Observations and typification of *Eunotia exigua* (Brébisson ex Kützing) Rabenhorst (*Eunotiaceae, Bacillariophyta*)

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Due to increased airborne acidification in the twentieth century, *Eunotia exigua* became one of the most frequent and abundant *Eunotia* species in Europe (Alles & al. 1991, Lange-Bertalot & al. 2011, 2017). Despite being one of the most common *Eunotia* Ehrenberg species worldwide, the type material of *Eunotia exigua* (Brébisson ex Kützing) Rabenhorst has never been studied. Originally described in 1849 as *Himantidium exiguum* Brébisson ex Kützing (1849: 8) based on material Kützing received from France, sent by his friend Alphonse de Brébisson ("*In Gallia. Specimina comm. amic. De Brébisson*"), the species was transferred by Rabenhorst (1864: 73) to the genus *Eunotia*. A short description was added in Kützing (1849: 8): "*H. minutum, laevissimum, fascias brevissimas formans, articulis a latere secundario arcuatis, apicibus productis, obtusissimis. Long. 1/250–1/150'''* [Small *H[imantidium]*, very smooth, forming very short valve faces, with bent segments on the secondary side, with protracted, very obtuse apices]" but an illustration was not given. Grunow (1862: 340, pl. VI [6], fig. 15) provided the first illustration of the taxon and suggested that the taxon may simply be a small form of *Himantidium arcus* (Ehrenberg) W.Smith, but added that at present he had insufficient data to say more while the taxon seemed rather rare (*Einstweilen fehlen mir hierfür aber noch alle Belege, um so mehr als dieselbe ziemlich selten ist*).

Hustedt (1932: 285–286) added several *Eunotia* taxa as synonyms to *E. exigua* such as *E. gracilis* W.Smith (1853: 16) and *E. minuta* Hilse (1861: 79), although it is unclear whether he actually had seen the original type material for either of the latter names. Krammer & Lange-Bertalot (1991: 198) discussed in detail the taxonomic history of *E. exigua* starting with the statement that the type material for *E. exigua* has not been checked. Moreover, their interpretation of *E. exigua* (Krammer & Lange-Bertalot 1991: pl. 153, figs 5–9) was based on a sample from the Rabenhorst exsiccata set *Algen Sachsens und Europa's* containing a population of *Eunotia gracilis* W.Smith [*non E. gracilis* (Ehrenberg) Rabenhorst], collected from a "*einem Torfbrüche von Dambrau bei Oppeln in Schlesien*" (nowadays Dąbrowa, Opole, Poland), although the freshwater type material for *E. gracilis* originates from Wareham, Dorset, England (Smith 1853: 16), collected in September 1849 by William Smith. None of the original types (*H. exiguum*, *E. gracilis*, *E. minuta*), however, have been investigated and illustrated so far as was mentioned for instance by Mayama (1997: 35, *However, it is necessary to find and examine the type material of* E. exigua *for the ultimate resolution of this taxonomical problem*) and Lange-Bertalot & al. (2011: 95, *Although the type material of Brébisson has not been under LM or SEM observation in the 20th century or later*…).

The original material of all three taxa has been discovered during a search of the Van Heurck collection (**BR**, Meise Botanic Garden, Belgium). Part the Van Heurck collection is formed by original William Smith material composed of unmounted samples and slides prepared by Smith's nephew, Charles Coppock (Hoover 1976). The samples are arranged in small envelopes on sheets, arranged according to Smith (1853). One of the sheets was marked *Eunotia gracilis* and contained an envelope labelled "Wareham 12:12:1849" and although the sampling date does not correspond 100% with the sampling locality given in Smith (1853: 16, Wareham, Sept. 1849), the material can be considered representing the type for *E. gracilis* (Kusber, pers. comm.). Another envelope on the *E. gracilis* sheet was marked in de Brébisson handwriting "*Himantidium exiguum* Bréb. in Kütz., Falaise, Sp. Alg. p. 8". The latter indication refers to Kützing's *Species Algarum* (Kützing 1849: 8)

where *H. exiguum* was described. As this can be considered original de Brébisson material from France, labelled by himself; we designate this material as lectotype for *H. exiguum*. The third species, described by Hilse in 1861 based on Rabenhorst exsiccata No. 1167, was also retrieved from the Van Heurck collection, the latter sample was collected from the Eulengebirge [Owl Mountains] near Wroclaw, Poland.

Here, we detail observations on specimens of all three species based on slides prepared from the original Brébisson material from Falaise, France (*H. exiguum*), the William Smith sample collected at Wareham on December 12th 1849 (*E. gracilis* W.Smith) and Rabenhorst 1167 (*E. minuta*), kept in **BR**, using light and scanning electron microscopy. The material from Falaise is designated as lectotype for *Himantidium exiguum*, whereas *E. gracilis* W.Smith [nec *E. gracilis* (Ehrenberg) Rabenhorst] and *E. minuta* are confirmed as heterotypic synonyms for *E. exigua*.

Eunotia exigua (Brébisson ex Kützing) Rabenhorst, 1864 (Figs 1–77)
Basionym: *Himantidium exiguum* Brébisson ex Kützing, *Species Algarum*, p. 8, 1849.
Lectotype (here designated): **BR**-4706, slide prepared from Brébisson sample Falaise, Normandy, France, leg. A. de Brébisson, original material present in the Van Heurck collection (**BR**). The lectotype is represented by Fig. 5.
Registration (of lectotypification): http://phycobank.org/103087
Synonyms: *Eunotia gracilis* W.Smith, 1853 (Figs 27–50), *E. minuta* Hilse, 1861 (Figs 51–77).

Description: Valves clearly arched with convex dorsal side and concave to weakly concave ventral side. Smaller valves with almost straight ventral margin. Apices clearly protracted, capitate, distinctly reflexed to the dorsal side becoming only weakly protracted, broadly rounded in smaller valves. Valve dimensions (n=40): length 10–16 µm, width 2.5–3 µm. Raphe branches short, running almost entirely on the narrow, hyaline valve mantle. Terminal raphe fissures short, on the valve face (Figs 24, 25). Terminal nodules very close to the apices. One rimoportula present per valve, located at one apex, close to the helictoglossa (Fig. 26). Striae radiate, equidistant throughout the entire valve, not denser at the apices, 22–24 in 10 µm. Striae uniseriate, composed of rather small, round, areolae, internally covered by hymenes (Fig. 25). Areolae not discernible in LM.

Eunotia gracilis W.Smith, 1853 (Figs 27–50)
Published in: Smith *A synopsis of the British Diatomaceae* 1: 16, pl. 30: fig. 249, 1853.
Lectotype (here designated): **BR**-4708, slide prepared from W. Smith sample Wareham, Dorset, England, original material present in the Van Heurck collection (**BR**). The lectotype is represented by Fig. 31.
Registration (of lectotypification): http://phycobank.org/103122

Eunotia minuta Hilse, 1861 (Figs 51–77)
Published in: Hilse, *Jahres-Bericht der Schlesischen Gesellschaft für vaterländische Cultur* 38: 79, 1861.
Lectotype (here designated): **BR**-4709, slide prepared from Rabenhorst sample 1167, Góry Sowie [Eulengebirge], Poland, leg. F.W. Hilse, original material present in the Van Heurck collection (**BR**). The lectotype is represented by Fig. 56.
Registration (of lectotypification): http://phycobank.org/103123

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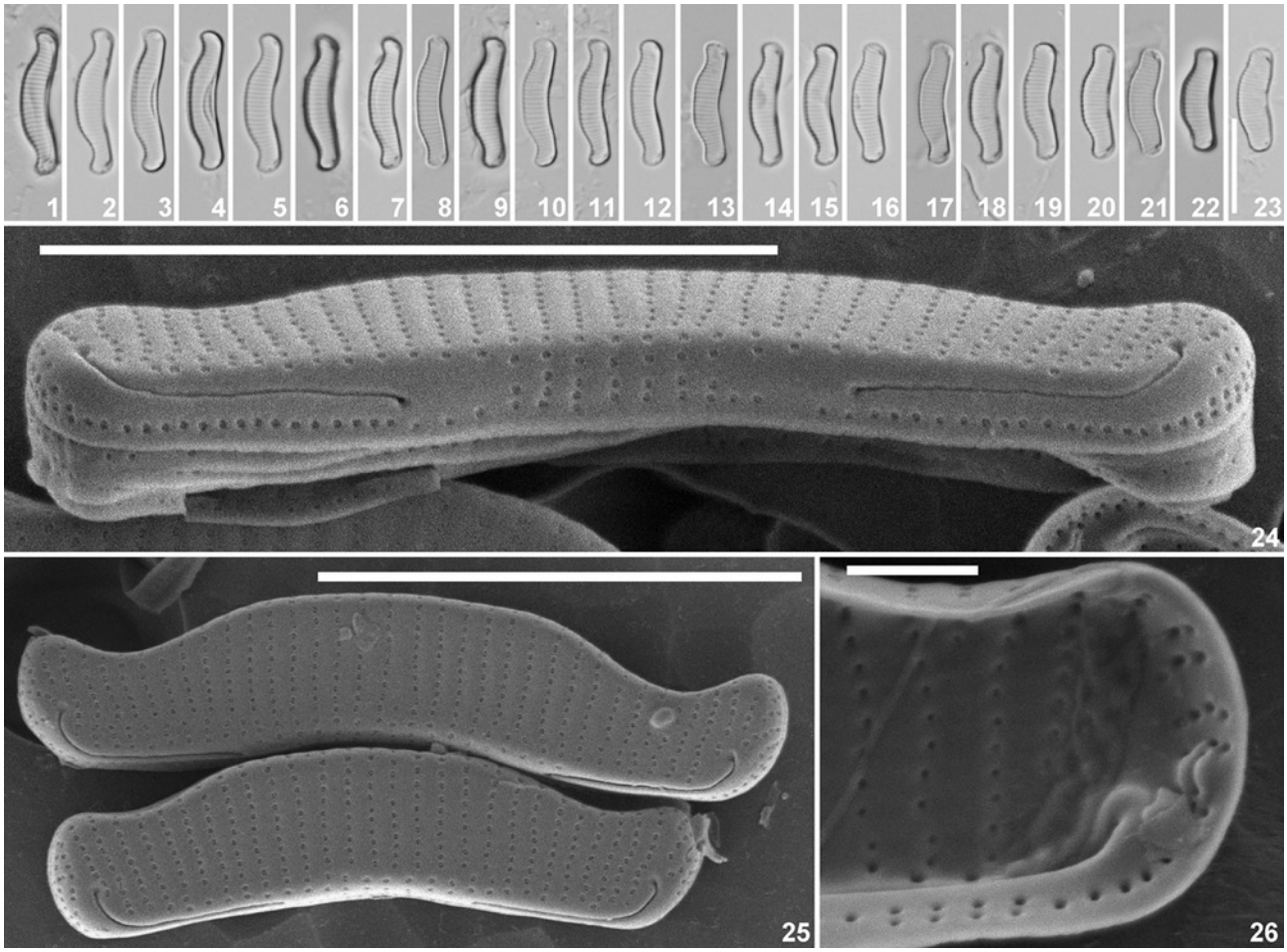
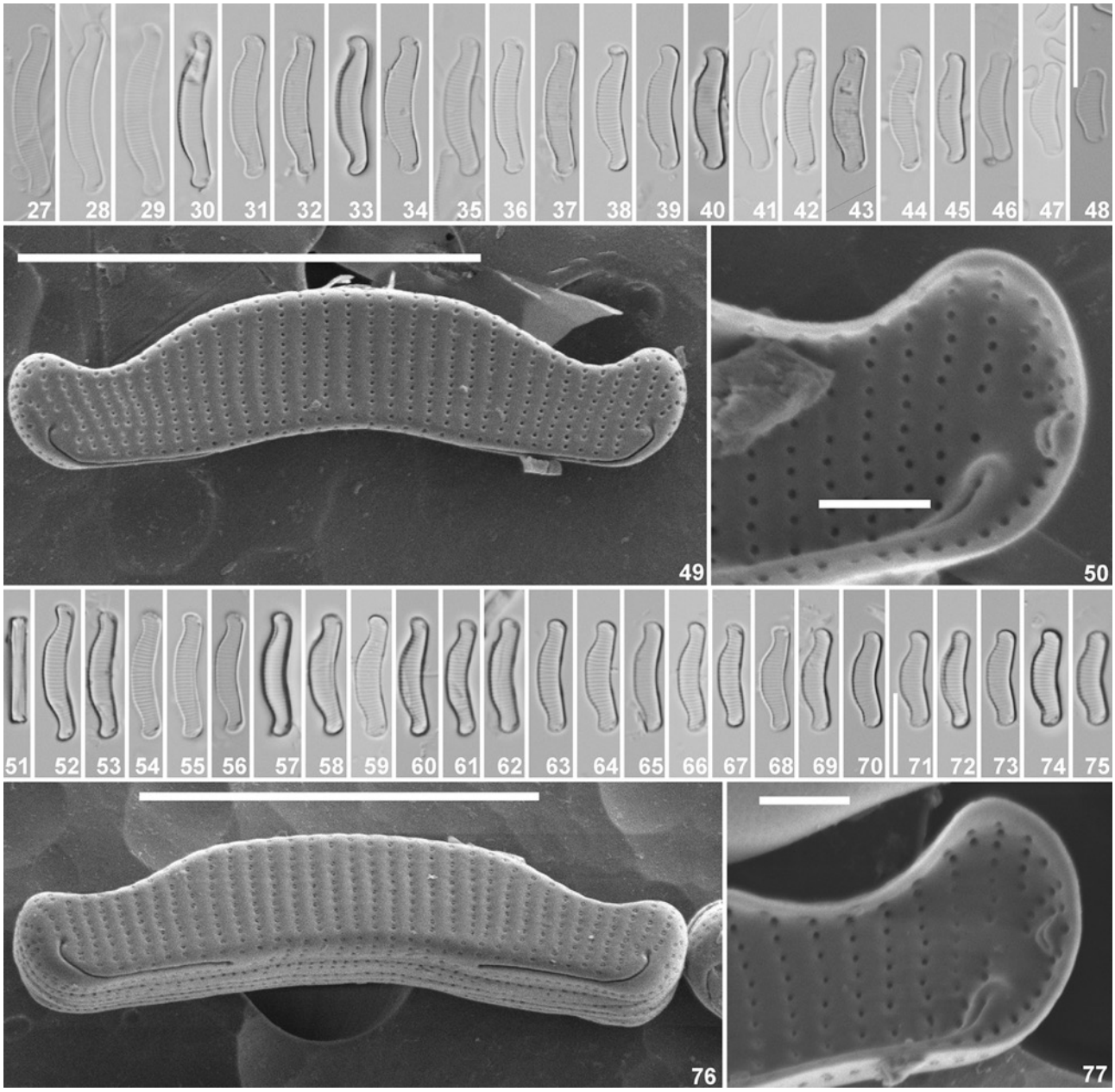


Figs 1–26. ***Eunotia exigua*** **(Brébisson ex Kützing) Rabenhorst.** LM and SEM pictures taken from the lectotype material (**BR**-4706, Falaise, Normandy, France, leg. A. de Brébisson). **Figs 1–23.** LM valve face views showing the cell diminution series. **Fig. 24.** SEM external oblique view of an entire valve showing the narrow mantle with the raphe branches. **Fig. 25.** SEM external view of two valves showing the variability of the valve apices. **Fig. 26.** SEM internal detail of the valve apex showing the helictoglossa and the rimoportula. Scale bar = 10 µm except for Fig 26 = 1 µm.



Figs 27–77. *Eunotia exigua* (Brébisson ex Kützing) Rabenhorst. LM and SEM pictures taken from the original material of *Eunotia gracilis* W.Smith (Figs 27–50, BR-4708, Wareham, England, coll. date 12/12/1849, leg. W. Smith) and *E. minuta* Hilse (Figs 51–77, BR-4709, Góry Sowie [Eulengebirge], Poland, leg. L. Hilse). ***Eunotia gracilis*: Figs 27–48.** LM valve face views showing the cell diminution series. **Fig. 49.** SEM external view of an entire valve. **Fig. 50.** SEM internal detail of the valve apex showing the helictoglossa and the rimoportula. ***Eunotia minuta*: Fig. 51.** LM girdle view. **Figs 52–75.** LM valve face views showing the cell diminution series. **Fig. 76.** SEM external oblique view of an entire valve showing the narrow mantle with the raphe branches. **Fig. 77.** SEM internal detail of the valve apex showing the helictoglossa and the rimoportula. Scale bar = 10 µm except for Figs 50, 77 = 1 µm.