

showing fenvalerate to be safe for *T. achaeae* confirms the findings of Singh and Varma (1986) and Varma and Singh (1987) on *T. brasiliensis*.

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Host Range, Development and Sex Ratio of *Leptomastix dactylopii* on different stages of Citrus mealybug, *Planococcus citri*

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ABSTRACT

An exotic parasitoid *Leptomastix dactylopii* How., introduced into India against the citrus mealybug *Planococcus citri* (Risso) also attacked *P. lilacinus* (Ckll.) under laboratory conditions. Five other species were not attacked in the laboratory. The ovipositional preference, development and sex ratio of *L. dactylopii* were studied on different stages of *P. citri*. The result indicated that third instar nymphs and adult mealybugs were preferred for oviposition. Parasitoid development was significantly faster when exposed to later stages of the mealybug. The sex ratio depended upon the stage of the host parasitized. More parasitoid females were obtained when partially gravid females of *P. citri* were exposed to *L. dactylopii*. For mass rearing of *L. dactylopii* 15 to 20-day old *P. citri* are ideal stages.

KEY WORDS: *Leptomastix dactylopii*, host range, development, sex ratio, different stage, *Planococcus citri*.

Leptomastix dactylopii Howard (Hym., Encyrtidae) is believed to be a specific parasitoid of mealybug, *Planococcus citri* (Risso) (Hom., Pseudococcidae) in the field (Lloyd, 1964). However, Bess (1939), Clancy (1944) and Lloyd (1964) reported that the parasitoid would attack other species of mealybugs under laboratory conditions. Under the All India coordinated Research Project on Biological Control Contribution No. 100/88 of IIHR, Bangalore

of Crop Pests and Weeds, *L. dactylopii* was imported from West Indies in 1983 for trials against *P. citri*. Efforts were therefore made to examine the host range of the parasitoid on common mealybugs to use them as factitious hosts for laboratory multiplication. To develop a mass rearing technique, another study was conducted to determine the development and sex ratio of the parasitoid on different stages of *P. citri* under laboratory conditions.

MATERIALS AND METHODS

RESULTS AND DISCUSSION

Host insects tested

Seven species of mealybugs including *P. citri* (as check) were tested. *Pseudococcus longispinus* (Targ.-Tozz.) (collected from citrus orchards), *Nipaecoccus viridis* (Newstead) and *Maconellicoccus hirsutus* (Green) (from vineyards), *Ferrisia virgata* (Ckll.) (from guava orchard), *Dysmicoccus brevipes* (Ckll.) (from pineapple field) and *P. lilacinus* (Ckll.) (obtained from Biocontrol Research Laboratory, Pest Control (India) Pvt. Ltd., Bangalore) were maintained separately as pure cultures on ripe pumpkins (*Cucurbita moschata* Duch.) as described by Chacko *et al.* (1978) and Krishna-moorthy and Singh (1987).

Host range

Five hundred, 18-day-old mealybugs of each species were exposed for 24 h to one-day-old 15 mated females of *L. dactylopii* in 30×30×30 cm cages with wooden frame covered with muslin cloth and having a sliding glass door in front. Five replicates were maintained for each species and observations were made on i) host species attacked (based on the recovery of adults), ii) total number of parasitoids recovered from each species, iii) developmental period and iv) sex ratio.

Development and sex ratio of *L. dactylopii* on *P. citri*

Five hundred first (5-day-old), second (10-day-old) and third (15-day-old) instar nymphs, adult females (20-day-old) and gravid females (25-day-old) of *P. citri* were exposed for 6 h to 25 adults of *L. dactylopii*. A total of five replicates were maintained with each stage. Observations were made on i) extent of preference (based on number of adults recovered), ii) developmental period (from oviposition to adult eclosion) and iii) sex ratio.

All studies were carried out at a temperature of $26 \pm 2^\circ\text{C}$ and 60-75% RH. The data were subjected to unpaired t-test and an 'F' test.

Host range

L. dactylopii attacked only *P. lilacinus* in addition to *P. citri* under laboratory conditions (Table 1). *L. dactylopii* did not attack *Ps. longispinus*, *M. hirsutus*, *M. viridis*, *D. brevipes* and *F. virgata*. *L. dactylopii* is known to attack *Pseudococcus maritimus* (Ehrh.), *Pseudococcus gahani* Green, *Pseudococcus adonidum* (L.), *Phenacoccus solani* Ferris and *Phenacoccus gossypii* Towns & Ckll. under laboratory conditions (Bess, 1939; Clancy, 1944; Lloyd, 1964). Nevertheless, Lloyd (1958) and Zinna (1959) were of the opinion that though the parasitoid attacked species other than *P. citri*, the mean number of progeny produced was less. A similar observation was made in the present study with *P. lilacinus* also. Kirkpatrick (1953) has also reported that *D. brevipes* and *F. virgata* were not attacked by *L. dactylopii*. Although the developmental period and sex ratio of *L. dactylopii* on *P. lilacinus* varied significantly compared to *P. citri*, the former could be used only as an alternative host for limited rearing. However, for mass rearing programme, *P. citri* should be used (Fisher, 1963).

Development and sex ratio

The stage of *P. citri* attacked had a direct influence on the development and sex ratio of *L. dactylopii* (Table 2). Except first instar nymph, all stages of *P. citri* were capable of producing *L. dactylopii*, indicating that first instar is either not preferred or not suitable for successful development. Females did not oviposit in first instar as the attachment of the eggs was difficult (Zinna, 1959). Chandler *et al.* (1980) reported that *Anagyrus pseudococci* (Girault) preferred third instar *P. citri* nymphs. According to Clausen (1978), egg laying females were not attacked by *L. dactylopii*. In the present study, a few 25-day-old mealybugs were attacked. Such adults even after parasitization tended to produce a few eggs before being killed. Similar observations were reported by Moursi (1948) with *A. aegyptiacus* Moursi

TABLE 1. Host range, development and sex ratio of *L. dactylopii* *

Mealybug	adults emerged/cage	\bar{x} (5 replicates) developmental period (days)	sex ratio (♂ : ♀)
<i>P. citri</i> (check)	79.20a	15.23a	1:1.17a
<i>P. lilacinus</i>	33.40b	17.01b	1:0.51b

* Pairs of means within columns followed by the same letter are not significantly different ($P < 0.05$) (mod. unpaired t-test).

The developmental period of *L. dactylopii* was delayed in second instar nymphs. Males developed faster than females in all stages and were found to emerge much ahead of females as observed by Nechols and Kikuchi (1985) with *Anagyrus indicus* Shafee. Although this difference appeared to be associated with sex-related developmental differences in its host (Ali, 1957), *L. dactylopii* generally attacked only females. There were no significant differences between the developmental periods of males and females except in the second instar host (Table 3). As observed by Nechols and Kikuchi (1985) for *A. indicus*, *L. dactylopii* required a shorter time to develop and emerge from adult females than from younger mealy

bugs. This may be due to the delay in development in early instars (Moursi, 1948; Nechols and Tauber, 1977). Zinna (1959) also reported that *L. dactylopii* required 14 to 18 days to complete development at 28°C.

Only one parasitoid emerged from a host. The sex ratio of the parasitoid varied significantly between the age of the mealybug. Thus, the parasitoid, might have been influenced by the host size for laying male or female egg (Table 2).

Although more number of females were recovered from 25-day-old mealybugs, the total number of parasitoids obtained from this stage was less, indicating that this stage was

TABLE 2. Effect of different stages of *P. citri* on oviposition, development and sex ratio of *L. dactylopii*.

Stage of <i>P. citri</i>	\bar{x} no. of adults* recovered/ cage	\bar{x} developmental period (days)		\bar{x} sex ratio ♂ : ♀
		♂	♀	
I instar (5-day-old)	—	—	—	—
II instar (10-day-old)	30.0b	16.39d	17.15c	1 : 0.23a
III instar (15-day-old)	71.6c	14.89c	15.00b	1 : 0.66b
Adult (20-day-old)	81.0d	14.46b	14.67b	1 : 1.34c
Advanced stage partially gravid (25-day-old)	23.4a	14.17a	14.21a	1 : 2.2d
SEM	2.214	0.087	0.128	0.101

* Mean of five replicates, each replicate consists of 25 parasitoids/500 mealybugs.

Pairs of means within columns followed by the same letter are not significantly different ($P < 0.05$) by L.S.D.

TABLE 3. Developmental period of male and female *L. dactylopii* on different stages of *P. citri*

Sex*	II instar	III instar	Adult	Adult/partially gravid female mealybug
Male	16.39a	14.89a	14.46a	14.17a
Female	17.15b	15.00a	14.67a	14.21a

* Differences between male and female significant ($P = 0.05$) by 't' test only in second instar.

less suitable for rearing. Twenty-day-old adult female mealybugs appeared favourable for *L. dactylopii* development as reported by Chandler *et al.* (1980) and Nechols and Kikuchi (1985) for *A. pseudococci* and *A. indicus* respectively. Based on the present studies, it is concluded that for rearing of *L. dactylopii*, 15-20-day-old *P. citri* is the ideal stage.

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