Pak. j. sci. ind. res., vol. 36, no. 8, August 1993

OVIPOSITION AND DEVELOPMENT OF THE MEALYBUG PARASITOID *ANAGYRUS PSEUDOCOCCI* (GIRAULT) AT DIFFERENT CONSTANT TEMPERATURES

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(Received October 25, 1992; revised August 11, 1993)

Oviposition and rate of development of the parasitioid, *Anagyrus pseudococci*, were determined at constant temperature of 18, 21, 24, 27, 30 and 33° in the laboratory. Most progeny were produced at 27° and 30°. The developmental rate for both the sexes showed good fit to linear regression model over a wide range of temperatures. Males developed faster than females at all temperatures. The lower developmental threshold was estimated to be 13.06° and 12.57° for males and females respectively. The estimated thermal requirement for development was 195.50 degree-days for males and 219.59 degree-days for females.

Key words: Developmental rate, Progeny production, *A. pseudococci*, Mealybug, *Planococcus citri*.

Introduction

The citrus mealybug, *Planococcus citri* (Risso), is an important pest of many fruits and ornamental plants in the field and greenhouses in most tropical, subtropical and temperate regions in the world. Orange and grapefruit are particularly susceptible to this pest [1,2]. The pest sucks sap from different parts with a general preference for tender stems, flower buds and young fruit clusters, and causes debilitation of the plant. Fruit become unsightly due to the growth of sapropghytic sooty mould on the honeydew produced by the mealybug, and heavy infestations may result in fruit drop. *P. citri* is difficult to control because it is largely protected from insecticides by its waxy covering and its preference for crevices and other protected sites on the host plant [3,4].

An encyrtid, *A. pseudococci* (Girault), is an important parasitoid of *P.citri* and can suppress the pest populaltion to acceptable level under certain condtions [3,5-7]. *A.pseudococci* is reported to be an important parasitoid of the striped mealybug *Ferrisia virgata* (Ckll.) in Bangladesh [8]. Studies on the effect of temperature on the development of *A. pseudococci* have been reported [9,10]]. The present study was carried out in 1991-92 at Wye College laboratory and describes the effect of temperature on the oviposition performance and development of *A. pseudococci*. The data on development rate could be useful in developing a degree-day model which could be used to predict generation phenology.

Materials and Methods

A culture of *A. pseudococci* was maintained in ventilated plastic sandwich boxes 173 x 115 x 65 mm) on its natural host, *P. citri*, reared on sprouted potato tubers inthe laboratory. The culture was maintained at 26 ± 1°, 50-60% r.h. and 12 light/12 dark cycles.

Oviposition. Five, 3-day old mated, inexperienced female parasitoids (the parasitoids which had not been exposed to hosts previously), were transferred into 6 plastic boxes (173 x 115 x 65 mm) each containing a sprouted potato tuber infested with at least 50 third instar and young adult female mealybugs and allowed to oviposit for 2 hours at constant temperatures of 18, 21, 27, 30 and 33°. The parasitoids were then removed. The boxes containing parasitized mealybug were kept in a incubator at 27° ± 0.5° and with 50-60% r.h. and 12L/12D photoperiods, and were checked twice daily for parasitoid emergence. Oviposition at all the tempeatures was tested simultaneously. There were 4 replications at each temperature.

Development. Ten 4-5 day old mated, female parasitoids were introduced into 6 plastic boxes each containing 2 sprouted potato tubers infested with 3rd instar and young adult female mealybugs (approximately 50/potato) and allowed to oviposit for 2 hrs at 26°. The parasitoids were removed and the punnet box containing the infested tubers were transferred to the incubator held at the experimental temparature. the rate of parasitoid development was examined at 18, 21, 24, 27, 30 and 33°. All the experiments were conducted at 12L:12D, 45-60% r.h. and thermal accuracy of ±0.5°. During parasitoid emergence, the host were checked twice daily. The date of emrgence and sex of each parasitoid were recorded. The effect of temperature was tested simultaneously. There were 3 replications at each temperature.

Developmental rate (reciprocal of the development time in days from oviposition to emergence) was plotted against temperature and the plot examined the linearity. Those data points which fell along a straight line, were used to calculate

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the regression line y = a + bx where y is the rate of development, x is the temperature (°C), a and b are the empirical constants [11]. The developmental zero or lower threshold (T1) was found by extrapolating the regression line until it cut the temperature axis (i.e. T1 = -a/b). The degree-day above the lower threshold was estimated by the reciprocal of the slope of the regression line (i.e., DD = 1/b).

Results and Discussion

Progeny porduction of *A. pseudococci* varied significantly with temperature (P<0.01). The mean number of progeny produced/female/2 hrs is shown in Table 1. The number of progeny produced increased with increasing temperature up to 30° and then declined. The results are similar to those reported by Niyazov [12].

A. pseudococci developed successfully from egg to adult over a temperature range of 18°-33° (Table 1). The mean developmental period decreased significantly with increasing temperatures (P0.01).The duration on development was longest at 18°. The developmental period of females was longer than that of males (P<0.01). The sex ratio of males to females averaged 1:1 over the experiments.

A close positive linear relationship between rate of developmnet (y) and temperature (x) was observed in the temperature range of 18°-30° (Fig. 1). Over this range the regression of developmental rate on temperature is represented as y = -0.066794 + 0.005115x (r^2 = 0.99, P<0.01) in males and y = -0.057252 + 0.004554x (r^2 = 0.99, P<0.01) in females. The point at 33° was omitted from the calculation because it deviates from linearity.

The lower developmental thresholds (T1) extrapolated from linear function were found to be 13.06° and 12.57° for males and females respectively. The thermal requirement for the development of males and females was estimated to be 195.50 and 219.59 degree-days respectively.

The results reveal that temperature greatly affects the developmental rate of *A. pseudococci*. A simple linear model has been used to determine the ralationship between developmental rate and temperature. Usually the raltionship between the developmental rate and temperature is calculated as linear, but actually it is curvilinear [13]. Many nonlinear functions have been developed for determining the relationship between the developmental rate and temperature [14] but for many species the calculation by linear regression is acceptable [15]. The estimation of lower developmental threshold by linear extrapolation has been used successfully for predictive purposes in several insects [16,17].

There are few references in the literature on the developmental rate of *A. pseudococci* in relation to temperature. Avidov *et al.* [9] calculated the lower thresholds of development (11.4° and 12° for males and females respectively) and the thermal requirements (285 and 297 degree-days for males and females respectively), but the calculation was based on the developmental period under variable temperatures. Our study indicates that the parasitoid has a slightly higher developmental threshold (Fig. 1) and requires 195.50 and 219.59 degree-days for males and females respectively for development. The reason for this variation might be the discarding of the highest temperature of 33°.

TABLE 1. PROGENY PRODUCTION AND DEVELOPMENT TIME OF *A. PSEUDOCOCCI* AT SELECTED CONSTANT TEMPERATURES.

Temperature °C	Mean⁺ number ±SE of off spring/ female/2 hrs	Developmental time			
		Male		Female	
		n	Days ±SE	n	Days ±SE
18	2.35 ± 0.24 a	48	39.17 ± 0.21 a	43	39.75 ± 0.29 a
21	3.47 ± 0.33 b	39	25.49 ± 0.21 b	41	27.32 ± 0.27 b
24	3.05 ± 0.34 b	38	17.37 ± 0.26 c	40	18.22 ± 0.20 c
27	5.80 ± 0.55 c	40	14.02 ± 0.17 d	39	15.70 ± 0.13 d
30	7.10 ± 0.42 d	37	11.60 ± 0.11 e	42	12.51 ± 0.16 e
33	2.65 ± 0.25 a	43	11.21 ± 0.14 e	44	11.99 ± 0.15 e

Means followed by the same letter in the column are not significantly different (P>0.01; Duncan's multiple range test).
⁺ Means based on offspring from 20 individuals from 4 replicates.

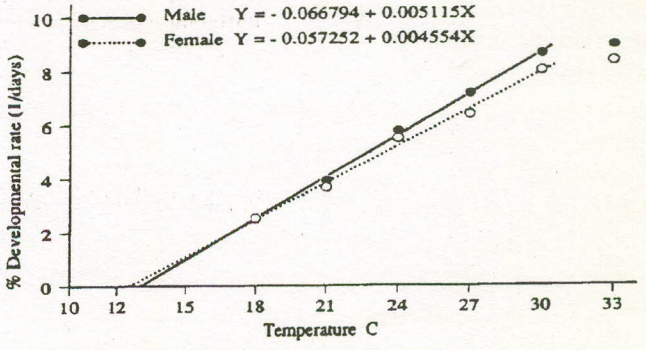

Fig. 1. Relationship between temperature and rate of development for male and female *A. pseudococci*.

The males always developed slightly faster thanthe females. This phenomenon is called 'protandry' [18]] and is widespread among parasitoids [19,20].

Sayed *et al.* [21] reported the developmental period of the host mealybug, *P. citri* at different temperatures. The result of the present study on the developmental period of *A. pseudococci* at different temperatures is comparable with the developmental period of its host [21]. The development period of this parasitoid was found much shorter than that of it hosts. A shorter generation period is considered an important characteristic for the parsitoid if it is to be a successful biological control agent of the mealybug over a wide range of temperatures.

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