PLANT AND SOIL NEMATODES

NEMATODE COMMUNITY ANALYSIS: ONE OF THE BEST METHODS OF COMPARING THE BIOLOGICAL STATUS OF VARIOUS SOILS

An associated fact sheet (PSN 024) explains how the soil nematode community can be assessed in a relatively simple way to provide land managers with information on the biological status of a soil. This fact sheet provides details of more comprehensive analyses that can be used to compare the biology of soils in different environments or under different management practices.

Why compare the biological status of various soils?

Soils are a non-renewable resource and there is increasing concern that they are being degraded by the management practices used in modern agriculture. To gain an understanding of the impact of tillage, fertiliser inputs, pesticides, and other factors on the health of the soil, scientists will often compare different soil types, natural and agricultural soils, soils under different management practices, and soils in different environments. As the organisms present in soil play a critical role in keeping it healthy, the soil biology will be one of the parameters assessed. Nematodes are generally considered to be one of the best biological indicators, and details of how they can be evaluated are given below.

Procedure

If you are considering using nematode community analyses to compare the biological health of various soils, read the book chapter by Sanchez-Moreno and Ferris (2018) before commencing the study. It provides a comprehensive account of why nematode-based indicators are useful tools for unravelling the effects of different factors on plant and soil health, describes how nematode analyses should be undertaken, and explains how to interpret the results.

Nematode community analysis involves the following four steps.

- Collect representative soil samples from the sites of interest, whether they be experimental plots, an agricultural field, or an area of natural vegetation
- Extract the nematodes using a standard method, determine the total number of nematodes, and identify them to family or genus level
- Tabulate the data in an Excel sheet using a standardised format
- Upload the data sheet into NINJA (https://shiny.wur.nl/ninja/). The Nematode Joint Indicator Analysis system will calculate a range of indices and metabolic footprints that describe the overall condition of the soil food web and the magnitude of the ecosystem services provided by nematodes.

Details of how indices and footprints are calculated and interpreted are given by Sanchez-Moreno and Ferris (2018) and only a brief overview is given here.

- Several Maturity indices can be calculated and they show the condition of the soil food web along an ecological succession trajectory. When **Maturity Index (MI)** values are low, soil fertility will be high due to an enrichment event but food web structure is poor, the soil is physically and chemically perturbed, and there is high sensitivity to a pest outbreak. In contrast, high MI values indicate that the soil food web is mature, organic matter is decomposing slowly, and a pest outbreak is unlikely.
- Four soil food web indices describe the overall condition of the soil food web, particularly with regard to two important ecological services provided by soil organisms: nutrient mineralisation and pest suppression.
    - The **Enrichment Index (EI)** and the **Channel Index (CI)** are indicators of organic matter decomposition and nutrient mineralisation mediated by bacteria (high EI values) or fungi (high CI values).

- The **Structure Index (SI)** and **Basal Index (BI)** are indicators of soil food web complexity. When SI is high and BI is low, the soil has the potential to regulate populations of invasive species due to the presence of high numbers and a diverse range of omnivores and predators.

EI and SI as indicators of the condition of the soil food web

When the EI and SI values for a particular sample are placed on a graph, they will fall into one of four quadrants, with their position indicating the condition of the soil food web (Fig. 1). The results of a study in which the nematode communities a vineyard and adjacent oak woodland in California were compared show the value of this interpretation scheme. The high EI values and low SI values in the vineyard indicate that fertility is high but the biology shows signs of disturbance. In contrast, the much higher SI values in the woodland indicate a mature ecosystem with higher suppressiveness to opportunistic or invasive species.

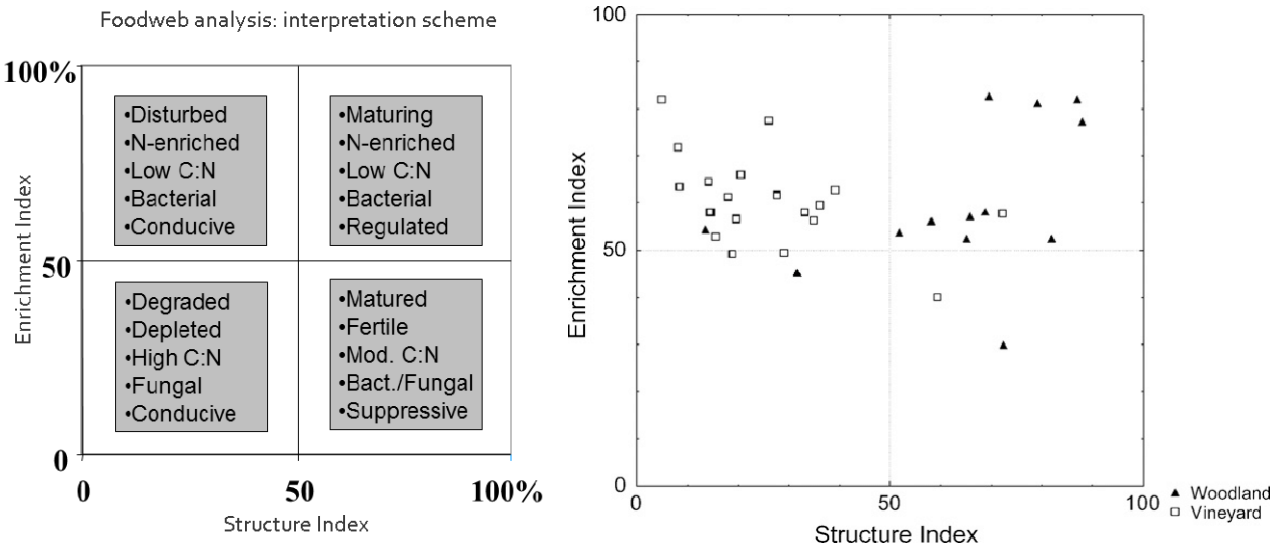

Fig. 1. A pictorial summary of the impact of EI and SI on soil food web condition (left), and results showing that the soil food webs in a vineyard and adjacent oak woodland in California are quite different (right). From Sanchez-Moreno and Ferris (2018).

Metabolic footprints

The diversity indices discussed above provide useful information. However, the magnitude of the functions and services provided by various functional guilds also depends on the biomass and physiological activity of the nematodes. Consequently, NINJA will also calculate metabolic footprints, as they better reflect the magnitude of the ecosystem services provided by the nematode community.

Literature cited and further reading

Sanchez-Moreno S, Ferris H (2018) Nematode ecology and soil health. In Sikora RA, Coyne D, Hallmann J, Timper P (eds.) *Plant-parasitic nematodes in subtropical; and tropical agriculture*. CAB International, Wallingford. Chapter 3, pp. 62-86.

Du Preez G, Daneel M, De Goede R et al. (2022) Nematode-based indices in soil ecology: Application, utility and future directions. *Soil Biology and Biochemistry* 169:108640 doi:10.1016/j.soilbio.2022.108640

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