerne and sainfoin, particulars of which will be found in Leaflets 160 and 280, are adapted for haymaking only in the drier districts of the South.

London, S.W.1,
May, 1903.
Revised, May, 1914.

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Leaflet No. 86.*

BOARD OF AGRICULTURE AND FISHERIES.

Brown Rot of Apples.

(*Monilia fructigena*, Pers.)

During summer and early autumn apple trees are frequently attacked by a disease which produces on the fruit soft brown areas which gradually increase in size until the whole apple is affected; meanwhile, small pustular swellings appear beneath the skin and soon burst through as yellowish, powdery, cushion-like outgrowths, usually in concentric circles (*see* Fig. 1 *b* and *c*). The diseased apples ultimately shrink in size and the skin becomes wrinkled. Such fruits, when hanging loosely, are easily detached, and many fall to the ground during a high wind; the rot continues to develop on these windfalls, and more pustules are produced, which act as a possible source of further infection. When, however, a diseased apple is in contact with other apples or with a branch the pustules produced at the point of contact become adherent and may so attach the apple to the tree that some little force is required to detach it.

Method of Attack by the Parasite.—The disease is caused by the fungus *Monilia fructigena*, Pers. The powdery pustules which sooner or later appear on the affected apples are outgrowths of the fungus growing in the flesh of the fruit, and each consists of numerous chains of spores or reproductive bodies. The spores readily fall apart and are scattered by the wind or carried by insects to other apples. If they gain access to the flesh of an apple through a cut or rupture of the skin they germinate, producing fungal threads (*mycelium*) which develop within the tissues of the apple and cause the characteristic "brown rot." The rot extends very rapidly and within a week or ten days the fruit will be largely destroyed.

When a diseased apple is in contact with others on the tree the latter may become infected by contagion, and frequently a bunch of apples is found which shows fruit with the rot in various stages of development. Fig. 1 is a photograph of such a cluster of apples obtained in late summer from a tree of Warner's King. The disease had commenced in the small withered apple (*a*); below this and in contact with it is another apple (*b*) which had evidently been affected for some time as it is much shrunken and wrinkled. The rot had extended from this apple to the

* Abridged from a more detailed description of the disease in an article by H. Wormald, M.Sc., of the South-Eastern Agricultural College, Wye, Kent, which appeared in the *Journal of the Board of Agriculture*, June, 1918.

one on the left (*c*), which, at the time the photograph was taken was permeated with the fungus and bore numerous powdery pustules; but it was only very slightly shrunken and its surface showed but little wrinkling. On the right is an apple which is still quite sound.

Mummied Apples and Methods of Overwintering.—Those diseased apples which become attached to the tree usually remain in that position throughout the winter, becoming dry and shrivelled, and they constitute the so-called "mummied" apples (Fig. 2). Many of the spores on the pustules of these "mummies" are washed away by rain in winter or dispersed by the wind; others remain on the pustules but these usually lose their power of germination. As summer approaches, however, the "mummies" produce a new crop of spores and these cause infection of the young fruit. A "mummy" frequently infects the growing apples through direct contact, but in any case apples in the neighbourhood of a "mummy" are liable to spore-infection and such newly-infected fruit will soon produce myriads of spores which serve to spread the disease. The spores are very minute in size and are easily dispersed by wind. Insects, too, crawling over the fruit, may not only carry the spores from one apple to another, but, in the case of biting insects, such as wasps, produce wounds which enable the spores to reach the exposed flesh of the apple, where they develop mycelium and reproduce the rot.

Spur Canker.—On some soft-wooded varieties of apples (*e.g.*, Lord Derby and James Grieve) the disease may extend along the stalk of the affected fruit into the fruiting spur, or even as far as the branch itself, producing in the latter a canker round the base of the spur. In this capacity of forming cankers the fungus resembles the "Blossom Wilt and Canker Disease" of apple trees caused by a closely-related fungus (*see* Leaflet No. 312). The two diseases are, however, quite distinct. In the case of "Blossom Wilt" infection occurs through the open flower while in the disease here described infection takes place, so far as is known, only through the fruit. Fig. 3 shows the pustules of the Brown Rot fungus occurring on a fruiting spur.

Control Measures.—From the preceding remarks it will be seen that the mummied fruits which are allowed to remain on the trees throughout the winter are the source of the new infection of the growing and ripening apples, and that the one certain preventive measure against the disease is the removal of these mummied fruits. In gardens, allotments and small orchards it is possible to examine the trees at frequent intervals and any apple showing a brown rot, even

FIG. 1.—A cluster of apples (Warner's King) attacked by *Monilia fructigena*.

FIG. 2.—Two mummied apples as found on the trees in winter. The mummies should be removed as they are permeated with the fungus which will develop spores and thus bring about the infection of the new apples in summer.

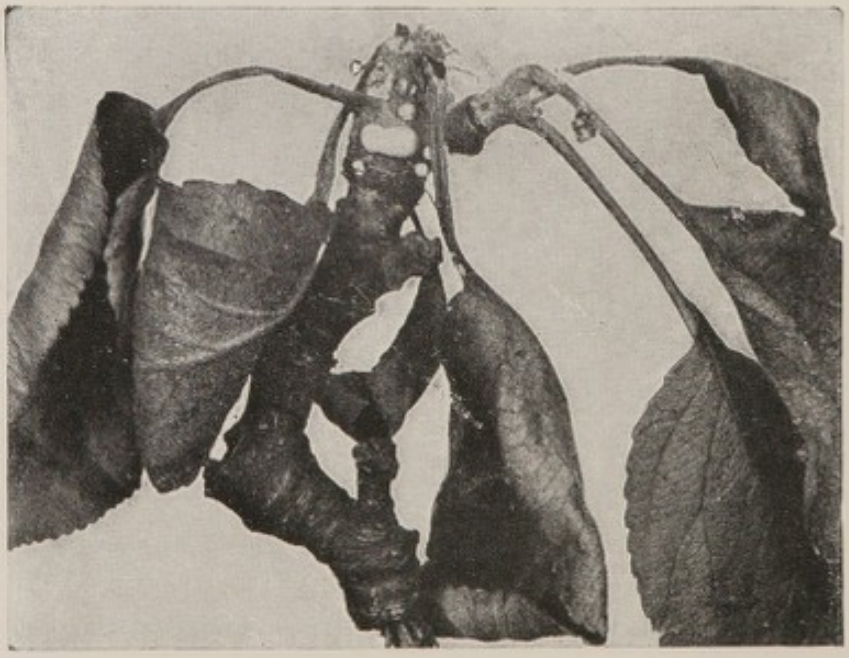

FIG. 3.—Fruiting spur, from a tree ot Lord Derby, bearing pustules of the same fungus.

in an early stage of development, should be promptly removed. On large fruit farms such a course would in most cases be impracticable, but the diseased apples should be removed as soon after as possible. This operation might be carried out at the time of picking the crop, the diseased apples being gathered, and either destroyed at once or dropped on the ground, where they are less dangerous than if left hanging on the tree. In any case, it is imperative that no mummied fruit should be allowed to remain on the trees over winter.

It is advisable to collect the affected fruit and remove it from the orchard or burn it; in plantations, where the ground is cultivated, such fruit should be dug in and buried.

In addition to the removal of infected fruit all affected spurs should be cut out, together with cankers on the stem. This operation is best performed in summer, but it may be done in winter provided it is completed before the fungus resumes its growth in spring.

The Disease on Stored Apples.—The Brown Rot fungus attacks apples not only while still growing on the tree, but also after they are picked and stored. At the time of storing the fruits should be carefully examined, and all those showing any trace of the rot should be discarded, for the disease will not only continue to develop in affected individuals, but may also extend to those around them. For the same reason great care should be taken when apples are selected for transmission to a distance in boxes; serious losses having occurred in boxed apples owing to neglect of these precautions.

Under certain conditions stored apples affected by *Monilia fructigena* turn black, the skin remaining smooth or nearly so for some time and bearing few or no pustules. Although there is often no evidence on the exterior of such apples that a fungus is present, the flesh is permeated by fungal threads, and particles of the flesh, placed on suitable culture media, give rise to the growth and pustules typical of *Monilia fructigena*. The precise conditions which cause the fungus to produce a brown rot in some cases and a black rot in others have not yet been determined.

London, S.W.1,
May, 1903.

Re-written, August, 1918.

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Leaflet No. 87.

BOARD OF AGRICULTURE AND FISHERIES

A Fungus Disease of Young Fruit Trees.

(*Eutypella prunastri*, Sacc.).

Every now and again this minute but very destructive parasite appears under the form of a disease wave, causing a very considerable amount of damage, hundreds, or in some instances thousands, of young trees being injured or completely killed during one of these sporadic attacks.

Young standard fruit trees, up to the age of eight years, are most liable to the disease, and as the stem or stock is the part attacked, the girdling of this portion of the plant by the fungus growing in the bark and cambium means the death of the entire tree, which in a dull and damp season favourable to the rapid growth of the parasite, usually occurs during the spring following the first year of attack.

In the case of nursery stock, plum (especially the variety called Victoria) and apple trees have suffered most severely in this country; peach, apricot, and cherry to a less extent. The fungus is also often very abundant on wild plum, bullace, blackthorn, &c., and it is the spores produced on such wild trees that infect cultivated stock.

The first indication of the presence of the disease is the premature yellowing and fall of the leaves, followed by a drying up, browning, and shrivelling of the bark of the stem. During the spring following the first year's inoculation, numerous minute, elongated cracks, arranged in dense clusters, appear in the dried-up bark. These represent the first form of fruit produced by the fungus (Fig. 1), and are followed during the second season after infection by larger, fewer, and more irregularly scattered cracks, always transversely arranged in the now dead bark, containing a second and more highly developed kind (ascigerous) of fungus fruit (Fig. 3).

The spores of the fungus are mature during late spring and early summer, and it is at this season that infections of

young fruit trees takes place, the spores gaining access to the stem either through the unprotected ends of pruned twigs or through the living bark itself.

All wounds on the stem exposed by cutting off shoots, *however small*, should be protected *at once* by a coating of gas-tar, until the tree is at least ten years old. If this precaution is neglected, spores frequently alight on the newly-formed wounds, where they quickly germinate and spread upward and downward in the living bark, which becomes discoloured; finally the fungus bursts through the bark it has killed, and produces spores on the surface (Fig. 6).

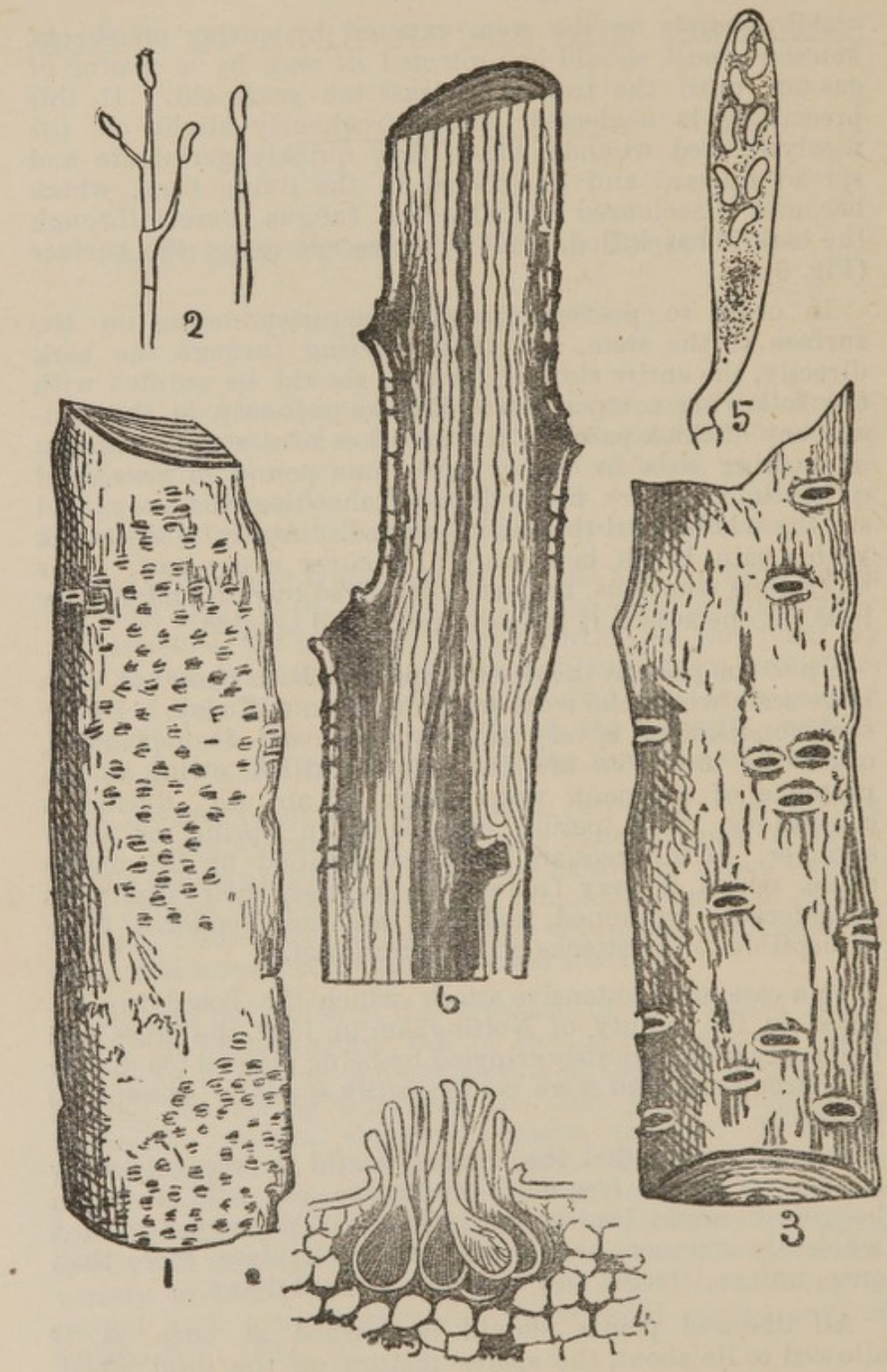
In order to prevent spores from germinating on the surface of the stem, and then entering through the bark directly, the entire stem of the tree should be painted with the following composition:—Reduce soft-soap to the consistency of thick paint by the addition of a strong solution of washing soda in water. Add one pound of powdered quick-lime to every five gallons of the dissolved soap, and stir the whole until thoroughly mixed. Apply to the trunk with a paint brush, being careful to cover every part. This mixture is tenacious, not easily dissolved by rain, and usually lasts for one season if properly made and applied.

Up to the present the disease has only been observed on a large scale where the trees are growing in stiff clay. Under such conditions it is very important to avoid deep planting, otherwise the roots are liable to be killed, owing to the presence of stagnant water, lack of air, &c., during a continuous rainy period, especially in spring or early summer. If the trees are not actually killed by this means alone, which is very frequently the case, their vitality is considerably weakened, and they are thus rendered more susceptible to the attacks of parasitic fungi.

In a case of an extensive attack which the Board investigated in the county of Nottingham in 1902, the trees had evidently been seriously crippled by being planted too deeply in a strong soil, and were consequently specially susceptible to attack.

It is important that the fungus should be recognised by gardeners, as its frequent occurrence on wild trees in hedgerows might lead to the infection of nursery stock in a wholesale manner, as has in fact taken place, more than once, unless detected and removed without delay.

All diseased plants should be burned at once, as, if allowed to lie about, the spores mature on the dead wood, and are scattered by wind, a risk of further infection being thereby incurred.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Description of Figures.

1. *Eutypella prunastri;* spore-bearing form of reproduction on an apple tree stem. Nat. size.

2. Spores. × 600.

3. Second, or ascigerous, condition of fungus-fruit on plum stem. Nat. size.

4. Section through a group of ascigerous fungus-fruits embedded in the bark. × 50.

5. Ascus containing 8 ascospores. × 400.

6. Median section through portion of the stem of a young apple tree, showing where the fungus had entered through the unprotected ends of pruned shoots. The mycelium of the fungus had discoloured the bark and wood, and finally burst through the bark to the surface. Nat. size.

London, S.W.1,
May, 1903.

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Leaflet No. 88.

BOARD OF AGRICULTURE AND FISHERIES.

Hop Aphis (*Phorodon humuli*, Schrank.).

The chief insect pest with which the hop grower has to contend is the Hop Aphis (*Phorodon humuli*, Schrank.), also known as the Hop "Fly" or "Louse." In former years, before the introduction of washing to combat this pest, the hop crop was often almost entirely destroyed by its attacks; and hops rose to famine prices. A general "black blight" occurred in 1882, since which year washing has been universal among the good growers of hops, but the years 1901, 1902, 1903, saw attacks which seriously affected the crop in quality or in yield, and again in 1904 and 1906 the harm done by the insect was very great. The first symptoms of an attack are usually to be seen early in June; here and there among the hops will be found a stout winged green aphis, and on the underside of the unfolding leaves near the tops of the shoots minute wingless "lice" may be detected, the soft growing points of the plant being always the parts first attacked. If the weather conditions are favourable and nothing is done to check the attack the aphides multiply with inconceivable rapidity; in a week or two the undersides of all the leaves become dotted over with wingless lice of all sizes, while the sticky exudations from the insects coat the leaves below and give them a dark shiny appearance. Finally, this "honeydew" turns black, the growing shoots shrivel and curl, and the development of the whole plant ceases. Sometimes after such a "black blight" the plant clears itself later in the season, and should heavy rain wash the leaves, it will put forth a little new growth on which a few hops will be carried. Should the conditions be less favourable for the rapid multiplication of the aphides, lice may be found on the plant during the whole season, and will then harbour in the cones of the hops; as they die there the remains turn black owing to the invasion of a fungus, and the hops, after picking and drying, will be found with black cores, their value being much depreciated.

Description and Life History.

The hop aphis belongs to the large family of plant lice which includes many of the most characteristic pests of the farm and garden, such as the well known "green fly" of the

rose, the black "collier" which infests the top of broad beans, the black cherry louse, the reddish lice of apples, plums, and currants, the aphis of corn, and of the turnip, &c.

The mature form of the hop aphis is about one-eighth of an inch long, with a plump body and three pairs of legs ; the mouth is prolonged into a proboscis adapted for piercing the leaves of the plant and sucking the sap upon which the insects live ; towards the extremity of the abdomen are two tubes from which exudes the sticky "honeydew." Two pairs of transparent wings may or may not be present, for both winged and wingless female forms occur, the former being generally distinguished as "fly" from the wingless "lice" ; there is also a winged male.

Two cycles of life history are known, one complete on the hop, the other involving a migration from the sloe, damson or plum back to the hop again. This latter cycle is the most important.

In the first cycle the wingless female form hibernates in the ground and crawls on to the hop plant in the spring, when she immediately begins to deposit living young upon the soft leaves. These young in their turn begin to reproduce themselves without the intervention of a male for many generations, multiplying with astonishing rapidity. Some of these lice enter the pupal state, from which they emerge as winged females and fly to other hop plants, where they again reproduce themselves asexually. Finally, towards the autumn most of the lice turn into pupae, and emerge as winged females and males, which copulate before leaving the hop. Some of the wingless females go to ground before winter and hibernate until they can resume their asexual reproduction on the young hop in the spring.

In the second cycle the winged female after fertilisation by the male in autumn leaves the hop and flies to the sloes, damsons or plums, where she deposits eggs near the tips of the shoots and in the forks of the twigs. In the spring these eggs hatch into lice, which in May or early June develop wings ; the winged females then fly back to the hop, where they reproduce living lice as before described for ten or twelve generations before fresh winged forms are developed. Migration may continue on through the summer. It is the enormous rapidity with which the wingless forms reproduce themselves that constitutes the danger of an attack of the hop aphis ; the whole plant may become completely smothered in lice if neglected for a week or two.

Natural Enemies.

The lady-birds, both in their adult and larval forms (when they are known in the hop gardens as "niggers") are great devourers of aphides and are sometimes numerous enough to keep a mild attack in check.

The lace-wing fly, which lays its white eggs in little groups, each supported on a long stalk, on the underside of the leaves of the hop and other plants, devours great numbers of aphides when in the larval stage.

Several species of chalcid fly are parasitic upon aphides; they lay their eggs in the living aphis, the interior of which is devoured by the larvae.

Treatment.

1.—The only way of dealing with the hop aphis is to spray or "wash" the hops with a mixture containing soft soap as a basis. As the aphis secretes something of a sticky or waxy nature it is not readily wetted by pure water; the presence of the soft soap causes the wash to touch the aphis, and as it dries the thin layer of soft soap clogs the breathing pores and kills the insect. A few growers use soft soap alone, but the majority add a decoction of quassia chips, the bitter principle of which is either directly poisonous to the aphis or renders the leaves distasteful to those which escape.

The soft soap should be carefully selected, it should be newly made and from such kinds of oil as do not yield hard flocks of curd when the soap is mixed with hard water. It is desirable to test beforehand the lathering powers and the character of the curd that is formed by dissolving one-fifth of an ounce of the soap in question in half-a-gallon of water, shaking well and observing the stability of the lather and whether any curd separates on standing. The amount of soap to be employed varies with the hardness of the water; with soft water four pounds per 100 gallons will be sufficient, while hard waters often require eight or ten. Large quantities of soft soap will scorch tender foliage, hence when the water is hard it is advisable to have an analysis made, as it is often possible to reduce the hardness by adding a little carbonate of soda.

6lb. of good quassia chips should be simmered for two hours with just enough water to keep the mass liquid. The decoction may then be strained off and the soft soap stirred in till it dissolves, a process which may be assisted by further boiling. This stock mixture should be diluted down as required with cold water to 100 gallons.

Many forms of spraying machines are used for distributing the wash. For small gardens a hand machine with two nozzles on flexible tubes may be used, but large acreages require the use of horse machines holding about 80 gallons of wash, the double or treble acting pump being driven by the wheels of the machine as it moves along.

The amount of wash required will vary with the machine and the state of the bine: for a fully-grown garden 200–400 gallons per acre will be needed.

Washing should begin as soon as lice are detected on the young leaves, as it is almost impossible to clean the garden if

once the aphis is allowed to get a start. In bad seasons washing may have to be repeated again and again, practically continuously throughout June and July and early August. Every effort should be made to get the plant clean before the hops begin to form, as it is impossible to reach the aphis if once it gets a lodgment inside the cones of the hop. For this reason a late attack of aphis is the most dreaded by the hop grower, because he is then powerless to stamp it out, though washing right up to the time of picking will keep down the numbers which enter the hop. The lower leaves and laterals, and the suckers about the base of the plant, should be stripped away, as they harbour lice and are difficult to wash.

The cost of washing on a large scale amounts to about 20*s.* per acre for both materials and labour, but much depends on the proximity of the water supply.

2.—As the hop aphis in the main migrates from the damson and plum to the hop, the use of the caustic wash, described in Leaflet No. 70, on the fruit plantations in the winter will tend to diminish the attack on the hops in the following summer by destroying the eggs of the aphis. A dilute paraffin emulsion should be used for the damson and plum in the spring against the aphides which issue from eggs that escape the winter treatment.

London, S.W.1,
June, 1903.

Revised, August, 1908.

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Leaflet No. 89.

BOARD OF AGRICULTURE AND FISHERIES.

Fluke, or Liver Rot in Sheep.

Fig. *a*. Adult Liver Fluke. *b*. Water Snail (*Limnæa truncatula*). Nat. size.

The disease known as Rot, Liver Fluke, Coathe, and Bane, in sheep, has existed in Great Britain for very many years, and has caused greater losses in this country than any other disease affecting this particular class of animal. The last severe outbreak occurred in 1879 and continued into the year 1880; and in the statistics prepared by the Board of Trade for 1881 there was a falling off in the number of sheep in Great Britain of no less than three and a half millions compared with that given for 1879. This decrease was reported to be mainly due to the prevalence of rot. The greatest losses occurred in England, Scotland being but little affected.

Life History of the Liver Fluke.

The common liverfluke (*Distoma hepaticum*) is found in the biliary passages of the liver of the sheep, where it produces many thousands of eggs, which find their way along the bile duct into the intestines and are expelled with the dung. Those which fall upon dry soil may remain dormant for months, but how long they may retain their vitality is not known; whilst those which reach the water in pools and dykes are at once hatched, and a free swimming *ciliated embryo* is produced. This little organism is provided with a small boring prominence, and as it swims about in the water it searches for a certain species of water snail, to the surface of which it fastens itself, and eventually bores its way into its body. It then becomes the *sporocyst*. The sporocyst grows slowly within the snail, and eventually the germ cells which it contains produce other organisms called *rediæ*, 5 to 8 in number, which eventually escape from the sporocyst and attach themselves to the liver of the snail. Within each redia are

formed from 12 to 20 individuals of the next generation, which are known as *cercariae*. These last-named organisms are somewhat similar to the adult parasites into which they eventually develop, their bodies being flat and oval in shape, but they are provided with a tail. After leaving the redia these cercariae pass out of the body of the snail into the water, where they swim about until they attach themselves to a blade of grass or some other object; subsequently they lose their tail, become encysted—that is, form a case—and remain quiescent until swallowed by the sheep, in whose stomach the wall of the cyst is destroyed. The liberated parasite ultimately finds its way to the liver of the sheep or other animal, and develops into the adult hermaphrodite fluke.

The fluke parasite runs through three reproductive generations, namely :—

1st. The sporocyst ;
2nd. The redia ;
3rd. The adult fluke.

There is a gradual increase in the number of the organisms derived from each of these generations. For example, the sporocyst containing germ cells gives rise to several (5 to 8) rediæ, and each redia to a larger number of cercariae (12 to 20), while it has been calculated that each adult fluke may produce the enormous number of 45,000 eggs. But for this remarkable fertility there would be comparatively small chance of the entire life-cycle of the fluke parasite being completed.

Symptoms of Rot in Sheep.

In consequence of the extremely slow development of this disease, the fact that the sheep are affected is scarcely ever realized until a long time after they have become infected. The symptoms of the disease progress slowly and are characterised by a very gradual sequence of changes, which vary in accordance with the different stages of the disease, and with the health of the animal. In the primary stage, when the flukes are first developed in the bile ducts of the sheep, their presence causes such an amount of irritation to the liver as is sufficient to produce an increased secretion of bile, which in itself has a tendency to aid the digestive process, and as a consequence the animal may feed well and for a time put on flesh. Soon after, as the number of the flukes increases, the liver begins to enlarge, and the bile becomes slightly tinged with blood. At this period the animal falls off in condition and displays pallor of the eyes and the gums. The appetite, which was formerly very good, now becomes capricious, and the animal loses strength. As the disease advances the sheep becomes extremely emaciated and weak, dropsical swellings are to be found under the jaws, and the abdomen becomes greatly enlarged ; while the respiration is short. If a post-mortem examination be made at this stage the bile ducts within the

liver will be seen to be thickened, and their walls when dissected will frequently be found to be calcareous. The bile has a dirty brown colour and abounds with mature and immature flukes and multitudes of ova. The organ is paler, harder and smaller than normal, owing to the contraction of the new tissue. When the disease appears among a flock of ewes it is a very common thing for many to abort, and the mortality in a flock may be very high.

Should the sheep survive this stage, which is quite unusual, a period of convalescence sets in of a slow and generally of an unsatisfactory nature. During its progress the flukes leave the liver and pass out in the droppings, but the pathological changes which their long presence has caused within the liver produce emaciation and debility in the animal. The period of time during which these various changes are in progress may be roughly stated as twelve or more months, *i.e.*, from the time of invasion to the time of disappearance of the flukes.

Distribution of the Fluke.

As a general rule rot is confined to the lowlands, valleys and marshes (except salt marshes), but it may occur in the high lands. It is also more frequent in wet than in dry seasons, and is most prevalent after prolonged rains in the late summer and autumn. It is often associated with the presence of "carnation grass" and similar sedges, and many farmers look with suspicion on land that carries these plants.

From the preceding sketch of the life history of the fluke it will be evident that the conditions necessary for the propagation of the disease in any district are :—

1st. The presence of fluke eggs.
2nd. Wet marshy ground or pools suitable for the hatching of the ova.
3rd. The special snail (*Limnaea truncatula*) to act as intermediate host.
4th. The presence of sheep or other animals to swallow the encysted parasite and thus become infected.

Preventive and Remedial Measures.

1.—As sheep are usually attacked by fluke on wet land, drainage is the most important preventive, and should be resorted to whenever practicable.

2.—The mud, reeds, etc., taken from ditches, pools and ponds when these are being cleaned out, should at once be carted away, or covered up with gas lime. Numbers of the snails and their eggs, and often the parasites within them, are destroyed when gas lime is put over this rubbish.

3.—On a farm subject to fluke, sheep should always be kept on the drier pastures during the summer and autumn months. If no sound pasture is available the pastures should be divided into two sections, one of which should be grazed by sheep in spring but not in summer or autumn, while the other should carry sheep in summer and autumn but not in spring.

4.—When it is impossible to arrange for grazing the pastures in the way suggested in the last paragraph, sheep should be frequently moved to fresh ground, and the land should never be over-stocked.

5.—If infected animals have been pastured on a given piece of ground, it would be advisable to have the droppings spread by chain harrowing, to assist in drying them, and thus hasten the destruction of the eggs; a little lime would assist this.

6.—When practicable, dressing the ground in late summer and autumn with salt alone, or with a mixture of salt and lime, will usually be attended with good results. Sheep should also have access to lumps of rock salt, and where sheep are getting cake, corn, chaff, &c., a little salt (¼ oz. per head per day) mixed with such food should always be provided where fluke is to be feared.

7.—Those sheep which are affected with fluke should be sent to the butcher at once while in a marketable condition, and the others moved on to dry ground. The latter should receive a daily allowance of concentrated food, 4 lb. salt, and 1 lb. sulphate of iron being incorporated with each hundredweight of the feeding stuff.

8.—The livers of the slaughtered sheep should be destroyed, or, if used for dogs' food, they should first be well boiled, as otherwise the fresh eggs might pass uninjured through the intestines of the dog and thus infect the soil.

9.—If rabbits and hares are plentiful on infected ground, they should be kept down, as it is possible that they may spread the disease; there is no proof, however, that they do so.

10.—Sheep ought not to be purchased from a flock reared on fluky ground.

11.—Whenever rot is suspected in a flock of sheep, sharp observation over the animals will often enable the owner to detect the disease before it has made any serious interference with the health of the majority; and if on a post-mortem examination of the first suspected cases flukes are found in the bile ducts of the liver, it becomes an important question to the owner whether it would not be to his interest to slaughter the whole of them at once, while they are in a marketable condition, rather than allow the disease to continue, since by leaving the animals alive they will probably be the means of permanently infecting his pastures.

London, S.W.1,
July, 1903.
Revised, June, 1908.

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BOARD OF AGRICULTURE AND FISHERIES.

The Pith Moth.

Much damage may be caused to young apple, and it may be to other fruit trees, by the caterpillars of the Pith Moth, a small moth belonging to the group *Tineinæ*. The moths of the group *Tineinæ* have narrow wings bordered with long fringes, the fringing being most marked on the hind pair of wings.

The caterpillars of the Pith Moth burrow into terminal and other shoots, and buds, the fruit spurs especially suffering. Infested buds fail to develop, the leaves of tunnelled shoots flag, and the shoots wither and fall away (Fig. B). The caterpillars of another small moth, the Bud Moth, one of the *Tortricidæ*, are also troublesome on fruit trees, and their work is sometimes confused with that of the caterpillars of the Pith Moth. The Bud Moth caterpillars, however, spin the leaves together, making leaf-nests.

Description.

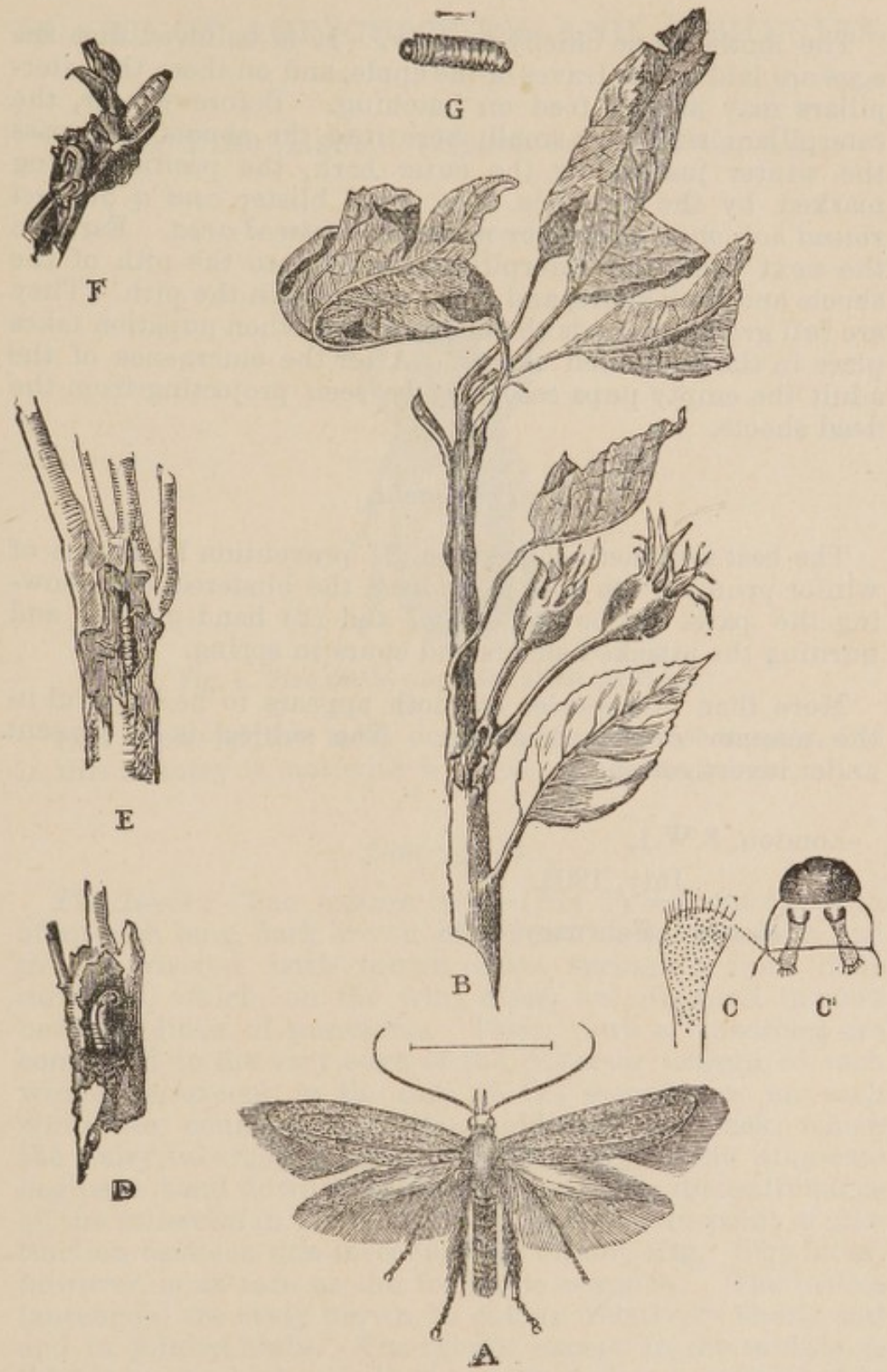
Moth.—The moth (Fig. A) varies in size and has a wing expanse of from $\frac{2}{5}$ to $\frac{3}{5}$ of an inch. The front wings are almost entirely black, or blackish, with white streaks and scales; the hind wings are grey and have long delicate fringes.

Larva.—The caterpillar (Fig. G) is dull reddish or flesh-brown, with the head, the first segment, and the last segment deep brown. Segments two and three show pale brown spots, while the abdominal segments have six brown bristle-bearing spots. The full-grown larva measures one-third of an inch.

Pupa.—The pupa (Fig. D) is of an ochreous hue; the head and front of the thorax and the tip of the body are mahogany red. It is cylindrical in form and measures about one-fourth of an inch long. On the under surface of the last segment but one are two blunt processes, separate and diverging outwards, and hairy at their tips (Fig. C); the eyes are black, and the wing cases and legs long, the former being pointed.

Distribution.

The distribution of the moth in our country may be given as from Lancashire southwards. Theobald has recorded it from Kent, Sussex, Surrey, Devonshire and Gloucestershire and Carpenter has recorded it from Donnybrook, Dublin.



THE PITH MOTH.

A Moth (magnified, line shewing natural size); B, attacked apple shoot, the upper portion shrivelling up and dying away; C, processes on pupa (magnified); D, pupa (magnified) in a shoot; E, larva (natural size) in a shoot; F and G, larvæ (magnified).

Life History.

The moths issue chiefly in July. It is believed that the eggs are laid on the leaves of the apple, and on these the caterpillars may at first feed on hatching. Before winter, the caterpillars, still very small, bore into the shoots, and pass the winter just below the outer bark, the position being marked by the presence of a small blister *and a distinct round hole opening into or near the blistered area.* Early in the next year, the caterpillars tunnel into the pith of the shoots and fruit spurs, and work upwards in the pith. They are full grown towards the end of June, when pupation takes place in the tunnelled shoots. After the emergence of the adult the empty pupa case may be seen projecting from the dead shoots.

Treatment.

The best treatment consists in (1) prevention by means of winter pruning, the hole in or near the blistered area showing the parts to be cut away; and (2) hand-picking and burning the attacked shoots and spurs in spring.

More than one species of moth appears to be harmful in the manner described above. The subject is at present under investigation.

London, S.W.1,
July, 1903.
Revised, February, 1908.

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BOARD OF AGRICULTURE AND FISHERIES.

The Pine Beetle (*Hylesinus piniperda*, L.).

Fig. 1. Pine beetle magnified about six times.*

This is one of the most destructive of forest insects, and in this country is met with wherever pines are grown.

Description.

The Beetle.—The mature beetle (Fig. 1) is about one-fifth of an inch long, dark brown or almost black in colour, and thinly covered with brown hairs springing from little tubercles, which, on the wing-cases, are disposed in rows between lines of punctures. These rows of tubercles are continued to the very edge of the posterior margin of each wing-case, except in the case of the second row on each wing-case, counting from the middle of the back, where the hairy tubercles cease at the point where the wing-case begins to bend down towards the apex. The discontinuance of the tubercles in these two rows is the main point of distinction between this insect and *H. minor*, Htg. The latter, however, is as rare as the former is common. The feelers (antennae) are rusty brown in colour, relatively short, and end in jointed clubs. The thorax, except in the middle, is thickly covered with shallow punctures, but not disposed in rows as on the wing-cases.

* The illustrations are reproduced, by permission, from *Trans. High. & Agric. Soc. of Scot.*

The Larvæ.—The larvæ are white, bent, and footless, with a brown head.

Life History.

The beetles pass the winter under a variety of cover, and take wing during sunny weather in March and April. They at once congregate for breeding purposes on the bark of pines that have died or that have been felled during the previous autumn or winter. Trees that have been dead longer than the period indicated are not attractive to the insects. All kinds of true pines, such as the Scots Pine, Black Austrian Pine, &c., are used for breeding purposes; and occasionally, though very rarely, the spruce, larch, and other conifers are also utilized. Trees or boughs of a size to carry thick rough bark are chiefly infested by the insect for purposes of breeding; but young trees, or branches with comparatively thin smooth bark, may be attacked. The

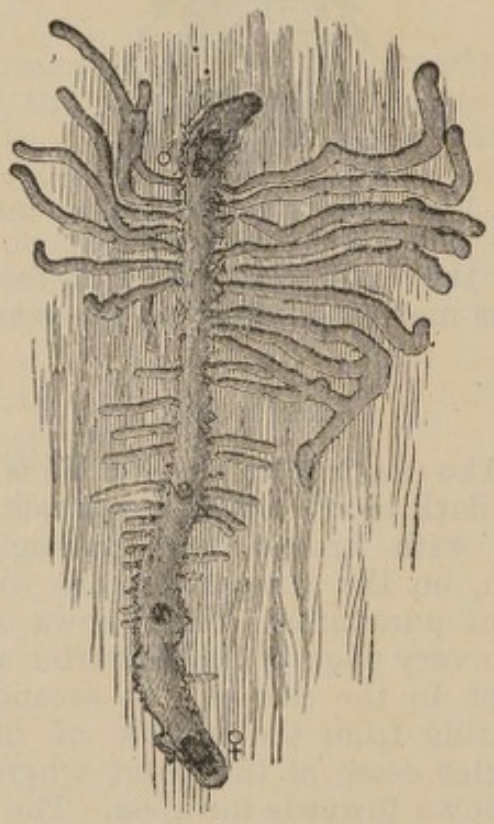

Fig. 2. Mother and larval galleries, showing two air-holes, natural size. The male keeps near the entrance, while the female carries on the work of excavation.

insects pair and proceed to bore into the bark, making a passage between the bark and the wood, the latter, however, being hardly broken. This passage has a slight bend at the starting-point, but afterwards is nearly straight (Fig. 2). It is usually about four inches long, and is generally supplied with one or more air-holes besides that by which the pair of insects entered. In making this gallery the dust is thrown

to the outside, where its presence quickly attracts the attention of an experienced observer.

As the gallery is proceeded with the female beetle lays eggs, depositing them alternately on either side, and laying in all about 100. On hatching from these the larvæ proceed to gnaw out tunnels, in the cambial region, at right angles to the mother-gallery. When full-fed the larvæ pupate at the end of their tunnels in a bed hollowed out in the bark; where the bark is thin the outermost wood may be excavated. The beetles, when ready, bite through the bark. As it often happens that a very large number of beetles breed in the same tree, the surface of the bark after the young beetles have emerged looks as though a charge of shot had been fired into it.

So far as dead or dying trees are concerned, the action of the insect up to this point is not of serious economic importance. So long as it can get such trees in which to breed, it will not attack healthy trees, but should suitable breeding material not be present it may make its breeding galleries in comparatively sound stems, which will soon be seriously crippled, or killed outright.

The young beetles appear in June and July, and they may do one or other of two things. They may fly off to other

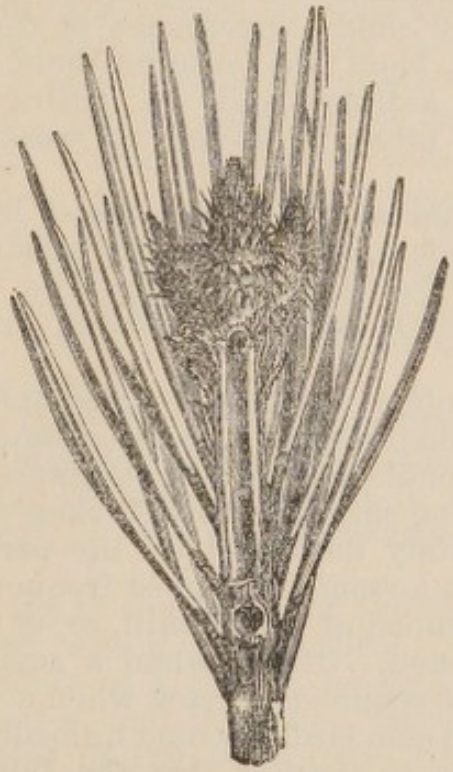

Fig. 3. Pine shoot with slice removed to show passage made by the beetle.

pine stems that have been felled or have been dead for a few months, in which case they pair and breed just like their parents, the earliest of the beetles of the next brood appearing in late September or October. In such an event there

is what is called a double generation, that is, two broods in a single season. But more frequently the young beetles that appear in summer do not breed in the year in which they are hatched. In this case they fly singly to the young shoots of the Scots or other pine, and into such shoots they bore, usually two inches or so beneath the terminal bud (Fig. 3). Having reached the pith the beetle bores upwards, but the passage thus made is only occupied for food or shelter, never for breeding, which is only performed underneath the bark of trees in the manner described above.

As a result of the leading shoot of a stem or branch being hollowed out in the centre it generally dies, or is broken off by the wind, and the trees become much deformed. They lose a considerable quantity of their foliage, and the yield of cones may also suffer to a serious extent, a matter of importance in natural regeneration. It is to this action of the beetle that the chief sylvicultural damage is due. Trees so affected become characteristically mis-shapen, and are easily recognised, even at a long distance. Underneath infested trees, especially after a high wind in autumn, the ground will often be found thickly strewn with the tips of shoots, each with a cavity in the centre, and not infrequently containing the beetle. On young, vigorous trees, especially in a sheltered situation, the shoots do not so frequently break off, but the sickly appearance of the leaves, and an outflow of resin from the entrance-hole, readily attract attention to the damage, and on cutting the shoot open the beetle will often be found at work in the central gallery.

The result of the action of the insect in destroying the ends of the branches, and frequently causing them to drop off, has earned for it in Germany the name of Wood Gardener or Tree-pruner, a designation first suggested by Linnæus.

Young trees, though severely crippled and reduced to the condition of mis-shapen bushes, are not often actually killed by the pine beetle; but old trees, whose shoots are more exposed to the wind, and being thin, are easily broken off when injured, are often completely destroyed by the persistent attack of this insect. Such a result will most frequently be observed in the neighbourhood of a saw mill, or of any place where pine logs are stored. Often, when a small proportion of standard pines are retained to grow when a wood is felled, it is found that such standards become unhealthy and soon die. This result is due to the fact that the felling of the wood has provided the insects with abundant opportunities for propagation (stumps, stools, stems, &c.), and from these in the month of June the standard trees are invaded by swarms of beetles. If the change that is induced in the appearance of their crowns be observed, the appropriateness of the name Tree-pruner will be at once apparent.

Preventive Measures.

Widespread and destructive as this insect is under irrational methods of forestry, it is by no means difficult to combat. This is secured either by preventing its getting suitable material in which to breed, or by providing it with such material, but taking care that the young beetles are destroyed before they have escaped from the places where they are bred.

Most trees are felled in autumn and winter, and to leave pines lying in their bark in or near woods till the middle of the following summer is a sure way to propagate this and many other destructive forest insects. There need be no fear of the pine beetle breeding in stems from which the bark has been removed, but the barking of winter-felled pines is a somewhat expensive proceeding. The removal of the trees, or their conversion before the month of June, should always be attended to, but the ideal method of procedure is as follows. The trees felled in autumn or winter should be allowed to remain in or near the wood till the month of May, by which time they will have attracted most of the pine beetles in the neighbourhood. By the end of May all such trees should be barked, and as the stems will then be thickly beset with larvæ, the bark can be removed quite easily. In delaying the process of barking till May the logs are not only rendered unfit to serve as future breeding places, but, what is most important, they are utilized as lures or traps, to which a large proportion of the beetles in the neighbourhood are attracted, and in which they are subsequently destroyed. On no account, however, must barking be delayed beyond the end of May. The bark removed may be deposited so that its inner surface, where the larvæ and pupæ are found, is freely exposed to the sun and birds, and if this is attended to there is small chance of any of the young insects escaping. It is, however, always safer to burn the bark which has been stripped off. When the bark is very thick there is a likelihood of the immature insects completing their development in the bark after it is stripped off, and, in such a case, burning should always be undertaken.

All pines that die in the course of the summer should be felled and barked within two months. It should be remembered that there is a certain irregularity in the issue of the adult beetles, and it would therefore be wise to arrange for a series of trap-trees from April onwards, two months always being allowed before barking.

Small brushwood does not offer satisfactory breeding facilities for this insect, but it may serve the purpose for others, so that it is well to destroy it. Large branches, however, should be treated as recommended for stems. The Pine Beetle will also breed in the part of the stools above

ground, and in the month of May the bark of stools should be pressed off by means of a spade or other suitable tool, and, being generally thick, should be burned.

Two beetles, *Clerus formicarius* and *Rhizophagus depressus*, attack and destroy *Hylesinus piniperda*.

London, S.W.1,
July, 1903.
Revised, June, 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.

BOARD OF AGRICULTURE AND FISHERIES.

Bunt and Smut in Wheat.

Wheat is attacked by two forms of Smut diseases, and as the treatment for the two is very different it is important that farmers should be quite clear as to the distinction between them. By far the most important is that known as Bunt, Stinking Smut or Slayne. The other is that termed Loose Smut, which, though widely spread, is not nearly so prevalent as Bunt. The diseases are described in detail below, and illustrations are given which will aid those not familiar with them to differentiate between the two.

Bunt or Stinking Smut.

Description of Disease.—In Bunt the ear possesses an almost normal appearance, and the grains swell up and differ little in appearance from those which are healthy. When broken, however, they are found to contain a mass of black powder, which consists of fungus spores. The fungus causing the disease is named *Tilletia tritici*.

Although affected plants for a long time show no unusual features, a trained eye will, a few weeks before harvest, detect them by their uprightness and deep-blue green ears. At harvest time the chaffy scales of the ear also spread out rather more than in a healthy plant. (*See* Fig. 1, *a* and *b*.) The affected grains are usually shorter and plumper than normal grains and of a browner colour. On breaking open it is seen that they consist merely of a shell full of black spores. The spores, which, as may be imagined from the fineness of the black powder, are exceedingly minute, are the reproductive bodies of the fungus, and it is they which, by adhering to the seed grain or falling down to the ground, bring about infection. The spores possess a more or less fishy smell, and hence the name "Stinking Smut."

Spread of the Disease.—When the crop is threshed many of the bunted grains burst, the spores are liberated in clouds, and the healthy grains become coated with them. Winnowing, though it is sufficient to remove bunted grains and broken fragments, does not free the grain from spores. If these spores are present in abundance the tips and grooves of the sound grain are blackened ; if they are

For a full account of these diseases, see article by W. B. Mercer, B.Sc., in *Jour. Bd. Agric.*, Vol. XXIII., No. 7, October, 1916, pp. 633-643, from which much of the subject matter and the illustrations of this leaflet are taken.

few in number no discoloration results, and the sample appears to be bunt free. Nevertheless, almost every

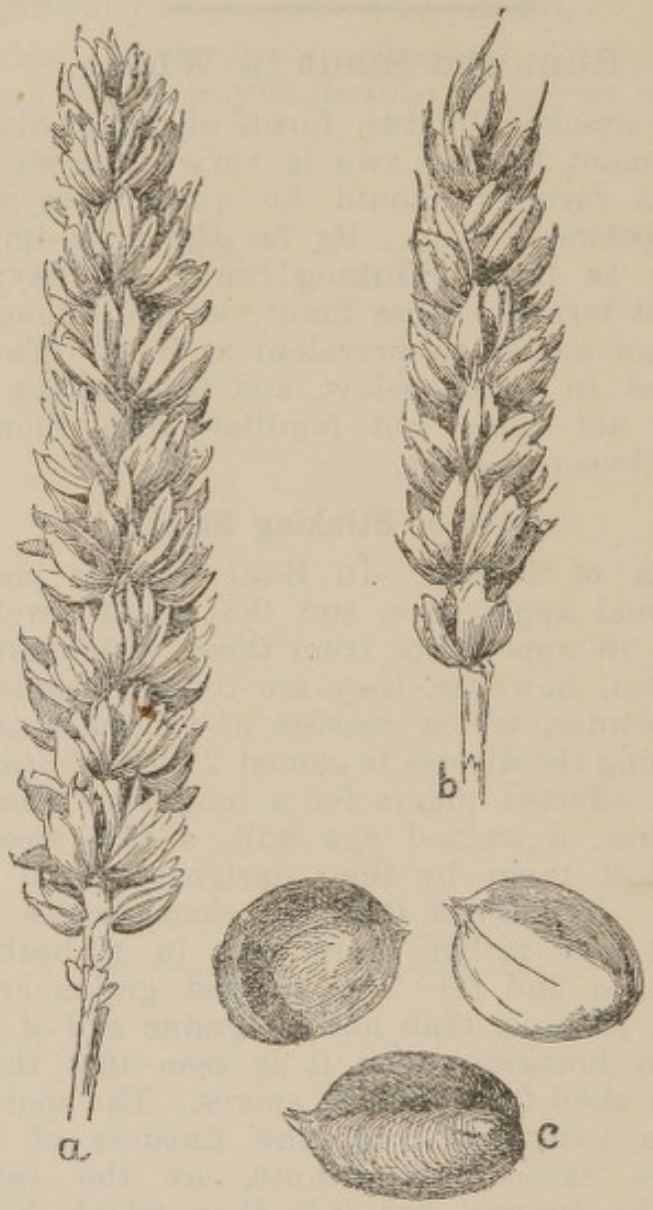

FIG. 1.—Bunt.

a and *b*. Bunted ears.

c. Bunted grain, containing black mass of Bunt spores (magnified about four times).

grain of it may carry a few spores, and it is certain that a very considerable proportion will, when sown, give rise to bunted plants.

Bunt is also spread by the thresher. A machine which has been used for a bunted crop becomes contaminated with spores, and serves to infect grain which subsequently passes through. Sacks in which bunted grain is stored become contaminated in the same way, and, as the spores retain their vitality two or three years, infect healthy seed subsequently put into them.

It is most important, therefore, to remember that unless it is perfectly certain that the crop from which the seed

is saved was quite free from Bunt, and that it has not been subsequently contaminated, all wheat seed should be dressed by one or other of the methods described below.

Method of Infection.—The manner in which the wheat plant is infected was formerly a much debated point, but it is now known that the plant is attacked by the fungus when quite young and that infection takes place in the soil. The spores introduced with the seed or already present in the soil germinate, and after a time other spores are produced which infect the young plant.

This can only take place when the wheat is in the seedling stage, generally before the shoot is ½ in. long. It will thus be evident that spores present on the grain when it is sown are very favourably situated for securing infection. On entering the plant the germ tube of the fungus bores its way into the young shoot, and the resulting mycelium (or fungus filaments) makes its way to the growing apex. The fungus grows with the plant, always maintaining itself at the apex, and when the ear is formed pushes its way into the young grain. As food passes up into the ear for the growth of the grain, the parasite seizes upon it, destroys the tissues, and eventually produces a solid mass of black spores in the grain.

Control.—The only method of ensuring freedem from Bunt lies in treatment of the seed corn with a fungicide, whether it appears bunted or not. This process is termed "pickling." Of the many substances which have been tried for pickling wheat as a preventive for Bunt, copper sulphate and formaldehyde (generally known as formalin) are the only two which have been tried on a large scale and found reliable.

Several proprietary substances, whose advertised good qualities include amongst other things the suppression of Bunt, are on the market. In the absence of experimental evidence it is impossible to generalise on their real worth, but in many cases experience has proved that they are of no value as a preventive of this disease. This much, at any rate, may be said : that no substance has yet been discovered which affords protection against both birds and Bunt, and where damage from birds is anticipated it is necessary to dress the seed twice—first with copper sulphate or formaldehyde to destroy Bunt spores, and then with whatever preparation is effective against birds.

Treatment with Copper Sulphate.—Copper sulphate is sold either as crystals or in the powdered form. The latter is preferable, as it dissolves more easily. It is of great importance that only pure copper sulphate should be used, and a guarantee of 98 per cent. purity should be

obtained. The most convenient method of application is to spread out the grain on a barn floor and water it with a solution made by dissolving 1 lb. of copper sulphate in 10 gallons of water. Iron or zinc vessels must not be used for this purpose. After shovelling over the heap till all the grains are thoroughly moistened, it may be spread out and allowed to dry. One gallon of solution is sufficient to treat 4 bushels of seed. Another method is to pour the seed into a vessel containing the solution and allow it to steep for 1 or 2 hours. This method has the advantage that bunted grains may be skimmed off when they rise to the surface.

Copper sulphate retards the germination of the grain, and a solution of the above strength will generally be found to lower somewhat the total germination capacity. Probably a solution of half the strength would be equally effective, but in the absence of experimental evidence on the point it is safer to use the stronger solution.

Treatment with Formaldehyde.—This substance, which is commonly sold in the form of formalin, is at the present time difficult to obtain, but when procurable its use is to be recommended. Formalin (a 40 per cent. solution of formaldehyde) should be used at the rate of 1 pint per 20 gallons of water.* For pickling small quantities of wheat, care is necessary in obtaining the right strength, as if the solution is too strong the grain will be damaged. The pickling solution should be thoroughly stirred before using, and should be applied to the grain in the same manner as copper sulphate.

If spore-containing grains are present in the corn, it is advisable to remove as many of them as possible by means of the winnower before "pickling."

Loose Smut.

The appearance of plants attacked by Loose Smut is totally unlike that of those affected with Bunt. The disease is first noticeable when the crop "shoots," *i.e.*, when the ear emerges from the leaf-sheath. It will then be noted that the ears are abnormally developed, and that they soon become coated with a black sooty mass of spores (Fig. 2, *a* and *b*). In contrast to Bunt, where the fungus spores remain enclosed in the ear, the spores are liberated and blown away with the wind, and hence, after a time, only a bare stalk remains. (*See* Fig. 2, *c*.)

* One pint formalin to 20 galls. water is one part formalin to 160 parts water. Two tablespoonfuls, measured in a medicine glass, are one-twentieth of a pint or one-160th of a gallon. So smaller quantities may be mixed at the rate of two tablespoonfuls of formalin to one gallon of water.

The fungus causing Loose Smut is named *Ustilago tritici*, and its method of attacking the wheat plant is

FIG. 2.—Loose Smut of Wheat.

through the flower. The Smut fungus requires a full year to complete its life-cycle. Introduced into the flower, the spores germinate and infect the young grain whilst it is still small and green. The development of the grain is not hindered by this infection, but it continues to grow and generally reaches normal size. Sometimes infected grains are small and shrivelled, but as a rule they cannot be distinguished from those that are perfectly healthy. But when these infected grains are sown next season the fungus grows with them ; it is not until the ear commences to form that the mass of black spores is produced. The spores are at first held together by a silvery skin, but this is soon ruptured and the black sooty spores escape.

Control.—It will be obvious, from the methods of infection just described, that pickling of the grain is of no value in preventing an attack of Loose Smut. The

fungus is already within the grain, and no treatment with chemicals will affect it. The only treatment which will kill the fungus is the application of heat. Various methods of applying heat have been devised, but in this country the only one likely to prove useful is dipping in hot water.

It may, however, be mentioned that the proportion of grains which become infected in the field is not great, and the disease does not appear to be seriously spread by wind. Hence, if the seed is saved from clean fields there should be little trouble from Loose Smut. When Smut, however, has been troublesome, or where seed has been saved from smutted fields, it should receive treatment.

The hot-water treatment is carried out as follows :— The grain to be treated is put into sacks and allowed to stand in cold water for 4 hours. The sacks are then lifted out and placed for ten minutes in a tank of water kept at from 52° to 54° C. (125° to 129° F.),* being repeatedly heaved up and down in the water to remove bubbles of air from around the grains. The grain is then removed and spread out to dry. This operation can be performed on any farm where there is a boiler. It has been carried out so extensively in the co-operative dairies in Denmark that the disease is now said to be practically exterminated. It appears to be practised largely in Holland also, and it is, undoubtedly, the method most suitable for use in this country. A loss of 10–20 per cent. in the germination capacity of the grain must be allowed for.

Hot-water treatment without previous soaking is not nearly so effective. The explanation of this is apparently due to the fact that the fungus in dry grain is in a dormant state, but after a few hours' soaking is "awakened" and brought into a condition in which it is more susceptible to outside influences.

London, S.W.1,
July, 1903.
Re-written, December, 1918.

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* Most English thermometers give the degrees according to Fahrenheit scale, generally referred to as F. To keep the water at the required temperature a bucket of cold water and a bucket of hot water should be kept handy, and cold or hot water added to lower or increase the heat in the tank till the thermometer shows that it is right.

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BOARD OF AGRICULTURE AND FISHERIES.

Farmyard Manure.

The substance that goes by the name of farmyard manure, fold manure, dung, or muck, chiefly consists of (*a*) the material that was used as litter, usually straw, sometimes peat, bracken, sawdust, &c.; (*b*) the food that passed through the animals in an undigested condition and has been voided in the solid form; and (*c*) the urine, which contains that part of the food which the animals digested but did not retain in their system. The urine also contains in part the waste of the tissues of the animal's body. The proportions of these parts will vary with circumstances. For instance, when it is the object of the farmer to use up as much straw as possible, a relatively large amount of the farmyard manure will consist of litter, but where litter is used more sparingly, the manure will contain a proportionately greater amount of the solid and liquid excreta.

Manure Produced by Stock.

A bullock or cow weighing 9 cwt. will produce, when kept under cover, about 7 tons of farmyard manure during the winter six months; if the stock consists, as it generally does, of a fair proportion of younger animals, the output may only average 3 or 4 tons. On a farm with a mixed stock of 50 head, including 3 or 4 horses, enough dung should be produced during winter to give a dressing of 10 or 12 tons per acre to about 15–20 acres of land, or 3–4 acres less when allowance is made for loss during storage.

Principal Constituents of Farmyard Manure.

From the manurial point of view the three substances that are of most importance in the food are nitrogen, phosphate and potash. Although only one-half of the solid matter in the food reappears in the manure, about three-quarters of the nitrogen, and nine-tenths of the phosphate and potash, are voided. These proportions will be reduced in the case of very young animals, and increased in the case of full-grown fattening cattle. Of the nitrogen that passes through an animal a larger proportion finds its way out in the urine than in the solid excreta. The same is true of the potash, whereas the phosphate is chiefly voided in the dung. It will thus be seen that two of the three valuable elements of plant-food are more abundant in the liquids than in the

solids of animal excreta, and not only so but, pound for pound, the substances in the liquids are much more valuable for crops because they are much more readily available. The Rothamsted experiments have shown that a considerable portion of the nitrogen in the solid part of dung can hardly be said to be of any use to plants, whereas the nitrogen of the liquid portion is almost as active and therefore almost as valuable as the nitrogen in nitrate of soda or sulphate of ammonia.

In a ton of ordinary farmyard manure there is as much nitrogen, phosphate, and potash as in twelve or fifteen shillings' worth of artificial manure, and if a ton of dung is not usually valued at even half these figures this is chiefly because a large part of the three substances mentioned never becomes available, or is lost before crops can make use of it. True, a ton of farmyard manure is more expensive to handle than 2 or 3 cwt. of artificials, and this, of course, reduces its relative value; but, on the other hand, farmyard manure has a beneficial though indirect influence on crops for the very reason that it is a heavy bulky substance, and the two considerations may therefore be held roughly to balance or to cancel each other.

Variation in the Quality and Character of Dung.

The quality and general character of dung is affected by :—

1. *The Kind of Food.*—Generally speaking, the richer a food is in fertilising materials, especially nitrogen, the richer is the dung produced, particularly the liquid portion. It may be added that the extra value of "cake-fed" manure is chiefly due to the greater amount of available plant-food, and as this is the part most easily lost, it is particularly important to exercise the greatest possible care in storing such manure.

2. *The Kind of Animal.*—Horses produce dry, "hot" dung that ferments and acts quickly, whereas the dung of cattle and pigs is "cold," slow-acting, and more durable. The dung of young stores and dairy cows is rather poor in all the important elements of plant-food, because, in the former case, these elements have gone, to a relatively large extent, to form bone and muscle, while in the latter case they have found their way into the milk. For instance, to quote the Rothamsted figures, while the excreta of a fattening bullock getting decorticated cotton cake will contain about 97 per cent. of the nitrogen, 96 per cent. of the phosphoric acid, and 99 per cent. of the potash present in the cake, the corresponding figures for a milk cow are only 87 per cent. for the nitrogen, 89 per cent. for the phosphoric acid, and 86 per cent. for the potash. This means that for every 3 lb. of nitrogen, 4 lb. of phosphoric acid, and 1 lb. of potash that the fattening bullock abstracts, the milk cow appropriates 13 lb., 11 lb., and 14 lb. respectively.

3. *The Age of Dung.*—Rotten dung is richer and more active, provided it has been properly "made," than comparatively fresh undecomposed material. It is, however, necessary to remember that in ordinary practice manure cannot be rotted or stored without serious loss taking place, and while well-rotted manure may contain more plant-food than an equal weight of fresh manure, a given quantity of fresh manure will contain more plant-food than will the rotten manure made from it.

4. *The Manner of Storage.*—Under any ordinary conditions of storage, farmyard manure suffers loss of nitrogen; with bad management the loss may be very great indeed, and fall on the potash as well as the nitrogen.

5. *The Nature of the Litter.*—Farmyard manure varies considerably in composition according to the character of the material used as a litter for the animals. Common litters which are employed are straw, peat moss litter, bracken, hop bine, leaves, spent tan, and sawdust, and these differ in their power of absorbing the valuable liquid portions of the manure, whilst they also vary in their own composition.

Storage of Dung in the Homestead.

Even when it is stored under the best conditions, farmyard manure loses a good deal of its most valuable plant-food; under bad conditions the loss may be very great indeed, and it is necessary to remember that the loss falls first on the most available material, and is proportionately much greater in the case of good "cake-fed" manure than in material of lower quality. With the general rise in the price both of manures and feeding stuffs, it will pay farmers to give much more attention to the prevention of this waste than was generally done before the war. The chief causes of loss are:—

(1.) Escape of the liquid manure. It is generally recognised that the liquid manure is valuable, but it is seldom realised how much more of the manure value of a concentrated food lies in the liquid than in the solid excreta. Of the manure values of ordinary cakes, from 80 per cent. to 90 per cent. is associated with the urine, and only 20 per cent. to 10 per cent. with the solid dung.

(2.) Escape of ammonia as a result of fermentation, particularly where the manure is exposed to air and allowed to become rather dry, under which conditions loss is very great.

The methods of preventing these losses will naturally depend on the conditions under which the stock is kept, but in every case the aim should be to get the manure into the soil at the earliest possible opportunity. Even if it is applied to light dry land in autumn, the loss in the soil will be less than with any system of storage. Furthermore, it is important to remember that every time the manure is turned over or disturbed in any way, fermentation is encouraged by the exposure to the air, and serious loss of nitrogen must follow.

With cattle fattened in covered yards the question is comparatively simple. For the comfort of the animals sufficient bedding must be used to absorb the liquid manure, and there is little or no drainage. The dung is kept well compressed by the animals and fermentation is reduced to a minimum. Under such conditions very little loss takes place.

With cattle kept in open yards the case is entirely different ; it is quite impracticable to use sufficient straw to absorb both the liquid manure and the rain falling into the yard, with the result that drainage must be provided for. Owing to the large bulk of the liquid and its dilute condition it is usually impossible or unprofitable to collect it in tanks or to cart it on to the land. If, therefore, the liquid cannot be dealt with by some system of direct irrigation, the only advice that can be offered is that the yard, or at least the greater part of it, should be covered. The cost will be recouped in a very few years in the increased value of the manure (even if the better fattening results are not taken into account).

In the case of dairy cows or other cattle tied up in stalls, the question of dealing with the manure is simpler. The liquid manure is practically pure urine, comparatively small in volume and highly valuable, so that it pays well to collect it in a tank and cart it out to grass (to be mown for hay) and other crops. If applied in dry weather direct to grass a certain amount of "burning" of the foliage will be caused, and it should therefore be either diluted with water or applied during showery weather when the ground is in a thoroughly moist condition. The solid manure as a rule contains very little litter, it ferments very slowly and little loss takes place provided that it is made into a compact heap and the drainings are collected.

The manure from other classes of animals, particularly horses, is very liable to suffer loss by fermentation, and special care should be taken to prevent this. Where cattle are kept in yards the manure from the stables should be carried into the yards and be well distributed. This will reduce the amount of litter required by the cattle and

prevent fermentation of the horse manure. If all the cattle on the farm are tied up in stalls, the horse and pig manure should be well mixed with the cattle manure and made into as compact a heap as possible.

Provision of Shelter.—Experiments carried out at Rothamsted show that exposure of the manure heap to rain causes considerable loss of crop-producing power, even more than is indicated by analysis, or by the value of black liquid that drains away. Even a slight shelter, such as a layer of earth, proved beneficial, and if nothing better can be done, the heap can be finished off with a sloping top so that the rain is thrown off instead of washing in.

Conservation Agents.

Attention has been directed from time to time to the prevention of loss in manure heaps through adding gypsum, superphosphate of lime, kainit, or sulphuric acid, but though good results have occasionally followed their use, it is now recognised that all are open to objection, and they are not recommended.

Moss litter or peat as a fixer of ammonia and absorbent of liquids is more efficient than straw, and, if for no other reason than to improve the manure heap, it is a good plan to have a little in use for some of the live-stock. Such peaty manure, unless it is being used in a yard, should be spread daily in the dungstead, and the quality of the resulting mass will be thereby appreciably improved.

Treatment of Dung in the Field.

Field Storage Heaps.—To save carting in spring, or to empty the dungstead or the yards, it is often necessary, in the course of the winter, to form large field storage heaps. The opportunities for loss in such heaps are much greater than in a proper dungstead, so that field heaps should only be formed if they are the means of gaining an important end. Where these heaps must be formed they should be placed on firm, level ground, and they should be made as deep and firm as possible. The so-called "draw heaps," on to which each cart-load is drawn, thereby consolidating the mass, are the best. Subsequently the sides should be trimmed up, and the top should be covered with a layer of soil about a foot thick. Such a covering consolidates the mass, prevents to some extent the passing of ammonia into the air, and runs off rain water, especially if the top be made somewhat roof-shaped.

Uniform Distribution.—When dung comes to be spread on the land, it should be distributed as equally as possible. Sometimes, unfortunately, one sees great lack of care in this respect. In some districts dung is roughly distributed straight from the cart, and if it is at once properly spread by hand labour the results are satisfactory. In other districts, and more frequently, it is unloaded in small heaps about six yards apart. If it is immediately spread this system is usually free from objection, though if the dung is very old, or if it is largely made from moss litter, the spots on which the heaps rest are apt to be left over-manured, and this is especially the case on rough meadows. Too often, however, one sees these small heaps lying unspread for days, and even for weeks, with the result that the rain washes the substance of the dung into the patches on which the heaps rest. These patches are consequently over-manured, as compared with the rest of the field, and an uneven crop is the result.

With farmyard manure, even more than with artificials the farmer should so arrange matters that the quantity of dung at his disposal is distributed over as large an area as is consistent with practical convenience. For instance, twenty tons of dung spread equally on two acres will give a much better return than the same quantity spread on one acre.

Best Time to apply Dung.—As regards the time of year at which dung should be applied, much depends on the circumstances of each particular case. On farms entirely under grass there is no choice but to use the dung on meadows or pastures, and on such farms it would be bad practice not to cart out all available dung as opportunity occurs in autumn, winter and early spring. Late spring dressings, unless the dung is very "short"—*e.g.*, dung made with moss litter—interfere with the work of the mowing-machine and mix with the hay, though this can be avoided by chain harrowing and raking the roughness off some time after dressing.

In the case of green crops, part of the dung may with advantage be ploughed in during autumn, but only on clean land. If foul land, and especially foul strong land, has to be cleaned in spring it will be found that autumn dung, by holding moisture, retards the getting of the land into condition in spring. Autumn manuring would further increase the work of cleaning foul land by promoting the growth of weeds. Again, the action of the cultivator brings much of the dung to the surface, and this, being collected with the weeds, is carted off the land, or possibly wasted by burning. Farmyard manure ploughed in during autumn will decay more rapidly—especially in a mild winter—than if left in the dung-heap, so that a relatively larger proportion will be available for the use of the first crop. On this

account the succeeding crops will not get so much benefit, and this fact has to be borne in mind in estimating the respective advantages of autumn and spring dressings.

Experiments on the proper time to apply farmyard manure have been made at several centres. In districts of high rainfall the best results have been obtained by applying in spring. In the West of Scotland twice as great an increase was obtained from spring dressings as from autumn. On the other hand in drier conditions—30 inches or less of rain—the winter dressings have given the best results, besides being often more convenient for the general working of the farm.

Comparative Value of Cake-fed and Ordinary Dung.

Experiments which have been carried out at Rothamsted and at the Norfolk Agricultural Station, during recent years, indicate that it is questionable if the practice of feeding large quantities of cake with a view to the production of rich manure is a profitable one. These experiments showed that, compared with the dung obtained by feeding roots and hay, the superiority of cake-fed dung, which lies chiefly in its greater richness in soluble nitrogen, is practically confined to the year of application. The second year benefits slightly, but no advantage is obtained in the third and fourth years. In adding to the humus content and improving the texture of the soil the ordinary dung is in no way inferior.

Further experiments on this subject are required, but, so far as the evidence goes, it would seem desirable, at any rate on light arable soils where dung is so very necessary, to feed smaller amounts of cake than are usual, and to supplement the dung from less concentrated feeding by the direct use of a nitrogenous fertiliser, which could be applied to whichever crop in the rotation would derive the greatest benefit, instead of employing feeding stuffs as a means of enriching the manure. This advice was sound even under pre-war conditions; at the present time, when the greatest economy in the use of feeding stuffs is essential, only the lowest quantity necessary to get the stock into the desired condition should be employed.

Scarcity of Potash Manures.

It has already been pointed out that potash is present in greater quantity and in more available form in the liquid than in the solid portion of the manure. In view, therefore, of the scarcity of potash supplies, the time seems specially opportune for taking measures to avoid wastage of

urine. It may be applied, after dilution, to the land direct, or, if this is inconvenient or impossible, it may be soaked up in some absorbent material such as good soil or turf mixed with peat moss litter. Fermentation will ensue, and the manurial value of the compost will be enhanced by the formation of appreciable quantities of saltpetre, a most valuable manure containing large percentages of readily available potash and nitrogen. It may be pointed out that one ton of farmyard manure and one ton of cow urine, each contain about as much potash as one cwt. of kainit.

London, S.W.1.
August, 1903.
Revised, December, 1917.

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BOARD OF AGRICULTURE AND FISHERIES.

Millepedes and Centipedes.

Millepedes and centipedes belong to the group of the animal kingdom known as *Myriapoda*. They are closely allied to insects (*Insecta*) but differ from them in many characters, among which the most obvious is the possession of one or two pairs of legs to almost every segment. In general appearance the more common forms are quite distinct from all other land animals occurring in this country. Owing, however, to the fact that they are sometimes referred to as "wireworms," confusion often arises between them and the true wireworms, which are the larvæ of various click beetles (*see* Leaflet No. 10, *Wireworms*). The possession of more than three pairs of legs will at once distinguish the millepede or centipede from the click beetle larva, to which the term wireworm should be confined.

Millepedes and centipedes are somewhat alike in general form, and since millepedes are distinctly injurious, while centipedes are on the whole beneficial, it is necessary to distinguish clearly between them. The following points will serve for this purpose. Millepedes have *two* pairs of legs to each segment of the body, which, with the exception of the genus *Polydesmus*, is rounded or cylindrical in form. Centipedes have only *one* pair of legs to each segment of the body, which is somewhat flattened. In addition millepedes are rather sluggish in habit and when disturbed coil themselves up like a watch spring, while centipedes are active and usually escape by running as soon as they are discovered.

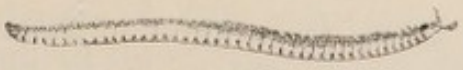

FIG. 1.

FIG. 2.

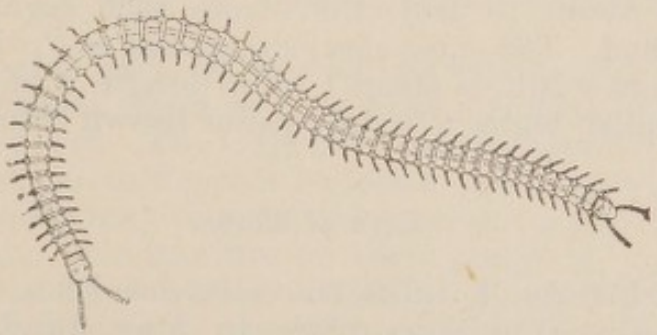

FIG. 3.

Figs. 1 and 2, Millepedes (1, *Julus pulchellus* × 3 ; 2, *Polydesmus complanatus* × 1¾); Fig. 3, Centipede (*Geophilus subterraneus*, magnified).

Centipedes.

As centipedes are not injurious to plants they may be dealt with briefly. The common genera in Britain are *Lithobius* and *Geophilus*. The former is rather large and stout, of a uniform brown colour, and is often to be found under stones and logs of wood. *Geophilus* differs from *Lithobius* in being long and slender; it is sometimes found under stones, but is more common in leaf mould and in the surface layers of the soil. Centipedes are carnivorous and feed mainly on small slugs, snails and insects.

Mention should, perhaps, be made of the fact that some centipedes, notably *Geophilus electricus*, are at times phosphorescent and yield quite a bright light. Little is known of the origin of this phosphorescence, but it appears to be derived from some material on the surface of the animal, which may leave a glowing track as it passes along.

Millepedes.

Millepedes of several genera are found in Britain, but for practical purposes it will suffice to notice two of these—*Julus* and *Polydesmus*.

Julus comprises those forms with a smooth cylindrical body of 30 or more segments. The most injurious species is *Julus pulchellus* (sometimes known as *Blanjulus pulchellus*). It is a small, slender millepede, about ½ in. in length when full grown; in colour it is yellowish, with a row of crimson or purple spots along each side, a character by which it may always be recognised. A second common species is *J. terrestris*, a larger millepede of a leaden black colour with whitish legs.

The species of *Polydesmus* differ from those of *Julus* in having only 20 segments to the body and in being rather broad and flat. The sides of the body are not smooth as in *Julus* but, owing to projections from each segment, appear to be notched. The most common species is *P. complanatus*, which, when adult, is about 1 in. in length, and varies from a pale purplish white to a dull red or brown colour.

Life History.

The life history of *Julus terrestris* has been described as follows:—Breeding takes place in May, June, and July. The female, when about to lay eggs, burrows down into the soil and forms a kind of nest from grains of earth glued together with saliva. The nest is like a hollow sphere

smooth inside but rough externally, and until the eggs are laid a small hole is left at the top. From 60–100 eggs are placed inside the nest, and the opening is then blocked up. The eggs hatch in about 14 days. The young millepedes at first have only three pairs of legs, the others appearing in groups by degrees. Growth in a millepede takes place by lengthening at the hinder end, the increase occurring between the last segment and the one before it.

Plants attacked.

The food of millepedes is almost entirely of a vegetable nature. Roots, bulbs and tubers of all kinds are attacked, and, when the animals are numerous the resulting damage may be considerable. There is nothing very distinctive in the form of injury produced, and the best method of diagnosis is the discovery of the millepedes themselves. In the case of *J. pulchellus* the millepedes may often be found in a cavity in the root or tuber, which is gradually eaten away; occasionally, however, they seem to attack the cuticle of the root only, and where the injury takes this form in potatoes a type of scab is produced which closely resembles "common scab." (*See* Leaflet No. 137, *Varieties of Scab in Potatoes.*) In the case of an attack by the larger species an examination of the soil near the injured plant, or of any rubbish close by, will usually show which species is responsible. It should be noted, however, that in all cases of attack a certain amount of decay is produced which attracts other enemies, and the identity of the original offender may be thus obscured.

Preventive and Remedial Measures.

1. In many cases of damage by millepedes which have been brought to the notice of the Board, there is also evidence of bad cultivation; where high cultivation is practised there is much less likelihood of a serious attack.

2. Care should be exercised in the use of fresh leaf mould and decaying vegetable matter, which frequently contain these pests.

3. Millepedes may be trapped by placing just under the ground mangolds, beets, or turnips the interior of which has been scooped out. The traps must be examined at frequent intervals and the millepedes collected and destroyed.

4. Millepedes may be poisoned by soaking pieces of potato, mangold, &c., in a mixture of Paris green in water (1 oz. Paris green in 1 gal. water). The bait should be placed near the attacked plants and covered with boards, stones, or large leaves to prevent them becoming very dry. It should be noted that baits so treated are poisonous to man and animals as well as millepedes.

5. There are various soil insecticides on the market which may be worked into infested land. If powdered naphthalene is available, it is worthy of trial and may be used at the rate of 1–2 oz. per square yard. Its effects appear to be greater if the soil is watered after the application.

6. Lime, distributed broadcast and dug in, and soot, or soot and water, have been found to be partial remedies.

London, S.W.1,
October, 1903.
Revised, July, 1917.

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BOARD OF AGRICULTURE AND FISHERIES.

Ringworm in Cattle.

Ringworm is a disease which may attack any of our domesticated animals, but is most frequently seen on cattle. It is also transmissible to human beings.

It is decidedly more prevalent on young animals such as calves and yearlings, and on stock that are in poor condition.

The disease is due to a variety of fungi of which *Trichophyton tonsurans* is one. It establishes itself at the base of the hair, which in consequence becomes brittle and breaks off. The irritation due to the fungus also causes the epidermis of the skin to become thickened and wrinkled in old cases. Bare, gray, scaly patches, two inches or more in diameter, appear upon the affected animal, especially on its head and neck, though also on other parts of its body.

As has been indicated, animals at pasture and lean are most apt to be attacked.

The disease is usually not difficult to cure, the substances employed for this purpose being very varied. In order to enable any substance employed to get thoroughly into contact with the fungus, the part attacked should first be well washed with soft soap. The patch may then be dressed with an ointment containing biniodide of mercury.

The ointment is poisonous, and should not be applied to a very large surface.

The disease is very contagious, and will linger on pastures, the woodwork of stalls, rubbing posts, &c., for many months. The woodwork should therefore be cleansed by washing with a 4 per cent. solution of carbolic acid, or some other disinfecting agent of equal strength.

London, S.W.1,
October, 1903.
Amended, October, 1918.

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Leaflet No. 96.

BOARD OF AGRICULTURE AND FISHERIES.

Milk Fever or Parturient Apoplexy.

Parturient Apoplexy, also called Milk-Fever, Dropping after Calving, etc., has long been recognised as a disease of cows, more especially of milking breeds. It chiefly occurs at the time when the cows have attained their fullest milking capacity, and may be a fruitful cause of loss to the agricultural community.

Symptoms.

The disease generally commences within from 12 to 48 hours after an easy parturition, but it may be delayed for a few days longer. (In only extremely rare cases has it appeared *preceding* parturition, or *later than* six days afterwards.)

The first noticeable symptoms are sudden cessation of feeding, rumination, and milk secretion, with uneasiness, moaning, a dull expression of the eyes, paddling of the hind legs, rapid breathing, swaying from side to side, and knuckling over of the fetlocks. Later on the cow drops. This may be succeeded by a stage of excitement, characterised by throwing about of the head and bellowing, but more frequently the cow passes into a semi-conscious sleepy condition, and is unable to rise. She remains in this state, moans slightly, and assumes a characteristic posture, with her neck flexed laterally and her nose touching the point of her shoulder.

As the disease progresses the cow becomes comatose, is unable to see, to swallow, or to void excreta; distension of the belly sets in and death supervenes.

Methods of Prevention and Treatment.

The nature of preventive treatment largely depends on the conditions under which the animals are housed; but the principle involved is always to bring the animal into a condition of body most nearly resembling the natural.

If the cow is very fat, her condition should be reduced by diminishing the amount and the richness of the food supplied for a week or so before and after parturition; this may be assisted by a judicious use of mild purgatives.

If the surroundings are suitable, the cow, for a fortnight before she is due to calve, might be turned out to graze in a field in which the grass is not too abundant and where she would require to move about in search of food.

Cows approaching calving time should be kept on a cooling, laxative, and somewhat restricted diet. For a couple of weeks before calving, the feeding of much dry food, especially chaff and "light" corn should be avoided.

Some dairymen believe that they secure a high degree of protection for their cows from an attack of the disease by rather frequent milking after calving, and by not abstracting more milk at a time than would naturally be taken by a calf.

It may be pointed out that the application of preventive methods is of most importance before the third, and especially before the fourth and fifth, calvings; heifers and old cows are less subject to attack.

Where a cow is considered to be predisposed to the disease, there is reason to believe that the injection of air mentioned below would be attended by good results, if used as a preventive immediately after calving.

When the symptoms are recognised, a veterinary surgeon should at once be called in. Before he arrives a simple enema (clyster) should be given and a dose of about 1 lb. Epsom salts and 1 oz. powdered ginger administered. The animal should be supplied with a comfortable bed.

The methods of treatment adopted to combat this disease have been many and various, and the success which has attended them has, to say the least of it, for many years been disappointing. Latterly, however, very good results have been obtained by adopting "Schmidt's Treatment." This consists of the injection of sterile air (by means of a special apparatus) through the teats into the mammary glands and subsequent careful and judicious massage of the udder. This method has produced very good results, and if promptly and properly applied, a large number of recoveries may be expected.

As the application of this treatment requires special knowledge and skill with delicate manipulation, it is not advisable that any but a veterinary surgeon should undertake it.

London, S.W.1,
October, 1903.
Revised, March, 1915.

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Leaflet No. 97.

BOARD OF AGRICULTURE AND FISHERIES.

Farmers' Co-operative Societies.

Societies for the Purchase of Requirements.—The purchase of goods in large quantities by an associated group of persons for distribution amongst themselves according to their needs was one of the earliest forms of co-operation in England, and where the goods were sold retail in small quantities, as in the case of the large working class co-operative stores, the advantages of the system were quickly recognised. The application of the principle to the co-operative purchase of farming requisites, on the other hand, at first made slow progress in this country, but farmers generally have now begun to realise the possibility of purchasing by combined effort at lower prices than are possible when each individual bargains for himself. There are a few large farmers' associations working on co-operative lines which have a successful history extending over thirty or forty years, and these have enabled their members to obtain in many instances their feeding stuffs, implements, manures, &c., on the most favourable terms. It is only comparatively recently, however, that any considerable advance has been made in the formation of societies for this purpose.

There are now in England and Wales about 451 Farmers' Co-operative Trading Societies. In addition, other forms of co-operative work, such as the co-operative holding of land, the working of allotments, keeping of pigs, the use of farm implements, insurance, and credit, are undertaken by societies, bringing the total number of co-operative agricultural societies in England and Wales on 1st February, 1919, to about 1,170. Many of the existing societies undertake two or more branches of work. For instance, the same society may arrange both for the disposal of produce and for the purchase of goods.

The benefit of co-operative purchase is most obvious in the case of the small farmer who only requires to buy manures, cake, seeds, and implements in small quantities. By purchasing large quantities direct from the manufacturer a co-operative society can sell to its members at a trifle above cost price, and thus enable the small farmer to procure his goods at a more moderate rate than would be possible if he purchased for himself alone from local dealers. He obtains also the benefit of lower rates for carriage, and is assured of the genuineness of the goods.

A society is not only in a position to buy from large merchants or manufacturers, but it can guard itself against adulteration or misdescription by arranging for analyses to be made, the cost of which when applied to large consignments is proportionately small.

Although it is evident that the benefit of such co-operative purchase is often considerable in the case of the small farmer, it is also of advantage to the large farmer. The quality of manures and feeding stuffs can practically only be tested by analysis, and even then some scientific knowledge is requisite to appreciate the results obtained and the relation between the price charged and the value represented by the analysis. Admitting that many farmers are fully qualified to bargain on equal terms with those engaged in the trade, it is certain that there are many who are not, many more who are indisposed to take the necessary trouble, and many again who are inclined to rely unduly on the description of the goods furnished by the seller. To such, a co-operative society, if properly managed, is of the greatest value, for the members can depend on their interests being duly safeguarded in every way. They know that they are paying only a fair price for an article and they have the further assurance that it is free from adulteration, and of correct description. All inducement to overcharge disappears as the society only exists for the benefit of those who do business through it.

Farmers should take great care to see that the co-operative society they join is of a genuine co-operative nature, as there are many associations in existence that call themselves co-operative but are not really co-operative in principle. In a genuine co-operative society—

(*a*) The total issue of capital must not be limited.

(*b*) As much of the capital as possible should be subscribed by those who trade through the Society.

(*c*) Interest on capital should be limited to a reasonable amount, say five per cent.

(*d*) A reserve fund should be provided for.

(*e*) The members should have an equal voice in its management.

(*f*) The balance of profits, after meeting interest on capital, placing a certain amount to reserve, etc., should be returned to the members in proportion to the business they do with the society, and not, as in joint stock concerns, in proportion to the amount of shares held. A member has then an additional inducement to support his society.

The Agricultural Wholesale Society, Ltd.—The advantages which members of a society obtain by combined effort are even more emphasised when societies co-operate to arrange for the joint purchase of their requirements. The Agricultural Wholesale Society (which is the wholesale society for the agricultural co-operative movement in England and Wales) provides this form of co-operation. It is the outcome of the Farmers' Central Trading Board reconstructed with a more ample amount of capital subscribed by those societies which constitute its members. Eventually it will be in a position to operate on the largest scale in the combined purchase, production, and distribution of farmers' requirements. The address of the Agricultural Wholesale Society is 48, Mark Lane, London, E.C.3.

The Agricultural Wholesale Society is being worked solely in the interests of agricultural co-operative societies. The Directors are elected by these societies, and are, therefore, in a position to understand thoroughly their needs and meet their requirements.. It is intended to cater for every branch of agriculture, and the society already has a special department for the supply of the requirements of allotment holders.

The present Board of Directors consists of 36 members elected by its societies. Directors may be either members, managers, or secretaries of societies in affiliation, and may represent either large or small societies. The Board appoints its own Executive and Finance Committee from amongst its members, and delegates to this Committee full power to deal generally with financial and trading matters, and also to appoint sub-committees to deal with special subjects. The sub-committees in turn have power to co-opt members and managers of societies in affiliation for consultation with regard to special purchases. In addition to this the directors of each section meet periodically to deal with matters arising within their own section.

The Board of Directors has been able to negotiate for combined orders on behalf of the societies, and has secured advantageous terms from manufacturers.

The Agricultural Department of the Co-operative Wholesale Society, Ltd.—To form a link with the Farmers' Societies and Agricultural Co-operative Societies generally, the Co-operative Wholesale Society, Ltd., has established an Agricultural Department which is in close touch with both growers and consumers. A large proportion of the Agricultural Societies are members of the Co-operative Wholesale Society, which is a federation of 1,200 Co-operative Societies. These elect their own representative directors from the share-holding societies, as there are no individual shareholders in the

Society. The federal society not only purchases agricultural supplies, machinery, manures, seeds, etc., for the Agricultural Societies in membership, but also buys very largely from them. In this way corn, milk, eggs and fruit are obtained for re-sale to the distributive societies.

The Co-operative Wholesale Society, for example, in addition to supplying its members with the requirements mentioned above, has eight flour mills in various parts of the country, an oil mill for making feeding cakes at Liverpool, manure works at Pontefract, and other establishments elsewhere. It also provides its members with banking and insurance facilities. The address of the Co-operative Wholesale Society is 1, Balloon Street, Manchester.

Societies for the Sale of Agricultural Produce.—The co-operative principle has also been applied largely with success to the sale of agricultural produce.

It is not always realised that there are two distinct branches of the farming industry, viz.: (1) the productive, and (2) the distributive. The object of societies for the sale of agricultural produce is to assist farmers in the second of these branches. At the present time growers attempt to deal with both branches of their business, and, however well qualified they may be with regard to the productive side, it is probably not too much to say that a large proportion of the farmers of this country have a great deal to learn with regard to the distributive side. A large co-operative society, on the other hand, can employ a qualified manager and staff to give their attention to the disposal to the best advantage of the produce sent in by members, as well as to the purchase of manures, cake, implements, &c. This is being successfully done by many societies, particularly in the case of the milk industry. It is, however, a direction in which there is much room for development.

While such societies may be of the greatest assistance to even the largest farmers, they may be said to be essential for the success of the small holder. It is only by combining the small quantities of produce grown on a number of holdings that such produce can be sold wholesale on satisfactory terms, or that the reduced rates of carriage which are available for large lots can be obtained. In no other way can the small holder hope to compete successfully on equal terms with bulked consignments from abroad.

By sending produce to a co-operative society, the small holder is saved the trouble and expense of marketing his goods, and can devote the time so saved to the cultivation of his holding.

A society for purchase can also be a society for sale, and it is better, as a rule, to begin with the former class of

business and proceed to the latter as the society progresses and prospers. The success of all co-operative trading societies depends equally on the loyalty of the members and on the efficiency of the management. Every member of a society who undertakes to consign his produce to it should feel bound in honour to offer all his produce other than what is required for his own consumption. If he tries to sell his best produce privately and only sends his inferior stuff to the society, he is acting unfairly and contrary to his own interests and those of his fellow members. This point cannot be too strongly insisted upon, and should form one of the rules of every society.

It is generally inadvisable for societies, unless very largely supported, to attempt too extensive a business at the beginning. It is usually better to begin with one or two lines of business, and to extend as experience is gained.

Co-operative societies in the same district should endeavour to work together as far as possible and so obtain the fullest advantage from co-operative buying and selling. To this end local societies should affiliate with the Agricultural Wholesale Society, Ltd., or with the federal Agricultural Department of the Co-operative Wholesale Society.

Just as a small society is in a better position than a single buyer, so a large society can obtain more favourable terms than a smaller one. A group of small holders trading through a society including in its membership many large farmers, is able to obtain as favourable terms as though its own purchases were on a big scale.

For instance, several members of a local society may require a ton or two of coals each. Their combined orders enable the society to buy several truck loads and thus to obtain it at an appreciably lower price per ton than if each member had ordered his lot separately. A society, however, which includes a number of large farmers spread over a big district, may very probably be in a position to make a contract with a colliery for several thousand tons of coal at a still cheaper rate, and the small society, by adding its demand for a few trucks, shares in the benefit of the large order and obtains its coal at a lower price.

Further, a society federated in this way also benefits by the experience of the committee of management and of the paid staff attached to a society operating on a large scale, while it is still free to manage its own affairs.

The liability incurred in federating is usually nominal.

General.—When the formation of an Agricultural Co-operative Society is decided upon, the first step to take is to obtain expert advice and assistance.

The Agricultural Organisation Society, Queen Anne's Chambers, Tothill Street, Westminster, S.W.1, will give all

necessary assistance in the formation of Agricultural Co-operative Societies in England and Wales, and the Scottish Agricultural Organisation Society, 5, St. Andrew's Square, Edinburgh, will act similarly for Scotland.

Both these organisations have been promoted to assist in the formation of registered Agricultural Co-operative Societies, but they do not themselves engage in trade. They are further prepared to send organisers to give information to agriculturists generally on the way registration can be secured, and to place at their disposal the model rules, approved by the Chief Registrar of Friendly Societies, under which the various forms of agricultural co-operative societies can be registered. All societies adopting model rules are allowed by the Chief Registrar to register at a reduced fee of £1. If, however, rules are drafted by the local committee, a fee of £5 will have to be paid. Copies of the model rules, as well as leaflets and other literature dealing with registration and agricultural co-operation generally, can be obtained from the Secretaries of the respective Organisation Societies.

London, S.W.1,
December, 1903.
Revised. May. 1919.

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Leaflet No. 98.

BOARD OF AGRICULTURE AND FISHERIES.

GRADING AND PACKING FRUIT AND VEGETABLES.

Intensive cultivation has in many places been carried to a high degree of excellence, and British horticulturists pride themselves, justly, upon their skill as producers. Admirable and necessary as the highest cultivation must always be, yet something more is required to ensure complete commercial success, namely, the conveyance of the produce in the best possible style to the market or to the consumer. It is at this point that too many fail, and a material proportion of unprofitable sales is mainly attributable to neglect in presenting goods in the most satisfactory manner. Proofs of this defect are evident in every British market, and the produce of the home grower may commonly be seen in direct contrast with that of his foreign competitors, to the conspicuous disadvantage of the former. It is the purpose of the following notes to give some directions which, with the exercise of intelligence in carrying them out, may assist in improving the selling value of both fruits and vegetables as produced in this country.

1.—Fruit.

To aid in grading fruits to the best advantage, it must be assumed that the preliminaries of successful cultivation have received due attention. The selection of the best varieties, suitable sites and soils, with every possible care in protecting the trees from attacks of insects and diseases, demand the cultivator's utmost skill and unceasing watchfulness. Further, in preparing for the actual work of grading, the method and time of gathering should receive the strictest attention, or much of the other labour will be reduced in value. It is not sufficiently recognised how readily all fruits are injured by rough handling. Even hard, unripe apples and pears are soon bruised, and not only do these marks show as serious defects in the appearance of the fruits, but the keeping qualities are also affected.

One general rule is applicable to all fruits, and that is they should never, if it can be avoided, be gathered when they are wet, especially if they have to be packed for sending a long distance.

In preparation for sorting, the fruits should be carefully spread on a table or bench, which may slightly slope to the front, and should be of a convenient height for the

packer to stand at. The soft fruits must be conveyed to the sorting room in shallow trays or baskets, so that they can be graded direct without turning them out. When experienced hands are employed some degree of sorting can be done at the time of gathering, thus saving further handling or removal of the fruits, and the grower should in every case endeavour to reduce this to the minimum.

Points to be Observed in Grading.

Several matters have to be considered in the actual work of grading, and an intimate knowledge of the characteristics of varieties is essential to the best results. The effects of seasons on large crops also demand attention; for the second grade of one crop might rank as the first of another. It is impossible to lay down a rule that would constitute a standard equally reliable under all conditions, but a general idea can be given of the relative values of different grades under similar circumstances.

The points of importance in classifying the best fruits are :—

1.—*Freedom from injuries and blemishes.*

2.—*Good, uniform size and shape.*

These two points are essential to all high-class fruits, and no defective, distorted, or undersized samples should be allowed in the leading grades of any kind.

3.—*Colour.*

This quality is a special one, which always possesses a marked value in fruits for dessert, and even amongst some used for cooking or preserving, as in apples, red currants, raspberries, and strawberries. A richly-coloured sample, though only of moderate size, will, if free from defects, often possess a higher market value than a larger and duller sample. Cox's Orange Pippin, for instance, may be sold in two grades, one large and dull or greenish-yellow, and the other a size smaller, but in its best colour, in which case the latter will command the larger price. This is true of many other fruits which have a characteristic colour, which is, however, sometimes deficient in the larger sizes.

4.—*High quality with ripeness.*

Mere size may also be a secondary consideration, provided the fruits are choice, in perfect condition for immediate use, and free from defects. This is especially true in the case of small packages of dessert fruits, such as the finest pears, plums of the greengage type, ripe cherries, peaches, and nectarines. A special market must be at command for such samples, or they should be sent direct to the consumers or retailers.

The bulk of fruit grading will, however, be mainly concerned with variations in size, provided the essentials of good form and freedom from defects are secured. It is of the

utmost importance to ensure that each grade is as uniform as close attention can make it, and then the full value of the work is most likely to be obtained.

Grading the Fruits.

A quick eye and some practice under good guidance will soon enable a packer to select the various sizes rapidly and in a uniform manner.

Apples.—Apples in particular can be readily graded into several sizes according to the variety and the crop. Occasionally four well-marked grades may be obtained, in other instances perhaps three, while sometimes only two are obtainable. The difference of a quarter of an inch in diameter will constitute a well marked grade. An American Association has adopted as the minimum standard for first grade apples of the largest types $2\frac{1}{2}$ inches diameter; while for the smaller types $2\frac{1}{4}$ inches is the minimum diameter for first grade fruits; in each case $\frac{1}{4}$ inch is allowed between the firsts and seconds. In practice it is found almost impossible to adhere to such exact grading; the general standard and range in size of the crop or variety must be judged, and the graduation founded upon this. These remarks especially refer to apples for cooking, or dessert apples equally well coloured, but what has been already said about the value of colour must be remembered, and a special grade of uniform size may be selected where there is a proportion of larger fruits deficient in respect to colour.

Pears.—Most of the details regarding apples are also appropriate to the grading of pears, but as a larger proportion of these are used for eating than cooking, they are more adapted for disposal in small packages, and hence repay the greatest attention in uniform grading. Several qualities can usually be obtained from one crop, and it generally pays best to sell in two or three grades, only those rejected in the selecting process being disposed of in bulk. Even when large crops from old orchard trees are being dealt with, a few dozens of the finest fruits carefully packed will help to raise the total returns considerably.

Stone Fruits.—These may be selected in various grades. *Plums for cooking* can be sorted into two or three grades, the largest fruit commanding the best market. A good medium size is in demand for bottling, and the smaller sizes are utilized in ordinary cooking or preserving. *Dessert plums* and *cherries* are readily graded on the same method, the finest in boxes or small packages and the others in bulk.

Soft Fruits.—Fruits such as *strawberries* and *raspberries* are worthy of much care, strawberries being sorted into at least two grades and sometimes into more. The best are placed in punnets, the next in small boxes, and a third grade can be sold in boxes or baskets holding from 6 lb. to 12 lb. Raspberries may be conveniently divided into two qualities

whenever a special sale can be commanded for the best fruits either in punnets or small boxes.

Nearly all other fruits also admit of some grading, even though it be only to the extent of excluding defective and malformed specimens; the results yield a satisfactory reward for the labour and expense.

Packing for Sale.

Wherever fruits have to be transferred a distance by road or rail, *the best culture and most careful grading may lose all their value through careless packing.* Many of the defects in market consignments are either due to this or materially increased thereby, and the complaints on this score are as frequent as those regarding inattention to grading. In dealing with fruits the following points should be remembered :—

1.—*Only perfectly sound fruits should be used.*
2.—*Packing must be done firmly, but without crushing.*
3.—*The best elastic odourless materials should be employed for packing.*
4.—*All choice and ripe fruits should be packed in small quantities in shallow packages.*

Baskets.—In the home trade baskets are much more extensively used than boxes, and the most common are *round baskets without lids* of the bushel, half-bushel, or half-sieve types. They are strong and durable, but are objectionable for all the best fruits as, even with the most careful packing, the top layers are liable to be bruised, and under careless methods they are certain to be damaged. When apples, pears, plums, cherries, or gooseberries are sent in such baskets a covering of paper, with straw or other material, is placed on the top and secured by cross pieces of willow or hazel, the points of which are forced through the sides of the basket below the rim. *Flat baskets with lids* are preferable but expensive, and the difficulty with them is that they must be charged for or returned. In extensive dealings with market salesmen baskets are supplied at very little cost to the producer, but where it is desired to promote more direct communication between the grower and the retailer or consumer some other method is preferable, or the producer must provide his own baskets.

It would be helpful in many districts if a local industry could be developed in cheap basket-making; there are few places where suitable willows could not be grown, and the basket-making might be performed in the winter evenings.

Boxes.—Much could be said in favour of boxes for fruits, and, where only small sizes are employed, they may be purchased or made so cheaply that they can be included in the

price of the fruit, and thus all the trouble of returning or collecting empties is avoided. Their more general use under the right conditions would assist producers to avoid overstocking the markets in seasons of heavy crops, and, by facilitating direct communication with the consumers, secure better prices. In a small way, boxes can be made at home at a cost of 1½*d.* to 1*s.* each ; on a larger scale, with the use of machinery, they may be turned out at about 8*s.* to 50*s.* per 100, according to the size, and boxes costing 1*d.* to 6*d.* can always be advantageously given with the best grades of fruit. Many of the leading railway companies have recognised this fact, and now supply boxes of various sizes at 1*s.* 6*d.* to 5*s.* per dozen, while several manufacturers also supply large orders at very reasonable prices.

Packing Materials.—Various materials are available for packing purposes, but much the best are the several grades of wood wool now prepared, the coarsest being suitable for large packages and heavy fruits, and the finest and softest samples for the choicest ripe fruits. But wherever it is to be in contact even with apples and pears only the softest make should be employed ; the rougher samples can be used for the bottom, or filling up at the top. All choice and delicate fruits should be encircled with bands of folded soft tissue paper, having a glazed surface, which must be in contact with the fruit. This is also required to place over the top layers, but a stronger paper is used for unripe apples or pears.

Method of Packing.—In the actual work of packing, an even layer of wood wool is placed at the bottom of the box or basket, this layer being covered with a sheet of paper, upon which the fruits are placed firmly. The best *plums*, *pears*, or *dessert apples* should never be in more than two layers, while they travel best in the smallest boxes holding one layer. If only one layer of fruits is made, the packing material at the bottom, and that at the top, besides the folded paper band round each fruit, will be all that is essential ; but if there are two layers, they must be separated by two sheets of paper, between which sufficient fine wood wool must be evenly spread to prevent injury to the lower fruits, and form a firm bed for the upper ones to rest upon. From one to four dozen of the best dessert apples, pears, or plums may be so packed in one box with safety for a long journey. *Peaches*, *nectarines*, and *apricots* demand the utmost care, and must always be in single layers.

Strawberries may be packed in lots of from 3 lb. to 6 lb. of selected fruits, but the first-named quantity is the best for the finest fruit, and the smallest of the railway boxes just holds that amount conveniently, allowing for a little packing material at the top and bottom. A box of the same size will hold 4 lb. of best *cherries*, 3 lb. of *raspberries* without their stalks, 3 lb. *red currants* (closely packed), or 4 lb. of *black currants* ; but the

last two may be packed in 6 lb. to 12 lb. lots if not too ripe ; the smaller quantities are, however, preferable and safer.

The finest *early strawberries* should be packed in 1 lb. punnets, which may be either deep or shallow, round-plaited chip punnets, or square ones (with or without handles). The round punnets are best packed in trays with lids, and those generally employed will take six punnets. They are only used for the earliest and choicest fruits, when prices are good. Crates may be employed to hold several such trays, those large enough for six being a convenient size and weight. The square punnets are packed more closely together on sliding shelves, or in trays like the others in crates.

Grapes are packed in shallow or handle baskets, the points of the bunches towards the centre and the stalks secured to the sides or rims, the top of the basket being covered with stout paper tied round the rim ; some handle-baskets, however, are fitted with lids. The sides and bases of the baskets are sometimes padded, but they are then always covered with a soft glazed paper. The great point is to avoid rubbing the surfaces of the berries and spoiling the "bloom."

In every case, besides ensuring the security of the finest fruit, it should be displayed to the best advantage, and if the grade is uniform, as advised, a little coloured or white tissue paper to fold over the sides when the box is opened is of great value.

The practice of topping is a common proceeding in the packing of fruit to which the attention of the Departmental Committee on Fruit Culture was drawn. The tenor of the evidence was to condemn the practice as dishonourable, and it was shown that it had led to much trouble in the trade, grower, salesman, and purchaser alike being involved. In packing fruit topping should be strongly discouraged ; if the fruit is properly graded the results are likely to be far more satisfactory, and no opening is given for the grower to be accused of dishonesty.

Branding and Labelling.

The question of branding or labelling must be carefully considered, for where good fruit only is being dealt with, the use of the words "Seconds" and "Thirds" is apt to give rise to a misconception that is unfairly against the seller's interest. For the finest samples "Extra," "Select," or "Special" may be employed. Some growers mark the next grade A 1, and the next No. 1, or if the letter X is employed, XXX would be used for the first grade, XX for the second, and X for the third. Another method is to term the best "Selected No. 1," and the other grades "Selected No. 2" and "Selected No. 3." Something of this kind is necessary to indicate that the lower qualities are not refuse but properly graded fruits. A grower should adopt a uniform system, and adhere to it, so that his brand may become known and have a market value, and

every package should bear the name of the variety and quality boldly printed on the label. Growers who intend to make a substantial business, and who deal honestly in the best produce, should have their own names on the packages. This is sometimes objected to in a market, but if a grower cannot make his business through the ordinary channels he must try fresh ones. It is best to endeavour to supply the shopkeepers, or to develop a trade with private customers, and send direct to them.

The reduced rates at owner's risk on the railways, and the parcels post, afford ample means for enterprising men to work up a business in small packages of choice fruits if they take the trouble to do so, either by advertising, by circulars, or by trade letters.

2.—Vegetables.

As in the case of fruits, most vegetables require careful preparation if they are to appear to the best advantage, either in the wholesale market or in the window of the retailer. This preparation should commence when the soil is made ready to receive the seeds, and only end when the produce is successfully placed on the market. To attain complete success grading and packing should receive every attention.

Grading the Vegetables.

The benefits derivable from careful and systematic grading are by no means confined to fruits, as vegetables also afford considerable encouragement to those who strive to make the most of them in the same direction. Especially is this the case with root crops, though in a general way the sorting adopted is of a very rough character.

Roots.—Potatoes are usually picked up in three sizes, the large tubers (or "ware") for sale, the seconds or "sets" (or "seeds"), and the small tubers (or "chats") to be used as food for stock. The large size should be again sorted into two or three grades; with them as with apples, a comparatively small proportion of coarse irregular tubers spoils the appearance of a large consignment. Even shape and uniformity of sample possess a distinct market value, and a medium sized potato having these characteristics, together with good quality, will bring a better return than huge distorted tubers of which size is the only recommendation. If an extra 6*d*. per bushel or £1 per ton can be secured by such care it may mean, with a good crop, sufficient clear gain to more than pay the expenses of cultivation.

A distinction can be made between the best or earliest *turnips* and *carrots* and the ordinary quality or crop in bulk, by marketing the former in bunches, while the latter are sent in bags or baskets.

Onions can be graded in several ways, the best being bunched or made into "ropes" while smaller sizes are sold

loose, the smallest ranking as pickling onions. It is always advisable to have several sizes, each sample fairly uniform, as some buyers have a preference for medium sized bulbs and others for large ones. In selling small quantities by weight the retailers have a difficulty with the largest onions, and usually find the medium size more convenient.

If roots are prepared for sale by being thoroughly cleaned it is a great help, and in any case wherever grading is followed all the best qualities should be so treated or the chief part of the labour will be nullified.

Pod-bearers.—Peas and *beans* should always be graded. Yet grading is seldom done by the grower, and, as with many other vegetables, it is usually left to the retailer. Large, well-filled pods of the former are always in demand, and if the colour is good their value is enhanced. But they are too often gathered without due care, and a number of insufficiently developed pods materially lower the value of the whole, while reducing future gatherings. Peas are frequently purchased from farmers by dealers who employ large gangs of pickers, men, women, and children. The peas are all torn off at one gathering and despatched to market in bags, old pods, well-filled pods, and flats being mixed. But this is a bad method. Two or three grades of peas can be readily formed, according to the condition of the crop and the varieties, some being much more even croppers than others. In supplying consumers direct, daily or at regular intervals, it is now becoming the practice to shell the peas, grade them by means of sieves, and consign to the purchaser in small boxes. *Dwarf kidney beans* and *scarlet runners* can be graded by selecting the long, straight, and even pods for the best samples, in smaller quantities, the bulk going for sale in bushel or half-bushel baskets.

Green Vegetables.—With such vegetables as *cabbages*, *savoys*, *kale* and *Brussels sprouts*, the principal point is to see that each sample is uniform and in the best condition, and this is largely a question of care in gathering. For ordinary markets the two first named must be large and have solid hearts; for special sale and for sending direct to consumers, a smaller size, but possessing all the other essential characteristics, is often preferred. *Brussels sprouts* should always be sorted into two grades, all the firmest and most compact into one, and the looser, rougher sprouts into another; the increased price of the first will pay for this in the majority of cases. To *cauliflowers* and *broccoli* similar remarks apply, the whitest and most even heads constituting the first grade, the rougher and discoloured the second. As with cabbages, large heads are required in general markets but for the best sales moderate-sized perfect samples are the most satisfactory.

Various Crops.—Rhubarb can be classed in two grades, the longest, straightest and best coloured forming "No. 1"

bundles. *Celery* may be divided into two or three grades, the heaviest and most solid in bundles for salad, the others loose for soups. *Asparagus*, too, should be placed in two or three grades, according to the length, substance and blanching; the smallest (Sprue) for soups; all the best in bundles of 25, 50, or 100, the last in larger numbers. *Seakale* can also be sorted, the whitest and best grown being placed in bundles set upright in baskets.

Tomatoes demand the utmost care in sorting; two, three and even four grades may be formed. The best are packed in boxes or shallow baskets. The brightest and most even coloured fruits take the lead; there is a special demand for the largest handsome fruits in some markets, but the principal general sale is for good, even-shaped, moderate-sized, uniform samples. *Cucumbers* are graded into two or three sizes; and *vegetable marrows* are also sorted, but in some places large specimens of the latter are most in demand, while in others a medium size is chiefly required.

Salading, like *lettuces* and *endive*, can occasionally be separated into two grades, but as a rule a uniform sample of one value is preferable, to be regulated at the time of gathering.

The general rules for grading vegetables of all kinds may be stated as follows :—

1.—*All immature, over-grown, coarse, or defective specimens must be excluded from the leading grades.*

2.—*Each grade should be made as uniform as possible.*

3.—*Freshness and fitness for use should be the characteristics of all vegetables when consigned to market or consumers.*

To aid in all this only the best varieties obtainable should be grown, and growers should watch closely for every real improvement on old sorts.

Packing.

In packing vegetables most of the general advice already given should be serviceable; but vegetables are disposed of in larger quantities than fruit and therefore require a different class of packages. *Bags* of various kinds and sizes, with *large light open baskets* or *crates*, are more extensively employed than boxes.

Early Channel Island *potatoes* are consigned in baskets, and are sold by the pound, Canary goods being sent in boxes, four of which form a "bundle."

The majority of roots are sent in bags, but the best samples of *turnips*, *carrots*, &c., that are bunched are sent in crates, while *radishes* and small roots are sent in baskets.

Green vegetables, like *cabbages*, are best marketed in crates, as also are *broccoli* and *cauliflowers*, but the earliest and best of the last named are often packed in flat baskets or

hampers and pay for every care. Italian cauliflowers arrive in little chip baskets termed "chips." These contain 1½ dozen each. Cabbages from Evesham are packed in pots, about 2½ dozen in a pot according to size.

Foreign saladings, such as *lettuces*, are usually packed in crates. Selected cos lettuces are frequently forwarded for sale in boxes, realising higher prices in proportion as they are regular in size and are not damaged in transit. *Radishes* from France are packed in large baskets termed pots, these being of a different shape to Evesham pots.

Peas and *beans* are packed in baskets, usually bushels or half-sieves, but, as previously noted, peas when shelled are forwarded in small boxes containing about three quarts each. Half-sieves are also used for *Brussels sprouts*, *pickling onions*, and other small vegetables.

Forced *rhubarb* is consigned in boxes; the later crop goes to market in bundles, loaded direct into the vans, or packed in crates. *Celery* is treated in the same manner, and is sent from the Home Counties in the washed, but from Lincolnshire and Huntingdonshire in the unwashed condition.

For all early and high quality vegetables shallow baskets or boxes are useful. *Cucumbers*, *tomatoes*, *mushrooms*, and many others can be conveniently sent in this way, and where periodical consignments of general vegetables are sent to private customers this is the best method.

It is necessary to pack firmly as with fruits, and where green or perishable vegetables have to travel a long distance it is desirable to gather them as shortly before packing as possible, preferably in the early morning when quite fresh, but not when drenched with rain. They should not be allowed to remain exposed to sun or wind for some hours before they are sent off, as they sometimes are, to the obvious disadvantage of the seller. Defective or decaying samples should on no account be admitted into the packages; the uniformity so strongly recommended as regards fruits should be maintained, and it will be found that the reputation gained is a satisfactory reward for the extra care.

London, S.W.1,
December, 1903.
Revised, 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.

Leaflet No. 99.

BOARD OF AGRICULTURE AND FISHERIES.

Relationship of Woods to Domestic Water Supplies.

This subject has, for more than twenty years, occupied much of the attention of Forest Experimental Stations, especially in Germany, France, Austria, and Switzerland; and in view of its importance the conclusions arrived at may be usefully summarised.

It has been asserted, and theoretically the contention is doubtless correct, that masses of woodland increase the rainfall. The causes of this result are sought for in the reduction of temperature associated with forests, and in the greater absolute and relative humidity of the air in woods. But although it may be possible to obtain experimental proof by means of elaborate and long-continued observations in a region where extensive afforestation or deforestation is taking place, it may at once be said that such tree-planting as is practically possible in Britain can have no appreciable influence on the rainfall. Trees do, however, under certain conditions of the atmosphere, condense dew on their leaves and branches, and this effect may often be seen in the wet state of the ground underneath trees on a foggy morning, when the surface elsewhere is comparatively dry.

But the case is materially different where the fate of the rain and snow that falls on a tract of woodland is considered. The foliage, branches, and stems of the trees intercept much of the rain and snow so that it never reaches the ground at all, the amount so intercepted usually ranging from 30 to 45 per cent. of the total, but much depends on the character of the rainfall, and on the species of tree. In a district of heavy annual rainfall a smaller proportion of the precipitations is caught by and evaporated from the trees than where the rainfall is light. Similarly in the case of heavy and long-continued rain, as contrasted with gentle showers; in the latter case, in fact, but little of the water reaches the ground through the leafy canopy of a dense forest. Then again much depends on the kind of tree, evergreens intercepting more water throughout a year than deciduous trees,

and a larger proportion of the rainfall is evaporated from the leaves and branches in summer than in winter.

But although less rain-water reaches the soil of a wood than finds its way to the ground in the open country, the moisture in the soil is much better conserved in the former than in the latter case. Long-continued observations have shown that more water drains from a wooded area than from one devoid of trees. The greater abundance of water in forest soil, in spite of the trees intercepting a large proportion of the rain-fall, is due partly to the reduction of evaporation owing to the exclusion of the sun's rays by the foliage, partly to the air in a forest being more humid, and thus better fitted to discourage evaporation, and partly to the absorbent and retentive character of the decaying vegetable matter that covers the ground of a dense and well managed wood. The lace-work of tree roots, too, that occupy the soil of a forest, offers mechanical resistance to the rapid surface-flow of water. It is also to be noted that roots penetrate to great depths, and when they die they leave holes through which water readily penetrates from the surface. The friable condition of the soil of a wood, too, permits ready percolation of water, whereas in the open country the denser character of the surface of the ground is less favourable to the entrance of water. The consequence is that streams in a wooded country are not so subject to rapid rises and falls, the flow being maintained more equably throughout the year. Where water supply for domestic or industrial purposes is concerned, the avoidance of violent freshets on the one hand, and scanty flow on the other, is alike desirable. Not only may the water of sudden and heavy floods be lost owing to the incapacity of the reservoir to contain it, but such floods have also the disadvantage of carrying much mud and similar material in suspension, and this gradually silts up reservoirs, besides entailing increased expenditure in filtering.

It may be pointed out that the water of a reservoir surrounded by well stocked woodland is not subjected to the same amount of violent agitation during gales as is the case when such sheltering agency is absent. The mud and silt deposited on the bottom, and especially along the margin, is consequently left comparatively undisturbed, with corresponding advantages in the matter of purity.

When a catchment area is covered with trees, and with the vegetable matter that accumulates on the surface of the ground, the water that reaches the soil as rain is impeded in its flow, and its evaporation is hindered, so that the general effect is equivalent to an increase in the size of the reservoir. It is also important to note that snow melts more slowly underneath trees than in the open country, so that at a time of thaw the snow-water is yielded up more gradually. Nor must the fact be overlooked that when snow in a

forest melts, the ground absorbs the water to a much greater extent than happens in the open country. In the latter case the ground is probably frostbound, so that the snow-water cannot be absorbed by the soil, whereas forest soil, being protected by trees, never freezes to the same extent, and is consequently in a better position to absorb snow-water. The result is that not only does a forest mitigate the violence of floods, but the snow-water that flows from its area is less muddy than would otherwise be the case.

Forests not only affect the degree of moisture in soil, but they also exert considerable influence on the soil temperature. Although this influence is greatest at the surface of the ground, it is also perceptible to a depth of several feet. On the average of a large number of continental stations it was found that woods of various species and ages depressed the mean annual temperature at the surface of the ground by about 2·6° F., while even at the depth of four feet the reduction of temperature was 2°.

This general cooling influence is due to a variety of causes. The foliage of the trees excludes the sun's rays, the decaying vegetable matter that covers the ground prevents the free exchange of air between the soil and the atmosphere, while the water in the soil absorbs much heat without its temperature being much affected.

While woods have a depressing influence on the mean annual temperature, it is found that this effect is usually confined to the period of summer. On the average of 11 German stations the July temperature of the surface soil in the forest was found to be 7° F. lower than that in the open field, whereas in December the former was rather warmer than the latter. Forests, therefore, tend to equalise the temperature of water collected in them, the temperature being slightly raised in winter, and markedly reduced in summer. This result would appear to be of considerable practical and hygienic importance where a supply of water for domestic purposes is concerned.

To the credit of forests is also to be placed the fact that they exercise a purifying influence both on the air and on the soil, germs of all kinds being markedly scarcer in a well-wooded district than in a similar extent of tree-less country.

London, S.W.1,
January, 1904.

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BOARD OF AGRICULTURE AND FISHERIES.

The Breeding and Management of Pigs.

Of all farm animals the pig is the most prolific; no other animal will give a quicker return in meat for foods consumed, or is better adapted for turning into wholesome meat material that might otherwise be wasted. Under a well-planned system of management, most of the work connected with pig-keeping can be undertaken efficiently by old or disabled men, by intelligent lads, or by women.

Whether the aim should be breeding or feeding, or both together, will depend largely on local circumstances, but when circumstances permit (*e.g.*, on the farm) it is generally more profitable to combine feeding with breeding, for the following reasons:—

(1) It usually costs less to produce pigs than to purchase them.
(2) Home-bred pigs usually fatten more readily.
(3) There is less risk of introducing swine fever.
(4) The pig-keeper is less affected by fluctuations in market prices.

In the production of pork and bacon, a carefully-selected cross-bred sow mated with a pure-bred boar will often give better results than a pure-bred sow, but, in view of the necessity for maintaining a suitable type of pig for commercial purposes at home and for supplying the probable future demands for export purposes, the breeding of pedigree pigs should repay the closest attention on the part of those who are able to undertake it.

The Boar.—It is always desirable to use a pure-bred boar. To whatever breed he may belong, he should be selected from a litter conspicuous for its uniformity, and, in common with his parents, he should possess those qualities which the breeder is desirous of reproducing. He should be of good quality, fine in bone and hair, lengthy and deep in the back and hindquarters, with comparatively light forequarters, and of a quiet disposition. The possession of a sufficient number of well-formed and evenly-placed (vestigial) teats is regarded by well-known breeders as desirable in a sire. Above all, sound health and great vigour are essential. To maintain this, he must be allowed sufficient exercise. After weaning, a boar may be allowed to run with other pigs until about five months old, at which age female pigs, at least, should be removed from his company. He may be used for service between the ages of eight months and five years. When ready for service he should be penned up and allowed only a yard for exercise.

The sow should be put to the boar after she has been in use a day or two, and removed after one complete service. A boar will serve about 50 sows per annum. An old or heavy boar should not be mated with young or small sows.

The food given to the boar should be regulated according to age, and the extent to which he is used. It should be such as will keep him in a healthy, vigorous "store" condition, and should include, if possible, some skim milk. Sloppy food made up of 3 to 4 lb. *per day* of barley meal or wheat offals, and including a little pea or bean meal when his services are numerous, should be given twice daily. In addition, he should be supplied with grass, clover, lucerne, or tares in summer, and swedes, kohl-rabi, mangolds and clover hay in winter. When he is not being much used, green food alone will be sufficient.

The Sow.—The brood sow should possess, on a more refined scale, as many of the above points as possible, with at least twelve teats, placed approximately equi-distant from each other and commencing close behind the forelegs.

As already indicated, purity of breed is not generally considered essential in the sow for commercial purposes; but, as with the boar, pig-breeders cannot be too strongly urged to keep for breeding only those gilts which are the produce of prolific, good-tempered, and free-suckling sows. They should be selected, if possible, from spring litters, as young sows will, as a rule, grow and develop better in summer than in winter, and will be ready to produce their first litter in the following spring. Too much attention cannot be paid to these important points. Young gilts should be allowed to run cheaply on grass and stubble, and be put to the boar in November, December, January or February, so as to pig down in March, April, May or June.

A beginner in breeding should, as a rule, start with a twelve weeks' old gilt. He will have to wait a year before he has pigs to sell, but, on the other hand, he will pay less money for his foundation stock, and a gilt can be cheaply kept.

Some breeders prefer to mate the gilt at five or six months old, contending that if left till a later age she is apt to develop flesh, and is not so readily got in pig. Generally speaking, however, it is better to wait until she is eight months old; she will then have her first litter when about 12 months old. One litter every six months is a fair allowance. Old pig-keepers have observed that the produce of sows that farrow large litters of even-sized pigs fatten most quickly and require least food for a given increase in weight; and that the produce of the more lusty and muscular sows, which are usually in good condition, grow and thrive better than the pigs of smaller litters from weakly and delicate sows. Matured, good-sized sows will generally produce larger and more pigs than will young or smaller sows.

It should be remembered that sows continue to produce good pigs for several litters. Considerable attention is at the present time being given to the system (which is common in some of the northern counties) of rearing but one litter of pigs and then fattening the sow. One reason given for this plan is that the young sow when fattened will approximate in value to a fat castrated male or a spayed female pig, and thus realise more per pound than would an aged sow when fattened. It is generally acknowledged, however, that the most successful pig-feeder is the one who has fat pigs to sell at all periods of the season, and particularly in months when the highest prices are obtainable for pork. It is perhaps on the whole best to fatten off the average sow after her third or fourth litter, but many sows may profitably be kept considerably longer.

The system of killing off young sows makes it impossible to improve one's stock of pigs by reserving the future breeding stock from the litters of the sows which have proved themselves to be superior milkers and the most prolific. These are two qualities of the greatest importance, which can only be discovered after two or three litters have been obtained from the sow. The continued selection by certain breeders of the best pigs from such sows has rendered their pigs superior to those in any part of the world.

The best Type of Pig.—There exists considerable difference of opinion as to the type of pig most generally profitable. The first point to be considered is the market which the pig-breeder proposes to supply; in some districts near London and some other large towns the chief demand is for pigs weighing about 60 lb. dead weight, or some 85 to 90 lb. alive. To meet this demand, the Middle White Yorkshire sow is much kept, and crossed either with a boar of the same breed or a Berkshire; some breeders prefer to cross the other way, but the pigs from a Middle White sow are generally more numerous and grow faster when young. Another suitable type is obtained by mating a Large Black sow with a Middle White boar.

In regard to bacon pigs, one of the first difficulties encountered in establishing new bacon factories is to obtain locally pigs which produce bacon suited to the public taste. The pig required for a Wiltshire side should have a small shoulder (as that is the coarsest part and in retailing realises the least money), a good deep middle, with a fine loin and a large ham, and not too great a thickness of fat on the back. Top prices are usually paid for pigs weighing from 120 to 190 lb. dead weight. A larger and fatter pig weighing 220 to 300 lb. is in demand in some parts of Yorkshire, Lancashire and other counties. Very much the same type of pig is needed to furnish both of these classes of pigs. The finer quality

Large White is the more general favourite, but in some districts the Lincolnshire curly-coated pig, the Berkshire and the Tamworth pigs, both pure and crossed, and the Large Black pig are preferred. Excellent bacon pigs may be obtained by crossing (1) a Large Black sow with a Large White boar, the progeny usually being white or white with dark spots, or (2) a Large White sow with a Middle White boar.

Management of Sows.—The system of managing sows varies with the district. In many, if not in most, instances, the sow may be kept at little expense during the first three months of pregnancy, as a run on grass or lucerne during the spring and summer will usually be sufficient; if pasture is scarce, some soaked maize, or peas or beans (when supplies and prices admit of it) or roots of almost any kind given raw—potatoes only being steamed or boiled—will suffice. Even the kitchen refuse from fair-sized houses will go far towards the keeping of the brood sow. During the later stage of pregnancy the diet must be more nourishing, since the drain on a sow in the production of a good litter is very considerable.

A few weeks before farrowing the gilt or sow should be moved into her particular sty in order that she may become accustomed to her new surroundings. A rail or iron tube should be fixed all round the sty, nine inches from the floor, and the same distance from the wall, to prevent the piglings from being crushed inadvertently by the mother.

It is well to arrange for young sows to farrow during the warmer months. Especial care should be taken that at the time of farrowing the sty should be free from draught and wet; a good bed of clean short or cut straw should be provided. If the weather is very cold, a good stable lamp may be left hanging in the sty for a day or two so as to raise the temperature.

Farrowing.—In general, the farrowing sow needs but little help. When assistance is needed, as when one of the little pigs is presented doubled up, the attendant's hand, after being well cleansed with soap and water and greased with carbolic oil, should be carefully inserted, and the pigling returned into the womb; then it will most probably be rightly presented and safely brought into the world. Piglings of abnormal size sometimes give the sow considerable trouble. If the sow is perfectly quiet, help can usefully be given by the attendant, care being taken not to injure the sow internally.

Some sows are rather vicious during farrowing. In such cases the little pigs as they are born should be placed in a basket lined with straw, and removed a little beyond the sow's reach. When farrowing is complete and the sow calm and quiet, they may be returned to her without fear.

If the bed be wet, it should be made up with an armful of short straw. The sow will then lie down and rest for several hours until her pigs are quite strong. If they bite the sow's udder, the little sharp teeth should be broken off with a pair of pincers. Piglings which are carried more than the usual sixteen weeks frequently have long and sharp teeth. The sow will usually show that the pigs' teeth require attention, by lying upon her belly and refusing to suckle; if this be continued for any length of time the accumulation of milk will cause inflammation of the udder, with disastrous results.

Feeding the Nursing Sow.—After farrowing, the sow should be given a small quantity of warm, sloppy food, consisting of sharps with a little oatmeal and skim milk or buttermilk, if available. The food should be gradually increased in quantity till from 9 to 12 lb. of meal are given daily. This may usually consist of 1 part bran, 2 parts sharps and 2 parts middlings, and should be fed in a somewhat sloppy condition. A large, deep-milking sow requires to be liberally fed on nourishing diet. Cooked potatoes or other succulent vegetables such as turnips or mangolds may be added to the above ration with advantage. Heating and fattening foods such as maize and barley and all refuse material which is not perfectly fresh and wholesome should be avoided. Sudden changes of food should be guarded against as being liable to cause scour in the litter.

Care of the Young Pigs.—Young pigs require clean, comfortable and sanitary surroundings. They begin to eat at three to four weeks old and should then be supplied, three times daily, with a small quantity of suitable food. This may consist of skim milk or fresh butter-milk, when available, mixed with some boiled potatoes, middlings, sharps or bran. Where no milk is available a little sharps, middlings or oatmeal and linseed meal (scalded) may be fed along with water. The young pigs should be fed from a special trough out of reach of the sow, and the trough should be thoroughly scalded at short intervals. Food which is too thick is frequently associated with (dietetic) convulsions, and this trouble is a source of much loss among young pigs. When the pigs are old enough they should be allowed to take exercise freely. Warmth, fresh air and sunshine—provided it is not too strong—encourage healthy, vigorous growth; access, however, to unhealthy situations, such as a hot manure heap, should never be allowed. When about seven to eight weeks old, the young pigs may be weaned, and should continue to receive the food for some time afterwards in a sloppy condition, three times daily.

If the young boars are not intended for stock purposes they should be castrated when about six weeks old. After

weaning, the sow will take the boar within three days or a week at latest, and if she is not too low in condition it is well to take advantage of the first "heat."

Fattening.*—*Pigs for Pork.*—The term of life for the pork pig should generally consist of only one part, the fattening period, not, as is far too frequently the case, of a store period, followed later on by a fattening period. The adoption of the second system may result in considerable loss. It must be remembered that as the pig advances in age the cost of producing a pound of meat from it will gradually increase. Again, the young and growing pig utilises most fully the various constituents of the food, and growing and fattening progress simultaneously, whereas the older or store pig chiefly needs only those constituents of the food which are required to fatten it. A certain quantity of food is necessary simply for its upkeep, so that if the pig lives only a month longer than is absolutely necessary the value of this amount of food is largely thrown away.

Success with this class of pig is best attained when, in addition to cereal meals and boiled potatoes, the feeder has access to dairy by-products. Separated milk given with meal and potatoes is normally worth at least 2*d.* a gallon for feeding to pigs.

Bacon Pigs.—In the case of bacon pigs, when a large frame is required, a store period is unavoidable, and this applies specially to pigs fed on refuse from hotels, boarding houses and public institutions.

Spaying.—The practice of spaying, *i.e.*, the operation by which female animals lose the desire for breeding, is falling into disuse in many parts of the country.

In the opinion of many breeders and bacon curers, however, the abandonment of spaying is unfortunate, as the practice is found to conduce to early maturity and to improve the quality of the pork, while it prohibits the development of unsightly "milk veins." The presence of the latter necessitates "belly stripping" or the removal of the udder when the pigs are slaughtered, and this may mean an appreciable loss to the bacon curer.

Notes on Feeding Stuffs.—In view of frequent fluctuations in the supplies and prices of feeding stuffs at the present time, it is only possible to indicate roughly the kind

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* A careful review of recent British experiments, in which 200 pigs were fed exclusively on meals until they weighed up to 300 lb., shows that on an average 4¾ lb. meal were required to produce 1 lb. of live weight; but the record of 100 of these pigs, until they weighed up to about 180 lb., showed a gain of 1 lb. live weight at a cost of only 3½ lb. of meal. Thus the lower weights are clearly the more economical, and this point should be borne in mind in connection with the methods of feeding now suggested.

of rations that may be considered suitable for the different classes of pigs. This subject is dealt with from time to time in the Board's *Journal*. Attention has been directed, however, to expedients that may be adopted with a view of cheapening summer rations, and it may be worth while to indicate generally the principles which should govern winter feeding under present conditions. Pigs require food containing a large proportion of starchy material. Barley meal is, on the whole, the best food for pigs, when obtainable at a reasonable price. Wheat offals (bran, sharps, and middlings), maize meal and rice meal also enter largely into pig rations, and the addition of pea meal and bean meal is particularly suitable for the "finishing" stages. Oats, suitably prepared, are just as well adapted for building bone and muscle in a pig as in a colt; for the weanling pig, up to about 12 weeks old, the husk should be sifted out, otherwise the whole grain should be ground very fine. If some damaged wheat, unfit for human food, is available for mixing with the oats, the combination will answer admirably for the young pig. As the pigs grow older, the woody fibre of the oat husks becomes less objectionable, and crushed oats may be fed with confidence to stores and breeding stock. The addition of a little linseed meal, pea meal or white fish meal, to oats, forms an excellent ration for stock of any age. Some of the newer feeding stuffs, *e.g.*, coconut cake (soaked), when obtainable at prices which compare favourably with the various meals enumerated, may be included with advantage in the rations for fattening pigs to the extent of about one-third of the total quantity of meals given.

Where they are available, chats or other unsaleable potatoes, cooked before use, should form part of the ration. (Working with small quantities, about 5 cwt. of coal will cook 1 ton of potatoes.) Roots, such as swedes, mangolds, and sugar beet, may be given uncooked. For feeding purposes it is estimated that about 4 lb. of potatoes or sugar beet are equivalent to about 8 lb. of mangolds or swedes or 1 lb. of cereal meals in mixed rations. It may be assumed, therefore, that when meal can be purchased for £8 a ton it will not pay to use potatoes for feeding if their market value exceeds £2 per ton.

For fattening stores a weighed quantity of potatoes should be cooked, mashed and mixed with an equal weight of wheat offals or rice meal and thinned with water to make a suitable gruel. Pigs will do well on this till about half fat. For finishing it is advisable to use a mixture of four parts of one or other of the above meals with one part of pea meal or bean meal mixed with the cooked potatoes as before.

For fattening newly weaned pigs to come out as "Londoners" or bacon pigs at about 7 months old, the ration should be somewhat more concentrated. Two parts, by weight, of potatoes may be cooked, mashed and mixed with six parts, by weight, of sharps or other suitable meal,

and one part, by weight, of coconut cake. The coconut cake should be soaked in water overnight before mixing. The mixture should be fed moderately thick and extra water given for drinking if necessary. Almost dry feeding, with water to drink, is probably the best practice during cold weather.

Purchased foods may be largely ignored where sufficient supplies of "tail" corn, small potatoes and dairy by-products are available. In the absence of these it might be worth while to sow, in spring, for pig food, a mixture such as the following :—

1 bushel		oats	per acre.
1	„	barley ...	
1	„	field peas	
½	„	spring beans	

The various grains produced might be ground up together, or the peas and beans might be screened out and fed separately.

The straw would make useful fodder for cattle.

A favourite American winter ration for fattening pigs consists of ground maize and linseed meal in the proportion of 9 to 1. Pigs weighing about 130 lb. at the commencement of fattening make from 1 lb. to 1¼ lb. daily gain in weight on an average total feed of 5⅓ to 5¾ lb. daily. The chief interest of this ration to the British feeder lies in the fact that he can grow linseed at present much more cheaply than he can buy it.

Use of Pasture and Forage Crops.—In view of the present high cost of feeding stuffs, attention is being directed to the practice of feeding pigs on pasture and special forage crops during the summer and autumn months.

Green food alone will not as a rule fatten pigs, but it will take the place of one-third or even one-half of the grain necessary to add 1 lb. of live weight. Mature pigs, thin in flesh, may be expected on good forage, without grain, to put on about ½ lb. daily. But, for the average store pig, suitable green forage will do little more than provide a maintenance diet, leaving the increase of weight to be produced by whatever extra food can be supplied. With the help of the concentrated foods available an average increase per pig per day of about ¾ lb. should be expected.

Barren sows have actually been fattened on good pasture without any supplementary foods, and palatable pork can also be produced under the same conditions.

It is necessary that pigs should be accustomed gradually to the outdoor life. Early spring farrows would appear to be best suited to summer grazing; and if born out of doors, or turned out with their mothers while quite young, they will become accustomed to nibbling grass while not dependent upon it for sustenance and will thrive all the better when weaned.

Pig-keepers should aim at having as many pigs as possible ready to turn on to good clovery pasture in May and June. Early maturing pigs will make good progress up to harvest with a minimum of meal, and the best of them may be fit to sell as porkers directly off the pastures. The others could be quickly fattened off with a few weeks' sty-feeding on "tail" corn, small or damaged potatoes or roots.

Pig-grazing might be more generally practised in standard orchards.

Before turning pigs on to pasture they should be ringed. They may be folded or allowed to run at large. Folds should not be too small, or the pigs tend to deposit their manure mainly on the boundaries.

Fencing is, of course, a difficulty at the present time: it may be worth mentioning, however, that in the event of pigs "nosing" under a fence, a barbed wire fixed close to the ground will prove a sure deterrent. Three strands of barbed wire fixed 6 in., 15 in. and 24 in. respectively from the ground will effectually confine all pigs. Hurdles are suitable for folding.

No hard and fast rules can be laid down for the guidance of pig-keepers in selecting a suitable type for grazing. Pedigree stock of probably all the breeds will soon adapt themselves to an outdoor life, but for general purposes a good quality sow of the local breed crossed with a boar of an early maturing breed, such as the Middle White, will usually prove satisfactory.

In the maize belt of America pigs are commonly run in the open pastures with cattle that are being fattened off upon maize. The pigs get a feed of grain daily and act as scavengers in consuming food that may be left untouched or undigested by the cattle—a practice akin to running pigs with bullocks in feeding-yards in winter time. Pigs fed in this way are "finished" by a month's fattening indoors.

Another system much practised in different parts of America consists in running or folding pigs on such crops as rape, lucerne, clover and peas, or a mixture of oats, clover or peas and rape (vetches alone are not suitable). It is found, however, that such crops alone will not produce an economical increase in weight, but must be supplemented by a daily allowance of grain. Pigs will then gain in weight at the lowest cost.

The usual quantity of grain (maize generally) fed in addition to the forage grazed is from 2 to 3 lb. per 100 lb. live weight, on which gains of from ½ to 1 lb. daily per pig are made. In grazing lucerne the number of animals is regulated to allow two or three cuttings yearly, the crop being cut at the time the little buds at the base of the stem begin to shoot. Over-pasturing without cutting injures the crowns of the lucerne plants. The cut lucerne is made into hay and fed to brood sows along with maize during the winter. From 4 to 4½ lb. of maize and 1 or 2 lb. of lucerne

hay fed from a rack are the usual allowances. Rape is usually sown in drills, and the pigs are turned on the crop when the plants are 10 or 12 inches high. When it is eaten down to 4 or 5 leaves per plant the animals are removed to give the rape a chance to recover. Rape contains somewhat less protein than lucerne or clover, and it is therefore customary in pasturing rape to allow the pigs a small proportion of meat meal or other albuminous food in addition to maize. Clover or peas are often sown in mixture with oats and rape, the following seedings being recommended :—

1.—½ bush. oats ... 8 lb. red clover 3 lb. rape ...	per acre, or	2.—1 bush. oats 1 bush. peas 3 lb. rape	per acre.

It is estimated that an acre of lucerne, rape, or the mixtures recommended above will keep from 12 to 20 pigs of 100 lb. live weight for 4 weeks. Where conditions do not permit of folding, the same crops may be used for soiling.

The chief advantages claimed for the outdoor system of feeding bacon pigs are :—

1. Reduced cost of food.
2. Saving of labour and attendance.
3. The animals are almost invariably in prime health, and when housed for finishing have generally good appetites and respond readily to liberal feeding.
4. The field is benefited by rich and even manuring.

In the summer of 1914 a pig-feeder in Co. Waterford depastured a field of 16 acres with 54 store pigs of four to five months old. The pigs cost, on the average 29*s.* 6*d.* each in May and June. In addition to grass the pigs were allowed to start with ¾ lb. per head daily of whole maize, which was increased to 1 lb. per head after the first fortnight. As the pigs got heavier the allowance was gradually increased until 3 to 4 lb. per head daily were being given. The maize, which was fed whole, was scattered on the ground twice daily, usually in a direct line. The pigs had access to water and to an open shelter shed. For the last month the pigs were finished off in feeding pens on a daily allowance of 6 to 8 lb. of a mixture of maize and pollards to which treacle water was added to make the meal sufficiently moist. As the pigs approached 2 cwt. live weight they were sent off in batches to the nearest factory, all being disposed of by the end of September. The total cost of the pigs, including the buying-in price and the concentrated food consumed, amounted to £209 16*s.* 10*d.*, and the total receipts for pork delivered at the factory amounted to £266 3*s.* 11*d.* After deducting a bonus of £2 5*s.* 0*d.*, allowed to the attendant, there remained a balance of £54 2*s.* 1*d.*, or 20*s.* per pig. The pork realised an average price of 60*s.* per cwt., and the manager of the factory reported that it was the best that had been cured in the factory for the season.

The experiment was repeated in 1915, 51 pigs yielding an average return of £1 8*s.* 10*d.* per pig.

(For further particulars of these experiments reference may be made to the *Journal of the Department of Agriculture and Technical Instruction for Ireland*, January, 1916.)

It is well known that pigs require less food in summer and early autumn than they do in winter to produce the same increase in weight, the reason being that in the warm weather less food is needed to maintain the bodily heat, and consequently more is available for the production of fat. In an experiment conducted in Ireland under the auspices of the Department of Agriculture and Technical Instruction, with 98 pigs fed from April to October, 3·91 lb. of meal yielded 1 lb. of increase, whereas in the case of 40 pigs fed from November to March, 4·23 lb. were required for each 1 lb. of increase.

In a case described in the Board's *Journal** nearly all the sows are farrowed out in movable wooden huts or shelters, which measure 8 ft. by 8 ft., and are bolted together in sections. An opening, 3 in. wide, is provided along the ridge of the hut for purposes of ventilation, and the entrance door is made in two halves, the upper half being kept shut in cold weather and the lower one always open. To facilitate moving, the huts may be provided with wooden runners, which also serve the purpose of keeping the floor off the ground.

During the winter all the larger gilts and sows from 12 months upwards are ringed and allowed to roam over the grass land. This is beneficial in two ways. The breeding pigs walk a lot in search of choice grasses, and at the same time pig manure is deposited all over the pasture.

Under this system it is found that :—

1. Breeding sows are more prolific and much hardier than those kept in sties.
2. The young are bigger and hardier than sty-bred pigs.
3. Feeding is more economical.

The breeds kept are pedigree Large Blacks and Middle Whites.

Tuberculosis in Pigs.—It should be noted that a very considerable number of carcases of tuberculous pigs are sent to the markets for sale as human food, and many persons have been prosecuted on this charge, and in some cases heavily fined. Pig-breeders and feeders are cautioned, therefore, against the risk of prosecution which they incur by offering such tuberculous carcases for sale. Tuberculosis is by no means uncommon in pigs, and is often caused by feeding

* *Jour. Bd. Agric.*, Jan., 1916, "Waste Woodlands for the Breeding of Pigs," S. F. Edge.

them on refuse milk from dairies in which cows with tuberculous udders exist, and on diseased offal from cattle. Especial care should, therefore, be taken to prevent swine from coming into contact with any parts of the internal organs of diseased cattle.

The indications of tuberculosis in the pig's carcass consist mainly of hard swellings in the glands around the throat, and the presence of white cheesy-looking deposits of tubercular material in the mucous membrane of the intestines, in the mesenteric glands or in the lungs (*see* Leaflet No. 277, *Tuberculosis in Farm Stock*). In the event of any of these conditions being found after death, the owner should not send the carcass to market before ascertaining from the Sanitary Inspector of his district or from his Veterinary Surgeon that the carcase is fit for human consumption.

Good sanitation and periodic disinfection of premises should be the order of the day wherever pigs are kept, and all empty pens should be carefully disinfected prior to the introduction of fresh stock.

Swine Fever.—In order to avoid infection, purchasers of pigs should always keep the newly-acquired animals separate from the home herd for at least 28 days; and farmers should be careful not to allow persons who may have been in contact with diseased swine to handle, or even to approach, their pigs.

Leaflets No. 29 (*Swine Fever*), No. 227 (*Swine Erysipelas*) and No. 121 (*The Construction of Pigsties*) should be read in conjunction with the present leaflet.

London, S.W. 1,
January, 1904.
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.

GENERAL INDEX.

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