

Differentiation of Cysts of *Heterodera schachtii* and *H. trifolii* by Fenestral Length

G. S. ABAWI, JANICE FOSTER and W. F. MAI¹

The sugarbeet cyst nematode, *Heterodera schachtii* Schmidt, 1871, was discovered by Mai et al. (4) in fields of 16 New York State commercial red table beet growers during a survey in 1970-1971. They reported that the clover cyst nematode, *H. trifolii* Goffart, 1932, which also has lemon-shaped cysts with bullae, was present in very low numbers in many of the fields sampled. Thus a rapid and reliable method was needed to differentiate cysts of these nematodes in the many soil samples collected.

Several workers have suggested that lemon-shaped cysts of *Heterodera* spp. could be separated by vulval cone structures (1, 2, 3, 5, 6). Oostenbrink and Den Ouden (6) suggested that for practical advisory work fenestral length may be useful in differentiating cysts of *H. schachtii* and *H. trifolii*. They reported that the average fenestral lengths of *H. schachtii* and *H. trifolii* were 32.1 and 45.6 μ , respectively. They also concluded that "an average of five specimens is adequate to place a population below or above 38.7, which is the limiting value between the two species according to statistical treatment of the presented data". Fenestral lengths reported by Mulvey (5) and Jimenez (3) substantiated this finding. Mulvey (5) also reported that no statistical correlation occurred

between cyst volume and fenestral length of *H. schachtii*.

The purpose of our investigation was to determine whether fenestral length could be used to differentiate the New York populations of *H. schachtii* and *H. trifolii*, and to determine if there is a correlation between cyst length and fenestral length.

Populations of *H. schachtii* and *H. trifolii* were maintained under greenhouse conditions on red table beet, *Beta vulgaris* L. 'Ruby Queen', and an unknown variety of white clover, *Trifolium repens* L., respectively. Cysts of each nematode were divided into three groups according to length: 380-490, 570-680, and 760-870 μ . The vulval cone of each cyst was cut in glycerine by a surgical eye-knife. Small drops of Zut were placed in a depression slide, and a cone with the vulva up was placed into the edge of the drops cementing the cone to the slide and leaving the cone tip protruding above the Zut. After the Zut was dry, the depression was filled with 2.5% Formalin or water, and a clover-slip placed over the depression. Fenestral length of 25 cysts of each group was measured under a compound microscope at 430 X. Cysts from a field population of *H. schachtii*, extracted from heavily infested red table beet soil, were also measured.

Results (Table 1) indicate a direct correlation between cyst length and fenestral length of *H. trifolii* but not for *H. schachtii*. When the fenestral length of each cyst of *H. trifolii* was plotted against the cyst-group length, a straight line relationship was suggested.

Fenestrae of *H. trifolii* cysts were longer than those of *H. schachtii*, with little overlap (Table 1). In fact, even the smallest group of *H. trifolii* cysts had longer fenestrae than the

Received for publication 20 April 1972.

¹ Research Associate, Research Technician, and Professor, respectively, Department of Plant Pathology, Cornell University, Ithaca, New York 14850. Senior author now Assistant Professor, Department of Plant Pathology, New York State Agricultural Experiment Station, Geneva, New York 14456. The suggestions of Dr. Hedwig H. Triantaphyllou, Department of Plant Pathology, North Carolina State University, Raleigh, concerning this investigation are gratefully acknowledged.

largest group of *H. schachtii* cysts. The average fenestral lengths of all cysts of *H. schachtii* and *H. trifolii* were 31.5 and 50.4 μ , respectively. These measurements are in agreement with those reported earlier (5, 6). The range (21.6-40.8 μ) and average (28.7 μ) fenestral lengths of *H. schachtii* cysts developed under field conditions on red table beet were similar to the range (21.6-40.1 μ) and average (31.5 μ) developed in the greenhouse. This small difference may be a temperature effect; in the greenhouse, temperatures were 23-27 C, whereas field soil temperatures 6 inches deep were 14.5-22.3 C during the growing season.

Shape of the fenestral area also is characteristic of each species. The cone-top of *H. schachtii* is almost circular, and that of *H. trifolii* is oval (see references 5 and 6 for photographs). Generally, the basin of *H. schachtii* is wider than that of *H. trifolii*. While preparing cone areas for temporary mounts, we found that eggs, etc. are difficult to remove from *H. schachtii* but relatively easy to remove from *H. trifolii*.

LITERATURE CITED

1. COOPER, B. A. 1955. A preliminary key to British species of *Heterodera* for use in soil examination, p. 269-280. In D. K. McE. Kevan [ed.]. Soil zoology. Butterworth, London and Washington, D.C.
2. GOFFART, H. 1960. Die taxonomische Bewartung morphologischer Merkmale bei den Systemen der Gattung *Heterodera* (Nematoda). Mitt. biol. BundAnst. 1d-u. Forstw. 99:24-51.
3. JIMENEZ, A. T. 1964. Especies del genero *Heterodera* A. Schmidt, 1871 (Heteroderidae: Nematoda) de la provincia de Granada. II. La *Heterodera schachtii* A. Schmidt, 1871 sus diferencias morfologicas con la *H. trifolii*

TABLE 1. Relationship between cyst length and fenestral area of *Heterodera schachtii* and *H. trifolii*.

<i>Heterodera</i> spp.	Cyst length (μ)	Fenestral length (μ)	
		Average ^a	Range
<i>H. trifolii</i> ^b	380-490	41.2 \pm 2.27	36.0-46.8
	570-680	49.7 \pm 5.66	38.4-60.0
	760-870	60.2 \pm 3.88	52.8-66.0
	Average	50.4 \pm 9.51	
<i>H. schachtii</i> ^b (greenhouse)	380-490	28.7 \pm 3.70	21.6-36.0
	570-680	32.4 \pm 5.20	24.0-41.8
	760-870	33.5 \pm 3.55	24.0-40.1
	Average	31.5 \pm 2.51	
<i>H. schachtii</i> ^c (field)	380-490	24.7 \pm 2.56	21.6-31.2
	570-680	29.9 \pm 4.10	20.4-40.8
	760-870	31.5 \pm 4.12	28.8-40.8
	Average	28.7 \pm 3.55	

^aEach number is an average of 25 measurements and standard deviation.

^bMaintained under greenhouse conditions.

^cObtained from commercial red table beet field heavily infested with *H. schachtii*.

- Goffart, 1932. Rev. Iber. Parasitol. 24:105-108.
4. MAI, W. F., G. S. ABAWI and R. F. BECKER. 1972. Population levels of *Heterodera schachtii* in New York and damage to red table beet and cabbage under greenhouse conditions. Plant Dis. Rep. 56:434-437.
5. MULVEY, R. 1957. Taxonomic value of the cone and the underbridge in the cyst-forming nematodes *Heterodera schachtii*, *H. schachtii* var. *trifolii*, and *H. avenae* (Nematoda: Heteroderidae). Can. J. Zool. 35: 421-423.
6. OOSTENBRINK, M. and H. DEN OUDEN. 1954. De structuur van de Kegeltop als taxonomisch Kenmerk bij *Heterodera*-soorten Met citroenvormige cysten. Tijdschr. Plantenziekten 60:146-151.