FEEDING AND DEVELOPMENT OF *NABIS ROSEIPENNIS* (HEMIPTERA: NABIDAE) ON *HELIOTHIS VIRESCENS* (LEPIDOPTERA: NOCTUIDAE) LARVAE[1]

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ABSTRACT

Feeding, development, and duration of life stages of *Nabis roseipennis* Reuter, on different size (2, 3, 4, or 5 mm) early instar *Heliothis virescens* (F.) larvae were studied in the laboratory. Three or 4-mm larvae were optimum for feeding, consumption, and development of nymphs and adults. *Nabis roseipennis* fed 3 or 4 mm larvae consumed more and survived longer than those fed 2 or 5 mm larvae. Prey size significantly affected the duration of the individual 5 nymphal stages. Nymphs fed 3 or 4 mm larvae developed faster than those fed 2 or 5 mm larvae. Nymphs feeding on 2 mm larvae did not develop to adults. Nymphs and adults can survive and mature satisfactorily for extended periods on small prey, but need larger prey to accelerate development and maintain a high growth potential.

Key Words: Predation, insect, nabid, tobacco budworm.

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INTRODUCTION

Among the arthropod predators collected in cotton, *Gossypium hirsutum* L., in Mississipi, a damsel bug, *Nabis roseipennis* Reuter, is frequently encountered and is particularly abundant during the early season (Brazzel et al. 1970; Dinkins et al. 1970; Hormchan et al. 1976; Laster and Brazzel 1968; Pitre et al. 1978). Whitcomb and Bell (1964), and Brazzel et al. (1970) reported that this species consumed large numbers of 1st and 2nd stage larvae of *Heliothis* spp. The effects of temperature on aspects of the biology of *N. roseipennis* have been reported (Braman et al. 1984; Nadgauda and Pitre 1985).

There is need for additional information concerning efficiency of this predator in relation to consumption of its prey. This paper deals with feeding, development, and duration of life stages of *N. roseipennis* fed 1st and 2nd stage larvae of *Heliothis virescens* (F.) of different sizes (lengths).

MATERIALS AND METHODS

Nabis roseipennis was reared in the laboratory as described by Nadgauda and Pitre (1978). *Heliothis virescens* larvae were reared on an artificial diet[3] and were

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used as prey for the predator. Newly hatched nymphs were removed from the rearing containers with a fine brush and placed in 133 ml jars containing a small amount of artificial *H. virescens* diet for the host. Each insect was observed as an experimental unit in specific feeding and development studies.

Heliothis virescens larvae, either 2 (early 1st stage), 3 (mid-1st stage), 4 (late 1st stage) or 5 (early 2nd stage) mm long, were placed in the jars, which were then covered with a thin sheet of polyethylene to prevent insect escape. Each jar contained larvae of only one treatment size throughout the experiment. Four larvae were placed in each jar on day 1. Because the larvae fed on the diet and increased in size, all surviving larvae were removed from the jar daily and replaced with larvae of the designated size for each treatment. Numbers of larvae required increased daily as the predators increased in size.

Larvae were measured immediately before being placed in the jars and were available to the predators at all times during the experiment. The jars were examined at 0.5, 1, 4, and 24 h after the larvae were placed in the containers, then daily (at these same intervals) through the adult stage until death of the predator. A cast nymphal skin and/or a newly molted nymph were used to identify growth of the predators from one stage to the next.

The number of larvae consumed by nymphs and adults, duration of stages, and longevity of adults were recorded. The laboratory was maintained at 22 - 24°C and 16:8 h photoperiod; humidity in the jars was near 100%. The test jars were arranged in a completely randomized design. Each of the 4 treatments (larval size, length) was replicated 20 times (1 predator/jar = 1 replication).

A factorial analysis of variance was conducted utilizing the computer program Rummage, developed in 1976 by M. Carter, Brigham Young University, Provo, UT. Means were separated by Duncan's multiple range test, adapted for unequal number of replications (Steel and Torrie 1960).

RESULTS AND DISCUSSION

Predator Consumption and Development

Nabis roseipennis nymphs generally consumed more 2, 3, or 4 mm than 5 mm *H. virescens* larvae during 24 h feeding (Table 1) and throughout their life (Table 2).

Table 1. Consumption of *Heliothis virescens* larvae by *Nabis roseipennis* nymphs and adults during 24 h. (Laboratory: 22 - 24°C; 16:8 h photoperiod).

Larval length (mm)	Mean number larvae consumed					
	Nymphal stage					
	1	2	3	4	5	Adults*
2(E1)†	1.5 a‡	1.8 a	2.1 b	4.8 b	6.2 b	§
3(M1)	1.8 a	2.7 a	3.2 a	7.9 a	19.5 a	24.5 a
4(L1)	1.7 a	2.4 a	3.7 a	9.6 a	18.8 a	27.6 a
5(E2)	0.6 b	0.8 b	1.3 b	1.3 b	1.7 c	2.4 b

* Both sexes.

† E1 = Early 1st stage, M1 = Mid-1st stage, L1 = Late 1st stage, E2 = Early 2nd stage.

‡ Means within columns followed by the same letter are not significantly different at the 0.05 level of probability as determined by Duncan's multiple range test.

§ No nymphs survived to adulthood.

Table 2. Total number of *Heliothis virescens* consumed by *Nabis roseipennis* in different life stages, total consumption and predator longevity. (Laboratory: 22 - 24°C; 16:8 h photoperiod).

Larval length (mm)	Mean number larvae consumed								Predator longevity (days)†
	Nymphal stage					Total	Adults*	Total*†	
	1	2	3	4	5				
2(E1)‡	6.9 a§	6.4 a	8.8 b	12.7 b	17.6 c	52.4 c	–¶	52.4 b	31.4 b
3(M1)	8.4 a	7.2 a	11.6 a	20.2 a	47.6 b	95.0 b	237.1 a	332.1 a	56.6 a
4(L1)	6.6 a	7.3 a	11.4 a	24.5 a	63.2 a	113.0 a	322.7 a	435.7 a	67.8 a
5(E2)	3.7 b	2.8 b	4.3 b	7.1 b	11.3 c	29.2 d	36.2 b	64.3 b	26.3 b

* Both sexes.

† From egg hatch to mortality.

‡ E1 = Early 1st stage, M1 = Mid-1st stage, L1 = Late 1st stage, E2 = Early 2nd stage.

§ Means within columns followed by the same letter are not significantly different at the 0.05 level of probability as determined by Duncan's multiple range test.

¶ No nymphs survived to adulthood.

Significantly greater numbers of 3 and 4 mm larvae were consumed by adults during the same periods. Nymphs did not complete development to adults when fed 2 mm larvae. However, in a separate study, overwintering adults each consumed an average of 53 (58 for ♀, 49 for ♂) 2 mm larvae in 24 h.

The differences in predator consumption of early instar *Heliothis* larvae of various lengths may be directly related to the relative size of the host. Preliminary observations revealed that 1st and 2nd stage nymphs did not feed on 6 mm larvae, and were often killed by larvae of this size. Nabids in general are timid predators (Arnold 1971), but despite the defensive action of the prey, they can successfully attack and feed on larvae somewhat larger than themselves. We observed that feeding attempts by early nymphal instars of *N. roseipennis* on 5 mm *Heliothis* larvae are frequently without success due to the defensive action of the larvae (Nadgauda and Pitre 1978).

The 2 mm *Heliothis* larvae do not appear to be sufficient as a diet for *N. roseipennis* nymphs to complete development, whereas, 3 mm and larger larvae are adequate for development to adulthood. Mukerji and LeRoux (1969a) report that the pentatomid, *Podisus maculiventris* (Say), survived satisfactorily for extended periods on small prey, but needed larger prey to accelerate development and growth. They found that on the larger hosts, the rate of attack by all predator stages decreased with increased rate of satiation. The nutritional value associated with increased size of the larval stages may affect predator consumption and development (House 1960), but nutritional values were not measured in our study.

In general, the number of *H. virescens* consumed by *N. roseipennis* increased with each stage of the predator (Table 2). First and 2nd stage nymphs consumed about equal numbers of 2, 3, and 4 mm larvae. Thirty percent of the 1st and 2nd stage nymphs that were fed 2 mm larvae reached the 5th stage, but none developed to adults. On the other hand, 70, 90, and 10% of the nymphs fed 3, 4, and 5 mm larvae, respectively, became adults. Mortality was high among early-stage nymphs fed 5 mm larvae; nymphs frequently could not feed due to the defensive actions of the larvae. In similar predator age-functional response studies, Mukerji and LeRoux (1969b), working with *P. maculiventris* preying on greater wax moth, *Galleria mellonella* (L.), larvae, reported that the total amount of food consumed by the predator increased as prey size increased, but that the number of prey items consumed decreased as prey size increased. In the present study the number of 2, 3, and 4 mm prey items fed on by *N. roseipennis* increased as prey increased in size.

Nabis roseipennis consumed significantly greater numbers of 3 or 4 mm *H. virescens* larvae throughout life and survived longer than when fed 2 or 5 mm larvae (Table 2). Thus, the relationship between *N. roseipennis* consumption of 2, 3, 4, or 5 mm *H. virescens* larvae and predator development and longevity can be directly related quantitatively to food intake and/or may be similar to the nutritional relationship expressed by House (1960). Nutritional differences may be only one factor (possibly the most important) limiting survival and development.

The physical condition of the predator contributes greatly to its ability to feed. It is possible that 2nd stage predator nymphs may not obtain sufficient nutrients from 2 mm larvae and/or the early stage predators expend much energy in attempts to attack the larger 5 mm *Heliothis,* thus resulting in weakness, reduced movement and even death. The poor searching ability and attack capability of

weak predators under these conditions could account for their poor performance. Fourth and 5th stage nymphs also consumed significantly fewer 2 and 5 mm larvae than 3 and 4 mm larvae The rate of energy accumulation by predators fed 2 mm larvae may have been deficient, and without sufficient reserves, the predator apparently was unable to develop past the 5th stage. Turnball (1962) suggested failure to escape from the old integument at molting as the possible cause of death related to inadequate energy and diet.

Duration of Predator Life Stages

The duration of the five nymphal stages and longevity of adults was affected by host size (Table 3). Shorter development periods were required for 1st and 2nd nymphal stages fed 2, 3, or 4 mm larvae compared to 5 mm larvae, but longer development periods were required for 3rd and 4th nymphal stages fed 2 or 5 mm larvae than when fed 3 or 4 mm larvae. Fifth stage nymphs developed to adults faster on 2 or 3 mm larvae than on 4 or 5 mm larvae. Shorter total nymphal period was also observed for predators fed 3 or 4 mm larvae than when fed 2 or 5 mm larvae, and adults showed increased longevity when fed 3 or 4 mm larvae compared to 5 mm larvae.

Table 3. Duration of nymphal stages and longevity of adults of *Nabis roseipennis* fed *Heliothis virescens* larvae of different sizes. (Laboratory: 22 - 24°C; 16:8 h photoperiod).

Larval length (mm)	Mean duration of stage (days)						
	Nymphal stage						
	1	2	3	4	5	Total	Adults*
2(E1)†	4.6 a‡	5.4 a	6.9 c	7.8 b	8.0 a	36.7 b	§
3(M1)	5.1 ab	4.9 a	5.5 ab	6.8 a	8.3 a	31.6 a	47.8 a
4(L1)	5.6 bc	5.2 a	5.2 a	6.5 a	9.0 b	30.5 a	44.5 a
5(E2)	6.0 c	6.8 b	6.4 bc	7.4 b	12.0 c	35.6 b	38.1 b

* Both sexes.

† E1 = Early 1st stage, M1 = Mid-1st stage, L1 = Late 1st stage, E2 = Early 2nd stage.

‡ Means within columns followed by the same letter are not significantly different at the 0.05 level of probability as determined by Duncan's multiple range test.

§ No nymphs survived to adulthood.

The first stage of *Heliothis* is probably the most critical period in its life, because the larvae are vulnerable to attack by predators and more sensitive to adverse climatic conditions (Fletcher and Thomas 1943). In studies of the behavior of *N. roseipennis,* Donahue and Pitre (1977) reported that this predator is frequently encountered on the abaxial surface of cotton leaves and on squares in the upper one-third of the cotton plant where eggs and early stages of *Heliothis* are also found. In nature this predator may consume more small larvae than mid-size larvae, or other available hosts (Fewekes 1960). The defensive action of the larger larvae will inhibit the effectiveness of the predator, which would favor survival of the more mature larvae.

We have demonstrated that *H. virescens* larval size limits *N. roseipennis* feeding and development. The ability of the predator to encounter and successfully attack and feed on the larvae is an important factor in development and longevity. Since

N. roseipennis was restricted to a single stage of one prey species in this study, we must use caution when interpreting these results in relation to normal development patterns under circumstances which could be expected in the field where multiple prey species and stages are available.

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