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doi:10.1016/j.tree.2008.06.014 Available online 25 September 2008

Research Focus

Testate amoebae and nutrient cycling: peering into the black box of soil ecology

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In some areas of ecology and evolution, such as the behavioural ecology of many well-studied bird species, it is increasingly difficult to make surprising new discoveries. However, this is not the case in many areas of soil and/or microbial ecology. Two recent studies suggest that the testate amoebae, a microbial group unfamiliar to most biologists, might play a much larger role in soil nutrient cycling than has hitherto been suspected.

The importance of soil

The soil is largely 'out of sight' to an ecologist without a spade and, for much of the 20th century, this meant that it was also 'out of mind' to most ecologists. At best, it tended to be treated as a black box, with the behaviour of its inhabitants lumped together under simple labels such as decomposers or nitrogen fixers [1]. Slowly, things are changing: indeed, it has been noticeable that since I started attending major ecology meetings (in the mid-1980 s), the number of papers and sessions on topics such as soil ecology or mycorrhizae has been increasing. One reason for this increase in interest might be the realisation that studying changes in soil respiration is crucial to predicting the future of the soil as a carbon sink [2]. This could be vital for understanding the effects of global warming.

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The silica cycle

When ecology textbooks describe soil microbiology, it is often in the context of nutrient cycling. One of the cycles

Box 1. Testate amoebae

Testate amoebae (also known as testate rhizopods or thecamoebians) are protozoa in which the single cell is enclosed within a shell usually referred to as a test, with a size range of 5–300 μm [11]. The tests are usually composed of either self-secreted material – which can be siliceous or proteinaceous – or 'agglutinated' tests, which incorporate material from the environment (such as sand grains, diatoms or the scales of smaller siliceous testates which have been consumed as prey) [12].

Like many microbes, testate amoebae have a relatively modest fossil record – for example, occasionally being preserved in amber. However, recently fossils very similar to modern testates have been described from rocks of around 740 million years old [13]. Although polyphyletic (traditionally placed in the phylum Rhizopoda), testates appear to form a reasonably uniform ecological grouping, occurring around the world in a range of terrestrial and freshwater habitats. They are especially common in habitats with high organic matter content, such as organic-rich soils, peats and mosses [12]. Many, but not all, of the identified morphospecies are cosmopolitan in their distribution [14,15].

The presence of tests means that taxa of testate amoebae can be identified by morphology and their populations can be enumerated by direct counting. Testate amoebae thus represent a microbial group whose ecology can be studied by approaches very similar to those used in the study of macroscopic organisms. There is also a long history of studies of testate amoebae autecology, dating back to 19th century microscopists (Figure I).

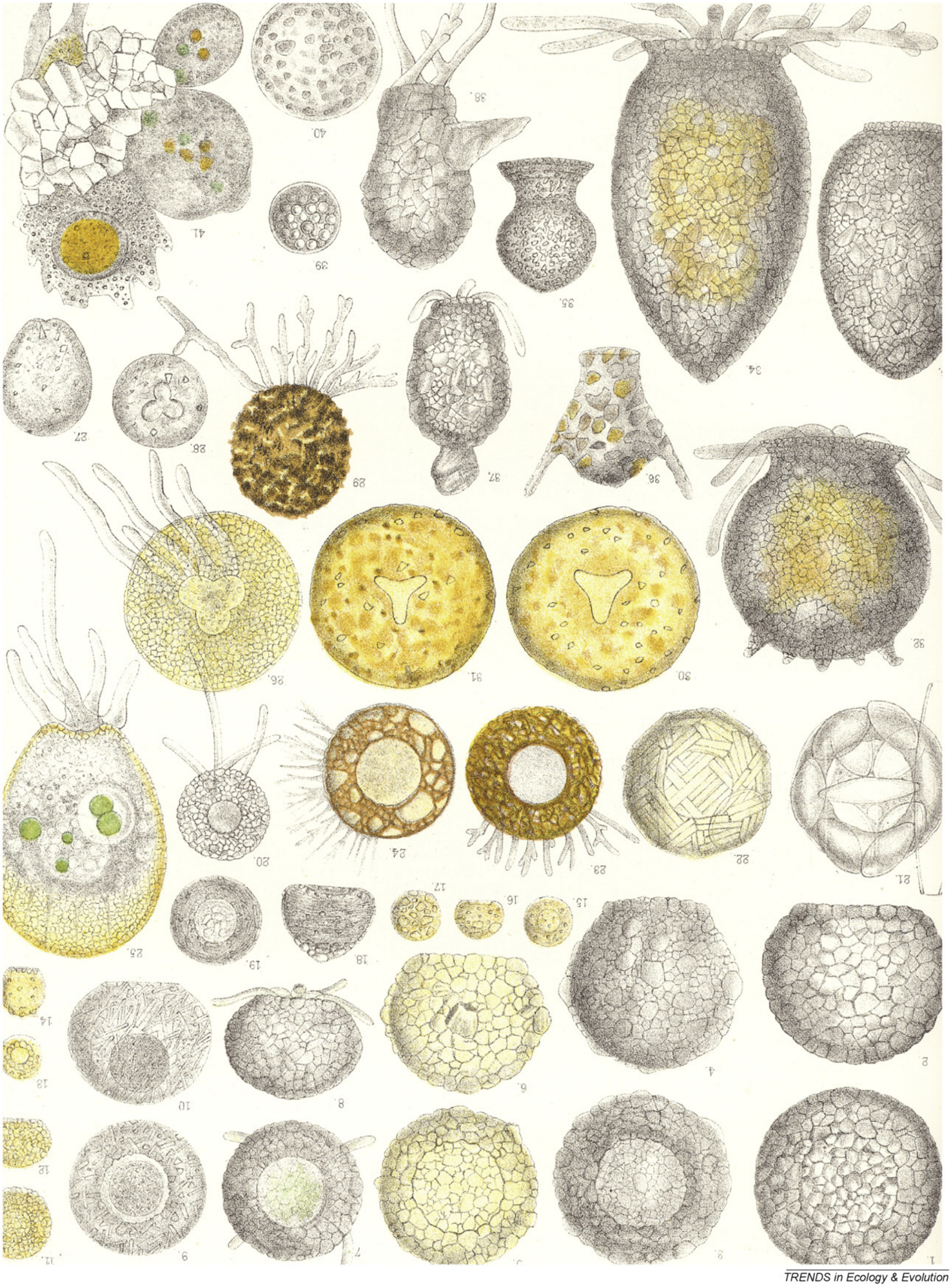

Figure I. Testate amoebae from the beautifully illustrated 1879 monograph on North American species by Joseph Leidy [16].

that tends to get very limited coverage in these texts is the silica cycle. However, this cycle is crucially interconnected with the more widely discussed carbon cycle. This is because in the long term, silicate weathering is the main sink for atmospheric CO_2 on geological timescales. In addition, on shorter timescales, leakage of silica from soils to the oceans is important for diatom primary production, which in itself represents a carbon sink when the remains