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Book of Abstracts

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p. 14

THE ETOSHA PAN IN NAMIBIA (SOUTHWEST AFRICA): A BIODIVERSITY CENTRE FOR SOIL CILIATES

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About 40 soil samples from the centre and periphery of the Etosha Pan, Namibia, were investigated for ciliates. The pan soil is a very special mixture of salt, clay, and lime having a pH range of about 6.0-9.7; the air-dried mixture is stone-like, but quickly doubles its volume and becomes a fluffy pancake when it is rewetted. Most of the soil is covered with a more or less distinct layer of filamentous cyanobacteria. The ciliates, respectively, their resting cysts were re-activated from the air-dried samples using the non-flooded Petri dish method. The species were determined from life and after silver impregnation. Furthermore, the morphogenesis of some key species was investigated. About 100 of the 280 ciliate species identified were new to science, indicating that the Etosha Pan is a "Biodiversity Centre" for soil ciliates. The high number of new species was obtained in spite of using a very conservative, morphological species concept, that is, species were identified with poorly described ones when at least one main character matched. To ensure stability, such taxa were neotypified, although they were not from or near the type location, as they should be according to the International Code of Zoological Nomenclature. However, as many (not all) ciliates are cosmopolitan, a broad interpretation of neotypification seems justified. Furthermore, a good deal of the old descriptions never can be unequivocally assigned to present-day species because many of the details necessary are recognizable only with silver impregnation. Types and neotypes are deposited in the Oberösterreichische Landesmuseum in Linz (LI), Austria. The high number of new species casts strong doubt on Finlay's hypothesis that most of the free-living ciliates (limnic, marine, terrestrial) are already known and global diversity of free-living ciliates does not exceed 3,000-4,000 species.
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p. 15

FEEDING AND ONTOGENESIS IN *SULTANOPHRYS*, A KARYORELICTID, TRACHELOCERCID CILIATE: EVOLUTION AT THE BASE OF THE CILIATE TREE

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Trachelocercids contain large metazoan preys, although they are very slender and lack conspicuous mouth structures. In the sixties, specialists assumed, but never observed, apical feeding because of the bulbous apical end (head). However, later Lenk & Small reported that trachelocercids feed by the glabrous stripe, a non-ciliated area, which extends the whole body length in the middle third of the left side. We reinvestigated the problem in flourishing cultures of *Sultanophrys arabica* and *Tracheloraphis* sp., using live observation and scanning electron microscopy. Both species feed through the apical end, which greatly expands and contains an inconspicuous but highly organised oral apparatus. Accordingly, the proposal by Lenk & Small that trachelocercids feed through the glabrous stripe is a misobservation and refused.

Division is homothetogenic and occurs in freely motile (non-encysted) condition. The parental oral apparatus does not reorganise and cell shape is maintained. Stomatogenesis is parakinetal, that is, the anlage for the opisthe oral apparatus is derived directly from the first ordinary somatic ciliary row right of the glabrous stripe and has no connection with parental mouth structures. The oral primordium appears slightly subequatorially and consists of an anarchic field of basal bodies, from which many short dikinetidal kinetofragments differentiate. The kinetofragments migrate centrifugally and assemble to a circumoral kinety and three minute adoral organelles (brosse kineties). The somatic kineties, the bristle kinety, and the lateral kinety divide without anlagen formation. Thus, morphogenesis of trachelocercid karyorelictids is distinctly different from that of loxodid karyorelictids, which develop the oral primordium buccokinetally. This shows that different stomatogenetic modes developed very early in ciliate evolution, which is emphasised by the heterotrichs, whose parakinetal stomatogenesis is rather different from that of the trachelocercids.

SOIL PROTOZOAN DIVERSITY: A LESSON FROM STUDYING A SINGLE SITE SEVERAL TIMES

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About 60 species of naked amoebae, 200 of testate amoebae, 260 of flagellates, 643 (at least 1000 when my unpublished material is included) of ciliates, and 3 microsporidians were originally described or later recorded from terrestrial habitats. However, soil protozoan diversity is very likely much higher. When a probability theory-based statistical approach was applied to large collections from Africa, Australia, and Antarctica, a ciliate diversity of at least 1330 - 2000 species resulted. This is in accordance with the constant rate at which new species have been discovered during a 20-year period of intensive research. To obtain more detailed information about the ratio of local:global soil ciliate diversity, I conducted a study in an about 400 m^2 area of a beech forest in Austria. About 150 species were found with various methods and at 17 sample occasions distributed over two years and all seasons; 15 of these species were undescribed. Most of the species (> 80%) were found in the first six samples, and more than 50% occurred in less than half of the samples. There is no reason to believe that this number would significantly increase if further samples were studied. Thus, local diversity is about 15% of global diversity. However, the ratio drops with every sample studied because still each contains, on average, 1 new species. Thus, I do not believe that Finlay's hypothesis "everything is (almost) everywhere" is correct. There are innumerable "local" ciliate communities each having a specific set of species. The main weakness in most estimations of protozoan diversity is the neglection of an important fact, namely, that undescribed species are considerably undersampled, mainly because they are often less abundant and hidden by a mass of common, ubiquitous species/specimens. Thus, and because many species are encysted, the percentage of new species per sample is usually lower than 10%, but increases to 30 - 50% when large collections (~ 100 samples) are analysed carefully by an *experienced* taxonomist.

454

FLOODPLAIN SOILS - UNTOUCHED PROTOZOAN BIOTOPES

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Floodplains are wetlands which oscillate between terrestrial and aquatic phases. Floodplain soils, which occupy a considerable portion of the landscape, have specific features: (i) they are wet, (ii) periodically flooded, and (iii) rich in organic matter. Accordingly, they should be an ideal biotope for protozoans; however, data are entirely lacking. Thus, I investigated a few samples each from the Amazon floodplain at Manaus, the Murray River floodplain in Australia, the floodplain of a temporary river in the Kruger National Park (South Africa), and the Danube River floodplain in Austria. Species numbers of ciliates were significantly higher (70 - 100 species/sample) in the floodplain than in the terra firma soils (40 - 60 species/sample). This observation provides strong support for the intermediate disturbance hypothesis, which predicts that high species richness is maintained in communities at intermediate scales of disturbance. Communities are a unique assemblage of aerobic and anaerobic inhabitants, and of terrestrial, benthic and even planktonic species, such as *Teuthophrys trisulca* and *Hastatella radians*. About 50 new species were discovered in the few samples studied, indicating that floodplain soils must contain hundreds or even thousands of undescribed species. Thus, it is unlikely that total diversity of free-living ciliates (limnic, marine, terrestrial) is close to 3000 or 4000 species, as proposed by Finlay. A more likely figure is 30,000. The most spectacular ciliate found during this study, is an about 50 µm-sized colpodid, which excysts within 1 - 2 hours after flooding the sample with water. Then, it covers itself with a 1 - 3 µm thick layer of minute clay particles, eventually looking like a floating smear globule, indicating that the clay cover could be an adaptation against predation. After about 20 hours, the species encysts, even if conditions are unchanged in the sample. Further highly remarkable records are *Maryna acuminata*, which never has been found since the original description in 1955, and *Stylonychia nodulinucleata*, a distinct species described in 1993 by Shi & Li from China.

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455

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1998 ABSTRACTS

79 (p. 10A)

Taxonomy of Plankton Ciliates: a Neglected Field. HELMUT BERGER*, WILHELM FOISSNER** and J. SCHAUMBURG***. *Technisches Büro für Ökologie, Radetzkystrasse 10, A-5020 Salzburg, Austria; **Universität Salzburg, Institut für Zoologie, Hellbrunnerstrasse 34, A-5020 Salzburg, Austria; ***Bayerisches Landesamt für Wasserwirtschaft, Postfach 190241, D-80602 München, Germany.

Ecology of planktonic protozoa has attained a high standard in terms of methods and interpretation of data. Even minor details are investigated with sophisticated techniques and at considerable expense. If, however, one looks at the identification of the organisms involved, the standard is often poorer than it was 50 years ago. It seems many ecologists forget that they are dealing with organisms. This deficiency seriously limits the usefulness of the data of, for example, grazing experiments or the analysis of community dynamics. Reliable results on these subjects largely depend on correct species identifications and very complete species inventories. You can hardly speak, as is usual at protozoological meetings and in many papers, of "community structure" and "seasonal succession" if only 20% of the species seen were identified to species level! Imagine a meeting of botanists dealing with the community structure and the seasonal succession of plant assemblages. What would happen if, as is usual at meetings of protozoan plankton ecologists, you were to speak of red flowers, blue flowers (e.g., oligotrichs), high trees and small trees ("protists larger or smaller than 20 µm") and of the changes in the numbers of red and blue flowers during the season? Thus, we are presently preparing a thorough guide to about 100 common euplanktonic freshwater ciliates. The book is organized like our "Blue Ciliate Atlas", and will be available in spring of 1999. Supported by the Bayerische Landesamt für Wasserwirtschaft, Munich, and the Österreichischen Fonds zur Förderung der wissenschaftlichen Forschung (Projekt PO 8924-Bio).

460

86 (p. 11A)

Morphological Characterization of Two *nomen nudum* Hypotrichs (Protozoa, Ciliophora): *Oxytricha nova* and *Oxytricha trifallax*. WILHELM FOISSNER and HELMUT BERGER. Universität Salzburg, Institut für Zoologie, Hellbrunnerstrasse 34, A-5020 Salzburg, Austria.

Oxytricha nova and *O. trifallax* were named and established as viable genetic systems (via frozen resting cysts) by molecular biologists, but never determined or described in a classical morphological sense. Thus, their identity is unknown and both are *nomen nudum* species according to the International Code of Zoological Nomenclature. In the present paper, this bewildering situation is rectified by investigating offsprings of the original populations. It is shown, by a detailed literature review and morphological analysis, using life observation, silver impregnation and scanning electron microscopy, that both populations belong to a single morphotype, viz. *Sterkiella histriomuscorum*, a cosmopolitan species very frequent in limnetic and terrestrial habitats. However, on the molecular level, *O. nova* and *O. trifallax* are very distinct, suggesting that they are different species. Thus, *S. histriomuscorum* is a complex of sibling species. For the sake of nomenclatural continuity and priority, we suggest to identify *O. trifallax* as *S. histriomuscorum* and to establish *O. nova* as a new species. Both species are diagnosed by a combination of morphological and molecularbiological characters. Field populations of *S. histriomuscorum* should be designated as "*Sterkiella histriomuscorum* complex", if no molecular data are available to decide whether they belong to *O. nova*, *S. histriomuscorum*, or to another not yet described species of the complex. Supported by the Austrian FWF, Project P-12367-BIO.

95 (p. 12A)

Triassic, Soft-Bodied Amber Protists. WILFRIED SCHÖNBORN*, HEINRICH DÖRFELT, WILHELM FOISSNER**, LOTHAR KRIENITZ and URSULA SCHÄFER*. *Universität Jena, Institut für Ökologie, Winzerlaer Strasse 10, D-07745 Jena; **Universität Salzburg, Institut für Zoologie, Hellbrunnerstrasse 34, A-5020 Salzburg, Austria.

U.-C. BAUER discovered Triassic amber in sandstone layers near Schliersee, Bavaria, Germany. The amber is 220–230 million years old and rich in microfossils. POINAR et al. (1993) described the oldest known softbodied protists from this amber; however, their analysis was not very detailed. Thus, we reinvestigated new material obtained from U.-C. BAUER. In an amber piece of only 0.003 mm^3, we found a highly diverse microcenosis, which probably lived in a semiaquatic habitat (very likely a phytotelma in the bark of the resin producing plant or an astatic pond naerby). This is indicated by the occurrence of both, aquatic and terrestrial protists, especially mycophagous ciliates. The following taxa could be identified: (number of species found in parenthesis): bacteria (several species), fungi (5; one new genus and species), flagellates (4), coccal green algae (2), testae amoebae (3; one new species), ciliates (7; mainly colpodids, one new *Paramecium* species). Most species and the community itself are extremely similar to extant ones. This morphostasis might be caused by very stable microniches or, in case of extinction events, by parallel evolutionary processes due to the extreme, specific habitat factors. Supported by the Austrian FWF, Project P-12367-BIO. POINAR, G. O. jr., WAGGONER, B. M. and U.-C. BAUER (1993): Terrestrial soft-bodied protists and other microorganisms in Triassic amber. Science 29:222–224

449

98 (p. 12A)

New Observations on the Extrusomes of *Pseudourostyla cristata* (Ciliophora, Hypotrichia). PAVLA TESAROVA* and WILHELM FOISSNER**. *Charles University of Prague, Department of Tropical Medicine, Studnickova 7, CZ-12000 Praha 2, Czech Republic; **Universität Salzburg, Institut für Zoologie, Hellbrunnerstrasse 34, A-5020 Salzburg, Austria.

Previous investigations showed that the extrusomes of *P. cristata* have a complicated, unique structure hardly found in any other protozoan. They consist of a bell-shaped electron-dense head and a compact, rod-shaped shaft embedded in fluffy, hyaline material; thus, the extrusomes look like little umbrellas in the light microscope, where only the shaft and the cup can be recognized. At the anterior pole of the head is an anvil-like, dense structure, the incus. Using various methods, we observed the following new details: (1) The cap is bell-shaped and extruded with the organelle, as revealed by the spiral appearance of the head in the SEM; (2) The cap microtubules have the same diameter as ordinary cortical microtubules; (3) The incus is connected via fine fibres to the unit membrane enveloping the extrusome; (4) Negative staining reveals a dense reticulum composed of many fine fibres around the head of extruded extrusomes; (5) The shaft has a narrow transverse striation possibly caused by spirally arranged extrusome material, as indicated by ultrathin sections and negative staining; (6) At the posterior end of the shaft is a globule recognizable after SEM and negative staining; (7) The fluffy material around the shaft is more distinct in cells treated with acetic acid; (8) The shaft ends in the proximal fifth of the extrusome; (9) There is ramified, fluffy material on the pellicle around the extrusome attachment site. Supported by ÖAA, ZL AD/1649-1/1996.

451

A SOFT-BODIED, SEMITERRESTRIAL PROTIST COMMUNITY IN 230 MILLION YEARS OLD AMBER

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U. Ch. Bauer discovered triassic amber ("Schlierseerit") in layers of Raibler Sandstone near the village of Schliersee, bavaria. The amber pieces have a size of less than 1 mm to up to 22 mm, and some contain an abundance of excellently preserved organisms, which were identified by Poinar et al. (1994) as bacteria, fungi, algae, testate amoebae, and ciliates. We investigated in detail the organism community in an amber fragment with a volume of about 0.003 mm^3 (Schönborn et al. 1999). The following taxa could be identified: several types of coccal and filamentous bacteria; four species of fungi, including a new genus and species (*Paleodikaryomyces baueri* Dörfelt); various algae (euglenoids and monadal chlorophytes similar to extant *Chlamydomonas*, *Chloromonas*, *Chlorella*, and *Chloricystis*); heterotrophic flagellates; testate amoebae (*Centropyxis aculeata* var. *oblonga* Deflandre 1929, *Cyclopyxis eurystoma* Deflandre 1929, and *Hyalosphenia baueri*, a new species); and many species of ciliates (*Pseudoplatyophrya nana* (Kahl 1926), *Mykophagophrys terricola* (Foissner 1985), *Cyrtolophosis mucicola* Stokes 1885, *Paracondylostoma* sp., *Brzometopus triquetus* Foissner 1993, *Tetrahymena rostrata* (Kahl 1926), and *Paramecium triassicum*, a new species). Most of the organisms corresponded to or diverged from extant species only slightly and indicated a terrestrial or semiterrestrial habitat, such as litter, tree-holes, or ephemeral ponds. How the morphological stasis of protists is achieved is still enigmatic.

How was the excellent preservation of the organisms brought about? Paleontological evidences indicate Cycadophyta as the resin source for the Schlierseerit, whereas carbon-13-nuclear magnetic resonance spectra favour Araucariaceae. Accordingly, we investigated the ability of fresh resin from *Cycas* sp., *Araucaria* sp., and *Picea abies* to preserve some extant ciliate species (*Paramecium aurelia*, *Tetrahymena mobilis*, *Mykophagophrys terricola*). In fresh resin of *Araucaria* and *Picea* the ciliates died within a minute and dissolved, while they survived and preserved excellently in *Cycas* resin. Although amber formation is a complicated process, our experiments indicate the possibility that soft-bodied protists can be preserved in certain resins.

Poinar, G.O. jr., Waggoner, B.M. and Bauer, U.Ch., 1994: Terrestrial soft-bodied protists and other microorganisms in triassic amber. Science, 259: 222-224.

Schönborn, W., Dörfelt, H., Foissner, W., Krienitz, L. and Schäfer, U., 1999: A fossilized microcenosis in triassic amber. (submitted).