Nematodes

Nematodes or eel worms are small, non-segmented worms. They are only 50 microns in diameter and about 1mm long or less. They have a resistant cuticle (skin) and an ability to adapt well to environmental change which has enabled them to become the most abundant multicellular animals on earth. Most nematode species have a beneficial role in the soil, but we tend to know more about the pest species because of their impact on agricultural production.

Nematodes live mainly in soil where they feed on fungi, bacteria and other soil organisms and in some cases plant roots.

Types of nematodes

There are three functional groups of nematodes:

Saprophytic nematodes

Saprophytic nematodes are also known as decomposers because they break down organic matter in the soil, release nutrients for plant use, and improve soil structure, water holding capacity and drainage. They are usually the most abundant type of nematode in the soil.

Predaceous nematodes

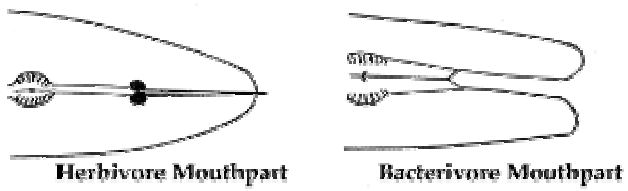
These nematodes feed on other nematodes, so can be useful in controlling pest species. They eat larger nematodes by attaching themselves to their cuticle and scraping away until the prey's internal body parts can be extracted. They also eat bacteria, fungi, and small single celled organisms (protozoa). The digested pests are then added to the soil organic matter reserves. Some have become specialised predators of insects, known as entomopathogenic nematodes

Parasitic nematodes

Parasitic nematodes cause problems in agricultural production because they feed on plant roots and slow plant growth. In some cases they also allow the entry of fungal rots that destroy the roots. Agricultural cultivation tends to encourage an increase in parasitic nematodes over other species

Mouthparts

Nematodes are described by their different feeding type or mouthparts. Bacterial feeding nematodes have a tube like structure to suck up bacteria. Fungal feeding nematodes have a piercing needle (stylet) which penetrates fungal cells and enables the nematode to suck up cell contents. Root feeding nematodes also have a stylet to pierce root cells. Predators feed on other nematodes and small soil organisms.



A herbivore nematode's mouthpart has a stylet for puncturing plant cells. The bacterivore nematode uses a hollow tube to suck up bacteria. Source: http://creatures.ifas.ufl.edu/nematode/soil_nematode.htm

What do nematodes do in the soil?

Nematodes are thought to play three main roles in the soil.

Nutrient cycling

Nutrients such as ammonium (NH_4^+), stored in the bodies of bacteria and fungi, are released when nematodes eat them. The bacteria and fungi contain more nitrogen than the nematodes need so the excess is released into the soil in a more stable form where it can be used by plants or other soil organisms. Nematodes also physically break down organic matter which increases its surface area, making it easier for other organisms to break it down further.

Dispersal of microbes

Bacteria and fungi cannot move around in the soil without 'hitching a ride' inside or on the back of nematodes. Nematodes are parasitised by some bacteria and fungi, which helps their dispersal through the soil.

Disease and pest control

Beneficial nematodes attack and kill a range of pests such as borers, grubs, thrips and beetles with negligible effects on non-target species. The life cycle of beneficial nematodes includes four juvenile stages plus adult and egg. It is during one of these

juvenile stages that the nematode is able to live freely in the soil and find a host to infect.

Beneficial nematodes use two strategies to find their prey. Some species wait for their prey to move past them in the soil and locate them by direct contact: this is called 'ambushing'. The ambushers function at the soil surface where they attack highly mobile pests such as cutworms. Others actively search out their prey using a 'cruising' strategy. They function at various depths in the soil and prey on slow moving targets such as grubs and weevil larvae.

When the nematode catches its prey, it penetrates the prey's body through a body cavity; one nematode genus even has a special hook to break in through soft cuticle. Once inside the body, the nematode releases bacteria from its gut. Each nematode species hosts a different bacteria species. Within 24-48 hours the bacteria cause the death of the prey. However the nematode will continue to feed on the multiplying bacteria while maturing and producing a new generation of nematodes. The life cycle of most nematodes is between 3-7 days so several cycles may be completed before a new host is needed. Once the prey has been consumed the nematode leaves to search for new prey.

Where are nematodes found?

As with most of the organisms that live in the soil nematodes are found in the top few centimetres of the soil. They live in the thin films of water surrounding soil particles, as they require water to move. They are generally found in well-structured soils with large pore spaces, or coarser soils, where food is easily available

Management effects on nematodes

To ensure nematodes remain in the earth, the soil environment must be kept as hospitable as possible. This means there must be enough food (organic matter), suitable hosts, water, and minimal disturbance of the soil. The use of pesticides that enter the soil can also affect nematode numbers in the soil. There may well be direct detrimental effects from some pesticides such as nematicides while other agricultural chemicals produce non-target effects that damage nematode populations. The loss of a specific host species from the soil when species-specific soil applied pesticides are used can also reduce food sources and thus nematode numbers.

Nematodes as indicators

Analysis of the diversity and complexity of nematode communities in the soil is a valuable tool which indicates soil biological fertility, or soil health. The different ratios of bacterial, fungal feeders and other types indicate the type of soil functions are occurring. Varying ratios can indicate if the food web is disturbed, maturing, structured or degraded.

More information

Soil biology basics is an information series describing basic concepts in soil biology. For more detailed information we recommend the Australian book *Soil biological fertility:A key to sustainable land use in agriculture* (2003), edited by Lyn Abbott & Daniel Murphy.

NSWDPI has online soil biology information at http://www.agric.nsw.gov.au/reader/soil-biology.

The University of WA has online soil biology information at http://ice.agric.uwa.edu.au/soils/soilhealth.

Also see

- University of Nebraska-Lincoln website: Plant and parasitic nematodes at http://nematode.unl.edu.

Written by Abigail Jenkins