Observations on and epitypification of *Synedra austriaca* Grunow (*Fragilariaceae*, *Bacillariophyta*)

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Fragilaria taxa, previously often described within the genus *Synedra*, form an important part of the phytobenthos and phytoplankton communities of our freshwater ecosystems (Kahlert *et al.* 2019), both in number of specimens and in species diversity. In the nineteenth and early twentieth century, a plethora of species, varieties and forms were described, sometimes based on a single specimen and often on a single illustration. Kützing (1844) and Grunow (in Van Heurck 1880, 1881, 1882, 1883, 1885) together described more than 25 taxa, some of which, but not all, are treated as *Fragilaria* species that we encounter regularly in our rivers and lakes today. Their identification, however, is often unclear and obscure due to an incomplete knowledge of the original type material. In recent years there has been an increased effort to examine original materials resulting regularly in the description or recombination of taxa (e.g., Tuji & Williams 2008, Delgado *et al.* 2015, Wetzel & Ector 2015). However, a large number of former *Synedra* taxa still await such revision, usually due to a complete lack or current uncertainty about the whereabouts of the necessary type material. One such taxon, *Synedra austriaca* Grunow (in Van Heurck 1881: pl. XXXIX [39], fig. 16 A, B, as "S. (amphicephala var. ?) austriaca") was described by Grunow based on sample 128 in the Grunow collection at Naturhistorisches Museum Wien (**W**) from a ditch near Fahrafeld, Berndorf , Austria [not "Fahrfeld" as incorrectly indicated by Krammer & Lange-Bertalot (2000)]. Some brief dimension and stria details are given the plate description, but a description is lacking as the taxon was based on only two drawings (reproduced here as Fig. 1). Hustedt (1930: 156, fig. 174) treated the taxon as a variety of *S. amphicephala* Kützing (Kützing1844: 64), separating both taxa based on the more lanceolate, broader valve outline of the var. *austriaca* and the slightly higher stria density of the latter. Hustedt (1932: 206, fig. 696 b–d) added *Fragilaria gracillima* Ant.Mayer (Mayer 1919: 197, pl. 5: figs 79, 80) as a synonym. The Mayer's material cannot at present be located making it impossible to determine a possible conspecificity (Krammer & Lange-Bertalot 1991: 126). The drawings in Mayer (1919) (see Fig. 2) show lanceolate valves with elongated, protracted and distinctly capitate apices, unlike the original drawings of *S. austriaca* Grunow (Van Heurck (1881: pl. XXXIX [39]: fig. 16 A, B). Lange-Bertalot (1980: 748) initially treated this taxon as a variety of *F. capucina* Desmazières, viz, *F. capucina* var. *austriaca* (Grunow) Lange-Bertalot. Krammer & Lange-Bertalot (1991: 126) subsequently lectotypified the taxon, designating sample Grunow 128 as the lectotype. In Krammer & Lange-Bertalot (1991: pl. 109: fig. 21), a single valve, found in the type slide 128 that showed a considerable similarity to the original Grunow drawings, was identified as *F.* (*capucina* var.?) *austriaca* and was therefore designated as the lectotype. Finally, Lange-Bertalot (in Krammer & Lange-Bertalot 2000: 581) raised the taxon to species rank as *F. austriaca* (Grunow) Lange-Bertalot.

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Material from sample 128 was retrieved from the Grunow collection at W and investigated but unfortunately even after having scanned several newly made slides of the material, *F. austriaca* could not be observed. Grunow's original notes do actually not mention the presence of the taxon in the list of encountered species (among which figure *S. amphicephala* and *S. amphicephala* f. *radians*, an unpublished name). A small note next to the original drawings indicates sample 128 (Fahrafeld, Berndorf, Baden District, Austria) as the origin for the drawings (A. Igersheim, pers. comm.).

In Europe, *Synedra austriaca* Grunow is regularly reported in diatom counts for water quality purposes (Straub, unpubl. res.), especially from streams in mountainous areas such as the Alps. One of the larger populations from the Swiss Alps was selected for further analysis. Some of the smaller valves showed a clear similarity to both the original drawings and the lectotype valve shown by Krammer & Lange-Bertalot (1991: pl. 109: fig. 21). Therefore, material from this population was further analysed to elucidate the ultrastructure of this Grunow taxon in order to establish its correct taxonomic identity.
Here we detail using light and scanning electron microscopy observations specimens from the alpine population. The sample was taken on 13 November 2006 from calcareous stones in the Sionne River (Hauteurs des Mayens d'Arbaz, Canton of Valais, Switzerland, 46.28460 N / 7.37536 E, alt. 1295 m). We here designate the Sionne sample as epitype linked to the lectotype in accordance with ICN Art. 9.8 (Turland *et al.* 2018).

Fragilaria austriaca (Grunow) Lange-Bertalot (in Krammer & Lange-Bertalot 2000: 581) (Figs 1, 3–23)

Basionym: *Synedra* (*amphicephala* var.?) *austriaca* Grunow in Van Heurck, *Synopsis des Diatomées de Belgique Atlas*, pl. XXXIX [39]: fig. 16 A, B, 1881.

Synonyms: *Synedra amphicephala* var. *austriaca* (Grunow) Hustedt (Hustedt 1932: 206), *Fragilaria capucina* var. *austriaca* (Grunow) Lange-Bertalot (Lange-Bertalot 1980: 748)

Lectotype: "Präparat 128 Graben bei Fahrafeld, in der Coll. Grunow", designated and depicted by Krammer & Lange-Bertalot (1991: 126, pl. 109: fig. 21).

Epitype (here designated for the above lectotype of *Synedra austriaca* Grunow): slide BR-4585 (BR, Meise Botanic Garden); sample P1014 (Sionne River, Hauteurs des Mayens d'Arbaz, Canton of Valais, Switzerland, coll. date 13.XI.2006, leg. François Straub); the epitype is here represented by Fig. 12.

Registration: http://phycobank.org/102172

Description: Frustules in girdle view rectangular, always solitary, never forming band-like colonies. Valves narrow, linear-lanceolate with weakly inflated central part, gradually tapering towards the apices. Longer valves very elongated. Apices protracted, clearly capitate throughout the entire cell cycle. Valve dimensions (n=25): length 25–70 µm, width 3.0–3.5 µm. Axial sternum narrow, very slightly widening towards the central area. Central area occasionally absent, often asymmetrical due to shortened striae on one side or the presence of ghost-like striae. Striae parallel throughout the entire valve, always alternating along the entire valve length, 13–14 in 10 µm. Striae composed of 3–5 shallow, rounded areolae, externally covered by individual hymenes. In the central area, striae often asymmetrically lacking. Virgae between striae raised. Striae continuing onto the mantle, interrupted by a continuous series of large spines. Spines resembling shark teeth present on the valve margin at each stria, placed between the virgae. Spines forming a flattened often weakly curved plate with the pointed tip pointing at the apices. Near the central area, spines semilunar in shape, opening towards the outside, encircling an areola. Large siliceous mantle plaques present at the mantle edge. Rimoportula present at one apex, obliquely located on the last stria. Apical porefield composed of up to 6 parallel rows of small poroids, covering the entire apex. Internally, virgae weakly raised. Central area bordered

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by several shortened striae. Rimoportula relatively large, oblique with clearly raised lips. Cingulum composed of several open copulae with serrated edge bearing one row of rounded perforations.

The original drawings do not show the presence of a central area. The lectotype specimen, however, shows an asymmetrical central area (Krammer & Lange-Bertalot 1991: 126, pl. 109: fig. 21). In the epitype population from the Sionne River, valves lacking a central area and valves showing an asymmetrical central area were both frequently observed. Longer valves tend to have a very elongated outline with very long apices. However, careful observation of the entire cell cycle from very short to very long valves showed a clear continuum precluding any possibility of two species being involved. However, as with many such diatoms, the entire cell cycle should be taken into account for a better understanding of the morphology of this species. Observations of other populations in alpine regions (Van de Vijver & Ector, unpubl.) strongly support this. Both Grunow (in Van Heurck 1881) and Lange-Bertalot (in Krammer & Lange-Bertalot 1991) only showed one or two shorter valves of the original population. Nevertheless, several longer valves from different populations were added, for instance in Lange-Bertalot (1980: figs 95, 96) and Krammer & Lange-Bertalot (1991: pl. 109: figs 22, 34) were published as *F.* (*capucina* var.) *austriaca*. Recently, Bey & Ector (2013: 214, 215, figs 1–16) and Peeters & Ector (2017: 176, 177, figs 1–25) presented large populations showing similar valve outlines. *Fragilaria austriaca* is a species that is most often found in oligo- to mesotrophic conditions, usually in calcium-carbonate rich lakes in alpine regions. It can often form conspicuous populations and generally indicates very good water quality (Lange-Bertalot *et al.* 2017: 257, pl. 7: figs 31–34).

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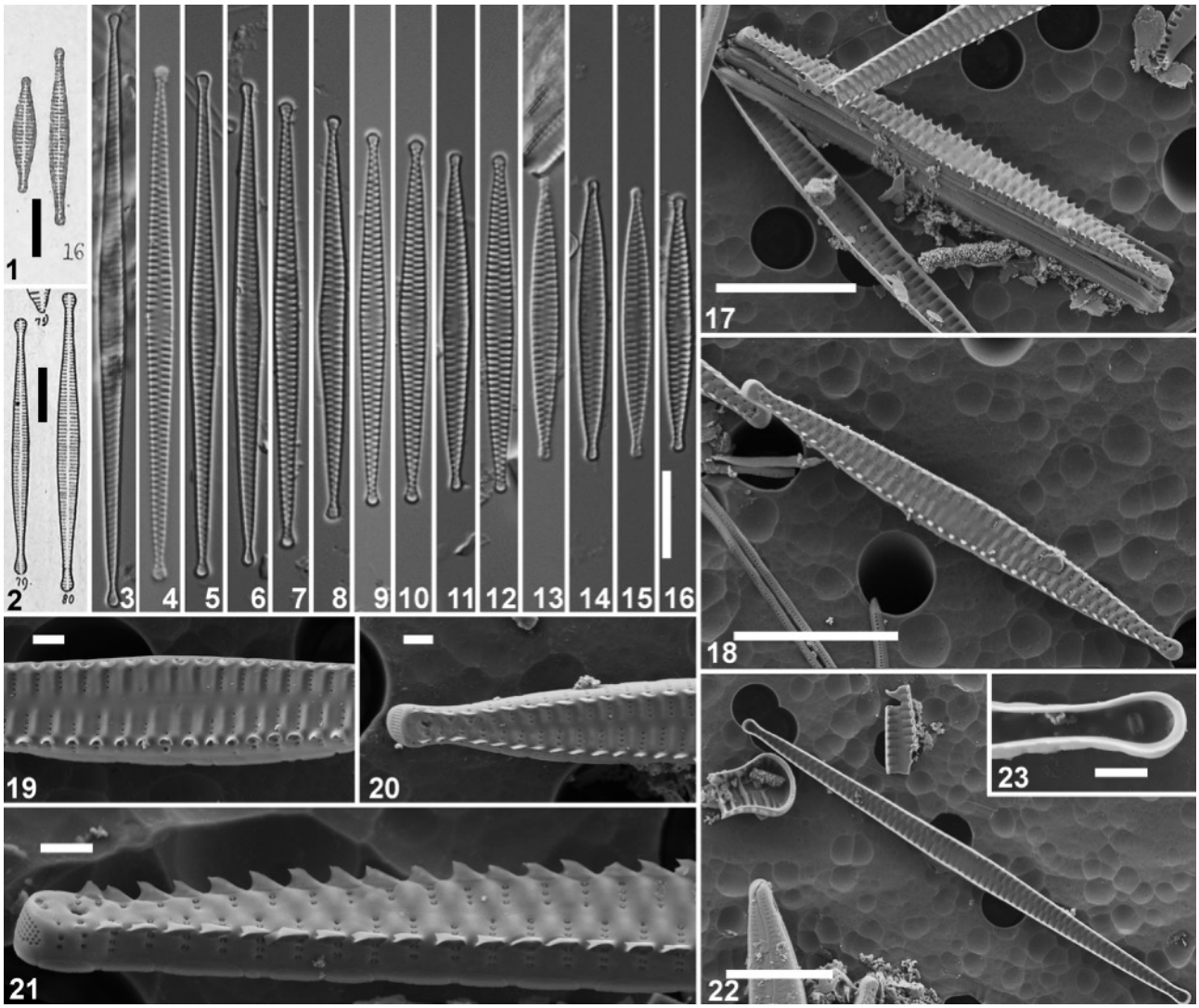

Figs 1-22. Fig. 1. *Synedra austriaca* Grunow. Original drawings from Van Heurck (1881, pl. 39: fig. 16 A, B). Fig. 2. *Fragilaria gracillima* Ant.Mayer. Original drawings from Mayer (1919: figs 79, 80. Figs 3–23. *Fragilaria austriaca* (Grunow) Lange-Bertalot. LM and SEM observations of the epitype population of *F. austriaca* from the Sionne River, Switzerland (sample P1014). Figs 3–16. Several valves showing the entire cell cycle. Note the changes in the valve outline with decreasing valve length. Fig. 17. SEM view of an entire frustule showing the girdle structure. Fig. 18. SEM external view of an entire valve. Fig. 19. SEM external detail of the central area with the half-moon shaped spines. Fig. 20. SEM external detail of the valve apex with the rimoportula and the apical porefield. Fig. 21. SEM external detail of the valve apex and mantle in girdle view. Note the shape of the spines and the silica plaques on the mantle edge. Fig. 22. SEM internal view of an entire valve. Fig. 23. SEM internal detail of the valve apex with the rimoportula. Scale bars represent 10 μm except for Figs 19–21 & 23 where scale bar = 1 μm.

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