DEPARTMENTAL NOTES

INSECT INFESTATION OF STORED CACAO

A SUMMARY OF RECENT INFORMATION

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WITHIN the last few years the whole problem of the insect infestation of stored cacao has been under investigation by a Joint Committee comprising representatives of the Cocoa Association of London, the Manufacturing Confectioners' Alliance, and the Research Association of the Cocoa, Chocolate, Sugar Confectionery, and Jam Trades.

A brief note on some of the more important points arising from these various investigations may be of interest to those in Ceylon who are concerned with the producing and exporting of cacao.

Munro and Thompson (1929, p. 7), in their report prepared for the Empire Marketing Board, drew attention to the increasing importance of this problem, which, they indicate, has three main aspects:

(1) Infestation in the exporting country;

(2) Infestation in the wharves and warehouses in the importing country;

(3) Infestation in the cocoa and chocolate factories in the importing country.

The Joint Committee, in the course of its investigations of this problem in all its aspects, came to the conclusion that its main object should be "prevention rather than cure", and with this end in view it has suggested certain "simple and practical measures of prevention" which it is hoped will gradually reduce insect infestation to a minimum not only in the tropical cacao-producing countries, but in the wharves, warehouses and manufacturers' stores in the importing country. These measures will be outlined later.

In the following notes we are concerned mainly with the first aspect of the problem, namely, the infestation of cacao in the exporting country. Early in 1931 the committee sent out a *questionnaire* to the Directors of Agriculture in all the cacao-producing countries, including Ceylon, with the object of obtaining as much information as possible as to the "original infestation of the cacao bean in the tropics". Among the more important points raised by the committee were the possible origin of the infestation, whether this occurs on the estate, either during the drying process or in the stores before despatch, or whether it takes place later in the merchants' godowns while awaiting shipment. Further questions asked were the care taken to avoid producing cracked beans, the duration of storage in the producing country, whether the beans are usually bulked, with the result that good cacao may be mixed with infested, and whether the cacao is exposed to infestation in any other way than those previously mentioned. In submitting the above questionnaire the committee pointed out that with most cacaos it has been found that the infestation is chiefly due to the cocoa moth, *Ephestia elutella.*

The replies received by the committee from the various cacao-producing countries have indicated that an appreciable amount of infestation by *Ephestia elutella* occurs in tropical countries, and that in many cases the cacao is stored before shipment for a period sufficient for infestation to take place. The committee urges the necessity for planters, merchants and others in the tropics to take the greatest care in examining their stores for any sign of infestation. Further, it points out that " the impossibility of judging by inspection whether eggs have been laid on cacao beans or bags makes it absolutely necessary to keep all places where cacao is stored or handled free from the cocoa moth and other insects", that is, the cacao should be stored under as ideal conditions as possible, such conditions being indicated in the recommendations given later.

Before outlining the recommendations suggested by the committee it is proposed to give a brief note on the three most important insects associated with cacao beans in various cacao-producing countries. These will be dealt with here in the order of their importance under Ceylon conditions, namely:

1. The cacao moth (*Ephestia elutella*).
2. The rice moth (*Corcyra cephalonica*).
3. The tephrosia beetle (*Araecerus fasciculatus*).

1. *The cocoa moth.*—Munro and Thompson (1919, p. 22) consider this moth to be by far the most important of the various insects which infest stored cacao generally. During their survey of the various insects found infesting stored cacao they were able to make "a careful though limited examination of about 3,270 bags of cacao". This survey was carried out in the Port of London between April and December 1928, and represents a sampling of 88 shipments of cacao from 15 different countries, including Ceylon. Various stages of *Ephestia elutella* were found in cacao from all the countries and in 49 bags out of 143 examined from Ceylon. They give a long list of the different types of food, apart from cacao beans, which the larvae of this moth will eat, and point out that "it is this catholicity of taste which constitutes one of the chief reasons why *Ephestia elutella* is so important as an insect economically".

Noyes (1930) gives details of the three species of the genus *Ephestia* which are known to attack stored cacao, namely, *E. kuhniella* (the Mediterranean flour moth), *E. elutella* (the cocoa moth) and *E. cautella* (the fig moth), and states that these closely resemble one another in appearance, habits, and duration of their life-histories.

The following notes on *Ephestia* are taken mainly from the articles by Munro and Thompson (1929, pp. 27-29) and by Noyes (1930 pp. 77-80). The moths avoid the light and during the day rest in the more shaded portions of the store. They are active at night when egg-laying takes place. Each female moth is capable of laying from 100-250 eggs, which may be deposited singly or in small clusters, usually on or near the future food. They are often pushed through the meshes of a sack by means of the ovipositor and laid on the cacao beans inside. The eggs are ovate, and white to pale-yellow in colour, about half the size of a pin's head and just visible to the naked eye. The moths are said to prefer a still, heavy atmosphere and dislike a draught. Under tropical conditions the eggs will probably hatch in about 5-9 days, and the young larva, which is very difficult to detect, immediately searches for a crack in the shell of cacao bean, into which it crawls and begins to feed, spinning around itself a silken tube within which it lives until full-grown. Larvae that are unable to find any cracks in the shells eventually die of starvation. Noyes points out that it is practically impossible for a moth to lay eggs inside a cacao bean unless the shell is cracked, but the young caterpillars may gain entry to a bean

through the smallest crevice. Munro and Thompson state that the larva feeds entirely inside the bean, gradually filling the cavity with small excretory nodules loosely bound together by webbing. Eventually the whole contents are devoured, leaving only the husk, excreta, and webbing; the presence of the webbed excreta protruding through a crack in the shell is a sure indication of *Ephestia* injury.

In the tropics the larva probably becomes full-grown in about 8-10 weeks and then eats its way out of the bean and searches for a suitable place in which to spin its cocoon. The larvae avoid the light as much as possible but wherever they wander before settling down they leave a trail of silken thread behind them; this tangled mass of threads crossing and recrossing is very noticeable in a heavily infested store. Under warm conditions the pupal stage lasts about 9-12 days; the total life-cycle being about 10-13 weeks under favourable conditions. The fig moth (*Ephestia cautella*) is also known to attack stored cacao in Ceylon, but is apparently of little importance as compared with *elutella*, which is the species usually found in shipments of Ceylon cacao on arrival in London.

2. *The rice moth* (*Corcyra cephalonica*).—This is another moth of cosmopolitan distribution which is sometimes found attacking stored cacao, although its natural food seems to be rice. Out of the 143 bags of Ceylon cacao examined by Munro and Thompson (1929, p. 20) only 6 were found to contain traces of *Corcyra*, and they mention that "traces" includes, larvae, pupae, adults and damaged beans. Traces of this species were found in cacao from ten countries out of the fifteen, but, except in one instance, the infestation was almost insignificant. The above authors, however, regard *Corcyra* as an insect "potentially dangerous to cacao" by reason of the fact that it has been found in all forms of cacao in widely distant parts of the world.

They noted that *Corcyra* larvae damage cacao beans in the same way as *Ephestia,* and found that the life-histories of the two insects are similar. Full-grown *Corcyra* larvae are larger than full-grown *Ephestia* larvae and the excretory nodules are larger. The cocoons of *Corcyra* consist of strong, thickly woven, very white silk, whereas those of *Ephestia* are smaller, thinly woven, greyish, sometimes almost transparent and much less conspicuous. The larvae of *Corcyra* appear to be somewhat gregarious and their cocoons are frequently found not merely close to one another, but actually matted together, so that it is a difficult matter to separate individual cocoons.

3. *The tephrosia beetle* (*Araecerus fasciculatus*).—This small beetle is important in Ceylon mainly as a pest of the seed pods of boga medeloa (*Tephrosia candida*) and is rarely found here associated with stored cacao. Munro and Thompson (1929, p. 18) record traces of this beetle in only 4 (3 doubtful, of the 143 bags of Ceylon cacao examined. They have described the characteristic damage caused by *Araecerus* larvae to cacao beans as follows: "There is usually a large exit-hole, while inside the bean a varying proportion of the cotyledons is replaced by the frass of the larva. The frass takes the form of rather fine dust, often yellowish in colour, and is entirely distinct from that *Ephestia* larvae, whose frass appears as small nodules, the colour of the cacao itself, adhering to strands of webbing exuded by the larvae as they move about. The beans are often considerably hollowed out by *Araecerus* larvae, not more than one of which is generally found in a single bean. Pupation as a rule takes place within infested beans, whereas in *Ephestia* the reverse is usually the case". They have also suggested that *Araecerus*, which bores into the beans, may serve as an auxiliary of *Ephestia*, whose larvae can successfully attack beans only when the shell or husk is broken.

Further investigation of the above pests is being taken up in Ceylon.

It will be seen from the above notes that the cocoa moth (*Ephestia elutella*) is the most important of the insect pests found to infest stored cacao in most of the cacao-producing countries and that this pest is being frequently introduced into the Port of London in cacao from these countries; traces of the other two pests are also found in cacao received from some of the countries. Ceylon cannot be held blameless in this respect and it is most important that local cacao planters should produce and despatch their cacao under the best possible conditions and that Colombo exporting firms should see that the cacao is kept as free as possible from insect pests before shipment.

The Joint Committee held a conference with the Association of Public Wharfingers of the Port of London with the object of securing the co-operation of the warehouse proprietors in carrying out certain essential measures which could be applied immediately without undue expense and which would have the effect of causing a marked reduction in infestation. The committee, as a result of this conference, was able to secure agreement on almost all of the essential points, namely those relating to cleanliness, ventilation, lighting, and stacking.

The committee require fuller information as to the condition of the cacao on arrival in London, in order to apportion the onus between the exporters and wharfingers. Steps are being taken by the committee to have a system of reports on cacao found to be infested on arrival; such reports would indicate which of the exporting countries are chiefly to blame for the re-introduction of *Ephestia* and other pests into warehouses.

CONTROL MEASURES

The following suggestions made by the committee with a view to keeping infestation of cacao at a minimum were forwarded towards the end of 1931 from London:

SUGGESTIONS TO MERCHANTS AND OTHERS WHO STORE CACAO

(1) Kill any cacao moth or caterpillar, or other insect seen in stores.

(2) Stores should be kept perfectly clean. The walls and roof should be whitewashed once a year; and any broken beans or debris should not be allowed to remain in corners, between sacks, or in any other places. Crevices and ledges, e.g., those formed by the junction of the walls and roof timbers, should receive particular attention.

(3) The store should be amply ventilated, with plenty of moving air round the cacao day and night. It should be well lighted.

(4) Cacao should be despatched, as far as possible, in order of date of production. The period of storage in the tropics should be as short as possible.

(5) Freshly produced cacao should be kept separate from that which has been stored over one month.

(6) Consideration should be given to the suitability and condition of other goods stored alongside cacao.

(7) Infested cacao should not be mixed with good cacao.

(8) If cacao is stored loose in bins, the surface should be kept covered with a clean cover.

(9) Use only clean sacks. If the bags of cacao are in the store some time before shipping, the ears and seams of the sacks should be examined for cocoons, and if they are found the cacao should be re-bagged.

SUGGESTIONS TO CACAO PLANTERS TO AVOID INFESTATION OF THE BEAN

(1) Kill any cacao moth or caterpillar, or other insect, seen on drying platforms or in stores.

(2) Sweep up and get rid of cacao fragments and debris from drying places, etc. Bean fragments should not be allowed to accumulate in cacao houses—in the crevices or joints—nor should the fractured shell be swept outside and allowed to accumulate. This applies to all places or rooms where cacao is dried, cleaned, sorted, bagged, or stored.

(3) Rooms or sheds in which cacao is dried, cleaned, sorted, bagged, or stored, should be cool and have the maximum ventilation, with plenty of moving air day and night. These rooms or sheds should be well lighted.

(4) All rooms or sheds where cacao is handled or stored should be whitewashed at least once a year.

(5) Planters should avoid, as far as possible, the production of cracked beans. Fragile shells are produced by over-fermentation, over-drying, or washing. Planters should avoid germinated beans as, like cracked beans, they allow easy access to the insect.

(6) Planters should avoid producing unfermented or damp cacao beans as the soft nature of these enables them to be more readily attacked by insects.

(7) Use only clean sacks.

The following note has been added by the committee to the above recommendations:

It will be readily understood that cacao may show no sign of infestation and yet later be obviously infested. It may be that moths have settled on the cacao and every moth has deposited 250 eggs. These eggs are altogether too minute to be noticed. The eggs may hatch out on the voyage, but the caterpillar is so minute as to escape detection. The minute 'grubs' start to feed on the beans and frequently only become obvious two or three months later when they are fully fed and come out of the cacao bags in large numbers.

REFERENCES

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