Influence of interspecific competition on the population dynamics of migratory plant-parasitic nematodes with r and K survival strategies

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SUMMARY

Samples taken over a five year period at a field site in which the dominant plant-parasitic nematode species were *Rotylenchus robustus, Trichodorus primitivus* and *Paratrichodorus pachydermus* indicated that the nematodes had K survival strategies. They had relatively low rates of multiplication and their numbers showed no obvious seasonal cycling. In soil where their numbers had been greatly reduced following treatment with the fumigant dichloropropene, numbers of a fourth species *Paratylenchus nanus,* initially present in small numbers, rapidly increased. This species had an r survival strategy, its numbers increasing rapidly in the absence of competition and also showing marked seasonal fluctuations. In non-fumigated soil *P. nanus* numbers remained low, probably due to interspecific competition, especially with *R. robustus.*

RÉSUMÉ

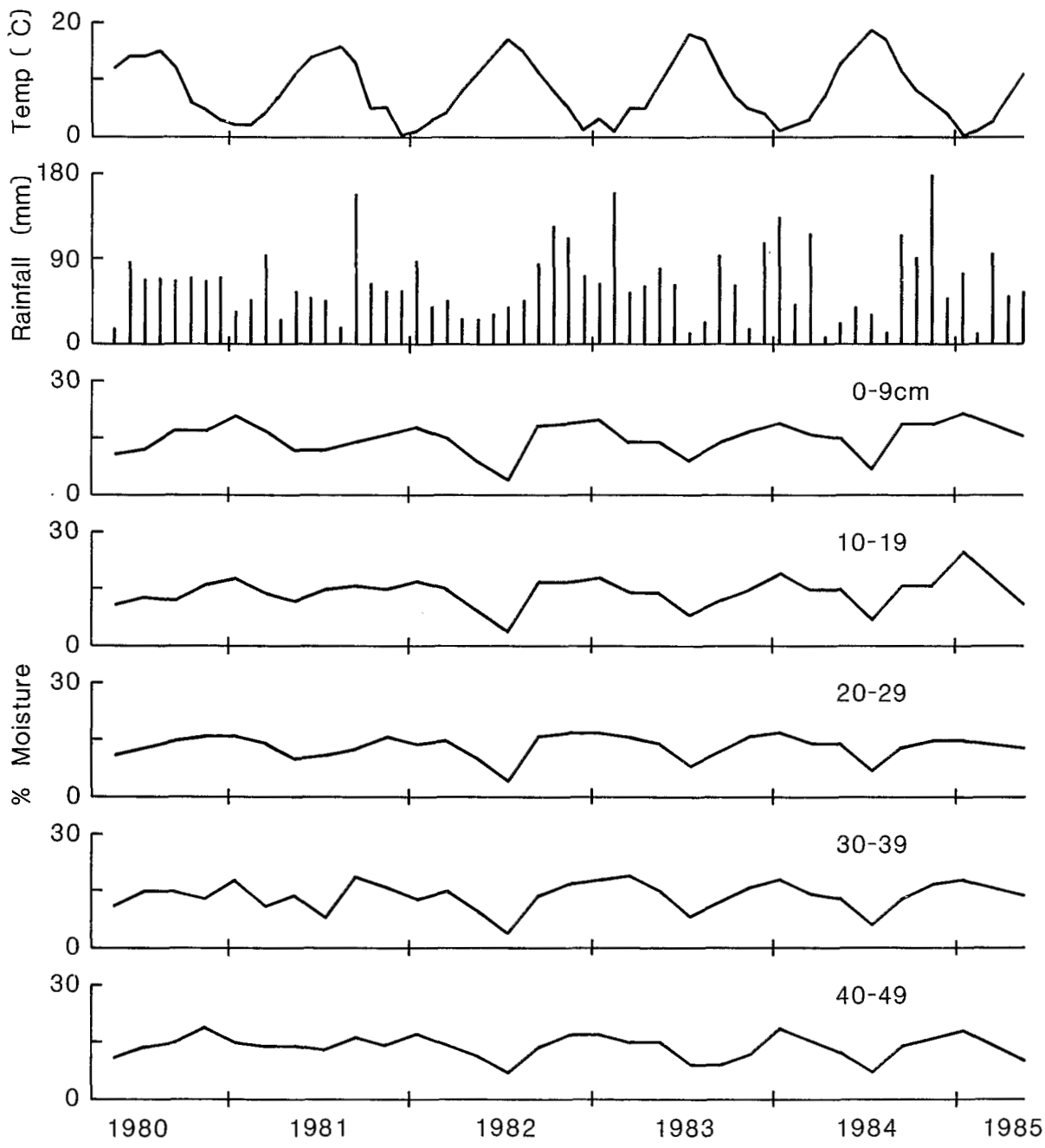

Fig. 1. Temperature and rainfall measurements from the Scottish Crop Research Institute, Invergowrie and percentage soil moisture content from samples taken under grass/clover sward at the forest nursery.

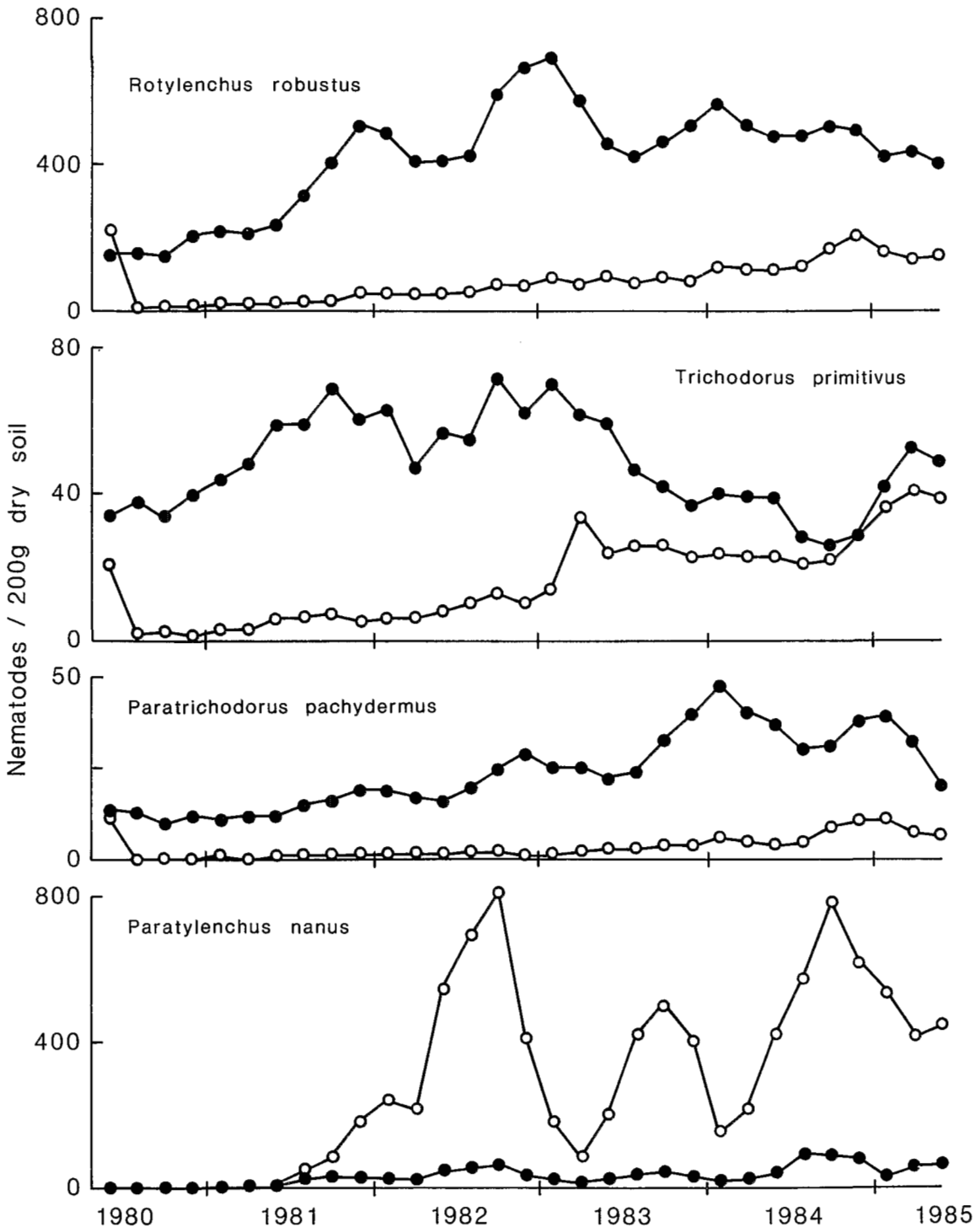

Fig. 2. Variation in mean nematode numbers (0,50 cm) May 1980 to May 1985, ○, fumigated; ●, non-fumigated.

killed, fixed, stored and counted as described by Boag (1974). Nematodes expressed as numbers per 200 g dry soil were transformed to (x + 1) for statistical analysis.

Observations showed that meteorological data periodically recorded at the nursery was very similar to that

Prior to fumigation in 1980 the most abundant plant-parasitic species were *R. robustus* (229/200 g soil), *T. primitivus* (31/200 g soil) and *Paratrichodorus pachydermus* (14/200 g soil). *Paratylenchus nanus* was ex-

A study of the depth distribution of the four species indicated that *T. primitivus* and *Paratrichodorus pachydermus* were generally found at greater depths than *R. robustus* and *Paratylenchus nanus* which were more abundant in the top 20 cm of soil (Tab. 2). The depth distribution of the two trichodorid species were significantly correlated ($r = 0.946$, D. F. = 3) and that between *R. robustus* and *P. nanus* was highly significant ($r = 0.979$, D. F. = 3).

Table 2

Depth distribution of *Rotylenchus robustus, Trichodorus primitivus, Paratrichodorus pachydermus* and *Paratylenchus nanus* [mean nematode numbers (May 1980-May 1985)/200 g dry soil]

Depth (cm)	R. robustus	T. primitivus	P. pachydermus	P. nanus
0-9	435 (35) *	36 (22)	16 (23)	321 (38)
10-19	384 (31)	42 (26)	18 (26)	316 (38)
20-29	226 (18)	42 (26)	19 (28)	138 (17)
30-39	126 (10)	26 (16)	10 (14)	37 (4)
40-49	79 (6)	17 (10)	6 (9)	25 (3)

* Figures in parenthesis refer to the percentage of the nematodes found at that depth.

Two nematophagous fungi, *Arthrobotrys oligospora* (Frss.), and *Monacrosporium hembicoides* (Drechsler)

(Rössner, 1971; Coursen, Rohde & Jenkins, 1958). Furthermore, studies using plants growing in agar (Rhoades & Linford, 1961; Klinkenberg, 1963; Boag, 1980) have shown that both these species feed in a similar manner ectoparasitically on the root epidermis and root hairs. Therefore, although it cannot be proved it seems probable that competition between the two species, occupying similar ecological niches, was the main factor preventing numbers of *P. nanus* increasing in the non-fumigated sub-plots. Once competition from *R. robustus* had been removed in the fumigated sub-plots *P. nanus* numbers increased rapidly. The density of *P. nanus* population in the fumigated plots was probably regulated by seasonal variation in the availability of food and by intraspecific competition.

This study also demonstrated the difference in survival strategies of the nematode species. Two types of survival strategies in animals have been described by Southwood (1981). K strategists tend to be large animals with slow multiplication rates and are not readily able to exploit changes in environmental conditions. In contrast r strategists are small animals with fast multiplication rates giving them the ability to rapidly colonise and exploit new favourable environments. *R. robustus, T. primitivus* and *Paratrichodorus pachydermus* had relatively low rates of multiplication, even when initial populations were small. Under Scottish conditions, the low rates of multiplication, relative stability in population infrastructures and lack of any marked seasonal

BIRD, G. W., BROOKS, O. L. & PERRY, C.E. (1974). Dynamics of concomitant field populations of *Hoplolaimus columbus* and *Meloidogyne incognita*. *J. Nematol.*, 6 : 190-194.

BOAG, B. (1974). Nematodes associated with forest and woodland trees in Scotland. *Ann. appl. Biol.*, 77 : 41-50.

BOAG, B. (1980). Observations of temperature on rates of feeding of the plant-parasitic nematodes *Rotylenchus robustus*, *Xiphinema diversicaudatum* and *Hemicycliophora conida*. *J. Nematol.*, 12 : 193-195.

BOAG, B. (1981). Observations on the population dynamics and vertical distribution of trichodorid nematodes in a Scottish forest nursery. *Ann. appl. Biol.*, 98 : 463-469.

BOAG, B. (1982). Observations on the population dynamics, life cycle and ecology of the plant-parasitic nematode *Rotylenchus robustus*. *Ann. appl. Biol.*, 100 : 157-165.

BOAG, B. (1986). The influence of host and intra-specific competition in controlling populations of the plant parasitic nematode *Rotylenchus robustus* (Nematoda : Hoplolaimidae). *Nematologica*, 31 (1985) : 344-351.

BUCZACKI, S. T. & WHITE, J. G. (1979). The value of soil sterilants for the control of clubroot on a field scale. *Pl. Path.*, 28 : 36-39.

JOHNSON, A. M. (1970). Pathogenicity and interaction of three nematode species and six Bermuda grasses. *J. Nematol.*, 2 : 36-41.

KLINKENBERG, C. H. (1963). Observations on the feeding habits of *Rotylenchus robustus*, *Pratylenchus crenatus*, *P. penetrans*, *Tylenchorhynchus dubius* and *Hemicyliophora similis*. *Nematologica*, 9 : 502-506.

KRAUS-SCHMIDT, H. & LEWIS, S. A. (1981). Dynamics of concomitant populations of *Hoplolaimus columbus*, *Scutellonema brachyurum* and *Meloidoygne incognita* on cotton. *J. Nematol.*, 13 : 41-48.

MILNE, A. (1984). Fluctuations and natural control of animal populations, as exemplified in the garden chafer *Phyllopertha horticola* (L.). *Proc. Roy. Soc. Edinburg*, 82 B : 145-199.

NICHOLSON, A. J. (1933). The balance of animal populations *J. Anim. Ecol.*, 2 : 132-178.

RHOADES, H. L. & LINFORD, M. B. (1961). A study of the parasitic habit of *Paratylenchus projectus* and *P. dianthus*. *Proc. helminth. Soc. Wash.*, 28 : 185-190.

RÖSSNER, J. (1971). Untersuchungen zur Entwicklung von *Rotylenchus robustus*. *Nematologica*, 17 : 255-261.

SEINHORST, J. W. (1965). The relationship between nematode