ber when a large number of galls are parasitized. There are 5–6 overlapping generations of the parasite in the period of its activity.

During the activity period of the parasite a record of the parasitism was kept as shown in the table.

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Zusammenfassung

Eupelmus tenuicornis Kieff. (Hym., Chalcidoidea) als Parasit der Gallmücke Bimba toombii Grov. (Dipt., Cecidomyiidae)

E. tenuicornis lebt ektoparasitisch an der Dritt- und Viert-Larve von *B. toombii.* Paarung und Eiablage-Verhalten werden beschrieben. Der Parasit hat 5 bis 6 sich überschneidende Generationen in seiner Aktivitäts-Periode. Die höchste Parasitierungs-Quote wurde im Oktober/November beobachtet.

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Studies on the reproduction of the coccinellid *Menochilus sexmaculatus* F. on four species of aphids

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Abstract

The reproduction of the coccinellid, *Menochilus sexmaculatus* F. was strongly influenced by the host aphids. Its fecundity was most enhanced when fed on *Aphis craccivora.* Maximum reduction in reproductivity was noted on *A. malvae.* The change of larval and

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adult foods also influenced the fecundity of the predator. Whatever may be the combination of food during larval and adult stages, the fecundity was enhanced if *A. craccivora* was used as either larval or adult food and reduced when *A. malvae* was the food in either of the stages. The aphid species *A. gossypii* and *Rhopalosiphum maidis* had medium effect.

1. Introduction

A previous study (RAJAMOHAN 1971) has shown that the four aphid species tested strongly influenced the growth and development of the predator, *Menochilus sexmaculatus* F. Several authors have reported earlier that many coccinellids could not reproduce normally on certain prey; examples will include *Leius conformis* Boisd. on various aphids and coccids (MOURSI and KAMAL 1946) and *Coccinella undecimpunctata aegyptiaca* R. on *Phenacoccus hirsutus* (IBRAHIM 1955). The present paper reports on the influence of four aphid species on the reproduction of the coccinellid, *M. sexmaculatus.* F.

2. Methods

The host aphids *Aphis malvae* K. on pumpkin *(Cucurbita moschata), Aphis gossypii* G. on bhendi *(Abelmoscus esculentus), Aphis craccivora* K. on cowpea *(Vigna sinensis)* and *Rhopalosiphum maidis* F. on sorghum *(Sorghum vulgare)* were collected from field and cultures were maintained in the laboratory. The predator, *Menochilus sexmaculatus* F. was collected from the field and reared on these four host aphids separately in cylindrical jars. Tender twigs with leaves infested with different aphids were confined in cylindrical glass tubes and kept turgid by means of cotton plugs soaked with water fitted at the cut ends. Rearing of the predator was made from the eggs laid by them in the laboratory. Every day morning and evening, the plant parts with aphids were changed to assure a fresh supply of enough quantum of aphids to the predator. Observations were made on the pre-oviposition and oviposition period as well as fecundity of the predator. The predator was reared upto the larval stage on one host insect but fed with another host during adult life to study the effect of different larval as well as adult food on the fecundity.

3. Results

The pre-oviposition period of the predator was minimum on *A. cracccivora* with 1.4 days as against 2.4 days on *A. malvae.* The maximum oviposition period observed was 23.0 days in beetles fed on *A. craccivora,* the minimum being 11.3 days on *A. malvae* (Table 1). The highest number of eggs was found when the predator was reared on *A. craccivora.*

Data on fecundity were also gathered in another experiment as eggs laid per three days during the entire oviposition period. It was observed that the beetle fed on *A. craccivora* uniformly laid more number of eggs per three days than on other aphids. It laid maximum number of eggs (189.8) in the second 3-day period. Though the fecundity was decreasing gradually, the eggs were laid upto 27th day. But on *A. gossypii* it showed a maximum fecundity on the ninth day. Reduced reproduction was noticed subsequently and oviposition was stopped on 18th day. The maximum fecundity of 117.7 eggs could be observed on 12th day when fed on *R. maidis* and egg laying

Table 1

Effect of four species of aphids on the pre-oviposition and oviposition periods and fecundity of *Menochilus sexmaculatus* F.

(Mean of 30 observations)

Host insects	Pre-oviposition period (days)	Oviposition period (days)	Fecundity per female
Aphis craccivora	1.4 (— 41.66)	23.0 (+ 103.53)	1107.1 (+ 301.7)
Aphis gossypii	2.0 (— 16.66)	17.3 (+ 53.09)	717.7 (+ 160.4)
Rhopalosiphum maidis	1.5 (— 37.50)	15.5 (+ 37.16)	522.0 (+ 89.4)
Aphis malvae	2.4	11.3	275.6
C.D. (P = 0.05)	0.47	0.21	137.9

Figures in parentheses represent % increase (+) or decrease (—) from *A. malvae.*

Table 2

Effect of changing the larval and adult food on the fecundity of the predator *Menochilus sexmaculatus* F.

(Mean of 30 observations) No. of eggs per female

Laral foods	Adult on *A. craccivora*	Adult on *A. gossypii*	Adult on *R. maidis*	Adult on *A. malvae*	Mean
Larva on *Aphis craccivora*	1312.8	849.6	585.6	494.4	810.6
Larva on *Aphis gossypii*	794.8	830.0	582.8	419.2	655.6
Larva on *Rhopalosiphum maidis*	600.4	434.0	479.8	406.4	480.1
Larva on *Aphis malvae*	618.4	518.4	432.4	304.4	468.4
Mean	831.6	658.0	520.0	406.0	
% increase (+) over adult on *A. malvae*	+ 104.8	+ 62.0	+ 28.0		

Significant at 1 % probability level, the C.D. (P = 0.05) being 44.7 for larval as well as adult foods. – Interaction between larval foods and adult foods is significant at 1 % probability level. C.D. (P = 0.05) = 89.5.

had ceased on 18th day. By contrast, on *A. malvae,* the fecundity was much lower at each period and reproduction virtually ceased from 15th day onwards, being minimum ovipositional period observed in the experiment.

The fecundity of the predator was also studied as influenced by the change of food during larval and adult stages. The predator when fed on *A. craccivora* during larval and adult stages laid more number of eggs up to 1312.8 (Table 2). The fecundity was much reduced when the adult food alone was changed to *A. malvae.* The beetle laid more number of eggs per every three days upto 27 days when fed during larval and adult stages on *A. craccivora* while the same when fed on *A. malvae* during adult stage fewer eggs were laid and reproduction stopped on the 18th day.

Likewise, the larva reared on *A. gossypii* when fed on *A. craccivora* during the adult stage, it laid eggs up to 21 days but reproduction stopped on 18th day if fed on *A. gossypii* during both stages. But reproduction was reduced and fewer eggs were laid progressively at every 3-day period when the larva reared on *A. gossypii* during the larval stage, was fed on *R. maidis* and *A. malvae*.

In the same manner, the larvae fed with *A. malvae* when transferred to *A. craccivora* during the adult stage, recorded maximum of 618.4 eggs per female while the beetle fed with *A. malvae* during both stages laid only 304.4 eggs per female. As adult food, *A. gossypii* and *R. maidis* were noted to increase the fecundity significantly from that continuously on *A. malvae* though not to the extent on *A. craccivora*. In all combinations of larval and adult foods, increased fecundity for longer period was noted when adult food was *A. craccivora*, and reproduction was reduced when fed on *A. gossypii*, *R. maidis* and *A. malvae* during adult stage, the maximum reduction being noted on *A. malvae*. Likewise when the adult food was common, the beetles reared during larval stage on *A. carccivora* laid more eggs for longer period than when fed on *A. gossypii*, *R. maidis* and *A. malvae*.

4. Discussion

Consistent data have been gathered and presented that certain aphid species can influence the reproduction of the coccinellid predator, *Menochilus sexmaculatus* F. Pre-oviposition period was minimum on *A. craccivora* and the egg production started earlier because of the highly suitable nature of the prey. The larva could have gained all its nutritive materials from this prey which induced the adults to lay eggs earlier. But on *A. malvae* it was prolonged indicating that quick reproduction was not possible because of the unsuitable nature of the aphid. In this connection HAGEN and SLUSS (1966) have shown earlier that the pre-oviposition period of *Hippodamia convergens* was reduced on the favourable *Acyrthosiphon pisum* than on the unfavourable *Therioaphis trifoli*.

The fecundity of the predator on *A. craccivora* was maximum and oviposition extended for longer period when compared to other three species of aphids. Marked variation in fecundity may be attributable to the quality of prey. In conformity with the above findings, several authors had reported earlier that many coccinellids could not reproduce normally when feeding on certain prey. *Leis conformis* on various aphids and coccids (MOURSI and KAMAL 1946), *Coccinella undecimpunctata aegyptiaca* on *Phenacoccus hirsutus* (IBRAHIM 1955), *Chilochorus bipustulatus* on *Saissetia olea* and *Adalia bipunctata* on mites and *Stethorus punctillum* on aphids (PUTMAN 1957, 1964) could not lay eggs normally.

The beetle reared on *A. craccivora* laid more number of eggs over prolonged period of oviposition than on other aphid species, and the predator in different stages was heavier and larger in size (RAJAMOHAN 1971). On the other hand, the fecundity was much reduced and the predators were lighter and smaller on unsuitable prey like *A. malvae*. These results are in accordance with those of SMITH (1965) who reported that fecundity and longevity were much reduced in small individuals of *Anatis mali* and *Coleomegilla* *maculata lengi.* He also reported that the latter coccinellid laid maximum number of eggs upto 1600 on *Acyrthosiphon pisum* whereas the fecundity was reduced to 75 eggs on *Aphis fabae.* The egg production of *Adalia bipunctata* was also much reduced on *Aphis fabae* (IPERTI 1966). HAGEN and SLUSS (1966) also reported that *Acyrthosiphon pisum* was suitable food for *Hippodamia convergens* than *Therioaphis trifolii.* Highest egg counts of *Coccinella septumpunctata* were noted on *Lipaphis erysimi* than on *Aphis gossypii* and *Myzus persicae* by AZIZ et al. (1969).

The results indicated clearly the nutritionally unsuitable nature of the prey. In this connection, the hypothesis of HODEK (1966) that certain aphids may contain some special substances or that the aphids are only deficient in nutritive value, may seem to hold good. He excluded the possibility that death was caused by starvation or by a very low feeding rate, based on the fact that artificially reduced feeding rates of essential foods did not cause substantial rise in mortality. HODEK (1956, 1957) further classified preys as some aphids on which the oogenesis of certain coccinellids is realized (essential food), certain aphids on which the vitellogenesis of eggs can not be completed while the ovarian morphogenesis goes on (alternative food), and some aphids which are toxic. In the present study, *Aphis craccivora* may be grouped as essential food, *A. malvae* being the alternate food. It is interesting to note that *Aphis malvae* which was unsuitable for the predator is frequently preyed upon by *Menochilus sexmaculatus* in the field. In this connection, HODEK (1966) suggested that naturally coccinellids have a wide host range from harmful foods to less harmful ones but which are still better than when the insects are starved.

The change of larval and adult foods significantly influenced the fecundity of the predator. Whatever may be the combination of foods during larval and adult stages, the fecundity was enhanced if *A. craccivora* was used as either larval or adult food and reduced when *A. malvae* was the food in either of the stages. It is evident that the food quality during both larval and adult stages could significantly influence the fecundity of the predator. This is contrary to the findings of EL-HARIRI (1966) that the species of aphid fed to *Adalia bipunctata* during the adult life (but not their larval life) affected fecundity. But much evidences are lacking in literature in this respect. Nevertheless, SMITH (1965) reported that the larva of *Coleomegilla maculata lengi* reared upto second instar on the suitable prey *Acyrthosiphon pisum* died four days later if transferred to the unsuitable aphid, *Aphis fabae.* Similarly, BLACKMAN (1966) reported that larva of *Adalia bipunctata* previously reared on *Acyrthosiphon pisum* when given *Megoura viciae* in the fourth instar, fed on the latter aphid but suddenly rejected it, vomitted and died.

Zusammenfassung

Über die Reproduktion des Marienkäfers, Menochilus 6-maculatus F. bei Ernährung mit 4 verschiedenen Blattlaus-Arten

Die Reproduktion von M. 6-maculatus wurde sehr stark von der Nahrungsart bestimmt. Die Fruchtbarkeit erreichte ihr Maximum bei Ernährung mit *Aphis craccivora*, ihr Minimum bei Ernährung mit *A. malvae*. Auch ein Wechsel von larvaler und imaginaler Nahrung beeinflußte die Fruchtbarkeit, jedoch war stets die höchste Eizahl beim larvalen oder imaginalen Fraß von *A. craccivora* bzw. die geringste Eizahl beim Fraß von *A. malvae* gegeben. Die Blattlausarten *A. gossypii* und *Rhopalosiphum maidis* zeigten einen mittleren Nahrungswert.

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