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HOST FINDING BY *CRYPTOLAEMUS MONTROUZIERI* (*COL., COCCINELLIDAE*) A PREDATOR OF MEALYBUGS (*HOM., PSEUDOCOCCIDAE*)

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Adult *C. montrouzieri* were able to detect their prey by visual and chemical stimuli. Presence of mealybug caused a significant increase in the number of turns and a sharp decrease in flight attempts suggesting detection by olfaction. In the light, adult predators found polystyrene dummies significantly faster than under dark (red light) conditions, but light had no effect on the time taken for adults to pass across an invisible test point. Fourth instar larvae could only perceive the prey by physical contact.

KEY-WORDS : *Cryptolaemus*, mealybugs, searching, visual and chemical cues.

For biological pest control, high host searching capacity is one of the most important characteristics for achieving a self-sustaining economic level of pest population by beneficial insects. **De Bach** (1974) stated that if the efficiency of a biocontrol agent is not linked with searching ability especially during host scarcity it cannot produce a stable and steady control.

There are several endogenous and exogenous factors which can influence insect movement. Temperature, relative humidity, wind, food resources, hunger, light intensity, host insect secretions and host plant are among the main factors which cause attraction or dispersal.

The searching behaviour of parasitoids has been widely studied (**Vinson,** 1976 ; **Hulspas-Jordan & Van Lenteren,** 1978 ; **Waage,** 1978, 1983 ; **Hagvar & Hofsvang,** 1987 ; **Keller,** 1987). Comparatively little attention has been given to coccinellid predators. Several authors have claimed that beetles are not able to detect their prey prior to physical contact (**Fleschner,** 1950 ; **Banks,** 1957 ; **Kehat,** 1968 ; **Murakami & Tsubaki,** 1984). **Nakamuta** (1984) reported that *Coccinella septempunctata* uses vision for short range ($< = 7$ mm) detection of its prey but in the dark is unable to recognise it until physical contact has been made. **Allen** *et al.* (1970) showed that adult *Anatis ocellata* (L.) is able to recognize the larvae of Jack-pine budworm *Choristoneura pinus* (Freeman) from 1.3-1.9 cm and then moves forwards to snatch the prey with their mandibles. **Stubbs** (1980) suggested that touch is not the only means of prey detection in coccinellids and similar conclusions have been reached by **Marks** (1977) and **Obata** (1986). The present study investigated the searching efficiency of adults and larvae of *C. montrouzieri,* an efficient predator of various mealybug species under laboratory conditions.

MATERIALS AND METHODS

Uniform sized, sexually mature adults were collected from a 10 day old culture at 28 °C and placed in a ventilated plastic box (175 × 115 × 65 mm) and fed for 24 hours with streaks of 50 % honey solution. Humidity was provided by wet cotton wool in a small Petri dish in the corner of the box. They were then moved to a similar box without any honey or water, for another 24 hours to stimulate searching behaviour. Temperature was maintained at 27 ± 0.5 °C, relative humidity ranged between 50-60 % and 300-400 W/m^2 light was provided by cold fibre optic laboratory lamp(s) (Schott KL 1500). Individual adults were isolated in a polyvinyl ring, 150 mm diameter with a 50 mm high wall, coated with Fluon (PTFE, GL3800 ICI). The bottom of this arena was covered with Letraset Pantone paper (Green 375A7) and the polyvinyl cylinder had a transparent plastic lid. A dummy, comprising a small piece of expanded polystyrene foam of similar size to a mealybug, a test point and a small patch of mealybug (female with ovisac plus one late third or fourth instar) were used as prey targets and each target prey was studied under red and visible light. The time needed to find the mealybugs, dummy or cross the test point was recorded. In each test the predator was introduced into the arena at the same start point and the location of target prey kept the same. The experiment was started first with the test point, then with the dummy and lastly with mealybugs and it was replicated 15 times with 15 fresh predators for each target. The number of turns (defined as a change in walking direction of more than 90°) and the number of jumps were recorded up to host finding and was calculated per unit of time. The predator's walking paths were traced onto a transparent sheet and a map measurer was used to calculate the absolute speed (cm/min). The experiment was repeated using fourth instar larvae. The larvae were selected just after their moult and kept 24 hours without food and water. The young fourth instar larvae were selected because they are the most voracious and active instars. If the larvae are in the middle or at the late fourth stage they become sluggish when kept under starvation and pupate quickly. Means were compared after analysis of variance using the L.S.D. method (**Cochran & Cox**, 1957).

RESULTS

Table 1 and 2 present the results of searching behaviour of adult and fourth instar larvae of *C. montrouzieri* with either mealybugs, dummies or test points under dark and bright illumination.

Observations during this experiment showed that adults can perceive the sign of mealybugs either by sight or odour from a certain distance. They were able to recognize the mealybug from more or less the same distance whether in darkness or light. In the experimental arena, when they arrived close to this distance, they stopped and then jumped towards the prey. This distance was measured and from records of twenty adult beetles was found to be 1.395 ± 0.35 cm. This method is similar to that used by **Stubbs** (1980). To calculate this distance the time (mean in light and dark, from table 1) needed to find the test point (T_1), or the prey itself (T_2) was inversely proportional to the diameter of the area in which the predator can reach the test point (D_1) or catch the mealybugs (D_2). Where D_1 is the diameter of test point plus width of the ladybird to each side (any part of the ladybird may touch the test point) and D_2 is D_1 plus the zone of prey detection to each side of the prey. Therefore :

$$T_1 \propto 1/D_1 \text{ and } T_2 \propto 1/D_2 \text{ and } D_2 = (T_1 \times D_1)/T_2$$

TABLE 1

The effect of light on searching behaviour of adult female C. montrouzieri *at 27 ± 0.5 °C and 45-55 % r.h.*

Treatments (Target host)	Time spent to find the target (min) Mean	s.e.	Number of turns/min Mean	s.e.	Number of jumps/min Mean	s.e.	Speed cm/min Mean	s.e.
Dummy (dark)	10.20	1.88 Z	2.75	0.49 B	2.45	0.65 a	69.59	4.07 X
Dummy (light)	2.56	0.76 Y	2.34	0.55 B	2.53	0.81 a	78.87	3.03 X
Test points (dark)	8.60	2.67 Z	2.96	0.3 B	2.66	0.55 a	61.04	2.82 X
Test points (light)	9.14	2.49 Z	2.46	0.26 B	2.06	0.74 a	58.31	3.71 X
Mealybug (dark)	3.37	0.48 Y	4.89	0.56 A	0.37	0.18 b	68.40	3.14 X
Mealybug (light)	3.47	1.19 Y	6.04	1.02 A	0.09	0.18 b	76.50	4.05 X
L.S.D. values	5 % = 4.65		5 % = 1.65		5 % = 1.62		1 % = 13.48	

Means within columns with the same letter are not significantly different. Dark = red light, Light = 300-400 W/m², Jumps = Short preparatory flights.

TABLE 2

The effect of light on searching behaviour of 4th instar larvae of C. montrouzieri *at 27 ± 0.5 °C and 45-66 ± 5 % r.h.*

Treatments (Target host)	Time spent to find the target (min) Mean	s.e.	Number of turns/min Mean	s.e.	Speed cm/min Mean	s.e.
Dummy (dark)	16.87	3.60 P	1.45	0.19 q	53.13	1.7 R
Dummy (light)	13.80	2.80 P	1.62	0.45 q	54.82	2.5 R
Test points (dark)	14.02	2.89 P	2.05	0.32 q	52.89	1.4 R
Test points (light)	13.20	3.87 P	1.79	0.46 q	49.98	1.6 R
Mealybug (dark)	14.15	4.30 P	1.41	0.28 q	57.14	2.2 R
Mealybug (light)	12.24	2.95 P	1.65	0.24 q	52.72	1.7 R
L.S.D. values 5 %	9.08		0.965		7.763	

Means within columns with the same letter are not significantly different. Dark = red light, Light = 300-400 W/m².

the diameter of the test point was 0.5 cm and the average width of predator was 0.60 cm therefore ; D_1 was 1.70 cm and $D_2 = (8.87 \times 1.7)/3.42 = 4.41$ and the actual distance at which prey can be perceived is :

$$(D_2 - D_1)/2 = 1.35 \text{ cm}$$

which is very close to 1.39 found by observation.

DISCUSSION

The mean searching time needed by adult *C. montrouzieri* to find the mealybugs under light or dark and the dummy under light conditions were not significantly different. This time was significantly shorter than the dummy in the dark and the test point with or without light ($P < 0.05$), suggesting that the predator can detect the prey either by sight (dummy and prey) and/or odour (prey). The mean number of turns were significantly higher in light and dark with mealybugs than any other treatments ($P < 0.05$) which suggests that the presence of mealybugs was detected by adult olfaction. The mean number of jumps with mealybugs were significantly lower than the other treatment ($P < 0.05$) suggesting that in the absence of the host the adults tend to fly. There was no difference in the absolute speed (speed without stops) of any treatment. Analysis of the results with fourth instar larvae for all test prey showed no significant difference either in the presence of the host by visual or chemical stimuli. The number of turns and the speed were not significantly different ($P < 0.05$) in any treatment.

CONCLUSION

Adult *C. montrouzieri* are able to detect their prey by visual or olfactory stimuli. This supports the theory of prey detection stated by **Allen** *et al.* (1970) and **Stubbs** (1980). Both authors showed that aphidophagous coccinellids can perceive their prey from a short distance prior to physical contact. However, the present observations are in disagreement with the same authors results that larvae are able to find their host insects by visual or chemical cues. Similar conclusions have been reached by **Banks** (1954, 1956, 1957), **Storch** (1976) and **Murakami & Tsubaki** (1984).

Finally, from these results it may be concluded that host finding under field or glasshouse conditions may be a combined result of a non-random and random search by adults. Once they have arrived in a new area to search for food they can recognise mealybugs from a distance and by increased turning and a reduced tendency to disperse, they are arrested in the patch.

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RÉSUMÉ

Découverte de l'hôte par *Cryptolaemus montrouzieri*, prédateur de cochenilles (Hom., Pseudococcidae)

Les adultes de *C. montrouzieri* sont capables de détecter leur proie grâce à des stimuli visuels ou/et olfactifs. La présence de la cochenille se traduit par une augmentation significative du nombre de changements de direction et par une diminution importante des tentatives d'envol. Ces observations suggèrent l'existence d'une détection de la proie par olfaction. A la lumière, les adultes de ce prédateur trouvent plus rapidement des leurres en polystyrène qu'ils ne le font à l'obscurité (lumière rouge). Mais la lumière est sans effet sur le temps mis par les adultes pour traverser un point test invisible. Les larves de quatrième stade percevrait la proie uniquement par contact physique.

MOTS CLÉS : *Cryptolaemus*, Pseudococcines, comportement de recherche, indications visuelle et chimique.

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