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Marine benthic diatoms of Guam: new records, *Dictyoneis apapae* sp. nov., and updates to the checklist [1]

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Abstract— This paper adds 25 new records to the Guam flora and corrects some earlier identifications, bringing the total number of identified taxa to 378, and provides a reference list of species added in taxonomic papers since the last records paper in 2015, nomenclatural updates on the species and higher taxa recorded in earlier reports, and a list of slides of Guam samples deposited in U.S. diatom herbaria. Of particular interest are: *Campylodiscus robertsianus*; *Amphora subhyalina*, which we show to have priority over *A. insulana*; *Coscinodiscus hauckii,* which we show to have no perforations in the central zone, nor rimoportulae; understudied species including *Biremis ridicula*, *Mastogloia* cf. *pisciculus, Nitzschia* cf. *jelinecki,* and genera including *Vikingea* and *Dictyoneis*. We describe *Dictyoneis apapae* sp. nov., a lanceolate species distinguished from the panduriform species by the external pattern of pseudoloculi and valve shape.

Introduction

When *Micronesica* published a collection of checklists of marine organisms (Paulay 2003a), the microscopic flora and fauna were conspicuous by their absence (Paulay 2003b). In the intervening 20 years there has been increasing awareness of the importance of biodiversity of microeukaryotes in coral reef ecology (Ainsworth et al. 2017). The importance of rare taxa in microbial communities is now recognized in the term "rare biosphere" (Logares et al. 2014): in eukaryotic microbial communities most taxa are usually rare, but the high-throughput technologies needed to study the immense diversity tell little about the organisms themselves. Implicit in checklists of organisms for a given place is an expectation that within a flora there can be cosmopolitan, zonal and local species (Risjani et al. 2021). However, direct evidence for endemicity among microbial eukaryotes is impossible to obtain (Finlay et al. 2002) and indirect evidence hard to adduce. The biogeographic question is not just whether there is or is not a regional endemic component to the microbial flora of, say, diatoms in Micronesia, but which are the potentially endemic taxa? There is now some evidence of endemicity in microbial communities (Foissner & Hawksworth 2009), mostly from freshwater systems, including diatoms (Vanormelingen et al. 2007, Williams & Kociolek 2017), but so far very limited evidence on regional endemicity in marine diatoms. Evidence for regional endemicity in a flora may be sought in genera or higher taxa over local scale (e.g., *Homoeocladia* between Micronesian islands: Lobban et al. 2023) or larger regions (e.g., *Licmophora* floras of Western Pacific vs Atlantic / Mediterranean: Lobban & Santos 2022). Among the marine microalgae, only

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diatoms have been studied in Micronesia except for two isolated papers on other groups (Lobban et al. 1995, Konno et al. 2019). The goals of biodiversity research include (1) identifying common taxa; (2) finding and identifying rare (potentially endemic) taxa; and (3) recognizing and describing new species, often with taxonomic and systematic benefits.

The Western Pacific Diatoms Project is an ongoing project started in 2007, focused on marine benthic taxa across Micronesia, with three new-records papers to date (Navarro & Lobban 2009, Lobban et al. 2012, Lobban 2015a) and many new species described (a list of those added since the 2015 records paper is given in Appendix 2). A paper on new species from Guam and Yap was recently published (Lobban 2021a), two papers on Chuuk were published (J.S.Park et al. 2018, 2022), and a major paper with additions to the flora of Yap is in preparation. The present report also summarizes nomenclatural changes to taxa in our flora and corrects errors in taxa misidentified in earlier reports.

Methods

The results reported here come from further analysis of samples in the Diatom Collection of the University of Guam Herbarium (GUAM). Collection sites and standard preparation and observation procedures for LM and SEM have been described elsewhere (most recently Lobban 2021b). Guam sample numbers are coded for the island/entity (GU = Guam), a number for the locality, a sequential alphabetical code for the collection date (at the main study sites now in the third time through the alphabet) and, following a hyphen, the bag number from that day, e.g., GU52Q-10. A map and list of the collection sites in Guam was included in Lobban et al. (2012) and a regional map in Lobban et al. (2023).

Terminology follows the standard definitions in Anon (1975) and Ross et al. (1979). In referring to the different valves in monoraphid diatoms we use the terms and abbreviations from Riaux-Gobin et al. (2011): raphe valve (RV) and sternum valve (SV).

Results

Results are presented in alphabetical order of genera. Five Appendices summarize (1) taxa removed from the flora; (2) species added in taxonomic papers since the previous checklist (Lobban 2015a); (3) nomenclatural changes affecting our previous records; (4) classification changes since 2012 of significance to our flora; and (5) list of slides of Guam samples in US diatom herbaria.

Actinocyclus cuneiformis (Wallich) F. Gómez, Lu Wang & Senjie Lin Figs 1, 2

Basionym.: *Hemidiscus cuneiformis* Wallich

Ref. illus.: Hustedt 1927–1930, p. 904, fig. 542d; Ricard 1987, Figs 30–34; the images in Round et al. 1990, pp. 192–193, are also evidently this species; Gómez et al. 2017, figs 1–23

Samples: GU66F-4

Dimensions: long axis 71–74 µm, short axis 41–45 µm

Diagnostics: Distinctively shaped, lens-shaped in valve view but the frustules wedge-shaped (cuneiform) because the valve faces are at an angle to one another. Areolae with a series of radiating patterns around the margin, especially on the more strongly curved side. Large rimoportulae visible in the oblique view. A pseudonodulus is present on the flatter side.

Comments: Two valves observed in one sample. The ventral curvatures of *A. cuneiformis* vary from straight to sinuous and Hustedt (1927–1931) combined several older *Eudotia* species as varieties. Although Round et al. (1990) say that the *valves* are cuneiform, it seems to us that Wallich's (1860) epithet refers to the shape of the frustule (described by Round et al. 1990 as "shaped like orange segments"), rather than to the shape of the valve. The genus *Hemidiscus* was subsumed into

Actinocyclus by Gómez et al. (2017); they did not discuss any varieties of *H. cuneiformis* but their images, like ours, conform to var. *ventricosa* (Castracane) Hustedt. We have therefore omitted any varietal designation.

Amphora spectabilis Gregory Figs 3, 4

Ref. illus.: Levkov 2009, p. 265, pl. 114, figs 1–5, pl. 252, figs 1–5 (SEM).

Samples: GU55B-5

Dimensions: Length 30 µm, width 12 µm, stria density 8 in 10 µm (dorsal) and 13 in 10 µm (ventral)

Diagnostics: More strongly and coarsely striated on the dorsal surface, dorsal striae often biseriate and bifurcating towards the sternum, ventral striae uniseriate.

Comment: Our specimens (seen also in Yap and Palau) are much shorter than the 68–129 µm given by Levkov (2009). A Palauan specimen (Fig. 4) seen in SEM shows that the striae are mostly biseriate, the bifurcations resulting from the two rows diverging; these images conform to the specimens shown by Levkov in SEM.

Amphora subhyalina Podzorski & Håkansson Figs 5–7

Syn.: *Amphora insulana* Stepanek & Kociolek

Ref. illus.: Podzorski & Håkansson 1987, p. 52; pl. 15, fig. 10, pl. 51, figs 7, 8; Stepanek & Kociolek 2018, p. 14, pl. 5, figs 13–16, pl. 8, figs 1–4.

Samples: GU44Y-13, GU44Z-15, GU52Q-1a, GU66G-2, GU68A-2

Dimensions: Length 27–45 µm, width 7–8 µm; dorsal striae 36 in 10 µm in the middle increasing to 39 toward the apices, ventral striae 38 in 10 µm.

Diagnostics: Valves and copulae frequently forming a hyaline oval pattern in LM. In SEM, more prominent elongated areolae on either side of the dorsal rib with the rest of the dorsal striae comprising small areolae; prominent conopea at the central raphe endings.

Comments: As far as we can tell from the SEM illustrations of valves in Podzorski & Håkansson (1987) and Stepanek & Kociolek (2018), the same species is being described and therefore the former name has priority. Although clearly shown in SEM by Stepanek & Kociolek (2018), they did not include a written description of ultrastructure. Podzorski & Håkansson (1987), although showing SEMs, also did not specify stria densities. Our SEM images show dorsal striae of irregular transapical slits, ending with a long, prominent slit at valve margin, mantle sharply delimited by a ridge and bearing a similar series of prominent slits (Figs 6, 7). Small central area on dorsal side of central nodule, and central striae somewhat more prominent. Ventral valve face with single row of slit-like areolae, interrupted by a conopeum developed ventrally and the ventrally deflected raphe. Internally, as shown in Stepanek & Kociolek (2018, pl. 8, fig. 4) the proximal raphe endings are straight. The girdle bands have a single line of slits along the narrow ventral part and faint striae on the wide dorsal part (Fig. 7 arrow). The lack of a ventral raphe ledge is indicative of *Halamphora* rather than *Amphora,* as summarized by Stepanek & Kociolek (2018, pp. 8–9 vs 28–29), but the broad girdle bands are indicative of *Amphora.* Neither Podzorski & Håkansson (1987) nor Stepanek & Kociolek (2018) showed girdle bands. Their materials were, respectively, from Palawan (Philippines) and Florida Keys.

These fairly large, hyaline frustules resemble *Halamphora hyalina* (Kützing) Rimet & R.Jahn (Rimet et al. 2018) and *Halamphora pseudohyalina* (Simonsen) Stepanek & Kociolek (2018) (neither yet recorded from our region) in the presence of the distinct central area and a ventral surface; *H. pseudohyalina* has fine dorsal striae 28–30 in 10 µm barely distinguished in LM and ventral striae ca 65 in 10 µm, whereas as *H. hyalina* and *A. vaughanii* Giffen have clearly visible striae, 20–23 in

10 µm and 28–30 in 10 µm, respectively. *Amphora hyalina*, reported from Yap by Navarro & Lobban (2009, figs 97, 98), has an exposed, dorsally deflected raphe with a conopeum extending dorsally on the dorsal raphe ledge; the striae are finely biseriate, the areolae consistently small, apically-elongated slits. *Amphora vaughanii* was recorded from Guam (Lobban et al. 2012, pl. 56, figs 7–9), it has biseriate striae of very fine pores on the dorsal surface and a line of very closely spaced slits on the mantle, conopea absent; its position in *Halamphora* or *Amphora* has not yet been considered.

Auricula densistriata Osada Figs 8, 9

Lobban et al. (2012) reported *A. complexa* (Gregory) Cleve from Guam, but J.S.Park et al. (2018) noted that the valve size and stria density of the voucher specimens match *Auricula densistriata* K. Osada (Osada 1997). Stria density for *A. complexa* is 15–20 in 10 µm (Peragallo & Peragallo 1897–1908), but Lobban et al. reported 26–28 in 10 µm. In SEM (Figs 8, 9) we measured 27 striae. *Auricula complexa* species was correctly reported from Federated States of Micronesia—Yap by Navarro & Lobban (2009) and Chuuk by Park et al. (2022)—and may well be present in Guam but we have no evidence of it, so for now remove it from the flora.

"*Bacillaria* Group B" sensu Schmid var. *tumidula* Figs 10–14

Previous Micronesian record: J.S.Park et al. 2022, p. 45, figs 144, 145

Samples: GU21AM-2, GU21AN-1; GU52J-3, GU52K-4, GU52S-2; GU58G-4D

Diagnostics: Colonial, as in *B. paxillifera*, the "slide rule" diatom, but inflated in the middle. Uniseriate striae with external costae.

Comment: As noted by Lobban et al. (2012) for the nominate form, marine forms were orphaned when Jahn & Schmid (2007) redefined *B. paxillifera* as freshwater/brackish, naming several new species, but excluding three marine groups distinguished by Schmid (2007). Our assignment of this variety to Group B, based on the nominate form, has not been verified and remains in limbo until Jahn completes her analysis. The short cristae at the central area are characteristic but we have images of specimens without them and without costae; further progress awaits completion of work on this group.

Berkeleya cf. *hyalina* (Round & M.E.Brooks) Cox Figs 15–25

Ref. illus.: Round & Brooks 1973, figs 1–4, 6–16; Cox 1975a, figs 7, 33, 35; Cox 1975b, figs 9, 18, 22, 23; Chastain & Stewart 1985, figs 1–14; Lobban 1985, figs 3–5; Witkowski et al. 2000, p. 156, pl.62, fig. 22

Samples: GU77A-2

Observations: Colonial (tube-dwelling) species forming wide, branched colonies with many narrow tubes bundled together, each narrow tube containing a single file of cells (Figs 15–17); plastids H-shaped (Fig. 18). Valves hyaline, 45–51 µm long, 6 µm wide, striae parallel except convergent near apices, 37 in 10 µm. Cells linear-lanceolate with broadly rounded ends (Fig. 19). In SEM, striae parallel except radiate near the apices, areolae quadrangular except a row of larger areolae along one side of the raphe (Figs 20, 21). Central raphe endings separated by 7.1–8.6 µm, curved slightly away from the side with the larger areolae.

Comments: These microscopic colonies are very much smaller than those in southern California but that is not unusual for Guam tube-dwelling diatoms (so far only *Homoeocladia* [*Nitzschia*] *martiana* C.Agardh colonies found at seaweed size; Lobban & Tsuda 1993). Our cells appear to differ from *B. hyalina* in larger size, wider separation of central raphe endings and shape of the apex, from *B. fragilis* in shape and longer central area, and from *B. micans*, which is longer but narrower with coarser striae and very long central area (Table 1). However, variability in some of these characters warrants caution.

Table 1. Comparison of *Berkeleya* populations

Character	***hyalina* - Togo**	***hyalina* - So. Cal**	**cf. *hyalina* - Guam**	***micans***	***fragilis***
length	30–35	25–40	45–51	70–85	40–90
width	5	5-7	6	4–5	4-6
valve shape	lanceolate	lanceolate	lanceolate?	+/- linear	linear to linear-lanceolate
apex shape	slightly capitate	capitate	broadly rounded	obtuse	obtuse
stria density in 10 µm	>40	32-38	37	26-28	ca. 40
wide pores on one side of axis	yes	yes	yes	yes	yes
distance between central endings, µm	5	3-5	7.1–8.6	10–20	4-5

First, there are discrepancies between Chastain & Stewart's (1985) California populations compared to type material, some of them noted by those authors, i.e., the stria density, the shape of the apex, and the extent of the axial row of enlarged areolae. The difference in stria density might be significant but Chastain and Stewart's statement is broad and imprecise ("approximately 32–38" in 10 µm), and Round & Brooks' is even more vague ("more than 40"). Lobban (1985) in a floristic survey including southern California, reported striae of *B. hyalina* to be "ca. 45 in 10 µm… visible only in the electron microscope" but no SEM was published. Perhaps a more significant difference lies in the hemilanceolate depression formed by the very long areolae in San Diego populations, which Chastain & Stewart noted as a "signal feature," though saying that "the row of enlarged pores… appears to be somewhat more prominent" than in the type material. All species of *Berkeleya* in Table 1 are reported in the literature to have a row of enlarged areolae along one side of the raphe, so what is distinctive in the San Diego populations is the width and the depression. Round & Brooks (1973, figs 7, 8, 15) noted that the larger pores appeared to be in a "slight depression;" the pores are trapezoidal, wider toward the axis. Chastain & Stewart (1985, figs 6, 10) show a single row of larger areolae in their TEM (fig. 6) but in the SEM (fig. 10) most in the widest part are divided. We have seen such depressed zones in a few samples that we could not identify to species (Figs 24, 25) and even, rarely, in the present colony. In all these, the distance between central raphe endings was <7 µm but perhaps not significantly different from the majority of the colony (in the two specimens in Figs 24, 25 = 4.2 and 6.2 µm but in Guam specimens up to 6.7 µm). This brings into question whether the depressed area is a consistent enough character to use for taxonomy, and how much distance between central raphe is needed to separate species. Chastain & Stewart noted the great difference in latitude and water temperature between Togo (type locality) and San Diego, to which we might add, the different ocean basins.

Second, there are the differences between our material and both of the other two populations which require additional material from Guam and re-examination of type material (or better, more samples from Togo as well!). At this point both the Guam and Togo populations can be considered inadequately studied. The biggest problem with the Togo material is the vague stria density given by Round & Brooks; we tried counting it from the published images (Round & Brooks 1973, figs 8, 15) and got answers very much higher than the >40 given, but only magnifications are given for the images and perhaps the plates were reduced in publication without correction of the captions. Thus, we have identified our specimens only as "cf. *hyalina*" and shown their morphology for future reference.

Biddulphiella tridens (Ehrenberg) Ashworth & Sims Figs 26–29

Syn.: *Biddulphia tridens* (Ehrenberg) Ehrenberg

Biddulphia tuomeyi (J.W. Bailey) Roper

Ref. illus.: Schmidt et al. 1874–1959, pl. 118, figs 1–7 and pl. 119, figs 1–6; Peragallo & Peragallo 1897–1908, pl. 94, fig. 2; Hustedt 1927–1930, fig. 491; Navarro 1981, fig. 15; Lobban & Jordan 2010, fig. 5q, 5r (all as *B. tuomeyi*); López Fuerte et al. 2010, pl. 12, figs 6–7; Ashworth et al. 2013, figs 5b, 5i; Sims et al. 2023, fig. 13

Samples: GU7Y-4

Dimensions: Length 42–63 µm, width 27–30 µm

Diagnostics: Deeply sculpted valve in girdle view, central dome flanked by two smaller ones that abut or are themselves separated from the tall pseudocellus-bearing horns on the two poles. Many spines on the domes and the central dome with two rimoportulae with very long external tubes. The deep grooves (sulci) (Fig. 29) were used to distinguish *Biddulphiella* from *Biddulphia* (Sims et al. 2023).

Comments: Differs from *Biddulphia biddulphiana* (J.E.Smith) Boyer (Navarro & Lobban 2009, figs 28–31) in the more elongate, rostrate valve outline and number of domes. VanLandingham (1968, p. 562) commented on which specific epithet had priority and listed the extensive synonymy under *B. tridens*.

Biremis ambigua (Cleve) D.G.Mann Figs 30, 31

Ref. illus.: Cox 1990, figs 19–28; Sabbe et al. 1995, figs 34, 35, 38, 51, 52; Witkowski et al. 2000, p. 158, pl. 155, figs 2–6; Tatarek & Wiktor 2005

Samples: GU52O-4

Dimensions: Length 38–54 µm, width ca. 6 µm; striae 9–10 in 10 µm

Diagnostics: Linear, symmetrical valve, similar in size and stria density to *B. ridicula* (see below), which is strongly asymmetrical.

Comments: *Biremis* is characterized by alveolate striae. Several smaller species have been observed but not yet identified.

Biremis ridicula (Giffen) D.G. Mann Figs 32–37

Ref. illus.: Giffen 1976, figs 10–13 (as *Amphora ridicula*); Round et al. 1990 pp. 548–549 (figs c, d, but not identified to species); Witkowski et al. 2000, pl. 154, figs 14–16

Samples: GU52O-4

Dimensions: Length 46–74 µm, width of valve 9 µm, width of frustule in girdle view 24 µm; striae 7 in 10 µm

Diagnostics: *Amphora*-like frustule, asymmetrical (Figs 32, 35). Valve asymmetrical (Figs 34, 36), lanceolate, with short, broad striae along each margin and the raphe strongly displaced to the "ventral" striae, leaving strongly asymmetrical axial area. Striae alveolate (Fig. 37).

Comments: This species is similar in size and stria density to *Biremis ambigua* (see above), but that species is symmetrical. The relatively large frustules are shaped like *Amphora arenaria* Donkin, with which it co-occurred in this sample from calcareous sand, but the striae are very distinctive. Round et al. (1990) described the areolae in this genus as consisting of two incompletely separated chambers, closed internally by a cribrum, and opening externally by slit-like foramina, one at each end of the areola, resulting in two longitudinal lines that are the most evident feature in external SEM views. Witkowski et al. (2000) mention this species being reported only from South Africa and the North Sea (Europe), populations for which there is no SEM yet; a comparison needs to be made to confirm the identity of the Guam specimens.

Campylodiscus robertsianus Greville Fig. 38

Refs.: Greville 1863, p. 14, pl. I, fig. 5; Schmidt et al. 1874–1959, pl. 17, figs 8, 9; pl. 207, fig. 22; Williams 1988, pl. 27, figs 3, 4

Samples: GU74B-4

Dimensions: Diam. 100 µm

Diagnostics: Lines of large, paired oval pores running along lines from the margin to the central area.

Comments: Greville noted that the most similar species is *C. diplostictus* G.Norman ex Greville (Williams 1988, pl. 26, figs 5, 6), but that species is twice the diameter and has many interpolated short "striae" not present in our specimen. Despite some vague topography in the central space, compared to completely hyaline in Greville's (1863) drawing, we are satisfied that we have *C. robertsianus*. The character of these pores (called punctae or granules by Peragallo & Peragallo 1897–1908) seems not to have been studied in SEM.

Arrangement of pores distinguish *C. robertsianus* from species with scattered pores, such as *Coronia daemeliana* (Grunow) Ruck & Guiry, already transferred from *Campylodiscus*. *Campylodiscus robertsianus* is one of several taxa present in the Guam flora and lacking infundibula that most likely qualify for transfer to *Coronia* but were not studied by Ruck et al. (2016a, b, Ruck & Guiry 2016), i.e., *Campylodiscus decorus* var. *pinnatus* (the species was transferred but not the variety), *C. humilis* and *C. brightwellii* in our flora. Park et al. (2018) already transferred the first of these to *Coronia decora* var. *pinnata* (Peragallo) Lobban & JoonS.Park, and we are tempted to propose here the transfer of *C. robertsianus*. However, Ruck & Guiry (2016) gave no unambiguous morphological diagnosis for *Coronia,* relying instead on sequence data. Nomenclaturally, while a variety must go with its parent species when the species is transferred, transferring *C. robertsianus* would require a decision that this species accords with the new genus, which is uncertain in the absence of molecular data. This species was described from Queensland, Australia and has been reported from Samoa. Greville (1863) delighted in it as "one of the most exquisite species of this charming genus." We have only this single specimen from Guam and a fragment from Yap, both in LM.

Cocconeis carinata Riaux-Gobin, Ector & Witkowski Figs 39–41

Ref. illus.: Riaux-Gobin et al. 2019, figs 1–35

Samples: GU70A-2A, GU68A-2, inter alia

Dimensions: Length 8 µm, width 5 µm; stria density 26 in 10 µm on both valves.

Diagnostics: Sternum valve with *crista marginalis* dividing the striae. Striae have single transapically elongate areola distal to crista and 2–3 areolae proximal.

Comments: Abundant in GU70A-2A. This species was recently described from Indian Ocean and Pacific Ocean sites, including the Marquesas I., French Polynesia.

Coscinodiscus hauckii Cleve Figs 42, 43

Ref. illus.: Hustedt 1927–1930, p. 388, fig. 200b

Samples: GU52O-4, inter alia

Dimensions: Diam. 27–30 µm, stria density at margin 21-22 in 10 µm.

Diagnosis: Ring of short striae surrounding flat central zone with or without short spines.

Comments: The stria density given by Hustedt is ca. 18 in 10 µm. Hein et al. (2008, p. 18, pl. 2, fig. 2) reported *C. hauckii* var. *mesoleia*, which has a clear center, with 28 striae in 10 µm. It is not clear from Hustedt's text about the nominate variety whether he thought the *unregelmäßig punktiertem Mittelfeld* was perforated, because he also used *punktiert* in reference to the short striae. The variety may not be justified, given that the difference in the central zone of the nominate variety comprises only small papillae, and there is only a slight difference in stria densities between the forms (20 in the variety). Our stria density is higher, and Hein et al.'s still higher. Our SEM shows that this species lacks rimoportulae, so it does not belong in *Coscinodiscus* (see Round et al. 1990).

***Dictyoneis apapae* Lobban, sp. nov.** Figs 44–50, 52–55, 57, 58

Diagnosis: Differing from *Dictyoneis marginata* in the broadly lanceolate outline, absence of field of small pseudoloculi around the central area, and smaller outer openings of the pseudoloculi, especially along the margin.

Holotype: Specimen at 10.2 mm E and 6.0 mm S of the mark on slide 3056, deposited at Diatom Collection, Academy of Natural Sciences of Drexel University, Philadelphia, accession number GC20106. Fig. 44.

Type locality: Guam, Apra Harbor, Scuba Beach, 13°27.840', 144°39.360', scarce in biofilm on calcareous sand ca. 10 m deep, in communities with *Arcuatasigma* spp. (Lobban & Reid 2018), *Progonoia* spp. (Lobban 2015b), and several species listed below. Sample GU52X-5b, 10 May 2015, coll. *C.S. Lobban & M. Schefter*

Etymology: Apapa, genitive noun in apposition, for the type locality in Apra Harbor, not far from Cabras Island. Ayong (2023) explains that, "Apra is a corruption of the Chamorro word '*apapa*' which means 'low.' *Apapa* is the original name for what is now known as Cabras Island."

Morphology: Valves broadly lanceolate (Figs 44–46), 94–115 µm long, 22–26 µm wide, outer pseudoloculi in rows giving apparent stria density, especially in LM, of 8–12 in 10 µm, (Figs 44, 45) but true striae measured on interior views 24–26 in 10 µm (Figs 52, 55). External raphe slits straight, bordered by thin ridges of silica (Fig. 48, arrow), terminal endings deflected in opposite directions. Inner layer of pores completely overlain by pseudoloculate framework forming larger pores, except in a variable zone near the sternum and at the apices where the outer openings are also small (Figs 48, 49 and cf. fracture wall, Fig. 54). The outermost areolae are very large and in LM give the impression of chambers (cf. *Mastogloia*) (Figs 44, 45) but are simply part of the outer layer (Figs 46, 47,49). There is also a long groove on each side in the outer layer near the apex (Figs 47, 50, 57). Figs 50 and 51 compare exterior features of the new species with a specimen of *D. marginata* (F.W.Lewis) Cleve from Georgia. Interior surface shows regular striae opening by transapical slits (Figs 52–55); many short striae and a few longer ones are interpolated on the mantle forming a denser fringe (32 striae in 10 µm), followed by a hyaline border (Fig. 53). Raphe bordered by thick ribs, central and terminal endings simple, the latter with a very small helictoglossa. Wall structure (Fig. 54) shows deep pseudoloculate outer network over the basal striate layer. Figs 55 and 56 compare the similar internal surfaces of the new species with *D. marginata*. Girdle bands (Figs 47, 57, 58): copulae open: valvocopula with deep notch at the closed end filled by ligula on 3rd copula (Fig 57, arrow), with two rows of pores along advalvar edge, scattered pores/pits elsewhere; two other copulae with similar structure.

Additional records: GUAM: GU52V-1! (biofilm); YAP, FSM: Y-D2 (seagrass leaves)

Registration: http://phycobank.org/104437

Comments: *Dictyoneis apapae* differs markedly from *D. marginata* [Hustedt 1931–1959, p. 576, fig. 1009; Montgomery 1978 pl. 81C–F; Round et al. 1990 p. 468 (implicitly showing *D. marginata*); Hein et al. 2008, p. 51, pl. 26, fig 2, pl. 27 fig. 1] but there seem to be additional discrepancies among the images in the literature. The apical groove in Round et al. (1990) is long like that in *D. apapae*, and they also note that the external raphe slits are bordered by thin ridges of silica, which can be seen in our images of *D. apapae* but not in our *D. marginata* specimens (Figs 50 vs. 51). Moreover, Round et al. (1990, p. 469, fig. h) show thick transverse costae and note that "the small poroids of the inner layer are difficult to distinguish because of the strong development of the ribs," a description that does not fit *D. apapae* (Fig. 54) or even our Georgia specimens (Fig. 56). These seem to be small discrepancies compared to the differences in the central area, marginal pore size and constriction (the latter two used by Cleve 1890 as taxonomic criteria); we are therefore confident that the Guam species cannot be included in *D. marginata*, but not so confident in our identification of the *D. marginata* specimen.

When Cleve (1890) erected the genus, he provided a key to the known species, of which only two were lanceolate, and only one of those had marginal pores larger than the ones on the valve face, that was *D. thrumii* Cleve, described in the same article. However, he gave no drawings and the description, based on a single specimen from a sea cucumber gut in China, mentions little of the structure. His valve was larger than our specimens, 150 µm long, 32 µm wide. Montgomery (1978, pl. 81A, B) showed an unnamed lanceolate species from Florida with broad semilanceolate zones of smaller pseudoloculi on each side of the raphe, clearly different from ours. There is need for further study of this genus, and the assertion by Round et al. (1990, p. 468) that, "only the type [species] is recorded at all frequently" should not be a license for assigning every constricted specimen to *D. marginata*.

Hyalosynedra cf. *al-turkii* J.S.M.Sabir & E.C.Theriot

Ref. illus.: Navarro & Lobban 2009, figs 48–51 (as *Hyalosynedra laevigata*); Sabir et al. (2018), figs 27–32

Samples: GU50D, GU52U-1

Dimensions: 35–40 µm long, 4–5 µm wide, 40 biseriate striae in 10 µm.

Diagnostics: Apex rounded; sternum lanceolate, narrow; ocellulimbus 6–8 pores wide.

Comments: This species is separated from *H. prasadii* by the dimensions according to the key in Sabir et al. (2018). Like that species, it has a lanceolate sternum, in contrast to other species in which the sternum is linear. The images published by Navarro & Lobban (2009) can be better identified as Sabir & Theriot's new species, although the stria density is higher than their specimens. *Hyalosynedra prasadii,* or something like it, has also been noted in a few samples, but both species were scarce and detailed comparison with Red Sea and Florida species is not yet possible and, because of the fine discriminations needed, it is possible that these species are regional endemics and that our western Pacific species are different. We make this provisional record now only to point out that the record in Navarro & Lobbban (2009) is not *H. laevigata*. This genus needs more detailed study in our region but *H. laevigata* is present in our flora, see below.

Hyalosynedra laevigata (Grunow) Williams & Round Figs 59–62

Ref. illus.: Sabir et al. 2018, p. 7, figs 2–16. Non Navarro & Lobban 2009, figs 48–51.

Samples: GU44Z-15, GU58G-4A

Dimensions: length 114–132 µm, width 5–6 µm.

Diagnostics: Long, lanceolate, hyaline cells, apices rounded to weakly capitate; linear midrib visible in LM; pseudocellus with three rows of pores; rimoportulae asymmetrical.

Comments: Differing from *H. lanceolata* Belando, Jiménez & Aboal, which has a broad, lanceolate sternum. It is so similar in size and shape to *Stricosus cardinalii* E.C.Theriot & Lobban (see below) that the two taxa can scarcely be distinguished in LM. In SEM, the character of the rimoportulae and the depth of the pseudocellus separate them. See also comments above on *H.* cf. *al-turkii*.

Licmophora complanata Lobban Figs 63, 64

Ref. illus.: Lobban 2021b, figs 1–25.

Samples: GU44AR-3

Dimensions: Length 135–143 µm, striae in 10 µm 9–10, increasing to 10–12 near apex.

Diagnostics: The apically oriented areolae, the triangular profile of the valve, always lying in girdle view, and the broad valvocopula with deep septum, together with apically elongated areolae, make this species unique so far even in LM.

Comments: Two specimens, including a complete frustule were found in LM. The apically elongated areolae are evident in both images; the three inflated areas are suggested by the focus and the short, intercalated striae (Fig. 63, black arrowheads), and the path of the midrib and septum are shown by arrow and arrowhead in Fig. 63. The septum is very unusual in this species (Lobban 2021, fig. 19). Previously known only from Majuro, Marshall Islands.

Mastogloia ovata Grunow Figs 65, 66

Ref. illus.: Hustedt 1931–1959, p. 476, fig. 895

Lobban et al. 2012, p. 281, pl. 35, figs 1, 2 (as "*M. pseudolatecostata*")

Lobban et al. 2012, p. 279, pl. 33, figs 7, 8 (as "*M. ovata*")

Samples: GU44T-1, GU44AJ, GU44AU-1; GU52P-7; GU70A-2A

Our specimen published as voucher for *M. pseudolatecostata* must be rejected because the stria density is too high (21–24 vs 12–14 in 10 µm). It is a better match for *M. ovata* than the voucher specimen cited in the same paper. SEM images of such specimens are shown in Figs 65, 66. A specimen from Bikar Atoll, Marshall Islands that matches *M. pseudolatecostata* is shown in Fig 67; this species not yet identified in Guam. The specimen claimed as a voucher for *M. ovata* in Lobban et al. 2012 less clearly matches the description in Hustedt (1931–1959) and close to Hein et al. (2008, pl. 40, fig. 3) "*Mastogloia* cf. *ovata.*"

Comments: The inner margin of *M. ovata* has indentations at each cross wall (Fig. 66), that of *M. pseudolatecostata* in the middle of each partectum (Fig. 67).

Mastogloia cf. *pisciculus* Cleve Figs 68–70

Ref. illus.: Cleve 1893; Hustedt 1931–1959, p. 473, fig. 990; Stephens & Gibson 1980, p. 228, figs 31–36; Pennesi et al. 2012. p. 1254, figs 7A–H; Loir & Novarino 2013, p. 42, pl. 18c

Samples: GU52X-5

Dimensions: Length 30–35 µm, width 14 µm, striae radiate, 25 in 10 µm

Diagnostics: Broadly lanceolate, rostrate, depressed area not strongly differentiated but a longitudinal line visible in the middle of it (Figs 68, 69 arrows). Chambers quadrate to elongate with convex inner edges, not reaching apices. In SEM external view (Fig. 69) uniform areolae in the outer zone, transapically elongated areolae in the depressed zone, irregular rib between them; raphe thickened. Internally, outer zone with transapical costae, inner zone smooth. Areolae opening internally, by quadrate set of small pores; outer zone of striae with costate virgae, inner zone with areolae in irregular longitudinal line, sporadically two lines (Fig. 70 arrow). Partecta 3 in 10 µm, in middle portion only, apically elongated with convex inner margins and scattered pores on the abvalvar surface.

Comments: Uncommon in this biofilm sample. Specimens were smaller than Cleve's and at low end of range in Hustedt. Hustedt (1931–1959), Stephens & Gibson (1980) and Loir & Novarino (2013) all show much variation. Moreover, there are considerable discrepancies between the various descriptions, leading us to qualify our identification with "cf." First, Hustedt (1931–1959: 558) said that although the forms he found (only near Seychelles) differed from Cleve's (1893) description (specimens from Florida), e.g. in stria density, he decided not to separate them. Stephens & Gibson reported stria densities in line with type material in Cleve (1893) and Boyer (1927). Specimens in Pennesi et al. were from Suluwesi, Indonesia. The SEM studies by Stephens & Gibson (1980) and Pennesi et al. (2012) are not completely comparable because partecta found by the latter were all broken. The partecta are square to apically lengthened with convex inner margins. Stephens & Gibson showed them to have delicate silica plaques with perforations; partecta in our specimens seem longer than in these other reports and we saw pores but no plaques (Fig. 70). Stephens & Gibson did not observe the edge of the mantle, where we and Pennesi et al. saw biseriate striae. Internally, there is a single line of quadripunctate foramina under the depressed area shown in both Stephens & Gibson and Pennesi et al. but in our specimens, there was a much looser row, sometimes double. Stephens & Gibson (1980; Florida) considered whether their specimens might match *M. arabica* Hendey, or if that might be synonymous with *M. pisciculus*. Establishing boundaries in these disparate populations of rare taxa will require more work; for now, we present our SEM observations to define what we found here.

Moreneis cf. *hexagona* J. Park, Koh & Witkowski Figs 71–74

Ref. illus.: J. Park et al. 2012, p. 192, fig. 6; J.S. Park et al. 2018, p. 108, fig. 26.

Samples: GU52O-4, GU44AS-4

Dimensions: Length 31–32 µm, width 13 µm; striae 15 in 10 µm, areolae 16 in 10 µm.

Diagnostics: Central and terminal raphe endings deflected in same direction, central endings in opposite directions (Fig. 73), distinguish the genus from *Petroneis* and *Navicula*. Species based on shape, dimensions, and stria density. Valve rostrate; striae radiate, some shorter ones in center.

Comments: Rare specimens match the description of *M. hexagona*, which is smaller and more finely striated than *M. angulata* (42–48 µm x 16–16.5 µm, striae 11 in 10 µm, areolae 12 in 10 µm). J. Park et al. (2012) noted a single areola at the Voigt faults (Fig. 72, arrows) and larger areolae adjacent to axial area, which are present in our specimen. Our SEM images are the first for this species and show the areolae to be c-shaped (Fig. 73). *Moreneis hexagona* is distinguished from several other species by shape and stria density. J.S. Park et al. (2018) reported *M.* cf. *hexagona* from Chuuk with some hesitation because of a size difference. Present in biofilm with another *Moreneis* sp. in GU52O-4, but also found in a gathering of *Halimeda* in GU44AS-4. The other species does not match any of the species in this newly erected genus but it may have been described under *Navicula.*

Nitzschia incurva Grunow Figs 75–78

Syn.: *Nitzschia lorenziana* Grunow in Cleve & Grunow (nom. illeg.)

Ref. illus.: Navarro 1982, pl. 35, fig. 4; Poulin et al. 1990, p. 87, figs 67, 68, 71, 72 (SEM); Witkowski et al. 2000, p. 392, pl. 210, figs 24, 25, pl. 211, fig. 3, pl. 212, figs 1–3 (all as *N. lorenziana*)

Samples: GU58G-4A, GU44I-1, GU44Z-15

Dimensions: Length 18.5 µm, width 7.4 µm; striae 20 in 10 µm.

Diagnostics: Weakly sigmoid in girdle view, keel eccentric except in long-rostrate apices, striation bold in LM because of external costae between the striae; central striae biseriate towards to keel, triseriate towards the margin (Fig. 78), becoming rings of pores with central row of pores and diminishing towards apex (Fig. 77). Eccentric keels of the two valves are on opposite sides of the frustule (nitzschioid, not hantzschioid) (Figs 77, 78). Keel canal is closed except for circular fenestrae (Fig. 77).

Comments: Guiry (2017) explains why *lorenziana* is illegitimate and provides the earlier synonym. The ultrastructure of our specimens clearly matches SEM images in Poulin et al. (1990). It is apparently a brackish/estuarine species, with wide temperature tolerance (from Gulf of St. Lawrence to Florida + Guam). Abundant in Vietnam and Indonesia (Witkowski, unpubl.). Lopez-Fuerte et al. (2010: p. 63, pl. 37, fig. 21) show var. *subtilis* Grunow from Mexico and list the nominate variety. *Nitzschia incurva* somewhat resembles *N. gaoi* Bing Liu, S. Blanco & B.Q. Huang (2019), but that has small conopeal canals and uniseriate striae. Lobban & Ashworth (2022b) did not transfer *N. gaoi* or their own *N. maiae* Lobban, Ashworth, Calaor & E.C.Theriot to *Homoeocladia* because of maintaining a narrow definition of the morphology of *Homoeocladia* and noted some other species in the region with doubtful formation of a conopeal canal that also have T-shaped external costae (one shown in Lobban 2023a, figs 4F, G).

Olifantiella mascarenica Riaux-Gobin & Compère Figs 79, 80

Ref. illus.: Riaux-Gobin & Compère 2009, figs 6–22; Riaux-Gobin 2015, figs 24, 25

Sample: GU52G-A

Dimensions: Valve 9.3 µm long x 2.3 µm wide; striae 50 in 10 µm.

Diagnostics: This species differs from *O. pilosella* Riaux-Gobin in the shape of the buciniportula, which here is a single trumpet.

Comments: *Olifantiella* spp. are barely discernable in LM, and the details are at the limit even of the desktop SEM. These images were taken at U. Texas on a full-sized SEM.

Parlibellus biblos (Cleve) Cox Figs 81–84

Ref. illus: Hustedt 1931–1959, p. 703, fig. 1178 (as *Stauroneis biblos* [Cleve] Hustedt); Cox 1988, p. 23; Lobban et al. 2012, p. 296, pl. 52, figs 4, 5) [as *Stauroneis retrostauron* (Mann) Meister]

Comments: J.S. Park et al. (2022, p. 14) made the case for recognizing this taxon as *Parlibellus biblos*. *Stauroneis retrostauron* must be deleted from the species list for Guam for now.

Plagiogramma minor (W.Gregory) Chunlian Li, Ashworth & Witkowski Figs 85, 86

Basionym: *Denticula minor* W.Gregory

Ref. illus.: Kaczmarska et al. 2017, p. 27, figs 13A–D.

Samples: GU52O-4, GU52X-5 (biofilm on calcareous sand)

Dimensions: Length 11–12 µm, width 5 µm; striae 17 in 10 µm

Diagnostics: rhomboidal valves with central elevation and two elevated apical pore fields; large flaps on the four most-apical spines.

Comments: Kaczmarska et al. (2017) compared their specimens to similar species and concluded that there was no match. Our specimens are very close to their fig. 13A. In their nomenclatural note, Kaczmarska et al. claimed that the correct epithet is *minus*, since *Dimeregramma* is a neuter noun, and Li et al. (2020, p. 13) used this transferring the species to *Plagiogramma* (also neuter). However, *minus* is an adverb and the correct adjective here is *minor*, which has the same ending across all genders in the nominative singular (Stearn 1973), as used by Gregory (1857) in the basionym.

Pleurosigma simulacrum Lobban & Sterrenburg

Ref.: Lobban 2021a, p. 253, figs 91–102.

Here we just want to note that this species, described from Guam and Yap and differentiated from *P. intermedium* W.Smith, is also similar in shape to *P. acus* A.Mann (1925, p. 133, pl. 29, figs 4, 5), described from the Philippines as being very similar to *P. intermedium*. Stidolph (2002) pointed out that *P. acus* has the diagonal striae at ca 80º to one another, contrasting with *P. intermedium* and *P. simulacrum*. *Pleurosigma simulacrum* and *P. acus* both lack the calcar slit at the apex, which is present in *P. intermedium*. Mann also noted that the striae of *P. acus* are much coarser than other straight species (14, vs 26 in 10 µm for *P. simulacrum*). Thus, there are at least four straight, narrow species of *Pleurosigma*, the fourth being *P. patagonicum* Ferrario & Sar (Sar et al. 2012) (Table 2). We have checked all images we attributed to *P. simulacrum*, now including specimens from Saipan, Chuuk and Palau (Lobban, unpublished), and confirmed that they were correctly identified.

Proschkinia complanata (Grunow) D.G.Mann Figs 87–90

Ref. illus.: Lobban et al. 2012, p. 296, pl. 1, figs 4–6 and pl. 53, figs 1–4 [as *P. complanatoides* (Hustedt) Karayeva]; Kim et al. 2020, p. 960, figs 2, S2

Samples: GU44Z-15, GU52Q-10a, GU62A-7, GU66G-5, GU68F-8

Dimensions: Length 32–48 µm, width 6–8 µm; striae 30–32 in 10 µm

Comments: Majewska et al. (2019, p. 625), working on *Proschkinia* spp. epizoic on sea turtles, described a new species *P. torquata* Bosak, Van de Vijver & Majewska, which they compared with *P. complanatoides*. They suggested that our Guam specimens might be a new species because they saw no widening of the central area (GU44Z-15: Fig. 90) and the internal fistula was not like *P. complanatoides*. However, Kim et al. (2020) studied Grunow's specimens of *P. complanata* with SEM and showed a fistula matching ours, also matching in the presence of a flap over the external fistula opening (Figs 87, 88) and a raised rib on the raphe internally for some distance from the central nodule (Fig. 90). One short stria on the side with the fistula (Fig. 88), and a silica flap over the fistula opening; central striae on opposite sometimes further apart (Figs 87, 88 vs. 90). Comparing our specimens to *P. torquata*, the fistula has a similar series of spheres, and the external opening is also covered by a flap, but *P. torquata* has longitudinal silica strips over the central part of the valve face and the apices are rounded rather than acute. Kim et al. (2020, table 4) listed Guam specimens with *P. complanata* not *P. complanatoides* and their images of authentic (including type) material convince us that there are no differences that would warrant a new species. We have seen this species across Micronesia, and it seems so far to be the only species present. We remove *P. complanatoides* from the Guam flora.

Table 2. Comparison of *Pleurosigma simulacrum* with other straight species.

Character	***P. simulacrum***[a]	***P. acus***[b]	***P. intermedium***	***P. patagonicum***
Length, µm	110–133	162–258	167–233	146–229
Width, µm	13–14	12–22	17–18	17–23
Transapical stria density in 10 µm	21–23	14 (20)	22	24–30*
Oblique stria density in 10 µm	18–20	14 (17)	21–22	24–29 *
Oblique striae angle, degrees	60	80	63	60*
Central raphe endings	nonoverlapping	nonoverlapping	nonoverlapping	overlapping
Calcar slit	absent	absent	present	present
Hyaline central area	absent	absent	present	absent
Duplex areolae at apex	2	unknown	continuous row	continuous row

[a] Data from Lobban 2021; stria densities recounted (transapical published as 26)
[b] Data from Mann 1925; Stidolph 2002 (in parentheses if different)
* differing center vs apex

Pseudictyota bicornis **(**Cleve) P.A.Sims & D.M.Williams Figs 91–93

Ref. illus.: Cleve 1878, fig. 30; Ashworth et al. 2013, fig 7b; Sims et al. 2018, figs 133–138

Sample: GU52U-1

Dimensions: 51 µm long (on the axis with the ocelli), 42 µm wide

Diagnostics: Quadrate, false pseudoloculate valve, having two elevations with ocelli and two unelevated points with rimoportulae.

Comments: Differing from *Pseudictyota dubia* (Brightwell) P.A.Sims & D.M.Williams (Navarro & Lobban 2009, figs 21–24), which has six angles, three with ocelli and three with rimoportulae; and from *P. reticulata* (Roper) P.A.Sims & D.M.Williams (Lobban et al. 2012, pl. 3, figs 3, 4, as *Triceratium dictyotum* P.A.Sims & R.Ross), which is broadly lanceolate with two angles each with both an ocellus and a rimoportula.

Serratifera andersonii Chunlian Li, Dąbek & Wachnika Figs 94, 95

Ref. illus.: C.Li et al. 2018, p. 63, figs 360–373

Sample: GU26A

Dimensions: Length 5.5–9.2 µm, width 2.3 µm, striae 15 in 10 µm

Diagnostics: Small, clavate (heteropolar), with a clear pore field at one pole, simple, stick-like spines arising from areolae, whereas in *S. rhombica* there are "accessory" spines flanking the larger central spines (C.Li et al. 2018).

Comments: Many small Fragilariaceae have been studied recently, incorporating much debate on generic boundaries. *Serratifera* Ashworth, Chunlian Li & Witkowski (in C.Li et al. 2016) was established largely on molecular grounds and emended on morphological grounds by the same authors (in C.Li et al. 2018). Morales et al. (2019: 274) argued against the new genus and for inclusion of its species in the older genus *Pseudostaurosira* D.M.Williams & Round. Witkowski did not accept the argument (personal communication during ms. preparation), so we have presented this and the next species under their original names. Morales et al. transferred them to *Pseudostaurosira andersonii* (S.Sato, Chunlian Li & Witkowski) E.A.Morales, Novais & C.E.Wetzel, and *P. rhombica* (S.Sato, Chunlian Li & Witkowski) E.A.Morales, Novais & C.E.Wetzel, respectively. The senior author cannot contribute to this debate. All small Fragillariaceae are rare in our Guam samples to date, probably because the frustules are washing in from their primary habitats (mostly sediments and biofilms).

Serratifera rhombica S.Sato, Chunlian Li & Witkowski Figs 96, 97

Ref. illus.: C.Li et al. 2018, p. 81, figs 431–436

Sample: GU52P-9

Dimensions: Length 8 µm, width 2.7 µm, striae 13 in 10 µm

Diagnostics: Small, rhomboidal (slightly heteropolar). Spines have accessory spines alongside, but these are not clear in our images.

Stricosus harrisonii E.C.Theriot & Lobban Figs 98–103

Ref. illus.: Sabir et al. 2018, figs 95–98

Samples: GU44U-2, GU44Z-15, GU44BV-3, GU52P-9, GU52Q-1a.

Description of wild material: Plastids relatively large, numerous (Figs 98, 99), valves 113–193 µm long, 7 µm wide, 40 striae in 10 µm (Figs 100, 101), ocellulimbus 8–9 pores tall (Fig. 102), usually two spines (Fig. 102), rimoportula symmetrical, as for the genus (Fig. 103).

Comments: Although the record of this species was established in 2018, we wish to add these further observations. *Stricosus harrisonii* is the only linear species of *Stricosus* found so far in Guam. It was described as 88–152 µm long, relatively broad (5–9 µm), with a narrow, linear sternum, 38–41 biseriate striae in 10 µm, and with a single spine over the ocellulimbus (Sabir et al. 2018). In a variety of wild samples, however, there were two spines, as shown here. Also described from the same material was *S. cardinalii*, (Sabir et al. 2018, figs 99–103), which usually has two spines over the ocellulimbus. While *S. harrisonii* is essentially linear, the shape and size of *S. cardinalii* is very much like *Hyalosynedra laevigata* (see above). In SEM, *S. cardinalii* is distinguished by the symmetrical rimoportulae and deep ocellulimbi characteristic of *Stricosus*. *Stricosus harrisonii* and *S. cardinallii* from Guam are distinct from similar large species in Florida/Caribbean (*S. navarroensis* E.C.Theriot & Ashworth, *S. blumbergii* E.C.Theriot & Ashworth) and the Red Sea (*S. alfageehii* Sabir & E.C.Theriot, *S. madanii* Sabir & E.C.Theriot) (Sabir et al. 2018), possibly suggesting regional endemicity. Belando et al. (2018) identified the sequence labeled GU44AI as being *H. laevigata* but it is actually *Stricosus harrisonii*, which was published concurrently.

Thalassiosira nanolineata (A. Mann) Fryxell & Hasle Figs 104–106

Ref. illus.: Mann 1925, p. 68, pl. 14, fig. 4; Fryxell & Hasle 1977 p. 32, figs. 74–80; Sar et al. 2002 Table 1; Y. Li et al. 2013, p. 99, figs 89–94; J.S.Park et al. 2016, p. 414, fig. 28

Samples: GU44Z-15, GU52P-9

Dimensions: 12.8–19.8 diam., areolae 8–9 in 10 µm

Diagnostics: Areolae linear, not radial, single row of fultoportulae around the margin, their external part ending in a cuplike structure with a central post. Rimoportula inserted between two fultoportulae (rather than replacing one). Two central fultoportulae.

Comments: Although the areolar density is lower than most records (Y.Li et al. 2013 the exception), these specimens seem to agree with the modern concept of the species originally described from the Philippines by Mann (1925). The surveys of *Thalassiosira* diversity in Argentina (Sar et al. 2002), Guangdong Province, China (Y.Li et al. 2013), and South Korea (J.S.Park et al. 2016) are all very helpful in identifying the species here.

Tryblionella cf. *jelineckii* (Grunow) D.G.Mann Figs 107–110

Ref. illus.: Peragallo & Peragallo 1897–1908 p. 268, pl. 69, fig 19, Hein et al. 2008, p. 84, pl. 58, fig. 19 (both as *Nitzschia jelineckii* Grunow); J.S.Park et al. 2022, p. 20, fig. 58.

Samples: GU52X-5

Dimensions: Length 121–158 µm, width 22 µm; striae 12–14 in 10 µm, fibulae 7 in 10 µm.

Diagnostics: Large panduriform species with prominent external costae running the width of the cell.

Comments: Similar to *T. plana* (W.Smith) Pelletan [Peragallo & Peragallo 1897–1908 p. 270, pl. 70, fig. 18; Sims 1996, pl. 194, fig 2; Lopez-Fuerte et al. 2010, pl. 38, fig. 1 (all as *Nitzschia plana* W.Smith)], but that has 19–20 striae in 10 µm. Not clear from literature that either species has external costae. Montgomery (1978) has two images (pl. 160C and 161D) labeled as "*Nitzschia jelinecki*" but neither has external costae. Peragallo & Peragallo (1897–1908) commented that they had only seen it in "exotic" samples, the one figured from Java; type was from the Nicobar Islands. This species needs much more study before we can say whether the Guam specimens belong in it or elsewhere.

Vikingea gibbocalyx (Brun) Witkowski, Lange-Bertalot & Metzltin Figs 111–113

Ref. illus.: Witkowki et al. 2000, p. 125, pl. 55, figs 8–16, pl. 56, figs 1–3, 5, pl. 57, figs 1–4; Hein et al. 2008, p. 40, pl. 16, fig. 25; Van de Vijver et al. 2009, figs 1–34, Riaux-Gobin et al. 2011, p. 40, pl. 81, figs 1–3, pl.82, figs 1–6

Dimensions: Length 25–28 µm, width 17–20 µm; striae 9 in 10 µm (RV), 7–8 in 10 µm (SV)

Samples: GU52X-5, GU52N-7, GU52P-3

Diagnostics: The raised apices of the RV are diagnostic of the genus in LM, the large circular central area diagnostic of the species in contrast to *V. florifera* Riaux-Gobin, O.E.Romero, Compère & A.Y.Al-Handel (2011), which has a broad fascia.

Comments: These specimens are in the lower end of the size range compared to most literature (see van de Vijver et al. 2009, table 1). There are two troubling differences between our specimens and those shown in the recent literature. First, comparison of the internal SV in our Fig. 112 with figs 16, 19 in van de Vijver et al. (2009) and similar images in Witkowski et al. (2000) and Riaux-Gobin et al. (2011) shows absence in our specimen of the elliptical opening and slit in the marginal ridges; this may be significant even though it was also absent in some specimens by van de Vijver et al. (2009, fig.20). Secondly, Van de Vijver et al. (2009: 271, fig. 27, arrow) show small costae extending from the RV margin into the first row of areolae, a feature clearly absent from the external RV shown in Fig. 113. This is yet another genus with strong potential for additional species to be found.

Discussion

The 25 new records including one new species bring the total number of taxa for Guam to 378, almost all from coral reef epiphytic communities, and the identified *Mastogloia* to 67. The total includes over 100 new species and ten new genera but there are still many unidentified specimens already imaged and many samples to survey. We have also begun to study biofilms associated with calcareous sediments, from which several of the present new records come: the two *Biremis* spp., *Dictyoneis apapae* sp. nov*.*, *Moreneis* cf. *hexagona*, *Mastogloia* cf. *pisciculus*, and *Plagiogramma minor*. These add to the new species already described from these samples in Guam, i.e., *Arcuatasigma arenicolum* Lobban and *A. marginale* Lobban (Lobban & Reid 2018), *Progonoia diatreta* Lobban and *P. intermedia* (A. Schmidt) Lobban (Lobban 2015b). Many more taxa await identification from this community; some common forms, such as the various oval *Diploneis* species, are particularly vexing to discriminate. We also recently began analysis of mangrove diatom communities, from which we so far reported only *Pinnunavis yarrensis* (Grunow) H.Okuno (Lobban 2015a).

Biogeography of microeukaryotes remains an open question. Records papers such as this one gradually increase awareness of rare taxa and add to SEM data but are prone to misidentification of understudied species which confound the geographic distribution (such as *Dictyoneis* spp., *Hyalosynedra* spp.; *Berkeleya* cf. *hyalina, Mastogloia* cf. *pisciciulus* and others reported herein, where “cf.” = “confer” means they are similar but we suspect they may be different species). Checklists also tend to encourage questions of comparison between islands and between regions. In the first Guam records paper (Lobban et al. 2012) we included an appendix comparing our list with those from several other regions. The sampling efforts in different studies are, of course, unequal, so we thought it might be more useful now to ask what species have been found in Guam that have not been reported from the much better studied areas in the Atlantic? To address that, we drafted a rough comparison (unpublished) of our 67 *Mastogloia* species vs a complied list for Florida + Bahamas. We found very few species only on the Guam side of this ledger, if we discounted those recently described by Pennesi and co-workers (because the lists pooled for the comparison mostly pre-date their work). This may be partly a reflection of our force-fitting Guam specimens into the same literature. Besides the difficulties with species such as *M. pisciculus*, discussed above, Lobban & Frankovich (2023) recently showed *M. frickei* Hustedt, described as rare from the Seychelles and rediscovered in Guam, had been misidentified in several papers from Florida and The Bahamas and had to be given a new name. Similarly, Pennesi et al. (2012) had shown that the "*M. omissa* Voigt" studied with SEM by Stephens & Gibson (1980) from Florida (and subsequently reported by Navarro 1982) was not Voigt's Indonesian species and they renamed it *M. sergiana* Pennesi & Poulin. Following the path of the series of studies by Pennesi et al. (2011, 2012, 2016), we have started more critically examining our *Mastogloia* floras with SEM to achieve more accurate identifications and biogeographies.

A broader approach involves large-scale projects in which widespread samples are analyzed by a single team, identifying specimens to species where possible and otherwise defining operational taxonomic units (OTUs) identified to genus or higher level. The standard statistical metrics do not always give answers (e.g., Blanco et al. 2012 on evaluating diatom communities vs trophic level of rivers) but this approach was used successfully to evaluate biogeography within Madagascar by Kryk et al. (2020) and within Indonesia by Risjani et al. (2021). Kryk et al. (2020) were able to identify to species only 35% of taxa discriminated. The ca. 65% OTUs were named separately in each study, so comparisons between regions were limited to quantifying the high species richness and biodiversity in Indonesia. Witkowski initiated a comparable study incorporating materials broadly from Micronesia and other countries around the Indo-Pacific region into one analysis to attempt to take this approach further and it is to be hoped that his colleagues still working at U. Szczecin and their collaborators will complete that study.

Acknowledgements

This report began with a meeting in Szczecin at the 11th International Phycological Congress (2017), when Andrzej Witkowski sat for several hours with the lead author's slide stacks of unidentified species from Guam and made suggestions for possible identifications. Over the next six years the manuscript waxed and waned as we added or deleted species for various reasons. The manuscript was first submitted to *Micronesica* only a few weeks before Andrzej's untimely death. In the end, the responsibility for the identifications proposed here rests on me (Lobban) and I appreciate the reviewers' pushback on some, which were subsequently modified or deleted in revision.

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Appendices

APPENDIX 1. SPECIES REMOVED FROM THE FLORA

Actinocyclus tenuissimus Cleve

Reported by Lobban et al. (2012), still a valid species but in view of discussion in J.S. Park et al. (2022), we reconsidered the specimens. While the size and stria density are in the range of *A. tenuissimus*, the central area and instinct interfascicular rows are characteristic of *A. subtilis* (Gregory) Ralfs, to which we now refer all our Guam specimens (see also Lobban & Tharngan in prep.).

Ardissonea fulgens (Greville) Grunow ex De Toni

Reported by Lobban et al. (2012), still a valid species but Lobban et al. (2022) showed that it differs from the species in our flora and renamed our species *Ardissoneopsis fulgicans* Lobban & Ashworth.

Ardissonea fulgens var. (Lobarzewsky) Rabenhorst

Reported by Lobban et al. (2012), Lobarzewsky's diatom proved to be a valid but dubious species and not what we have here, so Lobban et al. (2022) renamed our species *Ardissoneopsis appressata* Lobban & Ashworth.

Auricula complexa (Gregory) Cleve

Still a valid species but not what we have here; see *Auricula densistriata* above.

Climacosphenia moniligera Ehrenberg.

Reported by Navarro & Lobban (2009). Still a valid species but Lobban et al. (2022) show that the curved *Climacosphenia* in Guam is *C. scimiter* A.Mann.

Haslea howeana (Hagelstein) Giffin

Possibly still a valid species but Lobban et al. (2020) recognized our material as *Navicula tsukamotoi* (Sterrenburg et al.) Yuhang Li et Kuidong Xu

Lyrella hennedyi (W.Smith) Stickle & D.G.Mann (including var. *granulosa* Grunow)

Reconsideration of the literature to identify specimens in Yap lead to a better identification of specimens reported in Lobban et al. (2012) as *L. clavata* Gregory (Lobban & Tharngan in prep.), based on Hustedt's (1961–1966) key, differentiating groups on the basis of rostrate ends, including *clavata*, from those with rounded apices, including *hennedyi*. Stria densities are similar in these two species.

Nanofrustulum shiloi (J.J.Lee, Reimer & McEnery) Round, Hallsteinsen & Paasche

This species was reported from Guam by Lobban & Navarro (2009) (figs. 40–43) but based on recent work by C.Li et al. (2018), the specimens illustrated are not this species or genus and cannot be identified to any of the other genera described there. These specimens must await further study. We do not have any other specimens so far that can be identified as *N. shiloi*, although we anticipate it is present in the flora. The images remain posted in ProtistCentral under the name GU7B-UnID (http://www.protistcentral.org/Taxa/get/taxa_id/586261).

Proschkinia complanatoides (Hustedt) Karayeva
Still a valid species but not what we have here; see *Proschkinia complanata* above.

Stauroneis retrostauron (Mann) Meister
Still a valid species but not what we have here; see *Parlibellus biblos* above.

Synedra bacillaris (Grunow) Hustedt
Reported by Lobban et al. (2012). Lobban et al. (2022) renamed that species Grunowago bacillaris (Grunow) Lobban & Ashworth but were unable to establish its presence in Guam, so established a new species, Grunowago pacifica Lobban & Ashworth, for the Guam material.

APPENDIX 2. SPECIES ADDED IN TAXONOMIC PAPERS SINCE THE PREVIOUS CHECKLIST

Amicula micronesica Lobban, Ashworth & Witkowski in Gastineau et al. 2022
Arcuatasigma arenicolum Lobban in Lobban & Reid 2018
Arcuatasigma marginale Lobban in Lobban & Reid 2018
Ardissoneopsis gracilis Lobban in Lobban et al. 2022
Climaconeis desportesiae Lobban 2018
Climaconeis leandrei Lobban 2018
Climacosphenia elegantissima Lobban & Ashworth in Lobban et al. 2022
Craspedostauros paradoxa Ashworth & Lobban in Ashworth et al. 2016
Diploneis cerebrum Pennesi, Caputo & Lobban in Pennesi et al. 2017
Diploneis claustra Lobban & Pennesi in Pennesi et al. 2017
Diploneis craticula Pennesi, Caputo & Lobban in Pennesi et al. 2017
Diploneis crispanti Pennesi, Caputo & Lobban in Pennesi et al. 2017
Diploneis weissflogiopsis Lobban & Pennesi in Pennesi et al. 2017
Divergita biformis, Lobban 2021a
Divergita decipiens Lobban 2021a
Druehlago cuneata Lobban & Ashworth in Ashworth et al. 2016
Grammatophora ornata Lobban 2015c
Grunowago pacifica Lobban & Ashworth in Lobban et al. 2022
Haslea alexanderi Lobban & C.O.Perez in Lobban et al. 2020
Haslea apoloniae Lobban & C.O.Perez in Lobban et al. 2020
Haslea arculata Lobban & Ashworth in Lobban et al. 2020
Haslea fusidium (Grunow) Lobban & C.O.Perez in Lobban et al. 2020
Haslea guahanensis Lobban & C.O.Perez in Lobban et al. 2020
Hendeyella lineata Ashworth & Lobban in C.Li et al. 2016
Homoeocladia [*Nitzschia*] *alcyoneae* (Lobban, Ashworth, Calaor & E.C.Theriot) Lobban & Ashworth 2022b

Homoeocladia [*Nitzschia*] *asteropeae* (Lobban, Ashworth, Calaor & E.C.Theriot) Lobban & Ashworth 2022b

Homoeocladia [*Nitzschia*] *carahii* (Lobban, Ashworth, Calaor & E.C.Theriot) Lobban & Ashworth 2022b

Homoeocladia [*Nitzschia*] *celaenoae* (Lobban, Ashworth, Calaor & E.C.Theriot) Lobban & Ashworth 2022b

Homoeocladia coacervata Lobban, Sison & Ashworth 2023

Homoeocladia contraria Lobban, Sison & Ashworth 2023

Homoeocladia [*Nitzschia*] *dagmannii* (Lobban, Ashworth, Calaor & E.C.Theriot) Lobban & Ashworth 2022b

Homoeocladia [*Nitzschia*] *electrae* (Lobban, Ashworth, Calaor & E.C.Theriot) Lobban & Ashworth 2022b

Homoeocladia [*Nitzschia*] *guamensis* (Lobban, Ashworth, Calaor & E.C.Theriot) Lobban & Ashworth 2022b

Homoeocladia [*Nitzschia*] *jordanii* (Lobban, Ashworth, Calaor & E.C.Theriot) Lobban & Ashworth 2022b

Homoeocladia [*Nitzschia*] *meropeae* (Lobban, Ashworth, Calaor & E.C.Theriot) Lobban & Ashworth 2022b

Homoeocladia ornata Lobban, Sison & Ashworth 2023

Homoeocladia [*Nitzschia*] *schefterae* (Lobban, Ashworth, Calaor & E.C.Theriot) Lobban & Ashworth 2022b

Homoeocladia schefteropsis Lobban, Sison & Ashworth 2023

Homoeocladia sinuosa Lobban, Sison & Ashworth 2023

Homoeocladia [*Nitzschia*] *spathulatoides* (Lobban, Ashworth, Calaor & E.C.Theriot) Lobban & Ashworth 2022b

Homoeocladia [*Nitzschia*] *taygeteae* (Lobban, Ashworth, Calaor & E.C.Theriot) Lobban & Ashworth 2022b

Homoeocladia [*Nitzschia*] *volvendirostrata* (Ashworth, Dąbek & Witkowski) Lobban & Ashworth 2022b

Hyalosira mixta Lobban & Majewska in Lobban et al. 2021b

Hyalosira navarroana Lobban & Majewska in Lobban et al. 2021b

Hyalosira triseriata Lobban in Lobban et al. 2021b

Licmophora attenuata Lobban, Tharngan & Ashworth 2018

Licmophora ballerina Lobban & S.Blanco in Lobban & Santos 2022

Licmophora bulbosa Lobban, Tharngan & Ashworth 2018

Licmophora curvata Lobban, Tharngan & Ashworth 2018

Licmophora fugax Lobban in Lobban & Santos 2022

Licmophora graphis Lobban 2021a

Licmophora heronensis Lobban in Lobban & Santos 2022

Licmophora joymaciae Macatugal & Lobban in Macatugal et al. 2019

Licmophora kuetzingii Lobban in Lobban & Santos 2022

Licmophora labianatis Lobban, Tharngan & Ashworth 2018

Licmophora pisciformis Lobban in Lobban et al. 2015
Licmophora romuli Lobban 2021a
Licmophora repanda Macatugal, Tharngan & Lobban 2019
Licmophora undulata Macatugal, Tharngan & Lobban 2019
Mastogloia lyra Lobban & Pennesi 2014
Mastogloia parlibellioides Lobban & Pennesi 2014
Mastogloia frickei Hustedt (see Lobban & Frankovich 2023)
Microtabella rhombica Lobban 2015d
Nitzschia maiae Lobban, Ashworth, Calaor & E.C.Theriot 2019
Stricosus cardinalii Theriot & Lobban in Sabir et al. 2018
Stricosus harrisonii Theriot & Lobban in Sabir et al. 2018
Parlibellus paschalis Lobban 2021a
Plagiogramma subatomus Lobban, S.Konno, Y.Arai & R.W.Jordan 2021 in Lobban 2021a
Planothidium juandenovense Riaux-Gobin & Witkowski in Riaux-Gobin et al. 2018
Pleurosigma simulacrum Lobban & Sterrenburg 2021 in Lobban 2021a
Progonoia diatreta Lobban 2015b
Progonoia intercedens (A.Schmidt) Lobban 2015b
Rhoicosigma parvum Hein & Lobban 2015
Stricosus cardinalii Lobban & Theriot in Sabir et al. 2018
Stricosus harrisonii Lobban & Theriot in Sabir et al. 2018
Synedrosphenia licmophoropsis Lobban in Lobban et al. 2022
Synedrosphenia parva Lobban in Lobban et al. 2022
Synedrosphenia recta Lobban in Lobban et al. 2022
Thalassionema baculum Lobban 2021a

APPENDIX 3. NOMENCLATURAL CHANGES

The following notes report changes published elsewhere, in alphabetical order **of new name**.

Ruck et al. (2016a, b) and Ruck & Guiry (2016) revised the Surirellales and Rhopalodiales with consequences for a number of taxa in our flora, and left several others in need of transfer, which J.S.Park et al. (2018, 2022) have attempted to do. The correct names as understood now are as follows:

Campylodiscus neofastuosus (Ehrenberg) Ruck & Nakov
Synonym: *Surirella fastuosa* Ehrenberg

Coronia ambigua (Greville) Ruck & Guiry
Synonym: *Campylodiscus ambiguus* Greville.

Coronia decora (Brébisson) Ruck & Guiry
Synonym: *Campylodiscus decorus* Brébisson

Coronia decora var. *pinnata* (Peragallo) Lobban & JoonS.Park in Park et al. (2018)
Synonym: *Campylodiscus decorus* var. *pinnatus* H. Peragallo

Campylodiscus giffenii (M.H. Giffen) Lobban & JoonS.Park in Park et al. (2022)
Synonym: *Surirella scalaris* M.H. Giffen
Synonym: *Campylodiscus scalaris* (M.H. Giffen) Lobban & Joon S.Park in Park et al. (2018). Illegit.

Disymmetria excentrica (Lobban) Lobban 2023b
Synonym: *Lauderia excentrica* Lobban

Following were *Rhopalodia* spp., but Ruck et al. (2016a, b) did not make the name changes needed for our area. Several species originally in *Epithemia* reverted to their basionym; of these the only marine one in our flora is *E. musculus*.

Epithemia guettingeri (Krammer) Lobban & JoonS. Park in Park et al. (2018)
Synonym: *Rhopalodia guettingerii* Krammer

Epithemia musculus Kützing
Synonym: *Rhopalodia musculus* (Kützing) O.F.Müller

Epithemia pacifica (Krammer in Lange-Bertalot & Krammer) Lobban & JoonS.Park in Park et al. (2018)
Synonym: *Rhopalodia pacifica* Krammer in Lange-Bertalot & Krammer.

Florella intermedia (Grunow) Lobban, Navarro & TM Schuster 2021

Synonyms: *Striatella intermedia* Grunow
Florella portoricensis Navarro

Florella lindigiana (Grunow) Lobban, Navarro & TM Schuster 2021
Synonyms: *Striatella lindigiana* Grunow
Florella pascuensis Navarro

Luticola tropica Levkov, Metzeltin & Pavlov 2013
Synonym: *Luticola inserata* var. *undulata* (Hustedt) Navarro & Lobban 2009
Refs: Levkov et al. 2013, Rybak et al. 2021
Brackish species reported from Guam by Navarro & Lobban (2009)

Neofragilaria anomala (Giffen) Witkowski & Dąbek (in C.Li et al. 2015)
Synonym: *Neofragilaria nicobarica*

Perissonoë crucifera (Kitton in Prichard) Desikachary, Gowthaman, Hema, A.K.S.K. Prasad & Prema (1987)
Syn.: *Perissonoë cruciata* (Janisch & Rabenhorst) G.W.Andrews & Stoelzel
Reported by Lobban et al. (2012) under the synonym.

Plagiogramma porcipellis Ashworth & Chunlian Li in C.Li et al. 2020
Synonym: *Plagiogramma staurophoron* (Gregory) Heiberg (as given in Lobban et al. 2012, p. 254, pl. 10, figs 3–5) and possibly the same as "*Plagiogramma* cf. *pulchellum* Greville" reported from Chuuk by J.S.Park et al. (2018)

Pseudictyota dubia (Brightwell) PA Sims & DM Williams in Sims et al. 2018
Synonym: *Triceratium dubium* Brightwell
Sims et al. 2018, pl. 37, figs 133–138 (as *'Pseudodictyota dubium'*)

Pseudictyota reticulata (Roper) PA Sims & DM Williams in Sims et al. 2018
Synonym: *Triceratium dictyotum* (Roper) Sims & Ross.

Pseudictyota bicornis (Cleve) PA Sims & DM Williams in Sims et al. 2018
Synonym: *Triceratium bicorne* Cleve
Sims et al. 2018: 38, figs 139–43 (as *'Pseudodictyota bicorne'*)

[Note that *Triceratium pulchellum* was *not* transferred. Our images show valves with porate structure, not pseudoloculate, so this is not a *Pseudictyota*.]

Schizostauron cf. *trachyderma* (F.Meister) Górecka & Riaux-Gobin

Our species identified as *Achnanthes citronella* is a species of *Schizostauron* but we can so far only propose it as *Schizostauron* cf. *trachyderma* (F.Meister) Górecka & Riaux-Gobin. The difficulties in deciding whether it is that species, *S. kajotkei* Dabek, Górecka & Witkowski, or neither was discussed with reference to Chuuk specimens by J.S.Park et al. (2022), and the SEM images we have to date for this species do not resolve the question. See Riaux-Gobin et al. (2015), Davidovich et al. (2017) and Górecka et al. (2021).

Tetramphora decussata (Grunow) Stepanek & Kociolek 2016
Synonym: *Amphora decussata* Grunow

Tetramphora intermedia (Cleve) Stepanek & Kociolek 2016
Synonym: *Amphora rhombica* var. *intermedia* Cleve

APPENDIX 4. CLASSIFICATION CHANGES SINCE 2012 OF SIGNIFICANCE TO OUR FLORA

Two revisions of Protist classification have been published, most recently by Adl et al. (2019), which included major revision of “centric” diatoms by D.G.Mann. This high-level classification takes account of the major molecular advances in this group over the past decade and accords well with the trees developed by Ashworth and Lam (most recently in Lobban et al. 2022). Sims et al. (2018) erected Odontellaceae, which Mann (in Adl et al. 2019) moved into a new subclass Odontellophycidae. Cox (2015) gave a complete analysis of the diatom genera in the *Syllabus of Plant Families*, but introduced a number of taxa as “nom. prov.,” which are invalid designations (ICN Art. 36.1: Turland et al. 2018). Subsequently Medlin (2016) proposed the Urneidophycidae, which includes *Asterionellopisis* (very basal) along with Rhaphoneidaceae and Plagiogrammaceae, to which Lobban & Ashworth (2022a) added Koernerellales / Koernerellaceae for *Bleakeleya* (which had been misplaced in Asterionellopsidaceae), *Koernerella* and *Perideraion* (which had been overlooked in other classifications). Lobban et al. (2022) revised the Ardissoneaceae (Ardissoneales) to include six genera including *Toxarium* and *Climacosphenia*.

APPENDIX 5. GUAM TYPE SLIDES IN U.S. DIATOM HERBARIA

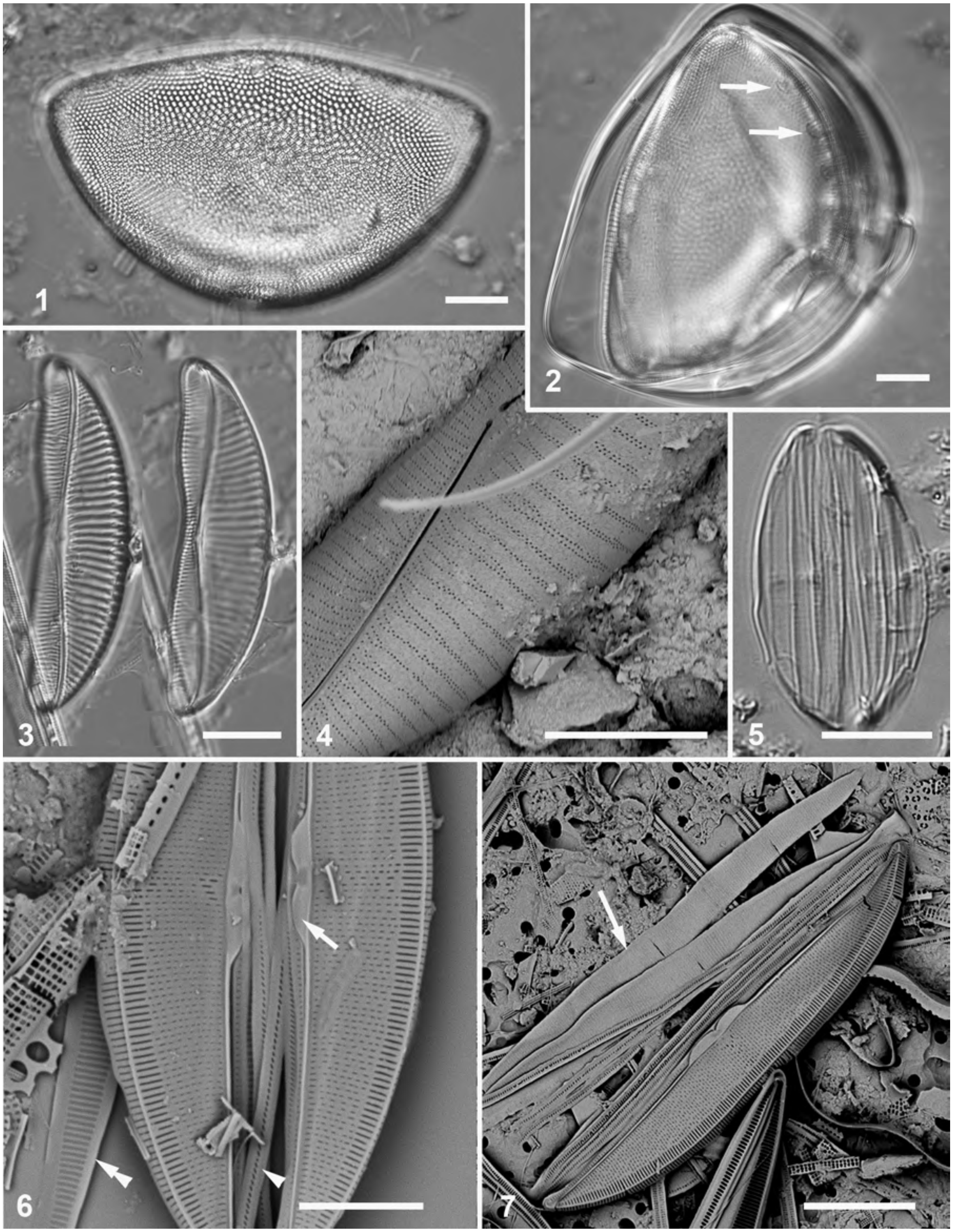
The many type slides for new species reported from Guam add up to a sizeable collection of materials available in North America, since each slide is a strew from a sample and contains many more taxa than just the one (occasionally more) designated types. These can be resources for diatomists studying tropical marine benthic taxa. Fifty-six slides are listed by sample number under one of the two herbaria (CAS and ANSP). In addition, a selection of 108 slides from the region was donated to the Diatom Herbarium at U. Szczecin, Poland (SZCZ); a spreadsheet listing these is in the Supplementary Material (https://micronesica.org/file/1131/download?token=bpmWANDN).

Sample #	Orig. slide #	Accession #	Slide #	Types included[a]
	California Academy of Sciences			
GU7N	unnumbered	627384	223006	*Perideraion montgomeryi*
GU7X-7	1319	627426	223042	*Rhoiconeis pagoensis*
GU32B	806	627397	223012	*Mastogloia lyra*
GU44AA-5	445	627406	223020	*Cyclophora castracanei*
GU44AJ	861	627416	223028	*Licmophora comnavmaria*
GU44AK-6	958	627425	223041	*Colliculoamphora gabgabensis*
GU44AL-3	927	627403	223017	*Licmosphenia peragallioides*
GU44BD-4	1567	627422	223039	*Grammatophora ornata*
GU44I-1	494	627427	223043	*Lauderia excentrica* and *Colliculoamphora gabgabensis* paratype
GU44I-4	235	627405	223019	*Cyclophora minor*
GU44L-A	485	627423	223039	*Rhoicosigma parvum* paratype
GU44U-1A	168	627394	223008	*Mastogloiopsis biseriata* paratype
GU44U-1B	200	627421	223038	*Druehlago cuneata*
GU44V-1	unnumbered	627375	222100	*Climaconeis undulata* voucher
GU44Y-13	unnumbered	627373	222098	*Climaconeis guamensis*
GU44Z-15	453	627409	223023	*Astrosyne radiata*
GU44Z-15	not noted	627383	223005	*Gato hyalinus*
GU44Z-15	451	627396	223010	*Hanicella moenia*
GU44Z-15	unnumbered	627386	223007	*Perideraion* spp., including *P. elongatum*
GU52J-3	254	627414	223026	*Cyclophora tabellariformis* paratype
GU52K-2	866	627404	223018	*Licmosphenia albertmannii* and *L. leuduger-fortmorelii*
GU52O-4	1696	627432	223050	*Arcuatasigma arenicolum, A. marginale*, and *Progonoia diatreta*
GU54B-4	113	627397	223011	*Mastogloia parlibellioides*
GU55B-4-1	unnumbered	627376	223001	*Climaconeis petersonii*

Sample #	Orig. slide #	Accession #	Slide #	Types included[a]
GU66A-3	1173	627424	223040	*Psammodictyon pustulatum* [mislabeled as *P. mammiferum*]
GU66F-8	1452	627430	223048	*Licmophora pisciformis*
GU66G-5	1694	627423	223040	*Microtabella rhombica*
		Academy of Natural Sciences Philadelphia		
GU43C	2765	GC36365	--	*Haslea alexanderi* [voucher of smaller population]
GU44AR-1	1095	GC20092	--	*Pleurosigma simulacrum*
GU44BH-2	1708	GC20070	--	*Licmophora bulbosa*
GU44BJ-2	1772	GC20069	--	*Licmophora attenuata*
GU44BJ-4	1831	GC20087	--	*Ardissoneopsis gracilis*
GU44BK-6	1828	GC36366	--	*Haslea apoloniae* and *H. arculata*
GU44BT-2	2232	GC 20073	--	*Climaconeis desportesiae*
GU44BV-1	2459	GC 20082	--	*Licmophora repanda*
GU44I-1	495	GC20099	--	*Plagiogramma subatomus* and *Thalassionema baculum*
GU44K-6	472	GC 20077	--	*Nitzschia electrae*
GU44K-6	499	GC20094	--	*Parlibellus paschalis*
GU44O-F	507	GC 20083	--	*Licmophora undulata*
GU44P-B	245	GC20098	--	*Licmophora romuli*
GU44T-1	128	GC 20114		*Mastogloia frickei* voucher
GU44X-3	203	GC 20071	--	*Licmophora curvata*
GU44Y-13	449	GC20111	--	*Ardissoneopsis appressata* and *Ardissoneopsis fulgicans*
GU44Z-15	146	GC20085	--	*Grunowago pacifica*
GU52P-9	826	GC36367	--	*Haslea guahanensis*
GU52S-3	1389	GC20091	--	*Hyalosira navarroana*
GU52U-2	1861	GC20108	--	*Climacosphenia elegantissima*
GU52W-3	1929	GC20079	--	*Nitzschia spathulatoides*
GU52X-5b	3056	GC20106	--	*Dictyoneis apapae*
GU52Y-4B-1	1981	GC20076	--	*Nitzschia maiae*
GU55B-4	455	GC20088	--	*Synedrosphenia licmophoropsis*
GU55C-6	2470	GC20072	--	*Licmophora labianatis*
GU66F-8	1417	GC36368	--	*Haslea alexanderi*
GU68B-5	2046	GC20084	--	*Licmophora joymaciae*
GU75A-4	2326	GC20086	--	*Synedrosphenia parva*
GU76A-1	2366	GC20074	--	*Climaconeis leandrei*

PLATES

Figures 1–7. Figs 1, 2. *Actinocyclus cuneiformis*, LM, arrows showing rimoportulae. Figs 3, 4. *Amphora spectabilis*: Fig. 3. LM at two focal planes showing different striae densities on dorsal and ventral surfaces. Fig. 4. Palau specimen in SEM showing character of striae. Figs. 5–7. *Amphora subhyalina*. Fig. 5 LM, showing the hyaline character. Fig. 6. SEM detail of valves with conopea at central raphe endings (arrow), also showing striae on dorsal (double arrowhead) and ventral (single arrowhead) part of girdle band. Fig. 7. Frustule showing broad dorsal part of some girdle bands. Scale bars: Figs 1–5, 7 = 10 µm, Fig. 6 = 5 µm.
Unless indicated otherwise, all light microscopy (LM) was with differential interference contrast (DIC).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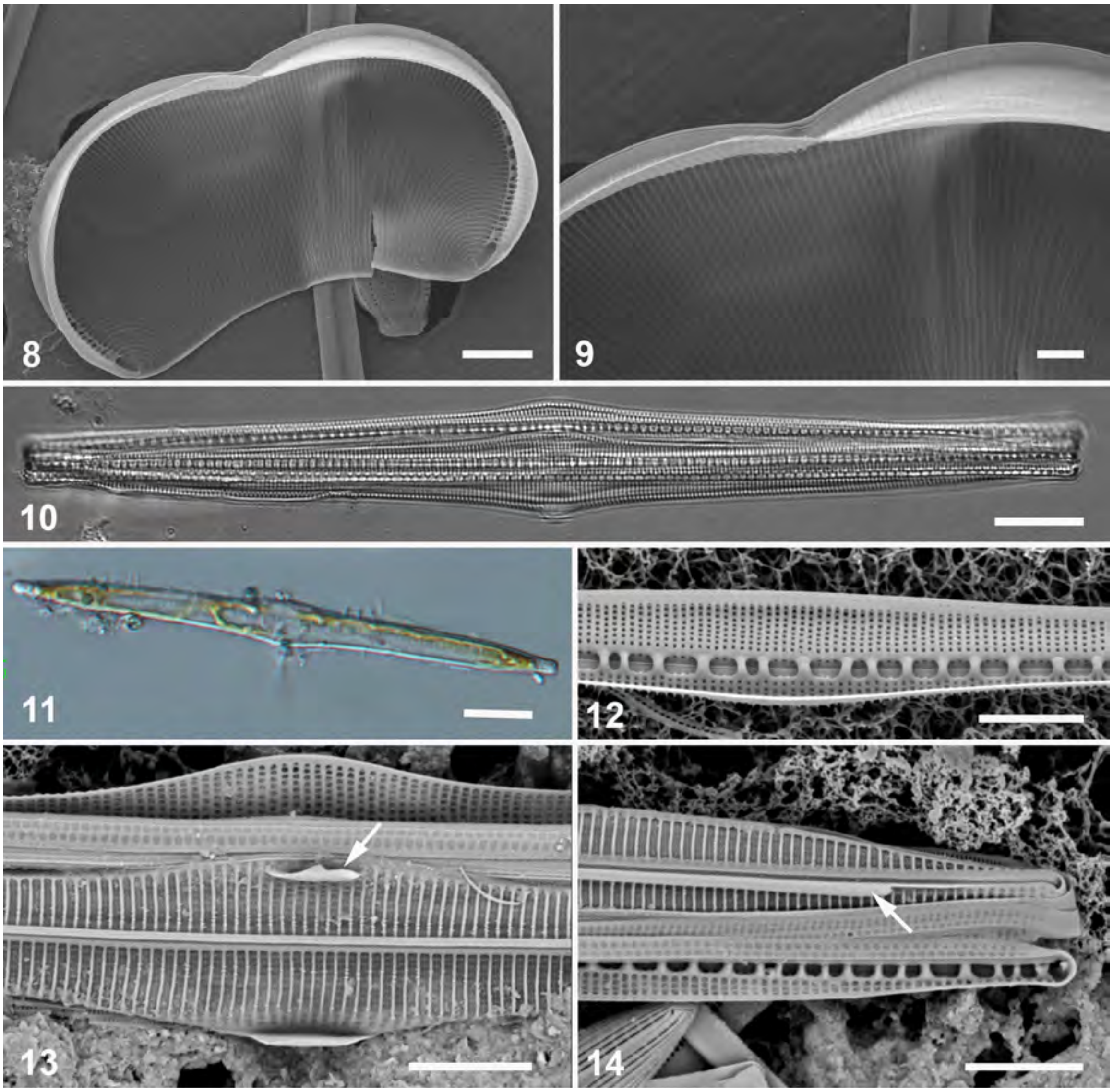
Figures 8–14. *Auricula* and *"Bacillaria."* Figs 8, 9. *Auricula densistriata*. Figs. 10–14. "*Bacillaria* Group B" sensu Schmidt, var. *tumidula*. Fig. 10. Acid cleaned frustules in LM. Fig. 11. Live cell. Fig. 12. Internal valve surface, SEM. Fig. 13. Wider central part of cell in SEM, showing external short cristae (arrow). Fig. 14. Apex of frustule in SEM showing the raphe flap (arrow) that links cells together and girdle bands. Scale bars: Fig. 11 = 25 µm, Fig. 10 = 10 µm, Figs 8, 9, 12–14 = 5 µm.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Figures 15–19. *Berkeleya* cf. *hyalina*. Figs 15, 16. Living macroscopic colonies in dissection microscope and low power compound microscope. Figs 17, 18. Detail of living cells in colony showing central plastids (cells all in girdle view). Fig. 19. Acid cleaned valve showing hyaline character. Scale bars: Fig. 15 = 1 mm, Fig. 16 = 100 µm, Fig. 17 = 25 µm, Figs 18–20 = 10 µm, Figs 21, 22 = 5 µm.


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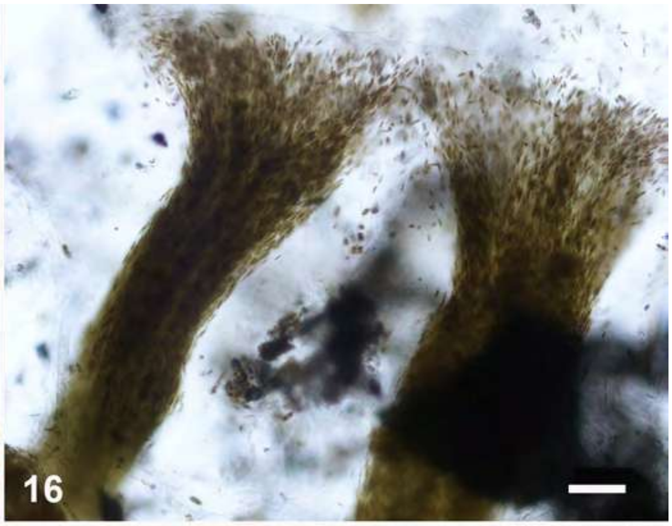
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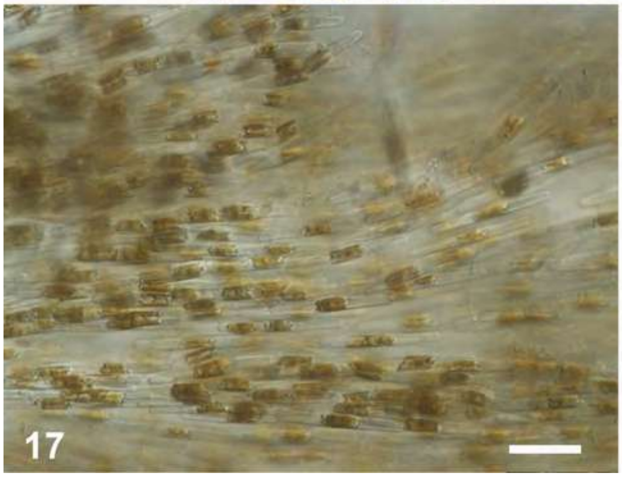
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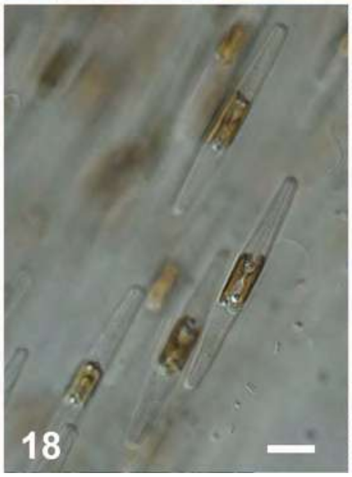
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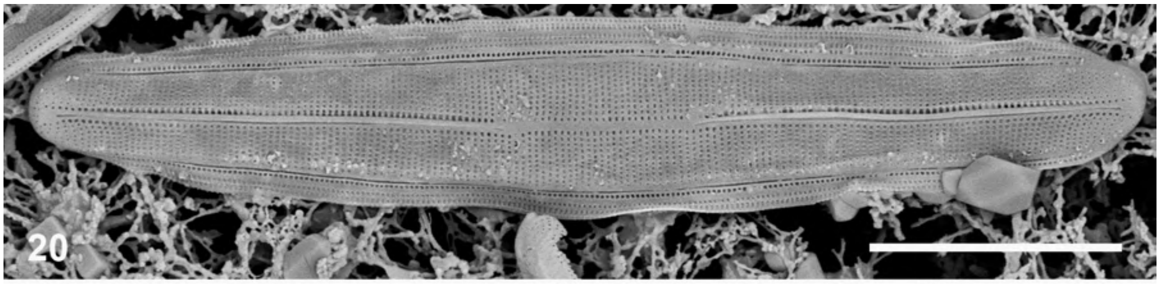
Figures 20–25. *Berkeleya* cf. *hyalina.* Frustules in SEM from whole mount. Fig. 20. Whole frustule. Fig. 21. Central portion showing row of larger areolae along one side of raphe (arrow) and distance between the slightly curved central raphe endings. Fig. 22. Apex of frustule shown in Fig. 20, with detail of terminal raphe ending and apical poration. Fig. 23. High resolution detail of the larger areolae with a papilla at the end of each vimen (arrow) vs. regular quadrate areolae (courtesy of Rafał Wróbel, U. Szczecin). Figs 24, 25. *Berkeleya* sp. from Majuro (M2-13). Fig. 24. External valve face showing central gap between raphe endings, unilateral zone of long areolae. Fig. 25. Internal aspect of apex. Scale bars: Figs 20, 21 = 10 µm, Figs 24, 25 = 5 µm, Fig. 22 = 2 µm, Fig. 23 = 1 µm.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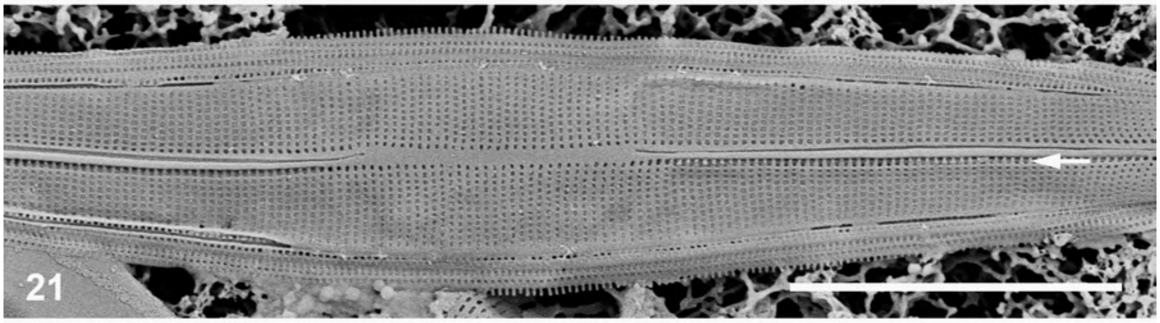
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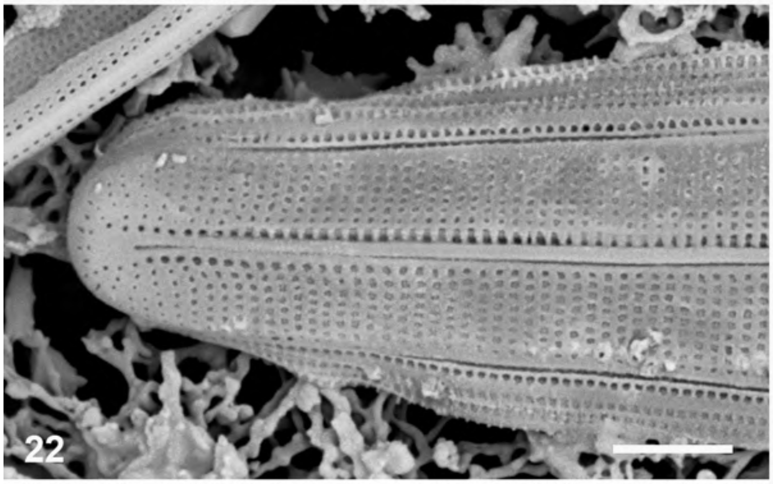
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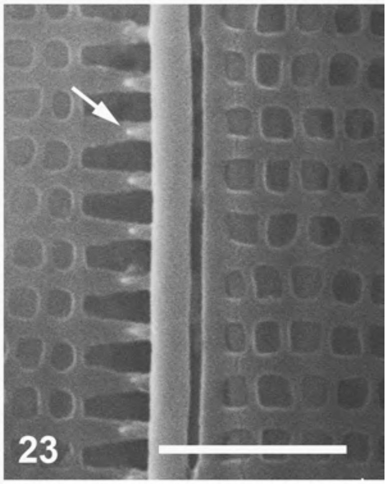
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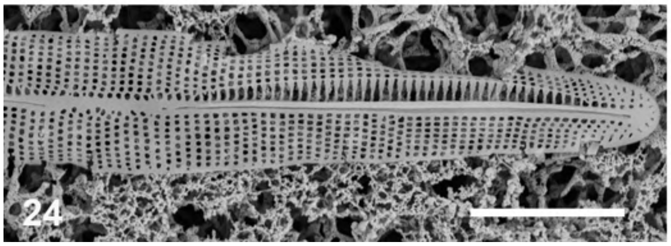
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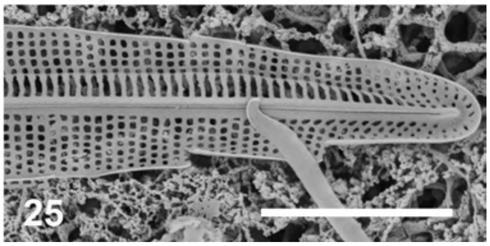
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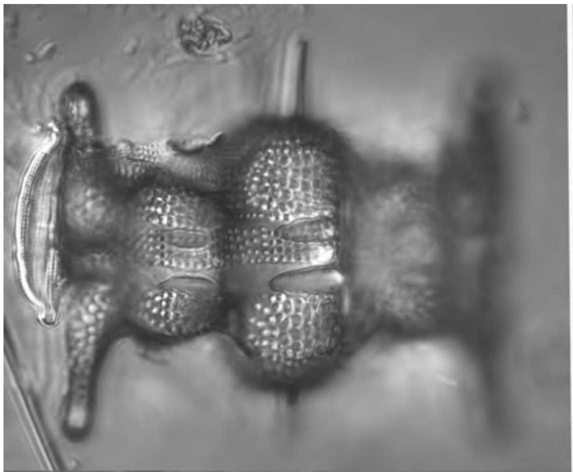
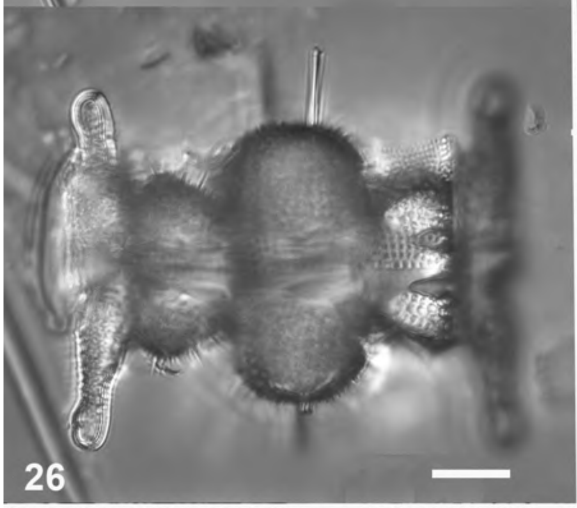
Figures 26–31. *Biddulphiella* and *Biremis.* Figs. 23–26. *Biddulphiella tridens*. Fig. 26. Frustule in valve view at two focal planes. Figs 27, 28. Valves in girdle and valve view, respectively, SEM. Fig. 29. Valve in oblique view, emphasizing the deep grooves (sulci) between the elevations. Figs. 30, 31. *Biremis ambigua* frustules in SEM. Fig. 30. Oblique view showing raphe and paired external alveolus openings. Fig. 31. Broken frustule showing internal side of alveoli (arrow) and exterior of girdle bands. Scale bars = 10 µm.





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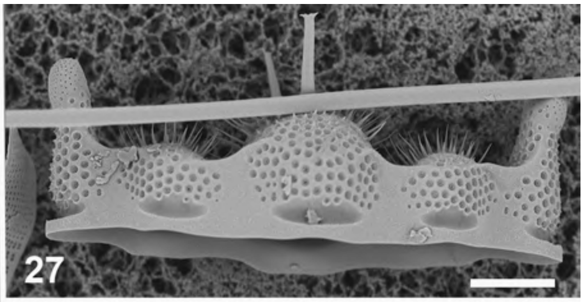

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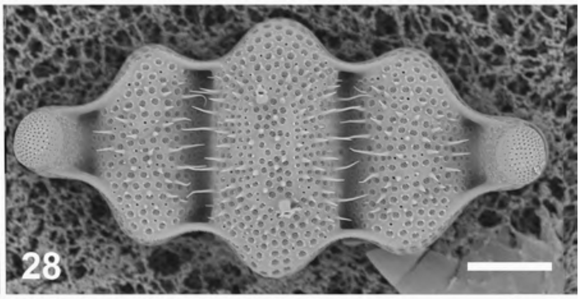

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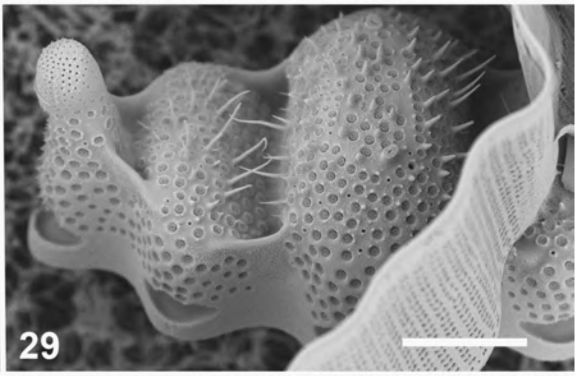

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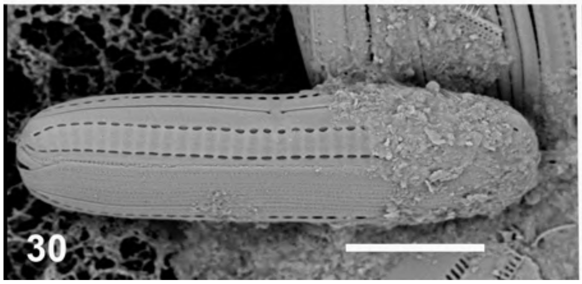

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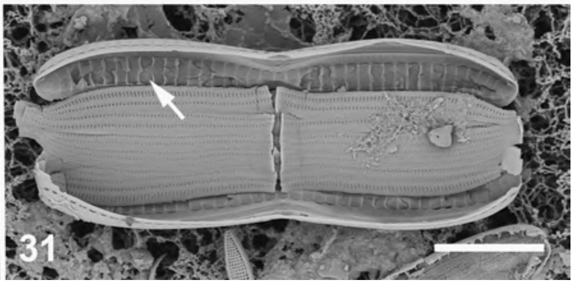

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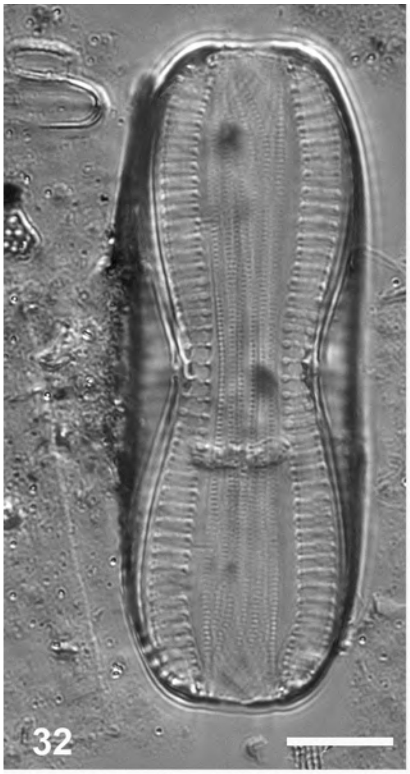
Figures 32–38. *Biremis* and *Campylodiscus.* Figs. 32–37. *Biremis ridicula*. Fig. 32. Frustule in "ventral" girdle view, LM. Fig. 33. Valve and girdle bands in girdle view at two focal planes, LM. Fig. 34. Valve, interior view, SEM. Fig. 35. Frustule in "ventral" girdle view. Fig. 36. Valve in valve view showing asymmetry. Fig. 37. Detail of Fig. 34 showing alveoli and asymmetry. Fig. 38. *Campylodiscus robertsianus* valve in LM. Scale bars: Fig. 38 = 25 µm, Figs 32–36 = 10 µm, Fig. 37 = 5 µm.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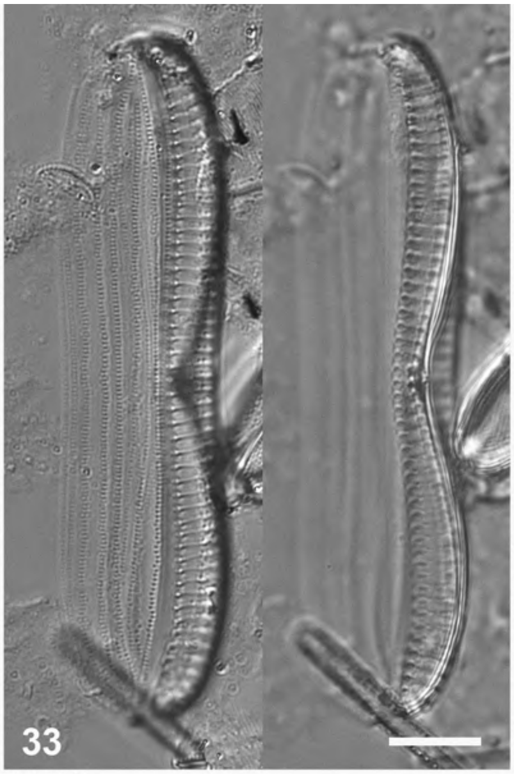
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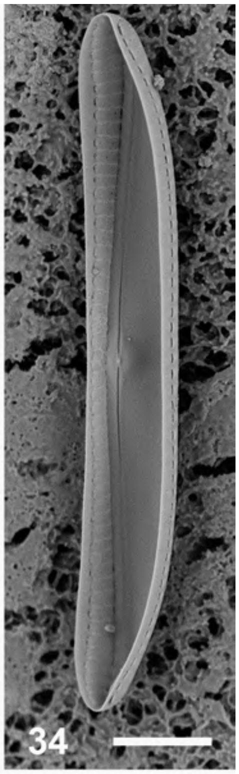
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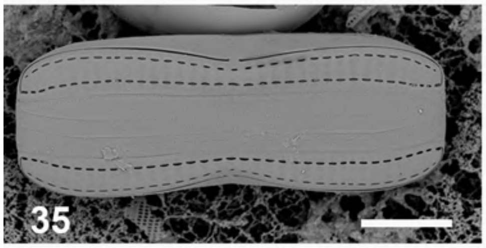
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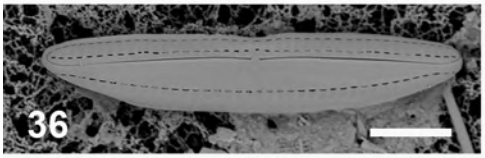
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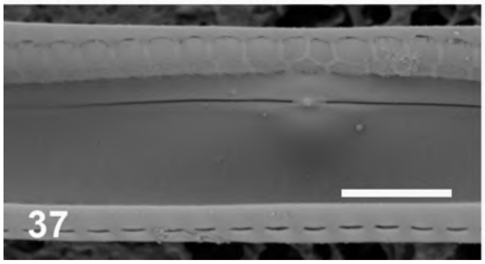
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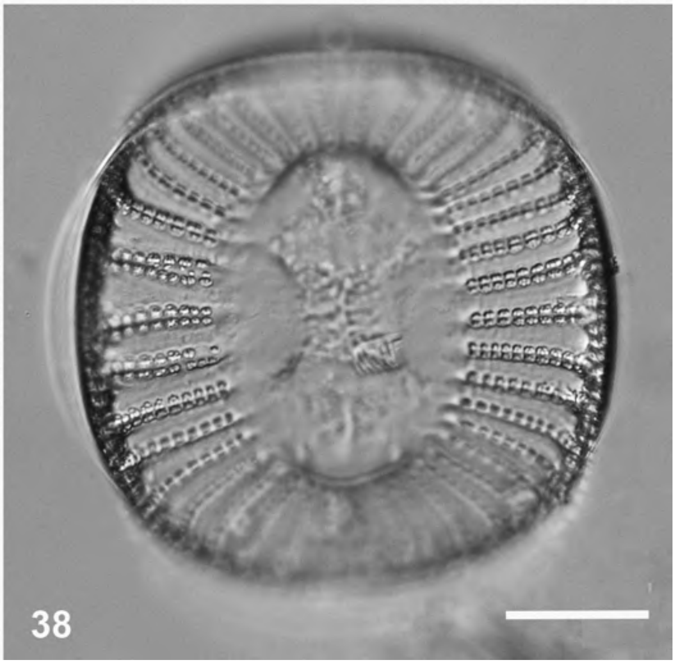
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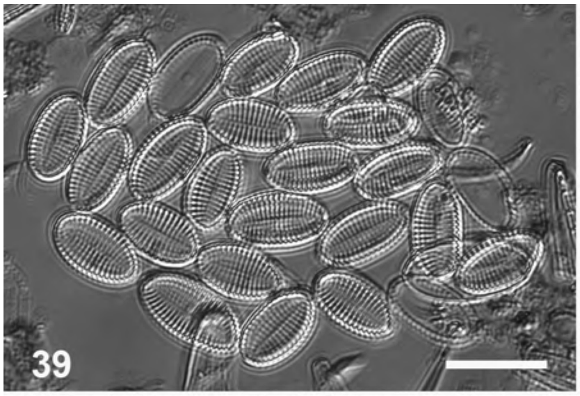
Figures 39–43. Figs. 39–41. *Cocconeis carinata*. Fig. 39. Cluster of cells in LM. Fig. 40. Sternum valve. Fig. 41. Raphe valve. Figs. 42, 43. *Coscinodiscus hauckii* in LM and SEM. Scale bars: Figs 39, 42 = 10 µm, Fig. 43 = 5 µm, Figs 40, 41 = 1 µm.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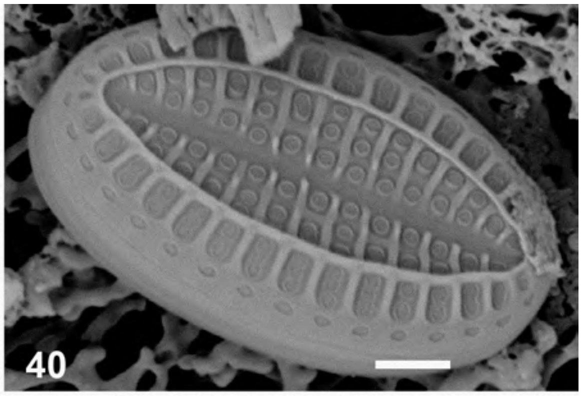
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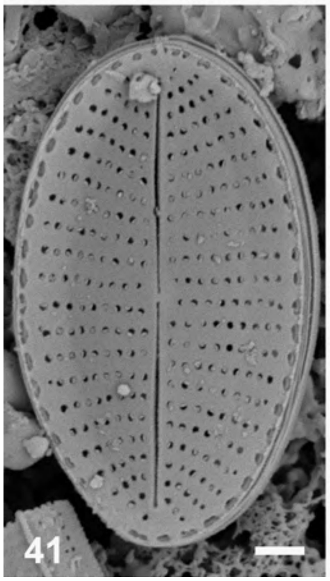
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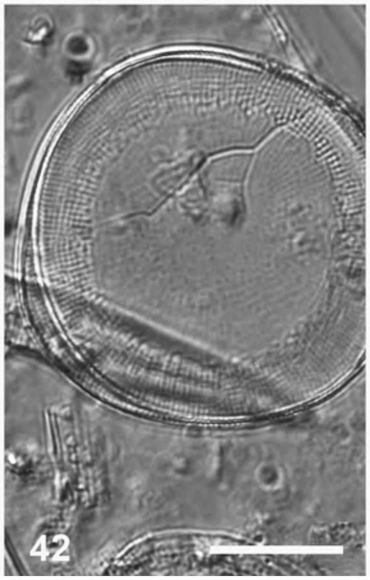
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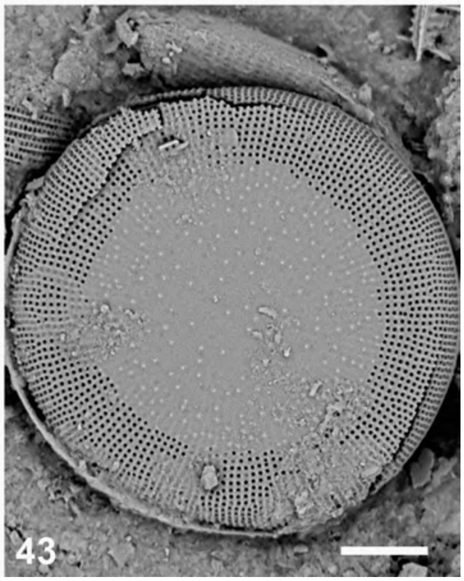
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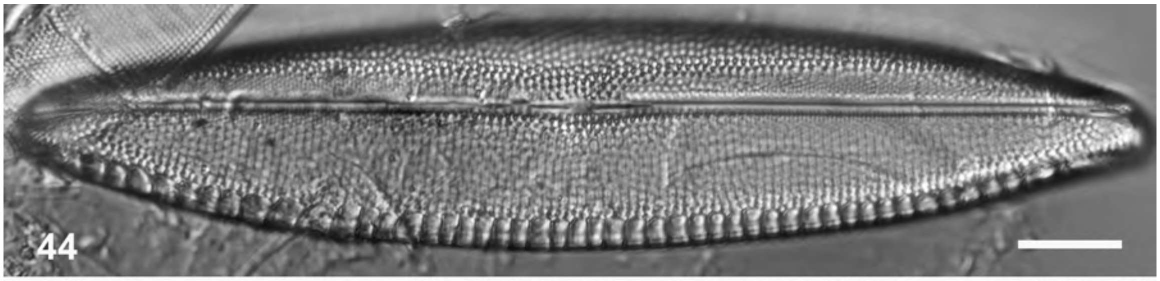
Figures 44–49. *Dictyoneis apapae*, sp. nov. Figs 44, 45 LM, all others SEM. Fig. 44. Holotype (stack of two focal planes), slightly oblique, showing apparent striae and apparent chambers on near side. Fig. 45. Valve straight on, central nodule focal plane. Fig. 46. Valve in SEM showing external side of pseudoloculi; note opposite deflection of terminal raphe endings (arrows); enlarged in next two figures. Fig. 47. Detail of apex showing large groove in mantle and two rows of pores in the valvocopula (VC). Fig. 48. Detail of central area showing double layer of external pseudoloculi; also showing external raphe slits bordered by thin ridges of silica (arrow), and absence of circular area of small pseudoloculi. Fig. 49. Detail of marginal pseudoloculi. Scale bars: Figs 44–46 = 10 µm, Figs 47–49 = 5 µm.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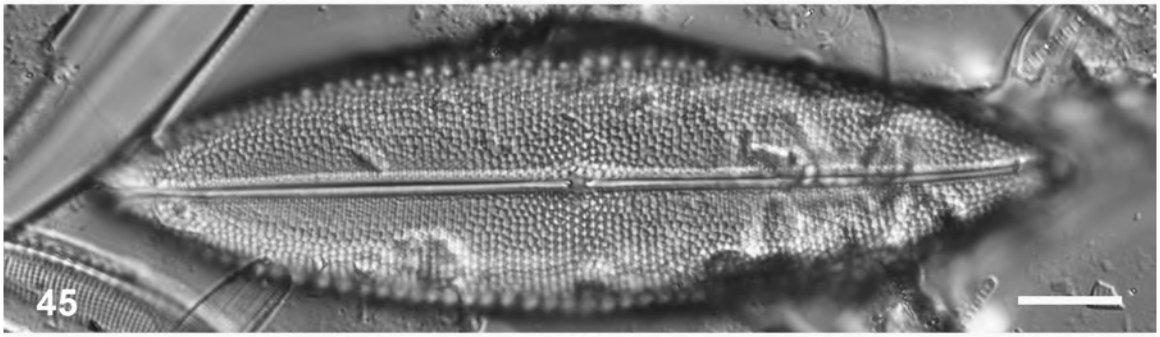
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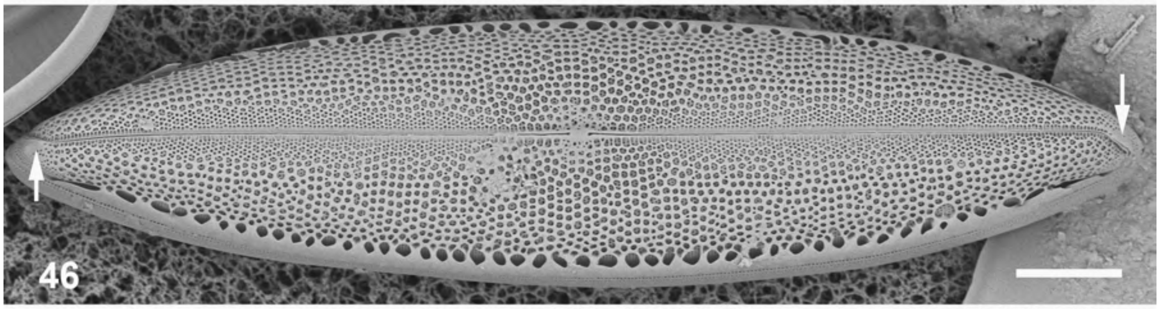
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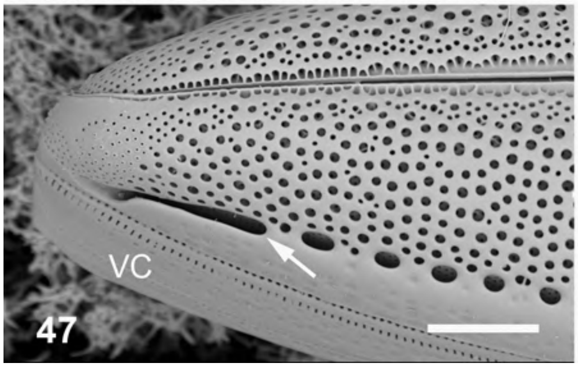
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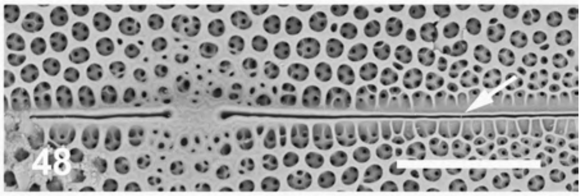
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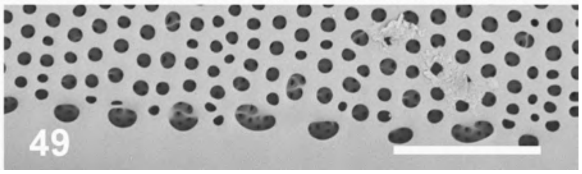
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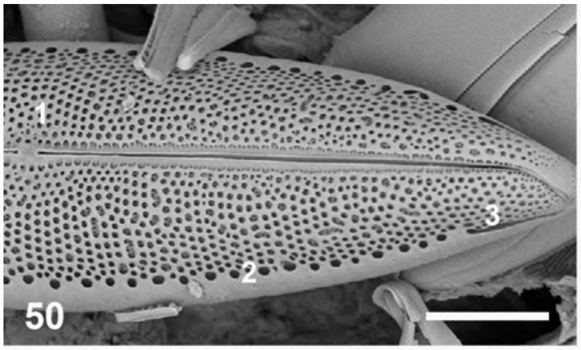
Figures 50–58. *Dictyoneis apapae*, sp. nov. (cont.), except Figs 51, 56, putative *D. marginata* from Gray's Reef National Marine Sanctuary, Georgia; SEM, cont. Figs. 50, 51. Comparison of the two species' exteriors with the following three points of distinction: 1. Central area; 2. Marginal pseudoloculi; 3. Apical groove. Fig. 52. Detail of an isolated valve apex. Fig. 53. Central region of isolated valve showing central nodule and poration on mantle with short intercalary striae, with a few longer (arrowhead), forming a denser band (arrow) before a hyaline border. Fig. 54. Fractured valve showing wall structure with large outer pores (arrow), smaller ridges defining smaller holes, and showing the slit-like inner foramina. Figs 55, 56. Comparison of the two species' interiors, both valves with valvocopula. Figs 57, 58. Opposite poles of a frustule in girdle view showing copulae. Arrow shows deep indent on end of valvocopula, which appears closed at that end as well as at the opposite; 2nd copula open and 3rd copula with large ligule that fills the indentation on the valvocopula. Scale bars: Figs 50, 51, 55–58 = 10 µm, Figs 52, 53 = 5 µm, Fig. 54 = 2 µm.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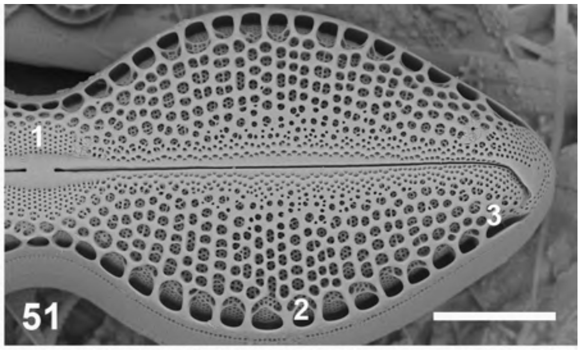
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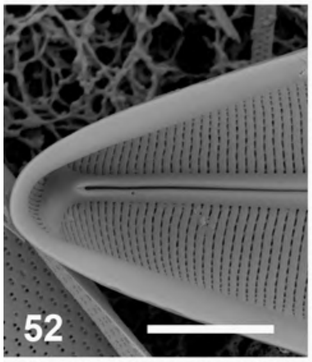
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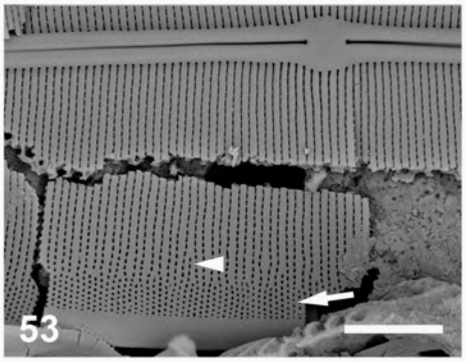
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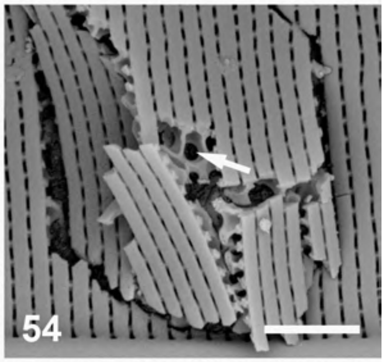
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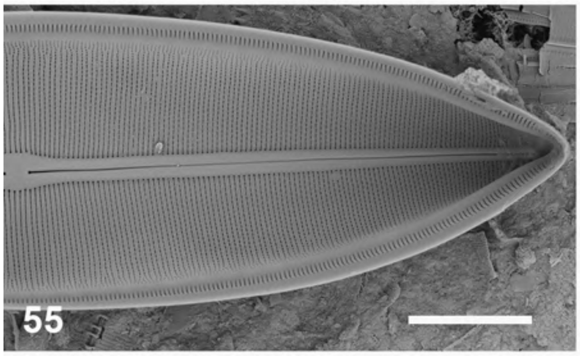
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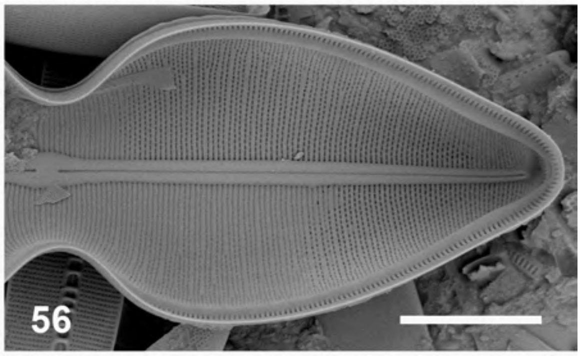
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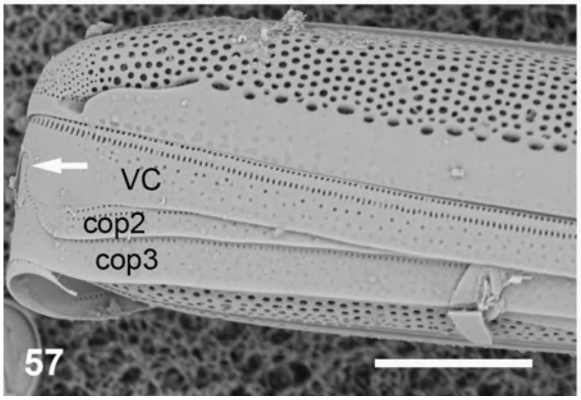
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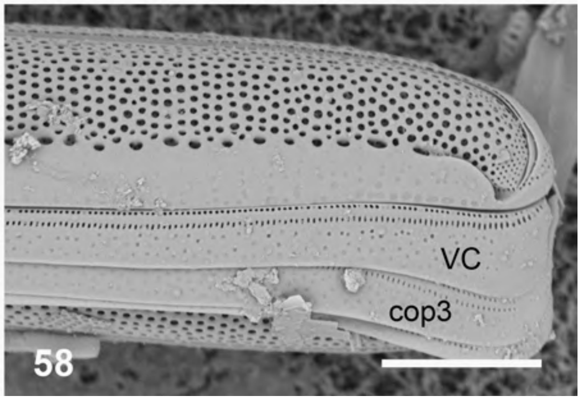
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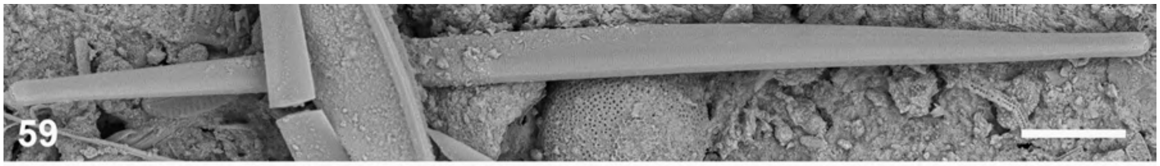
Figures 59–62. *Hyalosynedra laevigata*. Figs 59, 62. External view and detail of apex showing hyaline tip beyond the rimoportula opening (arrow) and the three rows of pores in the ocellulimbus. Figs 60, 61. Internal view with detail of apex showing character of the rimoportula (arrow). Scale bars: Figs 59, 60 = 10 µm, Fig. 61 = 2 µm, Fig. 62 = 1 µm.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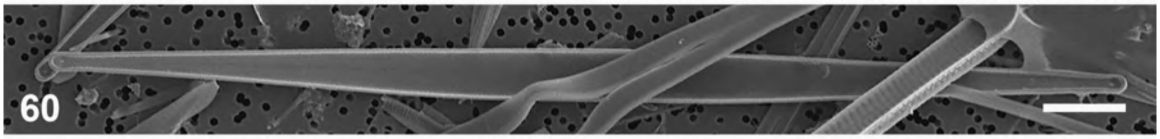
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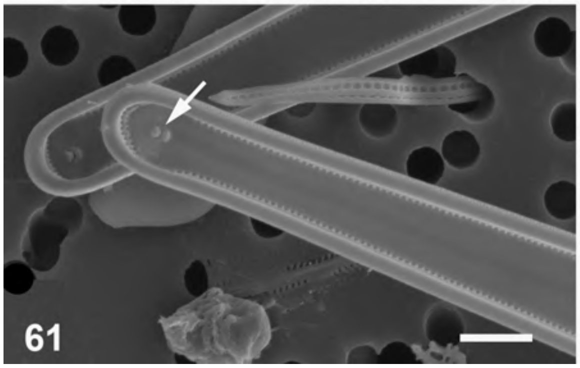
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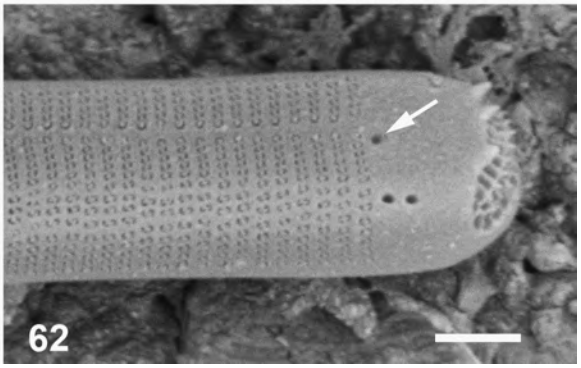
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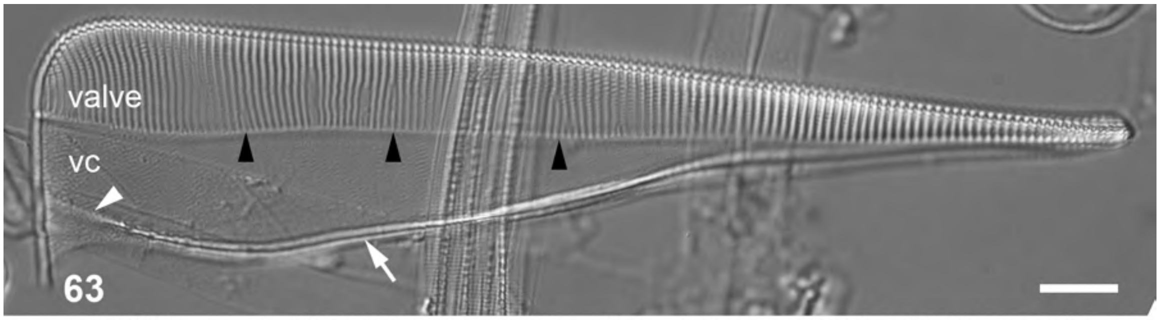
Figures 63–64. *Licmophora complanata*, LM. Fig. 63. Valve with valvocopula (vc); very narrow valve with deep mantle, vc even deeper; long septum, mostly along the abvalvar edge of vc (arrow) except where it continues the arc over ligule (arrowhead) and toward base where it crosses to advalvar edge of vc. Fig. 64. Frustule in girdle view. Scale bars = 10 µm.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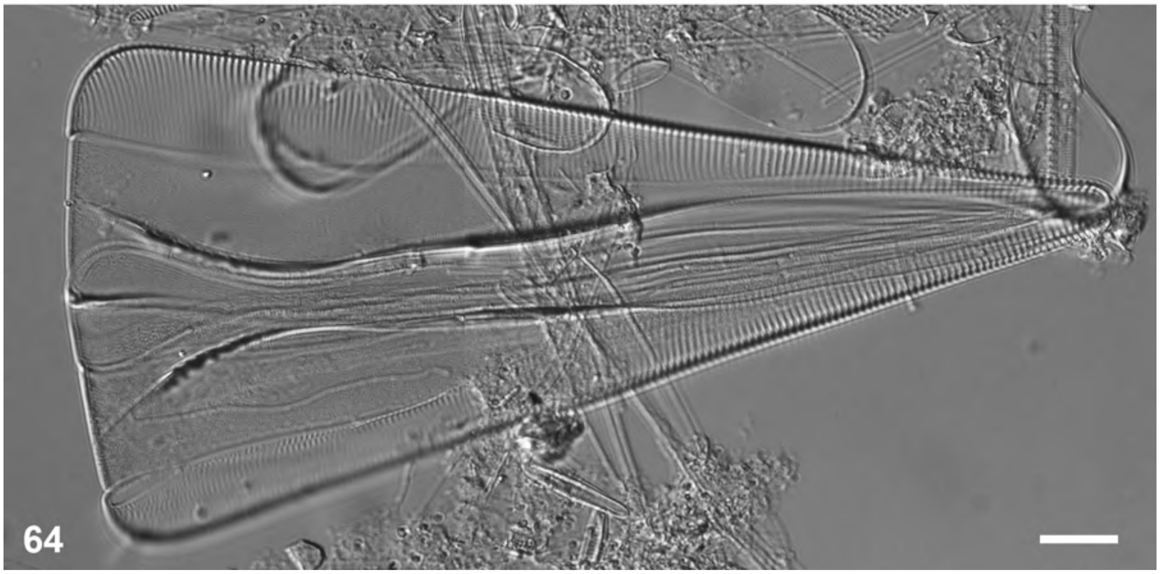
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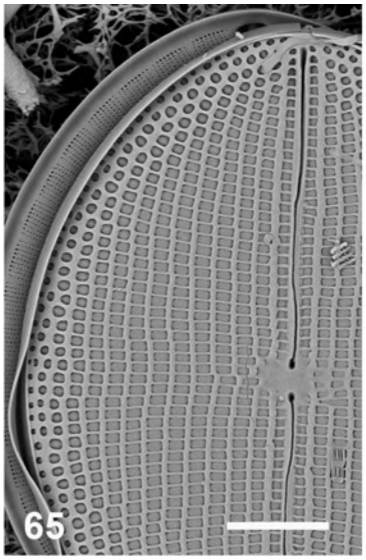
Figures 65–70. *Mastogloia*. Figs 65, 66. *Mastogloia ovata* exterior and interior valve faces. Fig. 67. *Mastogloia pseudolatecostata* (Bikar Atoll, Marshall Is.), external valve face with part of valvocopula showing partecta. Figs. 68–70. *Mastogloia* cf. *pisciculus*. Fig.68. LM (DIC) with foci on valve face and partecta Arrows on this and next image point to longitudinal rib bisecting the inner zone. Fig. 69. External surface, SEM. Fig. 70. Internal valve face and partecta, also showing partly double row of areolae (arrow). Scale bars: Figs 67, 68 = 10 µm, Figs 65, 66, 69, 70 = 5 µm.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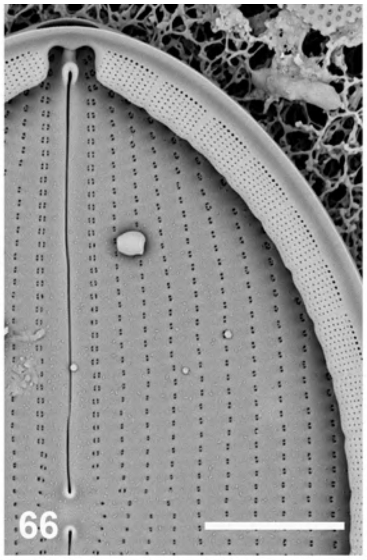
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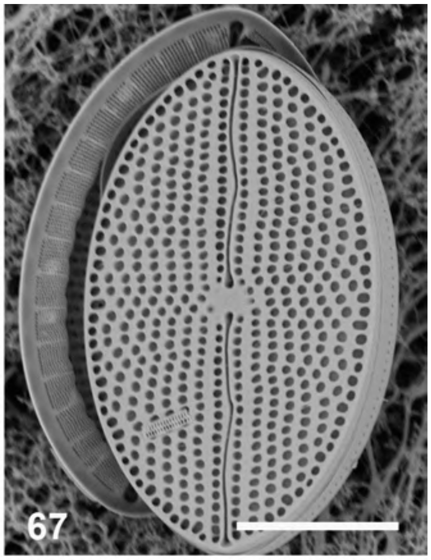
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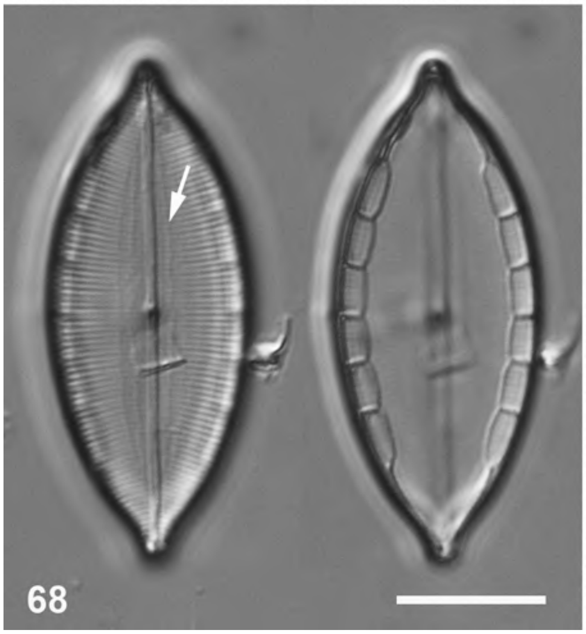
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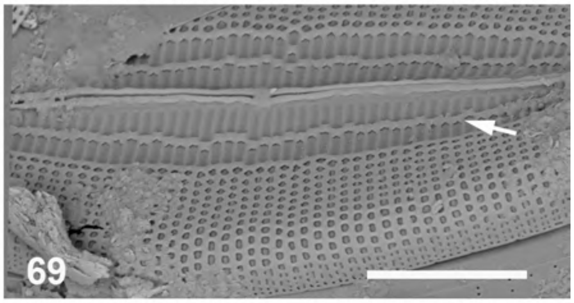
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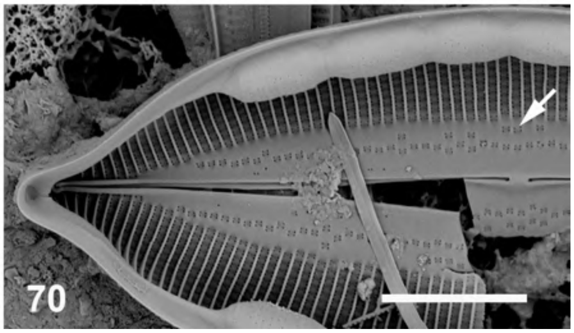
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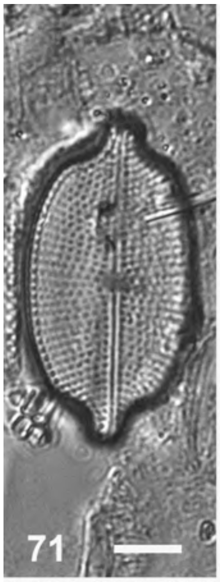
Figures 71–80. *Moreneis, Nitzschia* and *Olifantiella.* SEM except Fig. 71. Figs 71–74. *Moreneis hexagona.* Fig. 71. Valve in LM (DIC). Fig. 72. Valve exterior, showing isolated pores at the Voigt faults (arrows). Fig. 73. Valve exterior detail showing central raphe endings characteristic of the genus and c-shaped areolae. Fig. 74. Valve interior. Figs 75–78. *Nitzschia incurva.* Figs 75, 76. Guam voucher frustules at different angles. Figs 77, 78. Yap specimens showing interior and details of areolae. Figs 79, 80. *Olifantiella mascarenica* frustule showing the characteristic buciniportula (arrow). Scale bars: Fig 75 = 10 µm, Figs 71, 72, 74, 76, 77 = 5 µm, Figs 73, 78 = 2 µm, Figs 79, 80 = 1 µm.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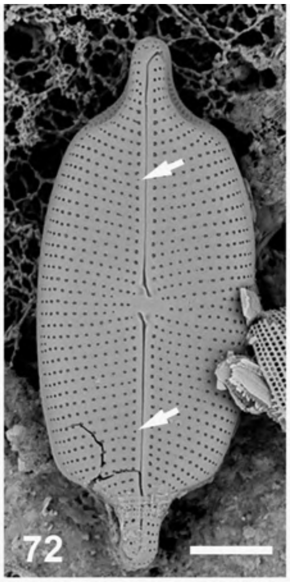
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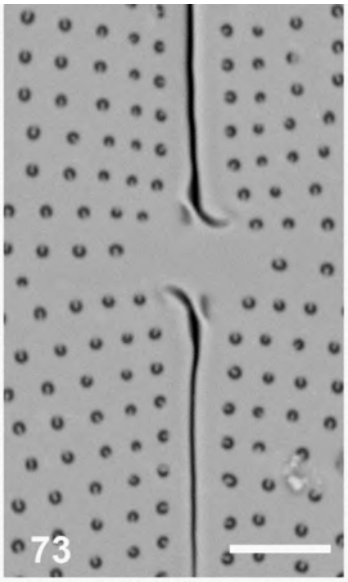
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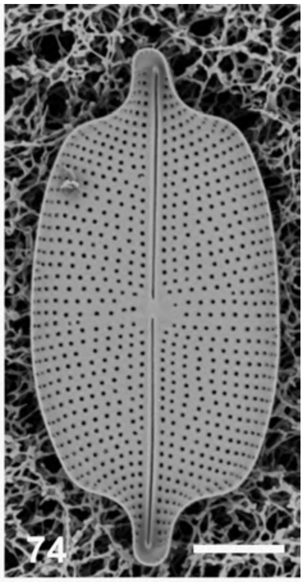
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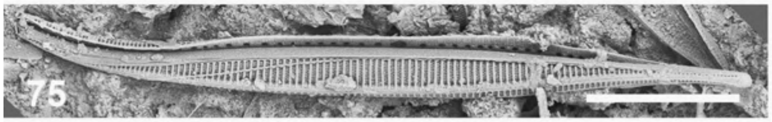
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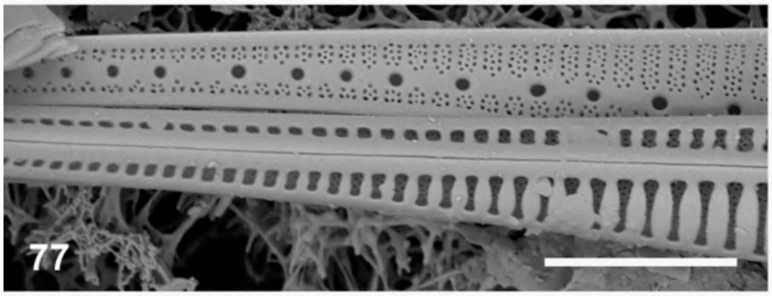
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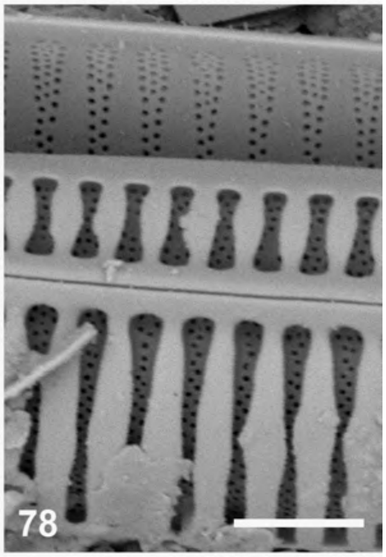
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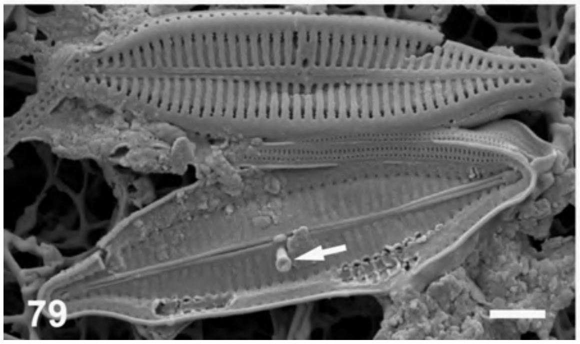
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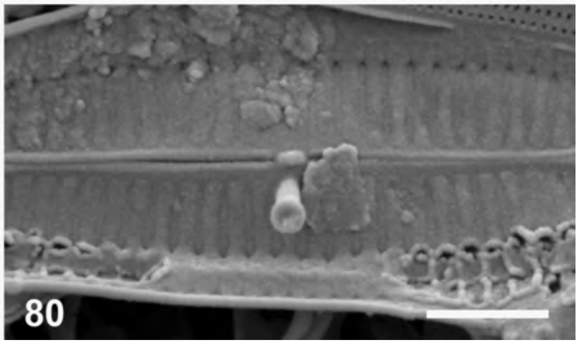
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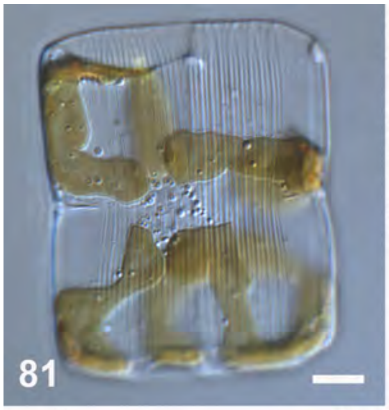
Figures 81–86. *Parlibellus* and *Plagiogramma*, SEM except Fig. 81. Figs 81–84. *Parlibellus biblos.* Fig. 81. Live cell showing plastids. Fig. 82. General view of portion of valve. Fig. 83. Detail of apex showing concentric circles of areolae around the raphe ending. Fig. 84. Detail of interior showing the stauros as a transverse bar not visible from outside. Figs 85, 86. *Plagiogramma minor* in girdle and valve view. Scale bars: Figs 81, 82 = 10 µm, Figs 84, 85, 86 = 5 µm, Fig. 83= 2 µm.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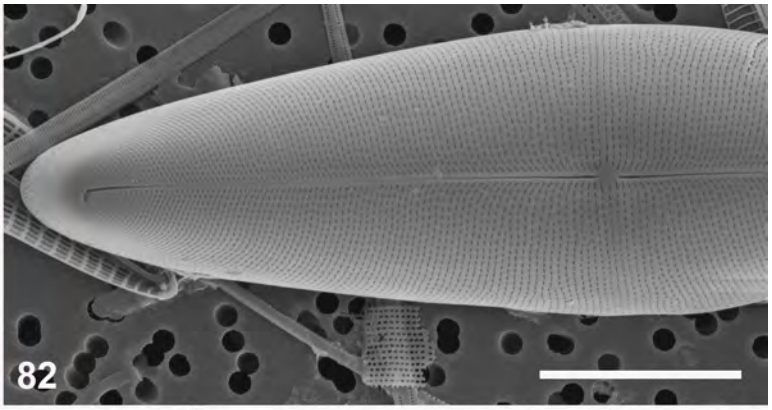
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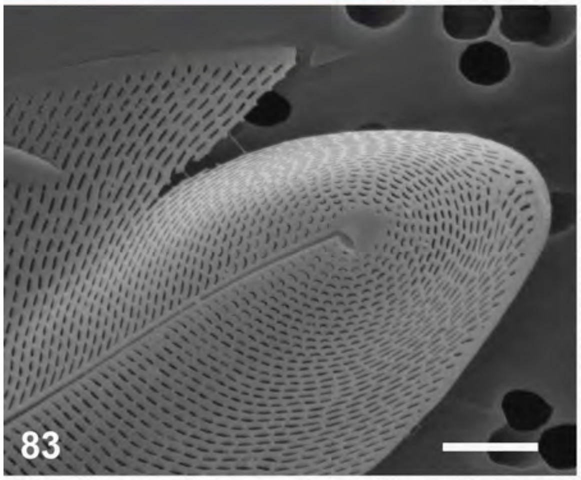
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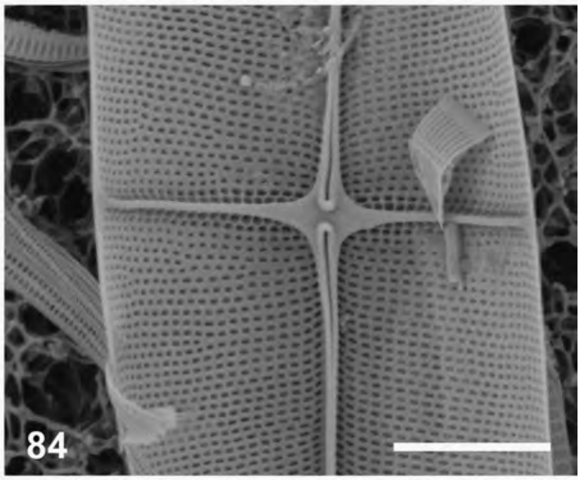
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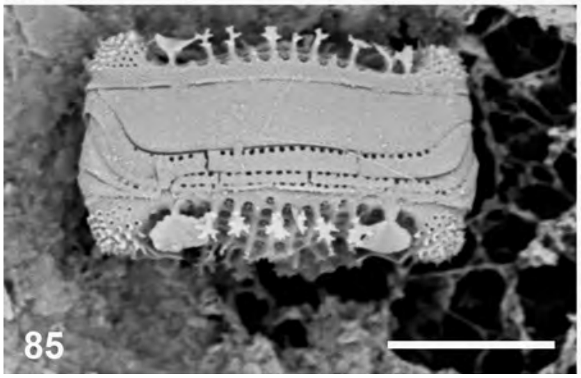
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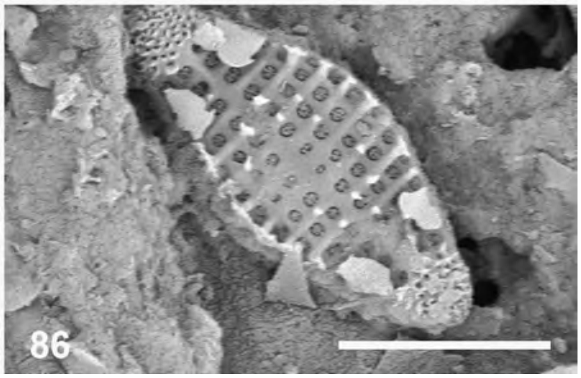
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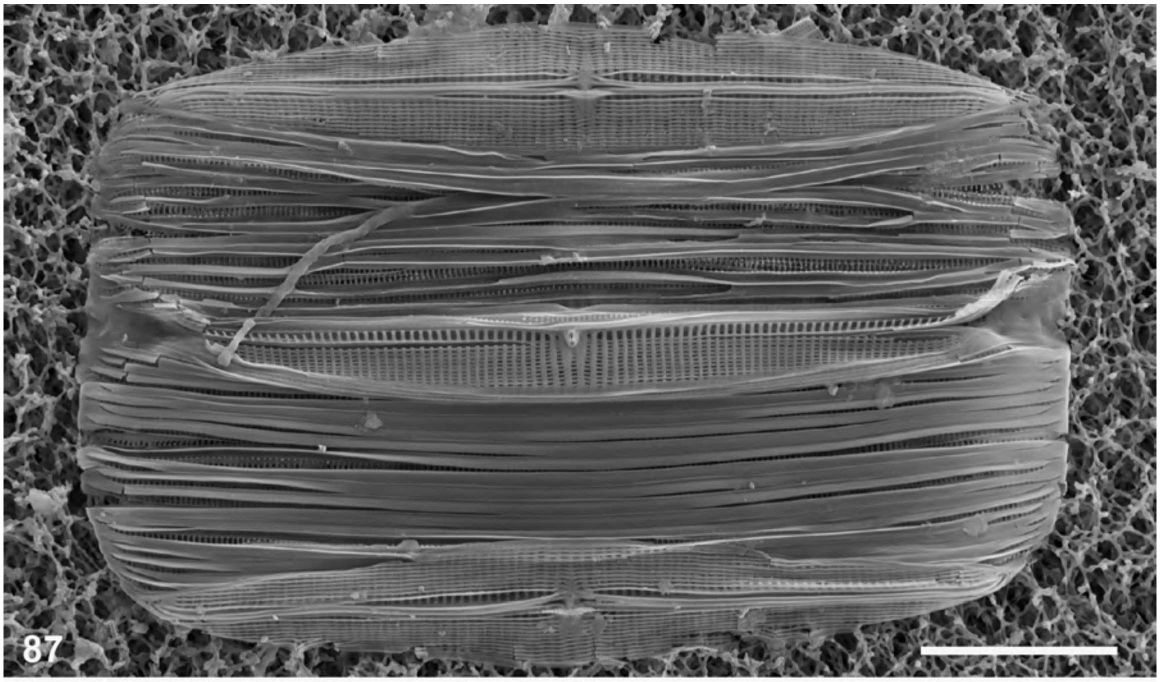
Figures 87–90. *Proschkinia complanata*, SEM. Fig. 87. Entire recently divided frustule showing two external valve faces and one internal, along with numerous girdle bands. Fig. 88. Detail of central area showing short stria on side with fistula (arrow) and flap covering fistula opening (arrowhead). Figs. 89, 90. Central area internal views showing fistula and accessory pores (arrows, Fig. 89); elevated raphe rib (arrow, Fig. 90). (Fig. 89 is detail of frustule in Fig. 87.) Scale bars: Fig. 87 = 5 µm, Figs 88, 90 = 2 µm, Fig. 89 = 1 µm.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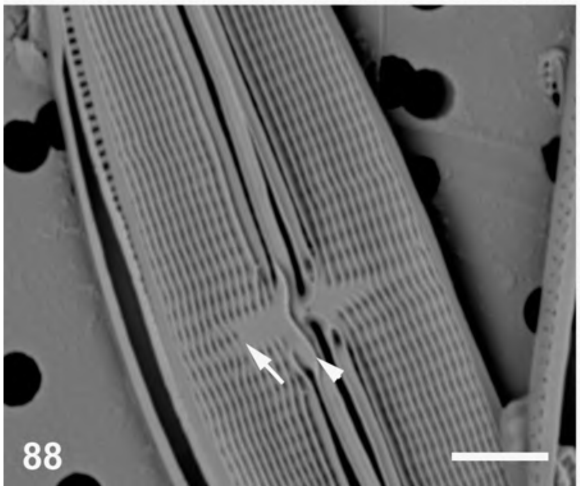
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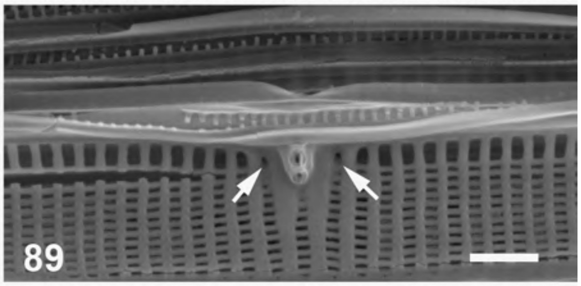
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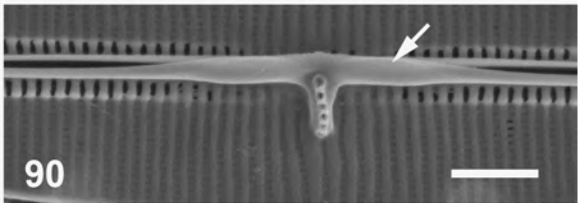
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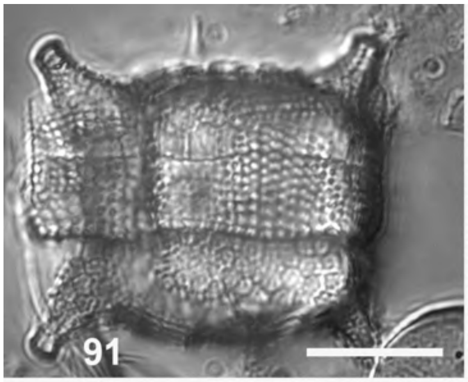
Figures 91–97. *Pseudictyota* and *Serratifera*, SEM except Fig. 91. Figs 91–93. *Pseudictyota bicorne.* Fig. 91. Frustule in girdle view, stacked focal planes. Figs 92, 93. Valve view in SEM and detail of pseudoloculi. Figs. 94, 95. *Serratifera andersonii* frustules in valve and girdle view. Figs. 96, 97. *Serratifera rhombica* frustules in valve and girdle view. Scale bars: Fig. 91 = 10 µm, Fig. 92 = 15 µm, Fig. 93 = 5 µm, Figs 94–97 = 2 µm.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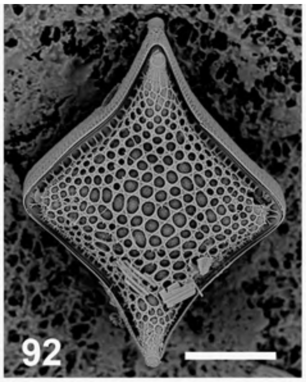
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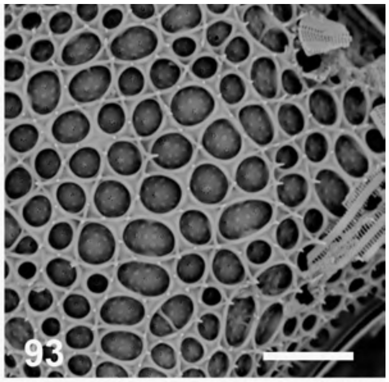
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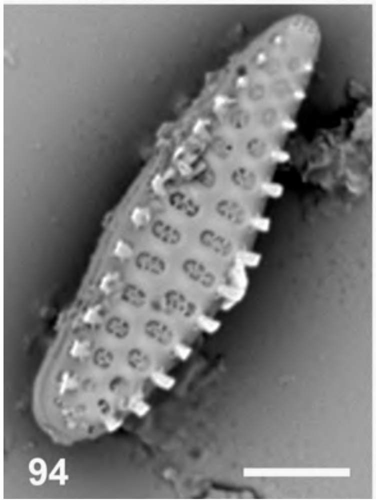
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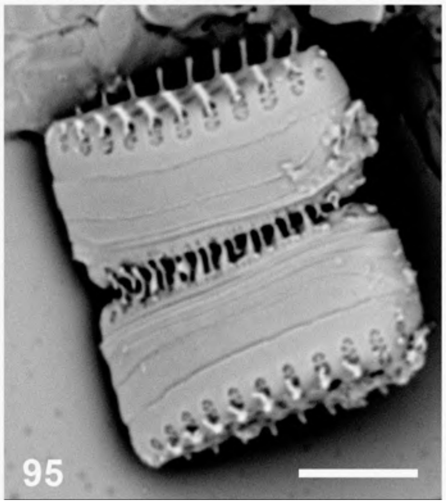
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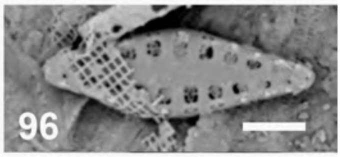
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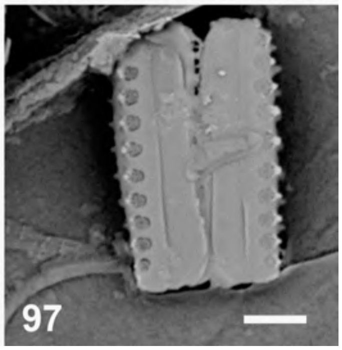
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Figures 98–106. *Stricosus* and *Thalassiosira*. Figs 98–103. *Stricosus harrisonii.* Figs 98, 99. Living cells showing plastids with pyrenoids. Figs 100, 101. Acid cleaned valves in LM and SEM. Fig. 102. External apex showing triangular hyaline area, two spines, rimoportula opening, and ocellulimbus with at least 7 rows of pores (contrast Fig. 62, *Hyalosynedra*). Fig. 103. Apex internal view showing symmetrical rimoportula (arrow). Figs 104–106. *Thalassiosira nanolineata*. Fig. 104. Valve in LM at two focal planes. Fig. 105, 106. External and internal aspects in SEM, showing central fultoportulae (F) and rimoportula (R) (arrows). Scale bars: Figs 98, 100, 101 = 20 µm, Fig 104 = 10 µm, Figs 99, 103, 105, 106 = 5 µm, Fig. 102 = 2 µm.


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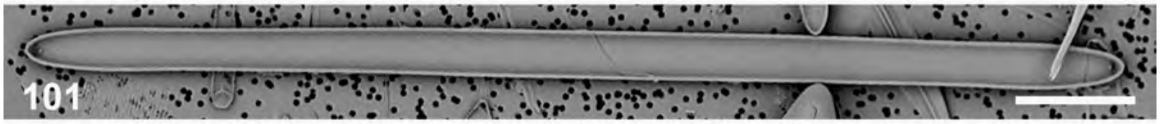
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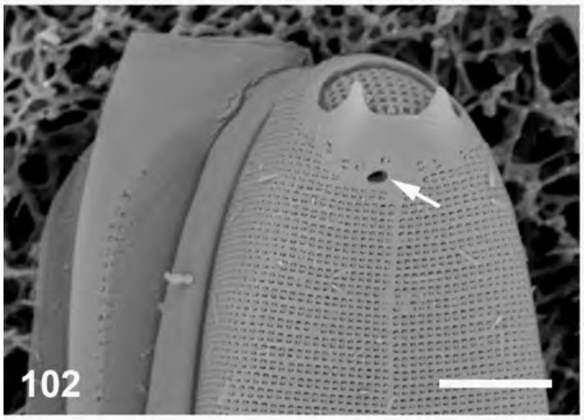
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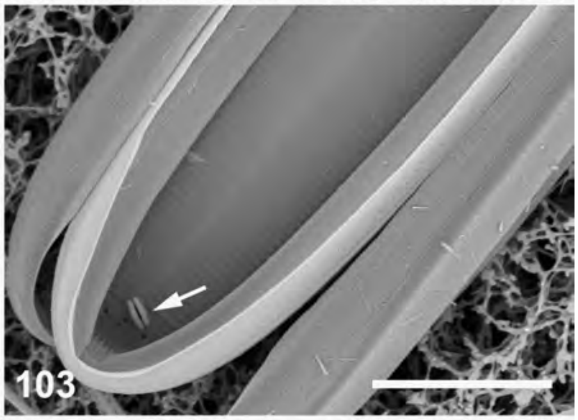
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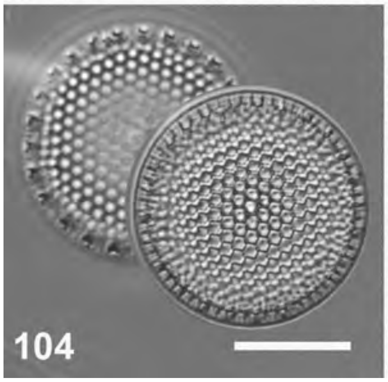
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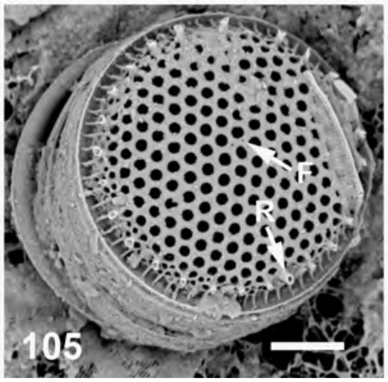
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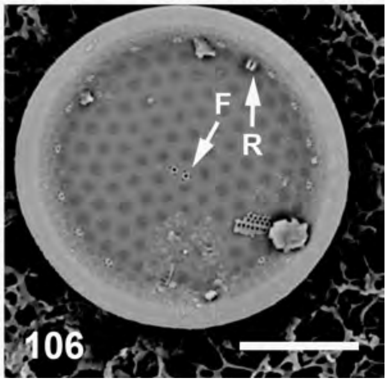
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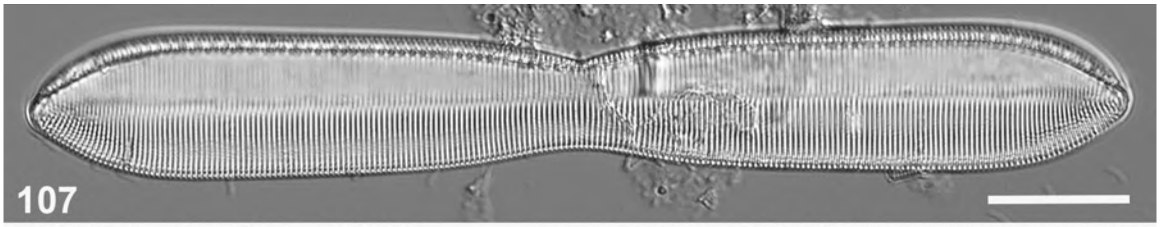
Figures 107–110. *Tryblionella* cf. *jelinecki*. Fig. 107. Valve in LM. Figs 108, 109. Valve external in SEM. Fig. 110. Valve apex internal aspect. Scale bars: Fig. 107 = 20 µm, Figs 108, 110 = 10 µm, Fig. 109 = 5 µm.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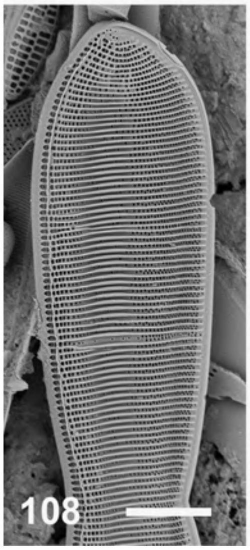
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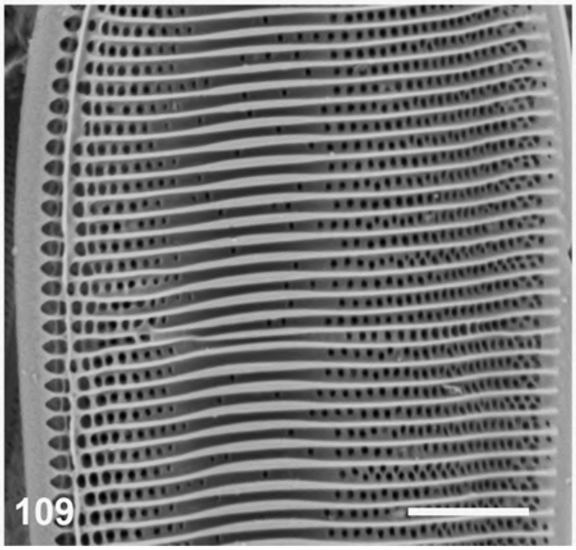
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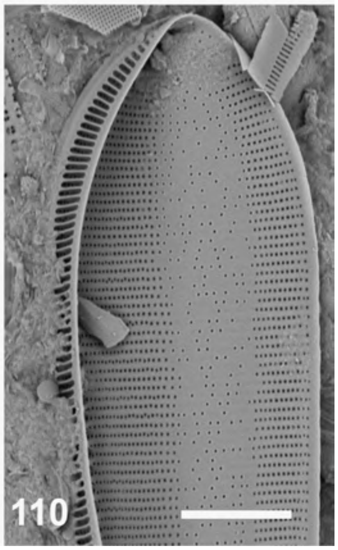
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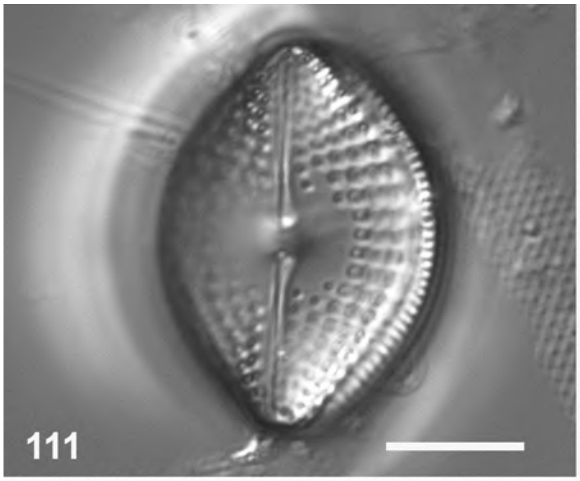
Figures 111–113. *Vikingea* cf. *gibbocalyx*. Fig. 111. Raphe valve in LM. Fig. 112. Sternum valve, exterior in SEM. Fig. 113. Broken frustule showing external raphe valve Scale bars: Fig. 111 = 10 µm, Figs 112, 113 = 5 µm.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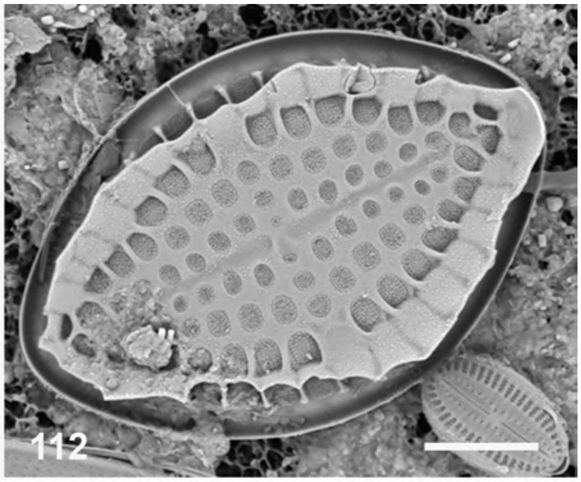
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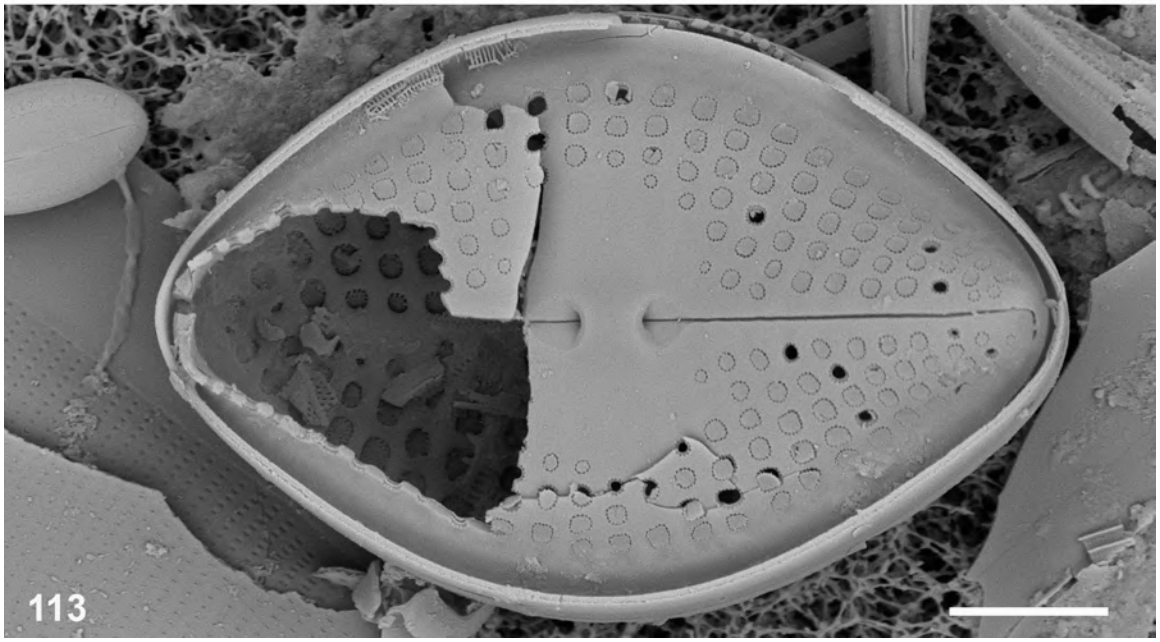
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