HANDBOOK

OF THE

DESTRUCTIVE INSECTS

OF

VICTORIA.

PART II.

FRENCH.

Price 2/6.

Edwin C. Van Dyke

Jo coloured Lithos

A HANDBOOK

OF THE

DESTRUCTIVE INSECTS

OF

VICTORIA,

WITH NOTES ON THE METHODS TO BE ADOPTED TO CHECK AND EXTIRPATE THEM.

Prepared by Order of the Victorian Department of Agriculture

BY

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Government Entomologist.

PART II.

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ERRATA.

At the bottom of plates XXX. and XXXI. (opposite pp. 114 and 116), for "C. C. Brittlebank, del.," read "Reproduced from drawings by A. L. Clément for Messrs. Hachette and Co., Paris."

On page 222 (Index), for "Wright, Allan," read "Wight, R. Allan."

On page 21, for "Mr. D. Carson," read "Mr. J. Carson"; and on page 216 (Index), for "Carson, D.," read "Carson, J."

Contents.

PREFACE TO PART II.

The second part of "The Handbook of the Destructive Insects of Victoria" has been prepared on the same lines indicated in the preface to Part I.

It is hoped that this part will prove a welcome addition to the library of the "grower," for whose special benefit the work has, by order of the Victorian Department of Agriculture, been undertaken. Technical terms, as before, are used only where considered absolutely necessary, although, on the suggestion of some entomological friends, the authorities for most of the specific names of the insects figured are here given.

To those who have offered suggestions I am greatly obliged, and whatever useful information I could obtain, no matter from what source, has been used for the benefit of those for whom the work is intended, and this plan will be continued until the end.

C. FRENCH.

Melbourne, 1893.

PLATE XV.

"Green Peach Aphis" (Myzus? sp.).

Fig.

1. Peach branch, showing curl of leaf caused by aphis. Natural size.
2. Female aphis, winged form. Magnified.
3. Pupa of female. Magnified.

4 and 5. Earlier stages of female. Magnified.

6. *Leis conformis* (common garden Ladybird). Magnified.

6a. Natural size of Fig. 6.

7. Pupa of Fig. 6. Magnified.
8. Larva of Fig. 6. Magnified.

9 and 9a. Hemerobidæ. Parasite on aphis. Slightly enlarged.

10. Hymenopterous parasite on aphis. Natural size.

10a. Magnified specimen of Fig. 10.

Plate XV

DESTRUCTIVE INSECTS OF VICTORIA.

CHAPTER XXI.

THE GREEN PEACH APHIS.

(*Myzus sp.*)

Order: *Hemiptera.* Sub-order: *Homoptera.* Family: *Aphididæ.*

This species is even more dreaded by growers than the so-called black Peach Aphis, as it appears later in the season, when the trees are in leaf; and as it curls the leaves by perforating them with its beak-like rostrum (see Fig. 1), it renders the labour of spraying much more difficult, and the chances of destroying the insects more remote.

The Green Peach Aphis in its habits is much like that of the black one, but the shape and colour of the insects in their various stages are different (see Plate XV.).

When the aphides leave the tree, which, as a rule, they do about the end of November, or even late in December, according to seasons, locality, &c., the young and perfect insects also congregate around the base of the roots, whilst large numbers, after perpetuating their species, die, and are either blown away or eaten by ants or birds. Ants will carry off dead aphides, but will on no account attack living ones, on which they are, however, partly dependent for their sustenance. Immense numbers of the eggs are deposited in the crevices, crotches, or on other parts of the tree, only to come forth as soon as favorable weather for their operations commences. This is the case with most aphides, and is the object of attacking them by spraying when the trees have shed their leaves, and again just before the swelling of the buds. The rostrum or beak of the Green Peach Aphis is slightly different to that of the Black Peach Aphis, being somewhat longer and narrower in proportion to the rest of the body. The body of the Green Aphis is broader and more cylindrical

than those of the Black Aphis which have come under my notice, and, being green, are not so conspicuous when on the tree.

On our Plate (Fig. 1) is shown a portion of the branch of a tree, there not being sufficient room for a figure illustrating the insects on the roots. This, however, is shown on the large charts which, by permission of the Department, I have had prepared for lecturing purposes, and which may be seen by any one interested at the office of the Government Entomologist, Exhibition, Melbourne.

With regard to the rostrum of an Aphis, which organ plays such an important part in the economy of the insect, Buckton remarks that aphides are wholly suctorial in their habits, and depend entirely upon the sap of different plants and trees for nourishment. As the sources of their food vary, so the rostrum undergoes modification to meet special requirements. Whilst some genera are furnished with exceedingly short rostra, others show the organs produced to an extraordinary length. The most marked example of this peculiarity may be noticed in *Stomaphis quercus*, which seeks its sustenance in the alburnum or inner bark of the dense trunk of the oak tree. Here the rostrum is nearly twice the length of the insect, and the setæ or hairs are very much longer. By these piercers the insect burrows under the hard masses of the cortex, and produces, by their irritating and inflammatory action, a plentiful flow of sap. The juices are drawn into the mouth by a sort of alternating or pumping motion, analogous to that seen in the honey bee. It may be interesting to know that, according to Buckton, in by far the greater number of cases the males and viviparous females of aphides are provided with four wings, as shown in Fig. 2, a female, of course highly magnified, the little cross beneath the figure being about the natural size of the insect with wings expanded, by which they transport themselves into other localities, either in search of fresh food or for the purpose of founding new colonies, and it is the nervation (nerves), or venation (veins), which entomologists find of such great value in determining or

subdividing this family into suitable genera; although, as Mr. Buckton remarks, that amongst *Aphidæ* caution is necessary lest the not infrequent abnormal characters of nervation should mislead us. This information is included for the use of any persons who may care to take up the subject, which will amply repay any one having sufficient time to devote to so interesting a matter.

Prevention and Remedies.

In our chapter on the Black Peach Aphis some account of the best methods for dealing with these pests will be given; it may, however, be mentioned that the early use of that useful article the "nicotine whale-oil soap" has been tried by many persons with great success. When the first part of this book was offered to the public, it contained a statement that this soap would probably prove very useful to growers for spraying purposes, and these prognostications, I am glad to state, have been amply verified. The chief difficulty which presents itself when dealing with the Green Aphis on the branches is, that the leaves through their being pierced by the aphides have curled up, thus forming a partially secure hiding place, and from whence it is exceedingly difficult to destroy them. It has to be attempted, however, so we must see to our machinery for spraying, and take advantage of any improvement whereby our efforts may be lessened or assisted. Many growers complain, and not without reason, that the spraying often does as much damage to the tree as do the aphides themselves. This statement, however, is only partly true; for if discretion is used whilst spraying, the tree, however tender, cannot suffer in any great proportion to the damage done by the aphis pests; and if done thoroughly and properly, as before explained and recommended, it cannot possibly kill the tree, which, unless prompt measures are resorted to, these pests will eventually do. We may, I think, fairly and safely take up the position, that with ordinary intelligence, and a high state of cultivation, in which is of course included perfect drainage, coupled with such

assistance and advice as the Entomologist and other experts of the Department can supply, ought to be the means of lightening the labours of those, all honour to them, who have spared neither expense nor trouble, combined with a practical outcome of enthusiasm, to keep their orchards clean and to present the fruits or other products in a proper marketable condition to the public, and, of course, with increased profit to the growers themselves. In America a motion has been carried by a very learned, practical, and influential society, that the man who has an orchard, farm. or vineyard, and cleaneth it not, be voted a public nuisance. It is to be hoped that this stigma will not be long allowed to apply to any grower in Victoria; still many of the smaller holdings are at present simply "breeding nurseries" for pests all and sundry.

On our plate are added figures of the common Lady-bird, *Leis conformis* (see Fig. 6), magnified—Fig. 6A representing the perfect insect in its natural size, and also on the wing; whilst in Fig. 7 the pupa, enlarged, is given; and in Fig. 8 the curious larva, which is such a terrible enemy to aphides and many other small pests, is also shown. In making a careful examination of a group of aphides with a lens, there may be often noticed a number of the insects which are dead, with the contents of their bodies, which have been hollowed or rather sucked out by the larvæ of certain parasites, amongst which are those of the *Hemerobidæ*, or "Lace-wings" (see Figs. 5 and 9); also by minute Hymenopterous insects, four-winged flies, which deposit their eggs in the body of the aphides, which they pierce by means of their fine hair-like ovipositors. The natural size of this little insect is given in Fig. 10, the enlargement being shown in Fig. 10A.

There are other insects which attack *Aphidæ*, the larvæ of some of the *Syrphidæ*, a two-winged fly, supporting itself erect by its hinder parts, and, whilst in this position, it seizes upon any unfortunate aphis which comes within its reach and devours it at once. This singular habit on the part of a larva is shown on Plate XXXV., Fig. 13, Cabbage Aphis.

One remarkable fact about these Peach Aphides, and which others besides myself have doubtless observed, is that in some of the old gardens in the city large peach trees, which may have been planted in the early days of the colony, would appear, upon a very careful examination, to be nearly free from blight of any kind, and, as fruit is occasionally borne, the tree would seem to be healthy. Here is a problem for our savants to solve. Why are these trees, which certainly show no signs of superior cultivation, so clean, whilst others, on highly-cultivated land, and which are very old trees, are often badly attacked and killed by these aphides? In this connexion it may be interesting to note that the soil in the city is generally of a very stiff and heavy nature, with a firm, hard, and often stony subsoil, and a knowledge of these facts may help us to unravel this mystery, and would appear to point to the heavy tenacious soil as one of the principal causes of the trees' immunity from insects of this kind. In another part of the present number an account is given of an implement by which bisulphide of carbon may be injected into the soil. This machine is fully explained, and, it is hoped, may prove as successful as has been represented. Once we can master the pests at the roots, success as to the other pests, if carefully attended to, will be sure to follow.

PLATE XVI.

"Black Peach Aphis" (Myzus cerasi. Fabr.).

Fig.

1 Branch of peach, showing insects on stem and young leaves. Natural size.

2. Winged female. Magnified.

3. Wingless female. Magnified.

4. Pupa. Magnified.

5. Winged male. Magnified. (After Buckton.)

6. Winged female, green. Magnified.

7. Rostrum (or beak). Magnified.

C.C.B. Wabash Del.

Plate XVI

CHAPTER XXII.

THE BLACK PEACH APHIS.

(*Myzus cerasi. Fabr.*)

Order: *Hemiptera.* Sub-order: *Homoptera.* Family: *Aphididæ.*

This is one of the two kinds of Aphis so much dreaded by growers of peaches throughout the colony. It is an introduction from Europe, where, according to Buckton, it does much injury to the cherry orchards in early spring, when they cluster by thousands under the leaves and dry them up as if scorched by heat. Fitch, in America, counted 190 ranged down the mid-rib of one leaf. They choke and gum up the pores of the leaves by the secretion which they eject from their conicles, or leaf-like processes. On account of this sweet substance the affected branches are much visited by ants, of which the little black one, with a vile smell, and a perfect terror to housewives, would appear to be the most common here.

To those unacquainted with the appearance of a peach tree which has been attacked by the Black Aphis, it may be pointed out that the small branches are mostly bent downward and otherwise twisted, often assuming a burnt and blackened appearance. This is a sure sign, and may be relied upon.

In England, Mr. Wallace states, two swarms usually occur in the year with a certain interval, one in June and the other in October. During the latter period the male makes its appearance. He describes them as being wholly black, and probably the older specimens are so coloured.

How long ago it is since the first advent of this pest into Victoria I am unable to say with any degree of certainty; but fruit-growers in this colony will well remember the time when peaches around Melbourne grew and

ripened splendidly. Now, what between the aphides, borers, and "fungus curl," growers are at their wits' end to know what to do to prevent or remedy all or any of these serious obstacles to successful peach-growing, at least in many districts throughout the colony.

In the coloured plates with which Part II., as in Part I., is illustrated, I have endeavoured to show you the Black Peach Aphis in many of its stages, and which, it is hoped, will assist the grower in recognising this pest at a glance. To many, however, the forms will, unfortunately, be but too familiar.

The Black Peach Aphis makes its appearance when the tree is bare of leaves, generally about the end of June or beginning of July. In some districts it will be earlier and in some later, according to locality and season. In Castlemaine, for example, Mr. J. Lang informs me that this pest on badly-affected trees is sometimes prevalent all the year round, but does most harm when the trees are in bloom and starting to shoot, completely destroying the young fruit and foliage, and in some cases destroying the tree also; but trees which are not so badly injured generally recover when the warm weather sets in, towards the end of November.

Near Melbourne, the Black Peach Aphis, especially in the Doncaster and neighbouring districts, where it is very prevalent, usually makes its appearance about the end of July or early in August, according to Mr. Thiele and other leading growers, just before the buds begin to open; so that we may safely believe that this species at any rate may be visible upon the branches of the tree nearly the whole year through.

As a rule, however, its disappearance may be said to date from the time at which the hot winds set in, and it is a fortunate thing for the grower that those little pests cannot stand many of our real scorching hot days; but if the weather be cool and moist the insects may remain on the trees, supposing no steps be taken to suppress them, until the middle of December, or even later.

A few years ago but little was known with certainty as to the life history of these pests. It has now been well ascertained that the insects are also on the roots of the tree not far beneath the soil, and are generally to be found clustering around the base of large roots near the stem of the tree, and from which, although many of the insects are in a partially dormant state, the nourishment necessary for their existence is obtained. The sap, as in the case of Aphis attacks in general, being sucked up after the bark of the tree or its roots have been perforated by the long beak-like rostrum, as shown in Fig. 7, and which beak, when the insect is at rest, is "tucked up" beneath the fore part of the body of the insect.

Lintner, in one of his valuable reports on the injurious insects in the State of New York, has the following remarks on an Aphis attack on the roots of peach trees, and communicated by Mr. Lorin Blodget, of Philadelphia. He says:—"The injury to the trees was first noticed in the year 1881, but its cause remained unknown until the early part of July, 1884, when upon pulling up a seedling peach tree, beginning to wilt, its stem for an inch below the surface was found to be crowded with dark-coloured aphides, numbers of ants being associated with them. In following up this discovery, of a hundred trees examined one-half at least were found to be so seriously injured that they were past recovery, and were accordingly destroyed. It was doubtful if any of the remainder could survive the attack. In one instance, some aphides were discovered above ground upon the succulent shoots, about a foot long, of a three-year-old tree, which were densely crowded with them, presenting a singular sight with their black shiny backs, covered with ants, and with large flies often upon them. During forty years' growth of seedling peaches no injury of this character had been observed before this attack."

When first seen on the branches they are to be found in clusters just below the bud, and at this period are of a dark plum colour, semi-transparent, and nearly black, as shown in Fig. 3; and before assuming the winged

stages (see Figs. 2, 5, and 6) they ascend the tree, the shoots of which they cover in vast numbers, drawing off the sap, so necessary at this period of the tree's existence, and thus causing the young fruit to wither and fall to the ground, and the shoots, which have now put forth their leaves, to assume a sickly appearance, often turning black at the point as if scorched by the sun.

There has been much speculation amongst growers and others as to whether the Black and the Green Peach Aphis are one and the same species. This matter I have submitted to Mr. Buckton, our best authority on this group, for his opinion, and he says they are different species, and I am indebted to that gentleman for the correct name of the one which we know as the Black Peach Aphis, the Green one being a distinct species of the same genus.

In many of the aphides the colour would seem to vary in a most remarkable manner, so that it is no difficult matter to fall into an error concerning the names. I mention this fact as there is a discrepancy between our plates and those in Mr. Buckton's fine work on British Aphides, although all in this plate, with the exception of Fig. 5, have been drawn from nature.

In a former number of the book I have already alluded to the enormous increase which takes place in this group of insects, and have also furnished some particulars which it is perhaps unnecessary to repeat here; and although such facts, which have been attested to by some of the best naturalists and observers of the day, may cause us to wonder at such a formidable array of figures as those supplied by Bonnet, Reaumur, and others who have so patiently devoted so much time to such an important subject, it should also be the means of putting us on our guard and making us the more determined to check if at all possible the enormous increase in pests of this kind.

Having given you a brief account of the habits and life history of this insect, I must now pass on to what is perhaps the most important part, viz., how to prevent

their coming; but should they make their appearance what are the best means to be adopted in getting rid of them.

Fig. 1, it may be remarked, as the text will explain, shows a portion of peach branch with insects both winged and without wings clustering around the stem, and here the little insects are shown in their natural sizes.

Prevention and Remedies.

We have already stated that the Black Aphis attacks also the roots of the tree; this knowledge is, or ought to be, to us a great assistance and advantage when adopting measures for prevention and eradication.

In the first place we have to consider the earliest and best time of the year when the tree should be treated for this Aphis; secondly, the easiest and least expensive methods; and thirdly, the best materials to be used; always bearing in mind that to recommend a remedy which, owing to its cost, is either impracticable or too expensive, is but to add to the difficulties under which our orchardists and others who are engaged in rural pursuits labour. It is only practical men, who have had to make their living from the proceeds of their orchards, farms, or vineyards, who are able to appreciate the truth of these remarks, as coming from one who has had some experience as a grower himself.

Taking it for granted, then, that the two aphides of the peach live on and breed also on the roots of the tree, the natural conclusion to which any one must come would be to first treat the tree whilst in its dormant state, and immediately before pruning.

Remove carefully the surface soil, using a fork where necessary; then take 1 oz. of bluestone (sulphate of copper), dissolve in two gallons of cold water, being careful that the water is not either salt or even brackish. Each tree of four or five years old, if vigorous, will take a couple of gallons at least of this mixture. In removing the soil from the surface, do not lay bare the roots, as the soil is only removed so that the mixture may have a more

direct effect. The mixture ought, if possible, to be applied from a wooden pail or cask, as it is easier and does not corrode the sprayer. When the soil has been watered with this mixture, cover the roots up carefully, which done, "paint" some lime, sulphur, and soap mixed around the stem of the tree; gas-lime would be preferable if spread over soil, and which the rains will wash in, but this latter must, according to the sound advice tendered to me by Mr. A. N. Pearson, of our staff, be exposed for at least three months before using, at any rate near ordinary fruit trees, and peach trees in particular. Professor Smith, of the New Jersey Agricultural College, U.S.A., speaks very highly of the successful use of a dressing of kainit and nitrate of soda spread on the surface over the root system, or placed in a trench at the tree at a distance of two feet from the trunk or stem. In spraying the trees for aphides, when on the branches, it must be borne in mind (this piece of advice is tendered for the benefit of beginners) that the peach is one of the most delicate of our ordinary fruit trees, so that when spraying or otherwise treating the tree, either for insect or fungous diseases, great care should be exercised.

Mr. Dumas, Permanent Secretary of the Academy of Science of France, recommends as being superior to the bisulphide of carbon treatment the use of the sulpho-carbonate of potassium and sodium and of barium as evaporating less quickly than the bisulphide of carbon, so useful in applications of this nature.

The sulpho-carbonate of barium decomposes under the influence of carbonic acid, and evolves, according to M. Dumas, sulphuretted hydrogen and bisulphide of carbon. Placed in the ground, by its slow decomposition, it should prove a powerful insecticide. Sulpho-carbonate of potassium, in addition to its toxic effect, has also a direct invigorating influence upon the plant.

At the head of the list of the best remedies for spraying for Peach Aphis would, according to the most overwhelming testimony from practical growers, coupled with carefully-conducted experiments both here and abroad, appear

to be kerosene emulsion; and it must be remembered that such preparations as London purple, Paris green, hellebore, and other poisonous compounds are of little, if any, use against aphides, since these pests suck the sap only, and do not, as in the case of the Pear Slug, caterpillars, &c., eat the tissue or surface of the leaf; so that they must be treated with a contact poison, and which will, if heated, be all the more powerful when applied to hardy trees. But in the case of peaches it would not be advisable to have the material more than lukewarm. When the tree is dormant, however, it can, without danger, be sprayed on whilst hot, say up to 130 degrees Fahr.

The resin compound is another most valuable remedy. In the case of tender trees, however, common washing soda should be used instead of the more powerful caustic soda recommended as one of the ingredients against the hardier scale insects, &c.

The following formula for the kerosene emulsion is recommended by the New Jersey Agricultural College Experimental Station, and I have not the slightest doubt as to its success if properly applied:—Kerosene, 2 gallons; water, 1 gallon; hard soap, ½ lb. Make a suds of the soap and water, and pour, boiling hot, into the kerosene. Churn well with a force-pump or a syringe, pumping out of and into the bucket through a rose nozzle until completely emulsified. If the mixture is sufficiently hot it will thicken in from five to ten minutes, and will be, when cold, of the consistency of butter or of soft soap. For Peach Aphis, dilute with fifteen parts of water. When the tree is without leaves, a much stronger proportion can be used, and the emulsion may then be used with safety at, say, one part of the emulsion to ten of water. This can be put on hot, as the remarks above quoted are only intended to apply to spraying trees when the young shoots are tender, or where the leaves are on the tree.

A friend of mine, who has an orchard in the Dandenong Ranges, assures me that he holds both kinds of Peach Aphis in supreme contempt, simply by spraying the trees

once just after pruning, and once after the fruit has properly set, with a solution of sulphate of potassium, in the proportion of 1 oz. to the gallon of water. This would also be a very cheap, effective, and safe liquid for applying to the roots of the trees.

One of the good old remedies against peach blight is to take 1 lb. soft soap, 1 lb. tobacco, to which add 20 gallons of water; boil, strain, and spray whilst hot.

Another grower, who has a large peach orchard, sends me the following formula, with which he assures me he has entirely mastered the aphides :—Water, 15 gallons; magic soap, 2½ lbs.; kerosene, 2 quarts. Slice the soap into the water, and when boiling add kerosene, stir well for five minutes, and use whilst hot. This, of course, is only to be used when the buds have not expanded, or the young leaves on the tree.

Mr. J. West, one of the best known growers in the Mooroopna district, declares that he has also mastered the aphis attacks by the use of the resin compound above. He prepares it after the manner of our old formula, viz. :—Common commercial resin, 20 lbs.; washing soda, 6 lbs.; fish-oil, 3 pints, and water to make 100 gallons. Place the resin and soda in a boiler, adding sufficient water to cover it. Boil freely when dissolved. Add fish-oil. Boil all together for about an hour rapidly, adding a little water occasionally to prevent boiling over. When finished add the 100 gallons of water. This preparation is specially useful for both aphides on peach, and is much weaker than that recommended for scale insects, &c.

These are the principal remedies to be used against this troublesome pest; and now that we are certain of the insects also living on the roots, we have a very strong clue as to how best to prevent, or at least successfully meet, their attacks.

A few months since I had great hopes that we might be able to discover something in the way of resistant or of even blight-proof stocks. A friend of mine having a small garden in which he has a row of peach trees trained, home style, against a fence, aspect northerly. I found that he

has the peaches planted alternately, a tree of the "Royal George" standing between such varieties as "Salway," "Early Rivers," &c. The Black Aphis on the latter varieties was very bad indeed, whilst the "Royal George" (supposing this variety to be true to name) was, so far as I could discover with the aid of a lens, absolutely free from blight of any kind. Here, thought I, is a discovery which, on mentioning it confidentially to my old friends, C. Draper and Geo. Neilson, caused them to shake their heads ominously, which, however, only made me the more determined to follow the matter up further. The trees were watched carefully, and on the 26th of the present month, June, 1892, I again visited the trees and found to my astonishment that the "Royal George" was the only one of the varieties attacked. I have mentioned this matter to point out the danger of superficial investigations of any kind, and more particularly in matters of such moment to our rural industries.

I still hope, however, that something may yet be discovered, as in the case of the resistant vines and apples, which, if not actually blight-proof, may be of such a nature as to help us to keep this and kindred pests in check.

The strictest watch should be kept on all imported trees, whether peaches or otherwise, and these, before planted, ought to be thoroughly treated according to the advice given in Part I. of this handbook. This is a matter that must be insisted upon, that is if we desire that the importations of new pests should cease.

Our tiny insect friends, the Ladybirds, should be protected by every grower throughout the land; and so that there may be no mistake as to the kind which needs to be protected, I have given some figures of same on Plate XVI. Many of the insectivorous birds, too, are great destroyers of aphides, and should be carefully protected from the senseless attacks of the "Pot-shot-man" and others not so vicious or mischievous, but none the less dangerous.

Spraying is a work that must be done with intelligence and care, and as one of our best American writers has

said, the effect depends on the thoroughness with which the work is done, not on the amount applied. The object is to get the thinnest possible layer of material on every leaf and fruit, and all beyond that is waste.

On a cool calm day spray at any hour. On a hot day spray during the early morning or late in the afternoon. Never spray any kind of fruit tree when it is in bloom. The soundness of this latter advice, *re* spraying the tree whilst in bloom, has been contested, but the testimony in its favour is of such an overwhelming nature that it cannot, I think, be successfully disputed.

In bringing these few remarks concerning the Black Peach Aphis to a close, I would here respectfully ask the kind assistance and co-operation of growers and others who, by their observations in the field, can be of the greatest service to this branch of the Victorian Department of Agriculture, by sending from time to time the results of their experiences, the receipt of which will greatly add to a more general knowledge of the subject, and which cannot fail to be of mutual advantage. I sincerely trust that growers will continue to accord me their support and active assistance, for the growers and the entomologist must go hand in hand to obtain the best results, as the grower is in the field daily and can tell how things are going on, and, as has been said by a distinguished economic entomologist, he is an assistant the entomologist cannot well do without.

PLATE XVII.

THE "PLUM CURCULIO" (CONOTRACHELUS NENUPHAR. HERBST).

Fig.

1. Branch of plum tree, showing fruit and weevils, also where fruit is entered. Natural size.
2. Plum fruit, showing larva inside. Natural size. (After Riley.)
3. Larva. Magnified. (After Riley.)
4. Pupa. Magnified. (After Riley.)
5. Perfect insect. Magnified. (After Riley.)

C. T. Frittlebank, Del. J. French, Direxit. F. A. Ashe, Lith.

Plate XVII.

CHAPTER XXIII.

THE PLUM CURCULIO.

(Conotrachelus nenuphar. Herbst.)

Order: *Coleoptera.* Family: *Curculionidæ.*

The Plum Curculio, which belongs to the great family of the so-called Weevils, amongst which is Leptops, that well-known destroyer of apple and other trees in Victoria, also many others too numerous to mention here.

There is considerable doubt as to whether we have this pest here or not, but years ago it will be remembered that one of our best known pioneer amateurs, Mr. D. Carson, of Kew, submitted specimens of an insect which he found to be attacking his plums, and which if not really identical with this species certainly resembles it in its more important economy. In those days the study of economic entomology in Australia was, for any practical purposes, we may safely say little known or but imperfectly understood; so we are in the dark as to the real culprit then attacking the plums at Kew. As we may, however, at no distant date have to deal with this much-dreaded pest, and as we look to such a brilliant future for the grower of fruits suitable for preserving and export, it has been thought advisable to include in Part II. a description of an insect which, in this age of fruit-tree importation and rapid steam communication, may be with us at any moment; so that when we see it, should we be so unfortunate as to unwittingly introduce it into Victoria, we may be able at once to recognise it and to take the necessary steps, which are here recommended by those who have had to deal with it in America and elsewhere, for its eradiction.

The notes here given are taken from Mathew Cooke's excellent work on insect pests already alluded to in Part I.

of this book, the plates being drawn from the admirable illustrations by Professor Riley, Chief State Entomologist of the United States, and for the accuracy of the original plates the name of that gentleman is a sufficient guarantee.

The branch of plum tree, with fruit and small beetles on same, is from nature, the insects being about the natural size, as per published descriptions. "Living in plums, cherries, pears, nectarines, apricots, quinces, and apples, a yellowish-white footless grub, see Fig. 3, which undergoes its transformations in the earth." This is undoubtedly the worst enemy (in America) with which the fruit-grower has to contend, in fact its operations have become so extensive that the raising of plums has become almost entirely abandoned in several sections of California.

"The female Curculio makes a small hole in the fruit with her snout (see Fig. 1), then turns around and therein deposits a single egg, after which she gnaws a crescent-shaped slit around and partially under the egg. This precaution is probably taken in order to prevent the fruit from growing over and thus destroying the egg. This crescent is a pretty sure indication that the fruit upon which it appears is infested with the Curculio, although upon apples and similar fruits the growth is so rapid as to obliterate the growth of the fruit in a short time.

"Each female is supposed to have a stock of from 50 to 100 eggs, and to deposit from five to ten a day, while those which appear earlier, begin this work by the middle of May; it is continued by others which appears later, so that the period of egg-laying is extended to a period of about two months.

"The larva which hatches from the eggs of the Curculio is a small footless worm, somewhat resembling a maggot, except that it does not taper so much, and it has a distinct head. It is of a glossy yellowish-white colour, but partakes more of the colour of the fruit which it infests. There is a lighter line running along each side of the body, with a row of minute black bristles below, and a

less distinct one above it. The under part is reddish-brown, and the head is yellowish or pale brown. When fully grown, it measures about five lines in length. As soon as it reaches its full growth the larva deserts the fruit, which usually falls to the ground before ripening, and enters the earth to the depth of a few inches, where it forms a small cell in which to pass the pupa state (see Fig. 4).

"It remains in the pupa state about three weeks, when the change to the perfect insect takes place.

"The perfect insect (see Fig. 5, magnified) is about two lines long, and is of a dark brown colour, variegated with white, yellow, and black. The snout is rather longer than the thorax, the latter being uneven. The wing cases have two black tubercles on them, one on the middle of each suture; behind these is a broad band of dull yellow and white. The thighs have two small teeth on the underside.

"This insect lives not only in the fruits mentioned at the head of this article, but also in the black-knot infesting plum and cherry trees.

"The perfect beetle feeds not only upon the fruit, but also upon the leaves, and even the bark of newly-formed twigs does not escape its attacks.

"The number of broods which this insect produces in a year is not definitely known, but most authors regard it as being single brooded.

"The perfect beetles hibernate beneath pieces of wood, &c., lying upon the ground.

"I am not aware that this insect has, up to date, been found in California, but as we have received so many injurious insects from the East, it is not improbable that the Plum Curculio will make its appearance amongst us. The greatest care should be taken to prevent its importation on nursery stock from infested districts."

Remedies recommended.

To 1 lb. of whale-oil soap add 4 oz. of flour of sulphur, mix thoroughly and dissolve in 12 gallons of water.

To half a peck of quick-lime add 4 gallons of water, and stir well together. When fully settled pour off the transparent lime-water, and add to it the soap and sulphur mixture; add to the same also, say, 4 gallons of tolerably strong tobacco water. Apply this mixture, when thus incorporated, with a garden syringe (or spray pump, which is vastly the better method—C.F.) to your plum or other trees, so that the foliage shall be well drenched. If no rains succeed for three weeks, one application will be sufficient. Should frequent rains occur the mixture should be again applied until the stone of the fruit becomes hardened, when the season for the Curculio's ravages is past.

This mixture is good to destroy the slug, caterpillar, green-fly, thrips, and a host of the enemies of vegetation. It is my impression that I found the wash stronger than needed or desirable, and diluted it to a considerable extent, but how much I cannot remember. The application was made by means of a garden engine. As a result the trees bore a full crop of perfect fruit, while that of my neighbours was destroyed as usual. Professor C. H. Dwinelle to Mr. Mathew Cooke.

We have here the best remedies which constant application, combined with practical experience, and for which our American friends are so justly famous, can devise, and to which we may add our advice formerly given as to the absolute necessity of not allowing rubbish of any kind whatever to accumulate in any orchard. Attention to this and other important matters will probably go a long way towards securing for us at least a partial immunity from this and other formidable pests of the farmer, fruit-grower, and vigneron, as well as for what ought to be of importance to us, viz., our great forest industry.

Dr. J. H. Lintner, State Entomologist of New York, in his second report, gives us a good hint which we would do well to note. He says, "On the ridge, or near Lake Ontario, ten miles to the northward, the Curculio attack had been increasing for several years, and was quite

serious the preceding year. Almost every farm of 100 acres had from five to twenty acres of apple orchard kept in permanent pasture, yet but little fruit could survive the combined attacks of the Codlin Moth, the Canker-worm, the Curculio, &c., &c., unless stock was kept in the orchards to feed the grass closely and pick up the fallen fruit." The excellent plan adopted by careful growers of picking up all fallen fruit, and either using it as food for stock or destroying it, is one which cannot be too highly recommended, knowing as we do that a large percentage of fruit which has fallen through the attacks of grubs, contains grubs in some form or other, and is, as a rule, quite unfit for human consumption.

It is to be hoped that should this pest make its appearance in Victorian orchards, growers will at once acquaint the Entomologist of the fact so that he may be able, by his advice and assistance, to help in its destruction and eradication.

A word of caution must here be given, as, when advising that fallen fruit which had been attacked by grubs be given to stock, it is, of course, to be understood that fruit of any kind which has been recently sprayed with any poisonous compound as Paris green, London purple, &c., must in all cases be excepted, as this should at once be raked up and destroyed by burning.

PLATE XVIII.

THE "CHERRY GREEN BEETLE" (DIPHUCEPHALA COLASPIDOIDES. GYLL).

Fig.

1. Branch of tree with fruit, showing beetles attacking leaves of tree. Natural size.
2. Larva. Magnified, and natural size in curved line.
3. Perfect insect. Magnified.

Plate XVIII.

CHAPTER XXIV.

THE CHERRY GREEN BEETLE.

(*Diphucephala colaspidoides. Gyll.*)

Order: *Coleoptera.* Sub-order: *Scarabœidæ.* Sub-family: *Melanonthidæ.*

This destructive little pest is a very serious enemy of the fruit-grower, more especially to those whose orchards are situate in the so-called heath-grounds, or anywhere within an easy distance of the sea-coast.

The perfect insect is a handsome beetle of a bright green colour, which, as it approaches to near the termination of its existence, sometimes changes to a bronzy colour; although, as a rule, this is not a common occurrence, at least with the kind now under consideration.

When just emerged from the soil it is about four lines in length, the body, particularly the under part, being covered with a sort of fluffy down, which looks not unlike powder, which, however, seems partly to wear off as age advances.

This beetle whilst in the larval stage is supposed to do but little damage, and then only to the roots of native plants. The larvæ lie beneath the soil, a fact which has been but recently ascertained, myself as well as many others having previously made several ineffectual attempts to find out where the grubs really are to be found. It was formerly supposed that they lived on or in the roots of the coast tea-tree (*Leptosperum lævigatum*). This opinion I found, however, to be an erroneous one, as, after a patient search, I discovered the almost perfect beetle just emerging from the soil in the moist heathy flats a few miles from the Caulfield Race-course. The larva or grub of this beetle is a little longer than the beetle itself. It has rather large jaws for so small an insect, and is of a dirty white colour. The beetles, when they emerge

from the soil, are, as is the case with all beetles, soft in comparison to what they are when fully developed; but a very little time of exposure to the air, especially in warm weather, helps them to develop and rapidly harden their wing cases and other parts of their bodies. When coming up out of the ground for the first time their motion is very sluggish, but as the sun gains power they soon become lively and at once take to flight, which they do in almost incredible numbers. The flight of these beetles may in all fairness be termed "swarming," as they rise slowly and very often the air for miles is "thick" with them.

When they make their appearance in an orchard, and which is about "cherry time," they make sad havoc, and, being in such countless multitudes, will strip a good-sized tree in the course of a very few minutes. How long it is since this beetle first made its appearance here as an orchard pest I cannot say; but I well recollect the great damage which in the years 1855–8 they did to the trees in the Cheltenham and other districts near the coast. Fortunately, however, these beetles will also alight on native trees, so that by this means orchards sometimes escape the visitation. With regard to the egg-laying of this insect, it has not yet, so far as I am aware, been observed, the supposition, which is a very natural one, being that the eggs are deposited either in the soil just beneath the surface, or in the roots of the native shrubs which abound in heathy districts throughout the colony. This latter is a very important matter, and has yet to be cleared up. It is also one in which the assistance, by observation, of those living on the spot could with advantage be undertaken, and it would be of great use and assistance both to the grower as well as to the entomologist in devising means for their prevention. The genus *Diphucephala* is confined to Australia, there being about 23 species known and described in various publications; this species would however, seem to be only one of the genus that visits us in such vast swarms, although some of those found inland and in the other colonies are

fairly numerous. The largest species of this genus, *D. Childrenii*, being found in Western Australia, whilst the smallest is from Northern Queensland and New South Wales. The present species has a wide range and is not confined to our colony. It would, however, be of some interest to know how far the other kinds are destructive to orchardists.

Prevention and Remedies.

When this pest first makes its appearance, there is no time to lose, as they swarm into an orchard after the manner of a horde of locusts. Growers, if they will only take the trouble, can easily anticipate one of these visits, as for days previous to the general swarming a few stray specimens, which have emerged early, may be seen hovering around, more especially when the day is hot, bright, and clear. When these "advance agents" are seen, there is no time to be lost. All hands, children, too, if there are any old enough to be of use in a garden, must turn out. If there be any hawthorn or other green hedges surrounding the orchard, light fires on the windward side so as to drive the beetles to the hedges where they will usually settle for a while without much trouble to the burners. When they settle, which they will do in millions, take a torch roughly made and dipped in tar or resin, fasten this to a long stick, and, when lighted, run quickly along the hedges, beating gently as you go to cause the beetles to rise, when enormous numbers will be either burned outright or so disabled as to be quite harmless.

In burning on hedges an exception must be made in the case of hedges of prickly acacia, *A. armata*, as this will burn as well green as when dry, and on this immense numbers may be killed by beating with boughs.

One of the old and favorite remedies against the attacks of this pest is to light fires, and thus smoke them from the grounds; this, although fairly effective, is after all but a half-hearted proceeding, as you simply drive them into, perhaps, the orchard of a neighbour, and it does not prevent the egg-laying.

When they have entered an orchard you must, to cope with them successfully, be astir at day-break, because before the sun gains power they are very sluggish and are easily destroyed. Obtain some old sacks (gunnies will do as well), cut them open, sprinkle them with kerosene; then shake the tree, gently if the fruit be on, over the bags spread under the tree for the purpose. When the bags are filled, which if the beetles are as thick as usual it will take but little time to do, roll them up and set fire to them. Another very good plan that I have seen adopted is to have a large copper, in which boiling water is kept, mounted on a hand-cart; this is to be wheeled along under the trees, mostly cherries, and the branches shaken gently over the hot water.

If the day be calm, cloudy, and sultry, vast numbers of the beetles may be destroyed by simply making a small fire under the trees, and upon which green boughs or damp grass could be thrown, as the beetles then usually drop to the ground, when they can be raked up and destroyed, and if the rake be dipped occasionally in tar or kerosene, very few of the insects will escape either death or mutilation. We have said that this insect attacks cherries when in fruit and nearly ripe. I have never heard of its attacking the fruit itself, but the leaves of a cherry, or even a peach or plum, are rapidly stripped from the tree, and, as a consequence, the fruit, more especially if it be hot weather, becomes either burned, scalded, or shrivelled.

This beetle increases very rapidly, and copulates shortly after leaving the soil. Fortunately for us it is but short-lived ; it would appear, however, to be on the increase in many parts of the colony.

In places near the coast it usually appears about October, often staying until the early part of December, or in some seasons even until Christmas, when they take their departure, their dead bodies being strewn over miles in area, also along the shore.

In the sandy districts of Oakleigh, Mulgrave, Cheltenham, &c., it is no unusual thing to see the shrubs for

miles in extent swarming with these handsome, though destructive, little insects, their bright-green wing cases on a sunny day glittering like gems.

The green beetle pest is one that must be stamped out, and this can only be done by united effort. Those growers who have suffered from their depredations will at once see the necessity for immediate action in endeavouring to rid the colony of a pest which threatens every year to become more formidable.

Another matter of congratulation for us is the fact that, so far as has yet been ascertained, the larvæ or grubs do no damage to growing crops of any kind. Many other insects, however, that have hitherto confined their attacks to our native trees, are now known to have left their original food plants for the purpose of attacking our introduced fruit trees, &c., and which furnish more congenial food for them. We should be on our guard against a probable increase of this pest, lest the former indications of indifference—to which many of our colonists must plead guilty—may be repeated in this case.

If each grower does but a little, and, with the co-operation of his neighbour, does this little at the proper time, it is hoped that what between prompt and concerted action and other causes, many of our pests, both native and introduced, may be successfully kept in check.

In the figures accompanying the illustrations to this chapter, it was found impossible to give an idea of what a swarm of these beetles are like, but the perfect insects, on the branch of a cherry tree, at about their natural size are given. In the other figures the grubs and the perfect beetle are shown, and are, of course, highly magnified. Should these pests, it may be observed, attack trees when not in fruit, a spraying of either London purple or Paris green, in the proportion as given for use against other insects, will prove highly effectual, as this beetle, being essentially a leaf-feeder, will, when attacking a tree that has been thoroughly sprayed, be at once destroyed. These remarks will also

apply to choice shrubs that the owner will no doubt be anxious to save from the attacks of these and other leaf-eating insects.

We should also remember that this beetle belongs to a group including in its ranks the common English cockchafer, an insect which in the larval stage does enormous damage to crops, and knowing this we must use our best endeavours for the purpose of either keeping it within reasonable bounds or stamping it out altogether.

PLATE XIX.

THE COTTONY-CUSHION SCALE (ICERYA PURCHASI.—MASKELL).

Fig.

1. Orange branch showing scale in various stages, with larva and perfect insect of *Novius cardinalis* (or Australian Ladybird parasite). Slightly enlarged.
2. Rhizobius beetle found attacking scale. Magnified (natural size smaller than *Novius cardinalis*).
3. Larva of *Novius cardinalis*. Magnified.
4. Pupa of above. Magnified.
5. Perfect insect of above on wing. Slightly enlarged.
6. Perfect insect of *Lestophonus Iceryæ*, on wing. Magnified.
7. Ditto ditto resting. Magnified.
8. Ditto ditto natural size.
9. Hymenopterous parasite on Icerya. Natural size.

9A. Ditto ditto. Magnified.

10. Perfect insect of *Novius bellus* (Blackburn). Very destructive to this scale. Magnified. (Natural size somewhat smaller than *Novius cardinalis*.)
11. Perfect insect, *Novius cardinalis* (Mulsant). Magnified.

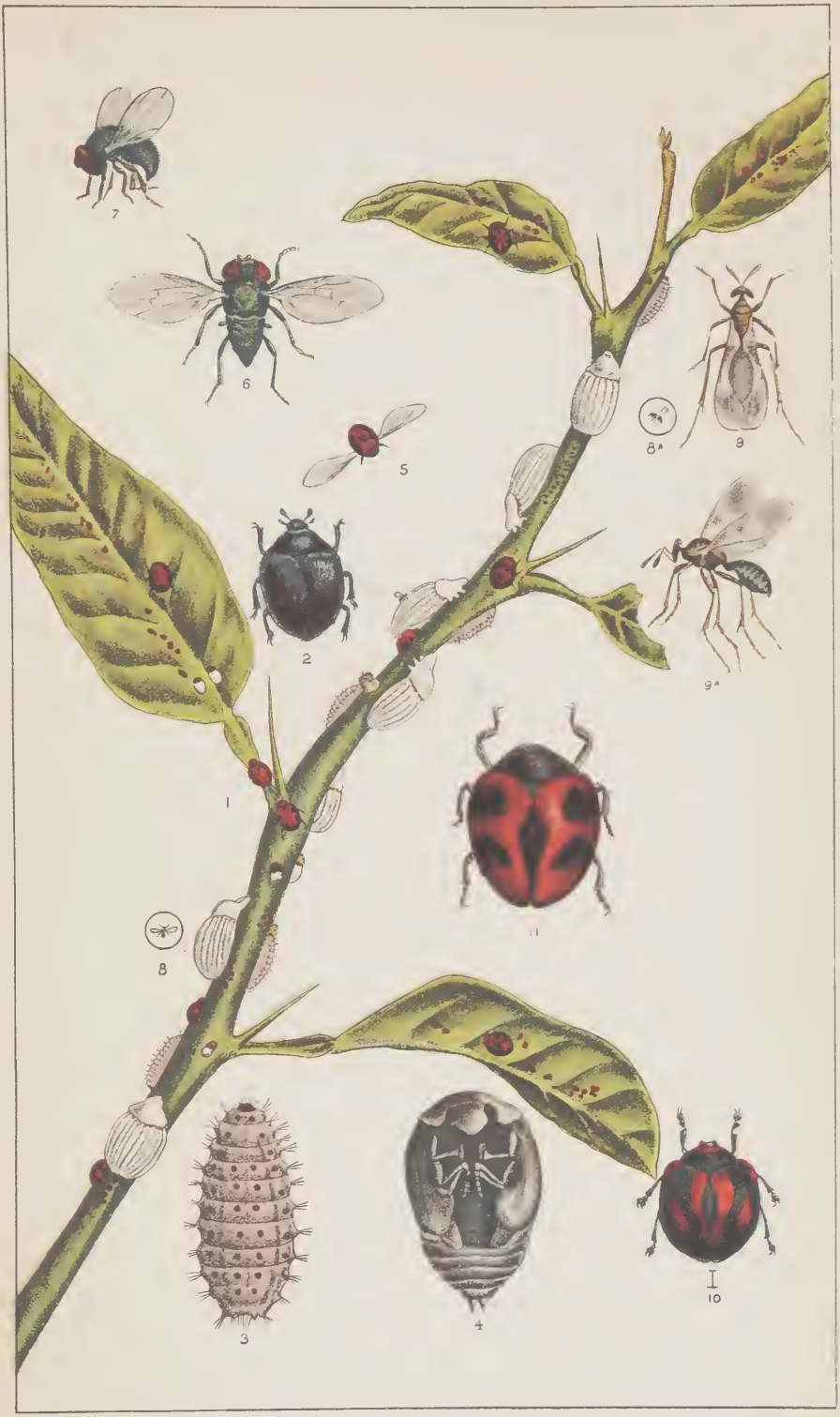


Plate XIX.

PLATE XX.

THE COTTONY-CUSHION SCALE (ICERYA PURCHASI.—MASKELL).

Fig.

1. Branch of orange showing young *Icerya* on leaves. Natural size.
2. Female, upper view. Slightly enlarged.
3. Female, under view, showing eggs. Slightly enlarged.
4. Female, side view. Slightly enlarged.

5 and 6. Young. Magnified (after Maskell).

7. Winged male. Magnified (after Maskell).
8. Antenna of male. Magnified (after Maskell).
9. Antenna of female. Magnified (after Maskell).
10. Male. Slightly Magnified (after Maskell).

Plate XX.

CHAPTER XXV.

THE COTTONY-CUSHION SCALE.

(*Icerya Purchasii. Maskell.*)

Order: *Hemiptera.* Sub-order: *Homoptera.* Family: *Coccididæ.*

This insect is the much dreaded cottony-cushion scale which has made such havoc amongst the orange groves of California, also at the Cape, and later on in Egypt and elsewhere.

The female (see Plate XX., Fig. 2), is a dark reddish-brown cushion-shaped insect, covered with a thin powder of a whitish yellow colour, with slender filaments, and, according to Mr. Maskell, who described the insect, is stationary at gestation, gradually raising itself on its head, lifting the posterior extremity until nearly perpendicular, filling the space beneath it with thick white cotton, which gradually extends for some distance behind it in an elongated white ovisac (egg-bag), longitudinally corrugated, ovisac often much longer than the insect, and becoming filled with oval red eggs (see Plate XX., Fig. 3). Length of female about $\frac{1}{5}$in., reaching sometimes to nearly $\frac{1}{3}$in. Insect covered all over with numerous fine hairs. The antennæ (horns) have eleven joints, tapering (see Plate XX., Fig. 9), each joint bearing hairs. Feet normal. Rostrum not long. Procreation commences soon after the first formation of the ovisac, the eggs being ejected into the sac as it grows; ovisac at completion containing as many as 350 eggs.

The young larva (see Plate XX., Figs. 5 and 6) are about $\frac{1}{24}$in. long; dark-red, elongated, flattish, active, and covered with yellow cottony down. Adult male (see Plate XX., Figs. 7 and 10) large, the length slightly varying, some specimens reach $\frac{1}{8}$in.; expanse of wings, $\frac{1}{4}$in.; length of antennæ, about $\frac{1}{8}$in.

Icerya Purchasii, then, is one of the very worst of the known scale insects, and is, as Mr. Maskell states, allied to *Icerya sacchari*, which damages sugar-cane in the Mauritius, but differing scientifically from that insect.

There has been some discussion and a great difference of opinion as to the real native country of this pest, and I feel quite certain that its real habitat is Australia, and probably Victoria, as more than thirty years ago it was as common, if not more so, throughout the colony, and especially near Melbourne, than it is at the present moment. Now, as then, it subsists mostly on the branches of the silver wattle, *A. dealbata*, especially where those pretty plants overhang a river.

In the early days, in Victoria at least, no one thought this pest to be capable of doing such enormous damage as it has done, to oranges and lemons especially. For upwards of twenty years specimens of its natural little enemy, *Lestophonus iceryæ*, have been in the National Museum collection here, these having been collected by Mr. W. Kershaw, senior, one of our best collectors and observers.

The Lestophonus fly, the species named after its host by Mr. A. Skuse, of the Australian Museum, Sydney, is a small bluish-black fly (see Plate XIX., Figs. 6, 7, and 8), which makes great havoc amongst the gravid females especially of the cottony-cushion scale, so much indeed that anywhere around Melbourne it is often very difficult to find a perfect specimen of the latter, the great majority having been attacked by the Lestophonus insect. The dense bushes of *Pittosporum undulatum* is a favorite food plant of Icerya; still the little fly seems to penetrate into the darkest and most difficult crannies in the tree, and the numerous holes from which the flies have escaped from the body of the Icerya will testify to the destructive powers of so tiny an insect.

Of late years a small Hymenopterous insect (see Plate XIX., Figs. 9 and 9A) have been found to attack the cottony-cushion scale, my friend, Mr. Brittlebank, having reared the insect from which he made the drawings from

the bodies of female Iceryæ. Let us hope that this latter little fly will be to us as valuable as the Lestophonus has been. With regard to the so-called Australian Ladybird, *Novius cardinalis*, a great deal has been written, especially in the very valuable American publications; also in Australian works, as well as those of other countries. It is also due to the exertions of the late Frazer Crawford, and especially to Mr. A. Koebele, who so ably and persistently stuck to the somewhat unthankful and difficult task of transporting these ladybirds to the United States and elsewhere, that the valuable orange groves of America and the Cape of Good Hope have been saved from utter destruction. *Novius cardinalis*—we prefer to use the old name (see Plate XIX., Figs. 5 and 11)—is a small dark-red and black little beetle, very lively, and covered with a kind of "bloom," which rubs off on the beetle being touched. The larvæ (see Plate XIX., Fig. 1) on branch is pinkish and hairy (see also Fig. 3), and is very voracious, tearing as it does the Icerya to pieces as a dog would tear a piece of meat. They increase very rapidly, and when introduced into an orchard where there is Icerya they soon make themselves quite at home and devour the scale in all directions. The beetle itself is also very partial to the Icerya, and they can be seen racing up and down amongst the branches until they come to an Icerya, large or small it is all one to the vedalia, who at once seizes it and kills it.

Another little beetle of the same genus, named by the Rev. Mr. Blackburn *Novius bellus* (see Plate XIX., Fig. 10), is also a great destroyer of scale, and was sent to me by Mr. Pye, of Dookie College, Victoria, as destroying a fluffy scale, which latter I afterwards found to be *Eriococcus multispinus*, and which by experiment I found the little ladybird to destroy in great numbers. I had no larvæ of the latter species of *Novius*, but the little beetle would appear to have all the sanguinary qualities of its colleague, *N. cardinalis*. A small species of Rhizobius (see Plate XIX., Fig. 2) I found to be "polishing off" the scale at a great rate, so that we may

yet be able to add to our Icerya parasites, and probably those of other scales also. There are several other small beetles not far removed in general appearance from these known scale destroyers, one being a small black and reddish-brown beetle, *Cryptolaemus Montrouzeri*, a veritable little glutton, and one that will tackle scale of many kinds.

The *Novius cardinalis*, or so-called Australian Lady-bird, would, at least in the perfect state, appear to be somewhat fastidious as to its food. For example, some were sent to me by my friend Mr. A. Wight, of Paeroa, New Zealand, and were tried by myself on a number of different kinds of coccidæ, including Eriococcus, Pulvinaria, and other kinds unprotected with a shield-like covering: but although the little beetles would scamper up and down the twigs on which I had placed the various scale, they would not tackle them, even after I had purposely kept them for some days without food, as an experiment to test their powers on coccids other than Icerya. It would interest me to be able to ascertain whether the insects whilst in the larval stage are equally particular as to their natural food, and the puzzle has been to many, myself included, as to why the Icerya could exist and do so much damage in New Zealand, in some parts of which, Mr. Wight informs me, the *Novius* is to be found in enormous numbers. This would appear to me to be as yet an unsolved problem.

Prevention and Remedies.

We have now to deal with a pest on which all simple remedies will if tried be comparatively wasted. We have also to remember that this insect does not confine its attention to orange and lemon trees, but it will attack nearly anything and everything, as pine trees, Pittosporums, and many kinds of trees and shrubs; and it is astonishing in what a short space of time they will entirely destroy a Pittosporum hedge, the rapid increase of an unchecked colony of these insects being something alarming.

In America they have well nigh exhausted the whole pharmacopœia of remedies, including the gas treatment, as explained in Part I. of this book. We have, however, a cheap and effective remedy in a timely application of kerosene emulsion, sprayed on whilst hot, 160° Fahr.; and this, if properly done, no cottony-cushion scale can, for any length of time, withstand.

In former times, the complaints have been that the material used cools before it reached the tree, but with the alterations that I have suggested, and of which an engraving is here given, it is hoped that these objections will have been permanently overcome. When an isolated tree is very badly affected, if it be not too valuable a one, grub it out at once and burn it on the spot. If it be a valuable plant, thin out as much wood as possible, burning same as before. Now get your spraying machine ready, light up, and when heated to, say, 150° or 160° spray the tree thoroughly, being careful that no portion of the tree or plant is missed. Do not wait until the plant begins to send forth its tender shoots, as in this stage the very hot mixture may scald the foliage, which in this stage is very easily affected. If the foliage remains unhurt after the first spraying, give another dressing in about a week's time, and the mixture in both cases may be used at about one part of emulsion to fifteen of water.

There is a great deal to be considered in making a good emulsion, otherwise the materials are sure to separate, in which case you simply use pure kerosene and pure water separately, and the wonder then is why the trees are damaged. This hot mixture should not be used on tender shoots.

In making an emulsion, use the mineral soap. I have tried this for spraying myself and find it to answer admirably, and in this case the emulsion when once made cannot separate, nor will it, so far as I have ascertained, injure the foliage of the most tender tree. The emulsion is so perfect that the material adheres to the

foliage (just what is wanted), and if properly applied will answer for most purposes. This soap is referred to in another part of the book.

In perusing the report of the United States Entomologist for the year 1886, which Professor Riley has been kind enough to send to me, a most complete and exhaustive series of reports are given concerning experiments which have been made by the clever field agents working under the direction of Professor Riley, and although the information thus recorded is practically invaluable to growers and economic entomologists, for want of space it cannot well be reproduced in this little volume. We can, however, gather from the accounts of the experiments made in the United States that the two best remedies against this pest are (gas-tents excepted) undoubtedly Kerosene Emulsion and the Resin Compound. The above information, which would alone fill a small volume, should be read by every one having access to these eminently useful, plain, and practical reports.

When spraying trees against this pest, also against other coccids, it should be remarked that any material must be used hot. In kerosene and other resin compounds we have cheap, valuable, and effectual remedies for most insect pests. Specifics against insect attacks to be of use for large growers must be cheap and easy of application, otherwise their use cannot become general.

We should carefully and jealously protect our native insectivorous birds, although birds do not seem to relish the coccidæ. Endeavour by all the means in our power to investigate and press into our service all natural parasites and enemies to our pests, but while doing this we should never relax our efforts in the spraying line. The time has now arrived when to be successful in fighting insect pests, and manage an orchard on modern principles, a good spraying gear ought to be part of the machinery in every well-ordered farm and on every well-managed orchard or vineyard throughout the colony.

In Victoria I hope we may not have much to fear from the attacks of the cottony-cushion scale, as so far it has

given us but comparatively little trouble, still we must be prepared, as the accursed sparrows render the successful introduction of ladybirds here next to an impossibility, these destructive birds being especially fond of our useful little ladybirds, also of the formerly common red and black spotted one, *Leis conformis*, which they destroy in large numbers. With the increase of sparrows, therefore, we may, partly through the destruction of these ladybirds, have the Icerya seriously attacking our orangeries and even other fruit trees, so we must be ready for any emergency of this kind. Having looked at the sparrows from most points, I am inclined to think them the biggest plague, locusts and rabbits excepted, that we have or ever had in Victoria, and we should lose no time or spare no expense in ridding the colony of such a rapidly increasing scourge.

The object in having the double plate in connexion with this insect is to show the scale with its parasites as far as possible without giving lengthy descriptions, which latter, although most excellent, are hardly suitable for a strictly practical work of this kind, as the coloured plates it is hoped will supply all that the growers require.

Dr. Lintner, State Entomologist of New York, in his admirable treatise, says :—"It occurred to Professor Riley, Chief of the United States Entomological Division, that the ravages of the Icerya could be stayed if the natural parasites that had kept it from being a pest in Australia could be secured, brought to California, propagated in sufficient numbers, and then turned loose to seek their prey. After much labour and many disappointments, a small appropriation was obtained, sufficient to defray the travelling expenses of two agents of the division. They were despatched to Australia, where they were successful in procuring some of the parasites and predaceous enemies of the Icerya, and in sending them alive to this country (U.S.A.). They were carefully cared for, propagated in confinement in large numbers, and then distributed throughout the infested districts. One of the imported species, belonging to the family of the

'ladybird' (*coccinelidæ*) has displayed wonderful powers of multiplication and remarkable fitness for the work assigned it. From the 514 individuals imported last winter, in five different sendings, the present progeny may be numbered by the million."

In speaking of the persistent trials that have been made by various persons to send these little beetles to the Icerya infested districts, the name of my respected friend and colleague, Mr. A. Wight, of Paeroa, N.Z., must not be omitted.

Judging from the bad way in which some of our plants here are affected, the good done by these ladybirds so far is hardly apparent, and to give the ladybirds a chance the sparrow must, at any cost, be stamped out.

Mr. W. M. Maskell, F.R.M.S., of New Zealand, whose very valuable work on the *coccidæ* is too well known to require any notice from me, gives in his book a most useful list of the various plants attacked by coccids of different kinds, at least so far as New Zealand is concerned. According to this list it would appear that the Icerya will tackle nearly anything and everything, from pine trees to roses, and even grasses. In Victoria we find them on a great number of plants, but as a list of these, although eminently suitable for a scientific work, would be of little use here, I have omitted to furnish one. This can, however, be managed should occasion require its being done.

Before closing these remarks concerning this abominable pest, I may mention that when a tree, especially if it be either an orange or a lemon, is attacked by the Icerya, it soon assumes a yellow and sickly appearance, and, as a rule, the "inside" of the tree is most affected. In a bad case the twigs are covered with a sticky substance.

When such occurs no time should be lost in tackling the pest, never resting until the tree is thoroughly clean again, as however few of the scale if left will spread again in an almost incredibly short time. Do not wait for this, but tackle the pest at once and keep at it, as from personal experience I know that even this scale can be mastered.

Keep your trees in vigorous health, avoid planting any of the Citrus family either too deep in the soil, too close together, or in water-logged situations, as trees and plants of all kinds are, when unhealthy, more liable to be attacked by insects of most kinds. The more vigorous the growth of the plant the less will be the trouble of the grower.

PLATE XXI.

THE "OLEANDER SCALE" (ASPIDIOTUS NERII.—BOUCHE).

Fig.

1. Branch of orange, showing scale on stem and leaves. Natural size.
2. Female scale. Magnified.
2A. Female scale. Natural size.
3. Male scale. Magnified.
3A. Male scale. Natural size.
4. Female scale, showing hole through which parasite has issued. Magnified.
4A. Natural size of Fig. 4.
5. Female, perfect. Magnified.
6. Male, perfect. Magnified. (After Cooke.)
7. Parasite. Magnified.

C. C. Brittlebank Del.   C. French, Direxit   Sands & McDougall Limd Imp.

Plate XXI

CHAPTER XXVI.

THE OLEANDER SCALE.

(*Aspidiotus Nerii. Bouche.*)

Order: *Hemiptera.* Sub-order: *Homoptera.* Family: *Coccididæ.*

A greyish white, often light greyish brown, scale insect, with female puparium nearly circular (see Plate XXI., Fig. 2), flat, diameter about $\frac{1}{12}$ of an inch. Male puparium oval (see Fig. 3), white or greyish brown, about $\frac{1}{25}$ of an inch in length. Adult female yellow, peg-top shaped (see Fig. 5), but almost globular; abdomen ending in six lobes, of which the two median are the largest; between and a little beyond the lobes are a number of scaly serrated extremities, also some scaly but smooth hairs, &c. Adult male (see Fig. 6) yellow or brownish, antennæ of ten joints, each with several hairs.

As many of the scale insects are often difficult to recognise from drawings, it has been thought advisable in such cases to give a short description of each species, the same having been taken from the work of Mr. Maskell, and alluded to elsewhere.

This most formidable pest is an introduction from Europe, where its attacks on oleander bushes particularly are very severe. I have not noticed it on these plants growing near Melbourne, as in Victoria its principal attacks have been made, so far, on native plants and trees, also on imported trees and shrubs in gardens both public and private. It occasionally attacks oranges, lemons, and other members of the Citrus family, and is a most difficult scale to dislodge or destroy when once a plant, no matter of what kind, is badly infested with it.

Dr. Cooke, in his valuable work on American Economic Insects, states that within the last four or five years this insect has been found on the lemon, plum, cherry, and

currant, and seems to prefer the fruit of the lemon, and in many cases infests the skin or peel to such an extent as to considerably reduce its market value. California, he says, cannot claim a sole proprietary right to this pest, as lemons imported from Europe are often offered for sale in Californian markets which are seriously infested with this scale.

In Victoria, as has been previously mentioned, this scale has not, so far as I am aware, done much damage to fruit trees of any kind; but, as it is now more common, *Aspidiotus Rossi* perhaps excepted, than any other scale insect of its kind in Victoria, we may at any moment hear of its tackling orange and other trees, so must be on the look-out for its coming.

Around Melbourne, in nearly all gardens, especially the public ones, a large number of trees and shrubs are literally swarming with these insects, and live fences of most kinds are in many places quite stunted by their persistent attacks.

On examining a number of these scales taken from trees of the *Corynocarpus*, *Pittosporum*, and other common garden shrubs, a large percentage of them I found to be perfectly riddled by a small parasitic fly (see Fig. 7), which gives an excellent representation of same. The fly in question having been drawn from a specimen reared from the body of a female scale of this species, being almost microscopic in size. In Fig. 4 is shown a hole, enlarged of course, from which the minute parasitic insects had escaped.

Should this scale tackle our orchards to any great extent it is feared that it will be a bad job for the grower. Though the justly-dreaded "Red Orange Scale"—*A. Aurantii*—is principally confined to plants of the Citrus tribe, this closely-allied pest may be found extending to over twenty feet up the tree, and would appear to increase at an alarming rate, so that as long as such "nurseries" for these and kindred insects are allowed to remain unchecked and uncared for it will indeed be a serious and almost hopeless task to attempt to either successfully cope with or eradicate them.

Prevention and Remedies.

Owing to careful observation having been made regarding this scale, I have found that early spring, also early summer, are the times when the young scale are mostly hatched. Plants, no matter of what kind, if otherwise healthy and robust, seem to outgrow the attack, however severe. Hedges of *Pittosporum undulatum*, also of the common laurel, have been seen to recover completely even after the leaves had been so thickly covered with this particular scale that it was a somewhat difficult matter to determine what the plants really were, every leaf both above and below being covered with thick layers of scales, often overlapping each other like oysters in an oyster bed.

Another peculiar fact that I have noted concerning this scale, viz., the so-called "honey-dew" is less frequent with this species, also *A. Rossi*, than with many other kinds, and thus the "soot-fungus" is not often present, and although the absence of "soot-fungus" lessens our task as regards spraying, the indications so constant an accompaniment of most coccidæ are thus wanting, so we must adopt other measures for the discovery of this insect in its early attacks upon the trees.

One very useful thing in an orchard, vineyard, or farm is an ordinary wool-classifier's lens, usually about three or four inches in diameter, and with this a portion of the tree at least can be scanned over, when the scale, or indeed other insects also, can be easily detected.

When any scale is found to be on the tree, do not wait, as is often the case, until the insects have had time to increase and spread over the tree, and which unless promptly tackled they assuredly will do, and that in an incredibly short space of time. Commence at once, and according to the then state of the plant, no matter of what kind, spray with either the kerosene emulsion or the resin compound, as described in another part of the book. Spraying, when properly carried out, cannot fail to at least check the increase of any scale, no matter how bad it may be.

As to the best means to be adopted for keeping under the scale on large trees or shrubs in our gardens and public recreation grounds, it would indeed be a somewhat difficult task to undertake. Thanks, however, to the enterprise of our American friends especially, and others, we have the gas-tents, spraying machines which will send jets of liquid for the purpose of destroying insects to a height of at least 30 feet, which, together with steam sprayers and a judicious thinning-out of any badly-infested plants, should render the task by no means an impossible one.

We may some day have to deal with another, I should say, almost irrepressible pest. I allude to *Aspidiotus Rossi*, so named by the late Mr. F. Crawford, of South Australia. This scale has, so far, kept chiefly to the native shrubs and trees, but has also already tackled the olive, cork-oak, and other valuable trees near Melbourne, and in many places in the country as well. As an instance of the difficulty in killing this scale, I may cite a case where, near Brighton Beach, some native plants, notably an Alyxia, which grow just above high-water mark, are covered with *A. Rossi*, and over a portion of these plants the sea frequently washes. The scale, however, would appear to be in no way affected by these constant drenchings with sea water, and, not contented with this hardy nature, I have discovered and brought under the notice of Mr. Maskell that it is able to alter its form from an almost perfect circular shape to that of a long oblong, so that it can adapt itself to the foliage of a plant, *Ricinocarpus*, on whose needle-like leaves one would hardly expect to find an insect of this kind.

It would appear to be a singular fact that this scale has not yet attacked our fruit trees, and as any speculation as to this reason would possibly not help us, it will, however, be well to be on the alert, as to be forewarned is to be forearmed.

Readers of this part of the book will please observe that the colour of the scale on leaves as shown on this plate is somewhat too bright, this having happened in the lithographing; otherwise the drawings are correct.

The common name of this insect, Lemon-peel Scale, is adapted from Dr. Cooke's work, as in America it would appear to be known by that name. In Victoria, however, when it does attack oranges or lemons, it is generally the leaves and not the fruit that suffer most. It has been thought advisable to retain the common name of Oleander Scale, as common names, more especially when not literally translated, are often not only useless, but absolutely misleading. In Victoria, however, the oleander is, so far as I am aware, attacked only by the olive scale, *Lecanium Oleæ*, and by an aphis.

PLATE XXII.

"Red Scale of the Orange" (Aspidiotus Coccineus.—Gennadius).

Fig.

1. Orange branch, showing scale on leaves and stem. Natural size.
2. Fruit, showing scale. Natural size.
3. Male puparia. Magnified.
4. Female. Magnified.
5. Male, top view. Magnified.

5A. Male, under view. Magnified.

Plate XXII.

CHAPTER XXVII.

THE RED SCALE OF ORANGE.

(*Aspidiotus Coccineus. Gennadius.*)

Order: *Hemiptera.* Sub-order: *Homoptera.* Family: *Coccididæ.*

Female puparium really dirty-white, but seemingly yellowish-brown from the colour of the insect beneath; sometimes dark-brown; circular, flat, diameter about $\frac{1}{11}$ inch.

Male puparium (see Plate XXII., Fig. 3) much smaller, rather oval.

Adult female (see Fig. 4) yellow, becoming brown at last; peg-topped shaped, but the abdominal segment is comparatively so small, and is so much overlapped by the others, that the insect looks almost globular. Length about $\frac{1}{15}$ inch. Abdomen ending in six lobes.

Adult male (see Figs. 5 and 5A) very small, brown or yellow in colour. Antennæ ten joints. Thorax short and thick. Wings oval, about as long as the body. Legs hairy.

The above descriptions are abbreviated from Maskell, for reasons before stated.

The well-known Red Scale, so commonly to be found attacking oranges and lemons in many districts throughout Victoria. This species will probably be better known as *A. Aurantii, Maskell*, although Mr. Maskell has adopted the name by *Gennadius* in preference to his own, and has stated his reasons for having done so. Professor Comstock has named it *A. Citri*, which is certainly a most appropriate name, as in Victoria at least it seldom attacks plants other than those of the Citrus family.

This insect, Mr. Maskell says, is European, and has been introduced into New Zealand from Australia. It is

exceedingly destructive to orange and lemon groves in America and Australia. Professor Comstock (*Report of the Entomologist, U.S. Department of Agriculture*, 1880, p. 295) records an instance in Australia where a grove of 33 acres, which in 1872 produced a rental of £1,800, fetched in 1878 only £120, on account of the ravages of this insect.

In the very useful list published by Mr. Maskell we find no mention of this species having attacked any plants or trees but the orange and lemon. This is identical with our experience in Victoria, for I have frequently seen orange trees which were very badly infested with this scale growing amongst shrubs of various kinds, and on no occasion have I observed such to be visited by the Red Scale as described above. Dr. M. Cooke (late Chief Executive Horticultural Officer of California), however, tells us that in California it has been found on grape vines and on the foliage of walnut trees, but gives it as his opinion (always a valuable one) that but little damage will be done to these plants by this pest.

This insect, in common with others of this group, increases very rapidly, and Dr. Cooke remarks that it is thought by some writers that the females of this species are viviparous. "I have," Dr. Cooke says, "watched the female insect ovipositing, and immediately examined the egg or sac under a microscope, using a high power, and could not detect any appendages; however, in 24 hours I noticed the presence of antennæ and legs. The insect produces from two to four of these eggs or sacs in 24 hours, and the number produced by each female is from 20 to 43; the latter is the highest number I have found."

In Queensland Mr. Tryon, in his valuable book, states that this scale, in the southern part of Queensland, also attacks and kills the mulberry trees. I have seen other kinds of scale on the mulberry trees here, but certainly not this species.

When this pest attacks a tree it may be easily detected by the dirty and sticky nature of the branches of the tree,

and for a general description of which I cannot do better than quote Mr. Tryon, who says—"It occurs equally on trunk, branches, leaves, and fruit. Every accessible spot on the bark of infested trees is at times occupied by it, a complete incrustation being thus formed.

"Oranges, if the scale has settled upon them in any quantity, after gathering become disgustingly black with its dead and discoloured remains. Previous to their ripening their natural bright-green colour gives place to a pale yellow, their growth is retarded, they do not reach their full size, and they may even fall from the tree. When the leaves are attacked by them they exhibit conspicuous yellow-green spots, the centres of which are occupied by the scale insects themselves, and either the assimilating power of the foliage is much diminished, or worse, the leaves are shed, and by both of these events is the health of the tree considerably impaired. When on the bark itself their presence is not quite so conspicuous, owing to a certain harmony of colour being maintained, but the injury which they occasion when in this situation is none the less."

The Red Orange Scale then is one of the worst and most troublesome of our imported pests, as it increases with great rapidity, and spreads itself over large areas in a short space of time. Any attempt at isolation, therefore, except it be done in a systematic and practical manner, will most likely prove a failure. It is readily carried from one orchard to another by means of grafts, cuttings, and by birds, &c., also by the wholesale distribution of infested fruit, which same may be seen exposed for sale in the fruit shops in Melbourne and elsewhere. and this without any attempt at concealment. The rapid spread of this plague need not therefore be wondered at. Unless some stringent measures are introduced for the purpose of arresting this broadcast distribution, it is greatly to be feared that our efforts to keep this pest in subjection must either be greatly handicapped or rendered comparatively futile.

Prevention and Remedies.

A very important matter is the methods of preventing the spread of scale insects, and Professor Comstock has some very wholesome and useful advice on this subject, which for the benefit of growers we venture to quote in the professor's own words:—

"In planting an orchard choose as isolated a spot as practicable, so as to be able to control as fully as possible the conditions upon which the introduction of pests depends. If isolation cannot be obtained, an effort should be made to induce the owners of neighbouring orchards to join in the determination to grow clean fruit. The greatest care should be used in the purchase of trees and in the importation of buds. Before planting, thoroughly wash all such trees with some substance, as a strong solution of soap, which will destroy insects without injury to the trees; buds and scions brought from other orchards should be treated in the same way before using. The fact that trees or scions appear free from pests should not deter one from using the utmost precaution, for the untrained eye would fail to detect the early stages of these insects. Do not visit infested orchards unnecessarily, and above all things do not carry home specimens of scale insects as curiosities. The trees should be watched carefully, and if one is ever found to be infested it should be destroyed at once. Remember that no better investment can be made than to burn such a tree, and that no other time is so good for doing it as the day it is first found to be infested. The system of exchange of fruit boxes which is practised in some markets, notably in San Francisco, is a very dangerous one. Each shipper should have his boxes marked, and insist on not receiving boxes belonging to other shippers, and in any case when boxes are sent to a market where fruit from infested orchards is received they should be scalded on their return. This precaution will tend to check the spread of the codlin moth and other pests as well as scale insects."

When an orange or lemon tree assumes a sickly appearance, and in warm weather is swarming with little black ants, look to the tree at once, and upon a very cursory examination it will be found to be suffering from the attacks of this or some other scale. If of an orange-red colour it will doubtless be this pest. If the plants are small it will be a comparatively easy matter, with the aid of a good spray pump, to clean them, but it must be done thoroughly to be at all effective. Thin out as many branches as possible and burn them at once. If the tree be in fruit, and the latter found to be affected also, take the fruit off at once and either clean by washing in a tub of soft soapsuds or destroy it, as the case may be. Then procure the emulsion or the resin compound before mentioned, and give the whole tree a thorough spraying with the hot mixture previously alluded to. Having done this, get some lime with a little sulphur and soft soap added, and with a brush wash thoroughly the stem and larger branches of the tree. If any shrubs are in the way, so as to prevent a free circulation of air into and around the tree, remove them if possible, as orange and lemon trees in particular require plenty of room and free space to grow in, that is, if they are to grow well. Keep the tree as vigorous as possible, and do not be contented with one or two sprayings, or even more if found necessary, because when this scale makes its appearance it usually "comes to stay," as our American friends say, and is by no means an enemy to be either despised or treated lightly.

In the drier districts of Victoria especially this scale would seem to flourish most alarmingly, but by adopting the precaution here given growers will, we hope, be able to deal with it effectually. To do this co-operation must be resorted to, as pests of most kinds, if neglected, soon spread from place to place, when the task of attempting to exterminate them becomes no doubt a most formidable one.

Amongst other supposed remedies against insect pests, all and sundry, is one in which I must confess to have no

faith. It consists in boring a hole in the centre of the stem of the tree and plugging it with either sulphur or corrosive sublimate. I have, to please an old grower who was very sanguine as to its efficacy, tried this for myself, with the result which I had expected, viz., that the tree after eighteen months has elapsed is just as bad as ever. This recalls to my mind a remark by Professor Comstock, who states it is claimed that the sulphur will be taken up by the sap and carried to every part of the tree, thus reaching and destroying every insect pest that infests it. Apparently no account is taken of the important facts that the sulphur is usually placed far inside of the cambium layer, and consequently where there is but little or any circulation of the sap, and that, as sulphur is insoluble in water, it would not be taken up by the sap even under the most favorable circumstances.

So far we have not been able to discover any parasite, at least in insects, which we could fairly look to to exterminate this scale. From some experiments which I have made, it was found that the *Novius*, which has worked such havoc amongst the Icerya, would not attack this Red Scale. The other little insects also, as *Cryptolæmus*, &c., &c., seem to make but little impression on this scale, at least in Victoria.

In America they are making most praiseworthy attempts to introduce parasites of this kind, but from private letters which I have received from that country it would appear that but poor results have so far been attained. Professor Riley, in some of his valuable publications, has given the names of several insects which he hopes to be able to use as auxiliaries in such cases, and our old friend Mr. Koebele is equally sanguine. We can only wish them every success, and they can rely upon the assistance of all Australian economic entomologists.

Mr. Tryon, in his book, mentions a fungus—*Microcera coccophila* (*Desm.*)—and remarks—

"This fungus, which really lives at the expense of the *Aspidiotus coccineus* or Red Scale of Orange, is usually

regarded as a pest itself. Its fungus nature is not even suspected, indeed, it is even looked upon as a coccus insect, and designated the scarlet scale. The following is its mode of occurrence and characteristic appearance :— When orange trees are infested with the "Red Scale," and especially when their branches also are black with the fumagine consequent on the presence also of the *Lecanium oleæ*, there may be observed small irregular rose-red bodies. These are especially noticeable on the blackened boughs. But when in this position, but more especially when situate on the leaves, it will be seen that these are closely connected with the present scale insects. In fact, they are small conical tufts, which emerge often to the number of three or four from the margin of the "scales," or when the scales themselves are concealed by the growth of the fumagine, these tufts appear to arise erect and stalked immediately from the boughs independent of such origin. Microscopical examination shows that the tufts are composed of minute nearly simple threads matted together, and that these threads terminate in narrow and sharp-pointed low crescent-shaped bodies, which are the spores of the fungus. This fungus is well known in Europe as the *Coccus microcera*, and has previously been noticed in this colony (Queensland) by Mr. F. M. Bailey, on a species of *Coccus* which infests the lemon. It is shortly described in the *Synopsis of Queensland Flora* of that author, and more fully by Mr. C. Cooke, who illustrates the species by means of a figure representative of its appearance when highly magnified.

Mr. Worthington Smith also alludes to this fungus, in his book on the *Diseases of Field, Crop, and Garden*, as being a parasite of *Cocci*. I am not aware of the existence of this fungus in Victoria, but probably our Vegetable Pathologist may know of it, and, if so, his aid will be sought, supposing that he considers this fungus to be any way valuable as an auxiliary in keeping down this and possibly other scale insects also. Fungus and insect enemies to these coccid pests are doubtless valuable, but for our own part we must adhere to our former opinion

as to the greatly superior value of spraying, more especially before and again shortly after the young scale are hatched, as by close attention to these matters we may reasonably hope to accomplish a great deal towards the extermination of insect pests, at least of most kinds.

As we have so many good observers in Victoria. these could be a great service to both grower and entomologist, and also to the Vegetable Pathologist, Mr. McAlpine, if they would from time to time forward any notes bearing on the natural enemies of pests of any kind, either insect or fungous.

PLATE XXIII.

Orange Moth (Hydrusa? sp.).

Fig.

1. Orange twig. Natural size.
2. Perfect insect, female. Natural size.
3. Perfect insect, male. Natural size.
4. Perfect insect, female, side view. Natural size.
5. Caterpillar. Natural size.
6. Caterpillar, partly enclosed by ichneumon cocoons. Natural size.
7. Ichneumon (parasite). Natural size.
8. Enlargement of Fig. 7.
9. Pupa. Natural size.
10. Pupa of moth in cocoon. Natural size.

C. C. Brittlebank Del. T. French, Direxit. Sands & M.Dougall Lith.t Imp.

Plate XXIII

CHAPTER XXVIII.

THE ORANGE MOTH.

(*Hydrusa sp.*)

Order : *Lepidoptera.* Section : *Heterocera.*

This handsome but destructive moth is to us in Victoria a comparative stranger, at any rate so far as attacking fruit trees is concerned, the year 1891 being the first and only time that I have received the caterpillars from any of my numerous correspondents.

The larva of this moth (see Plate XXIII., Fig. 5) is black, and the upper part of its body especially is covered with fine hairs. The colour of the moth is light-orange with black markings (size as shown in Figs. 2, 3, and 4). The pupa is light-brown, and is enclosed in a sort of silky web which is attached (see Fig. 10) to the twigs of the tree on which the larvæ feed. (As the figures of this moth and its life history are given in the natural sizes it will be unnecessary to further describe them.)

The eggs, which we have not seen, are probably deposited on the leaves of the orange tree, as the caterpillars when they were sent from one of the north-east districts of Victoria were very small and dark coloured. The piece of orange tree (see Fig. 1) on which the larvæ were sent was thickly covered with these little black and hairy caterpillars, and the foliage of the tree had suffered severely from their ravages. On trying to rear the larvæ, about 30 or 40 in number, I found I had reckoned without my host, for out of these I managed to rear only six specimens owing to the larvæ, even in so young a stage, having been pierced by a small hymenopterous fly (see Fig. 7), and many of which had hatched in the box, the cocoons thickly infesting certain of the larvæ when the

latter attained their full size (as shown in Fig. 6). This fly, which is closely related to the *Ichneumonidæ*, would appear to work great destruction amongst these grubs, and the fact that I have not received another specimen for so long a time almost convinces me that the flies have simply either destroyed the whole of the caterpillars in the part of the colony from whence the grubs were sent or have so reduced their numbers as to render their attacks comparatively harmless.

The genus *Hydrusa* contains some very pretty insects which, fortunately for the orange growers, are somewhat rare in Victoria.

In Fig. 8 the fly parasite of the orange-moth grub is given in a highly magnified form.

Prevention and Remedies.

In case an orange tree should be attacked by the larvæ of this moth, and the same remarks will answer for the treatment of most of the leaf-feeding caterpillars, lose no time. If the fruit on the tree be any size use kerosene emulsion as a spray, but if the fruit be off the tree or very young, a spraying of either weak Paris green or white hellebore will be all that is necessary, and with ordinary care these two latter solutions may be used with perfect safety, and without the slightest risk of danger to the fruit or consumer. Whilst on this subject, I may be permitted to quote from the evidence given by Mr. J. Fletcher before the Select Standing Committee of the House of Commons, Canada, Session of 1892. Let us see what Mr. Fletcher has to say on this subject, so important not only to growers but to the general public also.

Mr. Fletcher says :—"The subject of spraying with arsenites is one that has gained very much importance lately through the ridiculous and utterly absurd statements made throughout the world in newspapers. It was first stated by an obscure London horticultural journal—but when you read the article you saw at once that the

object was to get a little cheap advertising—that all American apples were saturated with arsenic. This statement was reproduced in many newspapers, and, as the original paper which started the falsehood, in a later issue, gloated over the fact that these articles were copied all over the world, the paper thus showed its hand—it wanted to get cheap advertising. The statement is absurd that any apple or other living vegetable tissue can be saturated with arsenic, from the fact that the poison is so exceedingly corrosive that before any vegetable could become saturated, even if this were possible, it would be destroyed before the poison could penetrate. The only suggestion of truth in regard to this statement is that we do spray our orchards with Paris green, which is an aceto-arsenite of copper. But that is not arsenic; it is an arsenical compound containing about 45 per cent. of soluble arsenic; but it must be remembered that this is not the same by any means as arsenic, which is soluble, while Paris green is almost insoluble; so it is not at all like putting on our trees a mixture containing 45 per cent. of soluble arsenic. It is only an insoluble compound which, by the special treatment recommended, never can and never does get into the fruit. Then, besides this, it is applied at the small rate of 1 lb. to 200 gallons or more of water. This quantity of water is sufficient to spray a great many trees—a tree of ordinary size takes from one to three gallons—and these trees bear many hundreds of apples, and thousands of leaves, so that there would be only a very minute quantity of poison on each fruit. Even supposing soluble arsenic were used, and every apple were covered with it, none could get into the apples. At the time apple trees are sprayed the fruit is very small, indeed hardly formed, and is then protected from anything falling on it by a thick covering of down and the spreading lobes of the calyx. In spraying, the liquid is applied as a very fine mist; most of this falls on the foliage; but some—a minute quantity—falls into the open calyx, where the eggs of the codlin moth are laid. It is an infinitesimal quantity, yet is sufficient to

destroy the insect if it be there, as frequent experiments have shown us. I cannot imagine anything more absurd, however, than the idea that there could be any arsenic in the apples which had been sprayed, as soon as the flowers had dropped, with Paris green. In the first place, the quantity of poison is so small it is practically insoluble, and above all it is not at all adhesive, so that directly the small amount of moisture in it which is sprayed on to the trees has evaporated it is a dry powder. Even supposing you put it on as thickly as you could all over the fruit, the natural expansion of the apple in growth would disseminate it and force it off the surface; the frequent rains we get during the summer, and the frequent winds, all help to remove it, and we know that it is entirely gone, as proved by experiment, long before the harvesting of the fruit takes place. Yet these articles appeared, and our own papers copied them and commented upon them. Now, this is where the injury comes in; spraying with arsenites is the remedy we have been trying for years to persuade the farmers to adopt in order to protect themselves from a great and unnecessary loss. I claim, by application of this one remedy for the apple-worm, that a saving of at least 75 per cent. can be made in the quantity and quality of the fruit. Such articles raise a doubt as to the advisability of using what is a good and safe remedy. We are told: 'Paris green is poison, and therefore is dangerous.' Of course it is poison, otherwise it would not do the work we use it for, but the statement as to the danger of poison getting into the apples is absurd because impossible. The quantity used is so small that the elements to which it is exposed would destroy or remove it long before it could penetrate a growing apple. Through the kindness of Mr. Woolverton, the editor of the *Canadian Horticulturist*, I procured some apples that had been sprayed twice, and had them analyzed most carefully by the chemist of the farm, who took very great care to analyze them all by a process by which, if there had been even one fifty-thousandth part of a grain of arsenic in them, it could have been detected.

He found there was not a trace of arsenic. Yet these people write such nonsense and spread it all over the world, and some foolish people, without taking the trouble to think, believe them. Our apples are perfectly safe as food. They have been tested by a chemical analysis that cannot fail, and this analysis is backed up by the common sense of any one who examines the matter. Many analyses have been done with great care, and show there is not the slightest danger in the use of Paris green, as directed by entomologists. It is important for all to know this and understand why it it so, when people say they won't use Paris green because they injure the crop. That is all nonsense. The only injury spraying could do would be by destroying the leaves, if it were used too strong. If the leaves of a tree are destroyed it cannot produce any fruit."

In England, also on the continent, the old-fashioned and excellent practice adopted by growers of painting their trees with sulphur and lime is still carried out, and while we advocate the use of Paris green as being much superior, we have no desire to condemn a practice so largely used by the practical growers of England and elsewhere. Lime and sulphur your trees by all means, but unless your neighbours do the same the grub will have the largest share of your apples and pears.

To those growers who may wish to paint their trees to destroy the grubs of the codlin moth, &c., I may add the receipt for preparing the mixture, as given in the *Australasian*, as follows :—Take of sulphur and lime each 6 lbs., to be boiled till all the sulphur is dissolved, and a clean brown liquid, four gallons in amount, remains. This should be diluted by mixing 60 quarts of water with one quart of the sulphur and lime solution. This is not only good against caterpillars, which may be hybernating in the crevices of the trees, but is also useful against borers, white ants, &c., &c. In the case of plants of the citrus family generally this would be partly impracticable, the branches being prickly and twiggy, still it could be done on the tree up as far as where the branches meet

the stem, as is often done in the case of treating for peach aphis, &c.

As this new pest of the orange is happily of rare occurrence, we may not be much troubled with it, but being an indigenous moth we can hardly expect to get rid of it altogether. Now, however, that we know something of its habits and life-history we may be able to at once recognise it from the figures on the plate, and take steps for its eradication.

PLATE XXIV.

THE ORANGE APHIS (SIPHONOPHORA ? SP.).

Fig.

1. Branch of orange, showing insects on stem. Natural size.
2. Wingless female. Magnified.
3. Winged female. Magnified.
4. Pupa. Magnified.
5. Pupa. Magnified.
6. Pupa, early stage. Magnified.

Pate XXIV

CHAPTER XXIX.

THE ORANGE APHIS.

(*Siphonophora? sp.*)

Order : *Hemiptera.* Sub-order : *Homoptera.* Family : *Aphidæ.*

A small dark-coloured species of aphis, not unlike in general appearance that of the so-called "Black Aphis of the Peach."

The viviparous wingless female (see Plate XXIV., Fig. 2) is often brown, sometimes of a dark-green colour, shorter and broader than many species of this group, nearly all of which are more or less destructive to the orchardist, and sometimes to the farmer also.

The pupæ are of various colours, often greyish or dark olive-green (see Figs. 4, 5, and 6, which have been enlarged and drawn from nature). The winged female (see Fig. 3) is of a dark leaden grey colour, with fine wings, on the upper pair of which are faint orange-coloured markings.

On Fig. 1 will be seen a portion of orange stem, where the aphides (natural size) are depicted in the act of swarming up towards the end of the shoot, which they attack, and which, if not attended to, will soon wither, turn blackish, and die off.

In January last, I received specimens of this pest from many parts of the colony, where it is said to be doing much damage to the oranges and lemons, more especially to the young shoots, twigs, and buds of these plants, and in the case of severe attacks the tree, no doubt, suffers greatly.

In Queensland and New South Wales they have, according to Messrs. Tryon and Olliff, attacking their oranges, lemons, &c., an aphis under the name of *Siphonophora citrifolii.* I have not seen this species, but

from what I can learn ours would appear to be different, excepting in habits, to the above introduced American species.

This species of orange aphis has not, so far as I am aware, yet spread far throughout the colony, and with a little care and watchfulness we may yet be able to keep it within reasonable limits, where it may be the easier dealt with.

Prevention and Remedies.

In another part of the book, I have endeavoured to point out the absolute necessity, if an orangery is to be a success, of selecting suitable soil, position, light, and last, but not least, good drainage, shallow planting, and plenty of room each way between the trees, and in very exposed situations a good breakwind of some suitable material —avoid prickly acacia or whitethorn shelters to an orchard—is oftentimes a necessity.

When the trees are planted out and commencing to start into growth, watch them carefully, and on the least sign of either aphides or scale lose no time, but tackle it at once, always bearing in mind that a very few scales if left upon a tree unheeded may stock, in a single season, the whole orchard with their abominable progeny.

It has also been pointed out that a good spray pump and gear (none of your toy pumps) should be part of the stock-in-trade of every orchardist who wants to grow good fruit and make it pay. Slovenly orchards may last for a time, but the day of reckoning must and will come ; but, unfortunately, the neglected orchard may in the meanwhile be the nursery or depôt from which orchards, whose owners try to keep clean, receive a constant supply of noxious insects all and sundry, and thus their praiseworthy efforts are rendered futile. I feel more and more convinced of the necessity of some means by which careless growers could be reached and compelled to take reasonable action in keeping their orchards clear of insect pests as well for their own good as for that of their more deserving neighbours.

When the orangery is well established it will be safe to go over it with a spraying apparatus and a weak kerosene emulsion, say, one part of the emulsion to 25 of water will be quite sufficient for the first dressing. This should, of course, be done either on a dull (not wet) day, or in the cool of the evening. The expense is inconsiderable, and it will pay to do it. In spraying with any material one must always be guided by common sense. We know that a young and tender shoot is more liable to injury than is a branch of the last year's growth. Buds are also easily damaged, so that when spraying with a material of a given strength is recommended it is supposed and hoped that the grower to whom the information is supplied will use some discretion, and take into consideration the condition of the plant at time of spraying.

It is a fact well known to both growers and economic entomologists that certain fruits, even varieties of one race, as apples, pears, &c., will not require or stand spraying with a like proportion of any given material. This must be determined by the experience of the grower, who has the facilities which to the entomologist are often unattainable.

These remarks will apply generally, but particularly in the case of peaches, plums, &c., also to oranges and other members of the citrus family, so that a little care is all that will be necessary to insure success in the spraying line.

Should the trees be badly affected a stronger dose of the emulsion must be used, and of late years we have two preparations, one by Messrs. Garrick, the other by Messrs. Martin ; that of the latter firm, of London and Melbourne, would appear to be eminently useful, being both safe and effective. The materials here mentioned are somewhat of a novelty, and when they can be made and disposed of at a cheap rate they will in all probability be largely used amongst orchardists, who want something both cheap, practical, safe, and handy.

Kerosene emulsion is very distasteful to the Aphis family, and the good old tobacco and soft-soap remedy has both

the merits of cheapness and effectiveness, and is also perfectly safe. The resin compound is also a splendid remedy for both aphides and scale, and should be largely used as occasion requires.

It is, so far as I am aware, not yet ascertained whether this pest of the orange also attacks the roots, as does the peach aphides, woolly aphides, &c., but I think it is not at all unlikely that it does do so.

In treating the orange for aphides on the roots, supposing them to exist there, we must be very careful, as most members of the citrus family are very susceptible to damage if their roots are disturbed, and on no account must the soil be opened out and the roots bared, as one could safely do with the apple, pear, plum, &c.

If the roots are found to be attacked the best plan would probably be to adopt the carbon treatment in a similar manner as is practised in Bordeaux and other large French vine-growing centres, a plate of the machine for which, I may again remark, is to be found at the end of the present part of the book.

The orange aphis is one which, if promptly and persistently tackled, should not cause us much alarm. Thin out the branches where possible, burn up all affected ones, and thoroughly spray the rest. Do not wait for the parasites to come around and help you, although they are valuable auxiliaries. Keep the sprayer and scarifier going, and your orchard will repay you for the extra trouble taken.

PLATE XXV.

THE "CASE MOTH OF THE ORANGE" (METURA ELONGATA.—SAUNDERS).

Fig.

1. Branch of tree, showing leaf eaten by larva.
2. Larva in case. Natural size.
3. Perfect male. Natural size.
4. Pupa (male). Natural size.
5. Larva taken from case. Natural size.
6. Perfect female. Natural size.
7. Eggs. Natural size.

C.Brittlebrk.Del C.French Direxit. Troedel&C° Lith.

Plate XXV.

CHAPTER XXX.

CASE-MOTH OF THE ORANGE.

(*Metura elongata. Saunders.*)

Order: *Lepidoptera.* Section: *Heterocera.* Family: *Psychidæ.*

This is the well-known large stick-case-moth of our colonists. In structure and in its habits the females of this group are, as Professor McCoy remarks, amongst the most abnormal and singular of all lepidopterous insects. The female (Fig. 6) is a thick, smooth, naked, fleshy, grub-like creature, totally destitute of wings, and having only rudimentary traces of legs, antennæ, or eyes. These apterous (wingless) females, which state is attributed by some to disuse, according to the above-named gentleman, never leave the case in which they dwelt whilst in the larval state; but, after meeting the males at the lower aperture of the case, commence to bring forth the young in myriads; these latter, escaping in crowds, let themselves down, each by a silk thread spun from the lower lip, until they reach a twig or leaf, and then immediately begin to construct each a separate case of tough silk and extraneous materials, such as particles of bark, &c., to protect it during the period of its larval existence.

I must here express some doubts as to the correctness of the assertion that the female never leaves the case, as good observers have noticed that these do occasionally leave the case, but only for a very short period, and for the purpose of mating with the male. With regard to egg-laying, I cannot say for certain whether eggs are deposited by the females of these insects or not; but the bodies of the females contain vast numbers of eggs, and on our plate we have figured a small cluster of same, as explained elsewhere.

The larval sacks or cases (see Fig. 2) are open at each end, the male caterpillar coming sufficiently out of the

anterior aperture to use its three pairs of thoracic legs for locomotion when feeding. It usually fixes a part of the edge of the aperture by fibres of silk temporarily to the twig it is on, so that, if alarmed, it can suddenly withdraw completely within the case, when it remains hanging with the apertures so completely closed that, if the nature of the object was not known, it would never be suspected to contain a large, vigorous, and voracious larva.

The male (see Fig. 3) is a singularly shaped and rapid flying moth, and it is, unless reared from the pupa (see Fig. 4), very difficult to obtain a perfect specimen of, as it flies so aimlessly about that it is at once damaged and injured, and thus falls an easy prey to ants.

Professor McCoy doubts whether any eggs of this curious insect have ever been found, but at Fig. 7 we give an illustration of a small cluster of eggs found in the body of a female. These eggs were given to me by Mr. Spry, who is an excellent observer, and on whose responsibility the little egg-cluster is figured.

The males may be captured by placing some of the females under a large perforated box, or a meat cover will suffice for the purpose, as the males are thus attracted to the female, when they may be taken and transported to the chloroform bottle, preparatory to pinning out in the cabinet.

The young larvæ of these curious creatures are, whilst in the early stages, very minute. I well remember a circumstance which happened some years ago. I had a box containing a number of the stick-nests of this moth, and these I placed for safety on a shelf at about ten feet from the floor. One evening I was busily engaged in arranging some insects in my cabinet, when, on accidentally looking upwards, I noticed a number of long silky threads reaching from the shelf to the floor. I was quite amazed, and could not divine the source of so singular a phenomenon, until it occurred to me to mount the steps and look at my box, and there to my astonishment I found a constant stream downwards of these little grubs, which were then so minute as to be hardly

perceptible. I then obtained a glass-stoppered bottle and held it directly under the descending larvæ, when in a few minutes I had it filled with a material not unlike the finest webs of a spider. This is a most singular part in the economy of this insect, as the young larvæ at once begin to spin cases for themselves and commence to eat quite voraciously.

Our drawings will sufficiently explain the insect in many of its stages, these having been taken from nature. The colour of the perfect male, however, is brighter and hardly as dark as that given on our plate, and which fault has occurred in the lithographic printing. Another well-known but smaller species is the *Entometa ignobilis* having a much shorter, rougher, and less tapering case or nest, but which is almost equally destructive, although I have never yet found it attacking oranges.

It may be remarked that the male cases of these insects are much smaller than those of the female.

Prevention and Remedies.

We have here an insect, the larva of which will attack quite a number of plants, amongst which may be mentioned oranges, lemons, quinces, vines, and especially the Abies group of the Coniferæ, also shrubs innumerable.

Growers of trees will have noticed them to be occasionally swarming with little clusters of leaf-like substances, which are constantly on the move. If they be examined carefully, it will be seen that the moving objects are these insects in their early stages, and even when so small it is surprising the amount of damage they will do in a very short space of time, and if they be kept and fed on green leaves they increase in size with great rapidity. A few of these insects, when nearly full-grown, will strip a good-sized tree of its leaves in a very short time.

On plum trees, even when deciduous, the young of these case caterpillars are very destructive as they "ring-bark" both the large and small branches of the tree, even extending their operation to the smallest twigs, being especially severe on stems of fruit buds. When the

tree is in leaf and fruit, both are often bitten off and destroyed. In the earlier stages of its existence this case-grub is very difficult of detection, as the little brownish nests or cases seem to be stuck on to the branches at right angles, and by the uninitiated may often be mistaken for some of the smaller spurs of the tree. In small gardens a boy with a bucket, in which a little kerosene and soap is placed, can go over a large number of small trees in a day; all that is required for this work being active hands and quick eyes for detection. The above remarks will also apply to cherries and other deciduous fruit trees, should such be attacked by this pest.

In a garden near St. Kilda is a very large quince tree which has been stripped and totally destroyed by the larvæ of this moth. Hand-picking had been resorted to, but next day there appeared to be nearly as many as ever.

Last year I received from several growers vines which were fairly covered with these singular little moving nests, and from which the heads of the grubs were, for the purpose of feeding, protruding.

In the Exhibition grounds, and also elsewhere near Melbourne, a large number of valuable trees have been killed by these pests, and when we consider the immense number of young ones which one full-grown female can bring forth, and how ravenous are their appetites, it will be easily seen where the vast numbers of these suspended nests infesting our trees come from.

The larvæ of all this class of moths subsist on the epidermis (or fleshy covering of the leaves), so that a clue has thus been obtained as to how to deal with them without going to the trouble, often adopted in small gardens, of hand-picking.

When any tree, which is not either in flower or in fruit, is affected by these case-grubs, take some Paris green (Blundell's preparation is the most useful), and to every pound add 100 to 160 gallons of water, according to the state and vigour of the tree about to be treated. If your holding be an extensive one, obtain a good powerful spray pump, and with this give the infested trees, and

others growing near also, a good spraying. If this be properly done the poison, with the addition of a handful of flour, will adhere to the whole surface of the plant treated, thereby killing all the grubs which are feeding upon the tissues of the leaves. One trial or two at most will convince any one as to the efficacy of this treatment for insects of this class.

When vines and very young trees are attacked, and the foliage of which is tender, reduce the strength of the mixture to, say, 1 part to 200 gallons of water. Repeat this dose for a couple of times, say at an interval of four or five days. When the garden is small, hand-picking may be resorted to, although this is a tedious and often costly method. A similar result may be obtained by the use of the so-called White Hellebore, *Veratrum album*, if the following directions are carried out:—1 lb. White Hellebore; 2 lbs. soft soap; handful of flour. Mix all together, let stand for one hour, then add 35 gallons of water, and spray as directed.

It will be understood, of course, that both these spraying materials, the former especially, are poisonous, so that care and precaution must be taken against accident, but with ordinary care they may both be used with perfect safety both to the tree and fruit.

A very curious matter connected with these stick-nests has just been brought under my notice, viz., that at a good elevation, on the branches of some Eucalypti growing in the Cheltenham district, a large number of the suspended cases have been found to have been split or rather torn open whilst in that position. How this could have happened is a puzzle to me, as it is somewhat of a difficult matter to tear open the cases even where they are removed from the tree, and most birds would appear to be unable to tear them open, especially when in a suspended position.

This is a singular enigma that we must try to solve, as there may be an enemy to these insects, which up to the present time has escaped our observation, and which may be turned to some good account.

Many of the Ichneumons and other flies are very destructive to these "stick caterpillars," some of them being of good size, whilst others are almost microscopic, and may be bred from either the cocoons of the *Metura* or *Entometa* by any one who may care to investigate these interesting and useful matters for themselves.

To those of my readers who may have leisure for making experiments with artificially reared parasites, I may mention that all that is necessary is a small box, say, 12 inches square, with perforated zinc sides, glass front, and door at back, and in this box the larvæ, chrysalides, and cocoons of various insects could be enclosed. The food-plant, which, if possible, should be a natural one, should be placed with its stem in a small jar of wet sand or water for the purpose of preserving its freshness, and a small circular piece of tin or stout paste-board placed over the top of the jar would prevent a possibility of the grubs falling into the water from above and being drowned.

The glass front will enable any one to watch for the parasites which escape from the specimens enclosed for the purpose, and these can then be captured and preserved, care being taken to properly and correctly note time of emergence, &c.

This rearing process is not only useful, but highly instructive, and may be the means of making important discoveries, useful alike to the grower and to the naturalist.

PLATE XXVI.

LEMON SCALE (MYTILASPIS CITRICOLA.—PACKARD).

Fig.

1. Branch of lemon tree, showing young scale on leaf. Natural size.
2. Fruit, showing scale. Natural size.
3. Female scale. Magnified.
4. Female scale, under view, showing eggs. Magnified.
5. Male scale, upper view. Magnified. (After Cooke.)
6. Winged male. Enlarged. (After Cooke.)
7. Larva. Enlarged. (After Cooke.)

Plate

Plate XXVI.

CHAPTER XXXI.

THE LEMON LEAF AND PEEL SCALE.

(*Mytilaspis Citricola. Packard.*)

Order : *Hemiptera.* Section : *Homoptera.* Family : *Coccididæ.*

We now come to a scale insect which in some countries would appear to do a lot of damage, but in Victoria it is, so far, mostly confined to the fruit of lemons which are imported from Italy and other parts of Southern Europe. Dr. Cooke, to whose works we are indebted for much information concerning scales of economic interest, describes this species as "an elongated slightly-curved scale insect infesting citrus trees," and also remarks that in America it is not a rare occurrence to find it on oranges, &c., which are imported from Europe, Australia, and Tahiti, and offered for sale on fruit stands throughout the States.

This scale in general appearance is, when seen on the skin of imported lemons, much like the well-known Mussel-scale of the apple, *M. pomorum*, but is darker in colour and more curved in shape (see Plate XXVI., Fig. 2). So far as I am aware or can ascertain here it seldom attacks the tree itself, and if it does do so the damage done is not serious. Fig. 1 of our plate shows a portion of lemon branch, on the underside of some of the leaves of which are young insects of this coccid, and on Figs. 3, 4, 5, 6, and 7 the insects in their various stages are shown as explained on the page opposite to the plate.

In America this is often called the purple scale, and, according to that invaluable publication *Insect Life*, kindly forwarded to me regularly by Professor Riley, the fruit-growers of California are very much disturbed over the importation of fruit trees from the State of Florida, and the May, 1892, number of the *Rural Californian* is

largely occupied with discussions of the probable damage which will be done by these pests, and the necessity for a rigid quarantine against the wholesale introduction of the same.

During the last few years there has been quite a number of lemons imported from the South European countries, notably from Italy and Portugal, and so far as my experience goes the greater portion of these are badly infested with this scale, and by the red scale of America and elsewhere. If lemons or even oranges infested by this scale have been sent from Australia to America, they have certainly not been grown in Victoria, and it seems unfair that Australia as a whole should be charged with exporting scale-affected fruit into the United States or elsewhere.

As an instance of how scale or other insect pests may be inadvertently introduced into any country I may cite an instance which happened during our last Melbourne Exhibition of 1888, when orange trees in tubs were sent over from New South Wales for the decoration of their court. On these small trees I found *Icerya Purchasi*, *Mytalaspis citricola*, and *M. Gloveri*, the latter species being quite new to Victoria. These trees were at my request specially treated by spraying, &c., and are now perfectly clean and healthy.

With regard to the introduction of the scale on imported lemons it has been pointed out to me that the paper in which the lemons so sent out are enclosed is specially prepared, and that it would be unlikely that the scales would reach here alive. I cannot vouch for the accuracy of this statement, but the scale on lemons which I have purchased from the fruit shops in Melbourne, and which are covered with the scale, have proved upon careful examination to have been all dead. This experiment, however, is hardly conclusive, and great care should be taken that all imported fruit suspected of being infested by disease of any kind should, before landing, be subjected to fumigation or other treatment which would destroy both the insects and their eggs if any. We have too

many pests of our own without importing these, and it is to the interest of every grower to bring about some permanent protection to themselves against inroads of this kind.

Prevention and Remedies.

As this scale is fortunately not as yet common in Victoria we should pay great attention, as remarked above, to a systematic inspection of all imported lemons, oranges, limes, and other members of the citrus family, both trees and fruit. As the wrappers may not always be specially prepared, and the fruit finds its way into many places in the colony, it behoves us to be on the alert to meet the danger of spreading this, to us, comparatively new pest broadcast throughout the colony.

When a tree or its fruit or both are found to be attacked, thin out as much wood as is consistent with the proper development of the plant. Having burnt the prunings set to work with the sprayer, using the resin compound, instructions about which are mentioned in various parts of this number of the book, also in Part I. As the use of the arsenical preparation of Paris green is comparatively new to us here, and as bee-keepers have complained that bees have been poisoned through sipping the nectar from the flowers of trees which have been poisoned by spraying, I thought it might be of interest to persons engaged in that important industry—agriculture—to furnish them with some information sent to me by my friend Mr. J. Fletcher, the clever chief of the Entomological Department of Canada, so that we may be able to avail ourselves of the experiences of a gentleman who has done a vast amount of good work in economic entomology throughout the British North American possessions and elsewhere in combating a very serious evil should such really exist.

Mr. Fletcher says—"Apiarists claim that fruit-growers have been spraying their trees whilst in blossom, and their bees have been poisoned by gathering the poisoned nectar. Of course the practice of spraying trees while in blossom

is quite wrong, and should be stopped with a firm hand for all considerations. The horticulturist is liable to injure his fruit directly, and if it be true that the bees are poisoned, he not only injures the bee-keepers, but also destroys his best friends. Bees are known to perform such an important part in the fertilization of many flowers that advanced fruit-growers keep bees in their orchards for that very purpose. We all know that the quantity of blossom on fruit trees in the spring cannot be taken as an index of the quantity of the crops that will be gathered, unless there be at that time sunny weather, so that the bees and other insects may visit the flowers and fertilize them. Botanists have discovered that it is far more advantageous for flowers of a plant to be fertilized by pollen taken from other flowers, and this is carried so far that nature herself provides, in many flowers, means by which fertilization by their own pollen is impossible. In some plants we find male and female flowers; these may be either on different plants altogether or on different branches of the same plant. Again, in cases where the flowers are perfect, and contain both male and female organs, we may find that these may mature at different times, so that when the female organ, the pistil, is ready to receive the fertilized pollen, the anthers of its own flower may have already shed their pollen, or *vice versâ*. Charles Darwin, the great physiologist, summed up his observations on this subject in the trite generalization that 'nature abhors self-fertilization.' Although in some cases self-fertilization may be possible, it is not so in all, and it is probably better in all plants that the pistil be fertilized by pollen from other plants. Now, with regard to bees being poisoned by gathering honey from flowers which have been sprayed with Paris green, although I do not know of any actual experiments having been tried, from what I have lately read on the matter I think it is quite possible that they can be poisoned, and if so we may just as well recognise it at once. Some enthusiasts go too far, some saying it cannot be done, whilst others say it can. What we want, however,

are facts ascertained by careful observation. Bee-keepers claim that they know of actual instances, when bee-hives have been located near orchards which have been sprayed during the time the trees were in flower, and that the bees have been found poisoned. A writer in a late number of the *American Bee Journal* claimed that the Paris green could be plainly seen in the bees' bodies. This last statement, however, I think must surely have been an exaggeration, although it is probably the case that they may have been poisoned either by the nectar or by drinking the water from the sprayed leaves. It was also claimed that the honey stored away in the comb was poisonous; but this last statement will require far more proof than has yet been brought forward. Honey, as it occurs in the comb, is an altogether different thing from the nectar of flowers. Before it becomes honey it has to be partly digested by bees, and is not honey at all when in the flowers. The bees suck up the nectar and elaborate it into honey. I am under the impression that before they could turn poisoned nectar into honey they would be killed by the poison. Another safeguard is this: At the time fruit-trees are in flower, although the trees might be poisoned, if some careless fruit-grower were to spray at that time, it would be very unlikely that poison would get into the honey we eat. The honey stored away in the honey-comb is only the surplus. At the time when spraying is done, early in the season, bee-keepers tell me that the bees use the honey they collect then almost entirely as food for their brood, and the honey we steal from them afterwards is only the food which they have laid up for themselves for use during the winter; or, in other words, there is no surplus honey, apiarists say, at the time of the year when fruit trees are in flower. I believe that bees have been found, and Professor Cook, of Michigan, a high authority on bees, states that larvæ have been found poisoned through partaking of this poisonous food. This is the whole thing, and the question came up for discussion before a committee of the Ontario Legislature, when I

was asked by the provincial Minister of Agriculture to go to Toronto and give evidence before the committee. The question that was put to me was this: 'Is there any practical or scientific reason why this Act to prevent the spraying of trees whilst in blossom should not pass?' I could not think of any reasonable objection, for spraying when the trees are in flower is quite unnecessary and is very inadvisable, because if, as the apiarists claim, their bees are poisoned if Paris green be applied when the trees are in bloom, and I maintain you do more harm than good by destroying the pistils of the flowers. Why do bees visit flowers? To get honey, and nature provides this so as to attract insects at the time when they can be of most use in fertilizing the flowers. Directly the pistil is fertilized no more honey is developed, it is no more use to the plant. If we wait for spraying until the flowers drop off, there is no danger of poisoning the bees, because they do not then visit the trees. There is nothing to take them there; but by spraying the trees after the flowers drop we do destroy the little caterpillar which hatches from an egg laid by the codlin-moth in the calyx, and the small quantity of Paris green which we recommend—one pound to 200 gallons of water—is sufficient to kill the larvæ, and as a consequent we get a return from our labour in 75 per cent. more fruit than we should otherwise have had."

The remarks as given above only tend to confirm the opinion held by the writer of this book, viz., that it is inadvisable, and it may be even dangerous, to spray a fruit tree of any kind whilst in bloom. Wait until the blossom has fallen; then, also before the buds make their appearance, is the time for spraying. If we are to be successful with our spraying we must depend much more than we have hitherto done on winter and early spring spraying.

In a recent publication received by me from America it is stated that in large orangeries the use of the gas-tents, as described in Part I. of this book, has nearly superseded the system of spraying. But in Australia, at

present at least, it is to be feared that the high price of labour and cost of material would likely be against the tent system being extensively used, more especially in large orchards.

PLATE XXVII.

THE "APPLE-ROOT BORER" (LEPTOPS HOPEI.—FAHRS).

Fig.

1. Branch of apple tree with perfect insects, showing female drawing edges of leaves together and depositing eggs. Natural size.
2. Larva. Slightly enlarged.
3. Pupa. Natural size.
4. Eggs on leaves, showing also silky covering to same.
5. Showing damage to apple-tree root by tunnelling.

C.C.Brettlebank Del

Plate XXVII

CHAPTER XXXII.

THE APPLE-ROOT BORER.

(*Leptops Hopei. Schœnh.*)

Order : *Coleoptera.* Family : *Curculionidæ.*

We now come to one of the most destructive and serious insect pests of the colony. The "Apple-root Borer" belongs, as stated in Part I. of this Handbook, to the great family of the weevils, and is one of the largest and best known of the Victorian species. It is, so far as I am aware, indigenous to Australia, and was described more than fifty years since by that great entomologist and specialist in this family, Schœnherr. More than fifty species of this genus have been described in various scientific publications as being found in the Australian colonies.

As this insect has been so recently described as a destroyer of apple trees, &c., it is considered unnecessary to do more than simply state some additional facts bearing upon matters of importance which have lately been noticed, and which must, of necessity, prove of great value and assistance to fruit-growers and others interested.

In Victoria, as has been previously remarked, this insect is fairly common, but it is only lately, and after its habits had been accurately noted, that its occurrence in such large numbers, judging from its apparently rapid rate of increase, has been observed.

At page 72 of the Handbook (Part I.) it is stated as my opinion that I suspected the female to deposit her eggs beneath the soil, and near the stem of the tree. Since then, however, and owing to observations made at my request by Mr. Geo. Powell, a fruit-grower at Castlemaine, in our colony, who has been good enough to

watch the case for me, it has been discovered that the female beetle (see Fig. 4) ascends the branches of the tree, having come forth from the soil at night, and, with her legs, folds the leaves of the tree together, fastening them with a glutinous secretion, then depositing her eggs, to the number of 40 or 50, in the manner as shown in the plate, holding the folds of the leaf together until it sticks. In some of these artificially closed leaves the very young grubs have been taken, and these descend to the ground and there ensconce themselves in the cracks or crevices in the roots, descending either vertically or horizontally as the case may be, when they at once commence to tunnel into the roots. The sap is thus drawn from the tree at a time when it is most required.

Having tested this matter of depositing the eggs in the closed leaves for myself, I can vouch for the accuracy of these facts as formerly ascertained by Mr. Powell.

These insects, unfortunately, do not confine themselves to attacking apple trees. They have been found to be as severe on pears as apples, and cherry trees are also greatly injured and often killed by them.

Of all the many serious insect pests with which growers of apples in Victoria have to contend this beetle may be fairly set down as the most formidable. In former years it was known, as a rule, to frequent wattles (*Acacias decurrens* and *mollissima*), but on these trees I am not aware, nor can I learn from experienced observers, that it attacked the roots, and it would appear to have done but little damage to these trees, being most commonly found on the young wattles of from 6 to 10 feet high. Fortunately for the grower this beetle cannot fly, so that it cannot be spread broadcast as is the case with many other pests of the orchard, farm, and vineyard. The larva, pupa, perfect insect, and root section are also figured at page 70 of Part I. of this Handbook, but as the lithographing is hardly up to expectation it has been considered advisable to reproduce it in Part II., together with the egg-laying process, &c., the illustrations here given being absolutely life-like.

There will, however, be no occasion to again describe this species in its various stages of existence, but as the discovery is of such great importance to growers it has been decided to have a brief notice of it in No. VI. of the Agricultural Department's publications *Guides to Growers*, lately issued, so that any one interested might not be kept waiting until the publication of Part II. of this book.

As showing the large numbers of these beetles which may now be found by a careful search, it may be mentioned that no less than 1,600 of the perfect insects have been found in one orchard within a very few months, and when we consider that a large proportion of these beetles have proved to be females, and each one of them deposits such a number of eggs, it will be at once seen with what a dangerous foe we have to deal.

A few months since, having learned of the very serious condition of the apple trees in many of the orchards around Doncaster and other places near Melbourne, I paid a visit to the former district, and, in one of the best kept orchards that I have seen in the colony, I found that a large number of the trees, as had been noticed by other growers, also through the medium of the public press, were in a very bad state. The tops of the apple, pear, and cherry trees having commenced to die off, the top branches showing the first indication of the presence of some insidious foe attacking the roots of the tree, and having had some experience with trees in the Geelong and other districts in which the trees seemed to be similarly affected, I at once came to the conclusion that the same culprit was at work in these orchards also. I now find that my surmise has proved to be correct, as Mr. Thiele, proprietor of one of the orchards referred to, has just written me to say that, in digging up some of the apple and other trees, he found all the roots which were within 8 inches of the surface to be perfectly sound, and, from a casual examination, would appear to have nothing wrong with them, but as soon as the roots took a "dip" downwards they were eaten more or less to

the depth of about 2 or even 3 feet from the surface. In some soils they may go deeper, in others shallower, but where these were taken out the soil was very firm below the trees.

Mr. Thiele has also sent me round pieces or balls of the clayey loam taken from near the tree, and from which the head of the perfect female can be seen protruding, and in a similar position the larva also. This convinces me more than ever that suffocation, combined with judicious root-pruning, are the best means to be adopted for their extermination when below ground.

To growers, the fact of seeing one's trees dying off one after another, from no apparent cause, is no doubt most discouraging; but now that we have a better knowledge of the economy and life-history of this insect we may reasonably hope to be able, by increased vigilance in picking off and burning the infected leaves between which the eggs are deposited—and which, after any one has once seen the illustrations, they will have no difficulty whatever in recognising both the insects and the appearance of the leaves on which the eggs, oval in shape, white in colour, and covered with a white silky film (as shown in Fig. 4), are deposited—to cope with the evil. Having in view these facts, which have been so recently brought to light regarding the life-history of the beetle, and the somewhat singular circumstances of their having left their natural food, and, unfortunately for us, adapted themselves to our introduced fruits, should cause us to seriously consider whether the assistance of the Forest Branch of the Mines Department should not be invited to co-operate with this branch of the Agricultural Department, also with growers in the event of any serious inroads of native insects taking place—that is, where forest or wattle reserves are in close proximity to either orchards or vineyards. This could, it is thought, be partly accomplished by obtaining permission from the former Department to destroy any native tree which, on examination, was found to be badly infested with noxious insects of any kind, and which, as in the case of this

weevil, would be likely to spread, as well in the interests of the timber and wattle-bark industry as for the farmers and fruit-growers themselves.

As an example of the serious damage caused by these weevils, Mr. King, the well-known orchardist of Geelong, informs me that from the years 1868 to 1878 he had to root up and destroy no less than thirteen acres of fine trees, most of which had been in full bearing. Mr. Powell also states that in his orchard, a few miles out of Castlemaine, a large percentage of his trees are dying off from the top downwards, and also remarks that in his district the beetles come out of the ground just before the buds begin to swell, laying their eggs in October and November, and by December seem to have disappeared altogether. Nearer Melbourne, however, the beetles are to be found much later on in the summer, and, in many cases, all the year round.

Prevention and Remedies.

When the leaves are on the tree, look very carefully for those that are sticking together. Pick them all off, and destroy by burning. If the fruit be on the tree shake the branches gently over and into a sheet. When the fruit has been gathered, a much more severe shaking can be resorted to, and which, if done carefully, cannot fail to dislodge large numbers of the perfect beetles, and possibly many of the young grubs also; and as the beetles are sluggish in their movements, often feigning death, it will be no difficult matter to destroy them either by burning or scalding water, as the whole family are, as a rule, most tenacious of life and not easily destroyed when captured, excepting, of course, by the means above mentioned.

The carbon process, as explained in Part I., together with such improvements as are given in another portion of this part of the book, should be persevered with. Great care must be exercised when replanting an orchard, supposing the affected trees to have been grubbed out, and in this case the land should be thoroughly treated with gas-lime before replanting, as the grubs may, by the

process of grubbing out, be detached from the roots, and will doubtless exist for a long time in the soil. All affected parts of the tree, both root and branch, should be at once destroyed by burning, and, if possible, in the holes from which the trees have been extracted.

The somewhat hasty plan of rooting up affected trees is to be deprecated, as with a little care and exercise of judgment many trees, even if badly affected by disease of most kinds, may be restored to health and bearing again, and in the case of this weevil scourge in particular, too much stress cannot be laid upon the value of preventive measures.

As this insect, whilst in the perfect or beetle state, is now known to feed upon the foliage of the tree, spraying, if the fruit on the tree is not either ripe or ripening, must be resorted to. To do this, use Paris green, Blundell's paste preparation, in the proportion of 1 lb. to 200 gallons of water. This should be applied with a spray-pump—not a syringe, which distributes the material too unequally, and also wastes a deal of it during the operation. If your cherry trees are infested, wait until your crop is gathered, then spray at once, and in the case of apples and pears it will be found a most advantageous precaution.

Root pruning is also highly to be recommended.

Where wattle trees especially are growing near an orchard, these should be carefully examined for the perfect specimens of this beetle; and the writer of these notes is one who does not approve of the hasty and so-called heroic measures so often recommended to fruit-growers and others whose trees are affected by blight. Keep your orchard clean and well looked after. Away with all prickly-acacia hedges, which are but breeding places for noxious insects of many kinds, to say nothing of harbors for rabbits, sparrows, hares, and other pests of the farmer and fruit-grower in the colonies. The whitethorn, so justly prized for its beauty and utility, is, when not very carefully kept, a great harborer of the dread mussel-scale, &c. It would seem almost "heretical" for me to say it, but a good substantial barbed-wire fence is, undoubtedly, in nine cases out of ten, in the long run by far

the cheapest and best fence by which any orchard can be surrounded. If shelter must be provided, let it be done in a practical and intelligent manner, always remembering when planting shelter trees to choose such as will be both ornamental and at the same time profitable. It is not part of my duty to recommend any particular plant or tree for this purpose, but this information can always be obtained on application to the Secretary of the Victorian Department of Agriculture, whose officers are always, in matters of this kind, at the service of growers who may require their advice and assistance.

PLATE XXVIII.

THE VINE MOTH (AGARISTA GLYCINE.—LEWIN).

Fig.

1. Branch of vine, showing caterpillars on leaf and stem. Natural size.

2 and 2A. Perfect insects, on wing. Natural size.

3. Pupa. Natural size.

4. Perfect insect at rest.

CHAPTER XXXIII.

THE VINE MOTH.

(*Agarista glycine. Lewin.*)

Order: *Lepidoptera.* Section: *Heterocera.* Family: *Agaristidæ.*

This moth, whilst in the larval stage, is one of the vigneron's greatest enemies.

The eggs, which are deposited on vine stakes and on the vine, and possibly on other small plants as well, are small, but can be plainly seen with the naked eye.

Professor McCoy, in one of his valuable "Decades," states that there are two or three broods in a year (I fancy there are the latter number at least), as the changes from the egg to the larva and from this to the pupa and perfect insect take but a comparatively short time. We can always reckon on their first appearance when the vine comes into leaf, near Melbourne, towards October; but, in some localities, either earlier or later, according to situation and elevation.

The first brood generally make their appearance about, as is stated, October, and, after a few weeks, enter the pupa state about the beginning of December, the moth coming out about the end of December, while the larvæ descended into the earth, formed their earth-covered cocoons beneath the surface at the end of March, and, according to the same writer, the perfect insect came out on the 18th of May. It will thus be seen how rapidly these insects increase, as the female is known to lay a large number of eggs, and these in turn are hatched very quickly, when they at once commence to tackle the vine leaves, as shown at Fig. 1, feeding and increasing in size with more than usual rapidity.

The moth, however, may often be seen long before the vines are in leaf, and Dr. Morrison, of East Melbourne,

has just brought me (16th July, 1892) one that had hatched from the pupa, but was deformed, and would, of course, fall to the ground, and most likely be devoured by ants.

When the larvæ are newly hatched they are of a dark greenish-black colour: but, as they increase in size, the colouring becomes very beautiful, the shades of green, yellow, and black being admirably blended, and this, together with the red marks just behind the head, adds greatly to the appearance of the caterpillar. Scattered over the body of the caterpillars are numerous little white hairs, which the lithographer informs me he could not well produce on the plate here attached.

The pupa (see Fig. 3) is oval, somewhat sharpened at one end, and this is enclosed in a thin crust of soil. (The figure on our plate is not at all good, having been injured in the printing.) The perfect moth is a very handsome insect (see Figs. 2 and 2A, natural size). The wings are black, or nearly so, with yellowish-white markings. The posterior end of the abdomen terminates in a sort of orange buff-coloured tuft, which greatly adds to its beauty (see Figs. 2 and 2A). When the caterpillars of this moth make their appearance they are, as I have said before, very small, but very voracious. In the course of a day or two they change greatly in size and colour. When full grown, about the size shown at Fig. 1, they are terribly destructive to vines. They strip the leaves as completely as if done with a pair of scissors, commencing from the outside of the leaf and eating towards the midrib, which is often left standing quite bare. In the case of young shoots, the full-grown grub will sometimes make a clean sweep of these as well, and with young vines a bad attack from these pests will not infrequently kill the plant altogether.

In connexion with this particular Vine Moth it may be observed that this is but another instance, unfortunately not an uncommon one, of an insect forsaking its native food for something which is no doubt easier eaten and much more palatable.

The specific name, as given by Lewin, is derived from a twining plant, *Glycine*, which grows in and around Sydney, also in many other parts of New South Wales; but within a good distance of Melbourne we have but one species of this plant, viz., *Glycine clandestina*, a slender lavender-blue flowered twiner, which at any time one may see for themselves.

How long this moth has been in Victoria, or whether it is indigenous, I am not prepared to say, but I can well remember having seen it near Melbourne in the early part of 1855, but I believe it was here much earlier than that, and certainly there were no plants of the New South Wales species of *Glycine* then growing near Melbourne, so that it was evidently not confined to any one particular food plant. Professor McCoy, however, tells us that before the introduction of the Vine Moth into Victoria, the larvæ fed on a species of *Gnaphalium*, one of the common "everlasting" flowers, but for our purpose this, of course, matters very little.

The flight of the Vine Moth is somewhat heavy, and it may be easily captured by means of a roughly-made net. They are gregarious, and the perfect insect may often be found in vast numbers hovering over the flowers of many kinds well known in gardens. After careful observation I could not detect the female in the act of depositing her eggs upon any plants other than vines.

Prevention and Remedies.

Catch or damage as many of the perfect moths as possible, this to prevent egg-laying. If the moths are but injured in any way so that they cannot fly, they soon fall a prey to the numerous ants, which are always on the look-out for disabled insects of any kind, and butterflies and moths in particular. When ants come across a moth which has been damaged so much as to impede its flight, you will see them trotting around the helpless insect until it would appear that they had made up their minds as to how their prey was to be tackled. This is

accomplished in many cases, particularly with heavy beetles which have been injured and are either lying helplessly on their backs or trying to roll over and over, by the ant first proceeding to gnaw off the feet of the insect attacked. Having done this they next bite off the palpi, little appendages near the jaws, generally finishing up by severing the segment which joins the body and thorax together, and sucking out the juices from inside the body. *Lepidoptera*, when too heavy to drag away, are bitten up into portable pieces in the same manner. It is quite certain that if a moth of any kind is bruised so that it cannot fly, eggs thus deposited will not come to anything. This fact should be remembered, for after all it is better to prevent this egg-laying, if at all possible, than to be compelled to deal with the hosts of young grubs which are certain to be hatched from the vines on which the eggs have been deposited.

Where stakes are used for vines, they must be carefully seen to, as the eggs are often deposited in crevices of any stake having a rugged exterior. A good washing with lime, sulphur, and soap mixed is of great advantage when cleaning up the vineyard.

Should the moths have deposited their eggs in spite of the above precautions, hand picking must be resorted to, although in a large vineyard this plan is too expensive to be generally adopted. The hand or knapsack spraying machine comes in well here, and a light spraying of Paris green, say, 1 lb. to 200 gallons of water would, if carefully carried out, destroy every caterpillar which ate the leaf or portion of it, if the plant had been carefully and thoroughly sprayed. The under part of the leaf can best be reached by using a bent nozzle. Hellebore, if dusted over the leaves, is also good.

In spraying for these caterpillars, be careful that the liquid is forced up well from below, as the larvæ are principally to be found feeding upon the lower edges of the leaves, and doubtless get on the back of the leaf for purpose of shelter, and possibly as a means of escaping detection.

The caterpillars of this Vine Moth are very numerous, and no sooner is a plant to all intents and purposes cleared of the caterpillars than lo! the next morning the plague would appear to be as bad as ever. Do not be discouraged, this will not last long, for if persevered in for a season, we must with the aid of birds and other natural enemies, together with our own individual exertions and co-operation of our neighbours, keep this pest in subjection. In small places, the somewhat original, though old, plan of clipping the caterpillars in halves with a sharp pair of scissors is not to be despised, and by this simple method vast numbers of the caterpillars can be destroyed, and which, if allowed to remain unmolested, would strip a small vineyard in no time.

Many persons imagine that the caterpillars of the Vine Moth do but little damage, excepting that they eat the leaves. This is only a portion of the harm done, because the vines when stripped of their leaves are thrown back in growth, and if in fruit, the latter becoming quite unprotected, frequently failing as a consequence to reach maturity, and shrivelling up as they grow on the plant.

Amongst the natural enemies of this species of Vine Moth are the two well-known birds, commonly called the bronze-cuckoo and pallid-cuckoo respectively. These birds, which are included in our list, are very fond of caterpillars generally, but particularly those of the Vine Moth; the singular fact being that although many of our domestic birds will hardly touch this caterpillar, these two cuckoos would appear to be singularly fond of them, and destroy enormous numbers.

Bronze cuckoos which for scientific purposes have been killed, upon examination of their stomachs, were found to be crammed with caterpillars of the Vine Moth under notice.

Another very useful ally to the vigneron is a small light-brown plant-bug, *Cuspicona*, which has a very powerful proboscis, with which it pierces the larvæ, and

the juices of the body are then sucked out. These little wood-bugs are not altogether desirable friends, however, as they smell vilely, more especially whilst in the larval stages, and are not at all particular in their choice of food, more especially when such fruits as strawberries, raspberries, &c., are in season. I am informed, however, by an old Bendigonian, Mr. Carolin, that some of his neighbours are preserving this bug as a means of assistance to them in keeping down the ravages of this beautiful but destructive caterpillar. In the first part of my book I mentioned that I was inclined to pin more faith in the judicious use of the various insecticides than to the chance of our natural parasites helping us to clear off pests. I must now confess to the feeling of a greater desire to foster and protect such parasites as can be proved to be destructive to our garden pests, both native and introduced. When we consider what has already been accomplished by my friend and fellow worker, Mr. A. Koebele, in America, through the introduction of the little Ladybird (*Novius*) for the purpose of destroying the dread cottony cushion scale, *Icerya Purchasi*, we cannot overlook the fact of the utility of insect parasites if judiciously introduced; but this in our colony would be well-nigh impossible, at least at present, as in such matters it would require a large staff, also field workers, inspectors, &c., with all the machinery necessary to carry out a large department. I must then partially adhere to my former statement, that well-regulated spraying and other means herein recommended are mostly preferable to any other methods for keeping insect pests in subjection.

The Vine Moth is one of our oldest enemies. We must pay strict attention to the destruction of the first horde of moths, remembering that by destroying these we largely check the increase at the outset. There are other methods for keeping off this pest, such as enclosing the vines under muslin covers; this, although a good plan, is of course, unworkable in a vineyard, where time is money.

In concluding these notes on the Vine Moth, it may be pointed out that we have two other, though more uncommon, species of *Agarista*, but on comparing these latter moths with the figure on our plate the difference will at once be recognised.

The large species of this genus, *A. Casuarinæ*, rare, is found in some parts of the colony, and so far as we know is perfectly harmless to introduced plants.

PLATE XXIX.

THE "SILVER-STRIPED VINE MOTH" (CHÆROCAMPA CELERIO.—STEPHENS).

Fig.

1. Branch of vine showing caterpillars. Natural size.
2. Perfect insect, on wing. Natural size.
3. Perfect insect, at rest. Natural size.
4. Pupa. Natural size.

C. Brittlebank. del. C. French. Direxit. Troedel & Co Lith

Plate XXIX.

CHAPTER XXXIV.

THE SILVER-STRIPED VINE MOTH.

(Chærocampa celerio. Linn.)

Order: *Lepidoptera.* Section: *Heterocera.* Family: *Sphingidæ.*

Very beautiful night-flying moths, the larvæ of which do great damage to vines by stripping them of their leaves.

This pest is probably an introduction from Europe, or it may be also indigenous. Be this as it may, this species is no doubt identical with the well-known "Celery Hawk Moth," of Europe, a species largely distributed throughout the world.

As will be seen from our plate, the moth is about 3 or 4 inches across the wings when expanded. The larva, or caterpillar, is a very formidable-looking creature, sometimes greenish and often brown in colour; the eleventh segment of the body has a sort of horn-shaped projection, as shown at Fig. 1, and which many people imagine to be placed near the head of the caterpillar instead of near the "tail;" and this description I have many times received from growers when sending specimens for identification.

The pupa is brownish in colour, and may be found on or amongst leaves below the vine, and in some cases just below the surface of any loose soil. The natural size is given at Fig. 4. I have not seen the eggs of this moth, but strongly suspect them to be deposited on the vines themselves.

Some years ago there appeared to be quite a consternation concerning some wonderfully-formed caterpillar attacking vines. This caterpillar was stated by some to have a huge horn above its head, two large eyes on its back, and when touched would "spring" at the intruder. On interviewing this "monster" among pests, however, I found it to be nothing more nor less than the larva of

one of our hawk moths; these, I need hardly remind you, being quite harmless to human beings or domestic animals.

When these larvæ are numerous, which luckily is not often the case, one of them will strip a vine in less time than it would take six caterpillars of the common vine moth to do, the quantity that they can get through being enormous.

In Australia we have about twelve species of this genus, many of these being very large and handsome. We have another large species in Victoria, *C. erotus*, also attacking the vine, and this will be figured in Part III. of the Handbook, our plates of the latter insect not being ready. The *Sphingidæ* are nocturnal in their habits, and about dusk may be seen hovering around flowering plants in our gardens. They fly very rapidly and make a whirring noise with their wings.

In many parts of Victoria, also near Melbourne, there is to be found a small cinnamon-brown coloured hawk moth, *C. scrofa*. This is a most interesting species, but does but little harm, and, being a great beauty, is much sought after by collectors of *Lepidoptera*.

To those who care to rear specimens of this family for themselves, it may be mentioned that the perfect specimens should never be taken in the hand whilst alive, as the somewhat conical-shaped and partly cylindrical body is difficult to hold between the thumb and finger. If specimens are wanted in a state of perfection, they must be reared from the chrysalides ; these latter should be placed upon some grassy turf, and kept in an airy light place until the perfect insects appear, when they should be chloroformed and at once pinned, and if stuffed with camphorated cotton wool or plaster of Paris are all the better.

Upon examining one of these moths it will be observed that they have a long spiral tongue, which they insert into the tube of a flower much the same as a humming-bird does with its long and slender bill, the honey being thus extracted.

Prevention and Remedies.

This is a pest which I am disposed to think need not cause our vignerons much apprehension, as they are fortunately not numerous, and, being large, are easily seen and destroyed.

When a vine is found to have had its leaves badly torn and jagged, as if they had been cut with blunt scissors, look under the plant, when black droppings about three times the size of an ordinary onion seed may be seen, this being a sure indication of the presence of one or more of these large caterpillars.

In some cases the whole of a vine on a trellis or verandah will be found to have been stripped of its leaves during the night. It is therefore necessary to look carefully before retiring to rest ; an ordinary lantern and a pair of good sharp scissors being all that is required for this somewhat cruel but effective means of protecting the vines, and getting rid of the culprits.

The larvæ of most hawk moths travel somewhat rapidly, and are active in their movements. Few people who are unaccustomed to the work would care to handle one of the splendidly-coloured larvæ of our largest and finest Australian species of the family, *Cæquosa triangularis*, because when taken in hand these huge grubs lash out right and left, and to the uninitiated must appear very formidable animals to tackle.

When the caterpillars have stripped one vine, they often travel along the ground and pass by several vines before ascending another plant to resume the attack. Their motive in thus acting has not, to my knowledge, been satisfactorily explained.

When leaves of the vine have become fairly firm, spray with a weak solution of one of the arsenites, as for the common vine moth. This must be done, however, before the berries are of any size.

Hand-picking, together with the use of the scissors, is after all the best method of dealing with a pest of this kind. The larvæ, pupæ, and perfect insects are easily

injured, so that the chances of their doing much damage would, by the adoption of the simple means recommended above, be reduced to a minimum.

In forwarding at any time living larvæ to the entomologist, they should be packed in a tin box with perforated sides, and in which some grass, green but not damp, should be placed. Any of the hawk moths, either in the larval or pupa stages, would be acceptable, such being required for the Museum of Economic Entomology now in contemplation.

PLATE XXX.

PHYLLOXERA, OR GRAPE LOUSE OF THE VINE (PHYLLOXERA VASTATRIX.—PLANCHON).

Fig.

1. Egg recently laid.
2. Egg near hatching.
3. Hatching of young phylloxera.
4. Larva at the first stage.
5. Larva at the second stage.

6 and 7. Third age, upper and under side.

8. Female of the galls, a little longer than the preceding one.

9 and 10. Pupæ, above and below, a little longer the female apter.

11 and 12. Winged female, above and below.

13. Male.
14. Impregnated female.
15. Egg from which the male proceeds.
16. Egg from which the female proceeds.

NOTE.—All the above figures are highly magnified, and have been drawn from the illustrations issued by Hachette and Co., Paris.

to be kerosene emulsion; and it must be remembered that such preparations as London purple, Paris green, hellebore, and other poisonous compounds are of little, if any, use against aphides, since these pests suck the sap only, and do not, as in the case of the Pear Slug, caterpillars, &c., eat the tissue or surface of the leaf; so that they must be treated with a contact poison, and which will, if heated, be all the more powerful when applied to hardy trees. But in the case of peaches it would not be advisable to have the material more than lukewarm. When the tree is dormant, however, it can, without danger, be sprayed on whilst hot, say up to 130 degrees Fahr.

The resin compound is another most valuable remedy. In the case of tender trees, however, common washing soda should be used instead of the more powerful caustic soda recommended as one of the ingredients against the hardier scale insects, &c.

The following formula for the kerosene emulsion is recommended by the New Jersey Agricultural College Experimental Station, and I have not the slightest doubt as to its success if properly applied:—Kerosene, 2 gallons; water, 1 gallon; hard soap, ½ lb. Make a suds of the soap and water, and pour, boiling hot, into the kerosene. Churn well with a force-pump or a syringe, pumping out of and into the bucket through a rose nozzle until completely emulsified. If the mixture is sufficiently hot it will thicken in from five to ten minutes, and will be, when cold, of the consistency of butter or of soft soap. For Peach Aphis, dilute with fifteen parts of water. When the tree is without leaves, a much stronger proportion can be used, and the emulsion may then be used with safety at, say, one part of the emulsion to ten of water. This can be put on hot, as the remarks above quoted are only intended to apply to spraying trees when the young shoots are tender, or where the leaves are on the tree.

A friend of mine, who has an orchard in the Dandenong Ranges, assures me that he holds both kinds of Peach Aphis in supreme contempt, simply by spraying the trees

Plate XXX.

PLATE XXXI.

PHYLLOXERA, OR GRAPE LOUSE OF THE VINE (PHYLLOXERA VASTATRIX.—PLANCHON).

Fig.

1. Healthy root.
2. Stock of a diseased vine, showing also the swellings of the rootlets and of the galls on the leaves.
3. A swelling full grown, covered by young phylloxera.
4. Winter eggs, and female after laying.

Plate XXXI.

CHAPTER XXXV.

THE PHYLLOXERA, OR GRAPE LOUSE OF THE VINE.

(*Phylloxera vastatrix. Planchon.*)

Order: *Hemiptera.* Sub-order: *Homoptera.* Family: *Aphidæ.*

The aerial apterous or wingless female of this most terrible scourge to the vignerons of Europe, America, and elsewhere, has, according to Mr. Buckton, from whose fine work the scientific descriptions here given have been taken, "a body nearly circular, flask-shaped, drawn out at the tail, which ends in a short and truncated ovipositor. Colour amber-yellow, fuscous or ferruginous; spotted from the numerous eggs which fill the body cavity. Head and tail-ends slightly browner. Eyes black, and very small. Antennæ short and very fine, three jointed, the last being much the longest. Legs very small, scarcely protruding beyond the body. Rostrum about one-fourth the length of the body.

"This insect is the immediate produce of the true ovum, which was laid in the autumn by the sexed female. Her history, after exclusion from the eggs, is probably somewhat different according to the climate, and perhaps the character of the vine on which it occurs.

"The aerial (above ground) forms are rare in the colder climates, but they increase in frequency as we go southwards or cross into America. Where the aerial forms occur, the foundress punctures the leaves in such a manner that the swelling masses close over and finally entomb her. The leaves become studded over the surface (and particularly near the edges) with gall-like masses, many of which are pedunculate. Each foundress appears to form a single gall, within which she lays hundreds, or even thousands, of yellow egg-like bodies. This oviposition continues through the summer, after which operation she dies.

"These galls are round, fleshy, and corrugated. They often number 100 or more upon a single leaf. A vine which is much infected soon becomes sickly. The leaves show distortion, turn yellow or brown, and during their decay yield a faint and unpleasant odour. The stock becomes stunted, and if the roots be uncovered they will be found (especially as regards fibrils) swelled into small blebs and tubercles. These are the result of the attacks of the young phylloxera, which, after their development on the leaf and escape from the gall, have descended into the ground and commenced their subterranean existence.

"These creatures are so numerous that the roots when turned up often appear dusted with yellow grains. In this condition they produce the greatest destruction to the European vines. In America the aerial form appears to produce the greatest evil.

"*Subterranean apterous female.*—These apterous larvæ are smaller than the fundatrix and are amber-yellow, with an olive stain towards the head and vent. In later generations the forms are more flask-like and colour ferruginous. During their life underground they oviposit. One specimen, however, on dissection contained only eight eggs, but this number is not constant. The egg-like bodies are of a pale yellow colour and shining. When the larger roots are attacked the cortex is loosened ; it rots and scales off under the irritation of the insects. When the small fibres are affected, swellings and nodules mark the injury done.

"Professor Riley states that this root modification of phylloxera passes through five or six generations, which fact will account for the various forms and sizes seen simultaneously crowding the roots of the plants. The American forms appear to be more tuberculate than those I have been able to examine through M. Lichtenstein's courtesy.

"About the month of July many of these underground forms pass into nymphs and come to the surface, where they develop wings, and then they fly to distant vineyards to carry on the invasion. In America, during August,

they swarm in thousands. A quart pot of earth containing infested roots will for three weeks yield a dozen of these alate (winged) forms daily, each of which contains one, two, up to eight egg-like bodies of different sizes, which are deposited sometimes under the leaf, and sometimes in the fissures of the bark. This winged insect is the "Pupifer" of Lichtenstein, and furnishes through the above pseudova the true males and females.

"*Winged* (*pseudo*) *female*.—Body greenish-yellow, fusiform. Abdomen tapering towards the apex. Head broad; eyes large and red. Antennæ rather short, third joint much the longest, strongly ringed, and apparently without any marked tubercle. Wings carried pentwise, membrane hyaline and very delicate. Cubitus broad and yellow. Stigma very faint. The three nervures pale yellow.

"The only specimen I have examined contained one single large egg, measuring 0·015 of an inch. The identity of species of these aerial and subterraneous insects is now too well known to require comment beyond the fact that Professors Riley, Balbiani, and Cornu have all proved that the two kinds may be compelled by artifice to change their habitats. The apterous larvæ taken from the roots, however, show much disinclination to feed on the leaves, and probably they never would raise the galls.

"Professor Balbiani has shown that the appearance of the winged insect is not necessary to complete the cycle of life. In this case, when a recurrence to the male becomes necessary, an apterous form must yield the eggs which give rise to the sexes, just as it occurs in the case of *Phylloxera punctata*.

"The American phylloxera appears to have as many as six different periods for egg-laying; but the European insect, from Lichtenstein's observations, would appear to have fewer. The root-feeding larvæ undergo a hybernation, during which time they shrivel up without losing vitality. In April they wake up, become supple and inflated from the imbibition of sap, and then it is that the chemical insecticides have the greatest activity upon them.

"Extreme cold does not affect the ova of insects much. M. Girard points out that the eggs of the silkworm will bear a cold of 25° C. in their passage over the mountains of Japan, and that the caterpillars may be frozen, "so as to ring like metal on a marble slab," and yet after a slow thawing they will come to life and feed like others. The fond hopes that cold would destroy the hybernating egg of phylloxera cannot therefore be realized.

"Balbiani states that the winged females deposit their pseudova amidst the down on the under-side of the leaf; and Riley says that this is the common habit of the American species. The insect, however, will drop them on the bark, or stem, or indeed almost anywhere.

"THE MALE AND FEMALE.—These perfect sexes were, I believe, first discovered by M. Lichtenstein, and afterwards by Professor Riley in America. They are exceedingly small, and have no true mouth parts. A small eminence is the sole representative of the buccal organs.

"THE APTEROUS (WINGLESS) MALE.—This minute insect is pale ferruginous yellow and cycloid: flat, testudinate, with a very small head furnished with small black eyes. Thorax proper there is none; the abdomen is coarsely ringed and corrugated; legs short, with obtuse tarsi and very minute claws. The male is so small that it may be easily overlooked.

"THE SEXED FEMALE is much of the colour of the male, but is larger. The abdominal cavity contains a single egg, which is the true ovum. The female delivers herself of it about the fourth day after she is hatched, and this without any real necessity of concourse with the male. Whether such eggs are barren it does not appear (see Riley, Eighth Report, p. 159). The true ovum is larger than all the preceding pseudova. It is yellow at first, but soon afterwards it becomes olive in colour, with a rough exterior. Its survival through the winter in the crevices of the bark has been substantiated by Balbiani and M. Lichtenstein, and there is no doubt that the foundation (the first form issuing from the fecundated egg) is the produce of the same, just as with other aphides.

"It has been stated that the phylloxera keeps below the soil in dry weather, but ascends the stocks in the wet season (Villedieu).

"M. Lichtenstein lays much importance on the fact that the males and females remain for several days after they have been deposited by the winged insect in certain delicate membranes, which at one time he regarded as cocoons.

"I gather from his remarks that when two winged generations appear in phylloxera, the first produces a rostrated progeny, and the last a non-rostrated. If the vine phylloxera shows but one alate generation it furnishes the non-rostrated sexes in the autumn. He warns all investigators against the confusion likely to arise by confounding an alate insect with its later winged successor.

"If there be no aerial forms in a cycle the foundress descends at once to the roots and no galls appear on the leaves."

Prevention and Remedies.

In the history of the world there has been no more deadly enemy to the vigneron of Europe, America, and elsewhere than the much dreaded hosts of this tiny but destructive little insect. Few indeed have been so well worked out by enthusiastic scientists, who, recognising the enormous amount of damage done, and the benefits to be derived from a careful study of the life-history of the pest, have given to the world the results of their labours both scientific and practical. To enumerate all the names of those who stand in the first rank as observers of the habits of this insect would be perhaps out of place here, but the names of M. Lichtenstein, Professors Riley, Cornu, Balbiani, Planchon, Buckton, Villedieu, and others cannot be overlooked, nor can their untiring efforts to combat this dire pest be forgotten.

Baron von Mueller in his work on "*Select Plants for Industrial Culture and Naturalization in Extra-tropical Countries*," one of the most valuable books which has seen the light in Australia, speaks of the phylloxera as follows:—

"As is well known the grape vine is subject to the attacks of various insect and fungous pests. The most

destructive by far being the insect called *Phylloxera vastatrix.* None of the remedies hitherto suggested seem to have proved really effective, or they are not of sufficiently easy and cheap application, and the phylloxera thus is still rapidly on the increase in Europe. According to latest accounts most vineyards of France were affected, and the disease is also spreading in Italy, Spain, Germany, Austria, Hungary, Algeria, Syria, and South Africa.

"The most effectual method of combating this enemy in France has been found in grafting the ordinary grape-vine on stocks of several American species of *Vitis.* It may be worthy of trial how far the grape-vine can be grafted on such other species not American as may not be attacked by the phylloxera. Professor Monnier, of Geneva, has introduced the very exhaustive sulphurous anhydrous-acid gas against the phylloxera. The cultivation of insecticidal plants to check the ingress of the phylloxera should be more extensively tried, as such plants might ward off the insect, at all events in its wingless state. Dr. Herman Behr, the well-known American entomologist, suggests for the mitigation of this plague the ignition of wood near vineyards, when the insects are on the wing, as all such insects seek fire and succumb in them, the attraction to the fire light being greatest when the sky is overcast, or when the nights are without moonlight. Dr. Leacock, in Madeira, applies a coating of a sticky solution of resin in oil of turpentine advantageously to the roots of the vines affected by phylloxera. Dr. Clemm extols an application of easily decomposed carbonates or sulphides to the soil with subsequent addition of any diluted acid, whereby the suffocating carbonic-acid gas or the sulphuret of hydrogen is formed and liberated, the resulting salts in their turn to invigorate and nourish the suffering plant (Dr. S. Krause). Successive broods of phylloxera maintained their vitality on remnants of vine roots for six years and more. Inundation to the depth of a few inches for about a month, when that is practicable, completely suffocates the phylloxera, but renders the vine for a time much less productive. In

sandy soil this dreadful insect is retarded in its development, action, and progress. Bisulphide of carbon has proved an efficient remedy; this fluid is introduced into the soil by a peculiar injector, or through porous substances (decayed wood) saturated with the bisulphide, the cost of this operation being, in France, £3 10s. to £4 per acre annually (Planchon, David, Marian, Robart).

"Dressing with sulpho-carbonate of potassium is still more efficacious and less dangerous, but involves an annual expenditure of about £8 per acre (W. T. Dyer). Sand might be dug in at the roots of vines, which may be in imminent danger of becoming a prey to phylloxera. Recently it has been insisted on by Mr. Bauer, of San Francisco, that it would be best to put minute quantities of mercury and chalk near the roots of vines affected with phylloxera, a measure which deserves every consideration, as the particles of quicksilver would only very gradually be dissolved and long remain stationary; and we know that metal in its solutions to be the most powerful antiseptic, a dilution of 1 part of bichloride of mercury in 5,000 parts of water proving strong enough for surgical purposes.

"The *Phylloxera vastatrix* and also its ova succumb at a heat of 113° F. (Cousanon and Solomon), and thus by a careful heating of the soil the insect and its eggs may be destroyed without hurting the plant dangerously."

Fortunately for Victorian vignerons, this pest, owing to the prompt and heroic measures which the Government of the day insisted upon, is believed to have been thoroughly stamped out, at least we sincerely trust that such is the case. Should this scourge again make its appearance in our vineyards, it is hoped that the very plain and concise account of the life-history of the insect, as given by Mr. Buckton and other eminent authorities, will enable the vigneron to at once recognise the insect, should he be called upon to again face such a calamity; and as the coloured plates are all that can be desired, having been adapted from the beautiful drawings issued

by M. Hachette and Co., of Paris, and mostly verified by microscopically mounted specimens kindly lent to me by Mr. J. Bosisto, C.M.G., M.P., of Melbourne, and, as colonial entomologists have had but little immediate experience with this pest, it has been thought advisable to furnish to growers the results, in a partly collected form, of what has been written and done in other countries, this information being greatly scattered, and much of it probably inaccessible to any but our leading vignerons. It is hoped that should the phylloxera ever show itself here again, growers will combine as they would against a common enemy against this great scourge and drawback to the enormous interests of the great wine industry of Victoria.

The information here given has been taken from the most reliable sources, so that its accuracy may be depended upon. To go on quoting the observations and remarks as contained in a large number of valuable works bearing specially upon the subject of phylloxera and its ravages, would take up the space of a half-dozen good-sized volumes, so that, as it would be well-nigh impossible to supply the whole of this valuable information in detail, it may be remarked that any person requiring additional information thereon may obtain it in the various European, American, and other reports ; also from those of Victoria and other colonies, including New Zealand. I am greatly indebted to Dr. Kirk for sending me a copy of his very valuable little work on phylloxera, and from which, as I know it will be acceptable to vignerons generally, I have taken the liberty of quoting freely.

Dr. Kirk says :—"The reports (*Report of J. H. Wheeler, Chief Executive Viticultural Health Officer to the Board of State, California, Viticultural Commissioners*, 1887) of the commission issued heretofore concerning this pest, and the best remedies for its extermination which we have urged for adoption, are more than ever confirmed at the time of writing. As proof of this I am able to give the following, which I translate from the report of the Commission Superieure du Phylloxera of France for

1887, representing as it does the results of unlimited experiments and long years of practical work." The struggle against the phylloxera goes on by submersion, insecticides, and by replanting with American vines in the following proportion :—

	Number of acres treated— 1887	1885
Submersion ...	... 66,662	50,847
Sulphide of carbon	... 165,512	101,462
Sulpho-carbonate	... 22,050	13,067
American vines	... 416,292	188,205

It may thus be seen that great preference is shown for resistant vines, the acreage rising in two years from 188,205 acres to the enormous figures of 416,292 acres. The answers to the question so often put to me by vine-growers, "Are resistant vines a success ?" We have published advice on the subject continuously, but there does not exist to-day in the whole state 2,000 acres of resistant vines. Those resistants which have been properly selected, planted, and cared for are to-day monuments of success, but they are too few to save us from the growing ravages of this pest.

It will be noted in the above that the use of carbon-bisulphide has largely increased in France ; that the use of sulpho-carbonates, because of the great expense attached, has grown less popular. The number of vineyards is nearly constant, because of the special natural requirements of this process.

California vineyardists can point with pride and assurance to the planting of grafted resistant vines belonging to Mr. Julius Dressel, of Sonoma, when, in the midst of ravaging phylloxera, and on soil of very moderate worth, a magnificent yield of choice varieties has already been secured by this means. Others have been similarly successful in growing and grafting resistant vines ; but I have, as yet, found no other test so severe in its nature as that conducted at Mr. Dressel's vineyard. Mr. Dressel states that he is perfectly satisfied with the "riparia" as a grafting stock, easy to root, and sufficiently vigorous in his soil to supply any vigorous growing variety. The

"Lenoir" has been growing rapidly in favour in California, because of its rapid development and easy grafting. It proves difficult to root, but is preferred over the "riparia" and some others, because it furnishes a wine suitable for blending as a direct producer. But grafting is both expensive and slow, and, in fact, the value of carrying on any warfare may be somewhat altered by the present depressed condition of the wine-making industry and the popularity and improved value of other branches of agriculture.

A very practical series of conclusions have been arrived at by the California State Viticultural Commissioners, 1882–83 and 1883–84, as under :—

We have learned sufficiently already to be able to make public certain conclusions, viz. :—

First.—That the ravages of the Phylloxera do not threaten rapid destruction of vineyards in this State.

Second.—That, by using wise precautions in disinfecting cuttings before planting, and avoiding the use of rooted vines from infected districts, new plantations may be made with little danger of infection, except in the direction of prevailing summer winds that blow from diseased places.

Third.—That whenever infection is discovered in a vineyard, prompt action in substituting resistant stocks for those diseased will not only check the evil, but will result in such a gradual reconstitution of the vines that the extra expense and losses will not be severely felt by the proprietors.

Fourth.—That in all cases of new plantations in the direction of known contagion, only resistant stocks should be planted.

Fifth.—That fear of future trouble from this pest may be avoided in any case by planting resistant stocks, even though present infection is not feared.

Sixth.—That grafting upon resistant stocks may be easily accomplished without extraordinary expenses, and that the cost is more than compensated for by the increased vigour and fruitfulness of the vineyards so treated.

Seventh.—That, in substituting resistant stocks of those diseased, efforts should be made to eradicate as

carefully as possible the insects already accumulated on the roots that cannot be removed, or that are grafted. This is important as a means of removing danger from the vicinity of the vines not affected, or of reducing the force of the invasions, and a protection to the young roots of the resistant stocks, which, while they resist, may be, in a measure, checked in growth by the efforts of the insects to maintain their position. The bisulphide of carbon and the sulpho-carbonate of potassium are the best known remedies for disinfecting diseased spots.

Eighth.—That although submersion of infected spots may preserve a vineyard whenever practicable if practised annually after the disease is known to exist in it, yet the simplest and cheapest remedy, even where the land is level and water plentiful, will be found in using resistant vines as substitutes, this being a permanent defence.

Ninth.—That all vine growers should commence by experimenting at once with the best known resistant stocks in limited numbers, so as to determine, in case of need, which varieties will flourish best in their soils, and to afford themselves and their workmen the opportunity to learn by practice the simple art of grafting."

A very interesting and useful chapter, in tabulated form, I have taken from Dr. Kirk's book, as the information ought to be extremely valuable to those about to plant resistant stocks. Dr. Kirk says :—"Early in the study of the subject it was found that the nature of the soil had a very marked influence on the success of the different sorts named as stocks. The subject has now been fully investigated in France, and the latest researches are formulated by the Experimental School at Montpellier in the statement quoted below, which will be of interest as giving the various classes of soils, together with the American vines best adapted to each :—

1. New, deep, fertile, soil :—Riparia (tomentous and glabrous), *Jacquiez, Solonis, Viala, Taylor and Cunningham.

* According to experiments which have been made by the Agricultural Society of Herault, as quoted in the *Cape Agricultural Journal*, it has been decided that the "Jacquiez" is not suited for a graft bearer, but on its own roots no exception need be taken as to growth.

2. Deep soils, somewhat strong, not wet :—Jacquiez, Riparia, Solonis, Cunningham, Viala, and Taylor.

3. Deep soils of medium consistency, new, and not dry in summer :—Riparia, Jacquiez, Solonis, Viala, Taylor, and Black-July.

4. Light pebbly soils, deep, well drained, and not too dry in summer :—Jacquiez, Riparia (wild), Taylor, and Rupestris.

5. Calcareous soils, with subsoil shallow or granitic :—Solonis, Rupestris.

6. Argillaceous soils, white or grey :—Cunningham.

7. Argillaceous soils, deep, and very wet, *V. cinerea*.

8. Deep, sandy, fertile soils :—Riparia (wild), Solonis, Jacquiez, Cunningham, Black-July, Rupestris.

9. Light pebbly soils, dry and barren :—Rupestris, York, Madeira, Riparia (wild).

10. Deep soils with a tufa base, and salt lands :—Solonis.

11. Soils formed of debris of tufa, but not sufficiently deep :—Taylor.

12. Ferruginous soils, containing red pebbles of silica, deep, and somewhat strong, well drained, but fresh in summer :—All the varieties indicated, and in addition Herbemont, Clinton, Cynthiana, Marion, Concord, and Herman.

The valuable kerosene emulsion is also spoken very highly of as a remedy against underground insects which at least in America is superior to the other insecticides before alluded to. "Diluted only by two or three times its volume of water, this emulsion has no injurious effect upon the roots of vines (being really beneficial), but destroys the Phylloxera, and what is still more important, kills the eggs even when in weak solution."—C. V. Riley.

Some very practical advice on this subject of phylloxera has been tendered by M. Sabaté, of the *Société Nationale d'Agriculture de France*, and which, for the benefit of readers of this part of the book, I have had translated and copied as follows :—

"It is not necessary to discuss the existence of phylloxera ; its habits and ravages are well enough known for me to dispense with any

explanations. But I would simply express with emphasis the great necessity for saving the vines in all of the provinces. Regarding that which has been said of the winter eggs, it is certain that if it were possible to take action in all of the provinces at the same time, the phylloxera would be completely destroyed and all the vines, whether American or European, would not be liable to fatal injuries.

"To preserve a vine from phylloxera, it is necessary to have some preventive treatment.

"The winter eggs must be destroyed. If they are not destroyed, the generations produced must be destroyed. To do the above is neither long, difficult, or costly. The annual barking of the vine-stalks should be done during the winter, when vegetable growth is at a stand-still—work not nearly so long as one would suppose, when a stem has been barked once. Annually, also, one should sprinkle the vine at its first vegetation, when the leaves have attained the diameter of three or four centimetres, with finely-powdered lime, thrown with a pair of bellows during the night dews. The caustic action of the lime is so strong and so instantaneous that one may see immediately the dead of the young phylloxera, freshly hatched, spread above and under the leaves.

"Any small insect, not only the caterpillars of two centimetres in length, and also the larger snails, provided they have not their live part completely covered by their shell, are instantaneously destroyed. The lime so spread will not allow the growth of any other vegetation; then the vine need fear absolutely no danger.

"I have practised the barking since 1874 and the liming since 1877. These two operations are made annually, and constitute the *preventive treatment.* This is an extra dressing (or mode) of 10 to 12 francs per hectare. When a vine carries the phylloxera on its roots, whether it be European or American, it is necessary to relieve them of it quickly, or it will succumb to the attacks. The lesser cures are well enough known and experimental; here are the most useful and efficacious:—

"1. The submersion. This is always efficacious, if the under-soil permits—if it is drainable, and if the water is abundant enough to cover entirely the whole surface of the vine, to submerge it during four days in the month. If the water is not fertilized, if it is not slimy, a manure might prove profitable. When the subsoil is compact and hard to drain, submersion is fatal to the vine.

"2. Sulpho-carbonate of potassium, when its application is possible, is the best of insecticides, because it brings to the vine a thickness (or strength) of vegetation of sufficient recompense.

"3. Sulphur of carbon, much as has been said against it, is also an excellent insecticide. It becomes almost a necessity for the strengthening of the vegetable growth.

"Never inject a solution into damp soil, especially in clayey (argillaceous) soils, because the diffusion of the poisonous gases has no effect beyond the sides of the hole made by the injector; the best time for injecting the solution is during the months preceding the dormant stage of vegetation, which varies, of course, with the climates.

"In the Bordeaux district the best time is from the 15th of November to the 15th of February, if the state of the soil is suitable, if it is not too damp, or if a long spell of rain is expected, following after the operation.

"The following is an estimate of the cost of these two operations reckoned at per hectare ($2\frac{1}{2}$ acres):—

"300 francs (say £12) for the sulphur of carbon.

"500 francs (say £20) for the sulpho-carbonate of potassium.

"I have experimented with another insecticide, of which much has been said, the sulpho-carbonate of calcium, and not costing so much; but I have not used it sufficiently myself to be able to recommend it.

"As in all circumstances and for all things, one must not be carried away with enthusiasm for a certain cause, as none can be regarded as perfect; you will not get the absolute destruction of phylloxera by submersion, or by sulpho-carbonate of potassium, or by sulphur of carbon; the phylloxera, which each year after the respective applications, whether in winter or spring, furnish the new re-invasions in June, July, or August, by the hatching of winter eggs, if these winter eggs have not been destroyed in time.

"My conclusion is that two operations are necessary, absolutely indispensable, to work advantageously against the phylloxera—the preventive treatment at once, and always, and the curative treatment to follow."

The following practical instructions on the treatment by sulphide of carbon are by Messieurs Marion, Conanon, and Gastine (France), and which I have extracted from Dr. Kirk's work:—

"1. *Doses of Sulphide of Carbon.*—This is a transparent liquid, without colour, and extremely inflammable. It vapourizes rapidly, and under certain conditions is explosive. It must therefore be manipulated with many precautions. Besides, the odour is so strong and so characteristic that the least quantity of vapour shows itself.

"When sulphide of carbon is introduced into the soil it vapourizes in mixing with the air contained in the particles of the soil, and these vapours have enough force to penetrate far from the point where they first took place, meanwhile destroying any insects which they meet. Scientific experiments, the result of which have been confirmed by many observers, have enabled the range of these vapours to be determined according to the doses employed, the duration of their persistence in the soil, and their relative insecticide-power. These data, and those concerning the resistance of the vine itself to various doses, have regulated the rules of application of sulphide of carbon to phylloxerated vines.

"The quantities of sulphide of carbon which should be employed per acre vary according to the depth and the state of permeability of the soil. No account need be taken of the state of the vine, as to whether it is old or young, vigorous or enfeebled, in determining the doses to be

used. In every case the object is to attack the insect at the roots, and to obtain as complete an insecticide effect as possible. For this it is indispensable that the whole mass of the soil should be impregnated, as completely, uniformly, and rapidly as possible, by the vapours of the sulphide, sufficient to render the atmosphere underground unrespirable by the insect. The dose is the same for killing one or thousands of phylloxera, so that the viticulturist must not make the doses any different for a field in which he supposes that there only exist very few insects than for one which is entirely invaded. The diminution of doses can only have the effect of employing uselessly a product which can only have a sufficient insecticide energy if used in proper quantities.

"The minimum of sulphide to employ is 20 grammes per square metre, or 200 kilogrammes per hectare (*i.e.*, $\frac{3}{4}$*oz. to* $10\frac{3}{4}$ *square feet, or, say,* 175*lbs. per acre*). Less than this quantity, even under the most favorable conditions of the soil, will not insure proper treatment. It is even desirable in soils of an average depth, to increase the dose to 240 or to 250 kilogrammes. This is the dose, in fact, which answers best in the majority of vineyards; and for deep soils one ought not to hesitate to increase the dose even to 300 kilogrammes, say 6 cwt., per hectare ($2\frac{1}{2}$ acres). The reason will be easily understood for this augmentation, since the object is to impregnate a greater depth of soil occupied by the roots and by the parasites.

"In the determination of the proper dose of sulphide of carbon, account must be taken not only of the depth of the soil, but also of the permeability both of it and of the subsoil in which the roots penetrate. Light and permeable soils contain more air than others, so that in order to impregnate them completely with toxical vapours a higher dose of insecticide is necessary. On the other hand, some subsoils are more favorable to a uniform distribution of these vapours. When the soil is at once permeable and deep, and the subsoil is one in which the roots penetrate easily, the maximum doses of sulphide ought to be applied. Vines submitted to too feeble a treatment remain each year under the influence of the parasite, which is not sufficiently attacked.

"2. *Distribution of Sulphide of Carbon.*—Sulphide is applied by divers instruments—by Pal-injectors or by traction injectors. The Pal-injectors distribute the sulphide by small doses, injected in holes which are regularly made in the soil; the traction injectors distribute the insecticide in furrows traced by the ploughshare.

"The soil of a vineyard is occupied entirely by roots, which cross each other and form a continuous network, even where the vines are planted in lines, leaving between them large spaces reserved for other cultivation. It is therefore necessary to inject the sulphide uniformly throughout the soil; and the doses must be calculated proportionately to the whole surface of the vineyard, whatever may be the method of plantation, and whatever may be the age of the vines.

"When, as is most often done, the treatment is by the Pal-injector, the disposition of the holes of injection should vary with the different modes of plantation, because the lines of vines serve as an indication

for the distribution of the holes. They are placed at equal distances one from the other, in regular alternation as on a chessboard, so as to produce a uniform impregnation of the soil. The number of holes of injection must never be less than two per square metre ($10\frac{3}{4}$ square feet). With less holes in that surface, the diffusion of the insecticide vapours cannot be insured, even in very permeable soils. In general, an augmentation of the number of holes, and a proportionate reduction in each, favours a good saturation of the soil. When the soil is not deep it is indispensable to augment the number of holes, to compensate the waste of vapours towards the atmosphere. The same argument is necessary for soils that are only slightly permeable. In general an average of three holes per square metre represents the most convenient disposition; but in the case of compact soils there should be four holes to the same surface. The depth of the holes of injection ought to be twenty-five to thirty centimetres (10 inches to 12 inches). The holes must be carefully covered over.

"The dose for each hole ought to vary according to the number of the holes and according to the quantity of sulphide which is to be distributed per hectare (about $2\frac{1}{2}$ ac.). Suppose, for example, that 240 kilogrammes (500 lbs.) are to be employed per hectare, and that three holes are to be made per square mètre; then the injector must be regulated so as to give a dose of eight grammes ($\frac{1}{3}$ oz.) at each stroke of the piston. It is always necessary to verify during the work whether the action of the injector is quite regular, and to take care that the apparatus is in a condition to ensure accurate action.

" The principles which regulate the application of sulphide of carbon by traction injectors are the same. In that case the distribution of the insecticide takes place by the regular displacement of the furrows traced along the vines. These lines of distribution ought not to be distant more than one mètre from each other.

" With this mode of application of the sulphide it would not be possible to attain, without injuring the roots, a depth of from twenty-five to thirty centimètres (10 to 12 inches), at which depth the sulphide is to be deposited. It is not possible to descend with traction injectors below fifteen to eighteen centimètres; it is therefore necessary to compensate the more rapid waste of vapours by an augmentation of the dose to about 25 to 30 per cent. over the quantities above indicated. This waste is, of course, diminished by taking care to make the return of the soil over the lines of injection as complete as possible. It may be taken for granted that any want of success in the regeneration or the maintenance of a vineyard will follow whenever traction injectors have been employed without taking these precautions.

"3. *Conditions of the Soil Favorable to Treatment.*—The treatment ought never to be applied after ploughing or digging, because when the soil is lifted the vapours of the sulphide escape towards the atmosphere without producing their proper effect; and for the same reason it is necessary to wait about fifteen days after treatment before any cultivation of the land.

"When the soil is either very wet or very dry the treatment ought to be delayed.

"The most favorable conditions for treatment to ensure the best distribution of the vapours of sulphide, and their persistence in the soil are those of a soil slightly humid, permeable, but close on the surface, and forming a crust after the action of rain. In these cases excellent results can be obtained, even in strong soils, which are the most difficult to defend. In light and permeable soils the treatment can be effected at any time of year.

"It is essential not to leave the vines long under the influence of an attack of phylloxera. To obtain good results the invasion ought to be treated at once, and before the vines show any enfeeblement. The vineyard must be treated in its totality, it would be useless to inject the sulphide only where spots are seen; and the treatment must be renewed every year.

"In the southern vineyards of France the extreme dryness of the soil and the great development of shoots at the beginning of summer are an obstacle to operations during that season, and the treatment in autumn, winter, or spring is the easiest and most efficacious. On the other hand, in most of the other viticultural regions, the rains of autumn and winter frequently prevent the work, and it is easier in spring or summer. Summer treatment, instead of being only done once, requires two applications, succeeding each other at an interval of from four to six days, half the dose being employed each time which would have been injected by a single treatment. The advantage of reiterated treatment is, that it maintains during a longer time the parasites under the action of the toxical vapours. It is, therefore, essential that the interval between the first and second injection should be short.

"4. *Manuring.*—The vine, like every other plant, requires manures to replace in the soil the elements which the crop takes away. Ordinary manures are sufficient for vines which have not been already greatly attacked by the phylloxera, and when the insecticide treatment is adopted without delay; but when the roots have been already partly destroyed by the parasite, reparatory and supplementary manuring is imperatively required, so as to favour a rapid re-constitution. Experience has shown that the applications of sulphide of carbon, if made with care, method, and persistence, bring back enfeebled vines into complete production, and maintain in full value vineyards which have been treated immediately on the appearance of the phylloxera."

About the phylloxera, its ravages, prevention, and remedial measures, &c., growers can hardly have too much information, so that although this chapter may appear a lengthy one, it is hoped that the great importance of the subject will be considered sufficient justification for the inclusion of these valuable, and often difficult to obtain, extracts and opinions of the best authorities, no

matter from what country or source through which such information has been obtained. By way of illustration it may be pointed out how unprepared we were when the unfortunate outbreak of phylloxera at Fyansford, in 1875, took place. Although we were handicapped from want of a practical acquaintance with the life-history of the insect, the prompt and effective measures then taken for its suppression are too well known to need repetition here. It is to be hoped that the fears entertained by some persons as to the probability of another invasion of this scourge may prove to be groundless.

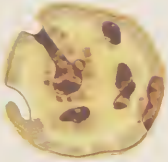
To be in the position to resist the attacks of any common enemy we must be prepared first with a possible means of resistance, and secondly, should the first fail, with methods by which the attack, if made, may be attended with the least possible danger. When the dread phylloxera makes its appearance, it comes as our American friends put it, to stay, so that no measures, however stringent, can be too severe, and when we know that the insects have been found on roots which have been left in the soil for six years, it will be easily seen with what a persistent and dreadful scourge we have to deal.

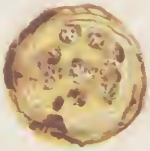
PLATE XXXII.

THE "WHITE ANT" (TERMES AUSTRALIS.—HAGEN).

Fig.

1. Portion of orange root attacked by White Ants, showing insects at work and damage done. Natural size.
2. Portion of vine stem attacked by White Ants, showing insects at work and damage done. Natural size.
3. Section of orange root destroyed by White Ants. Natural size.
4. Section of vine root, showing damage done by White Ants. Natural size.
5. Male, with wings folded. Natural size.
6. Male, with wings extended. Natural size.
7. Worker. Natural size.
8. Soldier. Natural size.
9. Queen. Natural size.
10. Head of "Soldier White Ant," showing the powerful jaws. Magnified.





CHAPTER XXXVI.

THE VICTORIAN WHITE ANT.

(Termes Australis. Hagen.)

Order: *Neuroptera.* Family: *Termitidæ.*

The so-called White Ant, which in reality has no affinity whatever to the true ants, the latter belonging to a different order (Hymenoptera), and in many respects also differing in economy from those of the latter insects.

The White Ant is a small yellowish-white and soft-bodied insect, which, however, to the ordinary observer, is in general appearance not unlike an ant, and may easily be mistaken for such.

In Victoria these insects are of small size, ranging from 3 to 4 lines in length; the wings being from about 8 to 10 lines, the tropical species being of a much larger size.

Of these singular insects there are a number of different species, as many as 41 having been given in the British Museum catalogue, published in 1852, as being in the collection of that noble institution, and but little difference, comparatively speaking, has been observed regarding their economy.

The late lamented H. W. Bates, so well known as a naturalist and traveller in the tropics, observes, "that each species of Termites consists of several distinct orders or castes, which live together, and constitute populous organized communities. They inhabit structures known as 'Termitaria,' consisting of mounds or hillocks, some of which in the tropical species are from 5 to 15 feet high, and are formed of particles of earth worked into a material as hard as stone. The 'Termitarium' has no external aperture for ingress or egress, as far as can be seen, the entrance being placed at some distance, and connected with the central building by means of covered

ways and galleries. Each Termitarium is composed of a vast number of chambers and irregular intercommunicating galleries, built up with particles of earth or vegetable matter, cemented together with the saliva of the insects." A family of workers consists of a "king" and "queen," of the workers, and of the soldiers. Our Fig. 9 shows the wingless queen, and in Figs. 5 and 6 the winged insects in different positions. Figs. 7 and 8 show the wingless "worker" and "soldier" respectively.

According to the researches of Lespes, Bates, and Fritz Müller, the workers and soldiers amongst the Termites are not sterile females, but modified larvæ, which belong to both sexes, and are arrested in their development, or, rarely, males and females in which the reproductive organs are rudimentary. Fritz Müller has also discovered that, in addition to the winged males and females which are periodically produced in great numbers, there exists in some, if not in all, of the species, a second set of males and females which are destitute of wings. These complementary males and females never leave the termitary in which they are born, and they may take the place of the winged males and females whenever a community fails to secure a royal couple at the proper period. The royal couple are the parents of the colony, and are always kept together, closely guarded by a detachment of workers in a large chamber in the heart of the hive, surrounded by much stronger walls than the outer cells. They are both wingless, and are immensely larger than the other workers and soldiers.

The queen, when in her chamber, is always found in a gravid (egg-laying) condition, her abdomen enormously distended with eggs, which, as fast as they come forth, are conveyed by a relay of workers, in their mouths, from the royal chamber to cells dispersed through the hive.

At the beginning of the rainy season (this of course refers to tropical countries) a number of winged males and females are produced, which, when they arrive at maturity, leave the hive and fly abroad. They then shed their wings (a special provision for this existing in a

natural seam running across the root of the wing and dividing the nervures) and pair, and then become the kings and queens of future colonies.

The workers and soldiers are distinct from the moment of their emergence from the egg, and they do not acquire their special characteristics in consequence of any different food or treatment. Both are wingless, and they differ solely in the formation of the head. Fig. 10 shows a head magnified of the "soldier form" of our White Ant. The duties of the workers are to build, make covered roads, nurse the young brood from the egg upwards, take care of the king and queen (who are the progenitors of the whole colony), and secure the exit of the males and females when they acquire wings and fly out to pair and disseminate the race. The duties of the soldiers are to defend the community from all attacks which may be made upon its peace, for which purpose the mandibles (jaws) are greatly developed.

It is most remarkable that both the workers and soldiers amongst these strange insects are mostly without eyes, and, as Mr. Woods remarks, are "blind soldiers directing the blind workers by some system of signalling which we cannot understand."

In proportion to the workers the soldiers are very few in numbers, scarcely more than 1 per cent.

Like the queen bee the female White Ant has but the one business in life, namely, to lay eggs, which she does perpetually, their numbers being counted not by tens of thousands but by millions.

I have thus given you the results of some of the observations made by celebrated naturalists as to the habits of these wonderful little creatures.

There are many other matters connected with their economy, but our space will not permit of much more information in this direction. To those of us who, in the summer time, have travelled in the country districts, especially in the warmer and drier portions of the colony the sight on a sultry summer's evening of myriads of these little flimsy-winged insects flying in dense clouds,

often coming into the houses and covering the walls, ceiling, &c., and not infrequently extinguishing our candles or other lights, is by no means an uncommon one. These, then, are the winged forms of the White Ant, and this swarming, which is familiarly known as pairing, takes place with the same insect but once, as the insects cast their wings, and those which escape from the attacks of birds, &c., usually descend into the ground, being then, of course, in a wingless state.

The White Ant is known to be one of the most troublesome of insects, destroying, as it does, timbers, furniture, books, cloth, boxes, boots, and many other articles too numerous to mention here; but it is only of late years, so far as I am aware, that we in Victoria can add to its enormities that of the destruction of vines, apples, and other fruit trees.

A few years ago Mr. Knight, our fruit expert, brought for my inspection some pieces of orange trees, root portion (see Fig. 1), also some vines (see Fig. 2), the plants of which had been destroyed by these little pests. This was my first experience of White Ants attacking and destroying fruit trees and vines.

The method of working of the White Ant is always most insidious, as there is seldom any outward indication to be perceived of the destruction that is taking place within the object attacked.

Take, for example, a fruit tree attacked by White Ants, and the tree will appear to be growing fairly well, when gradually the bark changes colour and assumes a yellowish and sickly appearance, and I am informed by a friend who has made many practical observations, living as he does, in a dry district much infested by these pests, that plants raised from seeds are less liable to attack than those which have been either grafted or budded.

I am, at present, not prepared to express an opinion upon this somewhat remarkable statement, although some of our growers doubtless have had experience in this matter, and for any further information bearing

upon this subject I would be greatly obliged. It may, however, arise partly through a defective union when grafting, in which case the traces would remain, forming a commencing point on which the first attack would in all probability be made.

It has also been found that "red deal" is less liable to attack than the "white deal" and kindred timbers.

In the dry country, so often composed of "box forests," as the ruling tree vegetation, the White Ants are particularly numerous, although in the moister districts of Gippsland and elsewhere, it is no uncommon sight to see the decayed earth-habitations of these insects extending for 20 feet up the trunks of our large Eucalypti, or so-called gum trees. In the drier districts the total collapse of a dwelling is of no unusual occurrence.

The White Ant, unfortunately, is very easy of introduction; and Mr. Morris, of Kew Gardens, London, informs us that a North African and South European species, *Termes lucifugus*, was introduced into France at about the end of the last century, and has now spread almost everywhere at La Rochelle. Many public and private institutions there are in a dangerous condition, and at the Prefecture the wooden beams have had to be replaced by iron ones. They have destroyed part of the archives, and it is found useless to attempt to grow certain plants in the garden, as geraniums, &c., as the ants consume the interior of the stalk. It has been found almost impossible to destroy or get rid of them. Dr. Müller also remarked that they had proved very destructive to vines in certain parts of France.

This bit of information should cause us to be on our guard against the probable introduction from Queensland of some of the larger and more formidable species which may be readily introduced in logs of timber and like commodities.

The above, then, will furnish some idea of the life-history and habits of this but too well-known pest, the

economy of which would appear to differ but little from the larger species which are mostly confined to the tropics.

Prevention and Remedies.

In the drier parts of the colony many of the orchards and vineyards are surrounded by the well-known "box forests," the dead trees of which in particular furnish unlimited breeding places for the White Ant.

When an orchard or vineyard is about to be formed, great care must be exercised to see that as many as possible of the roots of the newly-grubbed trees are taken away or burned on the spot, as it is here where a deal of the mischief takes place, the insects being in the dead wood of grubbed trees, and these, if left in the soil, will furnish excellent breeding places, and from which the newly-planted trees will receive, probably, their first infection.

This is a matter of the very first importance, and should be strictly carried out, as by such precautions much of the damage caused by these pests may be either averted or at least greatly lessened.

It has been found that trees, if they have escaped the attack for the first two or three years of their growth, usually either resist the attacks or escape altogether, so it is in the earlier stages of the tree's existence that we must concentrate our efforts if we are to succeed in combating this most destructive enemy of the vigneron and orchardist.

Before the trees are planted they should be submerged for a short time in a solution of either tar-impregnated water, as recommended for other trees, or Quibell's mixture; proportions, 1 to 30, which has been proved to be an excellent dip, as the smell of tar in any form is not only of a lasting nature, but is particularly obnoxious to insect life of all kinds.

Growers must not wait until their trees show indications of being attacked, and it is safe to treat them at least twice in a year until the time before specified shall have been reached, when, in accordance with former experiences, the dangerous period will have passed over.

In treating trees in which the White Ants are supposed to be concealed, the soil should be earthed up around the stem to a height of, say, 4 inches above the soil. Form the soil into a basin-like hollow on top, and into this pour a small quantity of the material, about a small bucketful to a dozen three-year-old trees. When the stuff (which in the case of Quibell's mixture should be used at, say, one part of the mixture to fifteen of water, less if the tree be naturally tender, or less robust than other varieties of the same fruits) has soaked into the soil, which in most cases will happen in a few minutes, cover up the soil in which the mixture has been placed, and the first dressing is then done with.

When young vines have to be dealt with, the quantity used for each plant must be, of course, lessened to about two-thirds of the quantity applied to apples and like trees, and the proportions may also be altered to, say, 1 in 20.

In parts of the colony where the White Ants are troublesome, books and other valuables of a like material should be kept in tin boxes, and in receptacles in the lids of which carbolic acid on a sponge or wadding should be kept, as the smell from this preparation is greatly disliked by insects.

It would seem to have been a very wise precaution on the part of our Government that they now insist on the timbers used in the erection of public buildings in the drier parts of the colony being specially treated with the "Preservative oil." This oil may be purchased in Melbourne at 1s. 6d. per gallon, each case containing eight gallons of the mixture. It is hoped that with these precautions, faithfully and intelligently carried out, together with the natural decrease in the remains of our

ring-barked forests, more especially where such are in close proximity to our orchards or vineyards, we may be able to combat this pest successfully.

With regard to the "ants" which shed their wings and take to the soil, we may be assured of this fact, that when the trees in an orchard are well looked after and treated, the White Ant will never obtain a permanent foothold, as in the latter stages they have many enemies, more especially amongst the insectivorous birds, and also amongst ants and predatory insects of many kinds. Keep a sharp look-out for any indications of this pest amongst trees, and with the disappearance of that antiquated though very useful article, the log-fence, many of our pests will no doubt be greatly reduced, or altogether disappear.

PLATE XXXIII.

"POTATO MOTH" (LITA SOLANELLA.—BOISD.).

Fig.

1. Moth. Magnified.
1A. Moth. Natural size.
2. Pupa. Magnified.
3. Head and first three segments of larva, upper side. Magnified.
3A. Head and first three segments of larva, under side. Magnified.
4. Potato sliced to show effects of attack by larvæ of Moth. Natural size.
5. Larva. Natural size.
6. Fore-leg, Moth.
7. Hind-leg, Moth.

C. J. Smithhawk del.

Plate XXXIII.

CHAPTER XXXVII.

THE POTATO MOTH.

(*Lita solanella. Boisd.*)

Order: *Lepidoptera.* Group: *Tineina.* Family: *Gelechidæ.*

In this little moth the potato-grower of many countries has in all probability his very worst insect enemy, not excepting, perhaps, the Colorado beetle itself.

The perfect insect is a small, narrow, brown and grey moth, about seven lines across the wings when expanded (see Fig. 1A).

The larva is of a pinkish colour, size as given at Fig. 5, slightly enlarged.

Although there exists much difference of opinion as to how the tubers of the potato are first attacked, I must agree entirely with M. Ragouet, of Paris (as quoted by Mr. Meyrick), that "the eggs are laid on the young shoots of the plant; that the larvæ, as soon as hatched, eat into the root stock and descend until they reach a tuber; and that they remain in this, eating galleries completely through its substance, during the remainder of their larval existence." The larvæ, Mr. Meyrick goes on to say, pupated within their galleries, which they closed with silk. These descriptions agree entirely with the results of my own observations and that of practical growers who have taken the trouble to work the matter out for themselves.

Mr. O. Tepper, of Adelaide, a good observer and an old friend, gives it as his opinion that the female moth deposits her eggs in the stem just above the ground, thereby bearing out in all the more important details the observations of M. Ragouet, alluded to above.

It has been stated that the insect is not in the potato while the latter is in the ground, and from these remarks

we may reasonably infer that the moth is supposed to deposit her eggs also on the potato after being dug. This may or may not be the case, but it is not at all improbable that while in the pit, if exposed, the moths may deposit eggs in the eyes of the tubers, and the young grubs, when hatched, would at once be able to eat their way into the potato. One thing seems perfectly clear, viz., that it is an almost impossible task for such a minute and fragile moth to descend into the earth, more especially when we find that the harder the soil, no matter how rich, the damage done is often greater than when the crop is grown on poorer and more sandy soil. Of course, where fissures occur in the soil, the moth might easily descend below ground. Again, I have received the haulms or stalks of the potato which have been tunnelled by some caterpillar from a foot above ground right down into the tuber.

About two years since several settlers in the rich Brandy Creek district of South Gippsland sent me samples of potatoes that had been attacked by the caterpillar of this moth, and from which our Fig. 4 has been taken. This tuber had been cut through in about equal parts, each part containing no less than sixteen and thirteen larvæ respectively. These people complained more of the potatoes having been destroyed while in the pit or raised mound—a fact that could be easily accounted for by finding many of the tubers to be swarming with grubs, and from which in due time the little moths would appear.

Mr. R. Lucas, of Ensay, Victoria, an old farmer and a very keen observer, is quite positive about the eggs being deposited on the stalk of the potato; in fact, he goes so far as to declare that he has seen the moth thus depositing her eggs. I have not been so fortunate as this, but I have found the grub in the stalk, and as it was working downwards only, it must necessarily have come from above; at least such are the conclusions at which I have arrived after a careful consideration of the facts.

In dealing with a pest of this kind, we must at once admit the great value of a thoroughly exhaustive study of matters connected with life-histories of insects, and this can only be done by those having time or being on the spot. It is here, therefore, we see more than anywhere the great value of "Field Agents"—entomologists whose duties lie exclusively in visiting infested districts, and who endeavour by every means in their power to fully investigate and report on facts connected with the life-history, parasites, &c., of any particular pest that may make its appearance. Such institutions practically exist only in America, where they have both means, population, and resources to carry on what is really a most necessary and useful although sometimes costly series of observations. How much can be done in this direction has been amply proved by the visit of my friend and fellow-worker, Mr. A. Koebele, to Australia, and whose valuable services have been recognised by the growers of the United States, and over whose Entomological Department Professor Riley so ably and admirably presides.

The history of the cottony cushion-scale in America, the damage caused by its ravages, and the introduction of its natural enemy, the Australian Ladybird (*Novius cardinalis*), are now matters of history, and furnishes one of many practical illustrations of the value of an Entomological Department in any country where fruit-growing plays an important part in the every-day life of a portion of its people.

But to return to the potato moth and its habits. It may again be stated that the greatest importance is attached to any discovery that can shed additional light upon the life-history of this most serious pest. The damage done to our potato crops in Victoria alone is almost beyond calculation; but knowing now fairly well where and how the eggs are deposited, should be of great assistance to growers and others when devising means for its destruction, more especially whilst the insect is in its earlier stages.

According to Boisduval, as quoted by Meyrick and alluded to by Tryon, in certain districts of Algiers, during a single season, three-fourths of the potato crop was destroyed by this pest, and Mr. Tepper, of Adelaide, says —"As far as my continued observation goes, the insect causes now (1891), in its immature form of the caterpillar or grub, the destruction of hundreds of tons of potatoes every year by boring them, and thereby inducing putridity." Again, that these moths occur in other situations less confined than the entomologist's hatching-case was gleaned latterly from the information a farmer gave to me when speaking on the subject. He said that—"He had several bags of potatoes of his own production, and quite healthy when dug, placed in his store-room, where they were left undisturbed for a considerable time. When he at last came to open a bag for use, quite a swarm of little moths greeted the event, and to his surprise he found the tubers spoiled by the grubs to a great extent."

So far as can be ascertained, there is no record of the natural home of this pest; but Mr. Meyrick remarks—"It does not seem to have been noticed in the home of the potato (America), and it is therefore perhaps more likely that it naturally feeds on some species of *Solanum* in the inland regions of Africa, and has spread thence on a congenial food plant being brought to meet it."

We have thus seen how much opinions differ as to the mode of attack practised by these moths, and Mr. G. Searle, in replying to questions as quoted by Mr. Tryon, states:—"I am perfectly sure that the insect is not in the potato while this is in the ground. We are almost daily using potatoes which were all dug at one time, immediately picked up, and placed in a dry-goods cask, in which straw was placed between each layer of tubers. The cask is covered up by a corn bag, and, with the exception of a few near the top of it, none are affected by the moth." In Tasmania it was "invariably found that the moth attacks the roots. The uppermost potatoes—those that are nearest the surface—are of course more easily reached; nor is it by any means a difficult matter

for the insects to penetrate to the depth of 3 or 4 inches where the soil is open, uncompressed, or lumpy. Not a single case of an infested stalk has yet been detected, but constant and numberless have been the instances in which, when uncovering the potatoes at the depths just indicated, moths have been dislodged and flown uninjured away." It has thus been, we may say, fairly shown that there still exists some doubt, which ought, in the interests of growers, to be cleared up as soon as possible, as to whether the depositing of the eggs is alone confined to the stalks of the potato, or whether the tuber is also attacked while below or above ground, as a correct knowledge of these facts, which have been attested to by so many good observers, would be of the greatest value in helping us to devise some speedy and direct method of attacking the enemy in its earlier stages, and thus prevent the egg-laying.

In Queensland, as lately reported by Mr. Tryon, this moth has also been found attacking the tobacco plant. We must, therefore, be on the look-out, as tobacco plantations in Victoria may also be in danger of a similar visitation.

Prevention and Remedies.

In the first place we must try to get rid of the moths themselves, and to accomplish this we should use the knowledge already possessed. As we are certain of this insect being a night-flyer, the first plan, then, that suggests itself is undoubtedly that of some cheap and effective lamp. In this connexion I may mention a letter which I have received from Mr. R. Lucas, who suggests the following:—"My plan is simple, homely, and at hand at all times, without the cost of a shilling. All that is required is a common tin soup-plate, with a clay wick-holder, to burn fat, with a short wick an inch in diameter, made of any cotton stuff. The wickholder should not be higher than the rim of the plate, and made to stand in the plate in its four lower corners, to enable the fat to gain access to the wick. The fat is best made hot at the first

lighting of the lamp, and the burning wick heats the clay wickholder and keeps the fat in a liquid state. The moths fly to the light, drop into the hot fat, and are destroyed. The lamps require lighting about dusk in the evening."

That these moths will be attracted by a light I have myself proved, so that I feel quite justified in quoting the experiences of Mr. Lucas, as above.

Here we have a remedy which may be termed a preventive one, and is one that growers can, without any outlay worth mentioning, use for themselves, as, should it be found that the moths can descend into the soil, they will in most cases be able to as readily ascend.

If the egg-laying is confined to the stems or young shoots, as supposed by Mr. Tepper and many other of our best observers, the "lamp" plan will answer all the same, and probably better.

The next point to be considered is, how to treat the tubers supposing the grubs to have already got at them? This would appear to be a most difficult matter, and probably the best advice that can be given would be to keep your lands as clear from weeds and rubbish as possible. Use none but "clean sets," which, to be on the safe side, might be planted at a greater depth than usual. Pay great attention to deep and careful earthing, and, after digging, get the tubers off the ground and bag as soon as possible. When in the pit keep them well turned over, and be careful to destroy any badly-infested tuber, as from these the moths will hatch, only to commence their depredations in another place. Lime, if judiciously used when the potatoes are in the pits, has a good effect. Seed potatoes should be carefully examined before planting out. After the crop has been dug, more especially on land where the moths are known to exist, if at all possible, a good dressing of gas-lime, at the rate of, say 30 bushels per acre, would be of much benefit. This must, however, as advised by our chemist, Mr. A. N. Pearson, be exposed for some weeks to the air before using. Air-slaked lime, if well harrowed in before planting the "sets," has been tried and found to be of very great use,

and a change of soil has also its advantages. Mr. Tepper suggests also that the tubers, prior to storing, should be washed clean and bathed in some solution which might be distasteful to moths or their progeny, and mentions the use of weak salt or sulphuric acid solutions. Mr. Tryon, however, thinks that alum would be more suitable, and I am inclined to agree with him in this respect.

It is to be feared, however, that in a country where potatoes are often sold at so low a figure, the latter methods, as proposed by the gentleman referred to, would be somewhat too expensive for general use. Still, for those tubers which are intended for seed purposes, it might be carried out with advantage by those having facilities for doing so.

In this age of wonderful discoveries it would not be too much to expect or at least hope that resistant kinds of potatoes may yet become general, in which case many of our troubles with these pests at least will be removed.

The slush-lamp system should have a good trial, and must be placed in a growing crop (Mr. Lucas thinks when in flower), also amongst the pits in which the tubers are usually stored.

The failure, even if only partial, of our potato crops is a serious matter for any community; so that in helping each other with advice, and the results of our experiences, we may be able to considerably reduce the damage done by this widespread and destructive little insect; and the same remark will apply all through. We must have, in addition to our own experiences, the co-operation of growers themselves.

The use of the tarred canvas frame would also be of great advantage, as immense numbers of moths of many kinds may be captured by its adoption. Take some light battens (soft wood is the lightest and best for the purpose), cut them into 5-ft. lengths, fasten together at the corners, and on this frame, to which should be attached a long handle, stretch some stout calico or light canvas, the latter being the more desirable. Smear the underside of the canvas with tar, which must be put on cold, and

without having been heated. With this machine go through amongst your growing crops, also amongst pits, bagged potatoes. If this canvas frame be judiciously used a vast number of moths can be destroyed. This plan has been found to answer well in the case of the cabbage moth, but in treating for the latter, the plants should first be struck with a bunch of twigs to cause the moths to rise. One trial of this plan will be sufficient to convince any reasonable person of its efficacy.

Before closing these remarks on this pest, it is advised, where at all practicable—and there really seems to be no insuperable obstacle to this being carried out—that the lands on which the potatoes are planted be so arranged that a machine, such as the Strawsonizer or the one invented by Mr. Pearson, could be used for the purpose of distributing tar or other cheap insecticides in a liquid form, such as before described. It is well known that tar in any form is particularly obnoxious to insects of most kinds, and by a timely application of such the moths may be prevented from depositing their eggs.

Any of the introduced *Solanæ*, such as the "Sodom apple," nightshade and others, should be rooted up and destroyed by burning, these being not only breeding plants for many of the smaller moths, but, when the fruits are eaten, are most injurious to children, also to stock, and should never be allowed to grow within miles of either farms, orchards, vineyards, or gardens of any sort.

If tobacco plants should be attacked, a light spraying of White Hellebore, mixed in the proportion as given elsewhere in this part of the book, would be effectual in destroying the grubs on any infested plants.

The introduction of noxious and often poisonous weeds into these colonies has been a real calamity, as in several cases the advent of destructive insects into Victoria may be traced to their agency.

PLATE XXXIV.

THE "CABBAGE MOTH" (PLUTELLA CRUCIFERARUM.—ZELLER).

Fig.

1. Leaf of cabbage, showing larvæ and pupæ, also damage done to leaf. Natural size.
2. Moths. Natural size.
3. Larva suspended by silken thread. Natural size.
4. Larva. Magnified.
5. Moth. Magnified.
6. Ichneumon (parasite). Magnified.
7. Ichneumon (parasite). Natural size.

Plate XXXIV.

CHAPTER XXXVIII.

THE CABBAGE MOTH.

(*Plutella cruciferarum. Zell.*)

Order: *Lepidoptera.* Section: *Heterocera.* Group: *Tineina.*

This very destructive pest is one that causes an immense amount of damage, and amongst market gardeners throughout many parts of the world the losses occasioned through the attacks of these insects are enormous.

The "Cabbage Moth," "Diamond-back Moth," and "Green Worm of Cabbage" are one and the same insect.

This is an insect on which a good deal has been written, and a vast amount of useful and valuable information published, the latest being a very able report prepared by Mr. Charles Whitehead, F.L.S., for the Intelligence Department of the Board of Agriculture, London, 1891, and from which I have taken the liberty of quoting freely, the author having kindly presented me with a copy of said report.

This little moth, the natural size of which is given in Fig. 2, is of a light greyish-brown colour, the secondary or inferior wings, as we will call them, being grey, fringed, and to the ordinary observer would appear to be very ragged and flimsy.

When these moths, which are remarkably active, are at rest, their wings are closed very tightly, and at their termination turn up a little, so that this particular species cannot easily be mistaken for any other kind. This rule, however, does not always hold good, as there are a few other kinds whose wings turn up in a somewhat similar manner. When an infested plant, cabbage, or whatever it may be is touched, the little brutes fly up in clouds,

and having been thus disturbed, come from under the leaves, where they usually lie concealed.

The eggs of this insect, which are of a dirty white colour, are deposited in large numbers on the leaves of cabbages, and, in Europe, on turnips and other plants of the same natural order. They may also be found deposited on the sides of crates in which cabbages and cauliflowers are packed for shipment. This latter is a constant and fertile source of danger in the way of carrying pests to and fro from one place to another, and thus destructive insects are distributed broadcast throughout the civilized world.

When the young are hatched from the eggs they commence to eat the young leaves. According to Mr. Whitehead and others, the caterpillar stage is supposed to last from twenty to twenty-eight days. Curtis, in his *Farm Insects*, states that in the case of chrysalides kept in cases the period was very irregular, ranging from ten to seventeen days. My own specimens were hatched in fifteen days.

The caterpillar, when fully developed, is less than half-an-inch in length, green in colour, very active, wriggling about in a very erratic manner. When disturbed they spin a silken thread (see Fig. 3) and rapidly descend, or rather drop to the ground, and on reaching it commence to crawl quickly away.

The chrysalides, which adhere mostly to the underneath parts of the leaves of cabbage, are enclosed in little woolly cocoons of a dirty white colour, and are often very numerous, and, as Mr. Whitehead remarks, stripped of the cocoon, is white or yellowish white.

Our Fig. 4 gives an enlargement of this caterpillar; at Fig. 5 an enlargement of the moth; and at Fig. 1 a leaf of cabbage showing larvæ at work, cocoons attached, and holes which the caterpillars have been eating.

With regard to the number of broods, we are, I am afraid, very much in the dark, especially in the colonies, as we cannot be guided altogether by information gained, however carefully, in cooler countries. Climatic

conditions often effect great changes and important departures from those in places where seasons of great regularity are known to exist. Curtis, who appears to have given this matter some attention, states that "in this country (England) there seems to be a succession of broods from midsummer until the approach of winter." Taschenberg, however, agrees with Miss Omerod, that there are only two broods or generations; and heavy rains, it has been observed, both here and in the old country, would seem to be unfavorable to their development. All the reports, according to Mr. Whitehead, agree in stating that when the heavy rains come the caterpillars cease work. This, however, does not apply to temperate Australia.

This destructive little moth would appear to be very widely distributed, and, according to Mr. Meyrick, the well-known authority on this important group of moths (as quoted by Mr. Tryon), is found throughout the whole world, from Greenland to New Zealand, and, from reliable sources, would appear to be the sole representative of the *Lepidoptera* in Spitzbergen.

In Victoria, for years past, the public have hardly been able to get a decent cabbage or even cauliflower, which, owing to the attacks of this pest, have been in a large number of cases unfit for human consumption. Clean and wash them as you will, the dirty little grubs will occasionally turn up just as one imagines that he has, at last, got hold of a clean vegetable.

It has been stated by writers that the outer leaves are the ones most affected. This is true; but I have frequently seen fine cabbages, and in the very centre of the heart the grubs, if carefully looked for, could be detected. The cocoons, however, are nearly always confined to the outer leaves, where, with the assistance of that disgusting insect, the cabbage aphis, the whole plant often becomes partially decomposed, and has a most offensive smell.

From what has been observed of the habits of this pest in Victoria, I think we may safely say that the gardens lying within an easy distance of the sea-coast are the

most liable to the more severe forms of attack. In places where the soil is heavy and stiff, the insect appears to make less headway; at least such is my own experience, as well as that of many large growers who have given some consideration to the matter.

Prevention and Remedies.

To be thorough in dealing with a pest of this kind we must commence with the young cabbage or cauliflower plants whilst in the seed beds, and again before being finally planted out into permanent positions.

To those who are acquainted with nursery work, it will be unnecessary to point out the great damage that the caterpillars of this moth do to the young plants grown for culinary purposes. It is no uncommon sight to see whole beds containing tens of thousands of these plants riddled by the caterpillars, giving them the appearance of having been shot at. These plants usually develop into dried-up and stunted "stuff," which no practical man would think of planting out for a successful crop.

Amongst the many remedies suggested for treating the young plants whilst in the seed-beds is one mentioned in that excellent and well-known publication—the English *Gardeners' Chronicle*. It would appear to be one of the cheapest and most effectual, and having tried it myself, I can bear testimony as to its efficacy. This plan is to simply take 1 lb. of coal-tar and boil it in a couple of gallons of water, and, when boiling, dilute in the proportion of two gallons of the liquid, as taken from the boiler, with 100 gallons of fresh water. If at all brackish it should not be used for this purpose. Having diluted it, it should be well stirred, so that the water may become impregnated with the tar flavour. Water with a fine rose watering-pot the beds in which the plants are growing; tar in any form being very obnoxious to insects in general and small grubs in particular.

A weak kerosene emulsion, say 1 part of emulsion to 25 or 30 of water, is just as effectual, though, of course, more expensive.

Before applying the tar-water or the emulsion, as the case may be, care must be taken that the plants are not previously disturbed, otherwise many of the grubs may temporarily absent themselves only to crawl up the stems again after the danger has passed.

Give the plants a thorough watering (the rose to do the work properly must be a fine one); spraying is of course the best system, and after having gone through the beds, water with the same material a narrow space around the beds, as the larvæ which have fallen to the ground will be on the look-out for a chance to escape, but will seldom attempt to cross the line of tar-impregnated surface of soil, where they will soon die.

Before planting, the bundles of young plants should be submerged in a decoction of weak tobacco-water, to which a little soft-soap and tar water could with advantage be added. In this they should remain for fully an hour, when they could be dipped into clean water, and planted out into the positions in which they are to remain until required for market.

Our plants may now be supposed to have been set out where they are to remain, and an occasional spraying would be the best, and in the end cheapest, for which purpose the Strawsonizer, or the admirable machine invented by the chemist to this department, Mr. A. N. Pearson, could be used. I feel sure that if such measures as these were adopted, the losses occasioned by the cabbage-worm pest in Victoria would be greatly reduced.

In cabbages, we know by the experience of some of our old and successful growers, there is a small fortune. A knowledge of this, therefore, should make us the more determined to adopt any reasonable precautions that can be easily carried out, taking the expense, of course, into serious consideration.

The cabbage aphis also cannot stand the smell of tar, so we can fight these two destructive pests at the same time and by almost the same methods.

When the cabbages are large, too large for the spraying material to reach the caterpillars or cocoons, which are

under the leaves, as has been stated previously, other means must be resorted to. In this matter I cannot do better than quote Mr. Whitehead, who, after taking evidence from leading growers in England and other portions of the United Kingdom, has come to the following conclusions:—"With respect to remedies adopted against this enemy, the application of the mixture of soot and lime is shown to be the best that was tried. If this is put on in good time with the Strawsonizer, adjusted for this purpose, which blows the pungent substance with great force and equal distribution over every part of the plant, it appears from the experiments made at Alnwick that it would effectually clear off the caterpillars. Paraffine, quassia, and carbolic acid solutions, from Mr. Hornsby's accounts, would also be efficacious to some extent. Brushing off the caterpillars by means of boughs fastened to horse-hoes proved to be a good practice, especially where the hoes were followed by other hoes or scufflers to bury or kill the caterpillars. Nitrate of soda and other stimulants were found of use in forcing the growth of infested plants, according to the evidence of many reports."

Miss Omerod, my respected correspondent, to whom I am indebted for a copy of her valuable little book on the *Injurious Insects of South Africa*, mentions a plan often adopted in the latter country, of placing a line covered with molasses or other sticky substances around the beds. This, however, would appear to be too costly and difficult in larger places or for general use; but it is a plan that might succeed admirably in small gardens.

We have here some of the best remedies, which have been proved trustworthy. So we must bestir ourselves, as it is hardly creditable to growers that so many of our favorite vegetables should be offered for sale in such bad and probably unwholesome condition.

I would here again urge upon growers the necessity for taking care of our best insectivorous birds, as they are most valuable auxiliaries when fighting insect pests of most kinds.

The parasites of the cabbage moth are many, and at Figs. 6 and 7 is shown one that works great havoc on the larvæ and cocoons of these moths. They are small black wasp-like flies, belonging to the Ichneumon tribe, and at any time these useful little insects may be seen hovering over or walking quickly about amongst the leaves of the plant. The female deposits her eggs in the larvæ, sometimes in the cocoons of the moth.

Curtis, in his *Farm Insects*, states that out of seventeen cocoons five moths only hatched, whilst the remaining twelve produced parasites, as figured in his book.

Another gentleman, Mr. Arkle, in a paper in the *Entomologist*, observes :—"Before considering what the agriculturist can effect in necessary war against this insect pest, it is interesting to observe what nature provides for its suppression. Probably no living creature has a harder time of it than the 'Diamond-back.' At least one-half of my larvæ, especially those from Yorkshire and Durham, were infested by the deadly 'Ichneumon.'"

As to how far this pest is distributed throughout Australia, or the amount of damage done, I cannot say; but in Victoria, at least, I know that it must be enormous. We must tackle this pest; so the sooner we set about it the better it will be, not only for the grower but for the local consumer, to say nothing of the great export trade from our colony to New South Wales and elsewhere.

It may here be remarked that an illustration of the machine invented by Mr. Pearson, and alluded to above, is given at the end of this part of the book; that of the Strawsonizer being in Part I.

PLATE XXXV.

THE "CABBAGE APHIS" (APHIS BRASSICÆ.—LINNÆUS).

Fig.

1. Flower stalk of cabbage, showing Blight (Aphis). Natural size.
2. Winged female. Magnified.
3. Wingless female. Magnified.
4. Pupa of winged female. Magnified.
5, 6, and 7. Various stages of the Aphis. Magnified.
8. Ichneumon (parasite). Magnified.
9. Eggs of Hemerobidæ (parasite). Natural size.
10. Larva of Hemerobidæ. Slightly enlarged.
10A. Larva of Hemerobidæ, with covering of skins. Natural size.
11. Cocoon of Hemerobidæ. Natural size.
12. Hemerobidæ (perfect insect). Slightly enlarged.
13. Larva of *Syrphus? sp.*, waiting to catch an Aphis for the purpose of sucking out its contents. Natural size.

(*The little lines below figures are meant to represent the natural size of the insects.*)

Plate XXXV

CHAPTER XXXIX.

THE CABBAGE APHIS.

(*Aphis brassicæ. Linn.*)

Order: *Hemiptera.* Sub-order: *Homoptera.* Family: *Aphididæ.*

The Cabbage Aphis, better known as Cabbage Blight, is unfortunately too well known to need any lengthy description here; and, as has been done all along, and will be continued to the end of the book, we rely more upon the plates with which the parts are illustrated than on lengthy descriptions, which in illustrated works of this kind would seem hardly necessary.

This pest, which has existed in Victoria since the very early days of the colony, is undoubtedly an importation from Europe; but how and by what means it has been introduced here, I, of course, cannot say. It may have reached us through the agency of some plants which were so commonly imported in Wardian-cases (boxes covered with glass), in which plants of many kinds were sent from England and elsewhere in a growing condition.

At Fig. 3 we show an enlarged drawing of a wingless female, which in many cases is covered with a mealy coat very much after the manner of the woolly-blight of the apple, the cornicles being, as shown on plate, short and nearly black. Our Fig. 2 represents a winged male, highly magnified, whilst the insects in their earlier stages are shown as per explanation.

The body of the insect is usually green, but varies in shade to a bluish green, often nearly grey.

In the year 1857 Mr. Sydney Gibbons, of this city, published a very interesting and well-written article, with

illustrations, of this pest, and as this gentleman has presented the volume in which the article appears to me, I am able to quote freely from it with mutual advantage, I hope, to myself as well as to growers.

"The aphis, although active in feeding—and more voracious in its way hardly could creature be—is in every other respect singularly torpid. In the feeding state it scarcely moves from the leaf on which it was hatched, but only crawls slowly forward to a new position when it has exhausted the nutriment from the place on which it stood. It thrusts its rostrum or beak into the leaf, penetrating the skin, and then sucks away the juices until none remain. It is careless alike of enemies and the change of weather. There it feeds unawed by the fate of its companions, and regardless alike of sunshine, storm, or predatory foes.

"Its body is soft and unprotected, and, so far from making any nest, it does not even seek the natural shelter which the leaves might afford. An aphis will almost submit to destruction rather than desist from eating. We attempted to dislodge one with a fine hair pencil while so engaged, but it merely wriggled and slewed round upon its rostrum as upon a pivot, to get its body out of the way, and continued sucking in sullen perseverance. The larva when hatched from the egg by warmth of spring, soon attains its full size, and passes without change of form into the pupa stage (see Fig. 4), which is the pupa of a winged female. It is then viviparous, and produces within a few days of its birth six or eight small insects like itself. This process is repeated through the summer, until at the close of the season, the last generation assumes the image or perfect state with wings.

"Up to this time all the aphides have been productive females, only attaining the pupa state; but the winged insects are of both sexes, and only appear at long intervals, usually from nine to eleven generations; but the pupæ have been preserved for a still longer time without the change taking place. This peculiar mode of propagation

has been called by Professor Owen, of London, 'Parthenogenesis.' Various experiments have been made by some naturalists to observe the transformation of the aphides, and to test the accuracy of their first impressions concerning their propagation. Barjin found that the aphides of the rose and poppy produced young without having paired. The experiments of Bonnet, as already mentioned in a previous chapter of this part of the book, are particularly interesting. He watched for the production of a young aphis from a mother without wings, that is from a fertile pupa; he then placed it on a leafy branch of the plant to which it belonged, having first ascertained that the twig selected was totally free from blight. He then fixed the branch with the insect in a glass tube inserted in a pot of garden mould, so covered over with a bell-glass as to prevent the possibility of any intrusion. The single insect was thus completely isolated, but provided with means of life. He then carefully watched his young nursling, and examined it at short intervals of time with a lens. He found that it gradually increased in size, and by the time that it had attained its full dimensions had changed its skin no less than four times. On the twelfth day of its imprisonment it produced a living duplicate of itself, and in the three weeks following brought forth no fewer than 95 young ones. Bonnet afterwards found that from nine to eleven generations were produced without pairing, and his observations were confirmed by the experiments of Lyonnet and Duvan.

"A single female (using the last word single in both senses) might thus in one season be the parent of the astonishing number of a hundred and fifty millions, assuming the descent to consist of nine generations, and each individual to have eight in family, and all to do well. For the first family will number eight ; the second eight times eight, plus the former ; the third eight times eight times eight, with the same addition ; and so on until figures refuse to express the result and the mind fails to form an idea of the vast multitude. About the ninth or tenth generation this remarkable fecundity becomes

exhausted, and not until then do the males appear. This does not occur until the end of the season, when the perfect insects pair and produce eggs for the next year."

The eggs are laid chiefly in crevices and folds of the leaves, and in the sheltered spots afforded by the footstalk.

As many of the plants on which the aphis feeds are annuals, there would be risk of the particular races becoming extinct. Gilbert White, in his evergreen and charming *Natural History of Selborne*, tells us that—"About three o'clock in the afternoon of the day (1st August), which was very hot, the people of this village were surprised by a shower of aphides. Those that were walking in the streets at that juncture found themselves covered with these insects, which settled on the hedges and gardens, blackening all the vegetables whereon they alighted. My annuals were quite discoloured with them, and the stalks of a bed of onions were quite coated over for six days after. These armies were then, no doubt, in a state of emigration, and shifting their quarters, and might have come, as far as we know, from the great hop plantations of Kent or Sussex, the wind being all day in the easterly quarter."

Numerous instances of the extraordinary rapidity with which these little pests increase might be quoted, but the above will suffice for our purpose, as showing with what a formidable foe we have to deal.

In the great market-gardening district of Brighton and neighbourhood, it is, in the summer-time, not at all pleasant to walk through the cabbage fields, as when the plants are badly attacked putrefaction takes place, and in such cases renders the smell almost unbearable, the plants themselves presenting a soft and flabby appearance, and being in many cases totally unfit for human consumption. The cabbage moth is bad enough, but this pest is much more disgusting, and even more difficult to get rid of when once fairly established.

The aphidæ are of great antiquity, and Buckton, in his fine work on the *British Aphides*, gives illustrations of many fossil kinds, whose preserved forms have remained

embedded in the geological formation in which they are found from time immemorial. How such delicate creatures as these are could have been thus embedded and their forms preserved is almost beyond human ken. It is often imagined that damage done by aphides consists solely in their having sucked or abstracted the juices of the plants which they have attacked. This is partly true; but in the case of aphides attacking peaches or other trees, it will be noticed that the bark is covered with a sticky substance, alluded to when treating of the peach aphis, &c. This sugary secretion closes up the breathing spores of the plant, and greatly assists in the ultimate destruction of the plant attacked. Similarly is the case of the soot-fungus, which is attendant upon many of the *Coccidæ* or scale insects; but in the latter case we must get rid of the scale, as the soot-fungus, having lost its host, rapidly disappears.

Our Fig. 1 shows a flower stalk of cabbage with aphides, which, together with the figures of the insects themselves, have all been drawn from nature.

Prevention and Remedies.

Before planting out, every bundle of cabbage plants should be dipped, roots and all, in warm soapsuds, using a little soft-soap with the ordinary kind of yellow soap; the presence of caustic soda in the soap rendering the suds more deadly to insect life in general, but particularly to those kinds having soft bodies. Tobacco water is also an old and well-tried remedy.

After the plants have been in the suds for say fifteen minutes or so, take them out and rinse in clean water before planting into permanent positions. When the plant has fairly started into growth, which should, of course, be encouraged by all available means, give an occasional sprinkling with tar-water, as recommended for cabbage worms.

When a cabbage is found to be so badly attacked as to be useless, dig it out, not merely pull it up, and burn it at once. If the plant be pulled up, a large number of the

aphides will be left in the soil, which, when sufficiently developed, will, of course, at once tackle the newly "set-out" plants. A great deal is to be gained by a properly-prepared soil for the reception of the plants. Where possible, changes of crops should be frequently made, and in this connexion the use of gas-lime is highly recommended by those who have tried it for themselves. The various fertilizers should be used whenever practicable, as the freer the growth in any plant the less liable it will be to disease of most kinds.

In the good old days of market gardening at Brighton and neighbourhood, the growers used to make holes around the stems of the cabbages, into which they poured the liquid from the manure heaps, mixed with soapsuds. This excellent though old-fashioned practice no doubt helped to destroy the aphides on the roots of the cabbages and cauliflowers, which, owing to these attacks, were even in the early days often in a very bad state.

The keeping of flocks of young ducks, chickens, and especially turkeys, is an old but a well-tried and most effectual plan, as the number of insects of all kinds which these young poultry will devour is enormous. The Silver-gull is another useful bird, which no one who has any pretensions to be a consistent and practical grower should be without. These beautiful birds are always at work, and are especially fond of insects, snails, &c., and other garden pests. They may be purchased alive in the Melbourne market at about 2s. 6d. per pair.

Amongst the best insect enemies of aphides are undoubtedly the often despised and badly-abused Lady-birds, an illustration of which, together with its larva, is given in another part of the present number of the book. The Ladybird deposits its eggs, which are of cylindrical form, and of a stone or dun colour, under the leaves of the tree. The larvæ or grubs are of a leaden colour, with orange marks at intervals. They are soon hatched, and at once spread themselves over the neighbouring

plants. They then commence the business of hunting for their natural food, and continue it through their different stages.

The larva of the Ladybird, if viewed through a powerful lens, is a singularly repulsive-looking creature, the jaws being long and powerful. Curtis, in his well-known *Farm Insects*, thus graphically describes their method of feeding:—"Their method of attacking the aphides is curious. I have seen one of the latter struggling while this little insect-alligator threw his fore-legs about it, and was greatly amused at the skill exhibited; for, fearing that the aphis might escape, it gradually slid along to the wings, which were closed, and immediately began to bite them, so that in a short time they were useless, being matted together. It then returned in triumph to the side of its helpless victim, and, seizing the thorax firmly in its grasp, it ate into the side, coolly putting one of its hind legs over those of the aphis, whose convulsive throbs annoyed its relentless enemy."

The Ladybirds are more useful, however, on fruit trees, as they can the easier hide from sparrows, which brutes are, unfortunately, very partial to these useful little insects.

Many Ladybirds are destroyed by the unthinking population, or else from a want of knowledge as to their usefulness to growers in any clime and in any country.

The so-called Syrphid flies, alluded to previously, are great destroyers of aphides. This fly has a proboscis not unlike that of a meat-fly, the proboscis, which is pointed, being terminated by two large lips, and enclosing the sucker in a groove. The larva is soft, and mostly yellow. Its body is divided by rings (see Fig. 13), and tapers in form, the anterior position being the narrowest, and thus, according to Mr. Gibbons, one of our very best microscopists, it attacks its aphis prey. It crawls along with ease and tolerable rapidity, but frequently attaches itself to a leaf by a glutinous substance, which it has the power of secreting. It then turns itself backward and forward, surveying the country until it meets with an aphis. It

then quickly thrusts its dart into the victim, and completely buries its head in the body, and instantly sucks up all the juices, and devours all but the skin, which it throws aside. Buckton, in his invaluable book on the British aphides, has a most interesting chapter on this subject. Our drawings have been taken from nature.

The *Hemerobidæ*, often called lace-wings, whilst in the larval stage, are great enemies of aphides. The eggs of this delicate though rapacious insect are deposited on the stalks of cabbages and on the twigs of trees (see Fig. 9). The larvæ (see Fig. 10) are of a pinkish-brown colour, and destroy vast numbers of aphides, the mandibles or jaws being, as in the case of those of the Ladybird, very powerful for so small an insect. The perfect insect, enlarged, is given at Fig. 12.

If we wish to keep these pests in subjection we must use such precautions as common sense will dictate. It is of no use sitting down in apparent contentment while the mischief is all the while spreading.

An artificial remedy must, as I have before remarked, be cheap to be really valuable to the grower, and for such we must always be on the look-out.

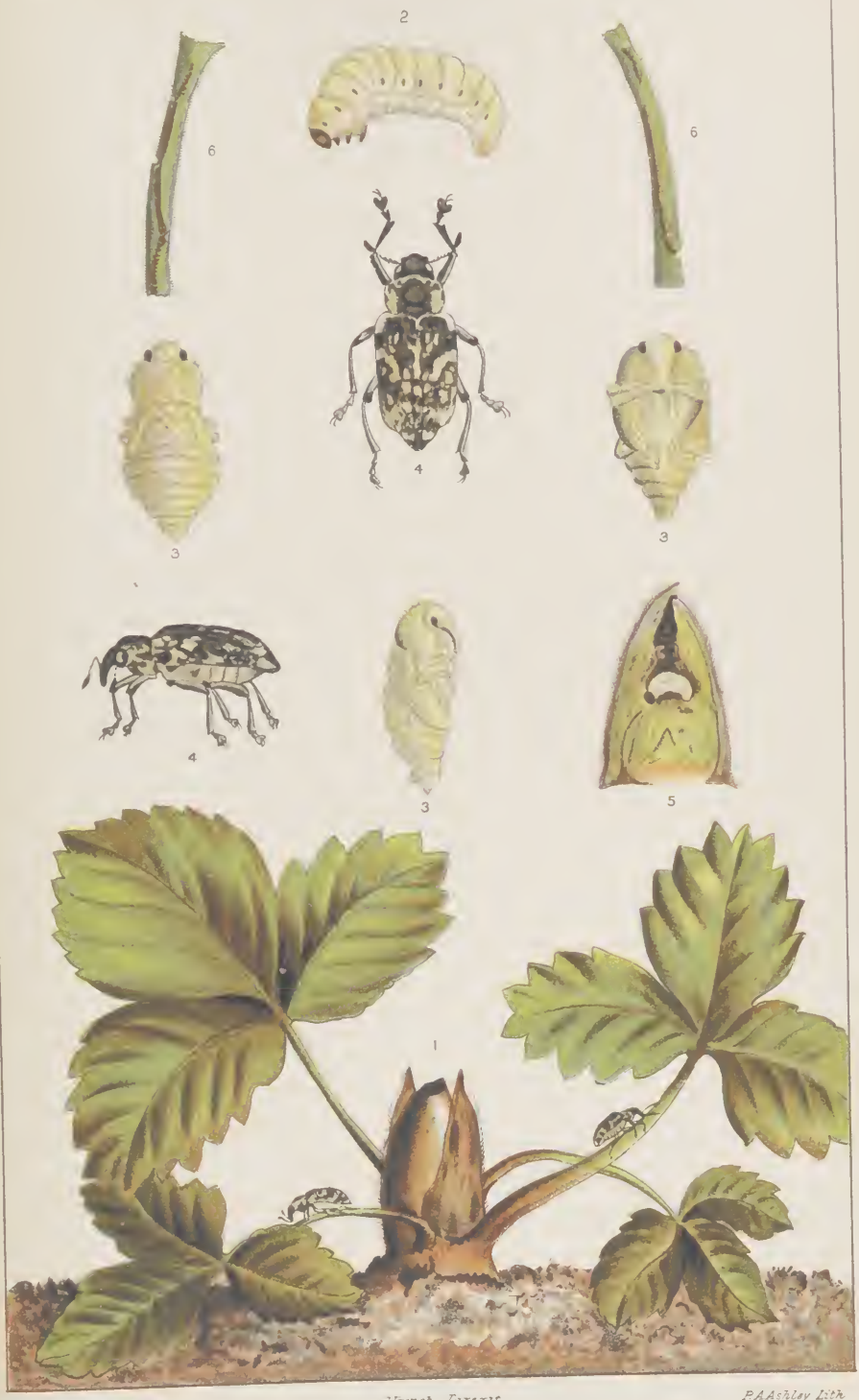
All land, whether there be a crop or no crop, should be cleared, and any blighted plants burned at once. All that is required is constant vigilance coupled with united action. Nature, in the shape of the many small parasites, as Ichneumons, &c., will help us, and the difference between the intelligent and careful grower and the careless and slovenly one must be, to quote the great Charles Darwin, the "survival of the fittest."

PLATE XXXVI.

THE STRAWBERRY BEETLE (RHINARIA PERDIX.—PASCOE).

Fig.

1. Strawberry plant with beetles on leaf stalks. Natural size.
2. Larva of beetle. Magnified.
3. Pupæ of beetles ; upper, under, and size view. Magnified.
4. Perfect beetle. Magnified.
5. Section of crown of strawberry plant, showing method of larva attacking same. Natural size.
6. Portions of leaf stalks, showing where they have been tunnelled by the insects. Natural size.



Brittlebank L. French Direxit P.A.Ashley Lith.

Plate XXXVI.

CHAPTER XL.

THE STRAWBERRY BEETLE.

(*Rhinaria perdix. Pascoe.*)

Order: *Coleoptera.* Family: *Curculionidæ.*

This very serious insect enemy of the strawberry grower, and, in some cases, to the grower of raspberries also, is a somewhat pretty beetle of a drab colour, with black and white markings, and belonging to the great family of the so-called weevils.

The perfect beetle (see Plate XXXVI., Fig. 1), on leaf stalks of strawberry plant is about $\frac{1}{4}$in. in length, and like many of this group seems somewhat bulky for the length of the insect. It was described by Mr. Pascoe, an eminent English worker on this family, in the year 1873, from specimens which had been sent to him from Victoria, but around Melbourne this beetle has been known for many years prior to its being named by the gentleman here mentioned.

The larvæ (see Figs. 2 and 5) are yellowish-white grubs, a trifle larger than the one shown in the section of strawberry plant in Fig. 5.

The pupæ (Fig. 3) have the peculiar mummy-like appearance common to most beetles before changing into the perfect or beetle stage.

The eggs, about which we at present know but very little, are supposed to be deposited by the female in the crown of the plant, but of this we are as yet not quite certain.

This beetle, unlike many of its brethren of the same family, has wings, which for the grower is unfortunate, as it can doubtless fly for a considerable distance, and is thus the better able to spread from orchard to orchard.

With regard to the hatching of the eggs the time is uncertain, although, as Mr. Thiele, one of the leading growers, remarks, the grubs are very small in the month of February, a statement that would naturally lead to the conclusion that the eggs may be deposited in January, or even earlier.

The beetles usually make their first appearance in November, although climatic and other conditions may cause a change even here. They are most plentiful in December, and may be found until the early part of February. Mr. Thiele also informs me that he first noticed these beetles in his orchard at Doncaster in 1875, though he had seen them at Hawthorn three years earlier. Specimens of the same insect are, however, in the Howitt collection of insects now at the Biological School, Melbourne University, which are labelled so far back as 1857, so that probably some of the early growers of strawberries had suffered from a pest the nature of which they were unaware.

In December these insects are reported to do the most mischief, as they destroy both the flower and even the leaf stalks by tunnelling, as shown in Fig. 6, often destroying the whole of the crop of fruit. The most serious damage, however, is done to the plant, which it often kills outright, the larvæ eating a large hole in the crown or centre of the plant, see Fig. 5, which soon decays and rots away.

It will thus be seen that we have to deal with a pest which in two stages of its existence is injurious. In the larval form it destroys the centre of the plant, and in the perfect stage it effectually prevents the plant from bearing either flowers or fruit.

When strawberry grounds are newly laid down and planted, it is, as a rule, not long before the young plants are found out by the beetles, the eggs deposited, and the work of destruction is fairly commenced.

As to what natural food this insect lived upon before the introduction of strawberries into Victoria we are, unfortunately, in the dark, but from what we know of a

closely allied species, the strawberry beetle may have lived and bred in the substance of some of the more succulent of our native plants, but this is, of course, merely conjecture. It would be not only interesting but probably useful also to have this matter cleared up, as it is hard to believe this pest to be an importation, as everything points to the fact of its being indigenous to this colony, of which there are not less than eighteen other species found in, and described from, various parts of Australia.

This is clearly another case of one of our native insects forsaking its natural food for something more palatable to its tastes, and herein lies the danger of new indigenous pests making their appearance. This serious difficulty in our orchards, however, has to be faced, and the main precaution to be taken is for every grower to be on the alert, so that if a new pest is discovered it should be reported immediately and measures taken for its extermination.

Prevention and Remedies.

When preparing the land for planting out a new crop see that as little rubbish as possible is left in or on the land. Be careful that the headlands are kept clear of weeds or rubbish of any kind whatever. If possible, give sufficient room both between the plants and in the rows, so that there may be space to work at them with the sprayer or other machines commonly used for the purpose.

The use of sulphate of ammonia in the proportion of 1 cwt. to the acre is to be commended, as also gas-lime. The latter, according to eminent agricultural chemists, should, in most cases, be exposed to the air for several weeks before turning it into the soil.

In soils where there is a deficiency of lime the superphosphate of lime, at the rate of about 2 cwt. per acre, will be not only a good fertilizer, but will help to keep down insects of many kinds. In using these artificial manures, however, growers would do well to ask the opinion of the Chemist of the Agricultural Department, who, by his advice, would probably save them both

time and trouble, to say nothing of the expenses which haphazard experiments often involve one in.

As it is known that the beetles can fly, the system of isolating the lands by trenches would probably be of little use. In the case of Leptops and other curculionidæ, which have no means of flight, this system would, no doubt, answer very well, as the insects would at least then be confined to a certain area, and could be the easier dealt with.

Before setting out the young plants in position they should be steeped in a bath of tobacco-water with a little Paris green mixed, the latter, say, 1 lb. to 200 gallons of water. Plunge the plants into the mixture, and without washing them they can be planted in the position in which they are to remain.

To prevent the eggs being deposited and to destroy both the beetles and grubs by poison must be the object of the grower, as in every case prevention is, of course, better than cure.

In mulching the plants be careful what material is used for the purpose, tan-bark being as good as any. In changing the mulching, or after it has been stored for the winter, care must be exercised so as to prevent eggs or larvæ of insects being conveyed to the plants by means of the mulching.

On a well-kept place an air-tight shed could be erected cheaply in which mulching, seeds, &c., could be treated with bisulphide of carbon, and so destroy all larvæ, &c., that may have hybernated in the old mulching. Where material for mulching can be had for the carting these precautions are hardly necessary, as the old material can be at once destroyed by fire.

When the strawberry plants are either setting or ripening their fruit, the Paris green must not be used. In such cases Quibell's Mixture, say from 1 to 30, would destroy the grubs if the mixture is poured into the crown of the plant. A mixture of bluestone (sulphate of copper), $\frac{1}{2}$ oz. to 1 gallon of water, and poured into he centre of plants, would destroy whatever insects

tackled them. Both these articles being poison, great care must be taken to keep the preparation labelled and beyond the reach of children and domestic animals.

Handpicking, though a tedious task, might with advantage be resorted to in small places, but this process is too slow and tedious for owners of large orchards to adopt, more especially for those who grow fruit for a living.

If handpicking be resorted to, the best plan is to place some strips of old blanket alongside the plants and well in under the leaves; having done this, collect the leaves together in a bunch and give them a short sharp shake, which will generally dislodge the perfect beetles, when these can be destroyed by boiling water.

Beetles belonging to this family are most tenacious of life, and will even feign death for many minutes, so that to effectually destroy them they must be either crushed, burned, or scalded, whichever plan comes readiest to hand. When the grub is in the centre of the plant, it cannot, as a rule, be dislodged by the hand without injury to the plant itself, and in this case pouring liquids into the centre must be resorted to.

In the case of raspberries, which I am informed it also attacks, the canes, where not required, should always be destroyed by burning, and a similar treatment to that recommended for the strawberry should be adopted.

In dealing with this pest, also with many others of a like nature, a great deal will depend upon a judicious treatment of the soil, also of the mulching, the latter being a very common method of transmitting pests of various kinds from one plant to another. For many kinds of plant bugs, and which also infest strawberries, mulching answers many purposes, viz., to protect the roots of plants from the heat of the sun, and to form a trap in which certain of these disgusting insects deposit their eggs, and which, when the crop is gathered and the hottest of the weather is passed, can be placed in heaps and burned, also to protect the strawberries from injury from dirt and other causes.

The strawberry, it must be remembered, is a very delicate fruit, and one which if sprayed or otherwise treated when ripe, or even near that stage, will suffer so much as to be unsaleable. An experiment which was made in Mr. Thiele's orchard convinced both him and myself that the benzole, although fatal to the Rutherglen Bug pest and uninjurious to the leaves of the vines, was quite fatal to the fruit of strawberries, which at that time were being attacked by a larger kind of plant bug, which will be described and dealt with in Part III. of this Handbook.

Strawberries, if grown well and on suitable soil, is one of our best paying crops, so it behoves every grower of them, and of raspberries also, to be on the alert. If every grower will only do a little towards the destruction of the strawberry beetle, I feel certain that we may be able to successfully resist its attacks.

As dealing with this comparatively new pest is one of experiment only, care should be taken to ascertain if it is really the same insect which is said to attack the raspberry; if it proves to be so, then the treatment here recommended will apply to both plants, but if on the other hand it should prove to be a different one, we must probably find other means of dealing with it. This I hope to investigate for myself as soon as time will permit. I shall be very glad to receive from any one, grower or otherwise, specimens of the raspberry beetle in question, together with any notes as to its habits, &c., as I should like, if possible, to have some account of this pest, supposing it proves to be a different one, in Part III. of this Handbook.

CHAPTER XLI.

FRUIT AND GRAIN EATING BIRDS.

As Part I. of the Handbook contains a list of the insectivorous birds of Victoria, it has been thought desirable to include in Part II. a list of those which feed principally on fruit, grain, and other vegetable products.

To those birds considered specially destructive to orchards, farms, vineyards, and gardens, an asterisk is attached, and I am again indebted to Mr. A. J. Campbell, F.L.S., for his kindness in going through the lists with me, and also for some corrections to the same.

In placing the "crows" in the above category, I feel that I am doing these somewhat nasty birds an injustice, as although they are rapacious in the extreme, and are very destructive to disabled sheep, also to poultry, &c., they devour enormous quantities of locusts and grasshoppers, subsisting often upon little else than the above destructive insects and crickets.

It would be hard indeed to draw any hard and fast line between many of the insectivorous and non-insectivorous birds, and as with ourselves in many cases necessity amongst them knows no laws.

Amongst many of our most practical growers there exists a great difference of opinion as to which birds should be destroyed and which should be protected; but having studied the matter fairly well, and with the aid of dissections of the stomachs of many of these birds, have convinced myself as to what is probably the correct view of the case. I can safely assert that the list here given will be found trustworthy, and in this connexion I may add that I am entirely in favour of the introduction of insectivorous birds of other countries; but, before such is

decided upon, the lists of such birds as are proposed to be introduced should be submitted to competent judges, both scientific and practical. The sparrows, rabbits, and foxes are terrible examples of indiscriminate and, to put it mildly, hasty and dangerous foreign introductions of this kind.

There are many other birds which feed both on grain and fruit, but as these are comparatively few in number it has been thought unnecessary to add them to the present list.

Alphabetical list of the principal indigenous birds which do damage in orchards, farms, vineyards, and gardens in Victoria, those marked * being the most destructive:—

Common Name.	Scientific Name.
Bell Bird	Manorhina melanophrys.
*Bower Bird (Satin)	Ptilonorhynchus violaceus.
Bower Bird (Spotted)	Chlamydodera maculata.
*Cockatoo (White)	Cacatua galerita.
*Crow (Hazel-eyed)	Corvus coronoides.
*Crow (White-eyed)	Corone Australis.
Crow-shrike (Pied)	Strepera graculina.
Crow-shrike (Sooty)	Strepera fuliginosa.
Dove (Peaceful)	Geopelia tranquilla.
Honey-eater (Black)	Myzomela nigra.
Honey-eater (Black-throated)...	Melithreptus brevirostris.
Honey-eater (Blue-faced) ...	Entomyza cyanotis.
Honey-eater (Fulvous-fronted)	Glyciphila fulvifrons.
Honey-eater (Fuscous) ...	Ptilotis fusca.
Honey-eater (Graceful) ...	Ptilotis ornata.
Honey-eater (Lanceolate) ...	Plectorhyncha lanceolata.
Honey-eater (Lewin's) ...	Ptilotis Lewini.
Honey-eater (Lunulated) ...	Melithreptus lunulatus.
Honey-eater (New Holland) ...	Meliornis Novæ-Hollandiæ.
Honey-eater (Painted) ...	Entomophila picta.
Honey-eater (Pied)	Certhionyx leucomelas.
Honey-eater (Red-throated) ...	Entomophila (Conophila) rufogularis.
Honey-eater (Sanguineus) ...	Myzomela sanguinolenta.
Honey-eater (Short-billed) ...	Melithreptus brevirostris.
Honey-eater (Singing) ...	Ptilotis vittata.
Honey-eater (Spine-billed) ...	Acanthorhynchus tenuirostris.
Honey-eater (Spiny-cheeked)...	Acanthogenys rufogularis.
Honey-eater (Sub-crested, or Helmeted)	Ptilotis cassidix.

Common Name.	Scientific Name.
Honey-eater (Tasmanian) ...	Meliornis (Lichmera) Australasiana.
*Honey-eater (Warty-faced) ...	Meliphaga phrygia.
Honey-eater (Wattle-cheeked)	Ptilotis (Lichenostomus) cratitia.
Honey-eater (White-cheeked)...	Meliornis sericea.
Honey-eater (White-eared) ...	Ptilotis leucotis.
Honey-eater (White-plumed) ...	Ptilotis penicillata.
Honey-eater (White-fronted) ...	Glyciphila albifrons.
*Honey-eater (Yellow-faced) ...	Ptilotis chrysops.
Honey-eater (Yellow-tufted) ...	Ptilotis auricornis.
*Leatherhead	Philemon corniculatus.
Leatherhead (Yellow-throated)	Philemon citreogularis.
*Lorikeet (Blue Mountain) ...	Trichoglossus Novæ-Hollandiæ.
Lorikeet (Little)	Trichoglossus (glossopsitta) pusillus.
*Lorikeet (Musk)	Trichoglossus (glossopsitta) concinnus.
Lorikeet (Porphyry-crowned)...	Trichoglossus (glossopsitta) porphyrocephalus.
*Lorikeet (Swift)	Lathamus discolor.
*Minah (Australian)	Myzantha garrula.
Minah (Yellow-throated) ...	Myzantha flavigula.
Oriole (New South Wales) ...	Mimeta viridis.
*Parrakeet (Red Lory, or Pennant's)	Platycercus Pennanti.
*Parrakeet (Rose Hill, or Rosella)	Platycercus eximius.
*Wattle Bird	Anthochæra carunculata.
Wattle Bird (Brush)	Anellobia mellivora.
*Zosterops (Grey-backed) ...	Zosterops cœrulescens.

Note.—Owing to an error in Part I., the following birds were given as insectivorous:—Whistling Tree Duck, *Dendrocygna vagaies;* Top-knot pigeon, *Lopholaimus antarcticus;* Blue Petrel, *Halobœna cœrulea;* Pied Crow Shrike, *Strepera graculina;* Sooty Crow Shrike, *Strepera fuliginosa.*

CHAPTER XLII.

Additional List of Materials in use for the Destruction of Noxious Insects.

1. Camphor for Plugging.—Of no use whatever.

2. "Deatholine."—Effective in some respects, but, as yet, too expensive for general use.

3. "Despatch Parasite Exterminator."—This solution, as introduced by Messrs. Allan and Bland, is very useful for destroying many kinds of scale. It is perfectly harmless to trees, but is at present too costly for general use.

4. Hellebore (White).—This material is rapidly coming into favour with fruit-growers, it being both fairly cheap and highly effective, and is now largely used against the "pear-slug." The so-called "white hellebore" is manufactured from Veratrum album, which is not a true hellebore. There would appear to be a difference of opinion as to the best method of preparing this material for the use of orchardists; but, judging from experiments which have been made by intelligent growers, it seems to be that the "powdered hellebore-root" is in the greatest favour, because it is cheaper than the extract, though the latter is easier to mix. Mr. Thiele, of Doncaster, is of opinion that the powder will kill all the "slug" and will retain its power longer than the extract. Proportions of powder, as used by Mr. Thiele, 1 pound to 30 gallons of water, cost 8d.; extract, 1 quart to 30 gallons of water, cost 1s. 6d. It is possible that other growers may have had different experiences, and which they will doubtless be guided by. It is recommended that the larger quantity be used, because, to be effectual, it should kill quickly and before the rain could fall and wash it off the leaves so treated.

5. "IXL."—This so-called specific comes to us from America with a very high reputation. It is, however, as yet, too expensive for general use here, or to successfully compete against the cheap and effective kerosene emulsions.

6. "PHYLLOXERA CURE" (PERRY'S).—This is reputed, by those who have tried it, to be effectual in clearing plants of many kinds of scale-insects, and has been used with success in the Carlton Gardens. I have had no experience with it on vines which have been attacked by phylloxera.

7. SOAP (GARRICK'S MINERAL).—This soap is intended to supersede the ordinary soaps hitherto used for the purpose of emulsifying the kerosene for spraying fruit trees. It makes both a cheap, safe, and nearly perfect emulsion, and is already largely in use in orchards and elsewhere.

8. "EMULSION" (MARTIN'S).—This, the most perfect emulsion which I have yet seen, and when it can be placed cheaply on the market, will, no doubt, be largely in demand by growers. The kerosene emulsions are certain to increase in popularity, and now that the emulsifying process has been brought to such perfection, a large sale of same is only to be expected.

9. SULPHATE OF COPPER (BLUESTONE).—This material, in addition to its great value as a fungicide, has been tried with success against the peach aphis when on the roots of fruit-trees.

10.* SULPHATE OF AMMONIA.—Has been used with much success against the "Army-worm," "Cut-worm," and similar pests.

11. SULPHATE OF POTASSIUM.—Has been used mixed with the above (No. 10), and for similar purposes.

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* It will be of interest for farmers to know that, at the late trials of material in use against caterpillars in the field-crops, and which took place in England, it was found that the following gave the best results:—

Sulph. of iron	...	...	1 cwt.	per acre.
Sulph. of potass.	...	...	1 cwt.	
Sulph. of ammonia	...	...	1 cwt.	

C. WHITEHEAD.

12. "Quassia Chips."—This preparation is used largely in Europe and America, but in the colonies we have had but little experience with it.

13. Spirits of Turpentine.—According to Professor Cooke, of Michigan, U.S., the above, if injected into the nostrils with a syringe, will effectually destroy the maggot of the sheep bot-fly, also maggots in the ears or any part of the body.

14. Stockholm Tar.—If placed on the nose and inside the nostrils, will, according to Professor Cooke, prevent the bot-fly from depositing her eggs or larva in the nose of the sheep. Place Stockholm tar in the bottom of a trough to the depth of one inch, and cover with salt. In this way the tar gets on the nose and into the nostrils while the sheep is gathering the salt.

15. "Whale-oil" and "Whale-oil Soap."—Largely used in America in the preparation of spraying material.

APPENDIX.

ADDITIONAL ILLUSTRATIONS OF SPRAY PUMPS AND OTHER MACHINES IN USE FOR THE DESTRUCTION OF INSECTS.

The object of including in Part II. of the Handbook additional illustrations of the various spraying pumps and other insect-destroying machines now in use either here or in other countries, is that farmers, fruit-growers, vignerons, and others may be able by aid of the figures and descriptions to select for themselves such articles as appear best suited for their requirements; and as our rural population is in some districts scattered, and so far removed from the great centres of population, it has been thought desirable to furnish some particulars as to cost, &c., as also names and addresses of firms from whom the machines may be obtained, taking them in the order in which I have received the particulars from the owners or agents, the author of each article or description being responsible for the statements contained therein.

A good spraying apparatus, if it is to last, should be carefully looked after, and immediately after use must be cleaned out, dried, and clear water forced through the nozzles before these are laid by and again used.

Mr. A. N. Pearson's Sprayer.

(*See Figs.* 1, 2, *and* 3.)

A spraying arrangement which will operate in a wholesale manner has recently been invented by Mr. A. N. Pearson, Government Agricultural Chemist, in connexion primarily with the work of the Intercolonial Rust in Wheat Conference.

From the drawings it will be seen that the arrangement consists of an iron tank. (or other suitable vessel), placed in an ordinary cart; attached to the top of this tank is a pump (either a rotatory or double acting piston pump), which is operated by means of chain gearing and spoke clamps on the cart wheel. This pump, when the cart is in motion, draws the liquid out of the tank and forces it into a long pipe or system of pipes bearing a number of atomizing nozzles, through which the liquid is ejected in a fine spray.

The invention consists principally in the use, arrangement, and manner of support of the long pipe or system of pipes. The pipe is made in sections, which can be screwed together in a variety of ways. In Fig. 1, all the sections are arranged in the form of a long horizontal pipe, 50 feet in length, supported, firstly, by two standards clamped on

to the sides of the cart, and, secondly, by a short mast with tie wires. Other tie wires suitably disposed can be added when required, to prevent horizontal swaying of the pipe. The two standards can, within certain limits, be clamped to the sides of the cart in any desired position, so that the long pipe can be placed at any distance between 3 inches and 10 feet above ground. In addition to, or instead of the nozzles attached directly to the pipe, there can be attached a number of thin backwardly curving branch pipes, as shown at the right hand in Fig. 1. These branch pipes deliver the spray on the under surface of the leaves of ground crops such as potatoes, and right in the interior of cereal crops, such as barley attacked by caterpillars, or wheat attacked by rust. Fig. 2 shows the sprayer arranged for spraying hops, and Fig. 3 for spraying vines, five rows at a time. The pipes may be similarly arranged for spraying fruit trees in an orchard.

The advantage of this machine is in the large area of ground that can be covered in a short time. Thus, with a pipe 50 feet long, the sprayer, moving at the rate of 2½ miles an hour, would cover more than 15 acres an hour, or say 160 a day of 12 hours, allowing time for refilling.

The tank is filled by disconnecting the pump from its chain gearing, inserting the indiarubber hose into the well or cistern containing the water or prepared solution, and working the pump by hand, backwards way. On referring to the drawings, a pipe furnished with a cock will be seen leading from top of the pump back again into the tank. This pipe serves a double purpose: 1st, it acts as a stirrer, for any liquid forced through it will stir up the liquid or emulsion in the tank; 2nd, it serves to adjust the amount of liquid to be delivered as spray, for it will be readily understood that the more liquid is allowed to pass through this pipe the less will pass through the nozzles. Further adjustment can also be made by placing the spoke clamps on the cart further from or nearer to the centre, so that the gearing chain works from a greater or less circle and therefore greater or less speed. A strainer is fixed on to the end of the feed pipe of the pump to prevent the entrance of particles which would stop up the nozzles.

The same system of piping can be adapted to the use of steam spraying, a small steam boiler being then placed in the cart instead of the tank, pump, and chain gearing.

The chief advantage claimed for this sprayer is the rapidity and wholesale manner of its operation. A machine which will cover 15 acres in one hour makes the cost of spraying little more than nominal. Another advantage is that it does next to no damage to the crop. The only damage done is by the cart wheels and the feet of the horse, which in a track of 50 feet in width cannot amount to more than one or two per cent.

This sprayer is extremely simple in construction; an ordinary cart is all that is required to carry it, and the pump can be used for other purposes when detached from the tank.

Agents: Messrs. John Danks and Son, Ltd., Melbourne. Price on application.

Peirce's Pumps and Sprays.

(See Figs. 4, 5, 6, 7, and 8.)

Simplex Knapsack Spray Pumps (Continuous Sprayer).—This pump (see Fig. 4) consists of a light, strong, and durable galvanized iron cylinder, self-locking cover, leather carrying strap, buckling yokes, and single easy hand working-to-and-fro pumps with mist-like sprays, to readily carry on the back, and instantly throw a continuous efficient spray of emulsion up, through, and around trees or vines under treatment. This pump is carried on the back. It is made in two sizes of 60 lbs. and 80 lbs. weight respectively.

Price: With single spray—6 gallons, fifty shillings; 8 gallons, fifty-five shillings. With triplet cyclone spray, five shillings extra.

Agitating Pail Sprayer.—This machine (see Fig. 5) consists of Peirce's double action brass pumps, in strong galvanized iron pails, with efficient fine mist triplet, cyclone, sprayers, strainers, and archimedean mixer, to carry down and thoroughly mix floating kerosene and other mixtures; cover to keep out leaves, &c. Capacity, 5 gallons.

Price: With triplet spray mixer and cover, sixty shillings; jet and rose, four shillings and sixpence extra; with one spray without mixer and cover, fifty-two shillings and sixpence; with jet, rose, and cover, without mixer for watering, fifty-seven shillings and sixpence.

Lever Pail Spray Pump.—This machine (see Fig. 6) consists of a strong galvanized iron pail with cover, and Peirce's double action brass lever pump, with 6 feet of delivery hose, director, and single or treble sprays.

Price: With single spray—5 gallons, seventy shillings; 8 gallons, eighty shillings; triplet cyclone spray, five shillings extra.

Sedan Heating and Spraying Apparatus.—This machine (see Fig. 7,) which has been suggested by the Government Entomologist, consists of a strong wrought iron combined galvanized cistern and furnace, with large conical body-heaters, fire and ash compartments, double action mist-like spraying pumps, agitating mixers, strainers, adjustable carrying handles and covers. Kerosene emulsion or any other emulsion can, by this machine, be applied hot by two men to the plants under treatment.

Price: With 10 feet of hose, director, and fine mist triplet cyclone sprayer, 15 gallons, £8 10s.; with two 10-feet sprayers, cut-offs, &c., thirty shillings extra.

Pristine Water Cart Spraying Apparatus.—This oscillating cart (see Fig. 8) is entirely of wrought iron, with strong galvanized iron tub, large broad tyred wheels, tubular shafts, and powerful double action brass adjustable pumps, long delivery hose and sprays. For one lad to drive and pump, and one or two to spray. The jet will throw a continuous stream 50 feet.

Price: Horse-power apparatus, as shown in Fig. 8, £20 and £15. Hand-power apparatus, £9 10s., £8 15s., and £7 15s.

Alfred E. Peirce (patentee and maker of the above machines), Bromby-street, South Yarra, Melbourne.

Danks' Spray Pumps.

(*See Figs.* 9, 10, 11, 12, *and* 13.)

Handy Spray Pump: This pump (see Fig. 9) is strongly made. The tube which forms the piston rod is arranged so as to act as an air chamber, giving a continuity and evenness of spray. The pump is screwed to an iron plate, the projecting portion of which forms the step plate shown in Fig. 9. By this means the whole affair is made thoroughly rigid, and the continual buckling to and fro of the bottom of the tank is an impossibility.

Price: £2 10s.

Acme Spray Pump: This sprayer (see Fig. 10) is suitable for medium sized orchards and vineyards, or in cases where it is not convenient to take a cart. Two lengths of hose, each 15 feet, and quadruple sprays.

Price: £13.

Knapsack Lever Spray Pump: This pump (see Fig. 11) is strongly placed, and the tank is constructed so as to be comfortable to the back.

Price: £3.

Champion Knapsack Spray Pump: In this pump (see Fig. 12) the lever is absent, the action is readily understood from the engraving. The piston is arranged to act as an air chamber. The pump itself is thoroughly rigid.

Price: £3.

Deluge Spray Pump: This pump (see Fig. 13) has been specially designed for the larger growers. The pump, which is on the semi-rotary principle, is very powerful, and would, if necessary, supply more jets than shown in our engraving. The air chamber is large, and the arrangement for distributing the liquid is very simple. The pump, which may be worked by the driver as shown, has an arrangement of taps whereby the liquid may be turned on to one or both of the sprays, or, when necessary, turned into the return pipe so as to thoroughly disturb the liquid. Two 20-ft. lengths of hose and the necessary directors and sprayers are supplied with this pump.

Price: £17.

Knowles' Pump and Sprays.

(*See Figs.* 14, 15, *and* 16.)

The "Knowlesly" Special A1 Spray Pump.

This pump has been specially designed for those fruit-growers who require one of a stronger and more powerful construction than the "Improved spray pump" described on page 129 of the first volume of this work.

It may be fixed in a vessel of any shape, holding from 10 to 100 gallons; but for general requirements they are sent out in a 10 gallon

drum, with cover, as shown in the illustration. These can be carried by a man and boy, wheeled in a barrow, or drawn through the orchard or vineyard on a newly designed sledge of light draught.

Its action is the "perfection of simplicity," being almost automatic. Two or three movements of the lever fills the outer cylinder with highly compressed air, which drives out a full head of spray for a minute and a half. This allows the user sufficient time to effectually spray a large tree.

A boy of 8 years of age can keep up a full and continuous pressure as well as a man.

They are fitted with an universal joint which prevents kinking of the hose pipe.

When desired, they are made with a delivery hose, on either side, so that two rows of trees may be sprayed at the same time.

It is so constructed that it cannot get out of order or be easily damaged.

Fitted with a "Knowlesly Triune" patent nozzle, it is at all times available as a powerful portable fire-engine capable of throwing a strong jet of water a distance of fully 40 feet.

It is, without doubt, the best spraying pump yet introduced.

Price: £7 7s.

Agents: McLean Bros. & Rigg, Limtd., Melbourne.

The Knowlesly Patent "Triune" Spray Nozzle.

This nozzle will prove a boon and blessing to fruit-growers. Should the Knowlesly nozzle choke, which is seldom the case, it can with ease be cleared in a quarter of a minute.

The No. 1 throws three distinct sprays and jet. 1st, by removing the cup from the inside; 2nd, by removing both cup and cap; 3rd, by using both cup and cap.

The No. 2 double spray nozzle will commend itself to all who use spray pumps, as it adapts itself to the user's varied requirements.

It can be used either as a single or double sprayer, as each nozzle "shuts off" when turned downwards, yet sprays at any angle, and will throw as much "Scotch mist" as can be utilized.

Price: Single 5s.; double 10s. Screwed to fit $\frac{1}{4}$in. pipe.

Agents: McLean Bros. & Rigg, Limtd., Melbourne.

MACHINES, AS USED IN FRANCE, FOR INJECTING BI-SULPHIDE OF CARBON, ETC., INTO THE SOIL SURROUNDING DISEASED VINES.

(*See Figs.* 17 *and* 18.)

With the advent of the phylloxera in France there resulted the invention of several syringe-shaped "injectors" or *pals injecteurs*, which have since proved of great value to French vine-growers as the best means of injecting bi-sulphide of carbon into the soil surrounding phylloxera-infested vines.

One of the earliest machines made was that of M. Gastine. This "injector" is composed of two principal organs, viz., a piston by which the course is regulated, and a valve to retain the liquid which is dissolved under the influence of hydraulic pressure. In this apparatus the liquid not only runs out, but is injected in a way that, if the hole begins to get clogged, it is at once cleared by the pressure of the liquid. All the "injectors" since placed on the market invariably have the two principal organs above mentioned. The following advantages are claimed for the Gastine "injector":—The injection is effected with certainty. The outlet can never be blocked. The liquid is always passed through in exactly equal doses.

The working of this machine is extremely simple. The "injector" is forced into the soil by the two handles and the pedal, and the actual injection of the liquid is obtained by a single movement. It is sufficient to push with the palm of the hand, the flat button-like handle which forms the top end of the piston above the receiver. The piston rapidly drops in the proportioning chamber in passing through the leather ring. To leave at once where it has passed through the leather, it condenses the liquid which fills the chamber of the tube just opposite the plug of the "injector." Under the effect of the pressure which it receives, it loses some of the properties that, supposing the liquids to be incompressible, this last lets pass a quantity of liquid exactly equal to that which represents the volume engendered by the descent of the piston. The liquid so forced under the plug escapes with force through the small outlet placed in the thickest part of the cone.

The piston having gone as far as possible, the injection of the liquid ceases. The valve closes itself tightly and automatically under the effect of a spring which is placed against the seat of the valve. The piston, left to itself, mounts again to its old position. The liquid precipitates itself into the empty space which it has left behind, and the apparatus finds itself ready for a new injection. The different motions above described are instantaneous. The springs employed for working the piston and the retaining valve render the priming certain, and completely automatic.

Fig. 17 shows the Gastine machine, and Fig. 18 a section of the same.

Another machine, which is in some parts an improvement on the Gastine, is the "Select," made by Vermorel. The advantages claimed by the "Select" machine consist, aside from its solidity, its movable pedal, which permits regulation of penetration, further facilitated by its steel point; in this, that the ring or lid is fixed at the extremity of the piston instead of being pressed by four buttons near the pedal, from which results one movement and a very rapid replacement of this ring, whereas in machines of earlier construction the tightening and loosening take a considerable time. Another advantage claimed by the Vermorel machine is in the length of the spring of the valve, which, instead of being below the valve and necessarily short, is above it and five or six times longer, and of which one may regulate easily the pressure to the way of the two screws.

The mechanism that assures the proportioning is nothing else than a syringe.

Vermorel has another machine called the "Excelsior," somewhat more complicated than the "Select" in its interior mechanism, but from all reports a better machine.

Figs. 17 and 18 have been reproduced from *Traité de la Vigne et de ses produits, Vol. III., par MM. L. Portes et F. Ruyssen, Paris, 1889,* the explanatory matter having been copied from the same work.

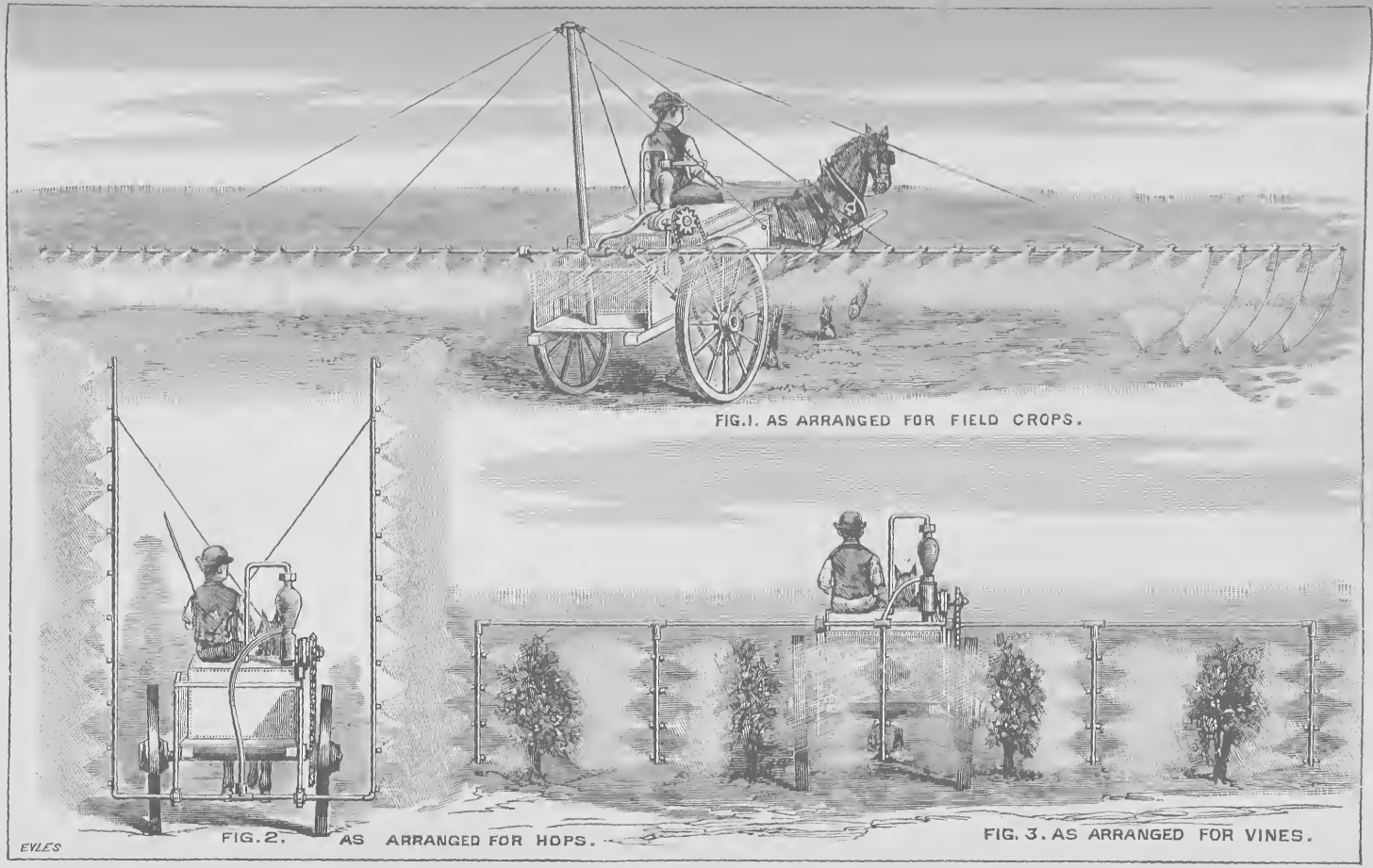
The Nixon Sleigh Barrel Spraying Machine.

(*See Figs.* 19 *and* 20.)

This apparatus is admirably adapted for places where it has to be drawn over soil of a loose nature, it being little liable to get bogged, as it would be likely to do if fitted with wheels. The machine has been specially designed, being a barrel holding from 25 to 30 gallons of liquid, and fitted on to a sleigh. This sleigh can either be drawn along the ground or placed in a cart as circumstances may demand. The machine is fitted with a brass plunger-pump and air chamber, also disturber, which are attached by both crank and lever motion to the handle of the pump; by this means every motion of the handle in pumping, the disturber (or agitator) is brought into action. It is also fitted with two lengths of hose, each 30 feet long, and sprays; also a shorter length with spray, so that one man can work the pump and spray. It is also so arranged that by opening a valve it is converted into a "three-men sprayer."

This machine is strongly made and will be eagerly sought for. It has been brought from America by Mr. J. West, Government Irrigation Expert, for the Victorian Department of Agriculture.

Price: Complete, £16.



Figs. 1, 2, and 3.—MR. A. N. PEARSON'S SPRAYER.

Fig. 4.—PEIRCE'S SIMPLEX KNAPSACK SPRAYER.

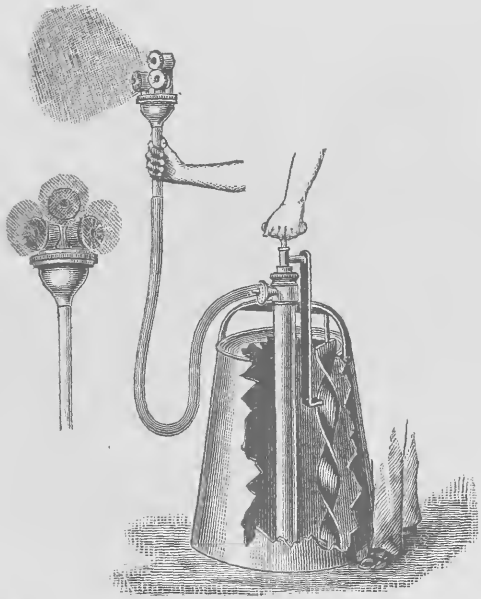


Fig. 5.—PEIRCE'S AGITATING PAIL SPRAYER.

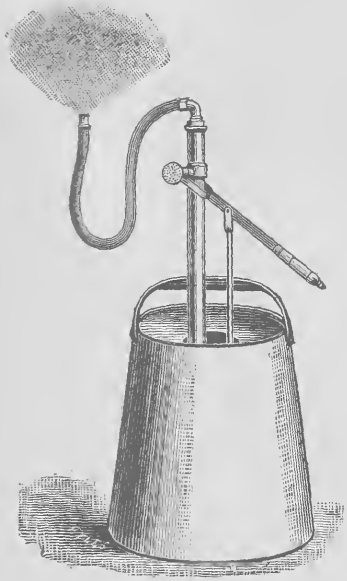


Fig. 6.—PEIRCE'S LEVER PAIL SPRAYER.

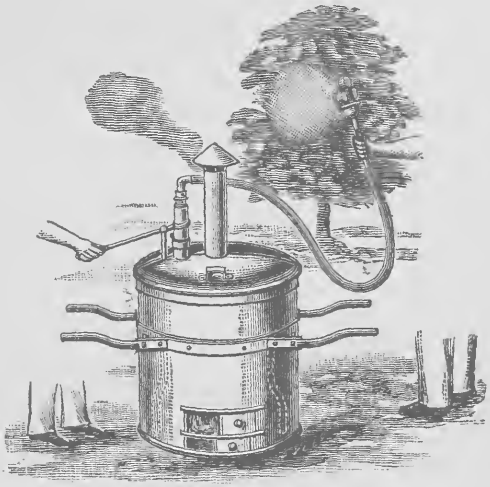


Fig. 7.—PEIRCE'S SEDAN HEATING SPRAYER.

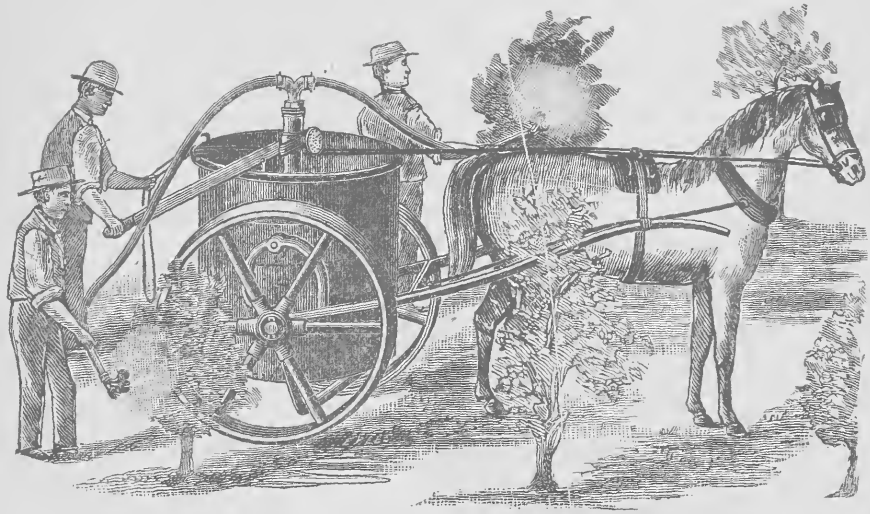


Fig. 8.—PEIRCE'S PRISTINE WATER-CART SPRAYER.

Fig. 9.—DANKS' HANDY SPRAY PUMP.

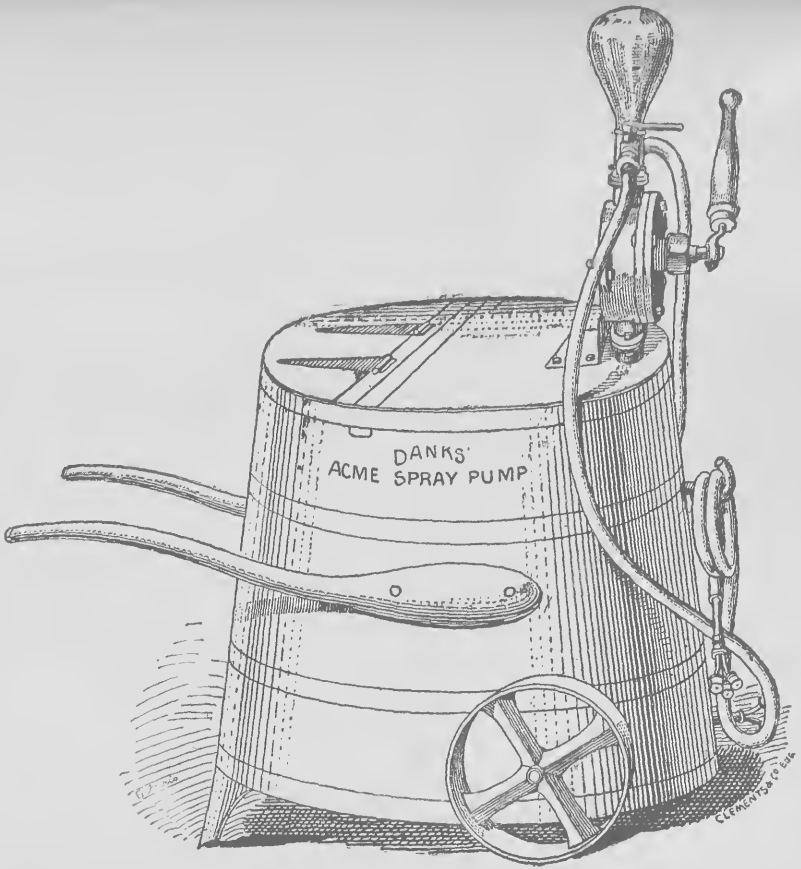


Fig. 10.—DANKS' ACME SPRAY PUMP.

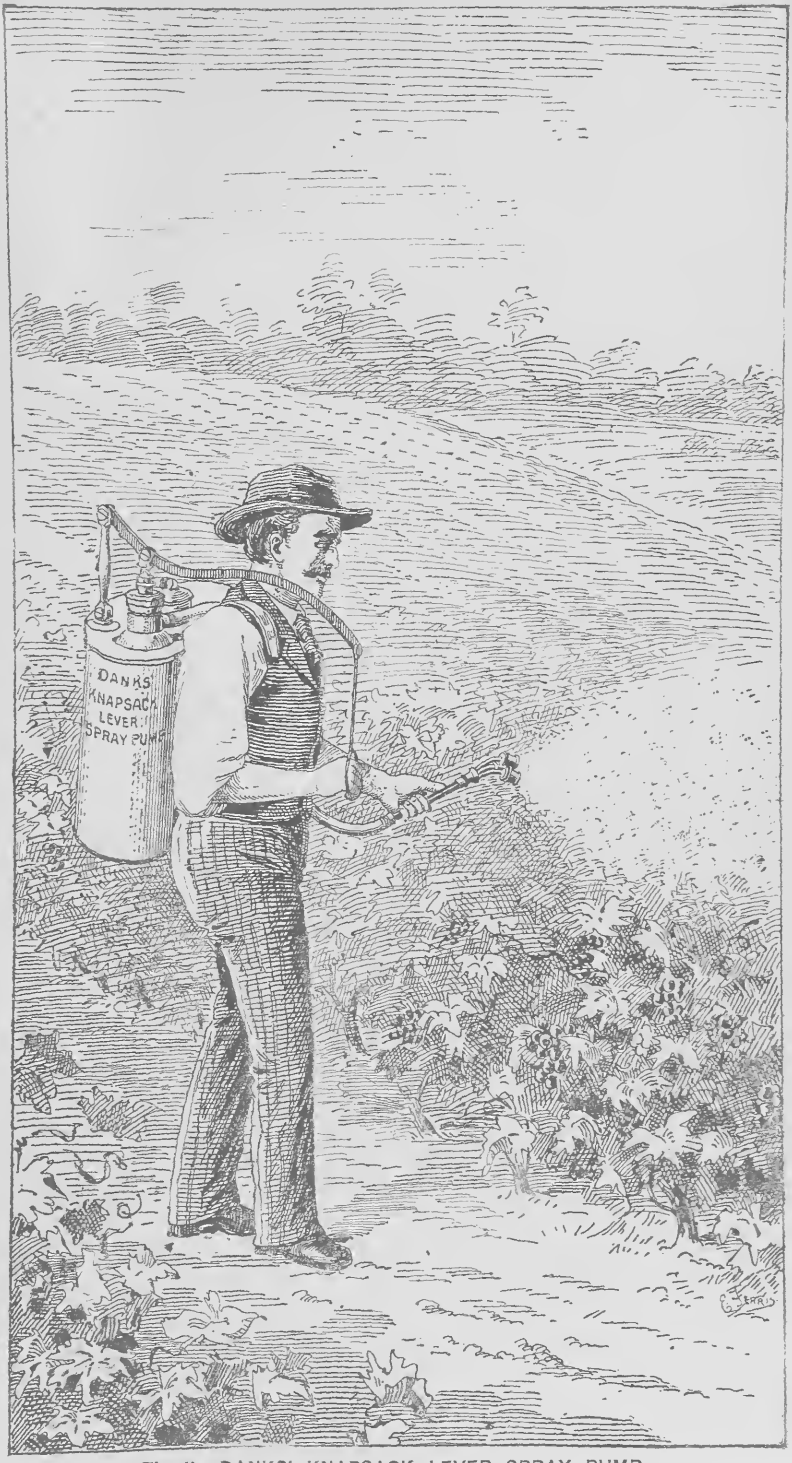


Fig. 11.—DANKS' KNAPSACK LEVER SPRAY PUMP.

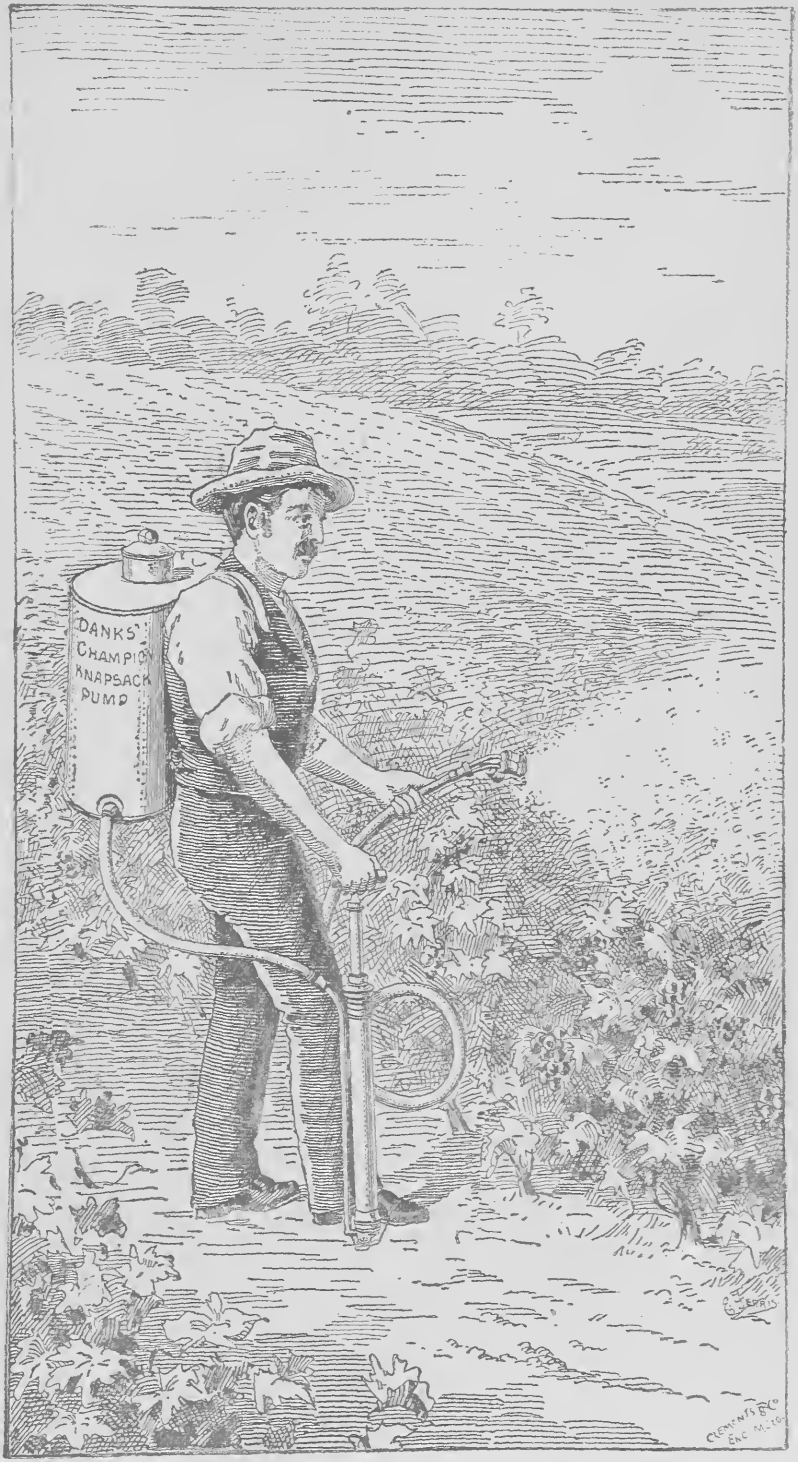


Fig. 12.—DANKS' CHAMPION KNAPSACK SPRAY PUMP.

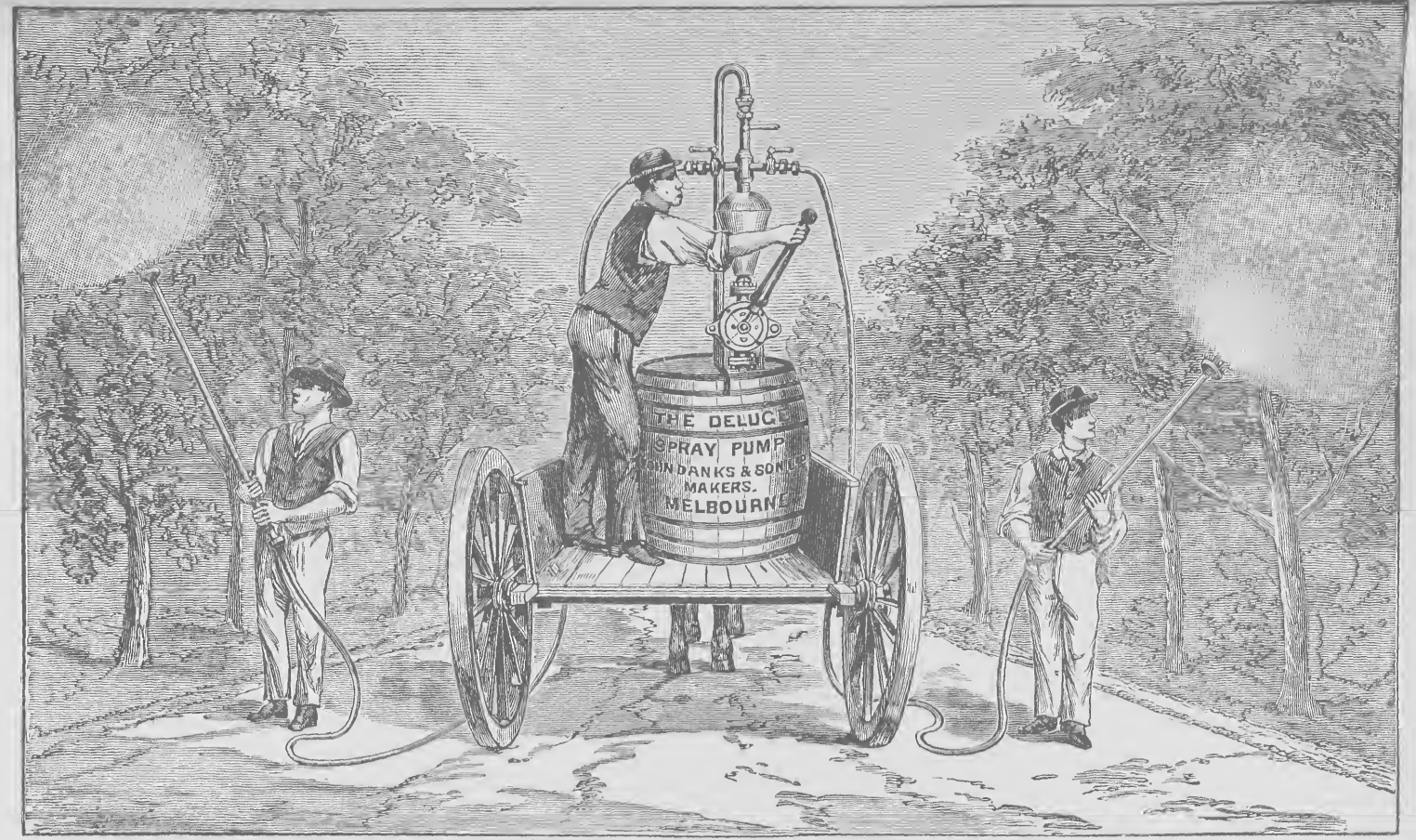


Fig. 13.—DANKS' DELUGE SPRAY PUMP.

Fig. 14.—THE KNOWLESLY SPECIAL A1 SPRAY PUMP.

Fig. 15.—THE KNOWLESLY PATENT "TRIUNE" SPRAY NOZZLE.

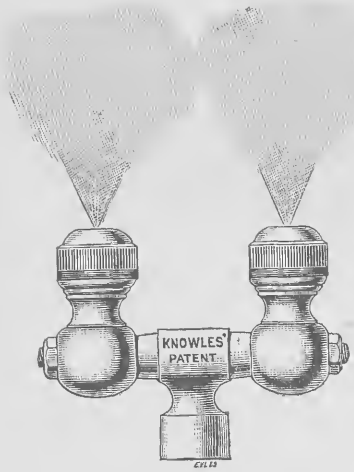


Fig. 16.—THE No. 2 DOUBLE-SPRAY NOZZLE.

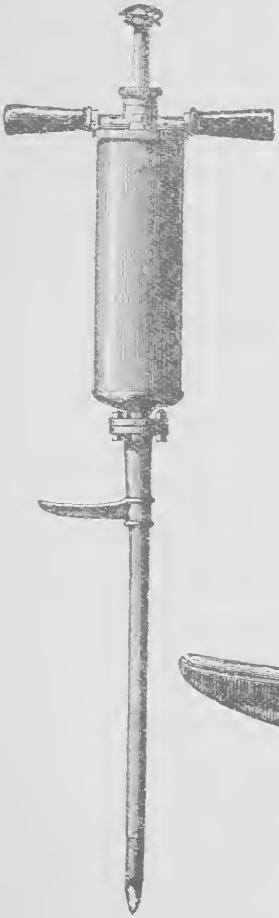


Fig. 17.—GASTINE INJECTOR.

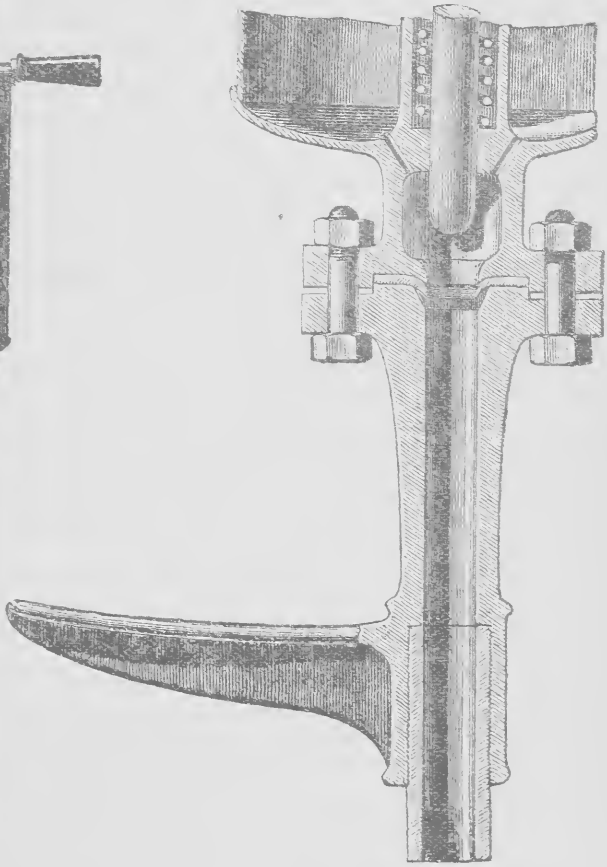


Fig. 18.—SECTION OF GASTINE INJECTOR.

Figs. 19 and 20.—THE NIXON BARREL SPRAYING MACHINE AND SLEIGH.

GENERAL INDEX TO PART II.

T.

V.

By Authority: Robt. S. Brain, Government Printer, Melbourne.