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NEOKERONOPSIS NOV. SPEC. (CILIOPHORA, SPIROTRICHEA), A FLAGSHIP CILIATE FROM SOUTH AFRICA SUPPORTS THE CEUU HYPOTHESIS

Neokeronopsis is a monotypic genus established by Warren, Fyda & Song (2002) for *Holosticha* (*Keronopsis*) *spectabilis* Kahl, 1932, a rare limnetic stichotrichine spirotrich. The flexible body and the cirral pattern, especially the zigzagging row of midventral cirri classify *H. spectabilis* into the family Urostylidae. However, the ontogenesis of the dorsal bristle rows is as in typical oxytrichids, that is, they originate from two anlagen formed within parental rows and de novo. Thus, Warren et al. (2002) could not classify the phylogenetic position of *Neokeronopsis*, but suggested that it might be a highly derived Urostylidae. We discovered a similar, but distinct species in floodplain soil from South Africa. The 18 rDNA classifies the African species within the Oxytrichidae family, viz., near to the genus *Cyrtohymena*. The contrasting morphological and molecular classifications are reconciled by the CEUU hypothesis (Foissner et al. 2004) which suggests convergent evolution of an urostylid cirral pattern in oxytrichs. Both species are about 300 µm long and coloured by cortical granules. Thus, they are biogeographic flagships showing the restricted distribution of certain ciliate species. (Supported by the FWF and DFG)

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MONOGRAPH OF THE SPATHIDIIDA (CILIOPHORA, HAPTORIA) VOLUME I: PROTOSPATHIDIIDAE, ARCUOSPATHIDIIDAE, APERTOSPATHULIDAE

The Spathidiidae belong to the subclass Haptoria, a group of rapacious, "lower" holotrichs. The family comprises about 200 described species, most belonging to the time-honoured genus *Spathidium*. Several colleagues doubted the validity of so many *Spathidium* species. However, our monograph shows not only the validity of most described species, but adds 50 new species discovered in over 500 samples from terrestrial biotopes worldwide. Now, the spathidiids consist of over 250 species distributed in four families and 20 (!) genera, several of which are described in this monograph. About half of the species have been described or redescribed with modern methods, and thus each needs an average of eight printed pages in the revision. Accordingly, we split the revision into two parts which form a harmonic unit, but can be used independently. Further, the split facilitates publication, which was considerably delayed because we had to perform basic investigations on ontogenesis, conjugation and resting cysts as well as to describe nearly 100 populations half of which represented new species.
Volume I is now available by Springer publisher, series Monographiae Biologicae, Volume 81, IX + 485pp.

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THE UNUSUAL RESTING CYST OF *MESERES CORLISSI* (CILIOPHORA: OLIGOTRICHEA): ENCYSTMENT AND GENESIS OF FIVE COMPLEX TYPES OF WALL PRECURSORS

Meseres corlissi Petz & Foissner (1992) is a rare, oligotrichine ciliate closely related to the common *Halteria grandinella*. We studied encystment, genesis of the cyst wall precursors, and the structure of the resting cyst, using light- and electron microscopy and cytochemistry. The resting cyst of *M. corlissi* has several outstanding features, viz., the wall contains a layer of chitin, the surface is covered by conspicuous globules (lepidosomes) up to 15 µm across, and there are five types of complex cyst wall precursors, each showing six to nine distinct developmental stages. When encysting, the conical body forms a discoidal "head". Then, the cell rotates rapidly and releases the lepidosomes within 5–20s. Then, the four other types of wall precursors are released almost concomitantly. When the wall precursors have left the cell, a second, slow rotation phase occurs, possibly distributing the wall material. Most or even all cyst wall precursors develop in Golgi vesicles and are released by exocytosis. None of the precursors is similar to those reported from other ciliates, suggesting the oligotrichs as a very distinct group of ciliates. (Supported by the FWF, P 16796-B06)

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PHYLOGENETIC POSITION OF *ARISTEROSTOMA MARINUM* KAHL 1931 AND THE FAMILY CYRTOLOPHOSIDIDAE (CILIOPHORA; COLPODEA)

We isolated a very small and fragile ciliate from the Famvaren Fjord, Norway, which we morphologically and ultrastructurally identified as *Aristerostoma marinum* Kahl, 1931 (order Cyrtolophosidida Foissner, 1978, class Colpodea). The organism is obligate marine and cannot survive salinities below 17‰. To date, only a single SSU rDNA sequence of the order Cyrtolophosidida is available from GenBank (*Platyophrya vorax*). Therefore, we sequenced *Aristerostoma marinum* and performed a detailed phylogenetic analysis including all available sequences of the class Colpodea as well as representative sequences of all other ciliate (ribo)classes. The phylogenetic analyses confirm the assignment of *Aristerostoma marinum* and, thus, of the family Cyrtholophosididae, to the class Colpodea. However, in contrast to other orders within the Colpodea, the order Cyrtolophosidida seems to be polyphyletic. The SSU rDNA sequence of *Aristerostoma marinum* identified five previously unassigned environmental SSU rDNA ciliate sequences as members of the order Cyrtolophosidida.

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COLPODIDIIDS FINALLY FIND THEIR HOME IN THE NASSOPHOREA (CILIATA)

Even twenty-five years after the discovery in a grassland soil of Afghanistan, the taxonomic assignment of the ciliate genus *Colpodidium* Wilbert, 1982 is vague. Originally, based on morphology, this genus was placed in the class Colpodea. Foissner's detailed revision of the genus in 1995 found some conspicuous morphological characters that first led to the establishment of a family (Colpodidiidae Foissner 1995) and eventually to a new order (Colpodidiida Foissner et al. 2002), and the suggested assignment of *Colpodidium* (and the order Colpodidiida) to the class Nassophorea. Despite a remarkable increase in the number of species, no sequence data were available to confirm or reject either assignment. We present 18S rDNA sequence-based phylogenetic analysis of the type species, *Colpodidium caudatum* (in vivo size 55-70x25-35 µm, with a short, slightly curved paroral membrane, 1 large adoral organelle and two posterior kineties with dikinetids anteriorly), isolated from a soil sample from Namibia, South-West Africa. Bayesian inference methods as well as evolutionary distance analyses undoubtedly confirm the assignment of *C. caudatum* to the class Nassophorea. We will analyze additional taxa to resolve the phylogeny of colpodidiids below the class-level.

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THE SPHAGNUM PONDS OF SIMMELRIED IN GERMANY: A BIODIVERSITY HOT-SPOT FOR MICROSCOPIC ORGANISMS

We describe 656 species of bacteria, protists, and micrometazoa occurring in the Simmelried, a three hectare-sized moorland in southern Germany. Each species is shown by an average of two colour micrographs. Further, the surface organization of most main groups is demonstrated by scanning electron micrographs. The Simmelried formed after the last ice-age, that is, about 15,000 years ago. The investigations indicate that the 656 species documented represent only two thirds of the taxa actually present. Thus, a considerable diversity accumulated over 15,000 years, emphasizing the great distribution capacity of micro-organisms. On the other hand, some common species are lacking (e.g., the ciliate *Colpidium colpoda*, the euglenid *Phacus pleuronectes*, and rotifers of the genera *Proales* and *Floscularia*) and many undescribed species were discovered. While a mass of undescribed species is comprehensible in the poorly researched amoebas, flagellates and ciliates, this is surprising in well-known groups, such as euglenids and chrysophytes. Thus, some of the undescribed species might be regional or local endemics.

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The book is already out of print, but a cheap (3€) electronic version is available: http://www.shaker.de/Online-Gesamtkatalog/Details.asp?ID=0&ISBN=3-8322-2544-7&Reihe=0

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MESERES CORLISSI, A COSMOPOLITAN CILIATE WITH LIMITED DISPERSAL AND BIOGEOGRAPHY

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Meseres corlissi is a cosmopolitan, but rare oligotrich ciliate dwelling in temporary freshwater habitats such as meadow ponds and flood plains. It is found in less than 2% of all suitable habitats, although the ciliate survives periods of drought in an encysted form and the species may be a superior competitor under standard laboratory conditions, relative to common oligotrich freshwater ciliates. Clonal isolates from 4 different continents were genetically almost identical at the 18SSU rRNA and ITS level, but differed with respect to their size, ecophysiology and life strategy. Cell size, temperature and pH response, and the factors triggering encystment generally increased with increasing geographic distance between the localities of their origin. Habitat temperature was the primary factor shaping the survival of the trophic cells and their encystment. Our study demonstrates that ciliates, that are morphologically and in highly conserved genes virtually identical, may have biogeographies leading to allopatric speciation.

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DIVERSITY AND GEOGRAPHIC DISTRIBUTION OF SOIL PROTOZOA

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Soil is inhabited by most main groups of protists, ranging from heterotrophic to autotrophic species, the latter being especially frequent in the litter layer. Two groups of soil protists have been investigated in considerable detail, viz., testate amoebae and ciliates. However, still all data refer to morphospecies because molecular investigations are difficult in the soil habitat. Data on flagellates are still rare, but one species, *Hemimastix amphikineta*, is a highly conspicuous flagship with restricted Gondwanan distribution. About 600 testate amoebae species have been recorded from terrestrial habitats globally, and rather many of them are palaeoendemics (break of Pangaea) or continental endemics, for instance, the genera *Apodera, Certesiella, Lamtopyxis* and *Matsakision*. Many of these are size flagships and thus provide indisputable evidences for a restricted distribution of protist morphospecies. Over 1000 species of soil ciliates have been reported. We show by faunistic and statistical analyses restricted distribution patterns, especially restricted Gondwanan/Laurasian occurrence. In sum, protist biogeography is similar to that of plants and animals, but with an increased proportion of cosmopolites, favouring the moderate endemicity model proposed by Foissner. Supported by FWF grants 19699, 15017 and by the Taiwan National Science Council, projects NSC-94-2118-M006-001, 95-2118-M007-003.

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A UNIQUE ASSOCIATION BETWEEN BACTERIA AND CILIATES: SILICIOUS RESIDUES FROM FOOD BACTERIA ARE THE MAIN COMPONENT OF THE CYST WALL OF *MARYNA UMBRELLATA* (CILIOPHORA, COLPODEA)

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Maryna umbrellata is an about 150 µm-sized, globular ciliate typically inhabiting ephemeral pools. It belongs to the class Colpodea, family Marynidae. *Maryna umbrellata* can quickly encyst and excyst and feeds on bacteria. The resting cyst, which has an average diameter of 105 µm, has a 10 µm thick wall. The interior half of the wall is of ordinary fine structure, while the exterior half consists of countless, minute globules with a size of 0.5 - 2 µm. Transmission electron microscopy (TEM), X-ray analysis, and treatment with hydrofluoric acid (HF) reveal the globules to be composed of amorphic silicon. The silicon globules are recognizable in the interphase specimens, where they appear as minute, strongly sparkling "crystals" when observed with interference contrast. Detailed TEM investigations showed that the silicon globules are not produced by the ciliate, but taken from certain food bacteria containing minute silicon spheres (proven by TEM, X-ray, and HF!). These spheres are agglomerated by the ciliate and extruded during the very early phase of encystment. To our best knowledge, such mechanism (slave silicon spheres) has not been described in any other protist, but likely occurs in several species of the family. Supported by the FWF, grants P-19699 and P-15017.

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THE SPHAGNUM PONDS OF SIMMELRIED IN GERMANY: A BIODIVERSITY HOT-SPOT FOR MICROSCOPIC ORGANISMS

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This study describes 656 species of bacteria, protists, and micrometazoa occurring in the Simmelried, a three hectare-sized moorland in southern Germany. Each species is shown by an average of two colour micrographs. Further, the surface organization of most main groups is demonstrated by scanning electron micrographs. The Simmelried formed after the last ice-age, that is, about 15,000 years ago. The investigations indicate that the 656 species documented represent only two thirds of the taxa actually present. Thus, a considerable diversity was accumulated over 15,000 years, emphasizing the great distribution capacity of microorganisms. On the other hand, some common species are lacking (e.g., the ciliate *Colpidium colpoda*, the euglenid *Phacus pleuronectes*, and rotifers of the genera *Proales* and *Floscularia*), and many undescribed species were discovered. While a mass of undescribed species is comprehensible in the poorly studied amoebas, flagellates and ciliates, this is surprising in well-known groups, such as euglenids and chrysophytes. Thus, some of the undescribed species might be regional or local endemics. The book has been published by Shaker, Aachen and is available in printed and electronic form: http://www.shaker.de/Online-Gesamtkatalog/Details.asp? ID=0&ISBN=3-8322-2544-7&Reihe=0.

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PHYLOGENETIC POSITION OF THE ODONTOSTOMATIDS INFERRED FROM THE SMALL SUBUNIT RRNA GENE SEQUENCE OF *EPALXELLA ANTIQUORUM* PENARD, 1922 (PHYLUM CILIOPHORA; ORDER ODONTOSTOMATIDA)

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The odontostomatid ciliates have remained a homogeneous order of ciliates since the 1930s when they were recognized as a monophyletic assemblage. Since that time they have been placed with the heterotrich ciliates, and more recently transferred as incertae sedis to the new "riboclass" Class ARMPHOREA. We were able to obtain the small subunit rRNA gene sequence of the odontostomatid *Epalxella antiquorum* Penard, 1922, collected from the meromictic alpine Lake Alatsee in Germany, in July 2005. An alignment with representatives of all 11 classes of ciliates unambiguously places the *Epalxella* sequence with other representatives of the Class PLAGIOPYLEA with 100% support in both maximum likelihood and Bayesian analyses. *Epalxella* is the basal lineage with trimyemid and plagiopylid ciliates forming the two terminal sister clades. While this molecular support is strong and unambiguous, there are no obvious morphological features to unite these three clades. Thus, the Class PLAGIOPYLEA must continue to be referred to as a "riboclass." Using the *Epalxella* sequence as a basal marker, we tentatively identified 20 environmental isolates to the terminal plagiopylean clades: eight to the genus *Trimyema*; four to the genus *Plagiopyla*; and eight to two new species, one of which might represent a new plagiopylean genus.

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CONJUGATION IN *HALTERIA GRANDINELLA*: THE MYSTERY OF ITS GENEALOGY PERSISTS

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The conjugants are isomorphic and fuse partially to a homopolar pair. The partners become ventrally concave, obtain an interlocking arrangement, and one is shifted slightly posteriorly. The pair almost achieves the size and outline of the morphostatic specimen. Before the macronucleus fragments, it becomes surrounded by argyrophilic vesicles (probably autophagosomes). The micronucleus performs three typical maturation divisions. While the mates are still connected, the synkaryon divides twice: one derivative becomes a micronucleus, one - a macronuclear anlage, and two disintegrate. Likely, the somatic bristle rows are reduced from seven to four in each partner, i.e., the first becomes imperceptible on the ventral side during pair formation, the second and third - when the contact of the partners becomes more intimate. During the second maturation division, somatic anlagen become recognizable as in ordinary ontogenesis; their fate remains obscure. During prophase I, the partners become dimorphic: the collar membranelles of the more anteriorly located conjugant arrange around the pair's anterior end, forming a membranellar zone for both partners; its buccal membranelles as well as the collar and buccal membranelles of the more posteriorly located conjugant disappear. Simultaneously, an oral primordium originates on the ventral side of both partners, probably generating only the collar membranelles. *Halteria* resembles the choreotrichid ciliate *Pelagostrobilidium* in the interlocking arrangement of the partners, while the dimorphism and the shifting of the partners as well as the common membranellar zone are like those in the Stichotrichida. Since data on the Oligotrichida are not available, the apomorphic character states are unknown.

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MONOGRAPH OF THE SPATHIDIIDA (CILIOPHORA, HAPTORIDA)

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The spathidiids belong to the ciliate subclass Haptoria (Protozoa, Ciliophora), that is, they are predators using toxicysts to overwhelm the prey. Spathidiid ciliates prefer terrestrial and semiterrestrial habitats, but many occur also in freshwater, and some are marine. Over 200 nominal spathidiid species have been described, sometimes based on seemingly minute differences. Thus, many protozoologists considered them as indeterminable and claimed for a detailed revision. The present monograph carefully revises the taxonomy, nomenclature, and ecology of all nominal species and shows that spathidiid diversity has been greatly underestimated. Based on reinvestigation of the described species with modern methods (silver impregnation, scanning electron microscopy) and the first description of over 50 new species, the family Spathidiidae is split into four families and 20 genera. Each species is described and figured in detail, making it unnecessary to go back to the original literature often difficult to obtain. Two identification keys are provided, viz., one for taxonomists and another, simple key for users not specifically trained in ciliate taxonomy. The first part of the monograph that contains the families Protospathidiidae, Arcuospathidiidae, and Apertospathulidae, has been published (Foissner, W. & Xu, K., 2006. Springer, Monographiae Biologicae, 487 pp). The second part will come out soon and contain the family Spathidiidae and a new family, Pharyngospathidiidae. This monograph is part of our attempt to revise the free-living ciliates. Supported by the National Natural Science Foundation of China (No. 40576072), the '100 Talents Project' of CAS, and the FWF, Project P-15017.

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MORPHOLOGY AND GENE SEQUENCE OF AN ENDEMIC, NEW COLEPID (PROTOZOA, CILIOPHORA) FROM THE ANCIENT LAKE BIWA, JAPAN

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Endemism is difficult to prove in micro-organisms. However, the ancient freshwater lakes (Lake Baikal, Lake Tanganyika, Lake Biwa, Lake Ohrid) provide a unique opportunity to look for endemic flagship species. Indeed, some unique protists have been described from all the lakes cited, but mostly algae, while ciliates have been poorly researched. We investigated some samples from Lake Biwa for ciliates and found two undescribed flagship species which are likely endemic to the region or even to the Lake. Here, we report on a new colepid which belongs to a group of ciliates with highly conspicuous cortical scales. We used live observation, silver impregnation, scanning electron microscopy, and molecular biology (SSU rDNA) to characterize the new species. Morphologically, the new colepid differs from most other members of the group by the lack of spines near to the anterior and posterior end of the cell. Genetically, it is far away from the common, likely cosmopolitan *Coleps hirtus* (U97109) and two *Coleps* sp. (DQ 487194 and X 76646) contained in GenBank. Thus, our ciliate likely represents not only a new species but also a new genus. Interestingly, colepids without spines have been described also from Lake Baikal (Obolkina, 1995) and Lake Tanganyika (Dragesco, Dragesco-Kerneis, 1991). Thus, this group of ciliates provides strong support for ciliate endemism. Supported by the Japan Society of Protozoologists, the Lake Biwa Museum Comprehensive Research Project 06-02, and the MEXT, Kakenhi (no. 18760431) (grants to S. Shimano); the Austrian Science Foundation (grants to W. Foissner).

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