FRUIT TREES AND THEIR ENEMIES

WITH A
SPRAYING CALENDAR

BY
SPENCER PICKERING, M.A., F.R.S.,
AND FRED. V. THEOBALD, M.A.

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SPRAYING CALENDAR

BY
SPENCER U. PICKERING, M.A., F.R.S.

DIRECTOR OF THE WOBURN EXPERIMENTAL FRUIT FARM

AND

FRED. V. THEOBALD, M.A.

VICE-PRINCIPAL AND ZOOLOGIST OF THE SOUTH-EASTERN AGRICULTURAL COLLEGE

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FRUIT TREES AND THEIR ENEMIES

THIS little volume is the outcome of suggestions which have frequently been made to the writers, that a Spraying Calendar is, at the present moment, much needed by fruit growers and gardeners. In the writing, the work has grown somewhat beyond the limits of a mere calendar, though it is still confined within very modest bounds, and does not profess to give more than a brief and popular account of such fruit tree pests as are more frequently met with in this country, as well as of the commoner insecticides and fungicides used in combating them.

The spraying of trees has now for many years been recognised abroad and in our colonies as an operation indispensable to fruit-growing, if clean fruit and heavy crops are to be obtained; and in many cases such spraying is even enforced by law. No doubt the necessity for spraying is not, and may never be, so great in this country as it is elsewhere; our variable climate, the smallness and highly mixed character of our plantations, as well as the large number of different varieties grown, whilst being disadvantageous in many ways to fruit production, indirectly benefit it, by

militating against the spread of fruit pests. But this must not be taken to imply that spraying can be dispensed with in any well-managed garden or orchard; and the efficient treatment of the fruit trees often involves applying a similar treatment to the neighbouring hedgerows and forest plantations; for these act in many cases as the breeding-grounds for the insects which attack the fruit trees (*e.g.* the winter moth, lackey moth, little ermine moth, scale-insects, etc.).

It is only during the last few years, however, that the necessity for spraying has begun to be generally recognised in Great Britain, and the eagerness displayed to make up for lost leeway is calculated to lead to an indiscriminate dosing of fruit trees with anything and everything which may be put on the market. Unfortunately, the Board of Agriculture has no experiment station where such matters can be investigated, nor has it even a department for dealing with horticultural subjects, so that the fruit grower can look for no authoritative advice from that quarter, and is left very much at the mercy of the enterprising advertiser.

Spraying, to be successful, must be done intelligently. The grower must know what to spray for, what to spray with, and when to do it. To spray a tree without any definite object is like giving a man physic without knowing what is the matter with him, or whether anything is the matter at all. Some acquaintance with the commoner diseases of trees is essential; and, for that reason, it appeared that a spraying calendar, without any description of some

of the commoner pests for which the spraying is done, would be somewhat useless. It is not, however, always easy to identify an insect or fungus from a mere description of it, and, whenever a grower feels doubt on the subject, he should send a specimen for identification to some authority on entomology or on plant diseases.

INSECTS

A KNOWLEDGE of the life-history of an insect or fungus is essential whenever it is a question of destroying it, for there is often only one period in its life when it is vulnerable, or when we can get at it so as to attack it with success. Generally speaking, there are four distinct stages in the lives of all insects : (1) the egg, (2) the larva, maggot, grub or caterpillar, (3) the chrysalis, nymph or pupa, and (4) the perfect insect or imago. The true pupal stage is absent in the case of mites and spiders, whilst in that of some insects, such as aphides and leaf-hoppers, there is no pupal stage similar to that existing in the case of a moth, where the pupa is quiescent, and does not feed.

Those insects which have a quiescent pupal stage, for the conversion of the caterpillar, maggot or grub into the adult form, are said to undergo a "complete metamorphosis," and beetles, sawflies and flies undergo such a change, as well as moths. Aphides, scale-insects, leaf-hoppers and bugs undergo what is called an "incomplete metamorphosis," wherein the changes between the larva and adult are gradual, the insect in the pupal stage resembling that in the larval stage, except that "wing-buds" appear, these giving place at the next moult to fully developed wings, and the insect then becoming perfect. During

the pupal stage in this case, the insect is active, and feeds throughout it, and these insects, therefore, are injurious all their lives. In the other cases, where the pupa is quiescent, damage is done during the larval and adult stages (beetles), or during the larval stage only (moths and sawflies).

True caterpillars have a pair of jointed legs on each of the first three segments of their bodies; the fourth and fifth segments have no legs, and on the next four segments, as well as on the last, or anal, segment, there are pairs of soft pro-legs, or sucker feet. In the case of "looper-caterpillars," this arrangement is modified, there being only one pair of pro-legs in addition to the anal pair, and these are on the ninth segment. False caterpillars, as the larvæ of sawflies are called, have always more than four pairs of pro-legs.

With moths and butterflies the insect can rarely be attacked when in the perfect state; it must be dealt with, either in the winter, by destroying the eggs and chrysalids, or in summer, by destroying the larvæ. In the former case, a strong insecticide can be used, for the trees are then devoid of foliage, and the substances selected should have, if possible, the twofold property of not only destroying the eggs, etc., but of removing moss, lichen and dead bark from the trees, thus reducing the number of lurking-places available for harbouring insects and their eggs; indeed, this is often the chief way in which winter washes are beneficial; for insect eggs are generally so resistant, or so well protected, that they cannot be destroyed by such washes without injuring the trees. For cleansing properties in a winter wash, we rely mainly on

caustic substances, such as caustic soda or caustic lime, but the destructive action may often be enhanced by the addition of some other substances, notably paraffin oil.

For summer treatment, a much weaker insecticide must be used, or the foliage of the tree will be injured. With moths—the damage being done by the insect when in the caterpillar or larval stage—the method of attack is generally based on poisoning its food, rather than on destroying its body by corrosive substances. This applies only, however, to caterpillars and false caterpillars which feed by biting the leaves; when we have to deal with sucking insects, such as the aphis (green-fly or black-fly), poisons are ineffective, for the insect punctures the leaves and extracts the juices, and these juices cannot be poisoned. In that case the insecticide must be one which acts externally on the body of the insect, either by corroding it, or by stopping up the breathing apertures in its body.

It will readily be seen from this how essential it is to have a knowledge of the life-history of the insect. But more than this is required; we ought to know the exact action which the various insecticides have on it at various times in its life-history, and in many, it may be said in most cases, our knowledge on this point is very deficient, and can only be increased gradually by very extended and laborious investigations. Every individual case has its own complications; thus the larval stage of an insect is generally divided into various sub-stages, the grub moulting (often five times) and changing its nature, and in some of these stages it may be more sensitive to poisons, or less protected

by external hairs, than in others. It does not necessarily follow that the earlier stages of the insect are those in which it is most sensitive, but it would appear that, as a rule, poisons are most effective in the earlier stages, and corrosive substances most effective in the later stages.

Of the poisons in use, those containing arsenic are, perhaps, the most prominent ; these, as is well known, are very deadly to animals, as well as to insects, but in many other cases it is found that substances which act as virulent poisons to vertebrate animals, have little or no effect on insects. This is so with many of the vegetable poisons ; of these there seem to be only a few which can be successfully used as insecticides, the most conspicuous being nicotine (tobacco), quassia, and hellebore, to which may be added pyrethrum, when used as a fumigant. Some recent work, however, has indicated that paraffin oil, when used in a suitable form and of a suitable strength, is more efficacious than the mineral or vegetable poisons mentioned above, though considerable more work is still required to determine the relative merits of paraffin and the compounds containing arsenic. Whether paraffin acts as a poison or as a corrosive agent does not appear to have been established ; probably it acts as both, and it may also act by blocking up the breathing orifices of the insects. Soft-soap is another substance which acts in this way. In the case of red spider and mites, sulphur, or compounds containing sulphur, are often very efficacious, but they seem to be uncertain in their action, and preference is now being given to paraffin emulsions for the destruction of these pests.

A large number of insects which prey upon trees pass a portion of their existence in the earth, the cocoons or grubs being in many cases buried during the winter at the depth of a few inches below the surface. Tillage of the soil is one way in which much good can be done in such cases, for it brings to the surface the various insects, and exposes them to destruction by birds. On the other hand, the growth of grass and weeds under fruit trees is very injurious, for, not only does it seriously interfere with the health and vigour of the trees, but it also affords facilities for the harbouring of many insects. For similar reasons, all prunings, dead leaves and rubbish should be cleared away from under the trees, and burnt, for they are often infested with the eggs and cocoons of insects, as well as with fungus spores.

The direct destruction of insects by applying insecticides to the soil is a branch of the subject about which little or nothing is known at present. With the exception of certain proprietary articles, the only substance used to any extent is carbon disulphide, a very volatile and inflammable liquid, which is injected into the soil round about the roots of the trees, by means of a syringe specially adapted for the purpose.

Vermorel has lately devised an apparatus for the destruction of moths and other night insects, consisting of an acetylene flame, which gives a brilliant light, surrounded by a tray holding paraffin. The moths are attracted by the light, and fall into the paraffin. It is known by the name of the "Meduse" lamp, and is sold at 18s. 6d.

FUNGI

BESIDES insect pests, the fruit grower has to contend with fungoid diseases. A fungus is a plant of the lower order (*Cryptogams*), which differ from the higher plants by possessing no flowers, and by producing none of the green colouring matter (*chlorophyll*) which characterises the leaves of ordinary plants. It forms seeds, however, known as spores, and also roots, in the form of exceedingly fine filaments, known as the *mycelium* or *hyphæ*, or, more commonly, as spawn. It is this mycelium by which the damage is done to trees attacked by a fungus; the hyphæ make their way through the wood, etc., breaking down the cells of which it is composed, and thus destroying the plant. This renders it practically impossible to apply any remedy once a tree has been invaded by a fungus, unless we can remove the whole of the part attacked; and our efforts, therefore, must be directed to preventing the fungus from seeding, and propagating elsewhere.

The seeds, or spores, which are microscopic in size, are produced in several ways. The mycelium itself in some cases becomes converted into a chain of spores, but the more usual process is for it to send out a number of branches, each bearing at its end a spore, or a receptacle containing many spores (*conidia* spores). The summer spores of a fungus are formed in this way, and the masses of spore-bearing filaments or

branches produce the appearance of a downy covering over the object attacked, familiar to us in the form of mildew or mould. The branches and spore receptacles constitute, in the larger fungi, the portion of the plant which is commonly called the fungus itself, such as the puff-ball, mushroom and toadstool.

The mycelium of a fungus also produces other spores, known as *perithecia*, which are often formed inside the host plant, and these are enclosed in a tough, leathery receptacle, which renders the destruction of them very difficult. These are the winter, or resting spores, and they are capable of resisting the most intense cold without being injured, and may remain unchanged for years, starting into activity only when they find themselves placed under favourable circumstances. This, as a rule, is in the spring.

A fungus, however, besides reproducing itself by means of spores, does so, also, more directly by means of its mycelium, parts of this becoming changed, and hardened into what is called *sclerotia*, in which condition it passes the winter, and develops in the following year, spreading itself through the soil and attacking fresh plants.

Fungi which attack living plants—*parasites*—are, naturally, of more importance to the fruit grower than those which feed on dead tissue—*saprophytes*; but the two classes sometimes merge into each other, and a fungus which is usually a saprophyte may, under altered conditions, become a parasite, and attack living plants. In some cases, also, a parasitic fungus only reaches the seeding stage on the dead wood of the plant which it has killed.

Moulds and mildews are commonly differentiated from other fungi by being confined more to the surface of the host plant, their mycelium penetrating only a short distance into the substance of the leaves, shoots, etc.

For the destruction of fungus spores, the fungicide must be applied either in summer or in winter, according as it is the summer spores or winter spores which have to be attacked. One essential to the successful dealing with the summer spores is to do the spraying on the very first appearance of the disease: in most cases, however, such spraying results only in a checking of the attack, for the mycelium is not destroyed by it, and a renewed formation of spores occurs later on, necessitating a repetition of the spraying operation.

Besides spraying the trees in winter for the destruction of the winter spores, it is very important that all dead leaves, shrivelled fruit, and prunings should be collected and burnt, for it is on them that the spores are generally found. All wounds should be attended to and tarred, for in many cases it is through some wound that the fungus spores gain an entry into the tree; unfortunately they may enter through wounds too minute to be noticed, such as those made by the woolly aphis, and the destruction of pests of that description is, therefore, one of the best ways of keeping the trees free from the attacks of fungi.

There are practically only two substances effectual in destroying fungus spores—potassium sulphide, and copper, the latter being generally used in the form of one of its sulphates.

SPRAYING

FROM what has already been said, it must be evident that spraying will always have to be adapted, both as regards the date of the operation and the substances used, to the nature of the pest to be dealt with. The idea of having some one substance which will cure all the ills to which a tree is liable, is just as unlikely of realisation, as is that of some panacea for all the diseases to which human beings are prone. Nevertheless, a simplification of the treatment of trees is highly desirable, and this has been attempted in the present treatise. Instead of giving all the remedies which have ever been recommended for each individual pest, the most promising one or ones (in the opinion of the authors) have alone been mentioned ; and, where a number of equally efficacious remedies appear to exist, preference has been given to that which is applicable in other cases as well.

It must be borne in mind that by far the greater number of pests have not yet been made the subject of careful study from the point of view of the best means of destroying them, and, till that has been done, all recommendations must contain a considerable element of uncertainty. Growers who are sufficiently interested in the matter to wish to make themselves acquainted with the evidence on which

the various recommendations are based, should consult the reports in which the experiments have been described : meanwhile, it is well that they should look with some distrust on such remedies as are recommended only on the strength of casual or isolated trials, for any one making such trials is not unnaturally apt to be misled into attributing real merit to some form of treatment which owed its success merely to chance or exceptional circumstances. Still more should growers hesitate to spend their money on proprietary articles of unknown composition, until the virtue of such articles has been thoroughly established by general experience : and it is well to remember that exaggerated praise in advertisements is not required, when the article advertised possesses real merit of its own.

Although the remedies recommended for each pest have been limited to the lowest possible number, all the ordinary remedies in use have been included in the list of spraying materials, together with the instructions for making them. Spraying, being a necessary part of the routine of fruit-growing, and being, moreover, an expensive part of it, all large growers should make it their business, if only for economy's sake, to acquire sufficient knowledge and skill to make their own insecticides. With smaller growers and gardeners it is otherwise, and the difference in the cost of buying or of making the insecticides, would hardly be counterbalanced by the probable superiority of these substances when made by the skilled chemical manufacturer.

In many cases a certain latitude may be allowed in

the proportions taken when making an insecticide ; but unless the alteration is based on actual knowledge or experience, it is well not to attempt it ; for too often such alterations may result either in injury to the trees, or in the failure of the spraying to effect its purpose. Still more should growers not attempt to mix various insecticides together, unless they are thorough masters of the chemistry of the substances concerned. Such haphazard mixing will generally result in the destruction of the valuable properties of one or all of the substances in question.

Above all, it should be remembered that it is mere waste of money to spray, unless the spraying is done thoroughly. One thorough spraying may succeed in destroying a pest, where several slipshod sprayings will have no permanent effect whatever. Every portion of the tree should be thoroughly wetted. If heavy rain falls soon after trees have been sprayed, the work may have to be done over again ; but a certain amount of rain is often beneficial, as it prevents the wash from drying up too quickly, and helps to distribute the liquid over parts which might otherwise not have been wetted by it.

Spraying, it should be remembered, is rather a curative than a preventive measure. There is no good in spraying a tree if there is nothing on it to be destroyed ; indeed, there may be positive harm in doing so ; for, though spraying, when required, results indirectly in improving the trees and the crops, by destroying pests attacking them, yet the substances used may of themselves be injurious to the plant, and the continual use of them often causes damage. Spraying a healthy

tree is very much the same as giving medicine to a healthy man. There are exceptions to this rule, perhaps, but they are chiefly exceptions only in appearance, and apply to cases where the insect or fungus is so widely distributed that its presence may be regarded as a certainty.

APPLIANCES

THE character of the appliances used for spraying is a matter of considerable importance. The chief points to be aimed at are to have a machine sufficiently powerful to send the liquid to the top of the highest trees in the plantation, and to secure a very fine and even distribution of the liquid. An ordinary garden syringe, even with the finest rose-jet attached, gives much too coarse a spray, and is a very wasteful, and, therefore, expensive piece of apparatus: when a syringe is used, one specially designed for spraying, such as the "Abol" syringe, should be selected. The various knapsack sprayers, of which there are several forms on the market, are the most convenient for use in gardens, and in small plantations of an acre or two. They generally hold about three gallons, and are strapped on to the back of the workman, who with one hand works the handle of a pump fixed inside the sprayer, whilst with the other he directs the jet of liquid, which is forced out through a tube attached to it. One of the first forms of knapsack sprayer—Vernorel's *Éclair*—is still, perhaps, the best on the market. It costs about 30s. The knapsack sprayers, however, are not sufficiently powerful to deal satisfactorily with thick liquids, such as lime-wash.

The form of nozzle fitted to the jet is, naturally, a

matter of importance, and whenever a nozzle becomes worn, so as to give too coarse a jet of liquid, a new one should be substituted for it. Nozzles designed for dealing with clear liquids, or with those containing solids in a minute state of division, are not suitable for washes containing much lime, for they soon become clogged or worn. A coarser nozzle should be used in such cases, or if the nozzle is adjustable, as some of them are, the opening may be enlarged. There is generally an arrangement for clearing the nozzle whenever it becomes choked.

Where an exceptionally fine spray is required, a pneumatic sprayer or "mistifier" may be used, from which the liquid, instead of being forced out by a pump, is ejected by means of compressed air. Small hand-sprayers, holding two or three quarts, are made on this principle, and they will be found exceedingly useful for spraying one or two trees, and also for use in greenhouses, and for experimental purposes. They cost about 22s. Larger machines, made on the same principle, are obtainable.

For spraying on a more extensive scale, more powerful and complicated appliances are required; but it would be beyond the scope of the present work to enter into a description of them, and any attempt to do so might involve preferential mention of the various engineering firms who devote their energies to this subject.

Two points which require attention in spraying should be mentioned: the one, that many of the liquids used contain insoluble substances which tend to separate out, either sinking to the bottom, or rising

to the top, and therefore, if the liquid is not constantly agitated, a very unequal distribution of material results. Some of the more recent machines contain an automatic agitator, which is worked by the pump itself: in the case of the knapsack sprayer, the motion of the man who carries it is generally sufficient to keep the liquid shaken up. The second precaution is that the sprayers after use should always be thoroughly washed out, pumping water through them for the purpose, as many of the liquids used corrode the metal and the rubber of the valves.

Spraying machines are now to be had with wooden, instead of metal tanks, and these present the advantage of it being possible to use the tank for making Bordeaux mixture, instead of having to make this in a separate vessel.

It is hardly necessary to mention that spraying cannot be done efficiently on a windy day. Even on a calm day it is not always a pleasant operation, especially when caustic washes are being used, and great care should be taken to prevent the workmen from being injured by these. The men should be provided with waterproof capes, broad-brimmed hats, and india-rubber gloves; and it is well to have a basin of vinegar and water handy to neutralise the alkali, in case any of it gets on to their faces or hands. When spraying lime-washes, the men should be provided with coloured glasses, and these should also be worn while making up any washes with caustic soda, as if the strong alkali splashes up into the eyes, the consequence may be serious.

Powders are distributed on trees by being blown on

to them by means of bellows. A knapsack apparatus designed on this principle is procurable, as also are other more powerful appliances, some of which are worked by horse-power. It is important that the powder used should be in a very fine state of division, and that it should be quite dry : on the other hand, the trees should be slightly wet, so that the powder may stick to them. The dusting of trees, therefore, is best done in misty weather, or after a heavy dew.

Liquids may be injected into the soil by means of a Vermorel's injector, which is a syringe with a long, sharp nozzle, which can be thrust into the soil to various given depths.

MATERIALS

ARSENICAL PREPARATIONS.—These are used for the destruction of caterpillars, etc., by poisoning their food, the application of them being generally made to the trees when just coming into leaf. Great care must be taken in using them, as they are intensely poisonous, to both man and beasts. Work in this country and in America has shown, however, that the use of arsenic compounds is not, under ordinary circumstances, attended with any danger of poisoning the fruit, or the herbage under trees in grass orchards ; but they should not be applied within three or four weeks of the ripening of the fruit, nor during the blossoming of the trees, otherwise bees visiting the flowers may be poisoned. Arsenical compounds must, also, always be used in an insoluble condition, for, when soluble, they are injurious to plant-life, scorching the leaves, and even killing the plant. None of the compounds in use are absolutely insoluble, and, consequently, a little scorching of the foliage is liable to occur in some cases. Considerable preference has been given of late to the arsenates as compared with the arsenites.

The compounds in most general use are the following—

1. *Aceto-arsenite of copper : Paris green.*—It is best for the grower to buy this, instead of trying to make

it himself. It is sold as a dry powder, or as a paste containing 70 to 80 per cent. of the powder; the paste is much the more convenient and safe for handling. Paris green nearly always causes some scorching of the leaves, often to a serious extent; this may be diminished, though not altogether prevented, by the addition of lime, which neutralises any free arsenious acid which may be present.

(1) Paris green paste	.	.	.	$\frac{1}{2}$ to 1 oz.
Lime	.	.	.	1 oz.
Water	.	.	.	10 galls.

Put the paste in a small pail, and stand it on a stool in the centre of a tub; while stirring the contents of the pail with a flat piece of wood, pour water into it, and let this overflow into the tub; the water will carry over only the finer particles, leaving all lumps behind in the pail; these are broken up by further stirring. The lime (see p. 36) may then be added to the mixture. It should be kept well stirred during use.

2. *Arsenite of calcium* (*Arsenite of lime: London purple*).

(2a) White arsenic	.	.	.	2 ozs.
Quicklime	.	.	.	4 ozs.
Water	.	.	.	10 galls.

Slake the lime (p. 36), add the powdered white arsenic to it, and boil the mixture with one quart of the water for half-an-hour; then add the rest of the water.

London purple is a waste product from dye works, and contains about 75 per cent. of calcium arsenite.

It generally contains, also, much soluble arsenic, and to prevent this from scorching the foliage, lime must be added. The quantities recommended are—

(2 <i>b</i>) London purple	$\frac{3}{4}$ oz.
Lime	$\frac{3}{4}$ oz.
Water	10 galls.

These quantities represent a much weaker liquid than those given for the arsenite in the formula (2*a*).

London purple does not, on the whole, seem to be so efficacious as Paris green, and the danger of scorching the foliage with it is greater.

3. *Arsenate of lead: Gypsine*.—This may either be made by the grower, or bought in the form of a paste. It is generally made by mixing together solutions of arsenate of soda and acetate of lead (sugar of lead), but care must be taken that these are mixed in the right proportions, otherwise the foliage will be scorched, the scorching being more serious if it is the arsenate of soda which is in excess. There are at least two different arsenates of soda on the market, and the proportions to be used depend on which of these is bought.

(3 <i>a</i>) Arsenate of soda, if “pure”	
or “crystallised,”	$3\frac{1}{2}$ ozs.
Acetate of lead	7 ozs.
Water	10 galls.
(3 <i>b</i>) Arsenate of soda, if “dry,”	
“crude,” or “commercial”	2 ozs.
Acetate of lead	7 ozs.
Water	10 galls.

The arsenate of soda and the acetate of lead are each dissolved separately in 5 gallons of the water, and the solutions mixed together. The dissolving may be effected most conveniently in this, and in all other similar cases, by tying the solid in a piece of sacking, and hanging it in the water, so as to be only just immersed below the surface.

The above proportions will ensure there always being an excess of lead present, and, as different samples of sodium arsenate are liable to contain less arsenic than those on which these proportions are based, the excess of lead may be considerable. It is more economical, therefore, to add the lead acetate gradually to the arsenate, examining the liquid between successive additions, by allowing it to settle, and adding no more of the lead as soon as further additions fail to produce any further cloudiness.

The strength of the wash mentioned above is the greatest which should be used, and weaker preparations are generally effective: the actual quantities in the 10 gallons may be reduced to one-half or one-quarter of those given, but both materials must be reduced in the same proportions, the weight of lead acetate being always double that of the crystallised sodium arsenate, or $3\frac{1}{2}$ times that of the crude sodium arsenate. Further details as to the arsenates of lead will be found in the Sixth Report of the Woburn Experimental Fruit Farm.

A ready-made arsenate of lead of American origin is now on the market, in the form of a paste (Swift's arsenate), containing half its weight of dry arsenate, and growers would find it more satisfactory to use

this, or similar preparations, than to make the material themselves. It should be mixed up with water in the same way as Paris green paste. The proportions to be taken are—

(3c) Lead arsenate paste	.	3 to 12 ozs.
Water	.	10 galls.

4. *Arsenate of calcium*.—This has been suggested as a cheap substitute for arsenate of lead ; but it seems to be somewhat less effective than the lead salt.

(4) Arsenate of soda, "crystallised"	3½ ozs.
(or if "crude" arsenate, 2 ozs.)	
Quicklime	3½ ozs.
Water	10 galls.

Dissolve the arsenate in the whole of the water, then add to it the lime, previously made into a milk (see p. 36).

Bordeaux mixture. See *Copper sulphate*.

5. *Carbolic acid (Phenol)*.—This has been very thoroughly tested both in this country and in America, and the conclusion arrived at is that its value as an insecticide or fungicide is too slight for it to be recommended for use. It has been tried in the form of a 1 to 2 per cent. solution in water, as well as in conjunction with glycerine, soap, lime, etc. Some of the much-advertised insecticides recently placed on the English market consist largely of carbolic acid.

6. *Carbon disulphide*.—This is a very volatile and inflammable liquid, which is used for preventing insects from destroying stored grain, and also for the destruction of insects in the soil, being then injected with the

syringe mentioned on p. 19. The quantity to be used in such cases is from 2 to 4 ozs. to each tree, distributing this at three or four points at a distance of a foot or two from the stems. The ground should not be too dry at the time of application, and the nozzle of the syringe should be thrust down to about six inches below the surface. In the vaporous condition, carbon disulphide does not seem to injure the roots of plants, but it does so when liquid, probably owing to the intense cold produced by its evaporation; consequently, if the end of the injector is felt to strike one of the roots, it should be withdrawn and inserted elsewhere.

Ants' nests may be destroyed by pouring half an ounce of carbon disulphide into the nest through a hole made in it, and then stopping up the hole. A second application is needed about two weeks after the first, as the sulphide does not seem to kill the pupæ.

COPPER COMPOUNDS.—With the exception of Paris green, described above, the compounds of copper are used as fungicides only. A great number of different preparations have been investigated, some consisting of the carbonate, but the majority of the sulphates in some form or another. Copper sulphate itself can be used only on trees when they are dormant, for it is acid in its reaction, and destroys the leaves. For summer use, therefore, the copper sulphate is converted by the addition of lime into a basic sulphate, which is insoluble, but which by the action of the carbonic acid of the air, gradually liberates small quantities of the ordinary sulphate, sufficient to act on the fungi, but not sufficient (as a rule) to result

in any material damage to the leaves. This basic sulphate is known as Bordeaux mixture. The injury to the leaves, which sometimes results from its use, is generally due to its having been improperly made, either by not adding enough lime to precipitate all the copper, or, possibly, by adding too much, the caustic lime being then the substance which causes the scorching: but, even when properly made, some scorching is still liable to occur under certain weather conditions. This cannot be obviated without preventing the liberation of the ordinary sulphate from it, and on this its fungicidal properties depends.

7. *Copper carbonate*.—This, dissolved in ammonia, forms a fungicide known as Cupram. There are various formulæ for making it: one is—

Copper carbonate	.	.	.	1 $\frac{1}{4}$ ozs.
Strong ammonia	.	.	.	16 liquid ozs.
Water to make up to	.	.	.	10 galls.

Dilute the ammonia with 12 pints of the water, and shake it up with the carbonate till this is all dissolved; then add the rest of the water. This has not proved to be such a satisfactory fungicide as Bordeaux mixture, but the danger of scorching the foliage with it is less.

8. *Copper sulphate* (*Blue vitriol*, *Bluestone*).—For dormant wood the proportions recommended are—

(8) Copper sulphate	.	.	.	$\frac{1}{2}$ to 1 lb.
Water	.	.	.	10 galls.

For the method of conveniently dissolving it, see p. 23.

A wooden or stoneware vessel must be used for the solution, as it acts on iron and zinc.

9. *Copper basic sulphate (Bordeaux mixture).*—A number of different compounds are formed when lime is added to copper sulphate, according to the proportions used, but they all behave similarly in reproducing by exposure to air a certain amount of ordinary copper sulphate, which acts as a fungicide; but the proportion of this which is thus reproduced varies in different cases, so that some of the mixtures are much more effective than others, or, what comes to the same thing, the same degree of effectiveness may be obtained at the expense of different amounts of copper taken. The amount of lime used in making Bordeaux mixture can only be regulated accurately when used in the form of the clear solution known as lime-water (see p. 37). The instructions for making Bordeaux mixture with this are—

(9a) Copper sulphate	.	.	.	10 ozs.
Lime-water	.	.	.	$8\frac{1}{2}$ galls.
Water to make up to	.	.	.	10 galls.

Dissolve the copper sulphate separately in about half a gallon of the water. Put about half a pound of quicklime, previously slaked (see p. 36), in a tub with 12 to 15 gallons of water; stir this up once or twice, and then leave it to settle. When the liquid is quite clear, run $8\frac{1}{2}$ gallons of it off into the solution of copper sulphate. Add whatever extra water is required to make the whole up to 10 gallons.

The lime-water may vary a little in strength, so that it is absolutely necessary to test the mixture to

make sure that the whole of the copper has been thrown down: therefore, before adding the additional water, ladle out a little of the mixture, and add one or two drops of it to a weak solution of potassium ferrocyanide in a white saucer (the ferrocyanide may be obtained from any chemist): if there is any brown coloration, the copper has not all been thrown down; a little more lime-water must then be added, and the test repeated. Another test for unprecipitated copper consists in immersing the blade of a knife in the liquid, and seeing whether it becomes stained: but this test is neither very delicate nor reliable.

Bordeaux mixture made with lime-water in this way is as efficient as that made in the ordinary way (No. 9c), though the latter contains two-and-a-half times as much copper sulphate. It also presents the advantages of being much finer in texture, and, therefore, less liable to settle to the bottom of the liquid; it also contains no particles of solid lime, which wear the spraying nozzles, and cause loss of material, by being easily knocked off the leaves, and, further, it exhibits its fungicidal action at once after it is applied, instead of necessitating a certain time to elapse before such action begins, as in the case of the ordinary mixture.

Bordeaux mixture may be emulsified with paraffin oil, and thus gives us a combined fungicide and insecticide of great efficiency. The mixture should be made exactly as described above, and then the paraffin added, and churned up with it by a few strokes with a syringe fitted with a rose-jet. This has been named Bordeaux Emulsion.

Bordeaux Emulsion.

(9b) Copper sulphate	10 ozs.
Lime-water	8½ galls.
Water to make up to nearly .	10 galls.
Paraffin (solar distillate) . .	22½ ozs.

The amount of paraffin may be varied from 16 to 24 ozs., but with 22½ ozs., as above given, the quantity is just sufficient (if it is the solar distillate recommended on p. 43) to buoy the copper sulphate up, so that it neither sinks nor rises in the liquid, thus obviating all need for keeping the liquid agitated during use. Bordeaux emulsion of ten times the above strength is sold by some manufacturers, and only requires diluting to be ready for use. It should, however, always be re-churned, either before or after dilution, in case it has not been properly emulsified. A few cases where foliage has been seriously scorched owing to the omission of this precaution, have been reported. Mere shaking of the emulsion is not sufficient.

For making Bordeaux mixture in the ordinary way, the following formula may be taken—

(9c) Copper sulphate	1 lb. 10 ozs.
Lime	½ lb.
Water to make up to	10 galls.

The copper sulphate is dissolved in nearly the whole of the water, and the lime, previously slaked and made into a milk (see p. 36), is run into it through a piece of sacking, or through the strainer belonging to the spraying machine. The lime should be added

gradually, and the addition stopped as soon as the green-blue colour of the precipitate changes to a full blue. It is not safe, however, to rely on this change of colour, as it is not always well marked, and it is better to test the liquid at intervals with ferrocyanide, as described above, during the addition of the lime. If the lime is quite fresh, and if the slaking has been carefully done, it will be found that little more than half the quantity mentioned in the formula will suffice to precipitate the whole of the copper.

Bordeaux mixture made with milk of lime may be emulsified with paraffin in the same way as that made with lime-water, though it does not make such a perfect preparation.

Both the Bordeaux mixtures here described are equivalent in fungicidal value to that known in America as the "normal" or "1·6" mixture. In England, weaker mixtures are often used, and, if such are required, the amount of copper sulphate may be reduced, reducing that of the lime in the same proportion. The writers, however, have rarely found any serious injury to be done to the foliage by mixtures of the "normal" strength, when carefully made. Many recipes recommend the use of a large excess of lime, under the mistaken impression that it will prevent scorching: this is not the case. A full investigation of the nature and action of Bordeaux mixture will be found in the Eighth Report of the Woburn Experimental Fruit Farm.

CAUSTIC WINTER WASHES.—These should be used only on the trees in the dormant state, the object of their use being to remove moss, lichen and dead bark,

all of which tend to harbour insects, and to protect their eggs ; but some caustic washes, especially those containing paraffin, will also destroy, by their chemical action, the eggs of certain insects (mussel scale, etc.) as well as some chrysalids of caterpillars. The caustic substances used are caustic soda or caustic lime : the latter, being a much less powerful agent, figures also in certain preparations used in summer.

Winter washes may be used at any time between the fall of the leaf and the swelling of the buds in the following spring ; but they seem to be generally more effective when applied late in the winter, say, February or March. It is well not to defer the operation too long, however, for bad weather may then occur and render it impossible. One thorough winter-washing every second or third year should be sufficient to keep the trees clean.

10. *Caustic soda.* (*Soda: Sodium hydroxide*).—This must not be confused with carbonate of soda or washing soda, both of which are practically useless for cleansing trees. By far the most convenient form in which caustic soda is sold is that known as “powdered” ; it is obtainable in tins holding 1 lb. and upwards, and is of 98 per cent. purity. If a less pure article is used, the quantities in the following recipes must be increased accordingly. It must be remembered that caustic soda is exceedingly injurious to the skin, and may cause considerable injury : the precautions requisite in using it have already been mentioned (p. 18), and it is only necessary to add that the solid absorbs both water and carbon dioxide very eagerly, so that the tins of it

must be kept tightly closed, or it will deteriorate and cake together. A solution of it prepared for spraying should be exposed to the air as little as possible. The strength to be used is—

(10a) Caustic soda (98 per			
cent. purity) .	.	2 to 2½ lbs.	
Water .	.	10 galls.	

The water should be stirred while the soda is shaken in, or the latter may cake together at the bottom.

The smaller proportion—2 lbs.—is sufficient to effectively remove moss and lichen from the trees under ordinary conditions, but a still smaller proportion will be only partially successful. By increasing the amount to 2½ lbs. the action on scale is considerably increased, but the risk to the workmen using it is proportionately greater. It appears that in the case of scale, the action does not consist of a direct destruction of the eggs, but of a softening, and subsequent glueing of the covering scale to the bark, which results in imprisoning the insects when the eggs hatch. A 2 per cent. solution is not strong enough to do this with certainty, though it is generally effective.

Caustic potash is just as effective as caustic soda, when equivalent chemical quantities are used, which means using about three parts of the potash instead of two parts of the soda; but, as potash, is much dearer than soda, there is no object in making the substitution. Many of the recipes still in circulation recommend substituting for half of the soda an equal

weight of "crude" potash, that is, of potassium carbonate or potashes: this is a great mistake; as the carbonate has little or no detergent or insecticidal value, and the use of it means so much waste of money, and a reduction of the strength of the wash below that at which it is efficient.

The efficiency of a caustic winter wash as an insecticide has been found to be much increased by the addition of paraffin, and such mixtures are to be recommended in preference to the simple caustic wash. The mixture is known as the Woburn Wash. The substances used for incorporating the paraffin with the soda are either soap, basic sulphate of copper, or basic sulphate of iron.

When soap is used attention should be paid to the brand, for with some soaps the addition of soda will cause the entire separation of the paraffin, and with others, the soap will separate in big clots, which clog the nozzles of the machines. The Chiswick Soap Co. sell a brand (The Woburn Soap) specially adapted for the purpose. The recipe for this waste is—

(106)	Soft soap	.	.	.	$\frac{1}{2}$ lb.
	Paraffin (solar distillate).				5 pints.
	Caustic soda	.	.	.	2 to $2\frac{1}{2}$ lbs.
	Water	.	.	.	$9\frac{1}{2}$ galls.

Dissolve the soap in the water (hot or cold): churn the paraffin up with it (p. 46), and then shake the soda into it.

The soda converts the soft soap (potash soap) into hard soap (soda soap), and this, together with the paraffin, tends to rise to the surface, so that the

mixture has to be stirred continually while being used. The necessity for stirring is almost obviated when basic sulphate of copper is used instead of soap, and the wash obtained has the further great advantage of being a fungicide, as well as a detergent and insecticide, for it practically contains Bordeaux mixture. The recipe for it is—

(10c) Copper sulphate	.	.	1½ lbs.
Quicklime	.	.	$\frac{1}{4}$ to $\frac{1}{2}$ lb.
Paraffin (solar distillate)			5 pints.
Water	.	.	9½ galls.
Caustic soda	.	.	2 to 2½ lbs.

The first four ingredients are mixed exactly as in 9c, and the caustic soda is then shaken in. Testing the liquid to see if all the copper is precipitated is not necessary in this case.

A wash precisely similar to the above, except that it possesses no fungicidal properties, may be made by substituting iron sulphate (which is much cheaper) for the copper sulphate. The amount of iron may also be reduced, if necessary, taking—

(10d) Iron sulphate	.	.	$\frac{1}{2}$ lb.
Quicklime	.	.	$\frac{1}{4}$ lb.
Paraffin (solar distillate)			5 pints.
Water	.	.	9½ galls.
Caustic soda	.	.	2 to 2½ lbs.

The lime in the above (but not in the copper wash) may be dispensed with, by adding some of the soda to the iron sulphate before the addition of the paraffin ;

but the resulting emulsion is not so fine as when lime is used. When the wash with iron is used, it turns brown on the trees, owing to the formation of rust. This does no harm whatever.

For the iron and copper washes a special paraffin oil (solar distillate, p. 43) should be used ; with the soap wash any oil will do, at any rate, so far as making a successful emulsion is concerned, but with solar distillate it is probably more effective than with ordinary lighting oil.

The iron emulsion, and also the soap emulsion, may be bought in a concentrated form, requiring only dilution and the addition of the soda to be ready for use. Re-churning, however, is advisable, as mentioned under Bordeaux mixture (p. 29).

11. *Lime*.—As a winter wash, lime is in many respects inferior to caustic soda: it is much less energetic, and, to remove moss and lichen effectively, the strength must not be reduced below 10 per cent.; it is advisable, indeed, to raise it up to 20 per cent.: its action in destroying scale, even when used at this strength, is generally less than that of the caustic soda wash, and it appears to be diminished, rather than increased, by the addition of paraffin oil. Such strong lime-washes, moreover, cause much wear of the spraying apparatus, and the whitened appearance of the trees is considered by many to be objectionable. On the other hand, lime-washing is held to be the only means of diminishing the attack of birds on fruit buds, and, when salt is mixed with it, a wash is obtained which has been found to prevent the hatching of the eggs of the apple-sucker (*Psylla*): for

that purpose, however, it is best applied a few weeks before the buds expand, when it must be regarded rather as a spring, than as a winter wash : an application at that date would be too late to prevent the depredations of birds.

In every case where lime is mentioned in this volume, the weights refer to that of the quicklime, and in every case this quicklime should be slaked before anything further is done to it. Failure in obtaining satisfactory results with preparations of lime are nearly always to be traced to want of care in starting with quite freshly burnt lime, or in slaking this. Quicklime is an oxide of calcium, which combines chemically with one-third of its weight of water to form calcium hydroxide, or slaked lime, a compound corresponding with caustic soda. The combination occurs only slowly at first, but much heat is developed by it, and if this heat is not dissipated, the whole becomes very hot, and then the action proceeds rapidly, the lime all crumbling up into a fine powder. If too much water is added at first, the rise of temperature is prevented, and the slaking takes place very slowly and imperfectly, hard lumps of unslaked lime being left in the product. In slaking, therefore, only just enough water should be added to wet the lime, without any actual water being left over ; and, if the lime does not become very hot, and crumble up in about ten minutes, a fresher sample should be procured. Air-slaked lime should never be used, for that always contains an unknown proportion of carbonate (chalk), which is useless for insecticidal purposes.

After the lime has been properly slaked, it may

easily be mixed with more water in any proportions, such a mixture forming a *milk-of-lime*: in using this, it should always be run through a piece of sacking or a strainer, to get rid of any grits which may be present. The milk consists chiefly of the fine particles of lime suspended in the water; when these are allowed to settle, a clear liquid is left, retaining a small portion of the lime actually dissolved in it: this is *lime-water*: it contains rather more than one-thousandth of its weight of lime. On exposure to the air it becomes cloudy at the surface, owing to its absorbing carbonic acid, and forming chalk.

For use on a small scale, where additional expense is not a consideration, it will be found very convenient to take pure slaked lime, which may be bought at any chemist's for 3*d.* to 6*d.* the lb. It forms a fine, impalpable powder, and its use obviates the necessity of any straining, or even of mixing it with water before adding it to sulphate of copper or iron. It should be kept in a well-closed bottle. The weights of quicklime given in the above formulæ may be taken to apply equally to pure slaked lime, for though the latter contains 27 per cent. of combined water, allowance has been made, in giving the weights of quicklime, for the presence of considerable impurity.

When a lime-wash is sprayed or painted on to the trees, the deposit of lime soon becomes converted into one of chalk, and it gradually flakes off. The addition of various substances has been tried so as to prevent this flaking, but without much success; some improvement will be obtained by adding to each 10 gallons of lime-wash either 3 lbs. of flowers of sulphur, or

5 pints of solar distillate (churning this up with it), or 1 lb. of water-glass. In the case of sulphur, a certain amount of chemical combination occurs, analogous to that occurring in the lime-sulphur-salt washes mentioned below: where solar distillate is used, the effectiveness of the wash on scale is diminished, whilst in the case of water-glass, the results seem to be very uncertain, there being sometimes an increased adhesiveness of the wash, sometimes the contrary.

Lime-sulphur-salt washes are applied in winter to trees, but more as insecticides and fungicides, than as detergent agents. They will be considered under Sulphur Compounds (p. 53).

12. *Lime-salt wash*.—This is recommended for the destruction of psylla, and should be applied a few weeks before the buds open.

(12) Lime	.	.	.	.	15 to 20 lbs.
Salt	.	.	.	.	2 „ 3 lbs.
Water-glass	.	.	.	$\frac{1}{2}$ „	1 lb.
Water	.	.	.	.	about 8 galls.

Slake the lime, and mix it with half the water; in the rest of the water dissolve the salt and the water-glass (sodium silicate); mix the two. It is not known yet what the mechanism of the action is in the case of this wash, especially as to the part played by the salt. The amount of this latter has recently been raised from 2 up to 3 lbs., and, if the action depended on it, it might be raised still further, even up to 10 lbs.; but it is stated that very little advantage has been gained by raising it to 4 lbs. The lime appears to act

to a certain extent mechanically, forming a coating over the eggs, through which the insects cannot break ; but it also, no doubt, acts chemically, the comparative weakness of its causticity being counterbalanced by the large proportion in which it is used, and the long time required for it to become entirely converted into carbonate.

In Canada this wash has been in use for many years for cleansing trees from moss, lichen and rough bark, and also for destroying scale ; and in Nova Scotia it is being tried for reducing the attack of the leaf-curling apple aphid ; but experiments in this country show that for removing moss, etc., and scale, it is inferior to the paraffin-soda washes.

As already stated, a powerful spraying machine fitted with a special nozzle is required for applying this and other lime-washes.

All these lime-washes appear to delay the expansion of the blossoms for a few days, which, on the whole, is an advantage, by increasing the probability of their escaping damage from frost. But other washes also (soda-paraffin washes) have a similar action, when applied late in the winter.

13. *Hydrocyanic acid (Prussic acid)*.—This is a gas, and is used for destroying various insects in green-houses (scale, mealy bug, thrips, weevils, etc.), and those on young nursery stock (woolly aphid, especially) before planting out. When used with the precautions mentioned below, and under favourable conditions, it should destroy also the eggs of these insects ; but if not, a second fumigation, in the case of greenhouse plants, will be necessary, to kill the insects hatched from the

eggs which survived the first fumigation. For mealy bug, this second fumigation should be done about a fortnight after the first.

The gas is a deadly poison, and operations connected with it should never be left to the care of workmen. It is made by acting on potassium or sodium cyanide (also deadly poisons) with diluted sulphuric acid. When stocks have to be fumigated, they may be placed in a small greenhouse, or under a skeleton box covered with oiled cloth. The operation should not be done in sunshine, nor when the temperature is above 60° F.; also, the house, earth, etc., should be as dry as possible at the time. The amount of material used depends on the cubic contents of the place to be fumigated: for every 100 cubic feet, two-thirds to one-quarter of an ounce of potassium cyanide is required, or one-half to one-fifth of an ounce of sodium cyanide, the quantity depending on the hardness of the plants treated. For each ounce of cyanide, one liquid ounce of strong sulphuric acid (oil of vitriol), previously diluted by pouring it very gradually into 3 or 4 ozs. of water, is required. A jar containing the diluted acid is placed on the ground, and the cyanide, wrapped up in a piece of netting or wire gauze, is lowered into it by means of a string, passing over a pulley, or tied to a long stick, so that the operator may work it while he himself is outside the house. Every opening in the house should previously have been closed, except the one necessary for lowering the cyanide. After one hour, the door may be opened, but no one should go in, till time has been allowed for thorough ventilation.

Trees growing in the open may be fumigated by covering them with dome-shaped tents.

The experience of both the writers of this volume has led them to state at various times that fumigation is not effectual in killing insect eggs, but further evidence shows that hydrocyanic acid is really fatal to eggs, provided it is applied in sufficient quantity and under sufficiently favourable circumstances, though success does not seem to be a certainty. The fact that it is soluble in water accounts for many of the discrepancies noticed, and this would always render its application to trees while in the ground very uncertain in this country; for the soil here is never dry during the winter. A hard frost is the best type of weather in which to treat such trees. For killing insect eggs, the maximum quantity of cyanide mentioned above should be employed, and, if it is the potassium cyanide which is used, this must be the "lump" cyanide, which is practically pure, and not "stick" cyanide, which contains only 40 per cent. of true cyanide. The operator should also make certain that the action has been complete, for occasionally the lumps of cyanide become coated with a deposit of acid sulphate, which protects them from further action before more than half of the cyanide has been attacked by the acid. To obviate this, the cyanide should be broken up into pieces not larger than beans, and it is best not to use paper for wrapping it up, as is generally recommended, for some paper becomes converted by the acid into parchment paper, and the packet of cyanide remains intact.

Sodium cyanide dissolves more easily than the

potassium cyanide, and on that account is preferable to it, though it is somewhat dearer. Weight for weight, it liberates 30 per cent. more gas than the potassium cyanide.

The damage done to trees by the gas is usually insignificant, and is generally confined to killing off the ends of a few shoots; but occasionally the damage will be more serious, and trees are sometimes nearly killed, even with doses not strong enough to destroy the eggs of the mussel scale. This discrepancy in behaviour is doubtless connected with differences in the water contents of the cells of the trees, which would affect the results when dealing with a gas soluble in water.

14. *Iron sulphate (Copperas : Green vitriol)*.—This appears to have little or no value as a fungicide, and cannot, therefore, be used as a substitute for copper sulphate in this respect. Merely as a substance for emulsifying paraffin oil, however, it is an efficient substitute for the corresponding copper salt. (See pp. 34, 48).

15. *Paraffin (Petroleum : Kerosene)*.—Paraffin is a generic name applied to certain substances possessing an analogous chemical constitution, but differing considerably in physical properties, and ranging from gases to solids. Those which are of use in the treatment of trees are all liquids, but these liquids vary largely as regards their volatility. If they are too volatile, they will evaporate before having time to act on the pests to be destroyed; if they are too stable, they will remain so long on the trees that the bark of these may be damaged. For general use the best oil is

one which contains only a small proportion, either of the very volatile, or very stable paraffins. One of the various products known as solar distillates has been found to answer these requirements, and is sold under the name of the Woburn Distillate. Ordinary paraffin lighting-oil will answer most purposes fairly well, but the solar distillate, besides being more efficient, possesses the further advantage of being cheaper, of not being an "inflammable" for the purposes of railway carriage, and of emulsifying well with the basic sulphates of iron and copper, whereas lighting-oil is less satisfactory in this respect.

Paraffin is sometimes sprayed on to dormant trees as a winter wash ; but it cannot be recommended for this purpose. It has little or no detergent action as regards moss, lichen, etc., and it is less effective in destroying mussel scale, etc., than is a caustic wash to which 6 per cent. of paraffin has been added. It is also liable to injure the trees, especially if used in successive years, the buds and tips of the shoots being destroyed. The heavier the oil, the more marked is this destructive action.

Young nursery stock may be immersed in petrol before planting for the destruction of woolly aphis, and this treatment has not been found to result in any injury to them : but no less volatile oil should be used for this purpose : even a good quality lighting-oil, such as White Rose, has been found to have a very deleterious effect on the trees ; and the use of a heavy oil, such as solar distillate, will prove fatal.

Apple trees may be effectively sprayed in summer

for woolly aphis, with a high class burning oil, such as White Rose oil, and very little damage to the foliage will result; but in this case neither the heavier oil (solar distillate) nor the lighter oil (petrol) must be used: the latter appears to destroy the foliage almost instantly. The use of undiluted paraffin—even White Rose oil—on trees in leaf, must, however, at present be considered a somewhat risky proceeding, and one which requires further investigation: it is well to apply such a drastic remedy only in cases where unimportant trees are infested, and where there is danger of the infection spreading to more valuable ones. But if paraffin is used, it should not be diluted—that is, made into a strong emulsion—under the impression that there will then be less likelihood of its doing damage, for the reverse has been found to be the case, strong emulsions causing more injury than undiluted paraffin.

In spraying paraffin a very fine spray, such as that produced by a “mistifier” or pneumatic sprayer (p. 17), should be used.

16. *Paraffin emulsion*.—For spraying in winter, an emulsion containing 6 per cent. by volume of paraffin is recommended, and no fear need be entertained of any damage being done by it, so long as the buds are not opening. It has already been used very extensively in conjunction with caustic soda (10*b*, 10*c* and 10*d*), and no damage has yet been reported, even in the case of peaches and nectarines; in some cases, too, it has been applied to mixed plantations when the gooseberries and currants were quite green with foliage, and the damage done to them was of the

slightest description, and often not noticeable. Mixtures containing as much as 12 and 18 per cent. have been found to be harmless to apples, while dormant; but it is probable that the repeated use of liquids of this strength would ultimately do harm; such, at any rate, has been found to be the case in America, though there, still stronger mixtures, often made with crude petroleum, have been used.

For use when the leaves are on the trees, emulsions containing $1\frac{1}{2}$ per cent. of paraffin are the strongest which should be used, though an increase to 2 per cent. causes only an amount of damage to the foliage which is generally too slight to be noticeable. While the trees are in blossom, paraffin insecticides should not be used at all.

For incorporating paraffin with water, special pumps are in use in America, but a much more satisfactory method is to add some substance which will emulsify the oil. In emulsification the paraffin is broken up into microscopic globules, and there must be present some substance which has the power of preventing these from reuniting: the mixture then remains permanently milky. Soap, and also solids in an extremely fine state of division, have this power, and several emulsions made with them have already been mentioned. For use in winter, paraffin emulsions are not of much service, unless mixed with caustic soda, for without the soda they will not destroy moss and lichen, and, therefore, those emulsions are preferable which are not broken up (de-emulsified) when soda is added to them. This is so with the emulsions made with basic iron sulphate and basic copper

sulphate, but only partially so with those made with soap, some soaps being satisfactory in this respect, and others not. A soap specially made for this purpose should be used (see p. 33).

Emulsions with soap.—The formula for making this when required for use as a winter wash with caustic soda, has already been given in 10*b* (p. 33); but the emulsion itself may be made in a concentrated form, according to the following recipe (16*a*), this stock emulsion, when required for use, being diluted in the proportion of 1 gallon to 9 gallons of water, and the caustic soda (2 to 2½ lbs. to the 10 gallons) being subsequently added, if required.

(16 <i>a</i>) Soft soap	5 lbs.
Paraffin	6 galls.
Water	3½ galls.

The soap is dissolved in the water, and the paraffin is added to it *gradually*, churning it up meanwhile with a syringe fitted with a rose jet. The resulting emulsion should be of the consistency of a thick cream. It is liable to de-emulsify on keeping, the paraffin separating from the rest of the liquid. If this occurs, pour the paraffin off, heat the watery liquid over a fire in the open air (in case of its catching fire), and then churn the paraffin into it again.

For use in summer, it is well to increase the relative proportion of soap in the emulsion.

The following may be suggested—

(16 <i>b</i>) Soft soap	2½ lbs.
Paraffin	16 to 24 ozs.
Water	9½ galls.

This emulsion, also, may be made of about ten times the strength required for use, emulsifying the soap and oil with half a gallon of water only, and adding the further nine gallons to it subsequently.

Another method of making emulsions with soap is by means of what is known as *Soluble Paraffin* or *Paraffin Jelly*. When soap, with a little water added to it, is heated, and mixed up with paraffin oil, a nearly clear liquid is obtained, which forms a jelly on cooling. As much as eight or nine volumes of paraffin can thus be incorporated with one volume of soap. When the "soluble paraffin" thus obtained is mixed with water, it forms an emulsion similar to that produced by churning the oil with a soap solution, as described above. One of the formulæ most in use for making paraffin jelly is : Paraffin, 5 gallons ; soft soap, 8 lbs. ; water, 1 pint.

A certain amount of naphthalene can be incorporated with such a mixture, and a product of this nature has received the name of *Paranaph*. The instructions for making it are—

(16c)	Soft soap	.	.	.	10 lbs.
	Water	.	.	.	3 pints.
	Naphthalene	.	.	.	1 lb.
	Paraffin	.	.	.	2 pints, 13 ozs.

Heat the soap and water together till the former is quite dissolved, stir into this the naphthalene, and, after removing the vessel from the fire, add the paraffin, and stir till the whole is incorporated. For use, one part by weight of the mixture should be diluted with 100 to 200 parts of soft water.

Preparations of "soluble paraffin" mixed with potassium sulphide are also made, these being recommended for use against red spider and mites, as well as for fungicidal purposes.

Emulsions with basic sulphates.—The de-emulsification mentioned as occurring sometimes in the case of strong emulsions made with soap, never appears to take place in those made with basic sulphates. For use as a summer wash, that is, where caustic soda has not to be added, the emulsions, both with copper sulphate and iron sulphate, may be made, or may be bought, of a strength tenfold that required for use; but with the washes for use in winter, it is only that made with iron sulphate which can be obtained in a concentrated form.

The emulsions made with the sulphates of copper and of iron for use in winter with caustic soda have already been described under 10*c* and 10*d*, respectively, whilst the emulsion with copper sulphate for summer use (Bordeaux emulsion) has been given under 9*b* and 9*c*. It only remains to mention the wash corresponding with the latter, but made with iron sulphate; this requires—

(16 <i>d</i>) Iron sulphate	.	.	.	10 ozs.
Lime (as a milk)	.	.	.	5 ozs.
Paraffin (solar distillate)	.	.	.	16 to 24 ozs.
Water to make up to.	.	.	.	10 galls.

That the iron has been completely precipitated, should always be ascertained in this case by testing some of the clear liquid (before the paraffin is added) with potassium ferrocyanide; if a prussian blue

coloration is noticed, more lime is required. If this wash is bought in a concentrated form, it should always be rechurned before use, as mentioned under Bordeaux emulsion on p. 29.

As to the comparative merits of emulsions made with different substances, the insecticidal value of those with copper and iron sulphate will be the same, but that containing copper has the advantage of being a fungicide as well. In the case of aphids, an emulsion made with soap may be preferable to those made with the sulphates, cleansing the leaves more effectually of the honey-dew and excrement deposited on them by the insects.

Besides soap and the basic sulphates of iron and copper, other substances have the power of emulsifying paraffin oil with water: starch, flour, milk and glue, all act in this way, though none of them is superior to soap or the sulphates for this purpose.

Although paraffin seems of itself to be one of the most satisfactory insecticides for summer use, it may sometimes be desirable to use other substances together with it. With some of these it can be emulsified by simply churning them up with it; this is so with freshly prepared lead arsenate and calcium arsenate; in other cases it is necessary to emulsify the paraffin with iron sulphate, as in 16*d*, before adding the other substance; Paris green, lead arsenate paste and potassium sulphide may thus be incorporated with paraffin (see p. 56). With various lime-washes, including the lime-sulphur-salt washes, paraffin may be emulsified directly by churning, but the emulsion is of a somewhat different nature, and is

not so perfect as in other cases. Paraffin cannot be emulsified with sulphur.

Those who are interested in the nature and behaviour of emulsions, will find some investigations on the subject described in the Eighth Report of the Woburn Experimental Fruit Farm.

17. *Soap*.—Ordinary soap is a “salt” of one of the alkali metals with a non-volatile fatty acid, generally oleic, palmitic or stearic acid, according to the substances from which the soap has been made—cocoa-nut oil, palm-kernel oil, olive oil, tallow, cottonseed oil, fish-oil, resin, etc. The sodium salts constitute the hard, or curd soaps, the potassium salts, the soft soaps. Both contain considerable percentages of water, and the latter may also contain a certain amount of glycerin, and a little free alkali. Soft soaps vary considerably in colour, ranging from amber-yellow to brown; those made from fish-oil are greenish, and possess an offensive smell, but other soaps are sometimes coloured green artificially. American fish-oil soaps are known as whale-oil soap, although they are not, as a rule, made from whale blubber.

Soft soaps are freely soluble in water, whereas hard soaps are comparatively insoluble; the result is that when any compound containing sodium, such as caustic soda or common salt, is added to a solution of soft, or potash, soap, this is converted into hard, or soda, soap, which is thrown out of solution, or “salted out,” as it is termed, forming a flocculent mass which rises to the surface. If paraffin has been emulsified with the soft soap, it also becomes

separated as soon as the soft soap is destroyed ; but this separation is often prevented to a greater or less extent by the presence of minute solid particles in the liquid, these being themselves capable of producing emulsification. This is the reason why, when a caustic emulsion is made with soap (106), the results vary with the character of the particular soap used, rendering it advisable always to use a soap specially prepared for the purpose.

Soft soap by itself possesses considerable insecticidal properties, partly due to the free alkali and glycerin present in it, and partly to its blocking up the breathing apparatus of insects. It is too feeble in its action, however, to be of any use, except for summer spraying, and, even then, it is generally better to supplement the action of the soap by adding to it some more deadly material, such as paraffin (*i.e.* using an emulsion), or nicotine or quassia, in cases where paraffin would do harm—*e.g.* in the case of hops, roses, etc.

When soft soap is used alone, the proportions taken may be varied between 1 and 5 lbs. to every 10 gallons of water. Soft water should be used, as hard water destroys some of the soap, converting it into an insoluble calcium soap.

For the same reason, soap should never be mixed with insecticides containing lime or other mineral substances : potassium sulphide is the only mineral insecticide which will not decompose it.

18. *Sodium chloride* (*Common salt*).—This is never used by itself as an insecticide, but it forms one of the constituents in the lime-salt wash already mentioned under 12, and in other washes described below.

Its efficacy, and the nature of its action, is a matter of some doubt; when sufficiently strong—about 10 per cent.—brine appears to act on the eggs of insects by osmosis, that is, by drawing the watery contents out of them, and making them collapse; but it seems doubtful whether such an action can occur with the weaker brines—2 or 3 per cent.—present in the washes in use. A similar action, however, does occur in the case of the cells of plants, and even a 3 per cent. brine scorches the leaves of apple trees, whilst stronger solutions destroy them altogether. Insecticides containing salt should, therefore, only be used while the trees are dormant.

19. *Sulphur and sulphides* are of use as fungicides, especially for surface mildews, and also as insecticides for the destruction of mites, red spiders and aphides. Sulphur by itself is largely used for destroying red spider on hops, when it is dusted on to the hops by means of apparatus specially designed for the purpose. It is probable that its action depends on the evolution of a small amount of vapour, for, though it is a solid, it is slightly volatile. When used in hothouses, this volatility may be increased by placing it on the hot-water pipes, the pipes being painted with a mixture of sulphur and water, or sulphur, lime and water. The form of sulphur which should always be used is that known as flowers of sulphur, or else “green” sulphur, which is in a still finer state of division than the flowers. For the treatment of trees it is more convenient to mix the sulphur with water, and spray them, instead of using the dry powder. Sulphur, however, does not mix easily

with water, and the best way of proceeding is to incorporate it first with a little hot water in a mortar, etc., and then to add the rest of the water to it. The proportions recommended vary very largely, from 2 ozs. up to 10 lbs. to every 10 gallons of water, though such a high proportion as the latter, would seem to be very excessive.

20. *Sulphur and lime*.—A mixture of sulphur and lime is to be preferred to sulphur only, as being probably more efficacious. Even when the two are not boiled together, a certain amount of combination occurs, calcium sulphide and other compounds being formed. The substances may be used in the dry condition, and dusted on to the trees, preferably when these are wet with dew or mist. Either equal weights of flowers of sulphur and ground quicklime, or two parts of sulphur to one of lime, are recommended. Some scorching of the foliage often occurs; this is reduced by using dry, freshly slaked lime, instead of quicklime, but the insecticidal value of the mixture is likely to be somewhat reduced in that case.

21. *Sulphide of calcium*.—When lime and sulphur are boiled with water for some time they combine to form a mixture containing various sulphides of calcium, which is useful for the treatment of surface mildews. It is hardly worth while, however, to make this sulphide, as it can be bought at a low price in the form of a 40 per cent. solution, and one part of this in 100 of water is sufficiently strong for application: moreover, the sulphide of potassium appears to be generally preferable to that of calcium.

22. *Lime-sulphur-salt wash (California wash)*.—This

is a winter wash, and although it consists largely of calcium sulphide, it owes some of its important properties to the presence of other sulphur compounds. The proportions of the different constituents vary considerably according to different recipes, but the following may be taken as being the most usual—

(22) Quicklime	.	.	.	6 to 3 lbs.
Sulphur	.	.	.	3 lbs.
Salt	.	.	.	3 lbs.

These are mixed together, and enough water added to slake the lime; while still hot, more water is added, and the mixture boiled for 45 minutes; after which it is made up with water to 10 gallons. Calcium thio-sulphate and pentasulphide are formed, and both of these gradually change into other compounds, depositing free sulphur. It is to this deposition of sulphur that the wash owes its chief properties, for sulphur deposited in this way is in a fine state of division, and adheres strongly to the trees, the result being that the wash remains on the trees a long time, and in some cases cements the eggs of insects, etc., to the bark, so that they cannot hatch. The sulphur and sulphide in it give it fungicidal properties, and there is sufficient excess of lime to make it to a certain extent a detergent agent. Whether the salt in it is productive of good or not, is a debated point; if it is, the proportion of it might well be increased, as also might that of the lime.

This wash possesses the great disadvantages of requiring prolonged boiling, and of rapidly changing when once made, when it loses its valuable properties;

it also varies considerably in efficiency with small variations in the details of its manufacture, so that it is never likely to become popular in England.

23. *Lime-sulphur-soda-salt wash (Oregon wash).*—This is a modification of the above, in which 1 lb. of caustic soda is used in addition to the other compounds, the result being that more heat is developed, the mixture boiling, and the chemical change becoming complete without the aid of external heating. The soda and lime are mixed together, and are slaked with hot water, in which the sulphur has previously been incorporated. If, however, the actual amount of solids taken is not considerable (about 20 lbs.), the heat generated has generally to be supplemented by external heating.

The sulphur in this case appears to combine with the caustic soda to the exclusion of the lime, and it is a question whether the lime could not be dispensed with altogether. Probably, however, it is of importance in forming with the sulphur an adhesive deposit on the trees. The caustic soda might well be increased to 2 lbs., or even 3 lbs., to make the wash more effective for removing moss, etc.

24. *Sulphide of potassium (Liver of sulphur).*—This is used as a fungicide, and it is specially valuable for mildews, such as the gooseberry mildew; it is very efficient, however, for aphids, especially when used in conjunction with soap. The proportions recommended are—

(24a) Potassium sulphide	.	.	3 to 10 ozs.
Water	.	.	10 galls. ;

the higher proportions being used for hardier trees, or when the plants are not in leaf.

The solution should be used as soon as it is made, as it decomposes on being kept. Liver of sulphur never dissolves entirely in water, as it always contains an excess of sulphur.

The addition of soft soap to this mixture—1 to 2 lbs. to every 10 gallons—makes it more effective as an insecticide for aphids, etc., and still better results may be obtained by combining it with a paraffin emulsion; this may be done by churning 16 to 24 ozs. of paraffin and 1 to 2 lbs. of soap with the sulphide solution, or making an emulsion with iron sulphate similar to 16*d*, but using water with potassium sulphide dissolved in it, instead of plain water. As the sulphide reacts with the basic sulphate of iron, the proportion of the former should be increased, and that of the latter reduced. The following proportions will be found suitable—

(24 <i>b</i>) Iron sulphate	. . .	2 ozs.
Quicklime	. . .	1 oz.
Paraffin (solar distillate)		16 to 24 ozs.
Potassium sulphide	. . .	4 to 6 ozs.
Water to make up to	. . .	10 galls.

The iron sulphate is dissolved in some of the water, the lime, as a milk, is mixed with it, and the paraffin churned in; the rest of the water, with the sulphide dissolved in it, is then added.

VEGETABLE POISONS.—Many of these have been tried as insecticides, but few of them have been found to be of much use, except Hellebore, Nicotine,

Quassia and Pyrethrum. All these, however, except Nicotine, are subject to the drawback of being difficult to prepare so as to be of known or constant strength.

25. *Hellebore*.—This is a light yellowish-brown powder obtained by grinding up the roots of *Veratrum album* or *V. viride*. It is useful as an insecticide for sawfly larvæ, and, being less poisonous than arsenical compounds, it may often be used in cases where the latter would involve the danger of poisoning the fruit, as, for instance, in the case of the gooseberry sawfly (p. 83). It may be used as a powder, dusting it over the bushes, in which case it may be conveniently mixed with twice its bulk of some other powder, such as plaster of Paris, lime or flour—the last of which is stated to make the hellebore adhere better—or it may be sprayed on to the bushes, mixed with water, in which case 3 or 4 ozs. should be mixed with every 10 gallons of water. It may also be used mixed with paraffin emulsion.

Hellebore deteriorates on keeping, and the samples used should, if possible, be freshly prepared.

26. *Nicotine* (*Tobacco*).—This, on the whole, appears to be the most effective of the vegetable poisons for destroying psylla, aphis, woolly aphis, etc., but, according to the experiments at Woburn, it does not compare favourably with a weak paraffin emulsion (9*b*, 16*d*, etc.) for the destruction of caterpillars, except when used in excessive quantities. It presents the advantage, however, of being harmless to trees when these are in full blossom, which paraffin is not; moreover, it can never harm the foliage, which paraffin

emulsion may do, if used too strong, or if made improperly.

The strength of solution which has been found very effective is one made by soaking 2 lbs. of strong tobacco in 10 gallons of water. For use on a practical scale, however, tobacco which has paid duty is too expensive, and what is known as denatured tobacco must be used. This is sold in the form of a powder, known as hop-powder, and contains about 70 per cent. of tobacco or snuff, mixed with sulphur, assafoetida and sago flour. It may be bought for 20s. to 30s. the hundredweight. The tobacco used in making it, however, varies considerably in strength, and it is well to take 4 lbs. of it to every 10 gallons of water for making the decoction.

It is better still to use nicotine instead of tobacco. This may be bought of about 96 per cent. purity for 12s. the lb., or weaker solutions may be obtained, specially prepared of guaranteed strength by dealers in insecticides. In either case the preparations should be diluted for use so as to contain 0.075 per cent. of nicotine, equivalent to $1\frac{1}{5}$ th ozs. to 10 gallons. Growers should be very careful to obtain a guarantee as to the strength of the solution purchased, as there are preparations of so-called commercial nicotine on the market, which are sold at a low price, but which contain only 2 to 3 per cent. of the substance.

The spraying of trees with nicotine solution during flowering does not interfere with the working of bees, and these seem to be quite uninjured by the poison.

Nicotine solution can be used in conjunction with soap, and also with any paraffin emulsion, or lead

arsenate, but it does not appear to enhance the action of the latter two to any considerable extent, and it seems better to use nicotine only in cases where the emulsion or arsenate is inadmissible.

There are various preparations of nicotine or tobacco in use for fumigating greenhouses.

27. *Pyrethrum*.—This is obtained by powdering the heads and stems of plants of the genus *Pyrethrum*. It is useful for the destruction of aphids and caterpillars, and forms one of the usual constituents of preparations used for fumigation. It is applied to plants in the open in the same way as hellebore powder, either dry, with or without the admixture of other powders, or as a 3 to 4 per cent. decoction in water; or it may be added to a paraffin emulsion. Like hellebore, also, it deteriorates on keeping.

28. *Quassia*.—This is made by boiling chips of the wood of *Picræna excelsa* in water. Together with soft soap, it forms a wash which is much used in summer for destroying aphids and other insects.

(28) Quassia chips	.	.	$\frac{1}{2}$ to 3 lbs.
Water	.	.	10 galls.
Soft soap	.	.	$\frac{1}{2}$ to 3 lbs.

The water and the chips are boiled together for fifteen minutes—some recipes give a much longer time—and the soap is then added. When the latter is all dissolved, the liquid may be strained off, and is ready for use. The lower proportions of quassia and soap mentioned in the above formula, are those generally adopted in England.

Extract of quassia and soft soap may be bought ready made. According to the experiments at Woburn, it does not compare favourably in efficiency with weak paraffin emulsion, but may be used in cases where paraffin would cause injury (p. 45).

PESTS

To the following description of the commoner pests which fruit growers have to contend with, there has been added in each case the remedy which appears to be most efficacious, reference being given to the numerals by which the various substances have been designated in the above list of materials.

Where "caustic emulsions" for work in winter are mentioned, one or other of the following paraffin emulsions, mixed with caustic soda, may be used—

10*b*. Emulsion made with soap.

10*c*. Emulsion made with copper sulphate.

10*d*. Emulsion made with iron sulphate.

But in cases where a fungicidal, as well as an insecticidal and detergent action is required, 10*c* is the one which should be used. All these caustic emulsions contain 6 per cent. of paraffin and 2 to 2½ per cent. of caustic soda.

Where "weak emulsions" for work in summer (without caustic soda) are mentioned, the following may be used; but it must be borne in mind that the experiments on which most of the recommendations for their use are based, have been made with emulsions containing a high boiling paraffin oil (solar distillate), and that if

an ordinary oil be used, the results may be less satisfactory—

- 9*b*. Made with copper sulphate (Bordeaux emulsion).
- 16*d*. Made with iron sulphate.
- 24*b*. The same, but with potassium sulphide in addition.
- 16*b*. Made with soap. To which, also, potassium sulphide may be added, if required, in the proportions given under 24*a*.

In most cases it is immaterial which of these is selected, but if fungicidal properties are required, either 9*b*, 24*b*, or 16*b* with potassium sulphide, must be used; also, in dealing with aphis, the emulsion made with soap (16*b*) should be selected in preference to the others. All these emulsions contain 1 to 1½ per cent. of paraffin.

Where “arsenate” is recommended, this refers to lead arsenate, made according to either 3*a*, 3*b* or 3*c*.

APPLES

Woolly Aphis or American Blight. (*Schizoneura lanigera*).—This pest is easily recognised owing to the white cottony threads which more or less cover the body of the insect, and which produce the appearance of patches of cotton wool on the infested trees. It exhausts the trees of their sap, and, by producing wounds, renders them liable to attacks of canker and other fungoid diseases. In winter, the insect exists (1) as a purplish-brown adult in

crevices of the bark, etc.; (2) occasionally in the egg stage, on the bark near the base of the stem; (3) as an adult, living below ground on the roots. In spring, the eggs give rise to larvæ, which, when mature, form the mother-queens, and these produce viviparously the woolly insect familiar in summer. Active adults also exist in summer underground, and these also may migrate spasmodically to the trunk and branches.

Treatment.—The pest cannot generally be extirpated by confining the treatment to those portions of the tree which are above ground. The trees should be thoroughly sprayed in winter with one of the caustic emulsions, and, before April, carbon disulphide should be injected into the ground as described on p. 24, or the surface soil should be removed, and the roots wetted with one of the above-mentioned caustic emulsions.

In summer, if the aphid appears on the trunks of trees which are old, these can be scrubbed with a hard brush, using a weak paraffin emulsion, such as 16*d*, or, in the case of younger trees, and also for branch treatment, a similar emulsion may be sprayed on to them, but for this to be effective, it must be applied with considerable force, more than can be attained with a knapsack sprayer. An "Abol" sprayer, set so that a jet of liquid hits the woolly patches, will answer the purpose. Undiluted paraffin oil of the best quality (such as White Rose), applied in the form of a fine spray, is very effective, and it rarely causes much damage to the leaves, but solar distillate or petrol must not be used (see p. 43). If

the attack is not a very severe one, and is confined to small trees, the aphid may be destroyed by touching the parts affected with a paint brush dipped in methylated spirits. Repeated treatment is generally required to keep the aphid in check, and to prevent it from spreading to other trees.

Nursery stock, which, unfortunately, is often infested with woolly aphid, should be freed from it before planting. This may be done effectually by immersing the stocks bodily in water at 115° for ten minutes: higher temperatures may damage the trees. It must be remembered that these will cool the water, and a supply of hotter water should be at hand, to be added as the temperature falls. Immersion for five minutes in petrol (not ordinary paraffin nor solar distillate), or a caustic emulsion, is almost as satisfactory. Fumigation with hydrocyanic acid (13) is generally recommended for the same purpose, but, to be effective, the gas must be used in the maximum quantity mentioned above, or the eggs will not be destroyed, and, even with every precaution, success is not always obtained.

The Leaf-curling Apple Aphid: Green Fly (Aphis pomi).—The eggs, which are at first yellow, and subsequently black, are often to be found in great numbers, clustered on young twigs; hence, pruning should reduce this pest considerably. They hatch when the buds are bursting, and the insect undergoes several changes of skin before it reaches the mature stage. This aphid attacks the leaves, and, by puncturing them, makes them curl, and causes

the young shoots to become distorted. The leaves also become discoloured, and the openings in them become blocked by the droppings and sticky "honey-dew" excreted by the insects. The aphides are always green in colour, and, in certain stages, have darker markings on the body. They are often covered with a grey meal. Winged forms occur in July and August, and fly from tree to tree. The egg-laying generation occurs in late autumn in the form of small yellowish lice on the under surface of the leaves, which crawl on to the shoots subsequently, and there lay their eggs.

Remedies.—Spraying, to be effectual, must be done before the leaves curl, preferably about the end of April: weak paraffin emulsion (16*b*, by preference), or nicotine (26), should be used. Much benefit results from spraying in autumn with a stronger paraffin emulsion, containing about 6 per cent. of paraffin, or with a lime-sulphur-salt wash (22 or 23).

The Rosy Leaf Aphis (Aphis sorbi).—This aphis works very like the preceding one, but the leaves attacked by it are more tightly curled, and become pale yellow or rosy red. The aphis is at first green or yellowish, but becomes dull blue, slaty or purple, and is covered with meal; in other stages it is rusty red to pink: the egg-laying female is lemon-yellow. The eggs hatch out in April, and the aphides disappear from the apples at the end of June and early in July, but come back again in September and October. They lay black ova on the spurs, axils of buds, shoots, and trunks of the trees, but

never in masses, as is the case with the Leaf-curling aphid.

Treatment.—The same as for the Leaf-curling aphid.

The Blossom and Leaf Aphid (Aphis fitchii).—The young hatch late in March, or early in April: the aphid, which is green, feeds on the developing buds; later it attacks the blossom, but it does not cause the leaves to curl. It migrates from the apple to corn and grasses in early June, and, late in September, or subsequently, it comes back to the apple, and lays its eggs singly in crevices in the bark of the small boughs and shoots.

Treatment.—The same as for the other aphides, but the spraying in April should be done about the middle of the month.

Codling Moth (Carpocapsa pomonella).—The larva of this is the familiar "maggot" found in apples. The moth is of a dull brown or grey colour, with a metallic patch in the corner of each front wing, and is four-fifths of an inch in spread. It first emerges from the cocoon at the time of flowering, and lays its eggs on the fruit as it sets, or at a later date. The maggot, on hatching, enters the fruit at the eye, and tunnels its way to the core, throwing out a small mass of brown "frass" at the entrance-hole: later on it forms a larger tunnel to the outside of the fruit. The grubs, when full grown, crawl out, and let themselves down to the ground by threads of silk; a few may crawl down the branches, and others fall with the apples. Sometimes they spin their cocoons early,

and pupate at once, in which case, a second brood of moths will appear in the autumn, and the larvæ from these latter may enter the apples at any point. As a rule, many maggots are still in the fruits when harvested, or when they fall prematurely, as maggoty apples generally do. The grubs which fall, re-ascend the tree, and spin their cocoons in any crevices under the bark, or elsewhere, even on the ground and on fences.

Remedies.—All fallen apples should be picked up at once and destroyed, and maggoty apples should be separated from the sound ones on gathering. The infested fruit should be given to the pigs. Caustic emulsions are very effective in destroying the larvæ indirectly, by exposing them to the attacks of birds in winter, and by reducing the number of crevices where they may be secreted. Old trees may be further cleaned by scraping with a piece of iron hooping, so as to remove dead bark. Spring treatment will probably be unnecessary if trapping, as described below, and winter washing have been adopted; otherwise, a poisonous wash must be applied before the maggot enters the apple, *i.e.* shortly after the fruit has set. The best substance to use for this is arsenate of lead, and the spraying should be done as soon as the blossom has fallen, as, after ten days, the calyx closes in, and prevents the poison from being lodged in the eye. Many larvæ may also be entrapped by winding a hay rope, or strips of old manure sacks, around the trees in June, leaving these till winter, and then burning them with the cocoons deposited underneath them. Cases which have been used for packing or importing fruit

often contain the Codling Moth larvæ, and should be thoroughly examined, and either cleansed or burnt.

Goat Moth (Cossus ligniperda).—A mottled grey and brown moth, 3 to 4 inches in spread of wings, which lays its eggs in the middle of the summer on the trunk, from the base of the tree up to a height of about eight feet. The caterpillars, which are mahogany red on the back, and dirty yellow at the sides, are 3 inches long, and live for three years. They bore their way into the stem of the tree. Their presence may often be recognised by the heap of reddish frass on the ground near the stem, the large holes in the bark, and the obnoxious smell emitted by them.

Remedies.—A coating of soft-soap, or of clay and cow-dung, smeared over the base of the stems, prevents the moth from laying its eggs there. The caterpillar may sometimes be destroyed in its tunnel by pushing up a wire, or squirting up paraffin, a piece of narrow india-rubber tubing being affixed to a syringe for the purpose: but the tunnels often run for 2 or 3 feet, and are very sinuous, so that it is only now and then that a wire will reach the caterpillars in them, except when these are nearly mature, and come close to the entrance (in autumn and spring) to pupate. They may also be killed by placing a piece of cyanide of potassium in the openings of the holes, and closing these with clay.

Lackey Moth (Clissiocampa neustria).—The caterpillars are $1\frac{1}{2}$ inches long, hairy, of a bluish-grey colour, with scarlet, orange, blue, white and black lines and markings. When first hatched in late

April or May, they are dark brown and hairy, and then live in colonies in web-nests or tents. The eggs are laid in bands encircling the young shoots, and are found all through the winter. The caterpillars sometimes do much damage to the foliage, not only of the apple, but also of the cherry, and occur also on hawthorn and other plants.

Remedies.—Prune off and destroy any young wood with eggs on it. The caterpillars remain in the webs during wet or cloudy days, and on such days the webs should be removed bodily and destroyed. Spraying with arsenate or with weak emulsions will destroy the caterpillars when they are out of the webs; a strong syringe should be used, instead of, or as well as, the spraying machine, to destroy the webs and any of the caterpillars which may be inside them. Caustic winter washes will not destroy the eggs.

Small Apple Ermine Moth (Hyponomeuta mali-nella).—Like that of the Lackey Moth, the caterpillars of this moth live in colonies in web-nests. The eggs are laid in roundish yellow or brown patches on the twigs, protected by a covering of gum. They hatch in October, the caterpillars then being very minute, yellow with black heads. They winter under the covering which protected the eggs, and emerge when the leaves expand; into these they burrow, living concealed till the late spring or early summer, when they eat their way out, and begin to feed on the surface of the leaf. They then collect together and build their web-nests.

Remedies.—The same as in the case of the Lackey

Moth. Caustic winter washes destroy many of the young caterpillars, by eating through the gummy covering which coated the eggs.

Winter Moth (Cheimatobia brumata).—The caterpillar of this moth does immense damage to the foliage of apples, pears, plums, cherries, nuts, etc. The eggs, which can just be seen by the naked eye, are laid in crevices, often near the ends of the shoots, but also on the boughs, and, even, trunks, and they commence to hatch towards the end of March. The caterpillar, when quite young, is dingy-green or dark grey, with a black head, but soon becomes bright green with pale lines; it is a looper, and measures nearly an inch in length. It lets itself down from the trees into the ground in June, and becomes a pupa, from which the moth emerges in October, November or December. The females cannot fly, and, therefore, crawl up the stems of the trees, by day as well as by night, to lay their eggs.

Remedies.—The caterpillars are easily killed in spring by weak emulsions, or by arsenate of lead. Preventive measures may be taken in the shape of “grease-banding” the trees: before the first week of October, bands of grease-proof paper, 6 to 8 inches wide, should be tied round the stems of the trees, fastening them with bast or string near the top and bottom edges; they are then smeared with cart grease, which must be of good quality, and which may be best applied by means of a brush. The female moths stick to the grease on their way up the trees, and may then be destroyed.

Mottled Umber Moth (Hybernia defoliaria).—This caterpillar is a looper, over an inch in length; the body is brown above, and yellow at the sides and underneath. The female moth is wingless, and its life-history closely resembles that of the Winter Moth.

Remedies.—The same as for the Winter Moth.

Apple Sawfly (Hoplocampa testudinea).—The attacks of this insect resemble those of the Codling Moth, except that the grub hibernates in the soil, and not on the trees. The sawflies appear with the blossoms, lay their eggs inside them, and the false caterpillars, which hatch out in late May and June, attack the young fruits, eating their way out of one fruitlet to enter another, one grub, in this way, destroying many prospective fruits before it finally takes up its abode in one of them. When young they are pale, with black heads, and are one-eighth of an inch long; after moulting, they are mottled or creamy, with chestnut-coloured heads, and half-an-inch long.

Remedies.—Collect and destroy all infested fruit. Spray with arsenate or weak emulsion when the fruit is set. Some recent experiments tend to show that injection of bisulphide of carbon into the soil destroys the hibernating larvæ.

Mussel Scale (Lepidosaphes ulmi).—Scales, resembling minute mussel shells, may be seen thickly covering the stems and branches of apples and other trees; these are merely shields, each covering 40 to 80 white oval eggs. The eggs hatch in June, and the insects may be seen as minute white specks swarming

over the bark of the trunk and boughs. They soon come to an anchor, and gradually cover themselves with a scale, under which, if females, they lay their eggs, and then die. The males are winged insects, and are very rarely met with.

Remedies.—Caustic winter wash (10*b*, 10*c* or 10*d*), applied in January to March. If any hatching occurs after winter washing, it will be very partial, and only from eggs which have escaped the wash; to destroy these, it is sufficient to paint the stems, wherever the insects are seen, with any weak emulsion. If the winter washing has not been properly done, it will be necessary to spray the whole trees, instead of merely painting those parts which are affected.

Apple-Sucker (*Psylla mali*).—The eggs of this insect are laid singly on the young shoots and spurs, chiefly around the leaf rings, amongst the fine hairs of the shoots, and in the axils of the buds. They are very pale yellowish in colour, spindle-shaped, with a tail-like extension, and large enough to be visible to the naked eye. They hatch in April (generally between the 10th and 30th), but in some years the hatching may be prolonged till the first week in May. The insect, which then resembles a small, dull yellow and brown, wingless louse, forces its way into the nearest blossom-bud, or, failing that, into a leaf-bud. The attacked buds either do not expand, or, after expanding, wither, the blossoms turning brown; these attacked clusters of blossoms often remain on the trees into the winter. Drops of "honeydew" near the stalks of unopened or opened flower-buds and trusses of blossom, notify the

presence of the insects. The insect becomes fully developed and winged in late May or June, and lays its eggs in September, October, and even November.

The prevalence of psylla has been increasing very much in recent years, but there are grounds for questioning whether the insect is really responsible for all the damage which is attributed to it; certainly, apple blossoms may often be infested with psylla, and yet set their fruit freely. The appearance produced by brown rot is very similar to that caused by psylla, but the damage done by the latter may generally be recognised by the number of cast skins or exuviae left on the leaves near, and in, the dead trusses.

Remedies.—Either just before, or during the blossoming, spray with tobacco or nicotine solution (26); if much rain falls afterwards, the spraying should be repeated. The liquid will not hurt the blossoms, even when they are fully expanded. Another remedy, which is proving successful, is the lime-salt wash (12), which should be applied in February or March, preferably two or three weeks before the buds open. Winter washing with caustic washes does not appear to have any effect on the eggs. Benefit results from spraying in late summer with paraffin emulsion, to destroy the adults, and so prevent egg-laying.

Apple-blossom Weevil (*Anthonomus pomorum*).—This is a black weevil, with ashy-grey pubescence, long-nosed, less than one-fourth of an inch in length, and easily recognised by the pale V-shaped mark on the back. The females make holes in the unopened flower-bud, and deposit one egg in each

blossom. The maggot, after hatching, feeds in the blossom, which, instead of expanding, turns brown, and dies, forming the so-called capped blossom. The beetles hibernate under the rough bark of trees, etc.

Remedies.—Winter-washing with caustic washes destroys the harbouring places for the insects on the trees ; keeping the surface of the ground clean and free from rough grass and rubbish, is advantageous for similar reasons. Spraying with a lime-salt wash is also beneficial, owing to its delaying the opening of the buds.

Scab (Fusicladium dendriticum).—This is a fungus, which causes the fruit to become covered with dark patches, and prevents its proper development, often causing it to crack. A similar fungus (*F. pirinum*) attacks pears with a like, and generally worse, result. In both cases it is the leaf which is first attacked, dark patches appearing on the upper surface of it. In winter the fungus occurs on the young wood, and the spores hibernate in cracks in the bark, and on fallen, diseased fruit.

Remedies.—Destroy all fallen leaves and useless fruits. If the disease is noticed on the young wood, spray with copper sulphate (8) or the caustic emulsion made with copper sulphate, in late winter, and, if the disease appears in the following summer, spray two or three times with Bordeaux mixture (9a or 9c) or with a weak emulsion containing a fungicide (p. 62).

Canker (Nectria ditissima).—This term is often applied by growers to anything which results in the destruction of patches of the bark and wood of trees,

but it is properly restricted to the work of the particular fungus named above. The bark on the stem or branches, especially in the fork of a branch, appears to be eaten away, exposing the wood beneath, the wound being surrounded by a thick rugged mass of bark: gradually the branch dies, and, in the case of a young branch, the spread of the disease is rapid, the outer bark along the whole branch becoming detached, thus giving it a light brown appearance. The canker fungus is a wound fungus, and gains entry only where the outer bark is punctured, as, for instance, where the tree has rubbed against the stake, etc., where the pruning knife has been at work, or where the bark has been injured by woolly aphis, hail, etc. The fungus has two forms of fruit, both of which may be found in the wounds—(1) minute white specks appearing in the late summer; (2) bright red little balls appearing in the spring. These red balls are often taken for red spider eggs; but the eggs are of a more shiny red colour, and are much more easily removed from the trees. A magnifying glass is necessary for distinguishing the fruit bodies of the fungus. Varieties of apples differ as to their susceptibility to canker (though locality affects their behaviour), those with the thinnest and softest bark being generally the most susceptible.

Remedies.—No real remedy is known, but the spread of the disease may probably be checked by spraying the trees, or painting the wounds, with copper sulphate (8), or potassium sulphide (24), as soon as the leaves are off the trees: and, when winter washing the trees, a wash containing a fungicide

should be selected (p. 61). All badly cankered branches should be cut off, and burnt, cutting them well below the cankered area, at a point where no staining of the wood is seen; other canker wounds should be cut away down to clean wood, and all fresh wood exposed in these operations, or in ordinary pruning, should be tarred. Stockholm tar is generally preferred for this purpose, but damage seems rarely, if ever, to result from the use of gas tar. In damp ground, the trees should be planted high, *i.e.*, placed on the surface of the ground, and the earth mounded up over the roots.

Apple mildew (Podosphaera lemotricha).—In spring and early summer the young shoots attacked by this mildew become covered with a powdery, silvery-white mould, and their development is arrested.

Remedies.—Before the buds open, spray with potassium sulphide (24), or copper sulphate (8), or with the caustic winter wash made with copper (10c); and, in early June and July, spray with potassium sulphide, Bordeaux mixture (9a or 9c), or Bordeaux emulsion (9b). The sulphide is more effective than the copper washes. These dressings seem only to check the mildew temporarily; but the early dressing will result in the strengthening of the tree during the blossoming, and thus help to secure a crop of fruit; while the later dressing will prevent the early falling of the leaves, and help to mature the wood. The disease may be further checked by cutting off and destroying all young shoots, as soon as they are found to be affected.

White Root Rot (*Rosellinia necatrix*).—Several fungi of this description attack the roots of apple and other trees. In the first year of the attack the leaves wilt, turn yellow and fall early; in the second year, these phenomena become aggravated, and there is often a heavy crop of useless fruit; whilst, in the third year, the tree generally dies. The roots will be found covered with a white downy fungus, some threads of which pass up between the bark and wood of the stem, whilst others spread in the soil, seeking fresh trees to attack. The fruit of the fungus appears only on the dead wood, and consists of minute black beads, which may be found in masses between the bark and wood.

Remedies.—Clear away the earth from the roots in autumn, sprinkle them with flowers of sulphur, and mix quicklime or gas-lime with the soil before replacing it.

Brown Rot of Fruit (*Sclerotinia fructigena*).—This is a fungus which attacks apples, pears, plums, cherries, peaches, etc. It first attacks the leaves, the fructification of it appearing on the upper surface of these, forming thin, velvety olive-green patches: the fruit is next attacked, scattered brownish patches appearing on the skin, followed by a growth of dull grey tufts, which arrange themselves in concentric rings, like fairy-rings. The fruit does not develop properly, and becomes hard and mummified, often hanging on the trees till the following spring or summer. Apples which have been attacked by the Apple Sawfly also often hang on until spring, but may be distinguished from those suffering from brown rot by having round

holes in them. The fungus also attacks the young shoots.

Remedies.—The same as for scab (p. 74). All fruits remaining on the trees should be removed and destroyed, they are always the most dangerous carriers of disease germs of all kinds.

CHERRIES

Cherry Aphis (*Myzus cerasi*).—This aphis is black, and may be found attacking the foliage at any time between the spring and autumn.

Remedies.—The same as for apple aphis. The aphis leaves much sticky excretion on the leaves, and an emulsion made with soap (16*a*) is, perhaps, more suitable for removing this than one made with metallic sulphates. Soap and quassia, and also nicotine solution (26), are very effective.

Cherry and Pear Sawfly. Slugworm. (*Eriocampa limacina*).—The larva is black and slimy, resembling a small slug, nearly half-an-inch long ; it feeds on the upper sides of the leaves, converting the leaf into a skeleton. When full grown, it casts its coat, and appears as a buff-coloured, dry larva, which goes down to the ground, and spins a cocoon covered with earth, from which the sawfly emerges the following summer, and lays its eggs in the under surface of the leaves.

Remedies.—Spray with arsenate when the slugworms appear, which they do at very various dates. Two or three successive dustings with lime have also

been found effectual. Spraying with weak emulsion or tobacco (26) may be suggested.

Cherry Leaf-scorch (*Gnomonia erythrostoma*).—Trees affected by this disease retain their leaves till the following spring or summer, and these leaves exhibit small black points on the under surface, which are the heads of the spore-conceptacles of the fungus. Each head contains many sacs, in each of which there are eight spores. The spores are ejected in the spring on to the young leaves, where they germinate, and destroy the tissue by invading them with their mycelium. The cells in the stalks of the leaves, being thus injured, do not develop properly, and hence the leaf is not shed in the usual way at the end of the season. The fruit, also, is attacked, hard cores form in the flesh, the fruits becoming distorted, and falling prematurely.

Remedies.—Remove and burn all dead leaves. Spray with Bordeaux mixture (9a, 9b, or 9c) before the blossoms open, and again after the petals have fallen.

CURRENTS

Current Aphides (*Rhopalosiphum ribis*, and *Myzus ribesiæ*).—Two aphides attack the current—one (*M. ribesiæ*) makes the leaves crinkle up, and the other (*R. ribis*) is found on those leaves which have red blotches on them. These aphides attack the underneath surface of the leaf, and can, therefore, not be reached easily by spraying, except before they curl up or distort the leaves, etc. The eggs are found on

the bushes in winter. *R. ribis* appears to migrate to lettuce.

Remedies.—The same as for Apple Aphis.

Currant Gall Mite. Big bud. (Eriophyes ribis).—This attacks the black currant, and it has also been recorded on red and white currants. Its presence is easily recognised by the buds appearing very large and round, instead of pointed. The infested buds contain numbers of long, tapering white mites, only visible under a strong hand lens or microscope. These buds may open out, but do not, as a rule, develop, and they wither as the season progresses. The mites and eggs are both present in the buds in January and February, and the latter begin hatching in March. From early May to the end of June the mites migrate in numbers to other parts of the bushes, and lay their eggs in the new buds; these are found already to contain mites inside them in July. Besides harbouring in the buds, the mite locates itself in the roots, and under the loose rind.

Remedies.—No winter treatment of the bushes has proved completely effectual. Dusting the bushes at intervals of a fortnight in the spring and early summer with a mixture of one part of ground quicklime and two of sulphur is said to have had good results; but others have found it useless. Picking off the big buds, and removing any badly infested branches, keeps the attack within bounds, when it is a mild one; but even cutting the bushes down to the ground will not master it entirely, and often the new shoots will come up from the roots more infested than the old ones. Cuttings

should never be taken from infected bushes, and a guarantee of freedom from mite should always be obtained when buying stock. If infection is suspected, the bushes should be immersed in water at 115° F. for ten minutes before planting. A similar mite attacks nut bushes, but as it is of a different species, there is no fear of its infecting currants.

Currant Shoot and Fruit Moth (*Incurvaria capitella*).—The caterpillar of this moth attacks the red and black currant. The moth is brown, three-quarters of an inch in spread, and lays its eggs in the fruit. The caterpillar leaves the fruit in June or July, spins its cocoon on the bush, and emerges next spring, to bore into the buds and young shoots. Here it feeds till April or May, when it passes into the chrysalis form, and thence to the moth form.

Remedies.—Spray with caustic emulsion in winter.

GOOSEBERRIES

Gooseberry and Currant Moth: Magpie Moth (*Abraxas grossulariata*).—This moth has a yellow body with black markings, and a black head; the wings are white with black spots, having yellow marks at the base, and an orange band at the middle. Spread of wings, $1\frac{1}{2}$ to $1\frac{3}{4}$ inches. It lays its eggs on the leaves in summer, and these hatch out in late August. Before the winter, the caterpillars go into their hibernating quarters amongst leaves which have fallen or which are still on the bushes, or into crevices in the bushes, or other shelter. From these hiding-places they emerge in April and May, and, after feeding, they

sometimes spin scanty cocoons, or may merely attach themselves to leaves by their tail-ends, and become black pupæ with yellow bands, from which the moths emerge in late July and August. The caterpillar is of a creamy or yellow colour, with black spots along the back and sides, and an orange-red stripe below. It is a looper, and is over one inch in length.

Remedies.—Either weak emulsion or arsenate should be used in the spring as soon as the caterpillars appear, and again in September, to kill the young larvæ. All hibernating caterpillars, either on the bushes or amongst the leaves on the ground, etc., should be destroyed in winter.

Gooseberry Red Spider (Bryobia, sp.?).—This is a minute mite, either red, grey or brown, with four pairs of legs, the front ones long. It is clearly visible to the naked eye. It is often seen in enormous numbers in March and April. In May and June it lays small shining red eggs on the bushes, etc., and these remain unchanged till the following year, hatching in February into minute six-legged reddish young, which remain closely huddled together in crevices in the wood, where they escape notice.

Remedies.—Spray with one of the caustic emulsions, or a paraffin emulsion of the same strength, but with the caustic soda omitted, about the beginning of March. Besides killing the young mites, the former will be beneficial in destroying the sheltering-places for the eggs. If the mites appear after this treatment, there should be a further application of a weak emulsion without soda.

Gooseberry and Currant Sawfly (*Nematus ribesii*).—The false caterpillars of this sawfly will often destroy the foliage of large plantations of gooseberries in a few days. This occurs mainly in May and June. The caterpillars when young are green, with dark heads, and minute black spots on their bodies: when full grown, they are nearly an inch long, and then some of the segments are orange-coloured: the black dots disappear with the last moult, after which they go down into the ground, and spin their cocoons. The sawflies emerge from these in about twenty days. There are two or more broods of these sawflies during the year: the last brood lives as larvæ in the soil all the winter in earthen cocoons, which pupate in spring, and the sawflies emerge in April and May, to lay their eggs on the under sides of the leaves.

Remedies.—In late winter dress the ground with gaslime. When the caterpillar appears, lose no time in spraying with weak emulsion; if the attack is an early one, arsenate may be used, but not in the case of later attacks, or there would be a danger of poisoning the fruit: arsenate also appears to be less efficacious than emulsion. Dusting with hellebore powder (25) is often very successful.

Gooseberry and Currant Scale (*Lecanium persicæ*, var. *sarothamni*).—These appear on the twigs as oval brownish warts, less than a quarter of an inch in diameter. They are the female insects, which eventually dry up, their skins remaining to shelter their minute eggs. The latter hatch in autumn, giving rise to small, flattish, oval, crimson or reddish-brown

insects, which attach themselves to other portions of the branches, and remain there all the winter, moving in spring on to the younger wood and leaves, and gradually growing into the brown mature scale insect.

Remedies.—Treatment with caustic washes, the same as for mussel scale (p. 72), or with paraffin emulsion (without the caustic soda), in March.

Gooseberry Mildew (Microsphaeria grossulariæ).—This may become prevalent when warm, moist weather in spring has been followed by a spell of cold, but it usually shows itself in summer, after the fruit is gathered. The leaves become spotted, and covered on both sides with white patches, which consist of the first spores of the fungus: these give place later on to the second form of spores, consisting of minute black particles, which ripen on the dead leaves, and infect the fresh foliage in the following year. The bushes become enfeebled by the loss of leaves, and the berries do not mature properly.

Remedies.—When the leaf-buds are expanding, spray with potassium sulphide, 6 ozs. to 10 gallons, and repeat the operation at intervals of a fortnight, if the mildew appears. Collect and destroy all fallen leaves.

(The *American Gooseberry Mildew* is a much more dangerous disease. It appears first on the leaves as white patches, which gradually become thick and felty, and of a dingy brown colour. It attacks the shoots and the fruit also. If its presence is suspected, communication should be at once made to the Board of Agriculture.)

NUTS

Nut Weevil (*Balaninus nucum*).—This produces the maggot familiar in nuts. The weevil is brownish, with a very long snout; it is one-third of an inch in length, and in early summer pierces the young nuts, depositing one egg in each. When full grown, the maggot bores its way out of the nut, and buries itself in the earth for the winter, changing into a chrysalis, and then into the weevil in the following May.

Remedies.—Select a dull day, place tarred sacks or boards on the ground, jar the weevils off on to these, and then collect and destroy them. Spraying with arsenate has been found to kill the weevils.

PEACHES

Peach Leaf-curl (*Exoascus deformans*).—This is a fungus attacking the leaves and shoots of peaches and nectarines. The leaves become fleshy, puckered and curled, turn yellow and reddish, and then exhibit a “bloom” on the upper surface, this consisting of the fruit of the fungus; at the same time the shoots become swollen and twisted, and do not elongate properly, so that the leaves appear in bunches at the ends of them. Cold, damp, variable weather in spring is that most favourable for the disease.

Remedies.—Remove the diseased shoots, and, in the following year, spray with Bordeaux mixture or emulsion (9a, 9b or 9c) before the buds expand. Caustic emulsion made with copper sulphate (10c) will not injure the trees while they are dormant.

Brown Scale (*Lecanium persicæ*).—This brown scale-insect occurs on peaches and nectarines.

Remedies.—The same as those for mussel scale on apples (p. 72).

PEARS

Pear Gnat Midge (*Diplosis pyrivora*).—An attack of this is generally recognised by the pears, when of the size of small marbles, being distorted, often assuming a rounded shape, and, a little later, becoming blackened, and then falling. On examination they will be found to be rotten inside, and to contain many maggots of a dull white colour, one-sixth of an inch long, which have the property of "skipping" like cheese maggots. The maggots usually escape from the fruitlets while still on the trees, and bury themselves in the surface soil; about midsummer they spin cocoons, from which the small gnat-like black flies emerge in the following spring, to lay their eggs in the blossoms, usually before these open.

Remedies.—Collect and destroy all infected fruitlets on the trees, if possible. A top dressing of kainit (half a ton to the acre) in late summer is stated to produce good results. The pest may, apparently, be stamped out by keeping poultry or pigs in the infested plantations.

Pear Leaf-blister Mite (*Eriophyes pyri*).—This is a minute mite, like the black currant mite, but larger, being 0.2 mm., or $\frac{1}{125}$ th of an inch, in length, whose presence is recognised by the leaves becoming covered

with blisters, which are at first pale green, and then red: the fruitlets, also, are similarly attacked. The blister shows on the upper side of the leaf, and there is a central hole in the portion below the leaf, by which the mite passes in and out. Similar blisters are produced by the pear scab, but these have no central opening. The attacked fruitlets die. The mite hibernates under the bud-scales.

Remedies.—In late winter spray with a caustic emulsion; an emulsion containing 10 per cent. of paraffin, without any caustic soda, has also been found to be effective. In early summer, if the leaves show the presence of an attack, spray with weak emulsion. Often a few leaves only, towards the base of the trees, are attacked; these may be picked off and burnt. Recent work in America has shown that this pest can be destroyed by lime-sulphur-salt washes, in late autumn or early spring.

Wood Leopard Moth (*Zeuzera æsculi*).—The caterpillars feed on the young wood of the cherry, pear, apple, plum, and other trees. The moth is 2 to $2\frac{3}{4}$ inches in spread, the wings white, with numerous metallic black spots. The eggs are laid in July in crevices in the bark, and are oval and orange-coloured. The caterpillars, which soon hatch out, are $1\frac{1}{2}$ inches long when mature, yellowish-white, with black spots and black markings near the head and tail. They feed for two years, during which time they burrow into the wood.

Remedies.—Cut off attacked branches, which are recognised by the flagging of the leaves.

Common Vapourer Moth (Orgyia antiqua).—The caterpillar feeds on the leaves of many trees, besides that of the pear. It is $1\frac{1}{2}$ to 2 inches long, dark grey with red spots, having four large tufts of dull yellow or brown hairs on its back, and five pencils of hair at the head, sides and tail. It spins its cocoon on the branches and leaves, from late May till August. The wingless female lays her eggs on the cocoon.

Remedies.—Remove and destroy the cocoons when found, especially those with eggs on them, or those found in winter. Spray in summer, while the caterpillars are feeding, with weak emulsion or arsenate.

PLUMS

The Plum Leaf-curling Aphis (Aphis pruni).—The leaf-curling plum aphis appears long before there are any signs of the buds swelling, and may be found early in March, near a bud, as a large, fat, dull, plum-coloured aphis. This mother-queen produces green living young, which are ready to attack the young unfolding leaves after the blossom has fallen. By piercing the leaves, they make these curl up, and thus effectually protect themselves from being reached directly by any spray-fluid. They have very short honey tubes, and can at once be distinguished by this from an allied aphis (*A. prunifoliæ*), which has long honey tubes. This latter aphis is green, and hatches later in the season.

Remedies.—*A. pruni*, as well as *A. prunifoliæ*, may easily be destroyed by spraying with weak emulsion, or caustic emulsion, before the buds burst. Lime and

salt wash has also been found to stop the young of the former (and commoner) species from hatching. Excellent results have been obtained, even after the leaves have become curled, with nicotine wash.

The Mealy Plum Aphis (*Hyalopterus pruni*).—This is quite a different aphis from those mentioned above, and does not curl the leaves, though it collects beneath them in dense mealy masses. These plant-lice form much gummy honey-dew, which falls on the leaves beneath, and also spoils the fruit for market. They make their appearance on plums in the summer, and, later in the season, winged forms arise, which then migrate elsewhere, though where they go, and whence they come from to the plums in the first instance, we do not know at present.

Remedies.—A weak emulsion, preferably one containing potassium sulphide (24*b*), kills this aphis.

The Hop-Damson Aphis (*Phorodon humuli*).—This aphis—the hop blight aphis or “fly”—passes the winter in the egg stage in the axils of the buds of wild prunes (sloe, bullace), and also of the damson, but very rarely in those of plums. It leaves the damsons, etc., from mid May to early June, and flies to the hops. It is greenish in colour, and can at once be recognised by the horn-like protuberances on its head and at the base of its feelers.

Remedies.—Weak emulsion (16*b*, 16*d*) should be applied to the damsons, etc., late in April: when hops have to be treated, soft soap and quassia (28), or nicotine solution (26), must be used.

Shot-Borers (*Xyleborus dispar* and *X. saxeseni*), and the *Fruit-tree Bark Beetle* (*Scolytus rugulosus*).—The first two species of these beetles attack plums and other trees, driving tunnels into the wood of the stems: the last also bores holes in the trees, but confines its operations to the portion between the bark and the hard wood.

Remedies.—If the attack is a bad one, it is best to destroy the trees: neighbouring trees should be smeared over with a thick mixture of soft soap and washing soda, to prevent the beetle from attacking them.

Red Spider.—Several different red spiders or mites are included under this designation, but the extent to which they are responsible for the damage commonly attributed to them, is doubtful. The red spider most abundant on plums and apples is the *Tenuipalpus glaber*. The eggs, which are round and red, are very noticeable in winter in the axils of the buds and on the shoots: they hatch in March and April, and the trees will often appear literally covered with the mite. They do not, however, appear to do any damage, and are, perhaps, beneficial, as they eat various fungus spores, beetle-mites and algæ. In cases where the leaves seem to have been injured by the mite, becoming mottled and yellow, and then falling, the real damage appears to have been caused by the rust fungus, or, occasionally, by leaf-hoppers. These red spiders do not spin webs.

The *Tetranych*i, which spin webs, and the *Bryobia* (easily distinguished by the length of their first pair of

legs), which do not spin webs, both occur on plums and apples, often in large numbers, and these may be directly responsible for damage to the trees. *Tetranychus telarius* is destructive in greenhouses.

All these red spiders have eight legs when adult, and six when young.

Remedies.—Spray with any weak emulsion, or with potassium sulphide and soft soap (24).

Leaf-Hoppers (*Typhlocyba quercus*, *Chlorita flavescens* and *Chlorita viridula*).—These insects, which are winged when mature, sometimes swarm in such numbers on plums and apples that they make the gathering of the fruit a matter of great difficulty, by jumping and flying on to the faces of the pickers. They feed by sucking the sap from the under side of the leaves, causing these to become pale, as if the tree was suffering from silver leaf. When nuts are attacked by them, the leaves show ragged irregular cuts and holes. The first of the leaf-hoppers mentioned above is very pale brown, spotted with orange and red; the other two are yellowish. They lay their eggs on the under sides of the leaves, and the larvæ, after hibernating, attack the young leaves in the early summer of the following year. Eventually they assume the perfect winged form.

Remedies.—Spray the trees with any weak emulsion: this stupefies the insects, and they fall on to the ground. They may then be destroyed by spraying them while there with an emulsion containing 20 to 30 per cent. of paraffin.

Silver Leaf (*Stereum purpureum*).—This attacks

other stone fruit besides plums, as well as Portugal laurels, laburnums, and, more rarely, apples. It is recognised by the silvery appearance of the leaves, which, however, is not due to the presence of the fungus itself, but is the result of changes produced in the leaf-cells by its action : the fungus only fruits on the dead wood, after it has killed the tree, forming thin purplish disks, often two inches or more in diameter. Infection seems generally to be spread by the spores of the fungus entering through a wound in the tree.

Remedies.—No remedies are known, but certain preventive measures may be taken. All large wounds should be tarred over, and in any plantation where the disease exists, the ends of pruned branches should also be tarred. If only one or two branches of a tree are affected, they may be removed, with some chance of stopping the infection ; if the whole tree is affected, it should be cut down and burnt. This is specially necessary when any of the fruiting fungus is found on the trees. The tools used in the operation should be disinfected by washing with carbolic acid or paraffin. Soft-wooded varieties, especially Victorias, are most liable to infection ; and high feeding, which results in rapid and soft growth, favours an attack. Trees which are not badly affected will sometimes recover without any removal of branches.

Wasps.—The damage done to plums and other fruit by wasps needs no description.

Remedies.—The well-known method of trapping them in bottles half full of sour beer and sugar is one

of the best. For destroying the nests, when these are in the ground, the holes should be located in the day-time, and, if there are several of them close together, all but one of them should be plugged up. In the evening, a spoonful of tar should be poured down this, or better still, an iron rod may be driven down, on to the end of which is fixed a piece of wool soaked in a solution of potassium cyanide. It must be remembered that this is a deadly poison. The tree wasps, which make hanging nests in trees, should be sought for, and the nests cut off or burnt at night. Wasps found in the early part of the year should always be killed, as they are the queens, and each will give rise to a separate colony.

RASPBERRIES

Raspberry Beetle (*Byturus tomentosus*).—This is a small brownish beetle, one-sixth of an inch long, which attacks the flower-buds of the raspberry, loganberry and blackberry, before they open. The beetle then lays its eggs, which, on hatching, produces dull greyish to yellowish grubs, one-third of an inch long when mature, and these feed in the receptacle of the fruit. This they leave when ripe, and pass the winter in cocoons in any crevice of the bark, etc.

Remedies.—Spray with arsenate when the beetles appear. The beetles may also be shaken off the bushes on a dull or cold day, so as to fall on freshly-tarred boards placed under the canes. On hot days they will fly away as soon as they are disturbed. Cut away the old wood, and burn all prunings.

Raspberry Stem-Bud Caterpillar (*Lampronia rubiella*).—This attacks the leaf-buds and shoots, not the blossoms; the eggs, however, are laid by the moth in the blossoms, and the caterpillars remain near the fruit till this is ripe; they then let themselves down to the ground and spin their cocoons, in which they pass the winter, emerging from them in the following spring, to attack the growth-buds. The shoots from the buds thus injured are weakly, and die off. The caterpillar is red, and about a quarter of an inch in length.

Remedies.—A common plan is to smear the canes in early spring with grease. Spraying with weak emulsion before the buds expand may be suggested.

STRAWBERRIES

Ground Beetles (*Pterostichus madidus*, *Harpalus ruficornis*, and *Calathus cisteloides*).—These three species of ground beetles often do much damage to strawberries, by devouring the fruit. They remain in the soil during the day, and feed at night.

Remedy.—Sink cheap pudding dishes, or similar vessels, into the ground, so as to be flush with the surface; put into them pieces of lights and sugar-water. The beetles come to feed on the lights, and cannot get out of the basins.

Cockchafer (*Melolontha vulgaris*).—The beetle is brown, and over an inch in length. It is active during May and June, and does much damage to the foliage of various trees. It lays its eggs 6 to 8 inches below the surface of the ground and the

larvæ, which hatch out of them in about a fortnight, are white, fleshy grubs, $1\frac{1}{2}$ to 2 inches long, with strong mandibles, and large, horny heads, six legs in front, and swollen bladder-like extremities; they lie in a curled-up position in the soil. They remain in the larval state for three years before changing into the beetle form, during which time they do much damage to the roots of grass, strawberry, apple, plum, cherry, nut and other trees.

Remedies.—The beetles are sometimes found in sufficient numbers to make it worth while shaking them off the trees on to cloths, and destroying them. They seem to shelter during the day, especially on isolated trees, and this facilitates collecting them.

VINES

Mealy Bugs (*Dactylopius citri* and *D. longispinus*).—Mealy Bugs are scale insects which are devoid of a scaly covering. They attack vines and other plants under glass in this country; their presence can be easily recognised by the white mealy coating they produce.

Remedies.—Clean the bark, and paint it with methylated spirit. The most certain way of clearing a house of these pests is by fumigating with hydrocyanic acid gas. This will have to be done twice, at two weeks interval, and is best done when the vines are dormant, but it may also be done when they are in leaf. In the latter case the proportions of cyanide taken should be reduced to about half the minimum mentioned on p. 40, namely, to 1 oz. of sodium cyanide,

or $1\frac{1}{4}$ ozs. of potassium cyanide, to every 1,000 cubic feet of air space.

Powdery Mildew (*Uncinula spiralis*).—The summer form of this fungus is alone met with in England. It forms white patches on the upper surface of the leaves in spring, and gradually spreads over the whole leaf, and attacks the fruit as well.

Remedies.—As soon as ever the disease is noticed, the vine should be sprayed with potassium sulphide, 1 oz. to 3 gallons. A second application should be given when the vines are in full bloom, and a third may be given three or four weeks later.

FRUIT TREES IN GENERAL

Birds.—Although the good done to the fruit grower by birds in destroying insects is unquestionable, it is equally beyond doubt that he suffers severely from them, both through their depredations on ripe fruit, and through their destroying the blossom-buds and blossoms. The damage done to ripe fruit is an evil with which the grower has always had to contend, as also is the destruction of the buds of gooseberries and red currants, and a limited damage to blossoms by sparrows, chaffinches, linnets, etc.: but the destruction of the buds of plums, pears, and even apples, has increased very much of late years, and is proving to be little short of a disaster to many small growers. Plum trees may sometimes be seen which have been stripped of every bud, and look like dead trees in spring, whilst plantations which were formerly profitable, have had to be grubbed up, owing to the

impossibility of securing any crop from them. This, no doubt, is partially due to a general increase in the number of birds within recent years, especially of bullfinches, but it is also due to some of these birds having altered their habits, and learnt to attack things which they formerly left untouched. It is noticeable that the damage done is very different in different localities, even when there is no difference in the numbers of birds present. In view of these facts, it seems probable that the depredations of birds are likely to increase still further, and to be extended to kinds of fruits which are at present immune. At the same time, we must not forget the good done in our plantations by some birds: the blue, cole and long-tail tits do much good by eating various destructive insects and their eggs. Now and then the two former peck the base of ripening pears, but they may be prevented from doing so by having patches of sunflowers here and there, planted so as to seed about the time the fruit is ripening. Another means of protecting choice pears is to slip a small conical cardboard cap over the base.

Of the birds which are most destructive to ripe fruit, the starling, sparrow, blackbird, jay, blackcap and thrush are the most prominent, and, beyond scaring them away in the case of rapidly ripening fruit, such as cherries, little can be done by way of prevention in large plantations. In gardens, of course, netting, or twisting thread round bushes, may be practised.

Of those which destroy the buds in winter, the bullfinch and sparrow are by far the worst. Some

good may be done in the case of gooseberries by leaving the bushes unpruned till the latest possible date ; with other fruits, the only method of protection is to spray the trees with a thick lime-wash, and, to economise labour and material, it is best to use one of the washes which will act as an insecticide and detergent agent as well,—either the lime-salt wash (12), or one of the lime-sulphur-salt washes (22 or 23). The adhesion of the wash to the tree would seem to be the chief point to be aimed at, for the washes appear to protect the buds more by concealing them from the birds, than by making them distasteful to them ; and, as birds seem to have no power of smell, it is useless to seek to protect the trees by pungent substances.

Considerable misapprehension exists as to the powers of fruit growers to destroy harmful birds, and the notices issued by the County Councils do little to elucidate the matter, often the reverse. The Wild Birds Protection Acts, 1880 to 1896, created a close time (March 1 to August 1) during which it is unlawful to destroy any wild birds or their eggs ; but the owners or occupiers of land, or any person or persons authorised by them, are exempted from this prohibition, except as regards certain birds, which are scheduled in the Act, these being, for the most part, rare birds, and, therefore, birds which do little or no damage. Both as to the extent of the close time, and as to the birds named in the schedule, modifications may be, and are, made by the Home Secretary at the instance of any County Council. Fruit growers, therefore, are at full liberty to destroy

all the birds which are most harmful to them at any time of the year; but it should be noted that this does not authorise them to employ more than one gun for the purpose without a gun licence, whatever the extent of their holding may be.

Ground Game.—Rabbits and hares, the latter especially, may do much damage in a young plantation, by barking and killing the trees. Various substances are sold for smearing over the stems and branches to prevent such attacks, but it is very questionable whether any of them can be used without injury to the trees. Wire netting appears to be the only safe means of prevention. In the case of standard trees, a strip of netting may be loosely rolled round the tree, and fastened to the stake: this is much better than tying gorse and other bushes round the stems, for these harbour all sorts of insects, and keep the stems wet, thus rendering them susceptible to attacks by fungi. With bush trees, the only satisfactory method is to wire in the whole plantation. The mesh should not be wider than two inches, and, if hares are prevalent, the netting should be 4 feet high: another 6 or 12 inches of it should be buried in the ground, but not vertically; it should be bent outwards, and covered with soil, the rabbits then will be prevented from burrowing downwards, and getting underneath.

Whenever trees have been damaged, the wounds should be trimmed, and the exposed wood painted with tar (see p. 76).

Spring Frosts.—The loss suffered by fruit growers

from spring frosts is probably greater than that caused by all other pests together, and it is the one against which they are most helpless. Spraying trees with thick lime washes, a few weeks before the blossoming season, retards, as a rule, the opening of the buds for about a week, and treatment with caustic emulsions seems to do the same ; but a week's delay may often be of no avail, and, with the variable incidence of frost in this country, may, on occasions, be actually prejudicial.

In considering other palliatives, it must be remembered that there are two kinds of frosts affecting trees: wind frosts, and radiation frosts. In the former, a current of cold air, generally from the north or east, causes the damage, and this damage is often due, not so much to the actual lowness of the temperature, as to the drying effect of the wind, and to its preventing the working of insects which fertilise the blossoms. The only means of mitigating the effects of such frosts is to provide ample shelter to the plantations.

A radiation frost is due to the earth losing its heat by radiation at night, when the sky is cloudless, and the air is clear and dry: the cooled earth then cools the layer of air in contact with it, which, in its turn, cools the blossoms of the trees, and thus destroys them. The cooling of the air is accompanied by the precipitation of the invisible moisture present in it, first into the liquid form of dew, and then into the solid form of hoar-frost, the minute particles of water, while still suspended in the air, forming a mist. Radiation from the earth is prevented by cloud, and diminished by

the moisture in the air, even when this is invisible moisture, so that radiation takes place more energetically in a high and dry situation, than in a damp and low one. Yet it is in the latter where trees suffer most from night frosts. The explanation of this apparent anomaly is, that the air which is cooled in the elevated situation, being made heavier by the cooling, flows down into the lower parts of the ground, and accumulates there; while, in the higher situations, warmer air is drawn in to take the place of that which has flowed away, and we get there a constant, gentle circulation, the cold layers never attaining the same depth as they do in the hollows, and generally not extending far enough from the ground to reach the blossoms. The laws which govern the flow of the cold and heavy air are identical with those governing the flow of water, and, in selecting a site for a plantation, attention to air drainage is just as important as attention to water drainage; any situation favouring the presence of stagnant air is one of the worst for fruit planting. Occasionally, however, there may be conditions which somewhat modify this rule, for if there is anything in the neighbourhood capable of raising the temperature of air, the evil effect of the position may be mitigated. A considerable body of water will do this; and it is found that trees in a low situation near such a body of water suffer less from frost than those which are some little distance away.

The trees themselves, just like the earth, lose heat by radiation, but it is hardly possible that such a comparatively minute object as a fruit blossom could ever

become appreciably cooler than the surrounding air, so that it is the temperature of the air which must alone determine whether the blossom is injured or not : for the same reason, the effect of this cold air is probably not increased by the presence of the liquid or solid water particles in it, for, although these make it a better conductor of heat, the blossoms would attain the temperature of the air almost immediately, whether this were dry or moist. We must not be misled by the fact that mist-laden air *feels* colder to ourselves ; for this is simply due to our bodies being at a much higher temperature than the air ; in which case the coldness of the air is more appreciable, according as it is in a better condition for conducting away our heat.

The loss of heat by radiation is much slower when the air is moist than when dry, and, moreover, much more heat must be lost before the temperature of this moist air is reduced by any given amount. Thus, to cool a mass of dry air one acre in extent and twenty feet thick, from 37° F. down to 27° F., requires the abstraction from it of nearly four times as much heat when the air is saturated with (invisible) moisture to start with, as when it is quite dry. Hence the saturation of the air with moisture is one of the best ways of preventing damage by frost, and experiments have shown that distributing fine jets of water, preferably warm water, over the ground and trees, gives better results than any other methods.

Placing a screen above the trees arrests the radiation, and the thinnest gossamer is as effective for the purpose as is the thickest material : a covering

may be applied, even on an extended scale, by using smoke for the purpose. Smudges, or smoky fires or lamps, are placed ready at various points in the plantations, and are lighted whenever a night frost is expected. The heat developed, as well as the smoke formed, helps to keep the air warmer. Very little, however, has been done in this matter in England, and we are still in want of methods for producing such smudge fires conveniently and economically. Heaps of rubbish and trimmings are of very little use for the purpose.

SPRAYING CALENDAR

CONSIDERING the diversity of the pests which attack fruit trees, and that hardly any one of them may be expected as a certainty in every season and in every part of the country ; and considering, further, that spraying is to be regarded as a remedial, rather than a preventive measure, it is not surprising that no spraying calendar of universal application can be drawn up, and that all that can be attempted in that direction is to set out an ordered list of remedies to be applied at stated times, in the event of those pests against which they are directed making their appearance.

There are only, at the most, three items in such a list which can claim to be regarded as likely to form part of the annual routine of fruit-growing. The first is winter washing the trees, in order to cleanse the bark ; the second is spraying them in March or April for the destruction of aphides, which are sure to be present, and for young caterpillars of various sorts, which will probably be present ; and the third is spraying with lead arsenate, emulsion, or Bordeaux mixture, after the blossoms have fallen, to complete the destruction of aphides, and to destroy various caterpillars and fungus spores. The second of the three operations here mentioned should be done

late in March or early in April in the case of plum trees, and somewhat later in April in the case of apples, and, if the winter washing has been delayed till a late date in March, which is often the case, the spraying of plums for the destruction of aphids will generally be unnecessary.

If winter washing and spraying in spring have been done thoroughly, spraying in summer may usually be dispensed with, without any material detriment to the trees; indeed, it is only as regards winter washing that universal adoption should be insisted upon. Apart from the consideration of the direct action of a winter wash in destroying various pests which are probably present, moss, lichen and dead bark must always accumulate, and the freer trees are kept from these, the healthier they will be, and the less will be the opportunities afforded for insects to flourish on them. But even winter washing need not be done every year, and a thorough application of a sufficiently strong wash once in every two or three years should be sufficient; indeed, in the neighbourhood of manufacturing districts, where the impurities in the air are hostile to surface growth on trees, an even less frequent application may be sufficient.

It is in this provisional sense, therefore, that growers should make use of the following calendar, nor is there much fear of their attempting to follow it in its entirety, if they wish to make any profit out of their fruit. It is scarcely necessary, however, to say that the calendar should not be used alone, without referring to what has been said in the previous part of this work, both as regards the pest to be destroyed,

and as regards the substances recommended for its destruction.

Details as to the meaning of "caustic emulsions" and "weak emulsions" will be found on p. 61.

January to March.—Spray trees with a caustic paraffin emulsion for cleansing them of dead bark, and destroying moss, lichen, mussel scale, small apple ermine moth, gooseberry and currant scale, gooseberry spider, currant shoot and fruit moth, pear leaf-blister mite, plum leaf-curling aphis (if the application is in March), and, possibly, other insects. If the caustic emulsion made with copper sulphate is used, fungus spores will also be destroyed. An application once every second or third year is generally sufficient, and February or March is the best time to make it.

If various lime washes are being used for special purposes, these will serve as fairly good substitutes for the above caustic wash. The lime-salt wash (12), or the lime-sulphur-salt washes (22 and 23), may be applied early in January to protect buds from birds; or the lime-salt wash (12) may be applied towards the end of February to prevent hatching of plum aphis eggs, or from the end of February to the middle of April to prevent apple psylla from hatching.

In late winter the ground may be dressed with gas lime to destroy various pests hibernating in it.

March or April.—Spray gooseberries with weak emulsion for gooseberry red spider and for scale; also currants for scale, and (perhaps) raspberries for the stem-bud caterpillar. Spray peaches for leaf-curl with Bordeaux mixture (9a or 9c) or Bordeaux emul-

sion (9*b*), unless the caustic emulsion with copper (10*c*) has already been applied. Spray gooseberries with potassium sulphide for mildew. Spray plums with weak emulsion for the leaf-curling aphid.

April.—Spray apples either just before or during the blossoming with nicotine (26) for psylla, unless they have already been treated with the lime-salt wash (12).

Spray cherries with Bordeaux mixture (9*a* or 9*c*) for cherry leaf-scorch.

Spray gooseberries with potassium sulphide (24*a*) for mildew, or with a weak emulsion containing potassium sulphide (24*b*) for mildew and sawfly, if the latter has appeared.

Spray apples and plums with a weak emulsion, or with potassium sulphide and soap (24), for red spider.

Spray raspberries with arsenate for the beetle.

Toward the end of the month spray apples, plums and currants with weak emulsion or nicotine for aphid.

May.—Spray apples, just after the blossoms have fallen, with arsenate for codling moth, or with weak emulsion or arsenate for the winter moth and mottled umber moth. A little later, spray them with weak emulsion or arsenate for the lackey moth, small ermine moth and sawfly. If mildew has been prevalent, preference should be given to emulsions containing potassium sulphide or copper sulphate, or the trees should be sprayed with potassium sulphide (24*a*) alone: at the same time, any shoots which are mildewed should be removed.

Spray plums and damsons with weak emulsion or nicotine as soon as ever any aphid appears, using an

emulsion with potassium sulphide in the case of the mealy plum aphid.

Treat gooseberries and currants with weak emulsion or arsenate (see p. 83) for sawfly and magpie moth, using an emulsion containing potassium sulphide if there is any mildew.

May or June.—Spray cherries and currants with weak emulsion for aphid, and pears with the same for the leaf-blister mite: also apples and pears with Bordeaux mixture (9a or 9c), or with an emulsion containing copper sulphate or potassium sulphide, for scab.

June.—Spray apples towards the middle of the month with weak emulsion for mussel scale and aphid: band the trees to trap the codling moth.

Spray cherries and pears with arsenate for the sawfly slugworm.

Spray apples and plums with weak emulsion containing potassium sulphide for the mealy aphid, which will also check fungus attacks.

Trap strawberry beetles and nut weevils, or, in the latter case, spray the bushes with arsenate in the beginning of the month.

June or July.—Treat apples for woolly aphid as described on p. 63.

September.—Spray gooseberries and currants with arsenate or weak emulsion for magpie moth.

October, etc.—Early in the month grease-band apple trees for the winter moth and mottled umber moth. In autumn spray apples with a 6 to 10 per cent. emulsion for aphid, psylla and leaf-hoppers.

In autumn or early spring spray pears with lime-

sulphur-salt wash (22 or 23) for leaf-blister mite, and destroy the goat moth as described on p. 68.

Destroy all fallen leaves, shrivelled fruit, etc., where fungoid diseases are present.

Inject carbon disulphide into the soil to destroy woolly aphis.

110 FRUIT TREES AND THEIR ENEMIES

RELATIVE AMOUNTS OF SUBSTANCES TO BE TAKEN TO MAKE ONE, TEN, OR A HUNDRED GALLONS OF A WASH, AND THE PERCENTAGE STRENGTH OF THE WASH OBTAINED.

(The percentages are the percentages by volume when dealing with liquids; but when dealing with solids, they express the percentages by weight, only when the wash is of nearly the same specific gravity as water.)

IN 1 GALLON	IN 10 GALLONS	IN 100 GALLONS	PERCENTAGE STRENGTH
<i>Ounces</i>	<i>Ounces</i>	<i>Ounces</i>	
—	$\frac{1}{4}$	$2\frac{1}{2}$	0'0156
—	$\frac{1}{2}$	5	0'0313
—	1	10	0'0625
—	$1\frac{1}{2}$	15	0'094
—	$1\frac{3}{5}$	16	0'100
		<i>lbs. oz. pts. oz.</i>	
—	2	1 4 1 0	0'125
$\frac{1}{4}$	$2\frac{1}{2}$	1 9 1 5	0'157
$\frac{3}{10}$	3	1 14 1 10	0'188
$\frac{1}{5}$	$3\frac{1}{5}$	2 0 1 12	0'20
$\frac{2}{5}$	4	2 8 2 0	0'25
$\frac{1}{2}$	5	3 2 2 10	0'31
$\frac{3}{5}$	6	3 12 3 0	0'38
$\frac{4}{5}$	8	5 0 4 0	0'50
1	10	6 4 5 0	0'63
$1\frac{1}{5}$	12	7 8 6 0	0'75
$1\frac{2}{5}$	14	8 12 7 0	0'88
		<i>gall. pts.</i>	
$1\frac{3}{10}$	16	10 0 1 0	1'00
	<i>lbs. oz. pts. oz.</i>		
2	1 4 1 0	12 8 1 2	1'25
$2\frac{2}{5}$	1 8 1 4	15 0 1 4	1'50
3	1 14 1 10	18 12 1 7	1'88
$3\frac{1}{5}$	2 0 1 12	20 0 2 0	2'00
4	2 8 2 0	25 0 2 4	2'50
$4\frac{1}{5}$	3 0 2 8	30 0 3 0	3'00
6	3 12 3 0	37 8 3 12	3'75
8	5 0 4 0	50 0 5 0	5
$9\frac{1}{2}$	6 0 4 16	60 0 6 0	6
16	10 0 8 0	100 0 10 0	10
<i>lbs. oz. pts. oz.</i>			
1 8 1 4	15 0 12 0	150 0 15 0	15
2 0 1 12	20 0 16 0	200 0 20 0	20

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