COMPARATIVE LIFE CYCLES OF FOUR SPECIES OF PREDATORY STINK BUGS[1,2,3]

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ABSTRACT

Four species of asopine stink bugs, *Alcaeorrhynchus grandis* (Dallas), *Euthyrhynchus floridanus* (L.), *Podisus maculiventris* (Say), and *Stiretrus anchorago* (Fab.), were reared in the laboratory under identical conditions. Two groups of each species were maintained; one under simulated Florida field conditions at a variable temperature ranging from 18°-30°C, averaging approximately 26°C, and the second at a constant temperature of 27°C. The photoperiod was 14 L:10 D for all groups, and all were fed at the same time with the same larval instars of the cabbage looper, *Trichoplusia ni* (Hübner), and the soybean looper, *Pseudoplusia includens* (Walker). At the given temperatures *P. maculiventris* and *S. anchorago* completed their life cycles in 1 month, while *A. grandis* and *E. floridanus* took 2 months. The egg stages lasted approximately 5 days for *P. maculiventris*, 6 days for *S. anchorago*, 16 days for *A. grandis*, and 19 days for *E. floridanus*. All species were reared through at least 1 generation from eggs laid by laboratory-reared individuals.

Predatory stink bugs are beneficial insects because they attack a number of plant feeding lepidopterous and coleopterous larvae (Forbush and Fernald 1896, Morrill 1906, Whitmarsh 1916, Knight 1923, Plummer and Landis 1932, Howard and Landis 1936, Hayslip et al. 1953, LeRoux 1964, Whitcomb and Bell 1964, Oetting and Yonke 1971, 1975, Warren and Wallis 1971, Whitcomb 1973, Waddill and Shepard 1974, 1975, Ables 1975). No laboratory comparisons of predatory stink bug life cycles have been made for 2 or more different species reared under the same experimental conditions. Such a comparison should reveal the reproductive strategies employed by each species. The life cycles of 4 common asopine stink bugs found in Florida were compared under identical laboratory conditions. All of the species studied, *Alcaeorrhynchus grandis* (Dallas), *Euthyrhynchus floridanus* (L.), *Podisus maculiventris* (Say), and *Stiretrus anchorago* (Fab.), have been reported from soybeans (Whitcomb 1973, Waddill and Shepard 1974, 1975) and may reduce numbers of lepidopterous pest insects.

MATERIALS AND METHODS

Specimens of *A. grandis* and *S. anchorago* were collected in a soybean

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[1] This publication was supported in part by the National Science Foundation and the Environmental Protection Agency, through a grant (NSFGB-34718 later known as BMS 75-04223), to the University of California. The findings, opinions, and recommendations expressed herein are those of the authors and not necessarily of the University of California, NSF, or EPA.

[2] Fla. Agricultural Experiment Station Journal Series No. 1104.

[3] Hemiptera: Pentatomidae.

field near Gainesville, Florida, in October 1977. All field collected specimens were kept at a variable laboratory temperature ranging from 18°-30°C, averaging approximately 26°C, with a photoperiod of 14 L:10 D. The *A. grandis* nymphs collected in the field were allowed to mature, mate, and lay eggs in quart jars. Adults of *S. anchorago* were also kept in quart jars and allowed to mate and lay eggs. Eggs of *E. floridanus* and *P. maculiventris* were obtained from laboratory cultures where the former had been maintained through 1 and the latter through many generations. Eggs of all 4 species were placed in petri dishes in the laboratory or in an environator (constant temperature of 27 ± 1°C.) The bottom of each petri dish was lined with filter paper and fresh green beans were added 2 to 3 times a week to maintain high humidity. When the nymphs became 2nd instars they were placed into individual petri dishes and fed caterpillars of the cabbage looper, *Trichoplusia ni* (Hübner), and the soybean looper, *Pseudoplusia includens* (Walker), 3 times a week. The nymphs were raised to adults, and 10 specimens of each nymphal instar were used for measurements of head, anterior pronotum, and humeral width. The time spent in each nymphal instar was recorded and statistically analyzed. Several additional egg masses were allowed to hatch and their hatching times recorded to obtain more data for comparison.

Results

Development times for the 4 species are presented in Table 1. The egg stages showed the greatest differences; approximately 16 days for *A. grandis,* 19 days for *E. floridanus,* 5 days for *P. maculiventris,* and 6-7 days for *S. anchorago.* The stink bugs differed in the arrangement and numbers of eggs laid. *A. grandis* egg masses consisted of 100-200 eggs in multiple rows. On soybean stems these were in 4-5 rows, but on paper toweling the mass tended to be broader, up to 10 rows wide. *E. floridanus* females laid 20-90 eggs in a loose oval mass. *P. maculiventris* deposited 17-70 eggs, also in a loose mass. *S. anchorago* laid 10-23 eggs in a double row. Total development time for these stink bugs, from egg to adult, ranged from approximately 30 days for *P. maculiventris* and *S. anchorago* to about 60 days for *A. grandis* and *E. floridanus.* Measurements of the various instars and adults of the 4 species are presented in Table 2.

Observations of pre-mating behavior indicate that in at least 3 species, *A. grandis, E. floridanus,* and *S. anchorago,* the male mounts over the head or rear of the female and then maneuvers so that he can take up the characteristic end-to-end copulation position of Hemiptera. The male of *S. anchorago* buzzes his wings every few seconds during mounting.

All 4 species were observed with natural prey in the field. An *A. grandis* 4th instar was collected in soybeans feeding on a last instar *Anavitrinella pampinaria* (Guenée) (Geometridae). A 4th instar *P. maculiventris* was observed consuming a *Phoebis* sp. larva. An *S. anchorago* adult was seen eating a larva of *Eurema nicippe* (Cramer) (Pieridae), both on *Cassia obtusifolia* L. in a soybean field. A 5th instar *S. anchorago* was collected on goldenrod, *Solidago* sp., feeding on a lepidopterous larva (undetermined), and an *E. floridanus* adult was captured eating an adult plant-feeding stink bug, *Euschistus servis* (Say), on corn *S. anchorago* has previously been reported to eat larvae of the alfalfa weevil, *Hypera postica*

TABLE 1. TIMES OF DEVELOPMENT FOR 4 SPECIES OF ASOPINE STINK BUGS IN THE LABORATORY (18°-30°C, AVERAGING CA. 26°C) AND ENVIRONATOR (27°C) PHOTOPERIOD FOR BOTH GROUPS WAS 14 L:10 D.

Species	Time in Days																			
	Egg stage Mean (n masses) Range		1st instar Mean (n) Range		2nd instar Mean (n) Range		3rd instar Mean (n) Range		4th instar Mean (n) Range		5th instar Mean (n) Range		Total egg-adult Mean	male/female
Alcaeorrhynchus grandis														
Laboratory	15.45	(7)	5.00	(40)	9.95	(37)	7.92	(36)	8.24	(34)	12.97	(33)	59.51	15/18
	14-17		5		8-12		5-11		6-12		9-18			
Environator	16.00	(3)	5.00	(40)	8.68	(34)	7.41	(34)	8.87	(31)	13.13	(30)	59.09	16/14
	15-17		5		8-11		5-10		7-13		10-16			
Euthyrhynchus floridanus														
Laboratory	19.10	(20)	6.00	(38)	9.55	(31)	6.03	(30)	7.85	(26)	9.69	(26)	58.22	8/18
	18-21		6		9-11		5-8		6-10		8-12			
Environator	19.80	(5)	7.00	(23)	10.78	(18)	7.50	(16)	8.07	(15)	10.50	(14)	63.95	5/9
	19-20		7		9-12		6-10		6-10		9-15			
Podisus maculiventris														
Laboratory	5.00	(4)	4.00	(20)	5.00	(20)	3.32	(19)	3.68	(19)	5.89	(18)	26.89	6/12
	5		4		4-6		3-4		3-4		5-7			
Environator	5.00	(5)	4.00	(20)	4.85	(20)	3.15	(20)	3.58	(19)	6.11	(19)	26.69	9/10
	5		4		4-5		3-4		3-4		5-7			
Stiretrus anchorago														
Laboratory	6.80	(5)	4.00	(15)	4.27	(15)	4.13	(15)	4.80	(15)	8.47	(15)	32.47	7/8
	6-8		4		4-6		3-5		4-7		7-10			
Environator	5.50	(2)	4.00	(6)	7.20	(5)	4.00	(3)	6.00	(3)	8.68	(3)	35.38	2/1
	5-6		4		7-8		3-5		4-8		8-10			

TABLE 2. BODY MEASUREMENTS OF IMMATURE AND ADULT SPECIMENS OF 4 SPECIES OF ASOPINE STINK BUGS. (N = 10 IN ALL CASES EXCEPT ADULTS).

Species	Measurements in mm					
	Head, incl. eyes		Anterior pronotum		Humeral region	
Instar	Width	SD	Width	SD	Width	SD
Alcaeorrhynchus grandis						
1st	0.73	0.02	0.74	0.00	0.93	0.03
2nd	1.00	0.03	1.06	0.02	1.26	0.00
3rd	1.48	0.06	1.67	0.07	2.26	0.11
4th	2.00	0.08	2.31	0.10	3.75	0.21
5th	2.70	0.07	3.17	0.12	6.45	0.36
Adult female (n = 5)	3.42	0.05	3.50	0.03	11.56	0.29
Adult male (n = 5)	3.01	0.08	2.97	0.07	9.34	0.33
Euthyrhynchus floridanus						
1st	0.74	0.02	0.76	0.01	0.96	0.02
2nd	0.90	0.04	0.97	0.04	1.14	0.04
3rd	1.23	0.04	1.28	0.03	1.69	0.08
4th	1.66	0.05	1.77	0.05	2.90	0.11
5th*	2.14	0.07	2.25	0.05	4.82	0.19
Adult female (n = 5)	2.43	0.06	2.28	0.07	7.16	0.50
Adult male* (n = 5)	2.25	0.03	2.10	0.07	6.40	0.09
Podisus maculiventris						
1st	0.63	0.03	0.74	0.04	0.89	0.03
2nd	0.88	0.02	0.98	0.04	1.30	0.09
3rd	1.25	0.04	1.40	0.06	2.04	0.07
4th	1.73	0.06	1.98	0.08	3.20	0.15
5th	2.20	0.06	2.54	0.08	4.81	0.25
Adult female (n = 5)	2.45	0.07	2.63	0.08	7.58	0.21
Adult male (n = 5)	2.33	0.03	2.45	0.05	7.01	0.16
Stiretrus anchorago						
1st	0.74	0.00	0.79	0.00	1.04	0.02
2nd	0.91	0.03	1.03	0.03	1.39	0.04
3rd	1.23	0.03	1.35	0.05	2.06	0.07
4th	1.60	0.07	1.81	0.08	3.04	0.14
5th	2.05	0.14	2.29	0.09	4.41	0.24
Adult female (n = 5)	2.34	0.09	2.46	0.06	6.17	0.24
Adult male (n = 5)	2.19	0.03	2.30	0.02	5.58	0.15

*Raised in environator at a constant 27°C, 14 L:10 D.

(Gyllenhal) (Richman 1977), and Mexican bean beetle, *Epilachna varivestis* Mulsant (Howard and Landis 1936, Waddill and Shepard 1974, 1975).

Discussion

The 4 species of predatory stink bugs studied differed in length of life cycle, rate of growth, and somewhat in seasonal abundance. *Alcaeorrhynchus grandis* was found in large numbers in late summer and fall, during outbreaks of velvetbean caterpillar, *Anticarsia gemmatalis* Hübner; *E. floridanus* has been collected the year around but is most abundant during spring and fall in Florida (Mead 1976). *Stiretrus anchorago* numbers also peak during spring and fall. *Podisus maculiventris* was collected throughout the spring, summer, and fall.

Podisus maculiventris and *E. floridanus* appear to have the most general feeding habits (Mukerji and LeRoux 1965, Mead 1976), but all 4 species take a wide variety of insects. The current study demonstrated that each will mature and produce viable eggs when fed on 2 species of lepidopterous larvae. Over 60% of eggs laid by laboratory reared adults of *S. anchorago* hatched, as compared to less than 25% in the study of Waddill and Shepard (1974) who fed their specimens exclusively with Mexican bean beetle larvae. The key element may be provisioning the stink bugs with more than 1 kind of larva.

In the following discussion our laboratory data are in parentheses after the data cited. The life history of *E. floridanus* has been discussed by Ables (1975) and Oetting and Yonke (1975). Ables found that eggs of *E. floridanus* took 18.1 (19.1) days to hatch and the nymphal stages lasted 39.5 (39.1) days at 26.7°C and 14:10 photoperiod. Oetting and Yonke found that *E. floridanus* eggs took 33.4 days to hatch and the nymphal stages lasted 66.9 days at 24°C and 13 L:11 D photoperiod. The cooler rearing temperature and shorter day length probably account for the long egg and nymphal stages.

Several workers have reared *P. maculiventris* in the laboratory. The life history was recorded first by Forbush and Fernald (1896) who reared their specimens in an insectary in Massachussetts under as close to natural conditions as possible. The eggs took from 7-9 (5) days to hatch and nymphal development time was at least 25 (22) days. Mukerji and LeRoux (1965) found that the eggs of *P. maculiventris* hatched in 4-7 days and that nymphal development lasted 25-31 days at 27°C. Warren and Wallis (1971) found that the eggs hatched in 6-8 days, and nymphal development took 28.7 days at 21°C. Given the temperature difference, our data seem consistent with published results.

The life cycle of *S. anchorago* has been discussed by Waddill and Shepard (1974). At 26.7°C with a photoperiod of 14:10, eggs of *S. anchorago* hatched in 6.3 (6.8) days and the nymphal stages lasted 18.4 (25.7) days. The reason for the difference found in our study is unknown; however, it is probably not a significant difference.

No studies have been published on the life cycle of *A. grandis*. We found that the egg stage lasted 16 days, and maturity was reached 43 days after hatching.

Podisus maculiventris and *E. floridanus* were the easiest to rear because they are prolific egg layers and do well in the laboratory. *Podisus* tends to be cannibalistic, but its life cycle is short, and thus as many as 9-10

generations may be raised in a year. Females may start producing eggs within 1 week of maturing (Mukerji and LeRoux 1965). *Euthyrhynchus* has limited cannibalistic tendencies, and nymphs cooperate in prey capture (see also Ables 1975). Only 4-5 generations could be reared per year because of the length of its life cycle and because adult females will not lay eggs for at least 2 weeks after maturing (Ables 1975).

Alcaeorrhynchus grandis nymphs also were observed to cooperate in prey capture. This species was not as easily reared as *E. floridanus*, although females produced larger numbers of eggs (100-200) per mass. Egg masses were not produced as often as those of *E. floridanus*, and the population level fluctuated more because of mortality in the early instars. This could be due to genetic load; periodic introduction of field collected specimens might help maintain the hardiness of the culture. *Alcaeorchynchus grandis* females reared in the laboratory also took 2 weeks after maturing to produce their first egg masses.

Stiretrus anchorago was the least promising for laboratory rearing. Although it goes through its life cycle very rapidly, females produce small egg masses (16.4 eggs on the average during this study and 7.1 eggs per mass in that of Waddill and Shepard 1974) and they start oviposition after 11 days at 26.7°C (Waddill and Shepard 1974).

Further research is needed on the life cycle of these predatory stink bugs before their role in the control of lepidopterous pests can be fully understood. While life tables have been prepared for some species (e.g. Mukerji and LeRoux 1969), none has been prepared for *A. grandis*. More field collected prey records combined with field cage tests would be useful for evaluating the effectiveness of these species under natural conditions.

ACKNOWLEDGEMENTS

We would like to express appreciation to Drs. Frank Mead, Robert Crocker, Barbara Saffer, and Reece Sailer for their suggestions, Dr. Robert C. Hemenway, Jr., for his help with some of the rearing, Dr. D. H. Habeck for identification of lepidopterous prey, and G. B. Edwards for some prey records.

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