Israel Journal of Entomology Vol VII, 1972

EFFECTS OF PARASITISM BY *VORIA RURALIS*[1] ON THE FEEDING BEHAVIOR OF LARVAE OF *TRICHOPLUSIA* NI[2,3]

C. F. Soo Hoo* and R.S. Seay

Entomology Research Division, Agr. Res. Serv., USDA
Mesa, Arizona 85201, U.S.A.

ABSTRACT

Larvae of the cabbage looper, *Trichoplusia ni,* digest over 40% of the leaves of collard and lettuce. Parasitism by the larva of *Voria ruralis* did not affect digestibility, but influenced the feeding behavior of the large larvae tested by causing them to eat considerably less than normal larvae. The reduction was most evident when larvae were reared through the 4th and 5th instars.

INTRODUCTION

The relationship between the tachinid parasite *Voria ruralis* (Fallen) and its host *Trichoplusia ni* (Hubner) results in the death of the host. In such cases, death that is attributable to the biological agent is the simplest yardstick of success. However, parasitized insects do not succumb immediately and can continue at least part of their normal activity. Therefore, an experiment was made to determine the feeding behavior of parasitized *T. ni,* particularly its ability to consume and utilize food.

METHODS AND MATERIALS

Two groups of 4th-instar larvae of *T. ni* from the laboratory colony were prepared as follows: One group of 12 unparasitized newly-molted 4th-instar *T. ni* was selected at random, and the larvae were reared individually as the standard. The second group of 10 parasitized 4th-instar larvae each containing one *V. ruralis* maggot (achieved by extracting an egg from a fertilized laboratory-reared female, placing it on the back of a 3rd-instar *T. ni* and watching the newly-hatched larva bore into its host) was selected randomly from larvae that had successfully molted to the 4th instar. All larvae were fed fresh collard leaves from an 8-wk-old planting until they molted. This was to insure that those parasitized were going to be as nearly normal as possible. Injured larvae would not have molted. The collard leaves used for each individual feeding were divided in half, then one half was weighed out and fed to a larva in a small (5 cm) petri dish; the other half was weighed wet, placed in a bag, dried, and reweighed so that the moisture content of each leaf could be calculated (Waldbauer 1962). From the percentage moisture of the leaf aliquot, we could also calculate the

[1] Diptera: Tachinidae.

amount of dry leaf matter presented to the larvae at each feeding. Enough leaf material was provided to last through 24 hr. The leaves were kept relatively fresh by placing moist filter paper on the bottoms of the covered dishes. Each day, frass and unconsumed leaves were removed to individual pans and oven dried to a constant weight. When the larvae molted to the 5th instar, they were weighed, dried individually in aluminum pans, and weighed again to derive dry weights after molting (Soo Hoo and Fraenkel 1966).

Each insect was treated individually because inherent virus diseases were present in the colony that could spread throughout the groups. Thus, one case of disease was discovered after the first day of the test, but the sick larva could be discarded before disease contaminated others.

The initial dry weight of a single 4th-instar larva was estimated by determining the average dry weights of 20 newly-molted 4th-instar larvae and multiplying this factor by the initial weight of each of the test larvae. The coefficient of digestibility (C.D.) was calculated as:

$$\text{C.D.} = \frac{\text{food consumed} - \text{frass}}{\text{food consumed}} \text{ X } 100.$$

All measurements were in dry weights. The efficiency of the conversion index (E.C.I.) of ingested matter to body weight was calculated as:

$$\text{E.C.I.} = \frac{\text{dry weight gained by animal}}{\text{dry weight of food ingested}} \text{ X } 100.$$

The efficiency of conversion of digested matter (E.C.D.) to body matter was calculated as:

$$\text{E.C.D.} = \frac{\text{food digested}}{\text{weight gain of insect}} \quad \text{X } 100.$$

In a companion test, a group of normal larvae were fed the leaves of 8-wk-old Romaine lettuce during the 4th and 5th instars. A second group of larvae each parasitized with two maggots of *V. ruralis* were fed lettuce leaves during the 4th and 5th instars. Since both groups digested about 40% of the plant material provided *ad libitum*, frass production was used as a means of calculating the amount of food consumed by each larva.

RESULTS AND DISCUSSION

The C.D. of the freshly-grown collards for normal and parasitized 4th-instar larvae was not affected by the presence of the parasites (Table 1), and the presence of parasites did not increase the E.C.D. Unparasitized larvae consumed 25.2 mg of collard leaves/larva, and parasitized larvae consumed 21.1 mg/larva, but the difference was not significant at the 0.1 level of confidence. Large test groups would, therefore, have been desirable; however, the time required to make the gravimetric determinations for each individual limited the numbers that could be tested.

Consumption of an average 23.5 mg of collard was necessary for every 1 mg gain in dry larval weight for parasitized larvae. However, the weight gain of the parasitized larvae included the weight of the tachinid parasite which was also growing; thus, the gain by the parasitized *T. ni* larvae was actually lower than recorded. Unparasitized larvae required only 19.4 mg of collard (dry-weight basis) to gain 1 mg weight/larva.

(These values, too, are only slightly different and are not significant at the 0.1 level).

Table 1.—A comparison of the consumption (C.D.), digestion (.E.C.D.), and utilization (E.C.I.) of fresh collard leaves by parasitized and unparasitized 4th-instar *T. ni*

Condition of larvae	Number	Av. wt. of food consumed, (mg)	C.D. a/ (%)	E.C.D. a/ (%)	E.C.I. a/ (%)
Normal	12	25.2 ± 7.6	48.1 ± 8.9	25.2 ± 9.7	19.4 ± 5.7
Parasitized	10	21.1 ± 4.2	46.9 ± 7.2	21.4 ± 3.9	23.5 ± 6.6

a/ See text for derivation.

Consumption and weight gain by parasitized insects are rarely considered because death or a reduced population have been the major interests. However, we found that parasitized *T. ni* larvae, in addition to providing host tissue for a generation of parasites, were also slightly less efficient in digesting food than unparasitized larvae, ate less food, and were less efficient in converting ingested food to body weight. Thus, though a parasitized larva will live until *V. ruralis* forms its puparium, the maggots immediately cause a reduction in host feeding. As a result, some plants may have an opportunity to grow and repair the damage caused by the insects.

The efficiency of conversion of food by unparasitized 4th-instar larvae of *T. ni* to weight gain was 25.2%, a value similar to that for another polyphagous larva, *Spodoptera eridania* (Cramer), which was found to be an excellent converter of plant food (Soo Hoo and Fraenkel 1966). The parasitized larvae in the present test were, of course, less efficient (0.1 level of significance) because the food ingested and digested had to sustain the parasite as well as the host. However, the reduction in efficiency was not so drastic as to prevent the parasite from developing and was higher than the 16-19% conversion factor for *Tribolium, Esphestia,* and *Dermestes*, living on stored dried food (Fraenkel and Blewett 1944).

Table 2.—Frass production dnd C.D. of *T. ni* 4th and 5th-instar larvae fed 8-wk-old Romaine lettuce

Condition of larvae	Number	% a/ C.D.	Frass produced/larva (g)
Normal	10	41.3 ± 6.4	0.14759
Parasitized (2 *V. ruralis* maggots)	8	42.9 ± 8.9	0.08310

a/ See text for derivation

The figures provided above have been based on one larval instar. To more fully appreciate what the parasites are doing to the feeding behavior of the host, fresh leaves of Romaine lettuce, another acceptable plant, (Table 2) were provided to 4th and 5th-instar *T. ni* larvae until the normal larvae pupated or until the parasitoids killed the looper larvae in the middle of the 5th instar. The average total frass/larva was used to reflect how much food was consumed during their late larval existence where the ravages of their destruction are most evident. Parasitized 4th and 5th-instar larvae produced only 56.3% of the frass of a normal larva. This can be interpreted as a 43.7% reduction in feeding. This adds support to our belief that immediate benefits are derived from the use of parasites by altering the feeding habits of their hosts. Parasitism of larvae even at an earlier instar would further reduce the amount of food a pest would consume, but the small quantities that earlier instars consume are difficult to measure, and therefore, not attempted because of technicalities.

REFERENCES

Fraenkel, G., and M. Blewett. 1944. The utilization of metabolic water in insects. Bull. Entomol. Res. *35*: 127-39

Soo Hoo, C.F., and G. Fraenkel. 1966. The consumption, digestion and utilization of food plants by *Prodenia eridania* (Cramer), a polyphagous insect. J. Insect Physiol. *12*: 711-30

Waldbauer, G.P. 1962. The growth and reproduction of maxillectomized tobacco hornworms feeding on normally rejected non-solanaceous plants. Entomol. Exp. Appl. *5*: 147-58.