# Revision of some spathidiid genera (Alveolata, Ciliophora, Spathidiida)

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# Revision of some spathidiid genera (Alveolata, Ciliophora, Spathidiida)

Edited by

Wilhelm **Foissner,** Kuidong **Xu** & Helmut **Berger**

Series Monographiae Ciliophorae

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**Cover:** *Epispathidium papilliferum* (front; see Fig. 6.11h–j in Chapter 6); *Neospathidium longinucleatum* (back; see Fig. 12.9j–l in Chapter 12)

In memory of Wilhelm Foissner (1948–2020)

# Contents

## Chapter 13



## Index

# Preface, authorship, acknowledgements, and funding

The spathidiids have been one of several favorite ciliate groups of Wilhelm Foissner. In 2001, W. Foissner started a revision of this large group of haptorids. During processing his huge archive after his sudden death in 2020, I found a well-advanced manuscript dealing with several spathidiid genera. In order to prevent this manuscript from being forgotten, I have decided to publish it in my monographic series on ciliates.

W. Foissner collected most samples, made the in vivo observations, the preparations, many morphometries, and wrote text. K. Xu made morphometries and illustrations, compiled the plates, and wrote text. I updated the text of the raw manuscript, organized the deposition of the slides in the Biology Centre of the Upper Austrian Museum in Linz, wrote the front matter, the general introduction, the material and method section including the summary of taxa (Chapter 1), the brief introduction to the spathidiids (Chapter 2), the chapter on *Neocultellothrix* Foissner nov. gen. (Chapter 13), and the back matter (index). Further, I made the layout and produced the final PDF.

The help of the following persons must be acknowledged: Sabine Agatha, Remigius Geiser, Eva Herzog, Wolf-Dietrich Krautgartner, Brigitte Moser, Birgit Peukert, Fritz Seyrl, and Andreas Zankl. Colleagues who provided samples are acknowledged in the individual species descriptions. I also want to thank Magdalini Christodoulou and Alexandra Aberham at the Biology Centre of the Upper Austrian Museum in Linz for help with the transfer of the Foissner archive from Salzburg to Linz.

Wilhelm Foissner, Kuidong Xu, and co-workers involved in this project got financial support by the Austrian Science Fund FWF (Project P15017-B06, "Monographie der Familie Spathidiidae (Ciliophora)"). I wish to thank Ilse Foissner who generously privately financed my work on this book.

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# Abstract

**Foissner W., Xu K. & Berger H. (Eds) (2025): Revision of some spathidiid genera (Alveolata, Ciliophora, Spathidiida). – Ser. Monogr. Cilioph. 6: i–xv, 1–465.**

This book deals with some spathidiid taxa. The following genera are treated and established, respectively: *Apospathidium* Foissner et al., 2002; *Centrospathidium* nov. gen.; *Epispathidium* Foissner, 1984; *Latispathidium* Foissner et al., 2005; *Schmidingerophrya* nov. gen.; *Semibryophyllum* nov. gen.; *Semispathidium* Foissner et al., 2002; *Supraspathidium* Foissner & Didier, 1981; *Pharyngospathidium* nov. gen. (type genus of Pharyngospathidiidae nov. fam.); *Neospathidium* nov. gen.; *Neocultellothrix* Foissner nov. gen. The latter genus "replaces" *Cultellothrix* Foissner, 2003, an unavailable genus because no holotype was fixed for the type species in the original description. In addition, 12 *Spathidium* species are reviewed, and three new species assigned to this genus are described. In total, four new subspecies, 19 new species, six new genera, and one new family are described, 13 species are transferred to other genera, and 41 known species and two subspecies are reviewed. Further, three "*Spathidium* groups" are discussed. The type slides of the new species and voucher slides of the redescribed species are documented.

**Key words:** Alveolata; biogeography; Ciliophora; cyst; diversity; Haptoria; monograph; morphogenesis; nomenclature; Protista; revision; soil biology; systematics; taxonomy

# Chapter 13

# Supplement to the Arcuospathidiidae Foissner & Xu, 2007: *Neocultellothrix* Foissner nov. gen. (Ciliophora, Haptoria, Arcuospathidiidae) with *Neocultellothrix velhoi* Foissner nov. spec. as type species, and transfer of six species from the unavailable genus *Cultellothrix* Foissner, 2003 to *Neocultellothrix* Foissner nov. gen., a step to fix a serious nomenclatural problem[1]

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## Abstract

*Cultellothrix velhoi* Foissner, 2003a, the type species of *Cultellothrix* Foissner, 2003a, was established without fixation of a holotype. However, according to the Code, the fixation of a holotype in the original description is a prerequisite for species described after 1999. Consequently, *Cultellothrix velhoi* is an unavailable name which therefore cannot serve as type species of *Cultellothrix* which is thus likewise an unavailable name. To fix these serious nomenclatural problems, we establish *Neocultellothrix* Foissner nov. gen., describe the type species *Neocultellothrix velhoi* Foissner nov. spec., and make the following new combinations: *Neocultellothrix atypica* (Wenzel, 1953) Foissner & Xu nov. comb.; *Neocultellothrix coemeterii* (Kahl, 1943) Foissner & Xu nov. comb.; *Neocultellothrix japonica* (Foissner, 1988) Foissner & Xu nov. comb.; *Neocultellothrix lionotiformis* (Kahl, 1930) Foissner nov. comb.; *Neocultellothrix paucistriata* (Foissner & Xu, 2007) nov. comb.; *Neocultellothrix tortisticha*

[1] This chapter should be referenced as follows: Berger H., Xu K. & Foissner W. (2025): Supplement to the Arcuospathidiidae Foissner & Xu, 2007: *Neocultellothrix* Foissner nov. gen. (Ciliophora, Haptoria, Arcuospathidiidae) with *Neocultellothrix velhoi* Foissner nov. spec. as type species, and transfer of six species from the unavailable genus *Cultellothrix* Foissner, 2003, a step to fix a serious nomenclatural problem. – Ser. Monogr. Cilioph. 6: 433–452.
For notes on "Material and methods", see Chapter 1 (Berger et al. 2025).

(Foissner & Xu, 2007) nov. comb. The nomenclature of the genus and each species is discussed in detail. For remarks, description, and occurrence and ecology of the individual species the reader is mainly referred to previous works. An important note on the type material of *Cephalospatula brasiliensis* Foissner, 2003b is made.

## *Neocultellothrix* Foissner nov. gen.

2003 ***Cultellothrix* gen. n.**[2] – Foissner, Acta Protozool. 42: 48 ("original description" of unavailable name, see nomenclature). Type species: *Cultellothrix velhoi* Foissner, 2003 (invalid species; see nomenclature).

2007 ***Cultellothrix* Foissner, 2003**[3] – Foissner & Xu, Monogr. biol. 81: 267 (detailed revision; unavailable name, see nomenclature).

2007 ***Cultellothrix* Foissner, 2003** – Jankowski, Phylum Ciliophora, p. 566 (unavailable name; generic revision of ciliates).

**Nomenclature:** *Neocultellothrix* is a composite of the Greek adjective *neos* (young, new; Hentschel & Wagner 1996, p. 420), the Latin noun (diminutive) *cultellus* (small knife; Hentschel & Wagner 1996, p. 191), the thematic vowel *·o-* (at the end of the first stem, when the second begins with a consonant; Werner 1972, p. 37), and the Greek noun *thrix* (hair, ciliate in present case; Werner 1972, p. 420). The name refers to the conspicuous knife-shape of the two species mentioned by Foissner (2003a). The prefix *Neo-* shall avoid that later workers use again the old, invalid name "*Cultellothrix* Foissner, 2003a". Feminine gender, like other genus-group names ending with *·thrix*, e.g., *Afrothrix*, *Australothrix*, *Gigantothrix* (Aescht 2001, p. 272, 274, 283). In future, this genus must be cited as "*Neocultellothrix* Foissner in Berger et al., 2025".

Foissner (2003a) did not fix a holotype (or syntype) for the type species (*Cultellothrix velhoi* Foissner, 2003a) of *Cultellothrix* Foissner, 2003a and further he did not mention where possible type material is deposited. However, the description of a new species published after 1999 must include the fixation of a holotype or syntypes (ICZN 1999, Articles 16.4, 72.3). Further, the original publication (Foissner 2003a) must contain a statement in which collection the holotype will be (or is already) deposited (ICZN 1999, Article 16.4.2). Thus, the description of *Cultellothrix velhoi* Foissner, 2003a is invalid and the binomen *Cultellothrix velhoi* Foissner, 2003a is an unavailable name ("nomenclaturaly unavailable" according to Aescht 2008, p. 185).[4] The review of *Cultellothrix velhoi* in Foissner & Xu (2007, p. 270) can likewise not serve as original description, inter alia, because the name ("*Cultellothrix velhoi* Foissner, 2003") is not indicated as new (ICZN 1999, Article 16.1).

A further question is if *Cultellothrix* Foissner, 2003a is a valid genus? According to Article 67.2 of the ICZN (1999), a nominal species is only eligible to be fixed as the type species of a nominal genus (*Cultellothrix* Foissner, 2003a in present case) if it is an originally included nominal species. Foissner (2003a) designated the new species *Cultellothrix velhoi* as

[2] Foissner (2003a) provided the following diagnosis: "Spathidiidae with dorsal brush on left side and ciliature in *Arcuospathidium* pattern."

[3] Foissner & Xu (2007) provided the following improved diagnosis: "More or less distinctly pleurostomatid-shaped Arcuospathidiidae with brush on left side of cell; individual brush rows without anterior tail of ordinary cilia."

[4] An unavailable name is a scientific name that does not conform to Articles 10 to 20 (Article 16.4 in present case) of the ICZN (1999).

type species by fixation in the original publication (ICZN 1999, Article 68). In the meaning of the Code the "originally included nominal species" comprise only those included in the newly established nominal genus or subgenus, having been cited in the original publication by an **available** name (ICZN 1999, Article 67.2.1). However, as explained above, *Cultellothrix velhoi* Foissner, 2003a is not an available name and therefore the genus *Cultellothrix* Foissner, 2003a is likewise unavailable. Since *Cultellothrix* Foissner, 2003a is unavailable, the combinations with *Cultellothrix* Foissner, 2003a made by Foissner (2003a) and Foissner & Xu (2007) are likewise unavailable.

Foissner & Xu (2007, p. 290, 294) described two new *Cultellothrix* species, namely *Cultellothrix paucistriata* Foissner & Xu, 2007 and *Cultellothrix tortisticha* Foissner & Xu, 2007. We did not find an article in ICZN (1999) which clearly regulates the fate of a new species erected in combination with an unavailable genus-group name (*Cultellothrix* Foissner, 2003a in present case). We follow Aescht (2001, p. 19), who found that, for example, *Akidodes* Lom, 1959 is a nomen nudum because no type species was fixed in the original description (Lom 1959, p. 475), a prerequisite for the establishment of a genus after 1930 (Heikertinger 1930, p. 8, Artikel 25c (3); ICZN 1961, Article 13(b); 1999, Article 13.3).[5] Therefore, Aescht (2001, p. 19; actually Lom in Aescht) established the genus "*Akidodes* Lom in Aescht, 2001" and fixed "*Akidodes symmetricus* Lom, 1959" as type species. Since *Akidodes* Lom, 1959 is invalid, Aescht (2001, p. 272) transferred *Akidodes symmetricus* Lom, 1959 to *Akidodes* Lom in Aescht, 2001, as *Akidodes symmetricus* (Lom, 1959) Lom in Aescht, 2001. We apply the same procedure for the two new species described by Foissner & Xu (2007).[6]

Because of this tricky nomenclatural matter, we establish a new genus, describe a new type species, and transfer the species concerned to the new genus. To avoid the use of the old, unavailable name *Cultellothrix* Foissner, 2003a we do not use this name (*Cultellothrix*) again but modify it. For morphological and other data, the reader is mainly referred to Foissner (2003a) and Foissner & Xu (2007).

**Diagnosis** (from Foissner & Xu 2007): More or less distinctly pleurostomatid-shaped Arcuospathidiidae with brush on left side of cell; individual brush rows without anterior tail of ordinary cilia.

**Type species:** *Neocultellothrix velhoi* Foissner nov. spec.

**Species assigned:** *Neocultellothrix velhoi* Foissner nov. spec. (type species); *Neocultellothrix atypica* (Wenzel, 1953) nov. comb. (original combination *Spathidium atypicum*); *Neocultellothrix coemeterii* (Kahl, 1943) nov. comb. (original combination *Spathidium coemeterii*); *Neocultellothrix japonica* (Foissner, 1988) nov. comb. (original combination *Arcuospathidium japonicum*); *Neocultellothrix lionotiformis* (Kahl, 1930a) nov. comb. (original combination *Spathidium lionotiforme*); *Neocultellothrix paucistriata* (Foissner & Xu, 2007) nov. comb. (original combination *Cultellothrix paucistriata*); *Neocultellothrix tortisticha* (Foissner & Xu, 2007) comb. nov. (original combination *Cultellothrix tortisticha*).

[5] Article 13.3 of the ICZN (1999) says: "To be available, every new genus-group name published after 1930 (except those proposed for collective groups or ichnotaxa) must, in addition to satisfying the provisions of Article 13.1, be accompanied by the fixation of a type species in the original publication [Art. 68] or be expressly proposed as a new replacement name (nomen novum) [Art. 67.8]." A nomen nudum is not an available name (ICZN 1999, p. 111).

[6] Lom in Aescht (2001, p. 19, 272) did not transfer *Akidodes henleae* Lom, 1959 (p. 477) to *Akidodes* Lom in Aescht, 2001. We make this formal act here: *Akidodes henleae* (Lom, 1959) Lom nov. comb. In future, this species has to be cited as "*Akidodes henleae* (Lom, 1959) Lom in Berger et al., 2025".

**ZooBank registration:** urn:lsid:zoobank.org:act:C3E408F9-4E90-4F3F-80BF-73AA7629CC84

**Remarks:** For remarks (e.g., classification and comparison with similar genera), see Foissner (2003a, p. 53) and Foissner & Xu (2007, p. 267).

## Key to species

The key below is from Foissner & Xu (2007, p. 269), but slightly modified. Further, the names have been adapted.

**1** Body outline distinctly knife-shaped; body usually >110 µm long in vivo. Macronucleus moderately long and tortuous ..... **2**
– Body outline more or less distinctly spatulate; body usually <110 µm long in vivo. Macronucleus reniform or in two globules with a micronucleus in between ..... **3**

**2** Body length 140–200 µm in vivo. Two ordinary ciliary rows between circumoral kinety and dorsal brush row 1. Postoral extrusome row likely lacking ..... *Neocultellothrix lionotiformis* (p. 446)
– Body length 80–150 µm in vivo. No ordinary ciliary rows between circumoral kinety and dorsal brush row 1. With postoral extrusome row (difficult to recognize!). Extrusomes about 6 µm long, curved rods ..... *Neocultellothrix velhoi* (p. 436)
**3** (1) Macronucleus reniform ..... **4**
– Macronucleus in two globules with a micronucleus in between ..... **5**
**4** Body size about 95 × 23 µm in vivo. Extrusomes about 6 µm long, curved rods. On average 12 ciliary rows ..... *Neocultellothrix coemeterii* (p. 443)
– Body size about 65 × 20 µm in vivo. Extrusomes narrowly ovate and about 3 µm long. On average 7 ciliary rows ..... *Neocultellothrix paucistriata* (p. 448)
**5** (3) Extrusomes rod-shaped or oblong ..... **6**
– Extrusomes narrowly ovate. On average about 12 ciliary rows ..... *Neocultellothrix japonica* (p. 445)
**6** Body size about 95 × 25 µm in vivo. On average 12 ciliary rows ..... *Neocultellothrix atypica* (p. 439)
– Body size about 55 × 10 µm in vivo. On average 7 ciliary rows ..... *Neocultellothrix tortisticha* (p. 449)

## *Neocultellothrix velhoi* Foissner nov. spec.

(Fig. 13.1a, b in present work; Fig. 1–11, 15–22 and Table 1 in Foissner 2003a; Fig. 82a–j, 137a–g and Table 29 in Foissner & Xu 2007)

2003 ***Cultellothrix velhoi* sp. n.**[7] – Foissner, Acta Protozool. 42: 49, Fig. 1–11, 15–22, Table 1 ("original description"; unavailable name because no holotype fixed in original description; see nomenclature at genus section).

[7] Foissner (2003a) provided the following diagnosis: "Size about 120 × 25 µm in vivo. Knife-shaped with blade (oral portion) approximately half of body length. Macronucleus about 40 µm long, usually tortuous. Extrusomes approx-

2007 ***Cultellothrix velhoi* Foissner, 2003** – Foissner & Xu, Monogr. biol. 81: 270, Fig. 82a–j, 137a–g, Table 29 (detailed revision; unavailable name, see nomenclature at genus section).

2007 ***Cultellothrix velhoi*** – Jankowski, Phylum Ciliophora, p. 566 (unavailable name; generic revision of ciliates).

**Nomenclature:** Dedicated to Dr. Luiz Felipe Machado Velho, Universidade Estadual de Maringá, Brazil, who provided the sample containing this and other new species (Foissner 2003a, p. 50), for example, *Cephalospatula brasilinensis* Foissner; 2003b (p. 128). The original description of *Cultellothrix velhoi* Foissner, 2003a is invalid because no holotype was fixed by Foissner (2003a); for details, see nomenclature at genus section. In future, this species must be cited as "*Neocultellothrix velhoi* Foissner in Berger et al., 2025".

**Diagnosis** (from Foissner & Xu 2007, p. 270, slightly modified): Body size about 120 × 25 µm in vivo. Body outline knife-shaped with blade (oral portion) approximately half of body length. Macronucleus about 40 µm long and usually tortuous; single micronucleus. Extrusomes rod-shaped and slightly curved, approximately 6.0 × 0.3 µm in size in vivo, form short, oblique rows in oral bulge and a long postoral row extending to dorsal side of cell. On average 12 ciliary rows, those left of circumoral kinety anteriorly modified to strongly heterostichad dorsal brush occupying about 31% of body length. Brush bristles up to 5 µm long: row 1 composed of an average of 29 dikinetids, row 2 of 23, and row 3 of 7 dikinetids followed by a short monokinetidal bristle tail.

**Type locality:** Floodplain soil of Paraná River (about 22°40'S 53°15'W according to Foissner 2003a), circa 150 km northwest of the town of Maringá, Brazil. Further details on this locality, see Foissner (2003a, p. 48).

**Type material:** The slide (Fig. 13.2a, b; accession number 2007/72) containing the holotype (Fig. 13.1a, b in present work; = Fig. 6, 7 in Foissner 2003a) and four paratype slides (Fig. 13.2c–i; accession numbers 2007/73–76) with protargol-prepared specimens have been deposited in the Biology Centre of the Upper Austrian Museum in Linz (LI).[8]

**ZooBank registration:** urn:lsid:zoobank.org:act:E2991E95-C71A-4F63-9477-4D13F06EBA2C

**Remarks:** For comparison of *Neocultellothrix velhoi* Foissner nov. spec. with similar species, see Foissner (2003a, p. 53) and Foissner & Xu (2007, p. 275).

**Description:** For description of *Neocultellothrix velhoi* Foissner nov. spec., see Foissner (2003a, p. 50) and Foissner & Xu (2007, p. 271).

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imately 6 × 0.3 µm, form short, oblique rows in oral bulge and a long postoral row extending to dorsal side of cell. On average 12 ciliary rows, those left of circumoral kinety anteriorly modified to dorsal brush; brush row 3 distinctly shortened consisting of an average of 7 dikinetids."

[8] Note by H. Berger: Foissner & Xu (2007, p. 270) mentioned that "Type slides, with protargol-impregnated specimens from type locality are deposited in the Oberösterreichische Landesmuseum in Linz, Upper Austria". However, this information did not prevent the problem of a lacking holotype fixation in the original description (for details, see nomenclature at genus section). Aescht (2008, p. 185) mentioned the accession numbers (LI) of the type slides (holotype [original designation]: 2007/72; paratypes: 2007/73, 2007/74; 2007/75; 2007/76). However, as explained above, Foissner (2003a) neither mentioned that a holotype was fixed (neither in the text nor in the figure legends) nor did he mention where type material is/will be deposited. Further, the numbers "2007/72–76" show that the slides have been registered in the museum just in 2007, that is, four years after the invalid publication of the species. We do not change the registration numbers nor the labelling of the slides, that is, the name of the present species (*Neocultellothrix velhoi*) on the slides is "*Cultellothrix velhoi*" (see Fig. 13.2a–i). The name "*Cultellothrix velhoi*" in the present book and on the slides is disclaimed for nomenclatural purposes (CZN 1999, Article 8.3).

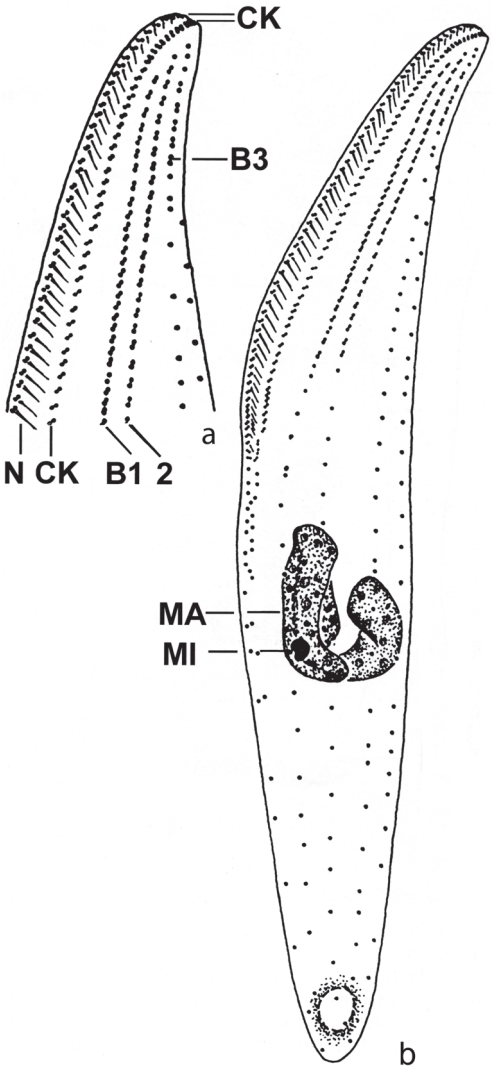


**Fig. 13.1a, b** *Neocultellothrix velhoi* Foissner nov. spec. (from Foissner 2003a, p. 49. Protargol preparation). **a, b:** Left side view (a, anterior portion; b, total view) of holotype showing ciliary pattern, nuclear apparatus, and contractile vacuole, 132 µm. B1, 2, B3 – dorsal brush rows, CK – circumoral kinety, MA – macronucleus, MI – micronucleus, N – nematodesmata (oral basket rods).

**Occurrence and ecology:** *Neocultellothrix velhoi* Foissner nov. spec. is a rare species because W. Foissner did not find it in about 1000 other soil and moss samples, including approximately 100 samples from similar habitats, collected world-wide. For type locality, see above. Although looking fragile, *Neocultellothrix velhoi* Foissner nov. spec. is a rapacious predator feeding mainly on large rotifers, showing that the oral apparatus can open widely and the body is very flexible. "*Cultellothrix velhoi* Foissner, 2003" not recorded by Foissner (2016). Likely no further records published so far.

**Note on type material of *Cephalospatula brasiliensis* Foissner, 2003b:** A paratype slide of *Neocultellothrix velhoi* (Fig. 13.2h, i; accession number 2007/76) is simultaneously the holotype slide of *Cephalospatula brasiliensis* Foissner, 2003b (p. 128) and the slides 2007/72, 2007/73, 2007/75, 2007/76 are simultaneously paratype slides of *Cephalospatula brasiliensis* (Fig. 13.2a–d, f–i). Slide 2007/77 is likewise a paratype slide of *Cephalospatula brasiliensis* (Fig. 13.3a, b).

The description of this species is based on three populations (Foissner 2003b, p. 114, 128, Table 2). According to ICZN (1999, Article 72.4.1), the type series of a nominal species-group taxon consists of all specimens included by the author in the new nominal taxon. However, since Foissner (2003b, p. 128) nominated a holotype (his Fig. 68–71) and paratypes from the population from the type locality (Paraná River floodplain, Brazil), the other specimens listed (surroundings of Rio de Janeiro, Brazil and Puerto Ayacucho, Venezuela) are excluded from the type series (ICZN 1999, Article 72.4.6). Thus, the slides shown in Fig. 13.3c–j containing *Cephalospatula brasiliensis* specimens from Rio de Janeiro and Puerto Ayacucho are voucher specimens, as already mentioned by Foissner (2003b, p. 128). These voucher slides are not listed by Aescht (2008, p. 147).

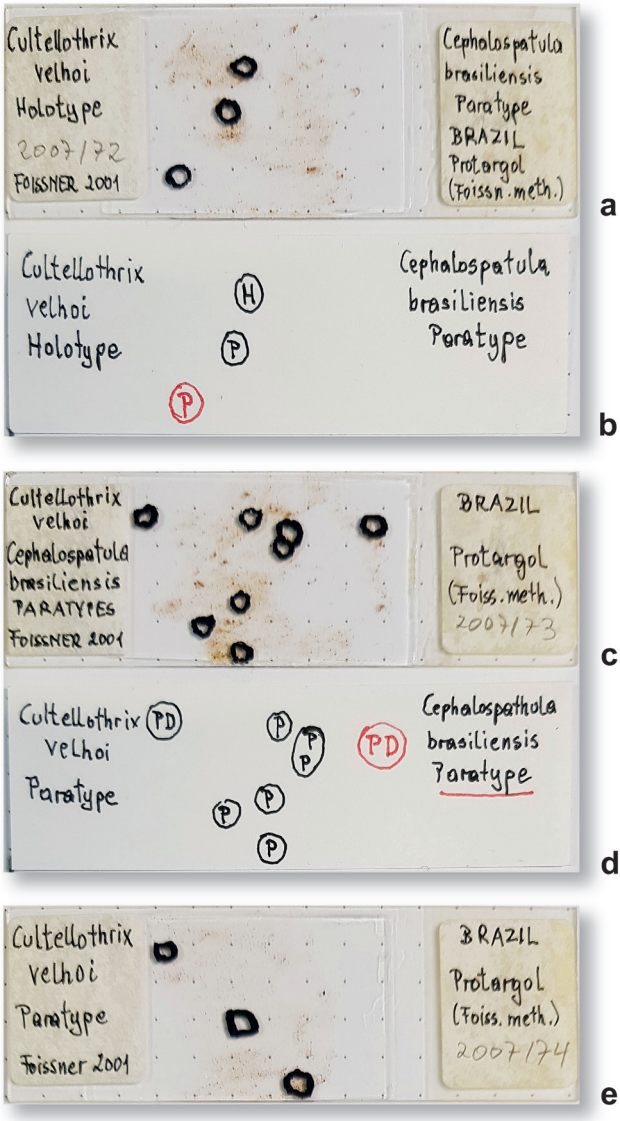


**Fig. 13.2a–e** *Neocultellothrix velhoi* Foissner nov. spec. and *Cephalospatula brasiliensis* Foissner, 2003b (originals. Protargol slides). **a, b:** Slide (a) and protocol (b) containing holotype of *Neocultellothrix velhoi* (H, black) and paratypes of *Neocultellothrix velhoi* (P, black) and *Cephalospatula brasiliensis* (P, red; type population). Accession number (LI): 2007/72. **c, d:** Slide (c) and protocol (d) containing paratypes of *Neocultellothrix velhoi* (P, black) and *Cephalospatula brasiliensis* (PD [paratype drawn], red; type population). Accession number (LI): 2007/73. **e:** Slide containing paratypes of *Neocultellothrix velhoi* (P). Accession number (LI): 2007/74. For nomenclature on *Neocultellothrix velhoi*, see text.

## *Neocultellothrix atypica* (Wenzel, 1953) Foissner & Xu nov. comb.

(Fig. 88a–u, 141a–l, n, o, 142a–d and Table 33 in Foissner & Xu 2007)

1953 ***Spathidium atypicum* nov. spec.** – Wenzel, Arch. Protistenk. 99: 81, Abb. 4 (Fig. 88a in Foissner & Xu 2007; original description; no type material available, see nomenclature).

1988 ***Arcuospathidium australe* nov. spec.** – Foissner, Stapfia 17: 99, Abb. 4a–g, Tabelle 3 (Fig. 88b–h in Foissner & Xu 2007; original description of junior, subjective synonym, see next but one entry. For type material, see nomenclature).

1998 ***Arcuospathidium atypicum* (Wenzel, 1953) nov. comb.** – Foissner, Eur. J. Protistol 34: 199 (combination with *Arcuospathidium*).

1998 ***Arcuospathidium australe* Foissner, 1988, synonym with *A. atypicum*** – Foissner, Eur. J. Protistol 34: 199 (synonymisation with *Arcuospathidium atypicum*).

2007 ***Cultellothrix atypica* (Wenzel, 1953) nov. comb.** – Foissner & Xu, Monogr. biol. 81: 299, Fig. 88a–u, 141a–l, n, o, Table 33 (detailed revision including description of populations from Austria, South America, and Malaysia; invalid combination, see nomenclature).

**Nomenclature:** No derivations have been given in the original descriptions. The species-group name *atypicus* (atypical) is a composite of the prefix *a+* (negation; Werner 1972, p. 58) and the Latin adjective *typic·us*, *-a*, *-um* (m, f, n; typical, archetypical, normal, true; Hentschel & Wagner 1996, p. 597). According to Foissner & Xu (2007, p. 301), this name likely refers to the unusual nuclear pattern which, however, meanwhile has been found in various spathidiids. The Latin adjective *austral·is*, *-is*, *-e* (m, f, n; southern, south, austral; https://www.frag-caesar.de/lateinwoerterbuch/australe-uebersetzung. html, accessed 25 Jan 2024) refers to the type locality which is in Australia (Adelaide), that is, in the southern hemisphere. *Cultellothrix* Foissner, 2003a is not an available name and therefore the combination made by Foissner & Xu (2007) is likewise invalid; for details, see nomenclature at genus section. In future, this

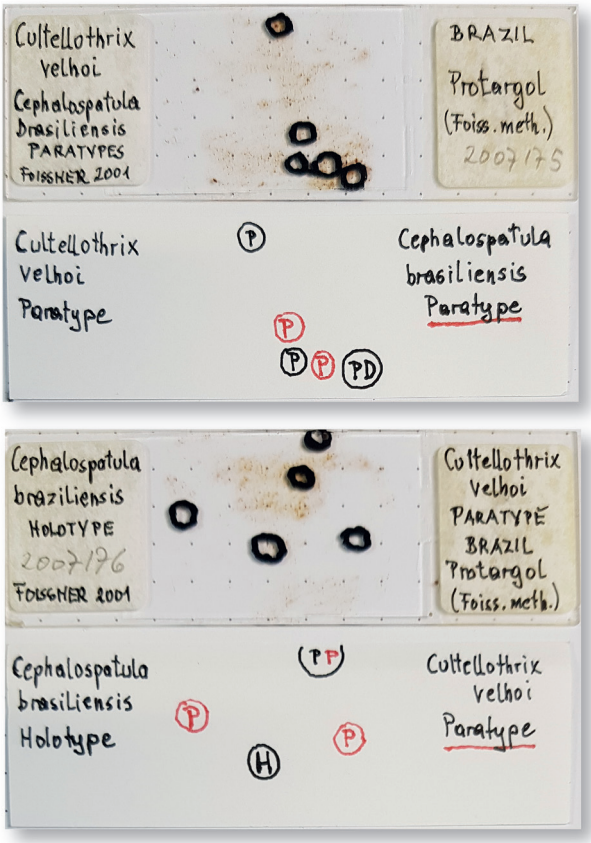


**Fig. 13.2f–i** *Neocultellothrix velhoi* Foissner nov. spec. and *Cephalospatula brasiliensis* Foissner, 2003b (originals. Protargol slides). **f, g:** Slide (f) and protocol (g) containing paratypes of *Neocultellothrix velhoi* (P, black) and *Cephalospatula brasiliensis* (P, red; type population). Accession number (LI): 2007/75. **h, i:** Slide (h) and protocol (i) containing paratypes of *Neocultellothrix velhoi* (P, red) and the holotype of *Cephalospatula brasiliensis* (H, black) and paratypes of *Cephalospatula brasiliensis* (P, black; type population). Accession number (LI): 2007/76. For nomenclature on *Neocultellothrix velhoi*, see text.

species must be named "*Neocultellothrix atypica* (Wenzel, 1953) Foissner & Xu in Berger et al., 2025" when classified in the present genus.

As shown in the list of synonyms, no type material is available for *Spathidium atypicum* Wenzel, 1953. *Arcuospathidium australe* Foissner, 1988 was classified as a junior subjective synonym of *Spathidium atypicum* by Foissner (1998) and Foissner & Xu (2007). Foissner (1988, p. 88) wrote that for each new species one holotype slide and 0–2 paratype slides are deposited in the Biology Centre of the Upper Austrian Museum in Linz (LI). None of the *Arcuospathidium australe* specimens illustrated by Foissner (1988) was designated as holotype. Foissner (1988) obviously deposited two slides in Linz (Aescht 2008, p. 144). The slide labelled as holotype (accession number 1989/37) has four marks, but unfortunately

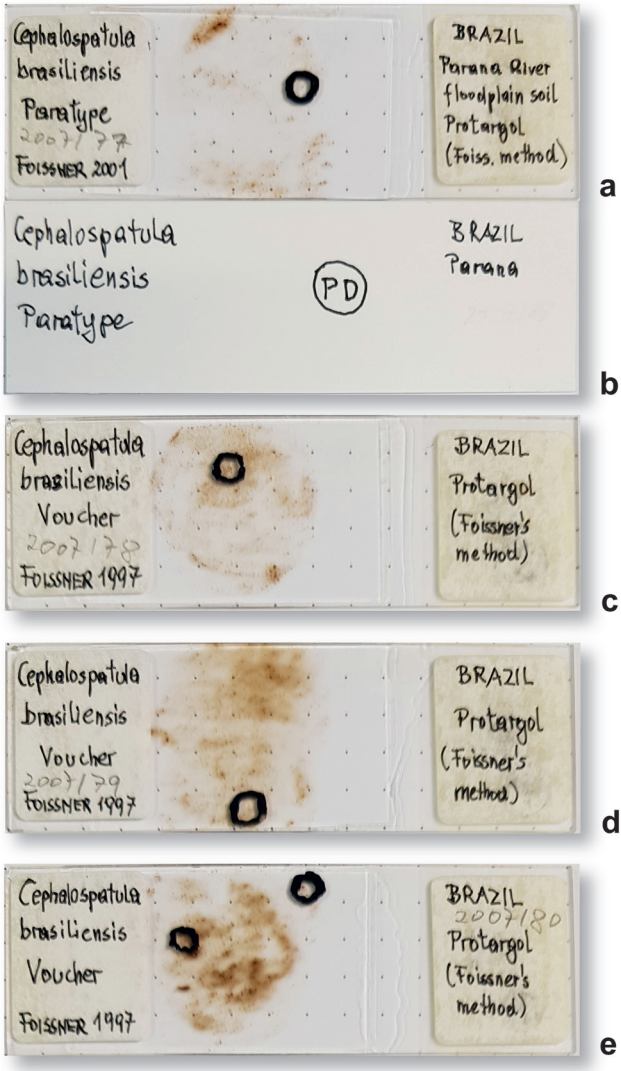


**Fig. 13.3a–e** *Cephalospatula brasiliensis* Foissner, 2003b (originals. Protargol slides). **a, b:** Slide (a) and protocol (b) containing paratypes (PD, paratype drawn; type population). Accession number (LI): 2007/77. **c–e:** Voucher slides from the second population from Brazil, namely from the Restingha area, Rio de Janeiro; details, see Foissner 2003b, p. 114). Accession numbers (LI): 2007/78, 2007/79, 2007/80.

none of them was labelled as holotype (see Fig. 21 in Aescht 2008, p. 135). The second slide (accession number 1987/38) was designated as "PP" meaning "paraphoront/"paratype"" according to Aescht 2008, p. 144, 233). Since no holotype was fixed by Foissner (1988) all specimens of the type series are automatically syntypes (ICZN 1999, Article 73.2). Foissner & Xu (2007, p. 299) discussed that the slides of *Arcuospathidium australe* can serve as neotype slides of *Spathidium atypicum* Wenzel, 1953 because *Arcuospathidium australe* is very similar to several Austrian populations studied recently by W. Foissner. This "neotypification" is however invalid because Foissner & Xu (2007) did not publish the qualifying conditions (ICZN 1999, Article 75.3). Especially the fact that the type population of *Arcuospathidium australe* has its type locality (Adelaide, Australia) very far away from the original

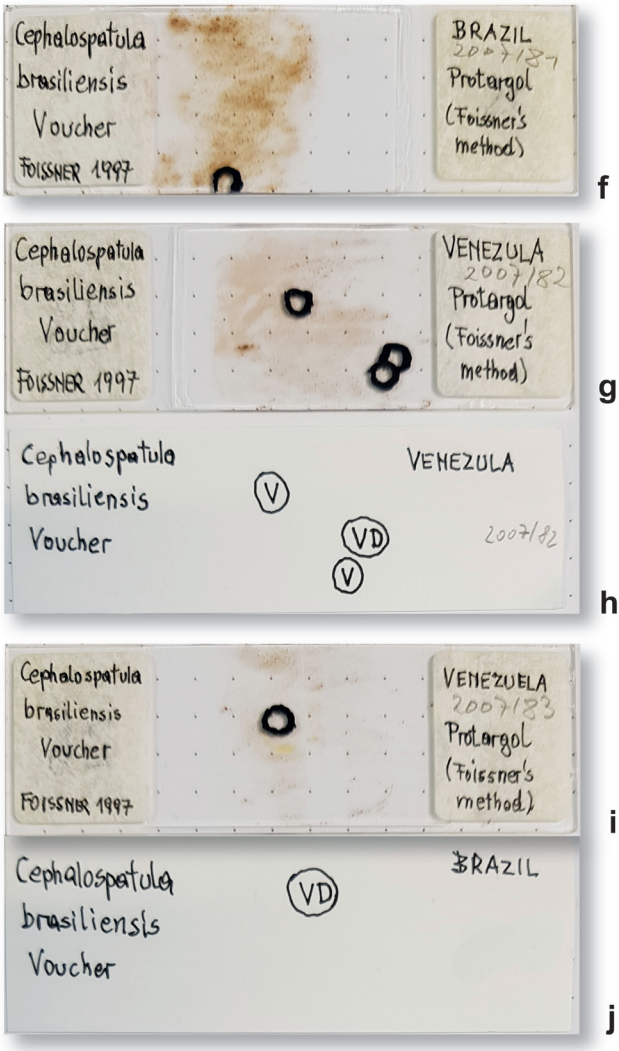


**Fig. 13.3f–j** *Cephalospatula brasiliensis* Foissner, 2003b (originals. Protargol slides). **f:** Voucher slide (from the second population from Brazil, namely from the Restingha area; details, see Foissner 2003b, p. 114). Accession number (LI): 2007/81. **g, h:** Voucher slides (g, i) and protocols (h, j; VD = voucher specimen drawn) from the population from Venezuela. Accession numbers (LI): 2007/82, 2007/83. The "Brazil" on the protocol (j) is very likely a slip of the pen.

type locality of *Spathidium atypicum* Wenzel, 1953 (surroundings of the city of Nürnberg, Germany; see below) disqualifies the Australian type slides as neotypes (ICZN 1999, Article 75.3.6). We recommend fixing a population from the Erlangen region as neotype of *Neocultellothrix atypica*. Further, more detailed studies will show if populations from Australia and Europe are indeed synonymous.

Three voucher slides (accession numbers 2024/175, 176, 177) of the population from Malaysia have been deposited in the Biology Centre of the Upper Austrian Museum in Linz (LI). They also contain voucher specimens of *Latispathidium simile* Foissner et al., 2025 (for details, see Fig. 7.8f–i, k, l in Chapter 7, that is, Foissner et al. 2025).

**Improved diagnosis** (from Foissner & Xu 2007, p. 299, slightly modified): Body size about 80–90 × 18–22 µm in vivo. Body outline narrowly spatulate with oblique oral bulge about as long as widest trunk region. Two macronuclear nodules with one micronucleus in between. Extrusomes rod-shaped, about 5 µm long. Approximately 12 ciliary rows, three left side rows anteriorly modified to heterostichad dorsal brush occupying about 20% of body length. Brush bristles up to 4 µm long; row 1 composed of an average of 7 dikinetids, row 2 of 10, and row 3 of 6 dikinetids followed by a monokinetidal bristle tail extending to mid-body.

**Remarks:** See Foissner & Xu (2007, p. 299, 306) and nomenclature above.

**Description:** For description of various populations, including one from Malaysia, see Foissner & Xu (2007, p. 301).

**Occurrence and ecology:** The type locality of *Neocultellothrix atypica* (Wenzel, 1953) is not definitely described in the original description. Wenzel (1953, p. 71) collected 298 samples from Bavaria (Germany), which are "mainly" from the immediate and further surroundings of the city of Erlangen, the Franconian Jura (Gößweinstein), and the surroundings of Seeon at lake Chiemsee. He found few specimens in two dry mosses. The type locality of the synonym *Arcuospathidium australe* is the upper soil layer (0–5 cm) of a *Eucalyptus* forest in the Belair National Park near Adelaide, Australia (further details, see Foissner 1988, p. 87 and Blatterer & Foissner 1988, p. 4, "FO14"; entry to National Park about at 34.99810°S 138.63370°E). The Malaysian population is from soil mosses from the fog rainforest on top of Mount G. Brichang, Cameroon Highlands (Foissner & Xu 2007, p. 303). For further records and for ecology, see Foissner & Xu (2007, p. 303). Foissner (2016, p. 27) recorded *Neocultellothrix atypica* from Venezuela (sample site 32, Foissner 2016, p. 17).

## *Neocultellothrix coemeterii* (Kahl, 1943) Foissner & Xu nov. comb.

(Fig. 83a–r, 84a–h, 85a–x, 138a–x, 139a–n and Tables 30, 31 in Foissner & Xu 2007)

1943 ***Spathidium coemeterii* sp. n.**[9] – Kahl, Infusorien, p. 27, Tafel VI, Fig. 19 (Fig. 83d in Foissner & Xu 2007; original description; no type material available).

2004 ***Arcuospathidium coemeterii* (Kahl, 1943) Foissner et al. 2004** – Foissner & Lei, Linzer biol. Beitr. 36: 18, Fig. 32a–h, 33a–x, 34–38, Table 7 (Fig. 84a–h, 85a–x, 139j–n in Foissner & Xu 2007; detailed redescription).

2005 ***Arcuospathidium coemeterii* (Kahl, 1943) nov. comb.** – Foissner, Berger, Xu & Zechmeister-Boltenstern, Biodiv. Conserv. 14: 652, Fig. 7a–r, 8a–t, Table 7 (Fig. 83a–r, 138a–g, k–p, t, u, 139e–i in Foissner

[9] Kahl (1943) provided the following very brief description (translated by Foissner & Xu 2007, p. 280): "Size 100 µm, similar to *Spathidium muscicola*, but with shorter toxicysts."

& Xu 2007; redescription and neotypification; three neotype slides [accession numbers 2007/157–159] have been deposited in the Biology Centre of the Upper Austrin Museum in Linz [LI], Aescht 2008, p. 149).

2007 ***Cultellothrix coemeterii* (Kahl, 1943) nov. comb.** – Foissner & Xu, Monogr. biol. 81: 275, Fig. 83a–r, 84a–h, 85a–x, 138a–x, 139a–n, Tables 30, 31 (detailed revision; invalid combination, see nomenclature).

2014 ***Cultellothrix coemeterii* (Kahl, 1943) Foissner and Xu, 2007** – Vďačny et al., Protist 165: 108 (gene sequence analyses of Norwegian population; GenBank number KF733755).

2016 ***Cultellothrix coemeterii* (Kahl, 1943) Foissner and Xu, 2007**[10] – Kim & Jung, J. Species Res. 5: 336, Fig. 1D (brief description of Korean population. Two voucher slides with protargol-prepared specimens have been deposited in the National Institute of Biological Resources in Korea (NIBRPR0000 107140, NIBRPR0000107141).

2021 ***Cultellothrix coemeterii* (Kahl, 1943)** – Foissner, Ser. Monogr. Cilioph. 5: 109 (brief comparison with *Levispatha australiensis* Foissner, 2021).

**Nomenclature:** No etymology has been provided by Kahl (1943). The species-group name *coemeterii* (likely from the Latin noun *coemeterium*; cemetery, graveyard, churchyard; Menge 1988, p. 743) very probably refers to the type locality which was obviously a cemetery (Foissner & Xu 2007, p. 275).

Kahl (1943), a monograph overlooked for a very long time (see Foissner & Wenzel 2004 for a facsimile of this monograph), did not describe the type locality. In addition, the original description is extremely short so that a neotypification was indicated to define the species objectively (ICZN 1999, Article 75). Kahl (1943) lived and worked in Hamburg (Germany) indicating that he collected the mosses harboring *Neocultellothrix coemeterii* in this region (however, Kahl sometimes studied material from other regions, e.g., Austria or USA). Thus, Foissner et al. (2005) fixed an Austrian population from a forest soil as neotype. Although they did not publish all qualifying conditions in detail (ICZN 1999, Article 75.3), we recommend accepting the neotypification.

Foissner & Lei (2004) mentioned "Foissner et al. 2004" as combining authors. However, the corresponding work was just published in 2005 (Foissner et al. 2005).

*Cultellothrix* Foissner, 2003a is not an available name and therefore the combination made by Foissner & Xu (2007) is likewise unavailable; for details, see nomenclature at genus section. In future, this species must be named "*Neocultellothrix coemeterii* (Kahl, 1943) Foissner & Xu in Berger et al., 2025" when classified in the present genus.

**Improved diagnosis** (from Foissner & Xu 2007, p. 275, slightly modified): Body size about 80 × 23 μm in vivo. Body outline narrowly spatulate with oblique, oblong to slightly cuneate oral bulge about as long as widest trunk region. Macronucleus slenderly reniform; single micronucleus. Extrusomes slightly curved, about 6.0 × 0.5 μm-sized rods. On average 12 ciliary rows, 3 anteriorly differentiated to strongly heterostichad dorsal brush occupying about 23% of body length. Brush bristles up to 3 μm long; row 1 composed of an average of 12 dikinetids, row 2 of 14, and row 3 of 5 dikinetids followed by a monokinetidal bristle tail extending to mid-body.

**Remarks:** See Foissner & Lei (2004), Foissner et al. (2005, p. 659), Foissner & Xu (2007, p. 280), and nomenclature above.

[10] Kim & Jung (2016) provided the following brief description: "Body size 55 × 18 μm in protargol preparations; body narrowly spatulate with oblong oral bulge. Macronuclear nodule reniform. Contractile vacuole at posterior body end. Cytoplasm colorless. Usually 12 ciliary rows; dorsal brush positioned distinctly lateral side; anterior cilia moderately reduced. Extrusomes cylindrical, colorless. Circumoral kinety closed."

**Description:** For description of various populations of *Neocultellothrix coemeterii*, see Foissner & Lei (2004, p. 187), Foissner et al. (2005, p. 652, neotype population), and revision by Foissner & Xu (2007, p. 275). For brief characterization of a Korean population, see Kim & Jung (2016); the specimens of this Asian population were (on average) only 55 × 18 µm in size after protargol preparation.

**Morphogenesis:** For detailed description of this part of the life cycle, see Foissner & Lei (2004, p. 191) and revision by Foissner & Xu (2007, p. 283). Note that this study is not based on the neotype population, but on a population from soil of a *Hordelymo-Fagetum* (Woodruff-beech) forest in the surroundings of Vienna, Austria (Foissner & Lei 2004, p. 187).

**Phylogeny:** Vd'ačny et al. (2014) sequenced the 18S rRNA (GenBank number KF733755; sequence length 1594 nt, GC content 42.97%). According to Figure 1 in this work, (*Neocultellothrix coemeterii* + *Neocultellothrix lionotiformis*) + *Apobryophyllum schmidingeri* form a cluster.

**Occurrence and ecology:** Likely confined to terrestrial habitats. The original type locality of *Neocultellothrix coemeterii* is not stated by Kahl (1943; see nomenclature above). The type locality of the neotype population is a *Pinus nigra* forest soil from the Stampfltal (47°53'N 16°02'E) near Vienna, Austria (Foissner et al. 2005, p. 652). Kim & Jung (2016) recorded the present species from two moss-covered soil samples from a trail of the Taeback mountain (37°06'N 128°54'E; collected May 2016), South Korea. Vd'ačny et al. (2014) isolated *Neocultellothrix coemeterii* from coniferous litter from the surroundings of Oslo, Norway. For further details, see revision by Foissner & Xu (2007, p. 279).

## *Neocultellothrix japonica* (Foissner, 1988) Foissner & Xu nov. comb.

(Fig. 89a–i, 141m and Table 33 in Foissner & Xu 2007)

1988 ***Arcuospathidium japonicum* nov. spec.**[11] – Foissner, Stapfia 17: 102, Abb. 5a–g, 15, Tabelle 3 (Fig. 89a, b, e–i, 141m in Foissner & Xu 2007; original description. According to Aescht 2008, p. 161, one holotype slide [accession number 1989/13] and one paratype slide [1989/14] have been deposited in the Biology Centre of the Upper Austrian Museum in Linz [LI]).

2007 ***Cultellothrix japonica* (Foissner, 1988) nov. comb.** – Foissner & Xu, Monogr. biol. 81: 306, Fig. 89a–i, 141m, Table 33 (detailed revision; invalid combination, see nomenclature).

**Nomenclature:** No etymology has been given in the original description. The species-group name *japonic·us*, *-a*, *-um* (Latin adjective [m, f, n]; originating in Japan; Hentschel & Wagner 1996, p. 335) refers to the country (Japan) where the species was discovered (Foissner & Xu 2007, p. 306). *Cultellothrix* Foissner, 2003a is not an available name and therefore the combination made by Foissner & Xu (2007) is likewise invalid; for details, see nomenclature at genus section. In future, this species must be named "*Neocultellothrix japonica* (Foissner, 1988) Foissner & Xu in Berger et al., 2025" when classified in the present genus.

"*Cultellothrix japonica* Foissner, 1988" in Aescht (2008, p. 193) is a nomenclaturally "non-existing" name. Thus, this entry in her Table 4 is irrelevant.

[11] Foissner (1988) provided the following diagnosis: "In vivo etwa 60–90 × 15–25 µm großes *Arcuospathidium* mit 2 leicht ellipsoiden Makronucleus-Teilen und dornenförmigen, 4–5 µm langen Extrusomen." (In English [translated by H. Berger]: In vivo about 60–90 × 15–25 µm sized *Arcuspathidium* with 2 slightly ellipsoidal macronucleus nodules and thorn-shaped, 4–5 µm long extrusomes).

Foissner & Xu (2007, p. 306) mentioned an incorrect original combination in their list of synonyms, namely "*Spathidium japonicum* Foissner" (this name is disclaimed for nomenclatural purposes; ICZN 1999, Article 8.3).

**Improved diagnosis** (from Foissner & Xu 2007, p. 306, slightly modified): Body size about 75 × 17 µm in vivo. Body outline narrowly spatulate with oblique oral bulge shorter by 16% than widest trunk region. Two macronucleus nodules with one micronucleus in between. Extrusomes acicular to narrowly ovate, about 5 µm long. Approximately 12 ciliary rows, three left side rows anteriorly modified to inconspicuous dorsal brush with bristles up to 3 µm long; brush row 3 indistinctly shortened.

**Remarks:** See Foissner (1988) and Foissner & Xu (2007, p. 306).

**Description:** For description of *Neocultellothrix japonica*, see Foissner (1988, p. 102) and Foissner & Xu (2007, p. 306).

**Occurrence and ecology:** A rare species according to Foissner & Xu (2007, p. 307). The type locality of *Neocultellothrix japonica* is a deciduous forest (526 m above sea level; 32°10'N 130°E) on Mt. Kado-yama, Amakusa Islands, Kumamoto Prefecture, Japan, where Foissner (1988, p. 87, 102; see also Foissner & Xu 2007, p. 306) found it with moderate abundance in the upper soil layer (0–5 cm; soil brown, pH 3.5; collector Tadao Matsusaka, Kumamoto University). Further record: in terra firma soil (pH 5.1) of a primary(?) rain forest on a small island of the Anavilhanas archipelago in the Rio Negro near the town of Manaus, Brazil (Foissner 1997, p. 320). According to Foissner & Xu (2007, p. 307), abundances were low in the non-flooded Petri dish cultures and the small and tiny species is well adapted to live in tiny soil pores.

## *Neocultellothrix lionotiformis* (Kahl, 1930) Foissner nov. comb.

(Fig. 82l, m in Foissner & Xu 2007)

1930 ***Spathidium lionotiforme* spec. n.** – Kahl, Arch. Protistenk. 70: 383, Fig. 7h, $h_1$ (Fig. 82m in Foissner & Xu 2007; original description; no type material available; see nomenclature).

1930 ***Spathidium lionotiforme* spec. n.** – Kahl, Tierwelt Dtl. 18: 165, Fig. $22_{29}$ (Fig. 82l in Foissner & Xu 2007; a second time described as new species; see nomenclature; no type material available).

1943 ***Spathidium lionotiforme* Kahl**[12] – Kahl, Infusorien, p. 26, Tafel VI, Fig. 5 (revision; figure very similar to Fig. 82l in Foissner & Xu 2007).

1984 ***Arcuospathidium lionotiforme* (Kahl, 1930) nov. comb.** – Foissner, Stapfia 12: 78 (combination with *Arcuospathidium*; misidentification, see remarks).

2002 ***Arcuospathidium cultriforme lionotiforme* (Kahl, 1930) Foissner, 1984 nov. stat.** – Foissner, Agatha & Berger, Denisia 5: 300 (classification as subspecies of *Arcuospathidium cultriforme* (Penard, 1922) Foissner, 1984; see nomenclature).

2003 ***Cultellothrix lionotiformis* (Kahl, 1930a) comb. n.** – Foissner, Acta Protozool. 42: 53, Fig. 12a, b (Fig. 82l, m in Foissner & Xu 2007; combination with invalid genus *Cultellothrix* Foissner, 2003a; see nomenclature).

2007 ***Cultellothrix lionotiformis* (Kahl, 1930) Foissner, 2003** – Foissner & Xu, Monogr. biol. 81: 269, Fig. 82l, m (detailed revision).

**Nomenclature:** The species-group name *lionotiform·is, -is, -e* (m, f, n; shaped/formed like a *Lionotus*, a pleurostomatid ciliate; see also Kahl 1930b, p. 165, key; Foissner & Xu 2007, p.

[12] Kahl (1943) provided the following very brief description (translated by H. Berger): Body size 140–200 µm. Oral bulge extends ventrally to mid-body, blade-like, *Sphagnum*, but also in *Hottonia*.

269) is a composite of the genus-group name *Lionotus*[13] and the Latin word *-formis* (-shaped; for details, see https://de.wiktionary.org/wiki/-formis, accessed 26 Jan 2024). *Cultellothrix* Foissner, 2003a is not an available name and therefore the combination made by Foissner (2003) is likewise invalid; for details, see nomenclature at genus section. In future, this species must be named "*Neocultellothrix lionotiformis* (Kahl, 1930) Foissner in Berger et al., 2025" when classified in the present genus. *Spathidium lionoliforme* in Kahl (1930a, p. 378) is an incorrect original spelling (ICZN 1999, Articles 19, 32). The correct original spelling is *Spathidium lionotiforme* (Kahl 1930a, p. 383, 415).

Kahl described this species two times as new (Kahl 1930a, b, see list of synonyms). Since the description by Kahl (1930a) is more detailed and was (very likely) published before Kahl (1930b) this work is considered as original description. *Spathidium lionotiforme* spec. n. in Kahl (1930b) is not a junior primary homonym because the name was not established for a different nominal taxon but for the same material (ICZN 1999, Article 57.2). *Cultellothrix lionotiforme* in Foissner & Xu (2007, p. 237) has an incorrect ending.

Foissner (1984, p. 8) obviously deposited four slides (accession numbers 1984/57–60) in the Biology Centre of the Upper Austrian Museum in Linz (LI; see Aescht 2003, p. 389; 2008, p. 162). According to Aescht (2008), the slides have been labelled (incorrectly) as paratypes by W. Foissner (for details, on paratypes, see ICZN 1999, p. 120). Aescht (2003; see also Aescht 2008, p. 162, 233) interpreted these slides as neotype slides by subsequent designation and thus the sample site (Baumgarten, Lower Austria) of *Arcuospathidium lionotiforme* sensu Foissner (1984) became the new type locality (sample site of neotype material; Aescht 2008). Regrettably, *Arcuospathidium lionotiforme* sensu Foissner (1984) is a misidentification, that is, now this population is classified as *Arcuospathidium cultriforme scalpriforme* (Kahl, 1930a) Foissner, 2003a (for details on complicated taxonomy, see Foissner 2003a, p. 54; Xu & Foissner 2005, p. 16; and Foissner & Xu 2007, p. 236).[14] The "neotypification" introduced by Aescht (2003, 2008) is, however, invalid because Foissner (1984) neither mentioned a neotypification nor did W. Foissner label the slides as neotypes; further, Aescht (2003, 2008) did not publish the qualifying conditions necessary for a valid neotypification (ICZN 1999, Article 75). Consequently, the slides mentioned above (1984/57 to 60) have to be interpreted as voucher slides for *Arcuospathidium cultriforme scalpriforme* (Kahl, 1930a) Foissner, 2003a. For notes on deposition of material investigated by Xu & Foissner (2005), see page 37 of their work.

**Diagnosis:** Not given in original description (Kahl 1930a denoted the detailed description as diagnosis). Should await reinvestigation with modern methods (Foissner & Xu 2007, p. 269).

**Remarks:** See Foissner (2003a, p. 54), Xu & Foissner (2005, p. 16), and Foissner & Xu (2007, p. 236, 270) and nomenclature above (last paragraph).

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[13] The name "*Lionotus*" is disclaimed for nomenclatural purposes (ICZN 1999, Article 8.3). *Lionotus* is an incorrect subsequent spelling of *Litonotus* Wrzesniowski, 1870; perhaps *Lionotus* was used for the first time by Blochmann (1886, p. 62, 65).

[14] Please note that the entries by Foissner (1984) and Foissner et al. (2002) in the list of synonyms serve only to show the nomenclatural acts made in these two works, namely, the combination of *Spathidium lionotiforme* with *Arcuospathidium* by Foissner (1984) and the classification as subspecies by Foissner et al. (2002), respectively. As explained above, the population described by Foissner (1984) does not belong to *Neocultellothrix lionotiformis*!

**Description:** For description, see Kahl (1930a, b) and Foissner & Xu (2007, p. 269). Note that the redescription of this species by Foissner (1984, p. 78) is a misidentification (see nomenclature above).

**Occurrence and ecology:** According to Foissner & Xu (2007, p. 270), *Neocultellothrix lionotiformis* is a limnetic and/or semiterrestrial species. Kahl (1930a) found two specimens in *Hottonia* of a marshland ditch (locality not mentioned). Later he found about 10 individuals in a *Sphagnum procerum* cushion; according to Kahl (1930b), this *Sphagnum* moss was collected near Hamburg, Germany, namely in the Eppendorfer Moor, a bog (Foissner & Xu 2007, p. 269). Unfortunately, neither Kahl (1930a) nor Kahl (1927) provided details on the sample sites. Further details on occurrence, see Foissner & Xu (2007, p. 270). Please note that all records of the present species made by W. Foissner until 2003 are misidentifications (see nomenclature).

## *Neocultellothrix paucistriata* (Foissner & Xu, 2007) nov. comb.

(Fig. 86a–m, 140a–g and Table 32 in Foissner & Xu 2007)

2007 ***Cultellothrix paucistriata* nov. spec.** – Foissner & Xu, Monogr. biol. 81: 290, Fig. 86a–m, 140a–g, Table 32 (original description. The slide containing the holotype [Fig. 86c–e in Foissner & Xu 2007; accession number 2007/56] and two paratype slides [2007/55, 57] have been deposited in the Biology Centre of the Upper Austrian Museum in Linz [LI], see Aescht 2008, p. 172; see nomenclature).

2008 ***"paucistriata Cultellothrix"* Foissner & Xu, 2007** – Aescht, Denisia 23: 172 (notes on type locality, type slides, and "Unavailability due to aphory, ICZN 1999, Article 72.3"; see nomenclature for details).

**Nomenclature:** The species-group name *paucistriat·us*, *-a*, *-um* is a composite of the Latin word *pauci-* (few; Werner 1972, p. 308) and the Latin adjective *striat·us*, *-a*, *-um* (m, f, n; striated, having streaks/stripes; Hentschel & Wagner 1996, p. 563) and refers to the low number (7 on average) of ciliary rows (Foissner & Xu 2007). *Cultellothrix* Foissner, 2003a is not an available name (see nomenclature at genus section) and therefore the species has to be transferred to an available genus (see heading). In future, this species must be named "*Neocultellothrix paucistriata* (Foissner & Xu, 2007) Berger et al., 2025" when classified in the present genus.

Aescht (2008, p. 172) notes under remarks "Nomenclaturally unavailable due to aphory (see Glossary; ICZN 1999 Art. 72.3)". Aphory basically means, in the present case, that the species was described without fixation of a holotype. For detailed discussion of this problem, see Chapter 1, that is, Berger et al. (2025).

**Diagnosis** (from Foissner & Xu 2007, p. 290, slightly modified): Body size about 65 × 20 µm in vivo. Body outline narrowly spatulate with oblique, slightly cuneata oral bulge shorter than widest trunk region by 40%. Macronucleus usually C-shaped; single micronucleus. Two types of extrusomes: type I narrowly ovate and slightly curved, 3.0 × 0.7 µm in size; type II oblong and about 1.5 µm long. On average 7 ciliary rows, those on left side anteriorly modified to heterostichad, three-rowed dorsal brush occupying about 20% of body length. Brush bristles up to 5 µm long: row 1 composed of an average of 8 dikinetids, row 2 of 8, and row 3 of 6 dikinetids followed by a monokinetidal bristle tail extending to midbody.

**Remarks:** See Foissner & Xu (2007, p. 292).

**Description:** For description, see Foissner & Xu (2007, p. 290).

**Occurrence and ecology:** The type locality of *Neocultellothrix paucistriata* is soil from the surroundings of Rio de Janeiro, Brazil, namely, the shrub zone of the Restingha area (about 23°30'S 43°W) about 1 km off the Atlantic Sea coast (Foissner & Xu 2007, p. 290). Further details, see Foissner & Xu (2007, p. 292). Post-2007 literature not checked in detail for further records.

## *Neocultellothrix tortisticha* (Foissner & Xu, 2007) nov. comb.

(Fig. 87a–s, 140h–o and Table 32 in Foissner & Xu 2007)

2007 ***Cultellothrix tortisticha* nov. spec.** – Foissner & Xu, Monogr. biol. 81: 294, Fig. 87a–s, 140h–o, Table 32 (original description. The slide containing the holotype [Fig. 87i, j in Foissner & Xu 2007; accession number 2007/59] and two paratype slides [2007/58, 60] have been deposited in the Biology Centre of the Upper Austrian Museum in Linz [LI], see Aescht 2008, p. 183; see nomenclature).

2008 ***"paucistriata Cultellothrix"* Foissner & Xu, 2007** – Aescht, Denisia 23: 172 (notes on type locality, type slides, and "Unavailability due to aphory, ICZN 1999, Article 72.3"; see nomenclature for details).

**Nomenclature:** The species-group name *tortisticha* is a composite of *torti-* (twisted, Schubert & Wagner 1979, p. 353; *tortus*, a verb in participle, participle of spin, turn/twist, for details, see https://www.frag-caesar.de/lateinwoerterbuch/tortus-uebersetzung.html, accessed 26 Jan 2024) and the Greek noun *stichos* (row; Schubert & Wagner 1979, p. 336). The name refers to the propeller blade-like twist of the circumoral kinety and oral bulge, a main feature of this species (Foissner & Xu 2007, p. 294). *Cultellothrix* Foissner, 2003a is not an available name (see nomenclature at genus section) and therefore the species has to be transferred to an available genus (see heading). In future, this species must be named "*Neocultellothrix tortisticha* (Foissner & Xu, 2007) Berger, Xu & Foissner, 2025" when classified in the present genus.

Aescht (2008, p. 183) notes under remarks "Nomenclaturally unavailable due to aphory (see Glossary; ICZN 1999 Art. 72.3)". Aphory basically means, in the present case, that the species was described without fixation of a holotype. For detailed discussion of this problem, see Chapter 1, that is, Berger et al. (2025).

**Diagnosis** (from Foissner & Xu 2007, p. 294, slightly modified): Body size about 55 × 10 µm in vivo. Body outline narrowly spatulate with oblique, cuneata oral bulge about 1.2 times as long as widest trunk region; bulge and circumoral kinety screwed like a propeller blade. Two macronucleus nodules with one micronucleus in between. Extrusomes oblong and slightly curved, 2.5–3.0 × 0.5 µm in size. On average 7 ciliary rows, those (three) on left side anteriorly modified to isostichad dorsal brush occupying about 12% of body length. Brush bristles up to 4 µm long: row 1 composed of an average of 5 dikinetids, row 2 of 4, and row 3 of only 3 dikinetids followed by a monokinetidal bristle tail extending to near posterior body end.

**Remarks:** See Foissner & Xu (2007, p. 299) and nomenclature above.

**Description:** For description, see Foissner & Xu (2007, p. 294).

**Morphogenesis:** For some details on this part of the life cycle, see Foissner & Xu (2007, p. 298).

**Occurrence and ecology:** The type locality of *Neocultellothrix tortisticha* is terra firma secondary rain forest soil from the bank of Rio Negro in the surroundings of Hotel Tropical

(about 03.064°S 60.107°W) at Manaus, Brazil. Further details, see Foissner & Xu (2007, p. 299). Post-2007 literature not checked in detail for further records.

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# Index

## Systematic index

The index contains all ciliate names mentioned in the book, including vernacular names for example, haptorids. Designations as, for example, "haptorid ciliates" are mentioned under the corresponding vernacular name, that is, "haptorids" in present example. Names in singular (e.g., haptorid) are mentioned under the plural version (e.g., haptorids). The index is two-sided, that is, species appear both with the genus-group name first (for example, *Apospathidium atypicum*) and with the species-group name first (*atypicum*, *Apospathidium*). Valid (mainly in W. Foissner's judgement) species and genera treated in detail are in boldface italics print. Valid taxa not treated in detail in the present book, invalid taxa, junior homonyms, synonyms, outdated combinations, incorrect spellings, and nomina nuda are not in bold. Suprageneric taxa are represented in normal type, valid ones treated in detail in the present work in boldface. A boldface page number indicates the beginning of the description of a valid taxon. "T" indicates the location of the table with the morphometric characterisation; "K" marks a key (e.g., of the genus *Apospathidium*) and the page where a taxon is mentioned in a key. The names on the slide figures and the names of the subchapter "Summary of nomenclatural acts and taxa described in Chapters 1–13" (see Chapter 1, pp. 18–20) are not included.

## Table index