TECHNIQUE OF MASS MULTIPLICATION OF *TENOBRACON DEESAE* (CAM.) HYMENOPTERA : BRACONIDÆ FOR USE AGAINST SUGARCANE AND MAIZE BORERS

By E. S. Narayanan and T. V. Venkatraman

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

Received August 23, 1951

(Communicated by Dr. S. V. Desai, F.A.SC.)

Introduction

Stenobracon deesæ (Cam.) is an important larval parasite of the sugarcane top borer *Scirpophaga nivella* F., the stem borers, *Argyria sticticraspis* Hmpsn., *A. tumidicostalis* Hmpsn., *Diatræa auricilia* Dudgn., *D. venosata* Walk., *Sesamia inferens* Walk., *S. uniformis* Dudgn., and the root borer, *Emmalocera depressella* Swinh., as well as the maize and jowar stem borer, *Chilo zonellus* Swinh. It is a large braconid which makes its appearance in sugarcane and maize fields for a short period (June-August) and parasitises a large percentage of larvæ. With an ovipositor longer than its body and measuring more than 16 mm. long, the female parasite (Text-Fig. 1) is endowed with the capacity of reaching borers living in protected situations, especially those inside the rootstock like the root borer (Narayanan, 1938). Though the parasite has apparently a number of hosts, most of them happen to be borers of allied crops so that it can be considered as a potentially effective agent of control of the sugarcane and maize borer complex as a whole.

Attemps to control the sugarcane stem and root borers by large-scale releases of the egg parasite, *Trichogramma evanescens minutum* Riley have given encouraging results in some parts of India. Laboratory studies and field observations have indicated that *S. deesæ* could similarly be successfully used to control the sugarcane and maize borers if a suitable laboratory host on which it can be propagated in quantities were obtainable. As a result of preliminary trials, a suitable host has been discovered in the larva of the "Rice Moth", *Corcyra cephalonica* Stn. The availability of an alternate host for the breeding of *S. deesæ* has opened up encouraging possibilities for releasing it in large numbers in the field, so as to bring about an effective control of the cane and maize borers by the combined use of both egg

and larval parasites. In this paper, the method of breeding the *Stenobracon* parasite in the laboratory on an alternate host is described in some detail.

It may, however, be borne in mind that in the case of *Stenobracon* mass multiplication would merely imply a large-scale breeding and not its production in millions, as is possible in the case of the egg parasite, *Trichogramma*, which by the improved methods recently developed, is now produced, a million a day at a cost of 6·5 dollars per million in the U.S.A. (Spencer, Brown and Phillips, 1935). In fact, the cost of production is only about Rs. 20 per million at the Parasite Laboratory of the Indian Agricultural Research Institute, New Delhi, which compares favourably with the cost of production in U.S.A. Even if the *Stenobracon* parasite can be bred in large numbers and if by properly timed liberations, the natural lack of synchronisation between the populations of pest and parasite can be remedied, the object can be achieved. The releases, however, will have to be combined with that of the egg parasite, *Trichogramma.*

Technique of Mass Culture

Host Material

The first problem was to find out an insect in which *Stenobracon* would oviposit readily in the laboratory and develop, and which could be easily propagated in the laboratory at fairly low cost. Among the factitious hosts tested were the wax moth, *Galleria mellonella* Linn.; the cotton bollworms, *Platedra gossypiella* Saund., and *Earias fabia* Stol.; the mulberry silkworm, *Bombyx mori* Linn.; the potato tuber worm, *Gnorimoschema operculella* (Zell.) and the Rice moth, *Corcyra cephalonica* Stn. The larva of the Rice moth, *C. cephalonica*, only proved to be attractive to the parasite and suitable for its development.

Laboratory-reared host material.—C. cephalonica is mass produced in the Parasite Laboratory of the Indian Agricultural Research Institute, in specially designed cabinets and cages at a very low cost. The eggs of the moth are being used for the mass production of the egg parasite, *Trichogramma.* The full grown larvæ are used to culture *Stenobracon* parasites. Crushed jowar is the host-supporting medium and small quantities of yeast and wheat bran are mixed with jowar to make the medium nutritionally as complete as possible.

Field-collected host material.—In the biological control of some insect pests it is always economical to supplement the mass breeding of hosts by field-collected host material. Field collection of the larvæ of the maize borer, *Chilo zonellus*, has been found to be practical and economical. At the time of harvest of maize crop, the larvæ are found in large numbers in the stems,

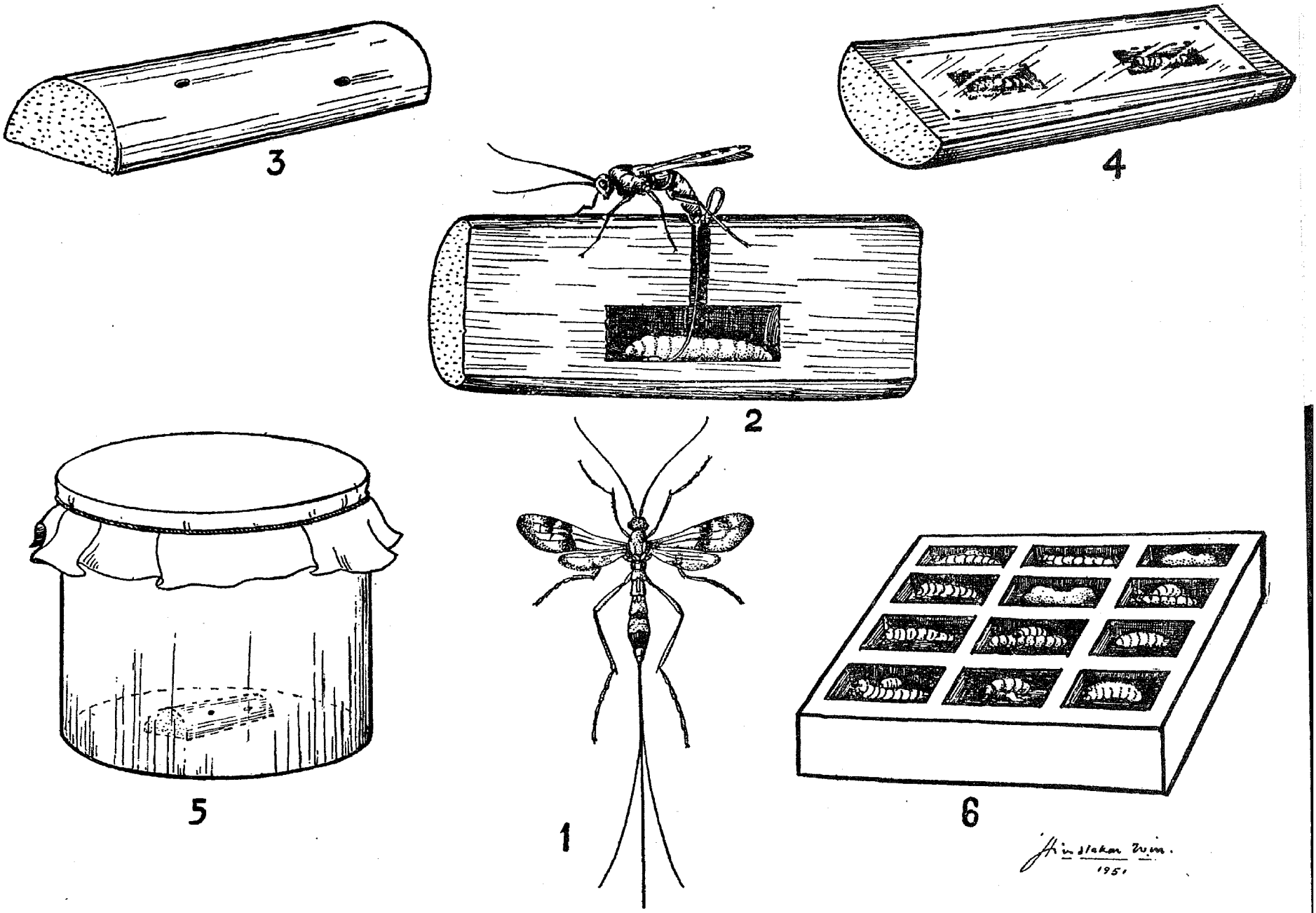


FIG. 1. *Stenobracon deesæ*, female, × 2.
FIG. 2. *Stenobracon* ovipositing on *Corcyra* larva in sugarcane stem.
FIG. 3. Sugarcane stem enclosing factitious host, from above.
FIG. 4. „ „ „ „ seen through celluloid covering below.
FIG. 5. Oviposition jar.
FIG. 6. Wooden block used for rearing parasite grubs.

hibernating in the advanced larval stage. Large quantities of the host material could be collected and stored *in situ* inside maize stems and used for the culture of the parasites as and when required. The stems containing the caterpillars are kept exposed to night temperatures in winter months, by hanging them from the roof of the Parasite Laboratory, which prevents pupation of the caterpillars to some extent. The caterpillars collected and stored in this way can be used for 2–3 months beginning from the month of Septemoer. The hibernating caterpillars of the sugarcane top borer, *S. nivella,* can also be collected in large numbers from the field at the time of sugarcane harvest and stored in a frigidaire at a temperature of about 15° C.

Mass Multiplication of Parasites

Method of offering host larvæ for parasitisation.—Several methods were tried to present the factitious host for parasitisation and from the point of view of maximum parasitisation the method described below has been found most suitable. Pieces of sugarcane stem (Text-Fig. 3) about 3–4″ long and split longitudinally into equal halves, serve very well to enclose the host larvæ. Two to three tunnels (each $\frac{1}{2}'' \times \frac{1}{4}'' \times \frac{1}{4}''$) are prepared in each piece by scooping out the stem from the cut side. The host larvæ are placed in these artificially prepared tunnels, one in each. The caterpillars are prevented from crawling out by means of rectangular pieces of celluloid fixed in position by small pins (Text-Fig. 4). One or two vertical holes about 1·5 mm. in diameter are drilled from the rind towards the tunnel. The parasitised larvæ can be easily made out through the transparent celluloid covering.

Preliminary experiments on the behaviour of the adult females have shown that the odour emanating from the frass of the natural host is a dominant factor in the initial attraction of the female parasite to the host. Hence the external holes on the stem are plugged with frass before exposing them in the oviposition cage. Fresh frass can be easily collected from the field in large quantities and stored in the refrigerator.

Mating.—The parasites, on emergence, are isolated and kept in pairs inside glass tubes (6″ × 2″) open at both ends, for mating. The species mate readily and are fed on 5% sugar solution or preferably on a solution of 1 part of honey and 10 parts of water. The mating tubes are kept in a well lighted place.

Oviposition.—Cylindrical glass jars (4″ × 4″) with muslin covering are very handy and suitable for presenting the host to the parasite (Text-Fig. 5). About 20–24 hours after emergence, the pairs are removed to the

oviposition cages, one pair in each, and sugarcane pieces containing the factitious host are introduced into it. Honey solution is provided in cotton swabs as food for adults. The females are ready for oviposition in about 20 hours after emergence. As soon as the female comes into contact with the piece of stem, it first tries to locate the host inside, by pulsating the antennæ and then begins to lay eggs after stabbing and paralysing the host (Text-Fig. 2). Plate I shows a *Stenobracon* female, caught by the camera, in the act of laying eggs, in the laboratory. Usually only one egg is laid on host but under laboratory conditions, more than one is laid. The oviposition cages are examined twice a day, and the parasitised larvæ are removed and stored in wooden blocks for further development. The rearing jars and muslin covering should be kept clean and free from fungus growth and mites.

Storing of parasitised material.—The parasitised host larvæ containing the eggs and grubs are carefully removed by means of a fine camel-hair brush to a wooden cavity block having rectangular shallow tunnels (Text-Fig. 6). Moistened bits of blotting paper are kept in the wooden cavities on which the parasitised material is placed. The blotting-paper prevents the host larvæ from drying up. If more than one egg is laid on a host, the superfluous eggs are transferred to other paralysed caterpillars on which no egg has been laid. The grubs when full fed, pupate on the blotting-paper and these can be easily removed from the wooden block and stored in petri-dishes for the emergence of parasites.

Development of the grubs.—It is found that more than one full-grown *Corcyra* larva was necessary for the completion of the development of a parasite grub. Several methods were tried to paralyse the host larvæ required for feeding the parasite grub. The codling and amputation methods used by Venkatraman, Negi and Gupta (1948) in the propagation of *Bracon greeni*, were not suitable as the larvæ thus treated decayed and were not liked by the grubs. *Corcyra* larvæ which are already stabbed and paralysed by a different braconid (*Bracon gelechiæ*) have been found quite suitable for this purpose. *B. gelechiæ* readily paralyses host larvæ within a few minutes of exposure and there was no difficulty in obtaining paralysed *Corcyra* larvæ for feeding the grubs. When paralysed *Corcyra* larvæ are offered to the parasite grubs they readily attach themselves to the host and start feeding in a few minutes. Usually two full-grown larvæ are sufficient for the normal development of the parasite grub, but rarely three may be consumed by a grub. Adults bred in this way are quite normal both in size and vigour.

Factors Bearing on the Reproduction of the Parasite in the Laboratory

Regulation of sex ratio.—In the culture of *Stenobracon* on the factitious host (*Corcyra*) there is a very high preponderance of males and a decline in the proportion of females in the successive generations was evident. This appears to be the only drawback in the culture of *Stenobracon* on the factitious host. The factors responsible for affecting the sex ratio is under analysis and one of the apparent causes seems to be the poor quality of the host contents which is again dependent on the nutritional qualities of the host-supporting medium, *i.e.*, jowar. Recently, Flanders (1949) has rightly stressed the need for special attention to nutrition in the case of some entomophagous insects propagated under artificial conditions. A recent advance in this direction is the use of artificial media for the propagation of the host (Theron, 1947). In the case of *Stenobracon*, the normal sex ratio is obtained when the *Corcyra*-bred adults are put back on the natural hosts (*Chilo* or *Argyria*) for breeding. Even under natural conditions the percentage of females is found to be as low as 30. This may be one of the reasons for the low population of the parasite in the field in spite of its polyphagous habit.

Temperature and humidity.—In order to obtain the maximum production per unit of time the rearing temperature and humidity should be such that normal development proceeds with maximum rapidity. A temperature of about 70° F. with about 80% Relative Humidity, is found quite suitable for the production of *Stenobracon.*

Superparasitism and cannibalism.—Under laboratory conditions, when there is a scarcity of host material, more than one egg is laid on a single host and under such conditions cannibalism is prevalent. While examining the parasitised material care is always taken to remove the excess number of eggs and grubs to prevent mortality due to cannibalism.

Our experience during the last three years have shown that if the above precautions are taken, the parasites can be bred in large numbers without any difficulty and the culture maintained in a healthy condition both during the summer and winter months.

Summary

Stenobracon deesæ (Cam.) is a potentially effective larval parasite of sugarcane and maize borers.

The equipment and methods used in the mass propagation of the parasite, *S. deesæ*, are described in some detail. A suitable laboratory host for the propagation of the parasite in the laboratory has been discovered in the

larva of the Rice moth, *Corcyra cephalonica* Stn. The method of exposing the factitious host (*Corcyra*) in artificial tunnels prepared in sugarcane stem is described. Fersh frass of the natural hosts (*Chilo* or *Argyria*) is used to stimulate the female parasite to oviposit on the factitious host, in the laboratory. Laboratory-bred alternate host material is supplemented by field collected natural hosts.

It was found that a single parasite grub requires more than one *Corcyra* larva to complete its development. *Corcyra* larva previously paralysed by another braconid parasite (*Bracon gelechiæ*), is given to the parasite grub, one by one until it becomes full fed.

The percentage of females bred on *Corcyra* is very low and one of the main factors responsible for this, appears to be the nutritionally incomplete quality of the host-supporting medium. The normal percentage of females is restored by putting the *Corcyra*-bred adults to oviposit and breed on the natural hosts.

ACKNOWLEDGMENT

We gratefully acknowledge the interest evinced in this piece of research by Dr. B. P. Pal, Director, Indian Agricultural Research Institute, New Delhi.

REFERENCES

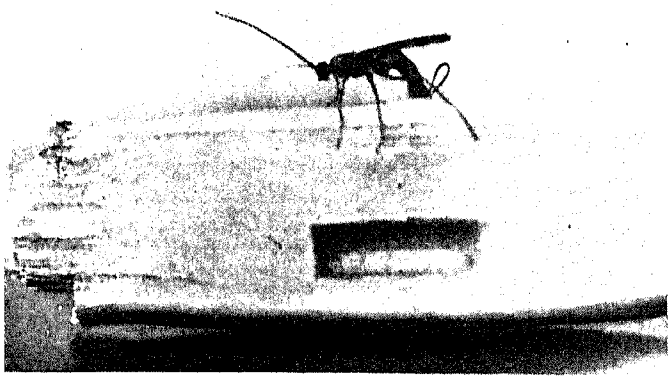
1. Flanders, S. E. .. "Culture of entomophagous insects," *Canad. Ent.*, 1949, **81**, No. II, 257–74.

2. Narayanan, E. S. .. "A Note on *Stenobracon deesæ* (Cam.), a parasite of the root borer of sugarcane," *Ind. J. Agric. Sci.*, 1938, **8**, Pt. II, 215.

3. Spencer, H., Brown, L. and Phillips, M. "New equipment for obtaining host material for the mass production of *Trichogramma minutum*, an egg parasite of various insect pests," *U.S. Dept. Agr. Circ.*, 1935, **376**, 17 pp.

4. Theron, P. P. A. .. "Studies on the provision of hosts for the mass-rearing of codling moth parasites. *Fruit Research* (Tech. Ser. 4)," *Union of S. Afr. Dept. Agr. Sc.* B, 1947, **262**, 45.

5. Venkatraman, T. V., Negi, P. S. and Gupta, S. N. "Preliminary trials in the propagation of *Bracon* (=*Microbracon*) *greeni*, on unnatural hosts," *Proc. Ind. Acad. Sci.*, 1948, **27**, 92–104.



Photograph showing *Stenobracon* in the act of oviposition on the factitious host in sugarcane stem.