ARTIFICIAL CONTROL OF INSECT PESTS.

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In a previous article in this *Gazette*,* biological control of insect pests was dealt with, and it was stated that, where this method could be successfully employed, it was ideal. However, most insect pests can be controlled only partially, or not at all, by parasites, and in these cases, artificial methods must be used. These may be roughly classified under two heads, preventive and curative, though there is a good deal of overlapping. The former are of course to be preferred to the latter, other things being equal.

Preventive methods may be grouped as follows:—

(*a*) Quarantine.

(*b*) Cultural.

(*c*) Use of resistant strains.

(*d*) Repellents and lures.

(*a*) *Quarantine.*—The object of quarantine regulations is, of course, to keep out of a country or district pests which do not already exist there, and which, if introduced, would cause damage to property. Most countries in our day have stringent quarantine laws covering a large range of insect pests, and these laws are frequently administered in a drastic fashion. An example of the application of domestic quarantine in the United States of America will serve to show how severe is the legislation enacted to restrict the spread of an insect pest which is a great potential danger.

Several years ago, it was discovered that the Mediterranean fruit fly, a destructive pest mainly of stone fruits, had made its entry into the fruit-growing areas of Florida, despite quarantine laws designed to keep it out of the United States of America. A large staff, totalling 70 entomologists, was immediately sent to cope with the danger, supported by large numbers of workers and a huge vote of money from Congress. It was realized that should this insect spread throughout the huge fruit-growing areas of Florida, it would cause immense loss, as it had done in the Mediterranean countries and elsewhere, including Australia. Fifteen thousand acres of orchard and virgin land were quarantined, including all areas where there was any likelihood of the fly having spread, and in this area, every fruit, wild or cultivated, was destroyed, though only a very small proportion was fly-infested. These measures were apparently successful in combating the menace, and Florida thus holds the record of being the only country where the Mediterranean fruit fly has become established and has been wiped out.

There are various opinions as to the effectiveness of quarantine of imports from other countries, some well-informed observers contending that the money spent in policing the regulations is largely wasted, and that it would be better spent on a concentrated campaign to wipe out each pest after it had been introduced from abroad. This is a very doubtful contention, for such a policy would necessitate prompt information as to the occurrence of any such insect, information which might easily not be forthcoming until too late. It would seem that a country or State with few points of entry should have an excellent chance of keeping out unwelcome insect visitors, and there is always the second line of defence if the pest

* See *New Guinea Agricultural Gazette*, Vol. 4, No. 1, January, 1938, p. 13.

does manage to penetrate the outer barriers. Western Australia has had signal success in excluding the codlin moth, present in the other States of the Commonwealth. The import of pome fruits, which the codlin moth attacks, is forbidden, but on about a dozen occasions the moth has become established in the apple orchards of the south-west. Nevertheless, it has been invariably wiped out, thanks to a rigid system of orchard inspection and quarantine of affected areas. In no other country has this pest been controlled once it has made its entrance. Immunity from the ravages of the insect means many thousands of pounds annually to Western Australia, and pays over and over again for the cost of enforcing quarantine regulations.

(b) Cultural Methods.—In the control of many insect pests, it has been found that correct cultural practice, and in some cases, special cultural methods, can play a big part. Such activities as the cleaning up of trash and stubble, or the burning over of harvested areas, are common-places of good farming for many crops. In the case of the rhinoceros beetle, a local pest of coco-nut palms, similar action is taken. It has been found that the destruction of surplus decaying vegetable matter on a plantation checks the activities of this insect, destroying its favourite breeding grounds. Similarly, wheat crops sown on weedy ground in Australia are subject to plagues of certain species of cutworm, whereas this trouble is avoided by utilizing clean fallow for sowing the crop. There are many such instances, all indicating that correct methods of agriculture can do much to limit the increase of injurious insects.

Ploughing and cultivating are useful also in that they expose insects living in the ground to the weather, and to the attacks of birds and other natural enemies, and also sometimes make the condition of the soil unsuitable for the development of these insects. On the outer fringe of the farming areas in Western Australia, for instance, much trouble has been experienced from the plague locust. This insect lays its eggs in hard, bare patches of ground, and the abandonment of many farms during the depression period provided large areas of cleared land suitable for this purpose. Ring-barked paddocks which had not been ploughed were also favoured breeding grounds. The only way to forestall a plague of locusts is to plough up the ground where the eggs are laid, exposing them to the sun, wind and natural enemies. Similar action would, no doubt, be useful in the case of the coco-nut tree-hopper (*Sexava spp.*) in this country, were ploughing and cultivating practicable, and in line with the cultural practice generally adopted.

Manuring has also been used to counteract the ravages of insect pests, as for instance in the case of the shothole borer of the tea plant in Ceylon. This borer girdles the branches with its gallery, and they frequently break off, causing considerable loss. However, it has been found that by the application of certain manures, chiefly nitrogenous, the plants are made more robust, and the loss of branches is considerably reduced.

Another practice which is often resorted to is the planting of "trap crops". These are favoured food plants of the pest which it is feared will attack the main crop. The trap crops are planted around the commercial crop, and are sown earlier, so that they reach maturity more quickly. When they are heavily infested by the noxious insect, trap crop and pest are destroyed, and thus a large number of insects which would otherwise have attacked the main crop are diverted and killed.

(c) *Use of Resistant Strains.*—Much work has been done on the breeding of plants which will resist the attacks of insects, and some good results have been obtained. Various methods are employed, including continued selection of the most resistant plants in a succession of crops, cross-breeding of two different varieties, and grafting of prolific but susceptible varieties on to a resistant stock. For instance, the Northern Spy apple has been freely used as a stock on to which commercial varieties are grafted, the Northern Spy being resistant to the attack of woolly aphis, which feeds on the roots as well as the aerial portions of the tree. Similarly, resistant stocks have been employed against the vine louse, *Phylloxera vastatrix*. Little has been done in the breeding of resistant animals, but one of the recommendations of students of the sheep maggot fly problem in Australia is that an effort should be made to breed out the wrinkles in the neck of the merino. The rancid grease collecting inside these wrinkles stimulates the fly to deposit its eggs there, and makes a suitable environment for the maggots. The wrinkles are, of course, the result of a deliberate breeding policy designed to increase wool production.

(d) *Repellents.*—Repellents usually take the form of chemical substances obnoxious to the insect pest concerned, though occasionally a crop is surrounded by a belt of some other crop distasteful to the pest, thus preventing the latter from approaching the threatened plants. Such a system is used against certain species of army-worm (caterpillars which attack in mass formation) in Australia. A protective barrier of oats, which the caterpillars dislike, is grown round the crop of wheat, which would be destroyed in an amazingly short time if the army-worms could gain access to it. Chemical repellents are frequently used to protect stock against the attacks of such irritating insects as stable-flies, blow-flies and buffalo-flies. The repellent, which may be a preparation of tar oil or crank-case oil, is sprayed on the animal, and helps to give it relief from its annoying enemies. A common practice in Australia is the "jetting" of sheep, that is spraying an arsenical solution under strong pressure in and around the crutch of the animal, to ward off the attacks of the sheep maggot-flies. This is supposed to derive some repellent action from its checking of bacterial action in the grease and dirt which fouls the wool, but it of course has the important effect of killing newly-hatched maggots which attempt to feed in the wool.

Other repellents go hand in hand with the forecasting of insect outbreaks. Some very effective work has been done in forecasting, the basis of the scheme being close observation of meteorological and other factors which favour the multiplication of the pests. When these have been tabulated for a number of years, and correlated with the activities of a pest, it is sometimes possible to predict the advent of destructive hordes, and thus provide an opportunity for the timely employment of preventive measures. In Australia, much is hoped from this system in the control of apple thrips, a destructive pest which every now and then assumes plague proportions, and may cause the total loss of the apple crop of a whole district. It is proposed to use repellent sprays on the apple buds when an attack is predicted, and thus keep the thrips off sufficiently long to allow fruit to set.

Attractants, though working in a way diametrically opposite to that of the repellents, are designed to produce the same effect, that is to keep insect pests away from a threatened plant or animal. Trapping of fruit-flies and blow-flies is

carried out extensively in Australia, the principle being the same in each case. A lure is placed in a trap, from which the insect, once it has entered, is unable to escape. Decaying meat is used to attract the blowfly, and various aromatic substances for the fruit-fly. Baits, also, are laid for fruit-flies, consisting of molasses and water containing a small quantity of poison. The bait is sprayed here and there on the leaves of the fruit tree, and the flies which are attracted to it sup up the fluid and are killed.

A method of prevention which has been experimented with locally against *Sexava* is "banding", that is, applying a band of adhesive material, somewhat similar to tanglefoot, to the trunks of palms in an area affected by the tree-hopper. The tests were made in Manus, where the great majority of the eggs of the insect are laid in the ground, the object of the bands being to trap any young *Sexava* which attempted to ascend the trunks of the palms after hatching from the eggs. During a period of between four and five months, the average catch per palm amounted to over 600. It must be remembered that the experiments were carried out in a very badly affected area, where the numbers of *Sexava* were huge. If an area of palms were treated in the early stages of an outbreak, it is possible that the bands might effect successful control. Similar bands give good results in Australian orchards.

The methods of artificial control which may be classed as curative, consist of the poisoning of the insect pest by spraying, dusting, fumigation and dipping. Spraying and dusting of plants attacked by insects are by far the most common methods of pest control, and generally give good results. In some cases, of course, it is not economically possible to use these methods, because the value of the crop is not sufficient to pay for the plant and materials necessary. However, orchardists and truck-crop growers throughout the world use vast quantities of materials in regular spraying and dusting programmes, and though the cost is considerable, the outlay is repaid many times over by the increased yield of crops. In the eastern States of Australia, for instance, apple trees have to be sprayed several times annually, in order to reduce the ravages of the codlin moth. Spraying for some purposes may be slightly cheaper and more thorough than dusting, while the latter has the advantage of mobility of plant and speed of application.

Some of the materials used kill by being ingested by the insect with its food, and setting up internal poisoning. Others, the "contact" insecticides, asphyxiate the insects on to which they are sprayed, while a third type, such as extracts of derris root, kills in both ways. The type of spray or dust used depends mainly on the feeding habits of the insect concerned. Some orders of insects, such as the *Hemiptera* (bugs, aphids, &c.), feed by inserting a long proboscis into the tissues of their plant or animal host, and sucking up the juices. Other orders, such as the *Coleoptera* (beetles) chew their food, while the *Diptera* (flies) include those which sup up surface fluids, as well as sucking species. A poison spray applied to the surface of foliage is of no use against a sucking insect, as it obtains its food from inside the leaf, so in this case contact insecticides are used. Some of the best known of these are oils, nicotine, derris and resin and soda washes. For the chewing type of insect, internal poisons are used, and arsenical preparations predominate, though the desire to employ something less dangerous to man and the higher animals has encouraged the use of derris, and various fluorides and fluosilicates. Some insects can be killed by internal poisons even though they may not ingest these

with their food. Among such are cockroaches and our local coco-nut tree-hopper (*Sexava spp.*). These pests have a habit of cleaning themselves by passing their feet and antennae through their mouths, thus removing any adhering particles of dust. Hence, if a poison dust is projected on to them, they frequently absorb a lethal dose in this way. This method is frequently used against cockroaches, sodium fluoride, which is non-poisonous to humans, being freely dusted in cracks and crevices and other haunts of the 'roaches. As the insects pass through the dusted area, a number of particles adhere to them, which they clean off later with fatal results. With such a wary feeder as the cockroach, this method is probably superior to any other.

It is hoped that successful control of *Sexava* will be obtained by dusting affected palms, and in this connexion many laboratory experiments have been carried out to ascertain the lethal effect of various dusts. At present, it appears that calcium arsenate possesses the best combination of cheapness and efficiency, and it has been shown by experiment that it kills the tree-hopper through both the cleaning habits and the feeding of the pest.

The practice of dipping probably needs little description here, as most people know of the regular dips given to sheep and cattle to control lice and so-called tick in the former, and tick in the latter. These dips are arsenical preparations, and experience has proved them to be most effective, so much so that legislation compels their use

Finally, there is the widely used control measure of fumigation. This is commonly employed against the pests of stored products, such as grain weevils, dried fruit moth and numerous others, and is also a standard method of controlling household pests and the scale insects attacking citrus trees. For stored products, the commonly used fumigants are carbon bisulphide, chlorpicrin, and hydrocyanic acid gas, while the last-mentioned substance is employed for citrus tree fumigation and house fumigation practically to the exclusion of all others. Hydrocyanic acid is sold in the form of powder, which, on exposure to damp air, gives off the gas. Fumigation of citrus trees is carried out under special gas-proof tents, and is an operation calling for knowledge and care. It is done at night, so that the air will be damp and the heat of the day avoided, but dew must not be present on the leaves, otherwise the gas dissolves in the dew, causing severe burning of the foliage. Of recent years, vacuum fumigation has been increasingly used with stored products such as grain, where difficulty might be experienced in securing a thorough distribution of the gas throughout the bulk of the material. Where vacuum fumigation is used air is drawn out of the space to be fumigated, and the fumigant is then liberated, and is drawn into the most inaccessible spots by the partial vacuum created. This ensures that fumigation is thoroughly carried out.

LOCAL TIMBERS FOR PLANTATION BUILDINGS, AND NOTES ON NON-INDIGENOUS HARDWOODS.

By G. E. Bliss.

The exports of timber from this Territory have advanced rapidly in the last two years and now form a valuable addition to the territorial income. These exports, however, are all in the form of logs and the imports of milled building