Number **1** / Year **2018**

Cyrtohymena citrina (Berger & Foissner, 1987) Foissner, 1989 (original combination: *Steinia citrina* Berger & Foissner, 1987) (Ciliophora, Hypotricha): update 1.0 on monographic treatment

Helmut BERGER
Salzburg, Austria

Berger, Consulting Engineering Office for Ecology, Salzburg, Austria

Imprint

Author: Helmut BERGER
Consulting Engineering Office for Ecology
Radetzkystrasse 10
5020 Salzburg, Austria
berger.helmut@protozoology.com; https://www.protozoology.com, https://www.protozoology.com/tb
ORCID iD: *https://orcid.org/0000-0002-1726-0082*
ZooBank registration number of author Helmut Berger: *urn:lsid:zoobank.org:author:DC477A8E-FC41-494C-A4A1-F23091512449*

Publisher: Helmut Berger, Consulting Engineering Office for Ecology, Radetzkystrasse 10, 5020 Salzburg, Austria

Print: druck.at

Print edition: 100 copies

Sale: Helmut Berger, Consulting Engineering Office for Ecology, Radetzkystrasse 10, 5020 Salzburg, Austria

Publication date: April 2018

Series title: Series Monographiae Ciliophorae. **Number:** 1. **Year:** 2018

Abbreviation of series title: Ser. Monogr. Cilioph.

Internet address of series: https://www.protozoology.com/smc

ISBN 978-3-902147-03-5

Information: This work has been published without peer-review process.

Archives: Print copies of the present work have been deposited at the following Austrian libraries: Österreichische Nationalbibliothek; Universitätsbibliothek Salzburg; Salzburger Landesarchiv

For nomenclatural purposes, this work should be referenced as follows: Berger H. (2018): *Cyrtohymena citrina* (Berger & Foissner, 1987) Foissner, 1989 (original combination: *Steinia citrina* Berger & Foissner, 1987) (Ciliophora, Hypotricha): update 1.0 on monographic treatment. – Ser. Monogr. Cilioph. **1**: 1–16.

Acknowledgements

I thank Wilhelm Foissner (Salzburg, Austria) that I could use his very comprehensive private library, the staff at the Salzburg University Library for their patient assistance in locating the vast literature on the hypotrichs, and the authors who sent me reprints or PDFs of their papers. This work has been written, like the Monograph of the Oxytrichidae, without financial support. Thus, it cannot be published Open Access. Consequently, each buyer of the present and later works of this series supports the production of further works of this kind.

Disclaimer

The present work is mainly intended as a guide or survey to the literature dealing with the protist *Steinia citrina* Berger & Foissner, 1987. No claim is made for the accuracy and/or completeness of the information provided in this work. The author and publisher of this paper is not responsible for problems resulting from the use of the information provided.

Contents

Abstract

Berger H. (2018): *Cyrtohymena citrina* (Berger & Foissner, 1987) Foissner, 1989 (original combination: *Steinia citrina* Berger & Foissner, 1987) (Ciliophora, Hypotricha): update 1.0 on monographic treatment. – Ser. Monogr. Cilioph. **1**: 1–16.

The present work is mainly a literature update to the monographic treatment by Berger (1999). *Steinia citrina* was discovered by Berger & Foissner (1987) in soil from Greece. In 1989 it was transferred to *Cyrtohymena* by Foissner. Later, it was classified in the nominotypical subgenus *Cyrtohymena (Cyrtohymena)* by Foissner (2004). However, the current systematic status is again *Cyrtohymena citrina* (Berger & Foissner, 1987) Foissner, 1989 because division of *Cyrtohymena* into subgenera has been overruled. So far, populations from Germany, Greece, Turkey, India, and Korea have been described more or less detailed. All relevant contributions are listed in a detailed synonymy. Type slides of *C. citrina* are deposited in the Biology Centre of the Upper Austrian Museum in Linz (LI). A brief morphological characterisation, based on the available descriptions, is provided. For details on morphology and for illustrations and micrographs the reader is referred to the original papers and revisions. In molecular trees, *Cyrtohymena citrina* usually clusters with *Paraurostyla weissei*. It is included in about 110 phylogenetic studies; references are listed separately for each sequence. The sequences available so far do not form a monophyletic group. Faunistic records are available from Europe, Asia, North, Central, and South Americas, Africa, as well as Australia. *Cyrtohymena citrina* is moderately common and occurs in terrestrial and limnetic habitats. 145 references dealing with this species are listed. The ZooBank registration number of *C. citrina* is: urn:lsid:zoobank.org:act:50B6E92E-26AF-4346-82DA-71340A61A2BB.

Key words: bibliography; guide; literature; monograph; nomenclature; review; revision; taxonomy

Introduction

Steinia citrina was discovered by Berger & Foissner (1987) in Greece, but the first illustrated record was provided by Kahl (1932), who, however, misidentified his population as *Histrio inquietus* Stokes, 1887. Foissner (1989) transferred *S. citrina* from the genus *Steinia* Diesing, 1866 to the newly established genus *Cyrtohymena* because of distinct differences in the pattern formed by the undulating membranes. *Cyrtohymena citrina* is a moderately common oxytrichid inhabiting both terrestrial and limnetic habitats.

In the revision of the oxytrichids I provided a detailed overview about *C. citrina* (Berger 1999). Since then, three redescriptions and several other studies have been published, largely dealing with faunistics and phylogeny. The present work is thus mainly an update and supplement to the 1999 revision, where some particulars, for example nomenclature, have not been treated in detail.

Material and Methods

In this section the various parts of the paper are explained.

Heading. The heading consists of two parts, namely the current name (above) and the original combination (ICZN 1999, see recommendation 51A for term; often also named basionym, a term not used in the ICZN 1999, but in botany), including authors and year. The original combination is mentioned in the heading because it never changes. By contrast, the current name is usually the combination most recently published.

List of synonyms. The list of synonyms contains all taxonomically and nomenclaturally important contributions, that is, the original description, all combinations, redescriptions, and other taxonomically important papers. Papers where solely molecular data are published are usually not included; these studies can be found in the chapter phylogeny and classification (see below). Each entry consists of the following components: year of publication; name of taxon as written in the paper, including "author(s), year", and/or nomenclatural terms like, for example, "comb. nov." (all these parts are in bold); the n-dash (–) separates the taxon from the bibliographic data of the work containing this name; author(s) of work; name of journal or (brief) title of book; volume of journal or book series; page number where description begins or where nomenclatural act is made (a page number with the letter K means a page where the taxon is mentioned in a key); figures and tables referring to taxon; in brackets, brief explanation of content, accession numbers of slides, problems, etc.).

The entry of the original description contains also the ZooBank registration number. Note that the registration in ZooBank (zoobank.org) is a prerequisite for the valid publication of a new taxon/nomenclatural act in online-only (electronic-only) journals since 2012 (ICZN 2012, Article 8.5), that is, online-only works which do not contain the registration (or at least a hint that registration has occurred) in the work itself are not published and thus the taxa described therein are not valid. An example for such an invalid original description is Shao et al. (2014). The corrigendum, which represents now the original description, was published by Shao et al. (2017).

Brief characterisation. The brief characterisation is based on the original description and other papers dealing with morphology (see list of synonyms). It is a summary of the main features and not an "improved diagnosis" or detailed description. The features are arranged as in my monographs. For details on morphology (e.g., exact arrangement of cirri and dorsal kineties), see text and figures in the original description, redescriptions, and revisions mentioned in the list of synonyms.

Nomenclature. In the chapter nomenclature the species-group name is explained and nomenclatural problems are discussed.

Valid names. This chapter lists all names validly published including original author(s) and combining author(s) and years. The names are listed chronologically.

Remarks. In the remarks section, taxonomic topics and issues are discussed more or less detailed.

Morphology. This chapter is usually brief because containing only hints to the original description, redescriptions, and revisions. Since the page numbers are mentioned you can find the data rather easily in the various publications, which are sometimes rather voluminous. My monographs usually contain most or even all relevant figures published until that time. Later papers are mostly available as PDFs in the www and thus (almost) instantly accessible.

Cell division etc. Chapters on cell division, physiology, or other issues are optional, that is, only available when data on these topics have been published.

Classification and phylogeny. The classification and phylogeny section begins with a brief comment on the supposed phylogenetic position. When sequences are available the origin (direct submission or via a paper) is mentioned as indicated in NCBI data base. In addition, all papers using the sequence are listed. When more than one sequence is published, then the references are kept separate.

Further literature. In this chapter papers are listed which cannot be assigned to other chapters.

Occurrence and ecology. The chapter occurrence and ecology provides a brief comment on the main habitats and the geographic distribution. Usually you will find a hint to the same chapter in the corresponding monograph (Berger 1999, 2006, 2008, 2011) where most or even all records are considered in detail. In addition, "all" records not considered in the corresponding monograph are listed. In the present case, this chapter contains all records published so far. The records are arranged according to continents; within the continents, the countries are listed alphabetically.

References. The reference section contains all papers mentioned in the present study. Papers not dealing with the present species (e.g., Diesing 1866, ICZN 1999) are marked with an asterisk.

Systematic index. This index contains all scientific names. It is two-sided, that is, species names (e.g., *Cyrtohymena citrina*) are mentioned as follows: *citrina, Cyrtohymena* and *Cyrtohymena citrina*.

The present review and the corresponding monograph (Berger 1999 in present case) contain "all" works dealing with *Cyrtohymena citrina*. However, I cannot exclude that papers in which the species is misidentified (e.g., as *Cyrtohymena muscorum* (Kahl, 1932) Foissner, 1989) are lacking. Such problems will be discovered when *C. muscorum* is updated.

For general terminology, see Corliss (1979) and Lynn (2008), for terms specific for hypotrichs, see Berger (1999, 2006, 2008, 2011), and Foissner & Al-Rasheid (2006).

***Cyrtohymena citrina* (Berger & Foissner, 1987) Foissner, 1989** (current name)

***Steinia citrina* Berger & Foissner, 1987** (original combination)

1932 ***Steinia (Histrio) inquieta* (Stokes, 1887)** – Kahl, Tierwelt Dtl., 25: 613, Fig. 120$_4$ (Fig. 96e in Berger 1999; misidentification; for correct name see nomenclature).

1985 ***Steinia citrina* Foissner** – Foissner, Peer & Adam, Mitt. öst. bodenk. Ges., 30: 109 (nomen nudum).

1987 ***Steinia citrina* nov. spec.** – Berger & Foissner, Zool. Jb. Syst., 114: 225, Fig. 81–84, Table 11 (Fig. 96a–d in Berger 1999; original description; the holotype slide [registration number 1986/83] and one paratype slide [1986/84] have been deposited in the Biology Centre of the Upper Austrian Museum in Linz [LI]; Aescht 2008, p. 149). ZooBank registration number of *Steinia citrina*: urn:lsid:zoobank.org:act:50B6E92E-26AF-4346-82DA-71340A61A2BB (registered by H. Berger on 2017.01.09).

1988 ***Cyrtohymena citrina* (Berger & Foissner, 1987)** – Blatterer & Foissner, Stapfia, 17: 7, 70 (see nomenclature).

1989 ***Cyrtohymena citrina* (Berger & Foissner, 1987) nov. comb.** – Foissner, Sber. öst. Akad. Wiss., 196: 239 (combination with *Cyrtohymena* Foissner, 1989).

1999 ***Cyrtohymena citrina* (Berger & Foissner, 1987) Foissner, 1989** – Berger, Monographiae biol., 78: 281K, 293, Fig. 96a–e, Table 20 (detailed revision).

2001 ***Cyrtohymena citrina* (Berger & Foissner, 1987) Foissner, 1989** – Berger, Catalogue of ciliate names 1. Hypotrichs, p. 79 (nomenclator containing all original combinations, combinations, and higher taxa of hypotrichs and euplotids).

2003 ***citrina Steinia* Berger & Foissner 1987** – Aescht, Beitr. Naturk. Oberösterreichs, 12: 383 (catalogue on type material deposited in Upper Austrian Museum in Linz).

2004 ***Cyrtohymena (Cyrtohymena) citrina* (Berger & Foissner)** – Foissner, Denisia, 13: 370 (classification in nominotypical subgenus; see nomenclature).

2007 ***Cyrtohymena citrina* (Berger and Foissner, 1987)** – Çapar, Hacettepe J. Biol. & Chem., 35: 47, Fig. 3a–c (description of Turkish population; site where voucher slides deposited not mentioned; see remarks).

2007 ***Cyrtohymena citrina* (Berger et Foissner, 1987)** – Jankowski, Phylum Ciliophora, p. 463 (revision of ciliates).

2008 ***citrina, Steinia* Berger & Foissner, 1987** – Aescht, Denisia, 23: 149 (catalogue on type material deposited in Upper Austrian Museum in Linz).

2012 ***Cyrtohymena citrina* (Berger and Foissner, 1987) Foissner, 1989** – Kim, Lee, Kwon & Shin, J. Species Res., 1: 79, Fig. 2A–I, Table 1 (description of Korean population; see remarks; site where voucher material deposited not mentioned).

2012 ***Cyrtohymena citrina* (Berger and Foissner, 1987) Foissner, 1989** – Shin, Invertebrate Fauna of Korea, 1: 28, Fig. 9A–I, Plate 4E–J, Table 4 (description of Korean population; see remarks and entry above).

2015 ***Cyrtohymena citrina* (Berger and Foissner, 1987) Foissner, 1989** – Singh & Kamra, Eur. J. Protistol., 51: 281, Fig. 1A–C, 2A–G, 4A–C, 5A–G, Table 1 (description of Indian population, morphogenesis, and deposition of nucleotide sequence at GenBank, accession number KC182574; all data from same clone; voucher material deposited in Natural History Museum in London, accession number NHMUK 2015.3.23.1).

Brief characterization. Body size (from life unless otherwise indicated): 120–150 × 35–45 µm (Berger & Foissner 1987; width estimated via length to width ratio [3.3:1] of specimen shown in Fig. 96a in Berger 1999); 90–100 × 25–30 µm (Çapar 2007); 145–210 × 30–55 µm (Kim et al. 2012); 80–125 × 25–40 µm (Singh & Kamra 2015b). Total range thus 80–210 × 25–55 µm. **Body:** outline in ventral view elongate elliptical, sometimes somewhat S-shaped, left margin slightly convex, right almost straight, both ends more or less broadly rounded; flexible, moderately contractile. **Nuclear apparatus:** two macronuclear nodules; 1–4, usually two micronuclei. **Contractile vacuole:** close to left cell margin about in mid-body, with two collecting canals. **Cortical granules:** about 0.5–1.5 µm in diameter, mainly around cirri and dorsal cilia, yellow to orange-yellow, make cells yellow at low magnification. **Movement:** without peculiarities, that is, moderately rapid. **Oral apparatus:** adoral zone formed like a question mark, composed of 31–43 (31–37, mean = 33.6, n = 11, Berger & Foissner 1987; 35–43, mean = 38.8, n = 20, Singh & Kamra 2015b) membranelles; undulating membranes in *Cyrtohymena*-pattern. **Ventral ciliature:** an 18-cirri oxytrichid, that is, three frontal cirri, one buccal cirrus, four frontoventral cirri, three narrowly spaced postoral ventral cirri, two pretransverse ventral cirri, and five transverse cirri. Right marginal row composed of 18–25 cirri (18–25, mean = 21.1, n = 11, Berger & Foissner 1987; 20–24, mean = 22.8, n = 20, Singh & Kamra 2015b), commences at level of frontoventral cirri, ends slightly subterminally; left marginal row composed of 17–26 cirri (17–24, mean = 21.5, n = 11, Berger & Foissner 1987; 21–26, mean = 23.5, n = 20, Singh & Kamra 2015b), begins left of buccal vertex, terminates at rear end of cell. **Dorsal ciliature:** usually six dorsal kineties including two dorsomarginal kineties, kinety 3 with fragmentation; bristles about 3 µm long; each one caudal cirrus at end of kineties 1, 2, and 4. **Ecology:** moderately common in terrestrial and limnetic habitats. **Geographic distribution:** reliably recorded from Europe (type locality in Greece), Asia, North America, Central America, South America, Africa, and Australia (details see below).

Nomenclature. No derivation of the species-group name has been provided in the original description or a later paper. The name *citrin·us*, *-a*, *-um* (Latin adjective [m, f, n]; lemon yellow; www.frag-cesar.de, accessed 21.09.2016) refers to the yellow to orange-yellow cortical granules. Since *Cyrtohymena* and *Steinia* are of feminine gender (Aescht 2001, p. 280, 301), *citrina* is the correct spelling of the species-group name (ICZN 1999, Article 31.2).

Kahl (1932, p. 611) classified *Steinia* Diesing, 1866 as subgenus of *Oxytricha* Bory de Saint-Vincent in Lamouroux, Bory de Saint-Vincent & Deslongchamps, 1824 (Kahl 1932, p. 599). Thus, the correct name in his revision is *Oxytricha (Steinia) inquieta* (Stokes, 1887) Kahl, 1932 (the current systematic status of *Histrio inquietus* Stokes, 1887 is *Rigidohymena inquieta* (Stokes, 1887) Berger, 2011; p. 548; for revision, see Berger 1999, p. 313).

Steinia citrina in Foissner et al. (1985) is a nomen nudum because it fails to conform Article 13 of the ICZN (1999; see there for details). Since a nomen nudum is not an available name, the same name is available later for the same (present case) or a different concept (ICZN 1999, p. 111).

The combination *Cyrtohymena citrina* was already used by Blatterer & Foissner (1988) although the genus *Cyrtohymena* was just established by Foissner (1989, p. 238). Thus, Blatterer & Foissner (1988) cannot be the combining authors because in that case the combination would have been made before the genus was available.

Foissner (2004, p. 371) established the subgenus *Cyrtohymena (Cyrtohymenides)* with *Cyrtohymena (Cyrtohymenides) aspoecki* Foissner, 2004 as type species. Thus, he automatically activated the nominotypical subgenus *Cyrtohymena (Cyrtohymena)* Foissner, 1989. The second species assigned to *C. (Cyrtohymenides)* Foissner, 2004 was *Cyrtohymena australis* Foissner, 1995[1]. Consequently, all other species (including *Cyrtohymena citrina*) previously classified in *Cyrtohymena* by Foissner (1989) and Berger (1999) have been automatically assigned to the nominotypical subgenus *Cyrtohymena (Cyrtohymena)*. Recently, however, *Cyrtohymena (Cyrtohymenides)* has been synonymized with *Australocirrus* Blatterer & Foissner, 1988 by Kumar & Foissner (2015, p. 211, 226), that is, *Cyrtohymena (Cyrtohymena)* is also obsolete and thus the current systematic status of the present species is again *Cyrtohymena citrina* (Berger & Foissner, 1987) Foissner, 1989.

Incorrect subsequent spelling: *Cyrtohymena citrine* (Li et al. 2008, p. 120).

Valid names. All valid names published so far are listed chronologically: *Steinia citrina* Berger & Foissner, 1987. *Cyrtohymena citrina* (Berger & Foissner, 1987) Foissner, 1989. *Cyrtohymena (Cyrtohymena) citrina* (Berger & Foissner, 1987) Foissner, 1989 in Foissner (2004).

Remarks. For brief comparison with *Cyrtohymena primicirrata* (Berger & Foissner, 1987) Foissner, 1989 (for revision, see Berger 1999, p. 300) and *C. australis* Foissner, 1995 (current systematic status: *Australocirrus australis* (Foissner, 1995) Kumar & Foissner, 2015; for revision, see Berger 1999, p. 296), see Berger (1999, p. 294). For key to species, see Berger (1999, p. 280) and Berger (2018, in preparation).

The specimens of the populations studied by Çapar (2007) and Singh & Kamra (2015b) are somewhat smaller (90–100 × 25–30 µm in vivo; 80–125 × 25–40 µm) than those described by Berger & Foissner (1987; body length 120–150 µm) and Kahl (1932; body length 100–170 µm). In addition, Çapar (2007) did not mention the colour of the cortical granules so that the identification is not quite certain.

By contrast, the Korean specimens analysed by Kim et al. (2012) are larger (in vivo 145–210 × 30–55 µm) than those of the type population (Berger & Foissner 1987) and that studied by Kahl (1932); however, the cortical granules are yellow as in the type population. Kim et al. (2012, p. 82) wrote that five (rarely six according to their Table 1) prominent transverse cirri are present. Interestingly, the specimen shown in their

[1] The "nov. comb." in the chapter "Species assignable" in Foissner (2004, p. 371) was superfluous because the generic classification did not change (ICZN 1999, Article 51.3.2).

Fig. 2B has only four transverse cirri indicating that something (perhaps the illustration?) is wrong.

Morphology. For detailed description of morphology see original description (Berger & Foissner 1987, p. 225) or revision by Berger (1999, p. 293); this review also comprises the data of the population studied by Kahl (1932, p. 613). For characterization of Turkish population, see Çapar (2007, p. 47); for description of Korean population, see Kim et al. (2012, p. 79) and Shin (2012, p. 28); and for Indian population, see Singh & Kamra (2015b, p. 281).

Cell division. For details on this part of the life cycle, see Singh & Kamra (2015b, p. 282). As is usual for non-stylonychid 18-cirri hypotrichs, cirrus V/3 (= rearmost postoral ventral cirrus) is involved in anlagen formation (see Berger & Foissner 1997, p. 137 and Berger 1999, p. 71 for details on this feature).

Cyst. Resting cysts smooth, about 40 µm across (Singh & Kamra 2015b, p. 282).

Classification and phylogeny. *Cyrtohymena citrina* is, according to morphological and ontogenetic data, a flexible and thus non-stylonychine 18-cirri oxytrichid (dorsomarginal kineties and simple dorsal kinety fragmentation [of kinety 3] present).

In many molecular trees, *Cyrtohymena citrina* clusters with *Paraurostyla weissei* (Stein, 1859) Borror, 1972 (original combination *Urostyla weissei* Stein, 1859) (type of *Paraurostyla* Borror, 1972; for revision of *P. weissei*, see Berger 1999, p. 844, 846), for example, Hewitt et al. (2003, p. 262) and Chen & Song (2001, p. 298). In the tree published by Foissner & Stoeck (2008, p. 16), one population of *C. citrina* is more closely related to *Neokeronopsis (Afrokeronopsis) aurea* Foissner & Stoeck, 2008 (now *Afrokeronopsis aurea* (Foissner & Stoeck, 2008) Foissner, Shi, Wang & Warren, 2010) than to a second *C. citrina* population (cause unknown). According to the tree by Kim et al. (2014, p. 530), the populations represented by the four sequences mentioned below (AF164135, AF508755, AY498653, KC182574) are not very closely related. According to the tree published by Jung et al. (2015, p. 293), *C. citrina* (AY498653) is not very closely related with the type species *C. muscorum* (Kahl, 1932) Foissner, 1989; the reasons are unclear. In the tree published by de Castro et al. (2016, their Fig. 18), the sequences KC182574, AY498653, and AF164135 do not form a monophyletic group indicating misidentifications.

A search in NCBI database provided four results under the nucleotide section (accessed 2017.09.06). Within the sequence paragraphs, the references are arranged chronologically.

AF164135 (direct submission by Prescott and co-workers on 1999.07.22). Papers dealing with this sequence: Chen & Song (2001, p. 292, 296, 298); Snoeyenbos-West et al. (2002, p. 1905); Liu et al. (2010, p. 707); Küppers et al. (2011, p. 117); Chen et al. (2013b, p. 1919); Lv et al. (2013, p. 462, next relative *Neokeronopsis aurea*); Singh et al. (2013, p. 295); Foissner et al. (2014, p. 62, 69); Kim et al. (2014, p. 530); Fan et al. (2014a, p. 4057; 2015, p. 381); Lv et al. (2015, p. 394); Shao et al. (2014b, p. 3023; clusters with *Cyrtohymena shii* (Shi, Wei & Wang, 1997) Shao et al., 2012; now *Australocirrus shii* (Shi et al., 1997) Kumar & Foissner, 2015); de Castro et al. (2016, p. 25/34); Paiva et al. (2016, p. 258); Li et al. (2017, p. 88).

AF508755 (direct submission by Hewitt and co-workers on 2002.05.02 and Hewitt et al. 2003, p. 259, 261). According to Hewitt et al. (2003, p. 259), the population from Maroon Creek, Aspen, Colorado, was identified by Wilhelm Foissner (Salzburg); in spite of that we could not exclude that the identification is doubtful (Foissner et al. 2004, p. 267). Papers dealing with this sequence: Coleman (2005, p. 70); Gong et al. (2007, p. 476); Schmidt et al. (2007, p. 203–205); Sonntag et al. (2008, p. 284); Paiva et al. (2009, p. 226, 231); Huang et al. (2010, p. 411, 412; 2012, p. 599; 2014, p. 339; 2016, p. 105, 106); Vd'ačný et al. (2010, p. 320, 329); Zhao et al. (2012, p. 321, 325); Singh et al. (2013, p. 295, next relative *Cyrtohymena (Cyrtohymenides) shii*); Chen et al. (2013b, p. 1919; 2014, p. 606; 2015, p. 2299); Kim et al. (2014, p. 530); Shao et al. (2014, p. 377, next relative *Neokeronopsis aurea*; the valid publication is Shao et al. 2017); Xu et al. (2014, p. 182); Chen et al. (2015, p. 318, next relative *Neokeronopsis aurea*); Luo et al. (2015, p. 467); Zhao et al. (2015, p. 241), Lu et al. (2016, p. 875).

AY498653 (direct submission by Foissner and co-workers on 2003.12.10 and by Foissner et al. 2004, p. 267, 273). Papers dealing with this sequence: Berger et al. (2004); Gong et al. (2006, p. 64, 71; next relative "*Oxytricha ferruginea*"); Schmidt et al. (2007, p. 203–205; 2008, p. 404, 405); Yi et al. (2009, p. 230, 232, 233); Paiva et al. (2009, p. 226, 231); Dai & Xu (2011, p. 1494); He & Xu (2011, p. 336); Hu et al. (2011, p. 98); Küppers et al. (2011, p. 117); Yi & Song (2011, p. 5); Zoller et al. (2012, p. 647); Chen et al. (2013, p. 596); Chen et al. (2013, p. 1200); Chen et al. (2011, p. 499; 2011a, p. 660; 2013, p. 464; 2013a, p. 1162; 2013b, p. 1919); Li et al. (2013, p. 254); Li et al. (2008, p. 120, 122); Jiang et al. (2013, p. 89); Singh & Kamra (2013, p. 608, next relative *Paraurosomoida indiensis* Singh & Kamra, 2013); Weisse et al. (2013, p. 264; next relatives are *P. weissei* and *Onychodromopsis flexilis* Stokes, 1887); Bharti et al. (2014, p. 2629; 2015, p. 768); Fan et al. (2014, p. 85); Heber et al. (2014, p. 271, next relative *Oxytricha ferruginea* Stein, 1859); Jung et al. (2014, p. 204; 2015, p. 293; 2015a, p. 378; 2016, p. 259); Kim et al. (2014, p. 530); Kumar et al. (2014, p. 257; 2015, p. 95; 2017, p. 14/19); Lu et al. (2014, p. 534; 2015, p. 3222); Shao et al. (2014a, p. 602, next relative *Notohymena apoaustralis* Lv et al., 2013); Bourland (2015, p. 368); Xu et al. (2015, p. 191; the presence of the stylonychine *Onychodromus grandis* Stein, 1859a close to *C. citrina* is likely a mistake); Yang et al. (2015, p. 460); de Castro et al. (2016, p. 25/34); Fan et al. (2016, p. 104); Kim et al. (2016, p. 141); Li et al. (2016, p. 69); Luo et al. (2016, p. 782; 2017, p. 484, *C. citrina* + ((*Paraurostyla weissei* + *Notohymena apoaustralis*) + (*Paraurosomoida indiensis* + *Cyrtohymena muscorum*)); Bharti et al. (2017, p. 687); Jung et al. (2017, p. 15); Kim et al. (2017, p. 881); Lu et al. (2017, p. 643); Park et al. (2017, p. 112); Park et al. (2017a, p. 454); Park et al. (2017, p. 122).

KC182574 (direct submission by Sing and Kamra on 2012.11.19; corresponding publication is Singh & Kamra 2015b, p. 281). Singh & Kamra (2015b, p. 287) found the following relationships: *Cyrtohymena citrina* KC182574 + (*Paraurosomoida indiensis* JX139117 + *C. muscorum* KM061384) + (*Urosomoida agilis* KJ864926 + *C. citrina* AY498653) + (*Notohymena apoaustralis* KC430934 + *Paraurostyla weissei* AF164127). The other *Cyrtohymena citrina* sequences (AF164135, AF508755) are

somewhat set off, indicating that these populations have been misidentified. Thus, I recommend using the sequences KC182574 and AY98653 in futures studies. Further papers dealing with KC182574: Kim et al. (2014, p. 530); Singh & Kamra (2014, p. 634, clusters as follows: (*Paraurostyla weissei* + *Notohymena apoaustralis*) + *Paraurosomoida indiensis* + *Cyrtohymena citrina*); Singh & Kamra (2015a, p. 63); de Castro et al. (2016, p. 25/34); Dong et al. (2016, p. 229); Kumar et al. (2016, p. 213); Wang et al. (2016, p. 87); Yang et al. (2016, p. 460); Bharti et al. (2017, p. 643); Chen et al. (2017, p. 138); Jung et al. (2017, p. 15); Wang et al. (2017, p. 9; 2017a, p. 191; 2017b, p. 240).

Papers in which no GenBank accession numbers have been mentioned: Foissner & Stoeck (2006, p. 262; 2008, p. 16; 2011, p. 47; each two sequences); Gao et al. (2010, p. 546; 2010a, p. 94); Li et al. (2009, p. 441; 2009a, p. 771); Shao et al. (2007, p. 262, next relative "*Oxytricha ferruginea*"; 2008, p. 2968, accession numbers available in supplement).

Further literature. Berger (2011, p. 547); Berger & Al-Rasheid (2008, p. 72, 76, 90).

Occurrence and ecology. *Cyrtohymena citrina* is moderately common in terrestrial and limnetic habitats. Likely with cosmopolitan distribution because so far recorded from Europe, Asia, North America, Central America, South America, Africa, and Australia (for individual records see below). This chapter contains all published records of *C. citrina*. Of course, I cannot exclude that one or another record was overlooked.

Type locality is a goat pasture (altitude about 1000 m) between the cities Nafplio and Tripoli, Peloponnesus, Greece, where *Cyrtohymena citrina* was discovered in the litter and upper layer of a very shallow soil (Berger & Foissner 1987, p. 194, 195, 225).

Further records of *Cyrtohymena citrina* substantiated by morphological data: katharobic waters with *Utricularia* and *Hottonia*, likely in or near Hamburg (Germany) where Kahl lived and worked (Kahl 1932); semiterrestrial soil from flooded zone of Gelinüllü Dam Lake, Yozgat Province, Central Anatolia Region, Turkey (Çapar 2007; see also Çapar 2007a, p. 208; the mention in the Turkish paper by Çapar 2008, p. 362 likely also refers to this record); soil from Barsey Rhododendron Sanctuary (27°19'42"N 88°11'83"E), Sikkim, India (Singh & Kamra 2015b); fallen leaves and soil under false acacia tree (*Robinia pseudoacacia*) in Jeokseong-myeon (37°01'07"N 128° 18'31"E), Danyang-gun, Chungcheong-buk-do, Korea (Kim et al. 2012, see also Jung et al. 2017a, p. 246; Shin 2012).

Records of *Cyrtohymena citrina* not substantiated by morphological data. Europe: soil from four Austrian forest preservation sites and beech forest in Salzburg, Austria (Foissner et al. 2005, p. 626); stagnant water bodies on alpine pasture (Palfner Alm) in the Seidlwinkl Tal, a valley in Salzburg, Austria (Gros et al. 2012, p. 43); detritus of a freshwater aquarium (24 °C; together with *Tetmemena pustulata*, *Anteholosticha monilata*, *Euplotoides patella*, *Vorticella campanula*, *Mesodinium pulex*, *Chilodonella acuta*, *Frontonia leucas*, *Urocentrum turbo*)[2] in Salzburg, Austria (Berger 1999, p. 296); floodplain soil from near the junction of Enns River and Danube River, Lower Austria (Foissner 2004, p. 370); various rivers (Schwemmbach, Enknach, Aschach, Dürre Aschach, Wegbach, Antiesen, Pollinger Ache, Pram, Kutschermüllerbach, Welser Grünbach, Enns, Perwender Bach, Traun, Feldaist, Große Naarn, Kleine Naarn, Naarn, Große Mühl, Kleine Mühl, Steinerne Mühl, Osterbach, Pesenbach, Große Rodl, Krems, Ager) in Upper Austria (Aescht 2012, p. 93, 127, 139, 143, 160, 177, 195, 200, 214, 233, 257, 268, 272, 275, 324, 343, 361, 363, 372, 398, 412, 433, 436, 445, 448, 459, 465, 481, 500, 512, 516, 532, 647; personal communications by H. Blatterer to E. Aescht); betamesosaprobic rivers (Ager, Alm, Krems, Traun; Steinerne Mühl, Große Mühl; Große Rodl) in Upper Austria (AOÖLR 1997a, p. 51, 59, 70, 112; 1997b, p. 105; 1997c, p. 98; all identifications by H. Blatterer); in October between leaves in the clean Illach River, Bavaria, Germany (Foissner 1997a, p. 183); soil from former industrial area (textile industry) in Nordhorn, Germany (Niebuhr 1989, p. 82; identification by W. Foissner and J. Niebuhr).

Asia: upper litter and soil layer (0–2 cm) of vegetable field about 40 km north of Riyadh and upper litter and soil layer (0–5 cm) of leguminose field in Al-Hassa oasis, few kilometres east of town of Al-Hofuf, Saudi Arabia (Foissner et al. 2008, p. 319); soil from Valley of Flowers, India (Kamra et al. 2008, p. 375); soil from grassland and sand dune from east coast of Singapore Island (Foissner 2008, p. 84).

North America: Maroon Creek, Aspen, Colorado, USA (Hewitt et al. 2003, p. 259; identified by W. Foissner according to Hewitt et al. 2003, p. 259, but in spite of that identification perhaps not correct, see Foissner et al. 2004, p. 267).

Central America: upper soil and litter layer (0–3 cm) about 5 km east of ranch house "La Casona" near small path to Pacific Ocean in Santa Rosa National Park, Costa Rica (Foissner 1995, p. 38; marked with "?", indicating that identification not quite certain).

South America: dark brown soil from Amazonian rain forest near Iquitos, Peru (Foissner 1997, p. 321); soils from six sites in Venezuela (Foissner 2016, p. 27; detailed description of sites and samples, see this paper).

Africa: upper litter and sandy soil layer under a leguminose tree in forest near Sheldrick waterfalls, Kenya (Foissner 1999, p. 322); four soil samples from Namib Desert, including Etosha Pan, Namibia (Foissner et al. 2002, p. 48, 59, 64).

Australia: upper soil layer (0–5 cm) from bush in Royal National Park, south of Sydney, and saline soil from shore of Lake Alexandrina (Point Pelican) near Adelaide, Australia (Blatterer & Foissner 1988, p. 7).

For details on food and biomass, see Foissner (1987, p. 127; 1998, p. 201) and revision by Berger (1999, p. 296).

References

Papers not dealing with *Cyrtohymena citrina* (e.g., Diesing 1866, ICZN 1999) are marked with an asterisk.

*Aescht E. (2001): Catalogue of the generic names of ciliates

[2] The original source of the material (plants, sediment) in the aquarium is not known.

(Protozoa, Ciliophora). – Denisia **1**: 1–350.

Aescht E. (2003): Typen-Liste der Sammlung „Wirbellose Tiere“ (ohne Insekten) am Biologiezentrum Linz. – Beitr. Naturk. Oberösterreichs **12**: 377–406.

Aescht E. (2008): Annotated catalogue of “type material” of ciliates (Ciliophora) and some further protists at the Upper Austrian Museum in Linz, including guideline for “typification” of species. – Denisia **23**: 125–234.

Aescht E. (2012): Wimperlinge (Protista: Ciliophora) aus Oberösterreichs Gemeinden und 7 weiteren Bundesländern – Daten zur Checkliste der Fauna Österreichs. – Beitr. Naturk. Oberösterreichs **22**: 83–832.

AOÖLR (Amt der Oberösterreichischen Landesregierung) (1997a): Biologische Güte und Trophie der Fließgewässer in Oberösterreich. Entwicklung seit 1966 und Stand 1995/96. – Gewässerschutz Bericht **18**: 1–143.

AOÖLR (Amt der Oberösterreichischen Landesregierung) (1997b): Kleine Mühl, Steinerne Mühl und Grosse Mühl. Untersuchungen zur Gewässergüte Stand 1992 - 1996. – Gewässerschutz Bericht **16**: 1–121.

AOÖLR (Amt der Oberösterreichischen Landesregierung) (1997c): Ranna-Osterbach, Pesenbach und Grosse Rodl. Untersuchungen zur Gewässergüte Stand 1993 - 1996. – Gewässerschutz Bericht **17**: 1–115.

Berger H. (1999): Monograph of the Oxytrichidae (Ciliophora, Hypotrichia). – Monographiae biol. **78**: i–xii, 1–1080.

Berger H. (2001): Catalogue of ciliate names 1. Hypotrichs. Verlag Helmut Berger, Salzburg. i–viii, 206 pp.

*Berger H. (2006): Monograph of the Urostyloidea (Ciliophora, Hypotricha). – Monographiae biol. **85**: i–xvi, 1–1303.

*Berger H. (2008): Monograph of the Amphisiellidae and Trachelostylidae (Ciliophora, Hypotricha). – Monographiae biol. **88**: i–xvi, 1–737.

Berger H. (2011): Monograph of the Gonostomatidae and Kahliellidae (Ciliophora, Hypotricha). – Monographiae biol. **90**: i–xiv, 1–741.

Berger H. (2018): *Cyrtohymena* Foissner, 1989 and *Cyrtohymena muscorum* (Kahl, 1932) Foissner, 1989 (Ciliophora, Hypotricha): update 1.0 on monographic treatment. – Ser. Monogr. Cilioph. **3**: in preparation.

Berger H. & Al-Rasheid K.A.S. (2008): Wilhelm Foissner: nomenclatural and taxonomic summary 1967–2007. Denisia **23**: 65–124.

Berger H. & Foissner W. (1987): Morphology and biometry of some soil hypotrichs (Protozoa: Ciliophora). – Zool. Jb. Syst. **114**: 193–239. ZooBank registration number of work: urn:lsid:zoobank.org:pub:F184483B-FF54-462 B-8CDD-0333BD1E57CC.

*Berger H. & Foissner W. (1997): Cladistic relationships and generic characterization of oxytrichid hypotrichs (Protozoa, Ciliophora). – Arch. Protistenk. **148**: 125–155.

Berger H., Moon-van der Staay S.Y., van der Staay G.W. M., Hackstein J.H.P., Krautgartner W.-D. & Foissner W. (2004): Reconciling morphological and 18S rRNA phylogenies in the stichotrichines (Ciliophora, Spirotrichea), including new sequences from some rare species. – Ber. nat.-med. Verein Innsbruck Suppl. **15**: 15 (abstract).

Bharti D., Kumar S. & La Terza A. (2014): Morphology, morphogenesis and molecular phylogeny of a novel soil ciliate, *Pseudouroleptus plestiensis* n. sp. (Ciliophora, Oxytrichidae), from the uplands of Colfiorito, Italy. – Int. J. syst. evolut. Microbiol. **64**: 2625–2636.

Bharti D., Kumar S. & La Terza A. (2015): Two Gonostomatid ciliates from the soil of Lombardia, Italy; including note on the soil mapping project. – J. Euk. Microbiol. **62**: 762–772.

Bharti D., Kumar S. & La Terza A. (2017): Description and molecular phylogeny of a novel hypotrich ciliate from the soil of Marche Region, Italy; including notes on the MOSYSS project. – J. Euk. Microbiol. **64**: 678–690.

Blatterer H. & Foissner W. (1988): Beitrag zur terricolen Ciliatenfauna (Protozoa: Ciliophora) Australiens. – Stapfia **17**: 1–84.

Borror A.C. (1972): Revision of the order Hypotrichida (Ciliophora, Protozoa). – J. Protozool. **19**: 1–23.

Bourland W. (2015): Morphology, ontogenesis and molecular characterization of *Atractos contortus* Vörösváry, 1950 and *Stichotricha aculeata* Wrzesniowskiego, 1866 (Ciliophora, Stichotrichida) with consideration of their systematic positions. – Eur. J. Protistol. **51**: 351–373.

Çapar S. (2007): Hypotrich ciliates (Protozoa: Ciliophora) of Gelingüllü Dam Lake, Yozgat-Turkey. – Hacettepe J. Biol. & Chem. **35**: 45–56.

Çapar S. (2007a): Checklist for ciliate species (Protozoa, Ciliophora) living in Turkish inland waters and flooded zones. – E.U. Journal of Fisheries & Aquatic Sciences **24**: 207–212.

Çapar S. (2008): Sulak alan siliyatlari (Protozoa: Ciliophora) ve morfolojik farklari (Wetland ciliates (Protozoa: Ciliophora) and morphological differences). – E.Ü. Su Ürünleri Dergisi **25**: 359–364 (in Turkish with English abstract).

Chen L., Liu W., Liu A., Al-Rasheid K.A.S. & Shao C. (2013): Morphology and molecular phylogeny of a new marine hypotrichous ciliate, *Hypotrichidium paraconicum* n. sp. (Ciliophora, Hypotrichia). – J. Euk. Microbiol. **60**: 588–600.

Chen L., Zhao X., Shao C. Miao M. & Clamp J.C. (2017): Morphology and phylogeny of two new ciliates, *Sterkiella sinica* sp. nov. and *Rubrioxytricha tsinlingensis* sp. nov. (Protozoa, Ciliophora, Hypotrichia) from north-west China. – Systematics and Biodiversity **15**: 131–142.

Chen W., Chen X., Li L., Warren A. & Lin X. (2015): Morphology, morphogenesis and molecular phylogeny of an oxytrichid ciliate, *Rubrioxytricha haematoplasma* (Blatterer & Foissner, 1990) Berger, 1999 (Ciliophora, Hypotricha). – Int. J. syst. Evolut. Microbiol. **65**: 309–320.

Chen X., Shao C., Liu X., Huang J. & Al-Rasheid K.A.S. (2013): Morphology and phylogenies of two hypotrichous brackish-water ciliates from China, *Neourostylopsis orientalis* n. sp. and *Protogastrostyla sterkii* (Wallengren, 1900) n. comb., with establishment of a new genus *Neourostylopsis* n. gen. (Protista, Ciliophora, Hypotrichia). – Int. J. syst. evolut. Microbiol. **63**: 1197–1209.

Chen X., Dong J., Lin X. & Al-Rasheid K.A.S. (2011): Morphology and phylogeny of a new urostylid ciliate, *Monocoronella carnea* n. g., n. sp. (Ciliophora, Hypotricha) from Daya Bay, southern China. – J. Euk. Microbiol. **58**: 497–503.

Chen X., Clamp J.C. & Song W. (2011a): Phylogeny and systematic revision of the family Pseudokeronopsidae (Protista, Ciliophora, Hypotricha), with description of a new estuarine species of *Pseudokeronopsis*. – Zool. Scr. **40**: 659–671.

Chen X., Shao C., Lin X., Clamp J.C. & Song W. (2013): Morphology and molecular phylogeny of two new brackish-water species of *Amphisiella* (Ciliophora, Hypotricha), with notes on morphogenesis. – Eur. J. Protistol. **49**: 453–466.

Chen X., Miao M., Ma H., Shao C. & Al-Rasheid K.A.S. (2013a): Morphology, morphogenesis and small-subunit rRNA gene sequence of the novel brackish-water ciliate *Strongylidium orientale* sp. nov. (Ciliophora, Hypotricha). – Int. J. syst. evolut. Microbiol. **63**: 1155–1164.

Chen X., Yan Y., Hu X., Zhu M., Ma H. & Warren A. (2013b): Morphology and morphogenesis of a soil ciliate, *Rigidohymena candens* (Kahl, 1932) Berger, 2011 (Ciliophora, Hypotricha, Oxytrichidae), with notes on its molecular phylogeny based on small-subunit rDNA sequence data. – Int. J. syst. evolut. Microbiol. **63**: 1912–1921.

Chen X., Miao M., Ma H., Al-Rasheid K.A.S., Xu K. & Lin X. (2014): Morphology, ontogeny, and phylogeny of two brackish urostylid ciliates (Protist, Ciliophora, Hypotricha). – J. Euk. Microbiol. **61**: 594–610.

Chen X., Gao F., Al-Farraj S.A., Al-Rasheid K.A.S., Xu K. & Song W. (2015): Morphology and morphogenesis of a novel mangrove ciliate, *Sterkiella subtropica* sp. nov. (Protozoa, Ciliophora, Hypotrichia), with phylogenetic analyses based on small-subunit rDNA sequence data. – Int. J. syst. evolut. Microbiol. **65**: 2292–2303.

Chen Z. & Song W. (2001): Phylogenetic positions of *Uronychia transfuga* and *Diophrys appendiculata* (Euplotida, Hypotrichia, Ciliophora) within hypotrichous ciliates inferred from the small subunit ribosomal RNA genes sequences. – Eur. J. Protistol. **37**: 291–301.

Coleman A.W. (2005): *Paramecium aurelia* revisited. – J. Euk. Microbiol. **52**: 68–77.

*Corliss J.O. (1979): The ciliated protozoa. Characterization, classification and guide to the literature. Pergamon Press, Oxford, New York, Toronto, Sydney, Paris, Frankfurt. I–XVI, 455 pp.

Dai R. & Xu K. (2011): Taxonomy and phylogeny of *Tunicothrix* (Ciliophora, Stichotrichia), with the description of two novel species, *Tunicothrix brachysticha* n. sp. and *Tunicothrix multinucleata* n. sp., and the establishment of Parabirojimidae n. fam. – Int. J. syst. evolut. Microbiol. **61**: 1487–1496.

de Castro L.A.M., Küppers G.C., Fernandes N.M., Schlegel M. & Paiva T.d.S. (2016): Ontogeny and molecular phylogeny of *Apoamphisiella vernalis* reveal unclear separation between genera *Apoamphisiella* and *Paraurostyla* (Protozoa, Ciliophora, Hypotricha). – PLoS ONE **11**: e0155825 (34 pp).

*Diesing K.M. (1866): Revision der Prothelminthen. Abtheilung: Amastigen. II. Amastigen mit Peristom. – Sber. Akad. Wiss. Wien, Mathematisch-naturwissenschaftliche Klasse, Abt. I **53**: 49–144.

Dong J., Lu X., Shao C., Huang J. & Al-Rasheid K.A.S. (2016): Morphology, morphogenesis and molecular phylogeny of a novel saline soil ciliate, *Lamtostyla salina* n. sp. (Ciliophora, Hypotricha). – Eur. J. Protistol. **56**: 219–231.

Fan Y., Chen X., Hu X., Shao C., Al-Rasheid K.A.S., Al-Farraj A.S. & Lin X. (2014): Morphology and morphogenesis of *Apoholosticha sinica* n. g., n. sp. (Ciliophora, Hypotrichia), with consideration of its systematic position among urostylids. – Eur. J. Protistol. **50**: 78–88.

Fan Y., Hu X., Gao F., Al-Farraj S.A. & Al-Rasheid K.A.S. (2014a): Morphology, ontogenetic features and SSU rRNA gene-based phylogeny of a soil ciliate, *Bistichella cystiformans* spec. nov. (Protista, Ciliophora, Stichotrichia). – Int. J. syst. evolut. Microbiol. **64**: 4049–4060.

Fan Y., Zhao X., Hu X., Miao M., Warren A. & Song W. (2015): Taxonomy and molecular phylogeny of two novel ciliates, with establishment of a new genus, *Pseudogastrostyla* n. g. (Ciliophora, Hypotrichia, Oxytrichidae). – Eur. J. Protistol. **51**: 374–385.

Fan Y., Lu X., Huang J., Hu X. & Warren A. (2016): Redescription of two little-known urostyloid ciliates, *Anteholosticha randani* (Grolière, 1975) Berger, 2003 and *A. antecirrata* Berger, 2006 (Ciliophora, Urostylida). – Eur. J. Protistol. **53**: 96–108.

Foissner W. (1987): Soil protozoa: fundamental problems, ecological significance, adaptations in ciliates and testaceans, bioindicators, and guide to the literature. – Progr. Protistol. **2**: 69–212.

Foissner W. (1989): Morphologie und Infraciliatur einiger neuer und wenig bekannter terrestrischer und limnischer Ciliaten (Protozoa, Ciliophora). – Sber. öst. Akad. Wiss., Mathematisch-naturwissenschaftliche Klasse, Abt. I **196** (year 1987): 173–247.

Foissner W. (1995): Tropical protozoan diversity: 80 ciliate species (Protozoa, Ciliophora) in a soil sample from a tropical dry forest of Costa Rica, with descriptions of four new genera and seven new species. – Arch. Protistenk. **145**: 37–79.

Foissner W. (1997a): Faunistic and taxonomic studies on ciliates (Protozoa, Ciliophora) from clean rivers in Bavaria (Germany), with descriptions of new species and ecological notes. – Limnologica (Berlin) **27**: 179–238.

Foissner W. (1997b): Soil ciliates (Protozoa: Ciliophora) from evergreen rain forests of Australia, South America and Costa Rica: diversity and description of new species. – Biol. Fertil. Soils **25**: 317–339.

Foissner W. (1998): An updated compilation of world soil ciliates (Protozoa, Ciliophora), with ecological notes, new records, and descriptions of new species. – Eur. J. Protistol. **34**: 195–235.

Foissner W. (1999): Notes on the soil ciliate biota (Protozoa, Ciliophora) from the Shimba Hills in Kenya (Africa): diversity and description of three new genera and ten new species. – Biodiversity and Conservation **8**: 319–389.

Foissner W. (2004). Some new ciliates (Protozoa, Ciliophora) from an Austrian floodplain soil, including a giant, red "flagship", *Cyrtohymena (Cyrtohymenides) aspoecki* nov. subgen., nov. spec. – Denisia **13**: 369–382.

Foissner W. (2008): Notes on soil ciliates from Singapore, with description of *Suturothrix monoarmata* nov. gen., nov. spec. (Protozoa, Ciliophora). – Soil Organisms **80**: 81–97.

Foissner W. (2016): Terrestrial and semiterrestrial ciliates (Protozoa, Ciliophora) from Venezuela and Galápagos. – Denisia **35**: 1–912.

*Foissner W. & Al-Rasheid K. (2006): A unified organization of the stichotrichine oral apparatus, including a description of the buccal seal (Ciliophora: Spirotrichea). – Acta Protozool. **45**: 1–16.

Foissner W. & Stoeck T. (2006): *Rigidothrix goiseri* nov. gen., nov. spec. (Rigidotrichidae nov. fam.), a new "flagship" ciliate from the Niger floodplain breaks the flexibility-dogma in the classification of stichotrichine spirotrichs (Ciliophora, Spirotrichea). – Eur. J. Protistol. **42**: 249–267.

Foissner W. & Stoeck T. (2008): Morphology, ontogenesis and molecular phylogeny of *Neokeronopsis (Afrokeronopsis) aurea* nov. subgen., nov. spec. (Ciliophora: Hypotrichia), a new African flagship ciliate confirms the CEUU hypothesis. – Acta Protozool. **47**: 1–33.

Foissner W. & Stoeck T. (2011): *Cotterillia bromelicola* nov. gen., nov. spec., a gonostomatid ciliate (Ciliophora, Hypotricha) from tank bromeliads (Bromeliaceae) with de novo originating dorsal kineties. – Eur. J. Protistol. **47**: 29–50.

Foissner W., Peer T. & Adam H. (1985): Pedologische und protozoologische Untersuchung einiger Böden des Tullnerfeldes (Niederösterreich). – Mitt. öst. bodenk. Ges. **30**: 77–117.

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. Part I: Text and line drawings. Part II: Photographs. – Denisia **5**: 1–1459.

Foissner W., Moon-van der Staay S.Y., van der Staay G.W.M., Hackstein J.H.P., Krautgartner W.-D. & Berger H. (2004): Reconciling classical and molecular phylogenies in the stichotrichines (Ciliophora, Spirotrichea), including new sequences from some rare species. – Eur. J. Protistol. **40**: 265–281.

Foissner W., Berger H., Xu K. & Zechmeister-Boltenstern S. (2005): A huge, undescribed soil ciliate (Protozoa: Ciliophora) diversity in natural forest stands of Central Europe. – Biodiversity and Conservation **14**: 617–701.

Foissner W., Quintela-Alonso P. & Al-Rasheid K. (2008): Soil ciliates from Saudi Arabia, including descriptions of two new genera and six new species. – Acta Protozool. **47**: 317–352.

*Foissner W., Shi X., Wang R. & Warren A. (2010): A reinvestigation of *Neokeronopsis* populations, including the description of *N. asiatica* nov. spec. (Ciliophora, Hypotricha). – Acta Protozool. **49**: 87–105.

Foissner W., Filker S. & Stoeck T. (2014): *Schmidingerothrix salinarum* nov. spec. is the molecular sister of the large oxytrichid clade (Ciliophora, Hypotricha). – J. Euk. Microbiol. **61**: 61–74.

Gao F., Yi Z., Gong J., Al-Rasheid K.A.S. & Song W. (2010): Molecular phylogeny and species separation of five morphologically similar *Holosticha*-complex ciliates (Protozoa, Ciliophora) using ARDRA riboprinting and multigene sequence data. – Chin. J. Oceanol. Limnol. **28**: 542–548.

Gao F., Yi Z., Chen Z., Al-Rasheid K.A.S. & Song W. (2010a): On four closely related hypotrichous ciliates (Protozoa, Ciliophora, Spirotrichea): molecular characters, interspecific relationships and phylogeny defined with multigene sequence information. – Acta zool. sin. **29**: 90–96.

Gong J., Song W., Li L., Shao C. & Chen Z. (2006): A new investigation of the marine ciliate, *Trachelostyla pediculiformis* (Cohn, 1866) Borror, 1972 (Ciliophora, Hypotrichida), with establishment of a new genus, *Spirotrachelostyla* nov. gen. – Eur. J. Protistol. **42**: 63–73.

Gong J., Kim S.-J., Kim S.-Y., Min G.-S., Roberts D.M., Warren A. & Choi J.K. (2007): Taxonomic redescriptions of two ciliates, *Protogastrostyla pulchra* n. g., n. comb. and *Hemigastrostyla enigmatica* (Ciliophora: Spirotrichea, Stichotrichia), with phylogenetic analyses based on 18S and 28S rRNA gene sequences. – J. Euk. Microbiol. **54**: 468–478.

Gros P., Bauch C., Foissner W., Heiss E., Hierschläger M., Lindner R., Lohmeyer T.R., Medicus C., Neuner W., Oertel A., Pfleger H.S., Pilsl P., Stöhr O., Taurer-Zeiner C., Türk R. & Wittmann H. (2012): Nationalpark Hohe Tauern, Seidlwinkltal (Rauris, Salzburg) - Geo Tag der Artenvielfalt. – Abh. zool.-bot. Ges. Österr. **38**: 1–70.

He Y. & Xu K. (2011): Morphology and small subunit rDNA phylogeny of a new soil ciliate, *Bistichella variabilis* n. sp. (Ciliophora, Stichotrichia). – J. Euk. Microbiol. **58**: 332–338.

Heber D., Stoeck T. & Foissner W. (2014): Morphology and ontogenesis of *Psilotrichides hawaiiensis* nov. gen., nov. spec. and molecular phylogeny of the Psilotrichidae (Ciliophora, Hypotrichia). – J. Euk. Microbiol. **61**: 260–277.

Hewitt E.A., Müller K.M., Cannone J., Hogan D.J., Gutell R. & Prescott D.M. (2003): Phylogenetic relationships among 28 spirotrichous ciliates documented by rDNA. – Molecular Phylogenetics and Evolution **29**: 258–267.

Hu X., Hu X., Al-Rasheid K.A.S., Al-Farraj S.A. & Song W. (2011): Insights into the phylogeny of sporadotrichid ciliates (Protozoa, Ciliophora: Hypotricha) based on genealogical analyses of multiple molecular markers. – Chin. J. Oceanol. Limnol. **29**: 96–102.

Huang J., Yi Z., Al-Farraj S.A. & Song W. (2010): Phylogenetic positions and taxonomic assignments of the systematically controversial genera, *Spirotrachelostyla*, *Uroleptopsis* and *Tunicothrix* (Protozoa, Ciliophora, Stichotrichia) based on small subunit rRNA gene sequences. – Systematics and Biodiversity **8**: 409–416.

Huang J., Dunthorn M. & Song W. (2012): Expanding character sampling for the molecular phylogeny of euplotid ciliates (Protozoa, Ciliophora) using three markers, with a focus on the family Uronychiidae. – Molecular Phylogenetics and Evolution **63**: 598–605.

Huang J., Chen Z., Song W. & Berger H. (2014): Three-gene based phylogeny of the Urostyloidea (Protista, Ciliophora, Hypotricha), with notes on classification of some core taxa. – Molecular Phylogenetics and Evolution **70**: 337–347 (published on 5.11.2013).

Huang J., Luo X., Bourland W.A., Gao F. & Gao S. (2016): Multigene-based phylogeny of the ciliate families Amphisiellidae and Trachelostylidae (Protozoa: Ciliophora: Hypotrichia). – Molecular Phylogenetics and Evolution **101**: 101–110.

*ICZN (International Commission on Zoological Nomenclature) (1999): International Code of zoological nomenclature. International Trust for Zoological Nomenclature, London. 306 pp.

*ICZN (International Commission on Zoological Nomenclature) (2012): Amendment of Articles 8, 9, 10, 21 and 78 of the International Code of Zoological Nomenclature to expand and refine methods of publication. – Bull. zool. Nom. **69**: 161–169.

Jankowski A.V. (2007): Phylum Ciliophora Doflein, 1901. Review of taxa. In: Alimov A.F. (ed.): Protista: Handbook on zoology, Vol. Part 2, pp. 415–993. Nauka, St. Petersburg (in Russian with English summary).

Jiang J., Huang J., Li L., Shao C., Al-Rasheid K.A.S., Al-Farraj S.A. & Chen Z. (2013): Morphology, ontogeny, and molecular phylogeny of two novel bakuellid-like hypotrichs (Ciliophora: Hypotrichia), with establishment of two new genera. – Eur. J. Protistol. **49**: 78–92.

Jung J.-H., Park K.-M. & Min G.-S. (2014): Morphology and molecular phylogeny of *Pseudouroleptus jejuensis* nov. spec., a new soil ciliate (Ciliophora, Spirotrichea) from South Korea. – Acta Protozool. **53**: 195–206.

Jung J.-H., Park K.-M. & Min G.-S. (2015): Morphology and molecular phylogeny of *Pseudocyrtohymena koreana* n. g., n. sp. and Antarctic *Neokeronopsis asiatica* Foissner et al., 2010 (Ciliophora, Sporadotrichida), with a brief discussion of the *Cyrtohymena* undulating membranes pattern. – J. Euk. Microbiol. **62**: 280–297.

Jung J.-H., Park K.-M., Min G.-S., Berger H. & Kim S. (2015a): Morphology and molecular phylogeny of an Antarctic population of *Paraholosticha muscicola* (Kahl, 1932) Wenzel, 1953 (Ciliophora, Hypotricha). – Polar Sci. **9**: 374–381.

Jung J.-H., Baek Y.-S., Kim S. & Choi H.-G. (2016): Morphology and molecular phylogeny of a new freshwater ciliate *Urosomoida sejongensis* n. sp. (Ciliophora, Sporadotrichida, Oxytrichidae) from King George Island, Antarctica. – Zootaxa **4072**: 254–262.

Jung J.-H., Park K.-M & Min G.-S. (2017): Morphology and molecular phylogeny of *Pseudocyrtohymenides lacunae* nov. gen., nov. spec. (Ciliophora: Oxytrichidae) from South Korea. – Acta Protozool. **56**: 9–16.

Jung J.-H., Park M.-H, Kim S.Y., Choi J.M. Min G.-S. & Kim Y.-O. (2017a): Checklist of Korean ciliates (Protozoa: Ciliophora). – J. Species Res. **6**: 241–257.

Kahl A. (1932): Urtiere oder Protozoa I: Wimpertiere oder Ciliata (Infusoria) 3. Spirotricha. – Tierwelt Dtl. **25**: 399–650.

Kamra K., Kumar S. & Sapra G.R. (2008): Species of *Gonostomum* and *Paragonostomum* (Ciliophora, Hypotrichida, Oxytrichidae) from the Valley of Flowers, India, with descriptions of *Gonostomum singhii* sp nov, *Paragonostomum ghangriai* sp nov and *Paragonostomum minuta* sp nov. – Indian J. Microbiol. **48**: 372–388.

Kim J.H., Vd'ačný P., Shazib S.U.A. & Shin M.K. (2014): Morphology and molecular phylogeny of *Apoterritricha lutea* n. g., n. sp. (Ciliophora, Spirotrichea, Hypotrichia): a putative missing link connecting *Cyrtohymena* and *Afrokeronopsis*. – J. Euk. Microbiol. **61**: 520–536.

Kim K.-S., Jung J.-H. & Min G.-S. (2016): A new soil ciliate, *Birojimia soyaensis* nov. spec. (Ciliophora: Urostylida) from South Korea. –Acta Protozool. **55**: 135–144.

Kim K.-S., Jung J.-H. & Min G.-S. (2017): Morphology and molecular phylogeny of two new ciliates, *Holostichides heterotypicus* n. sp. and *Holosticha muuiensis* n. sp. (Ciliophora: Urostylida). – J. Eukaryot. Microbiol. **64**: 873–884.

Kim Y.U., Lee J.M., Kwon C.B. & Shin M.K. (2012): Morphological redescriptions of three *Cyrtohymena* ciliates (Ciliophora: Sporadotrichida: Oxytrichidae) new to Korea. – J. Species Res. **1**: 78–86.

*Kumar S. & Foissner W. (2015): Biogeographic specializations of two large hypotrich ciliates: *Australocirrus shii* and *A. australis* and proposed synonymy of *Australocirrus* and *Cyrtohymenides*. – Eur. J. Protistol. **51**: 210–228.

Kumar S., Bharti D., Marinsalti S., Insom E. & La Terza A. (2014): Morphology, morphogenesis, and molecular phylogeny of *Paraparentocirrus sibillinensis* n. gen., n. sp., a "stylonychine Oxytrichoidae" (Ciliophora, Hypotrichida) without transverse cirri. – J. Euk. Microbiol. **61**: 247–259.

Kumar S., Kamra K., Bharti D., La Terza A., Sehgal N., Warren A. & Sapra G.R. (2015): Morphology, morphogenesis and molecular phylogeny of *Sterkiella tetracirrata* n. sp. (Ciliophora, Oxytrichida), from the Silent Valley National Park, India. – Eur. J. Protistol. **51**: 86–97.

Kumar S., Bharti D., Quintela-Alonso P., Shin M.K. & La Terza A. (2016): Fine-tune investigations on three stylonychid (Ciliophora, Hypotricha) ciliates. – Eur. J. Protistol. **56**: 200–218.

Kumar S., Bharti D., Shazib. S.U.A. & Shin M.K. (2017): Discovery of a new hypotrich ciliate from petroleum contaminated soil. – PLoS ONE **12**: e0178657 (19 pp).

Küppers G.C., Paiva T.d.S., Borges B.d.N., Harada M.L., Garraza G.G. & Mataloni G. (2011): An Antarctic hypotrichous ciliate, *Parasterkiella thompsoni* (Foissner) nov. gen., nov. comb., recorded in Argentinean peat-bogs: morphology, morphogenesis, and molecular phylogeny. – Eur. J. Protistol. **47**: 103–123.

*Lamouroux J.-V.-F., Bory de Saint-Vincent J.B. & Deslongchamps E. (1824): Encyclopédie méthodique. Histoire naturelle des zoophytes, ou animaux rayonnés, faisant suite à l'histoire naturelle des vers de bruguière. Vol. II, Agasse, Paris. I–VIII, 819 pp. (according to the "Catalogue général des livres imprimés de la bibliothèque nationale, Paris", 1824 is the correct year).

Li F., Xing Y., Li J., Al-Rasheid K.A.S., He S. & Shao C. (2013): Morphology, morphogenesis and small subunit rRNA gene sequence of a soil hypotrichous ciliate, *Perisincirra paucicirrata* (Ciliophora, Kahliellidae), from the shoreline of the Yellow River, North China. – J. Euk. Microbiol. **60**: 247–256.

Li F., Lyu Z., Li Y., Fan X., Al-Farraj S.A., Shao C. & Berger H. (2017): Morphology, morphogenesis, and molecular phylogeny of *Uroleptus (Caudiholosticha) stueberi* (Foissner, 1987) comb. nov. (Ciliophora, Hypotricha), and reclassification of the remaining *Caudiholosticha* species. – Eur. J. Protistol. **59**: 82–98.

Li L., Shao C., Song W., Lynn D.H., Chen Z. & Shin M.K. (2009): Does *Kütricha* (Protista, Ciliophora, Spirotrichea) belong to Euplotida or represent a primordial spirotrichous taxon? With suggestion to establish a new subclass Protohypotrichia. – Int. J. syst. evolut. Microbiol. **59**: 439–446.

Li L., Song W., Shin M.K., Warren A., Al-Rasheid K.A.S., Al-Khedhairy A.A. & Al-Arifi S. (2009a): Reconsideration of the phylogenetic positions of three stichotrichous genera *Holosticha*, *Anteholosticha* and *Pseudokeronopsis* (Spirotrichea: Ciliophora) inferred from complete SSU rRNA gene sequences. – Progress in Natural Science **19**: 769–773.

Li L., Zhao X., Ji D., Hu X., Al-Rasheid K.A.S., Al-Farraj S.A. & Song W. (2016): Description of two marine amphisiellid ciliates, *Amphisiella milnei* (Kahl, 1932) Horváth, 1950 and *A. sinica* sp. nov. (Ciliophora: Hypotrichia), with notes on their ontogenesis and SSU rDNA-based phylogeny. – Eur. J. Protistol. **54**: 59–73.

Li Y.-s., Niu Y.-n. & Liu L.-x. (2008): Phylogenetic studies of four species of ciliate inferred from 16s-like small subunit rRNA gene-sequences. – J. Forestry Res. **19**: 119–124.

Liu W., Shao C., Gong J., Li J., Lin X. & Song W. (2010): Morphology, morphogenesis, and molecular phylogeny of a new marine urostylid ciliate (Ciliophora, Stichotrichia) from the South China Sea, and a brief overview of the convergent evolution of the midventral pattern within the Spirotrichea. – Zool. J. Linnean Soc. **158**: 697–710.

Lu B., Wang C., Huang J., Shi Y. & Chen X. (2016): Morphology and SSU rDNA sequence analysis of two hypotrichous ciliates (Protozoa, Ciliophora, Hypotrichia) including the new species *Metaurostylopsis parastruederkypkeae* n. sp. – J. Ocean Univ. China **15**: 866–878.

Lu X., Gao F., Shao C., Hu X. & Warren A. (2014): Morphology, morphogenesis and molecular phylogeny of a new marine ciliate, *Trichototaxis marina* n. sp. (Ciliophora, Urostylida). – Eur. J. Protistol. **50**: 524–537.

Lu X., Shao C., Yu Y., Warren A. & Huang J. (2015): Reconsideration of the 'well-known' hypotrichous ciliate *Pleurotricha curdsi* (Shi et al., 2002) Gupta et al., 2003 (Ciliophora, Sporadotrichida), with notes on its morphology, morphogenesis and molecular phylogeny. – Int. J. syst. evolut. Microbiol. **65**: 3216–3225.

Lu X., Huang J., Shao C., Al-Farraj S. A. & Gao S. (2017): Morphology and morphogenesis of a novel saline soil hypotrichous ciliate, *Gonostomum sinicum* nov. spec. (Ciliophora, Hypotrichia, Gonostomatidae), including a report on the small subunit rDNA sequence. – J. Eukaryot. Microbiol. **64**: 632–646.

Luo X., Gao F., Al-Rasheid K.A.S., Warren A., Hu X. & Song W. (2015): Redefinition of the hypotrichous ciliate *Uncinata*, with descriptions of the morphology and phylogeny of three urostylids (Protista, Ciliophora). – Systematics and Biodiversity **13**: 455–471.

Luo X., Fan Y., Hu X., Miao M., Al-Farraj S.A. & Song W. (2016): Morphology, ontogeny, and molecular phylogeny of two freshwater species of *Deviata* (Ciliophora, Hypotrichia) from southern China. – J. Euk. Microbiol. **63**: 771–785.

Luo X., Gao F., Yi Z., Pan Y., Al-Farraj S.S. & Warren A. (2017): Taxonomy and molecular phylogeny of two new brackish hypotrichous ciliates, with the establishment of a new genus (Ciliophora, Spirotrichea). – Zool. J. Linnean Soc. **179**: 475–491.

Lv Z., Chen L., Chen L., Shao C., Miao M. & Warren A. (2013): Morphogenesis and molecular phylogeny of a new freshwater ciliate, *Notohymena apoaustralis* n. sp. (Ciliophora, Oxytrichidae). – J. Euk. Microbiol. **60**: 455–466.

Lv Z., Shao C., Yi Z. & Warren A. (2015): A molecular phylogenetic investigation of *Bakuella*, *Anteholosticha*, and *Caudiholosticha* (Protista, Ciliophora, Hypotrichia) based on three-gene sequences. – J. Euk. Microbiol. **62**: 391–399.

*Lynn D.H. (2008): The ciliated protozoa. Characterization, classification, and guide to the literature. Springer, Heidelberg. i–xxxiv, 605 pp.

Niebuhr J.W.H. (1989): Ökologische Studien an Bodenprotozoenpopulationen (Protozoa: Ciliophora) auf dem Gelände eines ehemaligen Textilindustriebetriebes in Nordhorn in Bezug auf ihre Verwendung als Bio-Indikatororganismen für anthropogen belastete Böden. - Unter Berücksichtigung einiger Verfahren aus der Spurenanalytik. Diplomarbeit Universität Oldenburg, Oldenburg. 181 pp.

Paiva T.S., Borges B.N., Harada M.L. & Silva-Neto I.D. (2009): Comparative phylogenetic study of Stichotrichia (Alveolata: Ciliophora: Spirotrichea) based on 18S-rDNA sequences. – Genetics and Molecular Research **8**: 223–246.

Paiva T.d.S., Shao C., Fernandes M., Borges B.d.N. & Silva-Neto I.D.d. (2016): Description and phylogeny of *Urostyla grandis wiackowskii* subsp. nov. (Ciliophora, Hypotricha) from an estuarine mangrove in Brazil. – J. Euk. Microbiol. **63**: 247–261.

Park K.-M., Chae N., Jung J.-H., Min G.-S., Kim S. & Berger H. (2017): Redescription of *Keronopsis helluo* Penard, 1922 from Antarctica and *Paraholosticha pannonica* Gellért and Tamás, 1959 from Alaska (Ciliophora, Hypotricha). – Eur. J. Protistol. **60**: 102–118.

Park K.-M., Jung J.-H., Min G.-S. & Kim S. (2017a): *Pseudonotohymena antarctica* n. g., n. sp. (Ciliophora, Hypotricha), a new species from Antarctic soil. – J. Eukaryot. Microbiol. **64**: 447-456.

Park M.-H., Moon J.H., Kim K.N. & Jung J.-H. (2017): Morphology, morphogenesis, and molecular phylogeny of *Pleurotricha oligocirrata* nov. spec. (Ciliophora: Spirotrichea: Stylonychinae). – Eur. J. Protistol. **59**: 114–123.

Schmidt S.L., Bernhard D., Schlegel M. & Foissner W. (2007): Phylogeny of the Stichotrichia (Ciliophora; Spirotrichea) reconstructed with nuclear small subunit rRNA gene sequences: discrepancies and accordance with morphological data. – J. Euk. Microbiol. **54**: 201–209.

Schmidt S.L., Bernhard D. & Schlegel M. (2008): Die Verwandtschaftsbeziehungen innerhalb der Stylonychinae Berger & Foissner, 1997 (Spirotrichea, Stichotrichia, Oxytrichidae) rekonstruiert mit Sequenzen der 18S rDNA. – Denisia **23**: 403–409.

Shao C., Song W., Yi Z., Gong J., Li J. & Lin X. (2007): Morphogenesis of the marine spirotrichous ciliate, *Trachelostyla pediculiformis* (Cohn, 1866) Borror, 1972 (Ciliophora, Stichotrichia), with consideration of its phylogenetic position. – Eur. J. Protistol. **43**: 255–264.

Shao C., Song W., Li L., Warren A., Al-Rasheid K.A.S., Al-Quraishy S.A., Al-Farraj S.A. & Lin X. (2008): Systematic position of *Discocephalus*-like ciliates (Ciliophora: Spirotrichea) inferred from SSU rDNA and ontogenetic information. – Int. J. syst. evolut. Microbiol. **58**: 2962–2972.

*Shao C., Song W., Al-Rasheid K.A.S. & Berger H. (2012): Redefinition and reassignment of the 18-cirri genera *Hemigastrostyla*, *Oxytricha*, *Urosomoida*, and *Actinotricha* (Ciliophora, Hypotricha), and description of one new genus and two new species. – Acta Protozool. **50**: 263–287.

Shao C., Li L., Zhang Q., Song W. & Berger H. (2014): Molecular phylogeny and ontogeny of a new ciliate genus, *Paracladotricha salina* n. g., n. sp. (Ciliophora, Hypotrichia). – J. Euk. Microbiol. **61**: 371–380.

Shao C., Chen L., Pan Y., Warren A. & Miao M. (2014a): Morphology and phylogenetic position of the oxytrichid ciliates, *Urosoma salmastra* (Dragesco and Dragesco-Kernéis, 1986) Berger, 1999 and *U. karinae sinense* nov. sspec. (Ciliophora, Hypotrichia). – Eur. J. Protistol. **50**: 593–605.

Shao C., Lv Z., Pan Y., Al-Rasheid K.A.S. & Yi Z. (2014b): Morphology and phylogenetic analysis of two oxytrichid soil ciliates from China, *Oxytricha paragranulifera* n. sp. and *Oxytricha granulifera* Foissner and Adam, 1983 (Protista, Ciliophora, Hypotricha). – Int. J. syst. evolut. Microbiol. **64**: 3016–3027.

Shao C., Li L., Zhang Q., Song W. & Berger H. (2017): Corrigendum to "Molecular phylogeny and ontogeny of a new ciliate genus, *Paracladotricha salina* n. g., n. sp. (Ciliophora, Hypotrichia). – J. Euk. Microbiol., doi:10.1111/ jeu.12418.

*Shi X.-l., Wei H. & Wang C. (1997): Morphology studies on a new species of *Oxytricha*, *Oxytricha shii* sp. nov. (Ciliophora: Hypotrichida: Oxytrichidae). – Acta zootax. Sin. **22**: 225–230.

Shin M.K. (2012): Ciliophora: Intramacronucleata: Spirotrichea: Stichotrichia. – Invertebrate Fauna of Korea **1**: 1–193.

Singh J. & Kamra K. (2013): *Paraurosomoida indiensis* gen. nov., sp. nov., an oxytrichid (Ciliophora, Hypotricha) from Kyongnosla Alpine Sanctuary, including note on non-oxytrichid Dorsomarginalia. – Eur. J. Protistol. **49**: 600–610.

Singh J. & Kamra K. (2014): Molecular phylogeny of an Indian population of *Kleinstyla dorsicirrata* (Foissner, 1982) Foissner et al., 2002 comb nov. (Hypotrichia, Oxytrichidae): an oxytrichid with incomplete dorsal kinety fragmentation. – J. Euk. Microbiol. **61**: 630–636.

Singh J. & Kamra K. (2015a): Molecular phylogeny of *Urosomoida agilis*, and new combinations: *Hemiurosomoida longa* gen. nov., comb. nov., and *Heterourosomoida lanceolata* gen. nov., comb. nov. (Ciliophora, Hypotricha). – Eur. J. Protistol. **51**: 55–65.

Singh J. & Kamra K. (2015b): Morphology and molecular phylogeny of an Indian population of *Cyrtohymena citrina* (Ciliophora, Hypotricha), including remarks on ontogenesis of *Urosomoida-Notohymena-Cyrtohymena* group. – Eur. J. Protistol. **51**: 280–289.

Singh J., Kamra K. & Sapra G.R. (2013): Morphology, ontogenesis, and molecular phylogeny of an Indian population of *Cyrtohymena (Cyrtohymenides) shii*, including remarks on the subgenus. – Eur. J. Protistol. **49**: 283–297.

Snoeyenbos-West O.L., Salcedo T., McManus G.B. & Katz L.A. (2002): Insights into the diversity of choreotrich and oligotrich ciliates (Class: Spirotrichea) based on genealogical analyses of multiple loci. – Int. J. syst. evolut. Microbiol. **52**: 1901–1913.

Sonntag B., Strüder-Kypke M.C. & Summerer M. (2008): *Uroleptus willii* nov. sp., a euplanktonic freshwater ciliate (Dorsomarginalia, Spirotrichea, Ciliophora) with algal symbionts: morphological description including phylogenetic data of the small subunit rRNA gene sequence and ecological notes. – Denisia **23**: 279–288.

*Stein F. (1859): Der Organismus der Infusionsthiere nach eigenen Forschungen in systematischer Reihenfolge bearbeitet. I. Abtheilung. Allgemeiner Theil und Naturgeschichte der hypotrichen Infusionsthiere. Engelmann, Leipzig. I–XII, 206 pp, Tafeln I–XIV.

*Stein F. (1859a): Characteristik neuer Infusorien-Gattungen. – Lotos **9**: 2–5, 57–60.

*Stokes A.C. (1887): Some new hypotrichous infusoria from American fresh waters. – Ann. Mag. nat. Hist., Serie 5 **20**: 104–114, Plate III.

Vd'ačný P., Tirjaková E., Tóthová T., Pristaš P. & Javorský P. (2010): Morphological and phylogenetical studies on a new soil hypotrich ciliate: *Kahliella matisi* spec. nov. (Hypotricha, Kahliellidae). – Eur. J. Protistol. **46**: 319–333.

Wang J., Lyu Z., Warren A., Wang F. & Shao C. (2016): Morphology, ontogeny and molecular phylogeny of a novel saline soil ciliate, *Urosomoida paragiliformis* n. sp. (Ciliophora, Hypotrichia). – Eur. J. Protistol. **56**: 79–89.

Wang J., Li L., Warren A. & Shao C. (2017): Morphogenesis and molecular phylogeny of the soil ciliate R*igidohymena quadrinucleata* (Dragesco and Njine, 1971) Berger, 2011 (Ciliophora, Hypotricha, Oxytrichidae). – Eur. J. Protistol. **60**: 1–12.

Wang J., Qi S., Chen L., Warren A., Miao M. & Shao C. (2017a): Morphogenesis of a saline soil ciliate *Urosoma salmastra* (Dragesco and Dragesco-Kernéis, 1986) Berger, 1999 with notes on the phylogeny of *Urosoma* (Ciliophora, Hypotrichia). – Eur. J. Protistol. **61**: 180–193.

Wang J., Ma J., Qi S. & Shao C. (2017b): Morphology, moprphogenesis and molecular phylogeny of a new soil ciliate *Paragonostomoides xianicum* n. sp. (Ciliophora, Hypotrichia, Gonostomatidae). – Eur. J. Protistol. **61**: 233–243.

Weisse T., Moser M., Scheffel U., Stadler P., Berendonk T., Weithoff G. & Berger H. (2013): Systematics and species-specific response to pH of *Oxytricha acidotolerans* sp. nov. and *Urosomoida* sp. (Ciliophora, Hypotricha) from acid mining lakes. – Eur. J. Protistol. **49**: 255–271.

Xu Y., Vick-Majors T., Morgan-Kiss R., Priscu J.C. & Amaral-Zettler L. (2014): Ciliate diversity, community structure, and novel taxa in lakes of the McMurdo Dry Valleys, Antarctica. – Biology Bulletin **227**: 175–190.

Xu Y., Li L., Fan X., Pan H., Gu F. & Al-Farraj S.A. (2015): Systematic analyses of the genus *Architricha* and *Pleurotricha curdsi* (Ciliophora, Oxytrichidae), with redescriptions of their morphology. – Acta Protozool. **54**: 183–193.

Yang C., Liu A., Xu Y., Xu Y., Fan X., Al-Farraj A.A., Ni B.

& Gu F. (2015): Phylogenetic positions of four hypotrichous ciliates (Protista, Ciliophora) based on SSU rRNA gene, with notes on their morphological characters. – Zootaxa **4000**: 451–463.

Yi Z. & Song W. (2011): Evolution of the order Urostylida (Protozoa, Ciliophora): new hypotheses based on multigene information and identification of localized incongruence. – PlosOne **6**: e17471 (12 pages).

Yi Z., Song W., Stoeck T., Al-Rasheid K.A.S., Al-Khedhairy A.A., Gong J., Ma H. & Chen Z. (2009): Phylogenetic analyses suggest that *Psammomitra* (Ciliophora, Urostylida) should represent an urostylid family, based on small subunit rRNA and alpha-tubulin gene sequence information. – Zool. J. Linnean Soc. **157**: 227–236.

Zhao X., Gao S., Fan Y., Strüder-Kypke M. & Huang J. (2015): Phylogenetic framework of the systematically confused *Anteholosticha-Holosticha* complex (Ciliophora, Hypotrichia) based on multigene analysis. – Molecular Phylogenetics and Evolution **91**: 238–247.

Zhao Y., Gao F., Li J., Yi Z. & Warren A. (2012): Phylogenetic analyses on the tintinnid ciliates (Protozoa, Ciliophora) based on multigene sequence data. – Acta Protozool. **51**: 319–328.

Zoller S.D., Hammersmith R.L., Swart E.C., Higgins B.P., Doak T.G., Herrick G. & Landweber L.F. (2012): Characterization and taxonomic validity of the ciliate *Oxytricha trifallax* (class Spirotrichea) based on multiple gene sequences: limitations in identifying genera solely by morphology. – Protist **163**: 643–657.

Systematic Index

This index contains all scientific names of ciliates. It is two-sided, that is, the name of a species (e.g., *Cyrtohymena citrina*) is mentioned as follows: (i) *citrina, Cyrtohymena* and (ii) *Cyrtohymena citrina*. Note that "*citrina*" is not the species name, it is the "species-group name". The species name (= name of the species) is *Cyrtohymena citrina* (for details, see ICZN 1999).

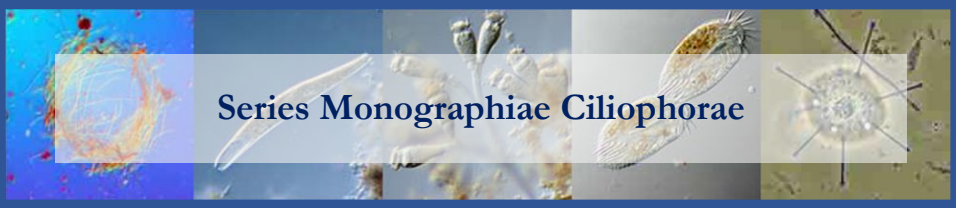
Berger H. (2018): *Cyrtohymena citrina* (Berger & Foissner, 1987) Foissner, 1989 (original combination: *Steinia citrina* Berger & Foissner, 1987) (Ciliophora, Hypotricha): update 1.0 on monographic treatment. – Ser. Monogr. Cilioph. 1: 1–16.

The present work is mainly a literature update to the monographic treatment by Berger (1999). *Steinia citrina* was discovered by Berger & Foissner (1987) in soil from Greece. In 1989 it was transferred to *Cyrtohymena* by Foissner. Later, it was classified in the nominotypical subgenus *Cyrtohymena (Cyrtohymena)* by Foissner (2004). However, the current systematic status is again *Cyrtohymena citrina* (Berger & Foissner, 1987) Foissner, 1989 because division of *Cyrtohymena* into subgenera has been overruled. So far, populations from Germany, Greece, Turkey, India, and Korea have been described more or less detailed. All relevant contributions are listed in a detailed synonymy. Type slides of *C. citrina* are deposited in the Biology Centre of the Upper Austrian Museum in Linz (LI). A brief morphological characterisation, based on the available descriptions, is provided. For details on morphology and for illustrations and micrographs the reader is referred to the original papers and revisions. In molecular trees, *Ccyrtohymena citrina* usually clusters with *Paraurostyla weissei*. It is included in about 110 phylogenetic studies; references are listed separately for each sequence. The sequences available so far do not form a monophyletic group. Faunistic records are available from Europe, Asia, North, Central, and South Americas, Africa, as well as Australia. *Cyrtohymena citrina* is moderately common and occurs in terrestrial and limnetic habitats. 145 references dealing with this species are listed. The ZooBank registration number of *C. citrina* is: urn:lsid:zoobank.org:act:50B6E92E-26AF-4346-82DA-71340A61A2BB.

ISBN 978-3-902147-03-5

Verlag: Helmut Berger © 2018

Print: druck.at



Dr Helmut Berger
Technisches Büro für Ökologie
Consulting Engineering Office for Ecology, Salzburg
Radetzkystrasse 10, 5020 Salzburg, Austria
https://www.protozoology.com