

# **Observations and lectotypification of *Fragilaria construens* var. *triundulata* Reichelt and *Fragilaria triundulata* Østrup and transfer to the genus *Staurosira* Ehrenberg (*Staurosiraceae*, *Bacillariophyceae*)**

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Two ‘araphid’ taxa bearing the same epithet of ‘*triundulata*’ were described more than a hundred years ago (see Williams 2023 for a discussion on the use of the epithet ‘*triundulata*’). The first, *Fragilaria construens* var. *triundulata* Reichelt ex Østrup, appeared in one of Østrup’s first publications in 1899, illustrated by a single line drawing (Hartz & Østrup 1899, fig. 15; our Fig. 1). Hartz & Østrup (1899) published a paper together containing two parts: the first, part A (*Diatoméjord-Aflejringerne*), authored by Nikolaj Hartz (1867–1937), dealing with a general description of diatom deposits, and the second, part B (*Diatoméerne*), of which Ernst Vilhelm Østrup (1845–1917) was the author. This second part constitutes the taxonomic summary of all diatom taxa found in the different deposits. One of these was *Fragilaria construens* var. *triundulata* Reichelt (in Hartz & Østrup 1899: 57).

The German phycologist Hugo Reichelt (1857–1923) had reported in [1895] 1892–1893 his observations on a small araphid taxon that he identified as *Fr(agilaria). construens*, var. nov., with specimens from a fossil sample collected near Klein-Saubernitz, a small village in Saxony, Germany (Hermann & Reichelt 1895, p. 74). The taxon was not rare in the sample and because of the valve outline, reminded him of *Nitzschia sinuata* Grunow (“Letztere Form ist in der unteren Schicht des Lagers besonders häufig. Der Umriss der Schalen ist dem der *Nitzschia sinuata*, Grün., höchst ähnlich.” [The latter form is particularly common in the lower layer of the deposit. The outline of the valves is very similar to that of *Nitzschia sinuata* Grunow.]) (Reichelt in Hermann & Reichelt 1895: 74), the latter characterised by an undulating valve outline (Van de Vijver, pers. obs.). Reichelt never formally described the species, but a few years later, Østrup, who had exchanged letters with Reichelt, recognised in Hartz & Østrup (1899) that the new taxon he had observed, most likely in his own Danish material, resembled the ‘var. nov.’ that Reichelt had mentioned in 1895. Østrup further wrote in Hartz & Østrup (1899: 57) that he had received material from Reichelt and examined the species in the sample from Klein-Saubernitz confirming not only the conspecificity but he also went on to describe the new variety as *Fragilaria construens* var. *triundulata* Reichelt (“Da jeg nu gennem et Præparat fra Klein-Saubernitz, hvilket skyldes Hr. Reichelts velvillie, har overbevist mig om, at den ved Hollerup forekommende variant af *Fr. construens* er identisk med Reichelts „var. nova“, har jeg—efter Brevveksling med Hr. Reichelt—opstillet den under Navnet: *Fr. constr.* (Ehr) Grun. var. *triundulata* Reichelt.” [What I now saw through a preparation from Klein-Saubernitz, which is due to Mr. Reichelt’s benevolence, has convinced me that the variant of *Fr. construens* is identical to Reichelt’s “var. nova”, I – after exchanging letters with Mr. Reichelt – have listed it under the name: *Fr. constr.* (Ehr) Grun. var. *triundulata* Reichelt]). Østrup in Hartz & Østrup (1899, plate II: fig. 15) illustrated one valve of the new variety, showing a rather stocky, small species with a weakly inflated central part and undulating valve margins (Fig. 1). According to the AlgaTerra database, Østrup should be considered the author of the new variety, with the contribution of Reichelt being indirect by supplying material and data (see <http://www.algaterra.org/oestrup.htm>).

The taxon was later reported under different variants of the name. Hustedt (1930: 140, fig. 136) listed the species as *F. construens* var. *triundulata* Reichelt, but several years previously, he used the name *F. construens* var. *sinuata* Reichelt in Schmidt's *Atlas* (pl. 296: figs 34–38), most likely an error caused by combining *F. construens* var. *triundulata* and *Nitzschia sinuata*, named in the original publication. Hustedt (1930: 140) reported a maximum valve length of 50 µm with triundulate margins. Mayer (1919: 197) called the taxon *Fragilaria construens* var. *venter* f. *undulata* Reichelt and illustrated his forma with two line drawings (Hustedt 1930, pl. V: figs 60, 61) with fig. 61 being a 'Sporangialform'. Mayer (1937: 70) later recognised that his "forma" was merely a synonym of the Reichelt taxon. Hustedt (1931: 158) added a few more potential synonyms. Cleve-Euler (1853: 35) also considered the Icelandic taxon as a earlier synonym and added that both may even be earlier synonyms of *Fragilaria construens* var. *trinodis*, a variety described in 1897 by Prof. Dr Julius von Istvánffi (also known by the name of Julius Schaarschmidt; 1860–1930). Unfortunately, Cleve-Euler did not see the latter variety and the material is no longer available (Van de Vijver, pers. obs.), so at present it is impossible to neither exclude nor confirm their conspecificity as the drawing in Istvánffi (1898, fig. 8) lacks sufficient detail to allow comparisons. Cleve-Euler (1853: 35) also added another possible synonym: *Fragilaria istvanffi* Pantocsek, described in 1902 (on the same page as *F. trigibba*). The drawings of both *F. istvanffi* and *F. trigibba* show a faint resemblance to the drawings of *F. construens* var. *triundulata* and *F. triundulata* but most likely insufficient to be conspecific.

The variety was later transferred several times to the genus *Staurosira* as *S. construens* var. *triundulata* (Reichelt ex Østrup) Bukhtiyarova. Bukhtiyarova (1995: 418) published the oldest valid transfer in a list of many new combinations for taxa observed in the Ukraine. In the same year, Hamilton (in Poulin & al. 1995: 75) proposed the same new combination as did Mayama & al. (2002: 90). The latter two combinations are merely isonyms. Kobayasi & al. (2006: pl. 92) illustrated the variety as *S. construens* var. *triundulata* (Reichelt ex Østrup) H.Kobayasi.

Some 20 years after the publication of *Fragilaria construens* var. *triundulata*, Østrup (1918: 60) described *Fragilaria triundulata* Østrup from a sample he had received from his friend Johannes Boye Petersen (1887–1961) collected on 16.viii.1914 from a stream near the Icelandic Lake Apavatn, a large freshwater lake about 40 km east of Reykjavik. The sample was numbered 247.1 and the slide No. 6622. Østrup added to the description: "This form has nothing to do with *Fr. construens* var. *triundulata* Reichelt (cnfr Øst Diat. Afl. 57, Tab. II, fig. 15)." But he also mentioned that there is some similarity with *Fragilaria trigibba* described by Pantocsek in 1902 (Pant. Hal. S. 79, Tab. IX, fig. 224), although Østrup (1918) also excludes conspecificity ("but it is scarcely identical with it").

The original slides of *Fragilaria construens* var. *triundulata* and *Fragilaria triundulata* were retrieved from the herbarium at Statens Naturhistoriske Museum in Copenhagen (C, Denmark). Unfortunately, only slides could be found as unmounted material was no longer available. Light microscopical analysis of both original slides led to two conclusions: first, the undulated valves seem to represent only the longest valves in the size diminution series with most of the valves in each series showing either convex or even almost straight, parallel margins lacking explicit undulations; and second, both taxa are not conspecific with *F. construens* var. *triundulata* having a larger width giving the valves a sturdier appearance.

Although scanning electron microscopy analysis is not possible at present, there are sufficient morphological characters to show that both taxa should not be placed in the genus *Fragilaria*, but are referable to the genus *Staurosira*, as was done with *F. construens* var. *triundulata* at the varietal level by Bukhtiyarova (1995). Unpublished analysis of the type material of *Staurosira construens* Ehrenberg (Van de Vijver & al., unpubl. res.) shows that *F. construens* var. *triundulata* should no longer be considered as a variety of *S. construens* and should be raised to species level as was also done for *Staurosira binodis* (Ehrenberg) P.B.Hamilton, *S. venter* Ehrenberg and *S. exigua*

(W.Smith) Van de Vijver & Guiry. By transferring *Fragilaria triundulata* to the genus *Staurosira* as *S. triundulata* (Østrup) Van de Vijver & Paillès, comb. nov., a new name needs to be introduced for the variety *triundulata*. In honour of Ernest Østrup, the name *Staurosira oestrupii* Van de Vijver & Paillès nom. nov. et stat. nov. is proposed. The original slides from C are designated as lectotypes for both species. In the present contribution, we document both taxa showing a large part of the cell diminution series. Apart from the original Østrup slide of *Fragilaria triundulata*, three additional slides, made by Max Møller (1909–1974), were retrieved from C. These slides were made from the original Østrup sample 247.1 but on a later (unspecified) date (slide numbers C-A-100560, C-A-100561). As the slides were of better quality, additional observations were made and illustrated in the present paper (Figs 93–132).

***Staurosira oestrupii* Van de Vijver & Paillès, nom. nov. et stat. nov. (Figs 1–55)**

Replaced synonym: *Fragilaria construens* var. *triundulata* Reichelt ex Østrup in Hartz & Østrup, *Danske Diatoméjerd-Aflejringer og deres Diatoméer. Danmarks Geologiske Undersøgelse II. Series, Number 9D*, p. 57, pl. II [2]: fig. 15, 1899.

**Lectotype (here designated):** slide C-A-100558 (Museum Botanicum Hauniense). Figure 7 best represents the lectotype.

Registration (of new name): <http://phycobank.org/104962>

Registration (of lectotypification): <http://phycobank.org/104963>

Type locality: Fossile Diatomeen von Klein Saubernitz, Sachsen, Germany

Homotypic synonyms: *Staurosira construens* var. *triundulata* (Reichelt ex Østrup) Bukhtiyarova (1995: 418); *Staurosira construens* var. *triundulata* (Reichelt ex Østrup) P.B.Hamilton (in Poulin & al. 1995: 75); *Staurosira construens* var. *triundulata* (Reichelt ex Østrup) H.Kobayashi (in Mayama 2002: 60).

Description: Frustules connected to each other forming ribbon-like colonies (Fig. 2). Valve outline highly variable, triundulate in larger specimens with middle undulation being widest (see for instance Figs 4–7). Smaller valves with inflated central part or even more convex valve outline but lacking further undulations. Apices protracted, capitate to subcapitate in larger valves, more weakly protracted and rostrate in smaller valves. Valve dimensions (n=50): length 9–25 µm, largest width in middle 5.5–8.0 µm. Sternum narrow, max. ¼ of the total valve width, linear-lanceolate narrowing towards apices. Striae weakly radiate throughout, 12–14 in 10 µm.

***Staurosira triundulata* (Østrup) Van de Vijver & Paillès, comb. nov. (Figs 56–132)**

Basionym: *Fragilaria triundulata* Østrup, *The Botany of Iceland*. Vol. II, Part I. No. 5., p. 60, pl. V [5]: fig. 81, 1918.

**Lectotype (here designated):** slide C-A-100559 (Museum Botanicum Hauniense). Figure 60 represents best the lectotype.

Registration (of new combination): <http://phycobank.org/104957>

Registration (of lectotypification): <http://phycobank.org/104958>

Type locality: Slide No. Østrup 6622, made from sample 247.1, stream at Apavatn, Iceland (Bæk ved Apavatn, strømmen ikke synderlig stærk [current not particularly strong])

Excluded name: *Fragilaria triundulata* Savel'eva-Dolgova, nom. illeg. 1925: 30, 46, fig. 2

Description: Frustules possibly connected to each other forming ribbon-like colonies (given that most valves could not be entirely focused as two valves were connected to each other showing only the valve interior). Valve outline elongated, highly variable, triundulate in larger specimens. Smaller valves with broadly convex margins but lacking undulations. Apices protracted, capitate to subcapitate almost throughout entire cell diminution series, more weakly protracted and rostrate in smaller valves. Valve dimensions (n=60): length 15–28 µm, largest width in middle 4.5–6.0 µm. Sternum narrow, max. 1/5–1/4 of the total valve width, linear-lanceolate narrowing towards apices. Striae weakly radiate throughout, 15–17 in 10 µm.

Foged (1974: plate III, figs 4 & 5) illustrated two valves he identified as *Fragilaria construens* var. *triundulata*. The largest population he observed in a sample collected on 15.vii.1954 from a small lake near Thingvellir (sample 29/1954). The material was designated by Van de Vijver (2023: 2) as the lectotype for *Pseudostaurosira borealis* (Foged) M.L.García & al. In this sample, also retrieved from C, several valves of what is now considered as *Staurosira triundulata* could be studied using scanning electron microscopy observations (Figs 133–140) and justify the placement of this taxon in the genus *Staurosira*.

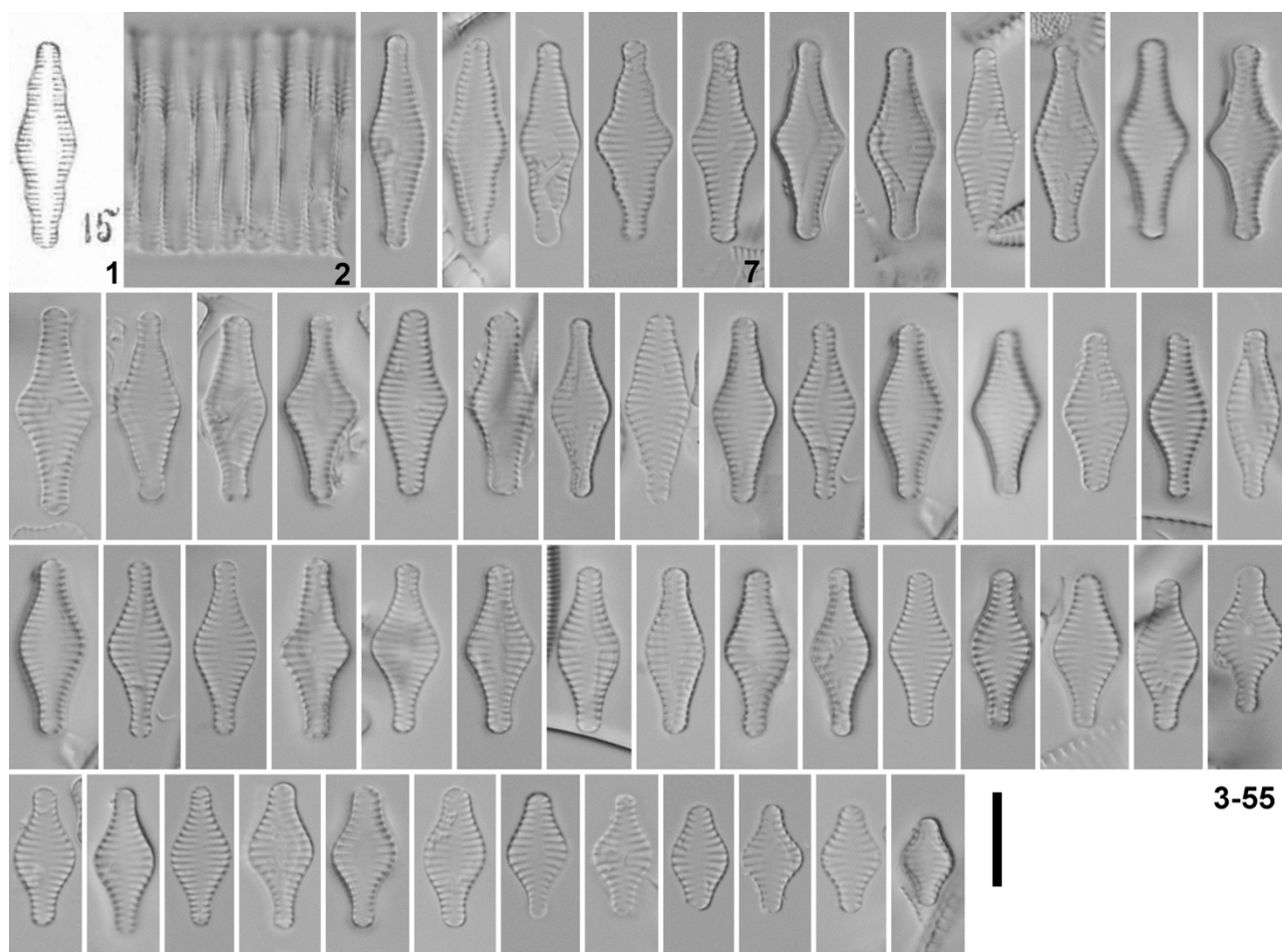
As only a small part of the cell diminution cycle of both species showed the triundulate valve outline, it is possible that the non-triundulate valves were misidentified in the past. It is highly likely that *Staurosira sviridae* Kulikovskiy, Genkal & Mikheeva (2011: 363) represents the smaller valves of *Staurosira triundulata*. Further analysis of the type material of *S. sviridae* will be necessary to confirm this hypothesis. Populations identified as *S. sviridae* were found in material from Iceland, France and Italy (Van de Vijver, pers. obs.) and the observed valves are morphologically similar to the smaller valves of *S. triundulata*.

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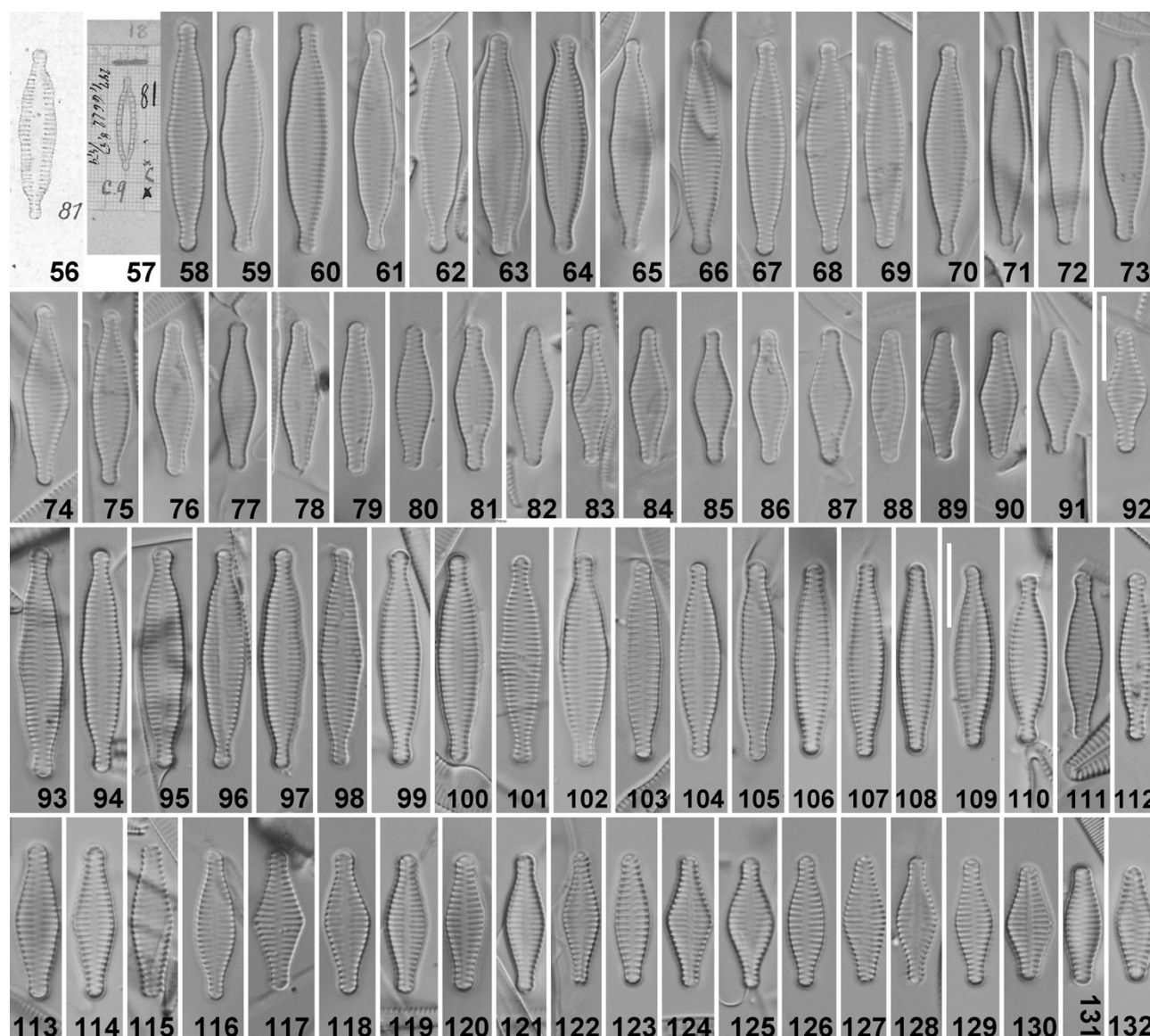
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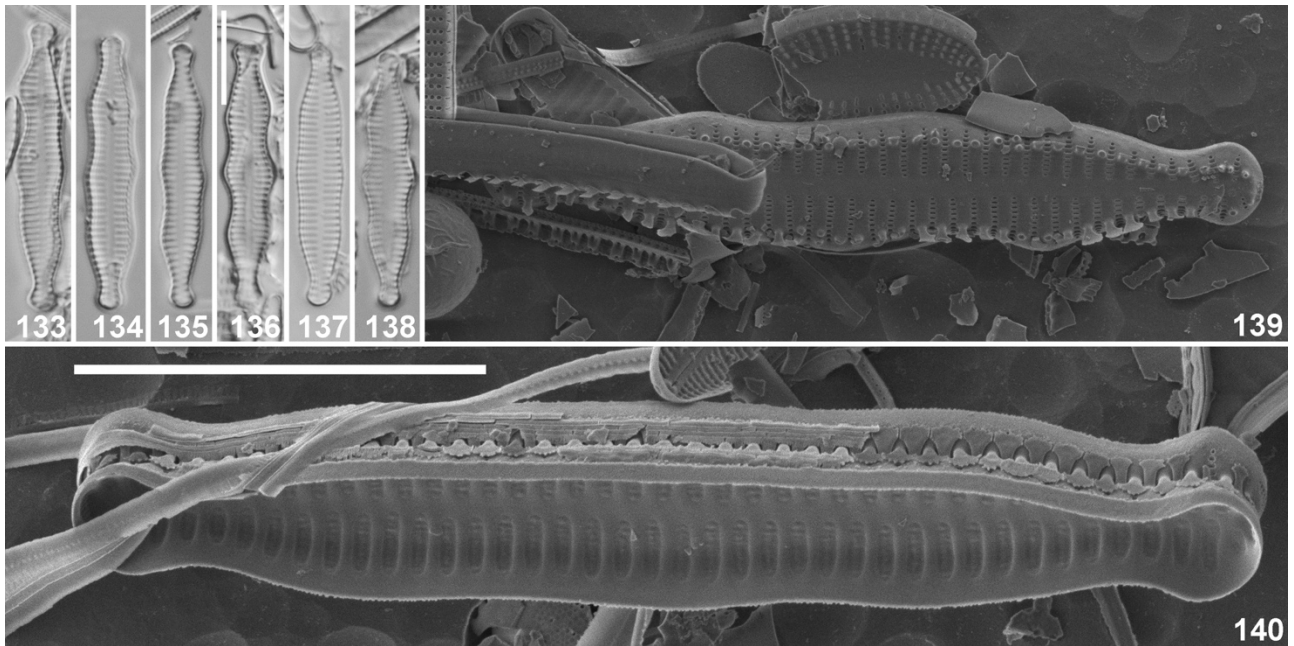
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**Figs 1–55.** *Staurosira oestrupii* (Reichelt ex Østrup) Van de Vijver & Paillès, *nom. nov. et stat. nov.* LM pictures taken from the lectotype sample (slide C-A-100558, Klein Saubernitz, Sachsen, Germany). **Fig. 1** Original drawing of *Fragilaria construens* var. *triundulata* published in Hartz & Østrup (1899, fig. 15). **Fig. 2** LM view of several frustules connected to form a ribbon-like colony. **Figs 3–55** LM views of a size diminution series. Scale bar = 10 µm.



**Figs 56–132.** *Staurosira triundulata* (Østrup) Van de Vijver & Paillès, *comb. nov.* LM pictures taken from the lectotype sample (slide C-A-100559, Apavatn, Iceland, Figs 58–92) and from two additional slides made by Max Møller (C-A-100560 & C-A-100561) (Figs 93–132). **Fig. 56** Original drawing of *Fragilaria triundulata* published in Østrup (1818, fig. 81). **Fig. 57** Original drawing of *Fragilaria triundulata* received from Østrup's original notes of sample 247.1. **Figs 58–92** LM views of a size diminution series taken from the original Østrup slide. **Figs 93–132** LM views of a size diminution series taken from the Max Møller slides. Scale bar = 10 µm.



**Figs 133–140.** *Staurosira triundulata* (Østrup) Van de Vijver & Paillès, *comb. nov.* LM and SEM pictures taken from Foged slide 29/1954 (small lake near Thingvellir, Iceland). **Figs 133–138** LM views of several valves showing a triundulate valve outline. **Fig. 139** SEM external view of an entire valve. **Fig. 140** SEM internal view of an entire valve showing spines and a neighbouring valve. Scale bar = 10  $\mu$ m.