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Our environment, our future

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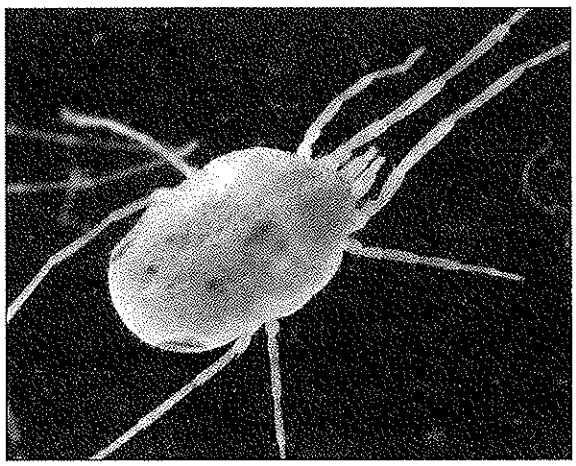
SOIL MITES

Adrianne Kinnear

What kinds of animals live in the soil?

Most of us, if asked this question, have no trouble identifying one or two soil animals – earthworms, ants or termites are common examples. In fact, our soil and the 'tablecloth' of leaf litter covering it, contains some of the most abundant and diverse animal communities in our terrestrial ecosystems! Even many biologists are unaware of this biodiversity and for this reason the soil has been referred to as the 'last biological frontier'. Below-ground and out of sight, complete communities of herbivores, predators and scavengers interact with the fungi and bacteria to process the world's organic matter, recycle essential nutrients and keep ecosystems functioning. In between the macro-earthworms and the micro-bacteria is a huge array of animals we rarely hear about or even more rarely see. Commonly grouped together as the mesofauna ('middle-sized'), these animals measure between 2 and 10 mm in size. Within the mesofauna, the free-living mites make up between 50 – 95% of the animals, and are the most diverse soil animals, both in morphology and ecology. A small core of rich, moist forest soil the diameter of your fist may contain 50 – 100 species!



A large, ground-running predator.

A collection of beetle mites, which are grazers.

The mites are tiny 8-legged relatives of spiders and scorpions and can occur in very large numbers in soil, ranging from several thousands per square meter in the arid soils such as in the Eastern Goldfields, to many tens of thousands in the tropical soils of northern Australia. Not only are they very numerous, but they display an amazing variety of feeding habits – fast-running predators, ambush predators, slow-moving fungal and baterial (microbial) grazers, piercing plant feeders and litter chewers. All these feeding types are represented in the soil and litter mite fauna. Their morphology is even more diverse with armoured beetle mites that become unpalatable balls of chitin to a fossiking predator, large litter mites covered with fringes of long red setae, tiny pink-coloured mites that can 'flash' their erect feathered setae, fierce ambush predators with strong pincer-spiked arms for mouthparts and perhaps most odd of all, mites with tiny skyscrapers of jewel-like columnar crystals covering their bodies and legs (we think this might be a possible adaption to arid climates).

For many decades, even in countries where the mite fauna was well-known, it was considered to contribute very little, if at all, to the decomposition of organic matter and the recycling of nutrients back to plant roots. There were

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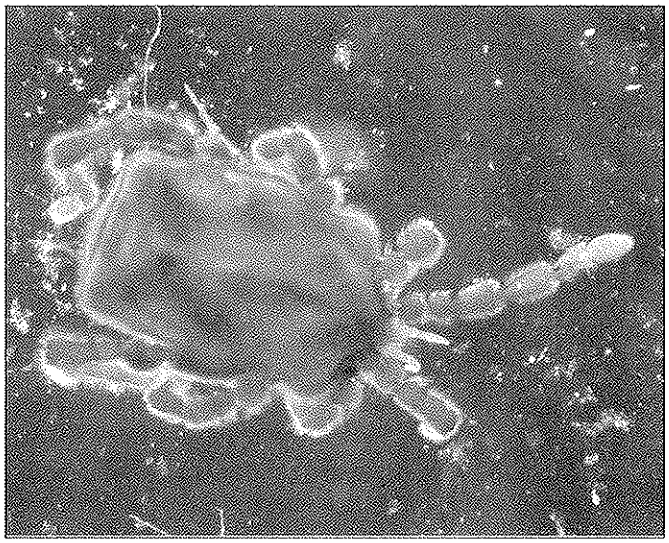
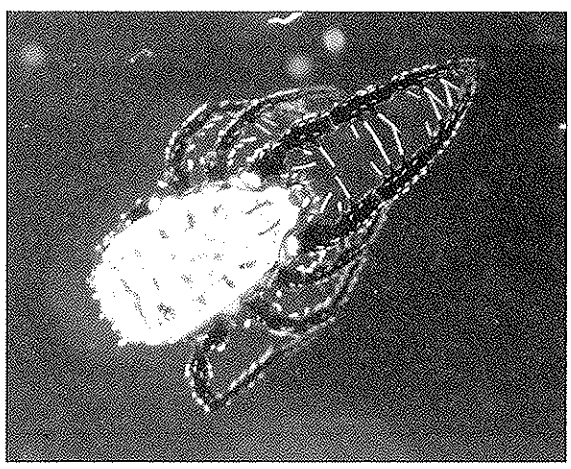
Soil mites



Another oddly-shaped ground-running predator

two main reasons for this. Firstly, the mites do not possess the chemical factories (the enzymes such as cellulases and lignases) that enable the bacteria and fungi to break down the leaf litter into its component raw nutrients so they can be reused. So how could they play any significant role in decomposition? Secondly, compared with the bacteria and fungi, the soil mites contribute very little to the actual weight of organisms in the soil. There is so much more bacteria and fungi that they far outweigh the larger fauna. So the larger fauna were considered unimportant. But these ideas were turned on their head in the latter half of last century when experiments demonstrated that, if mites and the other mesofauna (including the springtails) were excluded from samples of decomposing leaves, the leaves were much slower to decompose. In dryer climates, this slowing down of decomposition without the mite fauna can be as much as 30 – 40%.

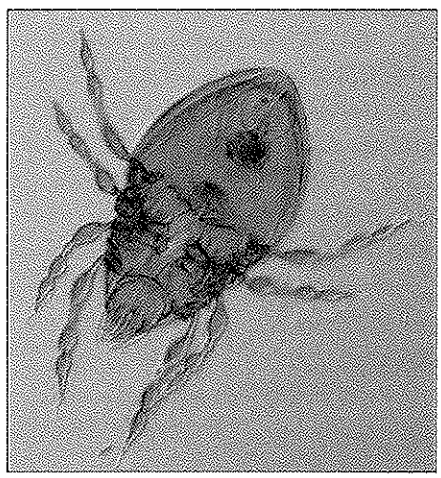


A rather spectacular ambush predator

So, if this tiny fauna cannot actually decompose the plant litter, what does it do?

We now know that the mites contribute to the breakdown of plant remains in indirect, but very important ways:

• As they graze on the colonies of bacteria and fungi covering the surfaces of the dead leaves, they fragment this leaf litter and repackage it into tiny, spherical fecal pellets mixed with the gut mucus and other digestive secretions. These pellets aid soil structure and are ideal food sources for the bacteria and fungi which colonise them. In fact, the presence of these fecal pellets is thought to activate inactive ('sleeping') microbial species, an interaction known as the 'sleeping beauty effect'! All of this accelerates the decay of the dead plant matter and is the most important way in which the soil mites influence decomposition rates.



A very tiny fungivorous mite

• The feeding effects of some mites can indirectly affect the composition and abundance of the bacterial and fungal communities. For example, by feeding on roundworm communities that feed on the bacteria, predatory mites can cause increases in bacteria which, in turn can affect nitrogen cycling in the soil.

• The mites act as miniature transport vehicles, travelling along the air channels between the large soil pores carrying fungal spores and bacterial cells on their bodies, and moving them through the litter layers and the soil profiles.

Long-term studies of different soil practices have demonstrated that over time, if the soil faunal diversity is reduced, important soil properties are affected detrimentally. These include soil structure, organic matter content and nitrogen storage and cycling. There is little doubt now that maintaining and enhancing the soil biodiversity generally is an important aspect of soil conservation.

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FAUNA

Soil mites

How can we best maintain and enhance soil mite diversity?

The soil mites are dependant on a soil structure which maintains their living spaces - the air-filled macropores, and a diverse array of energy and microbial sources dependant on organic inputs. Land use strategies that rebuild and restore soil structure and increase organic matter will accelerate the restoration of diverse soil communities with positive feedback on soil profiles, decay rates and nutrient retention. Where revegetation or rehabilitation of vegetated refuges are planned, a focus on litter management (something not often considered) can influence the development of local mite diversity. The development of an appropriate mixed-species litter cover (with natural barriers, if necessary, to prevent its removal by wind and water) is one of the most important management outcomes for restoring the above ground mesofaunal diversity and abundance, which in turn feeds the soil biodiversity. Litter islands which develop in vegetated landscapes, and the soil beneath them, are important hotspots of mite diversity, soil development and nutrient return. Just like we manage the larger landscape, so the micro-landscape of litter deserves our attention. From a mite's point of view, it is just a matter of scale!

Woodlands that have been grazed for many years (like this salmon gum/gimlet example at Perenjori) often have a very poor litter layer. This is due to the disturbance and trampling by stock, combined with wind and water erosion. Building up the litter layer will increase soil health, and so the health of the entire remnant.

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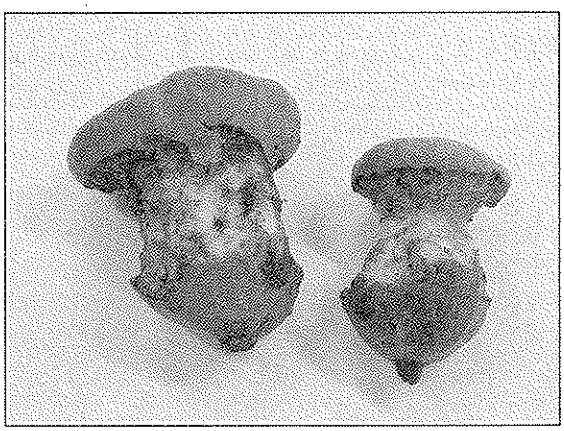
WHO ATE THESE HONKEY NUTS?

Bush Detective

Marri, *Corymbia (Eucalyptus) calophylla*, is a vitally important food tree for many different species of native fauna. The flowers are especially valuable as a food source through autumn, as are the fruits (honkey nuts) and the seeds they contain.



The softish outside flesh of these immature nuts has been chewed away in neat little bites, while the interior, with unripe seeds, has not been touched - rather like someone eating around an apple core. Western Wildlife has illustrated the characteristic signs of feeding on honkey nuts by twenty-eight parrots, red-capped parrots and Baudin's black cockatoos (WW 1/1) as well as by long-billed corellas and red-tailed black cockatoos in WW 1/4.

Given that this is none of the above - who ate these nuts?

They have been eaten by a brush-tailed possum. Thank you to Trish Gardner for this puzzle.