PROBLEMS IN THE BIONOMICS OF THE SQUASH BUG, *ANASA TRISTIS* (DeGEER) (COREIDAE, HEMIPTERA)

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Although numerous articles have been published on the squash bug, the bulk of the material concerns methods of control, and many questions in the area of its bionomics have either remained untouched or received insufficient consideration. The squash bug has several characteristics that favor it for observation and experimentation: (1) it is large —about ⅝ inch in length; (2) it is common; (3) the sexes are readily distinguished; (4) all the stages are passed in full view above ground and can be reared in captivity; and (5) while capable of flight, the adults tend to remain on foot if food is adequate and the temperature moderate. In view of its suitability for research, a brief summary of its essential bionomics is desirable.

The squash bug appears to confine its feeding to members of the family Cucurbitaceae, favoring certain varieties of squash and pumpkin. The coppery brown eggs are attached in loose groups to the underside of leaves, and the five instars of greyish nymphs and the brown adults appear on foliage and vines during the growing season. When frost kills the leaves, both nymphs and adults may accumulate, sometimes in large numbers, on the cucurbit fruits left in garden or field after harvest. The nymphs, while small, tend to remain congregated about the site of the eggs, but they become isolated as they grow larger. Only the unmated adults live through the winter, sheltered under rubbish, boards, stone piles, and similar cover. In the northern states, the wintered adults return to cucurbits in June, mate and deposit eggs largely in June and July. The nymphs grow through their five stages from midsummer to October, the old adults die by the late summer and the number of new adults increases from July to October. In this latitude and northward, there appears to be only one generation a year. The eggs are subject to attack by minute endoparasitic Hymenoptera of the families Scelionidae and Encyrtidae while the larva of a tachinid fly, *Trichopoda pennipes* Fabr., inhabits and destroys both the adults and nymphs (Beard).

Notes on Problems

Sex ratio.—While observing the behavior of confined squash bugs, Girault found that males mated repeatedly and with different females. From this polygamy, he inferred that the males are numerically inferior to the females. However, this inference is shown by the data cited below to be incorrect. In his study in Connecticut, Beard collected 1000 adults in August and September, 1935, which "showed 449 males and 501 females, indicating that the newly matured bugs have a sex ratio of .5. . . . Tabulations made during June and July, 1936, of 1430 overwintered bugs, gathered at random

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TABLE 1.—LENGTHS AND SEX RATIOS OF *Anasa tristis*

Date of Collection	Length in Millimeters						Total Bugs Collected	Males		Females	
	Males			Females							
	Number Measured	Extreme Lengths	Average Lengths	Number Measured	Extreme Lengths	Average Lengths		Number Collected	Percent	Number Collected	Percent
October 6.....	74	12.4 15.2	13.65	76	13.0 16.6	15.36	992	494	49.80	498	50.20
October 8.....	77	12.0 14.8	13.36	78	13.7 16.5	15.00	995	561	56.38	434	43.62
October 9.....	50	12.3 14.5	13.22	49	13.3 16.3	14.80	781	383	49.04	398	50.96
October 10.....	118	11.6 14.7	13.34	114	13.3 16.5	14.83	2,007	1,061	52.86	946	47.14
October 13.....	99	11.5 15.0	13.05	100	13.1 15.3	14.46	1,284	658	51.25	626	48.75
October 15.....	32	12.0 13.4	12.71	34	13.2 16.0	14.47	66	32	48.48	34	51.52
October 21.....	73	11.2 13.6	12.54	87	12.5 15.3	13.94	164	73	44.51	91	55.49
October 28.....	18	10.8 13.0	12.23	25	12.6 15.7	13.93	43	18	41.86	25	58.14
November 6....	3	12.8 13.0	12.93	4	13.5 14.7	14.07	7	3	42.86	4	57.14
Totals.....	544			567			6,339	3,283	51.79	3,056	48.21

in the field, included 653 males and 677 females, the difference being of no significance as tested by the Chi-square.''

In the fall of 1942, I discovered a fine population of nymphs and adults in a one-eighth acre of squash and pumpkin at Urbana, and used it to secure data on the relative numbers of the sexes. Nine separate collections were made, at times stated in the accompanying table, in the period October 6 to November 6. The numbers taken per day do not represent the total bugs then present, but reflect merely the intensity and duration of the periodic searches. However, all but a very few of the individuals that constituted the population were, I believe, secured by November 6. And because the bugs showed no inclination to fly when pursued, no significant part of the population was omitted through emigration, nor the number present supplemented significantly, if at all, by immigration from other areas. Only the obviously more mature dark-brown adults were taken on any date, to avoid prejudicing the measuring of lengths by the inclusion of smaller, newly molted unfed individuals.

The daily lots were assembled alive in a ventilated half-gallon fruit jar, the cover having a hole just large enough to receive a bug inserted lengthwise, in order to prevent escape. After asphyxiation in ether, the individuals were segregated as to sex and a sample of each sex measured. The ventro-caudal area of the male abdomen is transversely convex and entire, excepting a small median genital ''button,'' while that of the female tends to be flat and is subdivided into small genital sclerites.

Reference to the table will reveal that 51.79 percent of the 6339 bug that made up the collections wer males and 48.21 percent were fe males. It seems likely that each se would be found to constitute 50 per cent of the population or species i much larger samples were taken ove a succession of years and from number of separate fields. The vari ations in the percentages of male and females taken on the 9 dates ar probably to be attributed to chance and do not indicate an actual o normal fluctuation in numerical pre ponderance of one sex over the other Moreover, Beard found no evidenc to indicate a differential mortalit that alters the 50-50 ratio of th sexes throughout the year.

The females of this sample ex ceeded the males in length of bod by 1.39 mm. The 567 females meas ured averaged 14.53 mm., the 54 males averaged 13.14 mm. in lengt The largest female measured 16. mm., the smallest 12.5, while th largest male had a length of 15. mm., the smallest 10.8 mm. More over, the size of both males and fe males lessened perceptibly and some what gradually as the period of co lecting progressed. Since nymph were always purposely left in th field in order to permit them to be come adults, it is probable that th later collections contained a hig proportion of newly transforme adults. And because late-maturin individuals were obliged to feed o the old fruits, the leaves and vine having been killed by frost early i October, the phenomenon of dimi ishing size appears to reflect an i adequacy of food. Also the progre sive shortening of the days and low ering of temperatures as Octobe progressed may have contributed t this reduction.

The life cycle. — Gould, Bear

Worthley, and Weed and Conradi report one generation in a year in Indiana, Connecticut, Massachusetts, and New Hampshire, respectively. By inference, some writers suppose the squash bug completes one cycle annually also in other northern states, but this point needs to be checked by studies in the field. Moreover, this bug has two generations per year in Missouri (Haseman) and three in southern Kansas (Wadley), and may produce even more cycles still farther south. Such additional cycles, are, it appears, commonly presumed to result from the higher average temperatures prevailing at more southerly latitudes. However, these supernumerary cycles may be even more directly associated with the long occurrence of succulent growing cucurbit tissues that is made possible by the protracted warm period.

Diapause.—New adult squash bugs develop as early as July in the northern states. Although they exist at temperatures favorable to reproduction from July to September, they are known not to mate and produce eggs until the subsequent summer. Such failure to advance the life cycle at summer temperatures is a characteristic of diapause. The problem here concerns the identity of the presumed non-climatic factor that inhibits sexual activity in July-September, and limits the squash bug to one generation in the north. Some studies on diapausing insects point to the low water content of drying or aging plants as the diapause-producing factor. It is said to lower the water content in the insect. This suggests that nymphs and adults fed only on succulent seedling cucurbits may not be subject to a diapause. Simple laboratory tests embodying this suggestion can probably be easily carried out.

How cucurbits are injured.—Being equipped with piercing-sucking mouthparts, *Anasa tristis* removes sap from its food plants. However, such mechanical removal of sap, in itself, seems inadequate to explain the sometimes extensive wilting, searing, and dying of cucurbit crops. Various writers have called attention to this wilting, and Robinson and Richards (1930, 1931) state from their investigations that the wilt, for which they propose the name "*Anasa* wilt of cucurbits," is not caused by any parasitic form of bacterium, fungus, or virus. These and other observers suggest that the wilting results from a toxic substance injected by the bug while feeding. If so, the toxin is probably contained in the saliva, or salivary glands, and quantities of it might be analyzed by modern microchemical techniques and also injected artificially into potted, disease-free cucurbits to note whether it produces the symptoms of wilt as it occurs in the field. If the results prove to be positive, the substance might be injected into non-cucurbit plants to note whether it has the power to produce wilt in these also.

Why the preference for cucurbits?—The fact that the squash bug chooses cucurbits over numerous other plants present in its environment, and moreover, prefers certain varieties of squash and pumpkin over other species and varieties of the family, indicates it is capable of making fine distinctions, presumably through a keen sense of smell residing in the antennae or proboscis. This predilection also raises the question whether cucurbits contain a certain combination of nutrients

essential to the growth and reproduction of the squash bug. Two experiments are indicated above. First, to find what organ is the seat of selective sense. Second, to find whether the squash bug can be induced to feed on non-cucurbit plants, e.g. soybeans or corn grown in pots, when such plants are sprayed with extracts or decoctions from favored varieties of squash and pumpkin. If nymphs can be reared and adults maintained on such plants, it would be of interest further to note the effects on size, vigor, rate of growth, and capacity for reproduction. It is conceivable that the species might fare better on some non-cucurbits than on the preferred varieties of its chosen family of food plants.

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