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# SUPPLEMENT

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## 1996 ABSTRACTS

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Ecology and Taxonomy of Terrestrial Ciliates of Continental Antarctica, WOLFGANG PETZ and WILHELM FOISSNER, Universität Salzburg, Institut für Zoologie, Hellbrunner Strasse 34, A-5020 Salzburg, Austria.

Despite the severe environmental conditions (e.g. coldness, drought) in continental Antarctica, we found about 70 terrestrial ciliate species. On average, 1.3 species per sample occurred in the Antarctic soils, which was an order of magnitude lower than in alpine and temperate soils from Austria. Direct counts in fresh soil showed that ciliates were active in 70% of the samples. The highest abundance of active ciliates occurred in decaying moss ($\bar{x}$=354 individuals/g dry mass; n=5); less were found in ornithogenic ($\bar{x}$=78 ind./g dry mass; n=2) and in very dry mineral soils ($\bar{x}$=13 ind./g dry mass; n=12). The other main groups of soil invertebrates (testaceans, nematodes, rotifers and tardigrades) were active in at least 70% of the samples. Compared to the biomass of these organisms (39-109500 x $10^{-2}$ mg/kg dry mass of soil), that of active ciliates was low (65-9359 x $10^{-3}$ mg/kg dry mass of soil). The biomass was dominated by rotifers in mineral soil and by tardigrades in moss. Active Colpoda spp. occurred in 15% of the samples disproving the hypothesis of Smith (1973) that Colpoda is lacking in continental Antarctica. The morphology and morphogenesis of the hypotrichs Lamtostyla edaphoni and Onychodromopsis flexilis were studied. Lamtostyla differs by the apokinetal origin of the oral primordium from the closely related Amphisiella, whose oral anlage develops parakinetally from the amphisiellid median cirral row. Onychodromopsis flexilis, which differs from typical oxytrichids by having 2-3 right and 1-2 left marginal cirral rows, nevertheless belongs to this group because the FVT-cirral pattern and its origin are very similar to that found in Oxytricha granulifera and Oxytricha pseudosimilis. The increased marginal cirral rows of O. flexilis originate from two anlagen each within the outer right and inner left marginal row, while the inner right marginal row is morphogenetically inactive. Supported by Austrian Science Foundation (FWF) and Australian Antarctic Division.

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Cladistic Relationships of Oxytrichid Hypotrichs (Protozoa, Ciliophora), HELMUT BERGER & WILHELM FOISSNER, Univ. Salzburg, Inst. f. Zoologie, Hellbrunnerstr. 34, 5020 Salzburg, Austria.

The relationships of 13 common oxytrichid genera were analysed using Hennig's cladistic method. Twenty-three characters in 4 groups were selected, viz. the morphology of the oral apparatus (3 characters), the infraciliature of ventral and dorsal side (10 characters), cortical features (2 characters), and ontogenetic particulars (8 characters). All characters and character states are described and discussed using published and original data. Half of the characters originated independently in several genera at least twice, making it very difficult to follow oxytrichid evolution. The autapomorphies of the family Oxytrichidae are 18 characteristically arranged fronto-ventral-transverse cirri and the fragmentation of at least 1 dorsal kinety. The cladogram shows 2 major branches, termed subfamily Oxytrichinae and subfamily Stylonychinae. The Oxytrichinae have a unique synapomorphy, viz. the participation of cirrus V/3 in primordia formation. This subfamily contains the genera Cyrtohymena, Gonostomum, Notohymena, Onychodromopsis, Oxytricha, Tachysoma, Urosoma, Urosomida and, very likely, Australocirrus, Parurosoma and Pseudostrombidium. The Stylonychinae have 3 synapomorphies, viz. the rigid body, an oral apparatus of more than 40 % of body length, and the lack of cortical granules. This subfamily comprises Coniculostomum, Histriculus, Steinia, Sterkiella, Stylonychia and, very likely, Parastylonychia and Pleurotricha. Supported by the Austrian FWF (Project PO 8924-Bio) and the Bayerisches LAWW.

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Epicarchesium and Pseudohaplocaulus, two Rare Peritrichious Ciliates: Morphology and Confirmation of Genus Status, ANDREAS RODOLFO LEITNER and WILHELM FOISSNER, Universität Salzburg, Institut für Zoologie, Hellbrunnerstrasse 34, A-5020 Salzburg, Austria.

Species identification in peritrich ciliates is difficult not only because of many incomplete old descriptions but also because many recent descriptions and redescriptions are of poor quality too. Still, new genera and species are established solely on live observation and insufficient literature data. Typical examples are Epicarchesium Jankowski, 1985 and Pseudohaplocaulus Warren, 1988. They were founded on Carchesium granulatum Kellicott, 1887 and Haplocaulus nicoleae Precht, 1935, assuming that the tuberculate pellicle mentioned in the original descriptions is indicative of a reticulate silverline system. We reinvestigated a species each of these genera, using live observation, silver impregnation and scanning electron microscopy. Epicarchesium granulatum was rediscovered in activated sludge; Pseudohaplocaulus (a new species) occurred in great numbers on planktonic coenobia of Anabaena. Both species have a tuberculate pellicle and, as supposed by Jankowski and Warren, a reticulate silverline system. Thus, we recognize Epicarchesium and Pseudohaplocaulus as distinct genera, differing from their nearest relatives, Carchesium and Haplocaulus, by the reticulate silverline system (supported by FWF, P 10306/BIO).

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Morphology and Evolution in Trachelocercids (Ciliophora, Karyorelictea), WILHELM FOISSNER, Universität Salzburg, Institut für Zoologie, Hellbrunnerstrasse 34, A-5020 Salzburg, Austria, and JEAN DRAGESCO, Private Laboratory, 394 Boulevard du Grand Devois, F-34980 Saint-Clément-de-Rivière, France.

The generic classification of trachelocercids has been revised by reinvestigating the type species. Four genera could be distinguished: Trachelocerca Ehrenberg, 1840 (without brosse, circumoral kinety composed of a single row of dikinetids), Tracheloraphis Dragesco, 1960 (with brosse interrupting circumoral kinety composed of a single row of dikinetids), Trachelolophos Foissner & Dragesco, 1996 (with brosse in centre of oral bulge and thus not interrupting circumoral kinety composed of a single row of dikinetids), and Prototrachelocerca Foissner, 1996 (with brosse interrupting circumoral ciliature composed of many minute kineties). The genus Trachelonema Dragesco, 1960 is dissolved because its somatic and oral infraciliature is very similar to that of Tracheloraphis. Hennig's cladistic method suggests that the Trachelocercidae evolved from the Prototrachelocercidae and both have a common ancestor with the Loxodida. This conclusion is based on a "strong" synapomorphy, viz. the non-ciliated (glabrous) stripe framed by a highly specialized ciliary row (bristle kinety) extending on the left side of both trachelocercids and loxodids. Evolution within trachelocercids is not yet fully understood because the somatic infraciliature is highly similar in all genera and ontogenetic data are entirely lacking. Thus, only the oral structures could be used in the cladistic analysis, which indicates that the lack of a brosse in Trachelocerca is a derived character.



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Partial revision of the Genus Urotricha Claparède & Lachmann 1859 (Ciliophora, Prostomatida), GERALD PFISTER and WILHELM FOISSNER, Universität Salzburg, Institut für Zoologie, Hellbrunnerstrasse 34, A-5020 Salzburg, and Institut für Limnologie der ÖAW, Gaisberg 116, A-5310 Mondsee, Austria.

Four species of Urotricha with more than 3 caudal cilia, viz.: U. apsheronica, U. castalia, U. pelagica, and a new subspecies of U. matthesi, were reinvestigated using live observation, silver impregnation and scanning electron microscopy. The following characters were selected for species distinction: biotope (freshwater, terrestrial or marine), size, body shape (with or without posterior plug), macronucleus shape (ellipsoidal or distinctly elongate), symbiotic algae (present/absent), somatic trichocysts (present/absent, size and shape), number of somatic and brosse kineties, number and arrangement of caudal cilia, location of excretory pore of contractile vacuole (within or outside circle formed by caudal cilia). Based on these features and on the reinvestigation of the type slides of U. matthesi and U. puytoraci, 15 Urotricha species with more than 3 caudal cilia could be distinguished: U. alveolata, U. apsheronica, U. baltica, U. castalia, U. cyrtonucleata, U. faurei, U. matthesi, U. matthesi nov. subspec., U. multisetosa, U. pelagica, U. pusilla, U. terricola, U. tricha, U. valida, and U. venatrix. Urotricha rotunda was synonymized with U. castalia and U. puytoraci was transferred to the genus Longitricha. Some other nominal species were also transferred to other genera or are of uncertain systematic position. A simple key, usable also for ecologists, was designed. Supported by FWF P10306/BIO.

International Workshop "New Directions in Systematics" Hersonissos, Crete, 15th - 18th October 1997

# Abstract Volume

(without pagination)

## The World Soil Ciliate (Protozoa, Ciliophora) Fauna: Proposed Number of Species and their Geographic Distribution

**Wilhelm Foissner**
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Large sample collectives from Africa (92 samples), Australia (157) and Antarctica (90) were investigated for soil ciliates using the non-flooded Petri dish method, which reactivates the ciliates´ resting cysts from air-dried samples. Species were determined from life and by silver impregnation. The African samples were the richest, containing 507 species (240 undescribed = 47%), followed by the Australian (361 species, 154 = 43% undescribed) and the Antarctic (95 species, 14 = 15% undescribed) samples. The percentage of new species/sample was consistently low, viz. 4-8% on average, indicating that new species were considerably undersampled relative to described ones, very likely due to methodological shortcomings, i.e. usually only cysts of the more euryoecious species could be reactivated. Thus, the probability theory-based statistical approach suggested by Hodkinson & Hodkinson (1998) was applied to the data sets to compensate for the underestimated number of undescribed species. This procedure indicated that, depending on the region, 70 - 80% of the soil ciliates are stil unknown and global soil ciliate diversity amounts to at least 1330 to 2000 species. Several indicators, especially the constant rate new species have been found during a 20-year period of intensive research, suggest that this estimate is conservative.
An attempt was made to review the faunistic knowledge about soil ciliates. 643 species were originally described or reliably recorded from about 1000 soil samples world-wide, 49 (7.6%) of them were later recognized as junior synonyms, and 78 (13.2%) have been poorly described, leaving a total of 516 well-known species. Only about one fourth of the soil ciliate species has been reliably reported from freshwater habitats and from more than three out of five main biogeographical regions, indicating a high specificity of the soil ciliate fauna and a limited distribution of at least some species. This is supported by the observation that some very conspicuous species, e.g. *Krassniggia auxiliaris* and *Bresslauides discoideus*, have so far found only in Gondwanan, respecitively, Laurasian soils. Supported by FWF, projects P 10264-BIO and P 12367-BIO.

# 10th International Congress of Protozoology

THE UNIVERSITY OF SYDNEY
AUSTRALIA

Monday 21 July - Friday 25 July 1997



# Programme & Abstracts



## ULTRASTRUCTURAL DESCRIPTION OF FUSIFORM ORGANELLES IN THE BUCCAL CORTEX OF HETEROTRICH CILIATES (PROTOZOA, CILIOPHORA)

**ILSE FOISSNER**, WILHELM FOISSNER. Universität Salzburg, Austria

Highly structured "fusiform organelles" were discovered in the right wall of the buccal cavity of several heterotrich ciliates (*Blepharisma* spp., *Linostoma vorticella*, *Condylostoma* spp.). Actually, Giese (1973) mentioned such organelles in his book on *Blepharisma* but provided only few details. The fine structural investigations and some preliminary experiments indicate that these organelles are non-extrusive and might have some (mechano? chemo?) receptive function, as suggested by their precytostomial location and close contact with several organelles in the buccal cortex, especially the oral ribs. Fusiform organelles have as yet found only in heterotrichs with unciliated buccal cavity.

The arrangement and fine structure of the fusiform organelles vary considerably, depending on species. Generally, they are arranged in rows between the oral ribs; those of *Blepharisma americanum* form small, widely spaced groups; in *Condylostoma arenaria* they are singly and very narrowly spaced; in *Linostoma vorticella* they are also singly but widely spaced. The fusiform organelles are neighboured the proximal side of the oral ribs. They are, depending on species, 500 - 1500 nm long and up to 500 nm wide and surrounded by a unit membrane. The proximal half is embedded in the buccal cytoplasm, whereas the distal half projects above the cell surface. The middle portion is inflated and contains some fuzzy material, which sometimes forms a crystal-like structure. The main component of the fusiform organelles is a central core consisting of about 25 long, flattened filaments with a size of about 25 x 10 nm in transverse section. Both ends of the core bear a plug of electron-dense material, the proximal plug shows a distinct transverse periodicity of 17 nm. Depending on species, four to eight longitudinal microtubules each extend between the fusiform organelles and the neighbouring oral rib. Distinct cross-bridges occur between these and the oral rib microtubules as well as the unit membrane enclosing the organelle. Furthermore, the fusiform organelles seem to be associated with about 200 nm sized coated vesicles containing some fuzzy material.

Giese A. C. (1973) *Blepharisma*. Stanford Univ. Press, Stanford, 366 pp.

## GLOBAL SOIL CILIATE (PROTOZOA, CILIOPHORA) DIVERSITY: A PROBABILITY-BASED APPROACH USING LARGE SAMPLE COLLECTIVES FROM AFRICA, AUSTRALIA, AND ANTARCTICA

**WILHELM FOISSNER**. Universität Salzburg, Austria

Large sample collectives from Africa (92 samples), Australia (157) and Antarctica (90) were investigated for soil ciliates using the non-flooded Petri dish method, which reactivates the ciliates' resting cysts from air-dried samples. Species were determined from life and by silver impregnation. The African samples were the richest, containing 507 species (240 undescribed = 47%), followed by the Australian (361 species, 154 = 43% undescribed) and the Antarctic (95 species, 14 = 15% undescribed) samples. The percentage of new species/sample was consistently low, viz. 4-8% on average, indicating that new species were considerably undersampled relative to described ones, very likely due to methodological shortcomings, i.e. usually only cysts of the more euryoecious species could be reactivated. The probability theory-based statistical approach suggested by Hodkinson & Hodkinson (1993) was applied to the data sets to compensate for the underestimated number of undescribed species. This procedure indicated that, depending on the region, 70 - 80% of the soil ciliates are still unknown and global soil ciliate diversity amounts to at least 1330 to 2000 species. Several indicators, especially the constant rate new species have been found during a 20-year period of intensive research, suggest that this estimate is conservative. Possibly, this is true also in other habitats, including those addressed by Finlay *et al.* (1996), who did not take into account that most studies they analysed were cursory, i.e. did not investigate species richness in detail. "Directed" studies, i.e. detailed investigations of certain ciliate groups and/or habitats by recognised specialists often almost doubled the species known.

Finlay, B. J., Corliss, J. O., Esteban, G. and Fenchel, T. (1996) Biodiversity at the microbial level: the number of free-living ciliates in the biosphere. *Quart. Review Biol.* **71**, 221-237.
Hodkinson, I. D. and Hodkinson, E. (1993) Pondering the imponderable: a probability-based approach to estimating insect diversity from repeat faunal samples. *Ecol. Entomol.* **18**, 91-92.

## SOIL CILIATE (PROTOZOA: CILIOPHORA) DIVERSITY IN EVERGREEN TROPICAL RAIN FORESTS FROM AUSTRALIA, COSTA RICA AND AMAZONIA (SOUTH AMERICA)

**WILHELM FOISSNER**. Universität Salzburg, Austria

Evergreen tropical rain forests are famous for their rich diversity of plants and animals and thus have become a central paradigm in biodiversity discussion and conservation. However, investigations on soil ciliates are virtually lacking, except of a few species descriptions and abundance estimations. Thus, I analyzed 33 soil samples from rain forests of Australia, Tasmania, Costa Rica and Amazonia with the non-flooded petri dish method, which reactivates the ciliates' resting cysts from air-dried samples. 175 ciliate taxa were found, 34 of them were new species. Although this is a considerable number, it is much less than one would expect, considering that a single sample from a tropical dry forest in Costa Rica contained 80 species (Foissner 1995).

The data would be even more perplexing, if the four rich samples (up to 90 species/sample) from the Manaus (Amazonian) floodplain were excluded. Then, we would be confronted with about 90 taxa in 29 samples, of which 13 contained less than 10 species. A hypothesis is put forward that the non-flooded petri dish method is inappropriate for studying soil ciliate diversity in evergreen tropical rain forests because most species partially or completely lost the ability to produce dry-resistant (protective) resting cysts due to the permanent wetness of their habitats. This view is supported by a comparative analysis of a fresh (40 species) and air-dried/rewetted (2 species only!) sample from a cloud rain forest near Merida (Venezuela) and the observation that the capacity of soil ciliates to produce resting cysts often dramatically decreases after prolonged laboratory cultivation in liquid media. Direct microscopy of fresh samples seems to be an appropriate methodological alternative because specimens can be easily collected due to their considerable abundance (≥1000 ind./g wet mass of litter).

Foissner W. (1995) Tropical protozoan diversity: 80 ciliate species (Protozoa, Ciliophora) in a soil sample from a tropical dry forest of Costa Rica, with descriptions of four new genera and seven new species. *Arch. Protistenk.* 145: 37-79.