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A TECHNIQUE FOR ARTIFICIALLY CULTURING ICHNEUMONID PARASITES OF WOODWASPS (HYMENOPTERA : SIRICIDAE)

BY

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Oviposition under artificial conditions was readily induced in the primary parasites *Rhyssa persuasoria* and *R. amoena* and the cleptoparasite *Pseudorhyssa sternata*, ichneumonid ectoparasites of the larvae of siricid woodwasps.

A method of rearing their immature stages on natural and substitute hosts is described.

Rhyssa persuasoria L. and *R. amoena* Grav., which are primary ichneumonid ectoparasites of siricid woodwasps, drill through wood to locate their host larvae, which produce cylindrical galleries that are packed with frass and contain the larval exuviae. The frass and surrounding wood are permeated by a symbiotic fungus, *Amylostereum* sp., which is introduced by the siricid female during oviposition.

The cleptoparasite, *Pseudorhyssa sternata* Merrill, inserts its ovipositor down the oviposition holes made by the *Rhyssa* species, and deposits its egg near the egg or young larva of the primary parasite. The first instar larva of *P. sternata* kills the primary parasite by combat, and then develops on the siricid larva.

Frass from siricid galleries and also the *Amylostereum* symbiont, cultured on potato dextrose agar, stimulate *Rhyssa* females to drilling activity, but hosts alone do not stimulate drilling although their presence is generally necessary for egg deposition.

For studies on the biology of the parasites, it was found necessary to develop simple methods of securing oviposition and rearing the immature stages.

Method of obtaining oviposition

The technique for obtaining eggs of the primary parasites was as follows. Forty cavities (20 mm × 7 mm × 7 mm deep) were drilled in a Perspex (oviposition) sheet (30 cm × 15 cm × 1 cm thick) and a *Sirex* larva or pupa was put into each cavity on a layer of frass. (It was necessary to keep the frass wet in order to attract female *Rhyssa* species and ensure oviposition, and to prevent desiccation of the eggs). The cavities were covered with strips of thin, white paper fixed by cellulose acetate tape. The oviposition sheet was put on the top of a gauze-covered cage (30 cm × 30 cm × 30 cm) with the cavities facing downwards, and was maintained at 25°, 70% R.H. and normal laboratory lighting or total darkness.

Five mated *Rhyssa* females (0—3 days old) were placed in each cage and supplied with water, and honey containing 1 per cent protein hydrolysate. The mean length of life of *R. persuasoria* females at 25° was 55 days. The *Rhyssa* females were attracted to the frass-filled cavities of the oviposition sheet, palpated with their antennae over the paper covering, and then drilled into the cavities (Fig. 1). If the host was located, it was paralysed and an egg laid on it or the surrounding frass (Fig. 2).

The parasite eggs and paralysed hosts were removed daily and drilling activity was recorded by counting the holes drilled in the paper. Occasionally, *Rhyssa* females drilled through the polystyrene floor of the cages and into the wooden shelves supporting them. Several eggs were collected from the lower surfaces of the shelves.

To obtain eggs of the cleptoparasite, females of *P. sternata* and *R. persuasoria* were put together in a cage with the oviposition sheet. Alternatively, the cells were covered with paper drilled by *R. persuasoria* and only *P. sternata* females were put in the cage. *P. sternata* locates the holes made by *Rhyssa* in the paper covering, and inserts its ovipositor through them and into the cell. *P. sternata* oviposits in the absence of siricid or *Rhyssa* species larvae.

More than 100 eggs of *Rhyssa* species were obtained from 240 host larvae exposed by this method, with a maximum of 5 on one host. The maximum oviposition rate recorded for *R. persuasoria* was 13 eggs by 3 females in 16 hours, and the average was 2 eggs per female per day.

Method of rearing the immature stages

The parasite eggs were introduced with their original hosts into rearing cells made from three 10 cm × 15 cm sheets of Perspex (Fig. 3). The lower sheet (3 mm thick), which was supported on short legs, and the middle sheet (7 mm thick) had twenty-four coincident holes (20 mm × 7 mm), with filter paper separating the two sheets, forming a base to the cells to allow gaseous diffusion. The top sheet (3 mm thick) acted as a cover, and all three were held together with elastic bands. The rearing apparatus was put in a polythene box, and maintained at 24° in a saturated atmosphere over water until the eggs hatched, and then at 80% R.H. over a saturated solution of ammonium sulphate for subsequent development. Where more eggs were available than paralysed hosts, pithed woodwasp larvae were used.

The eggs of all species hatched in 2 days and the larvae reached the final instar 8—9 days later. The host was consumed in a further 5 to 10 days (Fig. 4). Host larvae were added if the original host decomposed, or to increase the size of the parasite.

Artificial rearing

To obviate the labour of obtaining *Sirex* larvae from logs, alternative hosts were sought.

Blowfly larvae (whether active or immobilised by ultra-violet irradiation) when

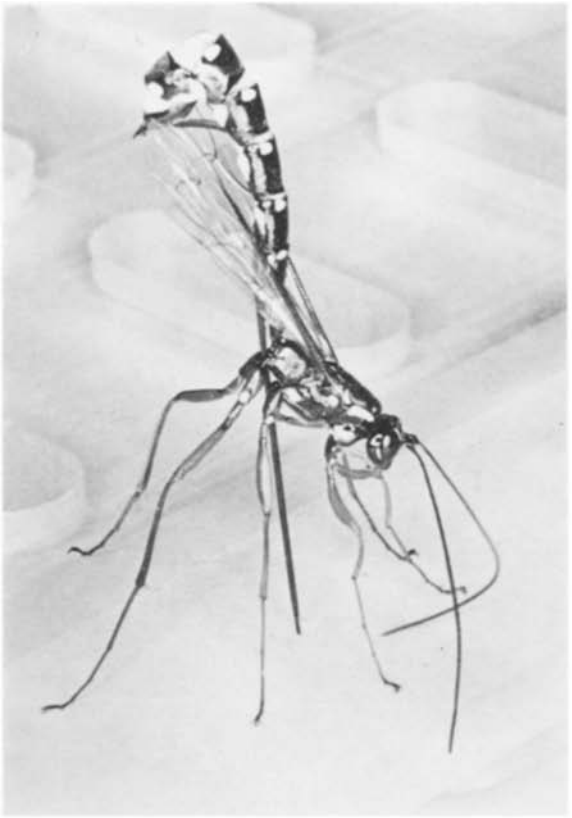

Fig. 1

Fig. 2

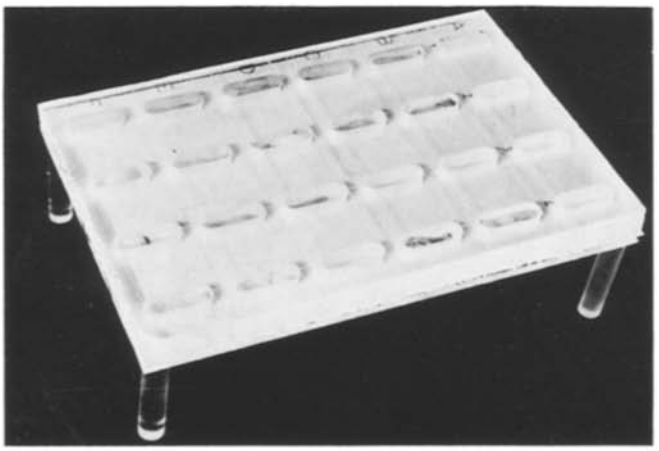

Fig. 3

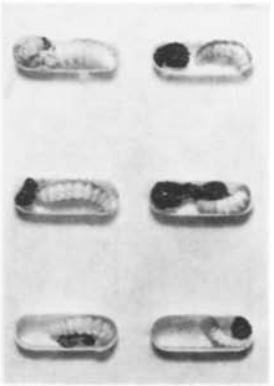

Fig. 4

Fig. 1. *R. persuasoria* female drilling through paper into a cavity of the oviposition sheet.
Fig. 2. Egg of *R. persuasoria* laid on a paralysed woodwasp host in a cavity of the oviposition sheet.
Fig. 3. Apparatus used for rearing the immature stages of the parasites.
Fig. 4. Mature *R. persuasoria* larvae and remains of siricid hosts lying on the paper base of the rearing cells.

exposed in frass-filled cells to *R. persuasoria* females, did not elicit oviposition although the larvae were stung. Larvae of the melandryid beetle, *Serropalpus barbatus* Schall., which are often found in close association with woodwasps, were also tried but without success, possibly because of their greater mobility compared with *Sirex* larvae. An unidentified cerambycid larva, found in Sitka spruce, was parasitised by *R. persuasoria* when exposed with *Sirex* frass.

Mature honey bee larvae and prepupae were used with considerable success for oviposition and rearing studies. The bees were washed to remove brood odour before putting them in the frass-filled cells. They were stung by *R. persuasoria* but rarely showed signs of paralysis. Over 50 eggs of *R. persuasoria* were obtained from 184 bee hosts exposed, with a maximum of 7 eggs on a single larva. Bee larvae were accepted as hosts by parasite larvae, and when the original individual had been consumed additional bee larvae were given to increase the size of the parasite. The development of *R. persuasoria* and *P. sternata* on bee hosts was normal up to the post-feeding and spinning stage.

DISCUSSION

The oviposition technique described is remarkably simple; extraneous components of the infested log environment are eliminated and factors that influence host detection can be critically examined. Parasite oviposition behaviour and reproductive activity can be studied quantitatively. The technique was used successfully in studies of the adult behaviour of *P. sternata*, and multiparasitism associated with the cynipid parasite, *Ibalia leucospoides* Hoch., and has been used by R. A. Bedding of this Unit to study the transfer of nematodes by parasitised *R. persuasoria* females.

The rearing method has simplified studies of parasite larval behaviour and development. The successful use of bees as substitute hosts for securing parasite oviposition, and rearing larval parasites, indicates that ichneumonid parasites of woodwasps may be mass-reared under these conditions.

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ZUSAMMENFASSUNG

EIN VERFAHREN ZUR LABORZUCHT VON SCHLUPFWESPEN, DIE AN HOLZWESPEN PARASITIEREN (HYMENOPTERA : SIRICIDAE)

Rhyssa persuasoria und *R. amoena*, primäre Ektoparasiten der Larven und Puppen von Holzwespen der Familie Siricidae, werden zum Eiablageverhalten angeregt, wenn sie entweder aus Holzwespengalerien entnommenem Fraß oder einer Kultur der symbiotischen Pilze der Siriciden (*Amylosterum* spp.) ausgesetzt sind. Wirtslarven sind gewöhnlich für die Anregung zur Eiablage erforderlich. Der Kleptoparasit *Pseudorhyssa sternata* führt seine

Legeröhre in die schon von *Rhyssa* spp. gebohrten Eiablagelöcher, und legt sein Ei in die Nähe des Eies oder der Junglarve des Primärparasiten.

Siriciden-Wirtslarven kamen auf eine nasse Fraßschicht in mit Papier zugedeckten, auf einer Perspex-Scheibe gedrillten Hohlräumen, wo sie zunächst legereifen Weibchen von *Rhyssa* spp. ausgesetzt wurden. Die Parasiten wurden von den Hohlräumen angelockt, bohrten in diese ein und legten ihre Eier auf die Wirtslarve oder den umliegenden Fraß ab. *P. sternata*-Weibchen wurden angelockt, entweder von Hohlräumen, worin die Primärparasiten gleichzeitig bohrten, oder von dem schon vorher von *Rhyssa* spp. durchbohrten Papier, und legten ihre Eier im Hohlraum ab. *P. sternata* kommt zur Eiablage, selbst wenn keine Siriciden-Larve und kein unreifes Stadium des Primärparasiten vorhanden sind.

Parasiteneier und Wirtsstadien wurden in Zuchtkammern gesetzt, die es erlaubten, Beobachtungen über Verhalten und Entwicklung der Parasiten zu machen. Larven und Vorpuppen von Honigbienen konnten mit Erfolg als Ersatzwirte benutzt werden, sowohl für das Erhalten der Parasiteneiablage als auch für die Zucht der Parasitenlarven. Das weist auf die Möglichkeit einer Massenzucht von Ichneumoniden-Parasiten der Holzwespen unter künstlichen Bedingungen hin.

Einige Anwendungen der Eiablage- und Zuchtverfahren werden angeführt.

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