CONTROL OF INSECT PESTS.

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If circumstances were such as to permit the natural increase, without check, of a single species of insect, the surface of the earth would, in a short time, be completely covered with them. As there are some half-million and more known species of insects, not to count the vast number of other animals, we may infer and prove it to be true that there is a great slaughter constantly in progress. This, of course, is one of the basic arguments set forth in the "Origin of Species" wherein the "struggle for existence" is emphasised.

Suppose we penetrate some primeval jungle, we shall see a dense undergrowth of plants of different sorts competing for nourishment in the soil, and trees reaching up, striving for a place in the sun. If we are sufficiently observant, we may see a moth fluttering about and laying eggs on plants destined to become the food for its progeny. Some of the eggs may fail to hatch, others get eaten or parasitised. Of the remainder which hatch, some die of constitutional weakness, others are attacked by ants, wasps and birds, or may fall victims to disease, or their food may run short. In the end, perhaps 1 per cent survive to carry on the race. This competition for existence is, in reality, a vastly more complicated affair than here indicated, depending as it does on ever-widening circles of inter-related factors. But, generally speaking, it may be said that a balance is struck between the various forms of life in a circumscribed area, which will vary only by small amounts and within fairly narrow limits. A large variation in any one factor may throw the whole completely out of balance. For example, a well-intentioned planter arrives on the scene and clears an area of jungle and plants it up with one crop. Our friend, the moth, discovers that this is just the stuff for its young, and consequently leaves its old haunts for pastures new. In due course follows an outbreak of caterpillars with disastrous results to the crop. It is reported to a central authority, which solemnly dons the black cap and makes it a notifiable pest; and it will probably have its effect, too, on the prices quoted for raw material in the exchanges of the world.

The nice balance that formerly existed is now upset by the extensive growth of a single plant. It immediately favours those insects which can feed on it. They do, of course, offer now large masses of food to their particular enemies, but they have had their innings first; and it often happens that for some reason their enemies are not able to take advantage of this opportunity. The result is a number of first-class pests, which take heavy toll of our crops:—wheat, maize, rice, cotton, tobacco, sugar and tea, to mention some of the leading staples.

Let us now consider in more detail some of the forces brought to bear on insects in nature:—

(1) Shortage of food may be brought about by decrease of the food plant or by excess of individuals. Such a condition may lead almost to the annihilation of an insect species.

(2) Of insect enemies, parasites are usually more important than others. They are dependent on the numbers of hosts available, and if a large number of the requisite host is available for a long period, the host may be reduced almost to vanishing point. This, however, will have a profound reaction on the parasite which now will have a very great numerical superiority. The host insects being almost exterminated, the parasite is left without being able to propagate and consequently will almost die out likewise. The result of this is twofold. At first, the crop will be remarkably free from the pest in question,but it gradually works up again and this time having far outstripped its parasite, may ravage the crop far worse than before.

(3) Diseases of various kinds take their place in the scheme of things. They may be of fungal or bacterial origin, or perhaps be due to a virus. Wilt attacks many caterpillars at certain times and may be ascribed to a virus until something more is known about it.

(4) Climatic effects are of great importance in the complex of insect life. Excessive high or low temperatures produce dormancy or death, and the same may be said of excessive drought or humidity. No insect activity is seen at the Poles or in the Great Gobi. In regions subjected to a continental climate, *i.e.* with a great range of heat and cold, insects have adapted themselves to these extremes by their ability to aestivate or hibernate, though even here excesses may prove fatal. For example, the boll weevil of America, which plays such havoc with the cotton crop, can hibernate, but a severe winter will kill off large numbers. The type of winter experienced there has its effect, therefore, on the "Futures" cotton exchanges.

All these considerations make up a complex which may be taken into the account of the "Struggle for Existence." The important point which emerges from it is the limitations imposed on populations living together in any given area. The factors act and react among themselves. There is a well-known complex in which the quality of beef in some parts of Britain depends on the number of cats in the neighbourhood. The beef depends for quality on clover which is only fertilised by Humble bees. The nests of the Humble bees are raided by mice which are themselves attacked by cats. The more the cats, the fewer the mice, the more the bees, the better the clover, a regular sort of "House that Jack built."

If we want to help ourselves in the fight against insects, we must first make our way into the great labyrinth of conflicting forces in an endeavour to study the plan. Only so will we be able to take a leaf out of the book of Nature, and, by the introduction of new factors not already existing, deliberately create a new balance in our favour. The only forces at our disposal to play with are diseases and enemies.

Experiments, designed to encourage the propagation of insect diseases, have for the most part met with failure; we shall, therefore,

not now consider them. On the other hand it has been possible to make use of insect enemies to control pests and, though in a few instances remarkable results have been achieved, they represent a small proportion of the attempts so made, and have been obtained under somewhat specialised conditions. These particularly favourable results have been attained where pests were originally introduced from outside into a well-defined circumscribed area of small dimensions such as an island. When the pests make themselves known, a search is made for their parasites in the country of origin. The two points of importance to be noted are—firstly, the limited area, and secondly, the fact that the pest was not indigenous.

The procedure adopted is to breed the parasites in their natural home, and then to despatch them to their future home in a parcel containing sufficient food to keep them alive on the way. If the period of transit exceeds the time of development of the parasites, they are shipped in cold storage, so that they pass most of the journey in a dormant condition. On arrival, they are transferred to the laboratory where development is completed and a new cycle started. Numbers may be thus bred and liberated at the appropriate time, *i.e.*, when the pest is about to become abundant. In a favourable climate a few such releases may be all that is required. The most favourable conditions are those permitting continuous propagation. A locality subjected to a succession of different seasons is not usually favourable in this respect. The reason for this is not far to seek. If, as in the case of Tortrix, the moths are only active for a month or two at a time, succeeded by a period of two or three months when there is no activity, the egg parasite, for example, can only flourish when egg masses are abundant. But as the parasite only takes two or three weeks to complete its development, it cannot survive in the intervening period. In actual practice, a very insignificant number do so, probably on chance eggs of various other moths. If conditions were such that Tortrix bred continuously, there would very possibly be no Tortrix problem, since the parasite would be greatly favoured by eggs always being on hand.

It may be permitted, for a moment, to touch upon the special problem of the Tortrix egg parasite. It has been chosen among several others for an experiment in natural control owing to the ease with which it may be had in large numbers, and also because it has no parasite preying on it. The central idea is to supply the deficiency caused by the blank periods previously alluded to. These periods, to repeat, bring about the destruction of the parasites through lack of hosts. If we can throw into the field a large number of parasites just when the Tortrix begins to get busy, so that in a short while it will increase to much larger numbers, we hope they will be able to

keep the Tortrix down. As things are at present, there may be, at the start of a season, one parasite per million eggs. We want to start with, let us say, ten thousand parasites per million eggs.

Let us now turn to other possibilities in control. The foregoing brief review refers to what is generally known as Natural Control, meaning the amplification of methods already existent in nature.

The next consideration is Artificial Control, which may be subdivided, for the sake of clearness, into Mechanical Control and Chemical Control. The former covers certain agricultural practices, such as cultivation, rotation of crops, times of sowing and harvesting, which mostly apply to annual crops. Handpicking and trapping may also be included in this category. Traps are designed to take advantage of certain habits found amongst insects, or, as we might say, their responses to different forms of external stimuli. The sense of smell is well developed in most insects, and so we find many insects may be captured by means of baits. Thus, molasses and alcohol will attract certain moths and other insects. Destructive fruit flies may be lured to similar enticing liquids which are poisoned with arsenic. Light is well known to attract moths and beetles and is sometimes used for the purpose. In the vine-growing districts of Europe, light traps are extensively used. Those insects which climb trees may be captured by the use of sticky bands around the trunks. Cutworms can be diverted from seedlings by putting down damp bran, in which Paris green has been mixed. And so, by a study of the habits and activities of individual insects, some sort of trap can often be devised.

Chemical Control is applied to spraying, dusting and fumigation with poisons. There are a very large number of substances which are poisonous to insects. Vapours and gases are used for fumigating stored products, ships and houses for getting rid of pests attacking grains and the like, cockroaches, rats and other vermin. Spraying and dusting are used in the open; dust being used on large areas. There are two ways of killing insects by means of poison which depend on the structure of the insect. Caterpillars and beetles are provided with chewing mouth parts, so that if a leaf is covered with a layer of poison and such an insect eats it, the said insect will die.

There is, however, a large group of insects provided with a sucking proboscis. These are "bugs" in a restricted sense, examples of which are scale insects, paddy fly, the mosquito bug and the bed bug. These cannot be poisoned in this way. If one were to cover one's skin with an arsenic wash and allowed a mosquito to bite, it would take no harm. Against such insects as these it is necessary to use some substances which will attack them externally. Such things are soap, paraffin and some plant alkaloids. Keating's powder, which "Kills Bugs, Fleas, Moths and Beetles" is one of these. The alkaloids include Nicotine, Pyrethrum, Derris and Tephrosin. The

latter is obtained from *Tephrosia Vogelii*. A couple of ounces of the green leaf of the last named mashed up in a gallon or so of water is a useful solution in which to bathe a dog, since the fleas are readily killed.

The spray to be used therefore depends on the nature of the insect; but it must also depend on the nature of the crops. It would scarcely be wise to spray tea with arsenic; if we could do so, Tortrix and Nettle Grub could be more easily dealt with. Neither can one use in this particular case the creosotes and tar oils which would give a strong flavour to the tea.

Nearly all the sprays, dusts and fumigants used only affect the active insect, that is to say, they have no effect on the eggs of insects. For this reason, they are sometimes supposed to be not very effective, since the eggs will hatch out untouched, and for this reason, again, a second application is often advisable.

A word may be added with regard to Mites. These little creatures are not insects, properly speaking. One characteristic of insects is that they have six legs, another is that they are often provided, in the adult state, with wings. They are nearer to the spiders in structure than to insects. As they differ in structure so they appear to differ in constitution, since most insecticides do not affect them as much as insects, but they are particularly susceptible to sulphur powder, which does not affect an insect. Hence, the standard remedy for Mites is sulphur, which may be applied as a dust, or in the form of a compound spray, such as lime-sulphur; but again, the eggs are not killed by this treatment, so that a second dose is recommended.

This is a brief review of some of the forms of control practised against plant pests. Many considerations call for investigation and it is only by a thorough study of the insect and its reactions to its environment that we can pick the right lines on which to carry on the enquiry.

DISCUSSION.

Mr. Carson-Parker asked if the Director could say what it was proposed to do in the way of combating Nettle Grub. He submitted that this was not only a pest of Uva, but that it had been reported from other districts and he believed that when once established it never completely disappeared.

Dr. Norris in reply said that he could not usefully add anything to what had been said by the Chairman of the Board and himself at a recent meeting of the Passara P.A. The serious damage caused by the pest was fully recognised by the Institute and the Board had already agreed to increase the staff required for its investigation. Any delay in doing this was due simply and solely to the difficulty experienced in finding suitable accommodation in the Passara area where the work was being carried out.

Mr. C. H. Callander asked for information regarding *Calotermes militaris* and whether work on this pest was being carried out by the Institute or at Peradeniya.

The Director said that Mr. Jepson of the Department of Agriculture had made a special study of Termites and it had, therefore, seemed advantageous that work on this subject should continue to be carried out at Peradeniya.