METHODS FOR COLLECTING PARASITES OF EARWIGS.

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(Plate XXX.)

It is widely known that the biological method for the control of insect pests is receiving considerable attention from Economic Entomologists at the present day. One of the insects against which this method is being tried is the common earwig (*Forficula auricularia*), which is a very serious pest of orchards, etc., in such countries as New Zealand where it it has been accidentally introduced from Europe.

Through co-operation between the Imperial Bureau of Entomology, Rothamsted Experimental Station, and the Cawthron Institute, Nelson, attempts have been made to control the earwig in New Zealand by the introduction of two Tachinid flies that are parasitic on it, *Digonochaeta setipennis*, Fln., and *Rhacodineura antiqua*, Meig. These flies are obligatory parasites, being entirely dependent on this particular host for the completion of their life-cycle, and they are lethal in effect. The larvae having emerged from their dead or moribund host, soon pupate, and it is in the pupal stadium that these insects can most conveniently be transmitted in cold storage. Mr. A. M. Altson, of the Imperial Bureau of Entomology, was in charge of this work in England in 1924 and 1925, but, unfortunately, owing to ill-health he was obliged to give it up. In the autumn of 1926, at the request of Dr. Tillyard, it was decided to forward a further batch of parasitic puparia to New Zealand. For this purpose large quantities of earwigs had to be captured in the field, and transferred to cages in the laboratory, in order that the parasites which emerged from the earwigs could be collected.

The collection of earwigs was commenced on 13th September 1926. Previous investigations by Altson had indicated that the percentage of parasitism decreased in October, so that it was desirable to secure the maximum number of earwigs in a minimum period of time. Further, as the time at the disposal of the writer for this work was limited, detailed investigations were impossible.

The first day was spent making a survey of the Harpenden district with a view to discovering localities likely to yield large quantities of earwigs. Situations examined included crevices of gateposts, underneath the bark of fences and trees, disused sacks found in hedges, etc. In each of these environments a few earwigs were discovered and captured with difficulty. The view that earwigs choose a vertical position when lying-up during the daytime was amply confirmed. The presence of a small hole in the stems of hogweed or cow-parsnip (*Heracleum sphondylium*) (Plate xxx) suggested the possibility of an ideal situation for the earwig's selective requirements. Several of these Umbelliferous plants thus damaged were examined, and in every case quantities of earwigs were present in the hollow stems. The number present in each stem naturally varied, but in three cases where actual counts were taken the number of earwigs present was 44, 56, and 48 respectively. Quantities in excess of these numbers were observed, and seldom was the number below 10. The compact nature of the environment considerably aided the handling of the earwigs. The stem was cut near the ground and each notch severed consecutively; the contents of the internodes were in turn shaken or blown into a bottle container. By this method it was possible to collect large numbers of earwigs (see the following table) in a comparatively short time. The actual time of collecting excluding the journey to the collecting ground was at most 3 hours in the morning and 2½ hours

in the afternoon. The localities visited were chiefly derelict areas of land, hedge-rows of lanes and the headlands of cornfields.

Numbers of Earwigs collected.

Date.	*Morning.*	*Afternoon.*	*Total.*
14th September	300 ...	500 ...	800
15th ,, ...	500 ...	500 ...	1,000
16th ,, ...	500 ...	400 ...	900
17th ,, ...	600 ...	600 ...	1,200
18th ,, ...	700 ...	300 ...	1,000
14th October	900 ...	— ...	900
			5,800

The hole present in the stems of *Heracleum* is caused by a Lepidopteron, *Dasypolia templi*, Thnb., adults (dead), empty pupa-cases, and parasitised larvae of which were found in the stems. It should be pointed out that only stems thus damaged contained earwigs, there being no evidence that the earwigs themselves bore into the stems. Bearing this point in mind, a small hole was cut near the base of unattacked stems so that entrance was possible. When visited a week or so later the efficiency of such traps was very evident, for large numbers of earwigs were again collected. This method was so successful that stems were brought from the field, treated as mentioned above and then arranged in the hedges surrounding the laboratory. Subsequent inspection yielded quantities of earwigs.

It was interesting to note that many of the stems of *Heracleum* in the vicinity of certain stackyards had been damaged, a longitudinal slit having been bitten down the stem. The explanation for this appears to be that an insectivorous mammal (judging by the teeth marks) had bitten portions of the stem, presumably in order to get at the earwigs. Excreta in the stems proved the previous presence of earwigs.

Each day's collection resulted in a few puparia of *Digonochaeta setipennis* (Plate xxx) being found in the stems of *Heracleum*. These were usually attached near the highest notch of the stem or present in the excreta in the base of the stem. In several instances two puparia were found in a single stem ; one instance of three in a stem was noted. On 14th October when stems, previously cut, were revisited 12 puparia were found in those along a short hedge row. This local distribution of parasites was very evident throughout these investigations, for the discovery of one pupa usually led to further discoveries in the vicinity. This is probably due to local oviposition by a single female. The prevalence of the Chalcid hyperparasite, *Dibrachys cavus* (*boucheanus*), renders all puparia collected in the field, and not actually bred from the earwigs, open to suspicion. When shipped to another part of the world each collected puparium—as distinct from those bred from the earwigs—needs to be carefully unpacked on reaching its destination and placed in a separate phial. The latter should be closed with bolting silk, and by this method the escape of any hyperparasites can be prevented. The accidental introduction of *Dibrachys* into a new country with the *Digonochaeta* would very seriously reduce the value of the parasites, and unless material is very scanty it is advisable to transmit only Tachinid puparia actually bred out from the earwigs.

The earwigs were transferred into cages in the insectary. The type of cage used (fig. 1) was one suggested by Dr. Imms, which is extremely useful for work of this nature. It is made of red deal, the measurements being 11 in. by $5\frac{3}{4}$ in. by $9\frac{3}{4}$ in. ; the double glass sliding panels permit easy handling of food, insects and puparia within the cage, and the space available in the base of the cage is convenient for holding sand. The two windows provide for ventilation and are closed by phosphor-bronze gauze of 50 meshes to the linear inch. In some cases bolting silk was used and is

very durable. It is highly important that the mesh is sufficiently fine to exclude such hyperparasites as *Dibrachys cavus*. This Chalcid is even liable to attack the *Digonochaeta* in the laboratory and is extraordinarily skilful in discovering its host. On several occasions Dr. Imms has found this species on the windows of the insectary containing the cages and on one occasion actually crawling over a cage in order to find a means of entry.

The earwig's choice of a vertical position for lying up has to be catered for in the cages. It was found necessary to place rolls of brown paper, cardboard or portions of the stem of *Heracleum* in a vertical position, otherwise the earwigs collect in seething masses in the upper corners of the cage, when the canabalistic habit is induced. The earwigs were kept in these cages (200 in a cage) for about two months. Their food

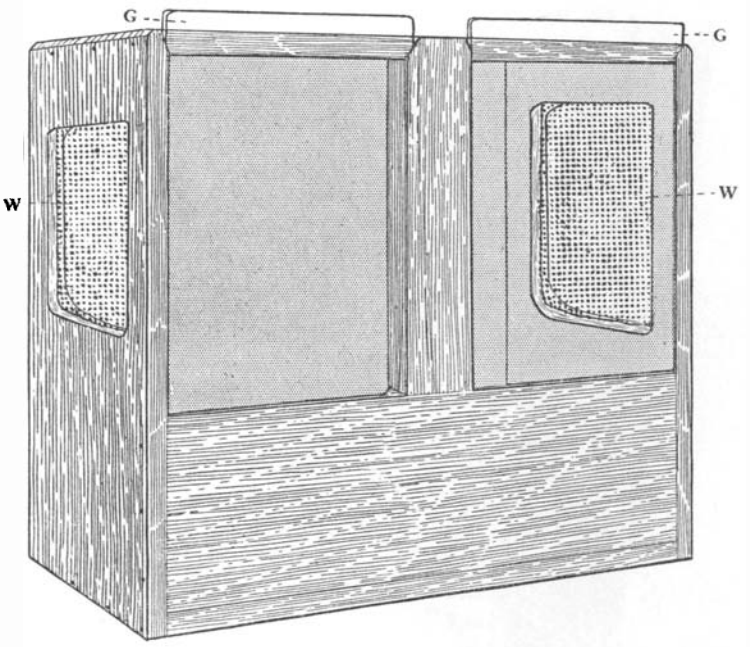


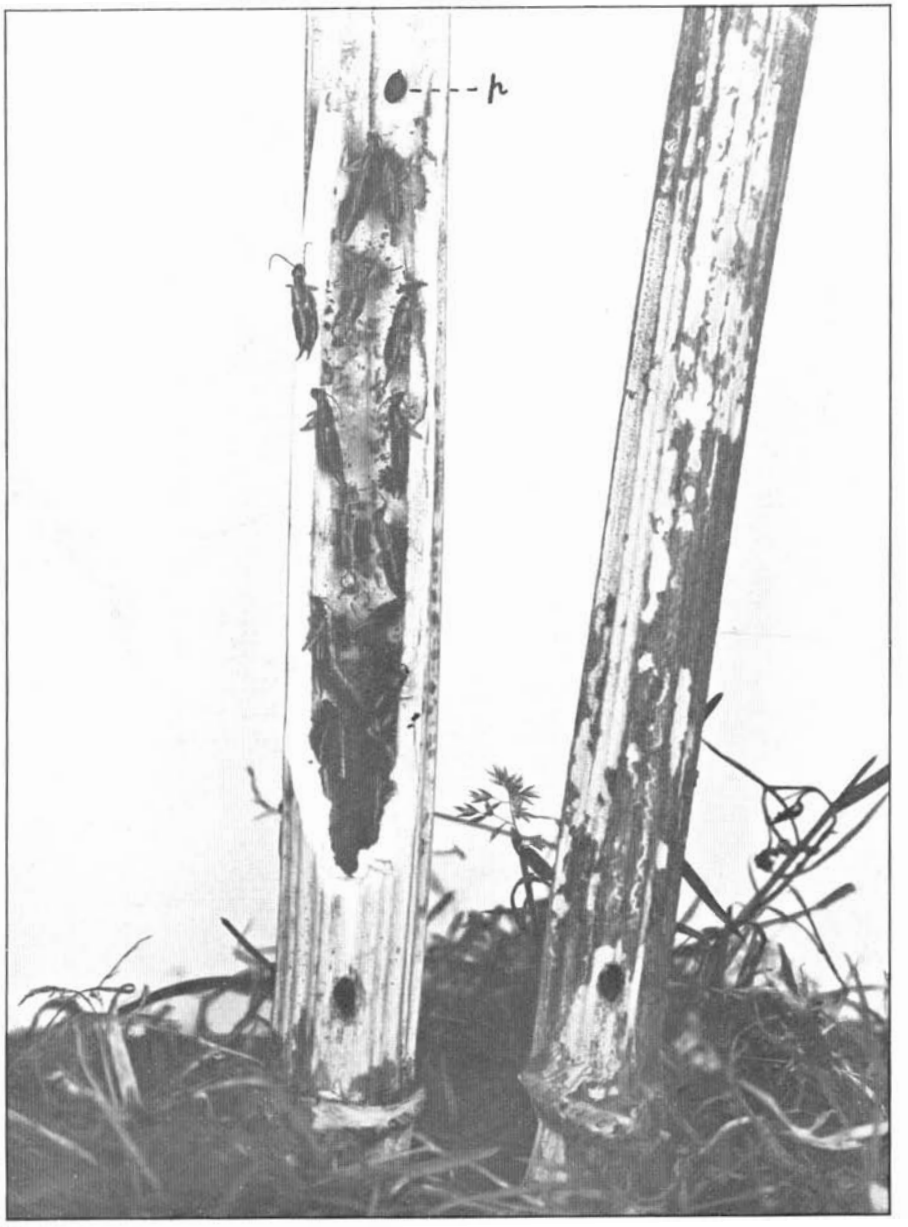
Fig. 1. Type of cage in which earwigs were kept in the insectary.

consisted of moist lettuce, cabbage leaves, sliced carrots and potatoes, etc., and their carnivorous diet was catered for by placing raw meat or mealworms in the cages. Periodically the cages were examined and any puparia of *Digonochaeta* or *Rhacodineura* that were observed were removed and placed in a refrigerator at 42°F. Puparia were found among the food, within the folds of paper, at the base of the stems of *Heracleum*, and some on, or below, the surface of the sand. On 1st December, prior to transmission of the parasites, the cages were finally examined. The sand was carefully sifted through a 2 mm. sieve and the embedded puparia thus removed. The most efficient method adopted for the disposal of the remaining earwigs was that of throwing the insects from both the sieve and the cages into a bucket of water which contained a small quantity of chloroform and a similar amount of benzene. The chloroform, being heavier than water, destroyed any earwigs that sank while the benzene rapidly killed any that floated.

Five per cent. of the earwigs proved to be parasitised. The puparia were packed in moist sphagnum moss and shipped to New Zealand in the cold-storage chamber.

These notes are published in the hope that other workers on biological control may find the information given of some assistance in their collecting work and also that entomologists interested in *Forficula* may avail themselves of this convenient method of securing material.

I am very much indebted to Dr. Imms for valuable suggestions and for the facilities afforded for this work.



Stems of *Heracleum sphondylium* showing (left) cut stem with earwigs and Tachinid puparia (*p*) *in situ*; (right) complete stem with entrance hole of Lepidopterous larva.