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XXIV. KONGRESS DER INTERNATIONALEN VEREINIGUNG
FÜR THEORETISCHE UND ANGEWANDTE LIMNOLOGIE

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COUNTING OF PROTOZOA AND SMALL METAZOA IN
ACTIVATED SLUDGE

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A method for the estimation of the abundance of protozoa and small metazoa in activated sludge is described. 5 x 10 µl of activated sludge are counted in vivo microscopically using a Thoma-Chamber and a magnification of 100:1. The efficiency of this counting method was tested by "recovery" experiments. 46–100% of the ciliates (mean 85%, n = 165 countings) were recovered. A positive correlation between body size and percentage of recovery could be found. Preliminary experiments showed that the method is suitable for nematodes (recovery 95%, n = 10), rotators (recovery 84%, n = 10) and testate amoebae (recovery 78%, n = 10), too. The described method is independent of the sludge-structure, is easy to handle and is an acceptable compromise between time spent and necessary degree of accuracy.

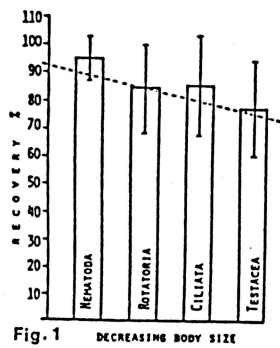


Fig. 1. Recovery (%) with standard deviation and correlation (stippled line) between body size and recovery for different taxa (all experiments pooled); number (n) of countings: ciliates (n = 165), nematodes (n = 10), rotators (n = 10), testate amoebae (n = 10).

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SUPPLEMENT

THE SOCIETY OF PROTOZOOLOGISTS

1988 ABSTRACTS

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'The Hemimastigophora, a New Protistan Phylum from Gondwanian Soils, WILHELM FOISSNER, HUBERT BLATTERER and ILSE FOISSNER, Universität Salzburg, Institut für Zoologie und Institut für Pflanzenphysiologie, Hellbrunnerstrasse 34, A-5020 Salzburg, Austria.

The morphogenesis and ultrastructure of *Hemimastix amphikineta* has been investigated. This species occurred in some Australian and in one Chilean soil, but was absent in more than 1000 soil samples from Laurasian localities. Thus, it has probably a restricted Gondwanian distribution. *Hemimastix amphikineta* is a very small (14-20 x 7-10 µm), colorless organism that looks distinctly Ciliophora-like because of its posteriorly located contractile vacuole and its two longitudinal somatic kineties each composed of about 12 cilia-like flagella. These two kineties are interposed between two large plicated and microtubule bearing pellicular plates which are arranged inversely mirror-image like. *Hemimastix amphikineta* has tubular (saccular) mitochondrial cristae, complex extrusomes, and two microtubular systems and a membranous sac associated with each kinetid. The nucleolus persists throughout division. A permanent cytostome-cytopharyngeal complex, pharyngeal rods, striated fibers, mastigonemes, and a paraflagellar rod are absent. This unique combination of characters demonstrates a very separate position of *H. amphikineta* within the known protists. Thus, the phylum Hemimastigophora has been established to include *H. amphikineta* and *Spironema multiciliatum* Klebs, 1892. The structure of the pellicle and the nuclear apparatus of *H. amphikineta* indicate some relationship to the Euglenophyta. Thus, the Hemimastigophora are included in the assemblage 'Euglenozoa' of Corliss (1984). Full paper will appear in European Journal of Protistology.

Supported by FWF, Projekt P 5889 and the ABRs.

THE SOCIETY OF PROTOZOOLOGISTS

1989 ABSTRACTS

The Journal of Protozoology

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Number 1

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Effects of organic fertilizers on the soil microfauna of a spruce forest, ERNA AESCHT and WILHELM FOISSNER, Universität Salzburg, Institut für Zoologie, Hellbrunnerstrasse 34, A-5020 Salzburg (Austria/Europe).

A large woodland, the "Böhmervald" in Upper Austria, shows marked signs of forest decline. Deficiency of magnesium has been proved. For revitalization, two types of fertilizers (type 1: Bactosol = bacterial biomass, type 2: Biomag composed of 90% magnesite and 10% Biosol-fungal biomass) have been applied to a young (30-40 years) and an old (80-100 years) spruce stand. With these special types of fertilizers it was assumed to minimize strong changes in the soil fauna and to increase the extremely low pH (about 3). The experimental plan corresponds to a completely randomized block design. The number of testate amoebae, ciliates, nematodes, and rotifers (direct counting method), the activity of some soil enzymes, and the litter decomposition have been studied in the needle layer (0-3 cm) 1, 6, 19, 50, and 70 weeks after fertilization. The effects are more pronounced in the old spruce forest and the bactosol variant (30 kg Bactosol and 20 kg Biomag/100 m²), than in the young stand and the biomag variant (20 kg/100 m²). A significant increase of pH occurred mainly in the needle layer: about one unit in the bactosol variant and half a unit by Biomag. Considering the statistically significant effects in the whole period of examination, the pH, the catalase activity, and the protease activity as well as the number of rotifers increased (10-40%), whereas the cellulase activity and the number of ciliates decreased (10-50%). One year after fertilization, these effects faded away. In sum, the applied fertilizers did not change soil life markedly.

(Supported by the Biochemie Ges. m. b. H., Kundl (Tirol, Austria))

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New Ciliates (Protozoa, Ciliophora) from Australia and Africa, WILHELM FOISSNER and HUBERT BLATTERER, Universität Salzburg, Institut für Zoologie, Hellbrunnerstrasse 34, A-5020 Salzburg (Austria/Europe).

By living observation and silver impregnation, 139 species of ciliates have been identified in 21 soil samples from Australia. With a few exceptions, all species are new for the fauna of this continent. Some of the new species occurred in soils from Kenya (Africa) too; they are probably restricted to the Gondwanian area. The following new families, genera, and species have been published by BLATTERER and FOISSNER in Stapfia 17: 1-84 (1988) and by FOISSNER in Stapfia 17: 85-133 (1988): *Pleuroplites*, *P. australis*, *Coriplites*, *C. terricola*, *Phialinides*, *P. australis*, *Arcuopathidium australe*, *Trihymanidae*, *Trihymana*, *T. terricola*, *Bresslauides*, *B. australis*, *Rostrophryides australis*, *Pseudoplatyophrya saltans*, *Cladotricha australis*, *Amphisiella australis*, *A. magnigranulosa*, *Hemiamphisiella terricola*, *Holostichides terricola*, *Australothrix*, *A. australis*, *A. alwinae*, *Holostichia australis*, *Tricoronella*, *T. pulchra*, *Keronopsis tasmaniensis*, *Oxytricha auripunctata*, *Oxytricha granulifera quadricirrata*, *Notolymna*, *N. rubescens*, *Australocirrus*, *A. oscitans*, *A. octonucleatus*. The genus *Amphisiella* GOURRET & ROESER, 1888 (synonym: *Uroleptoides* WENZEL, 1953) is redefined and restricted to species which have more than 1 cirrus to the left of the ventral cirral row and which have transverse cirri. Three new genera, *Amphisiellides*, *Paramphisiella*, and *Hemiamphisiella*, have been erected to include such species that do not fit on the diagnoses of *Amphisiella* and *Strongylidium*.

(Supported by the Fonds zur Förderung der wissenschaftlichen Forschung, project P 5889 and by the Australian Biological Resources Study)

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The Effects of Pesticides on the Soil Fauna of a Spruce Forest with Special Regard to Protozoa, WOLFGANG PETZ and WILHELM FOISSNER, Institut für Zoologie der Universität Salzburg, Hellbrunnerstrasse 34, A-5020 Salzburg (Austria/Europe).

The effects of mancozeb (fungicide) and lindane (insecticide) were investigated with a completely randomized block design in active ciliates, testaceans, rotifers, and nematodes. The effects were evaluated 1, 7, 15, 40, 65, and 90 days after application of a standard and a tenfold dose. Individual numbers were estimated with a direct counting method. Mancozeb, even at the high dose, had no pronounced acute or long-term effects on absolute numbers of the taxa investigated. The number of ciliate species, which decreased 1 day after treatment with the normal dose (0.05<p<0.1), soon recovered. However, the community structure of ciliate species was still slightly altered after 90 days. Testaceans were not reduced before day 15 at the higher dose or before day 40 at the normal one (0.05<p<0.1). A normal dose of lindane caused acute toxicity in ciliates and rotifers (p<0.05) but the latter soon recovered. The number and community structure of ciliate species were still distinctly altered after 90 days (0.05<p<0.1), indicating the critical influence of lindane. Testaceans were reduced only after day 15, nematodes only on day 40 (0.05<p<0.1). At the high dose of lindane severe long-term effects occurred in soil moisture, total rotifers (p<0.05), total nematodes (0.05<p<0.1), and in the structure of the ciliate community. Generally, there were marked differences in the effect of the normal and the high dose of lindane but not with mancozeb. Ciliates showed very pronounced changes after the pesticide applications, indicating their usefulness for testing biocides under field conditions. Testaceans were more resistant than ciliates. (Supported by the FWF, project P 5889).

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Investigations on the Soil Fauna of Ecofarmed and Conventionally farmed Vineyards, GABRIELE LÜFTENEGGER and WILHELM FOISSNER, Universität Salzburg, Institut für Zoologie, Hellbrunnerstrasse 34, A-5020 Salzburg (Austria/Europe).

Testate amoebae, nematodes and lumbricids were investigated in two vineyards, each using so-called "ecological farming" as well as more conventional techniques. In the first vineyard, 5 differently farmed areas of land were tested: (A) minimal method; (B) conventional method; (C) biodynamic method of R. Steiner; (D) organical-biological method of H. Müller; (E) semibiological method. In the second vineyard, a patch (I) with organic fertilizer and a patch (II) with compound fertilizer were compared. Generally, the ecofarmed plots showed a richer soil life than the conventionally farmed sites. Remarkably, no considerable differences exist between the unfertilized plot (A) and the conventionally fertilized plot (B). The highest abundance, biomass and species number of testate amoebae and the highest abundance of nematodes were found in the area (E); however, the abundance and biomass of lumbricids were remarkably lower when compared with (C) and (D). The abundance of lumbricids and biomass of testaceans were higher in (D) than in (C). Study area (I) gave greater values than area (II) for all parameters investigated. Concerning species composition and abundances of the testate amoebae, the communities of (C, D, B, A) were shown to be closely related, whereas the semibiological variant (E) and (I, II) were separated. The dominance index demonstrates that (E, D, C), (B, A) and (I, II) form distinct groups.

(Supported by the Fonds zur Förderung der wissenschaftlichen Forschung, project P 5889 and by the Bundesministerium für Land- und Forstwirtschaft)

SOIL FLAGELLATES

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

Soil flagellates have been largely ignored by taxonomists and ecologists. About 250 species have been reported from soils worldwide. Some 10 species seem to be restricted to terrestrial habitats, the other inhabit also limnetic and coprophilic biotopes. However, most of the taxonomic and faunistic work on soil flagellates has been done by ecologists and soil biologists not specially trained in flagellate taxonomy. I thus consider the faunal lists published as highly provisional and uncertain. Recent studies of soil ciliates and testaceans indicate that more thorough investigations will prove the existence of many flagellates restricted to terrestrial habitats (1). This is substantiated by the recent discovery of some highly unusual and interesting species, Spiromonas gonderi (2) and Hemimastix amphikineta (3), and a still unnamed form (Hülsmann, pers. comm.). The most frequently recorded species are the kinetoplastids Bodo caudatus, B. celer, B. edax, B. globosus, B. lens, B. saltans and Pleuromonas jaculans; the bodonids incertae sedis Cercobodo agilis and C. vibrans; the cercomonadids Cercomonas crassicauda and C. longicauda; the chrysomonadids Oikomonas mutabilis and O. termo; and the euglenid Scytomonas pusilla.

Detailed ecological literature on soil flagellates is almost nonexistent. Individual numbers between 0 and 10^6 /g soil have been reported. Most counts base, however, on culture techniques which do not give a realistic figure of the active cells present. Our own direct counts in soil suspensions (4) show the presence of 2.000-10.000 active flagellates/g dry mass in spruce forest litter. Recent studies by Meisterfeld (5) indicate that flagellates - in spite of their high numbers (about $\times 3 \cdot 10^9/\text{m}^2$) and short generation time - play a minor role in the carbon cycle of a submontane beech forest due to their small size and biomass ($0.054 \text{ g dry mass}/\text{m}^2$).

Future needs: taxonomic studies with modern light- and electron microscopic methods; thorough faunistic censuses in representative soil types and biotopes (saline soils, for example, have in my experience a highly characteristic flagellate fauna; as is true for the ciliates); estimation of numbers with direct counting methods; estimation of annual production in representative ecosystems.

1. Foissner, W. (1987) Progr. Protistol. 2: 69-212.
2. Foissner, W & Foissner, I. (1984) Protistologica 20: 635-648.
3. Foissner, W., Blatterer, H. & Foissner, I. (1988) Europ. J. Protistol. 23: 361-383.
4. Lüftenegger, G., Petz, W., Foissner, W. & Adam, H. (1988) Pedobiologia 31: 95-101.
5. Meisterfeld, R. (1989) Verh. Ges. Ökol. 17: 221-227.

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ABSTRACTS

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Systematic Position of the Enigmatic Soil Ciliate Colpodidium caudatum Wilbert, 1982, WILHELM FOISSNER, Universität Salzburg, Hellbrunnerstrasse 34, A-5020 Salzburg (Austria).

Wilbert (1982) classified C. caudatum as colpodid ciliate because of its somatic dikinetids and its 2 ciliary fields located in an inconspicuous vestibulum. However, a reinvestigation using various silver impregnation methods showed that C. caudatum has somatic monokinetids; an argyrophilic granule, presumably an alveolocyst, is tightly attached to each kinetid and was apparently mistaken as basal body by Wilbert. Dikinetids occur only in a short, curved kinety at the right margin of the "vestibulum"; this kinety is obviously a paroral membrane. A tightly meshed, irregular silverline system is clearly recognizable after dry silver nitrate impregnation. Division occurs in free-swimming condition. Three adoral membranelles and a small, but distinct cytopharyngeal basket are recognizable during stomatogenesis. Two of the membranelles and the nematodesmal basket are somewhat disorganized, or even partially resorbed during the last stages of the cytokinesis. These data show that C. caudatum is near the family Furgasoniidae, order Nassulida. This is supported by the location of the contractile vacuole and the cytopyge (both close underneath the oral apparatus), the tightly meshed silverline system, the somatic monokinetids and the paroral dikinetids). Colpodidium has some distinct apomorphies (displacement of the oral apparatus to centre of cell, rather distinct "vestibulum", partial resorption of the adoral membranelles and the cytopharyngeal basket) which suggest maintenance of the family Colpodidiidae Puytorac, Didier, Detcheva & Foissner, 1983. It is, however, transferred from the order Colpodida to the order Nassulida.

BESPRECHUNGSBELEG

Berichte über Landwirtschaft
Berichte der Deutschen Wissenschaftlichen
Kommission für Meeresforschung
Zeitschrift für Tierphysiologie,
Tierernährung und Futtermittelkunde
Zeitschrift für Tierzüchtung und
Züchtungsbiologie
Natur und Recht

Zeitschrift für zoologische Systematik
und Evolutionsforschung
Zeitschrift für Säugetierkunde
Zeitschrift für angewandte Entomologie
European Journal of Forest Pathology
Forstwissenschaftliches Centralblatt
Forstliche Umschau
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Zeitschrift für angewandte Ichthyologie

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(1991)

VERLAG PAUL PAREY · HAMBURG UND BERLIN · SPITALERSTR. 12 · 2000 HAMBURG 1

FORDHAM, B. G.: Miocene-Pleistocene Planktic Foraminifers from D.S.D.P. Sites 208 and 77, and Phylogeny and Classification of Cenozoic Species. Evolutionary Monographs 6, 1986. Chicago: University of Chicago 1986. 200 pp., 25 plates. \$ 28,- (institutions), \$ 24,- (individuals)

Die Studie bringt eine monographische Bearbeitung der planktischen Foraminiferen aus dem Känozoikum. Als Basis dienen die Tiefseebohrungen (Deep-Sea-Drilling-Project = D.S.D.P.) 77 und 208 im Pazifischen Ozean. Insgesamt anerkennt der Autor 138 Nominal-Arten, darunter auch mehrere neue. Er versucht, die Evolution dieser Taxa mit Hilfe einer kladistischen Methode (stratophänetische Analyse) aufzuklären. Die Resultate werden übersichtlich in Form von Tabellen, Kladogrammen und vielen rasterelektronenmikroskopischen Bildern dokumentiert. Kritische Anmerkungen und ergänzende Beobachtungen zu den einzelnen Phäna und ein umfangreicher Index zeigen die gründliche Auseinandersetzung des Autors mit diesem schwierigen Thema.

Die kladistische Basis der Revision wird in einleitenden Kapiteln ausführlich diskutiert und mit früheren Versuchen verglichen. Zur Benennung seiner „Klado-Gruppen“ entwickelt der Autor eine neue Nomenklatur, über deren Praktikabilität man sicher geteilter Meinung sein kann. Sind Namen wie „Globigerinivicesimaeseptimae“ oder „Globigeriniquintaedecime“ wirklich noch auszusprechen? Die Literaturübersicht endet leider mit dem Jahr 1979, da die Drucklegung des Werkes durch widrige Umstände lange verzögert wurde.

Diese tiefeschürfende Monographie kann allen einschlägig arbeitenden Protistologen bestens empfohlen werden.

W. FOISSNER, Salzburg

THE CILIATE ATLAS - MORPHOLOGY AND ECOLOGY OF THE CILIATED PROTOZOA
USED AS INDICATORS OF WATER QUALITY

Wilhelm FOISSNER, Hubert BLATTERER, Helmut BERGER & Fritz KOHMANN
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KOLKWITZ & MARSSON and LIEBMANN, the founders of the saprobic system, praised the ciliates as indicators for evaluating the quality of running and stagnant waters. This has been confirmed by later investigations. In spite of this, ciliates are increasingly ignored by field ecologists because their identification is supposedly more difficult than that of the mesofauna. This is correct inasmuch as handsome and accurate identification literature is lacking - a shortage which should be redressed by our "ciliate atlas". Furthermore, we reviewed the faunistic and ecologic literature distributed in thousands small papers. This provides the saprobic evaluation of individual species with a more reliable basis and shows research needs.

The taxonomic and ecologic revision of the ciliates used as biologic indicators in the saprobic system will comprise four volumes with about 90 species each. Volume I has already been published and is sold by the "Bayerisches Landesamt für Wasserwirtschaft, Lazarettstrasse 67, D-8000 München 19". Volume II is in preparation. Each species is treated monographically which causes a considerable size of the atlas. Such a detailed treatment was, however, called for since this is the best way to document the faunistic and autecologic literature properly. The very popular image-based keys are certainly short and user friendly, but easily mislead unspecialized users. In our atlas each species is pre-identified by such a simple picture-key; for accurate determination it is, however, also described in detail and documented by line drawings and photographs. Usually, keys and descriptions are prepared as to enable identification from life. To achieve this goal, we have reinvestigated most species and included photographs from live and/or prepared cells; in addition, many species are shown by scanning electron micrographs intended to please the eyes and to help beginners to get acquainted with the group.

Our revision addresses not only river biologists but also those who are engaged in the control of sewage plants, lakes and drinking waters. All data relating to these fields have been included.

Each volume contains a general part treating a special field in detail. Volume I, for instance, contains sampling advices and methods needed for successful identification of ciliated protozoa, e. g. live observation and silver impregnation protocols.

Supported by the Bayerisches Landesamt für Wasserwirtschaft

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ULTRASTRUCTURE OF THE MYCOPHAGOUS CILIATE GROSSGLOCKNERIA ACUTA
(CILIOPHORA, COLPODEA) AND PHYLOGENETIC AFFINITIES OF COLPODID
CILIATES

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Ultrastructural features of *Grossglockneria acuta* Foissner, 1980 are very similar to those known in the confamilial species, *Pseudoplatyophrya nana*. The somatic infraciliature corresponds to the typical colpodid dikinetid pattern. The peculiar oral apparatus is described in detail. The feeding tube contains about 17 concentric cytostomial microtubular lamellae and postciliary microtubules. The lamellae are interconnected by dense plaques and their innermost microtubules anchor in dense material at the distal end of the tube. The postciliary ribbons of the paroral kinetosomes extend subpellicularly into the proximal region of the tube. It is supposed that supernumerary postciliary microtubules are proliferated and assemble to the cytostomial microtubular lamellae during stomatogenesis. Few transverse microtubules are associated to some adoral and presumably all paroral kinetosomes; they do not extend into the tube. Most basal bodies of the single adoral organelle lack kinetosomal derivatives. The Grossglocknerida and Colpodida are suggested to be sister groups because they undergo a telokinetal stomatogenesis in reproductive cysts. The colpodid kinetid is characterized by a compound microtubular structure of posterior transverse ribbons to the left of the kinety. Several hypotheses as to the origin of the typical colpodid kinetid pattern, especially the posteriorly extending transverse microtubules, are discussed. Available evidence suggests haptorid or nassulid ancestors of the colpodids. Some data indicate a paraphyletic composition of the class.

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Schon KOLKWITZ & MARSSON und LIEBMANN, die Begründer des Saprobiensystems, schätzten die Ciliaten als Indikatoren bei der Erhebung der Gewässergüte. Spätere Untersuchungen haben dies bestätigt. Dennoch werden sie in neuerer Zeit immer seltener zur Bioindikation verwendet, weil ihre Bestimmung angeblich schwieriger ist als beim Makrozoobenthos. Dies ist nur insofern richtig, als es keine modernen und praktischen Anforderungen genügende Bestimmungsliteratur gibt. Diese Lücke soll durch unser Werk geschlossen werden. Außerdem haben wir uns bemüht, die in Tausenden Einzelarbeiten verstreute faunistische und autökologische Literatur kritisch zu sichten, um die saprobielle Einordnung der Arten entweder auf eine solide Basis zu stellen oder entsprechende Lücken aufzuzeigen.

Die taxonomische und ökologische Revision der Ciliaten des Saprobiensystems wird voraussichtlich 4 Bände mit je etwa 90 Arten umfassen. Band I ist bereits erschienen und kann beim Bayerischen Landesamt für Wasserwirtschaft bezogen werden. Band II ist in Vorbereitung. Jede Art ist monographisch dargestellt, was den beträchtlichen Umfang des Werkes verursacht. Wir haben uns für diese Art der Bearbeitung entschieden, weil nur so gewährleistet ist, daß die Determinationen in Zukunft genauer sein werden und die vielen faunistischen und ökologischen Daten ausreichend dokumentiert sind. Die so beliebten Bildbestimmungsschlüssel sind zwar kurz und benutzerfreundlich, täuschen aber gerade den nicht auf die Gruppe spezialisierten Bearbeiter über die Tatsache hinweg, daß damit leicht Fehlbestimmungen möglich sind. Jede Art kann zuerst über einen einfachen Bildbestimmungsschlüssel "vorbestimmt" und dann im speziellen Teil, wo sie durch Zeichnungen und Fotos genau dokumentiert ist, "nachbestimmt" werden. Viele Arten haben wir neu untersucht, um Fotografien von lebenden und/oder präparierten Zellen anzufertigen. Die meisten Arten sind auch durch rasterelektronenmikroskopische Bilder dokumentiert, was nicht nur das Auge erfreuen sondern hoffentlich auch dem Anfänger die Einarbeitung erleichtern wird.

Der umfassenden Konzeption entsprechend, richtet sich die Revision nicht nur an Fließgewässerbiologen/innen sondern genauso an jene Kollegen/innen, die in Klärwerken, bei der Seenüberwachung und der Trinkwasseraufbereitung tätig sind. Alle einschlägigen Daten wurden in die ökologische Auswertung aufgenommen.

Neben der Beschreibung der Arten enthält jeder Band einen allgemeinen Teil, in dem ein spezielles Kapitel ausführlicher dargestellt wird. Im Band I ist beispielsweise die "Probenahme und Untersuchung der Ciliaten bei der Bestimmung der Gewässergüte" detailliert beschrieben. Band II wird eine kurze allgemeine Ökologie, Band III die allgemeine Morphologie und Band IV einen Bestimmungsschlüssel für die Großgruppen der Ciliaten enthalten.

Vortrag bei der "Deutschsprachigen Limnologentagung" in Mondsee,
30. September bis 4. Oktober 1991

Autor(en): FOISSNER, W., BLATTERER, H., BERGER, H. & KOHMANN, F.
Universität Salzburg und Bayerisches Landesamt für Wasserwirtschaft

Titel: THE CILIATE ATLAS - MORPHOLOGY AND ECOLOGY OF THE CILIATED PROTOZOA
USED AS INDICATORS OF WATER QUALITY

Abstract: KOLKWITZ & MARSSON and LIEBMANN, the founders of the saprobic system, praised the ciliates as indicators for evaluating water quality. In spite of this, ciliates are increasingly ignored by field ecologists because their identification is supposedly more difficult than that of the mesofauna. This is correct inasmuch as handsome and accurate identification literature is lacking - a shortage which should be redressed by our "ciliate atlas". Furthermore, we reviewed the faunistic and ecologic literature distributed in thousands small papers. This provides the saprobic evaluation of individual species with a more reliable basis and shows research needs. In our atlas each species is pre-identified by a simple picture-key; for accurate determination it is, however, also described in detail and documented by line drawings, light microscopic and scanning electron microscopic micrographs. The revision will comprise four volumes with about 90 species each and addresses not only river ecologists but also those who are engaged in the management of sewage plants, lakes and drinking waters. Volume I has already been published and is sold by the "Bayerisches Landesamt für Wasserwirtschaft, Lazarettstrasse 67, D-8000 München 19".

Beispiel:

Autor(en): DOKULIL, M.T., SCHMIDT, R. & SKOLAUT, C.

Titel: UNTERSUCHUNGEN ZUR POPULATIONSDYNAMIK VON TABELLARIA FLOCCULOSA IM MESOTROPHEN MONDSEE, ÖSTERREICH.

Abstract: Im Jahresgang wies Tabellaria flocculosa var. fenestrata in den Jahren 1982 -1990 einen.....

DER BODENBIOLOGISCHE INDEX (BI) - EIN QUANTITATIVES
MASS FÜR DIE BODENQUALITÄT

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Der Bodenbiologische Index verrechnet folgende Eigenschaften von Taxozönosen zu einer einfachen Maßzahl: Artenzahl, Individuenabundanz, Individuen-
dominanz, Stärke der Bindung an das Biotop (Autochthonie) und das "ökologische Gewicht" der einzelnen Arten. Der Index ist so aufgebaut, daß er für verschiedene Gruppen von Bodenorganismen geeignet bzw. leicht modifiziert werden kann und daß weitere oder andere gruppenspezifische Strukturparameter aufgenommen werden können. Die Auswertung von Literaturdaten zeigte, daß die Maßzahl in den meisten Fällen gut mit der verbalen Interpretation der Resultate übereinstimmt. Der Index ist allerdings keine absolute Größe sondern nur sinnvoll in Verbindung mit (unbehandelten) Kontroll- bzw. Referenzflächen zu interpretieren.

1991

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70 (p. 12A)

Biology of a High-Rate Activated Sludge Plant of a Pharmaceutical Company, ERNA AESCHT and WILHELM FOISSNER, Universität Salzburg, Institut für Zoologie, Hellbrunnerstrasse 34, A-5020 Salzburg.

The number, biomass and species composition of activated sludge organisms were studied in 11 samples, collected monthly, from a very highly loaded (BOD_5 21 kg/m³.d; COD 38 kg kg/m³.d) bio-reactor purifying waste water consisting mainly of the medium used to culture *Penicillium chrysogenum*. High population densities of the microflora and microfauna indicate that the waste water do not contain toxic compounds beyond tolerable limits. The organic substance on average amounts to 16 g dry mass/l; it consists of 96% prokaryotic (bacterial) and 4% eukaryotic (protozoan) biomass. Related to suspended solids the protozoan biomass constitutes 2%; 4 tons protozoa (wet mass, corresponding to 800 kg dry mass) are produced in 1400 m³ waste water daily. On average 2 million flagellates, 1.3 million globular non-motile organisms, 340000 naked amoebae, 53000 ciliates and 29 rotifers occurred per ml activated sludge. The high organic load, the short retention time (24 hrs), the high temperature (30°C) and the lack of distinct flocs favour few well adapted polysaprobic protozoan species; a new hypotrich ciliate (*Parastrongylidium*) has been found.

77 (p. 13A)

Polyhymenophora JANKOWSKI, 1967: a New Name for the Spirotrichs of BÜTSCHLI? HELMUT BERGER and WILHELM FOISSNER, Institute of Zoology, University of Salzburg, Hellbrunnerstrasse 34, A-5020 Salzburg, Austria.

The subclass Polyhymenophora was established in 1967 by JANKOWSKI (Trudy zool. Inst., Leningr., 43: 45) as "nomen novum" to replace the Spirotricha of BÜTSCHLI (1889, Protozoa, p. 1719). The most important character of the Polyhymenophora JANKOWSKI, 1967, is the polyhymenium, a little-used term for denoting the multiple-membranelle situation manifest in the oral area of this group of ciliates. A comparison between BÜTSCHLI's spirotrichs and JANKOWSKI's polyhymenophorans shows no significant difference, i. e. both taxa contain largely the same taxa and have the same diagnostic features. JANKOWSKI introduced the Polyhymenophora as "nomen novum". This is, however, incorrect since BÜTSCHLI's name is not preoccupied. Obviously the "Polyhymenophora" extends only the already too long list of unnecessary names for higher categories of ciliates.

72 (p. 12A)

Ultrastructure of the Mycophagous Ciliate *Grossglockneria acuta* (Ciliophora, Colpodea) and Phylogenetic Affinities of Colpodid Ciliates, ERNA AESCHT, WILHELM FOISSNER and MARIA MULISCH, Universität Salzburg, Institut für Zoologie, Hellbrunnerstrasse 34, A-5020 Salzburg (Austria) and Universität Köln, Zoologisches Institut, Köln, FRG.

Ultrastructural features of *Grossglockneria acuta* FOISSNER, 1980 are very similar to those known in the confamilial species *Pseudoplatyophrya nana*. The somatic infraciliature corresponds to the typical colpodid dikinetid pattern. The peculiar oral apparatus is described in detail. The feeding tube contains about 17 concentric microtubular lamellae and postciliary microtubules which originate from the paroral membrane. It is supposed that supernumerary postciliary microtubules are proliferated and assemble to the microtubular lamellae during stomatogenesis. Few transverse microtubules are associated to some adoral and presumably all paroral kinetosomes; they do not extend into the feeding tube. Most basal bodies of the single adoral organelle lack kinetosomal derivatives. The *Grossglockneria* and *Colpodida* are suggested to be sister groups because they undergo a telokinetal stomatogenesis in reproductive cysts. The colpodid kinetid is characterized by a compound microtubular structure of posterior transverse ribbons to the left of the kinety. Several hypotheses as to the origin of the typical colpodid kinetid pattern, especially the posteriorly extending transverse microtubules, are discussed. Available evidence suggest haptorid or nassulid ancestors of the colpodids. Some data indicate a paraphyletic composition of the class.

93 (p. 16A)

Phylogenetic Relationships in Oligotrich Ciliates, WOLFGANG PETZ and WILHELM FOISSNER, Universität Salzburg, Institut für Zoologie, Hellbrunnerstrasse 34, A-5020 Salzburg.

The somatic kineties of *Strobilidium caudatum* form a spiral at the posterior pole. Strobilids without such a spiral are transferred to the genus *Rimostrombidium* Jankowski. 14 new combinations and a nomen novum are necessary. *Meseres* sp. is characterized by 8 somatic kineties composed of long, rather stiff cilia (not bristles like in *Halteria*). *Strombidium* sp. has an anterior and an equatorial girdle of extrusomes. The morphogenesis of *Meseres* and *Halteria* is very similar, i.e. the somatic ciliature of proter and opisthe and the oral primordium originate apokinetally on the cell surface; the parental somatic ciliature is resorbed. In strobilids and tintinnids, the oral anlage develops in a subsurface pouch and the parental somatic kineties, which are not resorbed, simply elongate by addition of new basal bodies. In strombidids, the oral primordium develops in a long intracellular sac or tube. These morphogenetic peculiarities and some distinct morphologic characters (e.g., somatic monokinetids, arrangement of adoral membranelles, lorica) were applied in reconstructing a phylogenetic system for oligotrichs using hypotrichs as outgroup. This shows that halterids are more closely related to hypotrichs than other oligotrichs.

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The Ciliate Atlas - Morphology and Ecology of the Ciliated Protozoa used as Indicators of Water Quality, WILHELM FOISSNER, HUBERT BLATTERER, HELMUT BERGER and FRITZ KOHMANN, Universität Salzburg, Institut für Zoologie, Hellbrunnerstrasse 34, A-5020 Salzburg and Bayerisches Landesamt für Wasserwirtschaft, Lazarettstrasse 67, D-8000 München 19.

Ciliates are excellent bioindicators. In spite of this, they are often ignored by field ecologists because their identification is supposedly more difficult than that of the mesofauna. This shortage should be redressed by our "ciliate atlas". We also reviewed the faunistic and ecological literature distributed in thousands small papers. This causes a considerable size of the atlas, viz. 4 volumes with 500 pages each. Volume I has already been appeared and is sold (50 US\$) by the "Bayerisches Landesamt für Wasserwirtschaft, Lazarettstrasse 67, D-8000 München 19". In our atlas each of the 400 species treated is pre-identified by a simple picture-key; for accurate determination each species is, however, also described in detail and documented by line drawings, light micrographs of living and silver prepared specimens and by scanning electron micrographs. Usually, keys and descriptions are prepared as to enable identification from life. Our revision addresses not only river biologists but also those who are engaged in the control of sewage plants, lakes and drinking waters. All data relating to these fields have been included.

Supported by the Bayerisches Landesamt für Wasserwirtschaft.

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Organization and Dynamics of the Cytoskeleton in Ciliates: An Immunocytochemical Study

A. FLEURY¹, M. LAURENT², J. C. CLÉROT¹,
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Three main cytoskeletal components scaffold the cortex and anchor the ciliature in ciliates: 1) the ecto-endoplasmic layer (LEE) of microfilaments made up from calcium binding proteins anchoring the proximal end of the basal bodies; 2) the epiplasm, patterned as a continuous submembranous layer interconnected with basal body associated rootlets; 3) a superficial layer of microtubules in which microtubular basal body rootlets are integrated. Data collected through immunocytochemistry have yielded a good knowledge at the whole cell level about the organization and the dynamics of these structures in relation to the patterning of the infraciliature.

Paramecium constitutes a wonderful model for studying the dynamics of the epiplasm and its interconnections with the infraciliature. Morphogenesis during division progresses through elongation and segmentation of epiplasmic scales following basal body multiplication; this process is correlated with sequential regression and elongation of one large basal body rootlet, the kinetodesmal fiber. Such a system thus appears to be basically a conservative one. On the contrary, ciliates in which the cortex is scaffolded with a superficial network of microtubules appear to be regulative systems. A discontinuity in the transmission of the infraciliary pattern may occur during the cell cycle; the study of basal body nucleation and microtubular movements during such a process shows that the main cellular territories are "printed" on the cortex via the patterning of the microtubules. Unfortunately, very few data are available about the dynamic of the LEE.

These results show that the main dynamic characteristics of morphogenesis may at least in part be related to the properties of the cytoskeletal components.

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The Fine Structure of two New Hemimastigophoran Flagellates Related to *Spironema multiciliatum* Klebs, 1893

I. FOISSNER and W. FOISSNER

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Spironema multiciliatum is a contractile, heterotrophic freshwater flagellate with two slightly spiralling flagellar rows. We found two similar organisms in a mesosaprobic river from Germany and in a soil sample from the Grand Canyon area (USA), respectively. The species from the Grand Canyon resembles an organism found by Goodey (1916) in an English soil but has a roundish nucleus. The fine structure of both species is very similar to that of *Hemimastix amphikineta* Foissner et al., 1988, i. e., its pellicle is composed of two plates having diagonal symmetry. Furthermore, they have very similar extrusomes and fibrillar associates of the basal bodies. The species from the Grand Canyon shows, like *S. multiciliatum* Klebs, pronounced euglenoid movement supporting our hypothesis that the Hemimastigophora are related to the euglenoids. Five hemimastigophoran flagellates can be distinguished according to shape, size and contractility of body, shape and size of nucleus, length of flagellar rows and details of pellicle and extrusomes. Our findings show that the Hemimastigophora are more widespread and more diverse than supposed.

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On the Biology and Ecology of Mycophagous Soil Protozoa

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Many soil protozoa are facultative mycophages; few are obligate yeast and/or fungal feeders, viz. the naked amoebae, *Thecamoeba granifera minor* and *Cashia myocophaga* as well as the ciliates, *Grossglockneria acuta*, *G. hyalina*, *Pseudoplatyophrya nana*, *P. terricola*, *P. saltans* and *Nivaliella plana*. Feeding occurs by perforation lysis (some amoebae, all ciliates) or general lysis. In perforation lysis, the fungal cell wall is breached by discrete holes and the fungal contents are discharged and utilized by the amoebae and ciliates. Those ciliates which are obligate fungal feeders belong to a single systematic group (class Colpodea) and have evolved a highly complicated feeding organelle, the feeding tube. Perforation is accomplished very likely by special enzymes, viz. cellulase and chitinase. Some species feed selectively on certain fungi and/or yeasts, including plant pathogens. There is evidence from pot experiments that such activities can reduce inoculum levels of plant pathogenic fungi in soils and can reduce the severity of take-all disease of wheat caused by *Gaeumannomyces graminis tritici*. It is, however, unlikely that mycophagous soil protozoa can significantly reduce soil fungal populations.

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Protozoan Bioassays of Heavy Metal Contamination of Soils Amended with Sewage Sludge Using *Colpoda steinii*

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A. WARREN

Natural History Museum, London, U.K.; Macaulay
Land Use Research Institute, Aberdeen, U.K.

The common soil ciliate, *Colpoda steinii*, was used to study the toxicity of sulphate solutions of cadmium, copper, nickel and zinc. Growth of *C. steinii* was reduced by 50 % by 0.22, 0.25, 0.10 and 0.85 mg/l of Cd, Cu, Ni and Zn, respectively within 24 hours. The same growth assay was used to assess the toxicity of soil solutions extracted from soil samples of field plots treated with heavy metals and sewage sludge at concentrations equivalent to, and twice the limits of, recent EC guidelines. The toxicity of the soil solutions varied with the season of the year. None of the soil solutions extracted in the winter (February 1991) inhibited the growth of *C. steinii*. In summer (July 1991), growth was reduced in solutions extracted from plots that were amended with sludge plus additional Zn and Ni. These changes in toxicity to *C. steinii* of the soil solutions between winter and summer were positively correlated with changes in concentrations of Zn and Ni between the two samples. These preliminary results suggest that regular protozoan bioassays may be used for rapid monitoring of the biological availability of heavy metals in soils especially when combined with chemical analyses of soil solutions.

TAXONOMISCHE UND ÖKOLOGISCHE REVISION DER CILIATEN DES SAPROBIEN-
SYSTEMS - BAND II: PERITRICHIA, HETEROTRICHIDA, ODONTOSTOMATIDA

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In der mesosaproben und polysaproben Verunreinigungsstufe sind die Ciliaten unverzichtbare Indikatoren. Auch greifen sie hier entscheidend in den Energiefluß ein, da sie eine Siedlungsdichte von mehreren Milliarden/m² aufweisen. Dennoch werden sie von Ökologen und Praktikern oft vernachlässigt, weil ihre qualitative und quantitative Erfassung angeblich viel schwieriger ist als beim Makrozoobenthos. Dies ist nur insofern richtig, als es keine modernen und praktischen Anforderungen genügende Bestimmungsliteratur gibt und hinsichtlich der quantitativen Erfassung noch ein beträchtliches Forschungsdefizit herrscht. Diese Lücke soll mit unserem "Ciliaten-Atlas" geschlossen werden, dessen erster Band eine erfreulich positive Aufnahme bei Praktikern und Fachkollegen gefunden hat.

Der zweite Band des Ciliaten-Atlas behandelt die "Glockentierchen" und die Faulschlamm-Ciliaten. Erstere sind besonders wichtig bei der Beurteilung der Reinigungsleistung von biologischen Kläranlagen, letztere sind strikte Anaerobier, weshalb bereits der Nachweis von Einzelexemplaren ausreicht, um Sauerstofffreiheit eines Gewässers zu belegen. So wie im Band I ist auch im Band II jede Art bzw. Artengruppe monographisch dargestellt, um eine sichere Determination zu ermöglichen und die vielen faunistischen und ökologischen Daten ausreichend zu dokumentieren. Jede Art kann zuerst über einen einfachen Bildbestimmungsschlüssel "vorbestimmt" und dann im speziellen Teil, wo sie durch Zeichnungen und Fotos ausführlich dokumentiert ist, "nachbestimmt" werden. Viele Arten haben wir neu untersucht, um Fotografien von lebenden und/oder präparierten Zellen anzufertigen. Viele Arten sind auch durch rasterelektronenmikroskopische Bilder dokumentiert, was nicht nur das Auge erfreuen sondern auch dem Anfänger die Einarbeitung erleichtern wird.

Der umfassenden Konzeption entsprechend, richtet sich die Revision nicht nur an Fließgewässerbiologen/innen sondern genauso an jene Kollegen/innen, die in Klärwerken, bei der Seenüberwachung und der Trinkwasseraufbereitung tätig sind. Alle einschlägigen Daten wurden in die ökologische Auswertung aufgenommen. Ferner enthält Band II einen umfangreichen allgemeinen Teil mit einer ökologischen Datensammlung (Abundanzen, Biomassen, Produktion, Respiration...) und eine allgemein verständliche Einführung in die Zoologische Nomenklatur.

Die Bände I und II sind beim Bayerischen Landesamt für Wasserwirtschaft, Lazarettstraße 67, D-8000 München 19, zu beziehen. Band III wird 1993 erscheinen. Jeder Band hat etwa 500 Seiten und kostet rund 80 DM.

Prof. Dr. Wilhelm Foissner, Zoologisches Institut der Universität Salzburg:

Zerstören die Bauern das Bodenleben?

Ergebnisse einer Vergleichsstudie zur konventionellen und biologischen Landwirtschaft

Das Institut für Zoologie (Tierkunde) der Universität Salzburg hat daher in den Jahren 1984 bis 1988 Untersuchungen über die Bodentiere in ökologisch und konventionell bewirtschafteten Acker- und Grünlandflächen durchgeführt. Studiert wurden insgesamt 13 Vergleichspaare in Salzburg, Niederösterreich und der Steiermark. Die Untersuchungen konnten unbeeinflusst von wirtschaftlichen und weltanschaulichen Aspekten durchgeführt werden, da sie vom Fonds zur Förderung der wissenschaftlichen Forschung finanziert wurden. Die Resultate sind kurz gefaßt folgende:

1. Viele der untersuchten bodenzologischen Merkmale sind in den ökologisch und konventionell bewirtschafteten Äckern und Wiesen fast gleich.

2. Auffallende Unterschiede im Artenspektrum und in der Gemeinschaftsstruktur der Einzeller (Protozoen), eine wegen ihrer kurzen Generationszeit und ihres hohen Beitrages zum Energieumsatz besonders wichtige Indikatorgruppe, sind nicht nachweisbar.

3. Alle statistisch absicherbaren Unterschiede weisen ausnahmslos in Richtung einer höheren biologischen Aktivität der ökologisch bewirtschafteten Flächen. Die zum Teil parallel mitgeführten bodenkundlichen Untersuchungen deuten darauf hin, daß dafür der etwas höhere Humusgehalt und der etwas lockerere Boden verantwortlich sind.

4. In Ackerflächen aus Trockengebieten ohne Viehwirtschaft (z. B. Marchfeld) beeinträchtigt die konventionelle Landwirtschaft die Bodentiere stärker als in der atlantischen Klimazone (z. B. Salzburg) mit gemischter Wirtschaft. Nur in den extremen Gebieten, wo z. B. Wasser ein begrenzender Faktor ist, wird das Bodenleben durch die Intensivlandwirtschaft schwer gestört.

Diese Daten zeigen, daß eine differenzierte Betrachtungswei-

In den letzten Jahren wird verstärkt der „ökologische“ oder „biologische“ Landbau propagiert, der weitgehend oder ganz auf rasch lösliche, synthetische Mineraldünger („Kunstdünger“), Pestizide (Insekten- und Unkrautvernichtungsmittel) und Wachstumsregulatoren verzichtet. Durch sorgfältig aufbereitete natürliche Dünger (Mist, belüftete Jauche, Steinmehl etc.) und durch schonende Bodenbearbeitung (Verzicht auf schwere landwirtschaftliche Maschinen, pflugloser Ackerbau) sollen das Bodenleben aktiviert und/oder erhalten und die Ertragsfähigkeit der Böden langfristig gesichert werden. Von den Gegnern der „Biobauern“ wurde aber mit Recht darauf verwiesen, daß es sich bei diesen Meinungen mehr um ein Glaubensbekenntnis als um wissenschaftlich fundierte Fakten handelt.

se nötig ist. Mit Schlagwörtern wie „die konventionelle Landwirtschaft zerstört das Bodenleben“ oder „alles ist in Ordnung“ ist niemandem geholfen. Die hier und auch in Deutschland nachweisbare Beeinträchtigung der Böden durch zu intensive Nutzung sollte ernst genommen, aber nicht dramati-

siert werden. Neue Wege in der Landwirtschaft müssen erprobt und von bodenbiologischer Forschung begleitet werden.

Anmerkung für Politiker

Zum letzten Punkt eine Anmerkung für Politiker und Interessengruppen. Man hat in Salz-

burg und in anderen Bundesländern einen sogenannten „Bodenkataster“ erstellt. Aber nicht, wie es schon der Hausverstand fordert, unter Einfluß der Bodenbiologie, sondern wiederum nur mit chemisch-physikalischen Methoden, obwohl dazu ohnehin schon zahllose Daten vorliegen.

Diesbezügliche Einwände von seiten der Experten hat man großzügig überhört, und das Angebot der Universität, entsprechende Untersuchungen durchzuführen, ist in den Schubladen der Beamten versickert. Ein Bodenkataster ohne Bodentiere ist ein „alter Hut“ (= unzeitgemäß), und die Politiker sollten über eine alte Weisheit nachdenken: „Handwerk ist auf die Dauer besser als Mundwerk.“

Die „sanfte“ Landschaftspflege

Naturnähe wird beim städtischen Gartenamt großgeschrieben

Das Stadtgartenamt setzt bei Pflege und Betreuung der vielfältigen städtischen Grünlandschaft bereits bei der Auswahl der dazu eingesetzten Mittel und bei der Erhaltung eines größtmöglichen Artenreichtums der Pflanzen und der mit ihnen in Symbiose lebenden Insekten auf Naturnähe.

Die Schönheit der Anlagen und die Früchte der „sanften Landschaftspflege“ bestätigen die Richtigkeit des eingeschlagenen Weges.

Schädlinge werden nicht durch Pestizide bekämpft, sondern durch den Einsatz nützlicher Lebewesen, Unkraut wird nicht durch chemische Vertilgungsmittel beseitigt, sondern mit Infrarotgeräten.

„Entwicklungshilfe“ für potentielle Biotope in öffentlichen Grünanlagen wird ebenso wie die naturnahe Bewirtschaftung von Wiesenflächen in Zusammenarbeit mit dem Institut für Botanik an der Universität Salzburg betrieben.

Die Sorgfalt beim Umgang mit der Natur wird auch auf die Sportplätze in der Stadt angewendet. Sportvereine müssen einen Düngeplan vorlegen, um die Düngemittel zu bekommen. Das Gartenamt sorgt auch für einen spielfesten Rasen im Leherer Stadion, eine Aufgabe,

die viel Erfahrung und Fachwissen verlangt.

Was im Grünbereich der Stadt einschließlich Stadtberge manchmal als „ungepflegt“ erscheinen mag, ist in Wirklichkeit der lebendige Ausdruck einer intakten Natur, die nicht „zu Tode gepflegt“ wurde.



Auch dafür sorgt das städtische Gartenamt: Daß der Rasen im Leherer Stadion auch für Spitzensport bespielbar ist. Foto: Krug

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W. Foissner (Salzburg) & G. Burkl (München):

Ciliates and testate amoebae in acidified mountain streams.

The ciliates (qualitative) and testate amoebae (qualitative and quantitative) in the sediment (0-3 cm) of three small streams with different pH (Eger, pH 6; Röslau, pH 5; Zinnbach, pH 4) were investigated in spring and autumn 1992.

The species number of ciliates decreased with decreasing pH (Eger 53, Röslau 41, Zinnbach 38) and acidophilic taxa were most numerous in the Zinnbach. The species number of the testaceans was similar in all streams (42 - 45 taxa). However, acidophilic species, mainly of the family Nebelidae, increased from the Eger to the Zinnbach. The individual number and the biomass of the testate amoebae distinctly with decreasing pH: Eger 8125×10^3 ind./m² (311 mg), Röslau 11250×10^3 ind./m² (606 mg), Zinnbach 14375×10^3 ind./m² (1323 mg).

These data indicate pH-dependent protozoan communities. The high number of testate amoebae in the sediment suggest that they play an essential part in the energy transfer, especially in acidified streams where the macrozoobenthos is often depleted.

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The Hemimastigophora, remarkable heterotrophic flagellates possibly related to euglenoid protists

Die Hemimastigophora, eine außergewöhnliche Gruppe heterotropher Flagellaten, die vielleicht mit den Euglenophyten verwandt ist

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The phylum Hemimastigophora was established in 1988 by Foissner W et al (Europ J Protistol 23, 361) for a unique flagellate, *Hemimastix amphikineta*, discovered in Gondwanian soils. Later, two new species and a new genus were found in freshwaters and soils from Europe and North America (Foissner I, Foissner W: J Protozool, in press). The Hemimastigophora have a unique combination of characters: 2 longitudinal rows of cilia-like flagella are associated with 2 microtubular systems and a membranous sac (Fig. 2); the flagella rows are interposed between 2 large, plicated and microtubule-bearing cortical plates having a diagonal (rotational) symmetry (Fig. 1); the nucleolus persists throughout nuclear division; the mitochondrial cristae are saccular to tubular; complex extrusomes; lack of a permanent cytostome-cytopharyngeal complex, pharyngeal rods, striated fibres, mastigonemes, and paraflagellar rods. Three of the five species known show distinct euglenoid movement (Fig. 3) which, like the special diagonal symmetry of the cortical plates, argues for a common ancestor with the euglenoid-kinetoplastid flagellates (Fig. 1). It is unlikely that such complex synapomorphies evolved twice. However, other characters, especially the lack of euglenoid mitochondrial cristae and the distinct flagella rows with their complex "infraciliature" indicate a long-lasting, separate evolution of the Hemimastigophora. We thus suggest to keep separate these puzzling organisms from the euglenophytes at phylum or class level. The Hemimastigophora give an idea how the complex infraciliature of the ciliates may have evolved (Fig. 2).

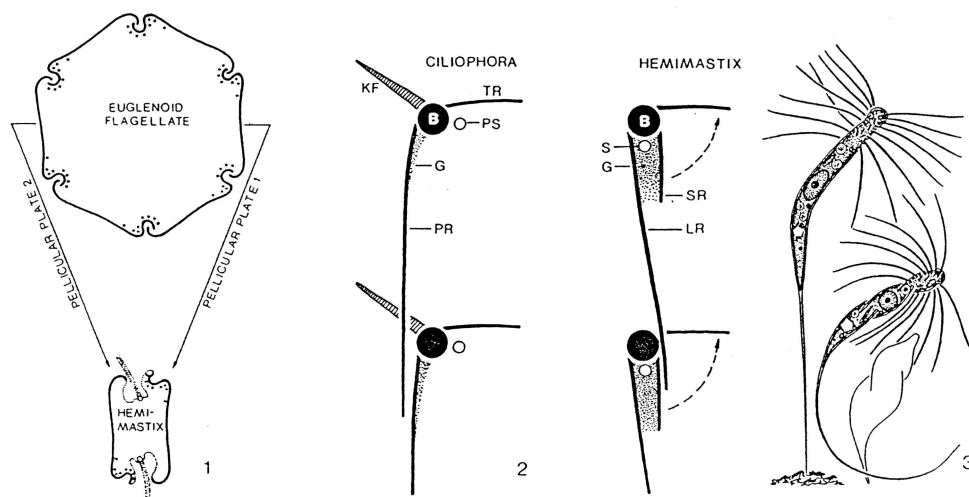


Fig. 1. A *Hemimastix*-like organism can be modeled by taking 2 opposite cortical plates and their associated microtubules (black dots) of an euglenoid flagellate and inserting 2 flagella rows between them. - Fig. 2. Comparison of structures associated with somatic monokinetids in the Ciliophora and in *Hemimastix amphikineta*. A simple rotation by 90° of the short microtubular ribbon (dotted arrow) of *H. amphikineta* produces a nearly (note, however, absence of kinetodesmal fibre) ciliophoran kinetid. - Fig. 3. Extended and contracting *Spironema terricola*. This species shows euglenoid movement. B = basal body, G = granular substance, KF = kinetodesmal fibre, LR = long microtubular ribbon, S = membranous sac, PR = postciliary microtubule ribbon, PS = parasomal sac, SR = short microtubular ribbon, TR = transverse microtubular ribbon.

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A Weighted Coenotic Index (WCI): Description and Application to Soil Animal Communities, DOMINIK WODARZ, ERNA AESCHT and WILHELM FOISSNER, Universität Salzburg, Institut für Zoologie, Hellbrunnerstrasse 34, A-5020 Salzburg.

The Weighted Coenotic Index (WCI) unifies in a single value four basic parameters of biological communities, i.e., the total individual abundance, the species richness, the dominance structure, and ecological weights, e.g., habitat preferences and positions of species in the r/K continuum. Studies with simulated biocoenoses show that ecological weights and dominance structure are major components of the index; the ecological weights must be related to the group of organisms studied and to the scope of the investigation. The WCI is a relative measure that needs a reference (control) site for a conclusive interpretation. Compared to several diversity indices, the WCI has a much better discriminant ability due to the inclusion of the ecological weights and the dominance structure. The index has been applied to published data from several field studies using protozoa (testate amoebae, ciliates) and earthworms. The results show that the WCI is an appropriate tool to measure changes and to monitor recovery processes in disturbed communities. The WCI has been developed on a protozoological background owing to the authors' familiarity with this field. Mathematically and practically it is also applicable to other groups of soil and freshwater organisms.

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SINGH'S DILUTION CULTURE METHOD IS INAPPROPRIATE FOR ESTIMATING INDIVIDUAL NUMBERS OF ACTIVE SOIL CILIATES
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Methodological problems interfered and still delay progress in soil protozoology. We have shown by direct examination of suspensions from various soils that Singh's widely used dilution culture method cannot reliably estimate the number of active soil protozoa. This is sustained by results from a comparative study counting the same soil samples with Singh's technique and our direct method (see TABLE).

Singh's method was used with a twofold dilution in 15 levels with 8 replicates per level. Direct counts were performed in soil suspensions using 0.4g soil and a magnification of X40-100. Recovery experiments proved an efficiency of about 70%.

The overestimation of the abundance of active soil ciliates is due to several peculiarities of Singh's method. Half of the soil sample is treated with 2% HCl to kill all active ciliates. The dilution series of the untreated half gives the total number of organisms, i.e. excysted and active forms. The number derived from the acid-treated portion, i.e. cysts, is subtracted from the total number giving the number of active ciliates. This estimation is therefore indirect and depends on the assumptions that all cysts survive the acid treatment and that all cysts excyst. These assumptions are obviously incorrect.

TABLE: Numbers (g^{-1} dry mass of soil) of active ciliates in meadow soils; confidence intervals in parenthesis.

SITE	DIRECT COUNTS	SINGH'S CULTURE METHOD
A2	98 (69 - 127)	27.000 (13.400 - 54.000)
A3	19 (13 - 25)	84.000 (45.200 - 158.100)
D1	0	37.000 (18.000 - 73.000)
D2	47 (33 - 61)	9.200 (4.600 - 18.600)

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The Ciliate Atlas - Morphology and Ecology of the Ciliated Protozoa Used as Indicators of Water Quality, WILHELM FOISSNER, HUBERT BLATTERER, HELMUT BERGER and FRITZ KOHMANN, Universität Salzburg, Hellbrunnerstrasse 34, A-5020 Salzburg.

Ciliates are excellent indicators of water quality. In spite of this, they are increasingly ignored by field ecologists mainly because their identification is supposedly more difficult than that of the mesofauna. This is correct inasmuch as handsome and accurate identification literature is lacking - a shortage which should be redressed by our "ciliate atlas". Furthermore, we reviewed the faunistic and ecologic literature distributed in thousands small papers. This provides the sagacious evaluation of individual species with a more reliable basis and shows research needs. In our atlas each species is pre-identified by a simple picture-key; for accurate determination it is, however, also described in detail and documented by excellent line drawings, light micrographs and scanning electron microscopic micrographs. The revision will comprise four volumes with about 90 species each and addresses not only river ecologists but also those who are engaged in the management of sewage plants, lakes and drinking waters. Printing quality is high and the price is low due to support by the Bavarian government. Volume I (Cytrophorida, Oligotrichida, Hypotrichia, Colpodea) is already available and can be ordered from the senior author (W. Foissner) or from the publisher (Bayerisches Landesamt für Wasserwirtschaft, Lazarettstrasse 67, D-8000 München 19, Germany). Price (including postage) for cversea orders 80 US-Dollar. The book has 473pp., 1320 figures and 34 tables.

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Divisional Morphogenesis in *Bakuella* sp. and Re-evaluation of the Classification of Urostylid Hypotrichs (Ciliophora), PETER EIGNER and WILHELM FOISSNER, Universität Salzburg, Institut für Zoologie, Hellbrunnerstrasse 34, A-5020 Salzburg.

A new hypotrichous ciliate, *Bakuella* sp., colonizing vineleaf and pear-tree litter is described. *Bakuella* sp. differs from the other species of the genus by having distinct rows of yellowish cortical granules. Several morphogenetic differences separate *Bakuella* sp. from *B. edaphoni* and other congeners, especially in that the transverse cirri do not participate in the formation of the oral primordium. The type population of *Pseudourostyla cristata* was reinvestigated. Two frontoterminal cirri are recognizable in dividing specimens indicating that this genus is valid, i. e. different from *Urostyla*, which very likely lacks such cirri. The urostyle hypotrichs are recognized as monophyletic taxon by two apomorphies, viz. the midventral cirri and the partial or complete reorganization of the proter's adoral zone of membranelles during cell division. Phylogeny and evolution within the urostylids are much less clear since character states are uncertain and morphogenetic data are still too sparse or inaccurate. This is exemplified on a selected set of genera using Hennig's phylogenetic method.

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Morphogenesis in some Freshwater Tintinnids (Ciliophora, Oligotrichida), WOLFGANG PETZ and WILHELM FOISSNER, Universität Salzburg, Institut für Zoologie, Hellbrunnerstrasse 34, A-5020 Salzburg.

The morphogenesis of four freshwater tintinnids was investigated using protargol silver impregnation and scanning electron microscopy. Division is rather similar in *Tintinnopsis cylindrata*, *Tintinnidium pusillum* and *T. semiciliatum*, e. g. the oral primordium develops apokinetally posterior of somatic kinary 1 and the somatic ciliature originates by two rounds of intrakinetical basal body proliferation before cytokinesis. The peculiar ventral organelles found in some species form without apparent contact with parental ciliary structures as do the adoral membranelles and the paroral membrane; thus, the ventral organelles might be part of the oral apparatus. The morphogenesis of *Codonella cratera* differs from that of the other species investigated by the reorganization of some parental ciliary rows and by a second round of somatic basal body proliferation after cytokinesis. Based on morphologic and morphogenetic similarities, *Tintinnopsis cylindrata* is transferred from the Codonellidae to the Tintinnidae. A unique combination of characters defines oligotrich ciliates, viz. the polar oral apparatus and the apokinetical origin of the oral primordium. A further synapomorphy is the enantiotropic cell division possibly caused by the restriction of the newly formed oral structures to a small area of the body becoming the apical pole of the cell. Morphogenetic similarities suggest a sister group relationship between tintinnids and strobilidiids. (Supported by the BMFWF)

IX. INTERNATIONAL CONGRESS OF PROTOZOOLOGY, Abstracts (July 25.-31., 1993, Berlin, Germany)

001 EFFECTS OF ORGANICALLY ENRICHED MAGNESITE FERTILIZERS ON THE SOIL CILIATES AND TESTATE P.3 AMOEBAE OF A SPRUCE FOREST

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A large woodland, the "Böhmerwald" in Upper Austria, shows marked signs of forest decline. For revitalization, two types of fertilizers (bactosol-dried bacterial biomass; biomag=90% magnesite + 10% dried fungal biomass) have been applied to an about 40y and an 80y old spruce stand once in 1987 in an amount of 30kg bactosol + 20kg biomag/100m² and 20kg biomag/100m², respectively. The experimental plan corresponds to a completely randomized block design. The number of protozoans (direct counting) and the activity of some soil enzymes were studied in the needle layer (0-3cm) 7 to 8 times during a 5-y-period. Fertilization caused a short-term increase in pH from 3 to 4.3; five years later, the pH differed by about 0.6 units from the control and the numbers of acidophilic testaceans like *Corythion dubium* and *Nebela* spp. significantly decreased, whereas the euryoecious *Cryptodiffugia oviformis* and *Trinema* spp. increased. None of the treatments substantially altered the species numbers, while the total abundances of ciliates and the biomasses of testaceans were significantly decreased. The dominances of *Avestina ludwigi*, *Rostrophryides australis*, and *Cyclidium muscicola* decreased after fertilization, whereas grossglocknerids and Colpoda spp. became more abundant indicating changes in the number and kind of fungi and bacteria. These observations suggest that both fertilizers slightly enhanced decomposition (increased catalase and protease activity, decreased abundances of active ciliates due to an enhanced production of antiprotozoal substances) and improved soil conditions (pH-rise, increased individual and species numbers of K-selected ciliates, increased dominances of acid-intolerant testate amoebae).

041 METHODOLOGICAL PROBLEMS IN SOIL PROTO- ZOOLOGY: ABUNDANCE ESTIMATION OF ACTIVE P.13 CILIATES

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Methodological problems interfered and still delay progress in soil protozoology. Therefore we compared Singh's (1946) widely used dilution culture method with the direct counting method described by Lüftenegger et al. (1988). Dilution methods estimate densities of organisms by using MPN (most probable number) calculations. Two dilution series are set up from one soil sample: One part is used to record the total (active + cystic) number of ciliates. To distinguish between active and cystic cells the second part of the sample is treated with HCl or heat to kill off the active cells. The number derived from this portion, i.e. cysts, is subtracted from the total number giving the number of active ciliates, which are thus ascertained indirectly. Our comparative counts from different types of soil show an overestimation of active ciliates up to 25.000 times by the dilution method! There are two main reasons for these highly disparate abundances. First, the MPN statistics require a homogenous distribution of particles (cells) throughout the liquid. This is extremely difficult to obtain with soil samples. To meet the second basic assumption for application of dilution culture methods all cells must excyst and multiply to a noticeable level during the incubation period; a highly unlikely assumption! The excysting rate is reduced by all known culture media due to the very diverse feeding and reproduction strategies of soil protozoa. Further, many cysts do not withstand the HCl or heat-treatment or, at least, do not excyst after this treatment. These deficiencies cause an overestimation of active cells due to the reciprocal relation mentioned above. Variance analysis showed that the direct counting method precisely differentiates the types of soil investigated (meadows, pine and beech forest litter). The time consuming MPN-method was even not accurate enough to render this distinction. Our comparative study proves that dilution culture methods are beset with methodological and biological errors. They are inappropriate to estimate the abundance of active soil protozoa.

037 THE CILIATE ATLAS: AN UNIQUE GUIDE TO THE P.12 IDENTIFICATION AND ECOLOGY OF FRESHWATER CILIATES

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Our ciliate atlas comprises 4 volumes with about 500 pages each and describes in detail the morphology and ecology of about 320 species listed by SLADCEK et al. (1981) as indicators of water quality. Many ciliates are valuable indicators of organic pollution because they are confined to 1 or 2 saprobic zones. Furthermore, their morphology is well known enabling a reliable identification from life. Each species is described monographically, including a list of important synonyms, a discussion of nomenclature and taxonomy, a differential diagnosis, and a comparison with similar taxa. The ecology section treats the occurrence and geographical distribution, the autecology, and the saprobiological classification. This section is followed by line drawings, light micrographs of living and silver prepared specimens, and scanning electron micrographs. Most species are documented by more than 10 figures. Volume I treats the Cyrtophorida, the Oligotrichida, the Hypotrichia, and the Colpodea; Volume II the Peritrichia, the Heterotrichida, and the Odontostomatida; Volume III is in press and contains the Prostomatida, the Hymenostomatida, the Scuticociliatida, the Hypostomata, and the Trichostomatida; and Volume IV will contain the Karyorelictida, the Haptorida, the Pleurostomatida, and the Suctorida. A speciality of Volume III is the detailed compilation of toxicological and ecological data from the widely distributed genera *Paramecium* and *Tetrahymena*. This should provide the user with background data to assess the effects of many hazardous substances common in aquatic ecosystems. Supported by the FWF (Projekt P8924-Bio) and the Bayer. LAWA.

048 REVISION OF THE GENUS GASTRONAUTA BÜTSCHLI, P.14 1889 (CILIOPHORA, CHLAMYDODONTIDAE)

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There are 3 well defined species of *Gastronauta* distinguished by the composition of the dorsal brush and the arrangement of the ventral kineties. All species were studied in vivo and in protargol silver impregnated slides.

G. membranaceus BÜTSCHLI, 1889: Postoral field non-ciliated; dorsal brush consists of 2 short kineties, viz., a row each at anterior end and in anterior third near left margin of cell. Lives in fresh and brackish water. Considering the highly characteristic dorsal brush *Gastronauta runcina* WILBERT, 1971 must be considered as junior synonym of *G. membranaceus*. PENARD (1922) supposedly found *G. membranaceus* in mosses; however, his specimens lack the non-ciliated postoral field and thus resemble *G. clatratus* DEROUX, 1976. PENARD did not mention the dorsal brush, thus his population cannot be reliably assigned.

G. clatratus DEROUX, 1976: Postoral field ciliated; dorsal brush consists of 4 short kineties, viz., 1 at anterior end, 1 at posterior end and 2 near anterior left margin of cell. Lives in fresh- and brackish water.

G. derouxi BLATTERER & FOISSNER, 1992: Postoral field non-ciliated; dorsal brush consists of about 7 groups of evenly spaced, paired basal bodies along anterior dorsal margin. Prefers terrestrial biotopes. Probably all soil records of *G. membranaceus* belong to *G. derouxi*; unfortunately, none is substantiated by an investigation of the dorsal brush.

Literature: BLATTERER H. & FOISSNER W. (1992): Morphology and infraciliature of some cyrtophorid ciliates from freshwater and soil (Protozoa, Ciliophora). - Arch. Protistenkd., 142: 101-118.

IX. INTERNATIONAL CONGRESS OF PROTOZOOLOGY, Abstracts (July 25.-31., 1993, Berlin, Germany)

150 THE FINE STRUCTURE OF CIRROPHRYA TERRICOLA AND COSMOCOLPODA NASCHBERGERI, TWO UNUSUAL COLPODID p.40 CILIATES FROM SOIL

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Cirrophrya terricola Foissner, 1987 is a colpoid ciliate with typical platyophryid somatic dikinetids and peculiar posterior protuberances which have a size of 4x2 µm and are used to anchor the ciliate to solid substrates. The cylindroid protuberances contain a cylindroid body which is bounded by two unit membranes and consists of an electron lucident and an electron dense portion filled with membranous cisterns, ribosomes, and a compound, nail-shaped stick. Developmental stages have been observed in the ciliate's cytoplasm. They show a nucleus and many microtubules which originate from a structure anchored on the inner nuclear membrane. The observations suggest that these "little feet" contain microsporidian symbionts (parasites?) possibly belonging to the family Metchnikovellidae.

Cosmocolpoda naschbergeri Foissner, 1993 has spectacular cortical ridges which are arranged transversely to the main body axis and thus form ladder-like patterns with the longitudinally coursing ciliary rows. The ridges are cortical differentiations and are supported by a thick layer of epiplasm; usually they contain a large cistern of rough endoplasmic reticulum. The fibrillar associates of the basal bodies separate the ridges from the longitudinally arranged mitochondria. The structure of the somatic dikinetids is very similar to that known from *Colpoda* spp., indicating that *C. naschbergeri* belongs to the family Colpodidae. The conspicuous cortical ridges, which do not contain special structures, are obviously a young acquisition possibly related to the biotope, viz. coastal sand soils.

152 THE COLPODIDS, AN INTRIGUING GROUP OF p.40 PREDOMINATELY SOIL-DWELLING CILIATES

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The lecture introduces my monograph on colpoid ciliates and discusses their phyletic relationships and evolution. Taxonomists, ecologists and cell biologists will find detailed keys and descriptions of all species and synonyms which are illustrated by 2000 line drawings and 900 photographs. Faunistic data and the ecological and physiological literature are comprehensively reviewed. This monograph should set a new standard in species revisions of ciliated protozoa and enables the user to determine species without referring back to the original literature.

Twenty years ago the colpoidids were a small group of trichostome ciliates consisting of about 10 genera and 50 species. Today, they are a separate class containing 7 orders, 20 families, 50 genera, and 175 species. This dramatic increase was not only due to the discovery of many new species but also due to the inclusion of many known but misclassified taxa. *Platyophrya* and *Sorogena*, for instance, were originally assigned to the lower gymnostomes, *Bursaria* and *Bryometopus* were considered to be typical heterotrichs, and *Pseudochlamydonella* has been classified as a cyrtophorid ciliate. These misclassifications were caused by incomplete observations of the oral structures which are unbelievable divers in colpoid ciliates. In contrast, the somatic ciliature (dikinetids with conspicuous transverse microtubular ribbons forming a "left kinetodesmal fibre") is highly conservative and the main class character. I could not find clear relationships between colpoidids and other ciliates, but haptorid or nassulid ancestors are likely. The phylogeny and evolution of the orders and families is also rather uncertain because there are some convergent evolutionary lines.

151 PROTOZOA AS BIOINDICATORS IN POLLUTED SOILS p.40

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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 evidence 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 thus 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 in diluted suspensions needs 3-8 hours per sample) and/or unreliable (e.g., dilution culture methods; see poster BERTHOLD & FOISSNER). Overcoming the methodological problems is a critical requirement for such problems as teratologic testing and adaptation to stress. Well designed field experiments are still rare and should help to make soil protozoology more reputable. There is, in my opinion, a genuine readiness by ecologists, governments and private companies to use protozoa in the future as rapid indicators for the re-establishment of biological activity in heavily polluted or disturbed soils and in assays for hazardous materials like pesticides and heavy metals.

202 MORPHOLOGY AND MORPHOGENESIS OF A COMMON FISH p.53 PARASITE, *ICHTHYOPHTHIRIUS MULTIFILIIS*

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Our observations on the morphology of the theront and the trophont of *I. multifiliis* largely agree with those by Canella & Rocchi-Canella (1976). However, we could reveal the somatic and oral infraciliature much more clearly using the pyridinated silver carbonate method and scanning electron microscopy. With these methods a detailed study was possible of the processes associated with divisional morphogenesis and the transformations of the infraciliature during the life cycle. Division occurs in reproductive cysts. The trophont rounds up, produces a thin membrane, and resorbs the oral structures. A proliferation of basal bodies produces an anarchic field which forms an oral primordium each in the proter and opisthe. Division continues until 200 to 1000 offsprings are produced. The size of the anarchic field decreases with increasing number of divisions. After the last bipartition the basal bodies of the anarchic field multiply and produce short streaks which develop to three double rowed adoral membranelles. At this late tomitic stage, a paroral membrane appears along the innermost vestibular kinety. Then the vestibulum deepens to a cylindrical depression which becomes lined by the multiplying vestibular kineties and the paroral membrane which, however, is resorbed in late theronts; at least, it is not recognizable in trophonts. The adoral membranelles orientate perpendicularly to the longitudinal body axis where the vestibular kineties abut. In the trophont they migrate deeper into the vestibulum and two of them are reduced to single rows of basal bodies. Our results do not agree with the findings of Roque et al. (1967), but show that the stomatogenesis of *I. multifiliis* is similar to that of *Ophryoglena mucifera* as described by Puytorac et al. (1983).