Soil sentinels

Legions of near-invisible worms report on life underground, says Aidan Keith.

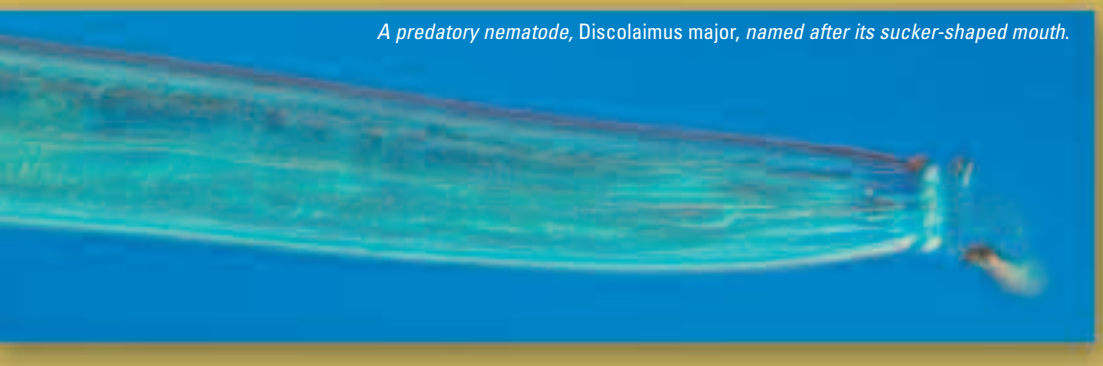
Aporcelaimus *spp, a predatory nematode containing eggs.*

Both photos: Lisa Stocking

Few people outside biology know of nematodes, and even those that do may not have seen them. They are practically invisible to the naked eye, generally between 0.4–1mm long and transparent, yet they are the most numerous multi-cellular organisms beneath our feet.

Strictly speaking, soil nematodes are aquatic creatures, as they inhabit water films and humid pores—they have to avoid drying out. They help regulate soil processes such as decomposition and nutrient cycling because they feed on plants and microbes, yet, because they're so tiny, they make up only a small proportion of the total weight of soil organisms.

Nematodes thrive in almost all habitats. In a typical grassland or deciduous forest, every square metre of soil could contain over two million. They even inhabit deserts and the dry valleys of Antarctica. Their huge numbers and widespread distribution encouraged an early 20th century researcher to speculate that, 'If all the matter in the universe except the nematodes were swept away, our world would still be dimly recognisable…' (Although that might be pushing it a bit!)



A predatory nematode, Discolaimus major, *named after its sucker-shaped mouth.*

At the Centre for Ecology & Hydrology (CEH), we've been observing nematodes through high-powered microscopes. That typical square metre of grassland or deciduous forest soil may host 100 different species. Researchers have identified around 12,000 species of free-living nematodes worldwide, but this may be only 5 per cent of the true number.

Nematodes have feeding structures that are adapted to suit their diet—so they can be classified according to their feeding preferences. Root-feeding nematodes have a protractible needle-like feeding tube called a stylet that they use to pierce root cells and suck out the contents. Other plant parasitic nematodes actually penetrate (and complete their lifecycle within) the hosts' roots. Nematodes that eat fungi usually have similar, but more delicate, apparatus to feed on hyphae (the root-like structures of fungi), whereas those that eat bacteria have a relatively simple tubular mouthpart, like a straw, to draw in a flow of microbial 'soup'. Predatory nematodes can look rather fearsome under the high-powered microscope, with large mouth cavities, and different shapes of teeth, depending on the species. They have dinosaur-like names to match as well, like *Anatonchus* and *Mylonchulus*. Their teeth puncture and shred the cuticle of other nematodes and invertebrates, which are sucked into the mouth cavity. Frequently, the prey is simply swallowed whole, and it is often possible to identify prey species within the intestine of the predator. Cannibalism is shockingly common.

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The huge number of different species makes nematodes very suitable for investigating what controls soil biodiversity. Soil nematodes respond quickly to environmental changes such as organic inputs, and the physical and chemical properties of soil. So nematode community composition can be a particularly useful environmental indicator and can reflect changes in vegetation or land-use.

At CEH, we've been collaborating with the Macaulay Institute to research what happens to biodiversity when birch and pine colonise moorland. We particularly wanted to study the links between above- and below-ground biodiversity during colonisation, and how biodiversity controls ecosystem processes. So far it seems nematode diversity increases with plant diversity, and experiments are running to help us understand why.

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