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The Life-cycle of *Biosteres persulcatus* with Reference to Adults' Reproductive Capacity on Eggs of Carambola Fruit-fly

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ABSTRAK

Kajian telah dijalan di makmal (26.5^{o}C ± 1.5^{o}C) bagi mengkaji edaran hidup, Biosteres persulcatus *Silvestri, parasitoid pada larva lalat buah* (Bactrocera (B) *sp. near* Bactrocera dorsalis *A). Terdapat 4 peringkat larva berasaskan kepada saiz peralatan mulut. Penjelmaan larva yang pertama berlaku dalam kepompong perumah yang baru dibentuk. Jumlah masa perkembangan kedewasaan jantan dan betina ialah 16.3 ± 0.80 hari dan 17.1 ± 0.80 hari. Purata keupayaan pembiakan semasa hidup ialah 67 ± 3.5 biji telur.*

ABSTRACT

A study of the life-cycle of Biosteres persulcatus *Silvestri, a larval parasitoid of (*Bactrocera (B) *sp. near* Bactrocera dorsalis *A), was conducted in the laboratory (26.5^{o}C ± 1.5^{o}C). There are 4 larval stages as indicated by the sizes of the mouthhooks. The first larval moult occurred in the newly-formed puparium of the host. The entire developmental period from egg to adult emergence for male and female was 16.3 ± 0.80 days and 17.1 ± 0.80 days respectively. The average reproductive capacity during the life span was 67 ± 3.5 eggs.*

Keywords: ***Biosteres persulcatus*** **Silvestri, larval development, reproductive capacity, carambola fruit-fly**

INTRODUCTION

The carambola fruit-fly *Bactrocera* (*Bactrocera*) sp. near *Bactrocera dorsalis* A (Diptera : Tephritidae) (White and Elson-Harris 1992) is of economic importance because of its climatic tolerance, geographical distribution and diversity of hosts. The *dorsalis* complex comprises many species (Drew 1989).

Bactrocera dorsalis complex has several natural enemies (Clausen *et al.* 1965, Bateman 1972). In Hawaii van den Bosch and Haramoto (1953) attributed the success of *Biosteres persulcatus* over other opiine parasitoids to its ability to inhibit physiologically the development of other parasitoids in their hosts. This parasitoid, *Biosteres persulcatus* which was originally from South Asia was introduced into Hawaii during the 1935-1936 project on biological control (Wharton 1989). Recently, effective trapping methods of *Biosteres persulcatus* in the field have been developed in Hawaii (Vargas *et al.* 1991; Messing and Wong 1992).

In Malaysia, seven species of opiine parasitoids were recorded from *Bactrocera dorsalis* complex (Rohani 1986). The effective parasitisation of *Bactrocera dorsalis* complex depends on the geographical location of the orchards (Ooi 1984; Vijaysegaran 1984, 1991; Palacio 1991). Therefore in an effort to evaluate the potency of *Biosteres persulcatus* in regulating the populations of *Bactrocera* (B) sp. near *Bactrocera dorsalis* in tropical fruit orchards, knowledge of the biology of the parasitoid is important. This work investigates the life-history of *Biosteres persulcatus* and the reproductive capacity of the adults.

MATERIALS AND METHODS

The biological studies were conducted under laboratory conditions of 26.5^{o}C±1.5 ^{o}C and 72.5 ±7.5% RH at the Department of Plant Protection, Universiti Pertanian Malaysia. The field trial was conducted at the university farm, Puchong, which has an orchard for production of carambola fruits.

For life-cycle study, slices of ripe guava var. Kampuchean, each measuring 4 x 5 x 1 cm were placed in a shallow pan (5 cm diam.) exposed to approximately 2000 females of *Bactrocera* (B) sp. near *Bactrocera dorsalis* A for an hour of oviposition. The first-instar larvae of the fruit-flies were then exposed to 100 females of *Biosteres persulcatus* in a cage measuring 20 x 20 x 20 cm for 3 hours. To determine the incubation period of

parasitoid eggs, 100 parasitised *Bactrocera* larvae were dissected under a stereomicroscope commencing 22 hours after exposure to the parasitoids. This was done at hourly intervals until all the parasitoid eggs had completed the incubation period. After hatching, another 100 parasitised hosts were dissected daily until all the parasitised larvae had pupated. The parasitised pupae were individually weighed and recorded for adult emergence.

To determine reproduction of *Biosteres persulcatus*, pairs of newly-emerged male and female parasitoid adults were confined separately in plastic cages measuring 4 cm tall and 4 cm diam. Each pair of *Biosteres persulcatus* was offered daily a slice of guava fruit (2 x 2 x 1 cm) containing at least 50 first-instar larvae of carambola fruit-fly. An undiluted commercial honey was regularly streaked on the inner wall of the cage to serve as food for adult parasitoids. Hosts offered to 20 pairs of adult parasitoids were dissected daily to determine the fecundity of the parasitoids. The hosts offered to another batch of 20 parasitoids were reared on an artificial diet until the emergence of the parasitoids. Ten female parasitoids of known age were dissected daily to determine the number of mature eggs in the ovaries.

Longevities of adult parasitoids when kept with and without hosts were measured. Twenty pairs of parasitoids were kept with fruit slices containing first-instar larvae of fruit-fly and another 20 pairs were only fed with diluted honey (10%). Their survival rate was recorded.

RESULTS AND DISCUSSION

Larval Development

Table 1 shows the entire developmental period of the parasitoids. The egg of *B. persulcatus* is elongated with rounded ends measuring 0.68 ± 0.005 mm long and 0.09 ± 0.002 mm wide when newly laid. A fully-incubated egg measured 0.76 ± 0.007 mm long and 0.17 ± 0.002 mm wide. The mean incubation period of eggs was 27.0 h with 95% hatchability.

TABLE 1

Developmental parameters of *Biosteres persulcatus* Silvestri at 26.0 ± 1.5°C and 72.5 ± 7.5% RH

Stage[a]	Duration (Days)		Survival (%)	
	Range	Mean	Range	Mean
A. Egg:	0.96 – 1.46 (23 – 35 hr)	1.12 (27.01 hr)	93.00 – 98.00	95.46
B. Larva:	9.00 – 13.00	10.96	88.00 – 96.00	91.00
I:	4.00 – 7.00	5.61	after hatching	
II:	6.00 – 9.00	7.89	after oviposition	
III:	7.00 – 10.00	8.46	after oviposition	
IV:	8.00 – 13.00	10.10	after oviposition	
C. Pupa:				
Female:	5.00 – 6.00	5.60	82.00 – 93.00	88.00
Male:	5.00 – 6.00	5.40	82.00 – 92.00	87.80
D. Entire Development:				
Female:	16.00 – 20.00	17.14	67.11 – 87.49	76.44
Male:	15.00 – 19.00	16.26	167.11 – 86.55	76.27
E. Sex Ratio:	1.10 female : 1 male			

[a]Determined from hourly dissection of 100 samples of parasitised hosts starting 22 h after oviposition for egg and daily for the succeeding immature stages.

The first instar is hymenopteriform with heavily sclerotised mandibles measuring 0.05 ± 0.002 mm long and 0.03 ± 0.001 mm wide. *(Fig. 1)*. The newly-hatched larva measured 0.76 ± 0.007 mm at the early stage increasing to 2.00 ± 0.05 mm at its later stage. The average period for first instar is 5.6 days.

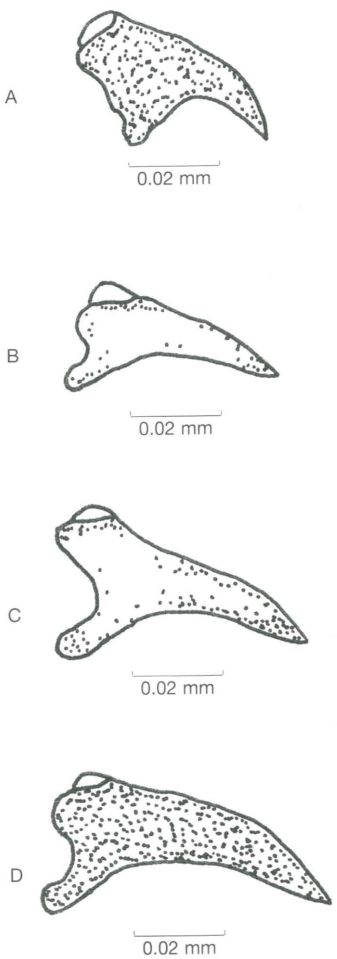

Fig. 1. Mandibles of first through larval instars of Biosteres persulcatus *Silvestri (A – D respectively)*

The second-instar larva is grub-like and the mandibles are unsclerotised. The larva measured 3.12 ± 0.005 mm long and 0.91 ± 0.003 mm wide and lasted one day at most in the newly-formed puparium of the fruit-fly. The third instar is similar to the second instar except that it had increased in size to 4.3 ± 0.004 mm long and 1.4 ± 0.002 mm wide. It lasted for at most one day only and at this stage was yellowish white.

The fourth instar is of similar colour to the third instar but it has numerous spines and 9 pairs of spiracles. The mandibles are heavily sclerotised measuring 0.08±0.002 mm long and 0.3±0.002 mm wide, with incisors curved and acute. The larva measured 5.62±0.07mm long and 2.07±0.05 mm wide and lasted 4 days. The prepupa is dirty white. Inside the host puparium, the pupa is enveloped by a paper-like cocoon. The exuviae of the fourth instar is attached along the apical part of the antennae of the male or ovipositor of the female.

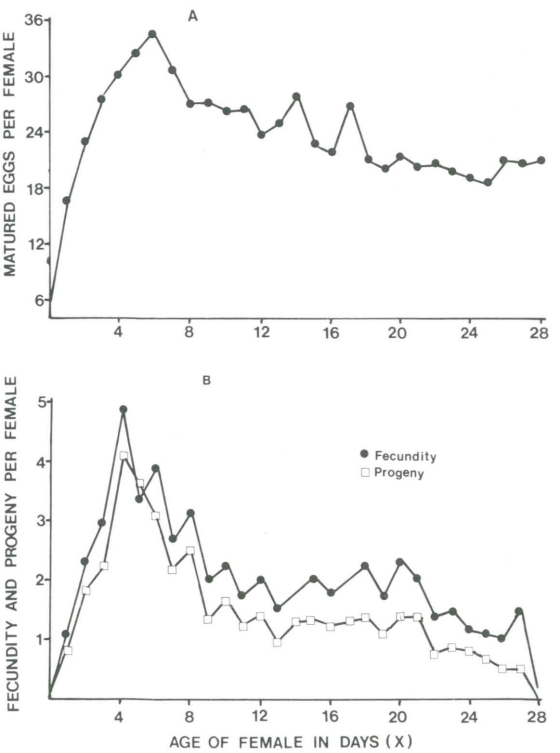

Fig. 2. Daily mean of mature eggs (A); and fecundity and progency production (B) of Biosteres persulcatus *Silvestri (Based on 10 females for A, and 20 pairs for B)*

The pupa is yellowish brown to piceous depending on the age. The female pupa measured 4.8±0.05 mm long and the male 4.7±0.05 mm. The average developmental period for male and female pupae was 5.6±0.6 days and 5.4±0.05 days respectively. The entire developmental period from egg to adult emergence averaged 17.1± 1.5 days for female and 16.2±1.5 days for male. The overall survival was comparable for both sexes, 76.4%±0.75 for females and 76.2%±0.75 for males with a sex-ratio of 1 : 1.

The newly-emerged adult has a reddish brown appearance. The ovipositor shaft is brown with swollen and trisinuate apex. Female adults measure 5.13±0.07 mm long from head to tip of abdomen and 1.22±0.02 mm wide. The male external genitalia is brownish and the aedegus dorsolventrally flat (Palacio *et al.* 1992).

Reproduction and Longevity

Pairs of male and female *Biosteres persulcatus* commenced mating and oviposition on the same day they emerged from pupae. The highest daily mean fecundity/female occurred on the 4th day of adult life, coinciding with peak of ovarian egg maturation *(Fig. 2)*. Production of adult offspring/female followed a similar trend to that of the eggs. The oviposition period lasted 27±1.35 days for *Biosteres persulcatus*. The daily average number of eggs/female was 2.50±0.5. This implies that the total number of eggs over the life-span of the parasitoid was 67.5±2.7 eggs. Females of *B. persulcatus* fed with honey and water but deprived of hosts lived longer than females which were continuously offered hosts *(Fig. 3)*. Greany *et al* .(1976) similarly observed that female *Diachasmimorpha longicaudata* provided with hosts throughout their lives died much sooner than those without hosts.

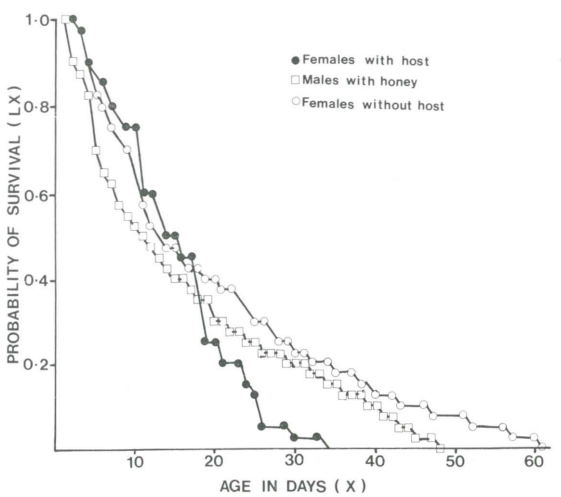

Fig. 3. Adult survival of Biosteres persulcatus *Silvestri in relation to availability of the host (Based on 40 adults each)*

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