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New or Poorly-known Oligotrich and Aloricate Choreotrich Ciliates (Ciliophora) from Marine Waters. S. AGATHA, University of Salzburg, Institute for Zoology, Hellbrunnerstrasse 34, A-5020 Salzburg, Austria.

The morphology and ciliary pattern of *Strombidinopsis minima* (Gruber, 1884) Lynn, Montagnes, Dale, Gilron & Strom, 1991, *Strombidium arenicola* Dragesco, 1960, and a new *Novistrombidium* species were investigated using live observation, protargol impregnation, and scanning electron microscopy. The species were found in samples from marine habitats in Italy, Venezuela, and Saudi Arabia as well as in a sample from a marine aquarium in Salzburg. Additionally, an updated compilation of marine planktonic oligotrich and aloricate choreotrich ciliates from European waters is presented. It comprises 78 species originally described or redescribed from this area or mentioned by reliable references, namely, by experienced ciliate taxonomists. Bare species lists established by ecologists and based on Lugol-preserved or live material only were, however, not included due to the rather doubtful species identifications. Supported by the Austrian Science Foundation (FWF; project T116).

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Epicortical Scales: A Tool for Estimating Restricted Geographical Distribution and Global Diversity of Free-Living Ciliates. W. FOISSNER and S. AGATHA, Universität Salzburg, Institut für Zoologie, Hellbrunnerstrasse 34, A-5020 Salzburg, Austria.

There is no direct way to prove endemism and global species diversity in microscopic organisms. Only careful analysis of a great number of habitats with a variety of methods will provide sufficient pros and cons over time. However, the trachelophyllids, a group of gymnostomatous ciliates with highly structured epicortical scales could be a tool for a rough estimation of endemism (via comparatively wide-meshed distribution data) and global species number of ciliates (via comparing the number of described and undescribed species in large sample collections). Unfortunately, trachelophyllids are rare in both freshwater and soil. Thus, the subject is difficult. None the less, 25 records from the past 10 years could be studied in detail, viz., in vivo, in silver slides, and the scanning electron microscope. The following species were found, all of them undescribed, except of *Trachelophyllum apiculatum* and *Epitholiolus chilensisa*): *Trachelophyllum apiculatum* (Austria, Japan, Venezuela); *T. pannonicum* (Austria); T. africanum (Namibia, RSA, Venezuela); *T. costaricanum* (Costa Rica, RSA, Japan?); *T. lineare* (Canada, Europe; species described by Lepsi and later by Nicholls & Lynn); *Epitholiolus chilensis* (Chile, Namibia, Europe); *Bilamellophrya australiensis* (from two sites of Australia); *B. etoschensis* (Namibia); *B. hawaiiensis* (Hawaii); *Spetazoon australiense* (Australia, Venezuela); new genus 1 (Venezuela); new genus 2 (Venezuela); new genus 3 (Venezuela, Argentina). These data suggest the following conclusions: (1) Silver impregnation and scanning electron microscopy roughly doubled the number of described species, indicating that at least 50% of the global free-living ciliate diversity is undescribed; (2) There are strong evidences for a restricted geographical distribution, at least for a restricted Gondwanan/Laurasian distribution of most species, indicating that traditional morphology over-estimates cosmopolitism due to lack of diagnostic features. This is supported by modern genetic and ecophysiological data. a) All species named are described in a forthcoming book: Foissner W., Agatha S. & Berger H.: Soil ciliates (Protozoa, Ciliophora) from Namibia (Southwest Africa), with emphasis on two contrasting environments, the Etosha region and the Namib Desert. Supported by the Austrian Science Foundation (FWF, P 12367-BIO).

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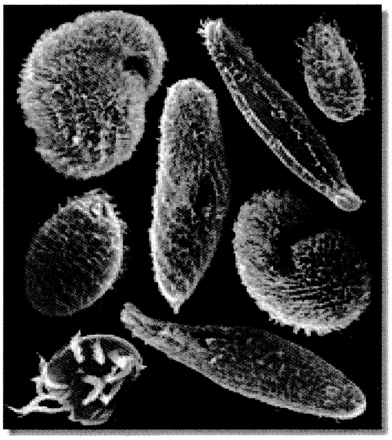
Biodiversity's Response to Ecosystem Productivity Depends on Historical Plant and Animal Relationships

Arlington, Va.—Some thirty million species now live on Earth, but their spatial distribution is highly uneven. Biologists since Darwin have been asking why. Now, scientists funded by the National Science Foundation (NSF), have discovered part of the answer: how plant and animal communities originally assembled is a predictor of future biodiversity and ecosystem productivity.



The experiment using microorganisms including the ciliates shown here indicates that historical events produce a remarkable variety of productivity-biodiversity relationships--a finding that would be difficult to reveal in natural ecosystems composed of large, slowly responding macroorganisms.
Photo Credit: Wilhelm Foissner, Andreas Zankl, University of Salzburg, Austria
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"Despite its importance, species diversity has proven difficult to understand, in large part because multiple processes operating at various scales interact to influence diversity patterns," said biologist Tadashi Fukami of the University of Tennessee at Knoxville, lead author of a paper on the subject published in the July 24th issue of the journal *Nature*. "On evolutionary scales, species diversity is a result of speciation and extinction. But evolutionary processes are variable across space, interactive over time, and consequently, hard to identify. On ecological scales, diversity is a result of community assembly, how species join ecological communities over time."

Fukami and co-author Peter Morin of Rutgers University in New Jersey attempt to provide a novel ecological perspective from which to view diversity patterns. They argue that we can better understand diversity by considering how the history of community assembly interacts with other ecological variables to affect diversity.

Their paper addresses a topic of central importance in ecology, specifically the cause of different relationships between productivity and biodiversity observed in natural ecosystems. Ecologists define productivity broadly as the amount of energy available for ecosystem development in a given location. In this experiment, productivity was manipulated by changing the nutrient concentration of growth medium in ecological communities of microorganisms housed in a laboratory.

"Fukami and Morin's study adds an important, new piece to the ecological puzzle that relates ecosystem productivity to species diversity," said Saran Twombly, program director in NSF's division of environmental biology. "The sequence of species used to create a community has a large effect on the productivity-diversity relationship. This novel result contributes substantially to our understanding of community ecology."

We know that the relationship between productivity and biodiversity takes various forms in nature, presenting a difficult challenge in understanding biodiversity patterns, said Fukami. "Using a rigorous experimental approach, we show in this paper that productivity-biodiversity relationships depend critically on the history of community assembly, in particular on the specific sequence of species arrival from a regional pool of colonists." The results argue that community assembly processes must be considered along with resource use, disturbance, and other factors that determine the ultimate form of productivity-diversity relationships. A key point is that these fundamental patterns are unlikely to have a single common explanation. Although this study was not based on a particular ecosystem, the study shows that historical effects are possible and may explain patterns observed in ecosystems.

These findings will be of broad interest to ecologists, environmental scientists, ecological economists, and others interested in the causes of biodiversity patterns, Fukami believes. "Scientific understanding of how biodiversity responds to productivity is important to the conservation and management of natural ecosystems that are experiencing nutrient enrichment by human activities [such as increased input of phosphorus and nitrogen into lakes, ponds, and estuaries]," said Fukami.

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4th European Congress of

Protistology

and

10th European Conference on

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Program and Abstracts

Edited by Gabriella Cavallaro and Pierangelo Luporini

Endemic ciliates (Protozoa, Ciliophora) from tank bromeliads: taxonomic and ecological implications

p. 18

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Bromeliads are tropical rosette plants mainly found in Central and South America; the most famous species is the pine-apple. The water cisterns (tanks) are formed by the coalescing leaf axils, which collect the rain water. Each leaf produces a little pond enriched by plant litter, dust (soil), and substances secreted by the bromelian plant. It is well-known that the tanks contain a rich, more or less specific fauna and flora, while heterotrophic protists were never investigated in detail. During the past years, I studied tank ciliates from 10–15 bromelian species in the Dominican Republic, Costa Rica, Brazil, and Ecuador, and discovered at least 10 new species, including 2 new families and 6 new genera. Considering that there are more than 3000 bromelia species, we can expect many more undescribed taxa, although some of the species discovered were found at two or more sites. Some of the new species are real giants (length 200–800 µm) that would have been recognized in Europe, if they were there. Thus, at least these species have a restricted geographic distribution, as do their plant "hosts". Of course, the tanks contain also many common ciliate species, but the communities are markedly different from holarctic pond communities, especially in having a high number of endemic tetrahymenids and peritrichs (mainly as symphorionts of insect larvae and oligochaetes), while haptorids, nassulids, cyrtophoreans, colpodids, and hypotrichs are comparatively rare. Thus, the tank communities are also different from soil ciliate biota, in which haptorids, hypotrichs, and colpodids dominate. Half of the new species found have the ability to produce macrostomes and to switch from a bacterivorous to a predatory feeding strategy; one, a giant tetrahymenid even switches to cannibalism, when food is depleted. The increased ability to macrostomy is likely caused by the strong competition in these minute habitats which, in spite of their ordinary appearance, contain a highly specific ciliate community.
Research supported by FWF-project 15017.

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From the temporary cytostome towards a permanent cytopharynx: a new evolutionary line in spathidiid gymnostomes (Ciliophora)

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Most spathidiids and haptorids in general have a temporary cytostome, which is on the bulge surface and recognizable only during food intake or, in the scanning electron microscope, by a small concavity. Typical examples are the 12 genera of the family Spathidiidae. Based on live observations, protargol impregnation, and scanning electron microscopy, we discovered several spathidiids with a permanent, funnel-shaped cytopharynx, and suggest to separate them at family level. This is supported not only by the permanent cytopharynx, but also by the observation that these species form two distinct groups: three of them have a *Spathidium* ciliary pattern and two have an *Epispathidium* pattern. The same evolution occurred in the Enchelyodontidae, where *Enchelyodon* has a temporary cytostome like usual spathidiids, while *Enchelydium* possesses a conspicuous cytopharynx like the new spathidiids. Certain spathidiid ciliary patterns and mouth structures occur not only in the above mentioned families, but also in the spathidiid family Myriokaryonidae, showing that they evolved convergently several times. Recognizing all these patterns and evolutionary lines increases generic and suprageneric spathidiid diversity considerably.
Research supported by the Austrian Science Foundation; FWF project 15017.

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Ontogenesis in a Spathidiid Ciliate, Arcuospathidium coemeterii (Ciliophora, Gymnostomatea)

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Ontogenesis in the spathidiid ciliate *Arcuospathidium coemeterii* (KAHL, 1943) was investigated using protargol impregnation. Division is homothetogenic and occurs in freely motile condition. Stomatogenesis is holotelokinetal and no changes are recognizable in the parental oral structures and dorsal brush rows. Division of *A. coemeterii* basically matches that of *A. muscorum* and other species of the family, but shows the following special features: (i) early dividers have a transient indentation, as yet found only in *P. serpens* (unpubl.), in the prospective fission area; (ii) the individual oral kinetofragments are basically completed in early dividers, but the final, total number of kinetids is obtained only in post-dividers; (iii) the left side oral kinetofragments curve rightwards earlier than the right side ones; (iv) shaping of the oral bulge and circumoral ciliature occurs distinctly later in *Arcuospathidium* and *Spathidium* than in *Protospathidium* (unpubl.); (v) the macronucleus distinctly elongates in very early dividers, while it remains unchanged in all other species investigated so far; (vi) curious, fibrous connections occur between the macronucleus and micronucleus in one ninth of morphostatic specimens and in a quarter of early dividers, where they become more distinct, suggesting some function in nuclear division. Likely, the fibres arise from the micronucleus, as indicated by their ramiform and radiate arrangement; unfortunately, we could not follow their origin. (Supported by the Austrian Science Foundation; FWF project 15017.)

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Endemic ciliates (Protozoa, Ciliophora) from tank bromeliads: a combined morphological and gene sequence study

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Bromeliads are tropical rosette plants, which collect rain water by the coalescing leaf axils. Each leaf produces a little pond inhabited by a rich, more or less specific fauna. In about 10 bromelian species from the Dominican Republic, Brazil, and Ecuador, we discovered at least 10 new ciliate species, of which the most interesting ones are shown on this poster. The most spectacular species is a gigantic, tetrahymenine ciliate from the Dominican Republic. It has an usual size of 200–500 µm, but may grow to 800 µm when it becomes cannibalistic due to food depletion. This ciliate has two mouths, both completely reorganized during ontogenesis: (i) a large funnel produced by the invaginated anterior body end and used to capture the prey, and (ii) a partially reduced, likely functionless, “original” tetrahymenid oral apparatus with, however, 4–8 (!) adoral membranelles near the left cell margin. Morphologically, this ciliate at least represents a new family, while gene sequence data suggest that it is closely related to *Tetrahymena corlissi*. A new glaucomid tetrahymenine genus each was discovered in bromeliads from Brazil, Ecuador, and the Dominican Republic. These taxa differ from *Glaucoma* in having a partially reduced somatic ciliature, the arrangement of the preoral ciliary rows, and the ability to form macrostomes. Morphological and gene sequence data agree that these ciliates are related to *Glaucoma*, a common freshwater ciliate. A small (20–50 µm), bacterivorous colpodid ciliate was discovered in Brazilian bromeliads. It is outstanding in forming macrostomes, by dividing in freely motile condition (most other colpodids of this type reproduce in division cysts), and in producing division chains with the individual pairs connected by a special structure highly reminiscent to an ordinary patent fastener. Ontogenetically, this ciliate represents a new family, while gene sequences place it somewhere between the orders Colpodida and Grossglockneriida.

Deciliation of ciliated Protozoa for scanning electron microscopy: a fast, simple method using tensides

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The methods available for deciliation of ciliates are either rather complicated or very specific, that is, deciliate only certain species, usually either *Tetrahymena* or *Paramecium*. In searching for a better method, I obtained excellent results in a great variety of species with ordinary, liquid soap, viz., Teepol®, which can be obtained in drug-stores, at least in Austria, or from the distributor (Sara Lee Company, A-1060 Wien). Teepol consists of three tensides, of which Marlon AS3 (4-C10-13-sec Alkylderivate of Benzolsulfonsäure; available from SASOL Company, D-45764 Marl) is the most important deciliation agent. Preliminary experiments show that many tensides have deciliating properties, but best results were obtained, as yet, with Teepol, Marlon AS3, and Nonidet P40®, another compound tenside consisting of 15 homologues (available from AppliChem, D-64291 Darmstadt). The method is quite simple and produces pictures of unseen clarity, although the adoral membranelles are rarely deciliated, showing that their cilia have quite different properties: (i) dilute in 1 litre tap water either 0.5 ml Teepol, 0.05 ml Marlon, or 0.25 ml Nonidet; (ii) mix the same amount (e.g. 1 ml) of tenside and ciliate culture in a flat vessel; (iii) immediately control deciliation under the dissecting microscope: as soon as ciliates become motionless and/or sink to the bottom of the vessel, usually within 30–90 sec, poor the ciliate/tenside mixture in Parducz's preservation fluid; (iv) fix for 30 min and proceed with your usual SEM procedure. The concentration and kind of tenside are decisive; thus, try some variations to obtain optimal results. Prolonged stay (> 120 s) in the tenside should be avoided because this distortes the cortical membranes; on the other hand, the oral cilia may detach more completely.

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Oral presentation Session 4

A HUGE, UNDESCRIBED SOIL CILIATE (PROTOZOA: CILIOPHORA) DIVERSITY IN AUSTRIAN NATURAL FOREST STANDS

Wilhelm Foissner, H. Berger, K. Xu, B. Moser and S. Zechmeister-Boltenstern
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We investigated 12 Austrian natural forest stands (eight beech forests, two lowland forests, two *Pinus nigra* forests) for soil ciliate diversity. Samples were taken at each stand in autumn and late spring and analyzed with the non-flooded Petri dish method. A total of 233 species were found, of which 33 were undescribed, a surprising number showing that soil ciliate diversity is largely unknown, even in Central Europe. Species numbers varied from 45 (beech forest on silicate) to 120 (lowland forest), and unexpected high diversities occurred in the pine forests, viz., 86 and 98 species. Individual numbers varied highly from 135 ml^{-1} (lowland forest) to 10925 ml^{-1} (beech forest on silicate) soil eluate. Species composition was different in the three main forest types, though many species occurred at all sites. Multivariate analysis showed a rather strong correlation between species number, pH, C/N ratio, nitrogen, and urease activity, while correlations between species numbers and individual biotic and abiotic parameters were insignificant, except of pH. This suggests that soil ciliate diversity is regulated by a complex assemblage of parameters.

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Importance of precise species identification in ecological studies of ciliates (Protozoa, Ciliophora)

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Since the discovery of the microbial loop, protists came into the focus of ecologists. Although still a lot of work need to be done, it is definitely known about 90% of the organic carbon mineralization and nutrient recycling is effected by microorganisms under 100 µm in size, largely protists (WETZEL 2001). Taxonomic expertise, in contrast, did not grow to the same level causing that the role of individual species is largely unknown, at least in heterotrophic protists, in spite of the fact that appropriate preparation/identification methods and user-friendly keys became available in the past decade (see references below). Certainly, not all ecological subjects require high taxonomic resolution, but it is dismaying to see so many papers on protozoan community structure, where most taxa are identified only to genus level or less, even in reviewed ecological journals, and even detailed ecological studies on certain species sometimes do not or misidentify the species involved. This causes, of course, that results become highly misleading and irreproducible. On community level, protozoan ecologists get a strongly biased view on protozoan diversity in general (great underestimation to total species number) and the principles guiding protozoan communities, which are probably basically the same as found in metazoan assemblages. Furthermore, the global distribution and cosmopolitism ("everything is everywhere, the environment selects") of protist species is also an artifact caused by the scant data in general and the innumerable misidentifications found in the literature. Thus, Editors and Reviewers of ecological journals should encourage papers which have not only a high "ecological standard" but also briefly describe the population(s) involved, emphasizing features deviating from those mentioned in the identification literature used. What is only a population today, might be a species tomorrow! Further, voucher slides should be required for papers on community structure.

References

BERGER H. (1999): Monograph of the Oxytrichidae (Ciliophora, Hypotrichia). Kluwer, Dordrecht, Boston, London. 1080 p.
BERGER H., FOISSNER W. & KOHMANN F. (1997): Bestimmung und Ökologie der Mikrosaprobien nach DIN 38410. Fischer, Stuttgart, Jena, Lübeck, Ulm. 291 p.
FOISSNER W. (1993): Colpodea. Protozoenfauna, 4/1: I-X + 798 p.
FOISSNER W. & BERGER H. (1996): A user-friendly guide to the ciliates (Protozoa, Ciliophora) commonly used by hydrobiologists as bioindicators in rivers, lakes, and waste waters, with notes to their ecology. Freshw. Biol., 35: 375-482.
FOISSNER W., BLATTERER H., BERGER H. & KOHMANN F. (1991): Taxonomische und ökologische Revision der Ciliaten des Saprobiensystems - Band I: Cyrtophorida, Oligotrichida, Hypotrichia, Colpodea. – Informationsberichte Bayer. Landesamt für Wasserwirtschaft, München, 1/91: 1-478.
FOISSNER W., BERGER H. & KOHMANN F. (1992): Taxonomische und ökologische Revision der Ciliaten des Saprobiensystems - Band II: Peritrichia, Heterotrichida, Odontostomatida. Informationsberichte Bayer. Landesamt für Wasserwirtschaft, München, 5/92: 1-502.
FOISSNER W., BERGER H. & KOHMANN F. (1994): Taxonomische und ökologische Revision der Ciliaten des Saprobiensystems - Band III: Hymenostomata, Prostomatida, Nassulida. Informationsberichte Bayer. Landesamt für Wasserwirtschaft, München, 1/94: 1-548.
FOISSNER W., BERGER H., BLATTERER H. & KOHMANN F. (1995): Taxonomische und ökologische Revision der Ciliaten des Saprobiensystems - Band IV: Gymnostomatea, Loxodes, Suctoria. Informationsberichte des Bayer. Landesamtes für Wasserwirtschaft, 1/95: 1–540.
FOISSNER W., BERGER H., SCHAUMBURG J. (1999): Identification and ecology of limnetic plankton ciliates. Informationsberichte Bayer. Landesamt für Wasserwirtschaft, München, 3/99: 1–793.
WETZEL R.G. (2001): Protists: Key ecosystem regulators. BioScience, 51: 997.

3.000 or 30.000 Free-Living Ciliate Species? Investigations about Soil Ciliates from Austrian Natural Forest Stands and Namibia

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„As protozoan species are probably globally ubiquitous, there is every reason to believe that all species of freshwater protozoa could eventually be discovered in one small pond" (Finlay & Esteban 1998). "It is unlikely that total diversity of free-living ciliates is close to 3.000 species, as proposed by Finlay. A more likely figure is 30.000" (Foissner 1999). These citations show the contrasting views presently held by protozoan biodiversity researchers. Likewise, it is disputed whether or not there are free-living protists with restricted geographic distribution. Basically, these and related problems have a simple, methodological reason, viz., undersampling. As compared to higher animals and plants, protists are extremely difficult to recognize because they are of microscopic size and encysted most of their life. Only when the appropriate conditions set in, do they excyst and become visible. Then, however, many of them may be hidden by an abundance of a few ubiquitous and numerically dominant species. Only when comparatively large samples are carefully (!) inspected by an experienced (!) investigator, are these rare species recognized. And it is well known that rare species comprise > 80% of the total species in practically all organism communities. These considerations are fully supported by two recent, comprehensive studies performed in Austria and Namibia. They show a lot of undescribed species, some of which very likely have a restricted geographic distribution, among a mass of ubiquitous cosmopolitans.

In Austria, we investigated 12 deciduous and coniferous forest stands in the surroundings of Vienna (Foissner et al. 2004). We found 233 species, of which 32 (14%) were undescribed, that is, about 2.7 new species per site. The richest was a floodplain soil with 120 species. In Namibia, we investigated 73 samples from a great variety of habitats (Foissner et al. 2002). We found 365 species, of which 128 (35%) were undescribed, that is, about 1.8 new species per site (near 2.4 when several unidentified, likely new species are added). The richest sample contained 141 species and was a mixture of mud and surface soil from road puddles in a Guest Farm. These data are in accordance with the observation that the rate at which new species are found (on average 1-2 new species per sample) did not decrease during a 20 year period of intense research. Thus, there must be a high number, likely thousands of undescribed ciliate species in soils globally. (Supported by grants of the Austrian Science Foundation and the Federal Ministry for Agriculture and Forestry, Environment and Water Management.)

Finlay B. J., Esteban G. F. (1998) Freshwater protozoa: biodiversity and ecological function. Biodiv. Conserv. 7: 1163–1186.

Foissner W. (1996) Floodplain soils – untouched protozoan biotopes. 3rd Europ. Congr. Protistol., Helsingor, Book of Abstracts, p. 30.

Foissner W., Agatha S., Berger H. (2002) Soil ciliates (Protozoa, Ciliophora) from Namibia (Southwest Africa), with emphasis on two contrasting environments, the Etosha region and the Namib Desert. Denisia 5: 1–1459.

Foissner W., Berger H., Xu K., Zechmeister-Boltenstern S.(2004) A huge, undescribed soil ciliate (Protozoa: Ciliophora) diversity in natural Austrian forest stands. (submitted)