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MORPHOLOGY, BIOLOGY AND PESTICIDE TOLERANCE OF *CHELOTOGENES ORNATUS* [*ACARI : CHEYLETIDAE*]

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This paper reports on the morphology, biology and pesticide tolerance of *Cheletogenes ornatus* (Canestrini & Fanzago), the most common predator of *Pinnaspis aspidistrae* (Signoret) in the region of Juazeiro-Bahia-Brazil. Some differences between *C. ornatus* from Brazil and redescriptions in the literature are mentioned in this paper. At 28 ± 5 °C the duration of the life cycle was 40.6 and 31 days for ♀♀ and ♂♂ respectively. Females had 2 nymphal stages while the only male obtained in the laboratory had a single nymphal stage. *C. ornatus* reproduced by thelytokous parthenogenesis, and ♂♂ were seldom produced. The peak reproduction rate was *ca.* 0.31 eggs/♀/day, and the peak prey comsumption rate was *ca.* 0.8 crawler of *P. aspidistrae*/♀/day. The least harmful chemicals to adult females of *C. ornatus* were methyl parathion, malathion, cyhexatin, zineb and sulfur. Those chemicals caused less than 20 % mortality of ♀♀ at the recommended rates on citrus. Concurrently, the first 2 chemicals caused over 70 % mortality of crawlers of *P. aspidistrae* in the laboratory at the recommended rates.

KEY-WORDS : *Cheyletidae, Cheletogenes ornatus, Pinnaspis aspidistrae,* pesticide tolerance.

INTRODUCTION

Cheletogenes ornatus (Canestrini & Fanzago) is found on citrus in high numbers associated with *Pinnaspis aspidistrae* (Signoret) (*Homoptera : Diaspididae*) all year around in the region of Juazeiro-Bahia-Brazil. It was previously reported from Brazil (**Arruda** *et al.,* 1969) and several other countries (**Baker,** 1949 ; **Avidov** *et al.,* 1968 ; **Summers & Price,** 1970 ; **Zaher** *et al.,* 1981).

Descriptions of immatures and adults of *C. ornatus* were given by **Smiley & Whitaker** Jr. (1981), **Summers & Price** (1970) and **Yousef** *et al.* (1980). Some differences between those descriptions and the mites from Brazil are presented in this paper. The biology of *C. ornatus* was studied by other authors using different methods and different prey species (**Avidov** *et al.,* 1968 ; **Zaher & Soliman,** 1971 ; **Zaher** *et al.,* 1981).

Under natural conditions, *C. ornatus* could probably exert some degree of control of *P. aspidistrae* in Brazil. In that case, indiscriminate use of pesticides on citrus for disease and pest control might result in pest population resurgence by reducing the population of *C. ornatus.*

The objectives of this study were to characterize morphologically the different stages of *C. ornatus* from Brazil, to study some aspects of its biology and to test the effect of some pesticides in the laboratory.

METHODS AND MATERIALS

The observations were conducted in a laboratory at 28 ± 5 °C and 80 ± 20 % RH, using mites from a stock-colony initiated with specimens collected from branches of citrus trees in a 2 ha-experimental orchard in Juazeiro-Bahia-Brazil.

Morphological observations were based on 5 to 10 individuals of each stage obtained in the laboratory and mounted in Hoyer's medium.

Development and reproduction studies were conducted in arenas consisting of translucent plastic rings (5 mm high, 2 mm thick and 12 mm inner diameter) glued with double stick-Scotch tape onto the upper surface of a lemon leaf. A thin layer of wax was brushed around the edge of the ring in contact with the leaf, to prevent mites from getting stuck to small sections of the Scotch tape eventually protruding inside the arena. The upper end of the arena was closed with a piece of thin, transparent wrapping PVC sheet (Magipack®). To prevent dessication, the leaves of the arenas were maintained on a layer of wet cotton. Mites were transferred to new arenas once a week. Inside each arena there was an empty armour of *P. aspidistrae* to provide a shelter for the mite. Only one mite was kept in each arena.

The study on the duration of the life cycle was initiated with eggs of known age obtained in the laboratory from ♀♀ collected from citrus in the field. Only unmated ♀♀ were used in the reproduction and prey consumption studies. Each mite was provided daily with 2 crawlers of *P. aspidistrae* as food, collected from citrus branches. Mites were checked once daily to evaluate the biological parameters.

The levels of resistance of *C. ornatus* to pesticides were determined by the slide-dip test method (**Anonymous,** 1968). Twenty field collected ♀♀ were placed venter up on each microscope slide, and the test was replicated 4 times at each concentration. For comparison, the resistance of crawlers of the prey *P. aspidistrae* was also studied, using the same methodology. Test solutions were prepared by diluting the commercial products at 0.01, 0.1, 1.0, 10.0 and 100.0 times the recommended rates for citrus pests. A control of distilled water was also used. After dipping, the slides were drained on a piece of absorbent paper for about 20 min and kept at *ca.* 28 °C on a wood frame inside a pan half filled with water, about 1 cm above the surface. Counts were done 24 h after treatments. For *C. ornatus,* counts were repeated 24 h later. Individuals that did not move after touched with a fine brush were considered dead.

RESULTS AND DISCUSSION

MORPHOLOGY

Adult females from Brazil agree well with the redescription of **Summers & Price** (1970) and **Yousef** *et al.* (1980), but have only 2 genital setae (instead of 3 mentioned by **Yousef** *et al.,* 1980).

Table 1 shows the palp and leg chaetotaxy of immatures and adults reared in this study. It is somewhat difficult to understand the chaetotaxy of palp and legs of *C. ornatus* in the way presented by **Yousef** *et al.* (1980) for material collected in Egypt, which precludes a comparison with the specimens from Brazil. The numbers of setae on genu and tibia I (2 and 4) of adult ♀♀ of this study are different from those mentioned by **Summers & Price** (1970) (3 and 5, respectively). In the immature and adult female stages, the solenidion of the tarsus of leg II is very tiny and difficult to see. The same is true for 2 of the tactile setae of the tarsus of leg I, for immatures and male and female adults.

TABLE 1

Palp and leg chaetotaxy and solenidiotaxy of different stages of Cheletogenes ornatus, *from Brazil (Palp, Leg I, II, III, IV). Setae on "coxae of palps" correspond to subcapitular setae. Numbers after "+" correspond to solenidia*

Stage	Segments					
	Coxa	Trocanter	Femur	Genu	Tibia	Tarsus
Larva	0,1,0,0	—,0,0,0	1,2,2,1	1,1,1,1	2,4,4,4	4,1+1,5+1,5
Protonymph	1,2,1,2,0	—,0,0,1,0	2,2,2,1,1	1,2,2,2,0	3,4,4,4,4	4,4+1,7+1,7,5
Deutonymph	1,2,1,2,2	—,1,1,2,1	4,2,2,2,1	1,2,2,2,2	3,4,4,4,4	4,4+1,7+1,7,7
Adult (♀)	1,2,1,2,2	—,1,1,2,1	4,2,2,2,2	1,2,2,2,2	3,4,4,4,4	4,4+1,7+1,7,7
Adult (♂)	1,2,1,2,2	—,1,1,2,1	4,2,2,2,1	1,2,2,2,2	3,4,4,4,4	4,4+1,7+1,7+1,7+1

On the venter of the gnathosoma and idiosoma, the following setae were observed : Larva — 2 pairs of intercoxals (ic1 and ic3 of **Smiley & Whitaker** Jr., 1981), and 4 pairs in the anal region (g1, G2, a1 and a2 of **Smiley & Whitaker**) ; Protonymph — 1 pair of subcapitulars, 2 pairs of intercoxals, 1 pair of paraanals and 3 pairs of anals ; Deutonymph — 1 pair of subcapitulars, 2 pairs of paraanals and 4 pairs of anals ; Adult Female — 1 pair of subcapitulars, 3 pairs of intercoxals (ic1, ic3 and ic4), 3 pairs of paragenitals plus 2 pairs of genitals (g1-g5), and 3 pairs of anals (a1-a3) ; Adult Male — 1 pair of subcapitulars, 3 pairs of intercoxals (ic1, ic3, ic4), 1 pair of paragenitals and 1 pair in the ano-genital region.

BIOLOGY

Table 2 shows the durations of female immature stages and adult female phases. The durations shown on the table are slightly shorter than mentioned by **Zaher** *et al.* (1981) for a study conducted at 25 °C. However, they are considerably longer than mentioned by **Zaher & Soliman** (1971) and considerably shorter than those given by **Avidov** *et al.* (1968), for studies conducted at about the same temperature as this study. This may be due to a difference in diet (prey species) as mentioned by **Zaher** *et al.* (1981). The durations corresponding to a single male obtained in thus study were : Egg — 13 days ; Larva — 6 ; Chrysalis I — 2 ; Nymph (only one nymphal stage) — 8 ; Chrysalis II — 2 ; Longevity — 45. Those durations were much shorter than reported by **Zaher** *et al.* (1981), who also reported only 1 nymphal stage for males. **Zaher & Soliman** (1971) reported 2 nymphal stages for males.

Figure 1 shows the variation in the daily rate of egg laying during the oviposition period of *C. ornatus*. The first egg was laid 5 days after female emergence, and the oviposition rate remained quite stable until *ca.* the 45th day after female emergence. The highest peak was 0.31 egg per female per day. The total number of eggs laid per female during the oviposition period was 8.2 $\pm$ 5.1. This number is much lower than reported by **Zaher** *et al.* (1981), which can be due to differences in predator biotypes, prey suitability or rearing methods. Although *C. ornatus* is commonly seen feeding on crawlers of *P. aspidistrae*, it is possible that it prefers prey eggs.

All of the 20 mites obtained from field collected eggs and 13 mites obtained from eggs laid by field collected adults were females. Only 1 male was obtained out of 48 mites

TABLE 2

Durations of immature stages and adult female phases of Cheletogenes ornatus *at 28 ± 5 °C and 80 ± 20 % RH (n = 20)*

Immature stage/ Adult phase	Duration ± Standard Deviation (in days)
Egg	10.6 ± 2.3
Larva	7.3 ± 2.2
Chrysalis I	2.1 ± 0.3
Protonymph	6.7 ± 1.9
Chrysalis II	2.4 ± 0.5
Deutonymph	8.5 ± 3.3
Chrysalis III	3.0 ± 0.8
Life cycle	40.6 ± 6.9
Preoviposition	7.4 ± 3.6
Oviposition	25.0 ± 23.0
Postoviposition	10.1 ± 11.4
Longevity	42.5 ± 29.6

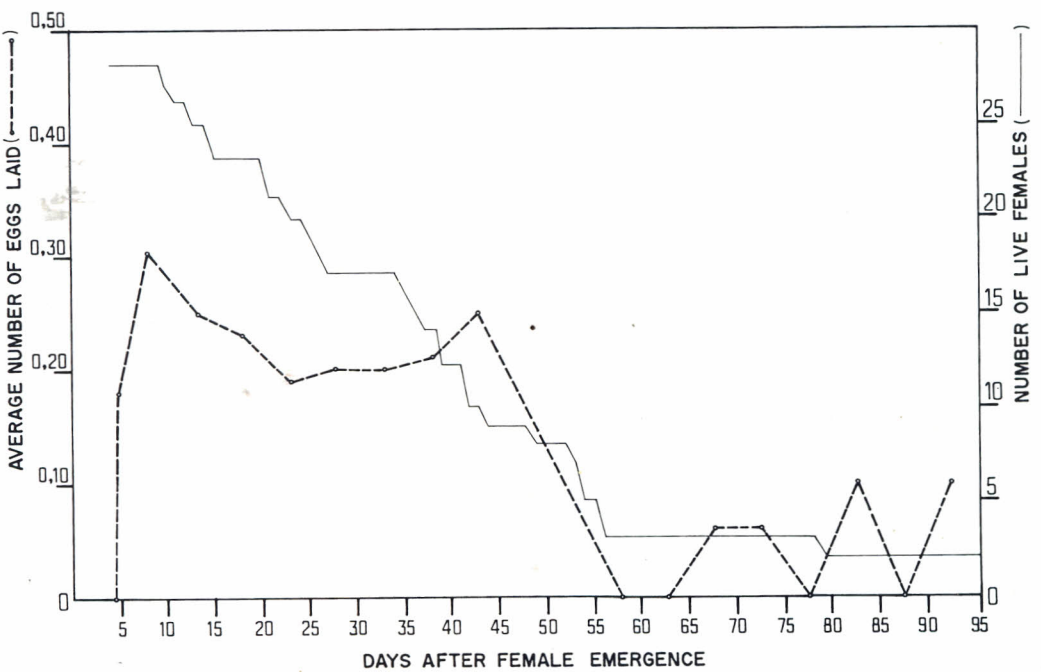

Fig. 1. Average daily rate of oviposition of *C. ornatus* when fed crawlers of *P. aspidistrae*, at 28 ± 5 °C and 80 ± 20 % RH. Rates calculated on the bases of the number of ♀♀ at the beginning of the test. Each point indicates the average for a 5 day-period.

TABLE 3

Percentage mortality of adult females of Cheletogenes ornatus *and crawlers of* Pinnaspis aspidistrae *at different dosages of pesticides (n = 80 individuals per concentrations). Data transformed by Abbott's formula*

Pesticide/ Dosage	Mortality Mite 24 h	Mite 48 h	Scale 24h	Pesticide/ Dosage (1)	Mortality Mite 24 h	Mite 48 h	Scale 24 h
Methyl parathion (60 EC)				*Bromopropylate* (50 EC)			
10000	44.6	75.0	98.6	6500	100.0	100.0	100.0
1000	31.1	31.9	97.3	650	77.8	95.5	97.1
100	18.9	16.7	78.4	65	87.5	98.5	67.6
10	9.5	6.9	44.6	6.5	18.1	22.4	23.5
1	10.8	2.8	14.9	0.65	8.3	11.9	14.7
Triona (80)				*Deltamethrine* (2.5 EC)			
100000	100.0	100.0	100.0	3000	87.0	94.8	100.0
10000	98.6	100.0	100.0	300	58.4	72.7	98.6
1000	76.8	72.1	97.1	30	23.4	36.4	90.4
100	20.3	17.7	87.0	3	5.2	7.8	94.5
10	0.0	0.0	81.2	0.3	1.3	5.2	69.9
Zineb (75 WP)				*Avermectin B1* (1.8 EC)			
1350	2.7	1.3	87.2	10000	100.0	100.0	100.0
135	1.3	6.5	62.8	1000	100.0	100.0	100.0
13.5	0.0	0.0	21.8	100	100.0	100.0	90.8
1.35	0.0	2.7	21.8	10	100.0	100.0	82.9
0.135	0.0	0.0	9.0	1	76.3	89.5	40.8
Malathion (50 EC)				*Pirimicarb* (50 GD)			
25000	79.5	89.0	100.0	5000	9.1	18.4	100.0
2500	16.4	26.0	96.1	500	0.0	0.0	98.6
250	0.0	0.0	85.5	50	0.0	0.0	2.8
25	0.0	2.7	84.2	5	0.0	0.0	0.0
2.5	0.0	0.0	23.7	0.5	0.0	0.0	12.5
Sulfur (80 SP)				*Propargite* (68 EC)			
40000	10.4	22.4	100.0	8500	35.1	54.1	—
4000	0.0	0.0	55.4	850	0.0	1.3	—
400	0.0	0.0	18.9	85	0.0	1.3	—
40	0.0	0.0	6.8	8.5	0.0	0.0	—
4	0.0	0.0	13.5	0.85	0.0	0.0	—
Cyhexatin (50 WP)				*Dicofol* (18.5 EC)			
4000	9.0	18.0	—	20000	100.0	100.0	100.0
400	0.0	2.0	—	2000	98.0	98.7	55.9
40	0.0	2.0	—	200	94.0	94.7	47.1
4	0.0	0.0	—	20	85.0	82.9	8.8
0.4	0.0	7.0	—	2	1.0	1.3	0.0

(1) In ml or g of commercial product/100 l.

obtained from eggs laid by unmated ♀♀ reared in the laboratory. These results indicate that *C. ornatus* reproduced by thelytokous parthenogenesis in this study. Of 173 specimens of *C. ornatus* randomly collected in the field in January of 1987, there were 9 larvae, 16 protonymphs, 48 deutonymphs, 96 adult females and only 4 adult males. The scarcity of ♂♂ in the material from Brazil contrasts with that observed by **Avidov** *et al.* (1968) in Israel, and **Zaher & Soliman** (1971) and **Zaher** *et al.* (1981) in Egypt. In the latter 2 papers, the authors report that copulation was observed. However, this difference may simply indicate differences in biotypes.

Based on observations conducted with 20 individuals, the total number of crawlers of *P. aspidistrae* consumed by each stage of *C. ornatus* was : Larva — 3.8 ± 1.8 ; Protonymph — 4.0 ± 2.0 ; Deutonymph — 5.2 ± 1.6 ; Adult Female — 18 ± 16.9. Thus, each mite consumed *ca.* 31 crawlers of *P. aspidistrae* during its life span. Daily rates of prey consumption by adult ♀♀ were variable, but were higher in the first 55 days after female emergence (fig. 2), which corresponds roughly to the time when the rate of egg laying was highest. The highest peak during that period was slightly over 0.8 crawler of *P. aspidistrae* per day. As mentioned by **Avidov** *et al.* (1968), *C. ornatus* seems not to chase its prey. Rather it waits in ambush under old scale shields for crawlers to pass by.

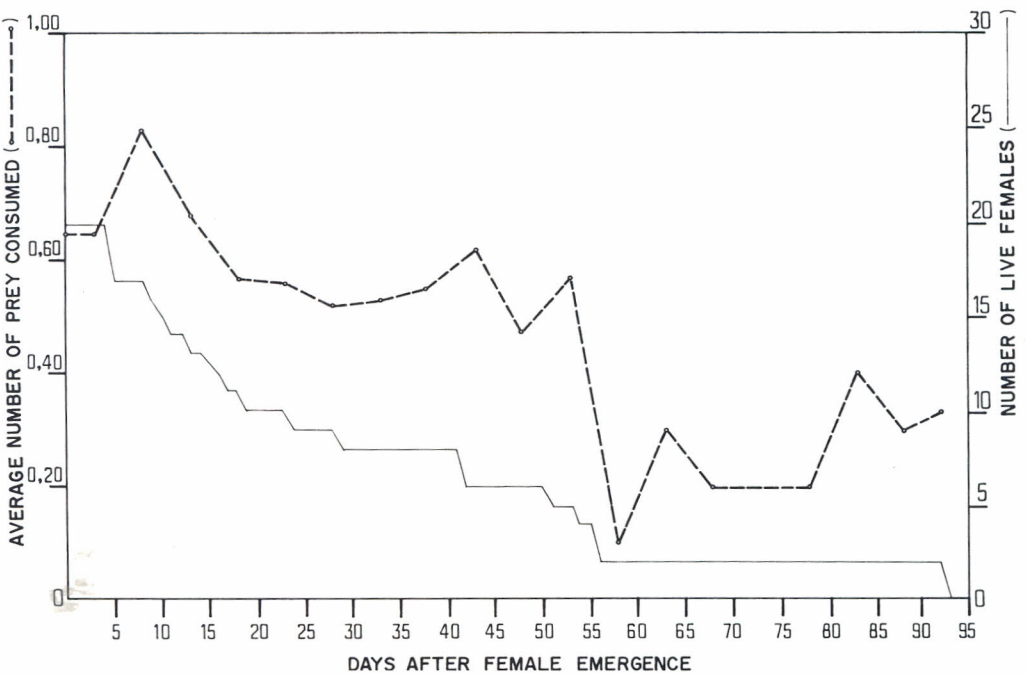

Fig. 2. Average daily rate of consumption of crawlers of *P. aspidistrae* by adult ♀♀ of *C. ornatus*, at 28 ± 5 °C and 80 ± 20 % RH. Each point indicates the average for a 5 day-period.

Tolerance to pesticides

Table 3 shows the percentage of ♀♀ of *C. ornatus* and crawlers of *P. aspidistrae* killed with different concentrations of some pesticides, most of which are commonly used on citrus. The least harmful products to *C. ornatus* were methyl parathion, malathion, cyhexatin, zineb and sulfur, which killed less than 20 % of the mites at the rates recommended on citrus. Furthermore, the 2 former products killed over 70 % of the prey, *P. aspidistrae*, at the recommended rates on citrus. Bromopropylate, avermectin B1 and triona were the most toxic to the mite, killing over 70 % of the individuals at the recommended rates, although also killing over 70 % of the prey at those concentrations. The major effect of all products tested was observed 24 h after treatment, although in some cases the percentage of mites killed increased an additional 10 to 20 % after another 24 h period.

In another study to investigate the effect of pesticides, **Avidov** *et al.* (1968) observed that zineb had very little effect on *C. ornatus,* while chlorobenzilate was quite toxic and a mixture of ethion and petroleum oil had an intermediate effect on the mite.

No effort was done in this study to compare the efficiency of *C. ornatus* as a natural enemy of *P. aspidistrae* with that of other organisms. The high numbers of *C. ornatus* on branches attacked by *P. aspidistrae* initially suggested a considerable effect of the first on the latter. Nevertheless, the abundance of *C. ornatus* could only indicate the suitability of *P. aspidistrae* as prey and have at best no relationship with its ability to control the latter. Field tests involving elimination of, or interference with, *C. ornatus,* e.g. by the use of a pesticide with minimum effect on *P. aspidistrae,* should indicate the effectivity of this predator. By the results of this study, it appears that low concentrations of Dicofol could be used for this purpose.

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RÉSUMÉ

Morphologie, biologie et résistance de *Cheletogenes ornatus* [*Acarien : Cheyletidae*] aux pesticides

Ce travail rend compte de la morphologie, de la biologie et de la résistance aux produits phytosanitaires de *Chelotogenes ornatus* (Canestrini & Franzago), prédateur le plus fréquent de *Pinnaspis aspidistrae* (Signoret), dans la région de Juazeiro-Bahia-Brésil. Quelques différences rencontrées entre les échantillons de *C. ornatus* récoltés au Brésil et les descriptions de cette espèce relevées dans la littérature sont également mentionnées. A 28 ± 5 °C, la durée totale des stades immatures fut de 31,0 jours pour les ♂♂ et de 40,6 jours pour les ♀♀. Ces dernières ont présenté 2 stades nymphaux alors que l'unique mâle obtenu au laboratoire n'en a présenté qu'un seul. *C. ornatus* s'est reproduit par parthénogénèse thélytoque et, en conséquence, les mâles apparaissent rarement. Le niveau maximum de reproduction a été de 0,31 œufs/femelles/jour tandis que la consommation maxima de proie a été de 0,8 larves mobiles de *P. aspidistrae*/femelle/jour. Les pesticides les moins toxiques pour les ♀♀ adultes de *C. ornatus* furent le parathion méthyl, le malathion, la cyhexatine, le zineb et le soufre. Ces produits ont causé moins de 20 % de mortalité chez les ♀♀ de *C. ornatus,* aux concentrations recommandées pour le traitement des citrus, alors que les 2 premiers pesticides cités ont entraîné la mort de 70 % des larves mobiles de *P. aspidistrae* aux mêmes concentrations, en laboratoire.

MOTS CLÉS : *Cheyletidae, Cheletogenes ornatus, Pinnaspis aspidistrae,* résistance aux pesticides.

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