BIOLOGY OF *ACROSTERNUM MARGINATUM* (HETEROPTERA: PENTATOMIDAE) ON COMMON BEANS

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ABSTRACT

The biology of *Acrosternum marginatum* (Palisot de Beauvois) (Heteroptera: Pentatomidae) on common bean, *Phaseolus vulgaris* L., was studied at a mean temperature of 24°C (range 19-32°C) near Palmira, Colombia. Total mean (±SEM) developmental time from egg to adult was 42.1±4.2 d. Head capsule widths of the five instars did not overlap. The female lived a mean of 44.4±2.84 d and laid 96.2±9.72 eggs in 7.5±0.74 masses. The mean preovipositional period was 10.1±1.31 d. The time interval between consecutive ovipositions fit the geometric distribution with P (the probability that a female will oviposit on any day) = 0.19 (included first oviposition) or P = 0.22 (excluded first oviposition). The mean number of eggs per mass was 12.8, with a marked peak at 14. There were no significant correlations between the number of days between consecutive ovipositions nor age of female versus number of eggs per mass. Mean emergence from egg masses was 80±0.77%. Percentage emergence was not significantly related to the number of days since the previous oviposition nor age of the female.

RESUMEN

Se estudió la biología de *Acrosternum marginatum* (Palisot de Beauvois) (Heteroptera: Pentatomidae) alimentado con fríjol, *Phaseolus vulgaris* L., cerca de Palmira, Colombia. El período promedio de desarrollo fue de 42.1 ± 4.2 días a la temperatura promedia de 24C. Las anchuras de las cápsulas cefálicas de los cinco ínstares no se sobrecruzaron. Las hembras vivieron un promedio de 44.4 ± 2.84 días y pusieron un promedio de 96.2 ± 9.72 huevos en 7.5 ± 0.74 posturas. El período promedio de preoviposición fue de 10.1 ± 1.31 días. El intervalo entre oviposiciones consecutivas se ajustó a la distribución geometrica con P (la probabilidad que una hembra oviposite cualquier día) = 0.19 (incluye la primera oviposición) o P = 0.22 (excluye la primera oviposición). El número promedio de huevos por masa fue de 12.8, con un pico marcado a los 14 huevos por postura. No hubo relaciones significativas entre el número de días entre oviposiciones consecutivas ni entre la edad de la hembra versus el número de huevos por postura. La emergencia promedia de las posturas fue del 80 ± 0.77%. El porcentaje de emergencia no se relacionó significativamente con el número de días desde la oviposición previa ni la edad de la hembra.

Several species of Pentatomids (Heteroptera) are considered important pests of the common bean, *Phaseolus vulgaris* L., in the Neotropics. Saunders et al. (1983) listed the following Pentatomids attacking beans in Central America: *Acrosternum marginatum* (Palisot de Beauvois), *Chlorochroa ligata* (Say), *Edessa confusionata* Breddin, *E. rufomarginata* (de Geer), *Mormidea pictiventris* Stal, *M. ypsilon* (L.), *Murgantia histrionica* (Hahn), *Nezara viridula* (L.), *Thyanta antiguensis* (Westwood), and *T. perditor* (Fabricius). The relationship between bean yield and Pentatomid population levels was studied by Costa et al. (1980) (*N. viridula*), Costa et al. (1981) (*Piezodorus*

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guildinii (Westwood)), and Hallman et al. (1985) (*A. marginatum*). In addition to reduction in yield caused by direct feeding on the pods, some species are implicated in transmission of *Nematospora coryli* Peglion, the pathogen of yeast spot disease (Costa et al. 1980). This study reports on aspects of the biology of *A. marginatum* (Palisot de Beauvois), the most common species of *Acrosternum* in Central America. It is found from the southwestern United States to Venezuela and Ecuador and throughout the Caribbean from Florida to Guadalupe (Rolston 1983). Besides beans, *A. marginatum* is also a pest of soybeans (Waldbauer 1977, Temerak & Whitcomb 1984).

Materials and Methods

A colony of *A. marginatum* was established in a screen house using bugs collected from common bean near Palmira, Colombia. Mean temperature within the house was 24°C (range 19-32°C), and the relative humidity (RH) averaged 80% (range 45-100%).

Twenty-five F_2 generation egg masses were taken from the colony over a period of two weeks and placed individually in petri dishes with a piece of moist cotton until eclosion. First instars were transferred on the day of emergence to potted common beans (line BAT 41) with young pods and placed inside screen cages (59 by 29 by 50 cm) inside the screen house. Field collected pods were also placed in the cages. The bugs were reared to adults, and date of ecdysis and head-capsule width for each instar were recorded.

Twenty-one F_4 generation teneral females collected over a period of 12 d were placed individually in cages on potted common bean (BAT 41) supplemented with field collected pods. Two males were maintained in each cage. Longevity of the adult female, dates of oviposition, numbers of eggs per mass, and percentage eclosion of the eggs were recorded. Observed discrete frequency distributions were fit to theoretical mathematical models where appropriate (Parzen 1960, Gates & Ethridge 1972). Linear regression was used to examine the relationship between pairs of variables (SAS Institute 1985, 183-260).

Results

Egg masses collected from the colony were found in the following locations: leaf underside, 59%; leaf upper surface, 14%; stems, 8%; pods, 4%, and cage 14%. Seventy-six percent of the eggs hatched. Developmental time and head-capsule width of the various stages are summarized in Table 1.

On eclosion, the nymphs were pale yellow, but darkened after 1-2 h to a mottled black and white color that persisted throughout their nymphal life. The newly hatched nymphs remained on the chorion for approximately 1 d. The second instars fed on the foliage for 3-6 d before becoming basically pod feeders. Young pods were preferred by early instars. The gregarious habit characteristic of immature pentatomids persisted throughout the nymphal period, although the groups became progressively smaller.

There was no overlap in the ranges of head-capsule widths between the instars (Table 1).

Teneral adults were a pale yellow-green, becoming green after 1-2 h. The green color darkened as the adults aged. Adult females were commonly observed to mate more than once.

Females lived a mean ($\pm$SEM) of 44.4 ± 2.84 d and laid 96.2 ± 9.72 eggs in 7.5 ± 0.74 masses. Eggs were laid in masses of 2-3 rows. A female would complete one row of 4-8 eggs before turning around and laying another row alongside the first, but in reverse order. The preovipositional period was 10.0 ± 1.31 d and ranged from 1 (three females) to 23 d. The number of days between consecutive ovipositions fit the geometric distribution (Table 2; Fig. 1). P is the probability that a female *A. marginatum* will oviposit

TABLE 1. DURATION AND HEAD CAPSULE WIDTHS OF IMMATURE STAGES OF *A. MARGINATUM* REARED ON COMMON BEANS (MEAN TEMPERATURE = 24°C).

Stage	n	Mean duration, d ± SEM	Head capsule width, Mean, mm ± SEM	Head capsule width, Range, mm
Egg	327	6.8 ± 0.053	—	—
Instar				
1	99	4.5 ± 0.14	0.71 ± 0.0023	0.67-0.76
2	76	6.5 ± 0.14	0.97 ± 0.0047	0.92-1.04
3	72	6.3 ± 0.16	1.42 ± 0.0048	1.35-1.45
4	50	6.0 ± 0.33	1.95 ± 0.0082	1.85-2.05
5	17	12.0 ± 1.2	2.51 ± 0.017	2.40-2.60
Egg to adult	17	42.1 ± 4.2	—	

on any day. When the preovipositional period was not included in the analysis the data still fit the geometric (Table 2). The data did not fit the binomial, zero-truncated Poisson, or log zeroes distributions, other discrete frequency distributions which could be used on this type of data (Table 2). No female was observed to lay more than one egg mass on the same day.

The mean number of eggs per mass was 12.8 (range 3-28) (Fig. 2). There was a marked peak at 14 eggs per mass, which may reflect the number of ovarioles (14) possessed by *A. marginatum*. The data did not fit the Poisson, negative binomial, binomial, Thomas double Poisson, Neyman type A, or Poisson-binomial distributions regardless of whether all of the data were included in the analysis or only those data up to and including 14 eggs per mass.

The correlations between days between consecutive ovipositions and the size of the following egg mass or between age of the female and number of eggs per mass were not statistically significant. For the correlation of days between oviposition and number

TABLE 2. FIT OF NUMBER OF DAYS BETWEEN CONSECUTIVE OVIPOSITIONS (INCLUDING DAYS TO FIRST OVIPOSITION) OF *A. MARGINATUM* TO FOUR DISCRETE FREQUENCY DISTRIBUTIONS.

Distribution	Parameter, X^2 value, or *df*	Value of previous column for[1] All data	Value of previous column for[1] Excludes first oviposition
Geometric	*P*	0.19	0.22
"	X^2	26.84	29.86
"	*df*	22	22
Binomial	X^2	666.44**	224.60**
"	*df*	12	8
Zero-truncated Poisson			
"	Theta	0.848	0.846
"	Lamda	5.02	3.96
"	X^2	295.93**	50.65**
"	*df*	10	11
Log zeroes	Theta[2]	$<1x10^{-15}$	$<1x10^{-15}$

[1]** Significantly different from distribution model at 1% level.
[2]Theta too small to permit fit to log zeroes distribution.

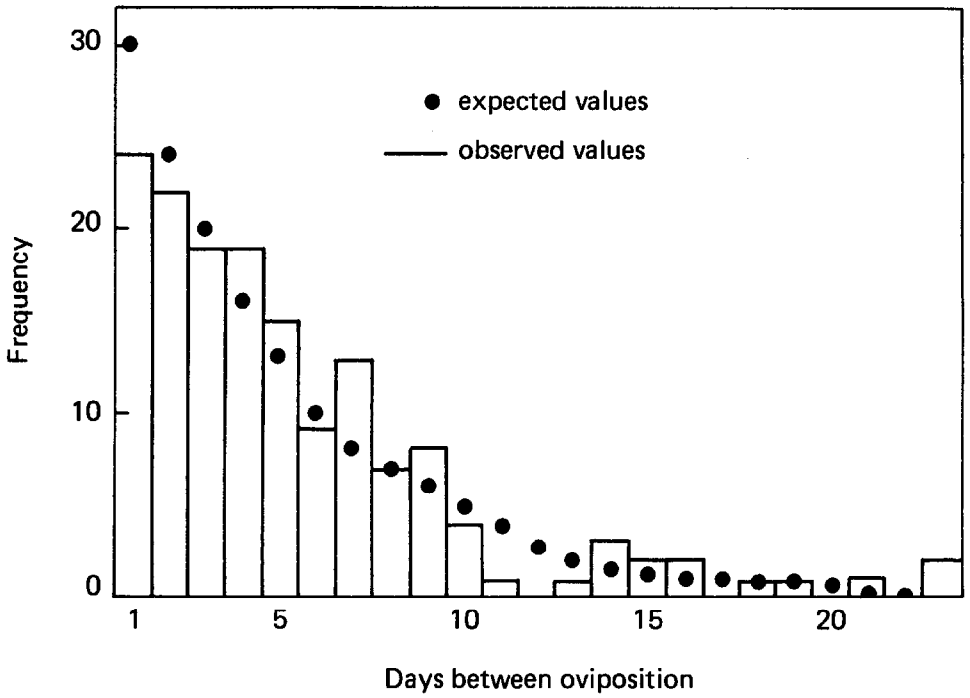

Fig. 1. Frequency of number of days between consecutive ovipositions (includes preovipositional period) of *A. marginatum* on common beans. Expected values are for geometric distribution with $P = 0.19$.

of eggs per mass, $F = 0.78$, $P > F = 0.72$, $df = 19$, and $r^2 = 0.097$; for the correlation between age of female and number of eggs per mass, $F = 1.32$, $P > F = 0.12$, $df = 55$, and $r^2 = 0.42$.

Mean (±SEM) percentage emergence of egg masses was 80±0.77%. Thirty-one percent of the masses had an emergence rate of 100%. Six of 139 masses had a frequency of emergence of ≤ 30%; the lowest emergence was 10%. Percentage emergence was not significantly related to the number of days since the previous oviposition ($F = 0.74$, $P > F = 0.76$, $df = 18$, $r^2 = 0.10$) nor age of the female ($F = 1.24$, $P > F = 0.19$, $df = 54$, $r^2 = 0.44$).

Discussion

Beans are a short season (2-3 months) crop, and the life cycle of *A. marginatum* is relatively long. The susceptible (pod-producing) stage of bush bean varieties at an ambient temperature of 24°C and a 12 h day length lasts about one month, insufficient time for *A. marginatum* to complete more than one generation in beans, even if the eggs were laid before flowering. With climbing beans the susceptible stage may last another week or two, still insufficient time for producing more than one generation. Hallman et al. (1985) showed that with infestation levels as low as one late instar *A. marginatum* per 0.6 m² of beans, significant yield loss occurred. Therefore, high infestation levels of *A. marginatum* are not necessary for it to cause significant damage.

The second and third egg masses of *Nezara viridula* (L.) (Heteroptera: Pentatomidae) were smaller than the first, and egg mass size gradually increased after the third egg mass (Kiritani 1963). In our research with *A. marginatum* the opposite tendency was observed, although differences in mass size were small. Mean numbers of eggs per mass

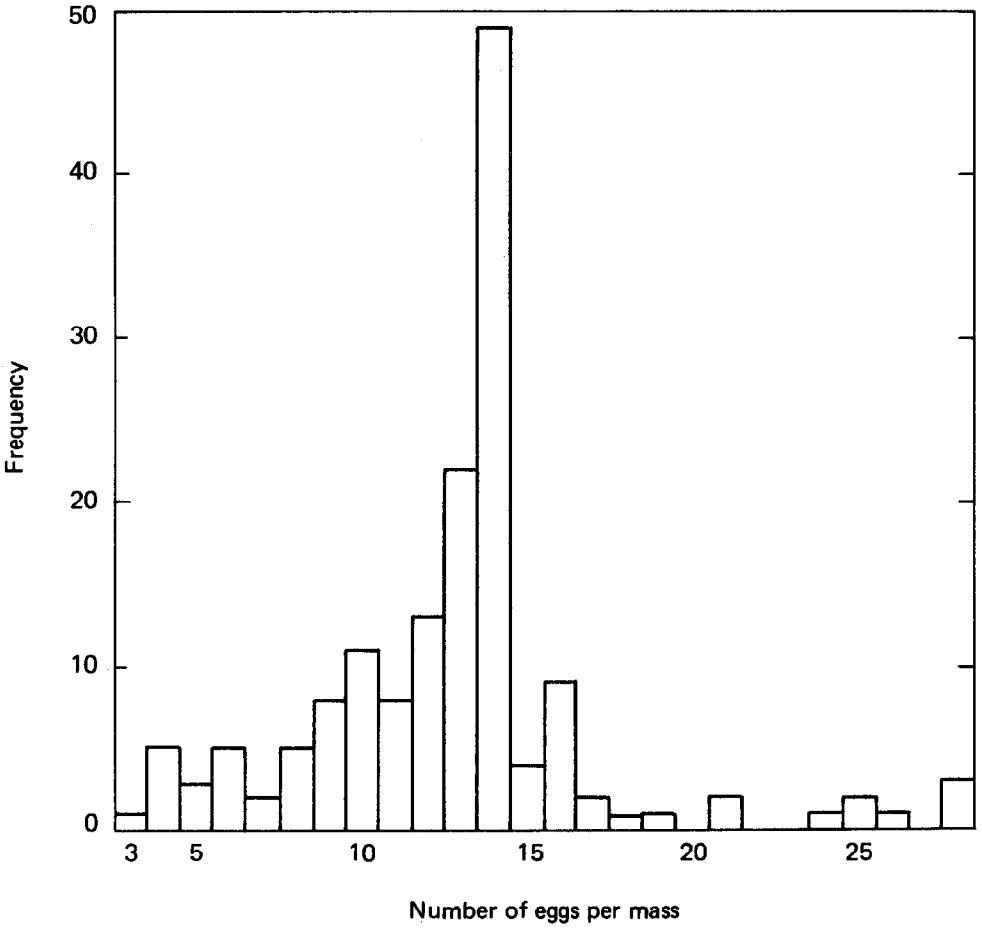

Fig. 2. Frequency of number of eggs per mass of *A. marginatum* reared on common beans.

(± SEM) for the first six egg masses (of those 14 females which laid six or more masses), consecutively, were: 12.7±0.75, 15.9±1.4, 13.8±1.4, 13.8±1.2, 12.6±0.71, and 11.8±0.74.

The fit of the number of days between successive ovipositions to the geometric distribution indicates that daily attempts to oviposit are independent and succeed with a probability of 0.19 (0.22 when the first egg mass laid per female is not included). Kiritani & Hokyo (1965) present frequency distribution data on the number of days between successive ovipositions of three pentatomids. It is obvious that their data do not fit the geometric distribution; the geometric distribution expects the highest probability at the lowest frequency with probabilities diminishing as the frequency increases. Their data appear to fit the normal distribution.

Kiritani (1963) found that the preovipositional period of *N. viridula* was 2-3 times greater than the time interval between ovipositions after the third egg mass. In our study with *A. marginatum*, the mean preovipositional period was 10.0±1.31 d, and the mean time interval between consecutive ovipositions after the first was 4.43±0.38 d. The difference is of the same order of magnitude as that observed by Kiritani (1963) for *N. viridula*.

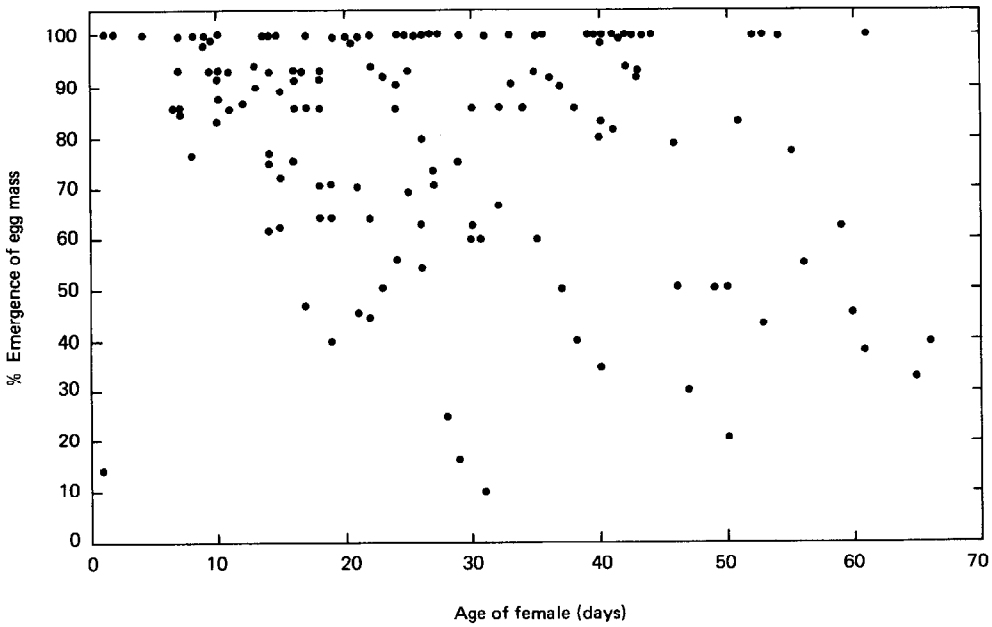

Fig. 3. Age of female *A. marginatum* versus percentage emergence of egg mass.

Because the number of eggs per mass was unrelated to the time interval between ovipositions, a female could lay average or greater sized egg masses on consecutive days. For example, one female laid a mass of 13 eggs followed by masses of 12 and 11 eggs at 2 d intervals, then masses of 16 and 12 eggs at one day intervals. Another female laid masses of 14, 14, and 8 eggs on consecutive days, followed by a mass of 14 eggs 2 d later and a mass of 25 eggs the day after that.

Although percentage emergence was not significantly correlated to age of the female, the tendency for higher rates of emergence to be associated with younger females cannot be ignored (Fig. 3). In only one instance (of 31) did an egg mass from a female younger than 15 d have < 75% emergence. Thirty-six percent of the egg masses from females > 40 d old showed emergence of < 75%.

Acknowledgments

We thank Jim Matis, Department of Statistics, Texas A&M University, for reviewing the manuscript and suggesting improvements.

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ASSOCIATIONS BETWEEN WATERHYACINTH WEEVILS (*NEOCHETINA EICHHORNIAE* AND *N. BRUCHI*) AND PHENOLOGICAL STAGES OF *EICHHORNIA CRASSIPES* IN SOUTHERN FLORIDA

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ABSTRACT

We studied *Neochetina eichhorniae* and *N. bruchi* populations at 22 sites in southern Florida during mid-summer 1985. Species composition, reproductive females (as a percentage of total females), and flight muscle development of *N. eichhorniae* populations varied greatly among sites. *N. bruchi* populations were heterogeneous among sites for these parameters and for sex ratio. The prevalent waterhyacinth (*Eichhornia crassipes*) phenostage and degree of biocontrol stress accounted for much of this variation. A higher proportion (74%) of *N. eichhorniae* females contained functioning ovaries when collected from mature, healthy plants, as opposed to developing colonies (57%), or declining plant populations (34%). The proportion of *N. bruchi* females with functioning ovaries was similar on mature, healthy plants (61%) and developing colonies (54%), but less (24%) on declining plants. More females from stressed plant populations possessed fully-de-