



Technisches Büro für **Ökologie** Dr Helmut Berger Consulting Engineering Office for **Ecology**

Abstract 23

How to cite the abstract:

Foissner W., Berger H., Zechmeister-Boltenstern S. (2003): 3.000 or 30.000 free-living species? Investigations about soil ciliates from Austrian natural forest stands and Namibia. - Österreichische Gesellschaft für Bodenbiologie, Bodenbiologie in Österreich - Vortragstagung - Innsbruck, 29.-30.09.2003. Abstract on p. 7

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Keywords: Hypotrichia, Ciliophora, forestry, Austria, Europe, soil biology, multivariate analysis, Acropisthium, Amphisiella, Apertospathula, Apospathidium, Arcuospathidium, Australocircus, Avestina, Bakuella, Balantidioides, Birojimia, Blepharisma, Brachysoma, Bresslaua, Bresslaurides, Bryometopus, Bryophyllum, Chilodonella, Chilodontopsis, Chilophrya, Cinetochilum, Circinella, Cirrophrya, Clavoplites, Colpoda, Colpodidium, Coriplites, Cyclidium, Cyrtohymena, Cyrtolophosis, Deviata, Dileptus, Dimacrocaryon, Diplites, Drepanomonas, Enchelyodon, Enchelys, Engelmanniella, Epispathidium, Erimophrya, Euplotopsis, Frontonia, Fuscheria, Gastronauta, Gastrostyla, Gonostomum, Grossglockneria, Halteria, Haplocaulus, Hausmanniella, Hemiamphisiella, Hemisincirra, Holosticha, Holostichides, Homalogastra, Idiocolpoda, Ilsiella, Kahllembus, Keronella, Keronopsis, Kreyella, Lagynophrya, Lamtostyla, Latispathidium, Leptopharynx, Litonotus, Maryna, Metopus, Microdiaphanosoma, Microthorax, Mykophagophrys, Nivaliella, Notohymena, Notoxoma, Odontochlamys, Opercularia, Orthoamphisiella, Orthokreyella, Ottowophrya, Oxytricha, Parabryophrya, Paracineta, Paraenchelys, Parafurgasonia, Paragonostomum, Parakahliaella, Periholosticha, Phacodinium, Phialina, Phialinides, Plagiocampa, Platyophrya, Plesiocaryon, Pleuroplites, Podophrya, Protocyclidium, Protospathidium, Pseudochilodonopsis, Pseudocohnlembus, Pseudocyrtolophosis, Pseudoholophrya, Pseudoplatyophrya, Pseudouroleptus, Rostrophryides, Sathrophilus, Spathidium, Sphaerophrya, Stammeridium, Sterkiella, Stichotricha, Tachysoma, Terricirra, Territricha, Tetmemena, Tetrahymena, Trithymena, Trithigmostoma, Uroleptus, Urosoma, Urosomoida, Vorticella, Amphileptus, Euplotes, Kuehneltiella, Oxytrichides, Rhabdostyla, Sigmocolpoda, Semibryophyllum, Lower Austria, Vienna, Wien, Forest, Wald, Naturwald, Bodenbiologie, Niederösterreich, Salzburg, Colpodea, Spathidiidae, Spathidiida, Hymenostomata, Boden, ciliates, Ziliate, Wimpertierchen

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Dr Helmut BERGER

Consulting Engineering Office for Ecology - Technisches Büro für Ökologie

Radetzkystrasse 10, 5020 Salzburg, Austria, Europe

Phone +43-(0)662-432538; Fax +43-(0)662-443139; email office@protozoology.com; <http://www.protozoology.com>

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

Wilhelm Foissner¹, Helmut Berger² and Sophie Zechmeister-Boltenstern³

¹Universität Salzburg, Institut für Zoologie, Hellbrunnerstr. 34, A-5020 Salzburg, eva.herzog@sbg.ac.at; ²Technisches Büro für Ökologie, Radetzkystr. 10, A-5020 Salzburg, helmut.berger@sbg.at; ³FBVA – Waldforschungszentrum, Institut für Forstökologie, Seckendorf-Gudent-Weg 8, A-1131 Wien, sophie.zechmeister@fbva.bmlf.gv.at

„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)