# Nematode Bio-Test


Photo: Caro Kapp

## The use of nematodes as bio-indicators of soil health

Sheila Storey
www.nemlab.co.za

## INTRODUCTION

### NEMATODES AS BIO-INDICATORS OF SOIL HEALTH

A healthy soil is considered to be a stable soil, rich in biological diversity, with high levels of internal cycling of nutrients and with a resilience to stress factors. Nematodes are omnipresent in all soil environments that provide a supply of organic carbon. They occur in habitats that vary from highly polluted to unspoiled, in all types of soil and under any climatic condition. Soil nematodes occupy key positions in the detritus food web, and can be placed in at least five trophic (feeding) or functional groups. They feed on most soil organisms (fungi, bacteria, nematodes, mites, unicellular algae and lichen) and are also a food source for some of these organisms.


Photo: Caro Kapp

### Nematode Trophic Groups

| | | |
|---|---|---|
| **Unicellular feeders** | Unicellular eucaryote feeding: yeast, algae, lichen | |
| **Bacterivores** | Feed on bacteria: use hollow tube | |
| **Fungivores** | Feed on fungi: stylet punctures hyphae | |
| **Herbivores** | Feed on/in plant roots: use stylets | |
| **Omnivores** | Feed on more than one type of food source: org. material etc | |
| **Predators** | Feed on other nematodes: puncture with tooth | |
| **EPNs** | Feed on insects (and bacteria): no stylet | |

The majority of soil nematodes fulfill beneficial roles in ecosystem processes and are not parasites or pests. Nematode community structure and functions change in response to land-management practices such as nutrient enrichment through composting, mulching, fertilization (by organic or inorganic nitrogen), cultivation, liming, drainage, plant community composition and age, and toxic substances such as heavy metals and pesticides.

The beneficial nematodes play an important role in the soil food web by controlling nutrient mineralization and the degree of decomposition by regulating the behaviour of the microbial community. These nematodes play an important role in the soil food web by breaking down organic material into various minerals and organic nutrients.

The latter serve as a food source for fungi, bacteria, algae, protozoa and smaller organisms such as mites. The populations of these microbes and organisms increase and so in turn do the nematodes feeding on these organisms.

However, during this process nematodes absorb greater amounts of nutrients, particularly carbon and nitrogen, than they require. The remainder is excreted into the soil which is then available as a food source for the microbes and other organisms and plants. Nematodes are known to contribute between 19% and 30% of the total soluble nitrogen in the soil.

The nematodes range in their life strategies from explosive colonizers (opportunists) to persisters (conservative survivalists). The scale ranges from early colonizers of extreme enrichment (such as raw manure) to general opportunists (of new resources) to persisters (in undisturbed habitats). Persisters demonstrate a greater sensitivity to pollutants and other disturbances. These strategies and the trophic groups are used to determine various indices.

| Colonizer - cp1 | Persister - cp5 |
|---|---|
| • short life cycle<br>• small body size<br>• highly prolific<br>• mainly bacterivores<br>• feed continuously | • longer life cycle<br>• larger body size<br>• less prolific<br>• mostly carnivores & omnivores<br>• very sensitive to disturbances |

The Structure Index (horizontal axis) reflects the abundance of resources and where recovery from stress is occurring. The occurrence and profusion of organisms higher up within the trophic level indicates the trophic connectance of a system. Soil food webs become enriched (Enrichment Index) when a disturbance occurs by the addition of a resource. This is a measure of the presence of opportunistic bacterivore and fungivore nematodes. On the enrichment axis, functional guild indicators are weighted according to growth and metabolic rates or resource consumption, while the structure axis is weighted according to sensitivity to disturbance.

A graphic representation of the structural and enrichment condition of the soil food web, the so-called Nematode Faunalyzer (Figure 1), is based on the relative weighted abundance of the nematode feeding guilds. Indices derived from the nematode community structure provide an indication of the food web structure, enrichment, and decomposition rate.

Most annual plantings would be reflected on the left (Sector A & D) where continued disturbance (eg. ploughing) would prevent structure (and thus lower the Structural Index (SI)). Perennials would mostly be reflected on the right (Sector B & C) where minimal interference takes place (and would thus have a higher SI). Enrichment, e.g. composting, mulches or living mulches (weeds and cover crops), is reflected on the vertical axis.

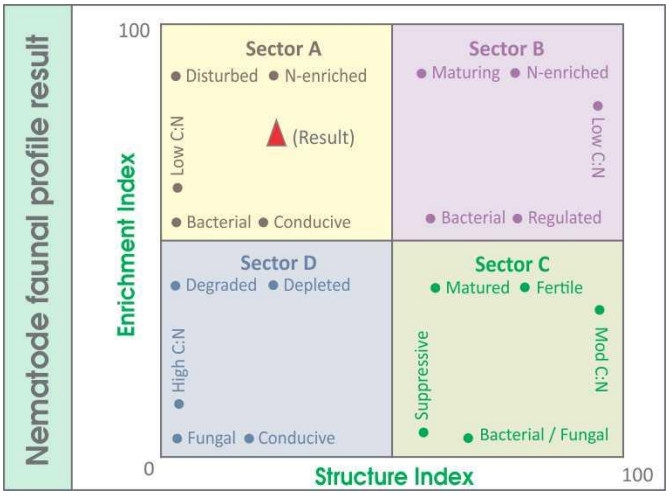


**FIGURE 1: Nematode Faunalizer**

The use of nematodes as bio-indicators of soil health cannot be a stand-alone measure, but forms an important part of an integrated system of measurements.

***Suggested literature to further enhance knowledge on this topic:***

Ferris, H., Bongers, T. and De Goede, R.G.M., 2001. A framework for soil food web diagnostics: extension of the nematode faunal analysis concept. *Applied Soil Ecology* 18:13-29.

Neher, D.A, 2001. Role of Nematodes in Soil Health and Their Use as Indicators. *Journal of Nematology* 33(4):161-168.

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Yeates, G.W., Bongers, T., De Goede, R.G.M., Freckman, D.W. and Georgieva, S.S., 1993. Feeding Habits in Soil Nematode Families and Genera – An Outline for Soil Ecologists. *Journal of Nematology* 25(3):315-331.