

Orientation and Development of *Heterodera schachtii* Larvae on Tomato and Sugarbeet Roots¹

ARNOLD E. STEELE²

Deviation of *Heterodera schachtii* from the typical development pattern was reported by Strubell (4), who observed that larvae attacking very small roots frequently matured while attached by their heads only. More recent reports on *H. schachtii* biology have not indicated an ectoparasitic habit (1, 3). Consequently, roots of sugarbeet (*Beta vulgaris* L., cultivar 'U. S. 75') and tomato (*Lycopersicon esculentum*, cultivar, 'Pearson A-1') were examined to determine the orientation of *H. schachtii* larvae. Fifty beet plants were grown from seed in, and 50 tomato seedlings in the cotyledon stage were transplanted to, individual 15-cm clay pots each containing approximately 1400 cc of sterilized clay-loam soil and sand mixture to which had been added 50 *H. schachtii* cysts containing eggs and larvae. After growing in the greenhouse 14–117 days, the external surfaces of roots were examined for larvae and adult sugarbeet nematode. Second, third, fourth-stage larvae and young adults were found on the roots of sugarbeet and tomato plants (Figs. 1–4) and within roots. There was wide variation in the

degree of larval penetration, ranging from completely endoparasitic to nearly completely ectoparasitic with only the cephalic region buried in the root. Larvae were often semiendoparasitic and somewhat wrapped around the root. All of the sexually differentiated larvae external to the roots were males with the exception of a single third-stage female observed on a tomato plant. All other females found upon the roots or penetrating the roots were either fourth-stage or adult.

No regular pattern of distribution of nematodes on the roots was detected. They occurred singly (Fig. 3) or in groups of two or more (Fig. 2). Groups contained males only or females only, or males and females together (Fig. 4). At least a few immature males were found on the root surface of all plants examined. However, the numbers of third and fourth-stage males on the root surface never exceeded an estimated 10% of the total population on a given plant.

Adult females and early third, fourth, and early fifth-stage males within larval integuments were found external and attached to the lateral feeder roots of sugarbeets obtained from a commercial field at harvest. No larvae or adults were found on the surface of the large well-formed tap roots or on the larger branched roots of beets.

Two sugarbeet plants were selected at random from a group grown 22 days in soil

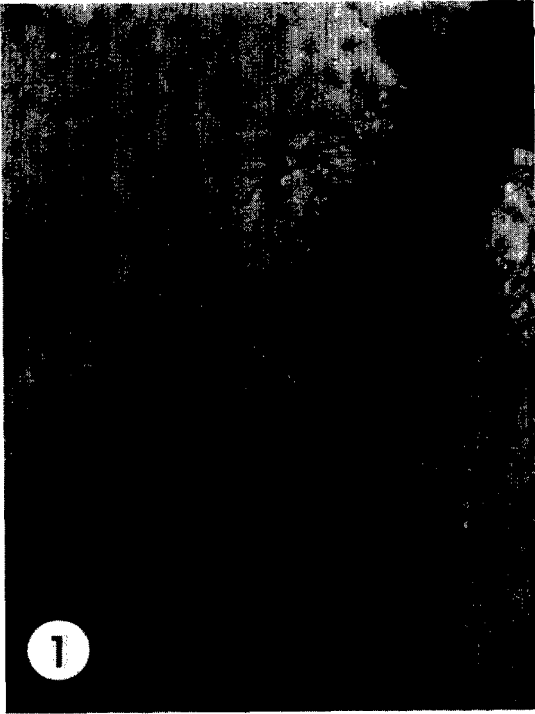
Received for publication 26 April 1971.

¹ Cooperative investigations of the Beet Sugar Development Foundation and the Plant Science Research Division, Agricultural Research Service, U. S. Department of Agriculture, Salinas, CA 93901.

² Nematologist, Nematology Investigations, Agricultural Research Service, U. S. Department of Agriculture, P. O. Box 5098, Salinas, CA 93901. The author is indebted to Madeline Mullins for her assistance.

→

FIG. 1–4. *Heterodera schachtii* larvae attached to roots of sugarbeet and tomato. 1. Second-stage larvae and third-stage male larvae on roots of sugarbeet grown 64 days in infested soil ($\times 140$); 2. fourth and early fifth-stage male *H. schachtii* larvae on root of tomato grown 22 days in infested soil ($\times 45$); 3. Fourth-stage male larvae partially embedded in root of sugarbeet grown 147 days in infested soil ($\times 116$); 4. Adult male within larval integuments and adult female on a root of a sugarbeet grown 82 days in infested soil ($\times 116$).



infested with the sugarbeet nematode. The roots were examined to determine the position of the larvae on or within the roots. Nearly twice as many larvae were found on or within lateral roots as were observed on tap roots of sugarbeet (94 and 58 larvae respectively). Forty-six % of the larvae were oriented with their anterior ends toward the root tip, 44% with their anterior ends toward the hypocotyl, and 10% were oriented nearly perpendicular to the root axis.

These observations demonstrate that the sugarbeet nematode can occur external to the roots of sugarbeet. However, with but one exception, all larvae in early stages of development observed on root surfaces were males. Since all stages of males were found on the lateral roots of tomato and sugarbeet, it is likely that males typically develop semi-endoparasitically on the external root surfaces of these plants. According to Strubell (4), the male emerges from the root only after it has emerged from its larval integument. In this study, however, late fourth-stage males and young males were found within larval integuments attached to the root surfaces (Fig. 4). In addition, adult

males were seen to emerge from larval integuments attached to root surface.

Larvae oriented near the root surface are less likely to stimulate formation of syncytia which, in sugarbeet, are invariably formed within the stele of the lateral rootlets (2). Since males may complete their development at or near the root surface, factors restricting deep penetration of larvae, such as, development of a tough periderm in older roots, may favor the development of males over females.

LITERATURE CITED

1. FRANKLIN, M. T. 1951. The cyst-forming species of *Heterodera*. Tech. Commun., Commonw. Bur. Agr. Parasitol. (Helminthol.), St. Albans, Farnham Royal, Bucks, England. 147 p.
2. NEMEC, B. 1911. Über die Nematodenkrankheit der Zuckerrübe. *Pflanzenkrankheit* 21:1-10.
3. RASKI, D. J. 1949. The life history and morphology of sugarbeet nematode, *Heterodera schachtii* Schmidt. *Phytopathology* 40:135-152.
4. STRUBELL, A. 1888. Untersuchungen über den Bau und die Entwicklung des Rüben-nematoden, *Heterodera schachtii* Schmidt. *Bibl. Zool.* 1:1-52.