Pertanika 11(1), 1 – 5 (1988)

Searching Behaviour of *Metaphycus helvolus*, (Compere) and *Scutellista cyanea*, Motschulsky on Hemispherical Scale, *S. coffeae* (Walker)

ABDUL GHANI IBRAHIM
Department of Plant Protection,
Faculty of Agriculture,
Universiti Pertanian Malaysia,
43400 Serdang, Selangor, Malaysia.

Key words: *Metaphycus helvolus; Scutellista cyanea; Saissetia coffeae;* temperature; host-searching.

ABSTRAK

Cara Metaphycus helvolus *dan* Scutellista cyanea *memburu perumah telah dikaji dalam dua keadaan suhu tetap: 18 °C and 26 °C. Semasa memburu, kedua-dua parasit melibatkan aktiviti: menebuk badan mangsa, pengendalian, mencuci anggota (kepak, kaki dan sesungut), berjalan dan berehat. Menghisap cecair badan perumah diamalkan oleh* M. helvolus. S. cyanea *menghabiskan lebih daripada lima puluh peratus masanya untuk berjalan mencari perumahnya pada kedua-dua suhu.* M. helvolus *pula menggunakan sebahagian besar masanya untuk tiga aktiviti: berjalan, menebuk perumah dan mencuci anggota. Masa yang ditumpu untuk menghisap cecair perumah oleh* M. helvolus *ialah kurang daripada 10 peratus. Kawasan memburu yang diliputi oleh* M. helvolus *dan* S. cyanea *pada suhu 26 °C ialah 933 mm² /jam dan 3517 mm² /jam.*

ABSTRACT

The host searching of Metaphycus helvolus *and* Scutellisa cyanea *were studied under two different constant temperatures of 18 °C and 26 °C. In the course of host-searching, both parasitoids were involved with host-drilling, handling, preening, walking and resting. Host-feeding only occurred with* M. helvolus. S. cyanea *spent more than fifty percent of the time walking at both temperatures. However,* M. helvolus *spent a greater proportion of time for three activities: walking, host-drilling and preening. The amount of time spent by* M. helvolus *on host-feeding was less than ten percent. The areas covered by* M. helvolus *and* S. cyanea *for host-searching at 26 °C were 933 mm² /hr and 3517 mm² /hr. respectively.*

INTRODUCTION

The hemispherical scale, *Saissetia coffeae* (Walker) is essentially an insect pest of tropical fruits, beverages and ornamental plants (LePelley, 1968). Today, the hemispherical scale is a nuisance in the heated glass houses and conservatories in temperate countries (Copland & Ibrahim, 1985). It has many natural enemies, amongst which are two hymenopterous parasitoids namely *Metaphycus helvolus:* (Compare) (Encyrtidae) and *Scutellista cyanea* Motschulsky (Pteromalidae). The former parasitoid parasitizes the nymphal stages of the scale whereas the latter on the gravid scales. These two parasitoids had been used extensively for the biological control of black scales, *Saissetia oleae* (Luck, 1981). In order for the parasitoids to be efficient they must have effective host searching capability. There are many factors affecting the host searching of a parasitoid such as the presence of the host's faeces or exudates, the physical structure of plant material accommodating the host as well as the stages of the host and density of the hosts itself. For instance, the presence of the honey dew could also indicate the presence of viable hosts in the area and this in turn, would motivate host searching (Vinson *et al,* 1978). This investigation is to study the pattern of host finding of both *M. helvolus* and *S. cyanea* on two different temperatures of 18 °C and 26 °C. The optimal temperature for development of scale in the heated glasshouse is 26 °C but during winter the temperature can be as low as 18 °C. These findings are useful in evaluating these parasitoids in a biological control programme of hemispherical scales in the heated glasshouses.

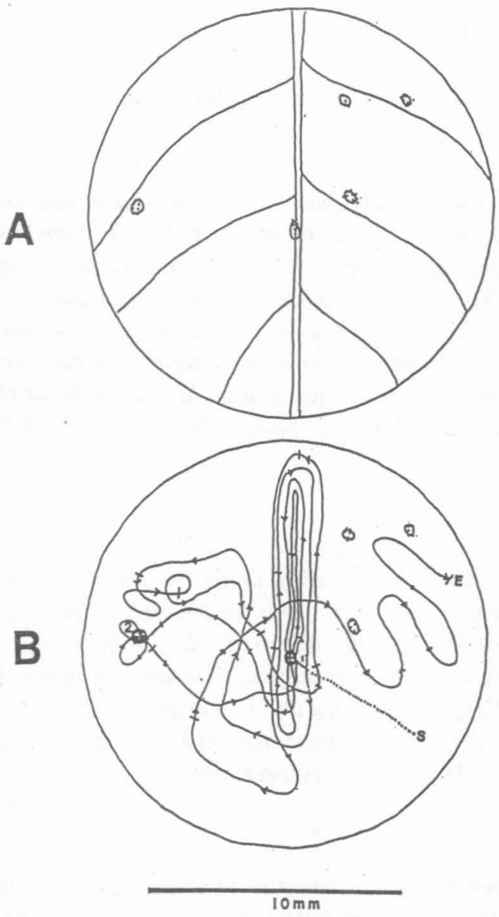

Fig. 1: (A), a portion of Aphelendra *leaf with the positions of 2nd instar* S. coffeae; *(B), example of a walking pattern of* M. helvolus *on the leaf portion. Dotted line: route followed before a host was met. Solid line: route after contact with the 1st host. Every 30 sec. a crossline was drawn (S = start. E = end, figures denote sequence of host encountered).*

MATERIALS AND METHODS

For studying the behavioural pattern of *M. helvolus,* one week old females were selected for this experiment. The parasitoids were offered detached leaf of ornamental plant, *Aphelendra squorrosa* (Acanthaceae) infested with five second instar *S. coffeae (Fig. 1).* The upper side of the leaf was fixed against a glass-slide using self-adhesive vinyl tape. A circular perspex ring (15 mm diam. 5 mm height) was placed on the lower leaf portion with suitable host scales. A female *M. helvolus* was transferred into the circular ring and another glass-slide was placed on top of the ring to prevent the escape of the parasitoid. This method facilitated the observation of the behaviour of the parasitoid under a stereomicroscope (x 10) for five minutes. The position of the hosts and the pattern of movement of the parasitoids were mapped (cf *Fig. 1*).

A slightly modified device was used to observe the activities of *Scutellista cyanea.* The upper side of the *Aphelendra* leaf with three gravid scales was fixed against a piece of glass slide (75 mm x 34 mm). A female parasitoid was transferred into a transparent petri-dish (52 mm diam. 10 mm height) containing scale infested leaf portion. This technique prevented the escape of the parasitoids and facilitated the examination of their activities. The response of the parasitoid to the gravid scales on the leaf was recorded *(Fig. 2).*

Twenty-five observations, each lasting five minutes, were completed on 25 *M. helvolus.* Similar observations were made on *S. cyanea.* The following behavioural components were analysed:

a. Pattern of movement. The pattern of movement on the leaf portion and their various activities: walking while drumming, walking, resting, preening and turning motions.

b. Encountering hosts. The parasitoids may respond differently to host scales such as host-drilling or even host-feeding as in the case of *M. helvolus.*

The behaviour components and their duration for each individual parasitoid were recorded using a stop-watch. The observations were made at two different constant temperatures at 18 °C and

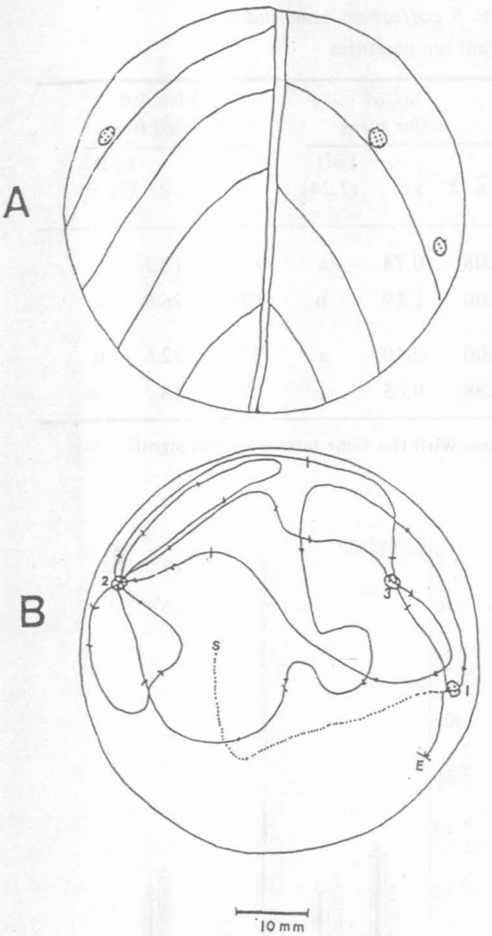

Fig. 2: (A), a portion of Aphelendra *leaf with the positions of gravid female scales; (B), example of a walking pattern of* S. cyanea *on the leaf portion. Similar procedure was adopted as in Fig. 1B.*

26 °C. The results were analysed using both F and X^2 –test (Snedecor and Cochran, 1967)

RESULTS AND DISCUSSION

Observations indicated that the parasitoid moved more frequently over the leaf vein in search of the host-scales *(Fig. 1B)*. The parasitoid passed a host scale at a distance of 1 mm and yet did not show any obvious reaction to it. During the first encounter with host scales, the female, *M. helvolus* did not immediately drill into the host scale but drummed the scale with its antennae. The antennal response of the parasitoid was similar to description by Williams (1951). The parasitoid did not change the walking speed after the first encounter with the host scale. This observation was also reported by van Lenteren *et al.* (1976) who studied the parasitoid of *Encarsia formosa* (Aphelinidae). On the other hand, Kajita (1976) reported of the decrease of speed after the parasitoid of arrow-scales encountered the host. The female *M. helvolus*, showed the 'turning motion' around a visited host scale such as Laing (1938) described for *Trichogramma evanesence* (Wood). This frequency of the 'turning motion' could be influenced by the nature of leaf surface for Kajita (1976) reported that the parasitoid of the arrow-scale *Unaspis yanonensus* (Kuwana) made many turns on the smooth surface of leaf infested with scales.

The host searching by *S. cyanea* was done by drumming the antennae on the leaf surface. On encountering the first host, the parasitoid would climb on the dorsal side of the scale and immediately insert the ovipositor beneath the scales. She made more than one attempt to drill into the gravid scale. After drilling into the first scale, the parasitoid continued its search for other host scales. The parasitoid neither changed its walking speed nor showed 'the turning motion' around the first visited host *(Fig. 2B)*. The number of encounters, female *M. helvolus* made with the host-scale was influenced by the temperature. It appeared that more encounters were made at higher temperature (26 °*C)* than at lower temperatures (18 °C). A similar trend was also observed with *S. cyanea.* However, no significant differences were detected on the frequencies of the two parasitoids encountering host at the two temperatures. (Table 1).

The distance travelled by a parasitoid depended on the temperature at which they were exposed to. *Metaphycus helvolus* travelled longer distances at 26 °C than at 18 °C but no significant differences were observed. On the other hand, female *S. cyanea* travelled greater distances at a lower temperature (18 °C) as compared to that at 26 °C. There was a significant difference ($P < 0.05$) between the distances travelled by *S. cyanea* at 18 °C and those of *M. helvolus* at similar temperature (cf. Table 1). The area searched by *M. helvolus* and *S. cyanea* at 26°C were 933 mm^2/h and 3517 mm^2/h. This calcula-

TABLE 1

Response of *M. helvolus* and *S. cyanea* to *S. coffeae* on *Aphelendra* leaves at two different constant temperatures

Parasitoids	Temp. (°C)	Frequency of host contact			No. of major turns			Distance travelled (mm)		
		$\bar{x}$ ±	s.e.	LSD (1.13)	$\bar{x}$ ±	s.e.	LSD (2.24)	$\bar{x}$ ±	s.e.	LSD (90.0)
M. helvolus	18	2.08	0.35	a	5.08	0.74	a	120.0	12.2	a
	26	2.64	0.48	a	8.00	1.19	b	130.0	26.9	a
S. cyanea	18	1.64	0.22	a	3.00	0.40	a	257.0	32.6	b
	26	2.16	0.51	a	2.88	0.65	a	195.0	48.2	ab

LSD = Least significant difference. Within column, figures with the same letters are not significantly different at the 5% level.

tion was based on the observation that *M. helvolus* and *S. cyanea* at 26 °C detected host 1 mm distance and therefore searched a path of 2 mm + headwidth i.e. 2.3 mm and 2.75 mm respectively. The bigger area of search by *S. cyanea* was attributed to its greater size than that of *M. helvolus.*

The behavioral activities of the parasitoids were influenced by different temperature regimes. There were significant differences in the average time spent by *S. cyanea* on host-drilling, resting and preening *(Fig. 3).* For instance, *S. cyanea* spent more than 50% of the time walking both at 18 °C and 26 °C. M. helvolus has the additional behavioral activity i.e. host-feeding. Following this host-feeding activity, *M. helvolus* spent a greater proportion of its time drilling to ascertain the suitability of the host for oviposition. These behavioral studies show that *M. helvolus* would spend more time in the vacinity of the host as compared to *C. cyanea* which spent more time in host searching. There is the potential of *M. helvolus* as a biological control agent for *S. coffeae* because the parasitoid has the capability of host feeding and oviposition on different individual nymphal scales.

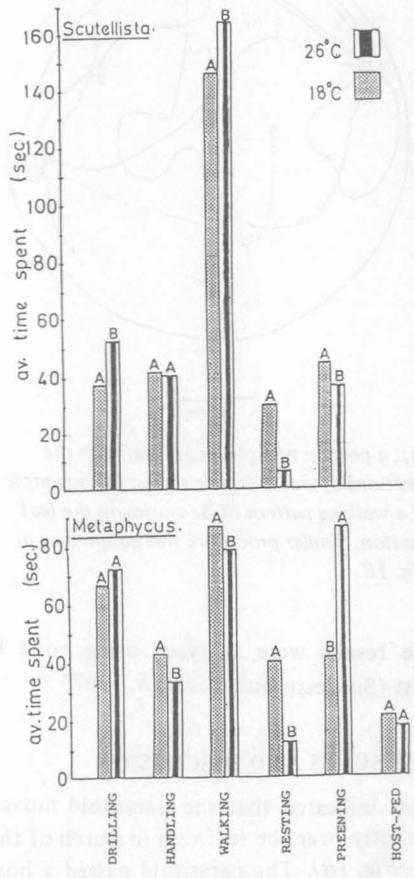

Fig. 3: Behavioural activities of parasitoids on Aphelendra *leaf infested with* S. coffeae. *Based on 5 min/observations and replicated 20 times. Similar letters on top of the bar for each activity indicates no significant difference using* X^2 *test of proportion.*

ACKNOWLEDGEMENTS

The author is indebted to Dr. M.J.W. Copland of the Department of Biological Sciences, Wye College (University of London) for guidance on the research. This work is part of a thesis submitted for a higher degree by the author who received funding from the 'Commonwealth Scholarship Commission'.

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(Received 5 March 1987).