

## DIVERSITY AND ECOLOGY OF SOIL PROTOZOA

Wilhelm Foissner

Universität Salzburg, Institut für Zoologie, Hellbrunnerstrasse 34, A-5020 Salzburg, Austria

A lecture was read on the diversity and ecology of soil protozoa on occasion of the XII Annual Meeting of the Brazilian Society of Protozoologists in Caxambu, a small town near Rio de Janeiro. This review is also available as a published paper (with many beautiful line drawings and micrographs, some even in colour) in the "Kataloge des Oö. Landesmuseums N.F. 71, 169-218 (1994)". About 1500 protozoan species are known to occur in soil. I suppose, however, that the real diversity is much greater, viz. between 5000 and 10 000 species. This estimate is based on my experience with ciliates. Almost each sample of soil collected in Europe, Africa, and Australia during the last decade contained at least one new species - and there are no reliable data available on the protozoa in soils from Asia and South America! The most important group of soil protozoa, in terms of the contribution to energy fluxes, are very likely, the testate amoebae. They occur not only in rather high individual numbers in many soils but are also active, whereas most other soil protozoa (naked amoebae, flagellates, ciliates) are probably inactive (cystic) most of the time. It is emphasized that fungi influence soil protozoa not only by being an essential food resource but also as parasites; possibly, most of the protozoan resting cysts are destroyed by parasitic fungi.

Protozoa have several unique characteristics favouring their use as bioindicators in natural and humanly-influenced ecosystems, viz., rapid growth, delicate external membranes, eukaryotic genomes, large numbers even in such ecosystems that are almost or completely devoid of higher organisms due to extreme environmental conditions (e.g., polar regions, deserts), and an almost stable and ubiquitous distribution. Current evidences suggest that soil protozoa are at least as sensitive to environmental hazards (pesticides, heavy metals, etc.) as more commonly used test organisms (e.g., earthworms). There is a strong likelihood that protozoa can replace vertebrates in some assays. Likewise, protozoa are very rapid indicators of the recovery of biological activity in soils that have been subjected to gross physical or chemical disturbance. Methodological problems still delay progress in soil protozoology and interfere with their use as bioindicators. The methods available for estimating the numbers of active soil protozoa are either rather time-consuming (direct counting) and/or unreliable (dilution culture methods). Well designed field experiments are still rare and should help to make soil protozoology more reputable.

## PHYLOGENY AND EVOLUTION OF KARYORELICTIDS, A UNIQUE ASSEMBLAGE OF MARINE, INTERSTITIAL CILIATES (PROTOZOA, CILIOPHORA)

Wilhelm Foissner

Universität Salzburg, Institut für Zoologie, Hellbrunnerstr. 34, A-5020 Salzburg

We reinvestigated the somatic and oral ciliary pattern (infraciliature) of all main groups of karyorelictids, a small (135 species) but unique assemblage of mainly marine, sand-dwelling ciliates having nondividing, paradiplous macronuclei originating from micronuclei during cell division. Previous data were highly incomplete and bewildering, mainly due to methodological inconveniences. Using a new, very strong fixative and Wilbert's protargol method, we obtained excellent preparations from many species, showing a world of new details, which were used to investigate evolution within karyorelictids and relationships between karyorelictids and other ciliates.

The cladistic analysis, although impeded by the almost complete lack of reliable ontogenetic data, showed two main clades, one containing loxodids and trachelocercids and another with geleids. The loxodid clade has a unique, strong synapomorphy, viz. a more or less wide glabrous (nonciliated) stripe surrounded by a highly specialized ciliary row (bristle kinety) on the left side of the cell. The loxodid branch contains two orders, the Loxodida (families Loxodidae, Cryptopharyngidae, Kentrophoridae) and the Trachelocercida (Trachelocercidae, Prototrachelocercidae), both supported by fairly convincing synapomorphies. *Kentrophoros* has, like the loxodids, a special dorsolateral ciliary row lacking in trachelocercids. Thus, the order Prostomatida Small & Lynn 1985, uniting kentrophorids and trachelocercids but excluding loxodids, is very likely artificial. The geleids have unique preoral kineties and oral structures completely different from those of other karyorelictids.

Ultrastructural and molecularbiological data have suggested a close relationship between karyorelictids and heterotrichs. s.str. (e.g., *Stentor*). Surprisingly, such a relationship is hardly, if at all, recognizable in the somatic and oral ciliary pattern, which shows some characters (e.g., the trachelocercid brosse) highly reminiscent of those found in haptorid gymnostomes (e.g., *Enchelyodon*) and especially prostomatids (e.g., *Coleps*). Stomatogenesis of *Loxodes* is buccokinetal, i.e. includes parental oral structures as in many oligohymenophorans, whereas the new mouth of the heterotrichs originates parakinetically, i.e. from parental somatic infraciliature. The karyorelictid infraciliature is highly complex and diverse. Thus, the nuclear peculiarities are very likely not ancestral but derived and probably evolved several times, as indicated by the highly different organization of geleids and loxodids/trachelocercids.

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