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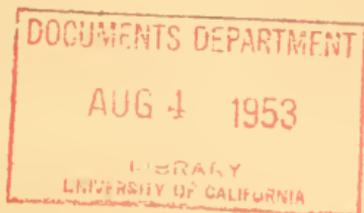
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BULLETIN No. 24.

DEPARTMENT OF AGRICULTURE

OF

BRITISH COLUMBIA.

FARMERS' FOES AND THEIR REMEDIES.

Anderson, J.R.

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DEPARTMENT OF AGRICULTURE

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FARMERS' FOES AND THEIR REMEDIES.

Hon. R. G. Tatlow,
Minister of Agriculture,
Victoria, B. C.:

DEPARTMENT OF AGRICULTURE,

VICTORIA, 15th January, 1908.

SIR.—In fulfillment of a long-standing promise, I have the honour of presenting the following bulletin on the various pests, animal, insect and disease, of stock-raiser and farmer, with their remedies. The information conveyed has been culled from various sources, and has been in course of preparation for over a year, and it is therefore hoped that it will meet the requirements of our people.

I have the honour to be,

Sir,

Your obedient servant,

J. R. ANDERSON.

Deputy Minister of Agriculture.

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FARMERS' FOES AND THEIR REMEDIES.

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CHAPTER I.—INTRODUCTION.

The purpose of the present bulletin is to afford a description in a succinct form of those pests which are prevalent, reported, or are likely to be introduced in the Province, and their natural enemies, with the remedies prescribed by competent authorities, or which have been found by experience to be the most effective.

The question of pests, whether insect, disease or animal, and whether of plant or animal life, intimately affects the welfare of every tiller of the soil and breeder of animals, to an extent not generally recognised. The running of animals on ranges and rounding them up, occasionally, or feeding them, even if done lavishly, about a farm, is not all the business of a breeder of animals, or the planting, cultivating and pruning of an orchard all that the fruit culturist has to do, to ensure success, or the sowing and reaping of grain all the farmer is called upon to perform. The enemies of the productions of these various avocations, whether of native or introduced origin, all demand close and constant attention. The lack of knowledge or of appreciation of the methods pursued by the successful person, not the least amongst which is the ceaseless warfare against insect and animal pests and diseases, is too often the cause of failure on the part of the farmer, and it is therefore hoped that the information furnished, which is culled from all available authoritative sources, may prove a real benefit to all concerned. In fulfilment, therefore, of the long-standing promise for a publication dealing with the subject, this bulletin is now presented, and which it is earnestly hoped will meet most, if not all, of the conditions involved, and awake our people to renewed efforts in adopting the repressive measures advocated against enemies and the protection of insect friends.

In presenting this brochure to the public, however, I do not for a moment pretend that the contents are all emanations resulting from my own observations. It would be presumptuous of me to set up my opinions against those of persons who have made a life-long study of their respective subjects, with all the necessary opportunities to study the life histories of insect and plant life, and the most reliable methods of combating the depredations of the enemies of the stockman, farmer and orchardist. I have, therefore, endeavoured, as far as possible, to cull the best from the researches of the most advanced entomologists and scientists of our own and other countries, supplemented by such information as naturally is obtained by constant contact with

the subject under review, giving credit in all cases to the authorities quoted. I have to express my thanks to Dr. James Fletcher, Dominion Entomologist, and the Rev. Geo. W. Taylor, of Wellington, for assistance rendered in revising my work; also to Dr. S. F. Tolmie on "Stock Pests," and Mr. E. F. Robinson on "Bee Pests." Nevertheless, I am quite aware that in a publication of this description mistakes will occur in spite of the most careful revision, and for all such I ask the indulgence of the public.

Kellogg, in his introduction to "American Insects," says:

"Throughout this book reference is constantly made to the injuries done by insects to our forest-trees, flowers, fruits, vegetables and grains. The millions of dollars lost annually because of the sap-sucking of the San Jose scale, the grape-phylloxera, the chinch-bug, and the Hessian fly, and the biting and chewing of beetles and caterpillars, grubs and borers, are a sort of direct tax paid by farmers and fruit-growers for the privilege of farming and growing fruit. If this tax were levied by Government and collected by agents with two feet, instead of being levied by Nature and collected by six-footed agents, what a swift revolt there would be! But we have, most of us, a curious inertia that leads us to suffer with some protesting complaint but little protesting action the 'ways of Providence,' even when we fairly well recognise that Providence is chiefly ourselves.

"When we reflect on the four hundred millions of dollars a year lost to our pockets* by insect ravages, we may incline to believe that the only kind of insect study which should claim our attention is the study of how to rid our lands of these pests. We may be excused for affirming of bugs, as was said of Indians by some epigrammatist, that the only good ones are the dead ones. When, however, we learn, as we are learning in these present days, that insects are not simply serious enemies of our crops and purses, but are truly dangerous to our very health and life, we must become still more extravagant in our condemnatory expressions concerning them.

"We have long looked on mosquitoes, house-flies and fleas as annoyances and even tormentors, but that each of these pests actually acts as an intermediate host for, and is an active disseminator of, one or more wide-spread and fatal diseases is knowledge that has been got only recently. Mosquitoes help to propagate, and are, almost certainly, the exclusive disseminating agents of malaria, yellow fever, and the various forms of filariasis; house-flies aid in spreading typhoid fever and other diseases; fleas are agents in distributing the germs of bubonic plague. Other insects are known to spread other diseases. Howard says: 'While in malaria and typhoid we have two principal diseases common to the United States which may be conveyed by insects, the agency of these little creatures in the transfer of the disease-germs is by no means confined to human beings. In Egypt and in the Fiji Islands there is a destructive eye-disease of human beings, the germs of which are carried by the common house-fly. In our Southern States an eye-disease known as pink-eye is carried by certain very minute flies of the genus *Hippelates*. The so-called Texas fever of cattle is unquestionably transferred by the common cattle-tick, and this was the earliest of the clearly demonstrated cases of the transfer of disease by insects. In Africa a similar disease of cattle is trans-

*In the United States.—J.R.A.

ferred by the bite of the famous biting fly known as the tsetse-fly. The germs of the disease of cattle known as anthrax are carried by gad-flies, or horse-flies, and when these flies subsequently bite human beings malignant pustules may result. And other discoveries of this nature are constantly being made. Even the common bedbug is strongly suspected in this connection.

"These statements are not guesses, they are proved facts of science. It will be some time before these facts and their significance receive their full recognition in the medical practice; the knowledge of medicine is always in advance of its practical recognition. But modern medical practice is much swifter to incorporate the new facts of biology than was the practice of even a decade or two ago, and in such lines of work as army and other governmental service the new methods of preventive medicine are quickly adopted. Already there are organised movements all over the world to make use of the new knowledge concerning the relation of insects to human disease. As I write these pages comes the report of the work of Major Ronald Ross, one of the discoverers of the malaria-disseminating capacity of the mosquito and one of the leaders in the anti-mosquito crusade, in nearly stamping out malaria in the long notorious pest-hole of Ismailia. Malarial cases have been reduced there from 300,000 cases annually to 300, by effective war on mosquitoes. Dr. Cruz reports that Rio Janeiro has abolished its old-fashioned quarantine regulations, and vessels with yellow fever on board will hereafter simply be disinfected and supervised. In October, 1903, Cruz directed the operations of 1,200 men especially employed in destroying the larvæ of the mosquito in their breeding-places in and around the city, and, as a result, only nine cases of yellow fever developed in the midsummer months of January and February (1904), as against 275 cases in the same months in 1903. In the period from 1850 to 1896, 51,600 deaths occurred in Rio Janeiro from this disease, and at times as many as 2,000 patients have been cared for in the isolation hospital, which is now closed. The benefits of the war waged on the mosquito at Rio Janeiro have been as great as those obtained at Havana, where the vigorous work of the American authorities during our occupation of the islands practically stamped out yellow fever in a city long notorious the world over as a plague-centre."—*Insects Injurious to Crops, by Dr. Fletcher.*

Every crop grown by the farmer and gardener is liable to be attacked and reduced in value by various insect enemies, from the time the seed is sown until it is harvested. Frequent inquiries concerning even the commonest and most injurious pests make it advisable to issue in concise form for reference, an account of some of the more important of these, together with the latest approved remedies, and the most convenient methods of applying them.

It must be acknowledged by all observant people that the losses due to the attacks of insects are every year enormous; and it should be more widely known that there are practical—that is effective, cheap and easily applied—remedies for most of those kinds which year by year levy such a heavy tax on all crops. For the effective use of remedies against injurious insects, a certain amount of knowledge as to the habits and structure of the latter is very useful, so that the most appropriate remedy may be made use of, and this at the time when it will be most effective.

LIVES OF INSECTS.

The lives of insects are divided into four well marked stages. These are: (1) the egg; (2) the larva (caterpillar grub or maggot), during which, as a rule, they are most injurious; (3) the pupa or chrysalis, in which, except in a few orders, they do not feed, and are, as a rule, without the power of locomotion; and (4) the perfect insect. Although most insects are injurious in one or two stages, only some are destructive in all three of their active stages. It therefore becomes important to learn their appearance and habits from the time the eggs are laid until the whole life history is completed, so that no opportunity of destroying them may be lost.

Biting and Sucking Insects.—All insects may be divided into two large classes, by the nature of their mouth parts. In the first or larger division, Biting Insects, they are furnished with mandibles or biting jaws, by means of which they consume the substance of their food, as in the case of caterpillars, beetles, grasshoppers, etc. In the second class, Sucking Insects, they have, instead of mandibles, a beak or tube by means of which they suck up their food in a liquid form from beneath the surface, as in the case of the true bugs, plant-lice, scale insects, mosquitoes etc.

 CHAPTER II.—REMEDIES.

NATURE OF ATTACK.

When insects are observed to be injuring a crop an examination should at once be made to discover the nature of the injury, so as to decide upon the proper remedy. It is plain that with Biting Insects, which bite off and swallow parts of the plant attacked, all that is necessary is to place upon the food plant some poisonous substance which will not injure the plant, but which being eaten by the insects attacking it, will kill them. With Sucking Insects, however, this treatment would be useless, for they would push their beaks through the poisonous covering on the outside of the food plant, and would with impunity suck up the sap upon which they live, from beneath the surface. For Sucking Insects, therefore, some substance must be used which will kill by mere contact with their bodies, or by suffocating them.

For nearly all the kinds of injurious insects which attack our staple crops, we have now good practical remedies; and all that is necessary for the farmer or gardener who sees that his crops are being injured by insects is to write at once to the Division of Entomology, at the Central Experimental Farm, Ottawa, stating plainly what the trouble is, and, whenever possible, sending specimens for examination. In most cases, useful advice can be sent back at

once, by which much loss will be prevented, because those insects which are most injurious to crops are naturally common species, and the life histories of nearly all of these have been worked out, and already practical remedies have been discovered.

There is at the present time in North America a large and earnest body of students working at problems connected with the discovery of new remedies or the improvement of old ones, by means of which insects which injure crops may be controlled. Something new is being learnt every day as to the means of either making or applying remedies, and day by day new facts are being learned concerning the life histories and habits of the insects which are the causes of loss. In the present bulletin an effort has been made to supply Canadian farmers with the best remedies and the latest developments in methods of applying them. So much is written nowadays in magazines, newspapers, etc., concerning insect injuries and the best ways of preventing them, that a great many experiments have been necessary to find out how reliable some of the proposed remedies were, and the present bulletin gives only the best results of such experiments as have been actually tried by officers of the Division of Entomology.

APPARATUS.

Nearly all insecticides may be used both as dry powders or in liquid. In the case of the useful arsenical poisons, it is necessary to mix them with some other substance as a diluent, on account of their caustic action upon tender vegetation, and also for convenience of distribution and to economise the material. For dry applications, suitable diluents will be found in flour, land-plaster, air-slaked lime, finely sifted ashes, or even road dust. The important point is that the powder shall be perfectly dry and in a very fine state of division, so as to mix thoroughly with the insecticide and thus insure even distribution. There are several implements for distributing dry insecticides such as bellows, insect guns, dusting boxes, etc., many of which will be found mentioned in the catalogues of our leading seedsmen. A convenient method for distributing dry poisons is to place the powder in a small bag of very fine muslin, then tie this to the end of a short stick so that it swings freely. If the bag is tapped lightly with another stick held in the other hand, the operator can walk erect and do much better work than by stooping along over his crop with an aching back. Dry mixtures should be applied in still weather and, if possible, when the plants are wet with dew. It is found by experience, however, that during the spring months when insecticides are most needed, there are often periods of several days when these conditions do not occur. It therefore becomes necessary to apply the poison in some other way, so that the material may be evenly distributed over the plant to be protected, and not blown away by the wind. For this purpose, mixing with water and then applying with a spraying pump is the most convenient plan.

I have no doubt that it will repay any one who has to apply insecticides, even in a small garden, to go to the expense of procuring a pair of proper bellows for dry mixtures, and a force pump with a spraying nozzle for liquid applications. Makeshift contrivances, such as watering cans, whisks, and even bunches of leaves, which are frequently used, actually cost far more in wasted

time and materials than would pay for the best special implements, in addition to which, when the work is done, it is neither satisfactory nor effective. There are a great many kinds of implements for distributing both dry and liquid insecticides, many of which are advertised in the agricultural and horticultural papers.

Pumps.—Before deciding on what kind to use, it is advisable for one who has not used these implements to consult his neighbours who have done so, then write for catalogues to the best known makers; and when buying make it a general principle always to procure the most suitable and the best of its kind. The difference in the initial cost between a poor, cheap implement and a thoroughly good one is small, compared with the subsequent loss and inconvenience from using a cheap pump or a poor nozzle. Spraying pumps are made in four sizes: (1) hand pumps, suitable for small gardens, which can be procured at prices ranging from \$2 to \$5; (2) larger pumps mounted on wheels or suitable for loading on a stone-boat, and consisting of an ordinary 40-gallon barrel, with a strong force pump to be worked by hand, which will cost about \$20, and will be all that is required in an orchard of from fifty to a hundred trees, or in a large garden; (3) knapsack sprayers, which are useful machines, consisting of a tank of about four gallons' capacity, to be carried on the back, and useful when treating outbreaks of cut-worms, turnip aphid, etc., in field practice; (4) power machines; these are of various kinds, and are for use in large plantations, or for spraying street trees where great power is required to elevate the spray. These are worked by steam, by being geared to the wheels of the vehicle on which the tank is drawn, or by the escape of carbolic acid gas. The cost of these will vary very much according to the make and size of the machines.

Spraying nozzles.—Of equal importance with a proper force pump in distributing liquid poisonous applications is a suitable nozzle, by means of which the liquid can be distributed evenly. The late Professor Riley, who did much in the development of spraying machines, said: "The desiderata in a spraying nozzle are: the ready regulation of the volume to be thrown, the greatest atomising power with the least tendency to clog, facility of cleansing or separation of its component parts, cheapness, simplicity and adjustability to any angle."

Almost every maker of spraying nozzles has some special make which he recommends; but many kinds now in the market have not the qualities necessary for spraying crops for injurious insects in the best way. All that can be said here is that some of these nozzles are far better than others, and that great care is necessary in choosing one which will come up to Dr. Riley's requirements, as mentioned above. The experience of others is a valuable guide in this work; and, both at the Dominion Experimental Farms and at the similar Provincial institutions, spraying work is carried on every year, which can be witnessed by all who wish to do so, and advice will be freely given by the officers in charge.

The operation of "spraying" consists of applying liquids by means of a force pump and spraying nozzle with such force as to break up the liquid so thoroughly that it falls upon the plants treated as an actual mist or spray. Such terms as *sprinkling* or *showering* are inaccurate for the operation here

intended. Unfortunately, much of the so-called spraying, as usually carried out, could more accurately be designated by these terms, which describe a much less careful and less even distribution of liquids.

REMEDIES.

Remedies are either Preventive or Active and must be applied in accordance with the circumstances of the case and the habits of the attacking insects. *Preventive remedies* are either agricultural or deterrent. The former of these consist chiefly of such methods as special rotation of crops, high culture, so as to stimulate a healthy growth of the crop and keep the land free of weeds and rubbish; early and late seeding, so as to present a crop to its insect enemies when they appear, in such condition that they cannot injure it, and rotation of crops, by which insects attracted to a locality by a crop will not have in that place the same crop to feed upon the following year. Deterrent preventive remedies consist of the application of mechanical contrivances, such as bands of paper or tin placed round plants to prevent cutworms getting at them, or the destroying or masking of the natural odours of some plants by scattering amongst them substances possessed of a stronger or a disagreeable odour, like gas lime, carbolic acid, etc. *Active remedies* include such methods as hand-picking and the application of various poisonous substances to the plants to be protected.

Arsenites.—The best known of these are Paris green, Arsenate of lead, the Arsenate of lime with soda, which has lately come into very much more general use, and Green Arsenoid.

In all of these poisons, arsenic is the essential ingredient, and other chemicals are mixed with the arsenic for the purpose of preventing it from injuring vegetation. There are many spraying compounds which contain arsenic, some of which are sold ready-made, and many others are made at home by combining the necessary ingredients.

Paris Green.—Undoubtedly the best known, and in many respects the safest, poison to use, is Paris green. It has passed through many years of trial, is well known, has a distinctive colour, and is a definite chemical compound containing 58.65 per cent. of arsenious oxide, 31.29 per cent. of copper oxide, and 10.06 per cent. of acetic acid. It is, therefore, an aceto-arsenite of copper. It is soluble in ammonia. Paris green, if demanded, is now obtained pure in all parts of Canada; but, as there is sometimes an adulterated article found in the market, it is wisest always to add an equal amount, with the Paris green, of freshly slaked lime, when the free arsenic will combine with the lime, and it can then be used safely at the rate of one pound of Paris green in 160 gallons of water on all vegetation, and, for a dry application, one pound Paris green in 50 pounds flour, land-plaster, slaked lime, or some other perfectly dry powder.

As a general principle, lime should always be used with Paris green whenever it is applied in a liquid insecticide. Paris green is very heavy, and the particles quickly sink to the bottom of any liquid with which it is mixed.

This makes constant stirring necessary. Paris green does not dissolve in water, and is merely mixed with water to facilitate its even distribution on vegetation in the very small quantities that are necessary to destroy insects. The finer the poison is ground, the quicker its effect on the insects which eat it, because the minute crystals are more rapidly dissolved by the digestive juices in the stomachs of the insects. The finer it is ground, the better also it will remain suspended in a liquid application. For most insects, one ounce of Paris green in 10 gallons of water is the standard strength; but some plants with coarse foliage, such as the potato, will stand double that strength.

Adulteration of Paris Green.—The unsatisfactory results so frequently reported from the use of Paris green against cutworms and other pests is largely due to the frequent adulteration of this article. The following are some of the methods by which pure Paris green may be known:

It dissolves wholly and freely in ammonia, forming a beautiful blue liquid. All of the material which fails to dissolve represents so much crude matter which has been added as an adulterant. While this affords valid grounds for rejection of the article, it must be borne in mind that white arsenic and a number of other substances used in the adulteration of Paris green are also soluble in ammonia, hence the test is but a partial one.

Another test of purity is to take a small quantity of the green upon a slip of glass, holding it at such an angle as will cause it to slide. If it is pure it will leave a bright green streak on the glass; if adulterated, this streak would be pale in colour with light and darker shadings, due to the presence of such articles as arsenic, gypsum, flour and other foreign substances which the intense green hides from view, unless critical examination is made with a compound microscope, which will show the Paris green to consist entirely of green spheres. In case of adulteration, the green spheres are mixed with matter more or less white, of crystalline irregular shape, entirely foreign to the pure article and should be rejected, as likewise should all samples showing any tendency to dampness or caking.

Arsenate of Lead.—A poison which has come into much notice since the work of the Massachusetts Gypsy Moth Commission is Arsenate of Lead, which has been placed on the market in a very convenient form under the name of Bowker's Disparene and Swift's Arsenate of Lead. The chief advantages of Arsenate of Lead are that it can be applied to all kinds of foliage with less danger of injury than is the case with Paris green; and, on account of its fine state of division, it lasts longer on the foliage, because it does not wash off so easily. The cost of using it is about the same as that of Paris green, because, although cheaper, pound for pound, it is necessary to use three times the amount of it to get the same results. Arsenate of Lead may be made at home. Formule for its preparation vary slightly; but in the United States Division of Entomology, Bulletin No. 41, the following instructions are given for making the Arsenate of Lead wash ready for use:—

Arsenate of soda	10 ounces.
Acetate of lead.....	24 ..
Water	150 to 200 gallons.

The arsenate of soda and acetate of lead should be dissolved separately and then poured into a tank containing the required amount of water. These chemicals unite readily, forming a white flocculent precipitate of lead arsenate, which is easily kept in suspension and can be used in excessive strengths on delicate plants without the addition of lime. When sprayed upon the foliage, it forms a filmy adhering coat, which is but little affected by ordinary rains.

Another formula for making Arsenate of Lead is that recommended by Prof. H. T. Fernald, and is:—

Arsenate of soda, 50 per cent. strength	4 ounces.
Acetate of lead	11 ..
Water	150 gallons.

Put the arsenate of soda in two quarts of water in a wooden pail, and the acetate of lead in four quarts of water in another wooden pail. When both are dissolved, mix with the rest of the water. Warm water in the pails will hasten the process. Prof. Fernald recommends that in mixing this with Bordeaux mixture one gallon of the above should be mixed with fifty gallons of the mixture.

Soap Washes.—The most effective soap wash is made with whale-oil soap, one pound to from four to six gallons of water. The term whale-oil soap is merely a trade name for a fish-oil soap, made with either potash or soda. The potash soaps, which are the best, because even strong solutions remain liquid when they cool, are soft soaps. The soda soaps are hard. Of the two, the potash soaps are considered the best to use on vegetation, as well as being more convenient. Both kinds should always be dissolved in hot water.

When bought at retail prices, these soaps cost from 15 to 20 cents per pound, according to the locality, but if obtained in large quantities, can be got at from 3 to 5 cents per pound. Fifty-pound kegs are supplied at 5 cents per pound. Two well-known brands of potash soft soaps which have been much used in Canada, and have given good satisfaction, are those made by W. H. Owen, of Port Clinton, Ohio, and by Good & Co., of Philadelphia, Pa. If thought desirable, these soaps can be made at home; but it is very unpleasant and dirty work, and it is besides doubtful whether such good or cheap results can be secured as by buying from firms which make a special business of manufacturing soaps with only the required amount of moisture and the proper grade and amount of potash. It has been found in experiments carried on at Washington that what is required for spraying purposes is a caustic potash and fish-oil soap, made with a fairly good quality of fish-oil, and from which water has been eliminated by boiling, so that it does not exceed 25 or 30 per cent. of the weight of the soap. Soaps made with caustic soda instead of caustic potash are unsuitable for spraying purposes. Dr. J. B. Smith, in his circular No. 5, "Whale-oil Soap and Its Uses," says: "Whale-oil, or fish-oil, soap is one of the most reliable materials for use against plant-lice, and generally against sucking insects which can be killed by contact insecticides. It kills by clogging the spiracles, or breathing pores, of the insects and also to some extent by its corrosive action. The advantages of fish-oil over ordinary laundry soap lie in the greater penetrating power, in the fact

that it remains liquid when cold, at much greater strengths, and that fish-oil itself seems to be more fatal to insect life than other animal fats. A good soap can be made as follows:—

Concentrated potash lye	3½ lbs.
Water	7½ gallons.
Fish-oil	1 gallon.

Dissolve the lye in boiling water, and to the boiling solution add the fish-oil; continue to boil for two hours, and then allow to cool. Any grade of fish-oil will answer."

Whale-oil soap may be applied in the strength of one pound in four gallons of water for brown or black plant-lice, and one pound in six gallons for green plant-lice; warm water should always be used when dissolving it.

Soaps of all kinds are very useful in adding adhesiveness to liquid mixtures when it is necessary to apply these to such vegetation as cabbages, turnips, peas, etc., which have their leaves covered with a waxy secretion which prevents water from lying upon them. Any kind of soap will answer for this purpose, and it may be remembered that one quart of soft soap is about equal to one pound of hard soap.

Carbolic Acid.—This fluid is very valuable as a preventative remedy, owing to its permanent and characteristic odour, which is found to be distasteful to many insects. A convenient form of using it is the Cook wash, which is so effective against root maggots. This consists of boiling up one quart of soft soap, or one pound of hard soap, in a gallon of water. When boiling, add half a pint of crude carbolic acid. Boil for a few minutes and stir thoroughly. The mixture is then ready to be stored away for future use. When required, take one part of this mixture by measure to fifty of water, and sprinkle or spray directly upon the growing plants once a week from the time they appear above ground.

Carbolised Plaster, Sand, Ashes or Sawdust.—This is simply one pint of crude carbolic acid, well mixed with fifty pounds of land plaster or some other diluent. It is used dry by sprinkling it among plants to be protected, and is said to be very efficient against flea-beetles, striped cucumber beetle, etc.

Poisoned Bordeaux Mixture.—The discovery of the great value of Bordeaux mixture as a destroyer of fungous diseases was soon followed by the equally important one that various poisons could be mixed with it and form a joint mixture destructive at the same time of fungous diseases and insect pests. All of the arsenical poisons can be mixed with the lime Bordeaux mixture, and this practice is now a general one, when it is necessary to protect crops against fungous diseases, and at the same time to destroy insect enemies. A useful formula for making the Poisoned Bordeaux Mixture for fungi and leaf-eating insects is given farther on.

INSECTICIDES.

No. 1.—*Lime and Sulphur Wash.*—For winter use.

This spray is now so universally recommended, and is so effectual, not only as an insecticide, but to a large extent as a fungicide, that it is deemed expedient to give a full resume of its uses and the formulæ for its manufacture in the various States and in Canada. From the U. S. Year Book, 1906, I take the following:—

"The lime-sulphur-salt, or so-called California wash, has been for many years the principal treatment for the San Jose scale (*Aspidiotus perniciosus*—Comst.) in orchards in California and elsewhere on the Pacific slope, and within the last five or six years it has become practically the standard treatment for this insect in the East. Originally developed as a dip for the control of scab on sheep, it was first used as an insecticide on fruit trees, according to Quayle, in 1886, by a Mr. F. Dusey, of Fresno, Cal., who experimented with a sheep dip prepared by Mr. A. T. Covell. The wash proved very efficient, and with modifications came quickly into favour. Lime-sulphur preparations, either dry or in the form of washes, have long been more or less used by orchardists in the control of insects and fungi, but these preparations are not comparable to the boiled lime-sulphur-salt wash, and practically the usefulness of the latter as a scalecide was an independent discovery. Since first used on fruit trees, the wash has been variously modified in formula, and it has been shown to have a considerable range of usefulness, both as an insecticide and as a fungicide.

"For small orchards, of 50 acres or less, it may not be considered advisable by owners to erect a steam-cooking plant, but the writer believes it would be economy to do so where orchards of 25 acres or more are to be treated, especially if the trees are large ones. If but small quantities of wash are needed, as for the treatment of a small home orchard, an ordinary kettle or hog-scalder will be satisfactory. It may be placed on bricks on the ground and the fire built beneath, as in the ordinary heating of water. The kettle should hold 35 to 40 gallons, and preferably more if a barrel spray pump is to be kept supplied; and it will be necessary to make final dilution of the wash in the spray-pump barrel. With some such facilities for cooking, one barrel sprayer can be kept busy most of the time.

"For larger orchards, if a steam outfit is not considered advisable, large iron kettles holding from 60 to 80 gallons should be placed in a brick furnace, one or more kettles being used, according to size of orchard and the number of spray gangs which it is proposed to run. With a battery of three or four large kettles and with proper water facilities, from 150 to 200 gallons of wash may be prepared every hour. An important objection to this method of cooking is that the wash, when prepared, must be dipped from the kettles and poured into the spray barrel or tank, entailing an important loss of time; and to prevent burning, while cooking, the wash must be constantly stirred. Time and labour-saving conveniences, however, may often be provided which will considerably lessen these difficulties."

The self-cooking method is not considered satisfactory, according to the U. S. Report quoted above, in which the following remark occurs:—"In the experiments of the Bureau of Entomology this wash has not been satisfactory. Sufficient heat is not generated during the slaking of the lime to bring into solution a sufficient quantity of sulphur." Nevertheless, Mr. W. E. Scott, whose formula here follows, has had the greatest satisfaction from the self-boiled spray.

FORMULA FOR SELF-BOILING LIME, SALT AND SULPHUR.

No. 1 Spray.—For winter use, while the trees are dormant:—

By W. E. Scott, Ganges Harbour, member of the Board of Horticulture.

1. Take 20 lbs. flowers of sulphur and stir into a paste with a little hot water in a coal-oil can. (Refined sulphur should only be used.)

2. Take 40 lbs. fresh lime—slaked lime is useless. (The better the lime the better the spray.)

3. *Pour into a 50-gallon barrel, from 12 to 15 gallons boiling water and immediately add the lime and sulphur. Cover the mouth of barrel with thick sacks to retain the heat and stir occasionally, whilst dissolving, with a wooden paddle.

In half an hour the sulphur will be well dissolved, and the mixture is ready for use after adding 15 lbs. salt and filling the barrel full up with hot water.

Strain into the spray barrel through a fine brass-wire sieve to prevent the nozzle clogging.

GENERAL REMARKS.

1. Apply this spray as hot as possible, the hotter the better.

2. A great many authorities omit the salt. The writer favours the use of it on account of it making the solution adhere better to the trees.

3. A nozzle which will throw a fine mist-like spray should be used, such as the 2 or 3 cluster spramotor nozzle.

4. Use a good spray pump and apply the mixture with as much force as possible.

5. *Spraying to be effective must be thorough, so as to cover every part of the tree with the mixture. To spray a tree, say 10 to 15 years old, it is necessary to spray from at least two sides, and preferably from three.*

6. A bamboo extension rod, long enough to reach the tops of the trees, should always be used.

7. To keep the spray pump in good working order, run through about five gallons of clean water every day when you have finished spraying. This is *very important*.

8. Anyone who has the means of generating steam on the place can improve this mixture by turning steam into the barrel, after it has been self-boiled, for about a quarter of an hour longer.

*Mr. Scott alludes to American gallons in his formulæ, equal to about 42 imperial gallons.

This mixture, thoroughly and conscientiously applied, will completely eradicate oyster scale, is a sure preventive against the borer, and will kill the eggs of the aphides and other insect pests, and from personal experience the writer is convinced that it is a *most valuable fungicide*.

WM. E. SCOTT,

Ganges Harbour, Salt Spring Island, B. C.

The following is the recommendation of the Provincial Inspector of Fruit Pests:—

Fresh unslaked lime	40 lbs.
Sublimed sulphur	20 "
Salt	15 "
Water	50 gals. (Imperial).

Place 10 lbs. of lime and 20 lbs. of sulphur in a boiler with 20 gallons of water, and boil over a brisk fire for two hours, until the sulphur is thoroughly dissolved. It will then be amber-coloured. Next place 30 lbs. of lime in a cask and pour water enough over it to thoroughly slake it. Add the salt. When dissolved, add the lime and sulphur and boil half an hour longer. Add enough water to make 50 gallons. Apply at a temperature of 130 degrees in the tank.

Spray when the trees are dormant, or as soon as the leaves fall, and again in the spring before the buds swell. A good force pump should be used, and care must be taken to thoroughly cover the infected trees from the ground to the tips of the shoots with the mixture, which should be constantly stirred when applying.

If you have facilities for cooking the number one solution (and you should have), I would certainly recommend you to use your own manufacture in preference to any brand that may be offered for sale. You are in a position to know that your own article is properly made. Be very sure that the lime which you use is perfectly fresh and very hot, also that you use only *sublimed* sulphur; use no other quality, no matter how cheap it may be. The sublimed article is well refined, and so finely ground that it quickly combines with the lime.

[Recent experiments have demonstrated that this wash is equally effective if the salt is eliminated. This spray is the standard insecticide for all scale insects, woolly aphid, etc., and is highly recommended for cleansing fruit trees, acting not only as an all-round insecticide, but to a great degree as a fungicide.

—J. R. A.]

Central Experimental Farm formula:—

Lime	12 lbs.
Sulphur, powdered	12 "
Water	40 gallons.

Ontario Department of Agriculture:—

Fresh lime	20 lbs.
Sulphur (flowers)	18 "
Water	40 gallons.

HANDLING THE SPRAY.

The pumps used with sulphur-lime wash must be washed out each night after using. Pumps with brass working parts will have a scaly crust formed over the brass after continued use. Brass nozzles are eaten out by several days' spraying, and a sufficient supply should be kept on hand to replace those worn out. Sulphur-lime will keep for several days. The horses as well as the men should be protected during the time of application. This is done by blankets and hoods of gunny-sacking or canvas. Sulphur-lime is caustic to the skin and may produce ulcers. It is a good plan to anoint the hands and face with vaseline before spraying.

No. 2.—*Quassia Chips and Whale-oil Soap*.—Summer spray for aphids:—

Quassia chips	8 lbs.
Whale-oil soap	7 ..
Water	100 gallons.

Boil the quassia chips in about 8 gallons of water for one hour. Dissolve the soap in hot water, strain and mix both solutions together, and dilute with sufficient water to make 100 gallons altogether. To be used with a spray pump with as much force as possible in applying. This mixture is the standard remedy for hop-aphids, and has given most satisfactory results against other forms of aphides, with no injury to the foliage of trees treated.

No. 5.—*Kerosene Emulsions*.—These are particularly valuable against insects as plant-lice, scale insects, and animal parasites. The best formula is:

Kerosene (coal oil)	2 gallons.
Rain water	1 ..
Soap	½ pound.

Boil the soap in the water till all is dissolved; then, while boiling hot, turn it into the kerosene, and churn the mixture constantly and forcibly with a syringe or force pump for five minutes, when it will be of a smooth, creamy nature. If the emulsion is perfect, it will adhere to the surface of glass without oiliness. As it cools, it thickens into a jelly-like mass. This gives the stock emulsion, which must be diluted with nine times its measure of warm water before using on vegetation. The above quantity of 3 gallons of emulsion will make 30 gallons of wash. Insects breathe through small openings along their sides. The effect of kerosene emulsion is to suffocate them, by stopping up these breathing pores.

Kerosene emulsions may also be made conveniently by using an equal amount of sour milk instead of soap and water in the above formula, and churning for the same time to get the stock emulsion. Recently another method has been suggested by Mr. F. T. Shutt and Mr. W. T. Macoun, of mixing kerosene first of all with flour and afterwards with water, by churning the two together. This convenient plan is a modification of a method proposed by Prof. Close, of the Delaware Experiment Station, in which it was shown that lime has the power of holding kerosene in suspension and forming an emulsion which does not separate for a long time. Lime is not conveniently obtainable in all parts of Canada, and Mr. Shutt made the valuable discovery that flour, which is to be had everywhere, may be used with equally good

results, if the emulsion is to be used at once. This gives us, then, by far the most convenient kerosene emulsion, when small quantities are required for immediate use.

The preparation is simple. The requisite amount of kerosene is placed in a dry vessel and flour added in the proportion of eight ounces to one quart of kerosene. It is then thoroughly stirred and 2 gallons of water are added for every quart of kerosene; the whole is then vigorously churned for from two to four minutes, and the emulsion is ready for use. When required for immediate use, two ounces of flour will emulsify one quart of kerosene; but, on standing a few hours, the kerosene will separate. However, it has been further found by Mr. Shutt that, by scalding the flour before adding the kerosene, an excellent emulsion which does not separate in the least after one week, can be prepared with two ounces of flour, by mixing the resulting paste with one quart of kerosene and emulsifying with two gallons of water.

Dr. Fletcher.

White Hellebore.—This is a vegetable poison, being the finely powdered roots of *Veratrum album*. It is useful for leaf-eating insects and root maggots. Although very poisonous to insects, owing to the poisonous principles being soluble, it can be safely used where the arsenites would be dangerous. It can be applied as a dry powder or as a liquid mixture, using one ounce to two gallons of warm water.

Insect Powder (Pyrethrum, Buchach).—This is another vegetable insecticide of special value, from the fact, although it is extremely active in its effects upon nearly all insects, it is practically harmless to human beings and the higher animals. It is the pulverised flowers of some plants belonging to the genus *Pyrethrum*. It is useful for many household pests, as flies, mosquitoes and wasps, all of which are quickly affected, either by having a small quantity thrown into the air of a room by means of an insect-gun or small bellows, or by a small quantity (a teaspoonful) being ignited and allowed to smoulder. It seems to have a marked effect upon the breathing organs of insects. Where practicable, a dry application gives the best results. If mixed with four times its weight of common flour, and then kept in a tightly closed vessel for twenty-four hours, the mixture will kill nearly all caterpillars it is applied to, and in this strength becomes the best remedy for the caterpillar of the Imported Cabbage Butterfly. It can also be used mixed with water, 1 oz. to 2 gallons of water.—*Dr. Fletcher.*

No. 6.—*Tobacco and Soap Wash*:—

Soak 4 lbs. waste tobacco in 9 gallons hot water for four or five hours (or in the same quantity of cold water for four or five days); dissolve 1 lb. whale-oil soap in 1 gallon hot water; strain the tobacco decoction into the dissolved soap and apply the mixture to affected trees with a spray pump, using a fine nozzle and all the force possible. Or the mixture may be applied directly to the insects with a swab or brush. A good summer wash for all forms of aphides.

No. 7.—*Resin Wash.*—For Aphid and Scale Insects:—

Resin	4 lbs.
Sal soda	3 ..

Place the resin and sal soda in a kettle with three pints of cold water (soft or rain water). Boil or simmer slowly until thoroughly dissolved, when it will look black. The sal soda will adhere to the sides of the kettle and must be scraped down. When sufficiently boiled, the resin being completely dissolved, add enough hot water to make 50 gallons. After adding the water it will become thick, but after boiling again it becomes thin. The above is ready for immediate use and should be used lukewarm. If desired for future use, make as directed above, but add only five gallons of water and boil until thick. When required for use, dilute with boiling water as follows and stir thoroughly, when applying:—

For hop-louse	1	gallon compound to 9	gallons water.
For woolly aphid.	1	..	7 ..
For scale insects.	1	..	6 ..
For green aphid.	1	..	9 ..

The spray is not injurious to the tree, for after three or four days' sunshine it dissolves or breaks away from the surface.

No. 8.—*Hellebore Spray*.—For Pear and Cherry Slugs, Gooseberry and Currant Worms:—

Hellebore	1 ounce.
Water	1 gallon.

Steep the hellebore for an hour in one pint boiling water, then add the balance of water cold. To be used with spray pump.

NOTE.—Hellebore may be applied as a powder, dusted on the trees or plants treated. A machine known as Leggett's Powder Gun is a very efficient means for its use on a large scale. In all cases, care should be taken to obtain good fresh hellebore, to ensure the results aimed at.

No. 9.—*Paris Green Spray*.—For Codling Moth, Caterpillars, and other leaf-eating insects:—

Paris green	4 ounces.
Fresh slaked lime	1 lb.
Water	50 gallons.

Make a paste of the Paris green with a little water. Make the lime into milk of lime of water, mix both these together, and add water to 50 gallons altogether. Paris green is a heavy powder, and will not remain long in suspension, hence it must be kept constantly stirred when using. Be sure that good fresh lime is used to prevent the burning of foliage. Apply with spray pump.

Paris green can generally be used to advantage with Bordeaux mixture, making a combined fungicide and insecticide, in the proportions given above, viz.: 4 ozs. Paris green to 50 gallons Bordeaux mixture. Apply with spray pump.

No. 15.—*Lye and Soap Wash*.—For winter use only:—

1 lb. concentrated lye.
1 lb. whale-oil soap.
5 gallons water.

Dissolve the lye and soap in the water heated.

This mixture may be applied with a swab or brush, or with the spray pump, if used warm. One thorough application in the fall, and another before growth commences in the spring, should be made when used against woolly aphides. This is also an excellent wash to remove moss and lichen from trees and bushes, and if used for this purpose alone, half the amount of soap is sufficient.

FUNGICIDES.

No. 4.—*Bordeaux Mixture*.—The formula recommended by the Board of Horticulture for summer use is as follows:—

Sulphate of copper (bluestone)	4 lbs.
Fresh unslaked lime	4 ..
Water (soft)	40 gallons.

Double strength for winter use:—

Sulphate of copper (bluestone)	8 to 10 lbs.
Fresh unslaked lime	8 lbs.
Water (soft)	40 gallons.

Bulletin 66 of the Washington Experiment Station recommends for apple tree anthracnose even of greater strength, viz.:—

Copper sulphate (bluestone)	12 lbs.
Quick-lime	8 ..
Water	50 gallons=40 Imp. gal.

The ordinary double strength mixture, viz., 8, 8, 40, is, however, sufficient for general purposes.

For poisoned Bordeaux mixture add 4 ozs. Paris green to the above. Make the Paris green into a paste by adding a little warm water and then pour into the barrel and stir thoroughly. The quantities are easily remembered, being all fours, viz.:—

Sulphate copper	4 lbs.
Lime	4 ..
Water	40 gallons.
Paris green	4 ounces.

The greatest care should be used in preparation of this mixture. If but a small quantity is to be used, prepare as follows:—Weigh out four pounds of fresh (never air-slaked) lime, add to it, gradually, warm water, a little at first, more as the slaking proceeds, being sure that at no time the lime lacks water enough, stirring all the while with a hoe. Continue adding water till a soft milk of lime is the result. Dissolve in a bucket or half barrel (never a metal vessel) four pounds of bluestone, using warm water to hasten solution. When this is completely dissolved, dilute both lime and bluestone with about 10 gallons of water. Strain the milk of lime into the spray tank through a rather close-meshed wire gauze, thus preventing any lumps, rocks, or fibers from going into the tank. Then, while one stirs the material in the tank with a hoe, another man gently adds the bluestone water, seeing that no lint or trash goes in by this means either. Then fill the tank

with water, stirring all the while, and the spray is ready to use. *Never* pour the undiluted bluestone water into the undiluted milk of lime, or a poor chemical union will result. Such a mixture has poor fungicidal value, settles rapidly and clogs the nozzles.

STOCK SOLUTIONS.

Where more than a barrel or two of Bordeaux is to be made, it saves time to make what are called stock solutions:—

Weigh out and put into a long, deep trough like a "feed trough" enough lime to make a definite number of barrels or tanks of spray. If the barrel holds 50 gallons, or the tank 100 or 150 gallons, use some multiple of four pounds of lime, say 40 pounds. Bring to milk of lime by adding just the number of gallons of water that you use pounds of lime, here 40 gallons. The lime slacks best if warm or hot water be used as a starter. Dissolve in a very large tub or wooden tank 40 pounds of bluestone in 20 or 40 gallons of water. Never use less water than 1 gallon to each 2 pounds of bluestone, or the material will recrystallise in the bottom and on the sides of the container.

Then all you have to do is to measure out 4 gallons of the milk of lime, 2 or 4 gallons of the bluestone water, dilute to about 15 gallons each and pour together into the barrel. If the spray-tank holds 2 or 3 barrels, you have to measure out two or three times as much and dilute two or three times as much as for the barrel.

TESTING SPRAY.

If the lime used is a fine lime, neither air-slaked, improperly burned, nor having much "rock" in it, 1 have found 4 pounds sufficient to each 4 pounds of bluestone. However, many stations now recommend using 6 pounds of lime to 4 pounds of bluestone, and this should certainly be done if the lime is not first-class. The best way to assure oneself that he has lime enough is to test the mixture. There are three ways of testing:—

1st. Dip a perfectly clean, bright blade of a pocket-knife into the Bordeaux and leave it in it for about one minute. If there is not lime enough, a thin, reddish stain of copper will be left upon the blade.

2nd. Fill a small bowl with the Bordeaux, and, holding it level with the eye, breathe gently upon and across the liquid. If it is properly made, and there is any excess of lime, the carbonic acid of the breath will cause a thin pellicle to form on top.

3rd. Dissolve in six ounces of water one ounce of ferro-cyanide of potassium. Pour some of the Bordeaux into a bowl and add a little of the solution to it, drop by drop. If a brownish discolouration takes place, you must add more lime to the stock solution and tank.

USES OF THIS SPRAY.

Apple Scab.—Use once before flowers open, best just as buds are bursting, and two or three times after fruit has set, according to the prevalence of rain and cloudy weather. In ordinarily pleasant seasons three sprayings are enough. When applying the last two sprayings the insecticide can be added to the spray, thus scab and insects being combated at the same time.

Powdery Mildew of Grape, Apple, Peach and Rose.—Apply first just as buds are bursting, and continue at intervals throughout the season. Each fruit-grower must demonstrate for himself just how many sprayings he needs, for this is governed largely by seasons, location and prevalence of diseases the previous year.

Peach-leaf Curl.—Apply just as buds are bursting, and two or three more times through the early season. Instead of Bordeaux, the lime-sulphur salt spray can be used for the first spraying with excellent effect.

Apple Canker or Anthracnose.—Professor Cordley, of the Oregon Station, says:—"Spray as soon as possible after crop is gathered, and repeat in two weeks." For all spraying, in the dormant season or fall, whether for this disease or others, best results are obtained by increasing the amounts of both bluestone and lime to six pounds.

Copper Sulphate Solution:—

Copper sulphate	2 or 3 lbs.
Water	50 gallons.

This spray is much endorsed by experiment stations both Eastern and Western, to take the place of Bordeaux during the dormant season. Though of equal efficiency with Bordeaux, and more easily made and applied, it is of so corrosive a nature when coming in contact with any iron or steel parts as to make its use very disagreeable. Iron nuts about the waggon or pump become in a few days so soldered to the bolts as to make it next to impossible to loosen them. Metal parts of the harness, and even tools employed, are soon rendered unsightly or even spoiled. Copper sulphate solution renders its best service in the treatment of grain, though formalin is largely displacing it.

No. 10.—Ammoniacal Copper Carbonate:—

Copper carbonate	5 ounces.
Ammonia (ammonia water of commerce)	3 or 4 pints.
Water	50 gallons.

Dissolve the copper carbonate in the ammonia and dilute with water to 50 gallons. The concentrated solution should be poured into the water. Keep the ammonia in glass or stone jar tightly corked.

Home Manufacture of Copper Carbonate.—As the precipitated form of carbonate of copper is not always obtainable, the following directions are given for its preparation:—

In a vessel capable of holding two or three gallons, dissolve $1\frac{1}{2}$ lbs. of copper sulphate in 4 pints hot water. In another vessel dissolve $1\frac{3}{4}$ lbs. sal soda (washing soda) in 4 pints hot water. When both are dissolved, pour the second solution into the first and stir briskly. When effervescence ceases, fill the vessel with water and stir thoroughly. Allow this to stand 5 or 6 hours, when a precipitate or sediment will have settled at the bottom. Now pour off the clear liquid without disturbing this sediment, fill up the vessel again with water and stir as before, then allow this to stand until the sediment has again settled, and then pour off the clear liquid carefully as before; the residue or sediment is carbonate of copper, and from the quantities given there should be formed 12 ounces weight. Instead of drying this (which is a slow process),

add to it 4 quarts strong ammonia, stirring well, and then add water to bring the whole quantity up to 6 quarts. This may be kept in an ordinary stone jar, but should be closely corked.

Each quart will contain two ounces carbonate of copper, which when added to 20 gallons water will furnish a solution ready for spraying, of the same strength and character as that obtained by the use of the dried carbonate of copper.

Caution.—Most of the copper compounds corrode tin and iron. Consequently, in preparing them for use, earthen, wooden or brass vessels should be employed; and in applying them, the parts of pump which come in contact with the liquid should be made of brass.

Though this is, in many respects, as good a spray as Bordeaux, it is more costly, and the ingredients less commonly attainable. It used to be recommended for the final spraying of almost all fruits, since it leaves no stain as does the Bordeaux; but since all of our first-class apples out west are now wiped before being packed, its usefulness has decreased. For grapes, or any other fruits attacked by fungi, and which cannot easily be wiped or cleaned in any way, this is superior to Bordeaux as a final spray. This is peculiarly the case with powdery mildew.

Formalin.

This is a 40 per cent, solution of formaldehyde gas in water, though, owing to the escape of the gas and to adulteration, the commercial article hardly ever contains 40 per cent. I have never yet happened to find any of so poor quality, however, as not to do the work expected of it. Such complaints are by no means infrequent, but I judge from my own success in the use of formalin that the cause of failure is to be laid more often to the door of the one using it. He either uses it too weak, or allows his grain or potatoes to become reinfested by the disease through careless sacking or handling after treatment. The grain or potatoes should be treated in the sacks in which they are to be left, or in the case of grain, where sprinkling is adopted, the sacks should be soaked before the treated grain is put back into them.

Formalin for Potato Scab:—

Formalin	½ pint.
Water	15 gallons.

Formalin for Smut of Grain:—

Formalin	1 pint.
Water	50 gallons.

Corrosive Sublimate:—

Corrosive sublimate	3 ounces.
Water	15 gallons.

Or,

Corrosive sublimate	10 ounces.
Water	60 gallons.

Dissolve the sublimate in warm water, and when dissolved pour into a vessel containing water and stir vigorously with a lath.

Treat the potatoes as with the formalin. As no better results were obtained by me with the corrosive sublimate than with formalin, and as the first is an intense and lasting poison whilst the latter is not, I advise the use of formalin.

No. 16.—*Potassium Sulphide*:—

This is a hard substance of a brown colour when fresh, though turning on the outside yellow on exposure to air or sunlight. It is, from its colour, often called "Liver of Sulphur." It should be kept in a closed vessel not exposed to sunlight.

Potassium sulphide	1½ oz. to 1 oz.
Water	1 gallon.

This spray is used for most of the powdery mildews, but I have had best results with it in combatting mildew on the gooseberry. Four or five sprayings will do away with mildew, when on previous years it has been so bad as entirely to spoil the crop. It dissolves readily in water slightly warmed, while it never clogs the nozzle, so perfect is its solubility. I found three sprayings would completely save the crop, but that one or two more were needed to do away with the disease completely. The first spraying should be applied just as the young leaves are putting forth, and the subsequent applications two or three weeks apart through the growing season.

Arsenite of Lime with Soda:—

White arsenic	1 lb.
Sal soda (crystal)	4 lbs.
Water	1 gal.

The ingredients are boiled in the required amount of water until dissolved, which will take place in a comparatively few minutes, after which the water lost by evaporation is replaced. To every 40 or 50 gallons of water a pint of this stock solution and from 2 to 4 pounds of fresh slaked lime are added. The chemical compound derived from the combination of the sal soda and the white arsenic is arsenite of soda. In the presence of lime this breaks down and arsenite of lime is formed. It requires 4.4 lbs. of crystal sal soda, or 1.6 lbs. of dry sal soda to combine with 1 lb. of arsenic and 2 lbs. of freshly slaked lime to combine with 1 lb. of arsenic to form arsenite of lime. It is always desirable to have an excess of lime present, in order to prevent all danger of burning; furthermore, this excess is a convenience to fruit growers, because they can see by the distribution and amount of lime in the foliage how well the spraying has been done. The formula, which is the Kedzie formula, with a few minor changes, has been used in many different sections of the country with unvarying success. In all of the practical tests under the advice of the writer, this solution is used and is found to be not only as efficient as other solutions, but far cheaper.

When it is desired to use Bordeaux mixture with this solution, it is added to the Bordeaux mixture in the same proportion as to a similar quantity of water.—*C. B. Simpson, Bull. 41, U. S. Div. Ent.*

The above combination of arsenite of lime with soda is preferable to arsenite of lime on account of the difficulty in making this latter combination perfectly, and, when this is not the case, the free arsenic is very destructive to foliage.

London Purple, which is an impure arsenite of lime, is now very seldom used, for the same reason. As it is a waste product in the manufacture of aniline dyes, it is very variable in composition, and therefore unsafe to use.

Green Arsenoid.—This is a convenient poison to use, being practically Paris green not crystallised, and is, in some ways, better. Being a very fine powder, it remains in suspension longer and adheres better to foliage. Its chief disadvantage is, it has a rather larger percentage of soluble arsenic, and, unless mixed with fresh lime, as suggested for Paris green, there is danger of it injuring foliage. It may be used in the same proportion as Paris green, viz., one ounce to 10 gallons of water.—*Fletcher.*

FUMIGATION WITH HYDROCYANIC ACID GAS.

During the past few years the method of destroying various insect pests by means of fumigation with hydrocyanic acid gas has been much advocated, and the recommendation has been made in certain of the Board's leaflets. For the destruction of mussel scale, woolly aphis, mealy bug, thrips, weevils and red spider in greenhouses, etc., the method is very valuable, while it may also be employed for the fumigation of poultry-houses in case of infestation by lice and mites.

Nursery stock fumigated with hydrocyanic acid gas before planting will be freed from insect enemies in all stages save that of the egg.

MATERIALS TO BE USED.

The materials necessary for purposes of fumigation are:—(1) potassium cyanide of 98 per cent. purity; (2) sulphuric acid of a specific gravity of not less than 1.83; (3) water; (4) jars and a glass measure.

The following quantities may be taken as a standard for use:—Potassium cyanide, 1 part; sulphuric acid, $1\frac{1}{2}$ parts; and water, $3\frac{3}{4}$ parts.

The proportions of cyanide, sulphuric acid and water to be used, and the amount of space per unit of cyanide, vary slightly as recommended by different authorities, three different workers recommending 1 oz. of cyanide of 98 per cent. purity to every 200, or 300, or 500 cubic feet of space respectively.

The variation in the amount of cyanide depends to some extent on the character of the plants that are being treated, on their strength, whether they are dormant or active, evergreen or deciduous, and also on the season. In the case of tender plants, 1 oz. of cyanide may serve for 500 cubic feet of space, while hardy plants may be treated with 1 oz. of cyanide to 200 cubic feet of space.

TREATMENT OF GREENHOUSES, CONSERVATORIES, NURSERY STOCK, ETC.

Method of Application.—The glass-house, or other place, which is to be treated, must be received as air-tight as possible.

The sulphuric acid should be poured very carefully and slowly into the water, which may be put in an earthenware vessel, *e.g.*, a large jam-jar. The cyanide of potassium, wrapped in thin blotting paper, should then be dropped into the now diluted sulphuric acid. The vessel into which the cyanide is dropped must be so near the door that it can be reached by the outstretched arm of the operator, who should *immediately* shut the door and close up its chinks by paper previously prepared. Another, and better, method is for the

operator to introduce the cyanide to the diluted sulphuric acid through a window, the cyanide being placed at the end of a long stick or rod, or being lowered into the acid by a string and pulley. The window must be closed immediately after the addition of the cyanide, so that the operator may escape the fumes. Strawson recommends the pouring of the diluted acid from a bottle fitted with a cork in which two slits are cut, one to let in air and the other to allow a small and even stream to flow upon the cyanide, the object being to provide a slow and even disengagement of gas. The bottle should be arranged so that it can be tilted up when all is ready.

It is of importance also that the hydrocyanic acid gas fumes be distributed over the house, and this may be done by an arrangement of fans which can be worked from the outside.

Fumigation should take place in the evening, or after nightfall, and not in strong sunlight. The temperature of the house should be from 50° to 60° F. The plants to be treated should be dry. The surface of the soil of the house should also be as dry as practicable. Experiment has shown that the eggs of the woolly aphid may remain unaffected, and therefore fumigation should be repeated in ten days. Eggs of the apple mussel scale are also unaffected by gas of the strength mentioned.

Points to be Carefully Noted.—The work should be done by a careful and skilled operator, for the cyanide and its fumes are very poisonous and dangerous to human and animal life.

The treated room or conservatory must be kept closed during fumigation from three-quarters of an hour to an hour, after which the room should be ventilated, the windows, etc., being opened from the *outside*, and no one should enter until an hour has elapsed. While opening the windows, etc., the operator should be careful not to inhale the escaping fumes.

It is safer not to fumigate when the plants are in bloom.

Nursery Stock.—In the treatment of nursery stock the bushes or young trees should be placed in an air-tight box or canvas tent of known capacity, and subjected to the fumes of hydrocyanide gas for one hour. Large numbers can be treated at once at little expense.

When the time has expired the tent or box should be opened in such a way that the wind blows the fumes away from the operator, and should be left to ventilate for half an hour before the stock is removed.

Trees in the orchard may also be treated by the use of a canvas tent or cover.

CANVAS COVERS FOR FUMIGATING.

The practice of using canvas covers for fumigating is not so common in Great Britain as in some other countries and the method followed in the Colonies may here be given for the guidance of those who wish to undertake orchard fumigation with hydrocyanide acid gas. According to Claude Fuller, the Natal Government Entomologist, the covers should be of a light, durable material, and comparatively gas-tight, the most suitable, probably, being canvas. Eight-ounce American duck canvas is recommended.

There are three types of covers—sheets, tents, and box covers. The *sheets* are octagonal in form, and can be further enlarged by sewing on a "skirt" round the edge. These can be easily lifted over small trees up to six or seven

feet in height, above which a hoisting apparatus must be used. *Tent covers* may be used for trees up to 13 feet in height. They take the form of dome-shaped tents, the mouth of which is kept open by a ring of gas-piping passed through canvas loops, and they can be quickly lifted over and removed from 8 to 13-foot trees by a couple of men, where the hoisting of a sheet would take three or four. *Box covers* are made to any convenient size by covering a wooden framework with canvas or calico; the latter material should be painted or oiled to make it sufficiently gas-tight. They are especially adapted for small trees and bushes.

NOTE.—As both the potassium cyanide and the hydrocyanide acid gas are deadly poisons, the former should be kept in a tightly-stoppered bottle and labelled *Poison*, whilst the gas as generated must on no account be breathed. Fumigation should not be carried out in a high wind, nor when the trees are wet, but otherwise it may be done at any season of the year.—*Board of Agriculture and Fisheries, 4 Whitehall Place, London S. W., January, 1908.*

CHAPTER III.—BENEFICIAL INSECTS.

The subject of parasitism among insects is not only a very interesting one, but it is one which, affecting as it does, either directly or indirectly, nearly every species of plant or animal on the face of the globe, has an economic bearing that, in all of its ramifications, is important even beyond our comprehension. If we look out upon the heavens on a bright summer night, we observe myriads of worlds each of which is rushing with resistless force and almost lightning rapidity along its course through trackless space, yet never colliding or jostling one another. We can only in a vague manner, at best, comprehend the magnitude of this mechanism, or realise the power which holds each planet in its proper place, and prevents it from rushing to its own destruction or that of its neighbour.

In our own natural world, assuming that species are living representatives of what we witness in the heavens, then one of the greatest, if not indeed the most powerful, force which holds each species in its proper sphere, is that influence which we call parasitism, and but for this influence, puny humanity would scarce be able to live out a miserable existence. As it is, the value of insect friends in combating insect, and I might also add plant, foes, is but little understood, and, in fact, very few of those receiving a direct benefit even know of the existence of their benefactors.

There are, of course, many destructive insects which are exceedingly abundant every season, but they are such as have been imported and their parasites left behind, or they are such of our native species as a change of environment, brought about by our progress and improvement, has, apparently, enabled to reproduce much more rapidly, and hence they have become too

strong to be controlled by those parasites which, doubtless, formerly held them within bounds; but even among these, were the partial checks removed, we should very soon feel their loss, and, perhaps, better appreciate their value.

The term parasite, as used in this country, is of a somewhat general meaning. Thus, the louse is a true parasite because it lives and has its home upon the body of its host, and while extracting its nourishment therefrom does not necessarily destroy life. The bee moth, *Galleria cecreana*, Fab., although it may cause the death of an entire colony of bees, is not a parasite at all, but simply a mess-mate. It does not devour the bees, but simply robs them of their store of food.

Our beneficial insects are of neither one of these two classes, because they not only feed upon the body of their host, but cause its death thereby; for this reason, that class of insects, which in this paper are termed parasites, are, by most foreign naturalists, designated as cannibals, which is really the more proper term. All beneficial insects are not necessarily cannibals, however, the scavenger beetles being a notable exception, while on the other hand, the cannibals are not all of them beneficial, as some of them destroy those which are directly engaged in preying upon the injurious species.

Of the beneficial cannibals we have two classes. First, such as deposit their eggs in or upon the body of their victim, the young hatching therefrom, feeding upon the living tissue. Second, such as catch and devour their prey, or extract the juices from it, rejecting the more solid portions of the body. The first of these classes is composed almost entirely of insects belonging to either one or the other of the two orders, *Hymenoptera*, the most numerous, and having four transparent wings, and *Diptera*, or flies, which have but two wings. The second class is made up of a vast multitude of insects, belonging to all orders. Some of these are cannibals in the larval or worm stage only, others during all of their stages of development.

The parasitic *Hymenoptera*, which so largely compose the first class, nearly all belong to one or the other of the three families, *Ichneumonidae*, *Ichneumonida*, egg parasites, *Proctotrupida* and the *Chalcidida*. The first are described as being readily recognised by the usually long and slender body, the long, exerted ovipositor, which is often very long and protected by a sheath formed by four stylets, of the same length as the true ovipositor. *Thalessa lunator*, so called on account of the crescent-like spots across the body, is a good illustration of one portion of this family. With the aid of her long ovipositor, the female is able to probe the burrows of wood-boring larvæ and deposit her eggs in their bodies. *Pimpla pedalis*, Cress., and *P. conquisitor*, Say., are both parasitic on the tent caterpillar, while *P. annulipes*, Br., commonly called the ring-legged pimpla, is parasitic on the larvæ of the codlin moth. Two other allied species, *Bracon charus*, Riley, and *Labena grillator*, Say., destroy the flat-headed apple tree borer. Another, a Braconid, *Microdus carinoides*, Cress., attacks the apple-bud worm, *Eccopsis mulana*, Fld. Two other species, *Sigalphus curculionis*, Fitch, and *Thersilochus conotracheli*, Riley, attack the larvæ of the plum curculio. The former during one season, in the vicinity of St. Louis, Missouri, was found by Dr. Riley to have destroyed three-fourths of the early developed larvæ of this pest. The long-tailed

ophion, *Ophion macrurum*, Linn. and the cecropia criptus, *Cryptus extrematis*, Cress., are parasitic upon the American silk worm, *Platysamia cecropia*, Linn. The large green worm infesting the vines of potatoes and tomatoes is often observed nearly covered with white egg-like cocoons, about the size of grains of rice. The worm is the larvæ of the five-spotted sphinx, *Sphinx cclus*, Haw., and the cocoons are those of another hymenopterous parasite, *Apanteles congregatus*, Say. The occurrence of these on the worm is brought about in this way: The adult parasite deposits her eggs in the body of the worm, just under the skin. As soon as the eggs hatch, the small, white, footless grubs which develop from them begin at once to feed upon the fatty parts of the worm, and continue to do so until full growth, when they eat their way out through the skin and spin their cocoons, within which they pass the pupal stage, and from which they emerge as adults. These parasites do not, however, always attach their cocoons to the body of the host, and those of this and other species may frequently be observed in clusters on twigs, grass or weeds, some of them being white, like those just mentioned, others yellowish, and still others are brown; but they all belong to some of the many species of these useful insects, and should never be wantonly destroyed. These parasites are frequently themselves attacked by a second, and we have even reared a third species.

Although very diminutive in size, among the entire family of Braconidæ, there are none more useful than those which attack plant lice or "green fly." The female parasite deposits a single egg in the body of the plant louse, often while the latter is quite young. On the hatching of this egg, the young larva at once commences to feed upon the body of its host, internally, while the plant louse increases in size, gradually assuming an unnaturally large and swollen appearance, and eventually changing to a brown colour. Within the body, however, the parasite has been developing, and when it has transformed to the adult it eats a round hole in the now dry skin of the long since dead host and makes its escape. These large, round, brown plant lice are often observed on the leaves of corn and cabbage or other vegetables, as well as on the leaves of trees, and illustrate to what extent these useful little insects are engaged in destroying the most insidious pest of the horticulturist and also of the farmer. *Aphidius avenaphis*, Fitch, destroys myriads of the grain aphid, and besides this species we have reared eight others from the same insect host. We have found in all twenty-one species of insects destroying this grain aphid during the last few years.

Syrphus flies are, as a rule, very gaily coloured, and may not unfrequently be mistaken by the unentomological for bees. Their maggots are particularly fond of plant lice, *Aphides*, and there are very few species of these prolific little pests which do not suffer severely from the attacks of these maggots. The eggs are deposited among the swarms of plant lice, and the young maggots, as soon as they hatch, begin to feed upon them. As the latter grow in age and dimensions they move about among the former and seize one and another of them, sucking out the juices from their bodies, leaving only the empty skin. These maggots are footless and eyeless, of wrinkled, flattened form, very pointed at the anterior and blunt at the posterior extremities. The colour is at

first nearly white, but they become greenish and brown. When full grown, they adhere by a glutinous secretion to the leaf, the body hardens and contracts, forming a half cylindrical puparium, from which, after a time, the adult emerges.

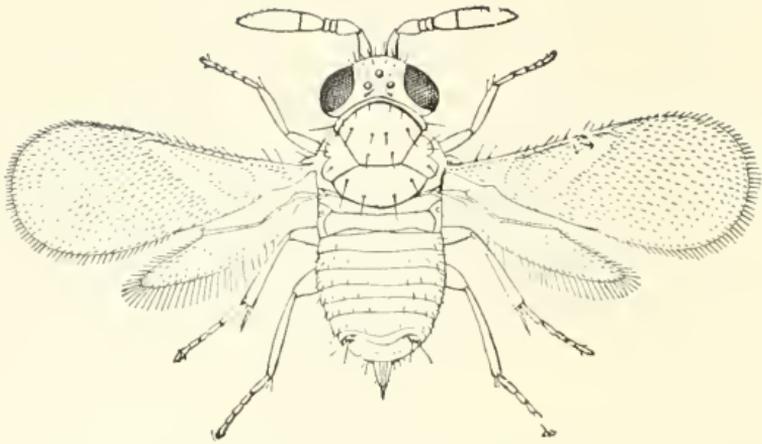
We have ourselves seen an outbreak of the plum aphid overcome by the larvæ of *Syrphus ribessii*, Fab. In cases where the aphid causes the leaf to curl, it is almost impossible to reach them with insecticides, and these parasites are then of the greatest value, and we cannot estimate the vast importance of their services, because we do not observe them at their work. In fact, they are supposed by some people to be the cause of this curling of the leaves, as it sometimes occurs that the larvæ will be the only living things found on these leaves, they having made a clean sweep of the true depredators.

The Tachina flies and closely allied species are shaped and coloured much like our common house fly, but are usually larger and heavier bodied. They attack other insects in a different manner from the Syrphus flies, the female placing her eggs on the surface of the skin of caterpillars and many other larvæ which feed in exposed positions. The eggs are somewhat elliptical in outline, flattened, and of a whitish colour, adhering tenaciously when once stuck upon the victim, and as the parent fly takes especial pains to place them on parts of the body of the larva where it cannot reach them, the eggs are probably seldom displaced. From these eggs young maggots soon hatch, eating their way downward through the shell of the egg and through the skin of their host into the fatty parts of the body, upon which they subsist, after the manner of the young hymenopterous larvæ. The empty shells cover the wounds caused by the maggots eating through the skin, thus saving the life of the victim for a still worse fate. Usually, only a limited number of these eggs are placed upon each larva, the number varying from about four to eight or ten. A case, however, came under our observation where the astonishing number of 228 eggs had been placed upon a single caterpillar of the handmaid moth, *Datana angustii*, Drury. The caterpillars of this species are some years very abundant, and defoliate our shade trees, especially the walnut. They are often attacked by myriads of a species of Tachina, and pursued on the ground and among the grass and weeds in the vicinity, often four or five flies being engaged in chasing a single caterpillar. These last are frequently a sight to behold, and from five caterpillars we have reared over fifty adults.—*Insect Parasites*, F. M. Webster.

The following are some of the beneficial insects found in the Province:—

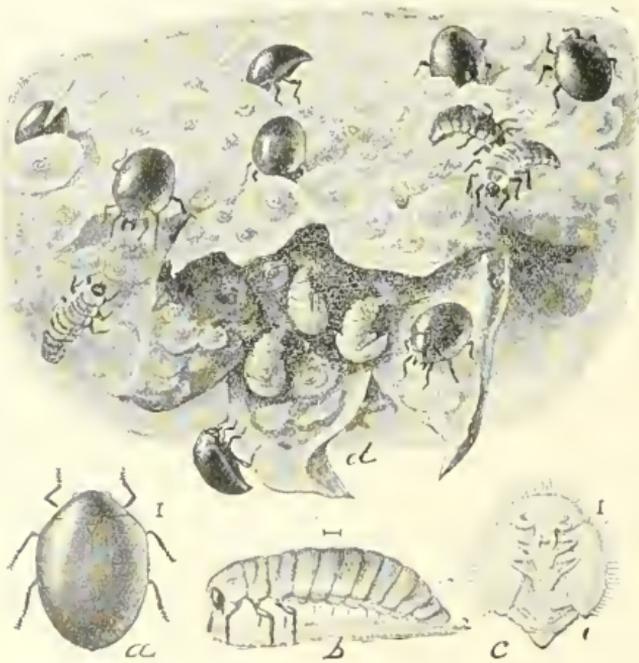
APHELINUS: FUSCIPENNIS (HOW.).

Is a common enemy of armoured scales. The general characteristics of *fuscipennis* are well shown in the accompanying figure of a closely allied species. (Fig. 1.) This parasite has been raised in large numbers in California. Mr. Alex. Craw reports it as doing very effective work in the neighbourhood of Los Angeles.

(FIG. 1).—(*Aphelinus diasphides*.)

(L. O. Howard and C. L. Marlatt, Bulletin No. 3, New Series, Division of Botany, U. S. Department of Agriculture.)

PENTILLA MISELLA.



(FIG. 2.)

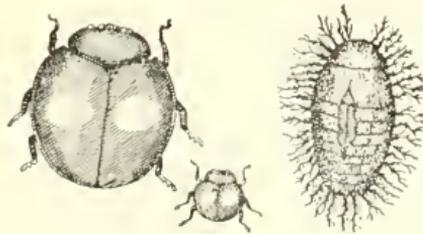
(a), beetle; (b), larva; (c), pupa; (d), blossom end of pear, showing scales with larvae and pupae of *Pentilla* feeding on them, and pupa of *Pentilla* attached within calyx—all greatly enlarged.

(L. O. Howard and C. L. Marlatt, Bulletin No. 3, New Series, Division of Botany, U. S. Department of Agriculture.)

Of predaceous insects, perhaps the most interesting is the little coccinellid *Pentilia miscella*. (Fig. 2.) Both larvæ and beetles feed upon the scales, the beetles seeming to prefer the full grown female scales, and their larvæ the young scales. It is found both in the Eastern States and, possibly, also on the Pacific slope.

TWICE-STABBED LADYBIRD (*Chilocorus bivulneris*).

This is a beautiful little black beetle with two bright red spots on its wing-covers. The larva is shown in the cut, and is black, crossed by a bright



Beetle.

(FIG. 3.)

Larva.

yellow band about the middle, and is armed with many soft, long, branching spines. This Ladybird preys upon various scales, and is especially destructive to the San Jose Scale (*Aspidiotus perniciosus*), and the Oyster-shell scale (*Mytilaspis pomorum*).

BROWN-NECK LADYBIRD. (*Scymnus marginicollis*).

This very small beetle feeds upon scale insects and delights in attacking the red spider. To the naked eye it appears deep black and shiny, and at the touch drops or rolls off, but before reaching the ground spreads out its wings and flies away. The colour of the body is yellowish-gray, and is thickly covered with mealy powder. The head is black and the neck brown. The wing cases are black and covered with hair.



(FIG. 4).

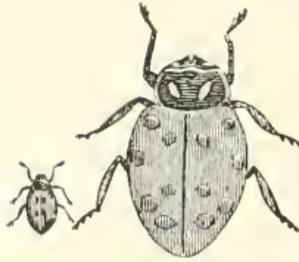
Much
Enlarged.

AMBIGUOUS LADYBIRD (*Hippodamia ambigua*).



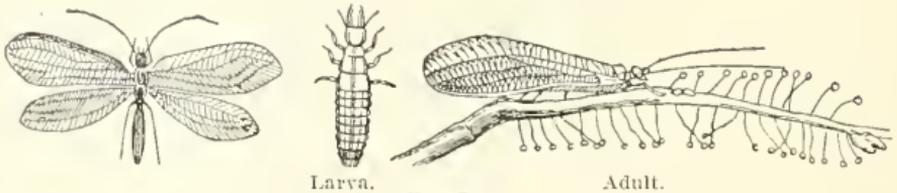
(FIG. 5.)

This is a blood-red Ladybird, which is very plentiful. The larva is one of the largest of the Ladybirds, and feeds upon aphides.

CONVERGENT LADYBIRD (*Hippodamia convergens*).

(FIG. 6.)

This beetle works destruction to aphids and scale insects, and is quite common.

LACE-WINGED FLY (*Chrysopa oculata*).

(FIG. 7.)

When the Ladybirds are great destroyers of scale and aphids, the larvæ of the Lace-winged flies rid trees and plants of million of *Aphida*. The fly has a slender body, with delicate, gauze-like wings, and its colour is generally green with golden eyes. The eggs are deposited on pedicles and laid in the midst of a group of aphides. The larva is supplied with sharp mandibles, with which it attacks the aphids.

SYRPHUS FLY, HOVERING FLY.



Fig. 1.

Natural size.

Fig. 2.

(FIG. 8.)

Natural size.

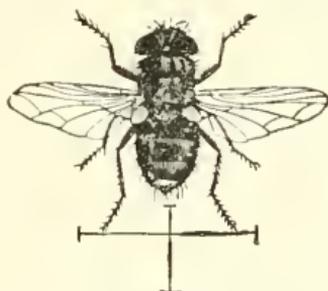
Fig. 3.

In the above cuts Fig. 1 represents the fly; Fig. 2, magnified, the case in which it transforms into a fly; and Fig. 3, magnified, the larva.

The Syrphus flies are also great destroyers of aphides. The larvæ feed entirely upon aphides, and appear and disappear as the aphides appear and disappear. The larva is a footless, eyeless, flattened, transversely wrinkled, gaily coloured, green and purple maggot, having a very extensible body, which enables it to reach up and grasp the aphids with its peculiar looking mouth. The single egg, deposited in a group of aphides, hatches forty-eight hours after it is laid, and the larva becomes full-grown and transformed into a pupa in five or six days. The reason of this extremely rapid development in the first two stages, the egg and the larva, is explained when we consider how brief is the existence of the aphids, and how suddenly its colonies appear and disappear. When the larva is actively feeding, it destroys dozens of aphides, one after the other, and its body changes colour. When filled to repletion the larva falls into

a lethargy, lasting two or three hours, during which the process of digestion changes the juices of the body to varying shades of brown. After the process of digestion has taken place, the larva again begins its work devouring aphides.

TACHINA FLY.



(FIG. 9.)

These are parasitic in habit, feeding largely upon caterpillars, and perhaps, preferably, upon cutworms. Frequently, when the latter are numerous, a large percentage will be noticed with one or several small white eggs, attached to the anterior segments, in such a position that the larvæ cannot possibly reach or destroy them. These eggs hatch in a very short time into little maggot-like creatures that at once bore through the skin of the caterpillar and live within its body, feeding upon the fatty masses and muscular tissue not absolutely necessary to life. When the maggots are full-grown, and the welfare of the unfortunate caterpillar no longer a matter of importance to them, they feed on, regardless of consequences. The maggots, sometimes without attempting to get out of their host, then change to small barred-shaped pupæ. Occasionally the maggots leave their host and make their way a little below ground to pupate. Some large caterpillars will attain their full growth with as many as thirty or more of these maggots feeding inside them.

Tachina flies are generally rather large for their class, robust in appearance, always bristly, and sometimes formidable looking from the array of sharp shiny points projecting in every direction from their bodies. They are among the most effective of nature's checks to caterpillars, especially cutworms.

CUTWORM LION
(*Calosoma calidum*)



(FIG. 10.)

C



(FIG. 11.)

BLACK GROUND WASP.
(*Ammophila luctuosa*).



(FIG. 12.)

There are two enemies of cutworms which deserve special notice, and from the good service they do should be known by sight to every cultivator. They are the fiery ground beetle or cutworm lion and the black wasp. Both of these are desperate enemies of the cutworms, the former feeding on them in all of its stages; the latter digging them out and storing its nest with them as food for its young grubs.

CHAPTER IV.—INSECT PESTS OF MEN AND ANIMALS, DISEASES OF POULTRY AND TREATMENT OF WOUNDS.

REMEDIES—PREVENTIVE TREATMENT.

There are so many of the external parasites of domesticated animals which, even though very widely different in structure and affinities, have very similar habit and can be reached by practically the same treatment, that a chapter devoted especially to general treatment will be of special importance. We may consider the subject under the heads of "Preventive Measures," "Insecticidal Substances," and "Methods of Application of Remedies."

PREVENTIVE MEASURES.

Prevention is, for a large number of parasitic forms, by far the most desirable plan. For some it is the only plan that can be of any service in avoiding injury.

The attacks of semi-parasitic forms, as mosquitoes, flies, buffalo-gnats, etc., may be abated by operating upon their breeding places and, further, their direct attacks upon animals, where the number to be protected is not too great, may be prevented, in some degree, by smearing the hair of the animals with preparations of fish-oil, tar, train oil and axle grease. Pennyroyal is also recommended as beneficial.

For the hot-flies it is important to destroy the eggs before the larvæ hatch, by shaving or clipping off those noticed on horses, or washing them with kerosene emulsion, carbolic acid solution, dipping solution, or if a dipping vat is available, by swimming the animals through the vat.

For the constant external parasites, as lice, itch, mites, etc., quarantine of all animals introduced into a herd, or thorough treatment of such animals to prevent infection of a herd that is free, cannot be too strongly urged. It is the most practical protection against these pests.

INSECTICIDAL SUBSTANCES.

In this enumeration of substances which may be used in treating insects affecting domestic animals, the aim shall be to include all that have a real value in this direction, either individually or in combination, and to indicate their valuable properties and, very briefly, the forms to which they may be applied.

Arsenic, a deadly poison, is used in some of the dipping solutions and kills quickly when taken into the alimentary canal or penetrating the tissues of the insect. It is, however, too dangerous a poison to be used except with the greatest care, and the possibility of the animal treated licking itself, or eating food upon which the solution has dripped to such an extent as to get a poisonous dose, is too great to give it strong indorsement. It has its greatest value in this connection in treatment of sheep scab, which often resists more simple remedies.

Carbolic Acid, one of the most effective of agents against parasites, and especially in certain combinations, is to be highly recommended. In many cases the crude article can be used to as great advantage as the refined, and at great saving in cost. Used externally, without other combination than with water, it should have a dilution of about 100 times its bulk of water. If used too concentrated or upon very susceptible animals, such as dogs, it may be absorbed and cause poisoning. Dr. Francis recommends it very highly in combination for cattle ticks, and the "Poultry World" gives it the highest praise as a combination with slaked lime, to be used in buildings for chicken lice.

Calomel is used in some cases, but is for the most part superseded by more satisfactory remedies.

Benzine may be used in the form of a spray or wash against bed-bugs and fleas, and in chicken-houses against ticks, though for this purpose it has no advantage over kerosene emulsion.

Gasoline may be used in the same way and for the same purpose as benzine. Both must, of course, be used with due regard to their inflammable properties.

Cotton-seed oil is strongly recommended by Dr. Francis for treatment of ticks in the Southern States, especially in connection with dipping solutions. Its action is similar to that of other oils, and while it kills some of the ticks, there are others on the same animal which apparently are not injured by it. In the States, where cotton is produced and the oil can be secured at low cost, it has special advantages, either alone or combined with other remedies, as an application for various external parasites.

Kerosene has a wide range of usefulness in the treatment of parasites, notwithstanding the fact that it does not seem to have fulfilled the requirements for a good dipping solution. It may be used free for the spraying of the interior of chicken-houses, for the destruction of bed-bugs, and for filming the surface of small ponds, water tanks, etc., in order to destroy mosquitoes or their larvæ, and abate the mosquito nuisance. In emulsion it is very effective against lice on cattle, killing both adults and eggs, for use as a spray to kill horn-flies, and as a wash to kill eggs of bot-flies or lice.

Emulsions may be made with either soap or milk, and according to the following well-known formulæ:—

Milk emulsion.—To one part milk add two parts of kerosene and churn by a force-pump or other agitator. The creamy emulsion which results is to be diluted with water, using eight or ten times the bulk of water.

Soap emulsion.—Dissolve one-half pound hard soap in one gallon of hot water, and while still at near boiling point add two gallons kerosene, and emulsify by use of force-pump or agitator of some kind. Dilute with water, one part emulsion to eight or ten parts water, and use as spray, wash or dip.

Oil of turpentine is recommended as an application for external parasites, but should not be applied to the skin of horses, though when suitably mixed it is sometimes prescribed for bots in these animals.

Coal tar is useful as a barrier to mites and lice in the poultry-house.

Dust and ashes are natural remedies used by fowls.

Lime, in form of fine slaked dust, mixed with carbolic acid and scattered throughout the buildings or applied as whitewash, is one of the best remedies for chicken pests, as well as for the lice and mange insects of other animals which infest stables and fences. It is also used as one of the ingredients in sheep dips.

Pyrethrum powder, known also as Persian insect powder, "Buhach" (the California brand), and Dalmatian insect powder, is a most excellent parasiticide, and the powder dusted in rooms troubled with fleas, lice, or bed-bugs, on dogs, cats, chickens, etc., is very effective. It has been found to be the only satisfactory remedy for lice and ticks on sheep in winter, when the long wool prohibits other treatment.

Sulphur, as a fumigating material, or dusted on the skin, in ointments and in dipping solutions, has a great range of usefulness.

Tobacco is a very effective agent against parasites and in fumigation, in dipping solutions, and in form of snuff, dusted among hairs or feathers, is applicable to many external parasites.—*U. S. Bulletin, No. 5, Dept. of Agriculture, Div. of Entomology.*

LIVER FLUKE IN SHEEP (*Dictyoma hepaticum*).

This is caused by an insect which attacks the livers of sheep, and is described in the Journal of the Royal Agricultural Society of England, Vol. 67, as follows:—

The mature fluke is flat and about an inch long. While in the liver, the female deposits her eggs, which are carried out and distributed over the pasture with the dung. If the fresh water snail (*Limnæa truncatula*) is available, the embryo enters it.

It will be seen that the egg must get into water and there develop into an embryo capable of boring into the body of a snail. This snail lives only in fresh and not in salt water. In the body of the snail the embryo develops, in three generations, many more, each of which passes out of the snail, and if taken in by the sheep with its food or water, becomes the sexually mature hermaphrodite fluke. The parasite, having gained the liver of its host, defies removal by any known means.

Prevention.

As there are no known means of expelling the flukes from the bile ducts, the importance of preventive measures is paramount. Moisture is essential to the development of the free-swimming embryo and of the snail (*Limnæa truncatula*) into which it bores. Without the snail, the embryo can advance no farther. The surest and probably the easiest way to prevent liver rot is to prevent the existence of this and all other fresh water snails. The snail will not live without water and that water must be fresh. All means should, therefore, be taken to prevent water standing in ditches, pools, etc., while the application of salt to infested pastures (5 to 10 cwt. per acre), in the autumn,

helps to establish conditions unfavourable to its life. Liming of pastures has been freely advocated, but it is difficult to see how this can be of substantial service. Livers containing flukes should be well boiled if to be used for dogs, etc., but under all circumstances the flukes it may contain should be destroyed. Sheep from affected flocks should not be brought on to a place. When liver rot is detected in a flock, and it seems likely that the disease has been acquired on the farm, it will probably prove most economical to kill the whole flock, as it is impossible to determine what animals may not be infested.

Plentiful supply of good dry food, to which has been added some edible salt and some bitter tonic, may assist the infested sheep to recovery, while it may help to expel any flukes which may happen to be in the intestines. Pastures should not be overstocked, and high ground is preferable.

SHEEP TICK (*Ixodes ricinus*, Linn.)

It differs from the other members of the family in never possessing wings. The head is small and sunken into the prothorax. The middle portion of the thorax is rather slender, contrasting with the development of this region in the winged forms.

It is of a reddish or gray-brown colour, about one-fourth of an inch long, and easily detected when present in any numbers on sheep. They never migrate from the original host, except it be to attach to another animal of the same species, and probably the principal movement is that which occurs after sheep are sheared, when the ticks tend to migrate to lambs. On the sheep, if abundant, they may cause considerable damage, indicated by lack of growth or poor condition, and when massing upon lambs they may cause great damage, resulting in the death of the victims if not properly relieved.

They are distributed over the world generally where sheep are kept, and are too well known by sheep breeders to make it necessary to emphasize the injury they may cause. All breeds of sheep seem alike subject to attack, but I know of no record of their occurrence upon other animals.

Remedies.

While the ticks may be greatly lessened in numbers by the vigorous use of pyrethrum—a most valuable remedy during winter—the most practical plan to adopt, and one which, if thoroughly followed, will make all others unnecessary, is to dip the sheep each year after shearing.

Of the numerous dips which are in use, and which are discussed more fully in the chapter on remedies, the kerosene emulsion is recommended for this form, and several of the patented dips on the market are good, while tobacco dips, tar dips, etc., may be used, if preferred.

It is, of course, desirable to use a dip that will effectually destroy not only these ticks, but the two forms of lice and the scab mites, in case any of these are present. A dipping tank is an essential part of the equipment for sheep-raising, and its construction is described in the chapter on remedies.

A flock once freed from the pests will not be again infested, except by the introduction of infested animals; hence, care should be taken in making additions to the flock to free the newcomers from parasites. It is also well to keep the sheep, for a few days after dipping, in a different inclosure from

what they occupied before, to avoid possible infestation from any stragglers that may have been caught on wool upon posts or brush, and if the wool is charged with them when clipped it should be stored where the ticks could not easily return to the sheep. The ticks cannot travel any distance independently, and will soon die when removed from the sheep, but proper care here will assure success. With due care to have an efficient dip, one operation should suffice, but it is a good plan to examine the herd a week or ten days after dipping, and if any parasites are found to have escaped, or to have issued from pupæ that survived, to repeat the operation.—*Bulletin No. 5, U. S. Dept. Agriculture, Div. of Entomology.*

CATTLE TICK (*Thipiccephalus annulatus*)

Attacks cattle and sometimes deer, goats and horses. The change from larva to nymph, and, according to Lounsbury, the further change from nymph to adult, may be effected on the host, and both adult and larval ticks may carry the parasite of Texas fever, red-water, or bovine piroplasmosis, which exists more or less extensively in the United States, Australia, South Africa, Argentine Republic, Mexico, Roumania, Italy, West Indies, Russia, Germany, Southern France, Finland, England, Ireland, etc.

It is probable that more than one species of tick transmits the parasite of piroplasmosis to cattle, as red-water occurs in places where no species of *Thipiccephalus* has been found. In some isolated outbreaks of red-water, the part played by ticks has not been ascertained, and it has been suggested that other agents than ticks may carry the parasite from diseased to healthy cattle.

The connection of infested ticks with the production of Texas fever was firmly established (1889-1893) by Smith and Kilborne's investigations, which have been summarised by Dr. G. H. F. Nuttall, F.R.S., Cambridge University.

The destruction of ticks in cattle can be effected by the application of acaricides in the form of a smear or a dip. Hand-picking may be tried when only a few animals are infested, the ticks being touched with benzine, petroleum, turpentine, or tobacco juice, then removed by forceps or by hand, and destroyed by burning. But hand-picking is both tedious and uncertain, as the larvæ and nymphæ are small enough to be overlooked. To be effective, this method should be followed by smearing with a mixture like that recommended by Cooper Curtice: Kerosene, 1 gallon; lard, 10 pounds; sulphur, 1 pound; pine-tar, 2 pounds. This smear is applied with a brush.

When large numbers of cattle are infested, dipping must be resorted to, the animals being made to swim through a tank containing from 400 gallons to 2,500 gallons of a reliable parasiticide. Norgaard was successful with chloronaphthol, 50 pounds, dissolved in 2,500 gallons of water containing 40 pounds of soap. Gray and Robertson (Rhodesia) employ a dip composed of arsenic, 6 pounds; soap, 24 pounds; washing soda, 24 pounds; wood-tar, 5 gallons; and water, 400 gallons.

With the object of bringing about the destruction of ticks on pastures, various measures have been advocated. Morgan, after experience of Texas fever, advises keeping cattle off infested pastures for eighteen months, or until the ticks, in the absence of their hosts, have perished. Others, including

Lignieres, suggest sowing the land with lucerne, better drainage, ploughing up, top dressing with gas lime, burning off the grass, fencing off infested parts, etc.—*Newman's Parasites of Domesticated Animals*.

Ways to Kill Ticks.

There are two general plans that may be followed in getting rid of ticks, and either one will prove successful if it is carefully followed out. The first plan, and the one that every farmer can adopt, is to use oil, either by dipping the stock in crude oil, or by applying the oil by means of a brush or mop; the second plan is to make use of pasture rotation, that is, to change the stock from one pasture to another during the summer and fall.

Use of Oil.

Constructing a dipping vat is too expensive for the farmer who may have from ten to thirty head of cattle on his farm. Such a stockman will devise other means of getting rid of the ticks. Several farmers in the neighbourhood of Stillwater have practised the following method of work, and their farms are now free from ticks. Build a small but substantial corral at some convenient place, and in this build a narrow chute that will accommodate one animal, and build it so that you can examine every part of an animal that is confined in it. Collect all of the stock on the farm and examine them closely for ticks every two weeks during July, August and September. The large ticks should be picked off and dropped into a can of oil. After this is done, apply crude petroleum by means of a brush or mop to every part of the animal where you can find young ticks. If there are ticks on an animal they will be found on the inside of the hind legs, in the flanks, on the belly, behind the forelegs, and on the side of the neck. Go over all of these regions carefully with oil. If crude petroleum cannot be had, then use the following: Three gallons of kerosene, one gallon of black machine oil, and one pint of oil of tar. Apply this in the same way as for the crude oil. If the cattle are carefully treated the first time, it will be light work afterwards if they are treated every two weeks. Don't expect to find small ticks on cattle by walking or riding among them, but get the stock into the chute and go over them with the hand. A little carelessness will allow some of the ticks to mature and drop off, and this will keep the pasture and cattle infected and there will be infection the next year. If the work is thoroughly done for three or four months during the summer and fall, any pasture or farm may be made free from ticks.—*Oklahoma Bulletin* 72.

TICKS IN CONNECTION WITH RED-WATER IN CATTLE.

In a previous Annual Report (Vol. 66, page 143) an account was given of the pathology of this disease, including some hints regarding measures of prevention. The disease is again referred to here because it has been found that the old erroneous opinions regarding its cause are still widely held.

It must therefore be repeated that red-water is caused by a microscopic blood parasite which is transferred from affected to healthy cattle by means of ticks. It is the fact that ticks play an essential role in the causation of the disease that explains the peculiar regional and seasonal occurrence of cases of red-water.

Cattle of any age can be infected with red-water, but whereas the disease is generally severe and frequently fatal in adults or animals over two years of age, it is so mild a character in calves or animals under a year old that it generally fails to excite in them any visible disturbance of health. As one attack of the disease tends to render an animal insusceptible, cattle which are infected during early life rarely afterwards become visibly affected or die, even though they are grazed on notoriously dangerous ground. Nevertheless, these animals are not entirely free from the disease, for the rule is that when once an animal has been infected it ever afterwards, or at any rate for years, continues to harbour the minute parasites which are the cause of red-water. This may in most cases be readily proved by using a small quantity of their blood for the inoculation of a healthy adult ox, the almost invariable result being that the inoculated animal develops the symptoms of red-water after about one week. On what may be called red-water pasture, the animals which were infected while young tend to perpetuate the disease, for ticks, in sucking their blood, become infected and pass the parasites on to other animals on the same pasture.

These facts give the clue to the prevention of the disease. If ticks could be eradicated from any given pasture, red-water would thereby be stamped out, but in actual circumstances such eradication is usually difficult. It may, however, be achieved by keeping cattle and other animals off the pasture for one whole year, as this probably exceeds the greatest possible lifetime of a tick which is denied the opportunity to suck the blood of an animal. Fortunately, however, there is a simpler and less expensive method of, so to speak, cleansing a pasture, and that is to graze it exclusively with horses or sheep for a full period of one year. Such a procedure does not lead to the extermination of the ticks, for these may maintain their existence and propagate their species on horses and sheep, but as only cattle can be infected with red-water, an infective tick ceases to be dangerous after it has attached itself to a sheep or horse. It is to be hoped that in this country attempts will soon be systematically made to stamp out red-water by taking advantage of the facts just mentioned. It must be noted, however, that an essential part of this plan is that after the full year has been allowed for the cleansing of the ticks, no animal of the ox species that has had an attack of red-water, or which has even been grazed on red-water ground, must be allowed on the purified pasture, because, as already explained, such animals often for life contain the germs of the disease in their blood, and would, therefore, provide the means for re-infecting the ticks.

Although the measures here advised can scarcely anywhere be altogether impracticable, it is obvious enough that in general a certain amount of loss and inconvenience would be caused in carrying them out, and it may, therefore, be asked whether there is any other means by which a farmer may prevent or reduce the loss which he annually suffers from red-water. That there is another method in reality follows from what has already been said, for it has previously been explained that the disease, when contracted in youth, is usually so mild as to be of little consequence to the animal, and yet protects it for the rest of its life. Hence, where the more radical measures sketched above cannot be put into operation, a farmer may seek to minimise his losses

by grazing the dangerous land exclusively with young cattle, or with cattle which have been for at least one season on such land. This plan, is, however, not free from risk, for although an animal may have been grazed as a calf on dangerous tick-infested ground, it may have accidentally escaped infection, and thus failed to acquire immunity. The probable consequence would be that when this same animal returned to the pasture next season it would contract the disease in a dangerous form. To counteract this risk, the owner might assure the infection of his calves, or of such of them as were afterwards to be grazed on the dangerous pasture, by having them inoculated with the blood of an animal known to have recently recovered from an attack of red-water, as experience shows that this is an operation attended with little or no risk in the case of animals under six months old.

In conclusion, it ought to be pointed out, however, that all animals which have thus been vaccinated against red-water, and all those which have been grazed on infected pasture, are capable of carrying the seeds of the disease to pasture previously healthy, provided they carry ticks with them or ticks are already there. This danger scarcely exists in moving infected animals to land subject to rotation of crops, for ticks cannot there permanently establish themselves, but the risk is a very real one when infected cattle are moved to permanent pasture or moorland.—*Journal of Royal Agricultural Society of England, Vol. 68.*

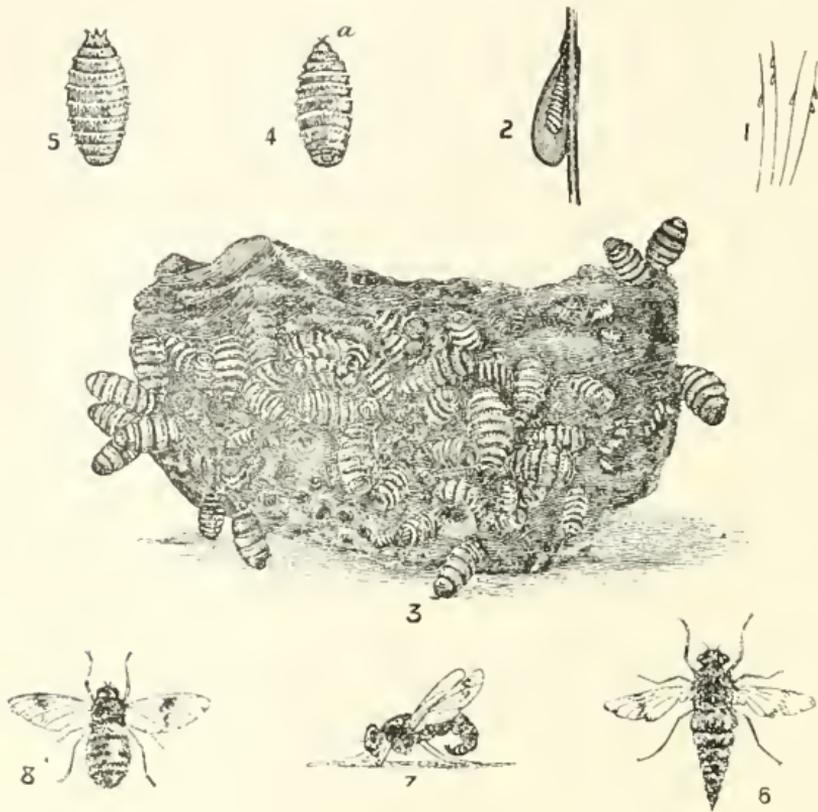
HORSE BOT-FLY (*Gastrophilus equi*, Fab.).

Bots in horses have been a familiar form of parasite to farmers, stockmen, and veterinarians for we know not how long. Whether they were familiar to the ancients has been a matter of discussion among learned men.

Adults of this species are about three-fourths of an inch in length; the wings are transparent with dark spots, those near the centre forming an irregular, transverse band. The body is very hairy, the head brown with whitish front, thorax brown, abdomen brown with three rows of blackish spots, which are subject to considerable variations. In the females the segments are often almost entirely brown with simply a marginal series of yellowish spots, while in males the abdomen may be almost entirely yellow or very light brown, with brown or dark spots very distinct. The males are rarely seen, for while it is one of the most common occurrences to witness the females around the horses, depositing their eggs, the males evidently hold aloof. The eggs are light yellow in colour, and will be found attached to the hairs of the shoulders, forelegs, underside of body, and sometimes even the mane and other parts of body, most commonly, however, on the forelegs and shoulders. The method of deposition has been frequently observed. The female hovers near the horse in a position which appears to be nearly vertical, since the body is bent downward, and the extended abdomen is thrust forward under the body to its full extent. The fly then darts toward the horse, the egg is glued to the hair in an instant, and the fly retreats a yard or two to hover till another egg is ready to be deposited. The eggs are held by a sticky fluid, which quickly dries and thus glues them firmly to the hairs.

In dealing with bots in horses, by far the most important point is to prevent the introduction of the larvæ, and while we have no opportunity, as in the case of the ox bot-fly, to completely exterminate the pest, it is certain that

proper attention to preventive measures would in a few years greatly reduce the numbers of the insect and procure comparative freedom. The better care usually accorded horses makes it possible to deal with it in some respects more easily than the species infecting cattle. The most vulnerable point of



(FIG. 13.)

1. Eggs, natural size, from specimens obtained in Wellington; 2. The same rendered transparent to show young maggot, magnified; 3. Portion of stomach of horse with larvæ attached, also showing "pits" from which larvæ have been removed, natural size (from horse that died at Christchurch); 4. Larvæ, further developed; 5. chrysalis; 6. Female fly, from specimen obtained at Hutt; 7. Side view of female, showing the way in which the abdomen is turned under; 8. Male fly. 1-7, from nature; 8, after Miss Omerod.—New Zealand Bulletin 19.

attack lies in the conspicuous position of the eggs. No horseman, probably, can overlook these objects when occurring on the horse he is caring for, and colts in pasture sometimes become so covered with them as to give a decided change in colour to the parts most affected. It is evident that removing or destroying these eggs previous to hatching is all that is necessary to prevent "bots" in the horse.

During July, August and September, or as late as eggs appear on the horses, those kept in pastures should be examined once every two or three weeks and the eggs destroyed or removed. This can be accomplished in

several ways. By using washes of dilute carbolic acid, about one part carbolic acid to thirty parts of water, or rubbing the affected parts over lightly with kerosene, by clipping the hair or by shaving the eggs off with a sharp knife or razor. Our own experience leads us to prefer the last. With a very sharp knife or razor (a dull one will glide over the eggs) the affected parts can be very quickly run over, without removing much, if any, of the hair. This method leaves no doubt as to whether or not the eggs have been touched, as in washes, and subsequent examinations are not complicated by a lot of dead eggs or shells. Perform once every two weeks, and there can be very few of the larvæ which gain entrance to the stomach. Will it pay, may naturally be asked by the man who has, say, from twenty-five to a hundred colts in the pasture. Possibly not, if but a single season is considered, but the loss of a single horse, or the poor condition of a number, resulting from bots, or the fretting of the whole number in pasture, would more than equal all the cost of removing the eggs from the entire lot. But when the presence on the farm of the pest year after year is considered with all its attendant evils, we believe most emphatically that it will pay.

Remedies for Bots.

The prescription of drugs for the removal of bots from the stomach, when their presence is known or suspected, belongs rather to the veterinarian than to the entomologist, but it may not be out of place here to call attention to a few of them. It is, of course, not an easy matter to determine during the life of the horse whether any particular disturbance of the digestive organs or lack of nutrition is due to the presence of bots or to some other agency producing similar symptoms, and even a competent veterinarian may be puzzled in diagnosis. If occasional bots are noticed in the excrement of the animal, together with poor condition, their presence in numbers may be inferred. It must be remembered that the bots are capable of withstanding almost any substance that the walls of the stomach can endure, and the safest plan, if intending to dose for them, is to employ a veterinarian. Turpentine is perhaps most generally given, but must be used with care.—*Bulletin No. 5, U. S. Dept. of Agriculture, Division of Entomology.*

BOT-FLY OF CATTLE—WARBLE FLY. (*Hypoderma lineata*.) Figs. 14 and 15.

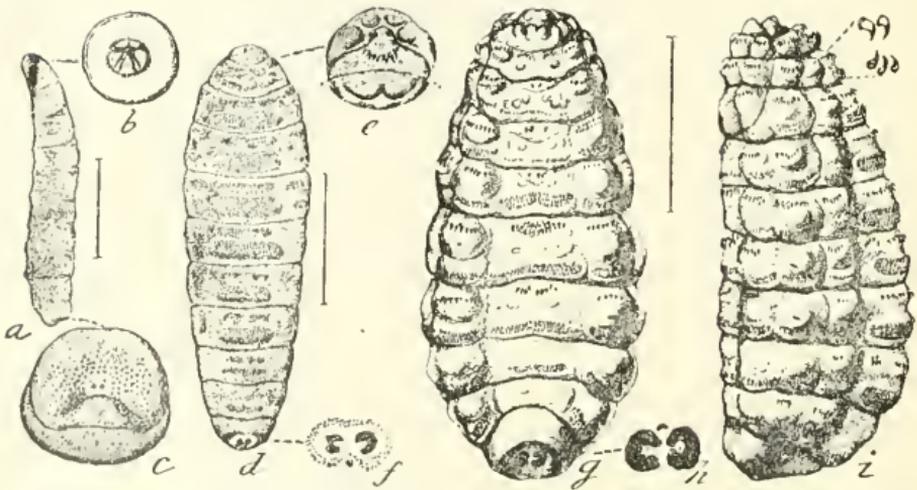
Until a few years ago it was assumed that the common bot-fly affecting cattle in this country was the same as the one most common in European countries, and the same specific name was applied to it, with apparently little careful examination of either larvæ or adults to determine the question with certainty. There is so much in common, however, in the habits and nature of the injury of the two species that it seems appropriate to discuss some of these general features for the two species, and then to give the distinctive features for the two forms, with reference to such differences of habit or treatment as may be necessary.

A considerable portion of this general matter was prepared prior to the discovery of the identity of our species with *lineata*, and, while written with *boris* in mind, applies properly to the former species.—*Bulletin No. 5, U. S. Department of Agriculture, Division of Entomology.*



(FIG. 14.)

Female; natural size indicated by side line.—Circular No. 25, U. S. Department of Agriculture.



(FIG. 15.)

(a) Second stage of larva from back; (b and c) enlargement of extremities; (d) ventral view of third stage. With details of extremities at (e) and (f); (g) dorsal view of mature larva, with enlargement of analspiracles at h; (i) the same, lateral view; natural size indicated by side lines.—From "Insect Life," Circular 25, U. S. Department of Agriculture.

OX-WARBLE, OX BOT-FLY, GAD-FLY (*Hypoderma bovis*).

The eggs are usually laid during the months of June, July and August. The female fly, which is provided with a very strong ovipositor, selects, if possible, a young beast, and, alighting on the back near the spine, manages to pierce the skin and deposit a single oval egg in the hole. This operation

is repeated till all her eggs are laid. After a time the eggs hatch, and tiny, worm-like maggots emerge. The gradual growth and movements of the grubs cause inflammation, and produce "tumours" or warbles. The grubs are found within these warbles, head down, the tail, provided with breathing tubes, being pressed against the opening.

Approaching the last stage they press constantly against the openings, which are thus enlarged sufficiently to allow the exit of the grubs. These fall to the ground, where, like the maggots of the horse-bot, they wriggle into the earth, or under any available shelter, and pass into the chrysalis stage, from which within a month the perfect flies emerge.

The fly has but two wings. The head and front part of the body are yellowish, the back portion of the body black; the abdomen is banded white, black and yellowish. One specimen in my possession measures just three-quarters of an inch in length.

It will be seen that not only does this fly ruin the hide, but it also injures the health of the beast, and causes it to lose condition. A correspondent states that the annual loss in the United Kingdom from this cause alone amounts to several millions sterling.

A Preventive of Warbles.

For preventing the attack of the warble fly, the dressing recommended by the late Miss E. A. Ormerod is very effective. This consists of 4 ounces of sublimed sulphur, 1 gill of spirits of tar, and 1 quart of train or whale-oil. Mix well together, and apply along the spine with a brush. The smell drives off the flies and prevents them from depositing their eggs; the cattle are left to graze in peace, and warbles are prevented.

MOSQUITOES.

These pests, not only a torment to man and beast but a fruitful cause of the spread of some fatal diseases, are so numerous in some parts of the country that every means should be used to mitigate the evil. Of course, in large wild areas of swampy land, it is all but useless to attempt any remedy, but near buildings and in circumscribed breeding areas, a great deal can be done towards ridding ourselves of the pests. The following treatment is recommended by Herbert Osborn, of the United States Department of Agriculture: "Probably the best, and certainly the easiest, of wholesome remedies against mosquitoes is the application of kerosene to the surface of breeding pools. The suggestion that kerosene could be used as a remedy for mosquitoes is not new and has been made more than once. Exact experiments out of doors and on a large scale were made in 1892 by the writer. These and subsequent experiments show that approximately one ounce of kerosene to each 15 square feet of water surface on small pools will destroy all the larvæ and pupæ in that pool, with the additional advantage that the adult females, not deterred from attempting to oviposit, are killed when they alight on the kerosene-covered water. Ordinarily, the application need not be renewed for a month, though varying circumstances may require more frequent applications in certain cases."

L. O. Howard (Bulletin No. 4, U. S. Department of Agriculture), says: "Altogether the most satisfactory ways of fighting mosquitoes are those which result in the destruction of the larvæ or the abolition of their breeding places. In not every locality are these measures feasible, but in many places there is absolutely no necessity for the mosquito annoyance. The three main preventive measures are the draining of breeding places, the introduction of small fish into fishless breeding places, and the treatment of such pools with kerosene. These are three alternatives, any one of which will be efficacious, and any one of which may be used where there are reasons against the trial of the others.

HOUSE-FLIES. (*Musca domestica*) LINN.

Under this general designation the several species which infest dwellings and are not only disagreeable, but from experiments recently conducted, it has been found that house-flies do carry about on their legs filth of all kinds, and are therefore not only disgusting but probably disseminators of disease. The common house-fly (*Musca domestica*, Linn.) breeds in manure and door-yard filth, and it is therefore of the utmost importance that cleanliness should be observed in and about the premises. Howard says: "There is not much that need be said about remedies for house-flies. A careful screening of windows and doors during the summer months, with the supplementary use of sticky fly-paper, is a method known to everyone, and there seems to be little hope in the near future of much relief by doing away with the breeding places. A single stable in which a horse is kept will supply house-flies for an extended neighbourhood. People living in agricultural communities will probably never be rid of the pest, but in cities with better methods of disposal of garbage, and with the lessening of the number of horses and horse stables consequent upon electric street railways and bicycles, and probably horseless carriages, the time may come, and before very long, when window screens may be discarded. The prompt gathering of horse manure, which may be treated with lime or kept in a specially prepared pit, would greatly abate the fly nuisance, and city ordinances compelling horse owners to follow some such course are desirable. Absolute cleanliness, even under existing circumstances, will always result in a diminution of the numbers of the house-fly, and, as will be pointed out in other cases in this bulletin, most household insects are less attracted to the premises of what is known as the old-fashioned housekeeper than to those of the other kind."

CLOTHES-MOTHS.

These are the dread of every housekeeper. The mere mention of the word "moths" is enough to conjure up visions of household treasures of woollen and fur eaten full of holes, their beauty gone, their usefulness past. It was formerly supposed that these well-known injuries were caused by a single species; but it has since been discovered that we have in this country three species of clothes-moths. These differ in habits as well as in structure.

The Case-bearing Clothes-Moth (*Tinea pellionella*).—The larva of this species is a true case-bearing, making a case out of bits of its food-material which are fastened together with silk. As the larva grows it enlarges its case

by adding to each end and by slitting it and inserting a piece. Instructive specimens can be obtained by rearing the larvæ and changing them from time to time from flannel of one colour to that of another. The shape of the successive additions to the case being of different colours, can easily be seen. The pupa state is passed within the case. The adult is a small brown moth with a few dark spots on its fore-wings.

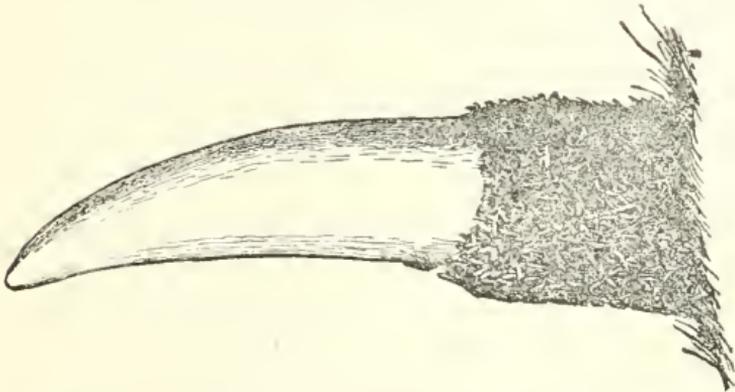
The Tube-building Clothes-Moth (*Tinea tapetzella*).—The larva of this species makes a gallery composed of silk mixed with fragments of cloth. This gallery is long and winding and can easily be distinguished from the case of the preceding species. The pupa state is passed within the gallery. The moth differs greatly in appearance from the other two species, the fore-wings being black from the base to the middle and white beyond.

The Naked Clothes-Moth (*Tinea biselliella*).—Although this species spins some silk wherever it goes, it makes neither a case nor a gallery. It may be termed, therefore, the Naked Clothes-Moth, in contradistinction to the other two species. But when the larva is full-grown it makes a cocoon, which is composed of fragments of its food-material fastened together with silk. The adult is of a delicate straw-colour, without dark spots on its wings.

Protection from Clothes-Moths.

In late spring or early summer all winter clothing, flannels, furs, and other articles that are to be put away for the summer should be thoroughly brushed and examined for these pests and exposed to the sunlight as long as practicable. Then they should be wrapped carefully in stout paper, or better, packed in pasteboard boxes, which can be procured at small cost, and the crack between the cover and the box closed by pasting a strip of paper over it.—*Insects, Comstock.*

CATTLE HORN-FLY (*Hæmatobia serrata*, DESV.) Fig. 16.



This troublesome pest of horned stock, which appeared first in Canada in 1892, has done much harm by irritating cattle with its bites, so that when it is abundant they fall off rapidly both in flesh and in yield of milk. From the time it first appeared in Canada this fly has spread over all parts of the Dominion, reaching the Pacific Coast in 1903, but is by far more troublesome

in the Eastern Provinces than in the West. The fly is a small and very active dark gray species, about one-third the size of the ordinary cattle-fly, and shaped just like that insect, with the same kind of biting, dagger-shaped beak, carried projecting forward in front of the head. When in large numbers these flies frequently cluster on the horns to rest. It was from this habit that they got their name. Statements that they bore holes into the horns are inaccurate. The only harm done by them is due to their very irritating bites on the bodies of the animals. The eggs are laid by the females in freshly deposited cow droppings. The maggots hatch in 24 hours and become full grown in about a week; they then burrow down a short distance into the ground and turn to brown puparia, from which the flies emerge in four or five days. There are several broods during the summer, and the last brood or maggots passes the winter as puparia.

Remedies.

Of the many remedies we have tried, the following have given the greatest satisfaction: (1) Smearing the parts most usually bitten with a mixture of lard, 5 lbs., and pine tar, 1 lb. Two applications each week when the flies are very bad. Mix well together and apply to the parts most attacked, brushing the mixture lightly over the tips of the hair. After two or three applications the treatment has more effect than at first. (2) Spraying the animals twice a week with ordinary kerosene emulsion. (3) Fish oil, 2 quarts, and oil of tar, 2 oz.; or fish oil, 2 quarts, coal oil, 1 pint, and oil of tar, 2 ozs. (4) Good work may be done by breaking up the cow droppings in the field. The maggots can only live in the dung while it is in a moist condition. A boy with a rake could go over a pasture three times a week and break up all the fresh droppings and the drying up of these by the sun or the washing away by rain would kill all the eggs or maggots, thus locally reducing the numbers very much.

CATTLE LICE (Trichodectes scalaris, Haematopinus eurysternus, NITZSCH.)

The loss from these disgusting and very common parasites of horned stock is far greater than is generally appreciated. Many animals turned out in spring in poor condition have been reduced in flesh by the constant discomfort of being preyed upon by myriads of lice, which might have been destroyed by a little attention on the part of those in charge of them. On account of the small size of lice, they are often overlooked until they have become very numerous and have done a great deal of harm. Lousy animals will neither rest nor feed well. They are prevented from putting on flesh, their growth is stunted, and their meat is neither so good nor produced so economically. It is well known that an animal kept in good condition and steadily increasing in weight costs much less to prepare for the market than one whose growth is checked and allowed to get into poor condition. Lice cause more loss in stock than is generally appreciated. This loss is unnecessary, because all of the common external parasites of live stock can be easily and cheaply treated. There are two kinds of lice found commonly on cattle, the small blue louse or biting ox-louse (*Trichodectes scalaris*, Nitzsch), and the big black louse or short-nosed ox-louse (*Haematopinus eurysternus*,

Nitzsch). Both of these parasites are sometimes found in great numbers on neglected cattle, and when the stalls have become thoroughly infested are hard to clear out entirely; but this can be done by continued effort and with great benefit to the stock and to the owner. Many remedies are known. We have used kerosene emulsion with much satisfaction, spraying it on to the animals and then rubbing it well in with the hands. Any of the recognised sheep dips will also answer and are very convenient. Recently zenoleum has been used for this purpose and answers well. All of the latter are used of the strength advised by the makers. An important part of the treatment consists of spraying thoroughly the stalls where the animals have stood, after cleaning them out. Both of these lice leave the animals and hide in the cracks and crevices of the woodwork.

HEG LOUSE (*Hematopinus suis*, LEACH).

This is the largest louse known, measuring one-quarter of an inch in length. It is of a dirty white colour marked with brown. The feet are provided with strong claws, with which they cling tightly to the hairs. Although, from the nature of the animals they infest and the usual way their pens are built, these lice are rather difficult to eradicate, the same remedies mentioned for the cattle lice will quickly and entirely kill these parasites also, as I have found on several occasions. It is necessary to spray the sleeping quarters very thoroughly.

SHEEP LOUSE (*Trichodectes sphaerocephalus*, NITZSCH).

This is a very small louse but is a very troublesome parasite, causing great irritation to infested animals, which show their discomfort by rubbing themselves and by biting at the wood. Most of the severest cases of infestation by sheep lice have been in the winter. Sheep should be examined before winter sets in, and if any lice are found they should be dipped.

FLEAS.

Two species of fleas very constantly attack man. These are the house flea (*Pulex irritans*) and the dog and cat flea (*P. serraticeps*). The rat and mouse flea (*P. fasciatus*) and other fleas will also occasionally attack him. Of all the fleas, that of the dog and cat is perhaps the most common in houses, and being less active than the house flea is more easily captured.

Remedies.

A very concise statement of the remedies to be applied for fleas is given in Circular No. 13, by Dr. L. O. Howard:—

"The larvae of the dog and cat flea will not develop successfully in situations where they are likely to be disturbed. The use of carpets and straw mattings, in our opinion, favours their development, since the young larvae can penetrate the interstices of either sort of floor covering and find an abiding place in some crack where they are not likely to be disturbed. It is comparatively easy to destroy the insect in its early stages (when it is noticed), as is shown by the difficulty of rearing it, but the adult fleas are so active and so hardy that they successfully resist any but the most strenuous measures. Even the persistent use of California bush and other pyrethrum

powders was ineffectual in one case of extreme infestation, as was also, and more remarkably, a free sprinkling of floor mattings with benzine. In this instance it was finally necessary to take up the floor coverings and wash the floors down with hot soapsuds in order to secure relief from the flea plague. In another case, however, a single liberal application of buhaeb was perfectly successful, while in a third a single thorough application of benzine completely rid an infested house of fleas.

"To sum up: Every house where a pet dog or cat is kept may become seriously infested with fleas if the proper conditions of moisture and freedom from disturbance exist. Infestation, however, is not likely to occur if the (bare) floors can be frequently and thoroughly swept. When an outbreak of fleas comes, however, the easiest remedy to apply is a free sprinkling of pyrethrum powder in the infested rooms. This failing, benzine may be tried, a thorough spraying of carpets and floors being undertaken, with the exercise of due precaution in seeing that no lights or fires are in the house at the time of the application, or for some hours afterwards. Finally, if the plague is not thus abated, all floor coverings must be removed and the floors washed with hot soapsuds. This is a useful precaution to take in any house which it is proposed to close for the summer, since even a thorough sweeping may leave behind some few flea eggs from which an all-pervading swarm may develop before the house is re-opened.

"Provide a rug for the cat or the dog to sleep on and give this rug a frequent shaking and brushing, afterwards sweeping up and burning the dust thus removed. As all the flea eggs on an infested animal will not, however, drop off in this way, and those which remain on it will probably develop successfully, it will be found wise to occasionally rub into the hair of the dog or cat a quantity of pyrethrum powder. If thoroughly applied, it will cause the fleas to fall off in a half stupefied condition, when they, too, may be swept up and burned."—*Bulletin No. 5, U. S. Department of Agriculture, Division of Entomology.*

BED BUG (*Cimex lectularia*, LINN.).

This species, described by Linnaeus a century and a half ago, has been a most familiar insect to man, though for how long a time it is quite difficult to determine.

It is by no means easy to estimate the amount of injury caused by this insect, for, so far as man is concerned, it consists of loss of time and comfort, while its effects upon other animals are involved in too much obscurity to allow of any estimates being formed. As found in houses infesting man, it can only be considered as semi-parasitic, living for the most part secreted in cracks and crevices and attacking its victims during the night. Probably its attacks upon other animals are of a similar nature, although it is referred to by some authors as a parasite of domestic fowls.

The eggs are oval in shape, of a whitish colour, slightly narrowed at one end, and will be found in great numbers in the cracks which furnish shelter for the adults. The young bugs escape from the eggs by pushing off a circular lid at one end.

There is some confusion as concerns the attacks of the bed bug or its parasitism on other animals than man. Packard (Guide to the Study of Insects, p. 551) states that "it lives as a parasite on the domestic birds, such as the dove," and further, same book and page, that "Mr. James Macdonald writes me that he has found a nest of swallows on a court house in Iowa swarming with bugs." In the American Entomologist (Vol. 1., p. 87) the following statement occurs:—

"Ordinarily the bed bug is confined to the dwelling-places of man and lives on the blood of us great lords of creation, but we have known it to swarm in prodigious numbers in a chicken house, where it must have fed exclusively upon chickens' blood, and it is said to occur also in European pigeon houses."

Whatever its foundation, there is a widespread belief that birds and bats carry bed bugs from place to place, and considering the suddenness with which they appear in new buildings, and sometimes in buildings never used for dwellings, it seems hard to otherwise account for their appearance. Still, to those familiar with the habits of the bed bug and its opportunities for transportation, there will be no insuperable difficulty in accounting for all such appearances. Another impression seems to be that bed bugs occur in the woods and under bark.

Prevention and Remedy.

Cleanliness and the application of the common remedies, such as benzine, corrosive sublimate, and hot water, will usually suffice to keep these pests reduced in ordinary dwellings, but in large buildings more general measures may sometimes be necessary, and in such cases there is probably nothing more effectual, when it can be done, than thorough fumigation with sulphur, brimstone or perhaps bi-sulphide of carbon.

"I have known a house which had long stood empty, and yet swarmed with them, thoroughly cleansed by fumigation with brimstone."—*Westwood*.

We know personally of an instance where a large building, badly infested with this pest, on being thoroughly fumigated with sulphur as a disinfectant against scarlet fever, remained for some time comparatively free from bugs.

Attention to the cracks in the walls and around casings, as well as to the joints of bedsteads, will do much to keep pests under control.

For immediate relief in a sleeping room, pyrethrum is most available, since it can be used while a room is occupied. Dusted between the sheets of a bed, it will protect the sleeper from the most voracious hotel bug.—*Bulletin No. 5, U. S. Department of Agriculture, Division of Entomology.*

LICE OF HUMAN BEINGS.

Children and people of dirty habits are especially subject to infestation by these, perhaps the most objectionable of all insects. Three kinds are commonly known to attack human beings. These are the head-lice (*Pediculus capitis*), the body louse (*P. vestimenti*), and the crab (*Phthirus inguinalis*). When once these insects appear they can only be exterminated by thorough watchfulness and cleanliness. Children (who are frequently attacked by the head-lice) require their hair to be frequently combed, as all lice are prolific breeders. Many children obtain lice at school by hanging their hats up near those of others. The head-lice seems to prefer the region just above the ears,

and in such places their eggs or "nits" may sometimes be seen in hundreds. On very dirty people the eggs may sometimes be seen thickly sprinkled like sand throughout the hair. On examination, these eggs will usually be found to be empty, as they will stick to the hair long after the young are hatched.

The body louse is seldom found on any but very dirty people, although anyone is liable to be attacked by it. It is a larger and thicker insect than the head-lice, and appears to live by preference on the under-clothes, into any fold of which it will creep, and from which position it will suck up the blood of its victim. It is best, therefore, to boil any clothes which harbour it.

The crab prefers the private regions, and causes intolerable itching. A person may be absolutely free from this pest, and yet within a fortnight be nearly driven mad by them, and on examination find them swarming on him. They are, fortunately, very readily killed by the use of mercurial or "blue" ointment. All lice are provided with strong claws for hanging on to hairs, but in the crab the claws are enormously developed.—*Agricultural Gazette, Tasmania*.

Washes and Dips.

Applications of liquid remedies are the main reliance in the treatment of external parasites, and the choice between methods depends largely upon the amount of work to be done. The most available substances are the solutions of tobacco, diluted carbolic acid, kerosene emulsion, infusion of stavesacre for lice, or some of the regular sheep dips.

For lice on cattle, a wash of kerosene emulsion, rubbed on with a rag or the hands to the parts where eggs and lice are most abundant, can be used even in winter, with some care to avoid exposure, and while not usually reaching every louse, will suffice to keep the pests in check.

Tobacco decoction.—A simple tobacco decoction is made by steeping tobacco leaves and stems in water. Such decoctions are poisonous to most animals, and should not contain more than 2 to 5 per cent. of tobacco. With horses they should only be applied to a part of the body at one time.

Tobacco and sulphur dip.—A combination, especially favoured in Australia, given by Curtice, consists of tobacco and sulphur, of one pound each to every four gallons of water to be used, the tobacco solution and sulphur being stirred together till of a creamy consistency and then diluted with required amount of water.

Sulphur and lime dip.—Flowers of sulphur, 25 pounds; quicklime, 20 pounds; water, 100 gallons. Lime is first slaked in the usual manner, then the rest of the water and sulphur are added. Boil for twenty minutes and strain well. Hold the sheep in the mixture until the scabs are thoroughly soaked. Immerse the head at least once. Use the dip at 100 to 110 degrees F. Dip twice, with an interval of ten days. The ingredients should be carefully sifted before mixing, and the sediment should not be thrown into the tank.

Tobacco, sulphur, and lye dip.—Thirty pounds of tobacco, 7 pounds of sulphur, 3 pounds of concentrated lye, dissolved in 100 gallons of water.

Lair's dip.—Tobacco, 16 pounds; oil of tar, 3 pints; soda ash, 20 pounds; soft soap, 4 pounds; water, 50 gallons. Sufficient for 50 sheep. The tobacco should be steeped, afterwards the other ingredients added at 70 degrees F.

Cotton-seed oil.—This is claimed by Dr. Francis to give on a large scale the most satisfactory results for ticks. The oil is simply poured on a vat filled with water, the cattle being drenched with it as they emerge.

For a few animals a small vat is sufficient, and pigs, lambs, dogs, etc., may be dipped in a tub or barrel. There is a patented dipping device for lowering animals into a tank.

Wherever dipping is to be practised to any great extent, the construction of a permanent tank or vat for the purpose will be a matter of economy.—*Bulletin No. 5, U. S. Department of Agriculture, Division of Entomology.*

DISEASES OF POULTRY.

Prevention is better than cure, and the breeder who keeps the houses clean, warm and properly ventilated, and has the water and feed vessels always clean, need have little to fear from diseases.

Roup.

This is the most to be dreaded of any of the troubles that the poultryman will have to encounter, as if it once gets a start the whole flock may go with it. This affection, if taken at the start, is easily checked, and the bird that shows any signs must be immediately isolated from the rest of the flock. The symptoms are: Eyes watering, nostrils closed, breathing deep and frequently swelling round the eyes.

As soon as it is detected, take the bird and after dissolving a teaspoonful of boracic acid in a small tin or cup of warm water, plunge the bird's head under and hold it there till it seems to choke, which action will draw the solution into all the cavities of the nose and throat, and I have found it a most effective remedy. Do not use any tins or cups that are wanted for any other purpose, as the disease is very infectious. Put the bird in a dry, warm place and repeat the treatment in a few hours. Zinc ointment or carbolated vaseline is also good to apply to the swelling round the eyes.

Cholera.

The fowl affected with cholera is dejected, sleepy and droopy, is very thirsty, has a slow, staking gait, and gapes often. They often stagger and fall from weakness. The wattles turn pale or sometimes dark and they have diarrhœa. At once remove all affected birds to a warm, light place with plenty of clean straw. Give no water except with "Boerhaas Mixture" in sauc, formula for which is given herewith. The droppings should be drenched with a solution of carbolic acid, to prevent the spread of the disease. Nothing but cooked food should be fed. Prevention is the only sure cure for this disease, but if anything will do any good, the above treatment is most likely to be effective.

Crop Bound.

This complaint is liable to affect birds in confinement more than those on a large range. It is caused mostly by over-feeding, and unless relieved promptly death is sure to follow. Relief may be quickly given by opening the crop on the side with a sharp knife, cutting a slit sufficiently long to remove the contents. Clean the crop with warm water and sew up again.

taking care not to sew the skin of the bird to the sack of the crop. Close the crop with white linen thread first, having the knot on the inside, then put a few stitches in the skin. Put in a warm place and give no water for twenty-four hours and only soft food, and it will soon recover.

Gapes.

Causes.—Foul water, exposure to wet, damp places, particularly at night, want of nourishing food, etc.

Symptoms.—The general symptoms, as the name implies, consist in constant gaping, coughing and sneezing, together with inactivity and loss of appetite.

Treatment.—Give the bird daily, until it recovers, a small piece of camphor about as large as a grain of wheat, and add a few drops of camphor or turpentine to the drinking water, or mix with the food, about ten drops to the pint.

Leg Weakness.

Cause.—It often arises from the inbreeding of the same strain of fowls for too long a period, but is usually caused by too high feeding, which increases the weight of the body out of proportion to the muscular strength of the legs; it more generally occurs in the large breeds, such as Cochins and Brahmas, particularly in the cockerels.

Symptoms.—Squatting around on their hocks, after standing for a short time, as if tired; in bad cases they are unable to stand on their feet at all.

Treatment.—In an early stage give the following pill twice or three times a day: One grain of sulphide of iron, five grains of phosphate of lime and half a grain of quinine.

Douglas Mixture.

"Douglas Mixture" is made thus:—Take of sulphate of iron (common copperas) 8 ounces; sulphuric acid, $\frac{1}{2}$ fluid ounce. Put into a bottle or jug 1 gallon of water, into this put the sulphate of iron. As soon as the iron is dissolved add the acid, and when it is clear the "mixture" is ready for use.

In hot weather, or when the flock is small, less may be prepared at once, but the above proportion should be observed. This "mixture" or tonic should be given in the drinking water every other day—a gill for every twenty-five head is not too much—and where there is infection it must be used every day, but where there is no disease, not so often, or in small quantities if used every day.

This preparation, simple as it is, is one of the best tonics for poultry known. It is alternative as well as tonic, and possesses, besides, antiseptic properties which make it a *remedy* as well as a *tonic*.

There are many other diseases that poultry are liable to, but the above are most prevalent and most likely to be met with.

VERMIN PESTS OF FOWLS.

To keep fowls in good healthy condition it is absolutely necessary to keep down the vermin. This particularly applies to chickens; turkeys are also troubled, but to a less degree, while ducks and geese are worried little if at all.

In British Columbia the vermin pest is even greater, though this is needless, than it is in any other part of Canada. But it can be controlled with comparative ease if proper methods be adopted.

So great has been found this plague to fowls that certain concerns have found an eager market for all kinds of patent fixtures for the positive prevention of the vermin pest. I term such fixtures luxuries and stamp them as non-essential. But it will be necessary for us to know something of the kinds of vermin which infest poultry houses and the fowls themselves, as well as something of the nature of the same, before we can intelligently discuss their prevention as pests.

Vermin pests are of two kinds, viz., lice and mites.

The lice stay on the fowl and are mostly the large grey louse.

Kinds of Lice on Fowls.

1. *Lescer lice*.—These are a small louse similar to the large grey louse.
2. *Large hen louse*.—Very common and very prolific; it trails a tickler behind it, making a very irritating sensation; lives chiefly on feathers. Hence it is a parasite and stays on the bird all of the time.
3. *Burnett's hen louse* is similar, though not so large as the large hen louse.
4. *Chicken louse*.—This louse is usually found upon young birds, is very small and very prolific.
5. *Long chicken louse* is similar to above, but different in shape, as its name denotes.
6. *Common hen louse* is a medium size, with habits similar to all of the above.

In fact, all of the six kinds of chicken lice above-mentioned are similar in their habits as they are in appearance, though differing much in size. Some are so small that they can scarcely be seen with the naked eye; other so secretive in habits as to be scarcely discernible among the feathers. The lice usually seen on the bodies of birds are the "large" and the "common" lice. When lice are plainly seen, even though it be only one here and there, it is a sure sign of great numbers of the pests.

Among the varieties of lice there is also:

- The common duck louse.
- Squalid duck louse.
- Clear duck louse.
- Clear goose louse.
- Biting louse of turkey.

Mites.

These are of two kinds, viz.:—

1. *Chicken mite* (4 legs), sometimes white and grey, but blood-red when full.
2. *Itch mite*.—About 1/50 of an inch in length, thus being so small as to be not discernible to the naked eye. It affects the legs and comb.

The chicken mite bites the fowl and sucks the blood, and when a poultry house becomes infected with this worst of all pests, such a thing as a good healthy fowl soon becomes impossible. The chicken mite leaves the body of

the hen before the fowl leaves the roost; as soon as the fowl begins to move it makes off. It lives during the day in crevices and under the roosts; cleats, loose boards, cracks, knot-holes, etc., make admirable hiding places. At dusk they come forth in search of the fowls. They are very prolific.

The *itch mite* produces scales on the legs and, as mentioned above, it also attacks the comb. The first appearance on the comb is little white points or scales, and the comb skin is not pure red but brown. The disease sometimes seems to stand still for perhaps a month, but all of this time the mite is at work. The base of the comb becomes swelled and is full of little burrows. The feathers of the head stand straight out and die, then, curling up, they imbed themselves in the flesh and result in the swelling called the itch. On the feet and legs this mite is also very active. The scales drop off or form in knots; a crust forms beneath the scales and the feet and claws smell badly. "Sealy leg" is nothing more nor less than an excessive state of the work of the "itch mite."

Remedies.

Isolate the affected birds. Then treat by using a solution of 5 per cent. creolin and bathe the affected parts, applying it about every two weeks.

CLEANLINESS OF HEN HOUSES.

I emphasise this point, and the individual who aims for success must insist upon it. A good system is to wash the hen houses with boiling water about three times a year—spring, midsummer and fall. Then whitewash with hot lime and 5 per cent. carbolic acid. Dry the house by fumigating well with sulphur. Put coal oil in the cracks and on the roosts. Lee's Insect Killer is good, as is also Persian Insect Powder.

To kill the vermin it is necessary to smother them. They breathe through tubes in their sides. Dust or a strong odour will close these tubes and hence effect their death. So, then, it will be understood that the fowls must always have access to a dust bath, and the place in which they roost should smell strongly of some tar extract.—*B. C. Bulletin, No. 19, Dunham.*

THE TREATMENT OF WOUNDS.

By J. L. Burns, V.S., Acting Chief Inspector of Stock of Western Australia.

Judging by the large numbers of inquiries from correspondents and others, there appears to be a good deal of ignorance as to the correct method of treating wounds and other injuries of a similar description; and it is with the object of endeavouring to help in this direction that the following remarks are offered, which are primarily intended for farmers and those in the bush in contact with animals, who are mostly out of reach of professional assistance.

There are people who think that in dealing with questions of this sort the use of highly technical language is necessary; but this is a mistake, and the constant use of which merely tends to mystify. If we are to understand each other, plain English will be the best; and on the present occasion we shall,

as far as possible, stick to it, leaving the jaw-breakers for the anatomy classes and for those anxious to impress others with the vast amount of knowledge they possess.

The keynote of success in dealing with every description of wound is cleanliness, and without this our efforts are often unavailing. No wound is so unimportant as to be looked upon as of no consequence; and the slightest scratch sometimes may lead to serious complications, ending perhaps in death itself. Simple precautions taken in time often prevent such things happening. The first thing to do in the case of a clean-cut wound on some muscular part of the body is to stop the bleeding, if excessive, but unless it is very great, and an important blood-vessel is severed, this need not bother us. In all cases, whether dirt can be seen adhering to the wound or not, it is advisable to wash it with an antiseptic. There are many such at present, such as carbolic acid (1 part of acid to 70 of water), lysol, permanganate of potash, phenyle, etc. All are good. This often prevents trouble afterwards, by helping to ward off infection of the exposed lacerated tissues caused by micro-organisms in the atmosphere, and which are ever ready to increase and multiply at our expense. A wound is the open door by which they enter our system, in many instances. All trouble with wounds is now well known to be due to these small organisms, and when means are taken whereby they are prevented from gaining access to the tissues much better results are experienced. Antiseptics have the power of arresting the growth or of entirely destroying these organisms. In days gone by, when antiseptics were not used and their action not known, the mortality from wounds and injuries, especially those affecting internal parts of the body such as the chest or abdomen, was sometimes dreadful, and fully 40 per cent. never recovered. In those times to amputate a leg or an arm, not to mention anything worse, was about as much as the patient's life was worth; and abdominal surgery was so dreaded on account of bad results that scores of people preferred to run all other risks rather than resort to it. Nowadays these things are done every day and it is not often we hear of death resulting from the operation itself. Antiseptic surgery has changed everything and operations of a nature which would have been laughed at as impossible by surgeons of 70 years back are performed now with success. Skill, no doubt, counts; but 50 years ago there were surgeons in France and England skilful enough for anything, yet they were doomed to failure without the assistance of antiseptics.

Punctured wounds are dangerous, such as a stab from a pitchfork, because they are difficult to clean out properly and are liable to close up on the outside before the internal parts heal; and often on this account discharges from the wound are imprisoned which sooner or later cause trouble. A word of warning is, therefore, necessary in such cases, so that precautions are taken to see the injury is thoroughly irrigated with some antiseptic before permitting the outside to heal up.

In bringing the edges of wounds together, it is always as well to be careful to cut away as little of the skin as possible, as it does not reproduce itself, and ugly blemishes are left where skin is removed.

The applications applied to wounds by ignorant persons are sometimes of an extraordinary description and do more harm than good. Cow dung, which is now mentioned in the pharmacopœia, finds great favour with some

persons as an application to the foot in cases of injuries by nails penetrating the sole. Burnt leather is another firm and universal favourite, only second, I think, to cow dung, and is further valued, according to some, for promoting the growth of hair. A more improper remedy than cow dung in cases of penetrating wounds of the foot could hardly be thought of, and burnt leather has no virtue in making the hair grow. If a poultice is necessary where the foot is concerned, linseed meal or bran, or marshmallows, will be found much better and cleaner.

Then there are people who must apply sulphate of copper (blue-stone) to every wound, whether it is wanted or not. Blue-stone may be used in cases where the proud flesh or granulations are excessive, but I am not aware that it does much good otherwise, its action being more of a caustic, killing living tissues, and retarding rather than assisting the reparative process of nature, and, therefore, should be used sparingly and with caution.

A very common practice is blowing ground glass into the eye, with the idea that it will do good in helping to remove opacities of the glassy portion (cornea) caused by injuries. Is it possible to think of a more barbarous remedy, which can only act something after the fashion of sandpaper on this most sensitive and delicate organ. Let anybody try to imagine the effect of finely powdered glass being suddenly blown into the eye. We have all occasionally experienced the pain and inconvenience resulting from a small speck having got into the eye, but think of this one speck multiplied thousands of times, grating and rubbing against the ball of the eye and surrounding structures. Of all the mad notions that ever entered the brain of man, and their name is legion, surely none ever equalled in absurdity this powdered glass treatment as applied to the eye.

With regard to wounds pure and simple, it is well to remember that when bringing the edges together it is advisable to take up a fair amount of skin, as unless this is done the stiches are liable to cut through if they have to support much weight. I need hardly say that each stitch must be entirely separate and tied on its own and it would never do to stitch away after the style of a tailor stitching a piece of cloth. This would not answer at all, as one part breaking, the whole would give way and our labour would be in vain. What is known, therefore, in surgery as the "interrupted" suture or stitch is the proper thing. The best sort of needle (they are of various sizes for different work) is one with a lance point and slightly curved. Ordinary needles are very difficult to pass through the skin and are awkward in many ways. Silk suture thread (carbolised) is very good, but ordinary twine, as long as it is clean and uncoloured, may be used at a pinch, previously having dipped it in some antiseptic solution.

One has to use common sense in every case and do what is best, always, as far as possible, sticking closely to the principle of things as laid down by the highest authorities and not bothering about fads and petty details.

Do not be prejudiced against twine because it is called twine, but be careful that it is clean, which is far more important than what material it is made of. Cat-gut makes good suture if procurable, and also wire made of silver is useful in special cases, but the latter must be removed when the

wound has thoroughly healed and no longer requires the support of the stitches. It will be found in nearly all wounds that when once brought together they do best afterwards with the application of dry dressings. Iodoform is excellent but expensive. Mixed with about 10 parts of boracic acid, it makes a useful dressing. Plain powdered charcoal answers well; it has the advantage of being cheap, and there is any amount of it in the bush after burning off. Half boracic and half charcoal does very well. The wound should be continually dusted over with it. Bandages are all right in their way, but if they can be done without, all the better. Wet applications, such as oils and lotions, do not seem to act so satisfactorily as dry dressings; they keep the wound weak, and there is a tendency to a prolongation of the natural process of repair. In the case of a wound that has not been attended to for some few days after the injury has happened, the edges of which are dry and beginning to scab over, it will be necessary, before attempting to bring it together, to scarify or scrape the edges with a knife until raw and bleeding, so as to make it as if it were fresh again and give things another start. Wounds no doubt will often heal if left entirely to nature, but nature does not always make a very artistic job of it, and needs a little help if we do not desire to see ugly blemishes remaining. A blemish, more especially one on the front of the knee of a valuable horse, lowers the value of the animal in the market; and it is wonderful what can be done to avoid such things if wounds are properly attended to and in time.

Flies are a great trouble in this country, as in all warm climates, and every injury requires to be very carefully covered up and kept protected from them. They often poison otherwise healthy wounds, by inoculating them with matter of an injurious nature. Tar, used so frequently in the bush as an application to all sorts of wounds, has certainly much to recommend it, and flies do not care about it. Farmers and those who are isolated in the wilderness and have to depend upon their own ingenuity in cases of emergency would do well to provide themselves with some simple remedies applicable to ordinary injuries.

A few surgical needles, suture thread, bandages, carbolic acid, phenyle, and such like, should always be on hand. As for medicine, well, it should seldom be wanted in this land of sunshine; and when proper attention is paid to the exercising, feeding, watering and housing of the animals, I am of the opinion that most of the physic may be thrown overboard, and it will never be missed.—*Journal of Agriculture, Western Australia, January, 1908.*

CONTAGIOUS ABORTION.

PREVENTION AND TREATMENT OF.

Aborting cows should be isolated from all others and from other breeding female farm animals. Separate stable utensils should be used and, if possible, separate attendants should care for these animals. All stalls where aborting cows have stood should be thoroughly scraped and cleaned and washed with

a solution of blue-stone, 5 ounces to 1 gallon of water. The cow-house gutters should be dressed this way about once a week. The whole of the interior of the stable should be sprayed with a solution consisting of 1 part crude carbolic acid to 30 parts of lime wash.

Spraying stall and floors twice a week with a 1-30 solution of crude carbolic and water is reported to have a very beneficial effect by some breeders, some claiming that the inhaled fumes act as a preventive in pregnant cows.

The vagina of aborted cows should be syringed out daily for a week, or until discharge ceases, with a mixture of alcohol, 1 ounce, corrosive sublimate 1 dram, and glycerine 1 ounce, dissolved in one gallon of water. The vulva, anus, back of the hips and root of the tail should be sponged with this liquid. This external washing may be applied to the whole herd. A 1 per cent. solution of acid carbolic may be used instead of the corrosive sublimate. When a cow aborts, the foetal membranes must be removed as soon as possible and burned or deeply buried with lime, and the stall should be at once cleaned and disinfected as above, and the vagina and external parts treated as described.

Aborting cows should not be bred for two or three months and care should be used in selecting a healthy bull for the purpose. The bull should have his sheath injected and belly washed, before and after service, with a 1 per cent. solution of carbolic acid.

When the disease exists in a district no outside cows should be received for service. Newly purchased cows should be kept isolated and treated as above before bringing them in contact with the others of the herd.

Cows usually abort from the third to the seventh month of gestation. Some very good reports are given of the use of carbolic acid internally in suspected cows, administered at the rate of half a dram daily, with feed. It is prepared by diluting freely with water and then mixing with food. Fattening and disposing of aborting cows will help to rid the herd of the disease.

Thorough disinfection of stable utensils, milk-stools, clothes of attendants, etc., is absolutely necessary, and over a year or more will elapse before you can safely say that you have succeeded. Any half-way measures will prove disappointing.

S. F. TOLMIE, V.S.

CHAPTER V.—ANIMAL PESTS.

GOPHERS AND GROUND SQUIBBELS.

These pests are very numerous in some parts of the Upper Country, doing great injury to crops of all kinds and fruit trees, by gnawing the roots.

The following method is recommended by the U. S. Department of Agriculture for the extermination of gophers:—

Bisulphide of carbon.—In most cases bisulphide of carbon is the simplest agent for the destruction of gophers. It may be used as follows:—Open the gopher hole where one of the freshest hills has been thrown out. Pour two tablespoonfuls of bisulphide on a bunch of cotton rags, tow, waste, or any such material, and push it well down into the hole; then close the opening. The bisulphide quickly forms a heavy suffocating gas that flows down the hole and along the galleries. Wherever it overtakes the gopher he is quickly killed. The whole operation is perfectly simple and easy. The only difficulty arises from the length of the tunnels, which is so great that the animals may be beyond the reach of the gas. Hence it is sometimes necessary to open the tunnel and introduce the bisulphide at two or more places.

The gas has a vile odour. It should be carefully kept from fire, as it is highly inflammable and explosive; otherwise no danger attends its use.

Fumigation.—Rude pumps, known as "fumigators," by means of which the fumes of burning sulphur may be forced into the burrows to suffocate the occupants, are extensively used in some parts of the West, particularly in California. They are, however, clumsy, expensive and less effective than bisulphide of carbon.

Trapping.—Gophers are easily trapped, and once exterminated in a field, others do not soon come in. Their manner of travelling is so slow that only those near the edge of the field will work in during a summer. In the spring the males in their wanderings may settle down in a new place, but this does not often happen. The process of trapping is perfectly simple, although many farmers have assured me that pocket gophers can not be caught in traps. Hence a few directions may be useful. Having selected a fresh hill and observed from which direction the earth is pushed out, dig down on that side until the open hole is found. Enlarge the hole sufficiently to admit a No. 0 steel trap and remove such loose earth as may have fallen in. The trap should be set very lightly, placed well down in the hole, sunk in loose earth to the level of the runway, and partly concealed by sprinkling of fine earth. Finding its hole open the gopher proceeds to repair the breach, in doing which he steps on the trap and is caught. If loose earth is left in the burrow it will be pushed out in front of the animal, covering the trap, so that it will fail to spring.

Other methods of trapping gophers have been tried with varying success, and numerous kinds of traps have been devised for the purpose. Five of these are figured in the bulletin of the Oregon Agricultural Experiment

Station (Bulletin No. 25, April 1893). Many of them are clumsy and expensive, and few, if any, can compete with the common steel trap when the latter is properly used.

Poisoning.—Poisoning is a simpler and more expeditious method of destroying gophers than trapping, but is more laborious than the use of bisulphide of carbon. The use of poison is always attended with danger, for in spite of all precaution, other animals than those for which it was intended are liable to get it.

The usual method is to insert a small quantity of arsenic or floured strychnine into a piece of potato and push the potato as far as possible into a fresh gopher's hole and then close the opening securely. The Honourable J. Sterling Morton, Secretary of Agriculture, has found arsenic on white potatoes and apples efficacious in destroying pocket gophers at his home in Eastern Nebraska.

Phosphorus has been used extensively in California, Washington and Oregon, in destroying ground squirrels, and to a less extent for pocket gophers. Mr. Allen Chattin, of Charter Oak, Iowa, states that he has entirely exterminated the gophers from his own and several neighbouring farms by the use of phosphorus. His recipe is as follows:—

Put a stick of phosphorus in a 5-gallon can with a little cold water; next pour in hot water, not quite boiling, until the can is half full, and stir with a stick. When the phosphorus is melted add, while the water is stirred constantly, 2 pounds of sugar, and immediately after the sugar is dissolved thicken to a stiff batter with corn meal and flour, half-and-half. Now add wheat and stir until stiff. While adding the wheat add also 15 to 20 drops of oil of rhodium. The wheat will soak up all the water in the mass and it will become quite hard. Keep in a cool place. Small pieces may be chipped off as needed. Gophers may get too little strychnine to kill them, but no matter how small a piece of phosphorus they get it will finally prove fatal. Dig down to an open hole, drop in a small piece, put a clod to keep the hole from filling, and cover over with loose dirt to exclude the light.

It should be borne in mind that phosphorus is one of the most deadly poisons. I do not wish to be held responsible for recommending the use of this or any other poison on the farm.

CARRON DISULPHIDE AS A SQUIRREL KILLER.

The use of carbon disulphide (or as is more commonly known, carbon bisulphide) as a solvent for grease and oils has been known for many years. Likewise its use as a germicide and insecticide in agriculture, museums and herbaria has been recognised for a considerable period of time. It has been employed for several years in the extermination of rats, gophers and prairie dogs, but I know of no one who has made careful use of it in the extermination of ground squirrels and then checked up his work. Therefore, I determined to give the substance a most careful test this spring, as my experience with it in former years had been of too haphazard a character to warrant its being placed in a press bulletin. Whenever, during the past two years, I had dug out the run-ways or dens, after employing the disulphide, I had found the squirrels dead, but I had found too few of them to say that it *always* kills them. After a trial this spring, I can state with certainty, that where

employed in the right way and in required amounts, it kills *all* of the squirrels in *all* of their dens. It has been thought that this knowledge would benefit growers of grain, alfalfa, clover or grasses in the State, and has led to the present bulletin.

Description of the Substance.

Carbon bisulphide (or more accurately, disulphide) is made by passing sulphur vapour over coke or charcoal which has been heated to a "cherry red" colour in a vertical retort of cast-iron or glazed earthenware. In so doing, two atoms of sulphur unite with one of carbon, giving us the compound CS₂. It is generally, when impure, as ordinarily sold and used, of a yellow colour and of a sickening fetid odour. When pure it has almost no odour and is glistening white, owing to its high refractive index. It is extremely volatile, that is, passes off readily into a gas, and should, consequently, be closely stoppered. It is extremely inflammable, its vapour taking fire at 149° centigrade, or 300° Fahrenheit, and it should never be used in the presence of lights, pipes or cigars. Its specific gravity is about 1.2923, making it, therefore, considerably heavier than water. In fact, compared with water, which weighs about 8.35 pounds per gallon, this would weigh nearly 10.8 pounds to the gallon. Though more poisonous to the smaller animals and to insects than to man, an unclosed jar or jug of it in a closed room could easily cause the death of the inmates in a short space of time. By keeping it well stoppered, and opened out-doors and away from lights or fires, there is absolutely no danger. I use the special precaution to pour it out, when in the field, on the side of me away from the wind, more to escape the sickening odour than from any real danger.

How to Use it.

Take it to the field in a common gallon or two-gallon oil can with spout. Have with you a bundle of the cheapest cotton, bought at the store or taken from an old unused bedquilt. Have with you also a spade or shovel to fill holes, and a small measure to tell how much of the liquid you pour out. An old tablespoon will answer, but far better is a little wine-glass marked off into "teaspoons" and "tablespoons," which can be purchased at almost any druggist's. By using this, none is wasted and you can tell with exactness how much you wish to employ. Pour out the required amount into the glass, pour it into a handful of the cotton just large enough to prevent the running through and loss of the rather costly liquid, stuff it down into a squirrel hole, throw on two shovels of earth, tramping each tight, fill up the other connecting holes in the same way, and every squirrel in the den will soon be *dead*.

How Much to Use.

In my experiments I tried to determine whether it were better to use a small amount in each hole or a larger amount in one hole but the results were inconclusive, as wherever the squirrels were found they were dead. Both ways have their advantages. If you poison only one hole, you are not sure that all the holes you close, *thinking* they connect with this one, really *do* connect, and you may have to go over the field two or three times before you get them all. On the one hand, of course, much more time is consumed in putting the poison in, say, four holes of the run-way than in one, and is

unnecessary if they connect. I depend much upon my judgment of whether there is a den or not, to which conclusion many things lead you, such as nearness of holes, size of holes, lay of the ground, amount of injury to grain or grasses, etc.

In my experiments this spring I likewise tried to determine how much would kill the squirrels. To be sure of the mortality, we *dug them out*, and did not rest content with seeing whether the holes *remained* closed. This is too uncertain, as visitors or strays may dig out holes from the *outside*.

Time to Use.

It can be put out any time in the day, but is best put out near evening, for two reasons. First, late in the afternoon all of the squirrels have gone into their holes, and the execution is more perfect. In the second place, a great deal of work can be done after supper, when during summer or late spring the evenings are long and darkness does not come till 8:30. It is remarkable the number of holes two persons, one to handle the spade and the other the poison, can attend to in two hours. If a field is simply overrun by squirrels, I would advise using the whole of several days for the principal poisoning, doing the finishing touches after supper.

Cost of Carbon Disulphide.

As retailed by druggists, the cost is high, varying from \$1.75 to \$2.25 per gallon. In five-gallon cans it can be bought for about \$7.50 per can, or \$1.50 per gallon. Owing to the danger in handling it, the freight charges are very high. It is likewise extremely volatile, as before stated, and there is consequently much waste in handling it. Could the farmers unite, however, and get a carload from the manufacturers direct, probably the price could be reduced one-half. I may add in conclusion that, though much more costly than phosphorus, or perhaps even than strychnine, it is *infinitely* better, as it kills all the squirrels in the holes, while food-poisons kill only a small per cent. of them.—*Idaho Bulletin, No. 11.*

WOLVES AND COYOTES.

These pests, particularly the latter, are so numerous and cunning that the production of some classes of live stock, such as sheep and poultry, in the Upper Country, is rendered unprofitable, and the almost human sagacity of coyotes is such that they are rarely caught in traps or killed by poison, and the bounty paid for their destruction, viz., \$2, is not a sufficient inducement for anyone to make a business of hunting them. Therefore, any method that can be suggested by which these wily animals can be circumvented will be hailed with the greatest satisfaction.

A Bulletin recently issued by the U. S. Department of Agriculture says that success in trapping wolves and coyotes depends largely on the use of a scent that will attract them and keep them tramping and pawing until caught. Meat bait alone is of little use, and often, indeed, scares the animals away. Of the many scents and combinations tested, the fetid bait has proved most successful. The following directions for its preparation and use are given:

Place half a pound of raw beef or venison in a widemouthed bottle and let it stand in a warm place (but not in the sun) for two or six weeks, or until it is thoroughly decayed and the odour has become as offensive as

possible. When decomposition has reached the proper stage, add a quart of sperm oil or any liquid animal oil. Lard may be used, but prairie-dog oil is better. Then add one ounce of tincture of Siberian musk, or Tonquin musk. If this cannot be procured, use in its place one ounce of dry, pulverised castoreum (beaver castor), or one ounce of the common musk sold for perfumery. Mix well and bottle securely until used.

After setting the trap, apply the scent with a stick or straw or by pouring from the bottle to the grass, weeds, or ground on the side of the trap opposite that from which the wolf would naturally approach. Never put scent on the trap, as the first impulse of the wolf, after sniffing the scent, is to roll on it.

This bait is very attractive also to cattle and horses, which are sure to tramp over and paw out the traps if set where they can get at them.

The Bulletin also recommends the following method of poisoning wolves and coyotes:—

—No poison has yet proved so effective as pure sulphate of strychnine, provided the proper dose is used. The most effective dose is 4 grains for wolves and 2 grains for coyotes. The common 3-grain gelatin capsules sold by druggists will hold, if well filled, 4 grains of strychnine, and are better than the larger capsules. The regular 2-grain capsules should be used for coyotes. The capsules should be filled, securely capped, and every trace of the intensely bitter drug wiped from the outside.

Each capsule should be inserted in a piece of beef suet the size of a walnut and the cavity securely closed to keep out the moisture. Lean meat should not be used, as the juice soon dissolves the gelatin of the capsule. The necessary number of poisoned baits may be prepared and carried in a tin can or pail. They should never be handled except with gloved hands or forceps. The baits may be dropped from horseback along a scented drag line made by dragging an old bone or piece of hide well saturated with the fetid scent, or they may be placed around or partly under any carcass on which the wolves or coyotes are feeding or along trails which they are in the habit of following.

Gelatin capsules quickly dissolve in the juices of the stomach. Strychnine taken on an empty stomach sometimes kills in a very few minutes, but on a full stomach its action is much slower, and the animal may have time to travel a considerable distance.

Further Instructions.

Circular No. 63, issued by the Bureau of the Biological Survey, Washington, D. C., gives the results obtained during 1907, in the way of wolf destruction. The methods of capturing wolves in common use are three:—(1) Trapping, (2) use of scents, and (3) poisoning. For trapping, the best No. 4 double-spring trap should be used with a heavy stone as a drag. When possible, the trap should be placed between two tufts of grass or weeds, so that it can be readily approached from one side only. The trap, stone and chain should be buried on a run-way. Scent is used to attract wolves to the vicinity of the trap. Fetid bait is made by placing half a pound of raw beef or venison in a wide-mouthed bottle and letting it stand in a warm place for from two to six weeks. When completely decomposed, add a quart of any animal oil, an ounce of pulverised asafetida and an ounce of Siberian or Ton-

quin musk. The mixture should be sprinkled over the grass, weeds and ground near the trap, but never on the trap. No poison is so effective as sulphate of strychnine; 4 grains should be placed in a capsule and inserted in a piece of beef-suet the size of a walnut.

The bounty on wolves, which has been up to the present time \$2 per head, was in January, 1908, raised to \$15.

COUGARS.

Commonly known as panthers, and often called mountain lions, are common on Vancouver Island, and less so on the Mainland, and are the principal enemy of the shepherd, often causing great loss amongst sheep, and to a certain extent amongst pigs. A good dog, who will track a panther and tree him, is about the best protection for a sheep-producer. The bounty on these pests has lately been raised from \$7.50 to \$15 per head. This will, no doubt, offer such an incentive that it is hoped the numbers will hereafter be materially reduced.

SKUNKS

Are a nuisance in several ways; their depredations in hen-roosts are well known, and the malodorous effluvia emitted when they are disturbed is of such a pungent character as to render dwellings uninhabitable on occasions.

Of course, shooting the pests is a quick way of ridding the hen-house, but there arise the disagreeable consequences alluded to. A method which the writer can vouch for, having seen it done, by which all disagreeable consequences are avoided, is to approach the animal gently, and by coaxing it and, as the performer observed, gaining its confidence, a noose at the end of about three feet of line, attached to a short stick, is slipped over its head, and he is at once lifted off the ground and then drowned. Mr. Kimpton, at Windermere, who rids his place by this method, assured the writer that as long as the hind feet of the skunk are kept off the ground, he is incapable of emitting his effluvia.

RACCOONS

Are very prevalent, especially in the vicinity of the sea, where their depredations are principally directed to hen-roosts and fruit. A good dog, such as a large fox terrier, with a little training, soon acquires the trick of tracking coons and killing them. A dog, unaccustomed to the tactics of a raccoon, however, generally comes off second best.

CHAPTER VI.—PESTS AND DISEASES OF BEES.

PESTS OF BEES.

Care of Empty Combs.—Remedy for the Bee Moth.

Almost any bee-keeper will have honey-combs that are for a time unoccupied by bees; even if through no other cause, colonies may have died in winter, leaving combs empty or containing honey or pollen. Such combs are valuable property and will repay the care required to preserve them. The three principal enemies of unoccupied combs are mould, mice and moths.

Combs kept in a damp, close cellar are likely to be affected by mould. This cannot be entirely prevented where bees are wintered in the cellar; for, even if no colonies die, it may happen that some of the outer combs unoccupied by bees will be covered with mould. Fortunately, the remedy is not difficult. Put a mouldy comb next the brood-nest of a prosperous colony in the working season, and you will be surprised to find how soon the bees will clean it up so that you will hardly recognise it as the same comb.

Mice must be kept away from combs by shutting these up in hives or in such other places where mice cannot enter. But be careful that you do not pen the mice in with the combs.

The chief enemy of the apiarist is the wax moth. If a colony dies in the spring and the hive remains unnoticed on its summer stand, it is almost certain that before the summer is over, you will find it containing a solid mass of webs and cocoons, with perhaps not a vestige of comb left. You may have sealed up the hive moth-tight before it is warm enough for a moth to fly; the result will be the same; for the eggs of the moth by some means have been laid, during the previous fall, in the hive, notwithstanding the presence of the bees. It is, however, not an easy thing to make a hive moth-tight, for a moth will squeeze through a much smaller crack than a bee. The right thing to do with a hive full of combs upon which a colony has died is to get the combs as soon as possible in the care of a strong colony of bees. Especially if of Italian blood, the bees will make short work of cleaning out the worms before they are large enough to do much harm.

There will be little danger to the combs from the moth until the weather has become warm and bees have been flying for some time, say, about the time of apple bloom. When a hive is noticed with unoccupied combs, clean out all dead bees, and put it under a hive occupied by a strong colony. If there should be any entrance directly from outside into the upper hive, close it up, so as to oblige the bees to pass through the lower hive in going in and out. Keep the entrance very small the first few days, for fear of robbers. After the colony has had this lower hive in charge for about a week, so as to get it cleaned out and get used to the work, you can give it a second hive of combs to clean out, putting the second in the place of the first.

If colonies have died in hives in the cellar, there will not be the same need of haste as to getting them in care of the bees. Indeed, it may not be a bad plan to take into the cellar hives whose bees have died on the summer stand; for in the cellar the worms will hardly get a fair start until the next spring, when the unoccupied combs will be needed to form swarms. It is well, however, to look at them occasionally to see that they are all right, for it is not difficult to see where the worms have run their silken galleries. The question is often asked whether it will do to hive a swarm in a hive in which a colony has died. Unless such a hive is exceedingly filthy, the bees will promptly clean it up, at the same time being saved much labour in building new combs.

It is well to know that freezing* destroys the worms. So a hive of combs that has been left out all winter is in no danger of worms until well along in warm weather, when moths have had time to mature and to lay eggs. If such combs are hung up in an airy place with a space of an inch between them, they will almost surely be safe from worms throughout the summer, and indeed worms may not trouble them all summer if left in the hive in their usual position.

If for any reason it is desired to kill worms in combs, sulphur is the material usually resorted to. A very little of the fumes of burning sulphur will finish the worms when they are quite small, but when full grown it takes a very heavy dose; so it is well first to pick out the larger ones by hand. For this take a sharp pointed knife and pick out the comb at one end of the silken gallery for half an inch, then commence at the other end and tear it open the whole length. This will drive the worm along till it comes out of the hole you first made. You can end its existence by what means may seem best. To fumigate a hive with sulphur, set into a pan or kettle partly full of ashes a small vessel of *iron*. In this put the sulphur and throw on it a shovelful of live coals or a red hot iron. This must be in an empty hive or some tightly-closed box or chamber, so that the fumes cannot escape. Great care must be exercised so that the fire does not extend to the surrounding wood. The combs placed over the burning sulphur may be prevented from catching fire by means of a piece of old sheet-iron placed under them. It must be further remembered that burning sulphur destroys only the worms, not the eggs. So it may be necessary to treat the combs a week or two later, when any eggs laid will have hatched.** Combs of honey for table use are not likely to be infested with worms; but in the case of black-bees, especially if the combs are left too long in the hives, there might be some worms. The dose of sulphur for these may be lighter than for brood combs; if the dose is too heavy, the white combs will assume a greenish colour, which, however, does not hurt them for eating.

When extracting combs are extracted for the last time in the season, it is the practice of most bee-keepers to allow the bees to lick them dry. A hive full of such combs may be placed over a colony, a propolis quilt with a small opening through it having first been placed over the brood frames, and this allowing but one or two bees to pass at one time. Thus the bees are not so apt to break down the combs and there is less danger of robbing; but a surer way is to set the hive at some distance from the apiary and let the bees have

*Note by Mr. E. F. Robinson.—Hard freezing, zero at least.

**Note by Mr. Robinson—Spoad.

free play at it. After being thoroughly cleaned, all hives containing combs should be removed to a dark room until late in the autumn, and then to a building where they will get the full benefit of frost during the winter.—*Dr. Fletcher, Report 1905.*

American Foul Brood.

American foul brood (often called simply "foul brood") is distributed through all parts of the United States and from the symptoms published in European journals and texts one is led to believe that it is also the prevalent brood disease in Europe. Although it is found in almost all sections of the United States, there are many localities entirely free from disease of any kind.

The adult bees of an infected colony are usually rather inactive and do little toward cleaning out infected material. When the larvæ are first affected they turn to a light chocolate colour, and in the advanced stages of decay they become darker, resembling roasted coffee in colour. Usually the larvæ are attacked at about the time of capping, and most of the cells containing infected larvæ are capped. As decay proceeds these cappings become sunken and perforated, and, as the healthy brood emerges, the comb shows the scattered cells containing larvæ which have died of disease, still capped. The most noticeable characteristic of this infection is the fact that when a small stick is inserted in a larvæ which has died of the disease, and slowly removed, the broken-down tissues adhere to it and will often stretch out for several inches before breaking. When the larva dries it forms a tightly adhering scale of very dark brown colour, which can best be observed when the comb is held so that a bright light strikes the lower side wall. Decaying larvæ which have died of this disease have a very characteristic odour which resembles a poor quality of glue. This disease seldom attacks drone or queen larvæ. It appears to be much more virulent in the Western part of the United States than in the East.

Treatment of Infectious Diseases.

Drugs, either to be given directly in food or to be used for fumigating combs, cannot be recommended for either of these diseases.

Shaking treatment.—To cure a colony of either form of foul brood it is necessary first to remove from the hive all of the infected material. This is done by shaking the bees into a clean* hive on clean frames with small strips of comb foundation, care being taken that infected honey does not drop from the infected combs. The healthy brood in the infected combs may be saved, provided there is enough to make it profitable by piling up combs from several infected hives on one of the weakest of the diseased colonies.** After a week† or ten days all the brood which is worth saving will have hatched out, at which time all these combs should be removed and the colony treated.‡‡ In the case of box-hives or skeps the bees may be drummed out into another box or preferably into a hive with movable frames. Box-hives are hard to inspect for disease and are a menace to all other bees in the neighbourhood in a region where disease is present.

*Mr. E. F. Robinson recommends new hives and new frames, with half-inch strips of comb foundation.

**Entrance should be closed to about half-inch.

†After 21 days.

‡‡Bees treated as before and united to a new colony or given a laying queen, killing the poor one in the weak colony.

The shaking of the bees from combs should be done at a time when the other bees in apiary will not rob and thus spread disease, or under cover. This can be done safely in the evening after bees have ceased to fly, preferably during a good honey flow. Great care should be exercised to keep all infected material away from other bees until it can be completely destroyed or the combs rendered into wax. Wax from diseased colonies should be rendered by some means in which high heating is used, and not with a solar wax extractor. The honey from a diseased colony should be diluted to prevent burning and then thoroughly sterilized by hard boiling for at least half an hour, if it is to be fed back to the bees. If the hive is again used, it should be very thoroughly cleaned,[‡] and special care should be taken that no infected honey or comb be left in the hive.^{‡‡}

It is frequently necessary to repeat the treatment by shaking the bees on to fresh foundation in new frames after four or five days. The bee-keeper, or inspector, must determine whether this is necessary, but when there is any doubt it is safer to repeat the operation rather than run the risk of re-infection. If repeated, the first new combs should be destroyed. To prevent the bees from deserting the strips of foundation, the queen may be caged in the hive, or a queen-excluding zinc put at the entrance.

Treatment with bee escape.—The shaking treatment may be modified so that, instead of shaking the bees from the combs, the hive is moved from its stand, and in its place a clean¹ hive with frames and foundation is set. The queen is at once transferred to the new hive, and the field bees fly there when they next return from the field. The infected hive is then placed on top of or close beside the clean hive and a bee escape placed over the entrance of the hive containing disease, so that the younger bees and those which later emerge from the cells may leave the hive, but cannot return. They, therefore, join the colony in the new hive.

Fall treatment.—If it is desirable to treat a colony so late in the fall that it would be impossible for the bees to prepare for winter, the treatment may be modified by shaking the bees into combs with plenty of honey for winter.² This will be satisfactory only after brood-rearing has entirely ceased. In such cases disease rarely re-appears.

In the Western States, where American foul brood is particularly virulent, it is desirable to thoroughly disinfect the hive by burning the inside, or by chemical means before using it again. This is not always practised in the Eastern States where the disease is much milder. Some persons recommend boiling the hives or disinfecting them with some reliable disinfectant such as carbolic acid or corrosive sublimate. It is usually not profitable to save frames, because of their comparatively small value, but if desired they may be disinfected.³ Great care should be exercised in cleaning any apparatus.⁴ It does not pay to treat very weak colonies. They should either be destroyed at once or several weak ones be united to make one which is strong enough to build up.

¹Hive should be scalded by pouring boiling water all over it, especially the inside.
²Or about the apiary.

Notes by Mr. E. F. Robinson.—1. New hives and new frames in all cases are better, as used material may not be absolutely clean. 2. Better feed them upon 20 lbs. of sugar syrup. 3. Cut out the combs, render the wax, and burn the frames. 4. Scald and boil everything possible, or bake.

Recently some new "cures" have been advocated in the bee journals, particularly for European foul brood, with a view to saving combs from infected colonies. The cautious bee-keeper will hardly experiment with such methods, especially when the disease is just starting in his locality or apiary, but will eradicate the disease at once by means already well tried.

In all cases great care should be exercised that the bee-keeper may not himself spread the infection by handling healthy colonies before thoroughly disinfecting his hands, hive tools and even smoker. Since it takes but a very small amount of infected material to start disease in a previously healthy colony, it is evident that too much care cannot be taken. In no case should honey from unknown sources be used for feeding bees. Care should also be exercised in buying queens, since disease is often transmitted in the candy used in shipping cages. Combs should not be moved from hive to hive in infected apiaries.

"Pickle Brood."—There is a diseased condition of the brood called by bee-keepers "pickle brood," but practically nothing is known of its cause. It is characterised by a swollen watery appearance of the larvæ, usually accompanied by black colour of the head. The larvæ usually lie on their backs in the cell, and the heads point upward. The colour gradually changes from light yellow to brown, after the larvæ die. There is no ropiness, and the only odour is that of sour decaying matter, not at all like that of American foul brood. In case the larvæ are capped over, the cappings do not become dark, as in the case of the contagious diseases, but they may be punctured. So far no cause can be given for this disease, and whether or not it is contagious is a disputed point. Usually no treatment is necessary beyond feeding during dearth of honey, but in very rare cases, when the majority of larvæ in a comb are dead from this cause, the frame should be removed and a clean comb put in its place, to make it unnecessary for the bees to clean out so much dead brood.

Chilled, Overheated and Starved Brood.—Many different external factors may cause brood to die. Such dead brood is frequently mistaken, by persons unfamiliar with the brood diseases, for one or the other of them. Careful examination will soon determine whether dead brood is the result of disease or merely some outside change. If brood dies from chilling or some other cause, it is usually soon carried out by the workers, and the trouble disappears. Brood which dies from external causes often produces a strong odour in the colony, but wholly unlike that of American foul brood, merely that of decaying matter. The colour of such brood varies, but the characteristic colours of the infectious diseases are usually absent, the ordinary colour of dead brood being more nearly gray.—*U. S. Circular No. 79.*

Note by Mr. E. F. Robinson.—*The established principles underlying the cure of foul brood are:—First, shake the bees into hives and fixtures, absolutely without contagion; new are the best. Secondly, compelling the bees to use all the honey in their honey sack, which they loaded themselves with when opened up before shaking, into wax for new comb, as it has been proved beyond doubt that it is the honey mostly that carries the contagion, being polluted by spores thrown off from the diseased dead larvæ.

CHAPTER VII.—PLANT DISEASES.

CROWN GALL OR ROOT GALL. Fig. 17.

This disease causes galls to appear on the roots of various trees and shrubs. On fruit trees it commonly forms spherical swellings of various sizes, occasionally as large as a walnut. These globular bodies have usually a peculiar warty surface. They should not be confused with the galls formed by woolly aphis, which, moreover, are smaller and usually oval or irregular. Besides, in aphis galls some of the "wool" is usually to be found.

It frequently happens that when the roots are affected with this disease the secondary roots are abnormally abundant and often somewhat spongy in texture.

Particular attention is called to this disease, because a good many nursery trees have been sold in the North-West with the roots affected by it. A safer rule is to reject all trees diseased with the galls, even if the latter have been removed. We have found that they are sure to appear again.

No remedy is known, and, as the disease appears to be contagious, every effort should be made to prevent the sale of nursery stock affected by it.

Prof. J. W. Toumey has recently discovered in Arizona that the crown gall of the almond is caused by a slime mould which he names *Dendrophagus globosus*.

I have been unable to discover this or any similar organism in the galls on apple roots.—U. S. Department of Agriculture, Bulletin 153—Piper.



Apple Crown Gall on grafted tree.

Hairy Root Disease on grafted apple tree.

(FIG. 17.)—Bull. 90, U. S. Department of Agriculture.

A paper on Crown Gall, by Prof. E. A. Popenoe, Entomologist, Kansas State Agricultural College, concludes as follows:—

"In closing I may say that as I read the results of experiments to check the growth of crown gall, they appear to be practically futile so far; and about all that can be done by the planter is to examine closely all trees before planting and burn any found infested; by the nurseryman to follow rigorously, and for his own final interest, the present practice of the conscientious grower, of burning all trees found, on digging, to be infested, and giving himself the benefit of the doubt that yet remains, to practise a strict rotation of susceptible trees with other crops or those not capable of infection."

GALL ON LINDEN TREES (*Eriophyes abnormis*.)

Gall on Linden trees occurring at Victoria was referred to Dr. Fletcher, who replied as follows:—

"The Linden leaf is the work of *Eriophyes abnormis*, Garman. This is a common gall on the basswood and linden, but cannot be said to do much harm other than producing an unsightly appearance on the leaves."

APPLE AND PEAR SCAB (*Fusicladium dendriticum* and *F. pirinum*.)

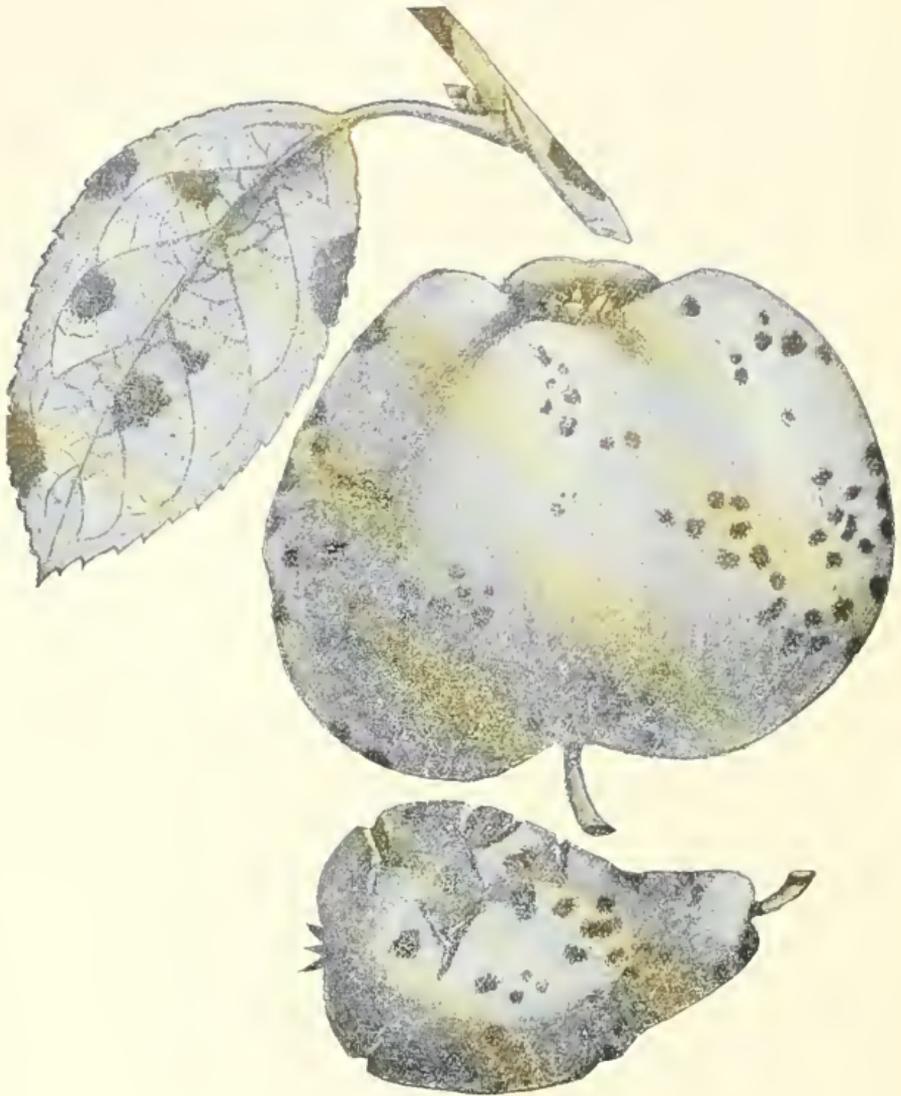
Description.

Although the fungi causing scab on apples and pears respectively are different species, they are very closely allied; but as the general appearance of the disease and the methods of treatment in each case are identical, separate descriptions are not necessary.

Scab is probably the most general and most widely distributed of fungus diseases attacking apples and pears, and during certain seasons the entire crop is much depreciated in value, or rendered altogether unsaleable, owing to the presence of numerous blackish blotches or scabs and gaping cracks on the surface.

To the casual observer scab is only recognised on the fruit, whereas in reality the fungus appears first on the leaves and young shoots, from whence the spores are washed by rain on to the fruit, which is the last to be attacked. If the fruit is nearly full-grown before it is infected, the spots formed by the fungus remain small and are irregularly scattered over the surface. Although the market value is thereby depreciated, such fruit is not materially injured, the scab being quite superficial. If, however, infection occurs when the fruit is young, its further growth is checked; the surface becomes more or less covered with scabs of various sizes, and at a later stage is irregularly cracked. On the leaves and young shoots the fungus forms minute velvety, dark-coloured patches, which have an olive-green tint when the spores are ripe.—*Board of Agriculture and Fisheries, Leaflet No. 131.*

The apple scab fungus has two stages—a summer, or parasitic stage, and a winter, or saprophytic stage. The summer stage infests the leaves, flowers and fruit; the winter stage lives in the dead leaves of the apple which fall off in autumn. The winter stage develops from the summer stage in the leaves, after they fall off in autumn. The winter stage produces the spores that cause the infection of the flowers, leaves and fruit in spring.



Remedies.

To destroy the fungus, destroy the fallen leaves in the fall or winter. To prevent the fungus attacking the apple in spring, spray with a properly prepared Bordeaux mixture.

The above experiments sprayed twice at the proper time, or just before the flower-buds opened and just after the petals fall, clearly indicate the value of the Bordeaux mixture as a preventive of the scab disease. It is also evident that two applications of the mixture, when properly prepared and

used at the proper time, will, to a large degree, prevent the ravages of the fungus. From past experience it is thought doubtful that a third application does sufficient good to make it worth trying. The only spray to be recommended at this writing is a properly prepared Bordeaux mixture of 6-4-50 formula. Further experiments may show that a weaker Bordeaux can be used with good results—that point has not yet been determined.—*Washington Experimental Station Bulletin No. 67.*

BLACKSPOT CANKER.

(*Macrophoma curvispora*, C. H. PECK; *Glocosporium malicorticis*,

A. B. CORDLEY.)

Common Name of the Disease.

Blackspot canker is known under a number of different names. Canker, Black canker, Blackspot Apple canker, Blackspot, Dead spot Apple tree Anthracnose and Sour Sap disease, are several of the names applied to it. There are several somewhat similar diseases of the apple throughout the United States. Among these are the New York Apple tree canker and the Illinois Apple tree canker. The term canker is a general one that includes nearly all the diseases involving the bark of trees. In order to retain uniformity of names and to retain the name which so accurately describes the canker, the author has chosen to use the common name of Blackspot canker.

Occurring on both Fruit and Bark.

Parasitic in the bark and sapwood of the trunk and the branches and on the stored fruit of the cultivated apple.

In the Bark.—Infested areas depressed, dark brown to blackish, oblong in outline one-fourth to six inches in length or longer; sometimes merging together when fully grown, free from the sapwood and bounded by a ragged fissure.

On the Fruit.—Decaying spots light to dark brown, concave, dry and leathery; acervuli numerous, usually larger than those in bark, usually concentrically arranged.

Cause of the Disease.

Numerous theories have been offered in explanation for the occurrence of the disease. Nearly all these theories have been abandoned. One which has been recently promulgated is the sour sap theory. This holds that the trees have been feeding on an excess of nitrates; that nitrates collect in the bark of the tree; that fermentation takes place and puts the bark in such a condition that the fungus is able to penetrate it. Such a theory is easily refuted by testing the bark for nitrates. Such tests have been made of infested bark in all stages and of healthy bark, and in neither case have nitrates been found.

It has been known and definitely proven for a period of several years that the canker is caused by a parasitic fungus. According to Minto (1), Pierce as early as June, 1895, grew the fungus from diseased bark collected at Olympia, Washington, inoculated healthy trees in the Sacramento Valley,

California, with the fungus and obtained the typical cankers. During the winter of 1900, D. A. Brodie produced the disease on apple twigs placed in water in the laboratory by inoculating them with bits of diseased bark collected in the field. Cordley (2) germinated the spores of the fungus in artificial cultures. Later, when the mycelium was developed far enough to be seen by the naked eye, the fungus was transferred to tube cultures. Later inoculations were made in apple twigs with the fungus. The fungus attacked the bark and caused small cankers, showing definitely that the fungus is the cause of the disease. Prof. C. V. Piper has done considerable work on the fungus and has reached similar results. All of the above work has been successfully duplicated by the writer and some additional work has been done on the life history of the fungus.

Insects Associated with Blackspot Canker.

In some localities where this disease exists, two kinds of insects work in or near the wounds caused by the fungus. One or both may sometimes be found in the same orchard.

The Bronze Apple-tree Weevil (Magdalis anseucus, Lev.).—The adult females are small bronze or nearly black beetles with long beaks. About the time the cankers are mature in size these beetles eat holes in the bark near the margins of the cankers. A single egg is deposited in each hole. A few to several hundred of these eggs may be deposited around a single canker. The work of the beetle and of the larvæ retard or prevent the growth of a callus.

The Woolly Aphis (Schizoneura lanigera, Hausmann).—After the cankers are surrounded by a fissure split down the centre, or the diseased bark has fallen out, the woolly aphis finds its way into the wound. The aphides multiply rapidly and soon involve the entire callular tissues. The action of these insects on the tissues causes them to become abnormal, forming a thick knotty callus which does not grow enough to close the wound.

General Description.

The time that new cankers make their appearance during a single season varies considerably with the seasons. Vary rarely new ones start during July and August. Their appearance at this time is exceptional and occurs only when weather conditions are favourable. They are few in numbers and never developed enough to be of economic importance. The first cankers that appear in the fall are usually found about the first week of November on the tender twigs of one and two years' growth. Others appear on the trunk and large limbs later in the season. The cankers that do the damage appear from early in November to early in February. The greater number appear during late November and early December.

When the young cankers have developed enough to be seen by the naked eye they are round, somewhat sunken and dark coloured—a colour characteristic of the infested areas. The canker increases very slowly in diameter, but the fungus penetrates through the bark into the sapwood beneath. Having entered the cambium or growing layer between the bark and the sapwood layers it grows rapidly and soon involves a considerable area of it—often many times larger than the outer portion of the canker. With the return of

the growing season of the host the cankers increase rapidly and are fully grown by the last of June, or a little later. When mature the fungus has involved the overlying epidermis, so that the outer portion of the canker is about the same size as the area of infested cambium beneath.

At first the cankers are circular, but later they become oblong in outline and nearly black in colour. When the cankers are mature in size the bark becomes dry and brittle and the dead tissues separate from the surrounding living ones, leaving a marked fissure. Beyond this fissure the fungus never spreads.

The mature cankers measure one-fourth of an inch to six inches or more in length by one-fourth to five or more inches in width. Very often they appear to be of much larger dimensions, but, as a rule, the larger ones are the result of two or more cankers merging together.

After the cankers are full grown the rest of the life of the fungus is spent in maturing the spores. The first indication of the formation of spores is a slight roughening of the epidermis at the centre of the canker, caused by the developing pustules. Later, other pustules appear nearer the margin, so that there are, near the close of the season, spores in all stages in a single canker. When the pustules are mature the over-lying epidermis has ruptured, exposing a creamy white mass which later becomes black. This mass is composed of hundreds of spores and a substance soluble in water. As the older pustules open first, spores are discharged from a single canker for a considerable period of time. The bark remains on the tree for a time and then drops out, leaving a scar.

Remedies.

Cutting out the Cankers.—Removing the cankered bark is an expensive and laborious method. It is possible to keep the disease in check on small young trees, when little diseased, by keeping all the cankers cut out. When the trees are large and have hundreds of cankers on them, with new ones appearing from November to February, it is impossible to keep the disease in check by such a method. In some cases the fungus matures spores in the sapwood even after the infested bark has been removed.

Double strength Bordeaux proves to be a valuable preventive when applied before the fungus attacks the trees in autumn.—*Washington Experimental Station, Bulletin No. 66.*

APPLE AND PEAR CANCER (*Nectaria ditissima*.)

Old canker-eaten trees which are, commercially, absolutely useless, are frequently left quite neglected from year to year. These only serve as nurseries for the spread of the disease for miles around, as the minute spores of this fungus can easily be blown for long distances by the wind. One of the main reasons for this apparent apathy is that many fruit-growers look upon canker as caused through some special physical condition of the soil, and not as the result of attack by a parasitic fungus. Thus they consider that preventive measures are quite beyond their control, and they do not rank this affection as a contagious disease and one that by the employment of certain methods can be kept well in check.

Cause of Canker.

True apple canker is caused through the infection of the tree by a parasite fungus known as the canker fungus (*Nectaria ditissima*). The spores of this fungus gain admission into the tissues of the tree through wounds which are always to be found on fruit trees. Hence the fungus belongs to that group of fungi which are often termed wound-parasites. Trees may have also what may be called "false canker," where the effects resemble those of true canker, but in them the nectaria fungus is not to be found. The cause of this "false canker" has been attributed to bacteria, and the researches of Byrzejinski seem to point to this conclusion.

Prevention and Remedies.

When young trees are attacked all affected branches should be carefully cut off below the point of infection and burnt. The exposed cut should then be protected with a coating of ordinary gas-tar. When thick branches are diseased the affected parts may be cut out and the cuts treated with tar.

It is most important never to use scions from a tree that is or has been diseased; through the neglect of this precaution thousands of young stock have been ruined. Where trees have been neglected and are badly diseased they should be cut down and burnt.

Healthy and diseased trees should not be pruned with the same knife, as spores are often carried from tree to tree during pruning, and the newly-cut surfaces offer an admirable starting place for fresh infection. The tools should be sterilised after pruning an infected tree.

Spraying is of very little use in destroying this disease; still, lime-and-sulphur mixture seems to lessen its ravages considerably. Proper cultural methods, and the keeping of the trees in a vigorous state, will generally prove successful in warding off this disease.—*New Zealand Bulletin No. 10.*

GUMMOSIS

Is the name given to a disease which attacks stone fruits, especially sweet cherries. Its nature is not well understood, and is described in Michigan Bulletin 25, as follows:—

The flow of gum from branches of plum, peach, cherry, almond, etc., has in some cases been attributed to the presence in the tissues of a parasitic fungus. Thus Masee described a gummosis of the flowering almond due to the attacks of *Cladosporium epiphyllum*, and a similar trouble on the same plant has been noted by the writer under the head of Brown Rot of Plum (*Sclerotinia fructigena*).

Cladosporium epiphyllum has also been found causing gummosis on the purple-leaved variety of the Myrobalan plum, grown for ornament at the Agricultural College, while the same disease on cultivated plums has been found to be associated with a species of *Cladosporium*. In many cases the trouble probably begins in some crack or wound which allows the fungous parasite to gain an entrance. The presence of the mycelium induces a flow of sap which exudes and hardens, forming tear-like drops, sometimes of considerable size. This gum is partly utilised by the fungus in the production of more spores. The portion of branch beyond the affected spot may in some

cases be killed or permanently weakened. In such cases the branch should be cut off below the diseased area and burned. The use of fungicides will serve to reduce the tendency towards gumming.

Boring insects of the peach, plum and cherry may also cause a flow of gum from the wound made in entering, and these wounds probably often serve to allow the entrance of fungi, hence the desirability of combating the insect enemies of these trees.—*Michigan Bulletin No. 25.*

FIRE BLIGHT (*Bacillus amylovorus*, BURRELL.)

That species of blight which is sometimes called "fire blight" frequently destroys trees in the fullest apparent vigour and health, in a few hours turning the leaves suddenly brown, as if they had passed through a hot flame, and causing a morbid matter to exude from the pores of the bark of a black ferruginous appearance; this happens throughout the whole course of the warm season.

Symptoms.

The first indication of fire blight is seen either in the browning and subsequent blackening of the leaves, or of the young twigs, or of the tender shoots. When the twigs or shoots are the principal parts affected the disease is spoken of as twig blight. Pears show the presence of the disease more frequently by the blighting and blackening of the leafy tufts of the spurs, and show it especially by the darkening of the blossom clusters on the larger clusters, while later the branches themselves become blackened. The progress of the disease is always downward, an inch or more each day, depending upon the season, until the larger branches are infected. In the more susceptible varieties it spreads more quickly, involving the whole tree; but in the more resistant varieties the progress of the disease is not so fast. When the disease is active the bark of the diseased branches cracks, and a thick, blackish, gummy fluid exudes, and later the infected bark becomes hardened, dry and shrunken. The disease occasionally appears on the larger branches and trunks of fruit trees when these have been bruised or otherwise injured, when its appearance is similar to the injury known as "sunburn" or "sun-scald." This disease of the trunks or larger branches is sometimes spoken of as "body blight" or "rough bark." The inner bark and cambium layer of the limbs and trunk are the most important parts of the tree killed by the blight. Instances are known of its attacking the fruit, producing watery ulcers accompanied by brown discolouration and decay. The disease may be known by its peculiar odour, said by some writers to resemble putrefaction.

When the disease is in progress, the discoloured blighted portion blends gradually into the colour of the normal bark, but when the disease has stopped there is a sharp line of demarcation between the diseased and healthy portions.—(*Waite.*)

Conditions Affecting the Spread of the Disease.

Fire blight differs in severity in different localities, and there are a number of conditions which affect the character and progress of the disease.

Every tree of the pome family is subject to the blight, but pears and quinces are more susceptible than plums and apples. The mountain ash,

service berry and hawthorn are frequently diseased, but not to such an extent as the first-named trees. There is a difference in the susceptibility of varieties. Thus, among pears, Clapp's Favorite, Flemish Beauty, and Bartlett are more liable to the disease than Keiffer and Duchess, and amongst apples, the Crab varieties are the least resistant.

Climatic conditions influence the disease; warm, moist weather with much rain favour it, whilst bright, dry, sunny weather tends to check it.

High cultivation, rich soil, heavy manuring, free use of fertilisers, heavy pruning, or any other treatment which has a tendency to induce new and succulent growth, favours the disease, as the bacteria grow with far greater rapidity and penetrate more quickly from cell to cell when the tissues are gorged with sap. Insects are more partial to young succulent shoots and leaves, and the bites and punctures of such insects whose mouth parts may be contaminated with pear blight germs often serve to infect the tree.

It is thus manifest that healthy, thrifty, vigorous, well fed and well cultivated trees *are more liable to the disease than others*, and hence the severity of an attack of fire blight may be lessened by conditions which are under the control of the grower.

Treatment.

The treatment of fire blight is of two kinds—that which is designed to put the tree in a condition to withstand the attack of the blight microbe, and these methods which aim at the extermination of the casual bacterium. Unfortunately, all methods which are used for hindering the attack of the microbe consist of restraining the full development of the tree, and hence any such system of procedure should not be followed unless an orchard is very badly attacked.

High cultivation, with pruning and the other conditions already mentioned as predisposing trees to blight, should be avoided, but the trees should be allowed to ripen the wood, and in order to do this the fruit-grower must use any method which will check the amount of moisture in the soil—for instance, by the growth of a clover crop.

The fire blight organism cannot be exterminated by spraying, as the microbe lives in the tissues beneath the outer bark, and it is impossible to reach it with any spraying solution, for, unless the bacteria come into contact with the germicide, spraying is ineffectual.

There is, therefore, but one remedy, to cut out and burn the affected parts of the tree. It is very necessary when cutting out a diseased branch or twig to cut well below the discoloured portion, as the bacteria are in most cases far below the discoloured portion, the discolouration not being produced immediately upon the appearance of a few bacteria, so that if only the discoloured portion were cut off numbers of bacteria would still be left in the stump, and these would continue to multiply, and the disease would soon be evident again.

Cutting of affected parts may be done at any time in the winter and spring, but it is not advisable to cut in the growing season, as fresh cases may be constantly occurring, and these, owing to lack of sufficient development, would not be seen.

The best time for cutting out affected branches is towards the fall, or when the trees have stopped forming new wood, when most of the blight has developed, and when the contrast between the discoloured leaves and branches and healthy tissues is easily seen.

Trees should be carefully inspected for blight during the winter and in spring before the blossoms come out, in order to destroy any affected parts that may have been missed at previous inspection.

All trees of the pome family in the vicinity should be examined as well, as these, if blighted, may serve to re-infect an orchard which has been carefully treated.

In cases where the bark of the trunk is affected, it can be cut out and the wound covered with a lead or oil paint. The cut surface of the branches over one-half inch in diameter should also be painted.—*F. C. Harrison, Ontario Bulletin, No. 136.*

When a tree blights, remove and burn at once, outside the orchard, every trace of diseased wood. Saw off the smaller branches about a foot below the least sign of disease, and dig out the spots on the trunk and larger limbs, cutting deep enough to remove all discoloration. The knife and saw used in pruning should always be disinfected with carbolic acid before leaving each tree, to avoid infecting the freshly-cut healthy wood of the next tree. The exposed surfaces should be at once painted to exclude germs that may be floating in the air.—*Oregon Bull. 27.*

LEAF BLIGHT OF PEARS (*Entomosporium maculatum*, LEV.).

The fungus causing this disease attacks the leaves and fruit of the pear and quince. On the leaves it produces small rounded spots of a brownish-red colour. On the fruit the spots soon lose their reddish colour, becoming much darker, while the surface sometimes becomes cracked in severe cases as with the scab. In the centre of the diseased spots small pimples may be seen, due to the formation of spores beneath the epidermis. Later these cracks open, allowing the spores to escape.

The spores themselves are very peculiar, each being composed of two large and several small cells, united and possessing several bristle-like processes giving them an appearance suggesting some kind of an insect. It is sometimes especially bad on nursery stock in the row.

It is quite readily controlled by the Bordeaux mixture, about three applications serving to keep the foliage and fruit free from the disease.—*Michigan Bulletin No. 25.*

The Shot-hole fungus (*Cylindrosporium padi*, K.) penetrates the entire leaf, but congregates in spots to produce spores. Here the tissue dies, becomes brittle and soon breaks away, riddling the leaves, which turn yellow and fall prematurely.

Remedy.

Spray with Bordeaux mixture or ammoniacal copper carbonate about June 1st, and every three weeks thereafter, if the disease is bad.—*Oregon Bulletin No. 27.*

ROTS.

To the uninitiated all "Rots" are pretty much the same, but a moment's reflection will show that if a remedy or preventive is to be forthcoming, the disease must be properly diagnosed. The following "Rots" affect fruit:—

1. Bitter rot or Ripe rot, due to a fungus scientifically named *Glосporium fructigenum*, Berk. This produces a soft brown rot, and the fungus is readily determined under the microscope.

2. Brown rot, which attacks a great variety of fruits besides the apple, is caused by a fungus which produces its spores in chains, and hence called *Monilia fructigena*, Pers.

3. Mouldy core, which begins at the core of certain varieties of apples and spreads outwards until the entire apple becomes rotten and worthless, is caused by the same fungus as the disease. It is simply a case of infection starting from the centre instead of from the circumference, and is naturally prevalent in those apples which have a passage at the blossom end leading to the core.

4. "Mouldy Rot" gives a mouldy taste to the apple, and is due to a fungus which is very common indeed, the "Blue-green Mould" or *Penicillium glaucum*, Link. I have called it the "Blue-green Mould" because there is a so-called "Blue Mould" on tobacco which is quite distinct from this one.

The *Penicillium* is everywhere present, and is more generally regarded as attacking decaying or decayed fruit, than as being itself the cause of decay.—*Victoria, Australia, Bulletin No. 30.*

BITTER ROT (*Glomerella rufo-maculans*, BERK.).

The diseased spots are usually a quarter to a half-inch in diameter before the fruit-grower ordinarily notices them, but they first appear as very small, yellowish-brown, sometimes watery, specks, frequently bordered with a ring of purple-red. The purplish margin is especially prominent on spots that are retarded by cool weather, and many late infections appear only as red or purplish specks, never developing farther on account of adverse conditions. On the other hand, the purplish colouration is likely to be entirely absent from a spot that is developing rapidly under favourable conditions. As the spot enlarges and grows older it becomes dark-brown in the centre, shading off into a light, watery margin. It is circular in outline, with a well-defined margin, and soon becomes sunken.

When the spots are about one-half inch in diameter, fruiting pustules begin to appear in the form of small black dots, slightly raised and usually arranged in concentric rings. These pustules soon break through the skin, discharging pink, sticky spore masses, which are readily washed off by dews and rains. As the disease progresses, other rings of pustules appear and give forth spores in great abundance. When the pink spore masses are washed away the pustules appear as black, ragged openings through the skin of the apple. An apple may have only one diseased spot, but in a serious outbreak there are usually several, and it is not uncommon to see a fruit literally peppered with points of infection. During the past season the writer counted 1,200 on a single apple, and estimated 1,000 on each of several others. When so numerous,

these spots are at first raised, appearing as small brown blisters on the skin of the apple, and are frequently so arranged as to suggest that the points of infection had followed drops of water trickling down the sides of the apple, the specks being distributed evenly over the upper or stem end, from which the specked areas extend in strips toward the calyx end.

When a number of spots appear on a single apple they soon coalesce, and three or four gaining the ascendancy, envelop the others and retain their circular shape, each producing its rings of fruiting pustules. Finally, the entire fruit is converted into a dark-brown shrivelled and wrinkled mummy, which may hang on the tree a year or more. However, the majority of the affected fruits fall to the ground before they are half rotten, and their decomposition is hastened by scavenger insects and decay fungi.

Influencing Conditions.

Weather.—The predominating conditions that influence the development of bitter-rot are temperature and humidity. A few rays of hot, showery weather may start an epidemic that will destroy the entire crop of certain varieties, provided the fungus is present.

Moisture.—Moisture is not only necessary for the germination of the spores, but it favours the growth of the fungus and hastens spore production. In a moist atmosphere the spores are produced much more rapidly than when the air is dry. Moreover, rain is an active agent in the spread of the disease, splashing the spores from an infected apple to adjacent healthy fruits. Heavy dews, followed by hot cloudy days with a humid atmosphere, appear to make ideal conditions for the rapid development of this disease.

Conclusions and Recommendations.

Summarising the results obtained, and considering the fact that the experiments were made during a season unusually favourable to bitter-rot, the following conclusions may be drawn:—

1. Bitter-rot can be completely controlled by proper applications of Bordeaux mixture, 93.3 to 98.9 per cent, of sound fruit having been saved by such treatment in these experiments, while the checks rotted completely.

2. Four applications, when made just at the right time, are sufficient to control the disease satisfactorily, but in order to be sure of covering the infection periods one or two additional applications may be necessary.

3. The applications should be made at intervals of two weeks, beginning about six weeks after the trees bloom.

4. It is necessary to spray the trees thoroughly, coating the fruit on all sides with fine mist-like applications.

5. Other diseases, such as scab, leaf-spot and sooty-blotch, may be controlled in connection with the treatment of bitter-rot.

For the treatment of bitter-rot alone, spray the trees thoroughly with Bordeaux mixture at intervals of two weeks until five applications have been made, beginning not later than forty days after the petals have fallen.

For the combined treatment of apple scab and bitter-rot, spray the trees thoroughly with Bordeaux mixture: (1) Just before they bloom, but after the cluster buds have opened and exposed the flower buds; (2) As soon as

the petals fall; (3) A week or ten days later; and (4) About forty to fifty days after the shedding of the petals, and at intervals of two weeks thereafter, until, in all, seven or eight applications have been made.

It is true, of course, that the number of applications required and the dates on which they should be made depend to a considerable extent upon the season, but the treatment should always begin before the infection period, which may occur as early as forty to fifty days after the fruit has set.

In a dry or cool season the intervals between the later sprayings may be lengthened, thus reducing the number of applications required, provided the fruit is first thoroughly coated, which will necessitate at least two applications.

On the other hand, in a hot, humid season it will probably be necessary to shorten the intervals and increase the total number of applications.

Should, for any reason, the treatment be delayed until after it is discovered that infection has taken place, the trees should be thoroughly sprayed twice in rapid succession with an interval of only a few days, in order to coat the fruit thoroughly as quickly as possible. With one application alone it is difficult to coat the fruits sufficiently to protect against bitter-rot, and the second application, which adheres better than the first, on account of the presence of the previous coating, and also reaches parts of the fruit not touched before, is necessary for thorough protection.—*U. S. Bulletin, No. 93.*

BROWN ROT (*Monilia fructigena*)

Affects all kinds of stone fruits. Warm, moist weather at the time the fruit is about full-grown, will almost certainly develop the disease to a very large extent in districts subject to its attacks, when measures of a preventive nature have been neglected, and cause the loss of a large portion of the crop.

The ash-coloured velvety coating, or mould, seen on plums infected with the disease, shows the final or fruiting stage of development. If examined with the pocket lens, this mould will be seen to consist of numerous tufts of minute thread-like projections, and if further examined under a compound microscope, it will be seen that each of these "minute threads" is composed of a number of small oval bodies, joined end to end, like a string of beads. These bead-like bodies are the spores of the fungus, and each infected fruit is capable of producing them in thousands.

These spores may remain unchanged for a great length of time, or, on the other hand, they may, when conditions are favourable, germinate and grow so rapidly that infected fruit soon becomes capable of producing fresh crops of spores. Through the agency of winds, insects, etc., spores are distributed widely, and when one of them lodges on a fruit sufficiently soft, and when moisture is present, it starts the disease again, sending out a germinating tube which penetrates the skin of the fruit; here it grows rapidly, branching through the pulp in all directions, forming a dense mass of mycelium, which absorbs the contents of the cells of the fruit, disorganising the tissues and causing the so-called "brown-rot."

Infected fruit first turns brown in spots, which gradually enlarge, until the whole fruit becomes brown and rotten, and in its turn becomes covered with fruiting spores.

The mycelium or plant body of the fungus remains dormant during the winter in the dried or mummied plums which are left on the trees infected with the disease, or on the ground beneath them, and when warm weather comes the following season will produce an abundant crop of spores to start infection afresh.

In dealing with this disease, it will be easily seen that the most successful treatment will necessarily be of a preventive nature. It is usually first noticed in the season on cherries, especially on soft varieties which burst their skins after a rainstorm, such as the Governor Wood, and, undoubtedly, infected fruits which are left to dry up on these trees are a fertile source of infection to plums later in the season. Great care should be taken to gather and burn these, and also the first infected mouldy fruit noticed on plum trees. In orchards which have been infected this season, the first thing to be done is to pick off, as soon as possible in the fall, all dried up or mummied fruit which may have been left on the trees, then with a fine-toothed garden rake gather together all fruit that may have fallen on the ground, together with fallen leaves and trash, and burn up all these sources of infection; after which the trees should be thoroughly sprayed with Bordeaux mixture of double strength, viz.: 8 pounds sulphate of copper, 8 pounds lime, and 50 gallons of water; the ground beneath the trees should also be well sprayed with the mixture. This should be followed by a thorough spraying with No. 1 Mixture (lime, salt and sulphur spray), during the dormant season, both of the trees and of the ground beneath them.

In the spring, the spraying of the trees with Bordeaux mixture of the ordinary strength should be commenced as soon as growth starts, and at least two sprayings given after the blossoms have fallen.

If there is reason to expect an attack of the disease after the fruit has attained its size and before ripening, Spray No. 10—the Carbonate of Copper Spray—should be carefully used, as at this stage the fruit is particularly liable to be infected. Cherry trees should be carefully sprayed with double strength Bordeaux mixture as recommended for plum trees, while the trees are dormant, and in the spring the trees should be sprayed with Bordeaux mixture of ordinary strength when growth commences, and again after the fruit has formed.

In Oregon, it is stated by Professor Cordley, "that now the disease is well-established, any prune or cherry grower who fails to employ preventive measures against brown rot deliberately takes the chance of losing a large proportion of his crop, even though such loss may occur every year," and this statement applies with the same force in Lower British Columbia.

In selecting and packing fruit for market too much care cannot be exercised to exclude not only infected fruit, but all that which has been in contact with it, and it has been amply demonstrated that this season almost the entire crop of some badly infected orchards was unfit for shipment. A good deal of the loss experienced this year was due to the development of the disease in the packages *en route* to market, the temperature inside cars filled with fruit being high enough, and sufficient moisture present to furnish favourable conditions for the spread of the rot to a large portion of the shipment.

PEACH LEAF CURL (*Eroasens deformans*).

This disease attacks various stone fruits, but especially the peach. The peculiar curl or blistered appearance which the young leaves of peach trees frequently present in spring is caused by a microscope fungus which attacks their tissues. The blisters sometimes extend across a leaf, sometimes along it.

The entire leaf may be so puckered up as to be unrecognisable, or only a portion may be attacked. The foliage becomes leathery, the blisters assuming various colours, from the normal green to red, purple, or white, or combinations of these. The foliage generally falls off, and another crop is thrown out; thus the tree is exhausted, and the yield of fruit greatly lessened and deteriorated, or in severe attacks completely lost, because it usually falls a few weeks after setting. The attacks are worst in damp, draughty situations and in changeable weather. The disease lives through the winter on the buds and in the wood; thus scions and buds from a diseased tree will carry the disorder into localities where it was previously unknown.

Preventions and Treatment.

Nursery stock is frequently very badly affected; therefore, take care that the young trees are obtained from a reliable firm. Be most particular to avoid scions or buds from any tree that has had the least trace of the disease within two years. Keep a sharp look-out, and directly the disease appears in a peach orchard give the tree the greatest attention and care. No trouble should be spared at this stage—"A stitch in time saves nine." All prunings and fallen leaves from diseased trees should be raked up and burned, especially in nurseries. Bordeaux mixture, properly made and applied, will check the disease. Soon after the leaves have fallen, prune the tree and treat leaves and prunings as suggested above; then spray the tree with Bordeaux mixture, full strength. Again, just before the buds burst, with a weak solution, and just after the petals have fallen, with the same strength.—*New Zealand Leaflet, No. 24.*

Peach leaf curl occurs during the early part of the season, and appears to be caused by a minute internal fungus in the pores of the leaf developed by cold weather. As soon as the leaves show any sign of curl, pick every affected leaf on the tree and on the ground, and burn them. Sometimes it will not appear again. The only permanent remedy is a thrifty growth, imparted by good cultivation and pruning back. When the disease is severe, it destroys most of the foliage and impairs and sometimes kills the tree.—*Thomas' American Fruit Culturist.*

GOOSEBERRY MILDEW (*Spharotheca mors-urae*, B. and C.).

The great drawback to the successful cultivation of the European gooseberry in Canada has been the annual loss occasioned by the prevalence of this disease. The external appearance of the fungus is well-known, showing on the young woods, leaves and fruit as a whitish, downy coating, usually appearing soon after the leaves have fully expanded. Grow on clay soils.

Treatment.

Successful results are reported by Prof. Goff, of the Agricultural Experiment Station of Wisconsin, by the use of potassium sulphide (liver of sulphur)

at the rate of one ounce, dissolved in four gallons of water. Spraying was commenced when the leaves were partly expanded, and repeated seven or eight times during the summer.

Without actual experiment, it would not be wise to recommend the unrestricted use of any remedy for this disease, but from our present knowledge of the general efficacy of the ammoniacal copper carbonate, it seems safe to advise a trial, at any rate, of this remedy, in the same proportions as those given for the apple or grape, viz.:—

Carbonate of copper	2 oz.
Ammonia	1½ pints.
Water	25 gals.

—*Central Experimental Farm, Bulletin No. 10.*

ROSE MILDEW (*Spherotheca pannosa*).

Very little description is needed of this only too well-known rose affection which clothes, with a felty, whitish mass of interwoven threads, the leaves, twigs and flower-stalks of roses. The treatment is to dust affected plants with flowers of sulphur mixed with one-third its volume of slaked lime. Spraying with potassium sulphide—1 oz. to 2 gallons water—is also equally efficacious. In this, as in all similar cases, it cannot be too strongly urged that all the diseased parts should be cut off and burnt to prevent the dissemination of the spores. Vigorous treatment always minimises disease.—*New Zealand Bull., No. 50.*

POWDERY MILDEW.

Powdery mildew (*Podosphara argyrantha*) occurs all through the coast districts on orchard trees. It usually appears in spring or early summer, especially during unfavourable seasons for growth. On nursery stock it is often later in making its appearance. It appears first as small, round whitish blotches, which soon enlarge and run together on the leaves and young shoots. The mildew is composed of a vast number of minute white threads, branching in all directions, which form the mycelium or "plant body" of the fungus. Soon after this mycelium gets well developed it assumes a powdery appearance, due to the production of quantities of minute white spores, which serve to spread the disease during the growing season. Towards the end of summer the mycelium develops small round black masses, just visible to the naked eye, and these are the cases which contain the winter spores and carry the fungus through the winter.

Treatment.

In orchards, cutting off and burning any shoots which show the fungus is the simplest method of treatment: nursery stock may be protected by spraying with Bordeaux mixture, or the carbonate of copper spray, which should be repeated at intervals of ten days, for three or four sprayings.

APPLE TREE MILDEW (*Spherotheca mali*, MAGNUS.).

The disease known as Apple Tree Mildew is a close ally of the hop mildew, American gooseberry mildew, and rose mildew. It is very prevalent, and is one of those pests likely to accompany apple trees to all parts of the world, as the mycelium is believed to tide over the winter in the bark or between the bud scales, and thus escape detection.

Preventive and Remedial Measures.

1. When the disease is present in its worst form, the only certain method of arresting its progress is to cut off and burn all the infected rosettes of leaves. The cut should be made about two inches behind the tuft of leaves. Trees that have been treated in this manner throw out healthy branches and remain free from the disease.

2. When the disease appears in a mild form on the scattered leaves the tree should be sprayed with a solution of potassium sulphide (liver of sulphur), one ounce dissolved in two gallons of water.

Infection of the leaves only takes place when they are quite young, and then is the time to look for the mildew. On the first symptoms of its appearance spraying should be commenced. If this opportunity is neglected and the mildew is allowed a start, spraying may be considered useless.

3. It would, under all circumstances, be advisable to spray trees where the disease had previously existed, commencing when the leaf buds are expanding.

4. No definite proof is as yet forthcoming as to whether insects assist in distributing the spores of the fungus, or aiding in its attack in any other way. It is, however, quite certain that mildew is most abundant on trees that are infested with "woolly aphis" and "green fly"; consequently, these pests should be dealt with.—*Board of Agriculture and Fisheries of England, Leaflet 204.*

APPLE POWDERY MILDEW.

The most serious injury to the seedling, caused by this disease, is the loss of its foliage. To prevent this, and thereby insure good working stocks for buds, spray the seedlings with the ammoniacal copper carbonate solution, first when the leaves are about half-grown and thereafter at intervals of twelve days. Following this plan, three sprayings will usually be made before budding, and at least two after this operation, making five in all. It is seldom that powdery mildew proves serious to budded or grafted stock, except upon certain particularly susceptible varieties. In such cases, practically the same line of treatment recommended for the seedlings may be followed.—*B. T. Galloway, U. S. Circular No. 10.*

ANTHRACNOSE OF RASPBERRY AND BLACKBERRY (*Glasporium vinctum*, SPERG.)

The anthracnose of raspberry and blackberry is a common disease of these plants and one which is capable of doing much harm. It affects the canes first, later appearing also on young shoots and leaves. The spots in the early stages of the disease are purple, but as the disease progresses these spots acquire a whitish centre and become somewhat sunken. In bad cases the spots run together, sometimes encircling the cane; at other times they run along one side, producing large patches of a grayish colour. During the second season the spots tend to dry out, producing cracks in the wood and scaling of the bark. On the leaves the spots are apt to be small, but numerous, and follow the general appearance of those on the canes. The effect of this parasite is to reduce the vigour and size of all parts of the plant. The fruit often fails to mature properly, but frequently dries up before ripening.

Treatment should consist of cutting out the worst diseased canes and spraying. Beginning in spring, the first application may be the copper sulphate solution (1 pound in 25 gallons of water) before the leaf buds open. The second, soon after the foliage is out, with Bordeaux mixture. A third spraying with the Bordeaux should follow the harvesting of the crop. Start new plantations from healthy canes or from root cuttings in case of red raspberry and blackberry.—*Michigan Bulletin, No. 25.*

IRISH BLIGHT, OR LATE BLIGHT OF POTATOES (*Phytophthora infestans*).

Symptoms.

The first indication of this disease is to be seen on the leaf in the shape of a slight reduction in the intensity of the colouring-matter of the leaf. This is rapidly followed by the appearance of small brownish blotches, commencing generally at the edge of the leaf. These spots soon increase in size and the tissues die, turning dark brown or nearly black. In dry weather these patches do not increase much, but in humid weather they spread over the leaves with immense rapidity. After destroying the leaves, the disease travels down the haulms, and in severe cases the whole of the aerial portion of the potato plant may within a few hours become a blackish mass of rotten plant-débris, which emits a characteristic and unpleasant odour. If the under-surface of the leaves be examined with a pocket-lens, there will generally be seen around the margin of each spot a more or less distinct border of whitish mould, looking somewhat as if fine flour had been sprinkled on the leaves. This white mould is the fruiting portion of the fungus causing the disease, and as myriads of spores are quickly formed on each leaf, it is easy to understand how it can be spread so rapidly.

This potato-disease is practically wholly propagated and carried on from season to season in the tubers themselves. It is, therefore, of the first importance that none but perfectly sound potatoes should be used for seed.

The appearance of diseased tubers is very characteristic. Numerous sunken, dead, brown patches are developed on the surface of the tubers. These may remain firm and hard for some time, but generally they become soft, and the whole tuber rapidly rots. This rot is accompanied with a particularly fetid odour, quite distinct from the rots caused by bacteria, fusarium, etc.—*New Zealand, 13th Report.*

Seed potatoes should be stored in a perfectly dry and well-ventilated shed. They should be examined at intervals, and any tubers showing signs of disease should be at once destroyed.

The dipping of seed potatoes in Bordeaux mixture, using the 4-4-40 formula, or, if the skin is well hardened, the 6-4-40 formula, is to be recommended. A large barrel should be used, and the potatoes placed in a basket made of wire-netting, or some such material, and the potatoes totally immersed for a few minutes, then lay them out in a warm place to dry before storing. It must be remembered that this dipping kills only the spores and those portions of the fungus that are on the surface of the potato, and is quite ineffectual in destroying the part which winters in the tissues of the tubers themselves,

should it have already obtained admission. It will, therefore, still be important to sort out the tubers from time to time, and remove any showing the least sign of rot.

The sprinkling of quick-lime amongst the potatoes is a useful measure, and helps to keep them dry and healthy.

Wide Cultivation.

It is important not to have the rows too close together; plenty of space must be left for high "earthing-up." This will enable one to cover the tubers with a good depth of soil and render them much less liable to be affected, even though the foliage may suffer severely. It prevents the spores from being carried down by rain and other agencies on to the tubers.

Manuring.

In districts where it is the practice to use manures, care must be taken to employ only those which are known not to encourage the disease. Numerous experiments carried out in many parts of the world have shown that crops manured with highly nitrogenous manures, such as nitrate of soda, blood, etc., contract the disease with great ease; while, on the other hand, when they are manured with potash-salts and phosphates they often escape the disease to a great extent.

Good Drainage.

As has been pointed out, the Irish disease is specially aided to spread by moist surroundings. It therefore follows that good drainage is very essential, and the addition of large quantities of lime to the soil will render crops grown on over-moist soils less susceptible to attack.

Spraying.

The most important method of preventing this disease is by means of thorough and systematic spraying with Bordeaux mixture.—*New Zealand Bulletin, No. 25.*

When to Spray.

So much depends upon the weather conditions for the development of the potato blight that no set time can be given for its appearance. Last year it appeared about the 1st of July, and the year before somewhat later. When it first appears, small mildewy spots appear on the under side of the leaves, then dead, brown spots appear. When once started the disease spreads very rapidly and has been known to spread over an entire field in one or two days. Soon the leaves and stems are reduced to a decaying mass which emits a very disagreeable odour. From this it is plain that as soon as the disease is developed no time should be lost in going to work.

Undoubtedly the *best* plan would be to spray once quite early, say about the middle of June, in order to be sure of heading off the disease. This should be repeated every two weeks to insure success, as a great deal depends on keeping the plants safely guarded against the attacks of the spores.—*Bulletin No. 46, Washington Agricultural College.*

EARLY BLIGHT, OR POTATO LEAF-CURL (*Macrosporium solani*).

This is caused by a fungus which attacks the foliage. It first appears on the older leaves in the form of small brown or grayish-brown spots, which gradually spread and join, so that soon a considerable area is involved, the affected parts becoming curled, hard and brittle, while the remainder frequently assumes an unhealthy yellowish colour. On the appearance of the disease the tubers cease to grow. Usually in about three weeks most of the leaves are dead; the stems remain green for some time longer, and then gradually perish. The tubers, being undeveloped and unripe, turn soft and will not keep. It has been proved by extensive experiments, both in Europe and America, that spraying with Bordeaux mixture will not only prevent or keep down fungous diseases, but will so increase the yield as to more than pay the extra expense incurred. Great care must, however, be taken in mixing and applying fungicides and insecticides.

The *Macrosporium* must not be mistaken for the extremely destructive "potato-rot," so much dreaded in older countries. There is no doubt that it has been so mistaken, both in England and America, and this mistake has given rise to reports that "potato-rot" (*Phytophthora infestans*) had broken out in various localities, when it was only *Macrosporium*, which, serious as it may be, is not nearly so bad as *Phytophthora*.

Treatment.

As the spores of the potato leaf-curl live through the winter on the dead haulms and leaves of affected plants, it naturally follows that to prevent a recurrence of the disease it is essential to carefully burn all tops, etc., that have in the previous season shown the least signs of infection. This burning should be done as soon after the potatoes are harvested as possible, as delays are always dangerous.

POTATO BACTERIOSIS (*Bacillus solanacearum*).

The first sign of disease is disclosed by the yellow colouration and premature wilting of the foliage. Sometimes only a few isolated plants are attacked, at other times whole rows may become diseased. At a later stage the veins of the leaves take on a darker hue than the rest of the foliage, which then rapidly discolours and dies.

If a diseased haulm is cut across it will be seen that the woody cylinder shows a brown discolouration, and the vessels are filled with bacteria, which gradually ooze out from the cut surface in dirty-coloured drops. In cases of severe attack the tubers become affected early and rapidly rot.

Preventive Means.

It has been definitely proved that this disease is transmitted from field to field through the agency of leaf-eating insects; in the United States the Colorado beetle being especially active in spreading this bacterial blight. In consequence of this, it follows that in districts where bacteriosis is known to exist all leaf-eating insects should be kept in check. For this purpose the addition of 1 oz. of Paris green to every 40 gallons of Bordeaux mixture will be found an excellent check.

All affected plants should on the first appearance of the disease be cut down to the ground, to avoid the affection spreading to the tubers, for it must be remembered that when once this bacillus has gained an entry into the tissues of the potato-haulm, spraying would be of no avail. The tops, when cut off, should, if possible, be burned.—*New Zealand Bulletin*, No. 25.

POTATO SCAB (*Oosporia scabics*).

Description.

At the present day *Oosporia scabics* is one of the most widespread of diseases affecting the potato. The fungus usually attacks the tubers while young, forming scattered rough patches or scabs on the surface; these patches gradually increase in size and number, and not infrequently when the tuber is full-grown its surface is more or less completely covered with scab.

The injury is confined to the surface of the tuber, the skin being broken up into fragments over the diseased patches. Although the market value is much depreciated when scab is present in quantity, the quality of the potato is not in the least impaired for eating.

Prevention and Remedies.

(1.) If scabbed potatoes are used for "seed" without having been sterilised, the resulting crop will almost certainly be diseased, and in addition the fungus will pass into the soil, where it is capable of living for several years. Scabbed potatoes may be used for "seed" without the slightest danger of spreading the disease if they are immersed for two hours in a solution consisting of one pint of commercial formalin (=formaldehyde, 40 per cent.) mixed with thirty-six gallons of water. The potatoes are then spread out to dry, when they may be cut and planted in the usual manner. Great care must be taken after potatoes have been treated as above that they are not placed in sacks or hampers that have contained scabbed potatoes.

(2.) Land that has produced scabbed potatoes is certain to be infected with fungus, and should not be planted with potatoes for several years afterwards; beet, swedes, carrots, and cabbages are also attacked by the fungus. Cereals may be sown with safety on infected land.

(3.) In the case of gardens and small allotments, where potatoes are of necessity grown every year, the trenches in which the potatoes are planted should be sprinkled with powdered sulphur.

(4.) Lime favours the development of the fungus in the soil; the same is true of stable manure, night-soil, etc. Acid manures only should be applied to land that is infected.

(5.) Peelings from infected potatoes should not be fed to pigs unless they have been boiled. Burning is the safest, and in the end the most economical, method of dealing with them.—*Board of Agriculture and Fisheries, London, Leaflet No. 137.*

What will prevent Scab on Potatoes?

There are two more or less standard remedies for the prevention of potato scab: (1.) Soak uncut seed potatoes in a solution of one ounce of corrosive sublimate in eight gallons of water; (2.) Soak cut or uncut potatoes in a solution of one pound of formalin in fifteen gallons of water. These solutions

are about equally effective, and one's choice will depend upon the ease with which they can be procured. Formalin has the advantage of not being a violent poison like the corrosive sublimate. For that reason, I prefer the use of formalin.—*Prof. John Craig, Cornell University.*

DRY-ROT OF POTATOES (*Fusarium oxysporum*).

The disease to which the name "dry-rot" has been given is caused by several different fungi, but the one which does the main amount of damage is known as *Fusarium oxysporum*, a fungus very closely allied to the sleepy-disease fungus of tomatoes. The *Fusarium* is fairly prevalent, but is generally not noticed until a considerable time after the tubers have been stored, although the disease is contracted while the crop is growing in the field. The foliage of diseased plants generally wilts, but as this does not occur till the tubers are nearly full-grown, very little notice is taken.

The disease enters the tubers at the stem end and gradually spreads through them, following the course of the vascular bundles, and thus shows up a discoloured ring when cut across. At first sight one is reminded of potato-bacteriosis, but it can at once be distinguished, owing to the absence of any watery matter oozing out from the discoloured ring. The tubers gradually shrink and the skin becomes wrinkled, while the whole interior becomes transformed into a more or less hard, crumbling mass of a gray colour. The fruiting part of the fungus appears on the surface of the tubers as specks of white mould, on the delicate filaments of which are produced the characteristic sickle-shaped spores, which are divided into four by transverse septa. Sound potatoes can readily contract the disease through coming in contact with diseased ones. Thus the loss that may be sustained through the storing of healthy and diseased tubers together can easily be imagined.

Treatment.

As this fungus enters the plant below the ground, and may gain access during any part of the season, it is difficult to cope with; nevertheless, the following measures will be found fairly satisfactory:—

1. Only sound tubers should be used for seed. It is equally important not to plant potatoes on land where the disease has recently appeared, for this fungus can live in the soil for a considerable time, probably for several years. Such infected land should be used for other crops, such as cereals or grasses.

2. Collect and burn all badly-diseased tubers and store suspected ones in a cool, dry place, where the temperature remains about 40 Fahr.

3. If it is found impracticable to store in a cool place, the tubers should be sold and eaten as soon after harvesting as possible. There is no danger in eating partly affected potatoes, as boiling kills the fungus; and even if they were eaten raw the fungus cannot harm human beings, as it cannot grow at ordinary blood temperature.

4. Nitrogenous manures have been shown to increase the virulence of this disease, hence they should be avoided as far as possible.

5. Never throw diseased tubers on the manure-heap; this is one of the most fruitful sources of the spread of nearly all fungus diseases.

6. Spraying with Bordeaux mixture makes the plants much more healthy than they would otherwise be, and helps them to resist this disease.

WET-ROT.

The disease known as "wet-rot" is often to be found in damp, muggy seasons, and in land which is badly drained. It is now considered to be caused by bacteria, but whether one or more separate organisms are primarily responsible has not as yet been ascertained. The affection appears when the tubers are in the ground, and commences as a soft spot underneath the skin of the potato. This extends rapidly, the tissues being completely destroyed and the whole interior converted into a brown, slimy mass, often greatly distended with various gases. Tubers in which this disease appears often decay with great rapidity, owing to the entrance of various saprophytic fungi and bacteria which are enabled to gain admission as soon as the rot has set in, and thus greatly aid its rapid spread.

Good drainage is the most important thing to attend to in localities where this "rot" is present, and wherever it is noticed that crops are being attacked they should be at once dug up and all the rotting tubers carefully burnt.

BACTERIAL DISEASE OF TOMATOES.

The symptoms are very marked and cannot be confounded with those of any other tomato disease at present known. When the tomato is about the size of a marble a minute blackish patch first appears at the base of the style. This patch gradually increases in size, retaining a circular outline, until eventually the entire fruit is reduced to a blackish, soft decayed mass.

Experiments have shown that infection takes place during the flowering stage, and that the bacteria causing the disease are deposited on the stigma by flies visiting the flowers. The stigma appears to be the only vulnerable part under ordinary conditions; nevertheless, if bacteria from a diseased fruit are introduced into the flesh of a healthy tomato at any point of its surface by means of the point of a very fine needle, infection follows. This disease does not appear to be influenced to any extent by the forcing method of cultivation commonly followed, as it has been observed in a house where the temperature was kept comparatively low.

When the disease appears all diseased fruit should be removed as quickly as possible, and not be allowed to decay and liberate the bacteria present in the tissues. Insects should also be excluded by using an insecticide. This last act would necessitate artificial pollination with a camel-hair brush.—*Leaflet No. 152, Board of Agriculture, England.*

DISEASE OF THE TOMATO.

Anthracnose (*Collectotrichum lycopersici*, C.) attacks the ripening tomato at the point where it has begun to colour and spreads rapidly, causing much loss before the fruit can be marketed. It appears as sunken discoloured spots with a dark centre; these increase in size, run together, cover a large portion of the decaying fruit and are surrounded by wrinkled, discoloured skin. Spray the vines and young fruit early in the season with potassium sulphide.

Southern, or Field Blight.

The leaves become yellowish and curled, the ends shrivel and droop, finally becoming dry and black. Gather and burn all diseased vines and fruit in the fall. Change the tomato patch to another field for two or three years.—*Oregon Bulletin, No. 27.*

ONION RUST, OR MILDEW (*Puccinia schleideniana*, UNG.).

This disease has been particularly bad in the vicinity of Nanaimo. It attacks the leaves and very soon destroys all the plants in a bed. As soon as the slightest sign of attack shows the plants should be sprayed repeatedly with fungicides, such as Bordeaux mixture. This may save the crop, but unless taken early and persisted in, the chances are against success. Above all, certain precautions should not be neglected, such as burning all tops and refuse, and since it is said that the spores of some fungous diseases survive for long periods in the ground, the best means of avoiding future trouble is to abandon old onion land and grow the crop only upon fresh soil. Possibly liming the onion beds and growing new crops on them would have the effect of eventually getting rid of the spores. I should also recommend the spraying of the soil of old beds with strong Bordeaux mixture before it is dug. You can safely use a very strong mixture, as high as twelve pounds of copper sulphate to eight pounds of lime and 50 gallons of water, for spraying old beds. The first appearance of this disease in the spring-time results from the presence of the resting spores, which are produced in the decaying leaves; hence it naturally follows that immunity from this disease depends largely upon the care that has been bestowed the previous year on the collecting together and burning of the decayed foliage.

STRAWBERRY LEAF BLIGHT. Fig. 18A.



Blight (*Sphaerella fragariae*, TUL.) usually causes its greatest injury by attacking the new growth which appears after the fruit is harvested, the old leaves then contain countless spores which will infect the young growing foliage. To prevent this, mow the plants with a scythe, rake up all the leaves, allow them to dry, and then burn carefully. Some recommend renewing the setting annually and planting in deep, well-drained soil. Spray with ammoniacal copper carbonate every fortnight, beginning the latter part of April. Four applications should be sufficient.

MINT DISEASE (*Puccinia menthae*).

Specimens of a disease which killed off most of the garden mint in Victoria were submitted to Dr. Fletcher, who reported on it as follows:—

"The trouble with the mint seems to be a species of rust, allied to grain rust, and known as *Puccinia menthae*, the nredo form being present at the time you plucked the specimens submitted. Curiously enough, I found associated with this fungus very small red maggots, very much like those of the common wheat midge, several of these larvæ being in the package that you sent me. I find this or a similar kind of maggot feeding on the spores of grain rust, and also I have recently found what appears to be the same thing feeding on the spores of a rust attacking the leaves of the May apple. These maggots devour the spores, but I fear can do but little in controlling the rust. As you know, we are almost helpless in controlling rust, and I regret that I am not able to suggest a remedy in your case. Its abundance on mint with you may be due to meteorological conditions, though it must be present in more or less abundance every year."

DISEASED GRASS (*Physarum cinereum*).

A specimen of diseased grass from the lawn of Mr. Justice Martin was submitted to the U. S. Department of Agriculture, and the following report was received from A. F. Woods, Pathologist:—

"The material was so broken before it reached us that only a small portion of the organism could be observed, which is by no means sufficient for a specific determination. Similar material from lawns is very frequently sent us, which, probably without exception, has proved to be *Physarum cinereum*, which occurs very commonly on richly manured ground. *Myxomycetes*, also called *Mycetozoa*, are peculiar organisms possessing both animal and vegetable characteristics; hence they have been claimed by both zoologists and botanists, probably not belonging rightly to either, although their descriptions are generally included in works of systematic cryptogamic botany. The life history of the *Myxomycetes* comprises a motile stage in which the plasmodium streams or spreads over a surface of perhaps even several square feet, and ascending substances, as the blades of grass, are completely covered with the fruit called sporangia. As far as I know, the *Myxomycetes*, with external sporangia, have never been reported as of any economical importance. Changes in temperature and humidity, unfavourable to the species on grass, may have already caused its disappearance, and it is doubtful if experiments with fungicides would be profitable."

SMUT IN GRAIN.

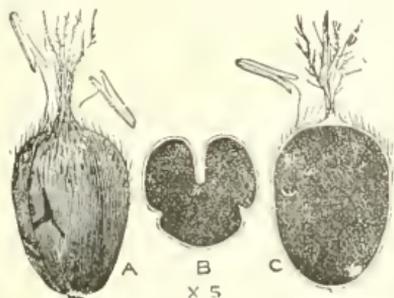
What the Smut is.

Wheat smut is caused by a small plant which steals its food from the wheat plant. The smut plants are distributed by the fine, black powdery grains of smut which cling to the seed wheat. Even when the wheat appears to be clean, they may be present in the grooves in the side of the grain or in the tuft of hairs at one end. When the farmer plants the wheat he also plants the smut. As the smutted kernel goes into the ground it carries with it several grains of smut. After being planted, the wheat grain grows and brings forth a small plant. So also the smut plant germinates and sends out a fine thread-like plant so small that it cannot be seen with the unaided eye. The smut plant soon produces small threads, which penetrate into the small wheat plant through its soft and delicate skin. After a few days, however, at about the time that the wheat unrolls its first leaf, its skin gets too hard to be penetrated by the smut, so that if the wheat has escaped thus far it is no longer in any danger from the smut.

If the smut has penetrated the wheat skin during its danger period it continues to grow in the wheat plant up through the stem. About the time that the wheat plant makes its seeds the smut sends its thread into the wheat kernel. As fast as food is stored up for the young wheat plant, the smut steals it and replaces it with its smut grains.

In the covered or stinking smut of wheat only the inside of the kernel is removed by the smut and a shell is left around it, but in the loose smuts, as for example the loose smut of oats, the whole kernel is destroyed and the spores are left exposed to be blown about by the wind.

The wheat kernels which have been smutted are broken in handling or in threshing, and the smut grains are thus scattered on to new wheat, and are ready for the next year's planting. Very evidently, the only way in which this disease can be reached and the smut plants killed is by treating the seed wheat with something which will kill the smut grains, but which will not injure the wheat.

HARD SMUT (*Tilletia caries*). Fig. 18B.

Tilletia caries (Tul.) and *T. larvis* (J. Kuehn.)

(a) A "Bunted" grain of wheat; (b) A transverse section of the same; (c) A longitudinal section. (All enlarged five diameters.)

The diseases of wheat known generally in North America under the name of "Bunt," "Hard Smut," or one of the other designations mentioned above, are due to the ravages of two parasitic fungi belonging to the family *Tilletia*.

In a "Bunted" kernel of wheat the whole of the farinaceous contents of the grain are destroyed by the invading fungus and their place filled by a black powdery dust—the ripe spores of its reproductive system—sometimes called the fruit.—*Bulletin No. 3, Central Experimental Farm.*

SMUT, OR LOOSE SMUT (*Ustilago carbo*). Fig. 1Sc.



"Smut," or as it is generally called, "Loose Smut," to distinguish it from "Bunt" or "Hard Smut," to which it is distinctly related, is very injurious to wheat, barley and especially oats, in many parts of Canada. The scientific name *Ustilago* is derived from the Latin word *ustus*, burnt, and the specific name *carbo* means charcoal. Both names refer to the appearance of the spore masses when they are produced in the ear. This disease is not of the same serious nature as hard smut, from the fact that the smutted ears are easily observed and can, with a little labour, be all removed and destroyed before

many of the spores are disseminated, and because, there being no fetid odour emitted by the spores, they do not spoil either the crop of wheat amongst which they grow or the flour made therefrom.

As with bunt so with this loose smut; it is evident that the disease begins at the bottom and works upwards. In all instances when the spores appear in the injured ears the spawn may be detected in every part from the root through the stem to the inflorescence. In no case, however, can this spawn be found in parts through which it is not necessary for it to pass in order to reach the point where the spores are formed; thus they are not found in the blades of the leaves. This smut is not restricted, like bunt, to the seeds alone, but the whole ear is destroyed.—*Central Experimental Farm Bulletin, No. 3.*

Remedies.—Wheat.

For wheat, probably nothing is more effective than the common bluestone treatment, using one pound of bluestone dissolved in a pail of water for eight or ten bushels of wheat. The solution should be sprinkled over the seed and the grain shovelled over several times, to insure that every kernel of grain is moistened with the solution. It is not always convenient to have boiling water to dissolve the bluestone, and it will not dissolve in cold water unless it be placed in a sack and suspended in water, just below the surface, when it is claimed it will dissolve in a few hours. The amount of bluestone necessary to make a barrel of pickle can thus be dissolved readily by suspending it in an old sack across the top of the barrel, just so that all the bluestone is submerged under water.

Formalin Treatment.

Formalin is a 40 per cent. solution of a gas in water. As obtained at the drug-store it has the appearance of water, but has a characteristic odour. It is poisonous in the strong solution in which it is bought and sold, but not in the weak solution in which it is used on the grain. About one pound of formalin is necessary to each 40 or 50 bushels of grain to be treated. One should be able to purchase it at the drug-store for about 45 to 60 cents per pound, buying it in pound lots or larger. Mix it with water at the rate of one pound of formalin to 60 gallons of water. Make a wooden trough about the size and style of a watering trough and a little wider than a shovel. Partly fill this trough with the formalin solution. Pour the wheat slowly from the sacks into the trough, so that the grains will separate and the smut balls and wild oats will float. Skim these off. Let the wheat remain in the trough, and see that it continues to be covered with the formalin solution for at least one and a half or, better, two hours; at the end of this time, shovel it out on to a barn floor which has been cleaned with boiling water, or shovel it into a canvas sheet which has been cleaned in the same way and is supported between posts. If the weather be favourable for drying the wheat, it may at once be put into the sacks and dried in them. Use only clean sacks, that is new sacks, or those which have been cleaned in boiling water. Soaking Little Club Wheat (which is the softest wheat raised in Eastern Washington) for one and a half to two hours will not appreciably soften it. At the end of that time it can scarcely be dented by the finger nail.

Another method of treatment may be used. Put the solution made as above in a barrel and dip the wheat, a half sackful at a time, leaving the wheat in the barrel one and a half or two hours. Except for the time, this is the same method as is often used for vitriol. By this method, however, neither the smut balls nor the wild oats will be removed. To get rid of the wild oats alone is worth very much to the farmer.

Care of Seed after Treatment.

One of the most important points in the whole matter is the care of the seed after the smut has been removed. If this wheat, which is now clean, is put into dirty sacks or into anything which is covered with live smut, it will again become infected and the treatment will be useless. After treating, then careful disinfecting must be used. The seeder especially is something that should be looked after carefully. Many a farmer plants away year after year with a seeder which is full of smut, and then wonders why his wheat has smut in it. Wash out your seeder thoroughly with boiling water and keep the smut out of it. Keep your wheat clean and you will have a clean crop; let your wheat get dirty with smut, and you will go into the smut-raising business, one which at present is not profitable for any farmer.

Oat Smut.—Formalin Treatment.

If the desire is to sow forty bushels of seed oats or less, secure from your druggist one pint of formaldehyde. Put into a barrel or tank thirty-six gallons of water and pour in a pint of formaldehyde liquid and stir thoroughly; next fill a gunny-sack with the seed oats and submerge it in the solution for ten minutes; then lift the sack from the barrel and allow it to drain for a minute or two, in order to save the solution. Empty the oats on a threshing floor or on some outside platform to dry, and repeat until all is treated; shovel the treated grain over at intervals until dry, or nearly dry, before sowing.

If a large quantity of seed is to be treated the work will be facilitated by having several barrels or a large tank which will hold a number of sacks of oats, so as to treat several bushels every ten minutes. The time saved by having an abundant supply of the solution in the tank or barrels will more than repay the extra expense of the formaldehyde purchased. *The oats must always be completely submerged for ten minutes.*

It is well to treat seed grain several days before sowing, in order to give it ample time to dry, or difficulty may be experienced when sowing with seeder or drill. If sown while damp, the seeder or drill should be set so that it will sow about one bushel more per acre than when sowing dry oats.

The formaldehyde solution here recommended is not poisonous to farm animals and will not injure sacks or clothing coming in contact with it. Oats treated with formaldehyde solution and not used for seed may be fed to stock, but when so fed should be mixed with other oats.

Hot Water Treatment.

This consists in soaking the oats for a given time in water of a definite temperature, 133° F., for ten minutes being usually recommended. This treatment in the 1897 experiments of the Station at Trumansburg entirely prevented smut. The method does not seem to gain in popular favour, owing,

no doubt, to the prevalent idea that it is difficult to keep the water at the required temperature throughout the treatment. The following directions, however, will enable anyone to secure excellent results with little trouble and only ordinary care. Near a large kettle in which the water may be heated a barrel should be sunk in the ground until the top is about a foot above the surface. A few feet from this barrel set a post with a pole across the top, to use as a lever in dipping the sacks of oats into the water. When the temperature of the water in the kettle is above 148° as tested by a *good* thermometer, pour part of it into the barrel and add hot or cold water until the mercury stands at 148° . About one bushel of oats enclosed in a coarse gunny-sack is now lowered into the water by means of the lever. The oats will cool the water and fresh supplies from the kettle should be added until the temperature is 133° . The sack should be moved constantly to insure perfect penetration of the water to all of the oats, and should be taken out at the end of ten minutes. The oats may be dried by shovelling them over upon a floor three times a day for a few days, and may then be sown as usual; or they may be sown broadcast within a few hours by cooling them with water. The soaking swells the oats so that about one-fifth more, by measure, should be sown.—*Experiment Farm Bulletin, No. 3.*

Barley Smut.

The same method of seed treatment prescribed for oat smut will be found effective for barley smut, excepting the solution is made by using one pint of formaldehyde with twenty gallons of water, instead of thirty-six, as recommended for the eradication of oat smut.

The barley hull may be more resistant to the formaldehyde and offers better protection to the smut spores than the oat hulls, or it may be possible that the smut spores of the barley are more resistant than the oat smut spores, consequently, need a stronger solution for their extermination.

A ROT OF STORED CELERY.

Celery may be dug in the fall and stored in a cellar to be used during winter and spring. It is usual to pack it closely, with the roots in soil which is kept moist. With right conditions of moisture and temperature the celery keeps well until spring, but if the soil is wet and the temperature varies, and especially if the celery freezes and thaws, it will decay. Decay follows close upon death. The bacteria and moulds are its active agents. They are always present in the soil in which the celery grows, and in the soil in which the roots are packed, and there are no practicable means by which they can be kept away from the plant; neither can they be killed without killing the plant. It remains then to keep the celery alive and in health so that it can resist the invasion of the bacteria. A constant temperature, a little above freezing, keeps the celery alive without growing, and keeps the bacteria in check, for they also become dormant at low temperatures and increase slowly, or not at all. If the celery freezes it becomes so much dead matter without resistance, fit food for bacteria, and, as soon as the temperature rises, the celery rots.

This was observed in some celery stored in the cellar of the Horticultural Department of the Ontario Agricultural College during the winter of 1903-4. The celery tops showed signs of having been frozen, but, as the temperature

continued low, it remained sound within, the outer leaves and stalks only showing signs of decay. While the weather continued cold the celery in the cellar remained sound, although it developed a sweet taste; but when warm weather came in early spring, what had not been consumed, rotted.

By such study we learn that bacteria cause decay, and that decay takes place under conditions in some measures known to us and under our control. To keep celery well it should be packed with the roots in clean soil. For this purpose it is best to use the humus, or muck soil, in which the celery is commonly grown. The soil in which the roots are packed should be kept moist, but not wet, with good water. The cellar or storage room should be kept at a uniform low temperature, a little above freezing. Free ventilation should be provided, both as a means of regulating the temperature and for the health of the plants. It should be remembered, also, that celery kept in a close, foul atmosphere becomes tainted.—*Ontario Bulletin No. 136.*

CHAPTER VIII.—APHIDES AND MITES.

RED SPIDER (*Tetranychus telarius*, and Allied Species).

These minute pests of the hop-grower and orchardist all have a similar life-history and habits, which, however, vary in different climates and localities. Infested fruit trees or plants show their presence by the unhealthy pale colour of the foliage, as the sap being sucked by a multitude of tiny mouths the leaves soon assume a yellowish cast, with patches of a grayish or lighter shade.

In the species most commonly found here, the eggs appear as ruby-red globules as seen under the microscope, and are sometimes found in vast numbers on the bark of fruit trees, on hop poles, or under rubbish and clods of earth at the base. These eggs are difficult to destroy, and two applications of the No. 1 spray, used as warm as possible, are advised to be made to infested fruit trees, in the winter or very early spring, before growth starts. During the summer months, a badly infested leaf has its under side completely covered with a dense web, under which are eggs and mites in all stages of development, and it is difficult to reach the pests with ordinary spraying.

In California, however, where they are very troublesome pests, the following methods are in use in spring and early summer as soon as the eggs are hatched out. The trees are thoroughly dusted with sulphur by means of a bellows or other appliance, after they have been wetted by a spraying. Some growers use a spraying mixture made in this way: Take 20 lbs. of sulphur, and mix to a paste with cold water in a barrel; then add to this wet sulphur 10 lbs. of caustic soda, 98 per cent., when it will boil up like lime slaking; have ready 20 gallons of water to add to it as it boils, to prevent burning.

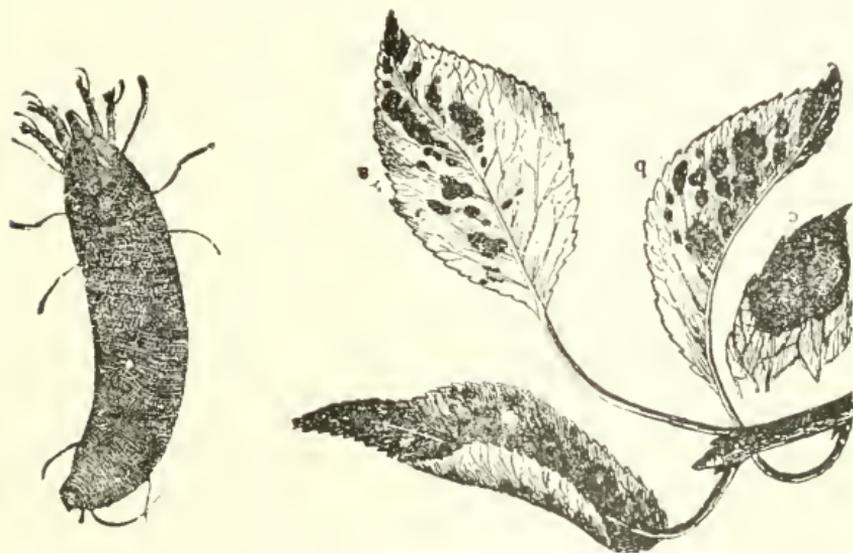
This forms a stock solution, and when ready to spray put 40* gallons of water in another barrel, and take half a gallon of the stock solution and add to it; strain, and apply with the spray pump, taking care to wet the under sides of the leaves.

At Chilliwack, a strong hot solution of whale-oil soap, applied with hand sprayers, has given good results against the red mite of the hop, but very careful work is required to reach the pests, and it must be done soon after the mites are hatched out.

Remedies.—Various preparations of sulphur and soap have been recommended, used separately or together, mixed with water, and applied to the bushes with a syringe. Plain soap and water, or water alone, freely applied, is regarded by some as efficient, as the insect is known to thrive best in a dry atmosphere. In applying any liquid, it is necessary to wet the under side of the leaves in order to make the application effectual, since, if applied to the upper surface only, the mites would remain uninjured beneath.—W. Saunders.

PEAR-LEAF BLISTER MITE (*Phytoptus pyri*, NALEPA).

A considerable amount of injury is done every year in all parts of Canada, where the pear is grown, by the operations of the pear-leaf blister mite. The irregular blotches, about one-eighth of an inch in diameter and frequently



(FIG. 19.) The Mite.

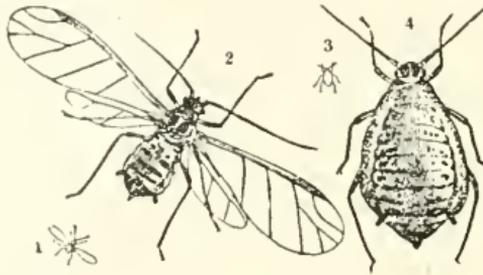
(FIG. 20.) Work of Mite.

confluent, caused by these mites, are frequently so abundant on the foliage as to make it impossible for the leaves to perform their functions. These blotches, when examined, are found to be hollow blister-like galls with a hole in the centre through which large numbers of almost invisibly small mites issue and attack fresh parts of the leaf. Few people recognise this injury as the work of an insect at first sight. It is nearly always sent in as a fungous

*American.

disease, but if one of these galls is cut open and examined with a strong magnifying glass, it is easy to detect the white elongated mites with which the inside is filled. The remedy for this insect enemy is to spray the trees just before the leaf-buds expand with the lime and sulphur wash. The sulphur is practically obnoxious to all kinds of mites, and it has been found that this serious enemy of the pear-grower may be practically exterminated with a single thorough spraying with the mixture above mentioned.—*Fletcher Report, 1906.*

TURNIP AND CABBAGE APHIS (*Aphis brassicae*, L.). Fig. 21.



(FIG. 21.) Natural size and enlarged.—*Fletcher.*

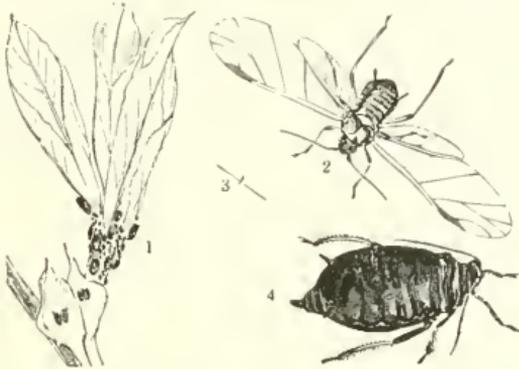
Attack.—Clusters of gray plant-lice situated all round the bases of the stems and beneath the leaves of Swede turnips and all kinds of cabbages, from which they suck the sap, causing them to become withered and stunted and, in serious outbreaks, destroying whole crops. As a rule, these plant-lice are not noticed until the end of the season; but in dry autumns, or on high lands, they increase with incredible rapidity and become one of the most destructive enemies of the turnip grower. The eggs are laid late in autumn upon the leaves and stems of the plants.

The Turnip and Cabbage Aphis is very widespread, occurring in all parts of the Dominion. In British Columbia it is frequently very destructive to early cabbages and cauliflowers; but in Eastern Canada the most important injury is to Swede turnips in fields at the time that they are forming their roots.

Remedies.—When cabbages in gardens are attacked, the colonies of plant-lice should be destroyed by spraying with kerosene emulsion or whale-oil soap on their first appearance. In turnip fields the injury is always in autumn, and the colonies of plant-lice should always be looked for when the turnips are being hoed and thinned. At this time good work may be done by simply hoeing out the infested plants and, having pulled some earth over them with the hoe, pressing it down with the foot. When the plant-lice are too numerous for this simple treatment, the infested plants, which at this time are generally in restricted areas, should be promptly sprayed with a knapsack sprayer, using kerosene emulsion or whale-oil soap, one pound in six gallons of water. As the eggs are laid late in autumn on the leaves of turnips and cabbages, remnants of these crops should always be ploughed down as soon as the crop is got in. Infested cabbages may be dipped in kerosene emulsion before storing for the winter.—*Fletcher.*

A correspondent states that he has successfully used a solution of salt as a spray, which he found effectual in destroying this pest. His method of preparing the spray is to place a quantity of salt in a vessel and fill it with water, allowing it to stand for 24 hours and then pouring off the water, which is then ready for use. The water will only take up salt to point of saturation. The quassia and whale-oil soap spray, No. 2, has also been found to be efficacious in this Province.

BEAN APHIS (*Aphis rumicis*, L.). Fig. 22.



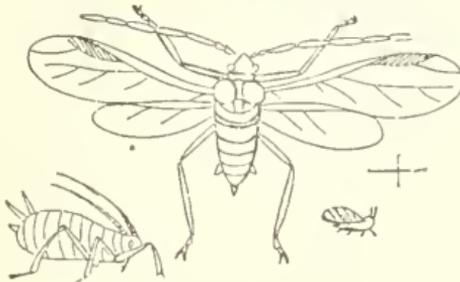
(FIG. 22.) Natural size and enlarged.

Attack.—Black plant-lice thickly clustered on the tips of horse beans and broad beans, and also occasionally on other smooth beans, at the time of flowering.

One of the great difficulties of growing horse beans in Canada has been the occurrence of this European species of plant-louse, which is such a serious pest of horse beans in Europe. As this crop is little grown in Canada, small attention has been drawn to it.

Remedy.—The usual practice in Europe is to cut off the tips of attacked plants, upon which the plant-lice are nearly always clustered, leaving the rest of the plant at the time of flowering free. This practice is also beneficial because it overcomes one of the chief difficulties in growing this crop, which is the failure of the pods to develop. This checking of the growth by cutting off the tips causes the flowers to set pods better than if the tips are left on.—*Fletcher.*

APPLE APHIS (*Aphis mali*).



(FIG. 23.) Greatly enlarged.

The eggs of the apple aphid are deposited in the fall, usually on the extremities of the new growth, or around the buds. Two thorough applications of the No. 1 spray, according to the directions given, or of the lye and soap wash (No. 15), will destroy the eggs, and this is by far the best method of dealing with the pest in the first instance. In a natural way the eggs hatch out just when growth commences in the spring, and the leaves of infested trees soon become curled and roll up, making it very difficult to reach the insect with any spraying mixture.

They multiply at an enormous rate, those first hatched giving birth to living young which in their turn reproduce in the same way, and so on for several generations, so that as fast as new leaves expand, they are attacked, if the weather conditions are favourable to the aphides.

For summer spraying, any one of sprays Nos. 2, 6 or 7 will, if used as directed in the earlier stages of attack, prove effective; two sprayings are usually required, and are better given with only a short interval between them, not more than three days. Care should be observed to make the sprayings very thorough, as the washes kill only by actual contact with the insects.

During the summer winged broods of the pests are born; these should be looked out for, and prevented from establishing themselves by a timely use of one of the spraying mixtures referred to.

BLACK CHERRY APHIS (*Myzus cerasi*)

is very injurious to the new growth, especially on young trees. It multiplies at an enormous rate in a similar manner to the last-mentioned pest. Badly infested trees are often a source of attraction for swarms of flies and wasps, which feed upon the sweet exudation from the bodies of the aphides.

Prompt and thorough spraying in the early stage of the attack is necessary to deal with this pest effectively. It is more resistant to the action of sprays than the green aphid, but the same remedies should be used, and better results will follow if the spraying mixture is made as hot as the leaves of the trees will bear without injury.

CURRANT APHIS (*Myzus ribis*).

is yellowish in colour and is found on the under sides of the leaves of currant bushes, which become curled, blistered and reddish in colour. They migrate during the summer, but return later on, and their eggs are deposited on the stems, especially around the buds.

Spray with the No. 1 mixture to destroy the eggs in the winter months, and with either of sprays Nos. 2, 6 or 7 in the growing season, directing the spray so that the under sides of the leaves are reached. It is most important that the work should be done early in the season* before the insects become too numerous, and the leaves roll up so that sprays cannot reach them.

They are particularly subject to attacks by predaceous enemies, such as the soldier-beetle (*Podabrus comcs*), ladybirds, etc., and are often completely cleared off in this manner.

MEALY PLUM APHIS (*Hyalopterus pruni*)

is a species of aphid which attacks the young shoots and under sides of the leaves of plum and prune trees. When first hatched they are whitish in colour, but as they increase in size they become darker. The insects and infested leaves are covered with a whitish powder.

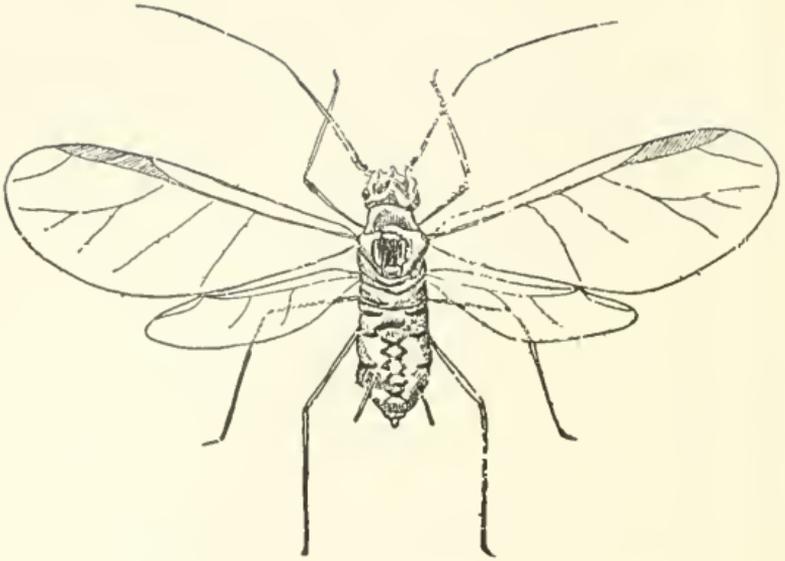
Their life history is similar to that of the green aphid, and the remedies used for that pest should be applied, taking care to wet the under sides of the leaves, and repeat the spraying to insure the destruction of the pests.

HOP APHIS (*Phorodon humuli*).

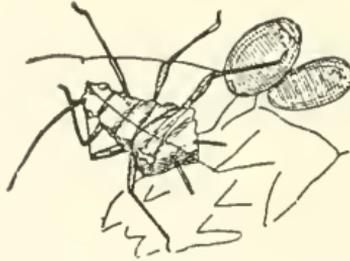
Wherever it occurs, whether in England or on the continent of Europe, in New York, Wisconsin, or on the Pacific Coast, the Hop Plant Louse (*Phorodon humuli*) has substantially the same life round. The eggs are laid in the fall on different varieties and species of the plum, both wild and cultivated. They are small, glossy, black, ovoid, and are attached to the terminal twigs, especially in the more or less protected crevices around the buds.

From an egg hatches in the spring, about the time when the plum buds begin to burst, a stout female plant-louse, known as the stem-mother, which differs from the summer individuals by having shorter legs and shorter honey tubes.

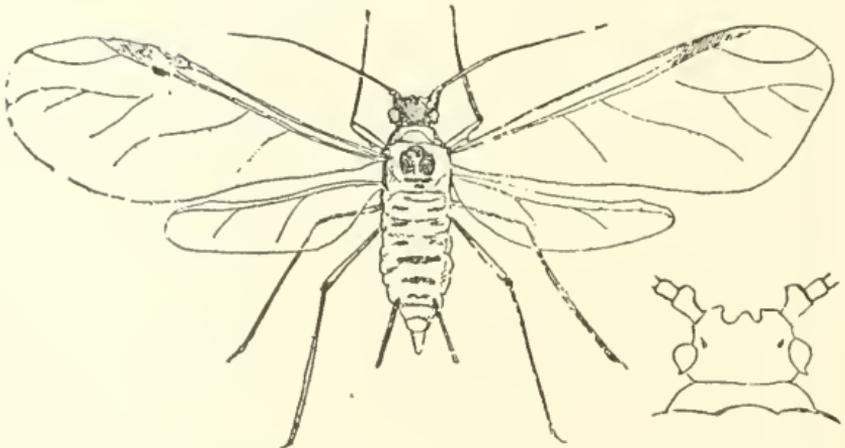
She gives birth without the intervention of the male, to living young, and this method of propagation continues until the last generation of the season. The second generation grows to full size and gives birth to a third, which becomes winged and develops after the hops have made considerable growth in the yards. The winged plant-lice then fly from the plums to the hops, deserting the plum tree entirely and settling upon the leaves of the hops, where they begin giving birth to another generation of wingless individuals. They multiply with astonishing rapidity. Each female is capable of producing on an average about one hundred young, at the rate of three per day, under favourable conditions. Each generation begins to breed about the eighth day after birth, so that the issue from a single individual runs up, in the course of a summer, to trillions. The issue from a single stem-mother may thus, under favourable circumstances, blight hundreds of acres in the course of two or three months. From five to twelve generations are produced in the course of the summer, carrying us in point of time to the hop-picking season. There then develops a generation of winged females (sexuparæ), which fly back to the plum tree and give birth to the true sexual females, which never acquire wings and never leave the plum tree. By the time this generation has matured, which requires but a few days, varying according to the temperature, belated winged individuals, which are the true males, fly in from the hop-fields. These fertilise the wingless true female upon the plum leaves, and these soon thereafter lay the winter eggs. Thus there is but one generation of sexed individuals produced, and this at the close of the life round—the females wingless on plum trees; the males winged on hops. All intervening generations are composed of virgin females only (*parthenogenetic*). This is the invariable round of the insect's life.



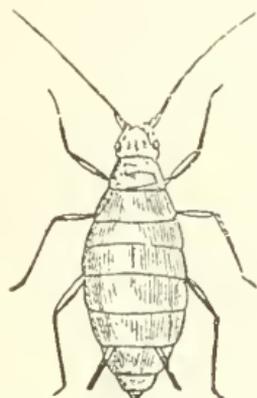
(FIG. 24.) The hop plant louse, male. (Enlarged.)



(FIG. 25.) Winter egg of the hop plant louse, and the shrivelled skin of the sexual female which laid them. (Enlarged.)



(FIG. 26.) The hop plant louse, third generation on plum.—the generation which flies to the hop plant. Head below at right. (Both enlarged.)



(FIG. 27.) The hop plant louse, true sexual female. (Enlarged.)

From the life history just given, three important facts are obtained. (1.) It will pay to make a preventive application of some of the mixtures mentioned further on, with apparatus before described, to all plum trees in the neighbourhood of hop yards, either in the spring, before the appearance of the first winged generation and its consequent migration to hop, or in the fall after hop picking and after the lice have once more returned to the plum, and are making their preparations for the laying of winter eggs. The latter time will, perhaps, be preferable, for the reason that in the fall the plum trees will be less susceptible to the action of the washes, and a stronger solution can be applied without danger to the trees. (2.) All wild plum trees in the woods through a hop-growing country should be destroyed. (3.) The hop vines should be either burned or thoroughly drenched with kerosene emulsion as soon after the crop is harvested as possible, with a view of killing the males, and thus preventing the impregnation of the females. (4.) If the above measures have been neglected and the lice have attacked the vines, the crop can still be protected by spraying with insecticide mixtures, which if thoroughly applied will prove effective, and there will be no danger of reinfestation from neighbouring untreated yards, since during the summer the lice cannot migrate except by crawling from one yard to another.

Mr. Chas. Whitehead, F.S.A., etc., etc., Agricultural Adviser to the Privy Council, says in reference to the formula given below: "There are no actual proofs that any other remedy or treatment than washing is at all effectual against the aphid blight. Lime has been thrown up over the plants without any results. Soot has been tried. Insecticides are dead failures, and manuring has had no marked influence."

The following formula for a spray is recommended by the Board of Agriculture of England and is found to be most effectual: A decoction of 10 lbs. of quassia chips made by boiling; 7 lbs. soft or whale-oil soap, and 100 gallons of water. The chips may be used twice, the second decoction being of course weaker. The hops should be sprayed at least five times during the summer, and if the insects are very bad, oftener.

WOOLLY APHIS (*Schizoncra lanigera*). After Riley.



(FIG 28.) Branch of apple infected. 1, 2, 3 and 4 the insect enlarged.)
New Zealand Bulletin 49.)

It is generally considered the most troublesome insect pest of apple trees we have, from the difficulty experienced in cleansing an orchard infested with it, and its harmful effect upon the trees. Its name of woolly aphis is derived from the secretion resembling fine cottony fibre, which more or less covers its body. The insects appear on infested trees during the summer in masses like tufts of cotton, attached to the twigs or leaves, beneath which will be found the bodies of the insects.

In the winter months they shelter under the bark or in cavities in the wood of the trees, or descend to the roots; large numbers will often be found at or near the collar of the root.

The eggs of woolly aphides are stated by Dr. Smith "to be found singly in crevices of the bark, enveloped in the dry skin of the female."

During the summer months they reproduce in the same manner as green aphides, but winged forms appear only in the fall.

During our mild winters in the coast districts, woolly aphides may be found in different stages of development, showing that if egg laying takes place, the eggs probably hatch off at once, and new colonies are started, or that viviparous reproduction goes on without the necessity of egg laying. The prevalence of dead-spot or bark disease in apple trees gives just the condition of the bark which favours the pests, by providing them with shelter, and increases the difficulty of reaching them with spraying mixtures.

It is therefore important that, as far as possible, dead and decayed bark and all surplus limbs and branches of infested trees should be removed before spraying is done, to allow the mixture used to penetrate all parts of the trees.

The best winter wash is the No. 1 spray; the lye and soap wash (No. 15) is also effective. At least two applications should be made to badly infested trees, and the spray applied warm, with all the force possible, by means of a good spray-pump. During the summer months, masses or colonies of the aphides occurring on the trunk or limbs may be destroyed by touching them with a swab or brush dipped in coal oil, or either of sprays No. 6 or 7, applied with a spray-pump. It will be necessary to repeat the treatment at intervals to keep the pests in check, until the strong winter washes can be used. For the root form of woolly aphides the No. 1 spray is effective, or the lye and soap wash used freely, especially where the stem and roots join. These substances will also act as fertilisers to the trees. To increase their effect, the roots of infested trees should be uncovered as far as possible before applying. Refuse tobacco dug in about the roots will also help to keep down the pests.

The Missouri Experimental Station has made extensive experiments with different methods of killing woolly aphides, particularly the root form of the pest, and a bulletin issued by the station states that the root form may be cheaply and easily killed, and kept away from the roots of apple trees by a liberal use of tobacco dust, applied by removing the earth from around the trunk for a distance of two feet, and four inches deep, evenly filling the space with tobacco dust, and covering with earth.

As a preventive measure, tobacco dust should be used freely among and over the roots of newly planted trees and nursery stock.

Quite frequently during the fall months other species of aphides, having a similar "woolly" appearance, are often mistaken for the true "apple woolly aphis," and specimens of woolly aphides of different species were sent to Dr. Fletcher, who writes in regard to them as follows:—"In the box of which you describe the specimens as taken off an apple twig badly infested with woolly aphides; these were the true *S. lanigera*, but amongst them were some other specimens of aphis *malifoliar*, which has the venation very similar to that of *aphis mali*. The difference between these two last-named species is chiefly colourational and in the size of the insert. The other box containing specimens of the "woolly aphis," which has given you so much trouble to identify, and which are flying in such myriads in your woods, are neither the alder aphis nor the true *woolly aphis*, but a species called *Pemphigus pyri*, which belongs to the same genus as the alder woolly aphis.

"The difference between these two genera is very easy to recognise when once pointed out, and that is, in the genus *Schizonocura* the third discoidal vein is forked, while in *pemphigus* all the veins are simple.

"*Pemphigus pyri* probably is a native species with you, and occurs through your woods on different species of pyrus and crataegus."

This species of woolly aphis (*Pemphigus tessellata*) is very common upon alder trees in lower British Columbia, and is often confounded with the woolly aphis of the apple, from which it is quite distinct. Like other aphides, they reproduce by giving birth to living young. Vast numbers of winged specimens appear in the fall and spread over the country, the air sometimes appearing full of the insects moving with the wind. They have not been found injurious to fruit trees, although many of these winged specimens are found on them. They do not seem to reproduce except on their proper food plant.

WHEAT MIDGE (*Diplosis tritici*, KIRBY).

Attack.—When wheat is in blossom in the month of June, minute yellow midges with black eyes may be found, particularly towards evening, flying over the fields and laying eggs in the florets of the ears of wheat. These eggs in about a week hatch into small reddish-orange maggots, which sometimes to the number of ten or twelve lie inside the chaff and suck the juices from the swelling kernel. When mature, they leave the ears of wheat and penetrate about an inch beneath the surface of the ground, where they spin tiny cocoons, inside which they remain normally until the following spring, when the perfect midges emerge. Under special circumstances, however, some of the flies appear in late summer and lay their eggs upon volunteer wheat or the young fall wheat.

It is many years since the Wheat Midge, which is generally known by farmers and millers as "the weevil," has been the cause of much loss in the wheat crop of the Dominion. Fifteen years ago the losses were enormous; but, just when it seemed at its worst, it suddenly disappeared entirely and since that time has not been the cause of widespread injury. There have been occasional outbreaks, as in the Niagara district in 1898, and last year in the fertile Chilliwack district of the Fraser River Valley, B. C., where it was estimated that in some fields fully half the crop was destroyed.

Remedies.—The remedies for the Wheat Midge depend largely upon the way it passes the winter. The methods which have given the best results are as follows:—

1. Deep ploughing directly the crop is carried, so as to bury the larvæ so deep that the flies cannot work their way out through the soil.

2. The burning of all chaff, dust or rubbish known as "screenings" or "tailings" from beneath the threshing machines, as these contain many of the larvæ which are carried with the crop. If fed to chickens or domestic animals, this should be done in a place where none of the puparia can escape destruction.

3. Clean farming, including the cutting of all grasses along the edges of fields and the ploughing down of all volunteer crops found in wheat fields before the winter sets in, so as to destroy an autumn brood where one exists.

4. The cultivation of such varieties of wheat as experience has shown are least affected by this insect.

GRAIN APHIS (*Nectarophora granaria*, KIRBY; ETC.).

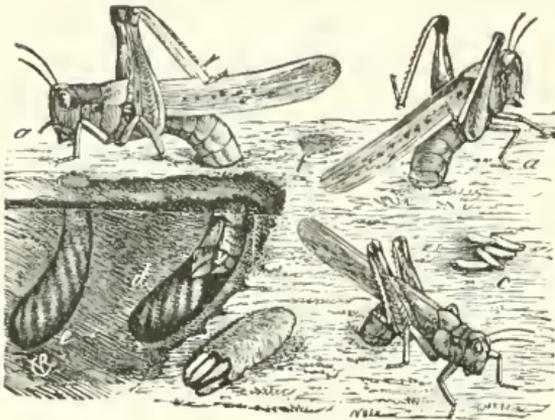
Attack.—Green, yellow, reddish or dark-coloured plant-lice, sometimes occurring in large numbers upon the heads and leaves of wheat, oats, barley and rye, weakening the plants and preventing the kernels from filling as well as they should. These plant-lice generally disappear suddenly just as the grain is beginning to change colour, being as a rule destroyed by their many parasitic and predaceous enemies before much harm is done to the crop.

It is probable that there are two or three species of plant-lice which attack grain as described above. It is known that some broods of several species feed upon one class of plants during part of their lives and upon grasses of various kinds at other periods of their existence. Some of these, as the apple aphid, occasionally may be found upon the small grains and grasses. It is convenient to speak of all these kinds occurring upon grain crops under the name of grain aphid.

Remedy.—So far, no treatment has been discovered for controlling plant-lice when on grain crops; but, fortunately, they seldom affect the output to any considerable extent. The apple aphid (*aphis mali*, Fab.) frequently develops into a serious enemy of young fall wheat; and, as this insect passes the winter as an egg upon the twigs of apple trees, the regular spraying of apple orchards with kerosene emulsion (Remedy 2) would not only clear those trees of a serious enemy, but also to a large measure protect the fall wheat of the following season. A similar alternation of generations takes place in the case of the hop aphid, which passes the winter in the egg state on plum trees, from which a winged brood of the plant-lice the following summer migrates back again to their summer quarters on the hop. Spraying the plum trees during the winter reduces largely the occurrence of hop aphid later in the year.—*Fletcher*.

CHAPTER IX.—INSECTS ATTACKING LEAVES AND TWIGS.

GRASSHOPPERS OR LOCUSTS.



(FIG. 29.) Locusts laying their eggs.



(FIG. 30.)

Attack.—Grasshoppers, or locusts, sometimes multiply enormously, especially during a dry season following another of the same character. They then become very destructive to grain and other crops. Most of the injurious species pass the winter in the egg state. The females deposit their eggs in the ground in "pods," or masses, of about thirty or more cemented together by a mucous fluid. The young grasshoppers are wingless and can only travel by hopping, but after several moults they acquire wings and are able to move freely from place to place, some species, especially the voracious so-called Rocky Mountain Locust (*Melanoplus spretus*, Uhler), being able to fly long distances. The species is found only in the West. It is about one and a quarter inches long, from the head to the tips of the closed wings. Another migratory and destructive species, rather smaller in size, is the Lesser Migratory Locust (*M. atlans*, Riley). This latter is much more generally distributed throughout the continent.

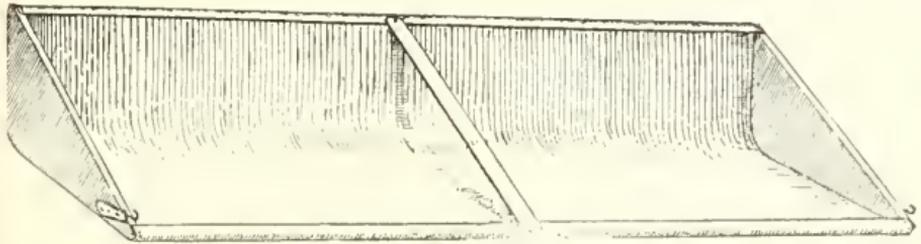
Several non-migratory locusts have in some years appeared in destructive numbers, as the Red-legged Locust (*M. femur-rubrum*, DeG.) and the Two-striped Locust (*M. bivittatus*, Say), in all parts of Canada. In the West, Packard's Locust (*M. packardii*, Scudd), and the Pellucid Locust (*Camnula pellucida*, Scudd), frequently add their injuries to those of other species.

Extensive losses from locusts have taken place in various parts of Canada in certain seasons; but by far the most important ravages have been wrought in Manitoba and British Columbia. Various species take part in this devastation, but the most destructive species in British Columbia has proved to be

Camula pellucida, Scudd), although much harm was done in the Nicola Valley by a species closely resembling the Rocky Mountain Locust, but a rather smaller species, called *Melanoplus affinis*, Coq., which has the same habits. In Manitoba the Rocky Mountain Locust and the Lesser Migratory Locust have done by far the largest proportion of injury to crops.

The eggs of the Rocky Mountain Locust are laid by preference in light soil with a firm surface, such as is presented in a field under a grain crop. So much is this the case that, when such conditions are available, hardly any eggs will be laid elsewhere. In Manitoba the young grasshoppers hatch in May, become full grown and have wings about the 1st July, when they begin migrating in swarms to fresh feeding and breeding grounds. Egg laying takes place mostly in August, and the numbers drop off rapidly from the beginning of September, although a few may be found lingering on until frost comes.

Remedies.—For the migratory species the remedies are: (1.) The ploughing down of the eggs in autumn or before the young hatch in spring. This is rendered easy by the fact mentioned above that the eggs are laid almost entirely in land which is or has recently been under crop and hardly ever on the bare prairie. (2.) The destruction of the young before the wings are developed, by ploughing down, poisoning, or by burning in windrows of straw placed as traps for them, and to which they will resort in large numbers at night. (3.) Catching in implements known as hopper-dozers, consisting of a light frame covered with canvas or sheet iron, in the bottom of which some water with a little coal oil on the top is placed.—Fig. 30a. (4.) Poisoning. This has been very satisfactory either with the poisoned bran-mash or

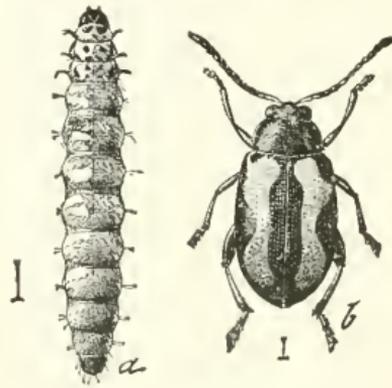


(FIG. 30a.) Hopper-Dozer.

with the recently devised Criddle mixture. In Manitoba, where for some years grasshoppers were very destructive, after a thorough trial of hopper-dozers, the implements have been entirely superseded by the use of the Criddle mixture, which was widely used and gave general satisfaction. The latest improved formula for making the Criddle mixture is as follows:—For convenience it is made in quantities of half a barrel at a time. Take fresh horse droppings 100 parts, Paris green 1 part (=1 pound) and salt 2 pounds, dissolved in half a pail of water, and mix thoroughly. In this connection Mr. Criddle, the originator of this mixture, says: "We usually measure with a three-gallon patent pail, because it is more convenient to farmers than to weigh the materials. Five pails, we calculate, approximately equal 100 parts of horse droppings, and each part equals in bulk one pound of Paris green.

A great drawback in using weights is that horse droppings are not always of the same weight." This mixture is made in a half barrel and drawn on a cart to the edge of an infested field, or one likely to be infested. The mixture is then scattered broadcast along the edge of the crop by means of a trowel or wooden paddle. Locusts are attracted to it from long distances and are killed in large numbers by eating the poison. If this mixture is distributed as above, and scattered loosely through the plants at the edge of a field of standing grain, there is little danger of stock or poultry being poisoned. Should any of the mixture be left over, it should be scattered loosely over a piece of land where its fertilising effects will be secured and where there will be no danger of poisoning animals. This is in every way the cheapest and most effective remedy for grasshoppers which I have ever tried. It has been found by Mr. Criddle that the most effective way of using this remedy is to spread a little at a time every other day, which gives far better results than scattering a lot at once, less frequently.—*Fletcher*.

TURNIP FLEA-BEETLE OR TURNIP FLY (*Phyllotreta vittata*. FAB.).



(FIG. 30b.) Enlarged eight times.

Attack.—Small active shining black beetles, $\frac{1}{4}$ th of an inch long, with yellowish marks on the wings, which eat the seed-leaves of turnips and other cruciferous plants directly they appear above the ground. When disturbed they hop to some distance.

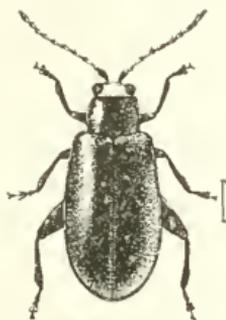
The injury by the Turnip Flea-beetle in hot, dry Junes is well known by farmers in every part of Canada. The larvæ have been found at Ottawa, feeding on the leaves of Curled Cress, a plant belonging to the same family as the turnip, but it is certain that this stage in the American insect is generally passed on the roots. As soon as young turnips appear above ground the beetles swarm on them and destroy the seed leaves, which are so important to the young plants, frequently destroying whole crops and making it necessary to re-sow large areas.

Remedies.—(1.) Paris green and land plaster, one pound of the former to twenty of the latter, dusted along the rows of young turnips, if possible when they are covered with dew, is an effective remedy against this trouble-

some insect. The land plaster acts as a stimulant to the plants and pushes on growth. As soon as the rough, true leaves are formed, the plants are, as a rule, able to make more growth than the beetles can destroy.

(2.) Late sowing. Careful observation has shown us that for Central Ontario, the third week in June is the most satisfactory time for sowing turnips to avoid injury by flea-beetles. By that time the perfect insects of the first brood have, as a rule, disappeared, and the young plants grow rapidly and produce as good crops as when sown two or three weeks earlier.—*Fletcher.*

THE RED-HEADED FLEA-BEETLE (*Systema frontalis*, FAB.).



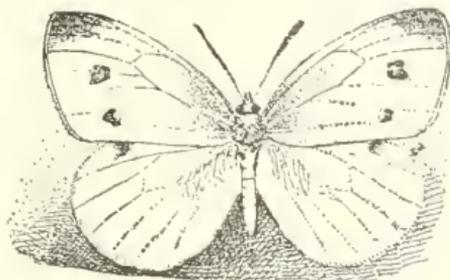
(FIG. 30c.) Enlarged eight times.

Attack.—Large, black, shining flea-beetles, $\frac{1}{4}$ th of an inch long, with a reddish blotch between the eyes. These sometimes occur in large numbers on potatoes and many other different plants, particularly clover, to which they are sometimes a serious pest. On the slightest disturbance they hop actively from the leaves which they are attacking.

The injuries to potatoes are sometimes rather severe, and, when this is the case, demand attention.

Remedy.—Spraying potatoes with the poisoned Bordeaux mixture (Remedy No. 7) is the best treatment. Other plants, as grape vines and many garden flowers, may be dusted with Paris green and lime, or, when convenient, sprayed with the poisoned Bordeaux mixture.—*Fletcher.*

SMALL WHITE CABBAGE BUTTERFLY (*Pieris rapae*, L.).



(FIG. 31.)

Attack.—Velvety green caterpillars, commonly known as Cabbage Worms, about an inch in length, with a broken yellow line along each side, and an unbroken one down the middle of the back. At first eating the outside leaves, but eventually boring right into the head of the cabbage. These, after three or four weeks, produce the white butterflies so common in gardens.

This injurious insect, which was imported into Canada about 1859, has now spread across the Dominion, and is every year the cause of considerable loss, not only to cabbages but also to turnips and other plants of the same family. It is, however, one of the easiest of the well known insect pests to control. There are two broods during the growing season, and sometimes a late supplementary one, of which the caterpillars are found as late as November. Farmers and gardeners should watch for the first appearance of the larvæ and apply the remedy promptly. The eggs are laid by the female butterflies on the leaves.

Remedy.—The caterpillars can be destroyed easily by dusting the plants with a mixture of one pound of pyrethrum insect powder and four pounds of cheap flour. Mix the whole together and keep it in a tightly closed canister or jar for 24 hours. The powder is then ready for use and may be dusted over the cabbages either with a cheese-cloth bag tapped lightly with a slender stick, or from one of the various insect guns, or dusters, now sold by seedsmen. The advantage of this remedy over many others which are recommended is that, although insect powder is so deadly to caterpillars and most insects, it is quite harmless to human beings and the higher animals.

The rather prevalent custom of using Paris green and other arsenical poisons on cabbages and other vegetables, must be condemned as being very dangerous without any commensurate advantage.

BLISTER BEETLES (*Epicauta sp.*).

Among the usually unimportant injuries to potatoes which on occasion become more extensive and involve large areas, are those due to swarms of Blister Beetles, long, cylindrical shaped beetles with soft bodies, which fly to fields and swarming over the potatoes devour the leaves rapidly. As a rule, these swarms remain only for a short time and then pass away.

A remedy which has been adopted successfully consists of driving the swarms from a crop by several people walking across it with branches or other conspicuous objects in their hands, waving them from side to side and driving these easily disturbed beetles ahead of them until they come to the edge of the crop, where they will disperse and seldom return. It is undesirable to destroy the Blister Beetles if this can be avoided, because in their larval form they are predaceous parasites on the eggs of grasshoppers; but, as in the case of nearly all leaf-eating insects, these can be destroyed by spraying the crops with a poisonous mixture such as one of the arsenites. Prof. F. M. Webster has found that crops sprayed with Bordeaux mixture are not attacked by Blister Beetles and as all potato crops should be sprayed with Bordeaux mixture every year, there is no reason why they should suffer from these insects. In addition to potatoes, many other crops and plants, particularly members of the pea family, are attacked by different species of Blister Beetles.

Species which have at different times been the cause of considerable injury to potato crops are the Black Blister Beetle (*Epicauta pennsylvanica*, DeG.), the Spotted Blister Beetle (*Epicauta maculata*, Say) and the Gray Blister Beetles (*Macrobasis unicolor*, Kirby, and *Epicauta cinerea*, Forst.)—Fletcher.

HOP FLEA BEETLE (*Psylliodes punctulata*, NELS.).

This pest has been reported during the last few seasons as doing great injury to hops at Chilliwack and Agassiz. On referring the matter to Dr. Fletcher, he replied as follows: "The course you suggested is exactly what I should have advised myself, viz., to spray the vines with a Bordeaux mixture poisoned with arsenate of lead, using 1 lb. of the poison to every 50 gallons of the mixture." In consequence of its habit of attacking the young shoots of hops denuding them of their leaves, it is a most difficult insect to cope with, and Mr. Wilson, Manager for Sir Arthur Stepney, at Agassiz, says: "I do not think the beetle will eat the poisoned foliage, as they get a new growth every day to feed upon." Mr. Hulburt first reported the pest on his hops at Chilliwack some years ago, and was recommended to use Paris green in the usual manner for leaf-eating insects, but he reported that it was a failure, probably for the same reason as given by Mr. Wilson. Mr. Hulburt afterwards reported that the only, in the least, successful method he had discovered was by spreading tarred sheets, which he placed as follows: "I take thin cotton sheeting and tack it on to a frame made of two laths with a centre piece of 2 in. x $\frac{3}{4}$ in., to which a light handle is attached.

"The cloth is painted with tar, which has to be constantly scraped off and freshly painted, so that it does not dry. These are placed under the vines, which are tapped or jarred with a light stick, when all the fleas fall off and adhere to the tar. The fleas can only be caught on a hot sunny day."

Mr. Wilson, writing on the 18th August, says: "We used the remedy recommended by Mr. Hulburt last season, but the beetles came in so numerous early this season that they did not give the vine a chance to grow, to allow us to trap them with tarred sheets; however, the beetles are disappearing now, and there are but few to be found in the yard."

Dr. Fletcher, writing under date of 26th March, 1907, says: "I have read the correspondence concerning the hop beetle in the Agassiz hop-yards. I cannot help thinking that the whole of this trouble is as you have gently suggested in your letter, that the arsenate of lead was not applied quite as it should have been. Your letter of 10th December to Mr. Roberts covers the ground thoroughly. The only thing at all in the matter which is not quite accurate, but which at the same time does not affect the question in the least, is your surmise that this beetle, *Psylliodes punctulata*, passes the winter in the pupal condition. It is much more likely that this insect always passes the winter as a perfect beetle, but the remedy you suggest would be beneficial for this form also.

"The amount of arsenate of lead used, 3 lbs. to 40 gallons, did undoubtedly kill a great many of the beetles, but, of course, Mr. Wilson would not be able to find them unless by chance he might find one by accident. If, as Mr. Wilson suggests, the flea beetles will not eat the poisoned foliage, he has attained the object aimed at. The growth of the hop-vine is not so rapid that it would supply enough unsprayed new foliage every day to feed the

beetles. The most effective time of spraying would be early in the spring, just as the plants were appearing, and I still believe that Bordeaux mixture, poisoned with Paris green or arsenate of lead, would be the best remedy.

"These insects feed freely at the time of the year when spraying is recommended, and one meal of the poisoned foliage is enough to destroy them, so that if all the foliage in the hop-yard were thoroughly covered, I have no doubt that most of the beetles would be destroyed by a single spraying.

"If 3 lbs. of arsenate of lead was not sufficient, it might be well to try 4 lbs. in the 40 gallons."

After a visit to Agassiz, by Dr. Fletcher and Mr. Anderson, in August, 1907, when a thorough inspection of Sir Arthur Stepney's hop-yards was made, the recommendation which follows was made by Dr. Fletcher and has been found to be efficacious in destroying large numbers of the beetles. The contrivance is simply a modification of the hopper-dozer used for destroying locusts, viz., a tin hopper, containing a small quantity of coal oil and water, to be dragged through the yard, the pan to be nearly as wide as the rows, and to be drawn on wheels or on a stone boat; the plants to be beaten lightly with branches or brooms to disturb the beetles, which would then jump from the hop plants and fall into the pan as it was drawn up the rows. Mr. Ackroyd found it advantageous to have a float in the pan to prevent the liquid from slopping over. The coal oil pan should be used from early in the season and in conjunction with spraying with arsenate of lead.

SLUGS AND SNAILS.

Slugs and snails belong to a group of animals called Mollusca. The Slugs (or *Limacidae*) and the Snails (or *Helicidae*) are terrestrial in habits, and feed upon all manner of substances. The majority of snails prefer green diet, such as plants of all kinds; many slugs also live upon plants, but others prefer dry vegetables and animal substances, and will not touch green matter unless under stress of circumstances.

Slugs are unprotected by an external shell, but they have a shell nevertheless in the form of a small flat plate buried under the skin in the front region of the body. Snails, on the other hand, have usually a large shell into which the whole body can be withdrawn. They also have the power of closing this shell completely by means of a hardened plate which is spread over the opening into the shell.

These so-called molluscous animals have a mouth composed of external fleshy lips, and within there is an apparatus, the chief part of which is a ribbon-like mass of teeth, by means of which they rasp away the tissues of plants and other substances which they employ as food. Both kinds of these molluscs move by means of a flattened muscular part of the body called the "foot." One notable feature is the copious flow of slimy mucus these animals can produce, and, in the case of slugs, this especially interferes with killing them. This slime cannot be produced continuously for long at a time, but it is necessary to give two or three dressings of irritant powder before the skin is reached. Many different kinds of slugs and snails occur in Britain, some being injurious, others of no economic value, while a few are even beneficial. Both slugs and snails have male and female sexual organs in the same individual. Both deposit eggs, and the young resemble the adults.

Natural Enemies of Snails and Slugs.

By far the greatest natural checks are birds, especially the thrush or so-called robin, which not only eats many slugs, but is especially partial to snails, breaking their shells against a stone and picking out the mollusc. Blackbirds devour large numbers of slugs, as also do starlings. Toads are great devourers of slugs and small snails. Moles and shrew mice also help to keep down the number of slugs. Poultry and ducks eagerly search for them. Centipedes attack slugs and ants frequently kill snails, but none of the foregoing, save birds, do any appreciable good in keeping down an excess of these molluscan creatures.

Prevention and Remedies.

The following may be mentioned as tending to prevent and lessen the attack of these pests:—

1. Drainage, because dampness favours them.
2. Avoid long manure, or, in fact, any organic manure where slugs are abundant in the soil. Employ artificials *for a time*.
3. Dry dressings of some irritant to kill the pests. (a) Soot and lime; (b) salt and lime; (c) lime and caustic soda; or to act mechanically, (d) powdered coke.

The lime must be in a very finely divided state and quite fresh. *Two or three dressings must be given*, the second some 15 to 30 minutes after the first. Lime and caustic soda is found to act best—four parts of caustic soda to 96 of lime, well mixed. Dry dressings, except powdered coke, should be applied very early in the morning.

4. "Rings" of slaked lime or fine ash soaked in paraffin may be put around choice plants.

5. In gardens and hop plantations heaps of bran-mash or moist oatmeal may be placed here and there. These baits attract the slugs, which may then be easily collected.

6. Heavy applications of soot are best to keep off snails, which should be dealt with mainly by hand-picking and by trapping with cabbage leaves.

7. Rows of peas, etc., are best protected either by spreading barley sweepings or cinders and lime along the rows, or by heavy dressings of slaked lime.

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

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

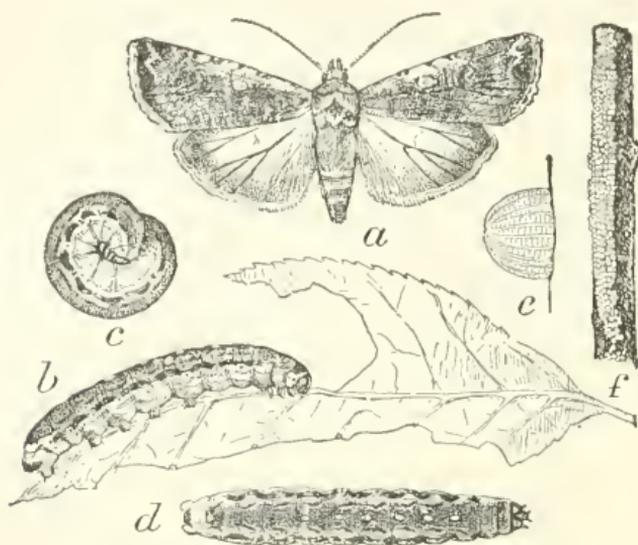
10. Wherever invasion is seen to come from a neighbouring copse or spinney a deep trench should be dug and filled with lime or tar, in order to trap the creatures.

11. Ducks and poultry should be kept in hop gardens in late autumn, and ducks in spring, and also, whenever possible, the latter should be penned on garden land, as they greedily devour both kinds of pests.

12. Thrushes should be encouraged. It is easier to keep them off our fruit than to suppress the snails and slugs which they largely devour.—*Board of Agriculture, England.*

NOTE BY REV. G. W. TAYLOR.—Our worst pest among the slugs is an importation from the Old Country. The native slugs (*Limax agrestis*) are not usually sufficiently abundant to do much damage.

VARIEGATED CUT-WORM (*Peridroma saucia*, HBX.).



(FIG. 32.)

a, moth; *b*, *c*, *d*, caterpillars; *e*, egg, enlarged; *f*, egg, mass on twig.

Description and Habits.

The moth, which is the parent of the variegated cut-worm, is a large species expanding from an inch and a half to nearly two inches when the wings are spread. It varies very much in colour; the forewings are, as a rule, rather dark-brown, but varying to ochreous or russet-brown, shaded on the disk and toward the end of the wing with a darker brown; occasionally specimens are quite light along the costal region and at the base of the wing. The wings are crossed by the usual four more or less distinct double spots on the costa. The reniform or kidney-shaped spot is usually darker than the orbicular or round spot, and the reniform bears a few white scales on the outer margin. The under wings are pearly white in the centre with a purplish sheen, bordered broadly and veined with dusky-brown and fringed with white (hence the English name of the moth, the "Pearly Underwing.") The thorax is of the same colour as the forewings, and bears in the centre a tuft of raised, light tipped scales.

The eggs are laid in elongated flat patches, and were first found by Dr. Riley, and figured in his first Missouri report for 1868. In years of great abundance it is probable that these eggs are laid in various places other than on the food plant. Eggs which were most probably of this species were

found upon curtains, in clothes hanging upon lines and on the woodwork of houses, by Mrs. Walton, of Armstrong, B. C., and Mrs. Place, of Dog Creek, B. C. On hatching, the young caterpillars, as in the case with some other cut-worms, are loopers, and resemble the larvæ of the geometrid moths, lacking some of the pro-legs which appear in the later stages.—*Dr. Fletcher's Report, 1900.*

(From Report of 1896).

"Cut-worms are the caterpillars of dull-coloured, active moths, belonging to the *noctuidæ* or owlet moths, of which there are upwards of 400 different kinds in North America. The caterpillars of these different kinds vary somewhat in their habits, but on the whole they are very similar, being smooth, almost naked, gray-looking caterpillars of some dull shade of colour similar to the ground in which they hide during the day. The head is smooth and shining, as well as a small horny plate and the segment next to the head. Their habits are almost always nocturnal; lying hid by day just beneath the surface of the soil, they come out by night to feed.

"When they occur in large numbers they change their habits somewhat, and feed by day as well, owing to the reduced food supply consequent upon their ravages. The eggs from which cut-worms hatch are laid by some species in the autumn, and by others in the spring or summer, and as a consequence cut-worms of all sizes can be found in the spring; for these insects, according to the species, may pass the winter in the state of either a perfect moth, a chrysalis, a partially grown caterpillar, or an egg."

The caterpillars under consideration are those of the moth known as "*Peridroma saucia*," of which Dr. Fletcher says in his report of 1900, "named somewhat inappropriately the variegated cut-worm." The parent moth is known in England under the name of the "Pearly Underwing."

When the caterpillars are first hatched they are minute, dark-coloured and hairy, and are at that time, and for about a week after, what are commonly known as loopers or geometers. As they attain a larger size, however, they are provided with six true legs and ten fleshy pro-legs, when they relinquish the habit of looping and assume the normal cut-worm habits.

When cut-worms are sufficiently abundant to cause wholesale destruction, they, as a rule, assume the habits of the army-worm, moving in large numbers from place to place as food becomes scarce, and it is frequently possible to head them off from further progress by scattering poisoned bait in front of the army. Ditches with perpendicular sides are also found good barriers, the caterpillars being unable to climb up the steep sides.

Remedies.

The use of the poisoned bran remedy is strongly recommended, it having proved to be most efficacious. Large numbers may be destroyed by placing between the rows of an infested crop, or at a short distance apart on infested land, bundles of succulent weed or other vegetation, which have been previously poisoned by dipping them into a strong mixture of Paris green (two ounces to a pailful of water). The cut-worms eat the poisoned plants, then bury themselves and die. In hot, dry weather these bundles should be placed out after sundown, and a shingle may be laid on each to prevent fading.

Spraying does not seem to be the most satisfactory way of applying poisons for cut-worms. The poisoned bran remedy gives really remarkable results, and is actually more attractive than green vegetation. The mixture consists of bran moistened with sweetened water and Paris green, mixed in the proportion of 1 pound to 50 pounds of bran. In making this mixture, the most convenient method is to dampen a small quantity with the sweetened water (a few ounces of sugar in a pail of water), and then add more dry bran, until the whole is almost dry again. If the Paris green is added to the bran without dampening, it sinks with remarkable rapidity to the bottom, even in this dry mixture, when it is stirred.

If it is desired to use the poison as a wet application, more water can be added until it is of about the same consistency as porridge, but if it is to be used dry, dry bran must be stirred in until the mixture will run through the fingers easily. The poison may then be applied to the land, either around or between the plants to be protected, or a row of it may be run close to the drills of crops planted in that manner.

This mixture is extremely attractive to cut-worms, being preferred to plants in all the instances which have come under my notice. It takes about ten pounds of this mixture to an acre of potatoes as ordinarily planted. Paris green being a deadly poison, care should be exercised to keep it out of the reach of children and domestic animals.

Salt in lieu of Sugar.

Walter W. Froggatt, F. L. S., Government Entomologist of New South Wales, in an article entitled "A Fight with Climbing Cut-Worms (*Leucania unipuncta*)," says: "The bran was brought up in bags, weighed, and 1 pound of Paris green added to every 16 pounds of bran. The bran, after being weighed, was poured out on large bag sheets, the Paris green scattered through it, and two men with long-handled shovels mixed it up thoroughly. When the whole was of a delicate green tint, water was added from a hog-head, in which about half a bucket of salt had been put, so that it just had a salty taste. The first lot of poisoned bait used before I arrived had been flavoured in a similar manner with sugar. This had a hardening effect upon any bait remaining over till the next day, so I substituted salt, with very good results; the caterpillars seemed to eat it more readily, and the food remained moist at night."

Hand picking or digging up the cut-worms whenever a plant is seen to be cut off should, of course, always be practised.

Traps made of disused tins, short sections of drain pipes and similar things sunk in the ground and covered over with boards, allowing sufficient room all round for the caterpillars to creep under, will capture numbers of the pests. Even ditches with steep, smooth sides, prevent a great many from getting from one part of the field to another, and when the ditch has water in it it is quite effectual.

Preventive Measures.

Preventive measures consist of: Clean culture, by which all vegetation is removed upon which the young caterpillars could feed in the autumn, or which would attract the moths to lay their eggs.

Cut-worms are heavy bodied insects unable to climb over smooth surfaces, therefore surrounding a plant or tree with a band of tin or even paper in the case of such plants as cabbages and tomatoes is an efficient means of protection. Tin bands may easily be made by taking pieces of tin six inches long by two and a half inches wide and bending them around a spade or broom handle so as to form short tubes. In placing them around a plant the two ends can be sprung apart to admit the stem and then the tube should be pressed a short distance into the ground. I have found this a useful means of disposing of tomato and other cans. To prepare these easily the cans need only be thrown into a bonfire, when the tops and bottoms fall off and the sides become unsoldered. The large piece of tin can then be used whole or may be cut down the centre with a pair of shears, so as to form two bands. It may be well to mention here that the two remedies so often mentioned in newspapers, salt and lime, have proved quite worthless in our experiments for preventing cut-worm injuries.

Another excellent plan to prevent cut-worms ascending fruit trees is to cut cotton batting in strips about four inches wide and sufficiently long to go round the trunk of the tree and to overlap an inch or two, according to the size of the tree. These bands should be tied round the trees with twine on the lower edge, the upper edge is then pulled down so as to form a sort of umbrella-shaped obstruction, over which the cut-worms are unable to climb, especially if the edge of the cotton batting is a little teased out.—*Report, 1906.*

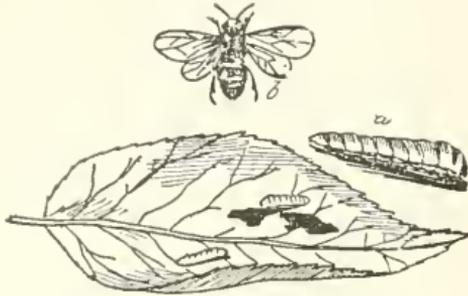
Cut-worms in Grain.

Different kinds of cut-worms attack grain crops during the spring and sometimes eat them bare. They seem to be most numerous where weeds have been allowed possession of the land during the previous autumn. The species which has been most frequently detected feeding upon the small grains is the Red-backed cut-worm (*Paragrotis ochrogaster*, Gn.). Two other species, however, when they occur, are much more difficult to reach, because they feed chiefly upon roots and work almost entirely beneath the surface. These are the Glassy cut-worm (*Hadena decastatrix*, Bracc), and the Yellow-headed cut-worm (*Hadena arctica*, Bdv.). These are of a dirty whitish colour, very similar in general appearance, but the former has a reddish-brown head, and the body is tinged with bluish green, while the Yellow-headed cut-worm has a smoky-gray body, and the head and neck-shield are tawny-yellow. The crops most attacked by these cut-worms are oats, wheat, corn, and grass in meadows.

Remedies.—When grain is found to be attacked by cut-worms the fields should at once be examined to discover if possible what species is at work. If the cut-worms are of a surface-feeding kind, like the Red-backed cut-worm, they may frequently be controlled with comparative ease by scattering poisoned bran lightly through the grain, near the spots where the caterpillars are most numerous, or ahead of them, where they are so numerous as to have assumed the marching habit. If land is systematically kept clear of weeds in autumn, there will seldom be trouble from cut-worms in the crop of the following year. Prairie or sod land which is to be broken for seeding the

next year should be fed off as late as possible or mowed before breaking. In this way the female moths will not be attracted to the tall vegetation on such lands when laying their eggs.—*Fletcher*.

PEAR AND CHERRY SLUG (*Scandria cerasi*).



(FIG. 33.)

This insect passes the winter in the pupa state under ground; the flies, the progenitors of the mischievous brood of slugs, appearing on the wing about the third week in May until the middle of June. The fly is of a glossy black colour, with four transparent wings, the front pair being crossed by a dusky cloud; the veins are brownish and the legs dull yellow, with black thighs, except the hind pair, which are black at both extremities, and dull yellow in the middle. The female fly is more than one-fifth of an inch long; the male is somewhat smaller. When the trees on which these flies are at work are jarred or shaken, or if the flies are otherwise disturbed, they fall to the ground, where, folding their antennae under their bodies and bending the head forward and under, they remain for a time motionless.

The female of this species begins to deposit her eggs early in June; they are placed singly within little semi-circular incisions through the skin of the leaf, sometimes on the under side and sometimes on the upper. In about a fortnight these eggs hatch.

The newly-hatched slug is at first white, but soon a slimy matter oozes out of the skin and covers the upper part of the body with an olive-coloured sticky coating. After changing its skin four times, it attains the length of half an inch or more, and is then nearly full-grown. It is a disgusting-looking creature, a slimy, blackish, or olive-brown slug, with the anterior part of its body so swollen as to resemble somewhat a tadpole in form, and having a disagreeable and sickening odour. The head is small, of a reddish colour, and is almost entirely concealed under the front segments. It is of a dull, yellowish colour beneath, with twenty very short legs, one pair under each segment, except the fourth and the last. After the last moult it loses its slimy appearance and dark colour, and appears in a clean, yellow skin entirely free from slime. Its form also is changed, being proportionately longer. In a few hours after this change it leaves the tree and crawls or falls to the ground, where it buries itself to a depth of from one to three or four inches. By repeated movements of the body the earth is pressed firmly on all sides, and an oblong oval chamber is formed, which is afterwards lined with a sticky,

glossy substance, which makes it retain its shape. Within this little, earthen cell the insect changes to a chrysalis, and in about a fortnight finishes its transformations, breaks open the enclosure, crawls to the surface of the ground, and appears in a winged form.

About the third week in July the flies are actively engaged in depositing eggs for a second brood, the young slugs appearing early in August. They reach maturity in about four weeks, then retire underground, change to pupæ, and remain in that condition until the following spring.

Pear and cherry growers should be on the look-out for this destructive pest about the middle of June and again early in August, and if the young larvæ are then abundant they should be properly attended to, since, if neglected, they soon play sad havoc with the foliage, feeding upon the upper side of the leaves and consuming the tissues, leaving only the veins and under-skin. The foliage, deprived of its substance, withers and becomes dark-coloured, as if scorched by fire, and soon afterwards it drops from the trees. In a badly infested pear orchard, whole rows of trees may sometimes be seen as bare of foliage during the early days of July as they are in mid-winter. In such instances the trees are obliged to throw out new leaves, and this extra effort so exhausts their vigour as to interfere seriously with their fruit-producing power the following year. Although very abundant in a given locality one season, these slugs may be very scarce the next, as they are liable to be destroyed in the interval by enemies and by unfavourable climatic influences.

Spray with Paris green or hellebore as soon as noticed; or small trees may be treated as for the currant worm, with hellebore or Paris green.

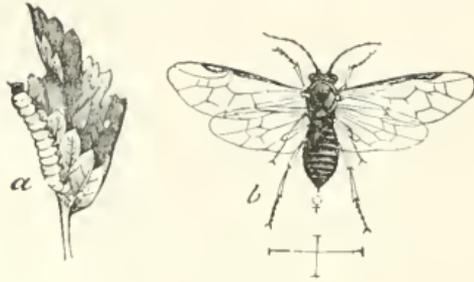
RASPBERRY SAW-FLY, OR RASPBERRY LEAF WORM (*Scandria rubi*).

The larvæ feed upon the leaves and young growth of raspberry and black-berry plants, and do very serious injury. The parent flies appear early in spring, having wintered in the pupal form beneath the surface of the ground near their food plants. Eggs are deposited in slits or cuts in the leaves, and the young larvæ soon hatch out and commence their work of destruction. Infested leaves become spotted in appearance on the upper surface, before the larvæ hatch out, and indicate the presence of the pests. The larvæ are light yellowish-green in colour, varying to darker shades, imitating the colour of the leaves upon which they are feeding.

Hellebore, used either dry or in the form of a spray, is the most useful remedy against these pests, but requires to be applied early in the attack, a few days' neglect resulting in much harm being done, as they are voracious feeders. Whether sprayed or dusted on, the hellebore must reach the undersides of the foliage for best results.

CICADA, OR "HARVEST FLY."

No injury is done by these insects in feeding, but their egg-laying habit causes considerable trouble. The eggs are laid in the twigs and branches of trees, a series of slits being cut by the ovipositor of the female, forming chambers in which the eggs are arranged in series. They are easily known by their broad, transparent wings, the large head, with prominent eyes set on each side, and by the shrill, loud noise or song, which is caused by the males, who have an elaborate drumming and sounding structure on their undersides.

GOOSEBERRY WORM OR CATERPILLAR (*Gymnomychus appendiculatus*, HARTIG.).

(FIG. 34.)

In the injurious stage of their existence they are small green caterpillars which feed voraciously upon the leaves of gooseberry and currant bushes. This species is a native one, identified from specimens of the parent fly, bred by the Rev. G. W. Taylor, of Nanaimo. The parents are members of the sawfly family, and there are at least two or three broods of these pests in a season. Late appearing broods, which are generally very numerous, are often neglected, and infested bushes become defoliated in a very short time.

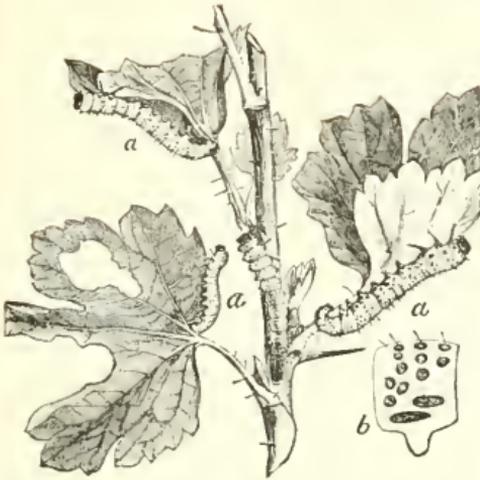
The first brood usually appears early in May. At this time there may only be a comparatively small number of the larvæ, but it is important to destroy these, as each succeeding brood is vastly increased in numbers under natural conditions. The eggs from which the larvæ hatch are deposited on leaves near the base of the branches, and the young caterpillars can be destroyed with a minimum of labour and expense, if attacked in the early stage of their existence.

Hellebore has been found the best remedy for this pest. It may be used in the form of a dry powder, or in water as a spray, at the rate of 1 oz. to 2 gallons water. On a large scale Legget's Powder Gun is a very quick and economical means for applying dry hellebore; by its use there is a great saving of time in the application as well as material.

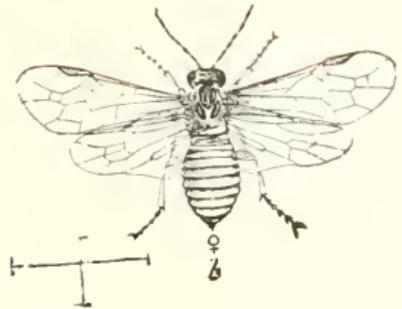
If desired, Paris green mixed with dry flour, at the rate of 1 oz. to 4 lbs. flour, can be used to dust the bushes for the early brood, or as a spray, but would not be advisable for later use, when fruit is on the bushes.

THE IMPORTED CURRANT-WORM (*Nematus ventricosus*, RING).

The insect appears soon after the currant and gooseberry bushes put forth their leaves, and the eggs are laid upon the under surface of the lower leaves, along the principal veins. The eggs hatch in a week or ten days into a pale, twenty-legged caterpillar, with a large, dull, whitish head. They soon become green and acquire shining black spots on the body, and the head becomes black. The full-grown worms are about three-fourths of an inch long, and are shown in various positions in Figure 34A; *a* and *b* give the position of the black spots upon magnified joint of the body. When they have completed their growth they leave the bushes and either hide just below the surface of the ground or under any leaves that may be on the surface, spin a thin cocoon of brownish silk, within which they assume the pupa state. Late in June, or early in July, sometimes not until August, the perfect



(FIG. 34a.)



(FIG. 34b.)

insects appear; a second crop of eggs is laid, and the same round is repeated; but this second brood does not issue from the pupa until the following spring. The perfect female is shown in Figure 34B, the lines showing the actual size.

Those who receive currant bushes from a distance, in order to avoid the introduction of this insect in the pupa state, should carefully wash the roots of the plants and burn whatever may be washed from them.

Remedies.—When the worms are not checked, they soon strip both the currant and gooseberry bushes of their leaves, and the partly-grown fruit shrivels and dies. The insect threatened to put an end to currant culture in localities where it is an important crop, until an effective remedy was made known. By the prompt use of white hellebore the insect may be subdued with but little trouble, and the crop saved. Some papers speak of the use of "hellebore," and it is necessary to specify white hellebore (*Veratrum album*), which is an entirely different drug from the black hellebore (*Helleborus niger*). The powdered root as sold at the drug stores, is of a light greenish-yellow colour, and excites violent sneezing when taken into the nostrils; hence care should be observed in handling it. The powder may be sprinkled upon the bushes by means of a tin sifter, but this is often attended by unpleasant sneezing, and is not so economical or effective as to apply it mixed with water. Place a heaping teaspoonful of the powder in a bowl; make sure that the powder is thoroughly wetted; then add more water, stirring until a quart, more or less, has been added. Turn this mixture into a pailful of cold water, stir well, and apply by the use of any garden syringe or hand-engine, or a watering-pot may be used. The object should be to wet every leaf; hence much force is not needed. In a few days, if any worms are found to have escaped, the application should be repeated; rarely are more than two doses needed. The use of white hellebore is so easy and so effective that none of the other applications that have been recommended need be noticed.—*Injurious Insects, Treat.*

WINTER MOTII (*Rachela occidentalis*)

Is one of the measuring worms in the province, of which, the Rev. Geo. W. Taylor says, the female is wingless.

Remedy.—Spraying with the Paris green wash (Spray No. 9) soon after the worms hatch.

OBLIQUE-BANDED LEAF ROLLER (*Cacarcia rosaceana*)

Injuring the buds and young leaves of apple and other fruit trees. This moth is a member of the *Tortricida* or leaf-rollers, so named on account of their habit of rolling up the leaves or portions of them into hollow cylinders, within which they live and feed. The larvæ commences operations as soon as the buds begin to expand; when full-grown they are about three-quarters of an inch in length, of a green or yellowish-green colour, with the head and top of the first segment brown; there is usually a darker stripe along the back, and a few smooth dots on each segment, from each of which arises a fine short hair.

The ravages of the larvæ are often quite serious, as they check the new growth and destroy the blossoms. Spraying, to be effective, requires to be done early in the season, using the Paris green spray. After the cases are formed, hand-picking and crushing of these is advised.

LACE BUGS (*Tingitidiv*).

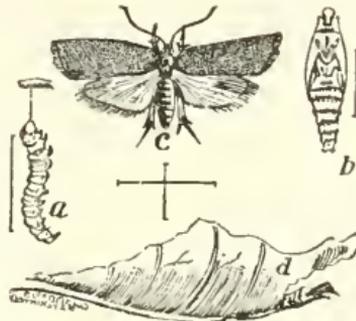
They are found on the under sides of the leaves—small, whitish, flat insects, with gauze-like broad wing covers, usually in masses together. They suck the sap of the leaves. The insects are black or brown in colour. Some of the adults usually live through the winter, and the females deposit their eggs in the spring, but sometimes eggs are laid in the fall and the winter passed in that stage. For shelter in the winter fallen leaves are used, or the adult insects creep under loose bark scales or into crevices. In the summer the insects may be destroyed by using either of sprays No. 2, 6, or 7 with the spray pump, taking care to reach the under sides of the leaves.

THRIPS.

Of this species of insects there are many members, some of which do considerable harm to fruit and ornamental trees and bushes. Rose bushes are very subject to attack, especially if suffering for want of moisture. The evergreen blackberry is also very often infested with these pests. They usually feed on the under sides of leaves, and take their food by suction; the infested leaves lose their colour in spots. They are small in size, slender and active, with the head so narrow that they seem to be pointed at both ends. The wings are laid longitudinally on the back, are narrow and transparent. They run and fly readily; some of them jump or spring when disturbed.

These insects thrive in hot, dry weather, hence become more injurious, as plants are less able to resist them, so that in addition to destroying the pests the plants should, if possible, be well watered and fed.

Either the tobacco and soap (No. 6), or the quassia and soap wash (No. 2), will give good results against these pests, but care must be taken to wet the under sides of the leaves.

LESSER APPLE-LEAF ROLLER (*Trus minuta*).

(FIG. 35.)

(a.), Larva; (b), Pupa; (c), Moth; (d), Folding case of leaves.

The caterpillar of the lesser apple-leaf roller is a greenish-yellow larva, smooth, with a pale brown head and whitish markings, affecting the young leaves of the terminal twigs, with which the insect forms a protective case. This species is remarkable in that two of the three broods of moths which appear during the year are of a bright orange colour, while those of the third brood are reddish-gray. It is an example of what naturalists call dimorphism.

The eggs are laid in the spring, on the unfolding leaves of apple and other trees and bushes, the larvæ soon hatching and feeding on the young foliage, some of which they roll into a protective covering.

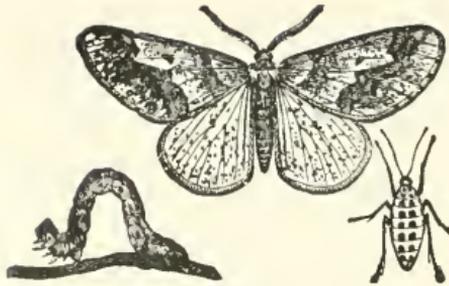
Here they continue feeding for about a month, when they pupate within the folded leaves, and a week or so later emerge as small orange-yellow moths. These moths lay eggs for another brood of larvæ, the moths of which are also yellow, and they in turn lay eggs for a third brood, which develop in the fall as reddish-gray moths. These winter in sheltered places and in the following spring deposit their eggs as previously stated.

The caterpillars feed together in numbers, usually stripping the branches of leaves as they proceed. When handled, they emit a transparent fluid having a strong acid smell. When full-grown they descend to the ground and conceal themselves under leaves or slightly below the surface, after a time changing to brown chrysalids.

The moths usually appear about June, and are described as follows:—The fore-wings are dark-brown on the inner and grayish on the outer margin, with a dot near the middle, a spot near each angle, and several longitudinal streaks along the hind margin, all dark-brown.

The hind wings of the male are brownish, or dirty white; those of the female dusky brown. When expanded, the wings measure 1 to 1¼ inches across.

The female deposits her eggs in a cluster on the under side of a leaf; these soon hatch into small caterpillars, which at first feed on the substance of the under side of the leaf; later on they consume the entire leaves. When not eating they remain close together, sometimes completely covering the branch they rest upon. On account of this habit they can be easily gathered and destroyed, or the limb cut off and trampled under foot. They are also easily destroyed by using the Paris green spray, No. 9.



(FIG. 36.)

MOTTLED UMBER MOTH (*Erannis defoliaria*).

Injurious to the foliage of fruit trees, especially plums and cherries. The larvæ are slender loopers or measuring worms, $1\frac{1}{4}$ inches in length, with chestnut red heads, dark reddish-brown backs, mottled with broken narrow black lines, the lowest distinct and waved; the sides bright yellow, paler beneath. There is a dark reddish patch, shaded with black, surrounding each spiracle. The male moth is of a dull ochre-brown hue, expanding $1\frac{3}{4}$ inches, and has the upper wings dotted and crossed diagonally by two dark waved bands; the space between these is pale and bears on each wing a dark discal spot; the lower wings are paler than the upper, and like them sprinkled with brown dots, and they have a dark spot near the middle. The female moth is brown, with two rows of conspicuous spots down the back. The wings are almost entirely aborted. When the moths appear in the autumn the females crawl up the trunks of trees and lay their eggs on the branches. In this condition the insect passes the winter.

The usual remedies for the canker worms are applicable for this species, and consist of tying sticky bandages or mechanical contrivances around the trunks of fruit trees to prevent the females from crawling up to deposit their eggs, or what will be found far more effective, spraying the trees in spring when the young caterpillars hatch, with Paris green and lime, 1 pound of each to 200 gallons of water, or the Bordeaux mixture and Paris green spray, No. 9.

THE DIAMOND-BACK MOTH

(*Plutella maculipennis*, CURTIS=*Plutella cruciferarum*, ZELL.).

Attack.—Small, green, exceedingly active caterpillars about one-quarter to three-eighths of an inch in length, which attack the leaves of cabbages, turnips, etc., eating numerous small holes through the younger leaves, and irregular blotches from the under surface of the older leaves. When disturbed they run backwards, wriggling their bodies violently from side to side, and, by means of a silken thread, fall to the ground, where they lie quite still.

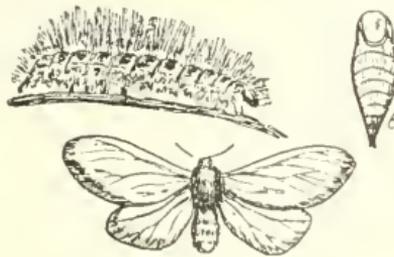
The caterpillar of the diamond-back moth is in some years a serious pest of cabbages, turnips, rape and almost all other cruciferous plants. In years of bad attack the whole plant soon turns white from the green cellular matter having been eaten away, and the plants dry up. It is probable that there are two regular broods in the year; but occasionally in late autumns some of the second brood emerge and produce a third supplementary brood, part of which

comes to maturity, and the pupæ winter over and form part of the spring brood of moths. The effects of the first brood are seldom noticed until about the first week of July, and, when seen, should at once be attended to. The active caterpillars can be recognized by their spindle-shaped bodies and their wriggling motions when disturbed. When full grown, they spin open net-work cocoons on the lower sides of the leaves, through which the black-lined white pupæ can be easily seen. The larval stage in summer lasts from three weeks to a month, and the pupal stage about a fortnight. The perfect moth is a slender little creature, very variable in size and markings. The general colour is ashy-gray with a stripe of light somewhat diamond-shaped marks on the back when the wings are closed.

The occurrence of the diamond-back moth in large numbers is fortunately very irregular. This is undoubtedly due to the large number of parasites which always appear with a serious attack. This is a fortunate circumstance, as it is a difficult insect to control. The injuries are generally more serious in hot, dry seasons.

Remedies.—Remedies which have given good results are: (1.) Dusting the infested plants with a dry Paris green mixture, using preferably lime or wood ashes as a diluent. In England where soot from soft coal can be easily obtained, this substance mixed with equal quantities of slaked lime is found to give the best results. (2.) Kerosene emulsion sprayed well under the leaves, has given excellent results in garden practice. (3.) As a supplementary treatment, inducing a vigorous growth with light dressings of nitrate of soda, or some special fertiliser, is most useful. (4.) Several reports mention the advantage of watering thoroughly the attacked plants, where this is practicable. (5.) As a preventive measure, care should be taken to keep down all weeds and plants of the mustard family, and to destroy in autumn all surplus plants of a crop which has been attacked. In this way the over-wintering brood will be destroyed.—*Fletcher*.

FALL WEB-WORM (*Hyphantria testator*).



(FIG. 37.)

The moth of this species deposits her eggs in broad patches on the under-side of the leaves, near the end of a branch, during the latter part of May or early June. These hatch during June and July. As soon as the young larvae appear they begin to eat and to spin a web over themselves for protection. They devour only the pulpy portion of the leaves, leaving the veins and skin of the under surface untouched. When full grown they are an inch or more in length, and vary greatly in their markings; some examples are pale-yellow

or greenish, others much darker, and of a bluish-black hue. The head is black, and there is a broad, dusky or blackish stripe down the back, along each side is a yellowish band, speckled more or less with black. The body is covered with long straight hairs, grouped in tufts, arising from small black or orange-yellow protuberances, of which there are a number on each segment.

The moth is of a milk-white colour, without spots. When expanded, the wings measure about $1\frac{1}{2}$ inches across. From their birth the web-spinning habits of the larvæ promptly leads to their detection, and as soon as seen they should be removed by cutting off the twig or branch and destroying it. As they remain constantly under the web for so long a period, the removal of the branch insures in most instances the destruction of the whole colony. See also remedy recommended for Apple-Tree Tent Caterpillar.

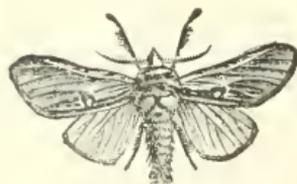
TUSsock MoTH (*Orgyia antiqua*).

Feeding upon the leaves of fruit and other trees. When mature, the caterpillars are very pretty, having bright red heads, and yellowish bodies, bearing a series of dense, abruptly cut-off brushes on the middle of their backs, with two pencils of black hair on the anterior, and one on the posterior of each.

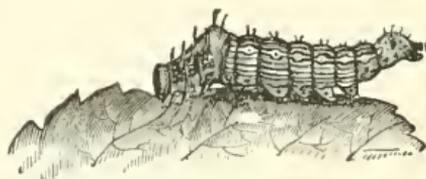
The eggs from which the caterpillars hatch are often noticed in winter on dead leaves which are fastened to the tree, with usually the empty cocoon attached. The injury from these pests is best prevented by the destruction of these egg masses during the winter.

The caterpillars may be killed by using the Paris green spray, or, if not too numerous, picking might be resorted to.

RED-HUMPED CATERPILLAR (*Edmusia concinna*).



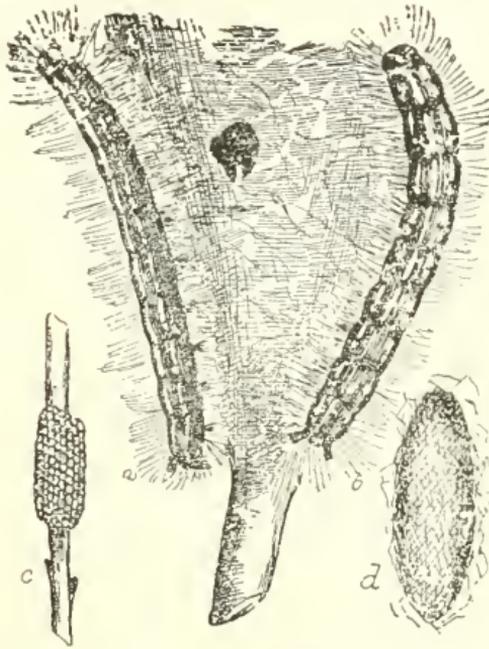
(FIG. 38.)



(FIG. 39.)

This caterpillar feeds upon the foliage of apple and other fruit trees. Its head is red, and there is a hump on its back of the same colour, on the fourth ring or segment; the body is marked lengthwise by slender black, yellow and white lines, and has two rows of black prickles along the back and other shorter ones upon the sides, from each of which there arises a fine hair. The hinder segments taper a little, and are always elevated when the insect is not crawling. It measures, when full grown, about $1\frac{1}{4}$ inches in length.

Dr. Fletcher, under date of 5th September, 1906, says: "This caterpillar has been rather more abundant than usual in all parts of Canada this year, but although it appears to be a very bad pest on account of the caterpillars feeding in large clusters, as a matter of fact it is not an important enemy of the apple, because the whole colony can be cut off and destroyed at once, whenever their presence is detected by their injuries."

TEXT CATERPILLAR (*Clisiocampa Americana*).

(FIG. 40.)

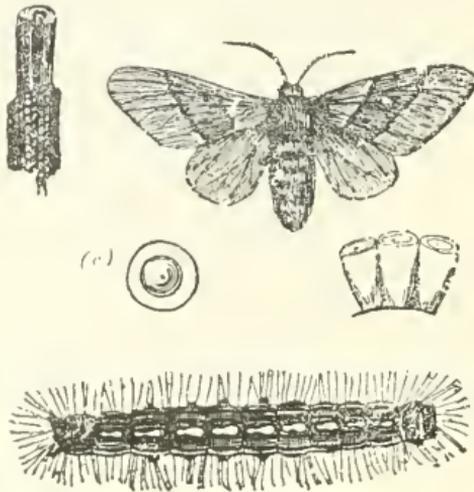
(a.), Side view; (b), Back view, full grown, at about six weeks old; (c), Cluster of eggs; (d), Cocoon, oval of pale yellow colour.

This pest of the fruit-grower is widely distributed throughout the Province and known by all fruit-growers by their habit of building webs or nests from which they issue to feed. The eggs of these pests are deposited upon the twigs of fruit and other trees in ring-like clusters or patches and covered with a viscid liquid, which dries into a sort of varnish, by the parent moths; this takes place during July and August.

On the principle that an ounce of prevention is worth a pound of cure, the easiest way of dealing with this pest, especially on small trees, is to destroy the egg masses, either removing them for the purpose, or cutting off the twigs on which they are found. Careful searching is required to do this, but the work can be accomplished in the dormant season, when there is not so much press of work in other ways. If the caterpillars are allowed to hatch out, they are easily detected by their conspicuous web or nest. In the early and late portions of the day they will all be found in these nests, and can be readily destroyed by crushing the nests and their contents with the gloved hand, by trampling under foot, or by using a torch to burn them out. Sometimes when a nest has been destroyed some of the caterpillars will be absent feeding, and within a few days the nest will be repaired and the remnants of the colony re-established, so that repeated visits should be made to the orchard in order that all may be destroyed. Neglected trees are soon stripped of their foliage and become exhausted by having to reproduce foliage at an unseasonable time, so that little or no fruit will be produced the following season.

Where these pests have been neglected till they become mature, it may become necessary to use the Paris green spray (No. 9) to prevent them from spreading.

FOREST TENT-CATERPILLAR (*Clisiocampa sylvatica*).



(FIG. 41.)

A near relation of the last-mentioned pest, and like it, widely distributed and destructive, both in orchards and to forest trees, such as willows, maples, birches, etc., often completely defoliating considerable areas. They do not spin such extensive webs as the preceding pest, and are great travellers during the latter part of the day, and often during the earlier portion too; they collect on the trunks and larger branches of infested trees in large masses; this habit can be taken advantage of in destroying them, but it is often difficult to protect orchard trees in the vicinity of infested forest areas. Constant watchfulness is needed in such cases and the Paris green spray must be used freely, combined with hand-picking and destruction of massed bodies of the pests.

BUD MOTH (*Tinctocera ocellana*).



(FIG. 42.)

The half-grown larvæ winter in inconspicuous temporary cocoons, which are usually secreted about the buds on the twigs and smaller branches. When the buds begin to open in the spring the larvæ leave their cocoons and attack both leaf and fruit buds. During the day time the moths remain quietly resting upon the trunks and larger branches of the tree, with their wings folded roof-like over the back. In this position they so closely resemble the

bark in colour that it is difficult to detect them. The moths probably live two or three weeks, and, beginning a few days after they emerge, fly about from tree to tree, mostly in the night, and deposit their eggs singly or in small clusters upon the leaves. In from seven to ten days these eggs hatch. The young larvæ, which is at first green, at once begins to feed, usually upon the lower epidermis of the leaf. It soon spins for itself a silken tube open at both ends, and usually located beside the midrib. Throughout the summer the larvæ work upon the leaves in this manner, but towards fall they retreat upon the twigs and branches and construct the temporary cocoons in which they pass the winter.—*Cordley, Oregon Horticultural Report, 1901.*

This insect is found attacking both leaf and flower buds upon the apple, and sometimes proves very injurious. The half-grown larva winters over, and appears in spring as a small brown caterpillar, just about the time the buds begin to open, and feeds upon them. It measures about half an inch when full grown. By rolling up one side of a leaf, and securely fastening it with silken threads, it forms a tube in which it enters the pupa stage, having lined the little chamber with a closely woven layer of silk. This condition lasts ten days. The imago is a small moth, resembling the codling moth in size and form. It is of an ash-gray colour. The front wings have a whitish-gray band across the middle; the hind wings are dusty-brown. The expanded wings measure half an inch across. It also attacks pear, plum, cherry, quince and peach trees, and blackberry buds.

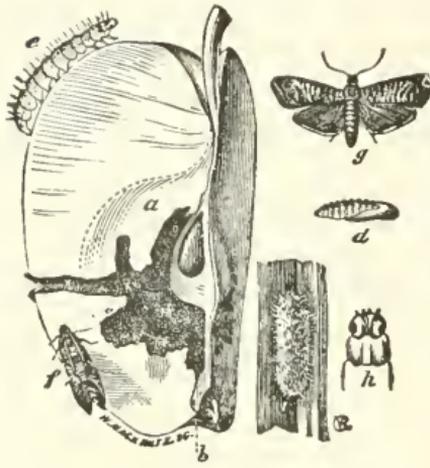
Remedy.—Paris green added to Bordeaux mixture, as directed for the treatment of the apple.—*Ontario Bulletin on Pests.*

For Twig Borer and Bud Moth.

Spray in the fall, as soon as all the leaves have dropped, with sulphur, lime, and salt solution, followed up in the spring, as soon as the buds begin to swell, with following wash: Sulphate of copper, 3 pounds; lime, 4 pounds; Paris green, 4 ounces; water, 45 gallons; and again with the same wash the latter part of May.—*Oregon Horticultural Report, 1903.*

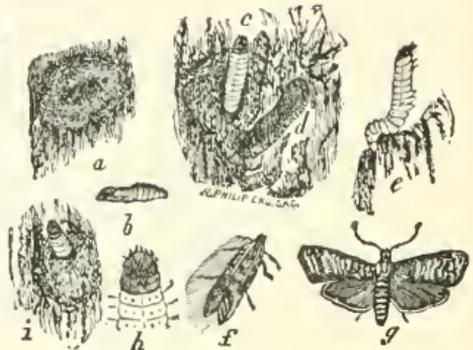
CHAPTER X.—INSECTS ATTACKING FRUIT.

SYNOPSIS OF LIFE HISTORY OF CODLING MOTH.

CODLING MOTH (*Carpocapsa pomonella*, LINN.)

(FIG. 43.)

The puncture made by the moth is represented at (b), the borings of the larva at (a), the mature worm at (c), the moth with wings closed at (e), the moth with wings expanded at (f), the cocoon at (g), the chrysalis, and (h), the anterior part of the body magnified.



(FIG. 44.)

(a), Nest of larva on outside of tree, under the old bark; (b), pupa; (c), larva exposed from nest; (d), old nest; (e), larva about to build nest; (f), the moth at rest; (g), moth with wings spread; (h), head of larva.

There are three stages in the life history of the codling moth:—

(1.) The larva or worm; (2.) The pupa; (3.) The moth or mature insect.

The insect always passes the winter in the larval condition, as a worm. It spins about itself in the fall a web called cocoon, to protect itself from the cold, rain, other insects and birds. It endeavours to find, and almost always succeeds in finding, some dry place to pass the winter, such as old fences, boards, scaly bark of trees, or even large clods. At varying times in the spring, according to the season or whether it has a warm or cool hiding place, this worm changes into that peculiar brown object called the pupa, and from this stage into the moth. Here is the first and most important point for the apple-grower, who intends to fight the moth successfully, to understand. You must know just *when* the moth appears in order to do intelligent work. Therefore, prepare yourself a *breeding cage* and confine some of the worms in it, that you may *know* with certainty when the moth comes out. One of the simplest cages is a wide-mouthed fruit jar, and in place of a lid tie some

light wire-gauze about the mouth securely, so that neither worm nor moth can get out. Place the jar in the orchard in a cool, dry place. About the time of apple blossoming refer to your jar daily. As soon as the first moth comes out you should begin your spraying, whether *all* the petals, or "blossoms," have fallen or not. It is rare that a moth emerges from its pupa-case before most of the petals have fallen; often it does not take place until a week or two after this time. To show how this varies from year to year, let me instance from other bulletins and from my own work. In Utah, in 1903, the first moths appeared, according to Ball, about the first of June. In 1899, according to Aldrich, the first moth appeared about June 16th, probably two weeks later than usual, while the blossoms did not fall till June 14-17. This year, the first moth appeared in my cage May 18th, while the apples were in full blossom about May 14th. This was due to the unusually warm, dry spring which forced out both moths and flowers a couple of weeks earlier than usual. To be in time to catch the first worms, which might have come out before those in my cage did, I had to spray before most of the petals had fallen. The transformations of the worm take about fifty days, and may be shown graphically as follows:—

(1.) Winter worms change to moths about when petals are falling. First spraying.

(2.) Moths mate and lay eggs in a day or two.

(3.) Eggs hatch almost always in about eight or ten days, while petals close in about ten days. "*First brood of worms.*"

Many advise a second spraying at this time, to get the poison into the calyx cups before the last of them close, and to catch the last of the young worms of the first brood before they enter the apple. No spray can affect the worm when once he has entered the fruit unharmed or unpoisoned.

(4.) Worm remains in apple about eighteen or twenty days.

(5.) He then comes out by enlarging the tunnel he made on entering, or by eating out a new tunnel, and lets himself down from the apple to the ground by a silken thread, or crawls down the trunk of the tree, seeking a hiding place in which to pupate.

(6.) Having found such a hiding place, he wraps himself up as did the winter worm, gradually changes to a pupa, and comes out as a moth in about twenty days. Simpson found this time varied from eleven to forty-nine days in Southern Idaho.

(7.) The eggs are again laid, and they again hatch in about eight or ten days. As this forms the time for the *third spraying*, or the second, if we have omitted the last one mentioned, we must again have recourse to the breeding cage. In fact, it is much more essential that we should know the exact time this set of moths appears than the first, as we are more or less limited in the first spraying by the date of full flowering. So, as soon as the worms come out of the apples, which can be told by the *bands* on your trees (and you should use bands), catch some, place them in your cage, watch when the first moth appears, add eight or ten days for hatching of young worms, and you will know when this *second brood* of worms is ready to enter the apples. Your spray should be on the apples soon after the emergence of the *first* moth, in order to catch early as well as late worms of this brood.

(S.) The young worms again eat their way into the apples, and remain inside the fruit for another twenty days or so. The first brood enters the apple mainly by the *calyx end*; hence the necessity of having the poison well down in the calyx cup and ready for them. The second brood enters the apple anywhere, but usually not by the calyx. When the mature worm emerges from the apple again he does not, about Moscow, change again this season into the moth, but seeks a hiding-place, spins about him his cocoon, and there spends the winter. Rarely they remain in the apple when stored.—*Henderson, Bulletin 55, Idaho.*

Remedies.

Spraying with the Paris green mixture No. 9, or with arsenate of lead, are the recognized sprays now universally used.

Destroying fallen fruit.—Fallen fruit should be promptly gathered and destroyed. It has been recommended that hogs be kept in the orchard for the purpose of devouring such fruit, and where they can be so *kept without injury to the trees or other crops, they would, no doubt, be useful.*

The following is from the U. S. Farmers' Bulletin, No. 247:—

Banding.—The use of bands to trap the full grown larvae of the codling moth was the only remedial measure of value employed before arsenical sprays were discovered. If an orchard has been given good care, and spraying is thoroughly done, it may be unnecessary to use bands. If, however, the trees are old and cracked, and have holes in the trunks and branches, or are planted close together, so that spraying is difficult, the use of bands will materially aid in bringing the insect under control.

Banding for this insect is simply affording it a good place to spin its cocoon, and killing the larva or pupa after it has gone beneath the band. Cloth bands, from 10 to 12 inches in width, are folded once lengthwise and placed around the tree. They can be fastened in such a way as to be easily removed and replaced, by driving a nail through the ends and then nipping off the head at an angle so as to leave a sharp point. If a tree is large, one band should be placed on the trunk and one on each of the larger limbs. Cloth bands of any heavy dark-coloured stuff are much preferable to bands of hay or paper. When bands are used, the trees should be scraped clean of rough or loose bark, to leave as few other attractive places as possible in which the larvae might spin cocoons. Inspection of the bands should be made regularly at intervals of ten days, and all larvae and pupae found beneath them should be destroyed with a knife. If used alone, banding is but little effective in badly infested localities, but it is a most valuable adjunct to spraying. Under no circumstances should banding be used as a substitute for spraying.

The use of arsenate of lead for the codling moth is thus referred to in the New Zealand Agricultural Report, 1907:—

"Spraying for Codling Moth.

"Such excellent results in the control of the moth have been derived through spraying with disparene (which is only another name for arsenate of lead) that it seems probable that either disparene or Swift's arsenate of lead will take the place of other forms of arsenic as an insecticide for codling

moth and other destructive eating-insects. The price at which arsenate of lead was put on the market previously has been almost prohibitive as far as extensive use in large commercial orchards was concerned, but recently a material reduction has brought it within the reach of all those who need to use an effective insecticide. (Swift's arsenate of lead is now being used to a very large extent in the Pajaro Valley, one of the largest apple-growing districts in California. The Port Albert apple-growers have derived splendid results from the use of disparene. By careful and thorough spraying they have reduced moth infection to next to nothing. In some young orchards of smooth-barked trees there is not more than 1 per cent. of infected fruit, while in the older orchards the infection is not more than 3 per cent.)"

How to Spray.

Spraying should be done with a definite object in view, and the method of spraying adapted to the accomplishment of that object. The first spraying for the codling moth is for the sole object of getting the poison into the calyx cup before it closes, and everything else should be subordinated to that end. It has been found by repeated experiments that a rather coarse spray, thrown with great force, will penetrate and remain in the cups better than the mist-like spray ordinarily used. At this time the apples are standing upright or out towards the light just as the blossoms were, and so to go into these cups the spray must be thrown *from above down* and *from the sides in*, and *not* from below *up*, as it is usually done. In the latter case the mist-like spray gathers on the stamens and either runs off or else dries there and does not carry any poison down into the cups. It will do no harm to continue the first spraying until the tree is dripping all over, as the liquid that has lodged in the calyx cups will stay there.

The second spraying serves two purposes, one to fill any calyx cups still open, and also to leave a coating of poison on leaves and fruit. The writer formerly used the mist spray for this application, but changed to the coarse spray and secured better results. This spraying should cease as soon as the tree begins to drip.

What Nozzle to Use.

For both these sprayings the best nozzle to use is one that throws a fan-like spray, such as the Bordeaux, manufactured by the Deming Co., or the Seneca of the Gould Co., setting the nozzle at about the medium capacity, so that under the working pressure of the pump the spray will be thrown 6 to 8 feet before a mist is formed. If such a spray is thrown up and down on a smooth surface at a distance of 6 to 8 feet, it will leave the surface covered with little drops of water the size of a pinhead or smaller, each one containing a grain or more of poison, which will be left there as the water evaporates. If spraying is continued too long these little drops will unite and run off, carrying the poison with them. If the nozzle is set too fine, progress will be slow, if too coarse the drops will run off. Care should be taken at all times to see that the pressure is kept up and that the mixture is well agitated.

The Bordeaux nozzle has a greater capacity than the other fan-shaped ones, and we have found that one of this style will cover as much ground and do better work than two of the other kinds.

When to Spray.

The first application should be made as soon after the bloom falls as possible—never while the blossoms are on. In a badly mixed orchard this might possibly be when a few blossoms were on the late trees, but in case the different varieties were separate, spray each variety three or four days after the petals fall. In planting an orchard different varieties should be kept in blocks, or at least in rows, so that they can be sprayed when ready.

The length of time in which the calyx remains open varies in different varieties and in different seasons; probably six to ten days would be a fair average. This can be watched and those that close the quickest sprayed first.

The second spraying should be made from ten days to two weeks after the first. This will catch those calyx cups that are late in closing and any from which the first spray has been washed, and will also leave a coating of poison on the now fairly well-grown leaves and the developing fruit.—*Bulletin No. 87, Utah.*

LESSER APPLE-WORM (*Grapholitha prunivora*, WALSH).

This is the insect which has so often been mistaken for the codling moth by our fruit-growers, and certainly in some respects there is a marked resemblance. It is also known as the plum-moth, and was first figured and described by Walsh as a plum enemy.

Full-grown specimen larvæ are described as follows: three-eighths of an inch in length, one-sixteenth of an inch in diameter, tapering slightly towards both extremities; reddish pink to pale pink in colour; lightest in colour between the segments. Head smaller than first segment, with blotchy, darkish brown markings; thoracic and anal plates also darkish, marked with brown. Body covered with white bristles, with finely dotted surface to the skin (under microscope). The parent moth expands about five-eighths of an inch across wings; the ground colour of the front wings is black, with large patches of rusty red and a central steel-blue patch. Along the costa are seven very conspicuous short white streaks, arranged 2, 2, and 3 together, of which the longest are the 1st, 3rd, 5th and 7th. These streaks are nearly parallel to each other, and are obliquely directed towards the posterior angle of the wing. The hind wings are dusky gray at the base, shading into black at the tip.

The common form of attack of this pest in cultivated apples is at the calyx end of the fruit, and in the majority of cases the larvæ do not penetrate very far into the fruit. There are, however, many exceptions to this, and quite a number of apples have been found in which the larvæ had bored into the centre of the fruit and even fed upon the pips, just as the true codling moth does.

From this habit of feeding, it is apparent that effective use can be made of the Paris green spray, or Bordeaux mixture and Paris green (No. 9), applied very soon after the trees have blossomed, and before the young fruit turns downwards, and wherever there is a probability of the pest appearing, this course should be adopted. In addition to this, infested fruits, which usually ripen prematurely, should be carefully collected and destroyed, as soon as

observed. A general observance of this practice would greatly lessen the numbers of the mature larvæ, and has the merit of costing nothing but a little time and care.

CURRENT MAGGOT (*Epochra Canadensis*, LÆW.)

Is a very serious pest of both red and black currants.

The parent fly varies in colour from pale yellow to pale orange, with abdominal markings, greenish iridescent eyes, and dark bands across the wings; it is two-winged and appears during the latter part of May or early in June, and is active during three or four weeks.

Eggs are deposited in the fruit during this period by means of the insect's ovipositor, and each female is capable of laying at least 200 eggs. The young larvæ hatch out very quickly, and feed upon the seeds of the fruit. Infested fruit at first has a clouded appearance, but soon turns reddish, prematurely on one side, where the pest is located, and later, blackish. Most of the infested fruit falls to the ground, and sometimes the ground is literally covered with infested fruit. When the larvæ are about to transform they crawl out of the currants and enter the ground for a short distance, or they may transform on the surface, under rubbish. In pupal form the insect is of a pale yellowish-brown colour. In this condition the insect spends several months of the year, gradually undergoing changes into the fly, which emerges in the spring.

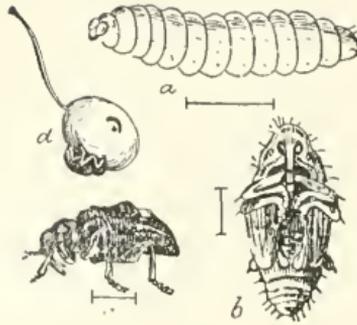
As a preventive measure, the bushes and ground adjacent should be sprinkled with a mixture of air-slaked lime and carbolic acid, just at or previous to the time when the parent fly is active, probably early in May. One pint of crude carbolic acid to one bushel of lime, well mixed together, is strong enough for the purpose. This method is useless after the eggs have been deposited, *so careful attention is necessary.*

Gathering and destroying the fallen fruit during June would reduce the numbers of the pest considerably, and as the pupal form is passed at or near the surface of the ground, these can be destroyed by removing and burying the soil to a depth of an inch, or by carefully digging and turning down the top-soil so that the young flies are unable to emerge in the spring. Much good is done by chickens in picking up the pests, and, if convenient, they should be given the run of the patch for that purpose.

Injury to currants, both black and red, by the larvæ of the currant fly are somewhat frequent in the West, and, unfortunately, up to the present time no very satisfactory remedy has been devised. The only treatment which has given any results is the labourious one of removing about three inches of the soil from beneath bushes which have been infested, replacing this with fresh soil, and then treating the infested soil containing the puparia in such a way that when the flies mature they cannot emerge.—*Fletcher, Report 1905.*

THE PLUM CURCULIO (*Conotrachelus nenuphar*, HERBST).

So far as known, this pest of plum-growers in Eastern States and Provinces does not occur in British Columbia, but it is advisable that our fruit-growers should know the appearance of the insect. It belongs to the family of snout beetles, so-called from the shape of the head, which is elongated into

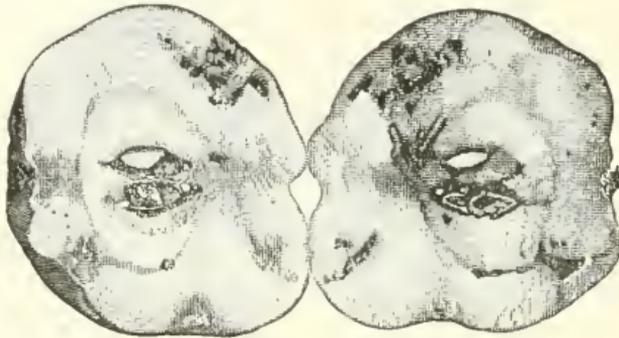


(FIG. 45.)

The different stages are shown in the engraving above: *a* represents the grub much magnified; *b* the chrysalis, and *c* the beetle, both much magnified; *d* the young fruit, showing the crescent-shaped mark made by the insect, and the cureulio, life-size, at its work.

a beak. The beetle is a small, rough, grayish insect, about one-fifth of an inch long. The female deposits eggs in the young fruit of plums and cherries, causing them to drop prematurely, generally before the larvæ are full grown.

APPLE-FRUIT MIXER (*Argyresthia conjugella*, Z.)



(FIG. 46.) Infested Apple—Halved.

The first apparent sign of infestation is the exudation of juice from the fruit, at the point where the larva entered, which generally dries up in the form of a little bubble, grayish in colour. The point of entrance is often between two fruits which touch each other, or under a leaf which covers part of the apple attacked. Later on, when the larva has left, the small hole in the side of the fruit through which it escaped can be seen on close examination.

Many fruits were found to be infested both with this and the lesser apple-worm (*Grapholitha prunivora*, Walsh). The full-grown larva is smaller than the last mentioned. It has been described as follows: Nearly cylindrical in shape; slender; about $\frac{1}{4}$ inch in length, when extended; body whitish, sometimes greenish-white, with black head; surface of the body uneven, intrasegmental folds deep; as also a medium transversal fold on each segment.

The cocoon within which the pupal stage is passed is double, consisting of a close, dense, white spindle-shaped inside cocoon, $\frac{1}{4}$ in. in length, enclosed in a network or loose, open bag of large meshes, $\frac{3}{8}$ in. by $\frac{1}{8}$ in. The inside cocoon is apparently open at one end, for in nearly every instance the larval head and skin are pushed out into the outer cocoon.

Specimens of the apple-fruit miner confined in a jar having a layer of moist earth at the bottom, and containing, also, loose pieces of bark, invariably choose the latter to spin upon, the cocoons being generally placed deep in a crevice, or under a flake of bark.

The moth is a very slender insect, measuring $\frac{3}{8}$ -inch across the expanded wings. Upper wings are silvery-gray in colour, mottled with darker patches. Along the inner margin, from the base to the middle of the wing is a broad silvery band of white ending abruptly on the inner margin, but in a spur running backwards at the outer angle of the band. This is followed by a conspicuous, black patch, which, widest at the inner margin, runs diagonally backwards across the wing; next to this is an elongated triangular white patch mottled with brown, having the base on the inner margin of the wing and the apex elongated and directed backwards towards the tip of the wing, which terminates with an eye-like spot somewhat like a peacock's feather. The dark gray lower wings are heavily fringed all round with long silky gray hairs, as also is the lower apical margin of the upper wings. The frontal tuft and the thorax are of the same silvery-white as the broad bands on the upper wings, which come together when the wings are closed and, joining with the thorax, form a continuous white dorsal stripe from the front to half way down the wings, where it is cut off by the dark bands which cross the wings diagonally. The two white triangular patches also come together when the wings are closed, forming a crescent-shaped saddle toward the tip of the wings. When at rest the posterior end of the body is raised up at an angle of 45 degrees and the insect is supported on four legs very widely separated. At such times the moth bears very little resemblance to an insect and may certainly be easily overlooked.

There is little doubt that this insect is indigenous in this Province, and when its proper food is abundant, would be of small consequence to fruit-growers, but it should certainly receive attention when numerous in orchards, as, if allowed to increase unchecked, its present habit of feeding upon cultivated fruit only occasionally may become changed, and yearly attacks the rule instead of the exception.

The life history of the insect, so far as known, does not disclose any vulnerable point of attack by means of spraying, but their numbers may be reduced by a systematic yearly destruction of all infested fruit, and by destroying, so far as possible, all crab-apple trees and bushes in the vicinity of orchards.

Infested wild crab-apple fruit turns black and may be readily distinguished on the trees by the difference in colour between this and sound fruit. It has been observed that specimen larvæ were ready to spin up early in August, and destruction of infested fruit must necessarily be done sufficiently early to catch the larva before this takes place—to be of any service.

JAPANESE FRUIT-BORER (*Larerna hercellera*).

An item appeared in a paper published in Sacramento, Cal., in November, 1907, to the effect that 6,000 boxes of apples from Orcas Island had been condemned in San Francisco on account of being infected with bud moth, and that a quarantine had been declared against British Columbia fruit for the same reason. This absurd statement naturally called forth an inquiry from this Department as to what was really meant. Whereupon Mr. J. W. Jeffrey, the State Commissioner for California, explained that the apples in question had been condemned by Mr. E. M. Ehrhorn, on account of being infested with the Japanese Fruit-Borer (*Larerna hercellera*). Mr. Jeffrey remarks furthermore: "The mistake as to the identity of this insect was not ours, and I hope you will give the facts to your people."

Mr. Ehrhorn, who, Mr. Jeffrey says, is an entomologist of national reputation, says:—

"Your letter of January 9th, addressed to Mr. J. W. Jeffrey, State Commissioner of Horticulture, Sacramento, Cal., was sent to me, as in it you express a desire for specimens and a description of the pest found in a shipment of apples from Orcas Island. I am sorry to say that I have no specimens of the insect, which is the apple fruit-borer, *Larerna hercellera*, and not the bud moth *Tnecocera ocellana*, as was reported in the various papers. I don't know how your Province came to be mentioned, but sometimes reporters get things mixed. I have from the start said that the fruit came from Orcas Island and was shipped from Bellingham to San Francisco."

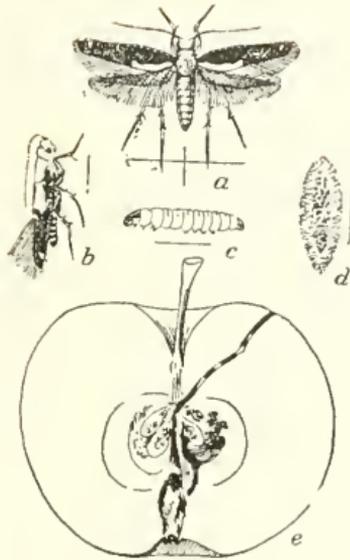
Under the circumstances, it is considered best to publish the following descriptions of two Japanese insects taken from the U. S. Year Book, 1897:—

"Of Japanese insects we need mention at this time only two species. These are the apple fruit-borer (*Larerna hercellera*, Dup.) and the pear fruit-borer (*Xephopteryx rubrizonella*, Rag.). Accounts of each have been sent us by Prof. M. Matsumura, of the Agricultural College at Sapporo. The figures which we introduce of these two insects are re-drawn from Prof. Matsumura's sketches.

APPLE FRUIT-BORER (*Larerna hercellera*, DUP.)

"Is said to be the most troublesome insect with which the fruit-growers of Japan have to contend. It is thought to have been introduced into the country, and is now met with there wherever apples are grown. The larvae live only in the core of the apple, injuring the seeds. They mature in about a month, make a passage through the flesh of the fruit, crawl or drop to the ground or emerge from the fallen fruit, making white cocoons in the earth and hibernating in the pupa stage. It produces only one brood each season.

"On the day that these words were written, November 11th, 1897, parts of two apples were received from Mr. Craw, at San Francisco, which a passenger on the steamer from Japan had given him, and which showed evidence of the work of what is very probably this insect. No specimens of the insect itself were found, but the apples contained the larval burrows leading to the core, and two of the seeds had been eaten out. It is not likely that the passengers would have bought damaged apples in Japan, and, therefore,



(FIG. 47.)

(a) adult; (b) same, side view; (c) larva; (d) cocoon; (e) injured apple. All slightly enlarged, except c, which is reduced. Re-drawn from Masumura.)

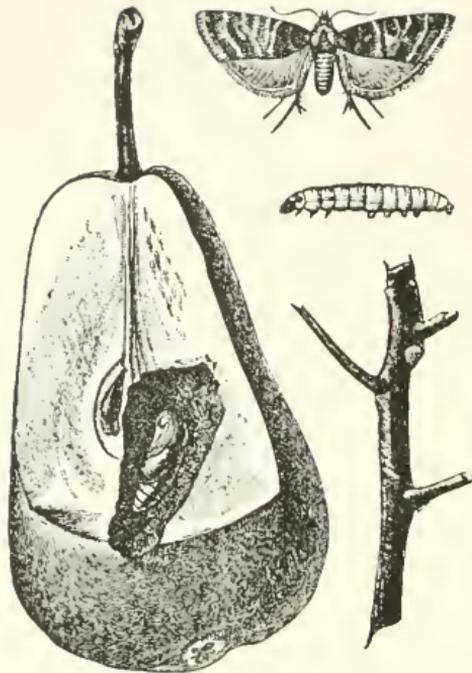
it is probable that the larvæ issued from the fruit on the journey; so that it appears to us that this insect is one which is particularly liable to be introduced. It has since been learned that this insect has already probably gained a foothold in British Columbia. (Not in British Columbia.—J. R. A.)

“PEAR FRUIT-BORER (*Nephopteryx rubrizonella*, Rag.).

“Is the larger of two species of similar habits found in Japan. Professor Matsumura states that pear-growers lose every year from 30 to 50 per cent. of their crops from this insect which is more troublesome than the apple fruit-borer. The eggs are laid under a small twig, in clusters of twenty, protected by a white silken web. They hatch early in June, at the time when the fruit has reached the size of a cherry. The young larvæ spin a considerable amount of silken thread on the twigs and make their way to different fruits near by, which they puncture to the core, always leaving a blackish opening at their entrance. Their presence is readily detected by these holes. The larval stage lasts three weeks or more, and the pupal change is undergone within thin silken cocoons inside the fruit. The insect hibernates in the egg stage.”

On the matter being referred to Dr. Fletcher, he wrote as follows:—

“I have your letter of the 9th January, and am much interested in the matter of the apples which were condemned. If the insect was the apple fruit-miner, *Argyresthia conjugella* (which probably is what Mr. Jeffrey means by the Japanese Fruit-borer, *Larrea herellea*) I think the Californian people were quite wise to condemn the shipment. You will find this insect treated of at some length in my annual report for 1898, at page 198; also in Bulletin No. 10, new series, U. S. Department of Agriculture, Bureau of Entomology,



(FIG. 48.)

Adult above, larva beneath; egg mass on twig at right; damaged pear with pupa at left. All natural size. (Re-drawn from Matsumura.)

and in *Canadian Entomologist*, 1899, page 10, where you will see that Prof. Reuter, in an article on an outbreak of the same insect in Finland, dissents, as I had done previously, from the opinion that our insect is the same as the Japanese *Larerna herellera*."

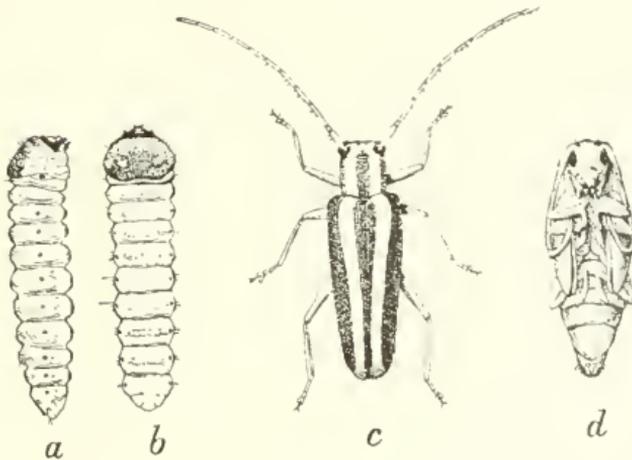
The report referred to by Dr. Fletcher, contains the following statement:—

"An interesting account of a Japanese insect (*Larerna herellera*, Dup.), which, if different, resembles in most respects the apple fruit-miner in a very remarkable manner, is given with an excellent figure in Bulletin No. 10, new series, Division of Entomology, U. S. Department of Agriculture, by Prof. Matsumura, of Sapporo, Japan. In a foot-note to this article, Dr. Howard has suggested, from the resemblance of Prof. Matsumura's figure to bred specimens of the apple fruit-miner from British Columbia, which he was good enough to examine, the identity of the two insects. Although it is true the figure cited and the perfect moths of the apple fruit-miner do agree closely, the habits of the larvæ, as given by Prof. Matsumura (*loc. cit.*) and as described in my annual report for 1896, differ upon what seem to be such important characters that for the present I can hardly think that the two attacks are by the same species. The writer of the article referred to says that the larvæ live only in apple cores, injuring the seeds, that there is usually only one egg deposited on each apple, and that the cocoons are made in the earth whenever possible.

"The British Columbian insect very rarely attacks the cores and seeds of the fruit. There are usually several, two, three or more, larvae in each apple, and the cocoons are made beneath flakes of the bark on the trees or beneath leaves or rubbish on the surface of the ground."

CHAPTER XI.—BORERS.

ROUND-HEADAD BORER (*Superda candida*).



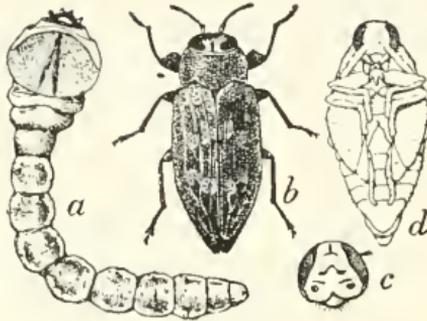
(FIG. 49.)

(a) and (b) larva; (c) beetle; (d) pupa. Enlarged.

The *eggs* are deposited about June, near the base of the trunk of the apple tree. The *larva* eats its way through the outer bark to the inner, and takes about three years to develop. It works in the sapwood, where it forms flat, shallow cavities, filled with sawdust-like castings. These are often seen on the bark, and indicate where the "borer" is at work. As it reaches maturity, it cuts a passage upwards into the solid wood and then curves towards the bark. In this channel it enters the *pupa* stage, about spring. When fully developed it is an inch long, with a round head that distinguishes it from the flat-headed borer, which also affects the apple tree.

The imago is a slender beetle, one inch long, with two broad, whitish stripes on the wing covers, and long jointed antennae. It appears about June.

Remedy.—Same as that for the following:

FLAT-HEADAD BORER (*Chrysobothris femorata*, FAB.).

(FIG. 50.)

(a) larva; (b) beetle; (c) head of male; (d) pupa. Enlarged.

This insect also attacks the trunk of the apple tree, but lays its eggs higher up the tree than the preceding one. The *larva* is a pale yellow, an inch long, and has a well-marked flat head, much wider than the body. It is sometimes found even in the limbs, and is not so long in developing as the round-headed borer. It cuts flat channels in the sapwood, and sometimes girdles the tree. Castings and discoloured bark indicate its presence. It finally bores into the solid wood, and becomes a *pupa* for about two weeks, and then emerges as an *imago* about half an inch long, somewhat flat, and of a greenish-black colour, with three raised lines on each wing-cover. The legs and under sides of the body present a coppery lustre.

Remedies.—1. Examine the trees in autumn, and where the sawdust-like castings indicate the presence of the "borer," a stiff wire may be pushed in and the larva killed, or sometimes the larva can be cut out with a knife.

2. About the beginning of June apply the following mixture to the trunk of the tree; one pound of hard soap, or one quart of soft, in two gallons of water; heat to boiling and add one pint crude carbolic acid; make a second application in three weeks. This can be well done by using an old scrubbing-brush to rub it in.—*Ontario Bulletin on Pests*.

PEACH TREE-BORER (*Sanninoidea crotiosu*).

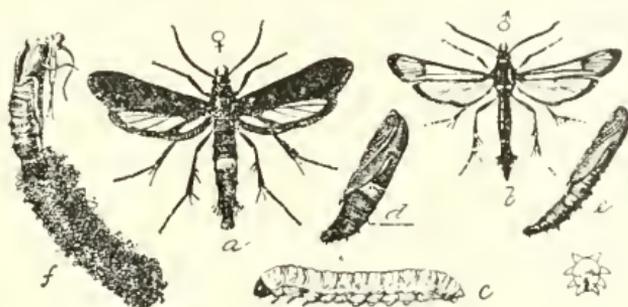
The peach tree-borer passes through four different stages during life.

It begins as an egg, deposited on the bark of the trunks of the trees from six to eighteen inches above the ground. From the egg there hatches, in a week or ten days, a minute larva, the young borer, which at once works its way into a crevice of the bark, and soon begins feeding on the inner layers of the bark.

It continues to feed in this manner, gradually enlarging its burrow under the bark, until winter sets in, when it stops feeding and hibernates. The winter is always spent as a larva or borer; a few of them may be nearly full-grown, but most of them will be considerably less than half-grown at this time.

In the spring they break their winter's fast and grow rapidly for a month or more, most of them getting their full growth in June. They then leave their burrows and spin about themselves brown cocoons, at the base of the trees.

usually just at the surface of the soil. A few days after its cocoon is made, the borer changes to a pupa, in which stage it remains for about three weeks. From the pupa, the moth emerges, thus completing its life cycle in a year, fully ten months of which are usually spent as a borer in the tree.



(FIG. 51.)

(a) female; (b) male; (c) larva; (d, e) female and male pupæ of cocoon.

The dates at which they hibernate and hatch out will vary with the locality and climatic conditions.

When fully grown the larvæ or "borers" are about an inch in length, of a light yellow colour.

CALIFORNIA PEACH TREE-BORER (*Sannania Pacifica*, RILEY).

Description.—*Female* differs from the Eastern species, in not having any yellow markings upon the abdomen. The head and eyes are jet black; thorax and abdomen are bluish-black, with slight bronze tint; edges of abdominal segments are marked with light blue; forewings are black, opaque, and in certain lights have a beautiful greenish lustre, tips are fringed; posterior wings transparent, with six black veins, narrow margin of black, and lower edge with purple fringe; antennæ and legs black.

Male.—Head, eyes, thorax, and abdomen bluish-black; forewings transparent, with a black blotch across the veins; extremity of wing black, with purple fringe; posterior wings transparent, with narrow black border; lower edge of wing furnished with purple fringe. Antennæ black, and upon inner edge are two rows of very minute hairs; legs black, with light yellow hairs at the joints between the femur and tarsus. Expanse of wings one and one-quarter inch.

Habit.—The female moth deposits her eggs on the bark, generally near the surface of the ground. The larvæ, soon after hatched, burrow into the bark and work downwards, and as they increase in size penetrate deeper, devouring the inner bark and sapwood, causing the tree to exude gum. This species has more of a tendency to work vertically, still where the borers are present in numbers the death of the tree is certain. I have recently examined apricot and peach trees where the entire bark around the collar was destroyed by this species.

Larva.—A soft, pale yellow cylindrical grub, resembling somewhat a full-grown apple-worm (*Carpocapsa pomonella*); head dark brown; first and last segments are darker than the balance; it has sixteen legs—six horny, and ten fleshy or membranous ones; very few short hairs upon the body.

Pupa.—When the larvæ are fully developed they crawl upwards, and near the surface they construct a pupa case with their castings and gum. In California they reach this stage of their existence in April, May and June, remaining in this condition three or four weeks. The pupa is brown, and when about to change to the moth it forces itself through the end of the cocoon, from which the moth afterwards issues.

How to Find Them.

Peach-growers should make a careful examination of their trees in the spring, by removing the soil a few inches deep around the trunk, brush the stem, and if any part shows an excess of moisture or gum it is a sure indication of the presence of borers, unless the tree has been injured in cultivating. Carefully remove the bark on the suspected part, and cut in the direction of the burrow until the larva is found. Hot water has been recommended by some, and others use a thin, flexible wire, with which they probe the wound; but the most certain and satisfactory way is the knife. After the borer has been found and destroyed, cover the part with moist soil; or, where the injured surface is large and the sapwood cut away, allow the wood to dry and apply two coats of rubber paint; afterwards cover with clean sand. This treatment will keep the wood sound and healthy until the bark again covers the part.

Preventive Measures.

Nearly all our warfare against insect pests has been carried on after they attack the tree, but with this one we have the means of preventing, to a great extent, any very serious damage. They prefer the moist, cool bark near the surface of the ground, and as this is the most vital part of the tree, it can be so protected that it will be impossible for the moth to reach it. The old system of banking the soil against the tree to the height of eight or twelve inches has been found of great benefit in preventing the borer from reaching the roots, if the banks are formed in May—before the moths deposit their eggs—and kept in position until winter. This will not prevent their attacks, but when the soil is removed they can be reached to better advantage. In our dry climate the placing of a small conical bank of soil against the trunk has no injurious effect, provided it be removed before heavy winter rains. The trees can then be examined, and the borers destroyed before they develop.—*California State Board of Horticulture, Bulletin No. 58.*

WESTERN STRAWBERRY CROWN-BORER (*Tyloclerma forcolatum*).

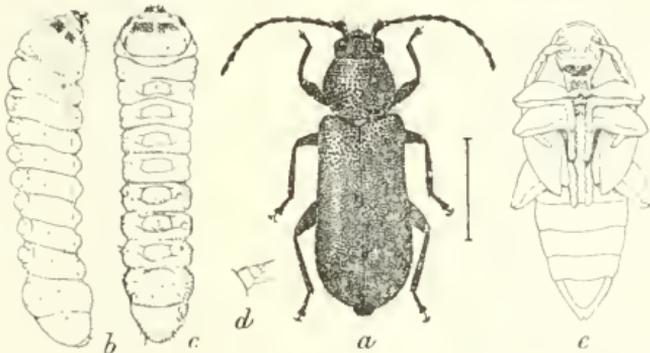
Destructive to strawberry plants. Both beetles and larvæ are destructive, and so far have not proved amenable to poisons. Changing the location of strawberry beds infested with this pest is recommended, being careful to get plants from locations where the insects are not found. The plants on infested beds should be dug up and burned as soon as the fruiting season is over.

BRONZE APPLE TREE-BORER (*Magdalis Noveboracensis*).

The parent beetles are active during the warm days in late May and June, preferring the sunny side of apple trees; the eggs from which the destructive larvæ hatch are deposited in perforations made in the bark, often where a twig has been broken or cut off, usually clustered together in a circular form, with spaces between each perforation; sometimes badly infested trees will have their trunks and main branches almost covered with these circular markings. The young larvæ soon hatch out, and commence to feed upon the bark and sap wood, seriously affecting the vitality of infested trees.

The preventive measures recommended for the larger borers are effective against these pests, but usually two applications are required, one not later than the middle of May, the other in two or three weeks' time, or late hatched beetles are apt to escape and continue their species.

Where young trees are slightly infested with larvæ they should be overhauled in the spring, the larvæ cut out with a sharp knife, and the stems bound up or covered with pieces of sacking, when the injury will be quickly repaired. It is usually observed that trees in an unthrifty condition are particularly subject to attack, and, in all cases, care should be taken, by drainage, cultivation and manuring, to induce a vigorous, healthy growth of the trees.

BLACK GOOSEBERRY BORER (*Xylocrinus Agassizii*, Sec.)

(FIG. 52.)

This is a very uncommon pest, and was found in this Province in young gooseberry bushes imported from Oregon. So far as observed, one larva or borer occurs in each infested plant. The borer usually starts in from a crotch in the branches, and works downward, apparently wintering in the roots, then working upward in much the same way as the Raspberry Cane Borer, pupating in a chamber hollowed out in the stem some inches above the ground. The male beetle is about $\frac{3}{4}$ inch and the female about $\frac{1}{2}$ inch in length. They are of a deep, dull black colour.

The illustrations given convey a good idea of the insects, and their manner of working in the stems of the plants.

All of the infested plants were destroyed in the instance mentioned, and the same course should be followed in case the pest is found anywhere else in the Province.

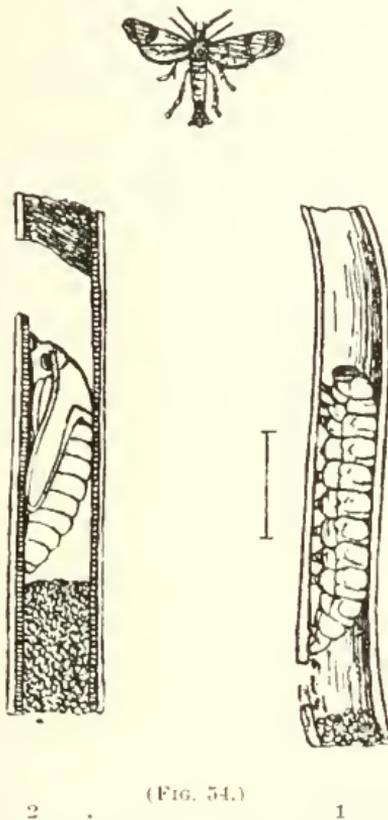


Fig. 53. The Black Gooseberry-borer; infested stem reduced one-third.



Larva in stem—slightly enlarged.

(FIG. 53.)

IMPORTED CURRANT BORER (*Egeria tipuliformis*).

(FIG. 54.)

(1) grub; (2) pupa, both enlarged; (3) perfect insect, natural size.

In the injurious stage of its existence this insect is a small whitish larva that burrows up and down the stems of currant and gooseberry bushes, stunting the growth and rendering them unfruitful. It hatches from eggs deposited singly on the young stems near the buds, early in summer, by a clear-winged, wasp-like moth, with a bluish-black body and three yellow bands across the abdomen. The wings are transparent except at the borders, where they are brownish-black. The young larvae gnaw through the stem to the centre, where they feed on the pith all summer, making a burrow several inches in length. When full-grown the larvae eat through the stem-wall almost to the outside and then change to chrysalides. When these are ready to transform, they burst through and the moths crawl out. So far only one brood has been noticed in the year.

All dead and weak shoots of infested bushes should be cut off and burnt, just as soon as leafing out shows where the attack is located, and every wilted shoot seen at any time should be cut off below the point affected, and burnt. Another preventive measure which has been found effective is to sprinkle the bushes and the ground adjacent with a mixture of air-slaked lime and

carbolic acid, at the time when the parent moth is active, usually about the middle of May to the first week in June, varying somewhat with the locality. One pint of carbolic acid to a bushel of lime.

RASPBERRY CANE BORER (*Oberca bimaculata*).

The adult of this insect is a slender-bodied black beetle, with a yellow collar just behind the head. It appears early in summer, usually during June, and deposits eggs in the green canes of raspberries and blackberries. The process of oviposition is peculiar. The beetle makes two transverse rows of punctures, about half an inch apart, in the cane; towards the tip and midway between these she deposits the egg. The rows of punctures make up a kind of girdling, which causes the tip of the cane to wither. A short time after the egg is deposited it hatches into a small cylindrical larva, that bores downwards through the pith. By autumn they have frequently reached the bottom of the cane, where they change to pupæ, and the following June emerge again as beetles. The larva is footless.

Soon after the canes are punctured by the beetle they wilt; consequently, if they are examined about midsummer, affected canes can easily be distinguished, and they should then be cut off below the lower ring of punctures and burned. If the injury is noticed later, the whole cane should be pulled up and destroyed, to be sure to get the larva.

RASPBERRY ROOT BORER (*Bombicia marginata*).



(FIG. 55.)



(FIG. 56.)

It is quite distinct from the cane-borer, having in the larval state sixteen legs, six of which are fully developed, the others not being very well defined. The parent moth is clear-winged, with a black body, prettily banded and marked with yellow. The eggs are deposited in July on the leaves of the raspberry, and the young larvæ, when hatched, find their way to the canes and feed upon the pith in the interior, gradually working down to the root, where they winter. In the following spring they work up again, usually through a fresh cane, to a height of six inches or more above ground, and eat the cane nearly through, in preparation for the exit of the future moth. Within the cane and near this prepared spot the change to chrysalides takes place, and these, when the time approaches for the moth to escape, burst through the outer skin of the canes, and the moths soon take their flight and commence to lay their eggs, as previously stated.

Little can be done towards the destruction of this pest, other than destroying the infested roots as soon as they are noticed. The application of boiling water to infested roots is advised by a Californian writer, but applicable only to very limited areas.

CHAPTER XII.—INSECTS ATTACKING ROOTS.

WESTERN TEN-LINED JUNE BUG (*Polyphyllo decemlineata*).

The larva of this insect, which is a large white grub, is a bad pest on many plants, amongst which are strawberries. In its larval stage it attacks the roots of plants, very soon killing them, by stripping off the bark from woody plants and biting off the root below the crown of strawberries and such plants.

Description.

The perfect beetle, like its prototype, the May Bug or June or Dor Bug of the East (*Lachnosterna fusca*, Froh.), has a disagreeable habit of coming through open windows and buzzing about, knocking themselves against walls and ceilings, and sometimes against one's face, which it strikes with considerable force. The beetle is about one inch and a quarter long, with a thick round body, half an inch or more in diameter, of a light brown colour, with eight white longitudinal stripes running the whole length of the wing covers, and two short ones; the breast is covered with a brownish down and the abdomen has three transverse stripes. The larva is about two inches long, with a thick body and brown head.

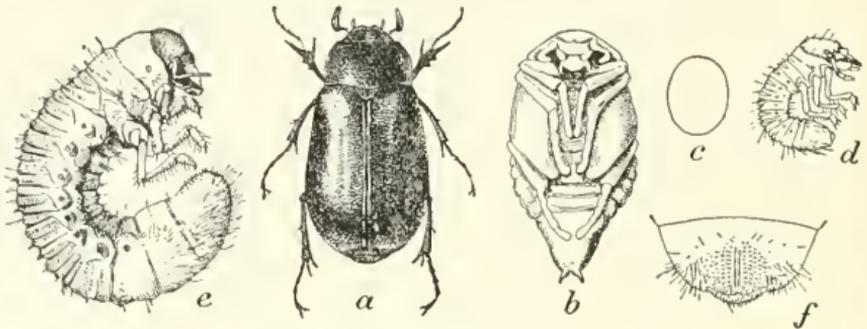
As in the case of the Black Vine Weevil, a frequent change of the beds is to be recommended as being the most efficacious remedy. It also resembles the last-named insect in its injurious habit, both in the larval and perfect stages. Naturally, on account of the nocturnal feeding habit of the beetle and the underground habits of the larva, it is a difficult insect to control. Referring to the June Bug, Saunders says:—

“It is very difficult to reach the larvæ underground with any remedy other than digging for them and destroying them. Hogs are very fond of them, and, when turned into places where the grubs are abundant, will root up the ground and devour them in immense quantities. They are likewise eaten by domestic fowls and insectivorous birds; crows especially are so partial to them that they will often be seen following the plough, so as to pick out these choice morsels from the freshly-turned furrow.”

WHITE GRUBS (*Lachnosterna fusca*, Froh.)

Attack.—White Grubs are the larvæ of the May Beetles or June Bugs, so called from their great abundance in May and June, when they may be found in large numbers flying around trees and bushes, showing particular preference for certain kinds, as willows, oaks, ashes, plums, maples and lilacs. The eggs are deposited in the ground, one to three inches below the surface, and hatch in from ten to eighteen days. The larvæ feed on roots during the remainder of the season and burrow very deeply into the ground

as winter approaches, returning again the following spring and doing a great deal of harm by eating the roots of grasses and many other kinds of plants, particularly corn and potatoes, their injuries being most noticeable in the



MAY BEETLE. (Fig. 57.)

(a) beetle; (b) pupa; (c) larva (white grub). Slightly enlarged.
(Chittenden Bull. 19, U. S. Div. of Ent., U. S. Dept. Agr.)

second year after sod has been ploughed down. It is claimed by Dr. S. A. Forbes that a second winter and summer is passed as a larva and that the grubs do not change to pupæ till June and July of the third season, the perfect beetles issuing from the pupæ two or three weeks afterwards, but passing the third winter in the pupal cells and emerging the following June. Thus three full years are consumed from the time the eggs are laid until the perfect beetles appear.

Remedies.—Unfortunately, there are no measures which can be depended upon for the destruction of White Grubs in most crops; but as the eggs are laid mainly in grass lands, land which has been in sod for several years should not be planted to corn or potatoes the second year after breaking. The first year the grass which is ploughed down, to a large measure, feeds any grubs which may be in the ground; and, as pigs are particularly fond of these grubs, a crop such as rape or turnips may be sown with advantage and the field turned into a hog pasture, when the pigs will not only feed on the crop, but hunt out many of the grubs in the soil. It is claimed that these animals will, in the course of a few weeks, completely clear a badly infested turf. On account of the depth to which the grubs burrow before winter, these crops should be fed off before the first frosts. Clover, it has been particularly noticed, is seldom attacked by White Grubs; therefore, this crop becomes of special value for growing on land which it is intended to use for corn or potatoes the following year. When, as is sometimes the case, White Grubs appear in large numbers in meadows, this fact is manifested by the dying of the grass in large patches. If, on examination, the grubs are noticed, pigs should be at once turned in, and before autumn the patches renovated with fresh seed.

Leaving land under grass for several years gives opportunities for White Grubs to increase; hence, a short rotation in which clover follows grass or is grown at short intervals, will prevent the increase of these insects. In this special rotation small grains should follow clover before corn or potatoes. The

collection of the perfect beetles by beating trees at night time has sometimes been practised with advantage, and a flock of poultry following a plough in infested fields, it is claimed, has done good work.

When May Beetles attack fruit trees or are found abundantly on other trees, spraying the foliage with arsenical poisons will destroy large numbers, or, as they are much attracted by lights, the beetles may be killed in lantern traps by placing lanterns in large pans of water with coal oil on the surface.

When White Grubs are found destroying lawns, some good may be done by spraying the grass freely with kerosene emulsion (Remedy 2) and washing it in with water.—*Fletcher*.

ONION MAGGOT (*Anthomyia ceparum* or *Phorbia ceparum*).

CABBAGE MAGGOT (*Anthomyia brassicæ*).

Attack.—Small white maggots which bore into the roots of radishes, freshly set-out cabbages, and into the bulbs of onions, and sometimes also injure the roots of beans and Indian corn.

The Cabbage or Radish Maggot, and the Onion Maggot, which for all practical purposes may be treated of here as the same species, cause great loss in crops of cauliflowers, early cabbages, turnips, radishes and onions, almost every season.

The maggots which are found attacking cabbages, radishes, cauliflowers and turnips, and those in onions, and in beans and corn, are very similar, but they belong to three different species, *Phorbia brassicæ*, Bonché, attacking plants of the cabbage variety, *Phorbia ceparum*, Meig., infesting onions, and *Phorbia fusciceps*, Zett., injuring beans and corn.

Corn sown during a cold, wet period, by which germination is unduly delayed, is very liable to be attacked by the Corn-seed Maggot (*P. fusciceps*). In such cases it is well to wait for warm weather to re-sow and then push on the crop with a light dressing of nitrate of soda, 200 lbs. to the acre.

The perfect flies of all these maggots are very similar to the ordinary observer and may be described as slender flies, somewhat smaller than the ordinary house fly, which fly about close to the ground and lay their white eggs on the stems of the young plants. Here, after a few days, the maggots hatch and work their way down beneath the soil, where they lie close to the root or burrow into it, tearing the tissues with their hook-like mandibles and living on the sap, thus soon reducing the root or stem to a rotten mass. When full grown, these maggots turn to reddish brown puparia in the soil close to the roots. The exact number of broods of these maggots which may be found in a season seems to be rather complicated by the overlapping of broods, and the delay in issuing of some individuals of each brood; but practically it may be said that cabbage and radish maggots do by far the greatest amount of harm during the month of June and early in July, and in many years their injuries are slight after that period. With onions the injury continues throughout the season and is most noticeable in June, August and September. The injury to beans and Indian corn is only in spring, and, as a rule, is confined to plants which have been weakened by the seeds being planted too deeply or by late frosts. However, in seasons of excessive abundance, cabbage and onion maggots may be found all through the growing season, and cabbages and cauliflowers are occasionally injured in autumn by the maggots attacking the heads of the plants.

Remedies.—Up to the present time it cannot be claimed that any perfectly efficacious remedy has been discovered for root maggots. In certain years they seem to be so extremely abundant that even the best remedies merely seem to prolong the lives of the plants, and only a very small proportion of a crop can be saved. In ordinary years, however, much can be done to protect crops liable to attack, and the following are the remedies which have given the best results:—

For Onions.—White hellebore dusted along the rows once a week from the time the young plants appeared above the ground gave comparatively clean onions, very few being attacked. Fresh gas lime broadcasted over onion fields at the rate of two hundredweight to the acre had a similar effect; but, when the caustic lime came in contact with the young onions, they were burnt out. A light dressing between the rows of onions of the same material gave almost as good results as where it was distributed over the whole field. When onions have begun to form their bulbs, the earth may be hoed or brushed away right down to the roots, and in some years the maggots do not penetrate the bulbs. As soon as the earth is hoed away in garden practice, a dusting along the rows with white hellebore makes the protection more complete.

Dressings of salt, Paris green and plaster, and wood ashes have been found useless in protecting onions from the attacks of root maggots.

For Cabbages.—(1.) Tarred Paper Disks.—Pieces of ordinary tarred paper three inches in diameter, with a slit running to the centre so as to allow of their being placed around the stems of young cabbages and cauliflowers at the time of planting, and pressed down close to the ground, will prevent to a large measure the flies from laying their eggs on plants so protected, or will kill the young maggots.

(2.) Insect Powder.—About half a tea-cupful of a decoction of pyrethrum insect powder (four ounces to a gallon of water), or of white hellebore of the same strength, poured around the root of each plant, after drawing away the earth, right down to the roots will destroy any maggots which may have started to work. The earth should be put back again and the plants well hilled up, when new rootlets will soon be formed. A light sprinkling of nitrate of soda, or some special fertilizer, will encourage a quick growth and much help the plants to overcome attack. Dressings of one ounce to the square yard may be used for this purpose. Cabbage plants should be examined late in June to see if the maggots are at work. The earlier the treatment with insect powder or white hellebore is applied the more effective it will be. If the mixture is applied to the roots with a force pump, although more liquid is consumed, it has the advantage of dislodging many of the maggots so that their injuries cease at once.

(3.) Cheese-cloth Inclosures.—A very effective and practical means of procuring early radishes, cabbages and cauliflowers, perfectly free from root maggots, is by growing them beneath cheap frames made of light wood covered with cheese-cloth. A convenient size for small beds is 8 feet long, 2 feet wide and 2 feet high. This frame can be made for about 25 cents, of one and a half inch square wood, nailed together at the corners, and with the

cheese-cloth tacked on the outside. In such a frame five cauliflowers and two rows of radishes have been grown to perfection. The frame was kept on from the time the young plants came up until the radishes were pulled.

Cauliflowers were sufficiently advanced to require no further protection and the frames were removed about the first of August.

For Radishes.—The maggot which attacks the radish is the same species as also attacks cabbages and turnips, the severity of attack on these different crops being about in the order in which they are named, so that in years of light attack radishes will draw off injury from the cabbages.

Injuries to turnips are seldom severe, and in most instances a crop shows little sign of this attack in autumn, even in seasons when the maggots may have been found in considerable numbers in the spring.

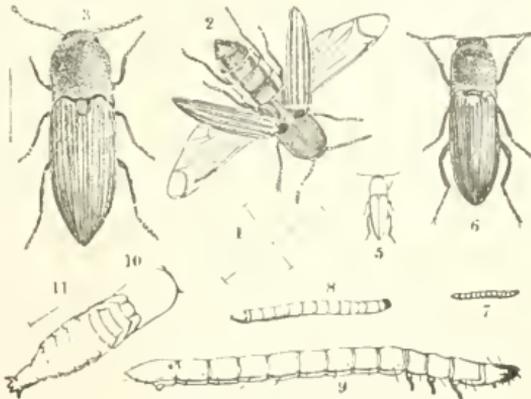
(1.) The Cook carbolic wash, consisting of one quart of soft soap, or one pound of hard soap, in a gallon of water, with half a pint of crude carbolic acid added, and the whole boiled together for a few minutes, to make the stock emulsion, has proved over and over again an excellent remedy for radish maggots. The stock emulsion can be kept in a closed vessel, so that dust and rubbish will not fall into it, and, when required for use, one part of this mixture, by measure, is added to fifty of water, and should be sprayed directly upon the growing plants from the time they appear above the ground, once a week until ready for the table.

(2.) White hellebore, dusted along the rows of radishes once a week from the time they appear above the ground, has given good results in most years.

From two years' experience with the cheese-cloth coverings, I have no hesitation in recommending these to amateur gardeners, however small their gardens may be, as a sure means of obtaining perfectly clean, as well as early radishes and cauliflowers of the very best quality at a comparatively light expense.

For Beans and Corn.—Injury to these crops in Canada is a rare occurrence. The only remedy which can be suggested is to sow these crops in good season in well prepared soil and not deeper than one or two inches.—*Fletcher*.

WIRE-WORMS (*Larva of Click-Beetles, Elaterida*).



(FIG. 58.)

Wireworms (7, 8, 9); pupa (10), enlarged; click beetles (5), natural size; (2, 3, 6) enlarged.—*Curtis*.

Attack.—Slender, cylindrical, yellowish or reddish-brown, tough and shining grubs with flattened heads and dark jaws. These grubs have only three pairs of legs on the three segments following the head, and a single short, sucker-like foot in the middle of the last segment, beneath. When full-grown they are about an inch long and only about 1-12 of an inch wide. With these will be found many specimens in spring of about just half the size of the larger ones. Wire-worms occur most frequently in low ground and attack the roots of almost all plants, but particularly young wheat and corn just as it is coming up. They also bore into the tubers of potatoes in autumn. This injury is most frequent on land which has been for several years in sod, and the attack is most severe in the second season after the sod has been ploughed down.

Wire-worms are the grubs of a large family of beetles known as click-beetles, easily recognized by their power of snapping their necks with a click with such force as to spring up into the air if they fall on their backs. These beetles are many of them dark-brown in colour, of an elongated oval form, about three times as long as broad, and tapering to the end of the body. The eggs are laid in summer about the roots of grasses and weeds, and the larvæ of most species take two years to come to full growth. They change to pupæ inside cells in the ground in July, and to perfect beetles about three weeks later, in August. Most of these beetles, like the May Beetle, remain in their pupal cells until the following spring before emerging.

Remedies.—Agricultural methods are the only ones that have been of much avail. The wire-worms which are injurious to the farmer are particularly those which feed on the roots of grasses. When sod is ploughed down, the larvæ during the first year feed for the most part on the decaying grass and its roots. Those in their second year of growth change to beetles in the first year, and do little harm, as they have had plenty of food in the decaying sod without attacking the crop; but the young larvæ, which were only half-grown when the sod was broken, attack the crop of the following year, because there is nothing else on the land for them to eat. It has been found that barley and rye are less attacked than any others of the small grains, and also that clover is little injured. Those early maturing grains are, therefore, better suited as a crop for the second season after sod, because the land can be ploughed immediately after they are harvested, and thus the pupæ and the freshly formed and still soft beetles are disturbed in their pupal cells, and many of them destroyed. Clover may be sowed in spring with either of these crops, and either ploughed down with the stubble in September or left on the land until the following autumn, when the land should be ploughed as soon as there is a good growth after the first cutting. A short rotation in which land is not left in grass for more than two years, will, to a large measure, prevent the ravages of wire-worms. Prof. S. A. Forbes recommends ploughing down sod in autumn and sowing to fall wheat or rye, with clover on these in the spring, the clover to be left for two years and then followed by corn or roots. Some farmers have obtained good results in clearing land of wire-worms by ploughing twice in the same autumn, the first time in August, the land to be well harrowed a week later, and then cross-ploughed in September.

Extensive experiments made by Prof. Forbes, in Illinois, and Prof. Slingerland, in New York, showed the uselessness of many recommended remedies, such as coating seed grain of all kinds with poison, the surface application of salt and other chemicals, and even of a clean fallow to starve the wire-worms out.—*Fletcher*.

Experiments conducted by Prof. M. V. Slingerland, of Cornell University, give the results of efforts to discover a practicable method of preventing the ravages of these pests, and a study of the life history of several common species, in Bulletin No. 107. He says: "Both defensive and offensive measures were used in our experiments. Thus we tried to protect seed from the ravages of the wire-worms, and we also tried to destroy the insects in each of three different stages of their existence—as wire-worm or larva, pupa, and adult; no eggs were obtained upon which to experiment." The general results are succinctly as follows: That it is not practicable to protect seed by the use of the various poisons and other means. That starvation by the growth of supposed immune crops, such as buckwheat, mustard and rape, was not successful. That destruction by means of insecticides, such as kerosene, crude petroleum, poisoned dough and bisulphide of carbon, were useless against wire-worms. That substances that also act as fertilizers, such as salt, kainit, muriate of potash, lime, chloride of lime and gas lime, to be effective, had to be used in such quantities that plants were destroyed, and the expense too great for practical purposes. Of starvation by clean fallow, he says: "It has been the general belief that the wire-worms which infest our fields could live but a short time in soil in which no vegetation was allowed to grow. No experiments were recorded, however, to show how long the worms could live in such soil.

"We kept several experiment cages in 'clean fallow' for nearly a year, and more wire-worms remained alive (many of them passed through the transformations to the beetle stage) in these cages than in similar cages in which grass was kept growing. Therefore, we would not advise the farmer to lose the use of his land for a season and the labour necessary to keep it free from all vegetation, in the hope that he may thus starve out the wire-worms."

Trapping.

"Our experiments on preventing the ravages of wire-worms by trapping were carried on in 1888 and 1889. Two methods were employed, trapping by baits, and by lanterns.

"*On trapping by baits.*—This method has been discussed in detail in Bulletins 3 and 33 of this Station, so that only the general results will be given here. The baits, which consisted of sliced potatoes, wads of green clover, and sweetened and unsweetened cornmeal dough, were placed under boards in various parts of a badly infested corn field. Instead of attracting the wire-worms, as was expected, their parents—the click beetles—came to the baits in large numbers; the clover attracted by far the larger number—65 per cent.

"It was found that the beetles were the most active at night, and that they seek their food chiefly by running over the surface of the ground.

"When it was found that they were so readily attracted to the baits, poisoned clover baits were used, with the result that most of the click-beetles were destroyed, proving that they fed upon the baits and thus suggesting a practical method of combating them. Where the insects are very numerous over a limited area, many of the beetles can be killed with the expenditure of very little labour in distributing these poisoned baits.

"*On trapping by lanterns.*—A series of six trap-lanterns were kept lighted every night here on the University farm from May 1st to October 1st, 1889. During the whole five months only eighty click-beetles were captured. Thus the method has no practical value in fighting wire-worms."

FALSE WIRE-WORMS (*Iulus*).

One species of this insect has been troublesome in the vicinity of Victoria, doing considerable injury to potatoes, which it enters in large numbers, consuming the interior and forming a disagreeable, ill-smelling mass, so that the tuber is rendered valueless. The particular variety alluded to is quite small, about half an inch long, and of a grayish colour. Numbers of a larger variety are to be found in damp woods during the summer, feeding on decaying vegetable matter. This species is about an inch and a half long, nearly black, with yellow bands. The following description of the genus generally is given by Treat:—

"Several worm-like creatures found in the soil are popularly called wire-worms, which are not of the larvæ of the snap-beetle, indeed, are not any kind of a larva. These are now regarded as belonging to a sub-order of insects, the *Myriapods*, which includes centipedes, millipedes, etc. The most common representatives of these belong to the genus *Iulus*. They have worm-like bodies, made up of numerous horny divisions, most of which bear two pairs of legs, and there are two short feelers at the head. They are of a blackish or dark-brown colour, and when disturbed, coil themselves into a ring. They undergo no metamorphosis like the proper insects, from which they are also distinguished by their numerous legs. Our species are from an inch to an inch and a half long, but in tropical countries they reach six and seven inches. Many of them feed upon decayed vegetable and animal matter, but some of them feed upon the roots of living plants. One of the largest species (*Iulus multistriatus*, Walsh.) has been found in some localities destructive to strawberry plants, carnations, and especially to lily-bulbs. Potatoes have also been much injured by smaller species. Traps in the form of potatoes, as mentioned under wire-worms, would be of service, or slices of apples, carrots, potatoes, or parsnips, placed upon the beds and covered with pieces of board, will catch many of these millipedes."

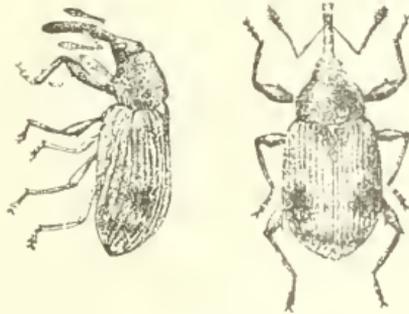
The trap mentioned is as follows:—

"In England, previous to planting the potato crop, potatoes, with a stick thrust into them to mark the place, are buried here and there to serve as traps: they are taken up at intervals, and any worms that may have collected on them destroyed."

CHAPTER XIII.—WEEVILS.

BLACK VINE WEEVIL (*Otiorhynchus sulcatus*, FAB.)

This beetle is probably the most destructive insect pest, both in its larval and perfect stages, on strawberries, that we have in British Columbia. The mature insect is brownish-black, about half an inch in length, with the long snout characteristic of all weevils. The larva is a small white grub, which attacks the crown of the roots and so kills the plant. Mr. Thos. Cunningham, Inspector of Fruit Pests, recommends burning off the tops of the plants after the crop has been gathered; this has the effect of destroying the beetles which shelter themselves amongst the leaves, and which they also attack. Dr. Fletcher says: "The only remedy which can be suggested for this beetle, as yet, is the planting of strawberries on new ground, and frequent renewal of the beds, the worst injuries being done to old plants." Mr. W. T. Macom, the Horticulturist of the Central Experimental Farm, considers the single crop method of growing strawberries the one which pays best, the fruit being finer and the land being kept clean much more easily. Some varieties which do not make runners freely might be left for two years.

STRAWBERRY WEEVIL (*Anthonomus signatus*, SAY.)

(FIG. 58A.)

The habits of the strawberry weevil are interesting. It passes the winter in the mature beetle form, and, just before the flowers of the strawberry unfold, the insects fly to the strawberry beds and may be found in large numbers upon the flowering stems. When the female lays her eggs she punctures a closed bud, for which purpose she generally chooses the earliest and largest. This is done with her sharp and slender beak, and the hole penetrates to the centre of the bud. She then deposits a single egg, pushing it down into the hole. Having done this, she crawls to the stem of the flower

and gnaws it nearly through, so that the bud hangs down and eventually drops to the ground. Inside the cut off bud the young grub hatches and passes through all of its stages, the dead flower remaining closed around it as a protection. When the grub is full-grown, it forms a brittle cocoon of the débris, and in about a month from the time the egg is laid, the perfect beetle eats its way out. The new generation of beetles may frequently be found at Ottawa in the latter half of July, and early in August. There is only one brood of this beetle, as far as is known, and, as all the beetles disappear suddenly in the beginning of August, it is supposed that they go into hibernation at that time, hiding away beneath moss or among bushes and perhaps in woods, where they remain in a lethargic condition until the following spring. The varieties of strawberries chosen by the females for egg-laying are always those which produce pollen in considerable quantities, and it is chiefly upon the pollen that the larvæ feed. Varieties of strawberries with entirely pistillate flowers are not attacked; consequently, when the strawberry weevil is abundant, growers will do well to plant pistillate varieties as much as possible, and only enough plants of varieties which produce perfect flowers (which have both stamens and pistils) as will ensure the proper fertilisation of the fruit. The numbers will, to a large measure, depend upon the variety grown and the number of flowers produced.—*Fletcher, Report 1905.*

PEA WEEVIL, OR PEA BUG (*Bruchus pisorum*, LINN.)



(FIG. 59.)

Attack.—A small, brownish-gray, very active beetle, one-fifth of an inch long, with two conspicuous black spots on the end of the body, which emerges from seed pease in autumn or in spring, leaving a small round hole.

The life history and habits of the pea weevil are well known. The egg is laid on the outside of the young pod, and the grub, on hatching, eats its way in and penetrates the nearest pea. Here it remains until full-grown, consuming the interior of the pea and passing through all its stages, from a white fleshy grub to the pupa, and then to the perfect beetle. As a rule, the beetles do not, under ordinary circumstances, leave the pease until these are sown the following spring. Some of the beetles, however, in certain seasons, escape from the pease, occasionally as early as harvest time, or during autumn, and pass the winter hidden away under rubbish, or about barns and other buildings. On reviving in spring, they fly to the fields of growing pease,

sometimes long distances away and for a time feed on the foliage of the pea-plants. As soon as the young pods are formed, the females lay their eggs on them. The beetles all become fully developed at the same time, which is about the middle of August, and all, whether they winter outside the pease or inside the grain, die about the same time the following season, viz.: during the month of June.

Loss by sowing Weevilled Pease.—That seed pease which have been bored by weevils are very seriously injured. I have proved by actual experiments, Weevilled small pease gave only from 13 to 20 per cent. of plants which bore pods, and these were all weaker than plants from perfect seed. Large pease gave a better percentage of from 16 to 28 per cent. Therefore, weevilled pease should not be used for seed if any other stock is obtainable. If, however, this is impossible, much more seed should be sown to the acre.

Remedies.

Fumigation.—Fumigation with bisulphide of carbon is a sure remedy, for the treatment of small quantities of seed, particularly by farmers, an ordinary coal oil barrel is very convenient. This will hold about five bushels, or 300 pounds of seed, and may be treated with 3 ounces of bisulphide of carbon which may be poured right on to the pease. Care must be taken to close up the top tightly. This is best done with a cap made specially for the purpose, but may also be done with fine sacks dampened and laid smoothly on the top, over which boards are laid, with a considerable weight on them to hold the covering down closely. The bisulphide of carbon should be of the best quality, which will vaporise without any residue, and the exposure should be for 48 hours. Pease should be fumigated as soon as possible after harvest, but they may be treated at any time when the temperature is above freezing. As the vapour of bisulphide of carbon is very inflammable, this work should be done at a distance from other buildings and no light of any kind must be brought near. No smoking must be allowed near the buildings where the bisulphide of carbon is being used. When large quantities of pease are to be treated at once, in specially prepared houses, one pound of bisulphide of carbon to every 100 bushels of seed, is the amount regularly used by large seed houses, as in these tightly constructed "bug houses" there is less waste of the vapour during the necessary exposure of 48 hours.

Holding over seed.—Where only a few seed pease are used, a most reliable remedy is the holding over of seed until the second year. Pease should always be bagged up and the sacks tied at once after threshing. The weevils are not able to eat their way through the bags, even when these are made of paper. All the weevils which emerge, either in autumn or the following summer, will perish inside the bags, and the seed can be sown the following year without danger; the sound seed will not be injured by being held over. Seeds showing the hole from which weevils have emerged should be sorted out before sowing.

Treating with coal oil.—A remedy which has been used by many farmers with satisfaction, is to drench the seed about two weeks before sowing with coal oil, using about half a gallon to a barrel, or five bushels of seed. Immediately after putting on the oil, the pease should be shovelled over and

over, so that all will be oiled, and the shovelling must be repeated every day for four or five days. This, if properly done, will kill all the weevils in the pease without injuring the seed.

Scalding seed.—Of the same nature, when pease are found at the time of sowing to contain weevils, is scalding the seed. This may be done by pouring them into scalding water and then either pouring the water straight off them again, or cooling off immediately with cold water.

Recommendations.

The control of the pea weevil, I believe, is possible, but this must be done, I think, not by legislation or by giving up the cultivation of such an important crop as pease, which we cannot well do without, but by persuading everyone who sows pease to abstain from sowing any seed which contains living weevils; when purchasing seed, to refuse determinedly to buy any without an assurance that they have been treated, and further, even with this, to examine for themselves to see that any contained weevils are really dead. I would also point out that, from the experiment already cited of growing pease from weevilled seed, such seed is only worth about one-quarter as much as sound seed. To secure a supply of seed pease free from weevil injury, it will be necessary for growers and farmers to handle their crop a little differently than has been the usual practice. The injury is of an exceptional nature, and exceptional measures must be taken to avoid loss.

There are, however, special features about this attack which renders its control a simpler matter than is usually the case with injuries of an equal magnitude. The pea weevil is not a native insect and has no native food plant, in which it could propagate, were there no cultivated pease. Indeed, it is so restricted in its food habits that no other food plant is known than the different cultivated varieties of true pease, belonging to the botanical genus *Pisum*. These pease will not live over the winter in our climate, if left in the open field, at any rate, in any part of the country where the pea weevil is known to breed, consequently, every seed pea sown for crop must, at some time before it was sown, have been under the control of someone by whom it could have been treated before sowing, to destroy the contained weevil, if it had one. The remedy is effective, easy and cheap, is well known and can be applied by anyone. If all growers would combine and do this, the larger number of the weevils would be destroyed in a single year. This, however, would not be sufficient, because a certain number of the insects sometimes leave the pease during the autumn when the seed ripens, and this sometimes before the pease are carried from the field. This fact is the one great difficulty in arriving at a perfect remedy, but I do not believe that it is insurmountable.

1. I suggest that all pease for seed should be treated before they are sown, to kill the weevil, and that seeding should be done as early as possible, so as to get the crop ripe enough for harvest earlier than is the usual custom.

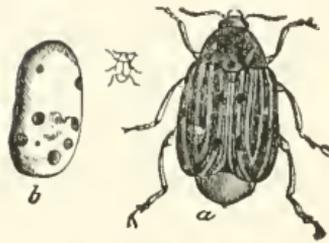
2. The pea-growers should harvest their pease as much on the green side as is safe, rather than, as is usually done now, when they are dead ripe, and thresh and treat them themselves, or sell at once to grain buyers. This has many advantages. Not only is the straw of very much higher quality for

feed, but the seed is heavier and better for every purpose, for export, for feed and also for seed, because it is of higher germinating power, and further, because the weevil at that time is much less advanced in growth, and consequently has destroyed a much smaller proportion of the bulk of the seed. The average dates for pea harvesting are from July 20th to August 20th.

Experiment has shown that the weevil at all stages may be killed inside the pea by fumigating the seed with bisulphide of carbon, consequently, if growers will harvest and thresh earlier than usual for a few years, and either themselves treat their seed immediately or sell to the grain buyers, who for their own sakes will do so, much good must surely result. When for any reason pease cannot be treated at once or disposed of, they should be bagged up and the sacks tied immediately, so as to prevent the escape of any weevils which might emerge in the autumn. When the grain is required for feeding, the pease should be ground as soon as they are dry enough, and to prevent the meal from becoming musty the new pease should be mixed with some old pease when grinding.

Difficulties to be met.—Sometimes pease ripen so unevenly that by reaping early it is feared that the sample will be very uneven when threshed; but, should this be the case, it simply means that the small and shrivelled pease are blown out of the seed pease when they are cleaned and are not lost, but can be used for feed. The greatest difficulty of all is with regard to the pease which are shelled out in the field at the time of harvesting. This, however, will be to a great measure obviated by reaping early, as the seed will not shell out nearly so much as when left till the regular time. The cleaning up of pea fields, moreover, by turning in hogs is a generally recognized practice, and the work is done thoroughly. Where hogs are not available, poultry will do the same work, and, where neither of these can be used, the land should be ploughed so deeply that the weevils cannot work their way out when they leave the pease. I am aware that it is not the custom to plough up pea fields for fall wheat, but simply to cultivate or disc them, because the land is left in such excellent condition; but it must be remembered that the loss from the pea weevil is now excessive, and, if this small change in method can be shown to be of great advantage, it surely is worth a trial.

Another difficulty suggested is that it would be hard to get all pease threshed before the autumn emerging weevils escaped, on account of the small number of threshing machines which would be available. In reply to this, experience has shown that demand will always produce supply; and I feel sure that the implement makers will not lose such an opportunity of pushing their business. The much higher price obtainable for the early threshed pease, to say nothing of the enormous value of future crops due to controlling the weevil, will very soon repay to the farmer the initial expense. Where, however, there is no possibility of getting a threshing machine, I would draw the attention of growers to the old-fashioned method of treading out the pease with horses. That this is advantageous is indicated by the fact that some of the seed merchants pay a higher price for pease threshed with horses.—*Fletcher*.

BEAN WEEVIL (*Bruchus obtectus*, SAY.)

(FIG. 60.)

Attack.—Small beetles closely resembling in shape and movement the pea weevil, but only half its size, namely, 1-10 of an inch long, oval in form, with the head bent down and more or less concealed, as seen from above, and prolonged into a short, squarely-cut snout. Antennae distinctly jointed, and enlarging towards the tip; the first four and the last joints reddish. The wing covers marked with ten impressed and dotted longitudinal lines. The whole body covered with short, silky hairs. The lines on the wing covers are broken up into pale, yellowish dashes and dark-brown spots. The tip of the abdomen extends beyond the wing covers and is of the same reddish tinge as the tips of the antennae and the legs, but is covered more or less with short, silky hairs and bears a central white line, but there is no appearance of the two black spots which are so conspicuous in the pea weevil.

The life history of the bean weevil differs in some important points from that of the pea weevil. The eggs of both are laid upon the pods while these are young and tender. On hatching, the young grub of the bean weevil eats its way inside and penetrates one of the forming beans, several grubs entering a single bean, each one forming for itself a distinct cell. They become full-grown and change to pupae in the autumn, and a little later to the perfect beetles. The date of emergence from the seed depends very much, as in the case of the pea weevil, on the temperature in the autumn months; it may be in the late autumn or not until the spring; when the seed beans are stored in a warm building, the beetles may emerge at any time through the winter. One of the important differences between the life histories of the pea and bean weevils is that, whereas in the case of the former the young grubs can only enter the soft, green seeds, those of the bean weevil can propagate for three or four generations in the dry stored seeds. This fact renders the well known domestic remedy for the pea weevil of holding over the seed for two years quite ineffective in the case of the bean weevil; that is, if a bag of pease infested with pea weevil were put away for two years, the pea weevils would emerge the first spring and die in the bag. But, in the case of a bag of beans infested by the bean weevil kept in the same way, the beetles on emerging would at once set to work to lay eggs upon the beans. The young grubs when hatched would penetrate the dry seeds and go through all their stages, and this breeding might be repeated as long as the supply of beans lasted. Curiously enough, the pea weevil does not bore holes through the paper or cotton bags in which infested seed has been stored, but in the

case of the bean weevil such bags are readily perforated and the beetles escape—frequently, when this happens in houses, as is sometimes the case, to the great consternation of the inhabitants.

The bean weevil seems to be a cosmopolitan species, the original home of which was in Asia. It was probably introduced into America through commerce, and has been the cause of considerable damage in various States of the American Union. It has been mentioned in the reports of several United States entomologists, full articles being given by Professors Riley, Popenoe and Lintner. There has been a great deal of discussion as to the proper name of the species. The last decision seems to be that the beetle should be called *Bruchus obtectus* of Say. The bean weevil has never been very injurious in Canada.

The European Bean Weevil (*Bruchus rufimanus*, Sch.) is occasionally imported in seed, but has never established itself as a pest.

Remedies.—As in the case of the pea weevil, the best remedy for this insect is the destruction of the weevils inside the beans as soon as possible after the crop is ripe. Fumigation with bisulphide of carbon is the best treatment in every way.

WEEVIL ON PEACH TREES.

At Summerland, in April, Mr. Jas. M. Sutherland's peach trees were attacked by a weevil, which ate the leaves and stripped the bark from the young shoots. The following recommendation was made by J. R. Anderson:—

"I cannot quite identify your weevil, but inasmuch as it works exactly in the same manner as the New York Weevil (*Athyrenus noroboracensis*), I think you cannot do better than to follow the directions given for the destruction of that insect.

"Treat describes the weevil mentioned as follows: 'This large snout-beetle kills the twigs by gnawing off the tender bark, in the early part of the season before the buds have put out, and later in the year it destroys the tender shoots which start out from old wood, by entirely devouring them. It attacks, by preference, the tender growth of the apple, though it will also make free with that of the peach, plum and pear, and probably of other fruit, as well as of forest trees.

"This beetle belongs to the same family as does the Plum Curculio; it is distinguished from most of the other snout-beetles by the antennae or horns being straight instead of elbowed or flail-shaped, as they are in the common Plum Curculio, for instance.'

"(Your pea weevil has decidedly elbowed antennae.)

"The female, in depositing, first makes a longitudinal excavation with her jaws, eating upwards under the bark towards the end of the branch, and afterwards turns round to thrust her egg into the excavation. The larva hatching from the egg is of the usual pale-yellow colour with a tawny head. We have watched the whole operation of depositing, and returning to the punctured twig a few days after the operation was performed, have cut out the young larva; but we do not yet know how long a time the larva needs to come to its growth, nor whether it undergoes its transformations within the branch, or leaves it for this purpose, to enter the ground; though the former hypothesis is the most likely.'

"(I would therefore recommend you to look carefully for the egg excavations alluded to).

"The same methods of catching this beetle may be employed as with the Plum Curculio, which are as follows:—

"The most effective method thus far discovered is to jar down the insects and catch them on sheets. The tree should have a sudden jarring, not a mere shaking. For this purpose it is a good plan to saw off a small limb, leaving a stump a foot or less long, upon which to strike with a heavy mallet; this avoids bruising the bark of the tree. To catch the insects, two pieces of sheeting, each two yards long and a yard wide, may be stiffened by means of small rods or sticks, one at each long side and one in the middle; make the ends of these sticks sharp, and cut a notch at a short distance from the end; the points of the sticks may be pushed into the cloth, and the notches will prevent that from slipping. A person can readily carry these from tree to tree, and placing them on the ground, one each side of the trunk, the tree is then to be jarred by a stroke of the mallet. The fallen insects may be crushed between the fingers, or be placed in a vessel of water, upon which there floats a small quantity of kerosene."

"I am referring the insect to Dr. Fletcher, and in the meantime, I hope that you will be able to keep the upper-hand, by following the directions given. I should imagine that spraying with Paris green would have the effect of destroying large numbers. The formula is 1 pound of Paris green, 1 pound of unslaked lime, and 160 gallons of water."

On referring specimens of the insect to Dr. Fletcher, he reported as follows:—

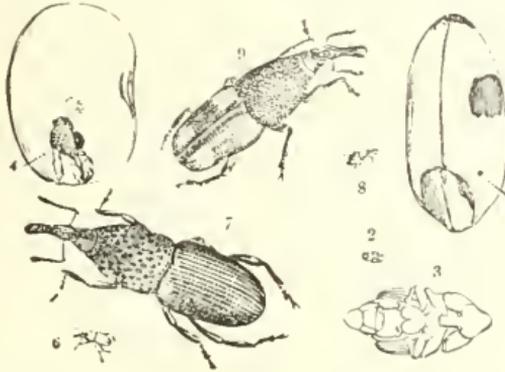
"With regard to the weevil from Summerland, I think that your answer to Mr. Sutherland will suit the occasion; but this is not a true weevil, but an *otiorhynchid*. I received a specimen, some years ago, from Watson, of Kelowna, but have misplaced it, and cannot recall the name just now. This one has more the habits of its close ally, the Gray Peach Weevil, which is referred to in my reports for 1893, p. 177, and 1894, p. 198. Beating the trees at night would probably be the best remedy. The attack would only last a very short time. Mechanical tree protectors, or even a band of cotton batting, might also answer the purpose."

GRANARY WEEVIL (*Calandra granaria*, L.)

RICE WEEVIL (*C. Oriza*, L.)

This beetle, as well as the two other insects mentioned in this short article, has long been known as a serious enemy to stored grain. When mature, the granary weevil is from an eighth to a sixth of an inch in length, of a dark, shiny, mahogany-brown colour, with the head prolonged into a slender snout. Some specimens are almost wholly black. Having no wings beneath the hard wing-cases, it is unable to fly. The eggs are laid in minute holes, which the female beetles bore into the grain with their slender beaks. On hatching from the egg the young grub at once begins to feed on the contents of the kernel, completes its growth and turns to a beetle inside the same grain, which does not show any sign of injury until the beetle

emerges, when it is found that the greater part of the inside has been consumed. In wheat and other small cereals a single larva inhabits a grain, but a kernel of corn furnishes food for several individuals. The mature beetles also feed upon the grain, and live for a long time, so that in warm



(FIG. 61.)

(9) Rice Weevil; (7) Common Granary Weevil.

places where grain is kept in store for a length of time, the injury may be considerable. In the course of a single year, it has been estimated that one pair of these weevils will produce 6,000 descendants, so it can be readily seen that they are capable in a short time of doing much damage.

RICE WEEVIL (*Calandra oryzae*, L.)

This insect differs somewhat in size and general appearance from the granary weevil. Unlike that species, it possesses fully-developed wings, has two yellowish blotches on each wing-case, is slightly smaller and of a pale brown colour. The life history of this insect is similar to that of the preceding species, except that in very warm climates the beetles are often found in fields away from any granary, and in the extreme South and in the Tropics the females lay their eggs in standing grain. The rice weevil is often found injuring stored grain in company with the granary weevil.

ANGOUMOIS GRAIN MOTH (*Sitotroga cerealella*, OL.)

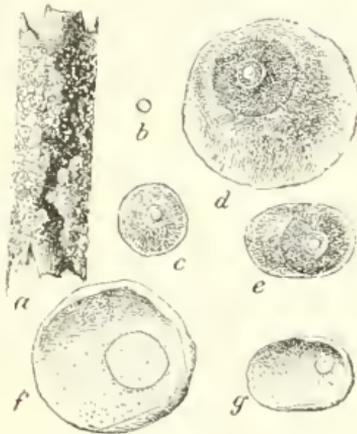
In Canada the grain moth has never developed sufficiently to be considered an important enemy of stored grain. In southern climates, however, where it is very abundant, this insect is a bad pest. The moths fly from the granaries to the field and lay their eggs upon the standing grain. The eggs, or young caterpillars are thus carried with the threshed grain into the granary, where they develop and cause great loss. The moths, however, have not so far been recorded as laying their eggs upon standing grain in Canada, and where damage has occurred, it has been to infested grain which has been imported. The eggs are deposited in groups of from 15 to 25, generally upon the under side of the grain or in the crease of the kernel. They are white at first, turning pink before hatching. The young caterpillar is a minute creature, slender, and covered with long hair. When mature it is two-fifths of an inch in length, and of a dirty white colour. As a rule

only one larva enters each grain, but when corn is attacked, two or three larvæ may be found in a single kernel. After completing its growth the caterpillar spins a thin, silken cocoon, and within this changes to a brownish pupa; in a few days later the moth emerges. The perfect insect resembles somewhat a clothes moth. The wings expand about half an inch, are of a satiny-cream colour and bear a few dark spots on the fore wings, which are narrow, pointed and fringed. The hind wings are darker and have much wider fringes.

Remedies.—When stored grain is found to be infested by one of the above three insects, or, in fact, by any insects which are known to work in dry cereals, it is a simple matter to destroy them. After repeated experiments, it has been found that the use of bisulphide of carbon will kill all the insects without any injury to the grain as to its wholesomeness for food, or as to its germinating quality for seed. Bisulphide of carbon is a colourless liquid with a very objectionable odour, which vaporises quickly at the ordinary temperature of the atmosphere. A convenient method for treating small quantities of infested grain, is to fill an ordinary coal oil barrel, which will hold about five bushels of grain, and the quantity of bisulphide to use is one ounce to every hundred pounds of seed. The bisulphide may be poured right on to the grain or placed in a shallow receptacle, but care must be taken to close up the top of the barrel tightly. This is best done with a cap made specially for the purpose, but may also be done with fine sacks laid smoothly on the top, over which boards are laid, with a considerable weight on them to hold the covering down closely. When grain in bins is being fumigated with bisulphide of carbon, these should be made as nearly air-tight as possible. This may be done by pasting sheets of paper over the outside, or by covering them with blankets or canvas. In tight bins the amount of bisulphide to use is a pound to a pound and a half to the ton of grain. Some entomologists claim that one pound of bisulphide to every 100 bushels of grain is sufficient to destroy all insects, even in open bins. Infested grain should be subjected to the fumes of bisulphide of carbon for at least 48 hours, but as the vapour is very inflammable, no light of any kind must be brought near and no smoking must be allowed near the building when this chemical is being used.

In Queensland it has been found that salt (1 quart dissolved in 2 gallons of water) will prevent weevils from attacking grain which has been sprinkled with this solution.—*The Canadian Entomologist*.

CHAPTER XIV.—SCALE INSECTS.

EUROPEAN FRUIT SCALE (*Aspidiotus ostreaformis*).

(FIG. 62.)

(a) Scales on twig; (b) natural size; (c) immature stage; (d) female; (e) male; (f) and (g) inside of scales.—*Bull. 34, U. S. Department of Agriculture.*

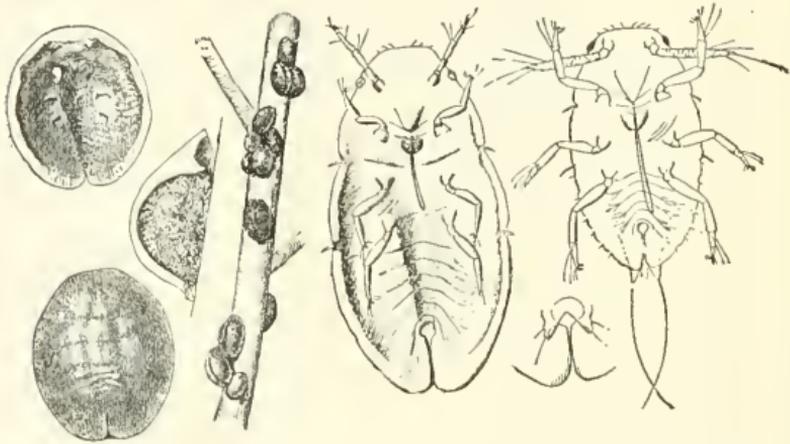
This insect was reported from Nanaimo as the San Jose Scale, which it resembles very closely. The writer, on instructions from the Hon. the Minister of Agriculture, investigated the matter in company with the Rev. G. W. Taylor, and pronounced it to be the European Fruit Scale. This opinion was afterwards confirmed by Dr. Fletcher. Drastic measures were adopted, viz., the destruction of the affected trees by fire, since which it does not appear to have spread. The following is taken from Prof. E. P. Felt's Bulletin No. 46:

"*Description.*—The general appearance of this species is similar to that of the pernicious or San Jose scale. The sides of the scale are dark gray, while the centre, which is nearly white, may be grayish or brown. The young appear to have quite a habit of arranging themselves at nearly equal distances from one another. The white or brown portion of the adult scale may break away and expose the yellowish cast skin or exuvia. Some of the young are always found among a mass of old scales, and when they are white, the gray of the old scales is lightened considerably. Sometimes masses of this scale insect are a dark gray, and then the young are usually grayish or brownish. The individual adult female scale may attain a diameter of nearly one-eighth of an inch. It has a yellowish or orange nipple a little to one side of the centre, and the gray part of the scale is normally marked with black specks, and, when on a rough tree, the edge of the scale is usually continuous with the outer layer of the bark.

"*Life History*.—The winter is passed by partly-grown individuals, which become mature toward the last of June. This insect, like the pernicious scale, is ovoviviparous; that is, gives birth to living young, which begin to appear about the last of the month, and continue to emerge for several weeks. This species produces but one generation in this latitude, and this restriction alone makes it much less dangerous than the preceding form.

"*Remedies*.—Methods of value against the pernicious or San Jose scale, should prove equally effective with this species, and, as a rule, it will probably be found much easier to control."

THE PEACH-TREE BARK-LOUSE (*Lecanium nigrofasciatum*, PERG.; *Lecanium persica*, FABR.)



(FIG. 62A.)

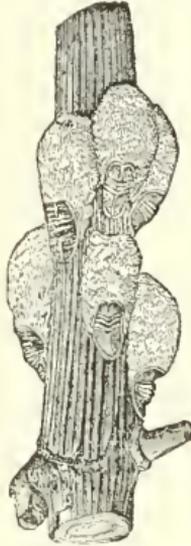
Adults at left, young at right.—Bull. 34, U. S. Department of Agriculture

It is found attached to the smooth bark of the peach twigs, frequently beside a bud, or at the base of a twig, appearing as a black hemispherical shell, about the size and shape of a split pea; its surface is uneven, shining, commonly showing a pale margin, and a stripe upon the middle. It feeds upon the sap, piercing the bark with its proboscis, and imbibing the juices. When mature, the removal of the scale discloses a multitude of eggs, which, in due time, hatch, and the young larvæ scatter over the twigs, and, fastening themselves to the bark, become permanently located, and live the full term of their lives without changing their position.—Saunders.

Remedy.—The treatment recommended for the Pear-tree Bark-louse, by Saunders, is applicable for this insect, viz.: Fortunately these insects are of such a size that they are easily seen. They should be looked for during the latter part of June, at which time the females will have attained their full size, and when discovered should be promptly removed. The under side of the limbs should also be well scrubbed with a brush dipped in some alkaline solution.

BROWN APRICOT SCALE (*Lecanium armeniacum*).

The scale is boat-shaped, when matured somewhat wrinkled. The colour is a shiny brown, darker in the centre than at the edges. It hatches from the eggs during May and June. The treatment advised for the Oyster Shell Scale should be followed in dealing with this pest.

WOOLLY-MAPLE BARK-LOUSE (*Psalmiaria innumerabilis*).

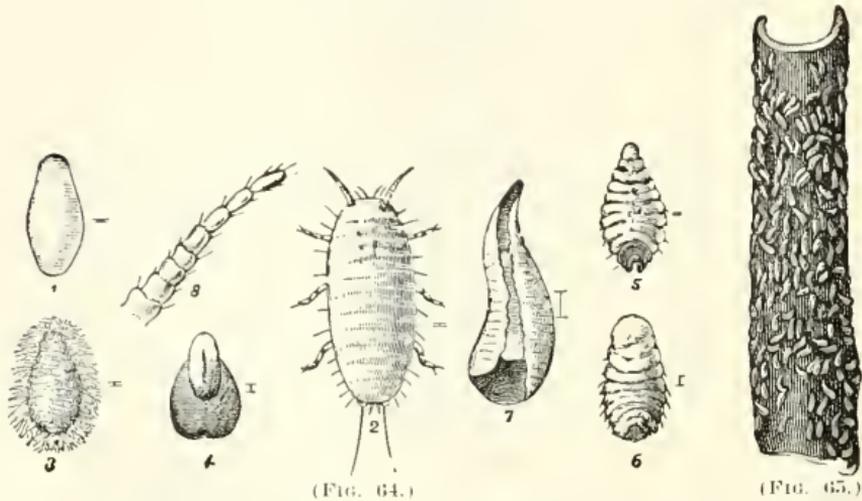
(FIG. 63.)

This "soft scale" insects occurs in some districts of the Province in considerable numbers certain seasons, infesting maple, willow, and alder trees. It has also been reported as injuring gooseberry and currant bushes in the Chilliwack District.

They usually attract attention in the spring, when white cottony masses become numerous on twigs or leaves of infested plants, increasing in size until they are a quarter of an inch or more in length, and only slightly less in diameter, somewhat irregular in outline. The mass seems cottony, but is really wax or gum. When this size is reached, it forms a bedding for innumerable, rusty-brown eggs, very small in size, which are laid by the female insects under the brown "scale" which seems to form the head of the mass. From these eggs minute, crawling larvæ hatch, similar in colour to the eggs, which spread in every direction over their host plant. In a day or two each larva settles and inserts its beak into a leaf or twig, sucks up the sap, and commences the formation of a small, flattened, oval scale—which gradually increases in size. Most of these are females, but there are always some male insects, and these come to maturity in the latter part of summer, appearing as small, two-winged flies; they mate with the females which remain under the scales, and these, before the leaves fall, move to the twigs or branches, and fasten themselves for the winter. They resume feeding in the spring, when the sap begins to circulate, and then the egg masses are formed.

In dealing with these pests on cultivated plants, a judicious pruning or thinning out should be the first step taken; in winter the treatment advised for the oyster-shell bark-lice is effective, and any that escape may be easily destroyed in the early summer, when the young larvæ emerge from the eggs, by using either of sprays No. 2, 6, or 7, as directed. But it must be borne in mind that, to be effective, this summer spraying must be done before the insects have protected themselves with defensive scales.

OYSTER-SHELL BARK-LOUSE OR SCALE (*Mytilaspis pomorum*, BORICHE.)
APPLE-TREE BARK-LOUSE.



(FIG. 64.)

(FIG. 65.)

This pest occurs in the form of minute scales, about one-sixth of an inch long, of a brownish or grayish colour, closely resembling that of the bark of a tree, and somewhat like the shell of an oyster in shape, adhering to the surface of the bark, and placed irregularly, most of them lengthwise of the limb or twig, with the smaller end upwards. In most instances the branches of apple trees may be found literally covered and crowded with these scales; and where thus so prevalent they seriously impair the health and vigour of the tree, and sometimes cause its death.

Under each of these scales will be found masses of eggs varying in number from fifteen or twenty to one hundred or more. These, during the winter or early spring, will be found to be white in colour, but before hatching they change to a yellowish hue, soon after which the young insects appear. This usually occurs late in May or early in June, and if the weather is cool the young lice will remain several days under the scales before dispersing over the tree. As it becomes warmer, they leave their shelter and may be seen roving about looking for suitable locations to which to attach themselves. Their actual length being only about one hundredth of an inch, to the unaided eye they appear as mere specks. When highly magnified they appear as at 2. A large proportion of them soon become fixed around the base of the side shoots of the terminal twigs, where, inserting their tiny sharp beaks, they subsist upon the sap of the tree. In a few days a fringe of delicate waxy threads issues from their bodies, as at 3. Gradually the insect assumes the form

shown at 4; 5 and 6 present the larvæ as nearly full-grown, and when detached from the scale, before the end of the season the louse has secreted for itself the scaly covering in which it lives and matures, shown at 7; 8 represents one of the antennæ of the young lice; 1 shows the egg highly magnified.

By the middle of August this female louse has become little less than a bag of eggs, and the process of depositing these now begins, the body of the parent shrinking day by day, until finally, when this work is completed, it becomes a mere atom at the narrow end of the scale, and is scarcely noticeable.

The scales of the male louse are seldom seen; they are most frequently found upon the leaves, both on the upper and under sides; they are smaller in size than those of the female, and different also in shape.

In the orchard and its immediate neighbourhood it may be spread by being carried on the feet of birds, or attached to the larger insects, or may be aided by the wind in passing from tree to tree, while it is itself so brisk in its active state that it can travel two or three inches in a minute, and hence might in this way reach a point two or three rods distant before it would perish. Although this insect essentially belongs to the apple tree, it is frequently found on the pear, and sometimes on the plum.

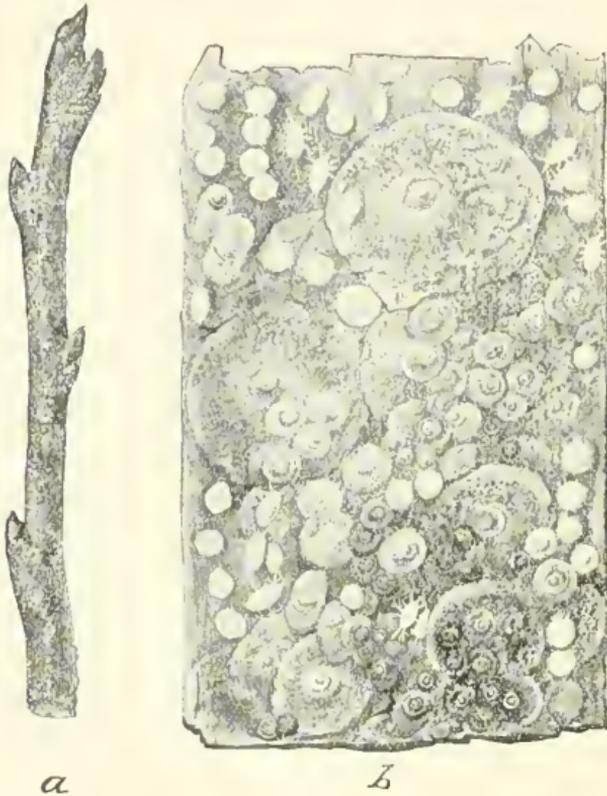
Apple trees should be examined during the winter months for this pest. When present in large numbers on the trunks and main limbs, a good scraping will remove many of them, and prepare the way for effective spraying or washing operations. The No. 1 spray is a good remedy to use; two applications are necessary, and the mixture should be used quite hot. Another very good application to be used with a brush or swab is made with 1 lb. of concentrated lye to 2½ gallons of water. Both these remedies, of course, can be used only during the dormant season. Still, it is almost impossible to cleanse the trees entirely in this way, especially the smaller branches, and hence the insect should be fought also at the time when the eggs are hatching and the young lice crawling over the limbs, as then they are tender and easily killed. With this object in view, the time of hatching of the remnants left after the winter work should be watched for, and while the young lice are active, before they have secreted their protecting scales, the trees should be thoroughly sprayed or washed with a solution of soft soap and washing soda, or with either of sprays 2, 6 or 7.

In experimenting for other pests, it was accidentally discovered by Mr. W. T. Maconn, Horticulturist, Central Experimental Farm, Ottawa, that ordinary whitewash made of good lime, painted on the trees, had the effect of dissolving the scales of the Oyster-shell bark-louse, so that they could be brushed off. This remedy, whilst effectual where it can be applied with a brush, cannot, of course, be used on the small branches, which should be sprayed as recommended above.

SAN JOSE SCALE (*Aspidiotus perniciosus*).

The San Jose Scale is the most destructive of all pests in neglected orchards. Nevertheless, by intelligent effort, it can be more easily controlled than any other first-class orchard pest; and when we come to realise that the one annual winter application of the lime, sulphur, salt spray, which is all that is necessary to reduce its ravages to the minimum, is also one of the best general "cleaning-up" sprays that has yet been devised, we shall, perhaps, be

ready to exclaim with J. H. Hale, the veteran peach-grower of Connecticut and Georgia, "Blessed be the San Jose Scale! It has compelled us to spray with the lime, sulphur and salt."



(FIG. 66.)

Appearance of Scale on bark. (a) infested twig, natural size; (b) bark as it appears under hand-lens, showing scales in various stages of development, and young larva.

(L. O. Howard and C. L. Marlatt, *Bulletin No. 3, New Series, Division of Entomology, U. S. Department of Agriculture.*)

One application of lime, sulphur and salt each winter will do more for the neglected orchard than can be done in any other way by the same expenditure of cash and energy. It not only destroys San Jose Scale, but it also destroys the branch form of woolly-aphis, the eggs of the green-aphis, the pear-leaf blister-mite, the hibernating larvæ of the prune twig-miner, probably the hibernating larvæ of the bud-moth, together with most other insects which may chance to be wintering upon the trees. It is also a good fungicide. If applied in early winter, it is nearly or quite equal to Bordeaux for the second application for apple-tree anthracnose; applied to peach trees just before the buds open in spring, it is a preventative of peach-leaf curl; and applied to apple trees under similar conditions it is a satisfactory substitute for the application of Bordeaux, which is usually recommended for that time.

With all its good qualities, however, the lime, sulphur, salt spray is not a cure-all. It does not, so far as known, reduce the number of wormy apples in

an orchard, nor can it be used as a substitute for Bordeaux while the trees are in foliage. It is a distinctly winter spray, and should be used, even in winter, only upon deciduous trees.

The San Jose Scale is very largely responsible for the present enthusiastic crusade against the old neglected, moss-covered orchards. Everyone is pruning and spraying. Why? To destroy the San Jose Scale. Yet I find that a very small percentage of our farmers know what this dreaded thing is which they are so earnestly endeavouring to destroy. If any other spray than the lime, sulphur and salt were being used, a reaction against all spraying would certainly follow the poor results of so much misdirected energy. By using the lime, sulphur, salt spray beneficial results are almost certain to follow, whether the scale be present or not. Nevertheless, everyone who grows trees or shrubs should learn to know this destructive little pest and be prepared to combat it, since it may at any time appear upon the ornamentals of the city lot as well as the trees of the old home orchard. Dr. L. O. Howard records it upon the following plants:—

List of Food Plants.

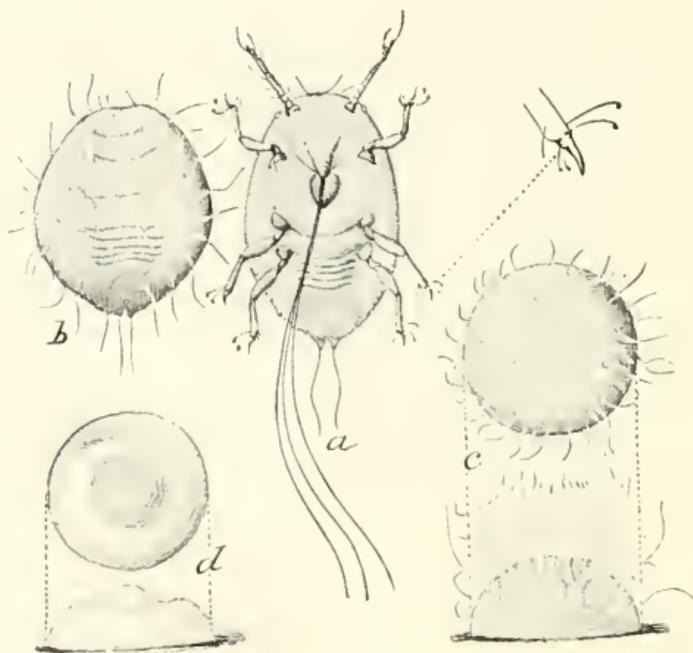
ORCHARD FRUITS.	BUSH FRUITS.
Pear,	Raspberry.
Peach,	Gooseberry.
Apple,	Grape,
Plum,	Currant.
Cherry,	Flowering Currant.
Rocky Mountain Dwarf Cherry,	Black Currant.
Persimmon,	NUT PLANTS.
Quince,	Almond,
Flowering Quince.	Chestnut.
SMALL FRUITS.	Pecan,
Strawberry.	Black Walnut.
	English Walnut.
	Japan Walnut.

Miscellaneous Ornamental Plants—Forest and Shade Trees.

Rose,	English Willow,
Hawthorn,	Golden Willow,
Spirea,	Laurel-leaved Willow,
Cotoneaster,	Milkweed,
Enonymus,	Catalpa speciosa.
English Huckleberry,	Lombardy Poplar,
Linden,	Carolina Poplar,
Acacia,	Silver Maple,
Elm,	Cut-leaved Birch,
Osage Orange,	Mountain Ash,
Alder,	Japanese Quince,
Sumac,	Actinidia,
Weeping Willow,	Citrus trifoliata,
Red Dogwood,	Snowball,
Juneberry,	Loquat,
Laurel.	Akebia.

How to Know the San Jose Scale.

Perhaps the worst feature of an attack by San Jose Scale is that, owing to its small size and inconspicuous colour it often remains unnoticed until the tree has been seriously injured or even killed. That the tree lacks vigour may be recognized, but the cause of its unthriftiness is overlooked. Yet it is not difficult to detect when one really looks for it. In the early stages of infestation a few scales may be found, usually clustered about the buds of the preceding season's growth, or even on two-year-old wood. The mature scales are grayish in colour, being usually, but not always, somewhat lighter than the bark to which they are so closely attached. The immature half-grown scales, which may be found with the mature ones, are at the present time somewhat darker in colour.

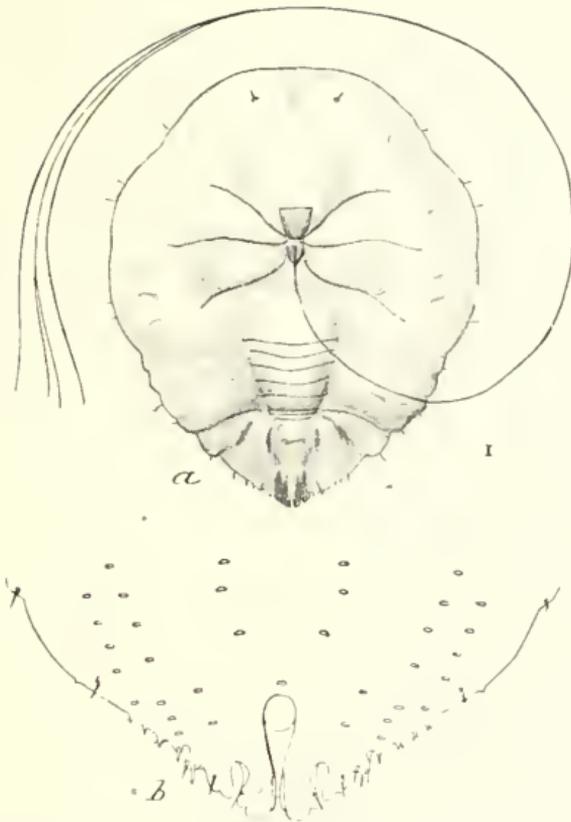


(FIG. 68.)

Young larvae and developing scale: (a), ventral view of larva showing sucking beak with setae separated, with enlarged tarsal claw at right; (b) dorsal view of same somewhat contracted, with the first waxy filaments appearing; (c), dorsal and lateral view of same still more contracted, illustrating further development of wax secretion; (d), later stage of same, dorsal and lateral views, showing matting of wax secretions and first form of young scale—all greatly enlarged.

(L. O. Howard and C. L. Marlatt, *Bulletin No. 3, New Series, Division of Entomology, U. S. Department of Agriculture.*)

The mature females are nearly circular in shape, are approximately one-sixteenth of an inch in diameter, and each is somewhat raised in the centre to form a slight protuberance or nipple, which is lighter in colour than the rest of the scale. If this scale is carefully examined by means of a small magnifier, several concentric circles may be observed between the nipple and the outside edge; and if it be carefully raised with the point of a pin or a knife, there will be revealed a minute bright yellow object, the insect itself.



(Fig. 69.)

Adult female before development of eggs: (a), ventral view, showing very long sucking setae; (b), anal plate, showing characteristic ornamentation of edge—greatly enlarged.

(L. O. Howard and C. L. Marlatt, Bulletin No. 1, New Series, Division of Entomology, U. S. Department of Agriculture.)

On badly infested plants the young scales settle wherever there is room to insert a beak into the bark, and as they increase in size they become much crowded and overlapped and have the appearance of a gray, scurfy deposit on the bark. The natural colour of the bark is obscured and the infested plant appears as though coated with fine ash-coloured bran. If the thumb-nail or other object is rubbed over this scurfy covering, thereby crushing the insects beneath the scales, a moist or oily appearance is produced and numerous scales will be overturned and many of the little yellow insects be revealed.

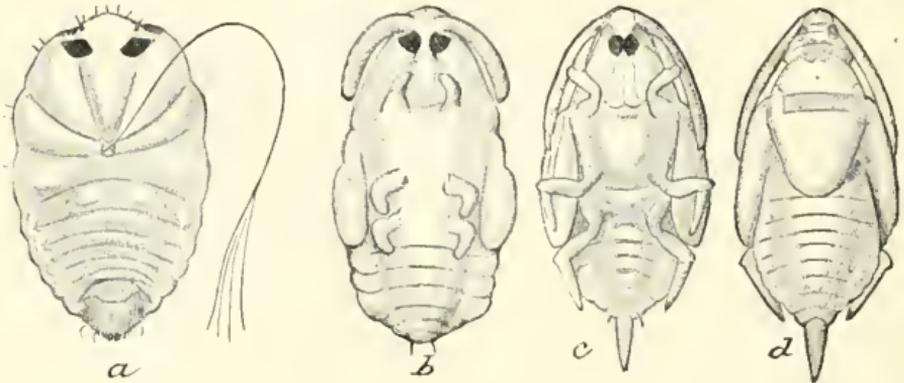
During the early stages of an attack, very few, if any, of the scales will settle upon the leaves or fruit. Later both may be attacked. Upon the leaves especially of the prune and peach, the young scales may be found on both surfaces, and more particularly clustered along the midrib. Each scale produces a minute purple spot. Upon purple prunes, red apples, etc., the scales appear only as minute gray specks, usually clustered about the cavities at either end; but upon the yellow fruits, like pears, peaches, and the yellow

plums and apples, each scale produces a bright, reddish discolouration. If badly infested, the fruit, particularly of pears and apples, becomes much pitted, distorted in shape, cracked and unmarketable.

For the benefit of fruit inspectors in particular, it should be noted that reddish discolourations upon yellow fruits are not always caused by San Jose Scale. Upon yellow apples, and particularly upon peaches, very similar spots are produced by attacks of certain minute fungi. Hence, such spots should not in themselves be taken as proof of infestation by the scale. This can be determined definitely only by a careful examination, and the actual detection of the scale. The presence of such blotches may well arouse suspicion of the presence of San Jose Scale, and should challenge a careful examination alike by growers, buyers and inspector; so also should the presence of dead and shrivelled leaves upon the trees in mid-winter invite examination, for although their presence is not proof of the presence of the scale, it is evidence that the vitality of the tree has been seriously impaired by some cause, and in regions where San Jose Scale is prevalent that cause in a vast majority of instances is the scale.

Development of San Jose Scale.

On the approach of winter scales of various ages and sizes may be found upon infested trees. A very large proportion, especially of the immature scales, usually perishes during the winter, but at the present writing, March 10, practically all are still alive. We may expect, therefore, with normal conditions for the remainder of the season, to witness a very decided increase in scale infestation during the coming summer.



(FIG. 70.)

(FIG. 71.)

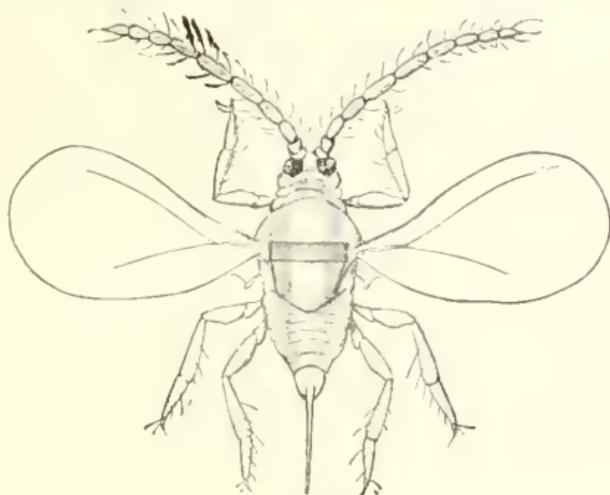
(FIG. 72.)

Development of male insect: (a.), ventral view of larva after first molt; (b), same after second molt (propupa stage); (c) and (d), true pupa, ventral and dorsal view, all greatly enlarged.

(L. O. Howard and C. L. Marlatt, *Bulletin No. 3, New Series, Division of Entomology, U. S. Department of Agriculture.*)

The male scales are not circular, but somewhat elongate. If one removes one of the large circular scales the little yellow object thereby revealed is a mature female. Under a moderate power of the microscope she proves to be

a nearly circular, yellow, sack-like body, with long, slender, bristle-like mouth parts. An examination of the male shows him to be more elongate, and to possess the rudiments of legs, wings, eyes, antennæ, etc.



(FIG. 73.)

Adult male, greatly enlarged.

(L. O. Howard and C. L. Marlatt, Bulletin No. 3, New Series, Division of Entomology, U. S. Department of Agriculture.)

The females live and die beneath their scales, never leaving them; but in April the males molt for the last time, and soon thereafter emerge from under their scales as minute, active creatures, with fully-developed wings. After mating the males die.

In May, possibly earlier, under favourable conditions, the females begin to give birth to living young, and may continue to produce for six weeks or longer. The young are minute, light orange-yellow, active creatures, with eyes, bristle-like mouth parts, two antennæ, or feelers, and six legs. After emerging from under the protecting scale of the parent, each wanders over the surface of bark, fruit or leaf until a suitable situation is found, when the legs and antennæ are folded beneath the body, the bristle-like beak is slowly worked through the outer bark into the living tissues beneath, from which it draws its sustenance. At any time during the summer months hundreds of these little pests may be seen, even with the unaided eye, as they crawl about over the bark or fruit of infested trees.

Even before the young insect has attached itself to the bark, the secretion of the scale has begun. At first it consists only of a fluffy, white mass of fine, waxy threads, which for the first day or so of its existence causes the young San Jose Scale to appear as a minute, downy white speck upon the bark. As these filaments become more abundant they become fused into a more and more compact scale, and assume a yellowish colour. Later the young scale-insect molts several times during its growth and the fully-developed scale is thus made up of fused wax filaments and the several molted skins.

Each female of the over-wintering generation is capable, under favourable conditions, of producing approximately one hundred young. In the course of but one month these reach maturity and the females begin to produce another generation. There are thus produced some four or five generations during the entire season. Under supposedly favourable conditions, single females of the later generations have been observed to produce approximately 600 young. Basing their estimates upon breeding-cage observations, Dr. Howard and Mr. Pergande have shown that it would be possible, under the most favourable conditions, for the progeny of a single female to reach the astonishing number of 3,216,080,400 individuals in a single season. Should each of these scales reach the largest size, one-tenth of an inch, and were they all placed side by side touching each other in all directions, there would be enough of them to cover, approximately, five acres of surface. It is almost needless to add that in the intense struggle for existence of organism with organism, and with climate conditions, such an astonishing rate of multiplication is not even approximated under natural conditions. Nevertheless, when one realises the enormous rapidity with which this pest multiplies, it is no longer a surprise that *careless* work in spraying fails to give satisfactory results. A few females here and there, upon very small portions of the tree which have not been reached by the spray, may, during a single season, completely re-infest that tree. Satisfactory results are obtained only by the most thorough work. Every square inch of surface of trunk, limbs, branches and twigs should be thoroughly covered. By far the most common cause of unsatisfactory results is the failure of those who spray to do thorough work.

How the San Jose Scale Spreads.

Since the female scale is motionless, and permanently attached throughout life to the branch on which it feeds, it is often asked how it is that the San Jose Scale can spread from tree to tree, orchard to orchard, and even for greater distances? It is only during the first few hours of its existence that one of these little pests can emigrate, and observation has shown that, even then, it is incapable by its own efforts of getting more than a few feet at most from the tree on which it was born. But birds and bees and other insects make good air-ships for the little creatures, and no doubt many a young scale has crawled upon the foot of a bird or upon some larger insect and thereon voyaged to the distant realm of another tree or orchard. No doubt, also, strong gusts of wind often tear them loose from the bark on which they are crawling and waft them to the branches of neighboring trees. These are provisions of nature for distributing the species. Through the channels of trade they are carried long distances, even from continent to continent, upon infested nursery stock, cuttings, etc., and probably to a lesser extent upon infested fruit. Buds and scions carelessly taken from an infested tree may transmit the pest to the orchard in which they are placed, or may infest an entire block of trees in some nursery, and thence be distributed to many orchards. It is also probable that many are carried about upon the hands and clothes of the men who prune the trees or pick the fruit or otherwise work about the orchards.—*Oregon Bulletin No. 88; Cordley.*

The general distribution of the scale through Canada and the States has been brought about by planting unfumigated nursery stock. Prof. L. O. Howard, of the United States Department of Agriculture, tells us that, in spite of the wide dissemination of scaly fruit in this country, and to some extent abroad, there is not a single authenticated instance of the scale having been established from such material.—*From paper by William Hopkins, read before Ontario Fruit-Growers' Association, November, 1907.*

HOW TO CONTROL THE SAN JOSE SCALE.

The San Jose Scale a Permanent Factor in Fruit-Growing.

The San Jose Scale is so widely disseminated and has become so firmly established in the principal deciduous fruit regions of this country that its extermination is now in most cases out of the question. In the main, therefore, the San Jose Scale must be recognised as a permanent factor, to be regularly dealt with as are other insect evils or the fungous diseases of plants.

Extermination is possible only where the scale is detected at the very outset on new or recently planted nursery stock, or, at least, before any considerable chance of spread has been afforded. It is true that by the greatest care in the introduction of nursery stock the San Jose Scale may be kept out of districts now free from it for years, perhaps, and one is warranted, therefore, in adopting every precaution to avoid introducing this scale and even to attempt extermination wherever the conditions are reasonably favourable. There is only one certain method of exterminating the scale, and that is in digging up and burning all infested trees. This is an heroic remedy and is advised only under the conditions of very recent introduction of nursery stock—in other words, where the scale is discovered within a few months after the purchase of the infested trees. If the scale has passed an entire breeding season in an orchard, it will have spread much more widely than any inspection will indicate and, very likely, will have gained a foothold on wild and ornamental plants, other than fruit trees, from which it will re-introduce itself into neighbouring orchards or into new plantings, however thorough may have been the attempts to eradicate it.

The San Jose Scale Can be Controlled.

While, therefore, one is undoubtedly justified in asserting that the San Jose Scale is to be a permanency, it by no means follows that the profitable growth of deciduous fruits is seriously menaced on this account. The experience in California, covering many years, has abundantly demonstrated that this scale insect can be controlled, and the more recent experience in the East points indubitably to the same conclusion. In other words, by proper repressive and remedial treatment, the value of which has been demonstrated by much practical experience, an orchard can be protected from serious injury and kept in a good paying condition, so far as influenced by the San Jose Scale.

In view of the above, it is certainly very unwise and wasteful to dig up and burn a large portion of an orchard because it is infested with this scale insect, especially since the re-planted stock, even if clean when purchased, would, with little doubt, be in the same condition of infestation in a very short time.

One of the main objects of this circular, therefore, is to emphasise the importance and value of honest efforts to control this insect for the great majority of districts where it has established itself, rather than efforts at extermination, which will prove successful rarely, at best, and will always be accompanied with great immediate loss. The other principal object is to designate, briefly the means of controlling this scale insect which experience has shown to be of practical value.

The Lime and Sulphur Wash.

This is the invariable remedy for the San Jose Scale in California and much of the Pacific Coast, and it is, under the conditions of climate obtaining in that region, undoubtedly very effective. Early experience with this wash in the East threw doubt on its efficiency as an insecticide under the climatic conditions prevailing throughout the eastern half of the United States. Some later experiments, however, have shown that wherever the weather conditions happen to be very favourable, duplicating, in a measure, the conditions on the Pacific Coast, this wash is effective in the East also. Unfortunately, the weather conditions cannot be relied on, and, therefore, its use in the East is not recommended. But if a considerable period (10 days or two weeks, at least) of dry weather could be assured after the treatment, it would probably give very satisfactory results when properly made and applied. It is a winter application and is applied in January or February, or at any time prior to spring growth.

This wash is applied nearly every year, or as often as the San Jose Scale develops in any considerable numbers. It has the advantage of leaving a limy coating on the trees, which acts as a deterrent to the young scale-lice, and where it is not washed by rains retains its value as an insecticide coating for some time, remaining in evidence on the trees for several months.—*Circular No. 2, U. S. Department of Agriculture, Division of Entomology.*

Orchards very badly infested with San Jose Scale should be sprayed twice, once in fall or early winter and again in spring before the buds open. It is well nigh impossible to cover every portion of the tree at one spraying—though that should by all means be the aim—hence, where orchards are badly infested, it is advisable to spray twice each year until the scale is well in control. Thorough application of lime-sulphur wash, covering the trees from top to bottom, is necessary if good results are to be expected. Too often orchardists spray their orchards without proper regard to thoroughness, and the result is that they fail to get good results and then think the wash is responsible. Lime-sulphur wash does not spread easily like oil emulsions, and great care in spraying is necessary if good results are to be obtained. On windy days it is almost impossible to cover a tree on all sides with any mixture and on such days the lime-sulphur wash has its advantage, because it is easy to see at a glance what portion of the trees has been covered. The white coloured wash will show for itself. Frequently it becomes necessary to spray one side of the trees one day and wait until the wind blows from another direction before finishing the spraying.

When spraying orchards to control the San Jose Scale, it is imperative that all trees be sprayed. Not simply the trees that show infestation, but

every tree in the infested orchard. It is false economy to spray only the trees visibly infested. Frequently trees may be slightly infested, so slight as to be overlooked by the average orchardist. If such trees are left without spraying the scale may increase so rapidly during a single summer that the trees will be seriously injured before the following winter.—*Bulletin No. 21, Georgia.*

FALL SPRAYING.

General Summary and Conclusions.

In the previous work upon this problem the results attending the application of the sulphur washes were somewhat conflicting, since some of the treatments caused serious injuries to the buds and blossoms, while others in no manner affected the health of the trees. But as regards the insecticidal value of the treatments, all the experiments showed that applications at this season were uniformly effective upon scale. The work indicated that the injuries sustained by the trees were balanced by their increased vigour and fruitfulness, due to the control of the scale.—*Bulletin No. 273, New York Agricultural Experimental Station.*

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