

SUPERPARASITISM IN *TRICHOGRAMMA*  
*EVANESCENS MINUTUM* RILEY (HYMENOPTERA:  
TRICHOGRAMMATIDAE), AN EGG PARASITE OF  
SUGARCANE AND MAIZE BORERS IN INDIA

I. Effect of Superparasitism

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INTRODUCTION

WITHIN recent years a good deal of controversy has centred round the chalcid wasp *Trichogramma evanescens minutum* Riley. Holloway and Loftin (1919) state: "The chalcis-fly *Trichogramma minutum* is universally distributed in the sugarcane fields of Louisiana and of the Rio Grande Valley of Texas, and is a very important factor in the control of the moth borer (*Diatraea saccharalis* Fabr.)." Hinds and Spencer (1928) have shown with actual figures of *Trichogramma* colonisation experiments carried out in Louisiana that "the percentage of borer eggs parasitised in the colonised fields was continuously higher throughout the season than in the check field or the average of all uncolonised fields". The colonisation of *Trichogramma* in the cane fields in Barbados has proved to be a success and Tucker (1932) says: "So long as *Trichogramma* can be mass reared economically, distributed effectively, and timed to achieve maximum effective parasitism, there is sufficient evidence in Barbados to prove that it is securing control, but none whatever to prove that it should be condemned or discarded for any other control measures, not one of which has yet been proved effective."

Evans (1930) states that ovipositing many times in one and the same egg and causing superparasitism and ovipositing even in foreign bodies, such as waxy lumps (possibly excreta of the moth *Ephesia kuehniella* Zell.), etc., by *Trichogramma* cause a dissipation of its doubtful beneficial effect. Box (1932) observes that even a high degree of parasitism by *Trichogramma minutum* does not appreciably affect the sugarcane borer population in Antigua. Tucker (1932, 1933), in evaluating the usefulness of *Trichogramma*, has enumerated the objections raised against this parasite by other workers;

some of the objections are that it is limited by restricted range of operation, it is unable to find host eggs except by random movements and it is not specific to one host. Salt (1935) observes that female *Trichogramma* parasites are unable to distinguish between suitable and unsuitable non-parasitised hosts and will select the latter for oviposition if they are of larger size than the former. He further says that when false hosts, such as flour particles, sand particles, tiny glass globules, globules of mercury, etc., are given, *Trichogramma* attempts to oviposit even in these objects, where they are of larger dimensions than the true hosts, which are available along with them.

It may be seen from the review summarised above that there are two distinct schools of thought among the economic entomologists as to the exact role that this parasite can play in the biological control of pests, mainly borers. In view of these conflicting opinions and conclusions, the authors carried out a series of experiments on the varied habits of this parasite under laboratory conditions, which have not been undertaken in detail by previous workers with this particular objective.

It is well known that superparasitism is of common occurrence in *Trichogramma*, when mass multiplied in the laboratory. We have not got enough data to show whether the progeny that result from superparasitism have the same vitality and fecundity as those that singly emerge from a host egg. During the course of the present investigations some of these aspects, namely, the emergence, vigour, mating and fecundity of the progeny that result from superparasitism, have been studied in detail. The experiments and the conclusions arrived at are described in the following pages.

#### MATERIAL AND METHODS

Though in the Parasite Laboratory attached to the Division of Entomology, a large culture of the parasite *Trichogramma evanescens minutum* Riley and its laboratory host, *Corcyra cephalonica* (Staint.) were maintained, a separate culture of the parasites for these experiments was started with a single pair of a male and a female parasite in order to obtain a reasonably pure genetic stock.

#### EXPERIMENTS

The following experiments were conducted to find out:

(a) the number of parasites that emerge from a single superparasitised egg of *Corcyra cephalonica* (Staint.),

(b) whether the progeny that result from superparasitism mate and successfully lay eggs, and

(c) the longevity and fecundity of individuals derived from superparasitised host eggs.

The experiments were conducted at a temperature of 25°–27° C. and at an average relative humidity of 75%. All the experiments were repeated at least six times.

#### OBSERVATIONS

*Number of individuals that emerged from a single superparasitised host egg.*—When the host egg was superparasitised, usually two *Trichogramma* emerged. These were either two males or two females, or a male and a female. Both had fully developed wings, or one had fully developed wings while the other had only crumpled reduced wings, or both had crumpled reduced wings. Sometimes only one parasite emerged from a host egg; but, on dissection, the egg was found to contain another partially developed individual. A few of the host eggs, from which only two *Trichogramma* individuals emerged, were found to contain, on dissection, a third partially developed form. Very rarely three parasites emerged from the same superparasitised host egg. In such cases, at least one of these had reduced wings only. In no case, however, more than three parasites ever emerged.

When the host eggs were subjected to prolonged exposure to parasites and after apparent heavy parasitisation, no emergence of the parasite took place. The host eggs, instead of turning black after parasite attack, became light brown and shrivelled. In other cases, even though the host eggs turned black, there was no emergence of the parasites; but, on dissection, the former were found to contain one or two partially developed forms.

*Mating and egg laying of individuals that emerged from superparasitised host eggs.*—Superparasitism has been found to have a definite influence on the selection of the opposite sex for mating. Mating between individuals derived from the same host egg was observed very rarely. A male parasite derived from a superparasitised host egg, however, often succeeded in mating with one derived from another superparasitised egg, but very rarely with a normally developed parasite,\* because such a male is significantly smaller than normal males. Also, it was observed that if the male was normally developed and if the female was derived from a superparasitised egg and was very small compared to the normally developed females, mating between them did not successfully take place. But when the size of the

\* Normally developed parasite refers to the one that emerges from a host egg without any superparasitism.

individuals derived from superparasitised eggs was big enough, they were able to mate with normally developed forms. Successful mating, however, was not observed between the largest and the smallest *Trichogramma*, although they attempted to mate.

When three individuals emerged from the same host egg, some did not show any tendency to mate, while others mated with individuals of about the same size.

Some of the females derived from superparasitised eggs laid eggs immediately after mating, while others did not lay any eggs even after mating.

*Longevity of individuals derived from superparasitised host eggs.*—The longevity varied just as in the case of normally developed parasites. It was usually less than twenty-four hours without food. As a rule, the males outlived the females.

*Fecundity of parasites derived from superparasitised host eggs.*—Mating between a male and a female derived from the same host egg, though very rare, was observed in two cases. One such female laid twenty-seven eggs while the other only nine eggs. When a female derived from a superparasitised host egg mated with a male derived from another superparasitised host egg, the maximum fecundity observed was thirty-nine and the minimum eight. The average of ten observations was twenty-two eggs.

*Vitality of parasites that emerged from superparasitised host eggs.*—The parasites that emerged from superparasitised eggs were not as active as normally developed parasites and took about twenty-four hours more to complete their development and emerge. Some of them were very inactive.

*Progeny of individuals derived from superparasitised host eggs.*—The progeny were apparently normal, although some females did not mate while others did not lay eggs even after mating.

#### CONCLUSIONS

From the above observations, it is seen that the number of adult *Trichogramma* that can emerge from a single superparasitised egg of *Corcyra cephalonica* (Staint.) varies from one to three, the usual number being two. In all cases of superparasitism, the progeny that successfully complete their development and emerge as adults, whether they are one, two or three, are always weak and usually have ill-developed wings, as compared with normally emerged individuals. Salt (1936) obtained upto two *Trichogramma evanescens* Westw. from a single egg of *Sitotroga cerealella* (Olivier).

When the host eggs were apparently heavily parasitised there was no emergence at all. Salt (1936) has observed this phenomenon in *Sitotroga cerealella* eggs also.

The competition between the developing parasites for the available amount of food in the host egg appears to be the factor that inhibits the normal development of the parasites, as Salt (1936) has stated. Ulyett (1936) has observed that the female of *Trichogramma lutea* Gir. has a conception of the size of the host and consequently it deposits only a single egg in the egg of *Sitotroga*, whereas it deposits three to four eggs in the larger egg of *Heliothis obsoleta* Fabr. However, in the case of laboratory breeding, on account of exposure to a large number of parasites and competition among them, superparasitism invariably results.

On account of their poor development, the mating habits are also adversely affected. Some do not show any tendency to mate; even if they mate, they very seldom do so with one emerged from the same host egg, always preferring one about their own size derived from another superparasitised host egg. They usually do not succeed in mating with a normally developed form of the opposite sex.

The fecundity is also very much affected. Such mated females lay only considerably fewer number of eggs than normal females.

#### THE PROBLEM OF ESTABLISHMENT OF THE PARASITE IN THE FIELD

Field colonisation of *Trichogramma evanescens minutum* Riley has been found unsuccessful in several cases, as has already been pointed out earlier in this paper. The observations made in the laboratory during the course of the present studies lead the authors to the conclusion that superparasitism is a potent factor which determines the success of colonisation.

In the liberations of the parasites in the field, the usual method employed is to expose the host eggs to the parasites under laboratory conditions and deploy these parasitised eggs on cards in the infested fields in a suitable manner. There is nothing to check or indicate whether the host eggs are superparasitised. If they are superparasitised, the observations made above would indicate a failure of the colonisation, on account of the following reasons:

1. The adults that emerge from the host eggs will be mostly defective ones; many do not have even a tendency to mate. Some will not lay eggs even after mating.

2. Even if the parasites by chance mate, the defective development, namely, ill-developed wings and inactive habit, stand in the way of their actively moving about in the field to find out the host eggs.

3. Even if the host eggs are sought out, the reduced fecundity will lead to a much lesser extent of parasitism.

From what has been stated above, it is more or less clear that if we want to colonise successfully infested fields with *Trichogramma* parasites and get the desired results, the parasites should be those that have emerged from such host eggs that have not been superparasitised at all, or even if superparasitised, it should be as low a percentage as possible. For this purpose special techniques, though very difficult, have to be evolved.

The population of the host eggs in the field at the time of liberation of the parasites is another important factor to be taken into consideration in successful colonisation. Should the population of the host eggs be too small in the field at the time of the first liberation, the parasites that emerge may superparasitise the available host eggs, which would result in encountering with the same problems as enumerated above. It is, therefore, essential to regulate the initial liberation of the parasites as well.

#### SUMMARY

1. There are two diametrically opposite schools of thought as to the utility of *Trichogramma evanescens minutum* Riley for the biological control of insect pests.

2. Experiments have been conducted to assess the role of superparasitism in *Trichogramma* field colonisation.

3. The observations from the experiments show that as a result of superparasitism, though, one to three adult parasites may emerge from the egg of *Coreyra cephalonica* (Staint.), they are defective; they generally have ill-developed wings and are inactive. They mate with forms of about their own size only, if they show any tendency to mate at all; and even if they mate the fecundity is comparatively low.

4. The reason for the improper development of the parasites is attributed to the sharing of the limited amount of food in the host egg between the developing parasites.

5. These observations lead the authors to the conclusion that superparasitism is a very potent factor that determines the success or failure of the colonisation of *Trichogramma* in the field.

6. For successful colonisation, it is suggested that when the parasites are reared in the laboratory for mass liberation, every care should be taken to avoid superparasitism of the host eggs, for which special techniques have to be evolved; and also the initial population of the borer eggs in the field has to be taken into consideration at the time of the release.

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