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THE PARASITES OF SPODOPTERA LITTORALIS BOIS (LEPIDOPTERA NOCTUIDAE) EGGS AND LARVAE IN ISRAEL

by

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ABSTRACT

Eggs and larvae of S: littoralis Boils, were collected in the cotton fields of Givat Brenner. Israel, and reared in the laboratory. Five species of parasites, Chelonus submuticus Wesm Habrobracon hebetor Say, Microplitis rufjypntns Kok. (Hymenoptera, Braconidae); Hyposeter didymator Thb. (Hymenoptera, Ichneumonidae) and Exorista nr. larvarum (Diptera, Tachinidae) emerged from the collected larvae. One hyperparasite of H, didymator was also obtained. The biology of the primary parasites is dealt with and the most striking morphological characteristics of the Hymenopterous parasites are described. Some of the factors contributing to the inefficiency of the said parasites are discussed.

The larval stages of Spodoptera littoralis Boisduval are destructive to both field crops and fruit trees. The life cycle of this pest and other aspects of its biology have been investigated (Avidov 1961, Rivnay 1968), but no record has been made of a systematic search for its insect enemies. The present paper is an account of one summer's work in which field collection and laboratory rearing of S. littoralis and its enemies were attempted.

MATERIALS AND METHODS

Eggs and larvae of S. littoralis were collected in the cotton fields of Givat Brenner (Coastal plain, about 22 km. south of Tel-Aviv. Israel) starting in May and ending in September. Occasional samples were also taken from various weeds (Amaranthus sp., Xanthium sp.) and from apple trees. No pupae were collected and, consequently, no pupal parasites are mentioned in the text.

The collected material was placed in sleeve cages or individual vials, and reared to adulthood on cotton or alfalfa leaves. Any emerging parasites were collected and identified.* The Braconid Habrobracon hebetor (Say) was also reared in the laboratory for two generations.

RESULTS

A total of 5 primary and one secondary parasites were found during the study (Table 1).

Table 1

The parasite species reared from S. littoralis, their collecting records and other collected host species

Family	Species	Dates of collection	Place	Stage of host	Stage of parasite	Host species
Ichneumon-idae	Hyposoter didymator Thb.	20.1.1962	Tel Izhak	larva	larva	Lasiocampa grandis
		17.3.1966	Petach Tikva	larval skin	pupa	Cucullia verbasci
		5.1966	Maoz Hayim	larva	larva	Chloridea sp.
		17.6.1968	Acre	larva	larva	Vanessa cardui
		3-6.8.1968	Kibbutz Hazor	larva	larva	S. littoralis
		20.8.1968	Givat Brenner	larval skin	pupa	S. littoralis

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* The Braconidae, except for Chelonus submuticus, were identified by Dr. M. Fischer, the Ichneumonidae by Dr. J. Aubert and the Tachinidae by Dr. J. Kugler.

Table 1 (con't)

Family	Species	Dates of collection	Place	Stage of host	Stage of parasite	Host species
Braconidae	Chelonus submuticus Wesm.	2. 1968	Rehovoth	none	adult	none
		26. 6. 1968	Givat Brenner	larva	larva	S. littoralis
		5. 10. 1968	"	none	adult	none
	Habrobracon hebetor (Say)	24. 6. 1968	"	small larva	egg and larva	S. littoralis
		28. 6. 1968	"	"	"	" "
		8. 1968	Timurim	large larva	larvae and pupae	Earias insulana
	Microplitis rufiventris Kok.	3-6. 8. 1968	Kibbutz Hazor	small larva	larva	S. littoralis
		25. 8. 1968	Givat Brenner	small larva	larva	S. littoralis
		1. 9. 1968	Givat Brenner	small larva	larva	S. littoralis
		19. 9. 1968	Rosh Ha'ayin	small larva	larva	S. littoralis
Tachinidae	Exorista nr. larvarum	8. 8. 1968	Kibbutz Hazor	small larva	larva	S. littoralis
		11. 8. 1968	"	"	"	S. littoralis
* Chalcididae		7. 1968	Givat Brenner	pupa	?	Hyposoter didymator

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* Hyperparasite

Chelonus submuticus Wesm. was first found in Israel by Vermes in 1962 (Personal communication). The biology of the genus Chelonus was studied by numerous authors the last of whom was Arambourg (1968), who also gave a list of the species studied and the corresponding literature references. Ch. submuticus is the subject of studies by Vermes (1967 and 1967/68) and its biology will be dealt with only briefly.

Ch. submuticus is an egg-larval parasite. In the laboratory, at about 25°C, it reaches 80-90% parasitism, the female being able to lay 100 eggs per day (Vermes 1967). As in the rest of this genus, the parasite larva develops in the host larva and emerges therefore shortly before pupation; it continues to feed on the succumbed host externally for a day or two and then leaves the host and pupates. Developmental duration according to Vermes (1967) is 23 days at 30°C and 30 days at 25°C. The data given by Rivnay (1968) differ somewhat and run between 49 days at 20°C and 17.5 days at 34°C. One alternate host, Anagasta sericarium Scott (kuehniella (Zell.)) was also recorded.

Ch. submuticus can be easily distinguished from other Braconid parasites of the same pest through the concave venter of its abdomen, a characteristic typical of all Chelonus species. The size of the parasite approximates 4-6 mm.. its body is all black except for a white spot on each side of the abdomen somewhat posterior to the short petiole. The coxae and trochanters are brownish black, the femora and tibiae brown and the 5-segmented tarsi are light colored near the tibiae and become darker towards the basitarsus. The antennae are black.

Habrobracon (Bracon) hebetor (Say) is a geopolitanly known external parasite of various lepidopterous larvae (Anagasta kuehniella (Zell.), Galleria mellonella (L.), Sitotroga cerealella (Oliv.), Vitula edmansi (Pack.) and others; (Muesebeck et al. 1951) . It was found mainly during June and was collected and reared in the laboratory for two generations. The following details of its life history were elucidated: The female parasite reacts readily in the laboratory when placed not more than 3-5 cm. from the host. She stands near the host, extends her abdomen forward and stings the caterpillar. which in turn twists and turns in sudden, abrupt movements. If stinging is successful, paralysis takes place and the female proceeds to lay eggs on the host larva. The eggs are laid singly or in small groups. They are most commonly found on body folds but may be deposited on most of the host's body parts. The female lays about 3-5 eggs during one ovipositional session, and proceeds to search for another suitable host. If none is found she may return to the first one and continue to oviposit. Up to 7 eggs and larvae were found on the same host. The paralyzed larvae are of the 2nd or early 3rd instars. They can be found on the cotton leaves or squares lying on their side, often folded in an unnatural pose, bearing the eggs or yellowish-white parasitic larvae. Once fully fed, the larvae leave the host to a close-by dry place and spin their cocoons. When reared in glass vials they preferred the corners rather than the floor or the wall of the vials. The cocoons are silken, white and are lined with a thin brittle film. The life cycle in the laboratory (maximal daily temperature 28°C) is as follows: egg 1, larva 4 and pupa 8 days.

The parasites were placed with larvae of Ectomyelois ceratoniae Zeller and Chloridea sp. in a host specificity test. They showed no interest in the former but readily attacked and oviposited on the latter. Anagasta kuehniella or other known hosts were not tested because of lack of material.

Host searching and ovipositional behavior of H. hebetor in the field were not observed but it was noticed that the attacked host larvae were all foliage feeders, most of which were found on the sepals of the squares. No burrowing larvae were attacked within the squares or within the flowers. It was therefore interesting to find a larva of Earias insulana Bois., within its tunnel in the cotton ball, that was successfully parasitized by H. hebetor*.

Percentage parasitism was not estimated because collecting was not extensive enough to get reliable data, but it was evident that the populations of S. littoralis in Givat Brenner cotton fields during July were generally low and that most of the larvae found on the plants were parasitized.

H. hebetor is a small parasite, its body being 2 mm. long. The mesoscutum, scutellum and lateral face of pronotum are smooth and polished, the antennae taper at the tip, those of the female have 13 to 15 segments and those of the male, 18 to 23 segments. The abdomen is smooth and shiny and the ovipositor sheaths are hardly half as long as the abdomen. Color patterns are not reliable characteristics within the genus Habrobracon but may be helpful to distinguish this species from other parasites attacking the same host. The collected specimens are brown with some dark yellow areas on them. The head is dark yellow except for its brown posterior, the antennae are brown as is the thorax, except for the yellow scutellum and two yellow stripes on the scutum that merge into the former. Abdominal segment 2 as well as most parts of the legs are also yellow, the rest being dark brown.

Microplitis rufiventris Kok. has been recorded from Chloridea armigera Hbn. and Laphygma exigua Hbn. in Russia (Meier 1929). In Israel, it was readily reared from S. littoralis at several locations. No laboratory cultures were made and all the biological information obtained was a result of observations of field-collected host material.

M. rufiventris is an internal feeder that spends its larval life within the parasitized host. When ready to pupate, it leaves the host larva and spins a dense, spindle-shaped (Fig. 1A) silken, light-gray cocoon that can be found stuck to the foliage of the host plant, and from which the adult emerges a few days later. The host larva dies only one or two days after the parasite larva has left it. It moves about in a seemingly normal manner but does not feed until death.

Individuals of this parasite were obtained only from August on and were more abundant than any of the other parasites specified; but they were also associated with areas of higher host densities than the other parasites mentioned.

* The parasites were morphologically similar to the rest of the H. hebetor material; no biological tests were carried out.

Specimens of M. rufiventris are about 2 ½ mm. long, they are distinctly bicolored, the head and thorax being black and the abdomen and legs brown. The antennae are black and, in the male, are distinctly longer than the body. The head and the thorax are covered with dense pubescence that is less prominent in some of the female specimens. The propodeum is rugosely sculptured. The ovipositor does not protrude at all and the individuals can be sexed either by the length of the antennae or by a thorough examination of the tip of the abdomen.

Hyposoter (Anilasta) didymator Thb. is a parasite with a very wide host range. In Israel it is recorded from at least 5 hosts (Table 1), whereas in Europe it attacks at least three others (Thompson 1957). It is probably active throughout the year and parasitizes whichever suitable lepidopterous hosts it can find.

H. didymator deposits its eggs in the host larva wherein they hatch and a parasite develops. The whole larval development is internal and the mature larva leaves the host only to pupate in its close proximity. It is commonplace to find the parasite puparium attached to the empty host skin by dried host remnants. The parasite's puparium is typically light gray and has a few dark spots upon it (Fig. 1B). It is attached to the substrate and remains at the point of pupation for a long time after host emergence.

Adult parasites can be seen flying or standing on plants during the morning hours, especially during the spring and early summer. They prefer open areas but were also found to attack S. littoralis in dense cotton foliage during August. They were reported to attack many larvae of Vanessa cardui when the population of this host was high (I. Teich, personal communication); in cotton fields, however, they were very rare irrespective of the host population.

H. didymator is 5-6 mm. long, it has a black head, antennae and thorax, the abdomen is brown with black markings especially at the terga of the interseqmental folds and on the antero-dorsum. The legs are light brown with darker stripes on the hind tibia.

Exorista nr. larvarum is the only tachinid (Diptera) found during the present study. The specimens reared from S. littoralis differ slightly from E. larvarum L. and are awaiting determination of their definite specific affiliations. They may prove to be identical with the latter, that was reported by Rivnay (1968) as a parasite of S. littoralis and by Thompson (1957) as a parasite of approximately 100 other species.

E. nr. larvarum attacks S. littoralis on several crops during the spring and summer. Parasitized larvae can be readily recognized by the white parasite egg that is attached to their body. The egg is often attached to the head, but any other body part, including the legs, is suitable. The egg is hemispherical and the emerging larva penetrates the host through the skin near the oviposition site. It then develops within the host until pupation, which occurs outside the host. The host larva shows no apparent ill effect except for possible "nervousness" until a few days before emergence, when the host becomes darker, shrivels and dies. The parasites were found during the spring and the summer, but in the present study, were rare.

The Chalcidid reared from the puparium of H. didymator was tentatively identified as Brachymeria sp. It has been sent for identification and, hopefully, its identity will soon be known. This parasite was reared from a pupa of a H. didymator found in a cotton field at Givat Brenner during the middle of June. It emerged in the first days of July, leaving a small, circular emergence hole in the host. It is the only hyperparasite received from some 20 hosts collected at different places and dates.

DISCUSSION

The efficiency and possible usefulness of the parasites found can be analyzed according to the following factors: host specificity, size and age of hosts attacked, location of hosts attacked, general abundance of the parasites, relative abundance of the parasites in relation to that of the hosts, persistence of the parasites in time and place, and the capacity of the parasites to reduce large host populations.

Chelonus submuticus and Microplitis rufiventris attack only a few host species each and can be considered oligophagous. In the field in Israel they were only recorded as parasites of Spodoptera species. Habrobracon hebetor and Hyposoter didymator have a wide host range, whereas the specific determination of Exorista nr. larvarum is not yet known and its host range cannot be determined. If it will be found to be cospecific with E. larvarum L., then it is a polyphagous parasite attacking over 100 host species.

It is often argued (DeBach 1964) that a narrow host range is an important asset of the successful natural enemy because its breeding capacity is limited to one or a few host species, thus forcing it to search for its hosts more efficiently than a natural enemy with a wide host range. Ch. submuticus and M. rufiventris are in this category whereas H. hebetor, H. didymator and possibly also E. nr. larvarum have numerous hosts, of which S. littoralis is in all probability only an occasional, and maybe an accidental one.

All the parasites mentioned are either egg-larval or larval parasites. Their hosts are, therefore, usually exposed on the leaf surface or on the squares, flowers or sepals. Only H. hebetor females were found to follow the host larvae into the tunnels that they make in the plant, a habit that increases greatly the age-range of the host larvae attackable by the parasite, by including not only the leaf feading but also the burrowing stages. DeBach (1964) mentions the fact that successful and complete biological control was attained by enemies of any host stage. Indeed, if the parasites could very efficiently reduce the host population to a low level during one generation and could keep it at that level thereafter, it would be immaterial at which host stage the process began. However, when the parasites are not very efficient in controlling the population throughout the growing season (see below), each parasite may be looked upon as a factor in reducing the immediate damage of the pest population. Under such conditions it is desirable to have parasites that prevent the larvae from causing immediate damage. This is done to a great degree by H. hebetor and to a somewhat lesser degree by M. fufiventris, E. nr. larvarum and H. didymator, whereas Ch. submuticus kills the host only after much damage is done.

The general abundance of the parasites ranged from rare (E. nr. larvarum) to common (H. hebetor and M. rufiventris) during a limited period. In no case were more than a few scores of parasites found at one time. Parasite abundance was usually directly proportional to host abundance, i.e. there were more parasites during periods of high host abundance than during periods of low host abudance. One possible exception was the common presence of H. hebetor larvae during the end of June and beginning of July in areas where S. littoralis populations were small.

A serious drawback that is associated with the lack of host specificity of most of the parasites is the lack of their persistence in time and place. The only parasite species found during the whole growing period was Ch. submuticus. E. nr. larvarum and H. didymator were present in the cotton field or its vicinity until September, whereas the two other species were found during one month each. Whether the reasons for seasonal parasite occurrence may be host-associated or climate-associated, it is clear that no continuous and stable control of host po-populations is possible with such parasites unless they act in sequence and complement each other's action. Such sequence was not found in the present study.

From all that is said above, as well as from the world-wide experience with the genera Chelonus and Habrobracon, it can be concluded that under the given conditions none of the parasites that were found is promising as an agent in the biological control of S. littoralis.

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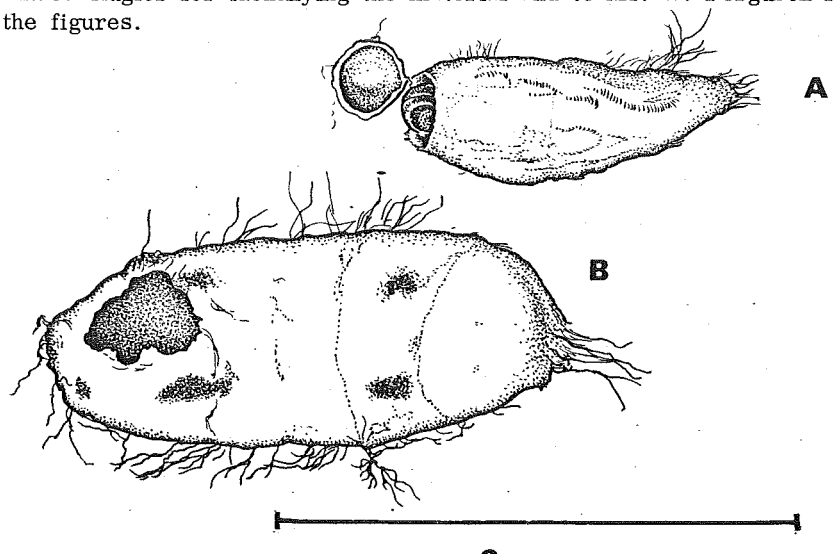

Figure 1 Empty puparia of A. Microplitis rufiventris and B. Hyposoter didymator, showing emergence holes

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