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MIGRATION OF *LONGIDORUS ELONGATUS*, *XIPHINEMA DIVERSICAUDATUM* AND *DITYLENCHUS DIPSACI* IN SOIL

by

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Nematode movement in soil is dependent on the physical and chemical properties of the medium (Pitcher, 1975). However, different species move at different rates. For example, it has been estimated that *Xiphinema diversicaudatum* (Micoletzky) Thorne spread from a hedge into woodland at an average rate of 30 cm per year over a period of 75 years (Harrison and Winslow, 1961); *Radopholus similis* (Cobb) Thorne migrated 15 m per year in citrus groves and 21 cm per month experimentally on *Solanum nigrum* L. (Suit and Ducharme, 1953; O'Bannon and Tomerlin, 1969); and *Globodera rostochiensis* (Woll.) Mulvey *et* Stone males rarely exceeded 1 cm in 5 to 12 h in response to the presence of white females of the same species (Evans, 1969).

The horizontal and vertical movement in soil, and their association with different hosts, of the virus-vector ectoparasites *Longidorus elongatus* (de Man) Thorne *et* Swanger and *X. diversicaudatum*, and of the smaller stem endoparasite *Ditylenchus dipsaci* (Kühn) Filipjev were investigated experimentally, to compare their rates of movement.

(1) Based on work done at the Scottish Horticultural Research Institute, Invergowrie, Dundee.

Materials and methods

The longidorids were extracted by sieving local field soils and the oat strain of stem nematode was revived in water from the quiescent stage on filter paper. The soil medium used was 20% steamed loam, 79% washed sand and 1% John Innes base.

Horizontal movement was studied in Perspex troughs, 1 m x 20 cm deep x 10 cm wide. The base of each trough, in which holes were bored for drainage, was covered with a polystyrene strip. The trough sides were lined with black polythene to reduce green algal growth. After filling with soil the troughs were placed in a glasshouse (Ca 18 °C). Young plants of *Fragaria* x *ananassa* Duchesne, *Lolium multiflorum* Lam. and *Trifolium pratense* L. were used for the longidorids and *F.* x *ananassa* and *Avena sativa* L. for. *D. dipsaci*. The plants of each species were spaced at 10 cm intervals in each trough. Troughs containing soil without plants served as controls. Approximately 750 *L. elongatus*, 50 *X. diversicaudatum*, and 75,000 *D. dipsaci* in water were added to the soil on the outside of each terminal plant and to a corresponding position in the controls. Soil cores, 2.5 cm diameter x 15 cm were collected at monthly intervals from alternate sides of each trough in the vicinity of 5 individual plants. After 7 months final soil cores (approx. 8 cm diameter x 13 cm) were collected. Nematodes were extracted by decanting in water on to 95 μm mesh nylon supports which were immediately placed in Baermann funnels for 12 hr. Virus infection of the plants was assessed by inoculating sap from the roots on to *Chenopodium quinoa* Willd. and *C. amaranticolor* Coste and Reyn test plants (Cadman and Harrison, 1960).

Vertical movement was studied using 40 cm soil columns inside 6.5 cm diameter plastic drainpipes cut in half longitudinally and held together by cellophane tape. A milk filter was wrapped around the base of each column which was inclined for inoculation of the nematodes through 1 cm diameter holes located at 5, 15, 25 and 35 cm from the surface. After inoculation the holes were sealed with cellophane tape. Single plants, similar to those used in the previous experiment, were planted at the top of each column; the controls contained soil and nematodes only. After 3 months' growth in the glasshouse the columns were placed in a horizontal position and immediately dismantled by removing one half of the drainpipe. Nematodes were extracted as before from 4 x 10 cm soil sections of each column and the plants were assayed for virus infectivity.

Results

In the horizontal plane *L. elongatus* migrated further and in greater numbers in the *F.* x *ananassa* and *L. multiflorum* treatments than in the *T. pratense* treatment, with hardly any migration detected in the controls (Table I). Maximum migration was 10 cm per month under *F.* x *ananassa* and *L. multiflorum* although the former grew poorly and had almost died out by the end of the experiment. Almost half of the initial inoculum of *L. elongatus* was recovered during the sampling period from the *F.* x *ananassa* soil; 12% from the *L. multiflorum* soil and 6% from the *T. pratense* soil. Few *L. elongatus* survived after the 7 month period of the experiment in the plant-free controls, indicating that the nematode requires relatively frequent access to a food source. At the end of the experiment tomato black ring virus (TBRV) was detected in the first plant of *L. multiflorum* and the first and second of *T. pratense*, raspberry ringspot virus (RRV) in the first *F.* x *ananassa*; virus infection of the plants was therefore not detected in all the plants reached by migrated nematodes.

In the smaller *X. diversicaudatum* inoculum most migration was 30 cm in 5 months on *L. multiflorum*. A bigger inoculum of *X. diversicaudatum* in another trough containing *L. multiflorum* revealed that a few individuals migrated 20 cm in one month. Virus was detected only in the second *T. pratense* which was infected with strawberry latent ringspot virus (SLRV).

Very few *D. dipsaci* migrated in relation to those found at the point of inoculation. However, total nematode recovery was only 1% of the original inoculum. Maximum migration detected was 10 cm per month but this was based on the finding of a single nematode in the *F.* x *ananassa* treatment one month after the start of the experiment. It is concluded that this rate of movement may not reflect the true migration of this species as a whole. After 7 months nematodes were found in the first plants of *A. sativa* and *F.* x *ananassa* and a single specimen in the second and fifth plants of the former. *D. dipsaci* would therefore appear to be a relatively sedentary soil inhabitant.

The rate of movement in the vertical plane was broadly similar to that horizontally (Fig. 1). The upward and downward migration of *L. elongatus* was most on *L. multiflorum* whereas in the controls it moved only downward at the same rate. The depth preference appears to be nearer 5 cm than 35 cm, most surviving at the former and least at the latter. The rate of *X. diversicaudatum* movement upward and

Table I - *Movement of* L. elongatus, X. diversicaudatum *and* D. dipsaci *in the horizontal plane in troughs of soil (nematodes introduced at plant station 1).*

Numbers of nematodes at plant stations (1-5)

Nematode	Months after inoculation	*Fragaria ananassa*					*Lolium multiflorum*					*Trifolium pratense*					Control				
		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Longidorus elongatus	1	9					4	5				5					15				
	2	8	5	1			4					6					3				
	3	4	1				4	4	7			3	4	2			1				
	4	3										1	1				4	1			
	5	3	0	0	5		7	5	1			2	4				15				
	6	2	2				1	0	2			0	4				1				
	7*	160	100	42	25	17	51	28	12	2		23	19	4			6	1			
Xiphinema diversicaudatum	1																2				
	2	1	1				1										1				
	3	1															2				
	4	1															0	2			
	5	2	1				1	0	0	2							1				
	6		1				1					0	2								
	7*	4	1	1			2	1				1	2	2							
							(*Avena sativa* only)														
Ditylenchus dipsaci	1	192	1				79										144				
	2	84					27										20				
	3	21					17	1									14				
	4	49	1				30										5				
	5	79					4	1									2				
	6	30					121	1									5				
	7*a	295	5	2	0	1	393	5	0	8							5				
	7 b	4					41	1	0	0	1										

a = soil; b = plant; * large cores taken.

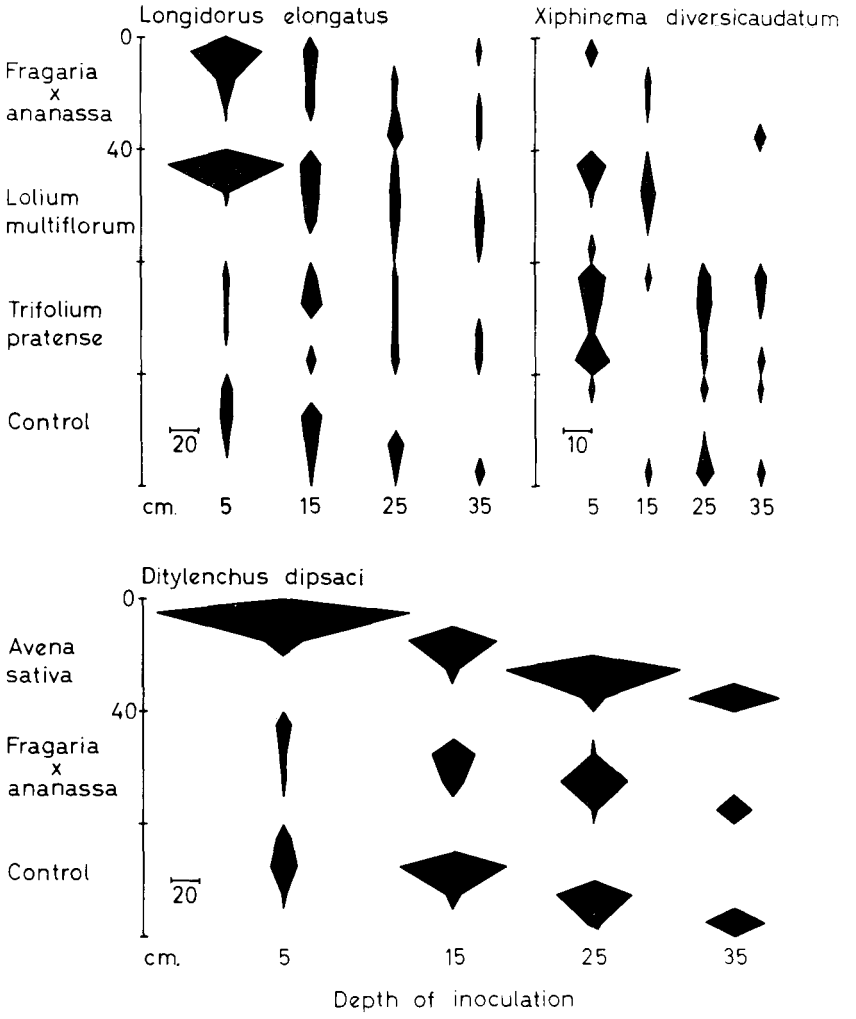

Fig. 1 - Vertical distribution of three nematode species inoculated at specific depths (see text).

downward was similar to that for *L. elongatus*. *D. dipsaci* moved at a rate of 7 cm per month but in all cases except one it was downward. In columns with *L. elongatus*, *L. multiflorum* was infected with TBRV and *T. pratense* with RRV and TBRV. No virus infection was detected in the plants in column with *X. diversicaudatum*.

The rate of horizontal movement (10 cm/month) of the Scottish

population of *X. diversicaudatum* contrasts with a rate of 1.4 mm per day observed by Fritzsche (1968) for a population of *X. diversicaudatum* from East Germany. The apparent difference in rates of movement may, however, be accounted for by differences in experimental procedure, in the host plants used (Fritzsche used *Petunia hybrida* Vilm), but possibly the two populations were distinct biologically. Brown and Taylor (1979) in an examination of 25 populations of *X. diversicaudatum* from several European countries, found significant morphometrical differences among many of the populations when compared with a Scottish population.

Discussion

The results of the experiments indicate the ability of the three nematode species to migrate in the vertical and horizontal planes through soil, with most movement occurring in soil containing favourable hosts. Little migration occurred in plant-free soils, which is in accord with the observation of Derrett (1979) who found that *Trichodorus viruliferus* Hooper moved horizontally in soil only 1 to 2 cm in the absence of plants. Derrett demonstrated that *T. viruliferus* move in an orientated manner to apple roots, but with the species used in my experiments it is not known to what extent the move was random or a response to root exudates or other plant attraction. It seems likely that a similar response to root emanations occurs with *L. elongatus, X. diversicaudatum* and *D. dipsaci.* The present experiments were conducted in relatively large volumes of soil in an attempt to simulate field conditions and, although root emanations might be expected to elicit a response by leaching in the vertical plane it would appear from the results obtained that a similar effect may be experienced in the horizontal plane. Furthermore, Rossner (1972) demonstrated that *Trichodorus* spp. and *Longidorus* sp. migrated vertically almost 2 cm per day to a depth of 160 cm after about twelve weeks in tubes of soil planted with barley (*Hordeum vulgare* L.); he suggested that during vegetative growth under natural conditions downward movements is less influenced by humidity and the root system than by other factors which may be dependent on temperature.

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SUMMARY

Longidorus elongatus (de Man) Thorne *et* Swanger and *Xiphinema diversicaudatum* (Micol.) Thorne moved through a sandy loam soil in the vertical and horizontal planes at rates of 7 and 10 cm per month, respectively. Very few *Ditylenchus dipsaci* (Kühn) Filipjev moved at similar rates.

RIASSUNTO

Movimenti di Longidorus elongatus, Xiphinema diversicaudatum *e* Ditylenchus dipsaci *nel terreno.*

Esemplari di *Longidorus elongatus* (de Man) Thorne *et* Swanger e di *Xiphinema diversicaudatum* (Micoletzky) Thorne hanno migrato verticalmente ed orizzontalmente in un terreno sciolto in misura di 7 e 10 cm al mese rispettivamente. Solo pochi individui di *Ditylenchus dipsaci* (Kühn) Filipjev si sono mossi in egual misura.

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