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Taxa related to *Surirella ovalis* from Tanzania, East Africa: Typification of O. Müller's taxa and description of a new species

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Abstract – Four diatom taxa from East Africa, *Surirella ovalis* var. *apiculata*, *S. ovalis* var. *apiculata* f. *minor*, *S. fasciculata* and *S. olungensis* are discussed. The species were observed in material sampled by Fülleborn at the beginning of the 20th century and formerly studied and named – except the last – by O. Müller. The first two taxa were described from a sample of a hot spring near Utengule (Tanzania) and from Lake Rukwa respectively. *Surirella fasciculata*, related to the previous ones, was described from Lake Ngozi (Tanzania). Besides translations of the original descriptions, lectotypes and/or epitypes were designated and their distribution given based on literature. A new taxon, also related to *Surirella ovalis*, was observed in a sample from the Olunga river (Tanzania) and is here described as a new species: *Surirella olungensis*. Besides this new taxon, some aberrant forms were observed in the same historical sample.

Diatoms / *Surirella ovalis* var. *apiculata* / *Surirella fasciculata* / *Surirella olungensis* / Taxonomy / Typification / East Africa / River Olunga / Tanzania

Résumé – **Taxons affines de *Surirella ovalis* récoltés en Tanzanie, Afrique de l'Est : Typification des taxons d'O. Müller et description d'une nouvelle espèce** – Quatre diatomées de l'Afrique de l'Est, *Surirella ovalis* var. *apiculata*, *S. ovalis* var. *apiculata* f. *minor*, *S. fasciculata* et *S. olungensis* sont étudiées. Ces espèces ont été observées dans du matériel récolté par Fülleborn au début du 20e siècle. Ces échantillons ont été étudiés antérieurement par O. Müller et les taxons ont été nommés par lui – à l'exception du dernier taxon. Les deux premiers taxons ont été décrits par O. Müller à partir respectivement d'un échantillon d'une source thermale dans les environs de Utengule (Tanzanie) et du Lake Rukwa. *Surirella fasciculata*, une espèce apparentée, a été décrite du lac Ngozi (Tanzanie). Outre la traduction des descriptions originales, des lectotypes et/ou des épitypes ont été désignés et leur distribution actuelle, basée sur la littérature, est donnée. Un nouveau taxon, apparenté également aux taxons précédents, a été observé dans un échantillon de la rivière Olunga (Tanzanie) et est décrit ici comme nouvelle espèce : *Surirella olungensis*. A part de ce nouveau taxon, des formes aberrantes ont été observées dans le même matériel historique.

Diatomées / *Surirella ovalis* var. *apiculata* / *Surirella fasciculata* / *Surirella olungensis* / Taxonomie / Typification / Afrique de l'Est / Rivière Olunga / Tanzanie

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INTRODUCTION

Diatoms belonging to the genus *Surirella* are a typical component of the East African Great Rift Lakes flora (Ross, 1983; Cocquyt & Jahn, 2007a; 2007b). They are not only reported from the large lakes Malawi, Tanganyika and Victoria, but also from smaller water bodies. At the beginning of the 20th century several new *Surirella* taxa were described by Müller (1903; 1904) from these habitats; e.g. from Lake Rukwa, from a hot spring and from a common watercourse near Utengule. Since many of the earlier described taxa from Central East Africa had been put into synonymy by later researchers, a re-evaluation of these taxa is necessary in order to be able to study species distribution, endemism and speciation as well as changes in the diatom flora of East Africa (i.e. Cocquyt *et al.*, 1993; Cocquyt, 1998).

This present paper deals with four taxa from these small water bodies in East Africa: one described by Müller as a new species, *S. fasiculata*, two classified by him as a variety and a forma of *Surirella ovalis* Brébission (Müller, 1904a; 1904b), and one described here for the first time as *S. olungensis*. The samples studied belong to the historical collections of algae material at the Botanical Museum Berlin-Dahlem (Jahn, 1996), collected by Dr. Fülleborn during the German "Nyassa-See- und Kinga-Gebirgs-Expedition", and from which Müller described over 100 new East African diatom taxa, (Müller, 1903; 1904; 1905; 1910; Jahn, 2002). To make his taxa available to modern research we have translated his German descriptions, lectotypified each taxon, included modern LM-photographs and, where possible, SEM photographs, made necessary nomenclatural changes and presented their current known distributions (Cocquyt & Jahn, 2005; 2007a; 2007b).

In addition to this publication, nomenclatural information will be made available via the AlgaTerra Information System (Jahn & Kusber, 2006).

MATERIAL AND METHODS

Material belonging to the original samples Fülleborn collected in 1899 was oxidized with Hydrogen peroxide (H_2O_2) and embedded in Naphrax to obtain new microscopic slides. Modern samples numbers were given to the historical material in the collection at the Botanical Museum Berlin-Dahlem (B). The information on the old sample labels is in accord with the list of collectors, collecting localities, and details published by Müller (1903), except for sample Nr. 58 as explained below.

B 2.0045 [Müller's Nr. 45]: Sample from Lake Ngozi [or Lake Wentzel], a brackish water lake in the crater of the Ngozi mountains on the northern edge of Kondeland, at 2000 m asl, taken from surface plankton on 21 October 1899.

B 2.0052 [Müller's Nr. 52]: Sample taken in a basin near the hot spring of Utengule, located on the Beya mountain (Tanzania), with a temperature of 48°C and apparently with few $CaC0_3$ in the water; sampled on 10 June 1899.

B 2.0053 [Müller's Nr. 53]: Sample from a common watercourse near the hot spring of Utengule, sampled on 11 June 1899.

[Müller's Nr. 58]: "the origin of this sample is problematic; it came from Ussangu, north of the mountain Kinga, the river Olunga or from Lake Rukwa" Müller writes (1903). On the other hand, he (Müller, 1905) mentioned Lake Rukwa as locality for sample Nr. 58.

B 2.0058: Sample from the river Olunga (as indicated on the rediscovered bottle label).

Investigations were done at both B and at Ghent University, Department of Biology (Belgium), with a Zeiss and a Leitz Diaplan microscope, respectively. Micrographs were taken with normal light or with Nomarski differential interference contrast (DIC) at a magnification of 630x (oil immersion) and 1000x. Scanning electron microscopy was done at the Botanical Museum Berlin-Dahlem (Germany) using a Philips 515 operating at 30 KV.

RESULTS

***Surirella ovalis* var. *apiculata* O. Müller 1903: 36, pl. 2, fig. 10** **Figs 1-2**

Surirella ovalis [var. apiculata] f. *minor* O. Müller 1903: 36, pl. 2, fig. 11.

Translated from the German, Müller's description reads:

"Valves broadly ovoid, head and terminal pole shortly protracted, truncate terminal pole more acute. Costae reaching from the margins to the pseudoraphe forming long alae, 3-3.5 in 10 µm. The striae between the costae do not entirely integrate at the margin. Valve face margins parallel with one undulation; undulation enclosing an oval area. Pseudoraphe straight, very narrow. Length 92 µm, width 53 µm. Close to var. *maxima* Grunow but differs in the protracted pole and the different form of costae. – Lives in a basin near the hot spring at Utengule (52) [Tanzania]."

Lectotypus (designated here): [icon] Müller 1903: pl. 2, fig. 10; reproduced as Fig. 1.

Locus typicus: basin near the hot spring at Utengule, Tanzania.

Habitat: benthic.

In all the available historical material at B studied by Müller, no valves conforming to the description or resembling the drawing of *Surirella ovalis* var. *apiculata* have been observed.

Distribution: Besides Müller's observations, this taxon has been reported from Angola (Woodhead & Tweed, 1960), Congo (Zanon, 1938), Ivory Coast (Zanon, 1941; Woodhead & Tweed, 1958), Tanzania (Zanon, 1938; Van Meel, 1954) and Upper Volta (Woodhead & Tweed, 1960). However, neither Zanon (1938; 1941) nor Woodhead & Tweed (1958; 1960) provided any drawings or information on the valve features.

Although we are treating *Surirella ovalis* [var. *apiculata*] f. *minor* O. Müller as a synonym, we typify it here for any future studies. Translated from the German, Müller's description reads:

"Like *Surirella ovalis* var. *apiculata*, but wider, terminal pole somewhat more acute. Length 55 µm, width 38 µm. – Lives in Lake Rukwa (58)."

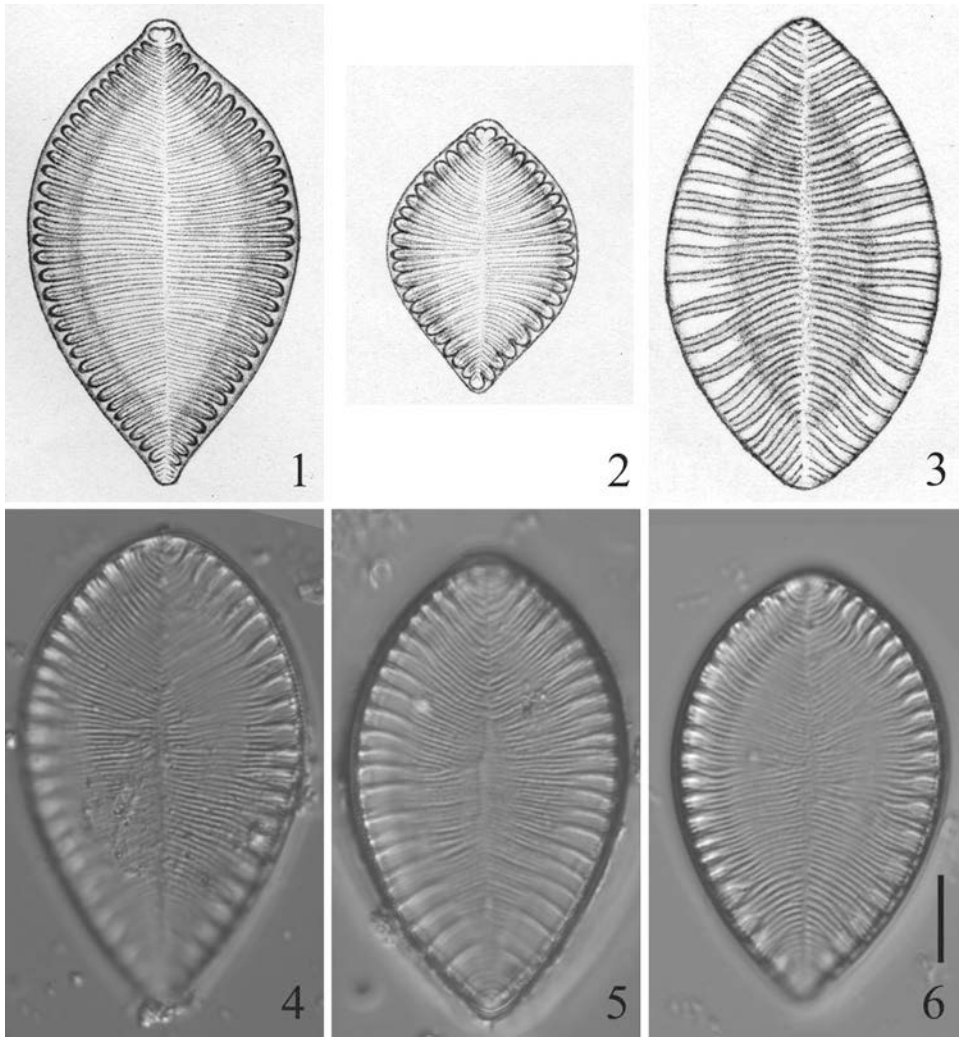
Lectotypus (designated here): [icon] Müller 1903: pl. 2, fig. 11; here reproduced as Fig. 2.

Locus typicus: Lake Rukwa.

Habitat: benthic.

In all the available historical material at B studied by Müller – not just from Lake Rukwa – no valves conforming to the description or resembling the drawing of *Surirella ovalis* [var. *apiculata*] f. *minor* have been observed.

Distribution: Besides Müller (1903) type locality, this taxon has been reported from Congo (Zanon, 1938; Woodhead & Tweed, 1958) and a hot spring (68°C) in Tanzania (Zanon, 1938). However, as is the case for *S. ovalis* var. *apiculata*, neither



Figs 1-6. **1.** *Surirella ovalis* var. *apiculata* O. Müller, lectotype [Müller's published drawing (1903, pl. 2, fig. 10)]. **2.** *Surirella ovalis* var. *apiculata* f. *minor* O. Müller, lectotype [Müller's published drawing (1903, pl. 2, fig. 11)]. Figs 3-6. *Surirella fasciculata* O. Müller. **3.** Müller's published drawing, lectotype (1903, pl. 1, fig. 14). **5.** Epitype (slide B 400 040 234). **4, 6.** Valves of sample B. 2.0052, basin near the hot spring of Utengule. Scale bars = 10 µm.

drawings nor any other information on valve features is given by Zanon (1938) or Woodhead & Tweed (1958; 1960).

***Surirella fasciculata* O. Müller 1903: 36, pl. 1, fig. 14** **Figs 3-6**

Translated from the German, Müller's description reads (1903: 36-37): "Valves ovoid, apical pole round, faintly protracted, terminal pole somewhat more acute. Costae constructed of bundles composed of 2-3 striae, from the margins to

the pseudoraphe; becoming divergent near the poles. 10 striae in 10 µm, those in between the costae do not reach the margin. Valve face parallel near the margins, with one undulation, enclosing an oval area. Pseudoraphe narrow, faintly truncate. Length 66 µm, width 38 µm. - Lives in the plankton of Lake Ngozi (45)."
Lectotypus: (designated here): [icon] Müller 1903: pl. 1, fig. 14; here reproduced as Fig. 3.
Locus Typicus: Lake Nogzi, a brackish water lake in the crater of the mountain Ngozi on the northern edge of Kondeland, at 2000 m asl, Tanzania.
Epitypus (designated here): slide B 400 040 234 (the valve representing the epitype is here illustrated as Fig. 4). Sample Nr. 2.0052.
Locus epitypicus: basin near the hot spring of Utengule, Beya Mountain (Tanzania).

No valves corresponding to Müller's description of *S. fasciculata* were observed in the sample from Lake Ngozi (2.0045). Therefore, a valve observed in another sample of O. Müller's material (2.0052) was chosen as epitype. The number of striae (10 in 10 µm), grouped in bundles of 2-3, fit Müller's description. However, the length of 52.5 µm and width of 32 µm, as well as the width-to-length ratio of 1.6, are somewhat lower than his description (1.7 calculated from the dimensions given by Müller, 1903).

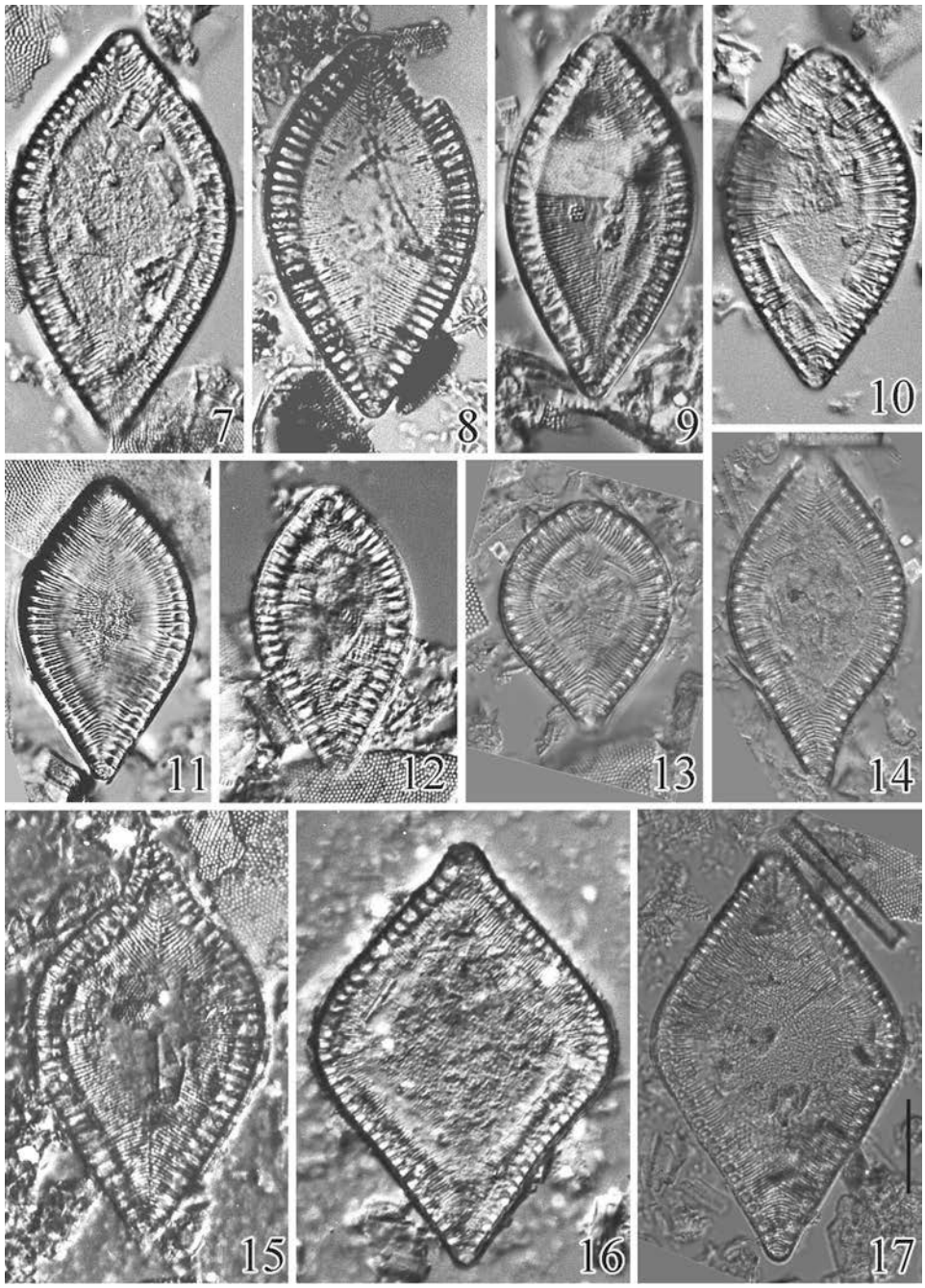
In material from Lake Tanganyika this taxon has a range of 76-100 µm length and 38-55 width (Cocquyt, 1998).

Additional description (Figs 4-6): The valve face is almost flat, only a small undulation is present near and parallel to the valve margin. The axial area (pseudoraphe) is only well defined near the poles; in the centre of the valve an axial area is absent and the striation becomes irregular or is replaced in the centre by irregularly placed puncta.
Distribution: Besides Müller's locality, this taxon was reported from Congo (Zaire) (Hustedt, 1942; 1949; Woodhead & Tweed, 1958), Uganda (Hustedt, 1949), Lake Albert (Idi Amin) (Hustedt, 1949), Lake Edward (Van Meel, 1954; Ross, 1983), Lake Kivu (Hustedt, 1949; Van Meel, 1954) and Lake Tanganyika (Cocquyt, 1998).

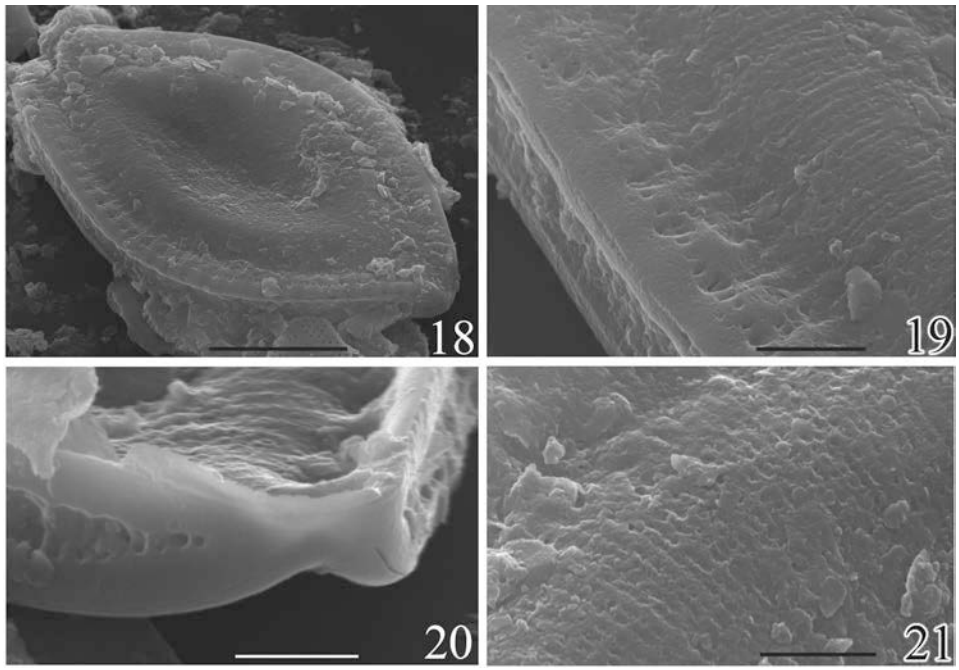
Specimens belonging to a taxon related to *S. ovalis* were found in a sample of the River Olunga, collected by Fülleborn during the same mission to East Africa. This taxon is described here as a new species:

***Surirella olungensis* Cocquyt *et* R. Jahn, sp. nov. Figs 7-12, 18-21**

Valvae ovatae latae, heteropolares; polo ad capitulum pedemque protracto turbinatoque, polo ad pedem acutiore. Area concentrica undulata parallela ad circumscriptionem valvae, includens aream ovalam. Costae ad marginem valvae initia area centralis attingentes, alas longas formantes, (3) 3.5 – 4.5 in 10 µm. Striae inter costas marginem non attingentes. Area centralis, si visibilis, recta angustissimaque. Valvae 53–92 µm longae, 53 µm latae, ratio longitudinis ad latitudinem 1.6 – 2.3.
Holotypus: preparatio B 400 040 232 (the valve representing the holotype is here illustrated as Fig. 7).
Isotypus: slide BR 4101, deposited at the National Botanic Garden of Belgium, Meise.
Locus typicus: Olunga River (Ohmga) in Ussangu northern Mount Kinga, Tanzania. (Sample B 2.0058).
Habitat: benthic.



Figs 7-17. *Surirella* valves from the Olunga river (sample 2.0058). **7-12.** *S. olungensis* Cocquyt et R. Jahn. LM. **7.** Holotype (slide B 400 040 232). **13-17.** Aberrant valves (voucher slide B 400 040 233). Scale bar = 10 µm.



Figs 18-21. *Surirella olungensis* Cocquyt *et* R.Jahn, SEM. **18.** External valve view. **19.** Detail of the raphe on the valve face – valve mantle junction. **20.** Detail of the terminal raphe fissures, bent towards the mantle. **21.** Detail of the valve face. Scale bars: fig. 18 = 20 µm, fig. 19 = 4 µm, figs 20-21: 3 µm.

Valves broad ovate, heteropolar; head pole and terminal pole protracted and truncate, terminal pole more acute. A concentric undulation runs parallel to the valve outline, enclosing an oval area. Costae starting at the valve margins reaching up to the axial area, forming transapical valve undulations, (3) 3.5 – 4.5 in 10 µm. Striae between costae not integrated in the margin. Axial area, if visible, is straight and very narrow. Valve length: 53 – 92 µm; width: 53 µm; length-to-wide ratio: 1.6 – 2.3.

Valve face with a central concentric depression, without a saddle as present in *S. brebissonii* (Krammer & Lange-Bertalot, 1987) (Fig. 18). Raphe canals present on both sides of the valve on the junction of the valve face and the valve mantle (Fig. 19). Apical raphe fissures not enlarged and bent to the mantle side (Fig. 20). No striae or areolae were observed on the external valve face. Many strong siliceous bars regularly connect two adjacent costae, giving the valve face a reticulate appearance (Fig. 21). No internal valve view or girdle bands could be observed. See also Table 1.

Aberrant valves were observed during investigations of the historical material (slide B 400 040 233, Figs 13-17). Some valves have a strongly protracted base pole (Fig. 14) or a strongly protracted head pole (Fig. 15) while others have a protracted base pole and rounded head pole (Fig. 13). Also valves with a typical rhombic shape were observed in the same material (Figs 16-17). As these rhombic valves (Figs 16-17) were only observed twice during the investigation of this historical material from East Africa, we are not able to say if they represent a new

Table 1. LM features of *Surirella olungensis*, *S. ovalis* var. *apiculata*, *S. ovalis* var. *apiculata* f. *minor, S. ovalis* and *S. fasciculata* from own observations on the historical material and from literature data.

	Length (µm)	*Width (µm)*	*Costae in 10 µm*	*Length-to-width ratio*
S. olungensis				
Sample 2.0058	53-92	53	3.5-4.5	1.6-2.3
S. ovalis* var. *apiculata				
Müller (1903)	92	53	3-3.5	1.7
S. ovalis* var. *apiculata* f. *minor				
Müller (1903)	55	38		1.4
S. ovalis				
Krammer & Lange-Bertalot (1997)	16-120	12-45	3.5-6	
Ruck & Kociolek (2004)	27-81	18-39	4-6	
Sample 2.0053	40-53	25-33.5	4-5	
S. fasciculata				
Sample 2.0053	49.2-52.5	32-33.8	4-4.5	1.5-1.6
Müller (1903)	66	38		1.7
Cocquyt (1998)	76-100	38-55	2.5	

taxon. Instead, we believe that these are initial cells produced after auxosporulation, since the valves are larger or above the maximum length compared with the discussed taxa. In order to call attention to these "aberrant" valves, we give here a short description: Valves heteropolar, 88.5-91.5 µm long, 54.9-64.5 µm wide, rhombic; length-to-wide ration: 4.2-4.5. Subacute head and base pole; head pole somewhat more protracted. Valves slightly undulated near the valve margin. 4.2-4.5 costae in 10 µm; 13-14 striae in 10 µm, 3 striae always end just before the costae.

DISCUSSION

VanLandingham (1978: 3851) synonymized *Surirella ovalis* var. *apiculata* and its forma *minor* with *S. ovalis* Brébisson. However, as we have shown earlier (Cocquyt & Jahn, 2005; 2007a, 2007b), we are convinced that Müller's African taxa, with names of varieties attached to European species, can often be considered independent species in our current taxonomic concept. Therefore, we similarly suggest that *S. ovalis* var. *apiculata* should not be synonymized with *S. ovalis* but is most likely independent from it. Unfortunately, we were unable to find any relevant specimens to support this viewpoint. With respect to Müller's f. *minor*, it seems reasonable to believe it a synonym of *S. ovalis* var. *apiculata* as it is probably the valves resulting from size diminution, as has been shown for *S. ovalis*, where the apical pole becomes less protracted than typical in the larger forms (Ruck & Kociolek, 2004).

The other valves observed in the historical material related to *Surirella ovalis* and here described as *Surirella olungensis* differ from *S. ovalis* in the protracted apical and base pole – but not as protracted Müller's *S. ovalis* var. *apiculata*. Moreover, the axial area, which is, if visible, straight and very narrow in *S. olungensis*, is always well delimited and somewhat broader in *S. ovalis* (see Lange-Bertalot & Krammer, 1987: pl. 53, figs 1-4). The pseudoinfundibulae reach and always fuse with the external edge of the raphe canal, never connecting at a lower point on the raphe, as has been described for *S. ovalis* (Ruck & Kociolek, 2004). The apical raphe fissures are bent towards the mantle side while in *S. ovalis* they are straight (Ruck & Kociolek, 2004).

In contrast to the above taxa, VanLandingham (1978) did not place *Surirella fasciculata* into synonymy with *S. ovalis.* O. Müller (1899) explained that his *S. fasciculata* differs from *S. ovalis* in the costae, which are composed of bundles reaching the margin, and in the striae which are also larger and located further from each other than in *S. ovalis*. Krammer & Lange-Bertalot (1988) mentioned that *S. fasciculata* from Central Africa resembles *S. ovalis*, not only in valve outline but in almost all other morphological details. Our investigation, however, has demonstrated difference in the striation: the striation is much coarser in *S. fasciculata* (10-12 striae in 10 µm) than in *S. ovalis* ((16)17-19 in 10 µm). Therefore we are convinced that S. *fasciculata* is a different taxon than *S. ovalis.*

Surirella fasciculata is a rare African species. In the historical material Müller studied, it was only observed sporadically. In Lake Tanganyika it was rarely observed and only reported once in six samples: in 5 different samples taken near Bujumbura (Burundi) and in one sample from Gatororongo (28 km south of Bujumbura, Burundi) (Cocquyt, 1998). Concerning the occurrence of the other taxa, Hustedt (in Huber-Pestalozzi, 1942) mentioned neither Müller's *S. ovalis* var. *apiculata*, its f. *minor*, nor *S. ovalis* Brébission. This is somewhat odd, since Hustedt (in Huber-Pestalozzi, 1942) is a valuable compendium of endemic tropical *Surirella* taxa from Africa, the Indo-Malaysian Archipelago and Hawaii, listing each taxon with description and distribution together with a key to the species. The restricted distribution of these taxa to smaller water bodies of East Africa cannot be an explanation for their omission, since *S. fasciculata* is included in Hustedt in Huber-Pestalozzi (1942), itself described from the small Lake Ngozi.

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