Influence of Temperature and Host on Life History Parameters of *Catolaccus Hunteri* (Hymenoptera: Pteromalidae)

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ABSTRACT *Catolaccus hunteri* Crawford is an external parasitoid of cryptic Coleoptera, particularly of Bruchidae and Curculionidae in flowerbuds, small fruits, and seeds. It is the most common parasitoid of the pepper weevil, *Anthonomus eugenii* Cano, in the United States, Mexico, and elsewhere, and was introduced from Guatemala to Hawaii for control of this pest. Studies were conducted to assess effects of temperature and host on life history parameters of *C. hunteri* as a step toward eventual mass rearing and inoculative release for pepper weevil control. Oviposition, postovipostion period and adult longevity were shorter at 30°C than at 20 or 25°C. Mean number of eggs oviposited per female was greater at the lower temperatures than at the highest temperature. Duration of all development stages was shorter at 30°C than at 20 and 25°C. Developmental period of *C. hunteri* was longer and adult longevity was shorter on boll weevil, *Anthonomus grandis* Boheman, than any other host. Female wasps laid most eggs on the cowpea weevil, *Callosobruchus maculatus* (F.), larvae. Transferring of *C. hunteri* reared on *C. maculatus* to pepper weevil or boll weevil caused a reduction in the mean number of eggs/female. Age-specific life tables and age-specific fecundity for *C. hunteri* were analyzed using three constant temperature regimes and five sources of host. These tables were used to calculate the innate capacity of natural increase (r_m), the finite rate of increase (λ), the mean generation time (T), the net reproduction rate (R_o), and the gross rate of reproduction. The results indicate that *C. hunteri* populations are capable of increasing in all of the environmental conditions tested in the current study. The optimum temperature for population increase for *C. hunteri* is 25°C. With respect to host suitability, greater numbers of *C. hunteri* female progeny were produced when this parasitoid was reared constantly and invariably on *C. maculatus* larvae than on any other host.

KEY WORDS parasitoid, temperature, host, biology, demography

THE PEPPER WEEVIL, *Anthonomus eugenii* Cano, is a common and important pest of pepper in Florida, California, Texas, Mexico, Central America, and the Caribbean (Patrock and Schuster 1987, Patrock et al. 1992). Feeding by larvae and adults causes severe yield loss and lowers the quality of fruit (Elmore et al. 1934, Schuster and Everett 1982). Walker (1905) reported 33% loss of the commercial crop in two consecutive years. Campbell (1924) found up to 100% infestation of the young pepper fruit in commercial fields. Similarly, Genung and Ozaki (1972) found 100% of fallen fruits to be infested with pepper weevil. This insect also causes damage to flower buds and flowers by feeding and oviposition punctures (Schuster 1983, 1984; Riley 1990). Infested fruits and flowers abscise and drop onto the ground (Riley 1990, Seal and Schuster 1995). Moreover, high populations of pepper weevil (30–40/plant) have been observed to defoliate pepper plants and to prevent fruiting (Rolston 1977).

The infestation of pepper weevil on pepper plants may be initiated before flowering (D.R.S., unpublished data); however, oviposition of the pepper weevil begins only after the plants produce buds. In severe infestations, 70–90% of flower and bud is infested with pepper weevil, and larval development is completed by feeding on pollen bodies and stamens.

Currently, pepper growers in South Florida use primarily oxamyl (Vydate 2 liter) to control pepper weevil. However, the repeated use of Vydate for several consecutive years has resulted in unsatisfactory control in some instances. Augmentative biological control using *C. hunteri* could be an effective tool for the management of pepper weevil. Specifically, *C. hunteri* can effectively control pepper weevil when infestations are being initiated in the flowers and buds or in the pepper off-season in small fruited hosts such as *Solanum* spp. nightshades.

In the current study, efforts were made to determine various biological parameters for *C. hunteri* when reared at different temperatures and various hosts.

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This information will facilitate the mass rearing of *C. hunteri* under laboratory conditions.

Materials and Methods

Stock cultures of *C. hunteri* were maintained at 25 ± 1°C, 55 ± 5% RH, and a photoperiod of 14:10 (L:D) h on early stage larvae of the cowpea weevil, *Callosobruchus maculatus* F. (Col.: Bruchidae), at the Tropical Research and Education Center (TREC), Homestead, FL. These *C. hunteri* adults had initially been collected from a fallow pepper field in Homestead in 1997 and reared in the integrated pest management (IPM) Laboratory at TREC as a stock culture for 10 generations.

Effect of Temperature. The experiments were conducted in incubators (Percival, Boone, IA, 50036) at temperatures of 20 ± 0.3, 25 ± 0.2, and 30 ± 0.2°C and a photoperiod of 14:10 (L:D) h. Humidity was maintained at 55–60% by placing a saturated sodium chloride solution in the growth chambers. Newly emerged virgin males and females (5♂ × 5♀) were placed in a plastic cage (30 by 30 by 30 cm) with *C. maculatus* larvae sealed individually in thin parafilm bubbles. The bubbles were prepared by sandwiching a parafilm sheet between an iron plate with rows of holes (1 cm diameter) and an iron plate with opposing metal pegs. After removing the parafilm sheet and placing a *C. maculatus* larva in each cell, a second sheet of parafilm was pressed against the first. The parafilm sheets along with the parasitoid eggs and host larvae were then placed in a plastic cup (9 cm deep, 9 cm diameter) to prevent escape of emerging adults and to allow complete development of the parasitoid life stages. Cups were monitored daily to collect emerging males and females. Freshly emerged adults (0–24 h old) were then placed as single pairs (1♂ × 1♀) in plastic cages (18.5 by 13.5 by 10.5 cm) for studying various life history parameters. Each plastic cage was provided with a vial of water and a streak of honey on the underside of the cage lid as a source of food for the adults. Fifteen *C. maculatus* third instars placed individually in parafilm bubbles were placed on the floor of the cage to facilitate oviposition. Cages were checked daily to record preoviposition-, oviposition-, and postoviposition period, fecundity and adult mortality. Host larvae were replenished at 24-h intervals. Numbers of eggs on the host larvae were recorded using a binocular microscope (10x). The study was replicated 10 times by collecting adults from the same cohort for each experimental temperature.

Developmental time of *C. hunteri* was observed for egg, larval, prepupal and pupal stages. Forty eggs (4.0 ± 0.2 h old) in four replications were retained on their individual cowpea weevil host larvae in each of three environmental chambers as described above. Eggs were checked every 4 h for eclosion. Development time for eggs was measured as the elapsed time from placement into a chamber until the time at which the larvae were discovered.

Larvae for developmental time studies were obtained from eggs deposited on cowpea weevil larvae housed in parafilm bubbles at each temperature (20, 25°, and 30°C). In each of three replicates, 10 larvae (2–4 h old), one per cowpea weevil host, were placed at each temperature and were examined daily for prepupation. The duration of development of each larva was measured from the time of eclosion until prepupation. Prepupal larvae stop moving and appear C-shaped. The color of prepupal larvae is slightly darker than earlier instars. The experiment was replicated three times.

Prepupae for the developmental time study were collected by placing sufficient numbers of eggs at each constant temperature. Ten prepupae (2–4 h old), one per cowpea weevil host, were examined every 4 h for pupation. The prepupal period was measured from the time of prepupation until pupation evidenced by wing pad presence. These pupae, 10 in each of three replicates, were then checked at 24-h intervals to estimate pupal period. Pupal period was measured from the time of pupation until adult emergence.

The development periods of eggs and prepupae were measured in hours, whereas larval and pupal periods were measured in days. All measurements were converted to days for analysis. Development rate was calculated as the reciprocal of duration multiplied by 100. The development thresholds for eggs, larvae, prepupae, and pupae were predicted from the regression equations for the development rates. Thermal unit values were calculated with the following formula: thermal units (degree days) = (constant temperature − development threshold) × development time in days.

Finally, the effect of temperature on population increase of *C. hunteri* was assessed based on various biological parameters including gross reproduction rate (GRR), innate capacity for natural increase (rm), finite rate of increase (λ), mean generation time (T), and net reproduction rate (R_o).

Tables of l_x (age-specific survival rate) and mx (age-specific fecundity) were constructed using age increments of 1 d (Andrewartha and Birch 1954). For any particular age group of x, l_x was the survival rate (proportion of individuals alive) at the beginning of the age interval and mx was the mean number of female eggs produced at the pivotal age of the female. Values of mx were obtained by dividing by 2 the number of eggs laid in a certain pivotal age on the assumption that the sex ratio was 1:1.

The values for r_m was calculated from the l_x and m_x tables by iterative substitution of trial values of r_m in the Euler equation:

$$\Sigma l_x m_x \exp(-r_m x) = 1$$

The values of r_m were then used to calculate the finite rate of increase ($\lambda = \exp r_m$, the multiplication per female per unit time) and the mean generation time ($T = \ln R_o / r_m$, the mean time from birth of parents to birth of offspring). The gross rate of reproduction ($GRR = \Sigma m_x$) and the net rate of reproduction ($R_o = \Sigma l_x m_x$) were calculated directly from the l_x and m_x tables.

Table 1. Assessment of various adult life history parameters of *C. hunteri* reared on cowpea weevil at three constant temperatures (mean ± SE)

Parameters	20°C	25°C	30°C
Preoviposition period, d	15.40 ± 3.02a	15.90 ± 4.42a	16.20 ± 1.01a
Oviposition period, d	51.10 ± 10.78a	30.20 ± 6.86ab	10.20 ± 1.85b
Post oviposition period, d	14.40 ± 6.05a	12.70 ± 6.00a	2.00 ± 0.21b
Male longevity, d	44.60 ± 6.05a	25.60 ± 2.73b	24.50 ± 2.27b
Female longevity, d	79.90 ± 12.51a	58.90 ± 7.29a	28.90 ± 2.24b
Mean no. eggs/female	354.8 ± 10.8b	583.2 ± 5.8a	115.6 ± 3.0c

Means within a row followed by the same letter do not differ significantly ($P > 0.05$; Waller-Duncan k ratio t-test).

Effect of Hosts. Evaluations of the suitability of hosts for population increases of *C. hunteri* were conducted using cowpea weevil, pepper weevil, and boll weevil larvae. The cowpea weevil and the pepper weevil larvae were obtained from colonies in the IPM laboratory at TREC, Homestead, where they were maintained for 10 generations at 27 ± 2°C. The boll weevil larvae were directly supplied by the USDA-ARS Laboratory at Mississippi State, MS. The study was accomplished using five different combinations of hosts: (1) initial host cowpea weevil—final host cowpea weevil, (2) initial host cowpea weevil—final host pepper weevil, (3) initial host cowpea weevil—final host boll weevil, (4) initial host pepper weevil—final host pepper weevil, and (5) initial host boll weevil— final host boll weevil. *C. hunteri* populations were reared for at least three generations on the initial host before transferring them to the final hosts. This was done to determine the acceptability of *C. hunteri* to the final host after transfer from the initial host. Host acceptability for *C. hunteri* was assessed by observing various biological parameters including adult longevity, preoviposition, oviposition, and postoviposition period, total number of eggs per female, and egg to adult development period. Other demographic parameters, such as, GRR, r_m, λ, T, and R_o were also measured to determine host acceptability.

For studying the effects of hosts on various biological parameters, *C. hunteri* adults were collected from the final host following the above methods. Fecundity, longevity and egg to adult development period on the final host were measured using the methods described above in the temperature study.

Statistical Analysis. Data on *C. hunteri* preoviposition, oviposition and postoviposition, adult longevity, mean number of eggs per female, development periods of egg, larva, prepupae and pupae at constant temperatures and various host combinations were subjected to square root (x + 0.25) transformation to stabilize error variance (Steel and Torrie 1980). Transformed data were analyzed by least squares analysis of variance (ANOVA) (Steel and Torrie 1980), but nontransformed means are presented in all tables. The Waller-Duncan k ratio procedure was used to separate treatment means where significant ($P < 0.05$) statistical difference occurred.

Results and Discussion

Effect of Temperature. The mean preoviposition peridod of *C. hunteri* did not vary significantly as temperature increased (Table 1). The preoviposition period ranged from 4 to 22, 2 to 36, and 3 to 22 d at 20, 25, and 30°C, respectively. Morales-Ramos and Cate (1992) reported that the preoviposition period of *Catolaccus grandis* Burks (Hymenoptera: Pteromalidae), an ectoparasite of boll weevil lasted for 3.8, 1.8, and 2.3 d at 25, 30, and 35°C, respectively, which were shorter than *C. hunteri* observed in the current study.

The oviposition and postoviposition period decreased as temperature increased (Table 1). Females lived longer than males in all experimental temperatures. Both males and females were shorter lived at 30°C than at 20 and 25°C. Mean number of eggs/female was higher at 25°C than at 20 and 30°C ($F = 4.39$, df = 81, $P = 0.02$). *C. hunteri* oviposited more eggs at 20 and 25°C than *Bracon mellitor* (Say) (205.6 eggs/female) at 26.5°C (Adams et al. 1969) and *Heterolaccus grandis* Burks (Hymenoptera: Pteromalidae; 240 eggs/female) (Johnson et al. 1973). In contrast, *C. grandis*

Table 2. Mean developmental time (DT) ± SEM, mean developmental rate (DR) ± SEM, and thermal units in degree-days (DD) for preimaginal life stages of *C. hunteri*

Temp, °C	DT	DR	DD	DT	DR	DD	Total DT
		Egg			Larva		
20	1.54 ± 0.01a	64.98 ± 0.33c	17.71	8.25 ± 0.13a	12.15 ± 0.18b	90.75	
25	1.06 ± 0.01b	94.98 ± 0.82b	15.99	4.33 ± 0.14b	23.33 ± 0.71a	69.28	
30	0.82 ± 0.01c	121.47 ± 0.93a	23.03	4.08 ± 0.08b	24.58 ± 0.42a	85.68	
		Prepupa			Pupa		
20	1.92 ± 0.08a	54.17 ± 4.17b	24.00	7.92 ± 0.19a	12.71 ± 0.31b	99.00	19.63
25	1.00 ± 0.00b	100.00 ± 0.00a	17.50	5.00 ± 0.28b	20.63 ± 1.01a	87.50	11.39
30	1.00 ± 0.00b	100.00 ± 0.00a	22.50	4.50 ± 0.19b	22.64 ± 0.88a	101.25	10.40

Means within a row followed by the same letter do not differ significantly ($P > 0.05$; Waller-Duncan k ratio t-test).

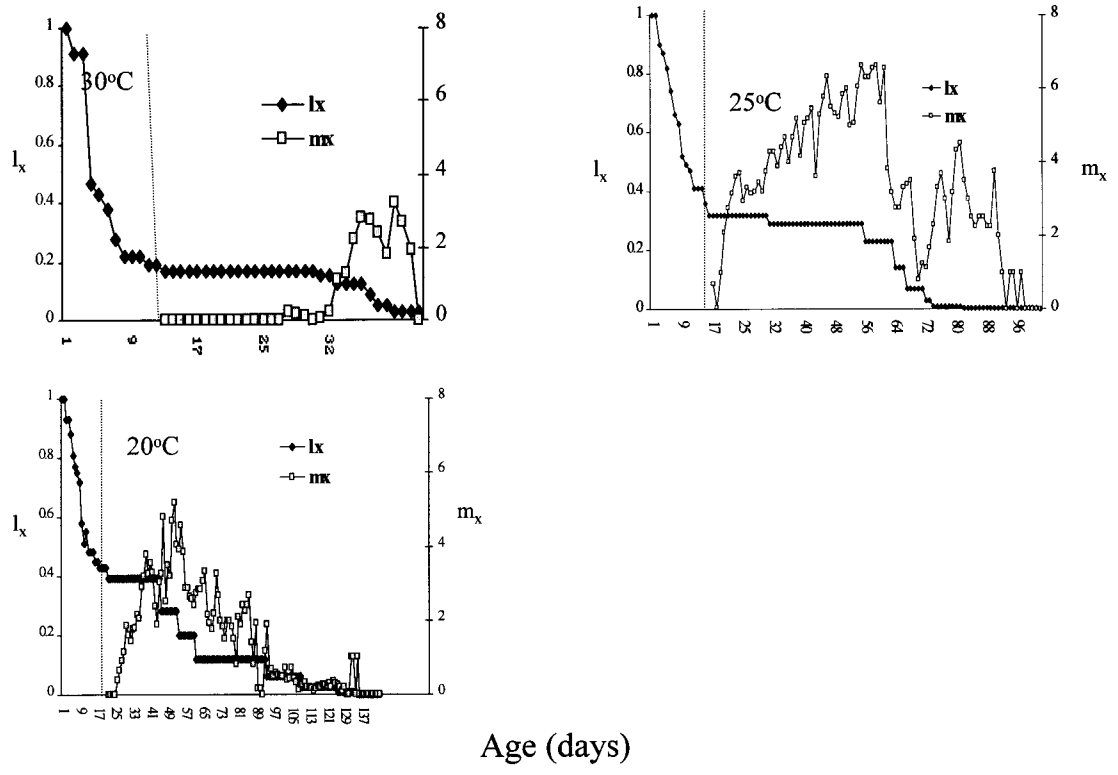

Fig. 1. Age-specific survival and age-specific fecundity ($m_x = 10x$) curves for *C. hunteri* in three temperature regimes. Vertical dashed line indicates adult emergence.

oviposited more eggs (500.3/female) on boll weevil at 27°C than *C. hunteri* at 25°C on boll weevil.

Embryonic development time increased as temperature decreased from 30 to 20°C (Table 2; $F = 1107.5$; df = 2, 157; $P = 0.0001$). Development time for *C. hunteri* larvae, prepupae, and pupae did not differ significantly between 25 and 30°C, but were lower at 20°C (larvae: $F = 370.70$; df = 2, 27; $P = 0.0001$; prepupae: $F = 121$; df = 2, 27; $P = 0.0001$; pupae: $F = 67.70$; df = 2, 27; $P = 0.001$). The egg to adult development period lasted 10.4 d at 30°C, which is almost half of that at 20°C. At 20°C, none of the adults emerged before 16 d postoviposition, whereas, the first adult emerged after 10 and 8 d postoviposition at 25 and 30°C, respectively.

Table 3. Population parameters for *C. hunteri* reared on cowpea weevil at three constant temperature regimes

Temp, °C	GRR[a]	R_0[b]	r_m[c]	λ[d]	T[e]
20	177.41	129.93	0.14	1.15	35.42
25	291.60	216.84	0.18	1.19	30.73
30	23.01	15.07	0.11	1.12	24.51

[a] Gross rate of reproduction (percent/generation).
[b] Net rate of reproduction (percent/generation).
[c] Innate capacity for increase (percent/day).
[d] Finite rate of increase (percent/day).
[e] Mean length of a generation (day).

Regression equations for linear relationships between development rate and temperature for egg, larva, prepupa, and pupal stages were $y = 5.66x - 47.43$ (slope SEM = 0.14 $P = 0.0001$, $r^2 = 0.95$), $y = 1.24x - 11.05$ (slope SEM = 0.12, $P = 0.0001$, $r^2 = 0.76$), $y = 4.58x - 29.86$ (slope SEM = 0.56, $P = 0.0001$, $r^2 = 0.66$), and $y = 0.99x - 6.15$ (slope SEM = 0.13 $P = 0.0001$, $r^2 = 0.64$), respectively.

The linear equation for development showed that development threshold was 8.5°C for embryonic development. The highest development threshold (9.5°C) was observed for larval development, whereas the lowest development threshold was observed for prepupal and pupal stages.

Thermal units for larval and prepupal development were the highest at the lowest temperature; whereas, thermal units required for the egg and pupal development was the highest at 30°C (Table 2).

Temperature had a pronounced effect on age-specific survival rate (l_x) of *C. hunteri* (Fig. 1). Age-specific survival curves reflect the longevity of adult females. Survival was significantly longer at 20°C than at 25 and 30°C. Like survival rate, the preoviposition period and birth rate of female eggs were also influenced by the temperature (Fig. 1). Females of *C. hunteri* produced female eggs (m_x) for a shorter period of their life span at 30°C than at lower temperatures.

Table 4. Assessment of various adult life history parameters of *C. hunteri* reared at 28 ± 1°C on five different combinations of hosts

Parameters	CW-CW	CW-PW	CW-BW	PW-PW	BW-BW
Preoviposition period	9.3 ± 2.5a	2.5 ± 0.6b	4.3 ± 1.7b	4.9 ± 0.9b	3.1 ± 0.5b
Oviposition period	52.4 ± 1.0a	61.6 ± 6.0a	15.8 ± 2.1b	59.1 ± 6.5a	33.9 ± 4.1ab
Post oviposition period	3.6 ± 1.4a	3.6 ± 0.5a	4.3 ± 1.9a	5.3 ± 1.9a	5.0 ± 1.4a
Male longevity	58.1 ± 5.5a	62.5 ± 6.0a	25.8 ± 3.0b	63.8 ± 6.9a	31.9 ± 2.5b
Female longevity	64.1 ± 7.2a	68.6 ± 6.0a	24.9 ± 2.4c	69.3 ± 8.0a	42.3 ± 3.3b
Mean no. eggs/female	592.3 + 94.0a	506.8 ± 74.0b	104.1 ± 19.0c	506.1 ± 90.0b	209.1 ± 58.0c

Means within a row followed by the same letter do not differ significantly ($P > 0.05$; Waller-Duncan k ratio t-test). CW-CW, cowpea weevil-cowpea weevil; CW-PW, cowpea weevil-pepper weevil; CW-BW, cowpea weevil-boll weevil; PW-PW, pepper weevil-pepper weevil; BW-BW, boll weevil-boll weevil.

The gross rate of reproduction is the average number of female offspring produced in a lifetime by a female that survives to reproductive age. This was greater at 25°C than at other experimental temperatures (Table 3). The net rate of reproduction (R_o) was higher at 25°C than at 20 and 30°C. The lowest R_o at 30°C resulted from heavy mortality of the immature life stages, and also of adults between emergence and peak oviposition. On the contrary, Morales-Ramos et al. (1996) reported that *C. grandis* provided a higher value of R_o (109.1) at 27°C than that of *C. hunteri* at 25°C in the current study. The highest rate of innate capacity for increase (r_m) of *C. hunteri* occurred at 25°C. This reflected the occurrence of a high oviposition rate early in adult life at this temperature. The value of innate capacity for natural increase of *C. hunter* at 25°C in the current study was comparable to that of *C. grandis* (0.183) as reported by Morales-Ramos et al. (1996).

Like the innate capacity of natural increase, the finite rate of increase was higher at 25°C than at 20 and 30°C. Unlike the other parameters, the mean generation time was the shortest at 30°C. This indicates that development of *C. hunteri* took place faster in this temperature than in the other temperatures.

Effect of Hosts. The preoviposition period was longest with the cowpea weevil to cowpea weevil (initial host-final host) host combination (Table 4). The oviposition period was significantly less when *C. hunteri* was transferred from cowpea weevil to boll weevil than when transferred from cowpea weevil to cowpea weevil or pepper weevil or when transferred from pepper weevil to pepper weevil.

Postoviposition period did not vary significantly over host combinations (Table 4). Females lived longer than the males irrespective of hosts. Both males and females lived shorter on cowpea weevil to boll weevil, and boll weevil to boll weevil than on other host combinations. *C. hunteri* females laid more eggs when only reared on cowpea weevil larvae. The mean number of eggs/female was the lowest when *C. hunteri* females were transferred from cowpea weevil to boll weevil ($F = 12.10$; df = 4, 195; $P = 0.0001$).

Egg development period of *C. hunteri* required ≈1.0 d, regardless of host combinations (Table 5). Larval, prepupal, and pupal development periods did not differ statistically among various host combinations. However, total development period (egg–adult) was less when *C. hunteri* was raised on cowpea weevil to cowpea weevil or pepper weevil to pepper weevil than when reared on boll weevil to boll weevil or cowpea weevil to boll weevil.

The age specific survival rate (l_x) was the highest when *C. hunteri* larvae were raised on the pepper weevil to pepper weevil combination, and was the lowest when raised on the cowpea weevil to boll weevil combination (Fig. 2). However, l_x for *C. hunteri* on the cowpea weevil to pepper weevil combination did not differ from the pepper weevil to pepper weevil combination.

Like l_x, age-specific fecundity (m_x) was greatest in the pepper weevil to pepper weevil combination (Fig. 2), but only slightly greater than mx for the cowpea weevil to cowpea weevil combination.

The gross rate of reproduction was the highest when *C. hunteri* was raised on pepper weevil to pepper weevil combination and the lowest on the cowpea weevil to boll weevil combination (Table 6). Indeed, almost 30–40% of the females did not oviposit when they were transferred from the cowpea weevil larvae to the boll weevil larvae.

Table 5. Mean developmental time (days ± SEM) for preimaginal life stages of *C. hunter* reared 28 +1°C on five different combinations of hosts

Parameters	CW-CW	CW-PW	CW-BW	PW-PW	BW-BW
Embryonic period	0.9 ± 0.1b	1.2 ± 0.1a	1.0 ± 0.1ab	0.9 ± 0.1b	1.0 ± 0.1ab
Larval period	4.6 ± 0.3a	5.3 ± 0.2a	5.5 ± 0.4a	4.9 ± 0.2a	5.5 ± 0.4a
Prepupal period	1.3 ± 0.2a	1.4 ± 0.2a	1.4 ± 0.2a	1.3 ± 0.2a	1.6 ± 0.2a
Pupal period	4.5 ± 0.2a	5.1 ± 0.3a	5.4 ± 0.3a	4.9 ± 0.3a	5.4 ± 0.3a
Egg-adult period	11.5 ± 0.4c	12.9 ± 0.4ab	13.3 ± 0.5a	11.9 ± 0.4bc	13.6 ± 0.5a

Means within a row followed by the same letter do not differ significantly ($P > 0.05$; Waller-Duncan k ratio t-test). CW-CW, cowpea weevil-cowpea weevil; CW-PW, cowpea weevil-pepper weevil; CW-BW, cowpea weevil-boll weevil; PW-PW, pepper weevil-pepper weevil; BW-BW, boll weevil-boll weevil.

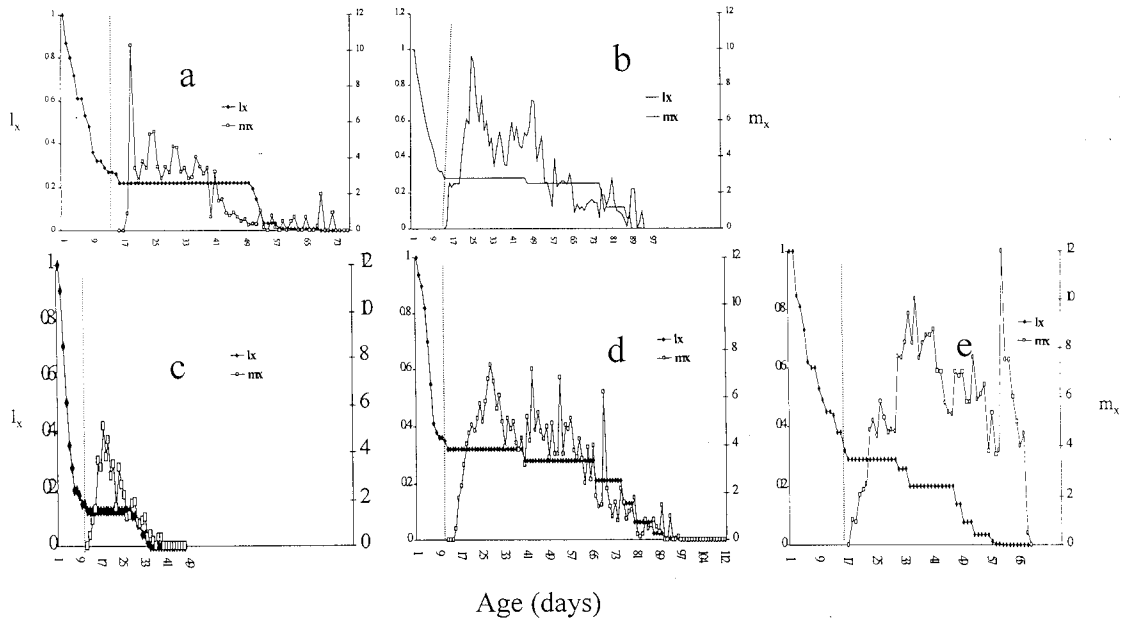

Fig. 2. Age-specific survival and age-specific fecundity (mx = 10x) curves for *C. hunteri* raised on various hosts. (a) CW-CW. (b) CW-PW. (c) CW-BW. (d) PW-PW. (e) BW-BW. Vertical dashed line indicates adult emergence.

The net reproduction rate (R_o) was the highest in the pepper weevil to pepper weevil combination followed by cowpea weevil to pepper weevil and cowpea weevil to cowpea weevil combinations (Table 6). The lowest R_o was seen when *C. hunteri* was raised on the cowpea weevil to boll weevil combination. The values of T (mean generation time) followed the same pattern as the values of R_o. The finite rate of reproduction was the highest for boll weevil to boll weevil combination followed by cowpea weevil to cowpea weevil combination. The innate rate of natural increase was the highest when *C. hunteri* was raised on the cowpea weevil to boll weevil combination. This indicates that most of the females had shorter life span and oviposited female eggs in the early part of their life.

Although the results show that innate capacity of population increase is the highest in cowpea weevil to boll weevil combination, the use of boll weevil is not practical because it is a quarantine insect in Florida. In addition, almost 30–40% of *C. hunteri* females failed to oviposit when raised on boll weevil. However, pepper weevil is difficult to mass rear in the laboratory. Thus, the use of boll weevil or pepper weevil for mass rearing *C. hunteri* is not a cost-effective option.

In summary, *C. hunteri* populations increased under all combinations of temperatures and hosts in the current study with the optimum at 25°C. The cowpea weevil is the most easily reared laboratory host. *C. hunteri* populations can be mass reared on cowpea weevil for the purpose of releasing them in the fields. Moreover, *C. hunteri* individuals raised on the cowpea weevil readily accept the pepper weevil, and this is indicated by the high innate capacity of natural increase of *C. hunteri* on the cowpea weevil to pepper weevil combination.

Table 6. Population parameters for *C. hunteri* reared at 28 +1°C on on five different combinations of hosts

Rearing host	Experimental host	GRR[a]	R_0[b]	r_m[c]	λ[d]	T[e]
CW	CW	296.17	188.74	0.22	1.24	23.90
CW	PW	223.41	234.71	0.27	1.31	20.09
CW	BW	52.07	51.57	0.40	1.04	9.75
PW	PW	307.75	261.76	0.18	1.20	30.15
BW	BW	105.32	97.73	0.29	1.34	15.67

PW, pepper weevil; BW, boll weevil and CW, cowpea weevil.
[a] Gross rate of reproduction (percent/generation).
[b] Net rate of reproduction (percent/generation).
[c] Innate capacity for increase (percent/day).
[d] Finite rate of increase (percent/day).
[e] Mean length of a generation (day).

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