

Observations and typification of *Fragilaria aequalis* Heiberg, the correct name for *Fragilaria tenuistriata* Østrup (*Fragilariaceae*, *Bacillariophyta*)

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Peder A.C. Heiberg (1837–1875) published in 1863 his *Conspectus criticus diatomacearum danicarum* [Critical overview of the Danish diatoms] in which he described several new species. One of these was *Fragilaria aequalis* Heiberg (1863: 61, pl. 4: fig. 12), which, considering the many localities listed in the text, is a rather common species in Denmark. Despite this supposed commonness, original Heiberg material has not been found at C (*vide* N. Lundholm, University of Copenhagen). Krammer & Lange-Bertalot (1991: 140) previously noted the absence of type material for *F. aequalis* (“*F. aequalis ist uns als Typenmaterial nicht bekannt*”). The only verified description and illustrations of the type available for this species are those of Heiberg (1863: 61, pl. 4: fig. 12).

After the original description, the taxonomic history of *F. aequalis* became rather complicated, probably due to the absence of type material analysis and a potentially erroneous observation Heiberg made when drawing *F. aequalis* (see below). Cleve & Møller (1877, slide 18) transferred the species to the genus *Staurosira* as *S. aequalis* (Heiberg) Grunow. The material for slide 18 in the Cleve & Møller diatom exsiccatae sets (1877–1882) originated from Sandhem in Westergötland, Sweden. The same material was later used by Van Heurck in his *Types du Synopsis des diatomées de Belgique* n° 313, labelled *Fragilaria capucina* var. *aequalis*, although he erroneously gave the collection locality as Sandheim [Bavaria, Germany]. In Grunow’s printed notes distributed to accompany the or *Types du* [sic] *Synopsis des diatomées de Belgique* (Van Heurck 1881–1885), the designation “*Fragilaria capucina* Desm. var. *aequalis* Grun. Sandheim” is introduced in the series XIII, slide 313 with “= *Fragilaria aequalis* Heiberg?”. Because of the question mark, this cannot be considered a recombination of the Heiberg name, or even a new name as there is no description in the notes or on the slide label.

A few years later, Grunow (in Van Heurck 1881, pl. 44, fig. 7) illustrated a valve he referred to *Fragilaria* (*Staurosira*) *aequalis* var. ? *producta* Lagerstedt, described by Lagerstedt (1873: 15, pl. 1: fig. 1) but added in the figure caption that he was not sure that this variety should be linked to *F. aequalis* since he believed it was more closely related to *F. capucina* Desmazières. De Toni (1892: 682) then introduced the combination *Fragilaria virescens* var. *producta* (Lagerstedt) De Toni. Astrid Cleve (1900: 18) effected the combination *Fragilaria capucina* var. *producta* (Lagerstedt) Cleve-Euler, but also considered the possibility that *F. aequalis* might be a synonym of *F. capucina* [“*Fallen aber F. aequalis und F. capucina, wie ich glaube, zusammen ...*” (But if *F. aequalis* and *F. capucina*, I believe, coincide ...)], rather than being a synonym of *F. virescens* Ralfs [referred later to *Fragilariforma virescens* (Ralfs) D.M. Williams & Round 1988: 265] as proposed by De Toni (*loc. cit.*). Østrup (1910: 187–189) discussed *F. aequalis* based on his own observations, but he could not find any valves in his samples that he could identify as *F. aequalis*. However, he reported on the analysis of a sample he received from Van Heurck from the Walker Arnott collection (sample S878, taken from the Copenhagen Botanic Garden, presumably by Heiberg for Eulenstein

sample 1064). Walker Arnott had noted in his catalogue that the sample contained *F. aequalis* in addition to *F. bidens* Heiberg and *F. mesolepta* Rabenhorst. Østrup (1910) was not able to identify any *F. aequalis* valves but remarked that the sample did not contain many valves; he also noted the presence of valves he considered being a variety of *F. capucina*. Østrup concluded that *F. aequalis* should remain an independent species [“*Fragilaria aequalis* Heiberg bør altsaa udgaa som selvstændig Art” (*F. aequalis* Heiberg should remain an independent species)]. Hustedt (1931: 144) however included *F. aequalis* as a synonym of *F. capucina*. Cleve-Euler (1953: 44, fig. 355), however, abandoned that synonymy based probably on Mayer (1937: 57, pl. 2, figs 11–18, pl. 4: fig. 30), who observed a large population near Regensburg (Germany) and illustrated several valves with a narrow axial area and lacking a central area. Mayer (loc. cit.) added in his discussion that unlike *F. capucina*, the valves of *F. aequalis* are entirely linear with parallel margins. Krammer & Lange-Bertalot (1991: 135) acknowledged that two contrasting views on *F. aequalis* existed. The concept of Grunow (in Van Heurck 1881) and De Toni (1892) of connecting *F. aequalis* via its var. *producta* to *F. virescens* was adopted by Krammer & Lange-Bertalot (1991: 135) by adding *F. aequalis* Heiberg 1863 *sensu* Grunow in Van Heurck 1881 *non sensu* Mayer 1937 (Typus?) as a synonym of *F. virescens*. The other view of Mayer (1937) of maintaining *F. aequalis* as an independent species was also adopted by Krammer & Lange-Bertalot (1991: 139). Based on the drawings in Mayer (1937), they however considered the species as a synonym of *Fragilaria nitzschoides* Grunow (in Van Heurck 1881: pl. 44: fig. 10) [transferred later to *Fragilariforma nitzschoides* (Grunow) Lange-Bertalot (in Hofmann & al. 2011: 268)].

During a survey of the genus *Fragilaria* based on historic samples in the Van Heurck collection (BR, Belgium), a slide (BR, IX-20-C8) made by E. Weissflog from material Heiberg collected at Copenhagen was discovered. The label on the slide indicated the following: ‘*Fragill. bidens, aequalis, tenuicollis, Asterion. gracilis, inflata* Heiberg Copenh.’ For the present contribution, we also analysed Van Heurck slide 313 representing the Cleve & Møller material from Sweden (Figs 2–9) and the Copenhagen population from the Heiberg slide (Figs 10–28). Analysis of the Heiberg slide revealed a dominant presence of *Fragilaria bidens* and a second taxon the valves of which agreed entirely with those in Cleve & Møller slide 18 from Sweden, identified by Grunow as *Staurosira aequalis* and by Walker Arnott as *Fragilaria aequalis* in his analysis of his sample S878 received from Heiberg. We believe, therefore, that these valves most likely represent *F. aequalis* although they show an indistinct hyaline central area, contrary to the drawings produced by Heiberg. However, in the central area, especially in the smaller valves, striae can be noted, making the Heiberg drawings more likely to represent this taxon. Moreover, in the drawings Heiberg made for the description of his *Fragilaria bidens*, he also depicted the entire central area with a normal striation pattern (Heiberg 1963, pl. 5: fig. 14.5 a), although analysis of the *F. bidens* specimens in the Heiberg slide showed a clear absence of striae in the central area (Van de Vijver, pers. obs.). This clear ‘error’ in these drawings sheds further light on the drawings of *F. aequalis* making it again more likely that in that central area striae should also not have been drawn. The valve outline of the Heiberg drawings shows protracted apices that could also be observed in some of the valves in the analysed slides. Østrup (1910) was unfortunate not to find valves exactly matching the Heiberg drawings in the material he examined for *F. aequalis*. Instead, he observed in several samples from Denmark populations of a species he described as *Fragilaria tenuistriata* Østrup (1910: 193, pl. 5: fig. 121). Krammer & Lange-Bertalot (1991: 123) considered the species as a synonym of *F. mesolepta*. Analysis of the type slide (Østrup 3601, C-A-99084, Figs 29–49) of *F. tenuistriata*, conserved at C (Denmark) showed no morphological differences with the valves identified as *F. aequalis* in the Heiberg sample and thus it is likely that both are conspecific. Østrup (1910) described another rather similar *Fragilaria* species as *F. subconstricta* Østrup (1910: 192, pl. 5, fig. 122), also considered as a synonym of *F. mesolepta* by Krammer & Lange-Bertalot (1991: 123). Tuji & Williams (2008, 2019) analysed the type materials of both *F. tenuistriata* and *F. subconstricta* and found sufficient morphological differences to separate them. We also reanalysed

the type material of *F. subconstricta* (Østrup 2958, C-A-99083, Figs 50–68) and noted that the latter has always larger valves than *F. aequalis* (*F. tenuistriata*) with a more pronounced constriction in the central area. Therefore, we agree with Tuji & Williams (2008, 2019) that both should be maintained as separate species.

Fragilaria aequalis has never been typified. Therefore, we designate the illustrations in Heiberg (1863: pl. 4, fig. 12) as lectotype and add the population in Heiberg slide IX-20-C8 from Copenhagen, kept at BR as epitype for the chosen lectotype.

Fragilaria aequalis Heiberg (1863: 61, pl. 4: fig. 12)

Lectotype (**here designated**): Plate 4: fig. 12 in Heiberg (1863) *Conspectus criticus diatomacearum danicarum*. Precise location not stated.

Epitype (**here designated for the above lectotype of *Fragilaria aequalis* Heiberg**): slide IX-20-C8 (**BR**, Meise Botanic Garden), Heiberg, Copenhagen.

Homotypic synonyms: *Staurosira aequalis* (Heiberg) Grunow (in Cleve & Møller 1877: slide 18) “*Fragilaria capucina* var. *aequalis* Grunow” (in Van Heurck 1882–1885, series XIII: slide 313), *nom. inval.*

Heterotypic synonym: *Fragilaria tenuistriata* Østrup (1910: 193, pl. 5: fig. 121).

Description: Frustules in girdle view rectangular, joined to form very long, ribbon-like colonies, often composed of several tens of cells. Valves strictly linear with parallel margins and a slight constriction in the middle. Valve apices broadly rounded, often weakly protracted, rostrate. Valve dimensions (n=50): length 28–55 µm, width 4.0–4.5 µm. Axial area very narrow but present, linear throughout. Central area constricted, forming a vague hyaline zone, bordered by very shortened striae. Striae parallel throughout the entire valve length, 15–17 in 10 µm. Areolae not discernible in LM.

In conclusion, the taxon described as *Fragilaria aequalis* by Heiberg in 1863 is clearly referable to the genus *Fragilaria* and therefore should not be considered a synonym of either *Fragilariforma virescens* (Ralfs) D.M. Williams & Round or *Fragilariforma nitzschioides* (Grunow) Lange-Bertalot. As it shows identical morphological features as in *F. tenuistriata*, the latter being described in 1910, the name *F. aequalis* has priority according to ICN Art. 11.3 (Turland & al. 2018) and *F. tenuistriata* will be considered a heterotypic synonym.

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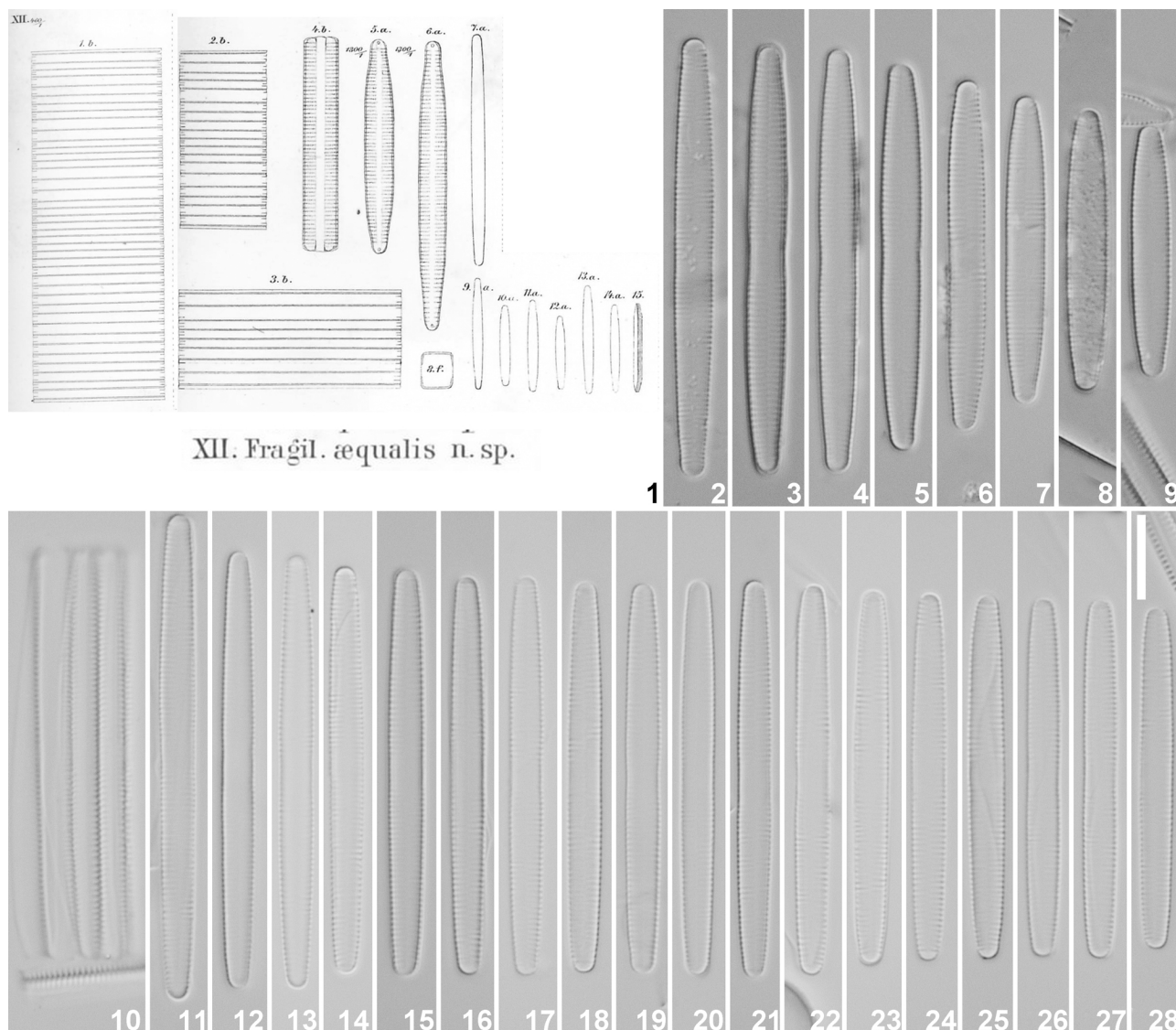
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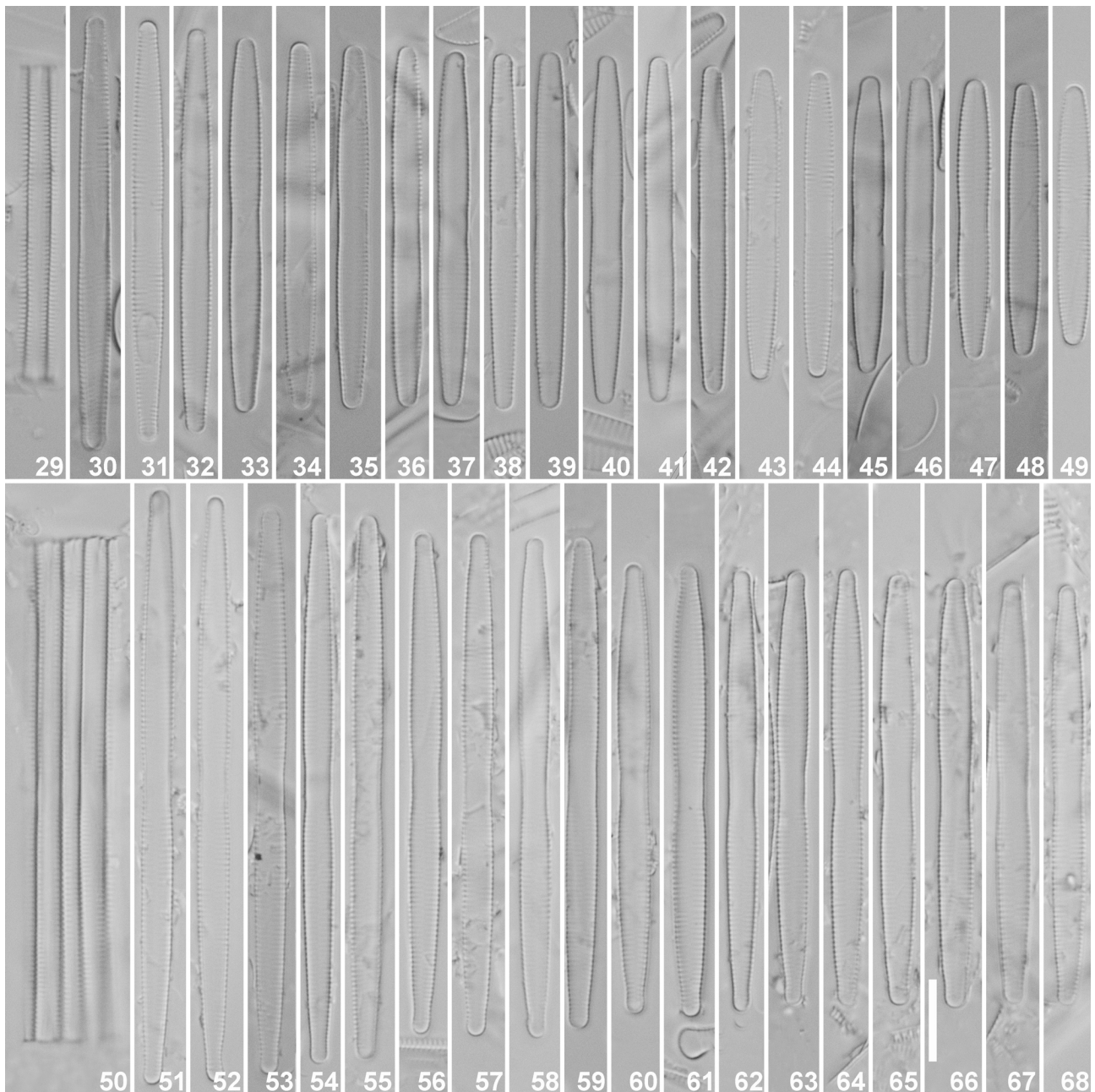
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Figs 1–28. *Fragilaria aequalis* Heiberg. Fig. 1. Scan of the original drawing in Heiberg (1863, pl. 4, fig. 12). Figs 2–9. *Fragilaria capucina* var. *aequalis*. Van Heurck, Types du Synopsis des Diatomées de Belgique slide 313, Sandhem, Sweden. Figs 10–28. *Fragilaria aequalis* valves from slide IX-20-C8 (BR) made by Heiberg based on material from Copenhagen. Cell diminution series cycle of *F. aequalis* showing the epitype material. Fig. 10 shows frustules in girdle view. Scale bar = 10 µm.



Figs 29–68. *Fragilaria tenuistriata* Østrup (Figs 29–49) and *F. subconstricta* Østrup (Figs 50–68). LM pictures taken from the type populations (*F. tenuistriata*: slide Østrup 3601, C A-99084 and *F. subconstricta*: slide Østrup 2958, C A-99083). Cell diminution series cycle for both taxa. Figs 29 & 50 show frustules in girdle view. Scale bar = 10 μ m.