AGGREGATION OF PLANT PARASITIC NEMATODES AND TAYLOR’S POWER LAW

By
B. BOAG and P. B. TOPHAM
Scottish Crop Research Institute, Invergowrie, Dundee DD2 5DA

Taylor’s Power Law was used to determine the aggregation of several nematode species at a number of sites. The results showed that the amount of aggregation of Longidorus elongatus apparently differed according to the distance between sampling points and was probably influenced by soil type. The nematodes appeared to be nearly randomly distributed when judged by samples taken close together, while those taken increasingly further apart suggested an increasingly aggregated distribution until a b’ value of just over 2 was reached. Aggregation then tended to remain relatively constant. At one site significant differences were observed in the amount of aggregation exhibited by different nematode species.

Keywords: distribution, ecology, soil type, Longidorus elongatus.

Knowledge of the spatial distribution of nematodes is important in understanding their biology and in devising sampling programmes. Distribution patterns can be regular, random or aggregated but most plant parasitic nematodes have been shown to have an aggregated distribution, which has often accorded with a negative binomial distribution (Anscomb, 1950; Goodell & Ferris, 1980; Barker & Campbell, 1981 and Seinhorst, 1982). However, the negative binomial model has been shown to have severe ecological limitations (Taylor et al., 1979; Taylor, 1984). Taylor’s Power Law has been found to give a satisfactory quantitative measurement of nematode aggregation (Mathias, 1969; Merny & Dejardin, 1970; Caubel, 1972) and Perry (1983) used Taylor’s Power Law to characterise the spatial distribution of cyst nematodes. Many studies with Taylor’s Power Law have either used naturally discrete sampling units such as plants, leaves or root systems or have come from insect traps where the sampling method takes no account of possible spatial structure. The level of infestation with soil nematodes commonly varies over relatively short distances within a field and there are systematic effects of depth. Many recommended sampling techniques for nematodes involve bulking soil cores collected in various ways from the sampled area in order to reduce the variation due to spatial aggregation. The purpose of the present paper was to investigate the extent to which the b’ values produced by Taylor’s Power Law were species specific (Taylor, 1971) for plant-parasitic nematodes and to study the effects on this index of aggregation of distance between samples and soil type.
The results used for this paper were from experiments at four different sites. The basic sampling tool—unless otherwise stated—was a bulb planter which produced a 5 cm diameter x 10 cm long core of soil weighing just over 200 g. A sample consisted of 200 g from such a core. Experiments 1 and 2 were close to the Scottish Crop Research Institute, Experiment 3 was at a forest nursery site near Scone, Perthshire, Scotland and Experiment 4 was at a poplar plantation near Lakenheath, Suffolk, England. Experiments 1, 2 and 3 were on sandy loam soils (Boag, 1981; 1983) and Experiment 4 was on a peat soil. Nematodes were extracted from the 200 g soil samples by a modification of a sieving and decanting technique (Boag, 1974). Specimens were counted and identified after being heat killed at 60°C and fixed in T.A.F. (triethanolamine-alcohol-formalin). To ascertain the index of aggregation b' the log variance and log mean were calculated and the slope of the regression of log variance on log mean was estimated by least squares, method I (Perry, 1981). Means and variances were computed from pairs of samples, the samples being combined in different ways from a grid of sampled points to give a range of spatial separations. The b' values for any grid are therefore not independent of each other and those for the larger sampling distances were estimated from fewer pairs, the reduction in precision being reflected by the larger standard errors. The possibility of marked gradients in nematode frequency was investigated by pairing samples in both N-S and E-W directions. Experiment 1 was designed for the study, but Experiments 2, 3 and 4 represent sampling prior to the application of treatments for nematode control.

Experiment 1. (Tables I, II and III) A level area of permanent pasture, mainly Lolium perenne and Trifolium repens, was used for sampling. Three areas of different size (A = 50 cm sq, B = 5 m sq, C = 50 m sq) were intensively sampled. One hundred pairs of soil samples were taken on a regular 10 x 10 grid of plots from within each area. The samples from the 50 cm square were obtained by returning the entire block of soil (depth 20 cm) to the laboratory and cutting it into 5 x 5 cm sections which were halved diagonally, (the total amount of soil in each half being used as a sample). Two samples from the plots in the 50 m, 5 m and 50 cm areas were combined for analysis.

Experiment 2. (Table V) A level area (28 x 28 m) of a ploughed field which had previously been permanent pasture was split into 49 plots each 4 x 4 m. Soil samples were taken at random from each plot at two depths 10-19 cm and 20-29 cm.

Experiment 3. (Table VI) A level area which had previously grown 4 yr old Sitka spruce (Picea sitchensis) trees was split into 24 plots (2 x 3 m). Paired soil samples were taken from each plot.

Experiment 4. (Table IV) A level area 110 x 160 m of a poplar (Populus sp.) plantation was split into 192 plots 11 x 8.3 m. Single samples were collected at a depth of 10-19 cm from each plot.