

## NOTE ON THE HYMENOPTERA PARASITIC ON BEETLES INFESTING GRAIN.

By EDWIN S. GOODRICH, F.R.S., Professor of Zoology and  
Comparative Anatomy in the University of Oxford.

This research was undertaken to ascertain how the presence of parasitic Hymenoptera may affect the various Coleoptera which commonly infest grain.

It is well known that several species of beetles infest wheat (*see* Barnes and Grove, "Memoirs of the Department of Agriculture in India, Chemical Series," Vol. IV, No. 6, 1916). Most of the samples I examined were kindly given to me by Prof. A. Dendy and Mr. J. Hartley Durrant, and contained *Rhizopertha dominica*, Fb., *Calandra oryzae*, L., *Calandra granaria*, L., *Tribolium castaneum*, Hbst., *Læmophloeus*, sp., and *Silvanus surinamensis*, L.

Usually small parasitic Hymenoptera were also present, sometimes in large numbers. For obtaining the identification of these I have to thank Mr. Durrant. By far the most abundant of these parasites belong to the family Chalcidæ, the commonest being the slender *Chaetospila elegans*, Wstwd., and the more bulky *Lariophagus distinguendus*, Först. Rarely a member of the family Proctotrypidæ occurred belonging to the genus *Cephalonomia*. Only *Chaetospila* and *Lariophagus* are dealt with in this Report.

The first point to determine was which of the many beetles commonly present are attacked by the parasites, and at what stage in their life-history. It was soon found that *Rhizopertha* and the two species of *Calandra* are the victims. Moreover it is the larval stage or rarely the pupa which falls a prey. On opening infested wheat grains larvæ of these beetles are often found with a hymenopteron larva attached, usually on the dorsal surface of the abdomen, sometimes on the ventral surface. Occasionally two parasites are found on one larva. The reason why these species are alone attacked is probably because the larva being bulky and of sluggish habit, with a swollen body of soft succulent tissue covered only by a thin cuticle, are unable to defend themselves and afford ample nourishment for the parasite. The larva of *Tribolium* and *Læmophloeus*, on the other hand, are elongated active creatures protected by thick chitin. The laying of the parasitic egg has not been observed; but presumably the Chalcid deposits it through the hole originally made by the beetle larva when it penetrated the grain in which it undergoes its development. The parasite absorbs the contents of its host which gradually becomes reduced to a brown and shrivelled

skin. The Chalcid then pupates and eventually emerges as a perfect insect from the grain. Every beetle larva attacked is irrevocably condemned to death; thus every adult Chalcid has accounted for one beetle. Since the Hymenoptera are sometimes very numerous they must seriously interfere with the multiplication of the beetles, and must therefore be reckoned as a useful factor in moderating their ravages. In some samples as many as 40 per cent. of the larvæ were parasitized. The Hymenoptera are all the more useful since they prey on the larvæ of just those beetles which are the most destructive; *Rhizopertha* and *Calandra* being those forms which attack and feed on uninjured wheat grains.

By experimental breeding I have proved that *Lariophagus* attacks *Rhizopertha dominica* and both *Calandra oryzae* and *C. granaria*. The experiments with *Chaetospila* were not quite so successful, and, although they establish that this Chalcid attacks both the species of *Calandra*, the evidence was not conclusive with regard to *Rhizopertha*.

The parasites develop quickly, their larval life being necessarily somewhat shorter than that of their hosts. It might, therefore, be thought that they would soon exterminate the beetles; but this never seems to happen, at least, in laboratory cultures. Rather is it the parasite that tends to die out, especially in small cultures. In fact, there is a heavy mortality among the parasites themselves. On opening infested grains a dead Chalcid imago is often found with the withered remains of the beetle larva on which it fed.

The next problem was to discover to what is due the premature death of so many of the Hymenoptera. An examination of the dead Chalcids revealed the fact that they had themselves fallen a prey to the parasitic acarid *Pediculoides ventricosus*, Newport. An excellent account of this species has recently been given by Brucker (Bull. Sc. de la France et Belgique, vol. 35, 1901). It is remarkable in that the female is viviparous, the hind region of her abdomen expanding into a large hollow sphere in which the young develop.

This voracious acarid has been recorded before as feeding on the larvæ of beetles, moths, and even bees, but, so far as I know, not on parasitic Hymenoptera. When the latter are absent the *Pediculoides* will feed on the larvæ of *Calandra*; but when Chalcids are present the acarids seem to attack them by preference. Strangely enough, while in the case of the weevils the larvæ or pupæ alone are attacked by *Pediculoides*, it is the late pupa or imago stages of the Hymenoptera which are parasitized and killed. In a grain of wheat are often found the shrivelled remains of the *Calandra* larva on which the hymenopterous larva has fed, the dead or dying Chalcid imago, and the *Pediculoides* attached to it.

Thus the whole series of events is permanently recorded in chitin, and the complete tragedy can be unfolded, even from unpromising material, by soaking it in a strong solution of potash.

A large number of experiments were undertaken to ascertain and measure accurately the effect of the Chalcids on the rate of increase of the beetles. For this purpose numerous sets of jars were incubated,

containing a given weight of wheat and a given number of weevils. After a month or more the jars were infected with a given number of Chalcids. After suitable intervals the insect contents of both infected and uninfected jars were counted and compared. Unfortunately the results have not been satisfactory, owing to various difficulties. It was found that in such comparatively small cultures, containing only one species of beetle, neither the weevils nor their hymenopterous parasites seemed to flourish normally. The parasites, indeed, die out as a rule in a few months, or even weeks, or, at all events, survive only in very small numbers. On carefully examining the cultures, I found them infested with *Pediculoides*, and have no doubt that the ill-success of these experiments was due in great part, if not wholly, to their presence.

Since the wheat used had been previously thoroughly sterilized by heat, it is clear that the *Pediculoides* had been introduced with the adult insects, and since the adult female *Pediculoides* could hardly have escaped notice and is not found on the adult beetles, the acarids must presumably have been transferred with them when quite young and small. At all events the adult weevil can act as the carrier of the *Pediculoides*.

Now it is obvious that in time both the Hymenoptera and the weevils would be exterminated by *Pediculoides*. But we know that in the mixed culture of ordinary infected wheat the weevils flourish, and the parasitic Hymenoptera continue to appear in large numbers for an indefinitely long time. In fact, a balance is established. It would appear then that some factor keeps down the number of *Pediculoides*—some factor less effective in the small pure cultures than in the large mixed ones.

*Pediculoides*, however, is probably not the only enemy the hymenopteron parasites have to contend with. Recently I have had under observation cultures of wheat, infested with *Calandra* and *Rhizopertha*, in which appear considerable numbers of the Chalcid *Lariophagus*. On opening grains dead Chalcid imagines are sometimes found, but so far no *Pediculoides*. Possibly some other acarid here attacks the Hymenoptera; but if so it has not yet been identified.

In conclusion it may be stated that several species of Hymenoptera attack and eventually kill the larva of *Calandra oryzae*, *C. granaria*, and *Rhizopertha dominica*; that these parasites considerably reduce the number of beetles infesting grain, but do not succeed in exterminating them because they themselves fall a prey to carnivorous acarids. Although the Hymenoptera may well be considered as valuable allies in the fight against weevils, yet the results of this research do not justify the hope that they could be successfully used in practice to get rid of the grain pests.

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