

# Distribution and Population Dynamics of Nematodes in a Rice Field and Pasture in India

C. C. Mishra and M. C. Dash<sup>1</sup>

**Abstract:** Ecological studies on soil nematodes were made in a tropical rice field and pasture. Parasitic species were more diversified in the pasture than in the rice field. Eighty-six and sixty percent of total nematodes occurred in the top 10 cm in rice field and pasture, respectively. Nematodes were not randomly or uniformly dispersed but aggregated. Parasitic forms were most abundant and correlated with root biomass in the 0–15-cm soil layer, the greatest number usually occurring at the 10–15-cm depth at both sites. In summer, however, they were densest at the 15–30-cm depth. Microbivores were most frequent in the top 5 cm of both sites. Miscellaneous feeders (food sources uncertain) usually occurred in highest densities at the 15–30-cm depth. Predators showed no distinct depth preference. Temperature and moisture of the soil apparently played an important role in regulating nematode population. Peak densities of  $31.3 \times 10^4/\text{m}^2$  and  $21.6 \times 10^4/\text{m}^2$  at a 30-cm depth occurred in January, while minimum densities of  $5.0\text{--}5.3 \times 10^4/\text{m}^2$  and  $4.1 \times 10^4/\text{m}^2$  occurred in July–October and April in rice field and pasture, respectively. Monthly mean biomass of nematodes was  $23.8 \pm 4.5 \text{ mg}/\text{m}^2$  in rice field and  $11.5 \pm 1.5 \text{ mg}/\text{m}^2$  in pasture. **Key words:** ecology, *Hirschmaniella mucronata*, *Orientylus orientylis*, population dynamics.

Because of wide adaptability of nematodes to various habitats, nematodes constitute an important part of soil fauna in many types of soil. Despite considerable work in nematode ecology (1,2,6,8,9,10,11, 14,15,16,17), many aspects of nematode ecology remain to be studied, including information on nematodes in tropical soils.

The aim of this investigation was to study the diversity, distribution, population dynamics, and biomass of different trophic groups of soil nematodes in a tropical rice field and pasture.

## MATERIAL AND METHODS

The rice field and pasture were located on the Sambalpur University campus in Orissa, India. The soil varied from a sandy loam to a sandy clay loam. In the top 10 cm the rice soil contained 3.4% organic matter and the pasture soil 4.8%. Soil pH was 5.73 for rice and 6.26 for pasture. At each site, two study plots 400 m<sup>2</sup> in area and divided into 400 subplots, each 1 m<sup>2</sup> area, were selected for sampling.

Plots were sampled in the second and fourth weeks of every month. Seven random

soil samples, 100 cm<sup>2</sup> in area  $\times$  30 cm deep, were collected on each sampling date from each site. Each sample was segregated by depth into five subsamples: 0–5, 5–10, 10–15, 15–20, and 20–30 cm.

For extraction, 250 cm<sup>3</sup> of soil were processed by a combination of Cobb's decanting and sieving method (4) and the Baermann funnel technique (13). Samples remained on the funnel for 24 h. Only late juveniles stages and adults were counted. The nematodes obtained from each soil horizon were classified into four ecological feeding groups (trophic groups): 1) plant parasitic forms (PP), 2) microbivores (MR), 3) miscellaneous feeders comprising Dorylaimida of uncertain trophism (MS), and 4) predators (PR), mostly Mononchidae.

After counting, nematode suspensions were concentrated and fixed in either 1.5% formaldehyde or F.A. 4:10 and prepared for identification and measurement by a glycerol-ethanol method (13). Tylenchids were identified to species and most others to genus.

Total numbers of the various trophic groups/m<sup>2</sup> (30 cm deep) were calculated taking all the subsamples of each horizon into consideration. Calculation of biomass was done by the formula of Andrassy (10).

## RESULTS

**Species diversity:** Plant parasitic species were more diverse in the pasture than in the rice field (Table 1). *Hirschmaniella mucronata* Das was dominant under rice

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Table 1. Species diversity in the study sites.

Nematode trophic groups	Rice field	Pasture
Plant	<i>Hirschmaniella mucronate</i> (Das, 1960) Timm	<i>Orientylus orientylis</i> Jairajpuri and Siddiqi
parasitic forms	<i>Hoplolaimus seinhorsti</i> Luc <i>Tylenchus sensu lato</i> spp. <i>Dolichodorus heterocephalus</i> Cobb <i>Orientylus</i> spp.	<i>Hoplolaimus seinhorsti</i> Luc <i>Tylenchus sensu lato</i> spp. <i>Hemicyclophora penetrans</i> Thorne <i>Hemicriconemoides cocophillus</i> (Loos) Chitwood and Birchfield <i>Aphelenchus avenae</i> Bastian <i>Dolichodorus heterocephalus</i> Cobb <i>Orientylus</i> spp.
Microbivores	<i>Acrobeloides</i> spp.	<i>Acrobeloides</i> spp.
Miscellaneous feeders	<i>Alaimus</i> spp. <i>Proleptonchus</i> spp. <i>Dorylaimus</i> spp. <i>Nygolaimus</i> spp.	<i>Alaimus</i> spp. <i>Dorylaimoides</i> spp. <i>Nygolaimus</i> spp.
Predators	<i>Mononchus aquaticus</i> Coetzec <i>Mononchus dentatus</i> Cobb	<i>Miconchus</i> spp. <i>Mylonchulus dentatus</i> Jairajpuri <i>Mylonchulus mulveyi</i> Jairajpuri

and found in every sample of each horizon. Other plant parasitic species occurred occasionally. *Dolichodorus heterocephalus* Cobb was sometimes found in deeper soil layers in the rainy season.

Under pasture the plant parasitic species *Orientylus orientylis* Jairajpuri and Siddiqi was dominant, occurring in every sample at each soil depth. *Hemicriconemoides cocophillus* Chitwood and *Hemicyclophora penetrans* Thorne were never found in the 0–10-cm soil depth in the pasture. Other parasitic species were recorded occasionally.

Most microbivores were *Acrobeloides* spp. Among the miscellaneous feeders, four genera were identified in the rice field and three in the pasture. Among the predators, two species were found in the rice field and three in the pasture.

The index of similarity (12) between the sites was 0.518 for all taxa, but 0.615 for plant parasitic forms. Nematodes were clustered in the upper 10 cm of the soil profile with numbers dropping drastically with depth. In January about 86% of all nematodes under rice occurred at the 0–10-cm depth and about 14% at the 10–30-cm depth. Similarly, 60% of the total nematodes under pasture occurred in the top 10 cm and 40% at 10–30 cm (Figs. 1, 2). Nematodes were abundant in the upper 10 cm of

the soil profile regardless of season or site, and their population density decreased with soil depth (Fig. 3).

Cluster analysis (10) during periods of maximum and minimum population density at a 30-cm depth from various sampling plots indicated that they were aggregated rather than distributed uniformly or randomly (Fig. 4).

*Distribution of trophic groups:* In the rice field, plant parasitic forms were most abundant in the 0–15-cm layer, except in summer when their numbers were higher at the 15–30-cm depth. Microbivores were most abundant at the 0–5-cm depth, with fewer at 15 cm and below regardless of month. Miscellaneous feeders were most abundant at the 15–30-cm depth, showing a pattern of distribution which was the reverse of that of the plant parasitic forms. Predator population density was very low in comparison to other feeding groups regardless of month or soil depth.

In the pasture, plant parasitic forms, microbivores, and miscellaneous feeders showed a trend of distribution similar to that of rice field. However, in summer months miscellaneous feeders were most abundant in the upper 15 cm. Predator distribution showed no differences correlated with depth.

Peak densities of  $31.28 \times 10^4/m^2$  (rice

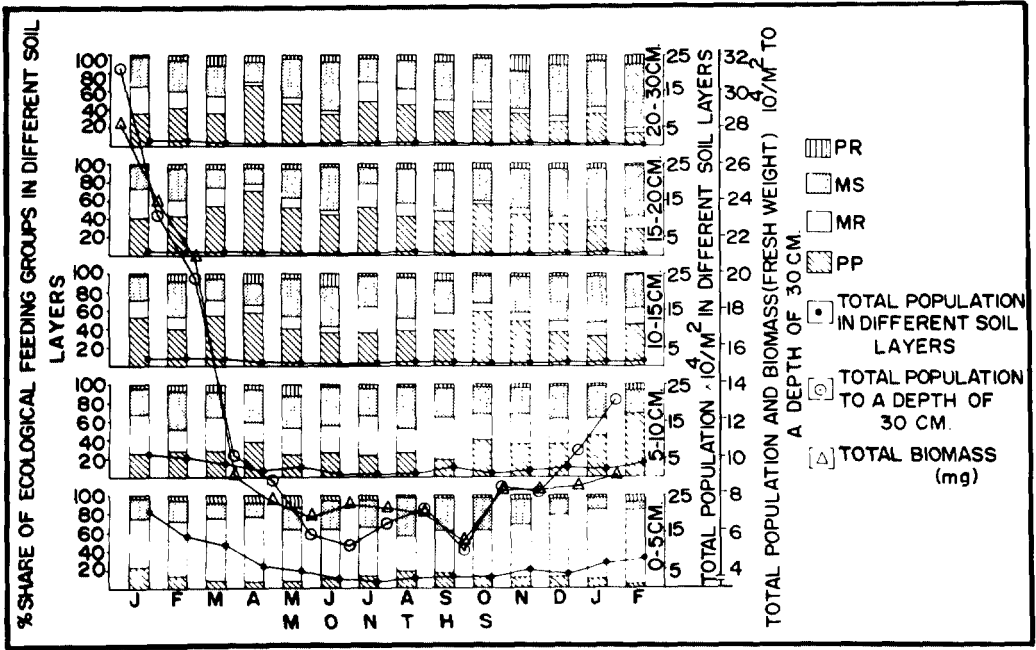


Fig. 1. Population dynamics, biomass, and percent share of ecological feeding groups of nematodes in different soil layers of the rice field.

field) and  $21.59 \times 10^4/m^2$  (pasture) were observed during January 78, and minimum densities of  $5.03-5.33 \times 10^4/m^2$  (rice field) and  $4.08 \times 10^4/m^2$  (pasture) were observed during July-October and April (Figs. 1, 2).

Nematode population density was much lower in January-February 1979 than in January-February 1978, possibly due to heavy rainfall and waterlogging (Fig. 5). However the population trends remained

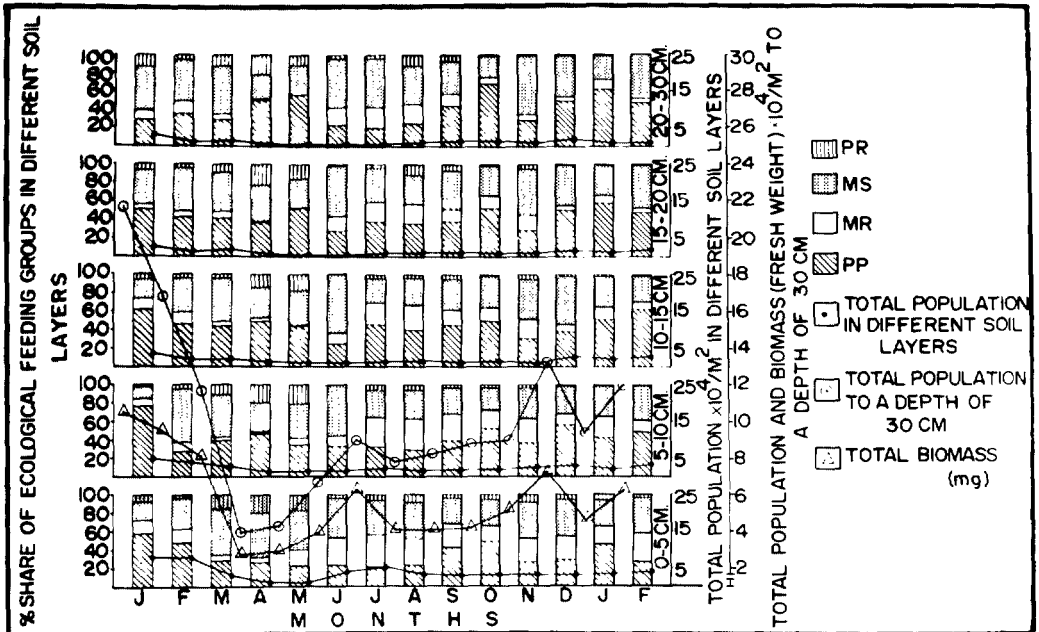


Fig. 2. Population dynamics, biomass, and percent share of ecological feeding groups of nematodes in different soil layers of the pasture.

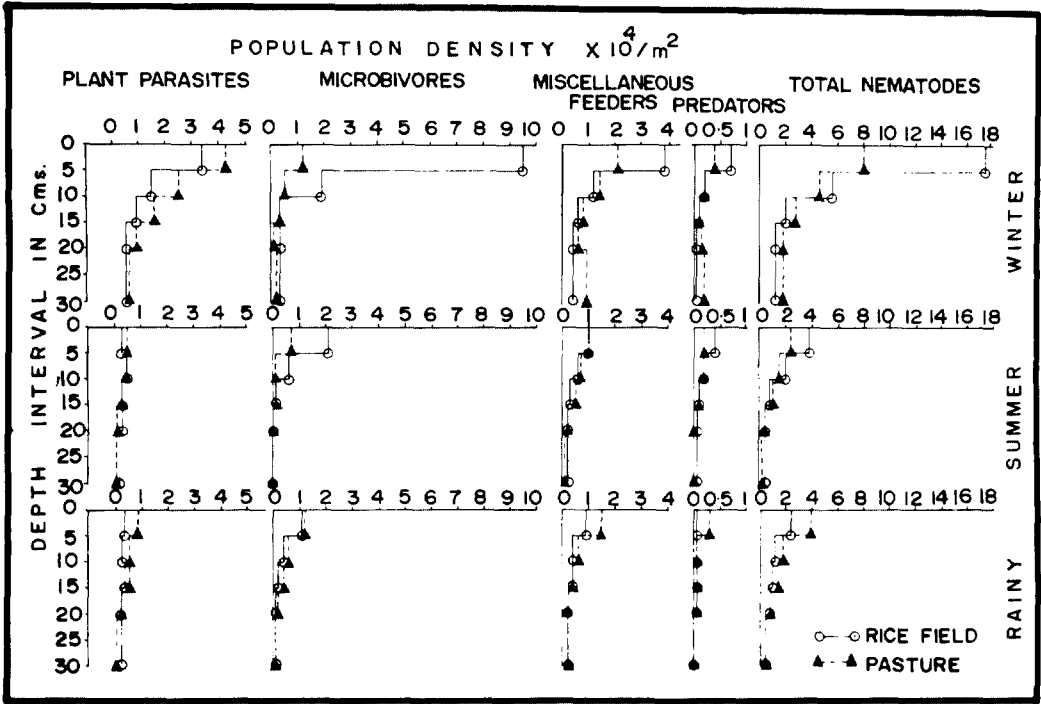


Fig. 3. Seasonal vertical distribution of trophic groups of nematodes and total nematodes in study sites.

the same in both the years. In the rice field, peak total population density was reached in winter and decreased through summer to

reach a minimum in the rainy season. In the pasture, the peak density also occurred in winter, but the minimum population den-

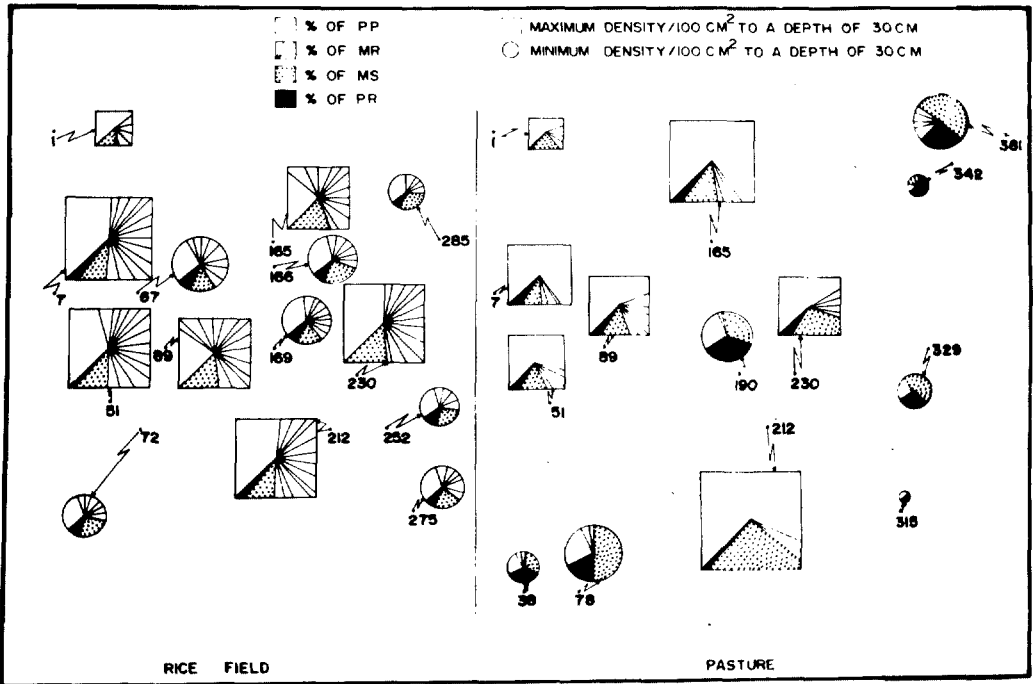


Fig. 4. Ordination of four trophic groups of nematodes during maximum and minimum population density period. Square and circle size depict relative abundance in study sites A) rice field and B) pasture.

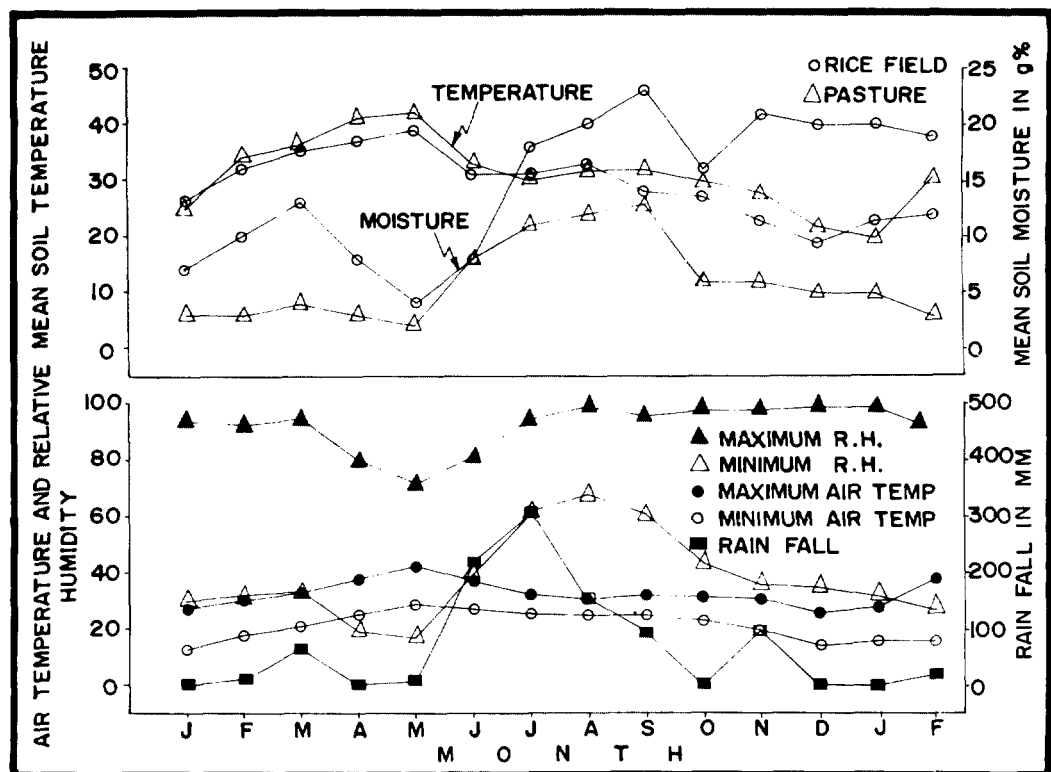


Fig. 5. Climatological data of the study sites.

sity occurred in summer instead of the rainy season.

**Biomass:** The average dry weight ( $\mu\text{g}$ ) for a plant parasitic, microbivore, miscellaneous feeder, and predator in the rice field was 0.23, 0.03, 0.41, and 0.29, respectively; in the pasture it was 0.06, 0.04, 0.19, and 0.23, respectively. The average individual nematode dry weight was 0.24  $\mu\text{g}$  for the rice field and 0.13  $\mu\text{g}$  for the pasture. The dry weight biomass was assumed to be 20% of the fresh weight (5). In the rice field, the biomass ranged from 11.14 to 56.44  $\text{mg}/\text{m}^2$  to a depth of 30 cm, with a monthly mean of  $23.8 \pm 4.46 \text{ mg}/\text{m}^2$ . In the pasture, the biomass value ranged from 5.53 to 20.97  $\text{mg}/\text{m}^2$  to a depth of 30 cm, with a monthly mean of  $11.48 \pm 1.49 \text{ mg}/\text{m}^2$ . Thus nematode biomass was generally higher under rice than the pasture (Figs. 1, 2).

## DISCUSSION

The pasture contained many types of grasses and shrubs, including short to medium-sized herbaceous plants such as

*Cynodon dactylon*, *Cyperus rotundus*, *Evolvulus* spp., *Eragrostis* spp., *Diospyros melanoxylon*, *Phoenix dactylifera*, and some unidentified graminaceous plants. The rice field contained mainly rice, with weeds and graminaceous plants occurring sparsely. The presence of a greater variety of host-plants accounts for the more diversified parasitic fauna in the pasture.

The most common spatial distribution of nematodes is aggregation. Distribution of plant parasitic forms in the upper 15 cm at both sites probably resulted from the distribution of roots on which they feed. Agricultural practices play a great role in the distribution of trophic groups of nematodes. The upper 15 cm of soil is better aerated by tillage, causing a more intensive development of microflora in the upper layer (3). Thus, microbivores thrived better in more shallow soil at both study sites. On the other hand, tillage could have a harmful effect on miscellaneous feeders because of their larger size and longer life cycle (6,7). This factor may have accounted for a higher proportion of microbivores and a lower

proportion of miscellaneous feeders in the rice field, and the reverse pattern in the undisturbed pasture.

The ratio, maximum population density/minimum population density, was 6 for the rice field and 5 for the pasture. This is of the same order of magnitude as similar ratios reported from other ecosystems (17).

Nematode population density under rice reached a peak during winter, was negatively correlated with soil temperature ( $r = -0.67$ ), and decreased continuously during the period when the rice field was ploughed. Rice was sown and rain commenced in June. Population density increased with rice growth, increased soil moisture, and decreased temperature (Fig. 5). The decline in the population density in October may have been caused by waterlogging. Thus there were two nematode population declines, one in July (caused by ploughing) and the other in October.

In the unploughed pasture soil, the peak population density was in winter. From January to June nematode population density was negatively correlated ( $r = 0.86$ ) with temperature, reaching a minimum in April. With the onset of rain, temperature decreased and moisture increased (Fig. 5), but there was no waterlogging. Thus nematode population density increased throughout the rainy period and winter, reaching a January peak.

The lower average biomass value in the pasture was due to lower population density and lower individual average dry weight. The present study shows greater individual dry weight for our study sites than in other ecosystems (17). Thus proportionately higher biomass value in relation to population size was observed.

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