HOST SELECTION AND OVIPOSITION RESPONSE IN *APANTELES ANGALETI* MUESEBECK (BRACONIDÆ: HYMENOPTERA)

BY E. S. NARAYANAN, F.A.SC., B. R. SUBBA RAO, F.A.SC. AND R. B. KAUR

(*Division of Entomology, Indian Agricultural Research Institute, New Delhi*)

Received June 16, 1958

INTRODUCTION

Apanteles angaleti Muesebeck is a solitary endoparasite of the pink bollworm *Platyedra gossypiella* Saunders in India. The parasite was first reared from infested bolls collected from experimental cotton fields of the Agronomy Division in the parasite laboratories of the Indian Agricultural Research Institute during the summer months of August and September 1954 and it was described as a new species to science by Muesebeck (1954). The parasite is being bred in large numbers on the alternate host *Corcyra cephalonica* Stainton in the parasite laboratories of the Indian Agricultural Research Institute by adopting the technique described by Narayanan *et al.* (1956). *Platyedra gossypiella* is a pest of world importance and causes severe damage to cotton bolls not only in India but also in the other major cotton-growing countries of the world, like Pakistan, Sudan, Egypt and U.S.A. The infestation sometimes is so serious that entire cotton fields are almost devastated. So the control of the pest assumes particular significance especially in relation to the rural economy in the cotton-growing areas of the Indian Union. Yet, the control of the pest is one of the baffling problems that has ever faced the economic entomologists, not only in India but also in other countries of the world where cotton is grown. The insecticidal method of control though practised in the most advanced countries of the west, notably the United States of America, has not effectively solved the problem. So the U.S. Department of Agriculture have sent their entomologists from time to time on missions to comb the other cotton-growing areas of the world, to discover new natural enemies of the pest with a view to introduce and establish them in the new world to control the pest. For, after all, the insecticidal method of control is only palliative that has to be repeated year after year. More fundamental in approach is the biological basis of the insect control. *Apanteles angaleti* is one of the primary parasites that can be utilized in the control of this serious pest. But before any parasite can be released in the

field it is of utmost importance that its biology and ecology should be studied in detail in the laboratory. Biology and ecology are the basis of all insect control. In fact, a good deal of work has been done on the host selection of ectoparasites but the studies on the endoparasites seem to have been neglected to a great extent. We have very few published literature on this subject. Salt (1935) has made an exhaustive study of host selection in *Trichogramma evanescens* Riley. But he as well as others have studied host selection by utilizing a number of different species of hosts, whereas the present studies are confined only to the selection of a suitable developmental stage of the same host, *Corcyra cephalonica* Stainton. In this paper the host selection and oviposition response in *A. angaleti* has been studied in detail.

MATERIAL AND METHODS

Corcyra eggs were kept in separate bottles every day for hatching and the bottles were numbered and particulars about the date on which the eggs were put into the bottles and the date on which they hatched were clearly written on the bottle by means of a coloured glass pencil. Freshly hatched larvæ were taken out by means of a fine camel hair-brush and a known number of larvæ were placed in a small petri dish containing a small quantity of fine flour (Maida). The petri dish was covered with a lid and held tight by means of India rubber bands. Three such dishes were prepared for each experiment each day and kept in a desiccator maintaining 70% relative humidity and the latter placed in an incubator running at constant temperature of $27 \pm 2°$ C.

Each of these petri dishes containing the required number of known aged larvæ was exposed to a pair of freshly emerged mated female parasites and a piece of raisin was given as food. The petri dishes containing the host larvæ and the parasites were placed back in the desiccator. After every 24 hours the dishes were removed and the parasites were carefully transferred to another set of dishes containing unparasitised host larvæ of the same age. This was continued until the parasites died. Every day the host larvæ were dissected to find out the number of eggs contained in each host larva. Knowing the age of the host larvæ, the number of hosts dissected, the number of hosts parasitised and the number of eggs laid, the percentage of parasitism was calculated. Olfactometer experiments were also performed to corroborate the results obtained by the dissection method.

OBSERVATIONS

The females after being confined to oviposition cages immediately start searching for the hosts if they have completed their pre-oviposition period,

which is usually 24 hours in this species, by vibrating their antennæ on the thinly spread flour above the host larvæ. After the host has been located, the selection of a suitable host is done by means of her ovipositor which can be observed piercing through the flour to reach the host larvæ.

The experiments were started with 24 hours old larvæ and were repeated with the increase in age by every 24 hours. During the course of these investigations, larvæ from one to eighteen days old were offered to the parasite to study the oviposition response.

The results obtained in the experiments on the dissected host larvæ are tabulated in Table I.

TABLE I

Showing the oviposition response of Apanteles angaleti *to different ages of the host larvæ*

No. of Exp.	Age of the host	No. of Dissections	Total No. of larvæ parasitised	Total No. of eggs laid	Maximum No. of eggs laid in a single host	Percentage of eggs laid	Percentage of parasitism
1	24 hours	.. 139	4	4	1	2·87	3
2	48 hours	.. 124	11	16	3	12·9	9
3	72 hours	.. 674	240	306	3	45·7	35·6
4	96 hours	.. 364	168	354	11	97·20	46·15
5	120 hours	314	189	314	8	100	60·2
6	144 hours	.. 248	180	277	**13**	**111·7**	**72·58**
7	168 hours	.. 600	364	670	7	111·66	60·66
8	192 hours	.. 467	200	342	10	73·34	42·82
9	216 hours	.. 415	58	102	9	24·57	13·97
10	240 hours	.. 252	23	34	4	13·5	9·1
11	264 hours	.. 249	16	24	2	9·6	6·4
12	288 hours	.. 140	..	..	..	..	..

It is quite clear from Table I that oviposition response is maximum when 6 days old larvæ are exposed, though there is not much significant difference among the 5, 6 and 7 days old larvæ. It is interesting also to observe that all these stages are of the same instar. The percentage of parasitism is 60·2, 72·58 and 60·66 respectively for the three different ages. Preference to 6 days old larvæ is also clearly indicated by the

maximum number of eggs laid, *i.e.*, 13 in a single host. After this age the oviposition response slowly decreases and when the host is of 12 days old hardly any egg is deposited.

Table I is graphically represented in Fig. 1. The curve shows a gradual rise in the percentage of parasitism from one day old larvæ to six days old larvæ, which is the peak of the curve and is therefore the optimum age of the larvæ suitable for oviposition. From 6 days onwards the percentage gradually falls down somewhat in the same way as it had risen in the beginning of the curve.

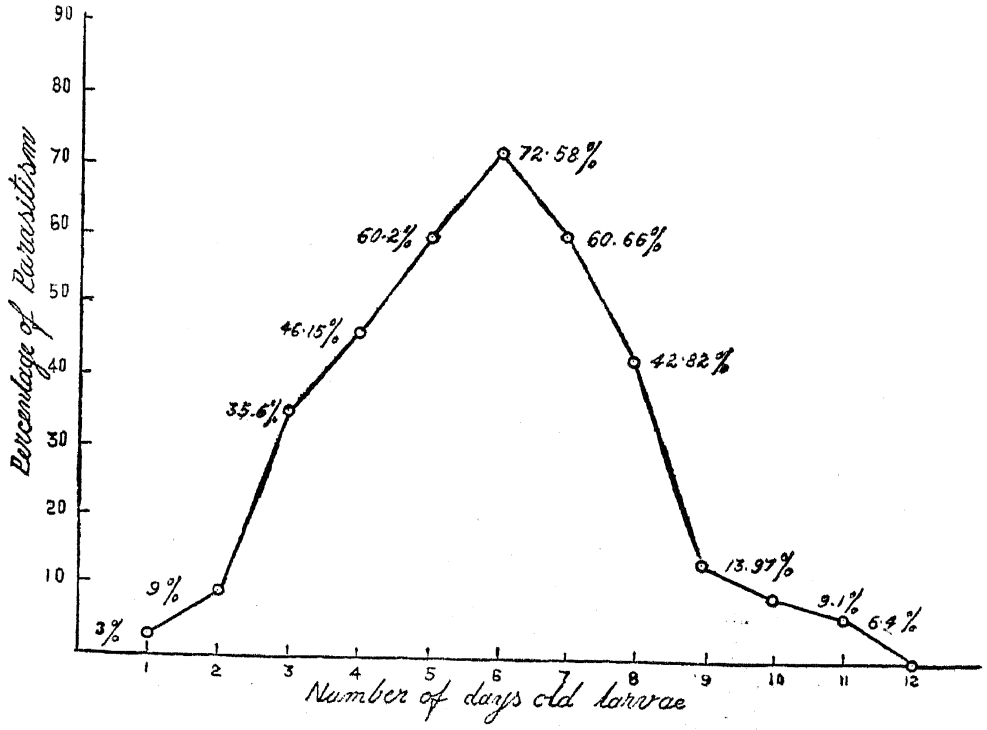

FIG. 1

After completing the experiments on host selection behaviour of *Apanteles angaleti* a few experiments were also conducted in a modified McIndo's Olfactometer to investigate the olfactory responses of the parasite to various stages of host larvæ. The Olfactometer experiments were conducted mainly to corroborate the earlier results obtained and also to find out whether the parasites could select the host through olfactory senses. Host larvæ of different ages were used for experiments and the following results have been obtained:

Oviposition response of Apanteles angaleti *to different ages of* Corcyra *larvæ in Olfactometer*

EXPERIMENT I

Sl. No. of Experiment	No. of females entered the arm of Olfactometer containing	
	1 day old larvæ	5 days old larvæ
(*a*)	5	10
(*b*)	6	6
(*c*)	4	6
(*d*)	10	4
(*e*)	3	2
TOTAL ..	28	28

EXPERIMENT II

Sl. No. of Experiment	No. of females entered the arm of Olfactometer containing	
	5 days old larvæ	9 days old larvæ
(*a*)	3	12
(*b*)	11	7
(*c*)	9	2
TOTAL ..	23	21

EXPERIMENT III

Sl. No. of Experiment	No. of females entered the arm of Olfactometer containing	
	6 days old larvæ	12 days old larvæ
(*a*)	6	7
(*b*)	6	7
(*c*)	5	2
TOTAL ..	17	16

EXPERIMENT IV

Sl. No. of Experiment	No. of females entered the arm of Olfactometer containing	
	5 days old larvæ	19 days old larvæ
(*a*)	7	9
(*b*)	4	12
(*c*)	3	12
(*d*)	1	8
TOTAL ..	15	41

The results of the above experiments are not very significant.

It is seen that irrespective of the age of the host larva the ovipositing females entered one or the other arm of the Olfactometer containing host larvæ. It is evident that the females are attracted only to the smell emitted by the host larvæ, but they are not able to discriminate further the age of the host larvæ by different smells or in other words there is no difference in the odour emitted by the larvæ of different ages.

DISCUSSION

Notwithstanding the mass of published literature that exists relative to the hosts of entomophagous parasites, we are completely in the dark as to the determining factors that govern certain parasites constantly to select certain host species, while others utilise hosts of different taxonomic relationships. The vast majority of parasites are but seldom restricted to a single host species. *Apanteles angaleti* is an endoparasite of *Platyedra gossypiella* Saunders in India which has not been recorded on any other host hitherto.

When insects reproduce in artificial confinement, the need for utilising the sense of smell for finding out their mates, food or egg deposition sites is generally diminished. Nevertheless, it has been observed that odour may be a critical factor in the mass production of certain species of parasitic Hymenoptera (Flanders, 1944). During the course of the present investigations on the host selection of *A. angaleti*, it has been observed that the faculty of chemical senses is not at all utilised. In this particular case the investigations were confined to the same species of host namely *Corcyra cephalonica* St.,

but to different ages of the host larvæ. It was observed that when larvæ were kept for development for about 12 days in small quantities of fine flour (Maida) some developed better than the others, in spite of the same ecological environments. When such a group of larvæ, though of the same age but of different growths were offered for parasitisation, the female parasites preferred the smaller ones. On the other hand, newly hatched larvæ were not preferred by the parasite. The percentage of parasitism slowly rises to the maximum when the host larvæ of about 6 days old are offered. From this period onwards the percentage of parasitism decreases and in 12 days old larvæ very few eggs are laid. From this experiment we can safely conclude that the parasite prefers larvæ that are 5, 6 or 7 days old and rejects freshly hatched or 12 days old larvæ. When too small or too big hosts are offered, the parasites tend to retain their eggs rather than deposit them and if a few eggs are laid, it is only due to the restraint on the part of the female parasites.

Salt (1935) made an attempt to discover by well planned scientific experiments and to express in precise scientific language some of the criteria by which ovipositing females of *Trichogramma evanescens* Riley, choose their hosts. The criteria which he examined were: (1) position, (2) odour, (3) texture, (4) colour, (5) absolute size, (6) shape. After examining all these criteria, the author came to certain definite conclusions. For instance, he defined the objects accepted as "hosts" and one on which the fertile offsprings can generally be reproduced as "suitable hosts". Taking this as an example, it can safely be said that the suitable stage of host of *Apanteles angaleti* in mass breeding is 4 to 8 days old *Corcyra* larvæ with the maximum reproduction in 6 days old larvæ.

It has been observed that *A. angaleti* is unable to distinguish a healthy host from that of a parasitised one and this results in superparasitism. Eggs are laid under darkness as well as light and a maximum of 13 eggs have been dissected from a single host. The female parasite in the site of the host larvæ goes on vibrating her antennæ to locate the host (which is imbedded in the flour) and once the host is located by means of her olfactory senses, the selection of a suitable host is done by means of her ovipositor. Hence it is not necessary that every time the ovipositor is seen piercing the host body, an egg should be deposited. In fact most of attempts fail if the texture of the larval integument is too tough for piercing. It is evident that oviposition is guided by a stimulus which is not chemical but physical namely the sense of touch. It can be stated with certainty that the selection of a suitable stage of host is dependent on its physical characters such as size or developmental condition and rigidity or hardness of the host integument.

A series of Olfactometer experiments conducted to find out the olfactory response of the female parasites to various stages of the host showed that the parasites could not distinguish between the two developmental stages of the host. Had selection been dependent upon odour, the majority of females should have shown preference to a suitable stage of the host larvæ but the results were most inconsistent and the preference to hosts based upon odour was not in agreement with the actual oviposition response experiments. There can be little doubt that the odour emitted by various stages of the *Corcyra* larvæ is more or less the same. Hence the parasite was only able to locate the host with the sense of smell but was not able to oviposit due to the lack of oviposition stimulus.

Most of the earlier workers have emphasised upon the chemical senses as the basis of the host selection. But their work concerns mostly with entomophagous parasites selecting a suitable host from different species. However, there is no literature on host selection of an endoparasite selecting a suitable host from the same species but of different developmental stages. So, the present studies add to our knowledge of the fundamental aspects of parasite specificity. The selection in case of *Apanteles angaleti* is based primarily upon the physical characters of the host larvæ and the stimulus for oviposition is the sense of touch and not that of smell which is often seen in most of the other entomophagous Hymenopterous parasites.

SUMMARY

1. *Apanteles angaleti* Muesebeck is a solitary endoparasite of the *Pink* bollworm, *Platyedra gossypiella* Saunders in India.

2. The host selection of the parasite has been studied in detail. The females prefer 4 to 8 days old larvæ for oviposition and the maximum eggs are deposited in 6 days old larvæ.

3. Various factors which stimulate oviposition in parasites in general and particularly in the case of *Apanteles angaleti* have been discussed. In this case the host selection is based primarily on physical characters of the host larvæ such as rigidity of integument. Stimulus for oviposition is the sense of touch and not that of smell.

REFERENCES

1. Flanders, S. E. .. "Olfactory responses of parasitic Hymenoptera in relation to their mass production," *J. Eco. Ent.*, 1944, **37**, 711–12.

2. Muesebeck, C. F. W. .. "Some Braconid parasites of Pink bollworm *Pectinophora gossypiella* (Saunders)," *Boil. Lab. Zool. gen. Agric., Portici*, 1956, **33.**

3. Narayanan, E. S., Subba Rao, B. R. and Gangrade, G. A. .. "The biology and rate of reproduction and the morphology of the immature stages of *Apanteles angaleti* Muesebeck," *Beitr. Zur. Ent. Band.* 6, *NR.* ¾, 1956, 296–320.

4. Salt, G. .. "Experimental studies in insect Parasitism—III. Host selection," *Proc. Roy. Soc.*, 1935, Series **B, 117,** 413–35.

116-59 Printed at The Bangalore Press, Bangalore City, by C. Vasudeva Rao, Superintendent, and Published by The Indian Academy of Sciences, Bangalore.