

Surirella fuellebornii (Bacillariophyta) and related taxa: lectotypification and distribution

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Abstract. – *Surirella bifrons* var. *intermedia* O.Müll. and *Surirella fuellebornii* O.Müll., including its infraspecific taxa, were re-evaluated using historical East African material collected in the early 20th century from which Otto Müller described more than 100 new diatom taxa. In addition, material from the Hustedt Diatom Collection together with material collected during the past decades in the region of the African Great Lakes was studied. The investigation of the original material of *Surirella bifrons* Ehrenb. in the Ehrenberg Collection allowed to elevate *Surirella bifrons* var. *intermedia* to species rank: *Surirella kusberi* nom. nov. The variation observed in the material studied supported the abandonment of taxonomic recognition of *Surirella fuellebornii* f. *subconstricta* O.Müll. and var. *constricta* O.Müll. On the other hand, var. *tumida* Hustedt and var. *elliptica* O.Müll. are here elevated to species rank: *Surirella crawfordii* nom. nov. and *Surirella friedel-hinziae* nom. nov. respectively. Finally, *Surirella fuellebornii* var. *worthingtonii* H.Bachm. was found to belong within the variability of *Surirella malombae* O.Müll.

Key words: diatoms, taxonomy, *Surirella*, lectotype, East Africa.

Introduction

In the first half of the 20th century, a number of tropical African *Surirella* species were described from East Africa by Otto Müller (Müller 1903, 1904; for a compilation see Jahn 2002). They are part of the typical diatom component of the algal flora of the East African Great Rift Lakes area (Ross 1983). Many of these *Surirella* taxa have been the subject of a recent thorough investigation (Cocquyt & Jahn 2005, 2007a, b, c) since we are convinced that many species of diatoms are not as ubiquitous and cosmopolitan as previously assumed. In addition, many of the taxa previously described from Central East Africa have been relegated into synonymy by later researchers. A re-evaluation of these taxa is thus necessary for studies on species distribution, endemism, speciation and changes in the diatom flora of East Africa (i.e. Cocquyt et al. 1993, Cocquyt 1998). To make these African taxa more easily accessible to modern research we translated Müller's German descriptions, lectotypified each taxon, included modern LM photographs and SEM photographs where possible. Finally, we introduced nomenclatural changes when necessary (e.g. Cocquyt &

Jahn 2005, 2007a, b, c). Historical and recent biogeographical references to other sources are included.

The present paper deals with *Surirella bifrons* var. *intermedia* O.Müll. and *Surirella fuellebornii* O.Müll. Besides Müller's two varieties and one forma of *Surirella fuellebornii* (Müller 1903), var. *tumida* Hust. (Hustedt 1942) and var. *worthingtonii* H.Bachm. (Bachmann 1933) are also discussed. *S. bifrons* (Ehrenb.) Ehrenb., described from Europe, was typified from original material in the Ehrenberg collection and a possible relation between this taxon and *S. bifrons* var. *intermedia* was investigated. In addition to the present publication, nomenclatural information will be made available via the AlgaTerra Information System (Jahn & Kusber 2007).

Material and methods

The following historical samples of material from East Africa, studied by O.Müller (1903, 1904) and kept in the Botanic Garden and Botanical Museum Berlin-Dahlem (B), were re-investigated (the text is according to Müller's list; current names of localities are in square brackets):

B 2.0014: Lake Nyassa [Lake Malawi], near Langenburg, [Tanzania], at 40-70 m depth, stormy; collected by Dr. Fülleborn on 17 August 1899.

B 2.0032: River Baka, Konde-Land [Tanzania]. Plankton. Collected by Dr. Fülleborn in December 1898.

B 2.0036: River Songwe, about 1 hour from discharge into Lake Nyassa ([Lake Malawi, Tanzania]. From the bank at lowest water level. Collected by Dr. Fülleborn on 2 December 1898.

B 2.0038: Lake Malombe after discharge of Lake Nyassa [Lake Malawi, Malawi], marshy pond, water 1-2 m deep, in the course of the River Shire; collected by Dr. Fülleborn on 3 February 1900.

B 2.0039: As B 2.0038 but collected on 7 February 1900. Label has extra word "Diatoms".

B 2.0040: As B 2.0038. Label has extra words "Polycystis, Aphanothece".

B 2.0041: As B 2.0038. Label has extra word "Plankton".

B 2.0058: Sample from the river Olunga (as indicated on the rediscovered bottle label). This sample is perhaps not identical to the sample Müller referred to as No. 58 from Lake Rukwa (see also Cocquyt & Jahn 2007c).

In the Hustedt Diatom Collection (BRM) the following slides were studied:

X6/63: type *Surirella fuellebornii* var. *tumida*; material from Lake Tanganyika; mounted on 01/01/1922.

X2/51: material from Lake Tanganyika, station 6 (near Rumonge, Burundi); mounted on 01/01/1924.

X2/48: material from Ethiopia; mounted on 01/01/1947.

X2/49: material from Ethiopia; mounted on 01/01/1947.

X2/47: material from Lake Tanganyika, mounted on 01/01/1927.

X2/50: material from Lake Tanganyika, mounted on 01/01/1927.

X2/46: material from Lake Tanganyika, station 6 (near Rumonge, Burundi); material sampled in 1913 and mounted on 01/01/1924.

Material from the Third Tanganyika Expedition conducted by Dr. W.A.Cunnington, 1901-1905 (West 1907) and deposited at BM, was also studied: 249: material from Lake Victoria, in the plankton near Bukoba, sampled on 18 April 1905.

More recent material of Lake Tanganyika sampled by A.Caljon (ACBUA 588, ACBUA 660, see Cocquyt 1998) and deposited at the National Botanic Garden of Belgium (BR) containing *Surirella fuellebornii* and infraspecific specimens, is also included in the present study as well as samples from the Mwanza Bay in Lake Victoria collected by H.Van den Heuvel in 1983 and put at our disposal by H.Van den Heuvel and Dr. W.F.Prud'homme van Reine (National Herbarium Nederland, University of Leiden, The Netherlands).

Additionally, we studied the original material of *Surirella bifrons* in the Ehrenberg Collection, Institut für Paläontologie, Museum für Naturkunde der Humboldt Universität zu Berlin (BHUPM).

The samples of B were oxidized with peroxide and embedded in Naphrax. Studies were made at B and at BR with a Zeiss Axioplan and a Olympus BX 51 microscope, respectively. Most photomicrographs were taken with Nomarski differential interference contrast (DIC) with 20x, 40x, 63x (oil immersion) objectives. Scanning electron microscopy studies were done at B using a Philips 515 operating at 30 KV.

The material in the Ehrenberg Collection was investigated using an Olympus BX 51 microscope equipped with an Olympus DP camera; the material in the Hustedt Diatom Collection was studied with a Zeiss Axioplan microscope equipped with an Olympus Color View III digital camera.

Lectotypes were designated among the newly made slides of the material studied by Müller. In the absence of a fitting sample or a valve resembling the original drawing and description, the original drawing of Müller was designated as lectotype.

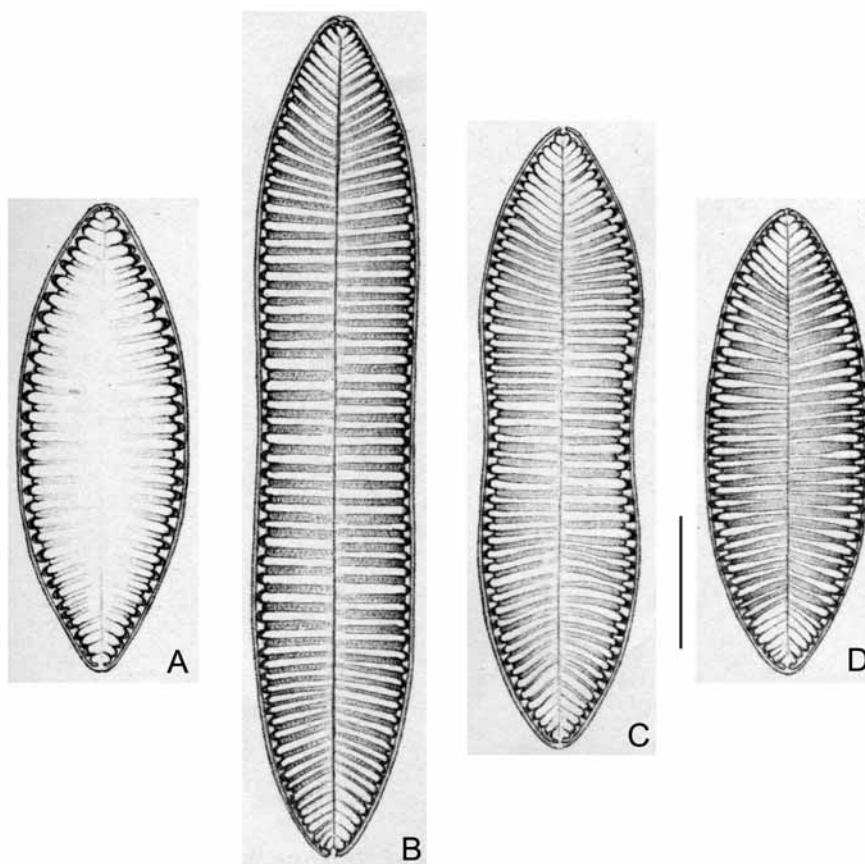


Figure 1. A, lectotype of *Surirella kusberi* Cocquyt & R.Jahn and Müller's published drawing of *Surirella bifrons* var. *intermedia* (1903, pl. 1, fig. 1); B-C, *Surirella fuellebornii* O.Müll.: B, Müller's published drawing of *Surirella fuellebornii* f. *subconstricta* (1903, pl. 1, fig. 11); C, Müller's published drawing and lectotype of *Surirella fuellebornii* var. *constricta* (1903, pl. 1, fig. 12); D, lectotype of *Surirella friedelhinzae* Cocquyt & R.Jahn and Müller's published drawing of *Surirella fuellebornii* var. *elliptica* (1903, pl. 1, fig. 13). Scale bar = 50 μ m.

Results

Surirella fuellebornii O.Müll., Bot. Jahrb. Syst. 34: 30. (1903). – *Lectotype* (designated here): slide B 400 040236, from Müller's material B 2.0038 (here illustrated as fig. 2C). *Type locality*: Lake Malombe.

Surirella fuellebornii f. *genuina, recta* O.Müll., Bot. Jahrb. Syst. 34: 30 (1903), **synon. nov.**

Surirella fuellebornii f. *subconstricta* O.Müll., Bot. Jahrb. Syst. 34: 30, pl. 1, fig. 11 (1903); see also Schmidt, Atlas Diatomaceenkunde pl. 246, fig. 3 (1904), **synon. nov.**

Surirella fuellebornii var. *constricta* O.Müll., Bot. Jahrb. Syst. 34: 30-31, pl. 1, fig. 12 (1903); see also Schmidt, Atlas Diatomaceenkunde pl. 246, fig. 4 (1904) **synon. nov.** – *Lectotype* (designated here): icon Müller 1903, pl. 1, fig. 12; reproduced here as fig. 1C. *Type locality*: not indicated in Müller (1903), Lake Malombe was later cited by Müller in the caption of pl. 246, fig. 4 (Schmidt 1874-1959).

Translated from the German, Müller's description reads (1903: 30) "Valves broadly linear, with blunt, subrostrate poles, costae 1.5 in 10 µm, strong, finely punctuated, radiate in the middle, divergent near the poles, not reaching the pseudoraphe. Strong alae near the margins with not so distinct wing projection. Pseudoraphe a continuous line. Pleura long linear with blunt poles and rounded angles, wings straight, fenestrae of medium height, wider than their supports. Length 320-350 µm, width 60 µm. Width-to-length ratio 1 : 5.3 - 6. – Lives in the plankton of Lake Malombe (40-41)."

For the girdle view Müller (1903) referred to pl. 1, fig. 4, representing the girdle view of *S. engleri* O.Müll. according to his caption; for the valve view he referred to pl. 1, fig. 11 (the drawing showing *S. fuellebornii* f. *subconstricta*), writing "but with straight margins".

Translated from the German, Müller's description of *S. fuellebornii* f. *subconstricta* reads (1903: 30): "As the nominate form, but the margins are slightly constricted. Length 287-373 µm, width 60-64 µm. Width-to-length ratio 1 : 4.8-6.2. – Lives in the plankton of Lake Malombe (40-41), in Lake Malombe (38), in the plankton of the river Baka, Konde-Land (32)."

Müller did not illustrate the nominate variety since the only difference from his f. *subconstricta* he observed consisted of its slight non-constriction; we also found his "f. *subconstricta*" to be the common form. We have chosen a lectotype from the original material that best fitted his diagnosis of *S. fuellebornii*.

The valve illustrated in fig. 2C is somewhat smaller than described by Müller: length: 282 µm, width: 61.5 µm, width-to-length ratio 1: 4.6; also the number of costae in 10 µm is somewhat higher, 1.7-1.8. All valves observed in sample 2.0039 fall within the range given by Müller, e.g. length: 310 µm, width: 62.5 µm in the constricted part, 67.5 µm in the broadest part, width-to-length ratio 1: 4.6-5; 1.6 costae in 10 µm. Valves of this taxon were also observed in another sample of lake Malombe (B 2.0039).

Although *Surirella fuellebornii* var. *constricta* is here treated as a taxonomic synonym, since we consider the more or less deep constriction of the valve margins to lie within the morphological variability, it is here lectotypified. Translated from the German, Müller's description of *S. fuellebornii* var. *constricta* reads (1903: 30-31): "As forma *subconstricta*, but the margins are more constricted. Costae 1.8-2 in 10 µm. Length 173-353 µm, width smallest 53-65 µm, largest 60-67 µm. Width-to-length ratio 1 : 3.8-4.6. – Lives in the plankton of the river Baka, Konde-Land (32), in a pool near Nyassa (29), in the plankton of Lake Malombe (40)."

Extended morphologic description

Valves broadly linear, with blunt, subrostrate poles; length 173-373 µm, width 53-67 µm, length-to-width ratio 4.6-6.2. Alar canals well developed, smaller than the fenestrae, 1.5-1.8 in 10 µm. Wing projection indistinct. Transapical valve undulations strong, finely punctuated, radiate in the middle and divergent near the poles; almost reaching the axial area (pseudoraphe) which is visible in LM as a continuous line.

Habitat. Planktonic.

Distribution. Besides Lake Malomba and tributary rivers of Lake Malawi (Müller 1903), this taxon was reported from many countries and lakes in Africa, viz. Burundi (Compère 1975), Burkina Faso (Compère 1975), Chad (Compère 1975), Congo (Zaire) (Hustedt, 1949, Woodhead & Tweed 1958), Ethiopia (Compère 1975), Kenya (Compère 1975), Malawi (Compère 1975), Mozambique (Compère 1975), Namibia (Cholnoky 1966), Sierra Leone (Mölder 1962), South Africa, Tanzania (Compère 1975), Uganda (Hustedt 1949), Zambia (Hancock 1979), Lake Edward (Hustedt 1949, Van Meel 1954, Ross 1983), Lake Kivu (Hustedt 1949, Van Meel 1954, Ross 1983), Lake Tanganyika (Van Meel 1954, Ross 1983, Caljon & Cocquyt 1992, Cocquyt 1998) and Lake Victoria

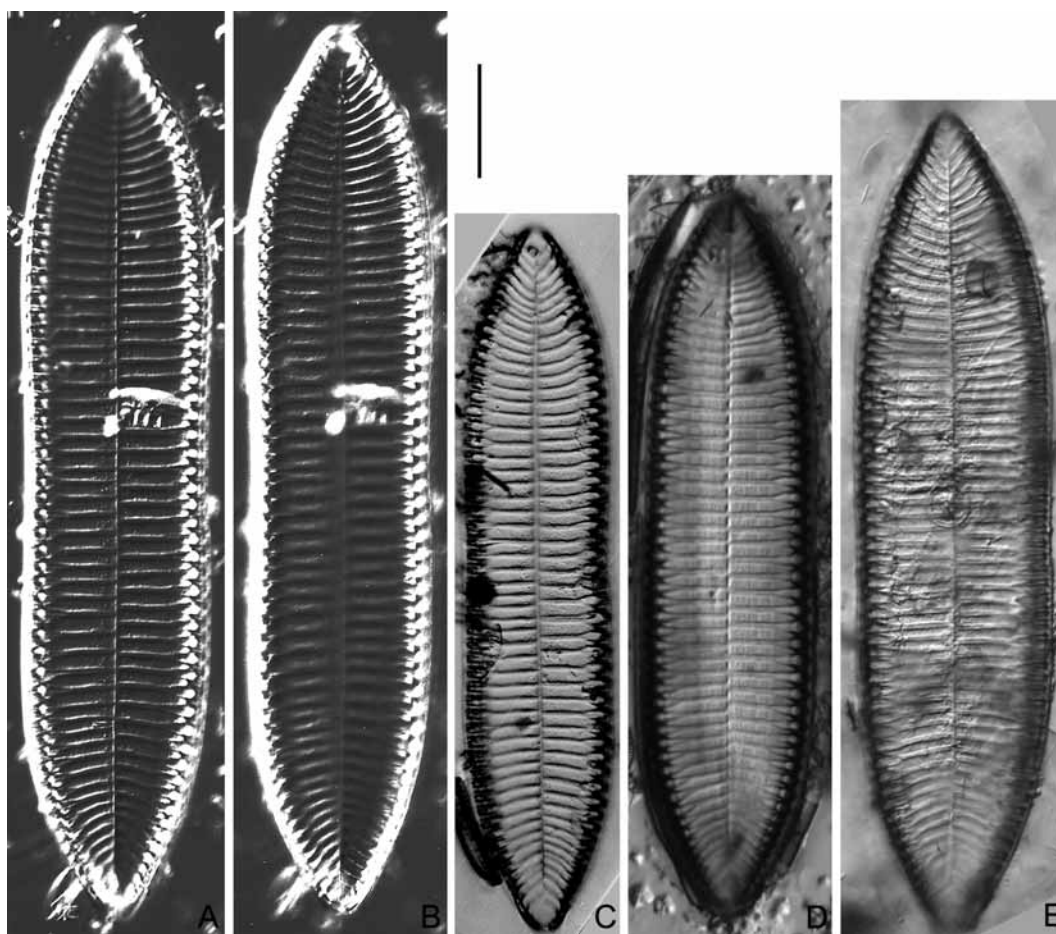


Figure 2. A-E, *Surirella fuellebornii* O.Müll.: A-B, different foci of a valve in material from Lake Malawi (B 2.0014); C, lectotype of *Surirella fuellebornii* slide B. 400 040263; D-E, material from 1983 collected by Van den Heuvel in Lake Victoria (Mwanza Gulf). Scale bar = 50 μ m.

(West 1907, Ross 1983, Van den Heuvel unpublished data). As *S. fuellebornii* f. *subconstricta* it was reported from Lake Malombe (Van Meel 1954) and Lake Kariba (Hancock 1979, Wołoszyńska 1914 as *S. fuellebornii* var. *subconstricta*), as *S. fuellebornii* var. *constricta* from Congo (Zaire) (Van Oye 1927, Zanon 1938, Hustedt 1949 as *S. fuellebornii* f. *constricta*, Woodhead & Tweed 1958), Ethiopia (Forti 1910), Tanzania (Zanon 1938), Zambia, Lake Edward (Idi Amin) (Hustedt 1949 as *S. fuellebornii* f. *constricta*), Lake Kivu (Hustedt 1949 as *S. fuellebornii* f. *constricta*), Lake Malombe (Van Meel 1954), Lake Tanganyika (Zanon 1938) and Lake Victoria (Van Meel 1954).

Müller remarked for this taxon that “he did not observe it in the plankton of Lake Nyassa; but present in the potamoplankton of the rivers Baka and Songwe which enter into the lake in the northernmost part, and in Lake Malombe where it appears to be more common. Thus, it is very probable that this species is also present in the plankton of Lake Nyassa. It belongs to the neritic forms, and

was also observed in the flora of pools near Lake Nyassa." However, we observed several specimens in the material of Lake Nyassa, also studied by Müller (B 2.00014; his No. 14) (fig. 2A-B), as well as in material from the Mwanza Bay, Lake Victoria (fig. 2D-E).

***Surirella friedelhinziae* Cocquyt & R.Jahn nom. & stat. nov.**

Replaced synonym: Surirella fuelebornii var. *elliptica* O.Müll., Bot. Jahrb. Syst. 34: 31, pl. 1, fig. 13 (1903); see also Schmidt, Atlas Diatomaceenkunde pl. 246, fig. 5 (1904). – *Lectotype* (designated here): icon Müller 1903, pl. 1, fig. 13; reproduced here as fig. 1D. *Type locality*: not indicated. – *Epitype* (designated here): slide BR 4101 (ACBUA 660/1) (here illustrated as fig. 3C). – *Isoepitype* (designated here): slide B 400 040242 (ACBUA 660/2). *Epitype locality*: Lake Tanganyika, Burundi; near Kibwe 105 km south of Bujumbura, sandy, stony beach with abundant tufts of *Vossia cuspidata* Griff. (Poaceae).

Translated from the German, Müller's description reads (1903: 31): "Valves elliptic with rounded, cuneate poles. Costae 1.8 in 10 µm, very strong, finely punctuated, in the middle radiate becoming strongly divergent near the poles, reaching the pseudoraphe, with very strong wings without distinct wing projection. Length 174-180 µm, width 60-63 µm. Width-to-length ratio 1: 2.9. – Lives in the river Songwe (36), in the plankton of the lower river Baka, Konde-Land (32), in Lake Rukwa (58)."

The dimensions of the valve representing the epitype are somewhat larger than given in Müller's description: length: 228 µm, width: 67.5 µm. The dimensions of *Surirella friedelhinziae* range between 160 and 228 µm for the length and between 58 and 71 µm for the width based on observation of specimens in material from Lake Tanganyika (fig. 3C-G, see also Cocquyt 1998) and Lake Victoria (fig. 4A-C).

Habitat. Planktonic.

Distribution: This taxon has been reported from tropical Africa, for instance, from DR Congo (Hustedt 1949, Woodhead & Tweed 1958), Ethiopia (Van Meel 1954), Tanzania (Van Meel 1954), Lake Malawi (Van Meel 1954), Lake Tanganyika (Cocquyt 1998) and Lake Victoria (West 1907, Wołoszyńska 1914, Hustedt 1942, Van Meel 1954).

Comment. The epithet is given in honour of Friedel Hinz for her kind and efficient help during our research in the Hustedt Diatom Collection. The renaming with specific status was necessary because of *Surirella elliptica* Bréb. ex Kütz., Kieselschal. Bacill., 61 (Kützing 1844).

***Surirella crawfordii* Cocquyt & R.Jahn nom. & stat. nov.**

Replaced synonym: Surirella fuelebornii var. *tumida* Hust., Huber-Pestalozzi, Die Binnengewässer 16 (2/2): 495, pl. 596 (1942); see also Simonsen 1987, pl. 116 fig. 1-2 (1987). – *Lectotype* (selected by Simonsen 1987: 83): X6/63, the valve representing the lectotype "holotype" is here illustrated as fig. 5A. *Type locality*: Lake Tanganyika.

Surirella fuelebornii var. *tumida* Hust., Schmidt, Atlas Diatomaceenkunde pl. 355, fig. 10 (1922); nom. inval.

According to Hustedt (1942) this taxon with a length around 150 µm and a width of 67 µm, differs from the other forms of *S. fuelebornii* in the strongly transapically widened valves and a length to width ratio of 2:1.

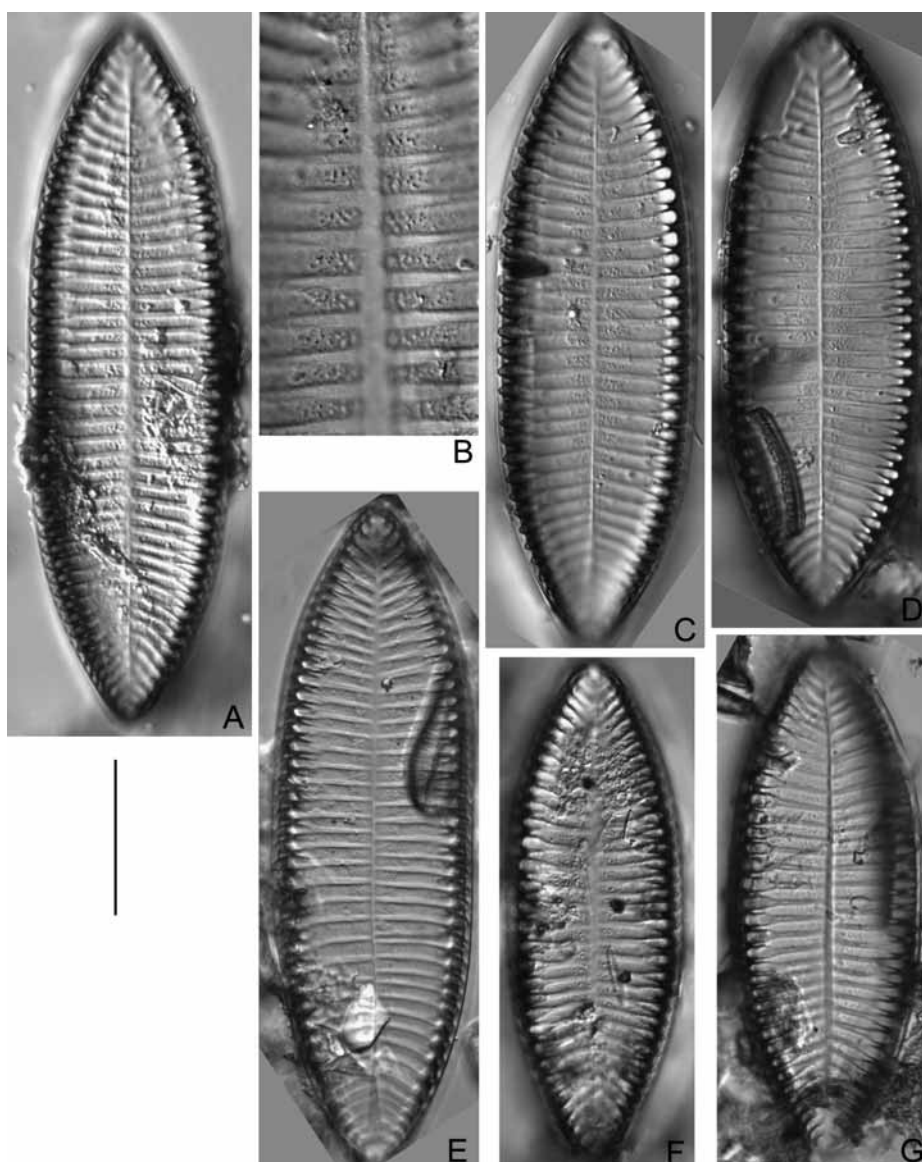


Figure 3. A-G, *Surirella friedelhinzae* Cocquyt & R.Jahn, material from Lake Tanganyika (ACBUA 660), showing the variability in valve shape: C, epitype, slide BR 4101; B, detail of the axial area and the transapical valve undulations. Scale bar = 50 μm : A, C-G ; = 22.5 μm : B

However, our own observations of the type slide, containing only one valve of this taxon, showed that the length is 265 μm , the width 118 μm , and that there are between 1.8 and 2.0 alar canals in 10 μm . These dimensions are in accordance with plate 116, fig. 1 in Simonsen (1987). A similar error in dimensions has been found (see Cocquyt & Jahn 2007a) for *Surirella malombae* O.Müll. as described by Hustedt (1942).

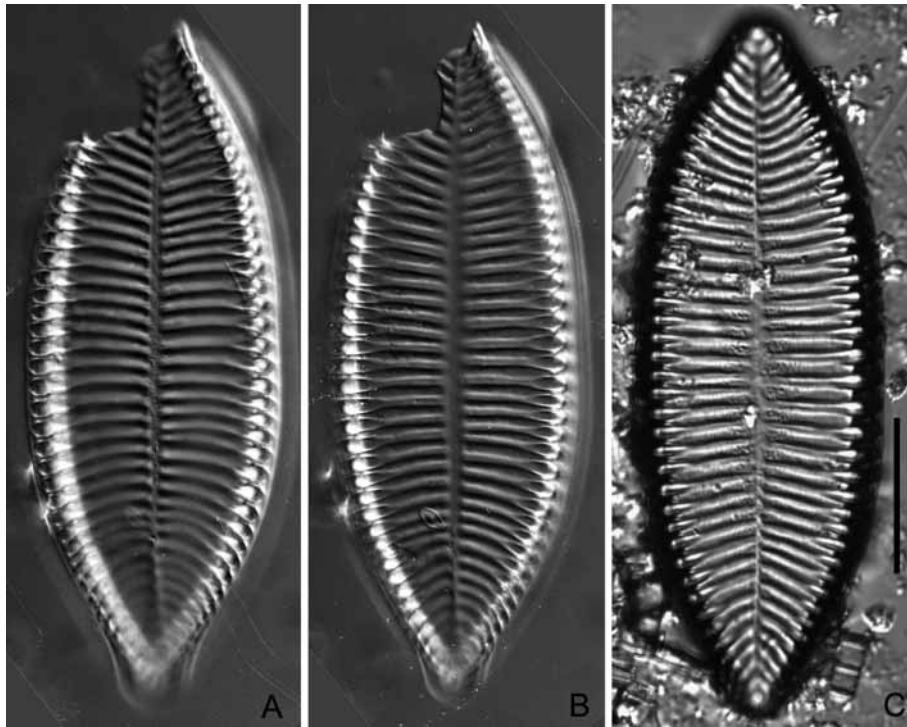


Figure 4. A-C, *Surirella friedelhinzae* Cocquyt & R.Jahn, material from Lake Victoria, showing the variability in valve shape: A-B, material collected in 1905 (West 249); C, material from 1983 collected by Van den Heuvel in the Mwanza Gulf. Scale bar = 50 μ m

Another, intact valve was observed in slide X2/51 (fig. 5B, D) and two valves in more material of Lake Tanganyika (ACBUA 588) taken near Nyanza-Lac (Burundi) in March 1986 (Cocquyt 1998) (fig. 6A-D). The description of this taxon can thus be amended: Valve length 173.5-265 μ m; width 88-118 μ m. Length-to width ratio 2.0-2.2.

Habitat. Planktonic.

Distribution. This taxon has only been reported from Lake Tanganyika (Hustedt 1942, Van Meel 1954, Cocquyt 1998) where it was rarely observed.

Unpublished data of Van den Heuvel mentioned this taxon in one sample taken in the Mwanza Gulf of Lake Victoria. However, during our investigation of this material we did not find this taxon but instead, we found *S. friedelhinzae* (= *S. fuellebornii* var. *elliptica*) which is depicted here (fig. 4C).

Comment. The epithet is given in honour of Richard Crawford, curator of the Hustedt Diatom Collection, on the occasion of his 65th birthday on 19 December 2006. The renaming with specific status was necessary because of *Surirella tumida* (O.Müll.) Cocquyt & R.Jahn in Willdenowia 35: 361 (2005), based on *Surirella bifrons* var. *tumida* O.Müll., Bot. Jahrb. Syst. 34: 27 (1903).

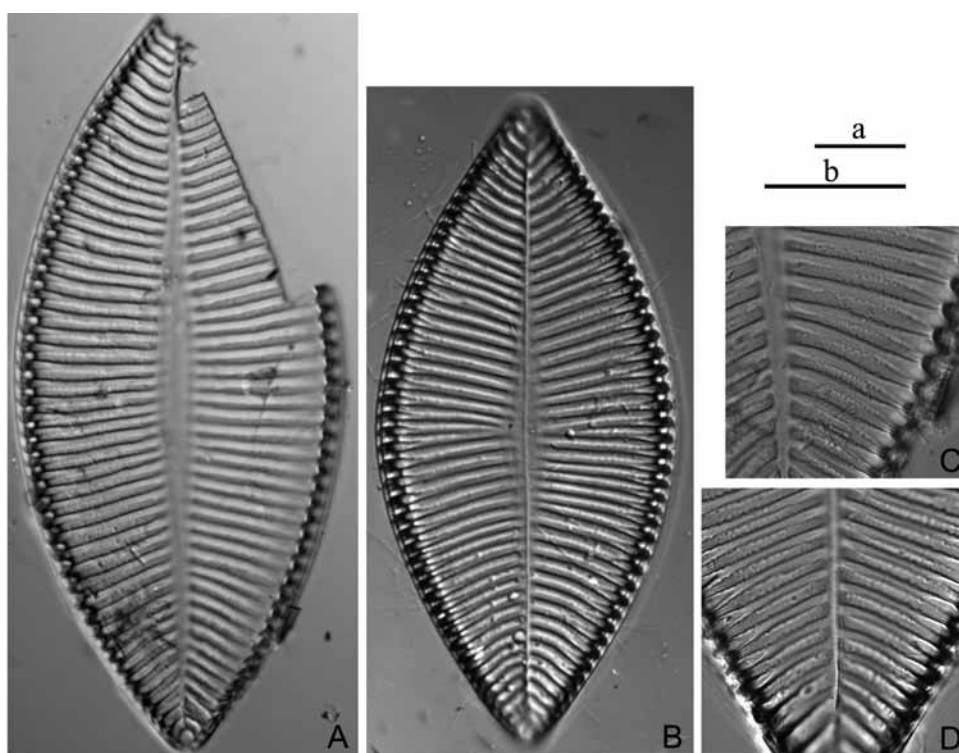


Figure 5. A-D, *Surirella crawfordii* Cocquyt & R.Jahn: A, C, type of *S. fuellebornii* var. *tumida* (slide X6/63); C, detail of the axial area near the pole; B, D, material from Lake Tanganyika (slide X2/51); D, Detail of the axial area near the pole Scale bar a = 20 μm : C-D; scale bar b = 50 μm : A-B.

***Surirella kusberi* Cocquyt & R.Jahn, nom. & stat. nov.**

Replaced synonym: *Surirella bifrons* var. *intermedia* O.Müll., Bot. Jahrb. Syst. 34: 27, pl. 1, fig. 1 (1903) (reproduced here as fig. 1A); see also Schmidt, Atlas Diatomaceenkunde, pl. 245, fig. 8 (1904). – *Lectotype* (designated here): Icon Müller 1903, pl. 1, fig. 1; reproduced here as fig. 1A. *Type locality*: unknown. – *Epitype* (designated here): slide B 400 040235, from Müller’s material B 2.0058 (the valve representing the epitype is here illustrated as fig. 7C). *Epitype locality*: The River Olunga (Tanzania).

Translated from the German, Müller’s description reads (1903: 27): “Valves lanceolate with rounded cuneate poles (apex truncatis). Costae not very distinct, 1.5 in 10 μm , straight in the middle region becoming divergent near the poles, not reaching the pseudoraphe. Margins bearing strongly developed alae and with indistinct wing projection. Pseudoraphe a hardly visible line. Length: 130 - 176 μm , width: 66 μm . Width to length ratio 1 : 2-2.7. – Lives in the plankton of Lake Malombe (41), Lake Rukwa (58).”

Typification. The valve representing the lectotype (fig. 7C) matches the description given by Müller, length: 173 μm , width: 64.5 μm , width-to-length ratio 1 : 2.7. The number of costae can become

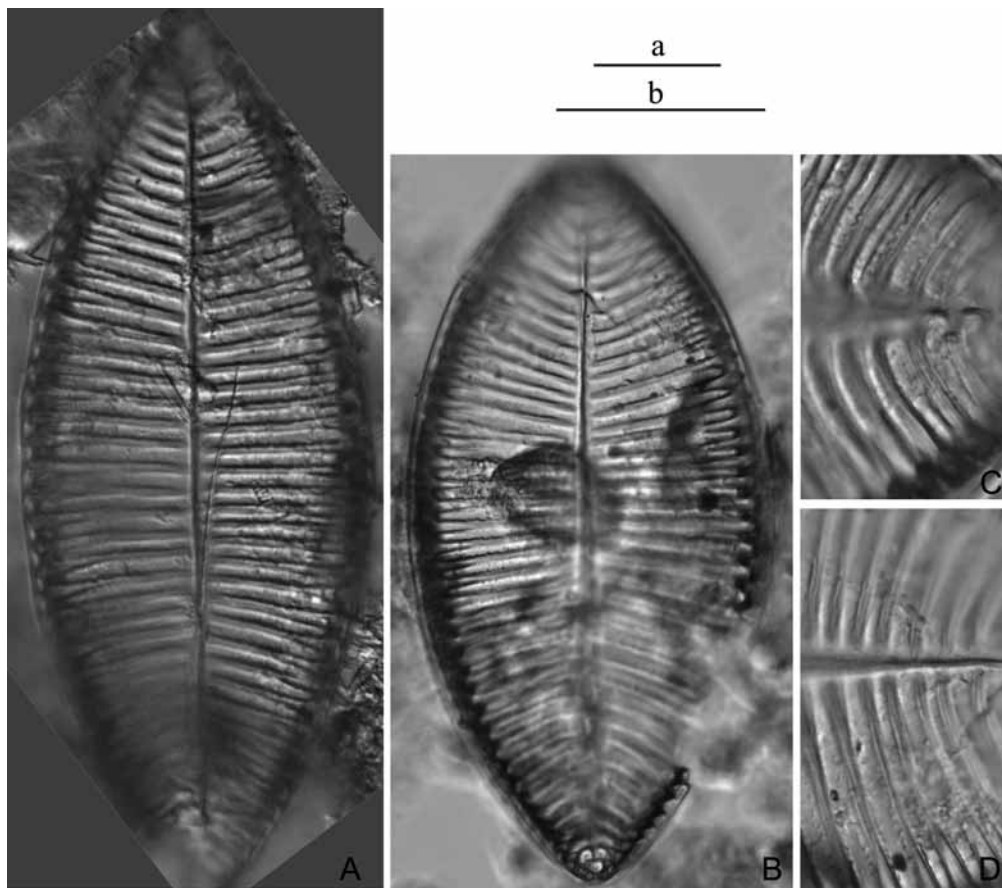


Figure 6. A-D, *Surirella crawfordii* Cocquyt & R.Jahn, material collected in 1986 in Lake Tanganyika (ACBUA 588):
C-D, detail of the axial area near the pole.
Scale bar a = 20 µm: C-B; scale bar b = 50 µm: A-B.

somewhat denser, however, 1.8 in 10 µm (Müller 1903: 1.5 in 10 µm) as observed in other valves on the type slide. Valves dimensions of other valves observed in the same material vary between 158.5 and 173 µm for the length, and 57 and 64.5 µm for the width (fig. 7A-B).

In his description of this taxon Müller mentions the localities Lake Malombe (41) and Lake Rukwa (58), the latter differing from the locality, the river Olunga, which is given here as type locality. This is due to the confusion that exists concerning sample 58, as already mentioned in material and method. Müller (1903) wrote that the origin of sample 58 is problematic: it came either from the river Olunga, Ussangu, north of the mountain Kinga, or from Lake Rukwa. However, in the description of *Surirella bifrons* var. *intermedia* he attributed only Lake Rukwa to sample 58. Since we followed the label on the rediscovered bottle at B, not knowing if the sample is identical to the sample Müller referred to as No 58, we decided to lectotypify the picture and use the available material to designate an epitype.

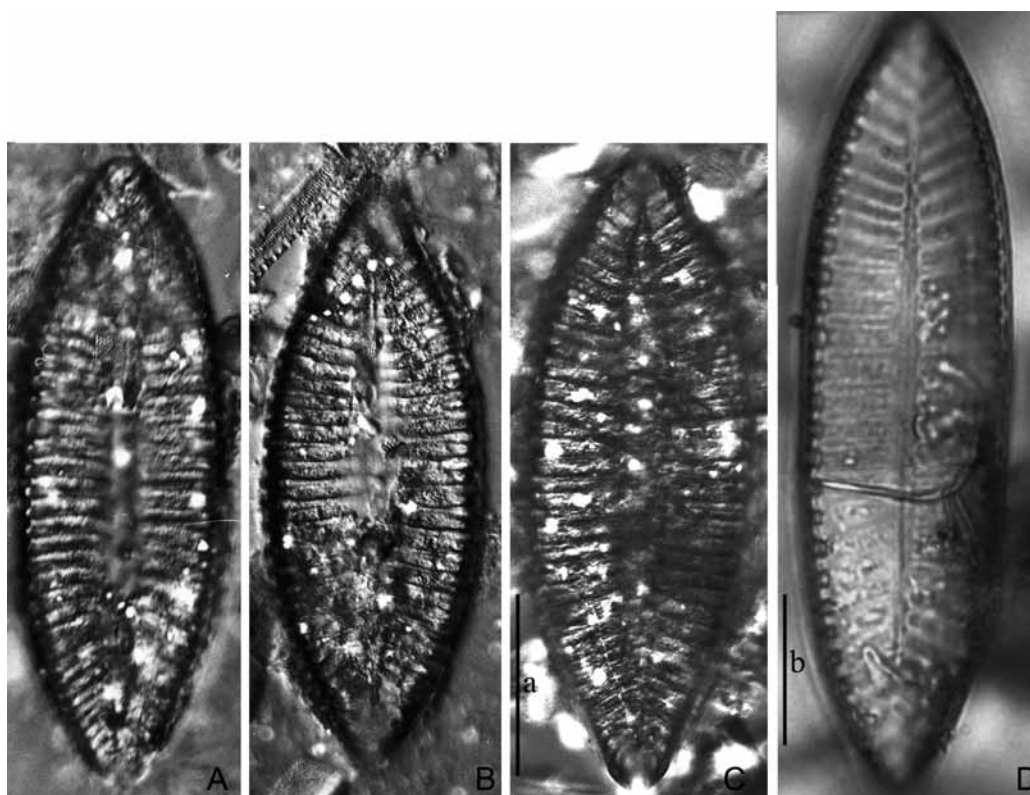


Figure 7. A-C, *Surirella kusberi* Cocquyt & R. Jahn, material from the River Olunga (sample 2.0058): C, epitype of *Surirella kusberi*, slide B. 400 040235; D, *Surirella bifrons* Ehrenb., BHUPM, Ehrenberg Collection 547806-3. Scale bar a = 50 μ m: A-C; scale bar b = 20 μ m: D.

Habitat. Planktonic.

Distribution. Beside the localities given by Müller (1903), Lakes Malombe and Rukwa, this taxon has been reported from Lake Malawi (West 1907, Van Meel 1954) and Lake Victoria (Wołoszyńska 1914, Van Meel 1954) and for Tanzania (River Olunga according to the label on the studied sample).

Comment. The epithet is given in honour of Wolf-Henning Kusber for his untiring help with nomenclature. The renaming with specific status was necessary because of *Surirella intermedia* Rabenh., Alg. Sachs. Dec. 65/66. no. 642. 1857 (Rabenhorst 1848-1860).

Surirella bifrons (Ehrenb.) Ehrenb., Abh. K. Akad. Wiss. Berlin, Physik. Kl. 1841, p. 388 (1843). – *Lectotype*: BHUPM, Ehrenberg Collection 547806-3, here illustrated as fig. 7D. *Type locality*: 10. Mai 1832, bei Berlin zwischen Conferven [Berlin, Germany, between filamentous green algae].

Basionym: *Navicula bifrons* Ehrenb., Abh. K. Akad. Wiss. Berlin, Physik. Kl. 1833: 259 (1834).

Morphologic description

Valves isopolar, length 102 µm, width 27 µm, with cuneately rounded poles and parallel to slightly constricted margins midvalve. Alar canals 2.6 in 10 µm, becoming denser near the poles. Wing projection distinct. Transapical valve undulations parallel in the middle of the valve, becoming radiate near the poles, almost reaching the axial area (= pseudoraphe), delimiting a small linear hyaline area; top of the undulations always broader than the depressions. Small spines probably present in the axial area.

This taxon was also observed in samples from the African Great Lakes area (Cocquyt 1998, p. 130 pl. 56 fig. 1).

Comment. In Ehrenberg (1834) *Navicula bifrons* was classified within the subgenus *Surirella*, established by Ehrenberg (1838). *Surirella* as a genus was accepted by Ehrenberg (1843).

Discussion

Müller (1903: 27) noted that his *Surirella bifrons* var. *intermedia* (\equiv *S. kusberi*) is very close to the typical forms of *Surirella biseriata*. However, during our study of Müller's material from East Africa it was more difficult to distinguish *S. kusberi* from *S. friedelhinziae* (\equiv *S. fuellebornii* var. *elliptica*). The descriptions given by Müller (1903) for both taxa are very similar; they have about the same length (130-176 and 174-180 µm respectively) and width (57-66 µm and 60-63 µm respectively); only the width-to-length ratio with 2.9 is somewhat higher for *S. friedelhinziae*. The number of alar canals (costae), 1.5-1.8 in 10 µm for *S. kusberi*, is close to the number given by Müller (1903) for *S. friedelhinziae* (1.8) according to our personal findings, but our observations on the latter taxon indicated a greater number of alar canals, 1.7-2.2 in 10 µm (table 1).

The valve of *S. kusberi* is lanceolate with only slightly curved margins in the mid-region whilst the valve shape of *S. friedelhinziae* is more elliptic. Müller found *S. friedelhinziae* in samples 2.0032 and 2.0036 where he did not report *S. kusberi*. According to Müller, both taxa must be present in sample 2.0058, but we only observed valves of *S. kusberi*.

Hustedt (in Huber-Pestalozzi 1942) did not mention *S. bifrons* var. *intermedia* (\equiv *S. kusberi*) in his description of *S. biseriata* var. *bifrons* (Ehrenb.) Hust. (\equiv *S. bifrons*) although most of the other African *Surirella* taxa are included in this work (except *S. ovalis* var. *apiculata* O.Müll. and its f. *minor* O.Müll., see also Cocquyt & Jahn 2007c). We do not agree with VanLandingham (1978: 3805) who synonymizes *S. bifrons* var. *intermedia* (\equiv *S. kusberi*) with *S. biseriata* var. *bifrons* (\equiv *S. bifrons*). Our study of Ehrenberg's type of *S. bifrons* (fig. 2D) revealed differences in valve shape, axial area, number of alar canals in 10 µm and wing projection. The axial area in *S. kusberi* and *S. bifrons* is elliptical and linear respectively. Because of these differentiating characters, we are convinced that Müller's African *S. bifrons* var. *intermedia* is not a variety of the European *S. bifrons* but must be considered as an independent species.

Observations on *S. fuellebornii* material from Lake Tanganyika (Cocquyt 1998) indicate that its f. *subconstricta* and var. *constricta* are within the range of variation of the species and support the abandonment of taxonomic recognition of these infraspecific taxa. This is in agreement with earlier findings, e.g. for *S. engleri* O.Müll. (Cocquyt & Jahn 2007b). Within the spectrum of *S. fuellebornii* a slight constriction of the valve margins seem to be more frequent in smaller valves. No difference was observed between valves sampled in different lakes: the dimensions of *S. fuellebornii* in

Table 1. Morphometric data for *Surirella kusberi*, *S. fuellebornii*, *S. friedelhinziae*, and *S. crawfordii* from Central and East African material.

Based on literature data and personal observations.
 For constricted valves, the greatest width is given in brackets.
 The data of the lectotype of *S. bifrons* Ehrenberg is also given.
 *personal measurements

Taxon	Reference	Length µm	Width µm	Alar canals in 10 µm	Length-to- width ratio
<i>S. kusberi</i> (= <i>S. bifrons</i> var. <i>intermedia</i>)	Müller 1903 Own observation	130-176 158.5-173	66 57-64	5 1.5 1.5-1.8	2-2.7 2.6-2.8
<i>S. fuellebornii</i> (nominate only)	Müller 1903 Cocquyt 1998 X2/46,48, this study	320-350 183-357 159.5-277.5	60 57-67 50.2-66	1.5 1.5-2.0 1.6-2.2	3.0-3.5
(<i>S. fuellebornii</i> f. <i>subconstricta</i>)	Müller 1903 Own observation	287-373 282	60-64 61.5	1.7-1.8	4.6
(<i>S. fuellebornii</i> var. <i>constricta</i>)	Müller 1903 X2/46,49, this study X2/49 (Ethiopia), this study	173-353 134.5-254.5 187-215.5	53-65 (60-67) 37.4-62.6(39.8- 64.9) 52.6 (56.5-57.8)	1.8-2 1.5-2.3 1.6-1.8	 3.5-4.1
<i>S. friedelhinziae</i> (= <i>S. fuellebornii</i> var. <i>elliptica</i>)	Müller 1903 X2/50, this study X2/47, this study Cocquyt 1998 X2/48 (Ethiopia), this study	174-180 162 219.5 160-215 158-276	60-63 66.5 52.6 (63.8-64.9) 58-71 50-60.5	1.8 2.0-2.2 2.2 1.7-2.0 1.6-2.0	2.9 2.4 4.2 2.5-2.9 3.1-4.6
<i>S. crawfordii</i> (= <i>S. fuellebornii</i> var. <i>tumida</i>)	Hustedt 1942 X2/51, this study Cocquyt 1998	150 (265)* 228.5 170	67 (118)* 108 88	(1.8)* 1.8-2.0 2.0-2.2	 1.9
<i>S. bifrons</i>	Type Ehrenberg Cocquyt 1998	102 178	27 62	2.6 1.8-2.0	3.8 2.9

material from Lake Tanganyika fall within the range given by O. Müller for Lake Malombe (table 1).

Another habitus linked to the name *S. fuellebornii* is var. *worthingtonii*, named and depicted by Bachmann (1933, fig. 7-8). However, this name was not validly published because a diagnosis is lacking. Moreover this taxon is not related to *S. fuellebornii* but falls within the range of variation of *Surirella malombae* O. Müll. The variability for this taxon and for *S. nyassae* O. Müll. is discussed and illustrated in Cocquyt & Jahn (2007a). Interestingly, Bachmann (1933) himself, in the legend of his plate, noted that these valves are intermediate forms between *S. nyassae* and *S. malombae*; nevertheless he named it a variety of *S. fuellebornii*. Hustedt (1942), on the other hand, accepted the variety and mentioned that it differs from the var. *constricta* in the more constricted valves and the somewhat more acute poles.

As observed for other *Surirella* species (e.g. *Surirella engleri*, Cocquyt & Jahn 2007b), we believe that in Müller's taxon concept his formae are only illustrating the extremes of the variability within a taxon, not necessarily signifying a genetically different taxon (see also Jahn 2002). Hence we treat the forma *subconstricta* as a taxonomic synonym of *S. fuellebornii*. Following our previous observation on more or less deep constriction of the valve margins (Cocquyt & Jahn 2007b) we also consider the variety *constricta* as a synonym of the nominate variety *S. fuellebornii*

var. *fuellebornii*. On the other hand, our observations showed that an elliptic valve outline does not fall within the valve variability in the genus *Surirella*, but is a stable character in contrast to constricted valve margins. This is in agreement with earlier findings (Cocquyt & Jahn 2005, 2007b, c) that Müller's African taxa, with names of varieties often attached to European species names, can be considered independent species according to our current taxonomic concept. Therefore *Surirella fuellebornii* var. *elliptica* is here raised to species level: *S. friedelhinziae*. However, the valve of *S. fuellebornii* var. *elliptica* depicted by Hustedt (1942, fig. 595 A), and originating from Lake Tanganyika, does not belong to this taxon. As in the case of *Surirella malombae* and *S. chepurnovii* (Cocquyt & Jahn 2007 a), the Lake Tanganyika and Lakes Malawi and Malombe specimens belong to different, well delimited species, probably evolved from a common ancestor. The Tanganyika specimens are more closely related to *S. crawfordii* (\equiv *S. fuellebornii* var. *tumida*), a species endemic to Lake Tanganyika. *S. crawfordii* differs from *S. friedelhinziae* in the very broad elliptic valve shape and the presence of an axial area. The axial area is always lanceolate but has a variable width ranging from rather narrow (fig. 6A-B) to rather broad (fig. 5A, the type). The presence of a line in the axial area, as depicted by Hustedt (1942, fig 595 A), depends on the way the valve is brought into focus.

Conclusions

Re-investigation of the historic material of Central and East Africa from O.Müller (B) and F.Hustedt (BRM) in combination with recent material from the African Great Lakes area (BR) allowed us to redefine the taxonomic entities related to *Surirella fuellebornii*: its two infraspecific taxa, *subconstricta* and *constricta*, are synonymized, but its var. *elliptica* is raised to species rank: *Surirella friedelhinziae*, as is its var. *tumida*: *Surirella crawfordii*. Its var. *worthingtonii* is not a separate taxon but falls within the range of variation of *Surirella malombae*. Finally, in typifying Ehrenberg's European *Surirella bifrons*, Müller's *Surirella bifrons* var. *intermedia* is raised to species rank: *Surirella kusberi*.

Regarding the geographic distribution of these planktonic African diatoms, *Surirella crawfordii* is endemic to Lake Tanganyika where it is only rarely observed. *Surirella kusberi* has a distribution area restricted to the East African Great Lakes area, as has *Surirella friedelhinziae* with the difference that this taxon has also been reported from Ethiopia. In contrast, *Surirella fuellebornii* is a more common taxon and has been reported from the African continent south of the Sahara.

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