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Soil Protozoan Diversity and Significance in Extreme Habitats

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Protozoa inhabit and are particularly abundant in those soil ecosystems that almost or entirely lack higher organisms, especially earthworms, due to the extreme environmental conditions. The lecture highlights this by representative examples from ciliates and testate amoebae.

High mountain habitats above the timberline and Antarctica are typical extreme environments, where protozoa often account for one third or more of the total heterotrophic biomass. For instance, up to 500 active ciliates and 1000 testate amoebae/g occur in moss carpets of Wilkes Land, East Antarctica. Compared to multicellulars, diversity is still high, that is, about 100 protozoan species in continental Antarctica and more than 200 species in high mountain areas. Another kind of extreme habitats is coniferous litter and soil. Usually, high acidity excludes earthworms, but is preferred by testate amoebae, which occur in over 100 species with an average of about 10,000 individuals/g dry mass. Thus, half of the heterotrophic biomass may consist of protozoa. Deserts and highly saline soils provide other examples for extreme habitats and were studied in Namibia, Southwest Africa. Both have a surprisingly high ciliate diversity composed of many undescribed species with specific adaptations. For instance, species with a very thick cyst wall or a vermiform shape occur in the Namib dunes, while many cyanobacteria feeder develop in the highly saline Etosha Pan. Detailed abundance data are lacking, but when dune sand of the Namib Desert or soil from the Etosha Pan is moistened, masses of ciliates appear within 48h showing the presence of high numbers of viable cysts. Testate amoebae, in contrast, are rare both in species and numbers. Recently, tank bromeliads were recognized as a highly compartmentalized, semiterrestrial extreme habitat with strong evolutionary pressure. In only a few samples, two new ciliate families and many new species were discovered. Some can

switch from a bacterivorous microstome habit to a protist feeding macrostome state. This and the many new species indicate extreme competition in these minute habitats, which are colonized also by a great variety of micro-metazoans (rotifers, oligochaetes, crustaceans...) and insect larvae.

These findings highlight protozoa as an ecologically important group in extreme ecosystems, which can serve as natural models for protozoan evolution and distribution. The many biogeographic "flagships" found contradict the fundamental paradigm that, in microorganisms, "everything is everywhere, the environment selects".

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