Observations on and typification of *Synedra gloiophila* Grunow (*Fragilariaceae, Bacillariophyta*) and its transfer to the genus *Fragilaria* Lyngbye

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Albert Grunow (1826–1914) described a large number of *Synedra* taxa, often based on only one or a few small line drawings. Many taxa first described in the genus *Synedra* have since been transferred to other genera, notably *Fragilaria* and *Ulnaria*. For Grunow's taxa, it often requires an extensive search of his notes and (unpublished) drawings kept at the Naturhistorisches Museum in Vienna, Austria (**W**) to find out which samples he used to describe a taxon, followed by a second search through the hundreds of slides and raw material to find the original slides and, when still available, the original material. In the past, several taxa in *Synedra* were revised this way, which led to a better understanding of many commonly observed taxa in the European diatom flora (e.g., Tuji & Williams 2008, 2013; Delgado *et al.* 2015; Van de Vijver *et al.* 2020).

Unfortunately, a search for missing (type) material is not always successful. Tuji & Williams (2008) attempted to revise *Synedra gloiophila* Grunow (in Van Heurck 1881, pl. 40: fig. 21). The species was described based on Grunow sample 643 from the Titisee (Titi Lake) near Freiburg in southwestern Germany, a sample that was given to him by Alexander C.H. Braun (1805–1877) in 1848 and taken from *Batrachospermum* (see Fig. 5). The coverslip was partly detached, and the authors could not find any valves on the damaged slide (see Fig. 1). As no material was available, they lectotypified the drawing in Van Heurck (1881, plate 40, fig. 21) and stated that based on the "outline of the valve, the density of striae, and the pattern of the central area" the species should be considered a synonym of *Fragilaria pectinalis* (O.F.Müller) Lyngbye. Blanco (2017) considered that the lectotypification was erroneous and that the single drawing in Van Heurck (1881) should be considered as holotype in accordance with ICN Art. 9.1 (Turland *et al.* 2018). However, Hustedt (1932: 194) considered *S. gloiophila* to be a synonym of *Synedra vaucheriae* Kützing. A search in the literature did not reveal any other record of the name *S. gloiophila*, making the original publication the only record for this taxon.

During a revision of the European taxa of the genus *Fragilaria* (formerly described in the genus *Synedra*) involving the Van Heurck collection held at Meise Botanic Garden (**BR**), which in turn includes some of the Kützing collection, a sample of *Synedra parvula* was discovered in the latter. The same sample, Kützing 867 (Titisee, collector: A. Braun), is also present in the collection of the Natural History Museum (**BM**) in London (UK) where a slide (BM 18175) and some unmounted material are kept. The sample was collected from the Titisee (Germany) on August 1847 by Alexander Braun from "*Batrachospermum* (*vogesica?*) *besonders an den alten Stiehlen der Gomphonemaceen die das Batr. überziehen*" [*Batrachospermum* (*vogesica?*) particularly on old stems of *Gomphonemaceae* covering *Batr.*]. There are two other samples from the Titisee in the Kützing collection held in Meise Botanic Garden (**BR**) and the Natural History Museum in London (**BM**) (samples 873 and 875) but they were collected from a *Nuphar*-vegetation and do not mention *Batrachospermum*. Therefor, the latter two samples were not taken into account in this analysis.

The sample contained a lot of diatoms including a fairly large population of an unknown *Fragilaria* (*Synedra*) taxon. *Synedra parvula* Kützing was described twice in 1844, first as a new name for *Frustulia parvula* (Kützing 1833: 551, pl. 1: fig. 20, for *Synedra parvula* see Kützing 1844: 64, pl 14: fig. 1a, b), and second as a marine species from an sample taken near Trieste (Kützing 1844: 67, pl. 15: fig. 9). The drawings, however, are of a different species. Williams & Round (1986) included the Trieste specimens in *Tabularia parva* (Kützing) D.M.Williams & Round, whereas the 1833 specimens might represent a *Nitzschia* rather than a *Fragilaria.* Kützing (1833: 551) noted that the species was freely moving, a feature only known for raphid diatoms.

In the notes Grunow provided for his sample 643 from Titisee, he presented an extensive list of diatoms he recorded in the sample (not all names were decipherable): *Navicula crassinervia*, *Navicula exilis*, *Tabellaria flocculosa* & *fenestrata*, *Gomphonema acuminatum* var. *coronatum*, *Gomphonema auritum*, *Achnanthes exilis* and further undecipherable *Cymbella* and *Melosira* species. Analysis of the Kützing sample 867 showed an identical flora with high numbers of the unknown *Fragilaria* species, *Frustulia crassinervia* (Brébisson ex W.Smith) Lange-Bertalot & Krammer (former *Navicula crassinervia* Brébisson ex W.Smith), *Brachysira neoexilis* Lange-Bertalot (formerly included in *Navicula exilis* Grunow), *Tabellaria flocculosa* (Roth) Kützing and *T. fenestrata* (Lyngbye) Kützing, *Gomphonema auritum* A.Braun ex Kützing, *Gomphonema coronatum* Ehrenberg [formerly *G. acuminatum* var. *coronatum* (Ehrenberg) Rabenhorst], *Achnanthidium* spp. and several *Encyonopsis* species (formerly in the genus *Cymbella*). Scanning the entire slide yielded a few valves of *Melosira varians* C.Agardh. The similarity in taxon composition between the Grunow 643 and Kützing 867 samples, both collected by Alex Braun from the same locality (Titisee) and the same substrate (*Batrachospermum*) indicate that the samples are probably one and the same, although there is a difference of a few months in the reported dates (Kützing: August 1847 and Grunow: 1848). As the samples were both collected by A. Braun from Titisee, the sample from the Kützing collection in Meise Botanic Garden (**BR**) and the material in the Natural History Museum in London (**BM**), should be considered as part of the original material used for the description of *Synedra gloiophila* by Grunow.

It is important to note that the analysis of the *Fragilaria* population revealed some differences in valve outline. Van Heurck (1881, plate 40, fig. 21) shows a relatively short valve with parallel sides and truncated, protracted, rostrate apices (Fig. 6). Almost all valves observed in the Kützing material have parallel margins and clearly protracted, rostrate to almost capitate apices (Figs 9–35). However, previously unpublished original drawings (Figs 2–4) kept in the Grunow collections (**W**), show a range of valves that are very similar to the *Fragilaria* specimens observed in the Kützing material, thus confirming the identity of these specimens as *Synedra gloiophila*.

The morphology of these specimens also indicates that the species should be transferred to the genus *Fragilaria*. The new combination *Fragilaria gloiophila* (Grunow) Van de Vijver, Ector, T.M.Schust. & J.Walter is proposed hereunder. In this contribution, we detail observations on specimens of *F. gloiophila* from a slide prepared from Kützing sample 867, kept in **BR**, using light and scanning electron microscopy. Sample 867 is therefore designated as epitype for the holotype in accordance with ICN Art. 9.9 (Turland *et al.* 2018).

Fragilaria gloiophila (Grunow) Van de Vijver, Ector, T.M.Schuster & J.Walter, *comb. nov.* (Figs 7–42)

Basionym: *Synedra gloiophila* Grunow in Van Heurck, *Synopsis des Diatomées de Belgique, Atlas*, pl. 40: fig. 21, 1881.

Holotype: Van Heurck, 1881, pl. 40: fig. 21, erroneously designated as lectotype in Tuji & Williams (2008) (Blanco 2017).

Epitype (here designated for the above holotype of *Synedra gloiophila* Grunow): slide **BR-4594**, prepared from Kützing sample 867, Titisee, Baden-Württemberg, Germany (leg. August 1847), material present in the Van Heurck collection (**BR**). The epitype is here represented by Fig. 18.

Description: Frustules in girdle view rectangular, solitary (Figs 7, 8). Girdle composed of several, open, perforated girdle bands (Fig. 36). Valves almost strictly linear with parallel to very weakly convex margins in most of its length, finally gradually tapering towards the protracted, rostrate to capitate apices. Large, irregularly shaped mantle plaques present on the mantle edge (Fig. 36). Valve dimensions (n=30): valve length 20–30 µm, valve width 4–5 µm. Axial area very narrow, linear, not widening towards the central area. Central area small, forming an asymmetrical fascia due to absence of striae on one side. Striae parallel throughout, never becoming radiate, regularly spaced, 14–16 in 10 µm, uniseriate, composed of relatively large, rounded areolae, individually covered by external hymenes (Figs 39, 41). Virgae between the striae very weakly raised (Fig. 37). Mantle striae continuing from the valve face till halfway to the mantle edge (Fig. 36). Broad, irregularly shaped, bluntly rounded spines present on the valve face/mantle junction (Figs 36, 37, 39, 40). Spines occasionally absent (Fig. 38). One rimoportula present at one apex, in line with the last stria at the apex (Figs 38, 41). Apical pore field present at both apices, relatively large, composed of up to six rows of relatively large, rounded to squarish pores (Fig. 41). Internally, rimoportula distinctly present at one apex, superimposed on one of the final striae at the apex, weakly oblique (Fig. 42).

The morphology of the specimens in the Kützing sample confirms that the species should be transferred to the genus *Fragilaria* following the definition of the genus proposed by Tuji & Williams (2006). There are hardly any other *Fragilaria* species that show a similar combination of features. The valve outline is somewhat similar to *Fragilaria amphicephaloides* Lange-Bertalot, but the latter is much longer (40–75 µm) with a lower stria density (10–14 in 10 µm versus 14–16 in 10 µm in *F. gloiophila*) (Lange-Bertalot *et al.* 2017). Grunow suspected a relation with this species since several of his drawings were labelled '*Synedra amphicephala* var. *gloiophila ad interim'*, a working name that was never validly published (Fig. 4). Two other taxa, *Fragilaria capucina* var. *distans* (Grunow) Lange-Bertalot and *Fragilaria fragilarioides* (Grunow) Cholnoky, also show a similar valve outline, but both form long, band-like colonies using linking spines, but the latter absent in *F. gloiophila* (Krammer & Lange-Bertalot 2000, Van de Vijver pers. obs.). Finally, *Fragilaria alpestris* Krasske is similar, but differs in being weakly constricted in its central part, lacking a clearly developed central area and it has more rostrate apices (Krammer & Lange-Bertalot 2000).

Many thanks to Dr David M. Williams for confirming the origin of the Kützing sample.

Blanco, S. (2017). On the misuse of lectotypification in diatom taxonomy. *Phycologia* 56(1): 108–113.

Delgado, C., Novais, M.H., Blanco, S. & Almeida, S.F.P. (2015). Examination and comparison of *Fragilaria candidagilae* sp. nov. with type material of *Fragilaria recapitellata*, *F. capucina*, *F. perminuta*, *F. intermedia* and *F. neointermedia* (Fragilariales, Bacillariophyceae). *Phytotaxa* 231(1): 1–18, 150 fig., 3 tables.

Hustedt, F. (1932). Die Kieselalgen Deutschlands, Österreichs und der Schweiz unter Berücksichtigung der übrigen Länder Europas sowie der angrenzenden Meeresgebiete. Vol. VII. Teil 2. Liefrung 2. In: *Rabenhorst's Kryptogamen Flora von Deutschland, Österreich und der Schweiz*. (Anon. Eds), pp. 177–320. Leipzig: Akademische.

Krammer, K. & Lange-Bertalot, H. (2000). Bacillariophyceae, 3. Teil: Centrales, Fragilariaceae, Eunotiaceae. In: *Süßwasserflora von Mitteleuropa. Band 2/3 (ed. 2)*. (Ettl, H., Gerloff, J. Heynig, H. & Mollenhauer, D. Eds), pp. 1–599, 166 pls. Heidelberg: Spektrum Akademischer Verlag.

Kützing, F.T. (1833). *Synopsis diatomearum* oder Versuch einer systematischen Zusammenstellung der Diatomeen. *Linnaea* 8: 529–620, pls XIII-XIX.

Kützing, F.T. (1844). *Die kieselschaligen Bacillarien oder Diatomeen*. pp. [i-vii], [1]–152, pls 1–30. Nordhausen: zu finden bei W. Köhne.

Lange-Bertalot, H., Hofmann, G., Werum, M. & Cantonati, M. (2017). *Freshwater benthic diatoms of Central Europe: over 800 common species used in ecological assessments.* English edition with updated taxonomy and added species (Cantonati, M. et al. eds). pp. [1]–942, 135 pls. Schmitten-Oberreifenberg: Koeltz Botanical Books.

Tuji, A. & Williams, D. M. (2006). Typification of *Conferva pectinalis* O. F. Müll. (*Bacillariophyceae*) and the identity of the type of an alleged synonym, *Fragilaria capucina* Desm. *Taxon* 55(1): 193–199, 7 fig.

Tuji, A. & Williams, D.M. (2008). Examination of types in the *Fragilaria pectinalis–capitellata* species complex. In: Y. Likhosway (ed.) *Proceedings of the Nineteenth International Diatom Symposium. Listvyanka, Irkutsk, Russia, 28th August – 3rd September 2006.* p. 125–139, 69 fig., 1 table. Bristol: Biopress Limited.

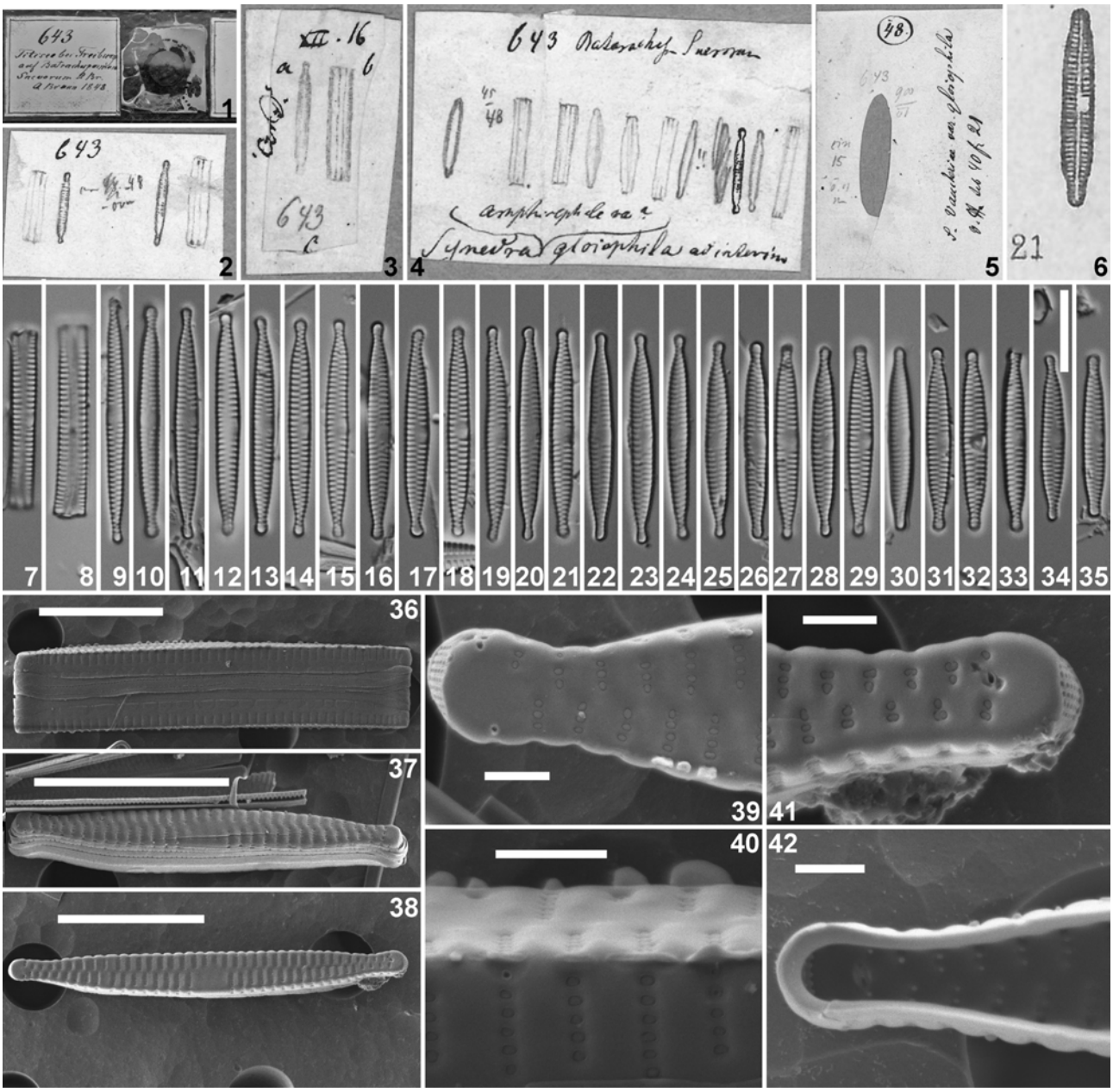
Tuji, A. & D.M. Williams (2013). Examination of types in the *Fragilaria vaucheriae–intermedia* species complex. *Bulletin of the National Museum of Natural Science, series B, Botany* 39(1): 1–9, 57 fig.

Turland, N.J., Wiersema, J.H., Barrie, F.R., Greuter, W., Hawksworth, D.L., Herendeen, P.S., Knapp, S., Kusber, W.-H., Li, D.-Z., Marhold, K., May, T.W., McNeill, J., Monro, A.M., Prado, J., Price, M.J. & Smith, G.F., editors (2018). *International Code of Nomenclature for algae, fungi, and plants (Shenzhen Code)* adopted by the Nineteenth International Botanical Congress Shenzhen, China, July 2017. *Regnum Vegetabile*, Vol. 159. pp. [i]–xxxviii, 1–253. Glashütten: Koeltz Botanical Books.

Van de Vijver, B., Straub, F., Wetzel, C.E. & Ector, L. (2020). Observations on and epitypification of *Synedra austriaca* Grunow (*Fragilariaceae*, *Bacillariophyta*). *Notulae Algarum* 130: 1–5, 23 fig.

Van Heurck, H. (1881). *Synopsis des Diatomées de Belgique.* Atlas. pls XXXI–LXXVII [31–77]. Anvers: Ducaju et Cie.

Williams, D.M. & Round, F.E. (1986). Revision of the genus *Synedra* Ehrenb. *Diatom Research* 1(2): 313–339, 71 fig.



Figs 1–42. *Fragilaria gloiophila* (Grunow) Van de Vijver, Ector, T.M.Schuster & J.Walter *comb. nov*. **Fig. 1.** Grunow slide 643 from Titisee with broken coverslip. **Figs 2–4**. Original unpublished drawings of the *Synedra* specimens present in sample 643 in the Grunow drawing collection (**W**). **Fig. 5**. Original sheet with the drawing used in Van Heurck (1881, plate 40, fig. 21) with the annotation of the sample number 643, the species name and the figure number in Van Heurck (1881). **Fig. 6**. Holotype of *Synedra gloiophila* Grunow in Van Heurck (1881). **Figs 7–35.** Cell cycle of *Fragilaria gloiophila* (Grunow) Van de Vijver, Ector, T.M.Schuster & J.Walter *comb. nov*. showing the epitype material (Titisee, Kützing sample 867). Figs 7–8 show frustules in girdle view. Fig. 18 represents the epitype specimen.

Figs 36–42. SEM micrographs of the epitype material (Titisee, Kützing sample 867). Fig. 36. SEM external view of an entire frustule showing the open girdle bands and mantle plaques. Fig. 37. SEM external oblique view of an entire frustule with irregularly placed marginal spines. Fig. 38. SEM external view of an entire valve lacking spines. Fig. 39. SEM external detail of one apex (without rimoportula) showing the occluded areolae and several marginal spines. Fig. 40. SEM external detail of the valve face/mantle junction showing several spines. Fig. 41. SEM external detail of the

apex bearing the rimoportula. Note also the structure of the apical pore field. Fig. 42. SEM internal detail of the valve apex with the rimoportula. Scale bars represent 10 μm except for figs 39–42 where scale bar = 1 μm.