Morphological investigation of the type material of *Epithemia hyndmanii* W.Smith and comments on the type of *Epithemia proboscidea* Kützing and *Epithemia smithii* Carruthers

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Epithemia hyndmanii W.Smith was first formally described, but without illustration, in Smith (1850: 124) from diatomaceous earth found in deposits at Lough Mourne (County Antrim, Northern Ireland): '*E. major, a latere secundario valde et æqualiter convex, apicibus obtusissimis rotundatis non recurvatis, striis transversalibus moniliformibus vix convergentibus: a latere primario oblonga medio valde dilatata. Long. 1/300-1/120 unciæ*.'; '[larger *E(pithemia).,* on the secondary side strongly and equally convex, valve apices very obtusely rounded, not recurved, striae punctate barely converging: on the primary side oblong, in the middle strongly widened. Length 1/300–1/120 of an inch]'. Smith (1853) provided a short English description: 'F.V. [= front view of frustule] inflated; V. [= valve] much and regularly arched, extremities rounded, not recurved; striæ moniliform, 16 in .001″; canaliculi inconspicuous, 9 in .001″. Length of F. [=frustule] ·0025″ to ·0076″' and illustrated the species with one valve and one frustule (Smith 1853: 12, pl. I, figs 1a, b, see Figs 10, 11). The specimens were 'freshwater' and from 'Lough Mourne deposit, Cantyre Peat' [Kintyre, Scotland]. These are two separate locations, the former being where *E. hyndmanii* was first described (Smith 1850).

Kuntze (1891: 891) proposed the new combination *Cystopleura hyndmanii* (W.Smith) Kuntze, because of Kützing's (Kützing 1844: 33) reference to Brébisson's name *Epithema* (Brébisson 1838: 33), and justified his preference of *Cystopleura* Brébisson ex Kuntze, *nom. illeg*., over *Epithemia* Kützing as *Epithema* Brébisson is a later homonym of *Epithema* Blume, a genus of the vascular plant family *Gesneriaceae*. Kützing (1849: 3) did not accept *Cystopleura* as a genus and only mentioned *Cystopleura alpestris* Brébisson and *Cystopleura ocellata* Brébisson as synonyms of *Epithemia alpestris* Kützing. and *Epithemia ocellata* Kützing, respectively (see Fourtanier & Kociolek 1999: 51).

Van Heurck (1885: 138) added *Epithemia hyndmanii* (as 'Hyndmanni W. Sm.)to his *Synopsis des Diatomées de Belgique* referring to Smith's 1853 illustration (Smith 1853: pl. I, figs 1a, b, see Figs 10, 11). Van Heurck added two drawings he published previously in his *Atlas* (Van Heurck 1881: pl. XXXI [31], figs 3 & 4) showing a valve face view and one frustule. He also added *Type du Synopsis* n° 252 as a reference slide to accompany his observations, stating that he did not observe the species in Belgium ('Non encore signalé') and that he believed that the species was nothing more than the sporangial form of *E. turgida* ('On croit que ce pourrait être la forme sporangiale de 1' *E. turgida*'). Unfortunately, the unmounted material of sample n° 252 is missing from the Van Heurck collection; we only know that the sample is from Germany (Van Heurck 1882-1885, Series XI: 72; Van de Vijver, pers. obs.).

In 1987, Krammer (in Lange-Bertalot & Krammer 1987: 72) designated a slide from the Van Heurck collection (BR IX-43-C4) as "lectotype" for *Epithemia hyndmannii* (also Krammer & Lange-Bertalot 1988: pl. 104: fig. 10).The slide is labelled 'XXXI f. 3–4' suggesting that this is the slide used to make the drawings in Van Heurck's *Atlas* as XXXI refers to pl. 31. Van Heurck also added 'tube 227 s' on the slide label, but no information about the locality. A considerable number of drawings in Van Heurck's *Atlas* were prepared by Albert Grunow in Vienna and later cut out and mounted onto plates for publication. The original drawings, together with the remaining sheets of the cut-outs, are conserved in the Grunow collection in **W**. Analysis of these drawings revealed no further information from which location the sample was taken to make the slide. Figures 12, 13 show the original slide together with the conserved drawings in **W**. On the bottom of the drawing, Grunow added '*E. Hyndmanni* specim. W. Arn. ', an indication that Grunow had based his drawings on specimens from the Walker Arnott collection, a series of almost 2000 samples in the Van Heurck collection, now conserved in **BR**. The handwritten catalogue of the Walker Arnott collection lists for number S 227, a sample from 'Cantyre Peat'. Unfortunately, there is no indication when the sample was taken or by whom but it is clear that the slide does not belong to the original Lough Mourne material from which the species was originally described. It appears that Lange-Bertalot & Krammer's (1987: 72) statement 'Cantyre Peat, June 1851, Lough Mourne Dep., Coll. Van Heurck', assumed that Cantyre Peat and Lough Mourne are the same locations, which they clearly are not (Smith 1850). Therefore, the designated lectotype in Lange-Bertalot & Krammer (1987: 72) should be superseded by one from the Lough Mourne deposit, the location from which Smith (1850) first described *E. hyndmannii.*

According to ICN Art. 9.19 (Turland & al. 2018), a lectotype must, amongst other things, conform to Art. 9.13, which states 'If no original material is extant or as long as it is missing, a neotype may be selected. A lectotype always takes precedence over a neotype, except as provided by Art. 9.16 and 9.19(c)' (Turland & al. 2018). Here we explain why the typification in Lange-Bertalot & Krammer (1987: 72) conflicts with Art 9.13. Smith (1850) described *E. hyndmannii* from the Lough Mourne deposit and only later added the sample from 'Cantyre Peat' to the material where he found additional specimens (Smith 1853: 12). Therefore, a lectotype should preferably be chosen from any extant Lough Mourne material. As we have demonstrated that slide IX-43-C4, designated as lectotype by Krammer (in Lange-Bertalot & Krammer 1987: 72), was actually made from 'Cantyre Peat' material, it should be therefore considered to be a neotype, and should be superseded by designating sample **BM** 83031 from Lough Mourne (=original type material) as lectotype.

Here, original material of *E. hyndmanii* was examined from several historic slides and raw materials held in the diatom collections of **BM** (The Natural History Museum, London, UK) and **BR** (Meise Botanic Garden, Belgium). The following samples were investigated: **BM** 83031 (Lough Mourne, Figs 1–4, 9), **BR** IX-43-C4 (Cantyre Peat, = Walker Arnott S 227, Fig. 14), **BR** IX-37-A1 (Cantyre Peat ashes, Walker Arnott, n°167, Figs 5–8), **BR** IX-43-C6 (small pond in Glen Felt near Shooting Lodge, Walker-Arnott, n°S271, Figs 15–20, 21–27, 38–43), and **LPC** (Museo de La Plata, "Joursac", Tempere and Peragallo II, slide 51, Figs 28–37).

Epithemia hyndmanii W.Smith (Smith 1850: 124)
≡ *Cystopleura hyndmanii* (W.Smith) Kuntze (1891: 891)
= *Epithemia hyndmanii* var. *perlonga* Héribaud (1903: 28)
= *Epithemia hyndmanii* var. *genuina* A.Cleve (1952: 40), *nom. inval*. (Turland & al. 2018, Art. 24.3)
Lectotype (**designated here**, taking precedence over the neotype "lectotype" by Krammer (in Lange-Bertalot & Krammer 1987, in conformity with Art. 9.13): **BM** 83031, *Epithemia*

hyndmanii W.Smith, 'Lough Mourne, leg. W.Smith' [Lough Mourne, near Carrickfergus, Co. Antrim, Northern Ireland] (Figs 1–4, 9).

Registration: https://phycobank.org/105639

Description: Valves arcuate, asymmetrical to apical axis, with convex dorsal and concave ventral margin, apices broadly rounded, not protracted. Length 48–196 µm, width 13–29 µm. Raphe positioned on valve mantle at apices and for ca. 1/3 of valve length at each end of valve, curving onto and positioned on valve face in ca. central 1/3 of valve. Raphe branches extending ca ½ the distance towards dorsal margin. Raphe with rim positioned in a groove. Axial area biarcuate. Striae punctate, parallel or slightly curved, composed of roundish to slightly irregular, complex areolae. Internally transapical ribs of equal width, 3–4 in 10 µm. 2–3 striae between transapical ribs. On dorsal side abrupt transition from valve face to mantle, striae continuing without interruption from valve face to mantle. Groove adjacent to raphe with many small spines. Several rounded pores of varying sizes on valve face and on mantle present in valve centre on ventral side of raphe branches, irregularly positioned or forming irregular rows. Cingulum composed of six plain copulae lacking perforations.

Epithemia perlonga Pantocsek (1892, pl. 16: fig. 238, 1905: 50) was described from freshwater at Bodos and Köpecz in Transylvania, Romania, and illustrated with a single line drawing (from Köpecz). Héribaud (1903: 28) described the new variety *Epithemia hyndmanii* var. *perlonga* from the Joursac deposits in the Auvergne, France, which was also listed in Héribaud (1908: 28). He referred to its similarity with Pantocsek's *E. perlonga* but noted that the latter has parallel valve margins. Tempère & Peragallo (1908) listed Héribaud's taxon from Joursac. *Epithemia hyndmanii* var. *perlonga* is almost certainly conspecific to the nominate form: 'On trouve, dans le dépôt de Joursac, une forme très semblable à l'*Epithemia perlonga* Pant., et qui se rattache certainement à l'*Epithemia Hyndmannii* W.Sm.; elle ne diffère de la Diatomée fossile de Hongrie (Pant. .. fig. 238) que par sa taille moins grande, et en ce que sa largeur décroît un peu du milieu vers les extrémités, tandi que l'*Epithemia perlonga* de Pantocsek a les bords parallèles' [In the Joursac deposit we find a form very similar to *Epithemia perlonga* Pant., and which is certainly related to *Epithemia Hyndmannii* W.Sm.; it differs from the fossil from Hungary (Pant. .. fig. 238) only by its smaller size, and in that its width decreases a little from the middle towards the valve ends, while Pantocsek's *Epithemia perlonga* has parallel valve margins]. Some catalogues report the name *Epithemia hyndmanii* (*hyndmannii*) var. *perlonga* (Pantocsek) Héribaud (see Mills 1934; VanLandingham 1969; Fourtanier & Kociolek 2011; Guiry & Guiry 2025), but this was never proposed by Héribaud.

Cleve-Euler (1952) provided four line-drawings (figs 1411 a, b, e, f) of *Epithemia hyndmanii* var. *genuina* A.Cleve ('α genuina'), *nom. inval.,* with the specimens in figs 1411 a, b being very similar to those in our Figs 10, 11. Specimens of Héribaud's taxon from Tempère & Peragallo II, slide 51 are presented in Figs 28–37. Kociolek & al. (2025) documented the size diminution series and valve ultrastructure of this species from Lake Cuithir, Scotland.

Based on literature data, the species has been regularly observed in Europe, USA and Japan. Cleve-Euler (1952) reported *E. hyndmanii* from a variety of places in Sweden and Finland and regarded it as typical of eutrophic (mineratrophic) clear-water lakes and mountain rivers. Several studies in southern Finland (e.g. Hyvärinen 1980, Haila & al. 1991, Meittinen & al. 1999) found it in sediment cores from southern Finland indicating the presence of a large freshwater lake (i.e. the Ancylus Lake). Werum & al. (2024) reported it to be widespread in fossil samples in temperate regions, but rarer extant, occurring in northern parts of Europe and in the Alps. Levkov & al. (2007) reported *E. hyndmanii* from Lake Prespa. The species is frequently found in the St. Naum Springs, adjacent to Lake Ohrid at its southern end. These springs are oligotrophic, carbonate rich with high

content of dissolved carbonates and conductivity of 400-500 µS/cm and have a temperature of 10-12 °C (Levkov pers. comm.). In the USA, Patrick & Reimer (1975) reported the species from Georgia, Texas, Tennessee, Illinois, California, Oregon and Washington, and in Japan it was found in lacustrine deposits of Owashi, Gujo City, Gifu and from the Tsumori Formation, Mashiki Town, Kumamoto (Tanaka 2014).

Epithemia proboscidea Kützing (1844: 35)

Type: Kociolek & al. (2024, figs 59–63) examined *Epithemia proboscidea* Kützing. (1844: 35, pl. 5, fig. XIII) material in **BM**. An image of the packet for the raw material was illustrated (Kociolek & al. 2024, fig. 63): '*Epithemia proboscidea* K. Lüneburg. Coll. Kütz. Diat.'. On the herbarium sheet where the packet has been mounted there are two pencil annotations, the first noting 'Slide no. BM 17810' and later, in a different hand, '& new slide'. The second annotation is most probably that of P.A. Sims, but the earlier handwriting cannot be identified. A single specimen of *Epithemia* is circled on the slide marked as 'Type' and designated as lectotype by Patrick & Reimer (1975: 181, "Im Bergmehl der Lünberger Haide!" […] Lectotype—Lüneburger Coll. Kützing # 906, B.M. 17810; see Kociolek & al. 2024, figs 59-61). Kociolek & al. (2024) concluded that these specimens are most likely those of *Epithemia picta* (Kützing) Brébisson (≡ *Frustulia picta* Kützing 1833). Other isolectotypes were noted (**BM** 17995, **BM** 18054, **BM** 18510) but not **BM** 82193, which is the 'new slide' referred to in the second annotation. **BM** 82193 is also marked as a type and was investigated here. The slide was labelled '*Epithemia proboscidea* Kütz., Lüneburg Coll. Kützing No. 906' and mounted by P.A. Sims (15.12.1966, Microps 163, Fig. 45). There are three valves within the circle on the slide with a strongly convex dorsal margin (Figs 46–48) similar to the specimen depicted in Kützing's drawings (1844, pl. 5, fig. XIII, reproduced in Kociolek & al. 2024, fig. 62, and here as Fig. 44). These specimens also resemble *Epithemia sorex* Kützing (Kützing 1844: 33, pl. 5, fig. XII: 5 a-c; Kociolek & al. 2024, figs 71–79). Kützing's drawings of *E. sorex* (Rabenhorst 1853, pl. I, fig. 7) and *E. proboscidea* (Kützing 1844, pl. 5, fig. XIII) show specimens that are similar in shape. The single specimen of *E. proboscidea* from slide **BM** 17810, illustrated in Kociolek & al. 2024 (figs 59–61), has more or less parallel valve margins, the dorsal margin is less convex, and the apices are more broadly rounded. Based on the specimens in slide **BM** 82193 and described below, *E. proboscidea* is likely conspecific with *E. sorex*.

Description: Valves arcuate, asymmetrical to apical axis, with strongly convex dorsal and concave ventral margin, apices protracted, rounded. Raphe positioned on valve mantle near apices and for ca. 1/3 of valve length at each end of valve, curving onto and positioned on valve face in ca. central 1/3 of valve. Axial area biarcuate. Raphe branches extending to dorsal margin. Striae punctate, parallel composed of roundish or quadrangular areolae.

Epithemia smithii Carruthers (in Gray 1864: 76, validating the illustration in Smith 1853, pl. I: fig. 8)

– *E. proboscidea* Kützing *sensu* W.Smith (1853: 13)

Type: **BR** V.30.C4 (W. Sm. 1853: 13, 'St. Ouen's Pond, Jersey, Aug.1852', lectotypified by K. Krammer 12.86, see Lange-Bertalot & Krammer, 1987: 72, 234, figs 4–6); **BM** 001222600 (raw material)

Description: Valves arcuate, asymmetrical to apical axis, with strongly convex dorsal and concave ventral margin, apices broadly rounded, slight protracted and slightly dorsally deflected. Length 34.5–49.0 µm, width 9.0–11.5 µm. Axial area biarcuate. Raphe positioned on valve mantle near apices curving onto and positioned on valve face in central ca. 1/3 of valve. Raphe branches extending to dorsal margin and bordered by a thin rim on the dorsal side. Striae punctate, more or less parallel, composed of roundish, quadrangular to slightly irregular, complex areolae. Areolae showing a dome-like covering, with volae observed on the latter. Siliceous

interconnections between the domed coverings present. Internally transapical ribs of unequal width and irregularly placed, wider ribs 4 in 10 µm. Two to four striae present between wider transapical ribs. On dorsal side abrupt transition from valve face to mantle, a small ridge occasionally present at dorsal valve face/mantle junction. Portules of the canal raphe rounded and of approximately the same size as the areolar openings. Kociolek & al. (2025) documented the valve morphology of this species in a population from Lake Tahoe, California.

Note: Carruthers in Gray (1864: 76) considered *Epithemia proboscidea* Kütz. *sensu* Smith (1853: 13, pl. I, figs 8a, b) to be a taxonomic novelty that was not conspecific with the original specimens of *E. proboscidea* Kützing (Kützing 1844: 35, pl. 5: fig. 13). Therefore, he referred to his new species as '*E. proboscidea*, Sm., not Kütz., Smith, Br. Diat. t. 1. f. 8' (Fig. 49), and he proposed *Epithemia smithii* for the Smith material. In this contribution, specimens from the lectotype slide **BR** V.30.C4 (Fig. 50, 'W.Sm. 1853: 13, St. Ouen's Pond, Jersey, Aug. 1852', lectotypified by K. Krammer 12.86, see Lange-Bertalot & Krammer, 1987: 72, 234, figs 4-6) are here documented as Figs 51–56. Later, Kuntze (1891: 891) made the combination in *Cystopleura* Brébisson: *Cystopleura smithii* (Carruthers) Kuntze.

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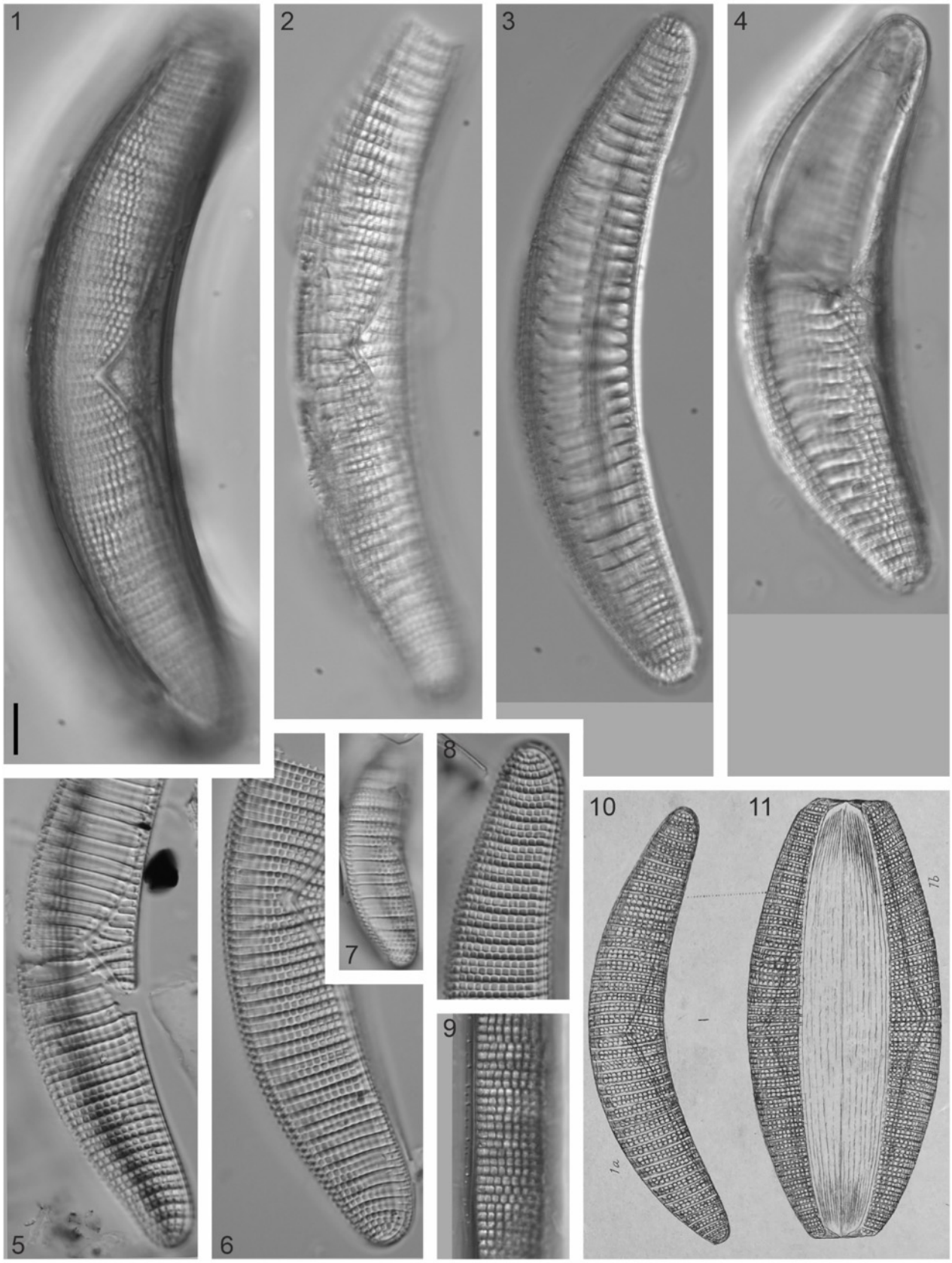
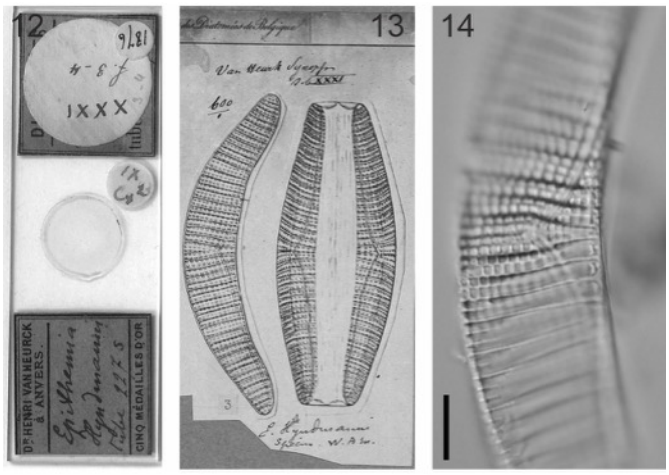
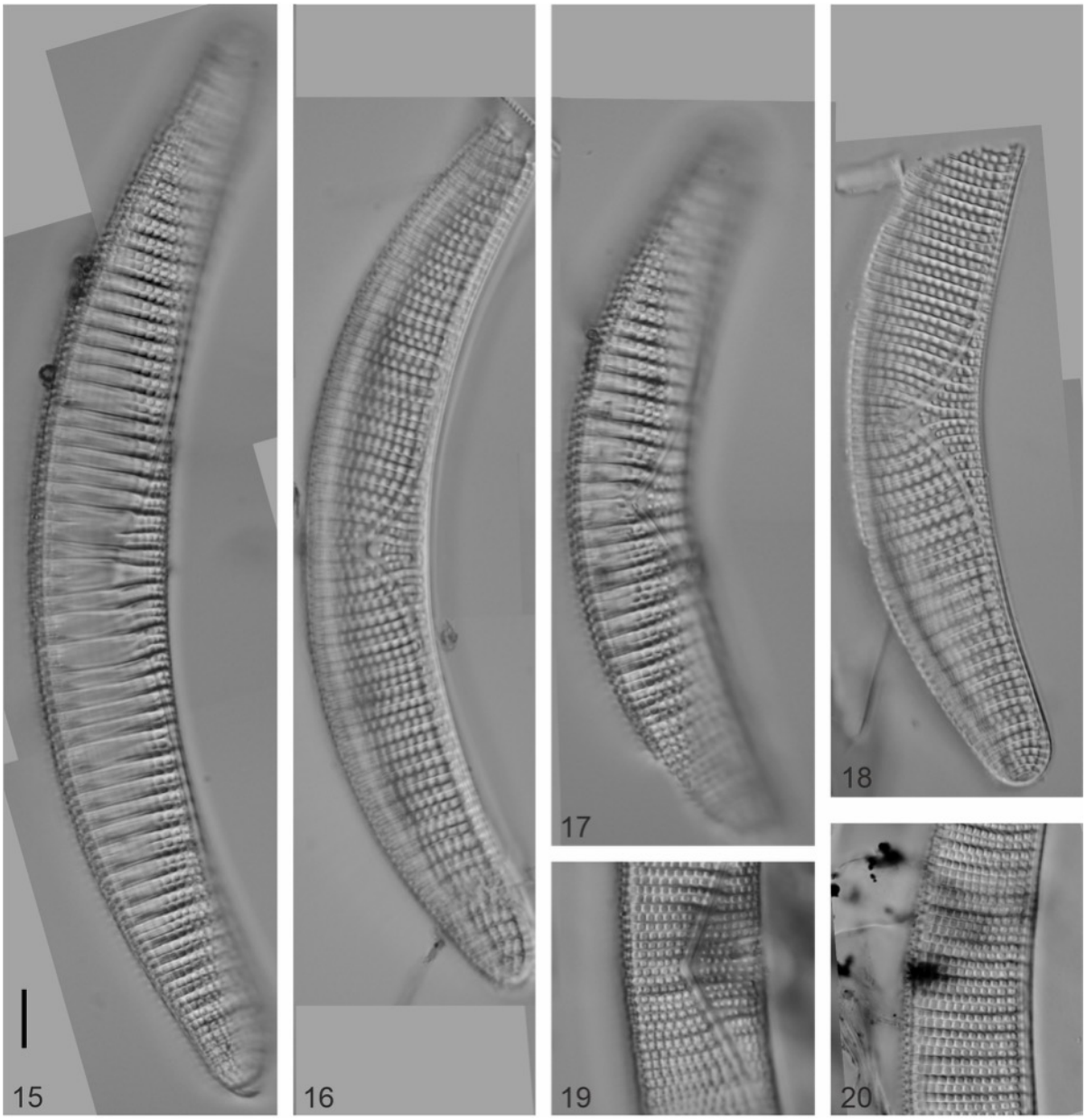


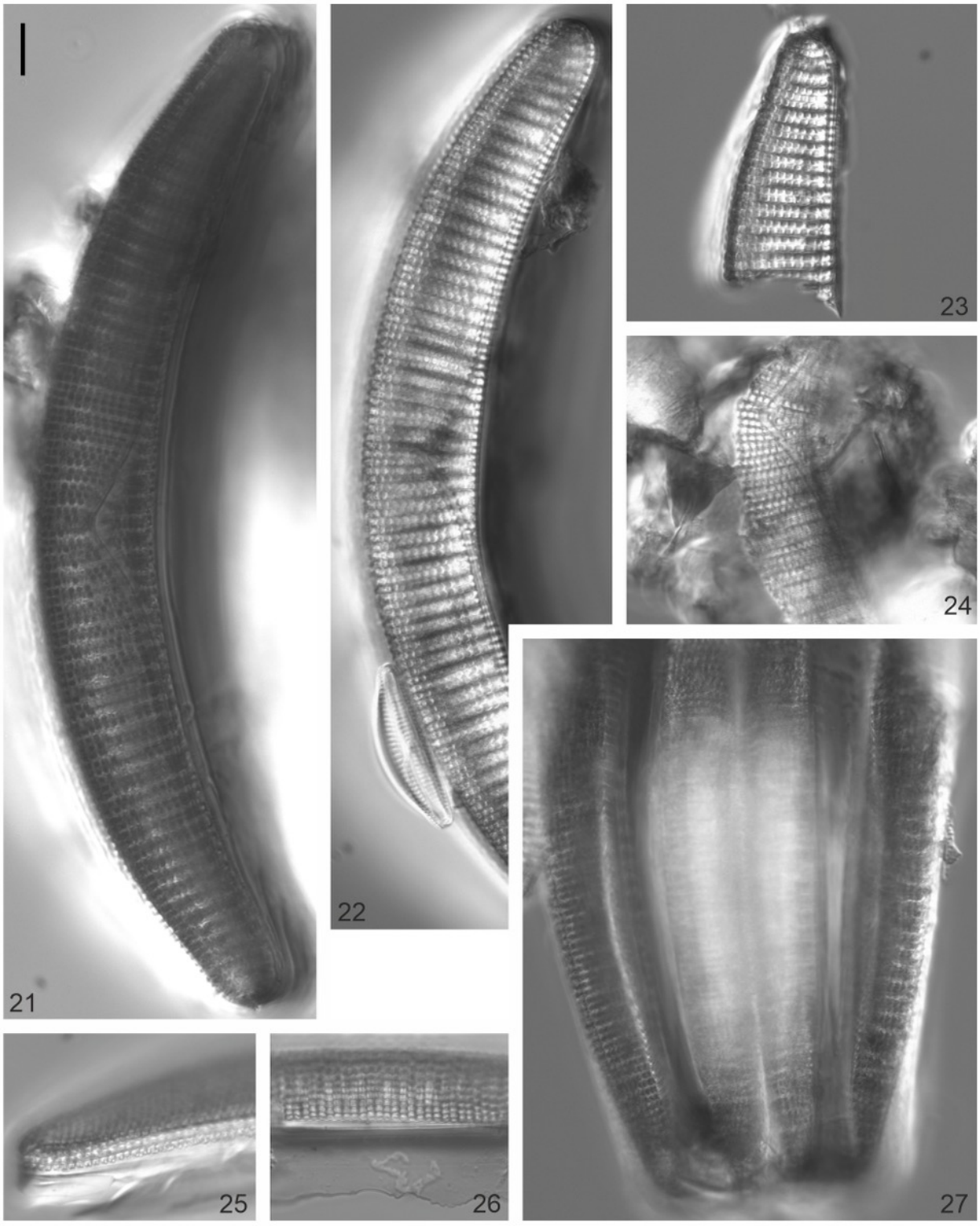
Figs 1–11. *Epithemia hyndmanii* W. Smith LM. Figs 1–9. LM. Valve views. **Figs 1–4, 9.** BM 83031, **Figs 5-8.** BR IX-37-A1, **Figs 10–11.** Reproduction of drawings in Smith (1853), pl. I, 1a, b.



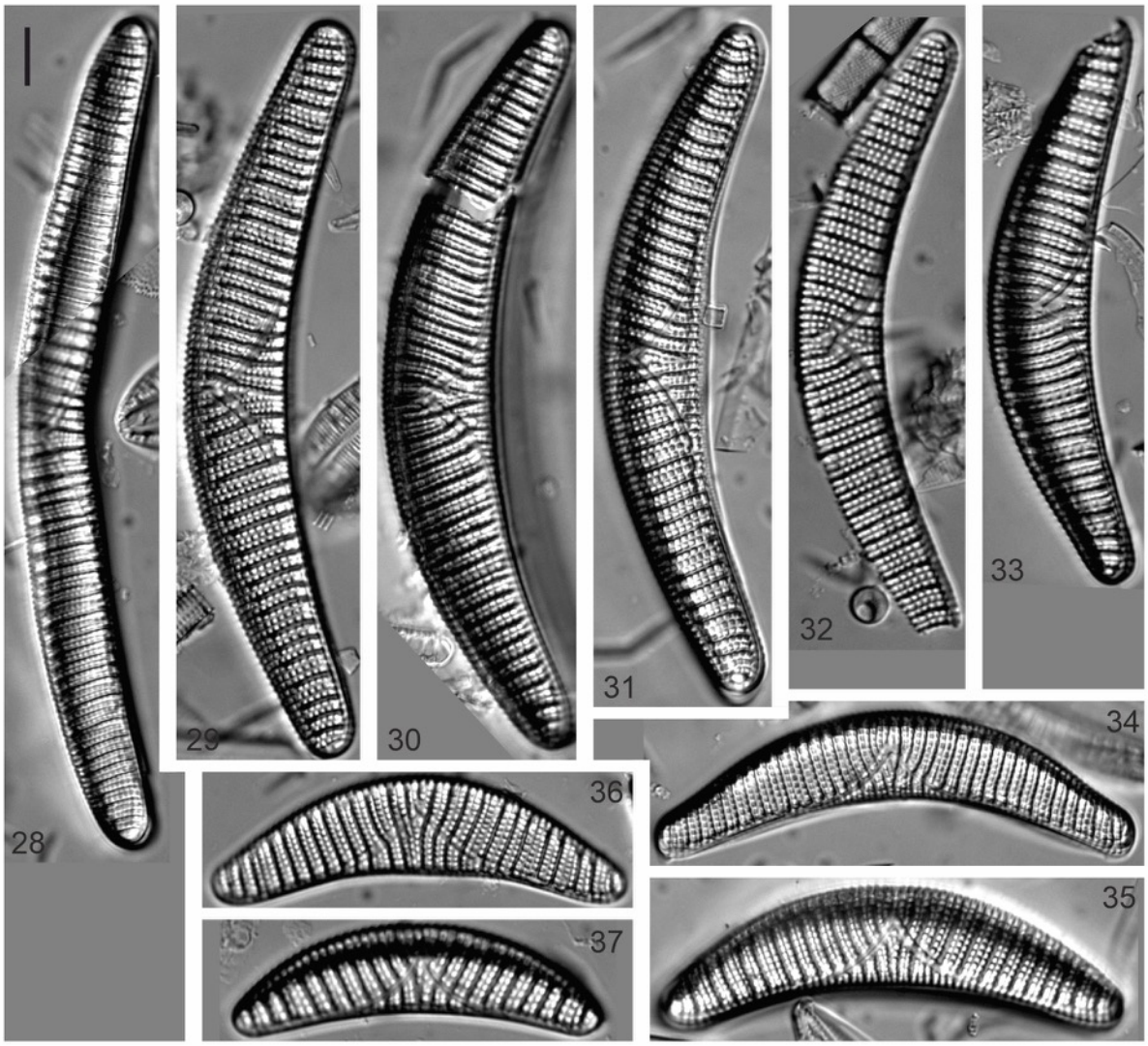
Figs 12–14. *Epithemia hyndmanii* W. Smith. **Fig. 12.** Slide BR IX-43-C4 (Cantyre Peat = Walker Arnott S 227) designated by Krammer (in Lange-Bertalot & Krammer 1985) as neotype "lectotype". **Fig. 13.** Original drawings from the Grunow collection in **W.** **Fig. 14.** Fragment on slide BR IX-43-C4.



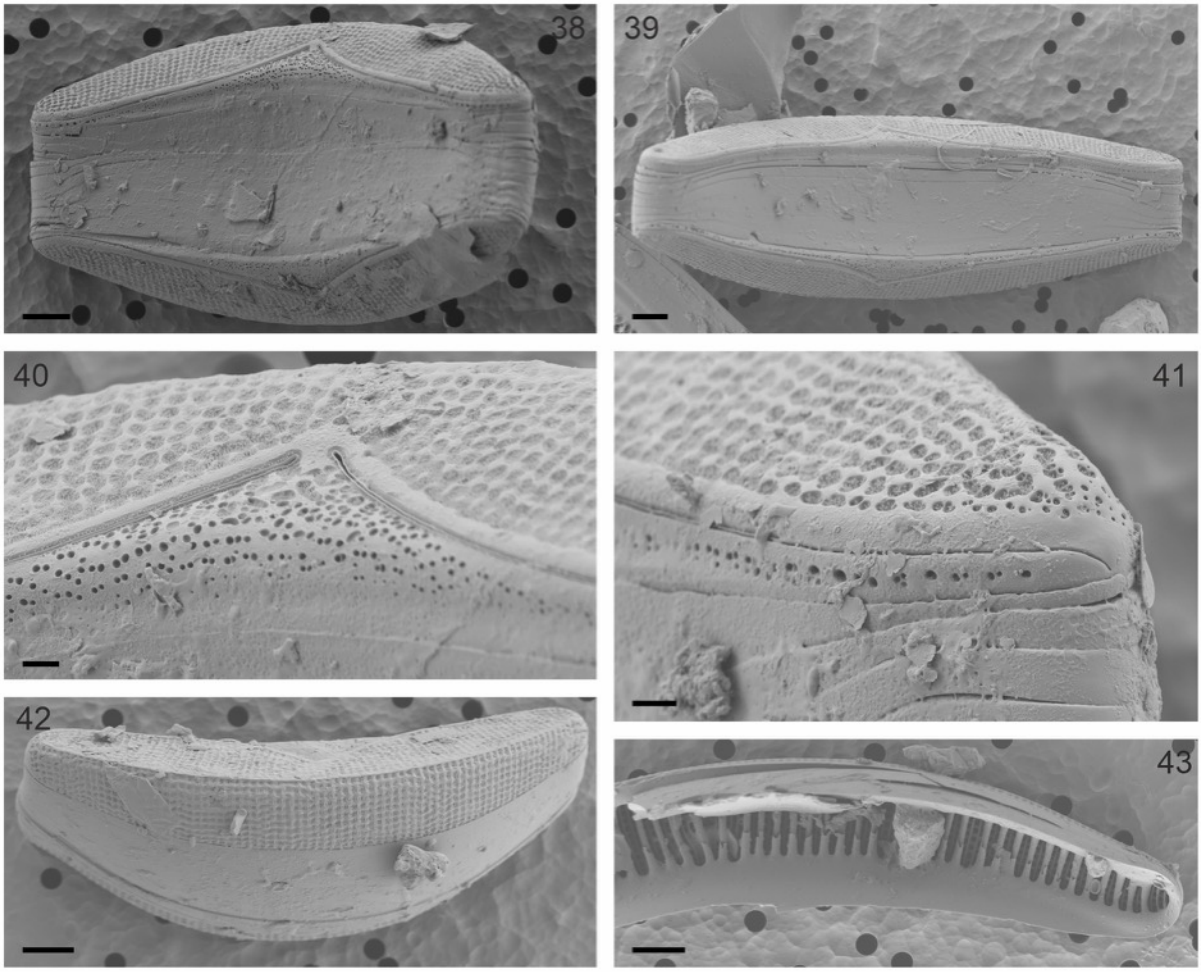
Figs 15–20. *Epithemia hyndmanii* W. Smith LM. LM. Valve views. BR IX-43-C6.



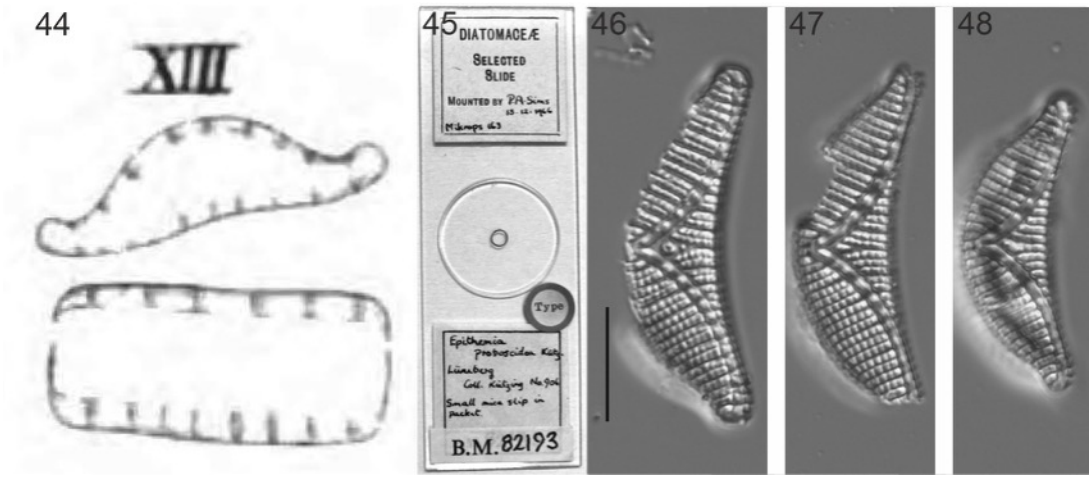
Figs 21–27. *Epithemia hyndmanii* W. Smith LM. Walker-Arnott, n°S271. LM. **Figs 21–24.** Valve views. **Figs 25, 26.** Views of the ventral and dorsal mantle. **Fig. 27.** View of the frustule seen from the dorsal side.



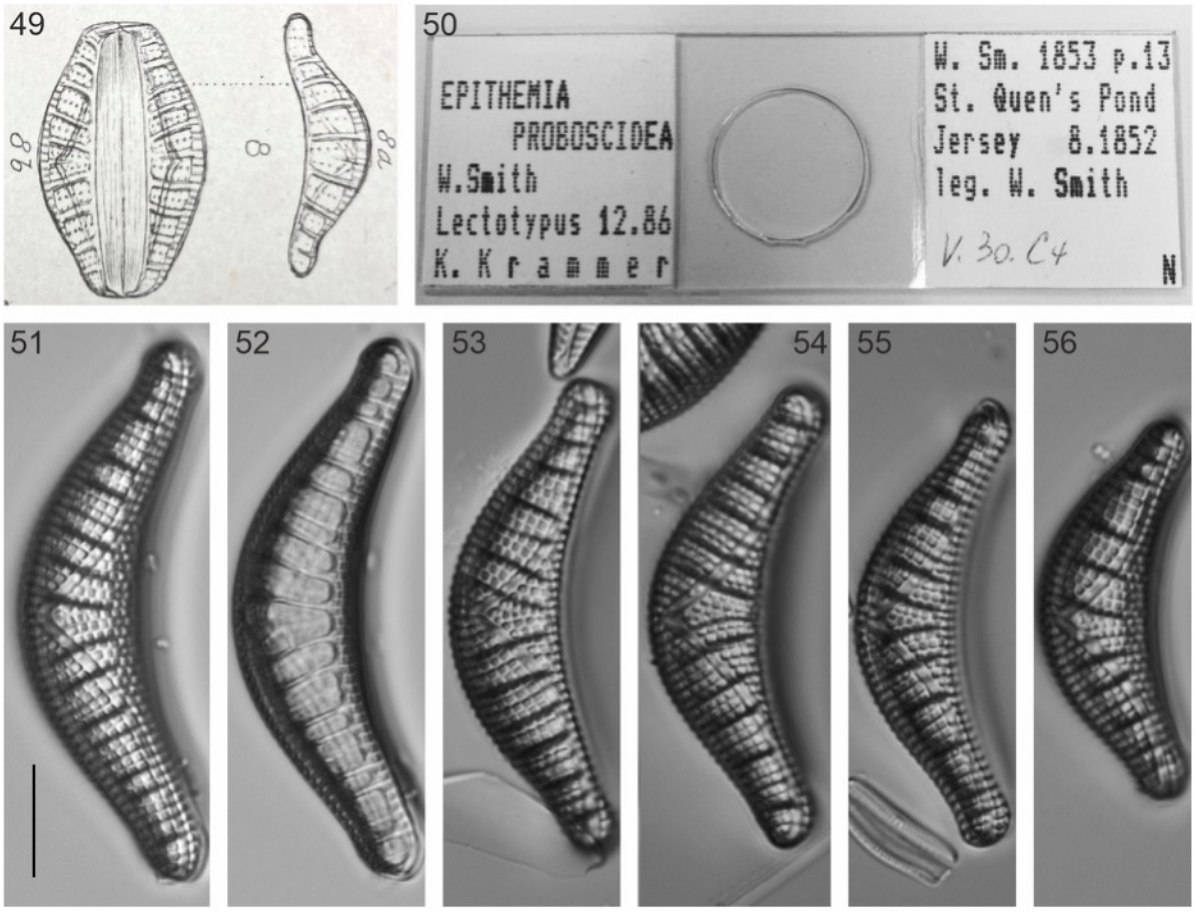
Figs 28–37. *Epithemia hyndmanii* W. Smith LM. Valve views. "Joursac", Tempere and Peragallo II, slide 51.



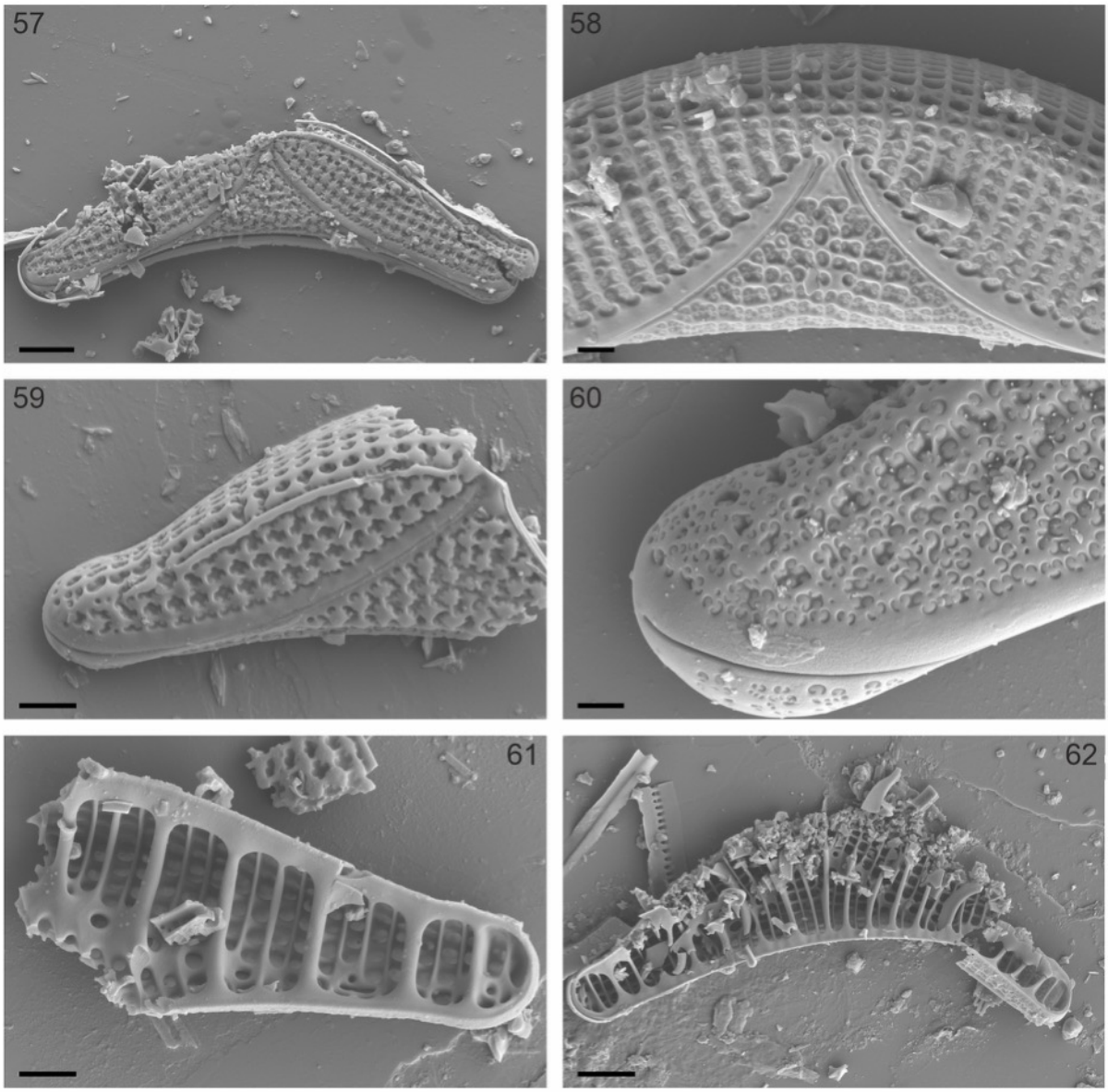
Figs 38–43. *Epithemia hyndmanii* W. Smith SEM. Walker-Arnott, n°S271. SEM. **Figs 38, 39.** Frustules showing valve face, mantle and bands from the ventral side. **Figs 40, 41.** View of valve face, raphe and ventral mantle. **Fig. 42.** Frustule showing valve face, mantle and bands from the dorsal side. **Fig. 43.** Inside view of valve showing transapical ribs. Scale bars: Figs 35, 36, 39, 40 = 10 µm, Figs 37, 38 = 2 µm.



Figs 44–48. *Epithemia proboscidea* Kütz. **Fig. 44.** Line drawing in Kützing 1844, pl. 5, fig. XIII. **Fig. 45.** Type slide BM 82193, Lüneburg ('Lüneberg'), Coll. Kützing No. 906. **Figs 46–48**. LM images taken of 3 specimens found inside the circle on the type slide.



Figs 49–56. *Epithemia smithii* Carruth. – *Epithemia proboscidea* Kütz. sensu Smith (1853). **Fig. 49.** Drawing in Smith (1853, pl.1, Fig. 8a, b). **Fig. 50.** Slide of the lectotype, BR V.30.C4, St. Ouen's Pond, Jersey, 8.1852, leg. W.Smith. **Figs 51–56.** LM images taken of specimens on the lectotype slide, Valve views.



Figs 57–62. *Epithemia smithii* Carruth. – *Epithemia proboscidea* Kütz. sensu Smith (1853). SEM images taken of specimens in material **BM** 001222600, St. Ouen's Pond, Jersey, 8. 1852. **Figs 57–60.** External views of valve showing the raphe, striae and areolae, and dorsal mantle. **Figs 61, 62.** Internal view of valve showing the transapical ribs. Scale bars: Figs 54, 59 = 4 µm, Figs 56, 58 = 2 µm, Figs 55, 57 = 1 µm.