Data report: diatom biostratigraphy of IODP Site U1371 in the South Pacific Ocean[1]

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Abstract

Diatom biostratigraphic analyses of late Miocene to Pleistocene sediments in Hole U1371D of Integrated Ocean Drilling Program Expedition 329 in the South Pacific Gyre are invoked although several reworked diatoms are included. The nine diatom biozones recognized indicate an estimated age of 8.67 Ma at ~100 meters below seafloor. Moreover, abundant occurrences of diatom resting spores at ~2.5 Ma indicate a eutrophication increase.

Introduction

During Integrated Ocean Drilling Program (IODP) Expedition 329, pelagic sediments were drilled in the abyssal environments of the South Pacific Gyre (SPG) (Fig. **F1**). The SPG is the largest of the ocean gyres and its center is farther from continents than the center of any other gyre. The SPG contains the largest portion of seafloor that has never been explored with scientific ocean drilling, and paleoceanographic transition of this region is not clearly understood.

At IODP Site U1371, located just south of the southern gyre edge, shipboard study revealed abundant and continuous occurrences of fossil diatoms in cored sediments (**Expedition 329 Scientists**, 2011). Diatom assemblages provide an essential age-control reference for the detailed examination of paleoceanographic evolution. This report presents diatom occurrences and abundances for the age-diagnostic taxa recovered in cores from Hole U1371D.

Materials and methods

The sediment at Site U1371 consists of ~104 m of diatom ooze and ~20 m of pelagic clay (Fig. **F2**). The strata of this site are divided into two lithologic units based on their markedly different modal composition. Unit I is ooze with average diatom and clay content of 56% and 17%, respectively. Unit II is a mixture of clay, zeolite, and red-brown to yellow-brown semiopaque iron manganese oxides. Unit II contains an average modal abundance of up to 26% diatoms but only in the upper 5 m of the unit where the lithology transitions from ooze to clay. Other minor constituents of the sediment include quartz, pyrite, manganese oxide/hydroxide, and biogenic particles including radiolarians, spicules, and silicoflagellates.

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Eighty-two microslides prepared for diatom analyses contained abundant and well-preserved fossil diatom, resting spore, radiolarian, and silicoflagellate assemblages. To prepare the microslides, silty to clayey sediments containing diatoms were selected between Samples 329-U1371D-1H-1W, 66–67 cm (top depth = 0.66 m uncompressed core depth below seafloor [CSF-A]), and 14H-4W, 35–36 cm (126.25 m CSF-A).

For standard diatom analysis, ~0.5 g of each wet sample was processed; the methods of sample preparation, counting, and other procedures that we followed were basically the same as those of Koizumi (1968) and Akiba (1982b, 1986) with a minor modification. Counting methods for vegetative cell valves of "normal" diatoms and *Chaetoceros* resting spores were followed after Akiba (1986) and Suto (2006b), respectively (Table T1). A single vegetative cell valve of Centrales species was counted as one when more than a half of a valve was observed. Broken specimens of Pennales species were counted as one valve when two apices were observed. Other criteria for identification of specific genera were used following after several papers (see the floral reference list for diatom taxonomy in the "Appendix").

Diatom abundance is expressed as an approximate number of diatom valves per slide calculated using the length of scanning lines. To determine the fluctuation of diatom assemblages, 100 vegetative valves of normal diatoms were counted at species level for each sample. After counting, the slides were scanned to record the presence of species missed in the original tally as indicated by a "+" in Table T1. The resting spore abundance is defined here as the number of spore valves encountered during a count of 100 vegetative cell valves of other diatom species.

In diatom biostratigraphic assignments, we applied the diatom zonal scheme of Harwood and Maruyama (1992) for examined samples. Diatom event (first appearance datum [FAD] and last appearance datum [LAD]) ages used in this study were after the midpoint of average range model (ARM) of Cody et al. (2008), which recalibrated the ages to the Cande and Kent (1995) timescale (Figs. F2, F3), although the usefulness of their ages of bioevents has been up for discussion. Magnetostratigraphic ages are presumed with the diatom biostratigraphic results according to the shipboard results in Expedition 329 Scientists (2011), although the polarity chrons were not described in this study. All subchron boundaries and diatom bioevent ages were converted to the Gradstein et al. (2004) timescale.

Results

All samples from Hole U1371D contained sufficient diatoms per slide (>400, usually nearly 1000 valves) and *Chaetoceros* resting spores (>100, usually nearly 400 valves), except for Sample 329-U1371D-12H-2W, 45–46 cm (104.35 m CSF-A), with very rare diatoms, and barren samples between Samples 12H-3W, 45–46 cm (105.85 m CSF-A), and 14H-4W, 35–36 cm (126.25 m CSF-A). The preservation and abundance of fossil diatoms and resting spores are good and common to abundant throughout all microslides except for some rare and barren samples mentioned above (Table T1). Diatom assemblages are mostly composed of useful biostratigraphic markers with continuous and abundant occurrences (Fig. F2; Tables T1, T2).

Core materials from Expedition 329 Hole U1371D investigated in this study correspond to several diatom bioevents (i.e., FAD and LAD) defining the diatom zones of Harwood and Maruyama (1992) (Fig. F3):

- *Thalassiosira lentiginosa* Zone (0.0–0.54 Ma, recalculated ages in midpoint of ARM by Cody et al. [2008]),
- *Actinocyclus ingens* Zone (0.54–1.24 Ma),
- *Fragilariopsis kerguelensis/Thalassiosira kolbei/Thalassiosira vulnifica* Zone (1.24–2.48 Ma),
- *Thalassiosira insigna–T. vulnifica/Fragilariopsis interfrigidaria* Zone (2.48–4.11 Ma),
- *Fragilariopsis barronii* Zone (4.11–4.40 Ma),
- *Thalassiosira inura* Zone (4.40–4.74 Ma),
- *Shionodiscus oestrupii/Fragilariopsis reinholdii* b Subzone (4.74–6.00 Ma),
- *F. reinholdii* a/*A. ingens* var. *ovalis* Zone (6.00–8.67 Ma), and
- *Thalassiosira torokina* Zone (8.67–? Ma).

However, the bioevents that define the bottoms of the *F. kerguelensis* Zone, the *T. kolbei* Zone, the *T. insigna–T. vulnifica* Zone, the *S. oestrupii* Zone, and Subzone a of the *F. reinholdii* Zone were not clarified because of the absence of index species (Fig. F2). Here, the magnetostratigraphic chron and subchron datums are presumed according to shipboard research results (Expedition 329 Scientists, 2011). We selected biostratigraphic diatom markers that did not contradict the magnetostratigraphic datums (Fig. F3). Several datums of other age indicators conflicted with chron and subchron datums, and these indicators were not used in this study because they might include reworked and/or contaminated diatoms. Moreover, some diatom species also were not used because of their sporadic and rare occurrences (Fig. F2).

The LAD of *A. ingens* Rattray (0.5–0.57 Ma) is recognized between Samples 329-U1371D-1H-3W, 66–67 cm, and 1H-4W, 112–113 cm (4.64 ± 0.98 m CSF-A). The interval between the top of Hole U1371D and the LAD of *A. ingens* is assigned to the *T. lentiginosa* Zone of Harwood and Maruyama (1992).

The LAD of *F. barronii* (Gersonde) Gersonde et Bárcena (1.19–1.29 Ma) is recognized between Samples 3H-3W, 112–113 cm, and 3H-4W, 112–113 cm (21.77 ± 0.75 m CSF-A). The interval between the LAD of *F. barronii* and the LAD of *A. ingens* is assigned to the *A. ingens* Zone of Harwood and Maruyama (1992).

In the interval between the LAD of *F. barronii* and the LAD of *T. insigna* (Jousé) Harwood et Maruyama, the *F. kerguelensis* Zone and the *T. kolbei* Zone are defined by Harwood and Maruyama (1992), but the boundaries of these zones, which are defined by the LAD of *T. kolbei* (Jousé) Gersonde (1.98 Ma) and the LAD of *T. vulnifica* (Gombos) Fenner (2.17 Ma), are not recognized because of the absence and sporadic occurrences of *T. kolbei* and *T. vulnifica*.

The LAD of *T. insigna* (2.45–2.5 Ma) is recognized between Samples 5H-2W, 112–113 cm, and 5H-3W, 112–113 cm (38.87 ± 0.75 m CSF-A), and assigned to the bottom of the *T. vulnifica* Zone of Harwood and Maruyama (1992). The LAD of *Shionodiscus tetraoestrupii* var. *reimeri* (Mahood et Barron) Alverson et al. (1.31–1.34 Ma), the LAD of *Proboscia barboi* (Brun) Jordan et Priddle (1.6–1.73 Ma), the FAD of *Fragilariopsis obliquecostata* (Van Heurck) Heiden et Kolbe (1.66–1.73 Ma), the FAD of *Shionodiscus gracilis* (Karsten) Alverson et al. (1.87 Ma), and the FAD of *F. kerguelensis* (2.18–2.21 Ma) are also recognized in the intervals consisting of the *F. kerguelensis* Zone, the *T. kolbei* Zone, and the *T. vulnifica* Zone (Fig. F2; Table T2).

The FAD of *T. vulnifica* (3.12–3.18 Ma), which is assigned to the bottom of the *T. insigna–T. vulnifica* Zone, is not defined in this study because of sporadic occurrences.

The FAD of *F. interfrigidaria* (McCollum) Gersonde et Bárcena (3.93–4.19 Ma), which defines the bottom of the *F. interfrigidaria* Zone of Harwood and Maruyama (1992), is recognized between Samples 7H-4W, 15–16 cm, and 7H-5W, 15–16 cm (60.30 ± 0.75 m CSF-A). The LAD of *T. inura* Gersonde (2.53–2.55 Ma), the FAD of *Actinocyclus actinochilus* (Ehrenberg) Simonsen (2.72–2.81 Ma), and the LAD of *Fragilariopsis praeinterfrigidaria* (3.45–3.49 Ma) are also recognized in the interval consisting of the *T. insigna–T. vulnifica* Zone and the *F. interfrigidaria* Zone (Fig. F2; Table T2).

The FAD of *F. barronii* (4.28–4.52 Ma), which defines the bottom of the *F. barronii* Zone of Harwood and Maruyama (1992), is recognized between Samples 7H-6W, 30–31 cm, and 8H-1W, 82–83 cm (63.96 ± 1.26 m CSF-A).

The FAD of *T. inura* (4.71–4.77 Ma), which defines the bottom of the *T. inura* Zone of Harwood and Maruyama (1992), is recognized between Samples 8H-4W, 82–83 cm, and 8H-5W, 82–83 cm (70.47 ± 0.75 m CSF-A). The FAD of *Rouxia diploneides* Schrader (4.61–4.7 Ma) is also recognized between Samples 8H-1W, 82–83 cm, and 8H-2W, 82–83 cm (65.97 ± 0.75 m CSF-A).

The bottom of the *S. oestrupii* Zone of Harwood and Maruyama (1992), defined by the FAD of *S. oestrupii* (4.8–4.95 Ma), was not determined.

The LAD of *Hemidiscus triangularus* (Jousé) Harwood et Maruyama (5.14–6.86 Ma), which defines the bottom of Subzone b of the *F. reinholdii* Zone, is observed between Samples 9H-4W, 92–93 cm, and 9H-5W, 58–59 cm (79.90 ± 0.58 m CSF-A).

The FAD of *Thalassiosira miocenica* Schrader (6.25–8.33 Ma), which defines the bottom of Subzone a of the *F. reinholdii* Zone, is not recognized in this study.

The FAD of *A. ingens* var. *ovalis* (8.6–8.74 Ma) defines the boundary between the *A. ingens* var. *ovalis* Zone and the *T. torokina* Zone; however, the FAD of *A. ingens* var. *ovalis* and the FAD of *Hemidiscus karstenii* Jousé in Jousé et al. (9.68–10.24 Ma) may be uncertain because lower samples lack continuous occurrences of those diatoms (Fig. F2; Table T2).

These biostratigraphic results match well with those of **Cortese and Alvarez Zarikian** (2015) based on radiolarian biostratigraphy from 30 meters below seafloor (mbsf) to the top of core and at ~100 mbsf, although the radiolarian and diatom biostratigraphic ages from 70 to 60 mbsf have more differences. The reason for these differences might be that reworked siliceous fossils are included in these cores.

Moreover, the abundant occurrence of *Chaetoceros* resting spores, which are a major contributor to primary production in nearshore upwelling regions and coastal areas (Rines and Hargraves, 1988) and are usually taken as a measure of diatom productivity and an indicator of nutrient-rich conditions (Sancetta, 1982), may indicate that eutrophication increased in the coastal regions after upwelling strengthened (Suto, 2006b). Also, the peak at ~2.5 Ma might coincide with the Pacific *Chaetoceros* Explosion Event-2 (Suto et al., 2012), which is characterized by relatively higher occurrences at ~2.5 Ma in the North Pacific region.

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Figure F1. South Pacific seafloor bathymetry map (Smith and Sandwell, 1997) illustrating tectonic setting and Expedition 329 sites. Site U1371 (45°58′S, 163°11′W, water depth = 5310 m) is located at the southern end of the southwestern transect. White lines = basement age in 10 m.y. increments. DSDP = Deep Sea Drilling Project, ODP = Ocean Drilling Program.

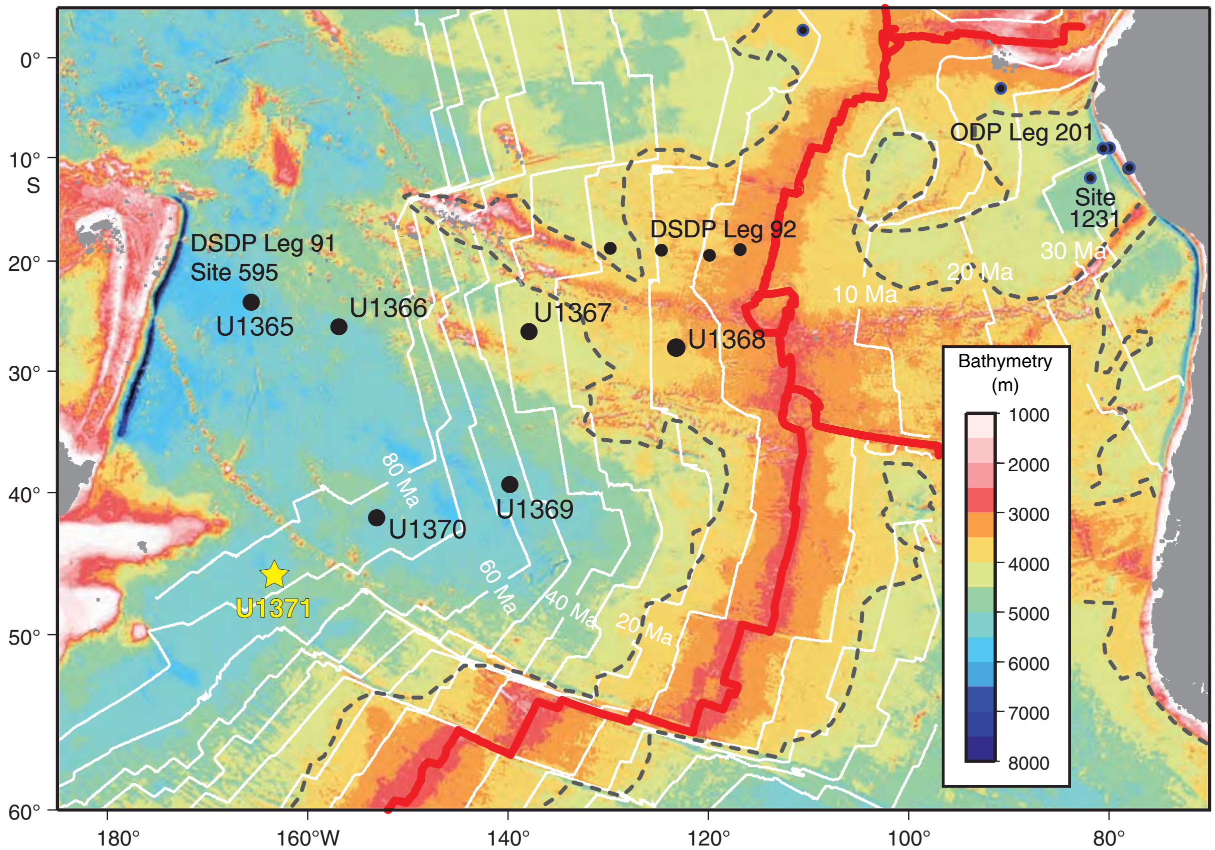


Figure F2. Stratigraphic distribution of selected diatom taxa, Hole U1371D. Note that the abundances of *Fragilariopsis kerguelensis* and *Chaetoceros* resting spores are compressed in width. Polarity after the shipboard results in Expedition 329 Scientists (2011). Chron boundary ages after the geomagnetic polarity timescale of Ogg and Smith (2004).

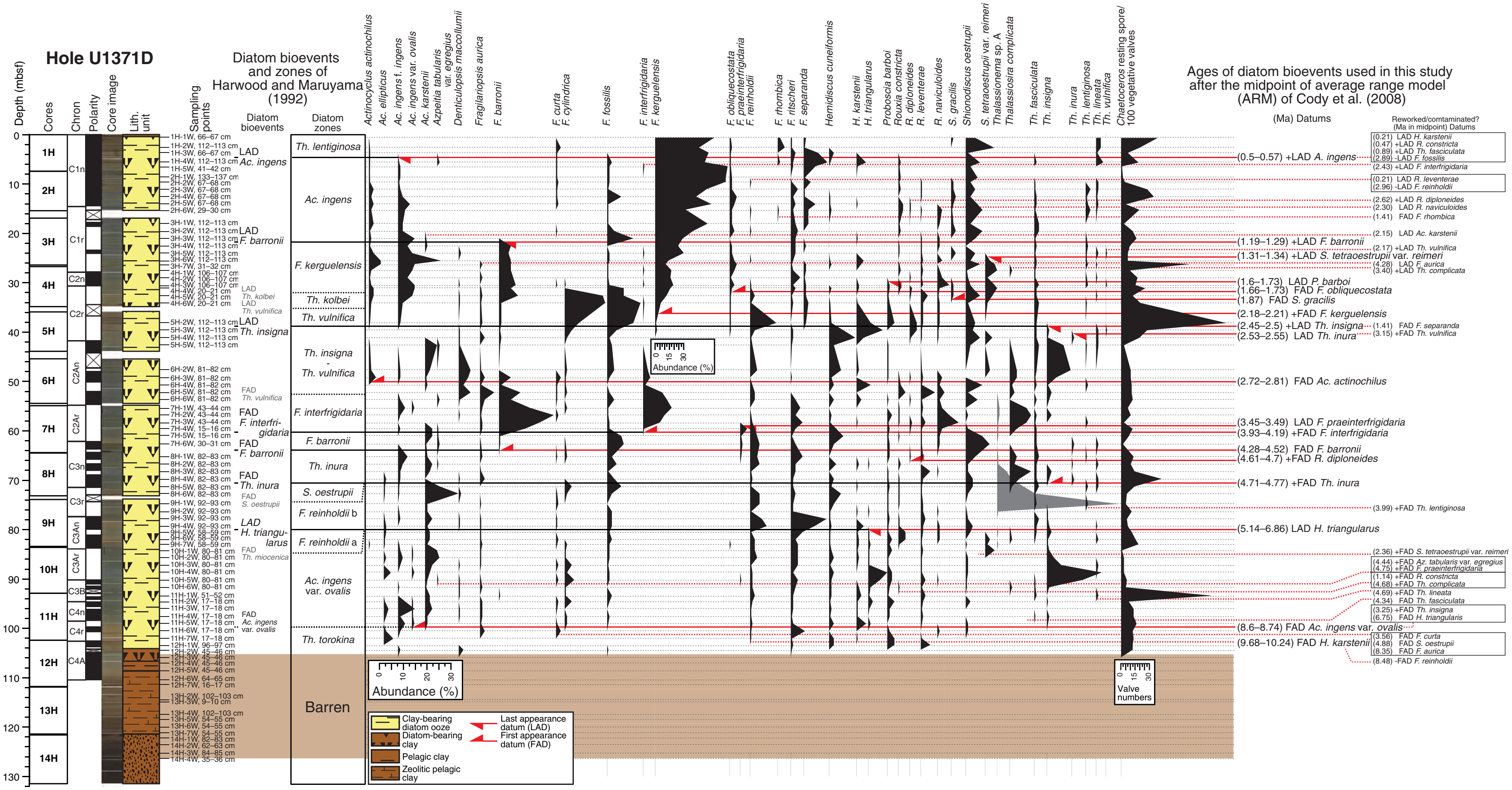


Figure F3. Age-depth plot, Hole U1371D. Ages of diatom bioevents are used after the midpoint of average range model of Cody et al. (2008). Polarity after the shipboard results in **Expedition 329 Scientists** (2011). Chron boundary ages after the geomagnetic polarity timescale of Ogg and Smith (2004).

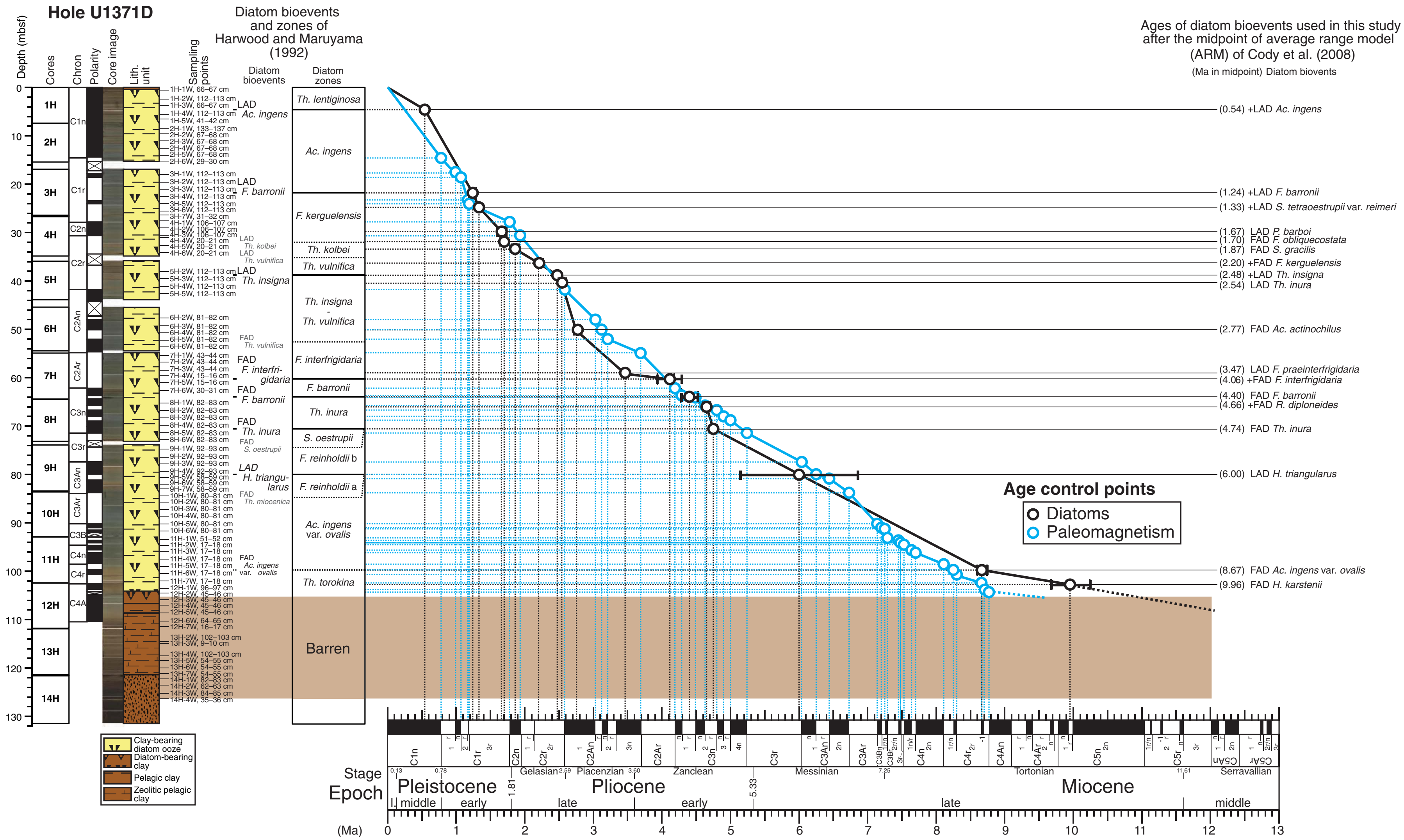


Table T1. Diatom occurrences, Hole U1371D. This table is available in an oversized format.

Table T2. Diatom datum events, Hole U1371D.

Datum event	Age (Ma)*	Core, section, interval (cm) Top	Bottom	Depth CSF-A (m) Error	Top	Median	Bottom
		329-U1371D-	329-U1371D-				
LAD *Actinocyclus ingens*	0.50–0.57	1H-3W, 66–67	1H-4W, 112–113	4.64 ± 0.98	3.66	4.64	5.62
LAD *Fragilariopsis barronii*	1.19–1.29	3H-3W, 112–113	3H-4W, 112–113	21.77 ± 0.75	21.02	21.77	22.52
LAD *Shionodiscus tetraoestrupii* var. *reimeri*	1.31–1.34	3H-5W, 112–113	3H-6W, 112–113	24.77 ± 0.75	24.02	24.77	25.52
LAD *Proboscia barboi*	1.60–1.73	4H-2W, 106–107	4H-3W, 106–107	29.71 ± 0.75	28.96	29.71	30.46
FAD *Fragilariopsis obliquecostata*	1.66–1.73	4H-4W, 20–21	4H-5W, 20–21	31.85 ± 0.75	31.10	31.85	32.60
FAD *Thalassiosira gracilis*	1.87	4H-5W, 20–21	4H-6W, 20–21	33.35 ± 0.75	32.60	33.35	34.10
FAD *Fragilariopsis kerguelensis*	2.18–2.21	4H-6W, 20–21	5H-2W, 112–113	36.11 ± 0.75	34.10	36.11	38.12
LAD *Thalassiosira insigna*	2.45–2.50	5H-2W, 112–113	5H-3W, 112–113	38.87 ± 0.75	38.12	38.87	39.62
LAD *Thalassiosira inura*	2.53–2.55	5H-3W, 112–113	5H-4W, 112–113	40.37 ± 0.75	39.62	40.37	41.12
FAD *Actinocyclus actinochilus*	2.72–2.81	6H-3W, 81–82	6H-4W, 81–82	49.96 ± 0.75	49.21	49.96	50.71
LAD *Fragilariopsis praeinterfrigidaria*	3.45–3.49	7H-4W, 15–16	7H-5W, 15–16	60.30 ± 0.75	59.55	60.30	61.05
FAD *Fragilariopsis interfrigidaria*	3.93–4.19	7H-4W, 15–16	7H-5W, 15–16	60.30 ± 0.75	59.55	60.30	61.05
FAD *Fragilariopsis barronii*	4.28–4.52	7H-6W, 30–31	8H-1W, 82–83	63.96 ± 1.26	62.70	63.96	65.22
FAD *Rouxia diploneides*	4.61–4.70	8H-1W, 82–83	8H-2W, 82–83	65.97 ± 0.75	65.22	65.97	66.72
FAD *Thalassiosira inura*	4.71–4.77	8H-4W, 82–83	8H-5W, 82–83	70.47 ± 0.75	69.72	70.47	71.22
LAD *Hemidiscus triangularus*	5.14–6.86	9H-4W, 92–93	9H-5W, 58–59	79.90 ± 0.58	79.32	79.90	80.48
FAD *Actinocyclus ingens* var. *ovalis*	8.60–8.74	11H-5W, 17–18	11H-6W, 17–18	99.83 ± 0.75	99.08	99.83	100.58
FAD *Hemidiscus karstenii*	9.68–10.24	11H-7W, 17–18	12H-1W, 96–97	102.72 ± 0.64	102.08	102.72	103.36

* = average range model ages from Cody et al. (2008). LAD = last appearance datum, FAD = first appearance datum.

Plate P1. Selected biostratigraphically useful diatoms, Hole U1371D. Scale bars = 10 µm (right: figs. 1–8, 11–28; left: figs. 9, 10). **1, 2.** *Actinocyclus ingens* Rattray (Sample 329-U1371D-2H-6W, 29–30 cm). **3, 4.** *Shionodiscus tetraoestrupii* var. *reimeri* (Mahood et Barron) Alverson et al. (Sample 3H-6W, 112–113 cm). **5, 6.** *Hemidiscus triangularus* (Jousé) Harwood et Maruyama (Sample 9H-2W, 92–93 cm). **7, 8.** *Thalassiosira insigna* (Jousé) Harwood et Maruyama (Sample 5H-3W, 112–113 cm). **9, 10.** *Proboscia barboi* (Brun) Jordan et Priddle (Sample 4H-3W, 106–107 cm). **11, 12.** *Rouxia diploneides* Schrader (Sample 2H-5W, 67–68 cm). **13, 14.** *Fragilariopsis interfrigidaria* (McCollum) Gersonde et Bárcena (Sample 6H-2W, 81–82 cm). **15, 16.** *Fragilariopsis praeinterfrigidaria* (McCollum) Gersonde et Bárcena (Sample 7H-4W, 15–16 cm). **17, 18.** *Fragilariopsis barronii* (Gersonde) Gersonde et Bárcena (Sample 3H-4W, 112–113 cm). **19, 20.** *Fragilariopsis kerguelensis* (O'Meara) Hustedt (Sample 3H-1W, 112–113 cm). **21, 22.** *Shionodiscus gracilis* (Karsten) Alverson et al. (Sample 4H-4W, 20–21 cm). **23, 24.** *Thalassiosira inura* Gersonde (Sample 8H-4W, 82–83 cm). **25, 26.** *Hemidiscus karstenii* Jousé in Jousé et al. (Sample 7H-2W, 43–44 cm). **27, 28.** *Actinocyclus ingens* var. *ovalis* Gersonde (Sample 10H-2W, 80–81 cm).

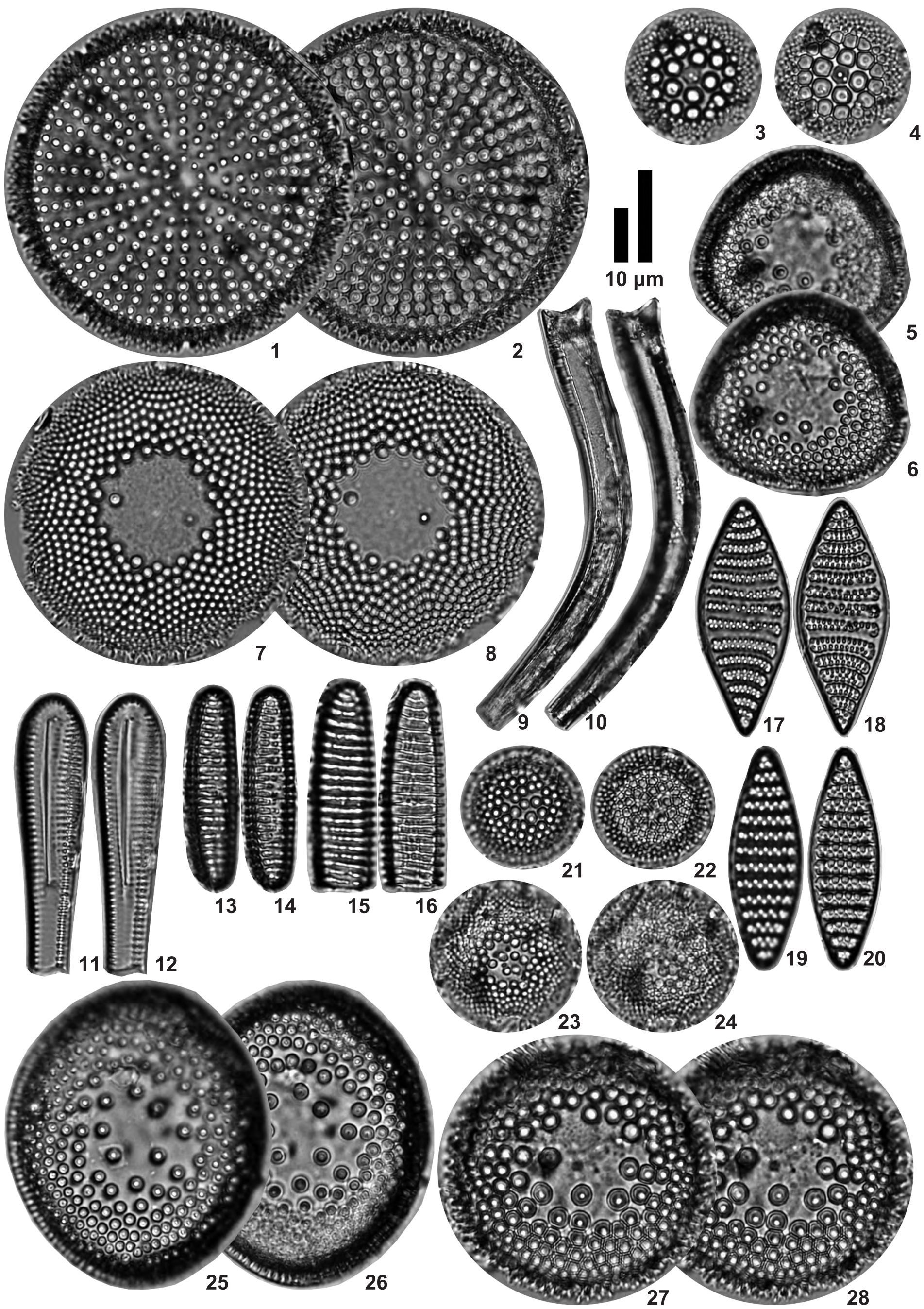


Plate P2. Light microscope images of diatoms, Hole U1371D. Scale bar = 10 µm. **1, 2.** *Actinocyclus curvatulus* Janisch in Schmidt et al. (Sample 329-U1371D-9H-2W, 92–93 cm). **3, 4.** *Actinocyclus ellipticus* Grunow in Van Heurck (Sample 9H-6W, 58–59 cm). **5, 6.** *Actinocyclus karstenii* Van Heurck (Sample 7H-5W, 15–16 cm). **7, 8.** *Actinocyclus* sp. A (Sample 2H-5W, 67–68 cm). **9, 10.** *Actinoptychus senarius* (Ehrenberg) Ehrenberg (Sample 3H-6W, 112–113 cm). **11, 12.** *Actinoptychus vulgaris* Schumann (Sample 2H-4W, 67–68 cm). **13, 14.** *Asterolampra* sp. (Sample 10H-2W, 80–81 cm).

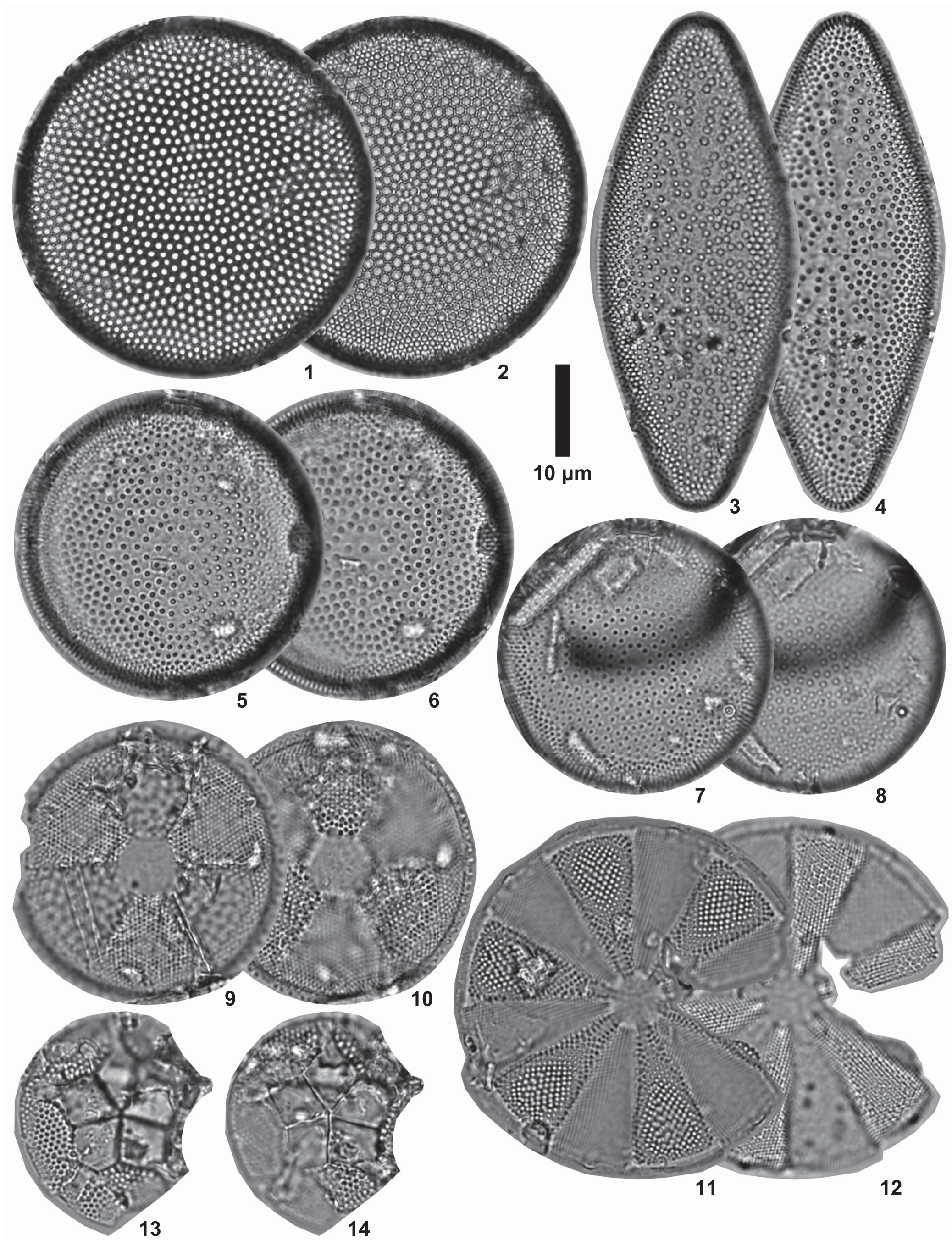


Plate P3. Light microscope images of diatoms, Hole U1371D. Scale bars = 10 µm (right: figs. 1, 2, 5–8; left: figs. 3, 4). **1, 2.** *Asteromphalus kennettii* Gersonde (Sample 329-U1371D-10H-3W, 80–81 cm). **3, 4.** *Asteromphalus oligocenicus* Schrader et Fenner (Sample 10H-4W, 80–81 cm). **5, 6.** *Asteromphalus parvulus* Karsten (Sample 3H-1W, 112–113 cm). **7, 8.** *Asteromphalus* sp. (Sample 10H-5W, 80–81 cm).

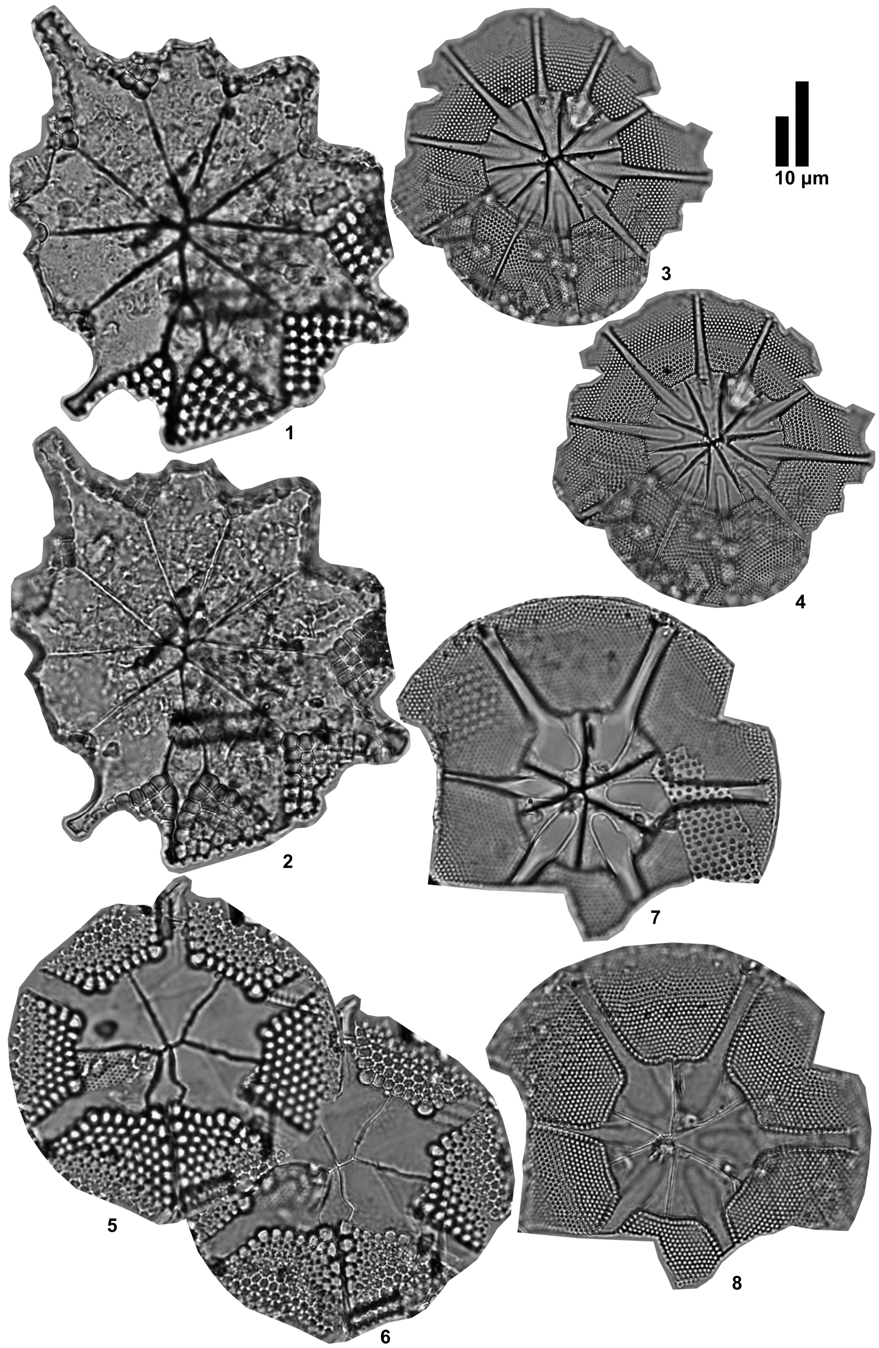


Plate P4. Light microscope images of diatoms, Hole U1371D. Scale bar = 10 µm. **1, 2.** *Azpeitia endoi* (Kanaya) Sims et Fryxell in Fryxell et al. (Sample 329-U1371D-10H-5W, 80–81 cm). **3, 4.** *Azpeitia tabularis* (Grunow) Fryxell et Sims in Fryxell et al. (Sample 8H-4W, 82–83 cm). **5–7.** *Azpeitia vetustissima* (Pantocsek) Sims in Fryxell et al. (Sample 7H-5W, 15–16 cm). **8–10.** *Bacteriastrum* sp. (Sample 8H-4W, 82–83 cm). **11, 12.** *Biddulphia* sp. (Sample 6H-5W, 81–82 cm). **13, 14.** *Bogorovia gombosii* (Desikachary) Yanagisawa (Sample 3H-6W, 112–113 cm). **15, 16.** *Chaetoceros* sp. (vegetative cells). **17, 18.** *Cocconeis californica* (Grunow in Cleve et Möller) Grunow in Van Heurck (Sample 2H-3W, 67–68 cm). **19, 20.** *Cocconeis placentula* Ehrenberg (Sample 6H-6W, 81–82 cm). **21–24.** *Cocconeis* sp. B (Sample 1H-1W, 66–67 cm).

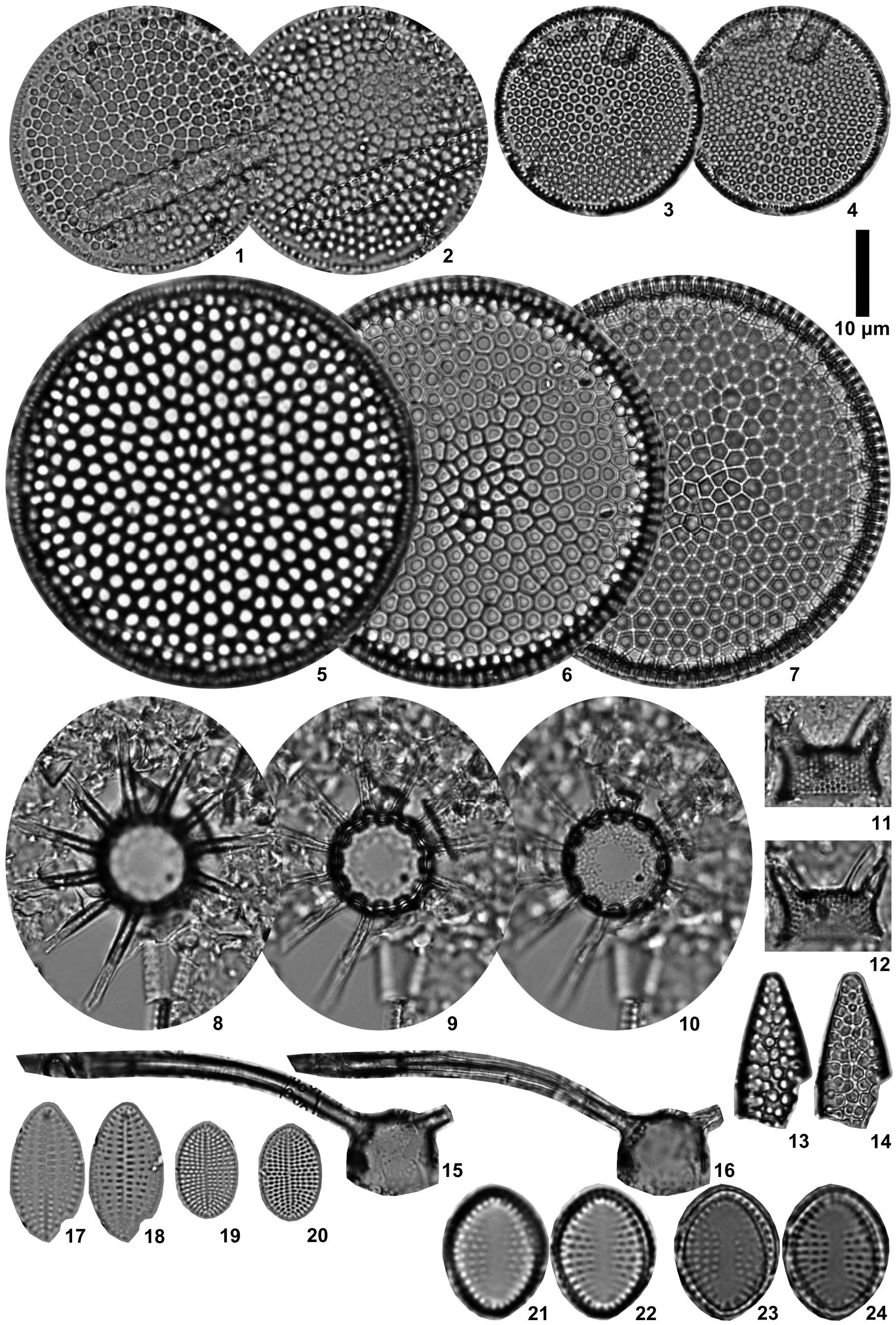


Plate P5. Light microscope images of diatoms, Hole U1371D. Scale bars = 10 µm (right: figs. 1, 2, 5–8, 11–38; left: figs. 3, 4, 9, 10). **1, 2.** *Coscinodiscus marginatus* Ehrenberg (Sample 329-U1371D-10H-3W, 80–81 cm). **3, 4.** *Coscinodiscus radiatus* Ehrenberg (Sample 1H-1W, 66–67 cm). **5–8.** *Costopyxis trochlea* (Hanna) Strelnikova in Gleser et al.; (5, 6) Sample 4H-4W, 20–21 cm; (7, 8) Sample 8H-2W, 82–83 cm. **9, 10.** *Crucidenticula kanayae* Akiba et Yanagisawa (Sample 7H-2W, 43–44 cm). **11, 12.** *Crucidenticula nicobarica* (Grunow) Akiba et Yanagisawa (Sample 6H-3W, 81–82 cm). **13–16.** *Cyclotella pantanelliana* Castracane (Sample 3H-3W, 112–113 cm). **17–19.** *Cymatosira* sp. (Sample 8H-4W, 82–83 cm). **20–22.** *Denticulopsis crassa* Yanagisawa et Akiba (Sample 11H-6W, 17–18 cm). **23–26.** Closed copula of *Denticulopsis dimorpha* (Schrader) Simonsen; (23, 24) Sample 6H-3W, 81–82 cm; (25, 26) Sample 11H-6W, 17–18 cm. **27–30.** *Denticulopsis katayamae* Maruyama; (27, 28) Sample 9H-6W, 58–59 cm; (29, 30) Sample 8H-5W, 82–83 cm. **31, 32.** *Denticulopsis lauta* (Bailey) Simonsen (Sample 11H-3W, 17–18 cm). **33–38.** *Denticulopsis maccollumii* Simonsen; (33, 34) Sample 4H-5W, 20–21 cm; (35, 36) Sample 6H-3W, 81–82 cm; (37, 38) Sample 8H-5W, 82–83 cm.

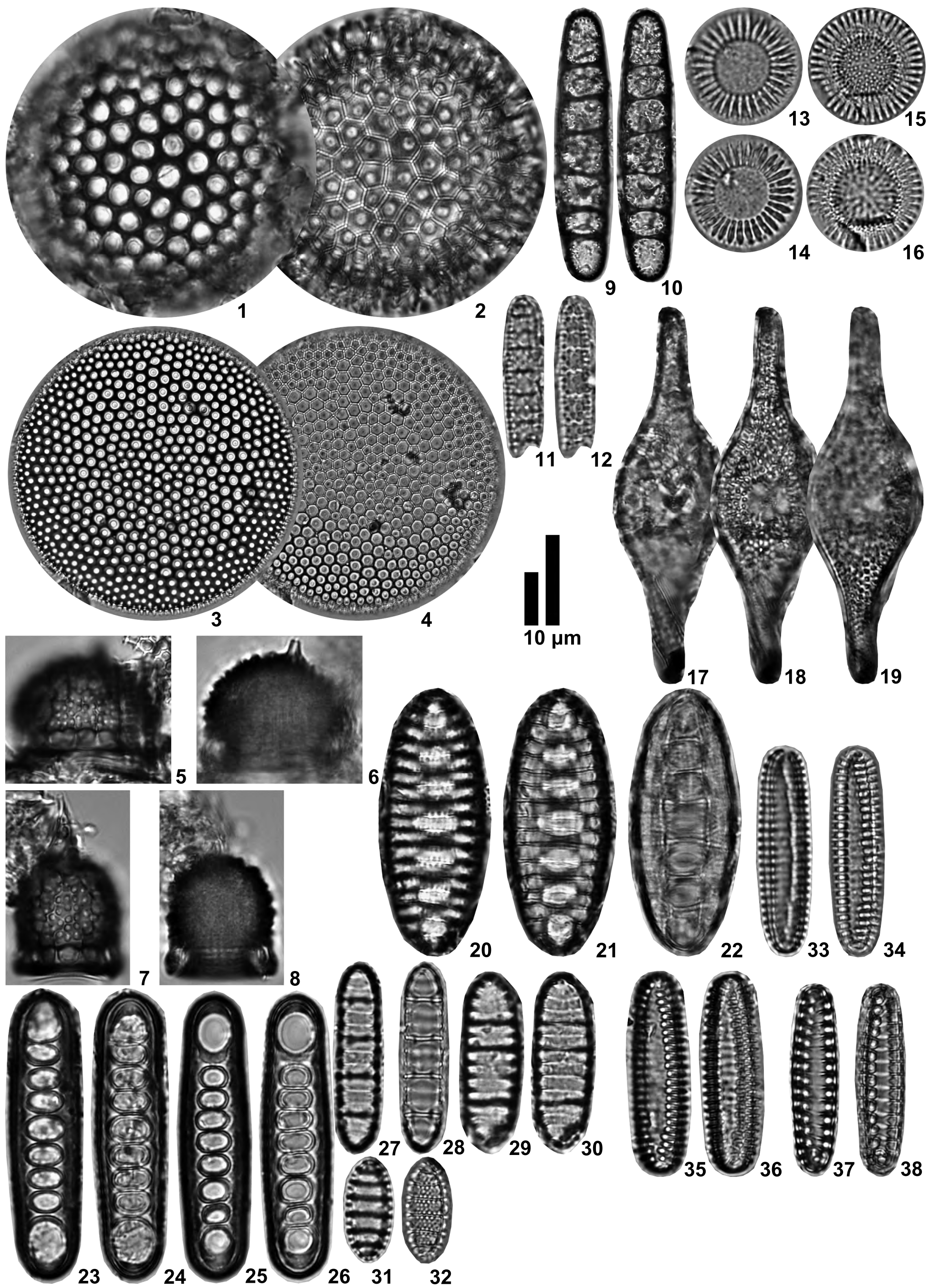


Plate P6. Light microscope images of diatoms, Hole U1371D. Scale bar = 10 µm. **1–6.** *Denticulopsis ovata* (Schrader) Yanagisawa et Akiba; (1, 2) Sample 329-U1371D-3H-3W, 112–113 cm; (3–6) Sample 6H-5W, 81–82 cm. **7–12.** *Denticulopsis simonsenii* Yanagisawa et Akiba; (7, 8) Sample 2H-6W, 29–30 cm; (9, 10) Sample 3H-3W, 112–113 cm; (11, 12) Sample 10H-3W, 80–81 cm. **13–16.** *Denticulopsis vulgaris* (Okuno) Yanagisawa et Akiba; (13, 14) Sample 6H-3W, 81–82 cm; (15, 16) Sample 11H-6W, 17–18 cm. **17, 18.** *Diploneis bombus* Ehrenberg (Sample 5H-3W, 112–113 cm). **19, 20.** *Discostella stelligera* (Cleve et Grunow) Houk et Klee (Sample 3H-5W, 112–113 cm). **21, 22.** *Distephanosira architecturalis* (Brun) Gleser in Gleser et al. (Sample 4H-4W, 20–21 cm). **23–26.** *Eucampia antarctica* (Castracane) Mangin; (23, 24) Sample 1H-4W, 112–113 cm; (25, 26) Sample 4H-1W, 106–107 cm. **27–30.** *Fragilariopsis aurica* (Gersonde) Gersonde et Bárcena; (27, 28) Sample 5H-4W, 112–113 cm; (29, 30) Sample 7H-3W, 43–44 cm. **31–38.** *Fragilariopsis curta* (Van Heurck) Hustedt; (31, 32) Sample 3H-2W, 112–113 cm; (33–36) Sample 6H-3W, 81–82 cm; (37, 38) Sample 1H-5W, 41–42 cm. **39–42.** *Fragilariopsis cylindrica* (Burckle) Censarek et Gersonde (Sample 4H-5W, 20–21 cm). **43, 44.** *Fragilariopsis doliolus* (Wallich) Medlin et Sims (Sample 10H-6W, 80–81 cm). **45, 46.** *Fragilariopsis fossilis* (Frenguelli) Medlin et Sims (Sample 1H-5W, 41–42 cm). **47, 48.** *Fragilariopsis maleinterpretaria* (Schrader) Censarek et Gersonde (Sample 9H-6W, 58–59 cm). **49, 50.** *Fragilariopsis obliquecostata* (Van Heurck) Heiden et Kolbe (Sample 4H-3W, 106–107 cm). **51, 52.** *Fragilariopsis oceanica* (Cleve) Hasle (Sample 10H-5W, 80–81 cm). **53–56.** *Fragilariopsis reinholdii* (Kanaya ex Schrader) Zielinski et Gersonde; (53, 54) Sample 5H-2W, 112–113 cm; (55, 56) Sample 7H-4W, 15–16 cm. **57, 58.** *Fragilariopsis ritscheri* Hustedt (Sample 3H-1W, 112–113 cm). **59–64.** *Fragilariopsis separanda* Hustedt; (59, 60) Sample 1H-4W, 112–113 cm; (61, 62) Sample 2H-5W, 67–68 cm; (63, 64) Sample 1H-1W, 66–67 cm. (Plate shown on next page.)

Plate P6 (continued). (Caption shown on previous page.)

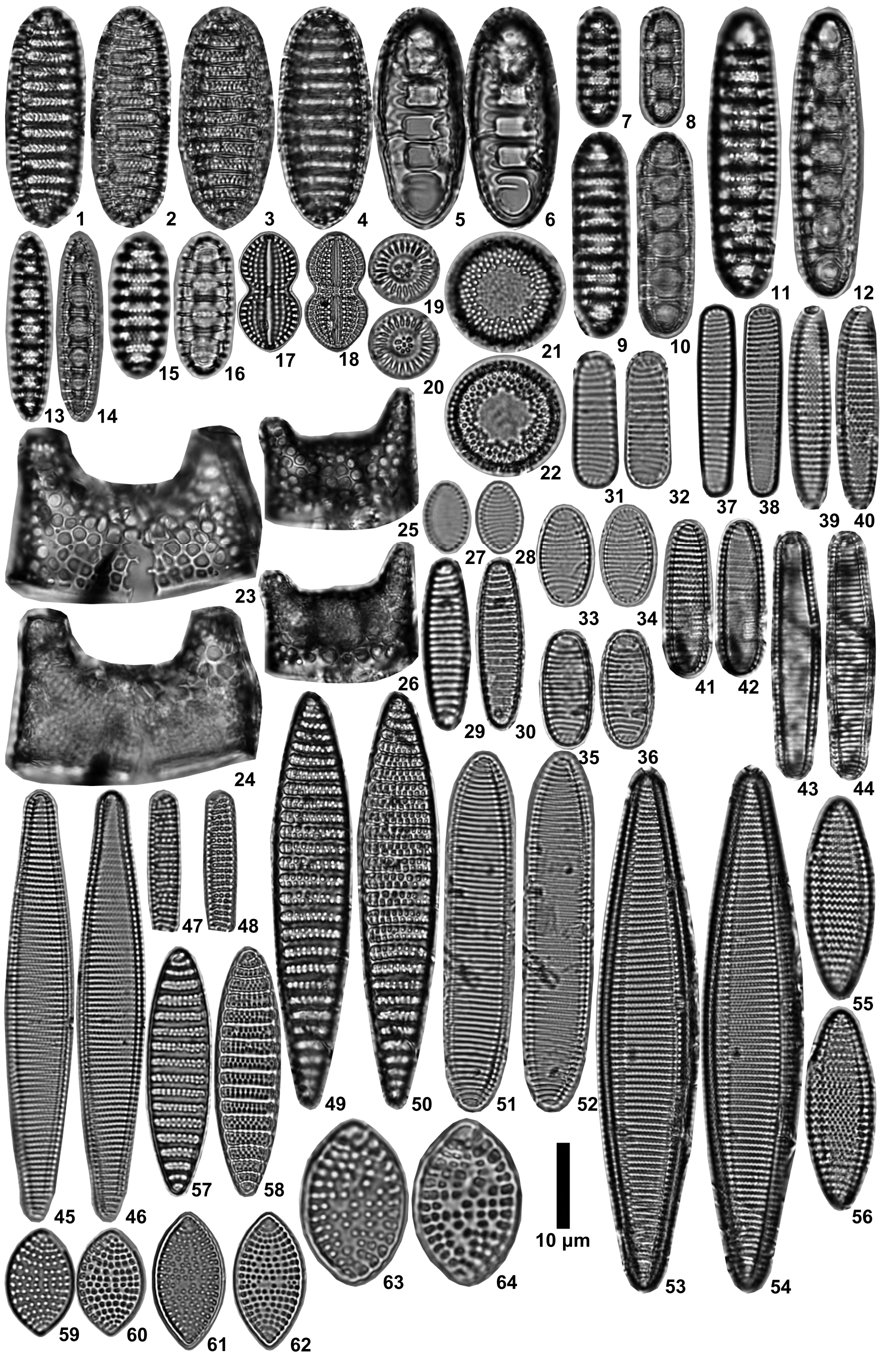


Plate P7. Light microscope images of diatoms, Hole U1371D. Scale bar = 10 µm. **1, 2.** *Fragilariopsis sublinearis* (Van Heurck) Heiden et Kolbe (Sample 329-U1371D-4H-1W, 106–107 cm). **3, 4.** *Goniothecium rogersii* Ehrenberg (Sample 10H-6W, 80–81 cm). **5–12.** *Hemiaulus* spp.; (5–8) Sample 8H-5W, 82–83 cm; (9, 10) Sample 9H-2W, 92–93 cm; (11, 12) Sample 9H-4W, 92–93 cm. **13–16.** *Hemidiscus cuneiformis* Wallich; (13, 14) Sample 1H-4W, 112–113 cm; (15, 16) Sample 8H-6W, 82–83 cm. **17, 18.** *Hemidiscus* sp. 1 of Zielinski and Gersonde (2002) **19, 20.** *Hyalodiscus* sp. (Sample 10H-6W, 80–81 cm). **21, 22.** *Koizumia adaroi* (Azpeitia) Yanagisawa (Sample 11H-6W, 17–18 cm). **23, 24.** *Navicula* sp. (Sample 1H-1W, 66–67 cm). **25–30.** *Odontella* sp.?; (25, 26) Sample 10H-6W, 80–81 cm; (27–30) Sample 11H-3W, 17–18 cm. **31, 32.** *Opephora* sp. (Sample 5H-2W, 112–113 cm).

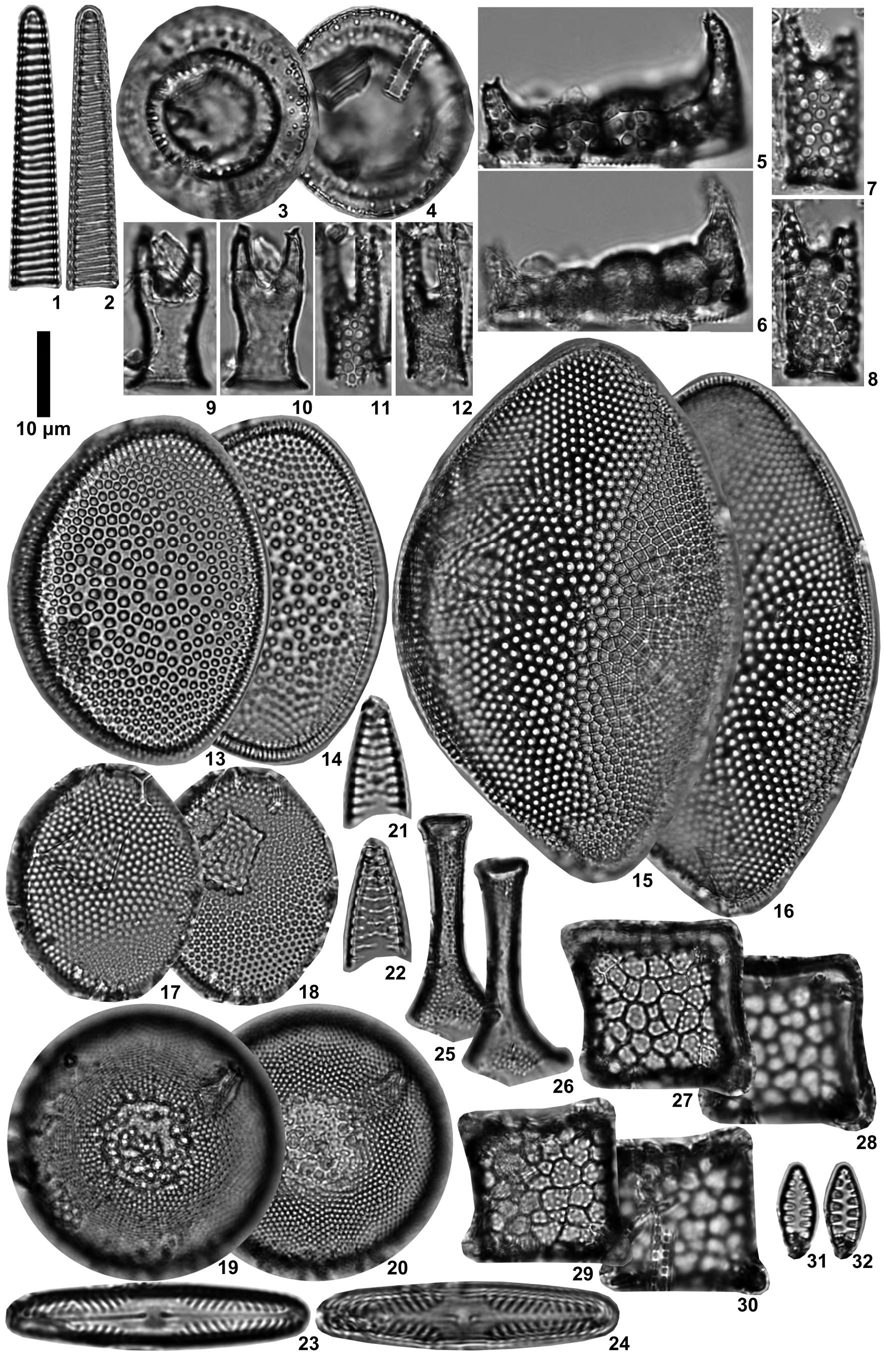


Plate P8. Light microscope images of diatoms, Hole U1371D. Scale bar = 10 µm. **1–4.** *Paralia sulcata* (Ehrenberg) Cleve; (1, 2) Sample 329-U1371D-3H-2W, 112–113 cm; (3, 4) Sample 10H-3W, 80–81 cm. **5, 6.** *Pleurosigma* sp. (Sample 4H-4W, 20–21 cm). **7, 8.** *Podosira* sp. (Sample 3H-6W, 112–113 cm). **9–14.** *Proboscia alata* (Brightwell) Sundström; (9, 10) Sample 2H-2W, 67–68 cm; (11, 12) Sample 4H-5W, 20–21 cm; (13, 14) Sample 10H-4W, 80–81 cm. **15, 16.** *Pseudo-nitzschia* sp. (Sample 5H-2W, 112–113 cm). **17, 18.** *Pseudopyxilla americana* (Ehrenberg) Forti (Sample 9H-1W, 92–93 cm). **19, 20.** *Pterotheca aculeifera* (Grunow in Van Heurck) Van Heurck (Sample 3H-7W, 32–33 cm). **21, 22.** *Rhizosolenia hebetata* Bailey (Sample 3H-3W, 112–113 cm). **23–26.** *Rhizosolenia polydactyla* Castracane; (23, 24) Sample 10H-4W, 80–81 cm; (25, 26) Sample 1H-1W, 66–67 cm. **27, 28.** *Rocella praenitida* (Fenner) Fenner in Kim et Barron (Sample 6H-2W, 81–82 cm). **29, 30.** *Rouxia constricta* Zielinski et Gersonde (Sample 2H-5W, 67–68 cm). **31, 32.** *Rouxia leventerae* Bohaty et al. (Sample 6H-5W, 81–82 cm). **33, 34.** *Rouxia naviculoides* Schrader (Sample 2H-6W, 29–30 cm).

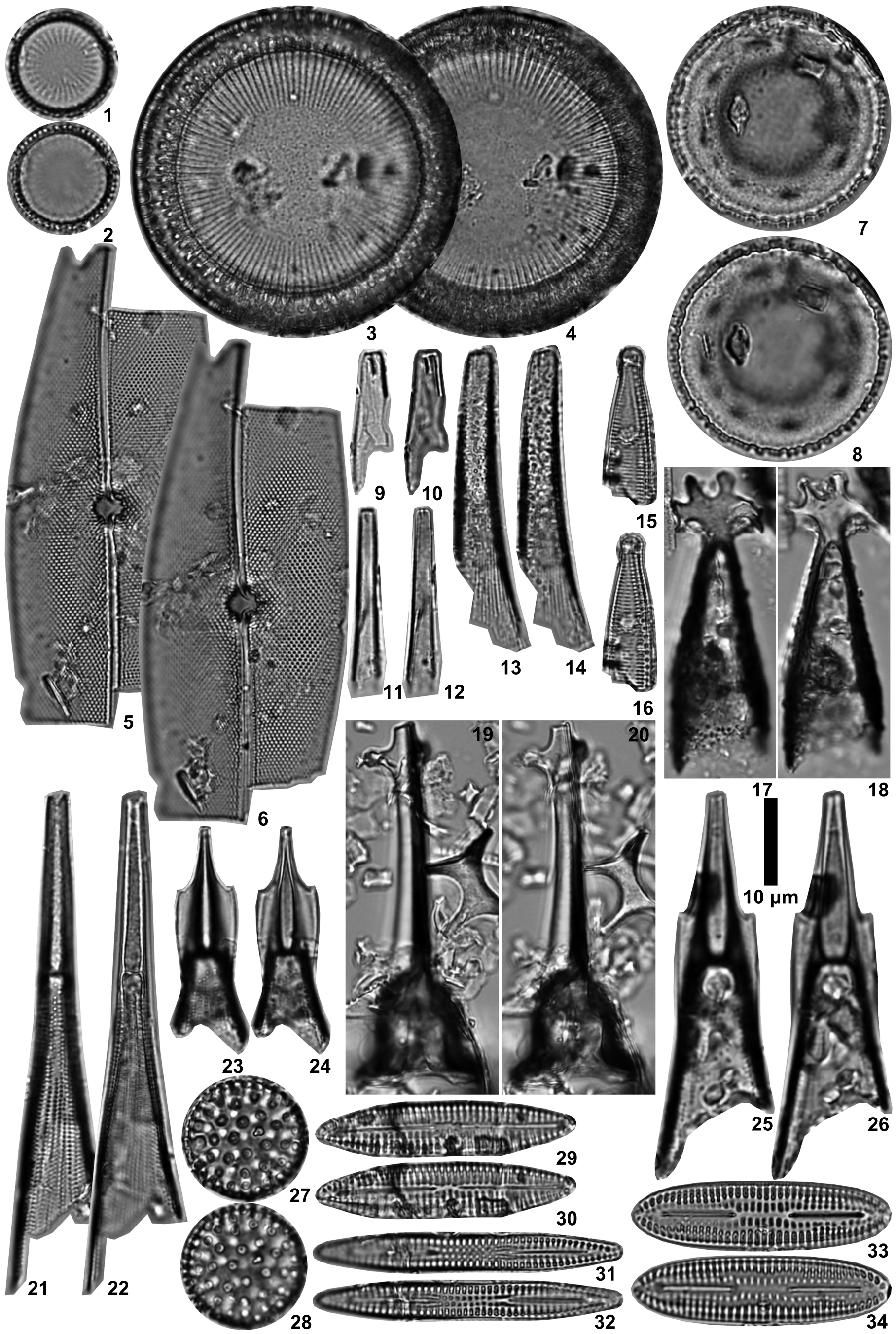


Plate P9. Light microscope images of diatoms, Hole U1371D. Scale bar = 10 µm. **1–6.** *Shionodiscus oestrupii* (Ostenfeld) Alverson et al.; (1, 2) Sample 329-U1371D-1H-2W, 112–113 cm; (3, 4) Sample 2H-5W, 67–68 cm; (5, 6) Sample 4H-4W, 20–21 cm. **7, 8.** *Shionodiscus tetraoestrupii* (Bodén) Alverson et al. (Sample 3H-6W, 112–113 cm). **9–18.** *Stephanopyxis* spp.; (9, 10) Sample 1H-4W, 112–113 cm; (11, 12) Sample 3H-6W, 112–113 cm; (13, 14) Sample 3H-7W, 32–33 cm; (15, 16) Sample 6H-4W, 81–82 cm; (17, 18) Sample 9H-2W, 92–93 cm. **19–22.** *Synedropsis recta* Hasle et al.; (19, 20) Sample 10H-3W, 80–81 cm; (21, 22) Sample 2H-4W, 67–68 cm. **23, 24.** *Tetracyclus* sp. (Sample 12H-2W, 45–46 cm). **25–40.** *Thalassionema nitzschioides* (Grunow) Mereschkowsky; (25, 26) Sample 3H-5W, 112–113 cm; (27, 28) Sample 4H-6W, 20–21 cm; (29, 30) Sample 4H-2W, 106–107 cm; (31, 32) Sample 8H-1W, 82–83 cm; (33, 34) Sample 10H-6W, 80–81 cm; (35–38) Sample 9H-5W, 58–59 cm; (39, 40) Sample 3H-4W, 112–113 cm. **41–44.** *Thalassionema* spp.; (41, 42) Sample 6H-6W, 81–82 cm; (43, 44) Sample 10H-4W, 80–81 cm.

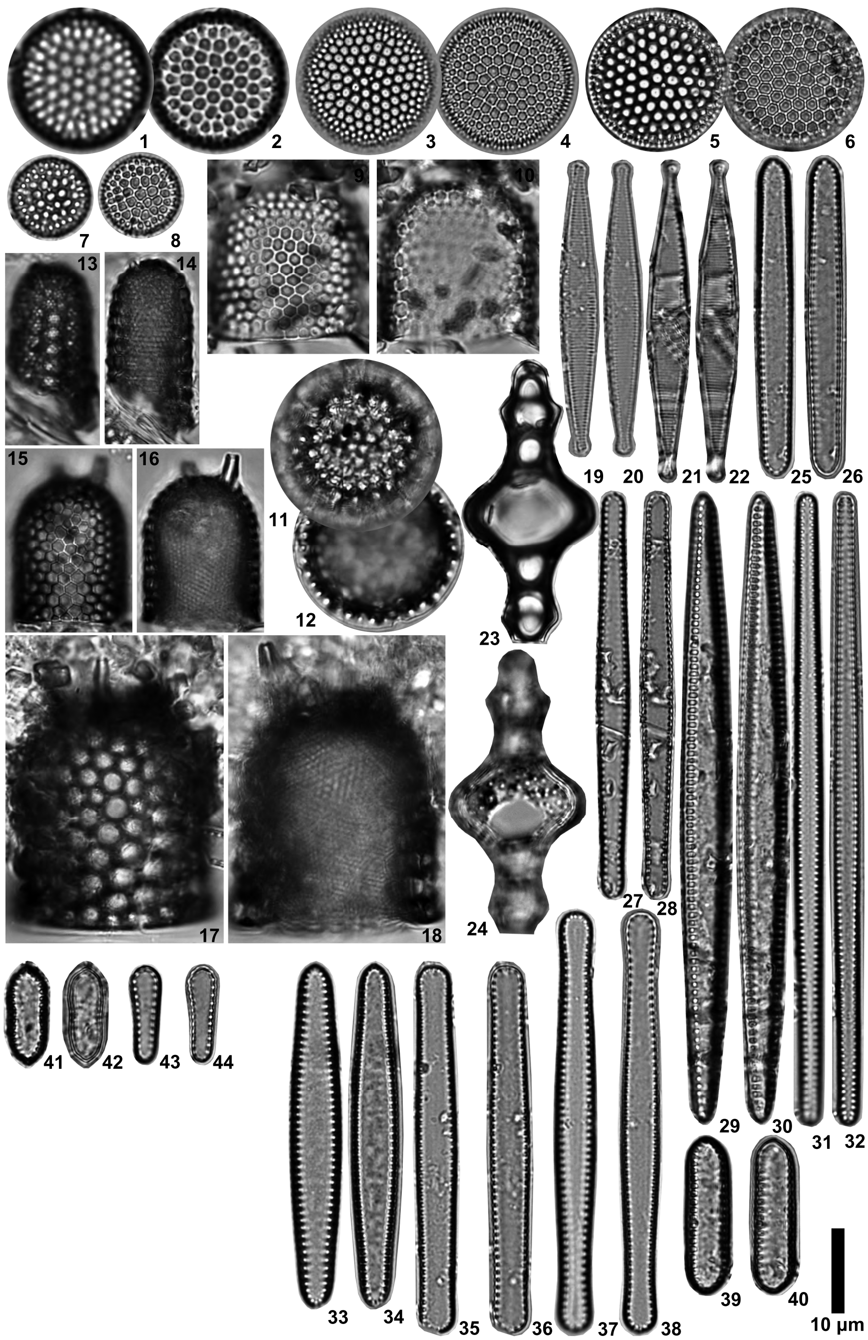


Plate P10. Light microscope images of diatoms, Hole U1371D. Scale bar = 10 µm. **1–10.** *Thalassionema* sp. A; (1, 2) Sample 329-U1371D-8H-6W, 82–83 cm; (3, 4) Sample 9H-1W, 92–93 cm; (5, 6) Sample 8H-4W, 82–83 cm; (7, 8) Sample 6H-6W, 81–82 cm; (9, 10) Sample 7H-2W, 43–44 cm. **11, 12.** *Thalassiosira complicata* Gersonde (Sample 7H-2W, 43–44 cm). **13–16.** *Thalassiosira eccentrica* (Ehrenberg) Cleve; (13, 14) Sample 3H-6W, 112–113 cm; (15, 16) Sample 4H-5W, 20–21 cm. **17–20.** *Thalassiosira fasciculata* Harwood et Maruyama; (17, 18) Sample 1H-4W, 112–113 cm; (19, 20) Sample 10H-6W, 80–81 cm. **21, 22.** *Thalassiosira kolbei* (Jousé) Gersonde (Sample 4H-6W, 20–21 cm).

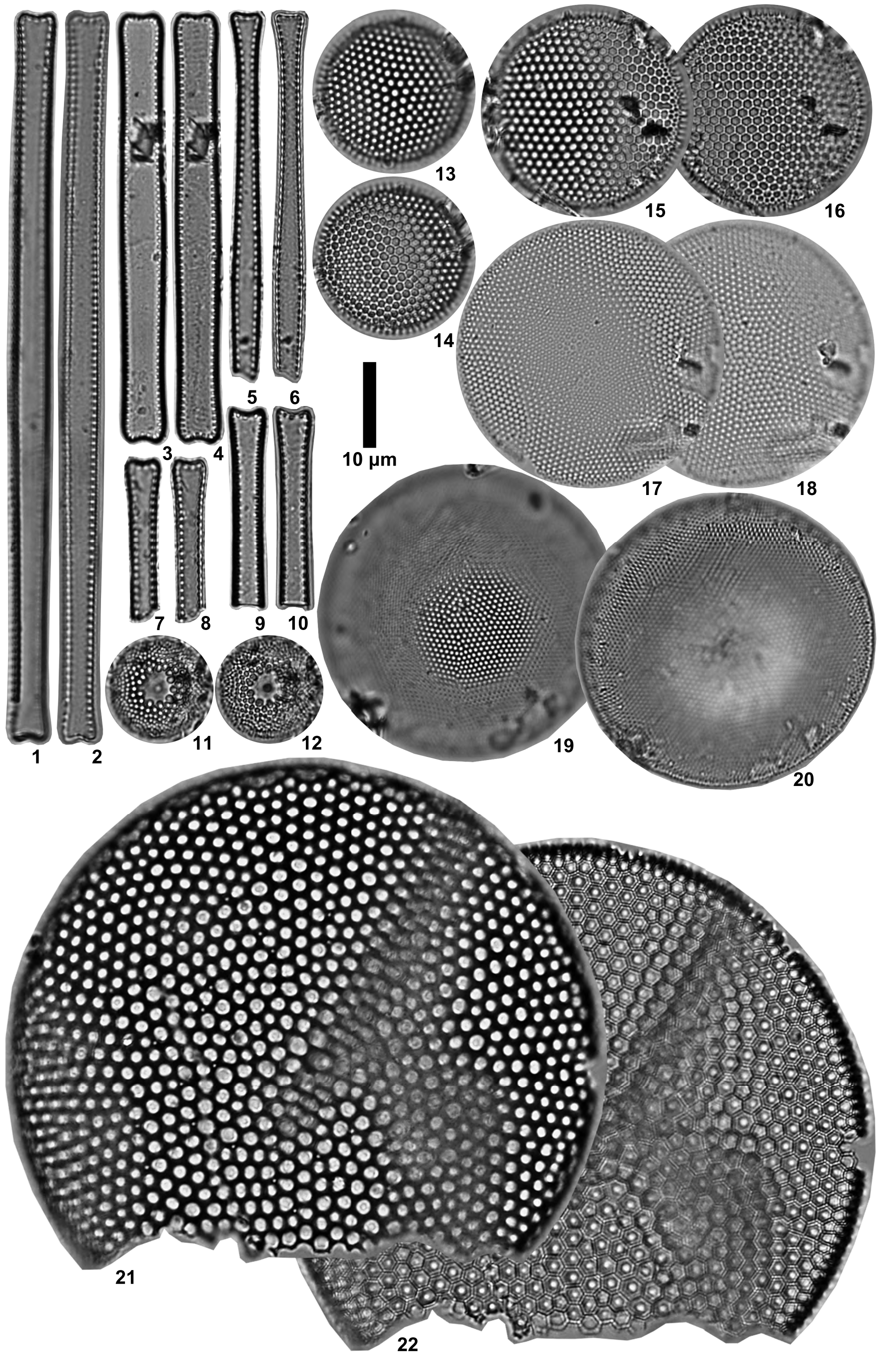


Plate P11. Light microscope images of diatoms, Hole U1371D. Scale bar = 10 µm. **1, 2.** *Thalassiosira lentiginosa* (Janisch in Schmidt) Fryxell (Sample 329-U1371D-2H-3W, 67–68 cm). **3, 4.** *Thalassiosira* cf. *nativa* Sheshukova-Poretzkaya (Sample 4H-6W, 20–21 cm). **5, 6.** *Thalassiosira oliverana* (O'Meara) Sournia in Sournia et al. (Sample 4H-6W, 20–21 cm). **7, 8.** *Thalassiosira oliverana* var. *sparsa* Harwood et Maruyama (Sample 10H-6W, 80–81 cm). **9, 10.** *Thalassiosira striata* Harwood et Maruyama (Sample 6H-2W, 81–82 cm). **11, 12.** *Thalassiosira* cf. *symmetrica* Fryxell et Hasle (Sample 3H-4W, 112–113 cm). **13, 14.** *Thalassiosira tumida* (Janisch) Hasle in Hasle et al. (Sample 5H-3W, 112–113 cm). **15, 16.** *Thalassiosira vulnifica* (Gombos) Fenner (Sample 4H-3W, 106–107 cm). **17, 18.** *Thalassiosira yabei* (Kanaya) Akiba et Yanagisawa (Sample 11H-6W, 17–18 cm). **19–22.** *Thalassiothrix longissima* Cleve et Grunow; (19, 20) Sample 2H-1W, 133–137 cm; (21, 22) Sample 4H-1W, 106–107 cm. **23–39.** *Triceratium* spp.; (23–26) Sample 4H-3W, 106–107 cm; (27, 28) Sample 6H-5W, 81–82 cm; (29–32) Sample 6H-6W, 81–82 cm; (33–35) Sample 7H-1W, 43–44 cm; (36, 37) Sample 9H-2W, 92–93 cm; (38, 39) Sample 8H-6W, 82–83 cm.

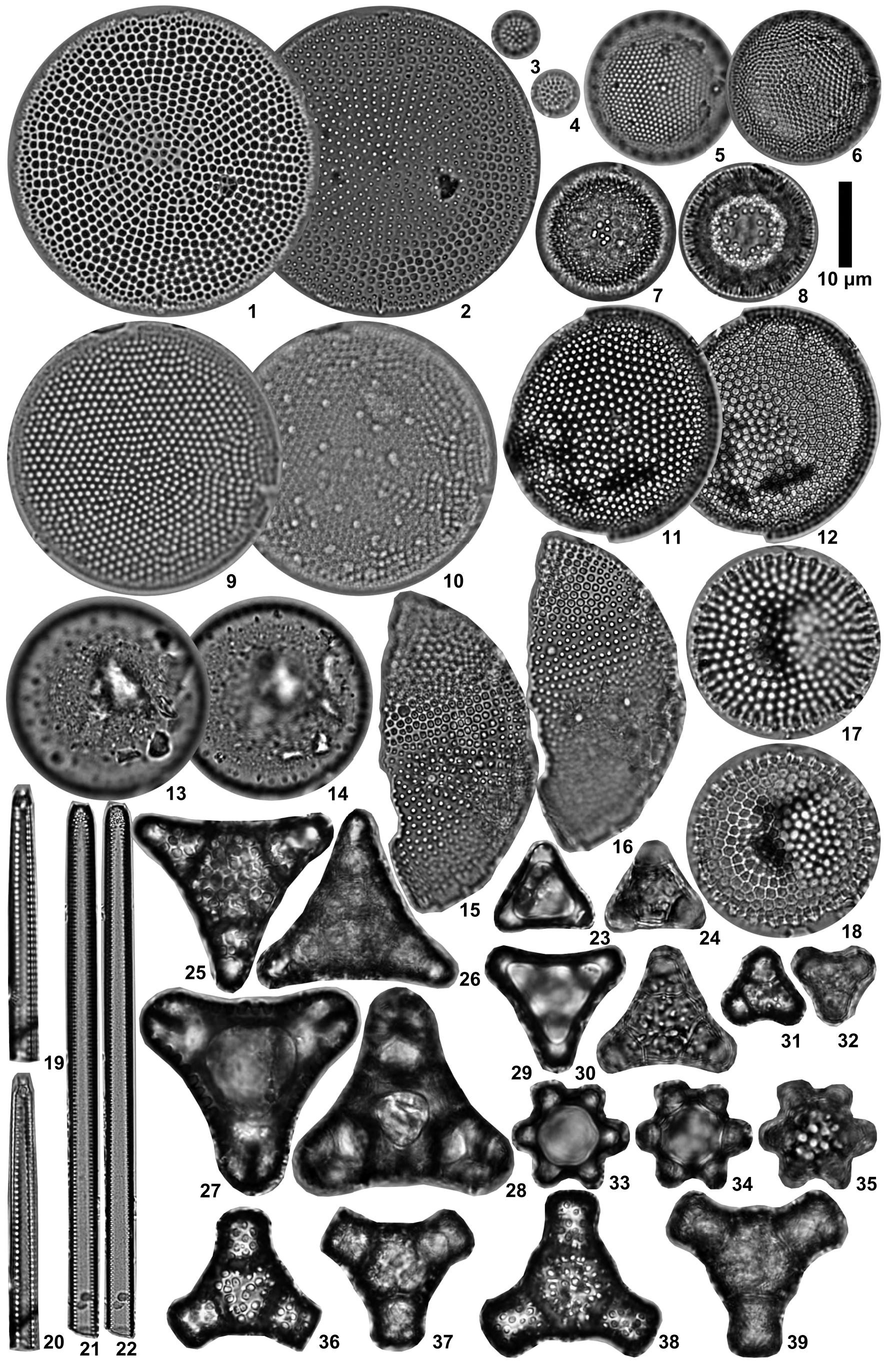


Plate P12. Light microscope images of resting spores of *Chaetoceros*, Hole U1371D. Scale bars = 10 µm. (right: figs. 1, 2, 4–40; left: figs. 3, 4). **1, 2.** *Coronodiscus collarius* Suto (Sample 329-U1371D-11H-1W, 51–52 cm). **3, 4.** *Dicladia capreola* Ehrenberg (Sample 3H-6W, 112–113 cm). **5, 6.** *Dispinodiscus pilusus* var. *pilusus* Suto (Sample 3H-7W, 32–33 cm). **7, 8.** *Dispinodiscus* sp. A (Sample 1H-1W, 66–67 cm). **9, 10.** *Gemellodiscus bifurcus* Suto (Sample 5H-2W, 112–113 cm). **11, 12.** *Gemellodiscus cingulus* var. *cingulus* Suto (Sample 4H-1W, 106–107 cm). **13, 14.** *Gemellodiscus geminus* Suto (Sample 7H-5W, 15–16 cm). **15–18.** *Liradiscus castaneus* var. *castaneus* Suto; (15, 16) Sample 4H-5W, 20–21 cm; (17, 18) Sample 4H-6W, 20–21 cm. **19–26.** *Liradiscus castaneus*? (Sample 3H-7W, 32–33 cm). **27, 28.** *Liradiscus japonicus* Suto (Sample 8H-3W, 82–83 cm). **29, 30.** *Liradiscus petasus* Suto (Sample 8H-5W, 82–83 cm). **31–34.** *Liradiscus plicatulus* Hajós; (31, 32) Sample 4H-5W, 20–21 cm; (33, 34) Sample 4H-6W, 20–21 cm. **35, 36.** *Quadrocistella paliesa* Suto (Sample 8H-4W, 82–83 cm). **37–40.** *Quadrocistella* sp. A; (37, 38) Sample 8H-3W, 82–83 cm; (39, 40) Sample 11H-7W, 17–18 cm.

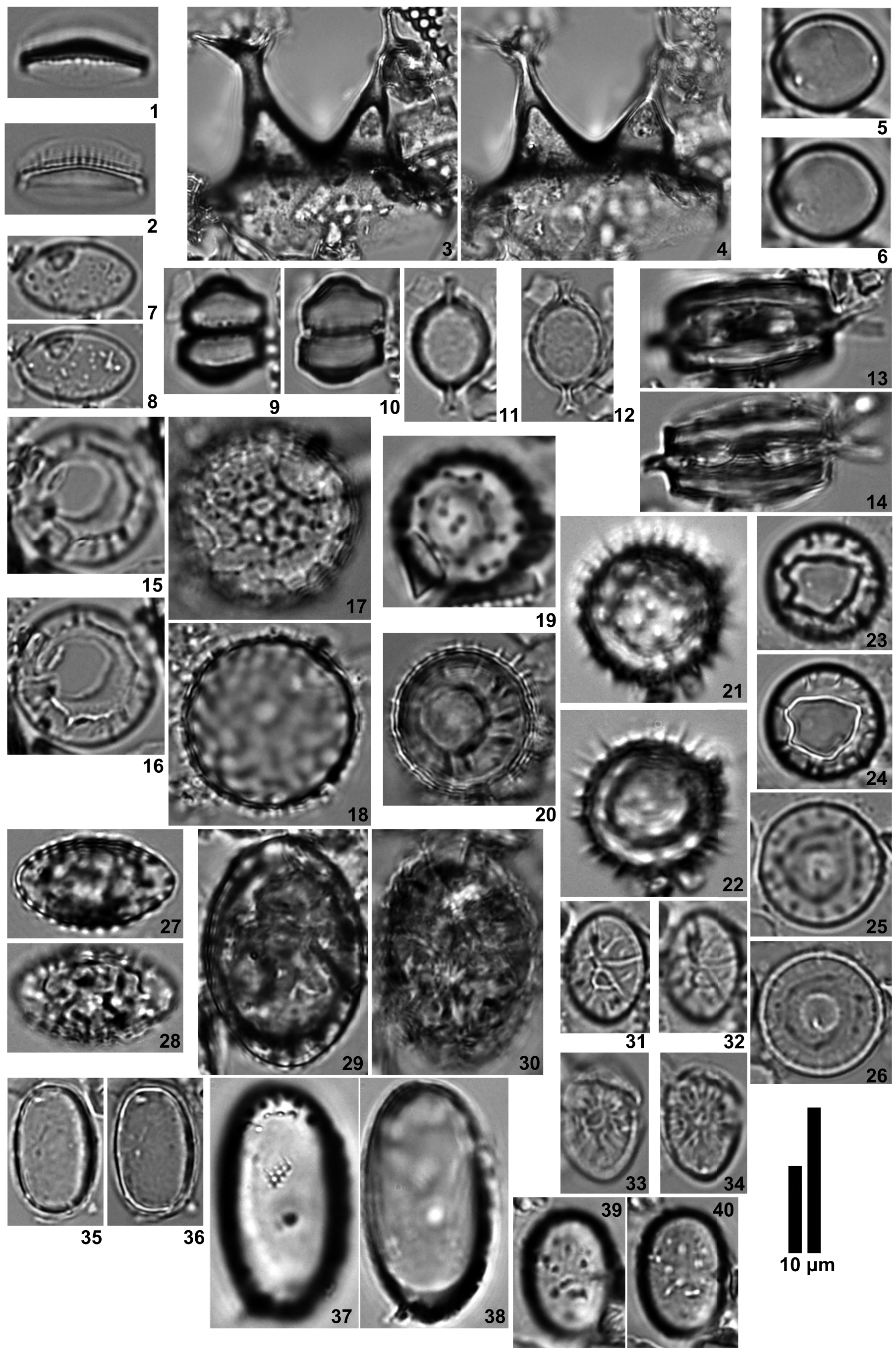


Plate P13. Light microscope images of resting spores of *Chaetoceros*, Hole U1371D. Scale bars = 10 µm. (right: figs. 3–16, 19, 20; left: figs. 1, 2, 17, 18, 21, 22). **1, 2.** *Syndendrium altantemna* Suto (Sample 329-U1371D-6H-3W, 81–82 cm). **3, 4.** *Syndendrium diadema* Ehrenberg (Sample 1H-1W, 66–67 cm). **5–10.** *Truncatulus tortonicus* (Hajós) Suto; (5, 6) Sample 5H-2W, 112–113 cm; (7, 8) Sample 4H-1W, 106–107 cm; (9, 10) Sample 8H-3W, 82–83 cm. **11, 12.** *Vallodiscus chinchae* (Mereschkowski) Suto (Sample 8H-4W, 82–83 cm). **13–16.** *Vallodiscus complexus* Suto; (13, 14) Sample 3H-2W, 112–113 cm; (15, 16) Sample 11H-4W, 17–18 cm. **17, 18.** *Xanthioisthmus biscoctiformis* (Forti) Suto (Sample 10H-3W, 80–81 cm). **19, 20.** *Xanthioisthmus maculata* (Hanna) Suto (Sample 8H-3W, 82–83 cm). **21, 22.** *Xanthioisthmus* sp. A (Sample 3H-6W, 112–113 cm).

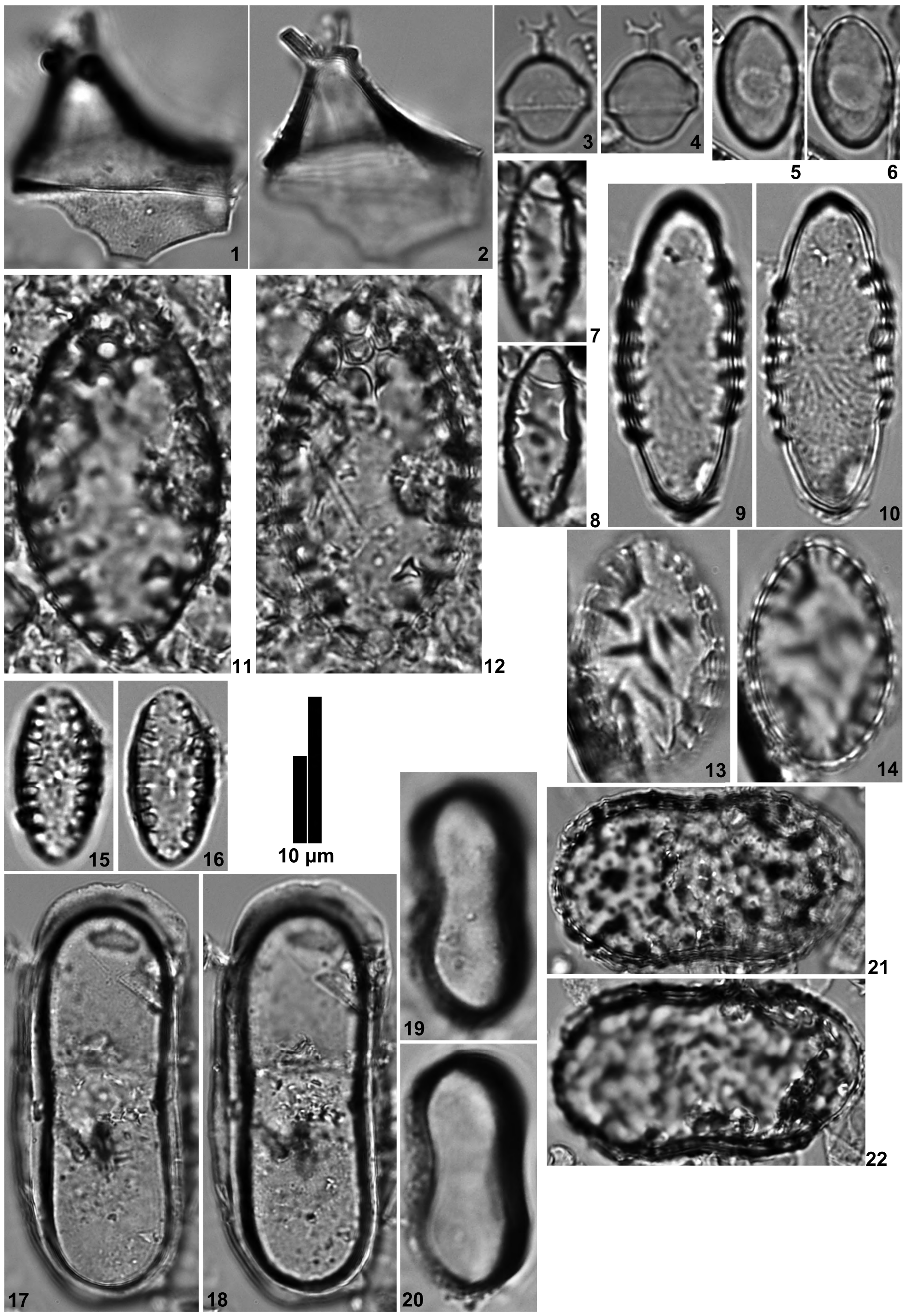
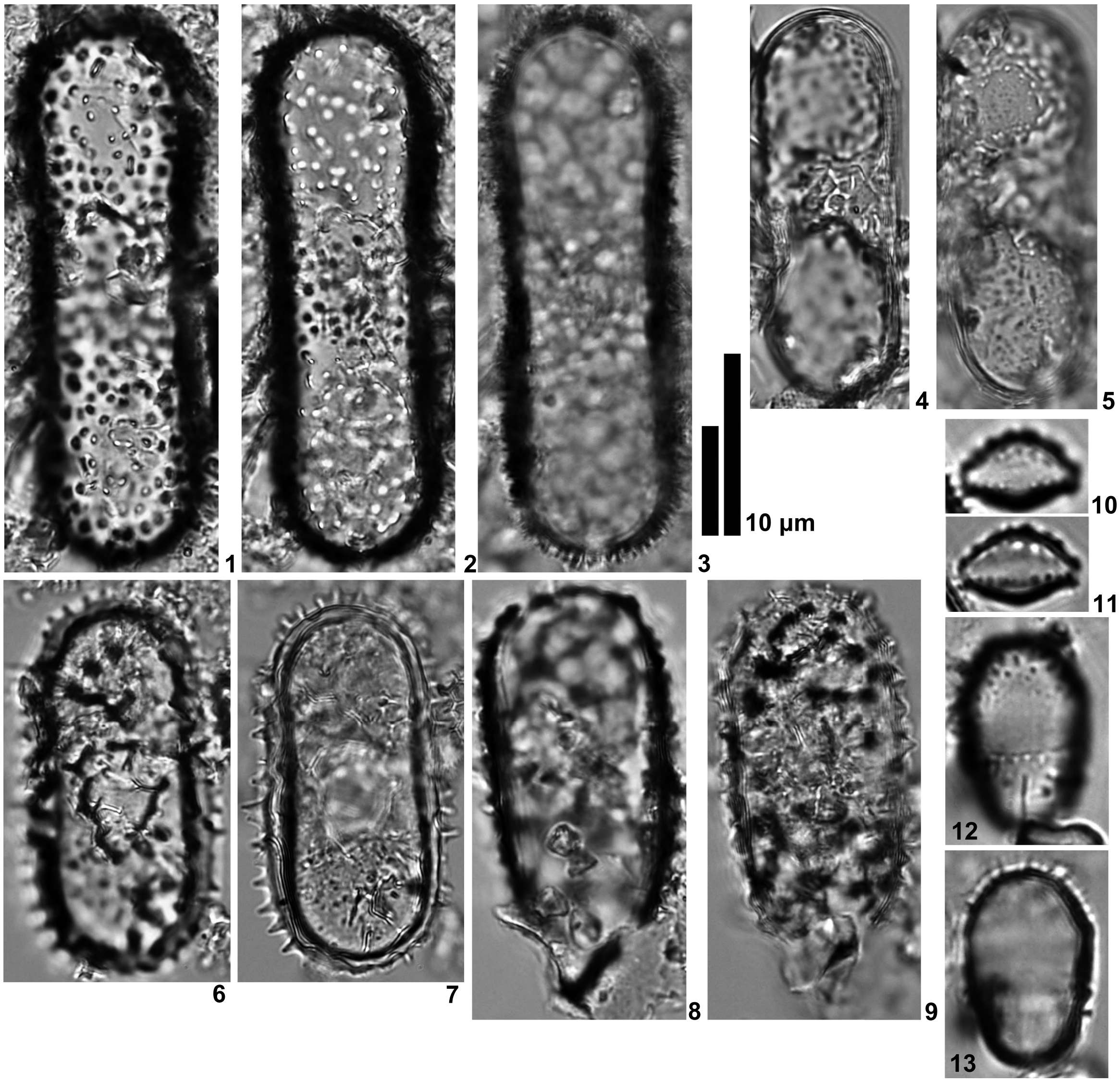


Plate P14. Light microscope images of resting spores of *Chaetoceros*, Hole U1371D. Scale bars = 10 µm. (right: figs. 10–13; left: figs. 1–9). **1–7.** *Xanthiopyxis acrolopha* Forti; (1–3) Sample 329-U1371D-8H-4W, 82–83 cm; (4, 5) Sample 9H-4W, 92–93 cm; (6, 7) Sample 10H-2W, 80–81 cm. **8, 9.** *Xanthiopyxis oblonga* Ehrenberg (Sample 7H-4W, 15–16 cm). **10, 11.** *Xanthiopyxis* type A (knobbly type) (Sample 4H-4W, 20–21 cm). **12, 13.** *Xanthiopyxis* type B (short spiny type) (Sample 8H-6W, 82–83 cm).



Appendix

Taxonomic notes and floral references

Taxonomic references for all species and varieties of diatoms (Bacillariophyta) identified from the Expedition 329 Hole U1371D sediments are listed below and shown in Plates P1–P14. The authority of each species is given as well as several good references that describe and illustrate the particular taxon collected around the Antarctic Ocean.

Actinocyclus actinochilus (Ehrenberg) Simonsen (1982), pp. 101–116, pls. 1–4; Harwood and Maruyama (1992), p. 699, pl. 12, figs. 9–11; Tanimura (1992), pp. 405, 407, figs. 3-2, 5-3; Mahood and Barron (1996b), p. 288, pl. 7, fig. 22; Bohaty et al. (1998), pl. 3, figs. 6, 8; Iwai and Winter (2002), p. 3, pl. P21, fig. 8; pl. P26, fig. 2; pl. P33, fig. 1; Suto et al. (2013), p. 32, pl. P1, figs. 1, 2 (no illustrations).

Basionym: *Coscinodiscus actinochilus* Ehrenberg (1844a), p. 200; Ehrenberg (1854), pl. 35A, figs. XXI-5.

Synonym: *Charcotia actinochilus* (Ehrenberg) Hustedt (1958), pp. 122–126, pl. 7, figs. 57–80; Fenner et al. (1976), p. 771, pl. 5, fig. 5; Gombos (1977), p. 592, pl. 1, fig. 8; Akiba (1982a), p. 42, pl. 3, figs. 7–10.

Actinocyclus curvatulus Janisch in Schmidt et al. (1874–1959), pl. 57, fig. 31; Fenner et al. (1976), p. 763, pl. 6, figs. 1, 2; Akiba (1982a), pp. 41, 42, pl. 5, figs. 5a, 5b; Harwood and Maruyama (1992), p. 699, pl. 12, fig. 12; Zielinski and Gersonde (2002), p. 253, pl. 3, fig. 1; Suto et al. (2013), p. 32, pl. P1, figs. 3–14 (Pl. P2, figs. 1, 2).

Actinocyclus ellipticus Grunow in Van Heurck (1880–1885), pl. 124, fig. 10; Schrader (1973), p. 701, pl. 8, figs. 7–9, 11–14, 16, 17; Akiba (1986), p. 441, pl. 16, fig. 5; Ciesielski (1986), p. 875, pl. 5, fig. 8 (Pl. P2, figs. 3, 4).

Actinocyclus ingens f. *ingens* (Rattray) Whiting et Schrader (1985a), p. 74, pl. 1, figs. 1, 2; pl. 2, figs. 4–10; pl. 3, fig. 13 (Pl. P1, figs. 1, 2).

Synonym: *Actinocyclus ingens* Rattray (1890a), p. 149, pl. 11, fig. 7; Akiba (1982a), p. 42, pl. 5, figs. 7–14; Akiba (1986), p. 442, pl. 16, figs. 6, 9; Harwood and Maruyama (1992), p. 700, pl. 8, fig. 10; pl. 11, figs. 4, 6; pl. 12, fig. 8; Mahood and Barron (1996b), p. 288, pl. 3, figs. 1a–4; pl. 7, figs. 20a–21; Bohaty et al. (1998), pl. 3, fig. 7; Iwai and Winter (2002), p. 3, pl. P15, fig. 3; pl. P29, figs. 1, 4; Suto et al. (2013), p. 32, pl. P1, figs. 15, 16.

Actinocyclus ingens f. *nodus* (Baldauf) Whiting et Schrader (1985a), p. 74, pl. 1, fig. 3; pl. 2, fig. 11; pl. 3, fig. 14 (no illustrations).

Synonym: *Actinocyclus ingens* var. *nodus* Baldauf in Baldauf et Barron (1980), p. 104, pl. 1, figs. 5–9; Ciesielski (1986), p. 875, pl. 1, figs. 8, 9; Gersonde (1990), p. 792, pl. 1, fig. 6; pl. 3, figs. 4–7; Censarek and Gersonde (2002), p. 350, pl. 1, fig. 4.

Actinocyclus ingens var. *ovalis* Gersonde (1990), p. 792, pl. 1, fig. 7; pl. 3, figs. 1–3; pl. 5, figs. 4, 7; pl. 6, figs. 1, 4, 5; Gersonde and Burckle (1990), p. 779, pl. 5, fig. 4; Baldauf and Barron (1991), p. 585, pl. 5, fig. 1; Censarek and Gersonde (2002), p. 350, pl. 1, figs. 6, 8; Iwai and Winter (2002), p. 3, pl. P15, fig. 5; Bohaty et al. (2003), p. 16, pl. P1, figs. 2, 3 (Pl. P1, figs. 27, 28).

Synonym: *Hemidiscus ovalis* (Gersonde) Harwood et Maruyama (1992), p. 703, pl. 11, fig. 2; pl. 12, figs. 1–3.

Actinocyclus karstenii Van Heurck (1909), p. 44, pl. 12, fig. 158; Harwood (1986), p. 84, pl. 8, figs. 8–10; Harwood and Maruyama (1992), p. 700, pl. 13, figs. 1, 2, 6–8, 10, 11, 13; Mahood and Barron (1996b), p. 288, pl. 3, fig. 5; Bohaty et al. (1998), pl. 3, figs. 4, 5; Harwood et al. (2000), p. 459, figs. 7j, 7k; Censarek and Gersonde (2002), p. 350, pl. 1, fig. 5; Iwai and Winter (2002), p. 3, pl. P20, figs. 5–8; pl. P24, fig. 8; pl. P26, fig. 1; pl. P27, fig. 9; Zielinski and Gersonde (2002), p. 253, pl. 3, figs. 4, 5, 7–9, 12 (Pl. P2, figs. 5, 6).

Synonym: *Actinocyclus fryxellae* Barron in Baldauf et Barron (1991), pl. 1, figs. 1, 2, 4.

Actinocyclus octonarius (Ehrenberg) Kützing (1844), p. 134, pl. 21, fig. 25; Iwai and Winter (2002), p. 3, pl. P20, fig. 3; Arney et al. (2003), p. 8, pl. P3, fig. 2 (no illustrations).

Actinocyclus sp. A (Pl. P2, figs. 7, 8).

Actinoptychus senarius (Ehrenberg) Ehrenberg (1843), p. 298, 301, 322, 328, 437, 438, 443; pl. I/I, fig. 27; pl. I/III, fig. 21; pl. III/VII, fig. 1; Akiba (1986), p. 447, pl. 29, fig. 2; Censarek and Gersonde (2002), p. 350, pl. 5, fig. 11; Suto et al. (2013), p. 35, pl. P5, figs. 1–10 (Pl. P2, figs. 9, 10).

Basionym: *Actinocyclus senarius* Ehrenberg (1837), p. 61.

Actinoptychus vulgaris Schumann (1867), p. 64; Akiba (1986), p. 447, pl. 29, fig. 1 (Pl. P2, figs. 11, 12).

Asterolampra spp. (Pl. P2, figs. 13, 14).

Asteromphalus hyalinus Karsten (1905), p. 90, pl. 8, fig. 15; Schrader (1976), p. 630, pl. 8, fig. 7; Fenner et al. (1976), p. 769, pl. 4, figs. 17–19; Akiba (1982a), p. 42, pl. 1, fig. 4; Suto et al. (2013), p. 32, pl. P1, figs. 35, 36 (no illustrations).

Asteromphalus kennettii Gersonde (1990), p. 793, pl. 2, fig. 1; pl. 6, fig. 2; Harwood and Maruyama (1992), p. 701, pl. 11, fig. 3; Censarek and Gersonde (2002), p. 350, pl. 1, fig. 2 (Pl. P3, figs. 1, 2).

Synonym: *Asteromphalus* sp. 1 of Ciesielski (1983), p. 655, pl. 6, figs. 1, 2, 6, 9.

Asteromphalus oligocenicus Schrader et Fenner (1976), pp. 965, 966, pl. 21, figs. 8, 13, 14; pl. 28, fig. 1; Gombos and Ciesielski (1983), p. 600, pl. 5, figs. 5–7; Harwood and Maruyama (1992), p. 701, pl. 4, fig. 17; pl. 5, fig. 5; Arney et al. (2003), p. 8, pl. P4, fig. 1 (Pl. P3, figs. 3, 4).

Synonym: *Asterolampra* sp. 2 of Schrader (1976), p. 630, pl. 8, fig. 2.

Asteromphalus parvulus Karsten (1905), p. 90, pl. 8, fig. 14; Fenner et al. (1976), p. 769, pl. 4, figs. 20, 21; Schrader (1976), p. 630, pl. 8, fig. 6; Akiba (1982a), p. 42, pl. 1, figs. 3, 5, 6; Koizumi (1982), p. 79, pl. 1, fig. 13; Harwood and Maruyama (1992), p. 701, pl. 19, figs. 1, 2 (Pl. **P3,** figs. 5, 6).

Synonym: *Asteromphalus symmetricus* of Harwood and Maruyama (1992), p. 701, pl. 4, fig. 18.

Asteromphalus spp. (Pl. **P3,** figs. 7, 8).

Aulacoseira granulata (Ehrenberg) Simonsen (1979), p. 58; Akiba (1986), p. 448, pl. 29, figs. 6–9; Suto et al. (2013), p. 36, pl. P9, figs. 1–8 (no illustrations).

Basionym: *Gaillonella granulata* Ehrenberg (1843), p. 415.

Synonym: *Melosira granulata* (Ehrenberg) Ralfs in Pritchard (1861), p. 820.

Azpeitia endoi (Kanaya) Sims et Fryxell in Fryxell et al. (1986), p. 16; Iwai and Winter (2002), p. 4, pl. P21, figs. 6, 7 (Pl. **P4,** figs. 1, 2).

Basionym: *Coscinodiscus endoi* Kanaya (1959), pp. 76, 77, pl. 3, figs. 8–11; McCollum (1975), p. 527, pl. 4, figs. 5, 6; Schrader (1976), p. 630, pl. 11, figs. 4, 8–10, 12; Gombos (1977), p. 593, pl. 2, figs. 6, 7; pl. 5, fig. 3; Akiba (1986), p. 442, pl. 2, fig. 2.

Synonym: *Azpeitia endoi* Kanaya of Arney et al. (2003), p. 8, pl. P3, fig. 5.

Azpeitia tabularis (Grunow) Fryxell et Sims in Fryxell et al. (1986), p. 16, figs. 14-1A–14-3B, 15-1A–15-4B, 30-1; Harwood and Maruyama (1992), p. 701, pl. 11, fig. 5; Censarek and Gersonde (2002), p. 350, pl. 1, fig. 7; Iwai and Winter (2002), p. 4, pl. P21, fig. 4; Zielinski and Gersonde (2002), p. 255, pl. 3, fig. 2 (Pl. **P4,** figs. 3, 4).

Basionym: *Coscinodiscus tabularis* Grunow (1884), p. 34 (86); Schrader (1976), p. 631, pl. 11, fig. 5; Fenner et al. (1976), p. 774, pl. 7, figs. 10–13; Akiba (1982a), p. 42, pl. 2, figs. 6–9; Koizumi (1982), p. 80, pl. 2, fig. 10.

Azpeitia tabularis var. *egregius* (Rattray) Desikachary et al. (1987), pp. 4, 5, pl. 115, fig. 8; Zielinski and Gersonde (2002), p. 255, pl. 3, fig. 6 (no illustrations).

Basionym: *Coscinodiscus egregius* Rattray (1890b), p. 518, sl. no. 934.

Synonym: *Coscinodiscus tabularis* var. *egregius* (Rattray) Hustedt (1927–1930), p. 428, fig. 230b; Fenner et al. (1976), p. 774, pl. 7, figs. 8, 9; Akiba (1986), p. 442, pl. 2, figs. 3, 4.

Azpeitia vetustissima (Pantocsek) Sims in Fryxell et al. (1986), p. 16 (Pl. **P4,** figs. 5–7).

Basionym: *Coscinodiscus vetustissimus* Pantocsek (1886), p. 73, pl. 20, fig. 186; McCollum (1975), p. 534, pl. 6, figs. 4–7; Schrader (1976), p. 631, pl. 11, fig. 11; Gombos (1977), p. 593, pl. 27, fig. 2.

Bacteriastrum spp. (Pl. **P4,** figs. 8–10).

Biddulphia spp. (Pl. **P4,** figs. 11, 12).

Bogorovia gombosii (Desikachary) Yanagisawa (1995), p. 27, figs. 4-1, 4-2, 5-1, 5-2 (Pl. **P4,** figs. 13, 14).

Basionym: *Rossiella gombosii* Desikachary in Desikachary et al. (1984), p. 338.

Synonym: *Bogorovia veniamini* Jousé of Schrader (1976), p. 630, pl. 5, figs. 22, 23; Gombos (1977), p. 593, pl. 1, fig. 6, 7; pl. 12, figs. 2, 4; *Rossiella* sp. of Gombos and Ciesielski (1983), p. 604, pl. 24, figs. 1, 2.

Cavitatus jouseanus (Sheshukova-Poretzkaya) Williams (1989), p. 360; Akiba et al. (1993), p. 20, 22, figs. 6-19, 6-20; Censarek and Gersonde (2002), p. 350, pl. 5, fig. 12; Arney et al. (2003), p. 8, pl. P2, fig. 1 (no illustrations).

Basionym: *Synedra jouseana* Sheshukova-Poretzkaya (1962), p. 208, fig. 4; Sheshukova-Poretzkaya (1967), p. 245, pl. 42, figs. 4a, 4b; pl. 43, figs. 12a, 12b; Schrader (1973), p. 710, pl. 23, figs. 21–23, 25, 38; McCollum (1975), p. 536, pl. 13, fig. 5; Gombos (1977), p. 598, pl. 12, fig. 7; Gombos and Ciesielski (1983), p. 605, pl. 24, figs. 3–7; Akiba (1986), p. 445, pl. 21, fig. 9; Harwood and Maruyama (1992), p. 706, pl. 11, figs. 8, 9.

Cestodiscus reticulatus Fenner (1984), p. 331, pl. 1, fig. 10; Harwood and Maruyama (1992), p. 701, pl. 3, fig. 4 (no illustrations).

Chaetoceros spp. (vegetative cells) (Pl. **P4,** figs. 15, 16).

Cocconeis californica (Grunow in Cleve et Möller) Grunow in Van Heurck (1880–1885), pl. 30, figs. 8, 9; Iwai and Winter (2002), p. 4, pl. P6, fig. 11 (Pl. **P4,** figs. 17, 18).

Cocconeis placentula Ehrenberg (1838), p. 194; Fenner et al. (1976), p. 771, pl. 11, fig. 13; Suto et al. (2013), p. 35, pl. P6, figs. 11–20; pl. P11, figs. 7, 8 (Pl. **P4,** figs. 19, 20).

Cocconeis scutellum Ehrenberg (1838), p. 194, pl. 14, fig. 8; Akiba (1986), p. 447, pl. 30, figs. 3, 11 (no illustrations).

Cocconeis sp. B of Suto et al. (2013), p. 35, pl. P6, figs. 32–39; pl. P11, fig. 4 (Pl. **P4,** figs. 21–24).

Cocconeis spp. (no illustrations).

Coscinodiscus asteromphalus Ehrenberg (1844b), p. 77; Arney et al. (2003), p. 8, pl. P3, fig. 3; Suto et al. (2013), p. 32, pl. P2, figs. 1, 2 (no illustrations).

Coscinodiscus marginatus Ehrenberg (1843), p. 412 (124); McCollum (1975), p. 527, pl. 16, figs. 2, 3; Schrader (1976), p. 631, pl. 10, fig. 3; pl. 12, fig. 2; Gombos (1977), p. 593, pl. 5, fig. 5; Akiba (1982a), p. 42, pl. 1, fig. 8; Akiba (1986), p. 442, pl. 1, figs. 1–4; Iwai and Winter (2002), p. 5, pl. P30, fig. 2; pl. P31, fig. 5; Arney et al. (2003), p. 8, pl. P1, fig. 1; Suto et al. (2013), p. 32, pl. P2, figs. 3, 4 (Pl. **P5,** figs. 1, 2).

Coscinodiscus radiatus Ehrenberg (1840b), p. 68 (148), pl. 3, figs. 1a–1c; Fenner et al. (1976), p. 774, pl. 7, fig. 1; Iwai and Winter (2002), p. 5, pl. P22, fig. 1; Suto et al. (2013), p. 32, pl. P2, figs. 5, 6 (Pl. **P5,** figs. 3, 4).

Costopyxis trochlea (Hanna) Strelnikova in Gleser et al. (1988), p. 51, pl. 32, figs. 17, 18; Scherer and Koç (1996), p. 86, pl. 8, figs. 8–10; Gladenkov (1998), pl. 1, figs. 11a, 11b; Tsoy (2003), pl. 2, fig. 12; Suto et al. (2009), p. 261, pl. 3, figs. 24–37 (Pl. **P5,** figs. 5–8).

Basionym: *Trochosira trochlea* Hanna (1927), p. 123, pl. 21, figs. 8, 9.

Synonym: See Suto et al. (2009).

Crucidenticula kanayae var. *kanayae* Akiba et Yanagisawa (1986), p. 486, pl. 1, figs. 3–8; pl. 3, figs. 1–6, 9, 10; Gersonde and Burckle (1990), p. 780, pl. 3, figs. 11, 12; Yanagisawa and Akiba (1990), p. 229, pl. 1, figs. 33–35, 39; pl. 8, figs. 14–17; Harwood and Maruyama (1992), p. 702, pl. 7, fig. 5; Censarek and Gersonde (2002), pp. 350, 351, pl. 2, figs. 35, 36 (Pl. P5, figs. 9, 10).
Synonym: See Yanagisawa and Akiba (1990).

Crucidenticula nicobarica (Grunow) Akiba et Yanagisawa (1986), p. 486, pl. 1, fig. 9; pl. 2, figs. 1–7; pl. 5, figs. 1–9; Baldauf and Barron (1991), p. 588, pl. 7, fig. 8; Censarek and Gersonde (2002), p. 351, pl. 2, figs. 25, 26; Arney et al. (2003), p. 8, pl. P1, fig. 13 (Pl. P5, figs. 11, 12).
Basionym: *Denticula nicobarica* Grunow (1868), p. 97, pl. 1a, figs. 5a, 5b.
Synonym: See Yanagisawa and Akiba (1990).

Cyclotella pantanelliana Castracane (1886b), p. 171; Suto et al. (2013), p. 38, pl. P9, figs. 9–18 (Pl. P5, figs. 13–16).

Cyclotella striata (Kützing) Grunow in Cleve et Grunow (1880), p. 119; Akiba (1986), p. 442, pl. 4, figs. 8–10 (no illustrations).
Basionym: *Coscinodiscus striatus* Kützing (1844), p. 131, pl. 1, fig. 8.

Cyclotella sp. A (no illustrations).

Cymatosira sp. (Pl. P5, figs. 17–19).

Denticulopsis crassa Yanagisawa et Akiba (1990), pp. 248, 249, pl. 3, figs. 21–27; pl. 12, figs. 1–8; Censarek and Gersonde (2002), p. 351, pl. 2, fig. 12; Iwai and Winter (2002), p. 5, pl. P1, figs. 15–18 (Pl. P5, figs. 20–22).
Synonym: See Yanagisawa and Akiba (1990).

Denticulopsis dimorpha (Schrader) Simonsen (1979), p. 64; Akiba (1982a), pl. 11, figs. 1, 5, 6a; Akiba (1986), p. 442, pl. 27, figs. 3, 4, 7–9, 11–13; Akiba and Yanagisawa (1986), p. 488, pl. 15, figs. 2–4, 17, 18, 20, 23–25; Ciesielski (1986), p. 876, pl. 2, figs. 5–8; Baldauf and Barron (1991), p. 588, pl. 7, fig. 4; Harwood and Maruyama (1992), p. 702, pl. 6, figs. 5–7; pl. 7, fig. 10; pl. 9, figs. 5–9, 15–18, 22, 23; pl. 10, figs. 5, 6, 12, 14; Censarek and Gersonde (2002), p. 351, pl. 2, figs. 8–11 (Pl. P5, figs. 23–26).
Basionym: *Denticula dimorpha* Schrader (1973), p. 704, pl. 1, figs. 37–44, 46.
Synonym: See Yanagisawa and Akiba (1990).

Denticulopsis katayamae Maruyama (1984), pp. 158, 159, pl. 12, figs. 1a–6; pl. 17, figs. 1–13, 15, 16, 18–23; Akiba (1986), p. 443, pl. 28, figs. 1–4; Akiba and Yanagisawa (1986), p. 489, pl. 17, figs. 1–3, 6; pl. 19, figs. 6–9; pl. 20, figs. 1, 4, 5, 7; Yanagisawa and Akiba (1990), pp. 245, 246, pl. 3, figs. 12, 13, 28; pl. 11, fig. 4 (Pl. P5, figs. 27–30).
Synonym: See Yanagisawa and Akiba (1990).

Denticulopsis lauta (Bailey) Simonsen (1979), p. 64; Maruyama (1984), pl. 14, figs. 1a–8b; pl. 16, figs. 9, 10; Akiba (1986), p. 443, pl. 26, fig. 15; Akiba and Yanagisawa (1986), p. 489, pl. 7, fig. 29; pl. 9, figs. 2–9; Yanagisawa and Akiba (1990), pp. 235, 236, pl. 2, figs. 6–8, 15; pl. 5, figs. 1–3; pl. 9, fig. 1; Baldauf and Barron (1991), p. 588, pl. 7, fig. 3 (Pl. P5, figs. 31, 32).
Basionym: *Denticula*? *lauta* Bailey (1854), p. 9, figs. 1, 2.
Synonym: See Yanagisawa and Akiba (1990).

Denticulopsis maccollumii Simonsen (1979), p. 65; Gersonde and Burckle (1990), p. 780, pl. 5, figs. 7–9; Yanagisawa and Akiba (1990), pp. 264, 265, pl. 2, figs. 39–41; Harwood and Maruyama (1992), p. 702, pl. 6, fig. 22; pl. 7, fig. 17; pl. 9, fig. 27; Censarek and Gersonde (2002), p. 351, pl. 2, figs. 32–34; Iwai and Winter (2002), p. 6, pl. P3, fig. 10; Arney et al. (2003), p. 8, pl. P1, fig. 9 (Pl. P5, figs. 33–38).
Synonym: See Yanagisawa and Akiba (1990).

Denticulopsis ovata (Schrader) Yanagisawa et Akiba (1990), pp. 257, 258, pl. 6, figs. 6–14, 24–32; Censarek and Gersonde (2002), p. 351, pl. 2, figs. 13–20; Iwai and Winter (2002), p. 6, pl. P1, fig. 20 (Pl. P6, figs. 1–6).
Basionym: *Denticula hustedtii* var. *ovata* Schrader (1976), p. 632, pl. 4, figs. 5, 6, 12, 14, 15.
Synonym: See Yanagisawa and Akiba (1990), Censarek and Gersonde (2002), and Iwai and Winter (2002).

Denticulopsis simonsenii Yanagisawa et Akiba (1990), pp. 242, 243, pl. 3, figs. 1–3; pl. 11, figs. 1, 5; Censarek and Gersonde (2002), p. 351, pl. 2, figs. 21–24; Iwai and Winter (2002), p. 6, pl. P1, figs. 1–6; pl. P28, figs. 1, 2 (Pl. P6, figs. 7–12).
Synonym: See Yanagisawa and Akiba (1990).

Denticulopsis vulgaris (Okuno) Yanagisawa et Akiba (1990), pp. 243, 244, pl. 3, figs. 4–8; pl. 11, figs. 2, 6–10; Iwai and Winter (2002), p. 6, pl. P1, figs. 7, 8 (Pl. P6, figs. 13–16).
Synonym: See Yanagisawa and Akiba (1990).

Diploneis bombus Ehrenberg (1844b), p. 84; Akiba (1986), p. 447, pl. 30, figs. 5, 13; Censarek and Gersonde (2002), p. 351, pl. 5, fig. 3; Suto et al. (2013), p. 35, pl. P7, figs. 1–6 (Pl. P6, figs. 17, 18).

Diploneis spp. (no illustrations).

Discostella stelligera (Cleve et Grunow) Houk et Klee (2004), p. 208; Suto et al. (2013), p. 36, pl. P9, figs. 31–44 (Pl. P6, figs. 19, 20).
Basionym: *Cyclotella meneghiniana* var. *stelligera* Cleve et Grunow in Cleve (1881), p. 22, pl. 5, figs. 63a, 63c.
Synonym: *Cyclotella stelligera* (Cleve et Grunow in Cleve) Van Heurck (1880–1885), pl. 94, figs. 22–26.

Distephanosira architecturalis (Brun) Gleser in Gleser et al. (1992), p. 68, pl. 56, figs. 1–9 (Pl. P6, figs. 21, 22).
Basionym: *Melosira architecturalis* Brun in Schmidt et al. (1874–1959), pl. 177, figs. 45–50; Gombos (1977), p. 595, pl. 26, figs. 5–7.

Eucampia antarctica (Castracane) Mangin (1915), p. 58, figs. 41, 42; pl. 1, fig. 1; Hasle and Syvertsen (1990), pl. 16.1, figs. 7–13; Mahood and Barron (1996b), p. 290, pl. 1, figs. 1–3; pl. 7, figs. 1, 2; Harwood et al. (2000), p. 459, figs. 7r, 7s; Iwai and Winter (2002), p. 6, pl. P7, fig. 12; pl. P27, fig. 6; Suto et al. (2013), p. 32, pl. P1, figs. 37, 38 (Pl. P6, figs. 23–26).

Synonym: *Eucampia balaustium* Castracane (1886a), p. 97, pl. 18, fig. 5; McCollum (1975), p. 534, pl. 16, figs. 8, 9; Schrader (1976), p. 632, pl. 14, fig. 7; Fenner et al. (1976), p. 774, pl. 5, figs. 7–9; Gombos (1977), p. 593, pl. 1, figs. 1, 2; pl. 11, fig. 1; Akiba (1982a), p. 43, pl. 6, figs. 1–9; Koizumi (1982), p. 80, pl. 1, fig. 12; Tanimura (1992), p. 407, fig. 3-13.

Eucampia spp. (no illustrations).

Fragilariopsis aurica (Gersonde) Gersonde et Bárcena (1998), p. 92; Censarek and Gersonde (2002), p. 351, pl. 3, figs. 9–12; Iwai and Winter (2002), pp. 6, 7, pl. P4, figs. 24–28; pl. P25, fig. 2; pl. P28, fig. 7; Zielinski and Gersonde (2002), p. 257, pl. 1, figs. 13–15 (Pl. P6, figs. 27–30).

Basionym: *Nitzschia aurica* Gersonde (1991), pp. 144–146, pl. 1, figs. 18–25; pl. 3, fig. 5; pl. 4, figs. 5, 6; pl. 7, fig. 6; Gersonde and Burckle (1990), p. 780, pl. 2, figs. 10–12; Harwood and Maruyama (1992), p. 704, pl. 17, figs. 21–23.

Fragilariopsis barronii (Gersonde) Gersonde et Bárcena (1998), p. 92; Harwood et al. (2000), p. 459, fig. 10m; Iwai and Winter (2002), p. 7, pl. P25, fig. 3; Zielinski and Gersonde (2002), p. 257, pl. 1, figs. 29–31; Suto et al. (2013), p. 32, pl. P3, figs. 1–4 (Pl. P1, figs. 17, 18).

Basionym: *Nitzschia barronii* Gersonde (1991), pp. 146, 147, pl. 3, fig. 6; pl. 4, figs. 1–3; pl. 5, figs. 7–17; Gersonde and Burckle (1990), p. 780, pl. 1, figs. 11–13; Baldauf and Barron (1991), p. 589, pl. 7, fig. 14; Harwood and Maruyama (1992), p. 704, pl. 17, figs. 27, 28; Mahood and Barron (1996b), p. 290, pl. 2, figs. 3a–4; pl. 7, figs. 16, 17.

Fragilariopsis barronii/kerguelensis transitional form of Zielinski and Gersonde (2002), p. 257, pl. 1, figs. 25–28; Suto et al. (2013), p. 32, pl. P3, figs. 5–10 (no illustrations).

Fragilariopsis curta (Van Heurck) Hustedt (1958), p. 160, pl. 11, figs. 140–144; pl. 12, fig. 159; Hasle (1965), pp. 32, 33, pl. 6, fig. 6; pl. 12, figs. 2–5; pl. 13, figs. 1–6; pl. 16, fig. 6; pl. 17, fig. 5; Bohaty et al. (1998), pl. 4, fig. 3; Harwood et al. (2000), p. 459, fig. 10l (Pl. P6, figs. 31–38).

Basionym: *Fragilaria curta* Van Heurck (1909), p. 24, pl. 3, fig. 37.

Synonym: *Nitzschia curta* (Van Heurck) Hasle (1972a), p. 115; Schrader (1976), p. 633, pl. 5, figs. 21, 23, 24; Fenner et al. (1976), p. 775, pl. 4, figs. 5–9; Akiba (1982a), p. 44, pl. 10, figs. 1–2b; Koizumi (1982), p. 80, pl. 1, figs. 1, 2; Harwood and Maruyama (1992), p. 704, pl. 17, figs. 1–4; Tanimura (1992), p. 407, figs. 4-17–4-23.

Fragilariopsis cylindrica (Burckle) Censarek et Gersonde (2002), pp. 349, 350; Suto et al. (2013), p. 32, pl. P3, figs. 11–16 (Pl. P6, figs. 39–42).

Basionym: *Nitzschia cylindrica* Burckle (1972), p. 239, pl. 2, figs. 1–6; Gersonde and Burckle (1990), p. 780, pl. 1, fig. 27; Baldauf and Barron (1991), p. 589, pl. 7, fig. 10; Iwai and Winter (2002), p. 8, pl. P2, figs. 5, 6.

Fragilariopsis doliolus (Wallich) Medlin et Sims (1993), p. 332; Zielinski and Gersonde (2002), p. 257, pl. 1, fig. 1; Suto et al. (2013), pp. 32, 33, pl. P3, figs. 17, 18 (Pl. P6, figs. 43, 44).

Basionym: *Synedra doliolus* Wallich (1860), p. 48, pl. 2, fig. 19.

Synonym: *Pseudoeunotia doliolus* (Wallich) Grunow in Van Heurck (1880–1885), pl. 35, fig. 22; Fenner et al. (1976), p. 778, pl. 14, fig. 12; Akiba (1986), p. 444, pl. 22, figs. 1, 2.

Fragilariopsis fossilis (Frenguelli) Medlin et Sims (1993), p. 332; Censarek and Gersonde (2002), p. 351, pl. 3, figs. 3, 4; Zielinski and Gersonde (2002), p. 257, pl. 1, figs. 5, 6; Suto et al. (2013), p. 33, pl. P3, figs. 19–22 (Pl. P6, figs. 45, 46).

Basionym: *Pseudonitzschia fossilis* Frenguelli (1949), p. 118, pl. 1, figs. 6, 7.

Synonym: *Nitzschia fossilis* (Grunow) Grunow in Van Heurck (1880–1885), pl. 68, fig. 24; Gombos (1977), p. 595, pl. 8, fig. 17; Akiba (1986), p. 443, pl. 22, figs. 6–8; Gersonde and Burckle (1990), p. 780, pl. 1, figs. 19, 20.

Fragilariopsis interfrigidaria (McCollum) Gersonde et Bárcena (1998), p. 92; Iwai and Winter (2002), p. 7, pl. P3, figs. 16, 17; pl. 25, figs. 6–8; Zielinski and Gersonde (2002), p. 259, pl. 1, figs. 20, 21; Bohaty et al. (2003), pp. 21, 22, pl. P2, figs. 15–18 (Pl. P1, figs. 13, 14).

Basionym: *Nitzschia interfrigidaria* McCollum (1975), p. 535, pl. 9, fig. 9; Schrader (1976), p. 634, pl. 3, figs. 5, 6; Gombos (1977), p. 595, pl. 7, fig. 3; Ciesielski (1983), p. 655, pl. 1, figs. 11–18; Ciesielski (1986), p. 876, pl. 3, figs. 6, 7; Gersonde and Burckle (1990), p. 780, pl. 1, figs. 1–3.

Synonym: *Nitzschia praeinterfrigidaria* of Ciesielski (1983), pl. 2, figs. 15, 16.

Fragilariopsis kerguelensis (O'Meara) Hustedt (1952), p. 294; Hustedt (1958), p. 162, figs. 121–127; Bohaty et al. (1998), pl. 1, fig. 12; Iwai and Winter (2002), p. 7, pl. P3, figs. 1–3; pl. P24, fig. 3; pl. P25, fig. 1; Zielinski and Gersonde (2002), p. 259, pl. 1, fig. 24; Bohaty et al. (2003), p. 22, pl. P2, fig. 13; Suto et al. (2013), p. 33, pl. P3, figs. 23–38; pl. P11, fig. 1 (Pl. P1, figs. 19, 20).

Basionym: *Terebraria kerguelensis* O'Meara (1877), p. 56, pl. 1, fig. 4.

Synonym: *Nitzschia kerguelensis* (O'Meara) Hasle (1972a), p. 115, figs. 1, 2; Fenner et al. (1976), p. 776, pl. 2, figs. 19–30; Gombos (1977), p. 595, pl. 8, figs. 13, 14; pl. 9, fig. 2; Akiba (1982a), p. 44, pl. 9, figs. 1a–4b; Koizumi (1982), p. 80, pl. 1, figs. 7–11; Tanimura (1992), p. 407, figs. 3-1–3-9; Arney et al. (2003), p. 9, pl. P1, fig. 14.

Fragilariopsis maleinterpretaria (Schrader) Censarek et Gersonde (2002), p. 350, pl. 3, fig. 26.

Basionym: *Nitzschia maleinterpretaria* Schrader (1976), p. 634, pl. 2, figs. 9, 11–19, 21, 24; Gersonde and Burckle (1990), pp. 780, 782, pl. 2, figs. 13–16; Harwood and Maruyama (1992), p. 704, pl. 6, fig. 21 (Pl. P6, figs. 47, 48).

Fragilariopsis obliquecostata (Van Heurck) Heiden et Kolbe (1928), p. 555; Mahood and Barron (1996b), p. 290, pl. 2, figs. 1, 2; pl. 7, figs. 9–14; Bohaty et al. (1998), pl. 1, fig. 14; Suto et al. (2013), p. 33, pl. P11, fig. 2 (Pl. P6, figs. 49, 50).

Basionym: *Fragilaria obliquecostata* Van Heurck (1909), p. 25, pl. 3, fig. 38.

Synonym: *Nitzschia obliquecostata* (Van Heurck) Hasle (1972a), p. 115; Fenner et al. (1976), pp. 776, 777, pl. 2, figs. 15–18.

Fragilariopsis oceanica (Cleve) Hasle (1965), p. 11, pl. 1, figs. 15–19; pl. 2, figs. 6–9; pl. 3, figs. 1, 2; pl. 16, figs. 1, 2 (Pl. P6, figs. 51, 52).

Basionym: *Fragilaria oceanica* Cleve (1873), p. 22, pl. 4, fig. 25.

Synonym: *Nitzschia grunowii* Hasle (1972a), p. 115; Fenner et al. (1976), p. 776, pl. 2, figs. 1–5; Akiba (1986), p. 443, pl. 24, figs. 19–21; Tanimura (1992), p. 409, figs. 4-32–4-35.

Fragilariopsis praeinterfrigidaria (McCollum) Gersonde et Bárcena (1998), p. 92; Censarek and Gersonde (2002), p. 352, pl. 3, figs. 22, 23; Iwai and Winter (2002), p. 7, pl. P3, figs. 13–15; Zielinski and Gersonde (2002), p. 259, pl. 1, figs. 22, 23 (Pl. P1, figs. 15, 16).

Basionym: *Nitzschia praeinterfrigidaria* McCollum (1975), p. 535, pl. 10, fig. 1; Gombos (1977), p. 595, pl. 7, figs. 1, 2; Ciesielski (1983), p. 655, pl. 2, figs. 1–8, 13, 14; pl. 3, fig. 5; Gersonde and Burckle (1990), p. 782, pl. 1, figs. 4–10; Baldauf and Barron (1991), p. 589, pl. 7, fig. 12.

Fragilariopsis reinholdii (Kanaya ex Schrader) Zielinski et Gersonde (2002), p. 251, pl. 1, figs. 3, 4; Censarek et Gersonde (2002), p. 352, pl. 3, figs. 1, 2 (Pl. P6, figs. 53–56).

Basionym: *Nitzschia reinholdii* Kanaya et Koizumi (1970), pp. 58, 59 (described in Japanese); Schrader (1973), p. 708, pl. 4, figs. 12–16; pl. 5, figs. 1–9; McCollum (1975), p. 535, pl. 16, figs. 4, 5; Akiba (1986), pp. 443, 444, pl. 22, figs. 4, 5; Ciesielski (1986), p. 877, pl. 3, figs. 1–4; Gersonde and Burckle (1990), p. 782, pl. 2, fig. 1; Iwai and Winter (2002), p. 9, pl. P25, fig. 4; pl. P28, fig. 13.

Fragilariopsis rhombica (O'Meara) Hustedt (1952), p. 296; Suto et al. (2013), p. 33, pl. P3, figs. 39, 40 (no illustrations).

Basionym: *Diatoma rhombicum* O'Meara (1877), p. 55, pl. 1, fig. 2.

Synonym: *Nitzschia angulata* Hasle (1972a), p. 115; Fenner et al. (1976), p. 775, pl. 1, figs. 17–39; Gombos (1977), pl. 8, fig. 16; Koizumi (1982), p. 80, pl. 1, fig. 5; Ciesielski (1986), p. 876, pl. 3, fig. 13; Tanimura (1992), p. 407, figs. 4-24–4-26; Iwai and Winter (2002), p. 8, pl. P3, fig. 6.

Fragilariopsis ritscheri Hustedt (1958), p. 164, figs. 133–136; pl. 12, fig. 153; Bohaty et al. (1998), pl. 1, fig. 8; Zielinski and Gersonde (2002), p. 259, pl. 1, fig. 7 (Pl. P6, figs. 57, 58).

Synonym: *Nitzschia ritscheri* (Hustedt) Hasle (1965), pp. 20, 21, pl. 1, fig. 20; pl. 4, figs. 1–7; pl. 7, fig. 8; Fenner et al. (1976), p. 777, pl. 3, figs. 1–12; Akiba (1982a), p. 44, pl. 9, figs. 5–10; Koizumi (1982), p. 80, pl. 1, fig. 6; Tanimura (1992), p. 409, figs. 4-10–4-13.

Fragilariopsis separanda Hustedt (1958), p. 165, pl. 10, figs. 108–112; Zielinski and Gersonde (2002), p. 259, pl. 1, figs. 16, 17 (Pl. P6, figs. 59–64).

Synonym: *Nitzschia separanda* (Hustedt) Hasle (1965), pp. 26, 27, pl. 9, figs. 7–10; pl. 10, fig. 1; Fenner et al. (1976), p. 777, pl. 1, figs. 1–16; pl. 2, figs. 23–29; Akiba (1982a), p. 44, pl. 10, figs. 3–5, 9–11; Koizumi (1982), p. 80, pl. 1, figs. 3, 4; Tanimura (1992), p. 409, figs. 4-27–4-29.

Fragilariopsis sublinearis (Van Heurck) Heiden et Kolbe (1928), p. 554; Bohaty et al. (1998), pl. 1, figs. 15–17 (Pl. P7, figs. 1, 2).

Basionym: *Fragilaria sublinearis* Van Heurck (1909), p. 35, pl. 3, fig. 29.

Synonym: *Nitzschia sublinearis* (Van Heurck) Hasle of Akiba (1982a), p. 44, pl. 9, fig. 12; Tanimura (1992), p. 409, figs. 4-36–4-40.

Goniothecium rogersii Ehrenberg (1843), p. 416 (description); Ehrenberg (1854), pl. 18, figs. 92, 93 (illustrations) (Pl. P7, figs. 3, 4).

Basionym: See Suto et al. (2008) for synonymy and description of this taxon.

Grammatophora spp. (no illustrations).

Hemiaulus spp. (Pl. P7, figs. 5–12).

Hemidiscus cuneiformis Wallich (1860), p. 42, pl. 2, figs. 3, 4; Fenner et al. (1976), p. 774, pl. 11, fig. 17; Harwood and Maruyama (1992), p. 703, pl. 11, fig. 11; Censarek and Gersonde (2002), p. 352, pl. 4, fig. 5; Iwai and Winter (2002), p. 8, pl. P21, fig. 2; Zielinski and Gersonde (2002), p. 260, pl. 4, fig. 10; Suto et al. (2013), p. 33, pl. P2, figs. 9, 10 (Pl. P7, figs. 13–16).

Hemidiscus karstenii Jousé in Jousé et al. (1962), p. 78, pl. 2, figs. 7–9; McCollum (1975), p. 535, pl. 9, figs. 3, 4; Schrader (1976), p. 632, pl. 14, fig. 2; pl. 15, figs. 17, 18; Gombos (1977), p. 595, pl. 4, fig. 8; Ciesielski (1983), p. 656, pl. 3, fig. 6; pl. 4, figs. 2–5; Censarek and Gersonde (2002), p. 352, pl. 3, fig. 27; Iwai and Winter (2002), p. 8, pl. P21, fig. 5; Suto et al. (2013), p. 33, pl. P2, figs. 11–14 (Pl. P1, figs. 25, 26).

Hemidiscus triangularus (Jousé) Harwood et Maruyama (1992), p. 703; Censarek and Gersonde (2002), p. 352, pl. 4, figs. 1–4 (Pl. P1, figs. 5, 6).

Basionym: *Cosmiodiscus insignis* f. *triangula* Jousé (1977), pl. 79, fig. 2; Ciesielski (1983), p. 656, pl. 5, figs. 1–10; Ciesielski (1986), p. 876, pl. 4, figs. 5, 6; pl. 6, figs. 7, 8.

Hemidiscus sp. 1 of Zielinski and Gersonde (2002), p. 260, pl. 4, fig. 8; Suto et al. (2013), p. 33, pl. P2, figs. 15–18 (Pl. P7, figs. 17, 18).

Hyalodiscus spp. (Pl. P7, figs. 19, 20).

Koizumia adaroi (Azpeitia) Yanagisawa (1994a), pp. 600–602, 604, figs. 8-1–8-7, 8-12, 8-13; 9-1–9-3 (Pl. P7, figs. 21, 22).

Basionym: *Cymatosira adaroi* Azpeitia (1911), p. 201, pl. 9, fig. 5.

Synonym: See Yanagisawa (1994a).

Mediaria splendida f. *tenera* Schrader (1973), p. 706, pl. 3, fig. 13; Yanagisawa (1994b), pp. 419, 420, figs. 3-6–3-8, 8-1–8-7 (no illustrations).

Synonym: See Yanagisawa (1994b).

Navicula spp. (Pl. P7, figs. 23, 24).

Odontella sp.? (Pl. P7, figs. 25–30).

Opephora spp. (Pl. P7, figs. 31, 32).

Paralia sulcata (Ehrenberg) Cleve (1873), p. 7; Akiba (1986), p. 447, pl. 29, fig. 4, 5; Iwai and Winter (2002), p. 9, pl. P8, fig. 7; pl. P25, fig. 17; pl. P29, fig. 9; pl. P32, fig. 2; Arney et al. (2003), p. 9, pl. P1, fig. 5; Suto et al. (2013), p. 36, pl. P5, figs. 17–23 (Pl. P8, figs. 1–4).

Basionym: *Gaillonella sulcata* Ehrenberg (1838), p. 170, pl. 21, fig. 5.

Synonym: *Melosira sulcata* (Ehrenberg) Kützing (1844), p. 55, pl. 2, fig. 7.

Pleurosigma spp. (Pl. P8, figs. 5, 6).

Podosira spp. (Pl. P8, figs. 7, 8).

Proboscia alata (Brightwell) Sundström (1986), pp. 99, 100, figs. 258–266; Iwai and Winter (2002), p. 9, pl. P5, fig. 21; Suto et al. (2013), p. 33, pl. P3, figs. 51, 52 (Pl. P8, figs. 9–14).

Basionym: *Rhizosolenia alata* Brightwell (1858), p. 95, pl. 5, figs. 8, 8a; Fenner et al. (1976), p. 778, pl. 13, fig. 1; Akiba (1986), p. 444, pl. 18, fig. 6; Tanimura (1992), fig. 3-16; Harwood and Maruyama (1992), pl. 18, figs. 15, 17.

Proboscia barboi (Brun) Jordan et Priddle (1991), p. 56, figs. 1, 2; Harwood et al. (2000), p. 460, fig. 8d; Iwai and Winter (2002), p. 9; Suto et al. (2013), pp. 33, 34, pl. P3, figs. 53, 54 (Pl. P1, figs. 9, 10).

Basionym: *Pyxilla barboi* Brun (1894), p. 87, pl. 5, figs. 16, 17, 23; *Rhizosolenia barboi* (Brun) Tempère and Peragallo (1915), p. 26, no. 47; McCollum (1975), p. 535, pl. 11, fig. 13; Schrader (1976), p. 635, pl. 9, figs. 11–13; Akiba (1986), p. 444, pl. 18, fig. 2; Ciesielski (1986), p. 877, pl. 3, fig. 22; *Simonseniella barboi* (Brun) Fenner (1991), p. 108, pl. 3, figs. 1, 3; Harwood and Maruyama (1992), p. 706, pl. 11, fig. 13.

Proboscia curvirostris (Jousé) Jordan et Priddle (1991), p. 57, figs. 5–7; Suto et al. (2013), p. 34, pl. P3, figs. 55, 56 (no illustrations).

Basionym: *Rhizosolenia curvirostris* Jousé (1959), p. 48, pl. 2, fig. 17; Jousé (1968), p. 19, pl. 3, figs. 1–3; Akiba (1986), p. 444, pl. 18, fig. 3.

Psammodictyon panduriforme (Gregory) Mann in Round et al. (1990), p. 676 (no illustrations).

Basionym: *Nitzschia panduriformis* Gregory (1857), p. 57, pl. 6, fig. 102; Suto et al. (2013), p. 36, pl. P6, figs. 52–57; pl. P11, figs. 5, 6.

Pseudo-nitzschia heimii Manguin (1957), p. 131, pl. 6, fig. 43; Fenner et al. (1976), p. 776, pl. 3, figs. 21–23 (no illustrations).

Pseudo-nitzschia spp. (Pl. P8, figs. 15, 16).

Pseudopyxilla americana (Ehrenberg) Forti (1909), p. 28, pl. 1, fig. 6 not fig. 7; Proschkina-Lavrenko (1949), pp. 200, 201, pl. 98, figs. 4a, 4b not 4c; Sheshukova-Poretzkaya (1967), pp. 263, 264, pl. 39, figs. 2a, 2b; Hajós (1968), p. 137, pl. 38, fig. 4; Strelnikova (1974), p. 112, pl. 54, figs. 1–15; Barron (1975), pp. 151, 152, pl. 11, fig. 12; McCollum (1975), p. 535, pl. 10, fig. 11 not figs. 2, 3; Andrews (1976), pp. 19, 20, pl. 6, figs. 11, 12 not figs. 9, 10; Schrader and Fenner (1976), p. 994, pl. 9, fig. 7; Andrews (1980), p. 33, pl. 3, fig. 6; Abbott and Ernissee (1983), p. 302, pl. 15, fig. 7; Hajós (1986), pl. 28, fig. 15; Baldauf and Barron (1987), p. 7, pl. 11, fig. 12; Harwood et al. (1989), pl. 3, fig. 20; Lee (1993), p. 43, pl. 2, fig. 9; Harwood and Bohaty (2001), p. 329, pl. 1, fig. 26; Gladenkov (2003), p. 46, pl. 7, fig. 4 (Pl. P8, figs. 17, 18).

Basionym: *Rhizosolenia americana* Ehrenberg (1854), pl. 18, figs. 98b, 98d not figs. 98a, 98c, 98e–98i.

Synonym: *Pyxilla americana* (Ehrenberg) Grunow in Van Heurck (1880–1885), pl. 83, figs. 1–3; Pantocsek (1903), p. 45, pl. 28, fig. 283; Hanna (1970), p. 192, fig. 61; *Pseudopyxilla capreolus* Forti (1909), p. 16, pl. 1, fig. 4; Proschkina-Lavrenko (1949), p. 201, pl. 98, figs. 5a–5c; *Pseudopyxilla capreolus* var. *gracilior* Forti (1909), p. 17, pl. 1, fig. 5.

Remarks: *Pyxilla americana* in Van Heurck (1880–1885, pl. 83, figs. 1–3), Pantocsek (1903, p. 45, pl. 28, fig. 283) and Hanna (1970, p. 192, fig. 61), *Pseudopyxilla capreolus* in Forti (1909, p. 16, pl. 1, fig. 4) and Proschkina-Lavrenko (1949, p. 201, pl. 98, figs. 5a–5c), and *Pseudopyxilla capreolus* var. *gracilior* Forti (1909, p. 17, pl. 1, fig. 5) are synonym of *Pseudopyxilla americana* because these specimens possess the branching process on the top of conical valve.

Rhizosolenia americana in Ehrenberg (1854, pl. 18, figs. 98a, 98h, 98i), and *Pseudopyxilla americana* in Forti (1909, pl. 1, fig. 7), Proschkina-Lavrenko (1949, pl. 98, fig. 4c) and Hajós and Stradner (1975, p. 933, pl. 12, fig. 3) belong to *Pseudopyxilla dubia* (Grunow in Van Heurck) Forti because the cylindrical and convex valve without branching process.

The specimens of *Rhizosolenia americana* in Ehrenberg (1854, pl. 18, figs. 98c, 98g), McCollum (1975, pl. 10, figs. 2, 3) and Andrews (1976, pl. 6, figs. 9, 10), *Pyxilla americana* in Hasegawa (1977, p. 86, pl. 26, fig. 10), and *Pseudopyxilla americana* in Abbott and Andrews (1979, p. 249, pl. 5, fig. 6) are identified as *Pseudopyxilla directa* (Pantocsek) Forti because of their cylindrical and conical valve with slender hyaline process (see also Suto et al., 2009).

Pterotheca aculeifera (Grunow in Van Heurck) Van Heurck (1880–1885), pl. 83 bis, fig. 5; Suto et al. (2009), pp. 282, 284, 286, pl. 9, figs. 1–47 (Pl. P8, figs. 19, 20).

Synonym: See Suto et al. (2009).

Rhaphoneis amphiceros (Ehrenberg) Ehrenberg (1844b), p. 87; Akiba (1986), p. 447, pl. 20, fig. 19; Ciesielski (1986), p. 877, pl. 6, figs. 1–3; Suto et al. (2013), p. 36, pl. P6, figs. 58–63 (no illustrations).

Basionym: *Cocconeis amphiceros* Ehrenberg (1840a), p. 206.

Rhaphoneis spp. (no illustrations).

Rhizosolenia hebetata Bailey (1856), p. 5, pl. 1, figs. 18, 19; Suto et al. (2013), p. 34, pl. P3, figs. 63–68 (Pl. P8, figs. 21, 22).

Rhizosolenia polydactyla Castracane (1886a), p. 71, pl. 24, fig. 2; Suto et al. (2013), p. 34, pl. P3, figs. 69–74 (Pl. P8, figs. 23–26).

Synonym: *Rhizosolenia styliformis* Brightwell of Schrader (1976), p. 635, pl. 9, fig. 4; Fenner et al. (1976), p. 779, pl. 13, figs. 3–5, 9; Akiba (1982a), p. 44, pl. 7, fig. 3

not fig. 4; Harwood and Maruyama (1992), p. 705, pl. 18, fig. 20; Mahood and Barron (1996b), p. 292, pl. 1, fig. 7; pl. 7, figs. 4, 6; Iwai and Winter (2002), p. 10, pl. P7, figs. 1–3; pl. P28, figs. 18, 19. See also Armand and Zielinski (2001) and Suto et al. (2013).

Rocella praenitida (Fenner) Fenner in Kim et Barron (1986), p. 177, pl. 4, fig. 3; Harwood and Maruyama (1992), p. 705, pl. 4, figs. 1–5; Arney et al. (2003), p. 9, pl. P4, fig. 5 (Pl. **P8**, figs. 27, 28).

Basionym: *Coscinodiscus praenitidus* Fenner in Schrader et Fenner (1976), p. 972, pl. 14, figs. 7–9, 12; pl. 27, fig. 8; pl. 35, fig. 24; pl. 36, fig. 5; Gombos and Ciesielski (1983), p. 601, pl. 22, figs. 4, 5; Ciesielski (1986), p. 876, pl. 6, fig. 11.

Rouxia constricta Zielinski et Gersonde (2002), p. 251, pl. 2, figs. 11–19; Zielinski et al. (2002), pl. 1, figs. 8–14 (Pl. **P8**, figs. 29, 30).

Rouxia diploneides Schrader (1973), p. 710, pl. 3, figs. 24, 25; McCollum (1975), p. 535, pl. 11, figs. 11, 12; Harwood and Maruyama (1992), p. 705, pl. 17, fig. 12; Iwai and Winter (2002), p. 10, pl. P5, fig. 8 (Pl. **P1**, figs. 11, 12).

Rouxia leventerae Bohaty et al. (1998), pp. 444, 445, pl. 1, figs. 1–6; Zielinski and Gersonde (2002), p. 261, pl. 2, figs. 1–7; Zielinski et al. (2002), pl. 1; figs. 1–7 (Pl. **P8**, figs. 31, 32).

Rouxia naviculoides Schrader (1973), p. 710, pl. 3, figs. 27–32; McCollum (1975), p. 535, pl. 11, figs. 14, 15; Schrader (1976), p. 636, pl. 5, figs. 13, 18; Gombos (1977), p. 597, pl. 7, figs. 10, 11; Gersonde and Burckle (1990), p. 782, pl. 4, fig. 16; Harwood et al. (2000), p. 460, fig. 9r; Iwai and Winter (2002), p. 10, pl. P5, figs. 1, 2; Zielinski and Gersonde (2002), p. 261, pl. 2, figs. 8, 9 (Pl. **P8**, figs. 33, 34).

Shionodiscus gracilis (Karsten) Alverson et al. (2006), p. 259 (Pl. **P1**, figs. 21, 22).

Basionym: *Coscinodiscus gracilis* Karsten (1905), p. 78, pl. 3, fig. 4.

Synonym: *Thalassiosira gracilis* (Karsten) Hustedt (1958), pp. 109, 110, pl. 3, figs. 4–7; Fenner et al. (1976), p. 780, pl. 9, figs. 12–20; Akiba (1982a), p. 46, pl. 4, figs. 11a–12; Koizumi (1982), p. 81, pl. 2, figs. 4, 5; Tanimura (1992), p. 409, figs. 3-3–3-6; Iwai and Winter (2002), p. 12, pl. P12, fig. 4; pl. P24, fig. 2; Suto et al. (2013), p. 34, pl. P2, figs. 26, 27.

Shionodiscus oestrupii (Ostenfeld) Alverson et al. (2006), p. 258 (Pl. **P9**, figs. 1–6).

Basionym: *Coscinosira oestrupii* Ostenfeld (1900), p. 52.

Synonym: *Thalassiosira oestrupii* (Ostenfeld) Proschkina-Lavrenko ex Hasle (1960), p. 8, pl. 1, figs. 5, 7, 11; Hasle (1972b), p. 544; Fenner et al. (1976), p. 780, pl. 9, figs. 1–11; Gombos (1977), p. 598, pl. 5, figs. 1, 2; Akiba (1982a), p. 46, pl. 4, figs. 2a, 2b, 8–10; Koizumi (1982), p. 81, pl. 2, figs. 1–3; Akiba (1986), p. 446, pl. 14, figs. 1–6; Gersonde and Burckle (1990), p. 782, pl. 3, figs. 13, 14; Harwood and Maruyama (1992), p. 708, pl. 16, figs. 5–7; Bohaty et al. (1998), pl. 2, fig. 3; Censarek and Gersonde (2002), p. 353, pl. 5, figs. 9, 10; Iwai and Winter (2002), p. 13, pl. P26, figs. 6a, 6b; Suto et al. (2013), p. 35, pl. P4, figs. 1–10.

Shionodiscus tetraoestrupii (Bodén) Alverson et al. (2006), p. 260 (Pl. **P9**, figs. 7, 8).

Basionym: *Thalassiosira tetraoestrupii* Bodén (1993), pp. 63, 67, pl. 1, figs. A–G; pl. 2, figs. A, B, H, J; Mahood and Barron (1995), figs. 9–19, 25, 26, 28–46; Mahood and Barron (1996b), p. 296; Iwai and Winter (2002), p. 13, pl. P16, figs. 8, 9; pl. P27, fig. 7.

Shionodiscus tetraoestrupii var. *reimeri* (Mahood et Barron) Alverson et al. (2006), p. 260 (Pl. **P1**, figs. 3, 4).

Basionym: *Thalassiosira tetraoestrupii* var. *reimeri* Mahood et Barron (1995), p. 2, figs. 1–8, 20–24, 27; Mahood and Barron (1996b), p. 296, pl. 4, figs. 6a–7; pl. 8, figs. 9–12; Zielinski and Gersonde (2002), p. 264, pl. 5, figs. 6–9.

Synonym: *Coscinodiscus donahue* Mukhina in Jousé (1977), pl. 79, fig. 6 not figs. 3–5, 8.

Stellarima spp. (no illustrations).

Stephanogonia hanzawae Kanaya (1959), pp. 118, 119, pl. 11, figs. 3a–7; McCollum (1975), p. 535, pl. 12, fig. 6; Arney et al. (2003), p. 10, pl. P1, fig. 12 (no illustrations).

Synonym: *Stephanogonia* sp. in Iwai and Winter (2002), p. 10, pl. P8, figs. 3, 4; pl. P31, fig. 3.

Stephanopyxis spp. (Pl. **P9**, figs. 9–18).

Synedropsis recta Hasle et al. (1994), p. 252, figs. 27–30, 51–55, 57–60, 68–75, 142c (Pl. **P9**, figs. 19–22).

Tetracyclus sp. (Pl. **P9**, figs. 23, 24).

Thalassionema nitzschioides (Grunow) Mereschkowsky (1902), p. 78; Akiba (1982a), p. 45, pl. 8, figs. 15a–18; Akiba (1986), p. 445, pl. 21, figs. 11, 19; Suto et al. (2013), p. 36, pl. P8, figs. 35–48 (Pl. **P9**, figs. 25–40).

Basionym: *Synedra nitzschioides* Grunow (1862), p. 403, pl. 5/8, fig. 18.

Synonym: *Thalassionema nitzschioides* (Grunow) Van Heurck (1896), p. 319, fig. 75; Ciesielski (1986), p. 877, pl. 3, fig. 17; Iwai and Winter (2002), p. 11, pl. P5, fig. 18.

Thalassionema sp. A (Pl. **P10**, figs. 1–10).

Remarks: The valve of this taxon possesses slender and linear outline with slightly compressed and rounded ends that can easily be separated from other *Thalassionema* taxa with broadly rounded ends to lanceolate with subcapitate ends such as *Thalassionema nitzschioides* complex (Tanimura et al., 2007) and *Thalassionema schraderi* (Akiba, 1982b). The stratigraphic occurrence in Hole U1371D ranges from Samples 329-U1371D-9H-7W, 58–59 cm to 6H-6W, 81–82 cm (82.98–53.71 m CSF-A) with a distinct peak, where it comprises over 50% of diatom assemblage, at Sample 9H-1W, 92–93 cm (74.82 m CSF-A) (Fig. **F2**; Table **T1**). The high occurrence may correspond to the *Thalassionema* increasing event in 5.7, 5.2–4.7 and 4.4–3.7 Ma reported from the Antarctic Peninsula's Pacific margin by Bart and Iwai (2012), although the taxa are differentiated. This taxon is potentially useful for diatom biostratigraphy, because it is relatively short-ranging with specific characteristics that allow for easy identification in practical stratigraphic analysis.

Thalassionema spp. (Pl. **P9**, figs. 41–44).

Thalassiosira complicata Gersonde (1991), pp. 150, 151, pl. 3, figs. 1, 2; pl. 5, figs. 18–20; pl. 6, figs. 1–6; pl. 7, figs. 1–5; Gersonde and Burckle (1990), p. 782, pl. 4, figs. 1, 2; Harwood and Maruyama (1992), p. 707, pl. 14, figs. 18–21; Iwai and Winter (2002), pp. 11, 12, pl. P11, figs. 1–9; pl. P12, fig. 1; pl. P26, fig. 3; Zielinski and Gersonde (2002), p. 263, pl. 4, figs. 3, 4 (Pl. **P10,** figs. 11, 12).

Thalassiosira eccentrica (Ehrenberg) Cleve emend. Fryxell et Hasle (1972), p. 302, figs. 1–18; Fenner et al. (1976), p. 779, pl. 10, figs. 1, 2, 4, 5; Akiba (1986), p. 445, pl. 14, fig. 13; Bohaty et al. (2003), p. 25, pl. P1, fig. 6; Suto et al. (2013), p. 34, pl. P2, figs. 21–23 (Pl. **P10,** figs. 13–16).

Basionym: *Coscinodiscus eccentricus* Ehrenberg (1840b), p. 146.

Thalassiosira fasciculata Harwood et Maruyama (1992), p. 707, pl. 15, figs. 4–6; Mahood and Barron (1996a), pp. 287, 289, 291, figs. 15–24, 27, 28; Zielinski and Gersonde (2002), p. 263, pl. 5, figs. 3, 4 (Pl. **P10,** figs. 17–20).

Synonym: *Coscinodiscus bullatus* Janisch of Hustedt (1958), figs. 26–28.

Thalassiosira insigna (Jousé) Harwood et Maruyama (1992), p. 707, pl. 14, figs. 3–5; Zielinski and Gersonde (2002), p. 264, pl. 5, figs. 14, 15; Bohaty et al. (2003), p. 26, pl. P1, fig. 4 (Pl. **P1,** figs. 7, 8).

Basionym: *Cosmiodiscus insignis* Jousé (1959), pl. 4, fig. 9; McCollum (1975), p. 527, pl. 8, fig. 5; Gombos (1977), p. 593, pl. 4, figs. 4, 5; Ciesielski (1986), p. 876, pl. 1, figs. 1–5.

Thalassiosira inura Gersonde (1991), p. 151, pl. 6, figs. 7–14; pl. 8, figs. 1–6; Gersonde and Burckle (1990), p. 782, pl. 3, figs. 15–17; pl. 5, fig. 14; Harwood and Maruyama (1992), p. 707, pl. 5, fig. 14; pl. 14, figs. 12–16; Bohaty et al. (1998), pl. 4, fig. 8; Harwood et al. (2000), p. 460, fig. 7b; Censarek and Gersonde (2002), p. 353, pl. 4, figs. 11, 12; Iwai and Winter (2002), p. 12, pl. P12, figs. 2, 3; pl. P26, figs. 8, 9; pl. P27, fig. 3; Zielinski and Gersonde (2002), p. 264, pl. 5, figs. 12, 13 (Pl. **P1,** figs. 23, 24).

Synonym: *Cestodiscus*? sp. of Gombos (1977), pl. 5, fig. 8; *Thalassiosira gracilis* of McCollum (1975), p. 536, pl. 14, fig. 3.

Thalassiosira kolbei (Jousé) Gersonde (1990), p. 793, pl. 1, fig. 2; pl. 5, figs. 3, 5, 6; Gersonde and Burckle (1990), p. 782, pl. 3, fig. 1; Mahood and Barron (1996b), p. 294, pl. 4, figs. 1, 2; pl. 8, figs. 1a, 1b; Zielinski and Gersonde (2002), p. 264, pl. 5, fig. 2 (Pl. **P10,** figs. 21, 22).

Basionym: *Coscinodiscus kolbei* Jousé in Jousé et al. (1962), p. 73, pl. 1, figs. 7–9; McCollum (1975), p. 527, pl. 4, figs. 7–9; Gombos (1977), p. 593, pl. 6, fig. 3; Ciesielski (1986), p. 875, pl. 4, figs. 1–4.

Thalassiosira lentiginosa (Janisch in Schmidt) Fryxell (1977), p. 103, figs. 13a–13d, 14a–14d; Harwood and Maruyama (1992), p. 707, pl. 19, fig. 15; Tanimura (1992), p. 409, figs. 3-1, 3-9; 5-1, 5-2; Mahood and Barron (1996b), p. 294, pl. 4, figs. 4a-5; pl. 8, figs. 2a, 2b; Bohaty et al. (1998), pl. 3, fig. 3; Iwai and Winter (2002), p. 13, pl. P20, figs. 1, 4; pl. P24, fig. 4; Suto et al. (2013), p. 35, pl. P2, figs. 28, 29 (Pl. **P11,** figs. 1, 2).

Basionym: *Coscinodiscus lentiginosus* Janisch in Schmidt (1874–1959), pl. 58, fig. 11; McCollum (1975), p. 527, pl. 5, fig. 1; Fenner et al. (1976), p. 773, pl. 7, figs. 4–6; Gombos (1977), p. 593, pl. 3, figs. 4, 5.

Thalassiosira lineata Jousé (1968), p. 13, pl. 1, figs. 1, 2; Fenner et al. (1976), p. 780, pl. 11, figs. 8–10; Akiba (1982a), p. 46, pl. 4, figs. 3, 4; Akiba (1986), p. 446, pl. 14, figs. 7, 9; Suto et al. (2013), p. 35, pl. P2, figs. 30–33 (no illustrations).

Thalassiosira cf. *nativa* Sheshukova-Poretzkaya (1959), p. 41, pl. 1, fig. 8; pl. 4, fig. 5; Schrader (1976), p. 636, pl. 12, figs. 8–11; Baldauf and Barron (1991), p. 591, pl. 6, fig. 5; Iwai and Winter (2002), p. 13, pl. P19, fig. 9, 10 (Pl. **P11,** figs. 3, 4).

Thalassiosira nordenskioeldii Cleve (1873), p. 7, pl. 1, fig. 1; Gombos (1977), p. 598, pl. 4, figs. 6, 7; Akiba (1986), p. 446, pl. 5, fig. 8 (no illustrations).

Thalassiosira oliverana (O'Meara) Sournia in Sournia et al. (1979), p. 191, figs. 8, 9; Harwood and Maruyama (1992), p. 708, pl. 14, figs. 1, 2, 6, 11, 17; Mahood and Barron (1996b), p. 296, pl. 5, figs. 1–3; pl. 8, figs. 3–4; Harwood et al. (2000), p. 460, fig. 7c; Suto et al. (2013), p. 35, pl. P4, figs. 31, 32 (Pl. **P11,** figs. 5, 6).

Basionym: *Actinocyclus oliveranus* O'Meara (1877), p. 58, pl. 1, fig. 7.

Synonym: *Schimperiella antarctica* (Grunow) Karsten (1905), p. 88, pl. 8, figs. 6a, 6b; Fenner et al. (1976), p. 779, pl. 14, figs. 1–5; Akiba (1982a), p. 45, pl. 3, figs. 1–6; Koizumi (1982), p. 81, pl. 3, figs. 1–4; Tanimura (1992), figs. 3-7a, 3-7b; *Thalassiosira oliverana* (O'Meara) Makarova et Nikolaev (1984), p. 89, pl. 1, figs. 1–11; pl. 2, figs. 1–11; Iwai and Winter (2002), p. 13, pl. P14, figs. 1, 2; pl. P33, fig. 8; Zielinski and Gersonde (2002), p. 264.

Thalassiosira oliverana var. *sparsa* Harwood et Maruyama (1992), p. 708, pl. 16, fig. 13; Censarek and Gersonde (2002), p. 353, pl. 5, figs. 1, 2; Iwai and Winter (2002), p. 13, pl. P14, fig. 4; pl. P33, fig. 9 (Pl. **P11,** figs. 7, 8).

Basionym: *Coscinodiscus* (*Cestodiscus*) *intersectus* Brun (1891), p. 22, pl. 20, fig. 5.

Synonym: *Cosmiodiscus intersectus* (Brun) Jousé (1959), pl. 2, figs. 3, 4; McCollum (1975), p. 527, pl. 8, fig. 4; Schrader (1976), p. 631, pl. 12, fig. 13; Gersonde and Burckle (1990), p. 780, pl. 4, fig. 13; Baldauf and Barron (1991), p. 588, pl. 6, figs. 3, 6.

Thalassiosira striata Harwood et Maruyama (1992), p. 708, pl. 15, figs. 7–9; Iwai and Winter (2002), p. 13, pl. P15, fig. 4; pl. P27, fig. 2; Zielinski and Gersonde (2002), p. 264, pl. 4, fig. 7; Suto et al. (2013), p. 35, pl. P4, figs. 11, 12 (Pl. **P11,** figs. 9, 10).

Thalassiosira cf. *symmetrica* Fryxell et Hasle (1972), p. 312, figs. 37–46; Fenner et al. (1976), p. 780, pl. 11, figs. 1–3 (Pl. **P11,** figs. 11, 12).

Thalassiosira tumida (Janisch) Hasle in Hasle et al. (1971), pp. 326, 328, figs. 1–43, 46; Fenner et al. (1976), p. 780, pl. 10, figs. 6, 7; Akiba (1982a), p. 46, pl. 4, figs. 1a, 1b; Bohaty et al. (1998), pl. 2, fig. 1 (Pl. **P11,** figs. 13, 14).

Basionym: *Coscinodiscus tumidus* Janisch in Schmidt (1874–1959), pl. 59, figs. 38, 39.

Thalassiosira vulnifica (Gombos) Fenner (1991), p. 108, pl. 2, fig. 2; Harwood and Maruyama (1992), p. 702, pl. 15, fig. 1; emend. Mahood et Barron (1996a), pp. 285, 287, figs. 1–14, 25, 26; Iwai and Winter (1992), p. 708, pl. P15, fig. 1; Zielinski and Gersonde (2002), p. 264, pl. 5, figs. 10, 11 (Pl. **P11,** figs. 15, 16).

Basionym: *Coscinodiscus vulnificus* Gombos (1977), p. 593, pl. 4, figs. 1–3; pl. 42, figs. 1, 2; Ciesielski (1983), p. 656, pl. 6, figs. 7, 8.

Synonym: *Coscinodiscus* sp. 2 of McCollum (1975), p. 527, pl. 8, figs. 1, 2.

Thalassiosira yabei (Kanaya) Akiba et Yanagisawa (1986), p. 493, pl. 27, figs. 1, 2; pl. 28, figs. 1–9; Akiba (1986), p. 446, pl. 7, figs. 5, 6 (Pl. **P11,** figs. 17, 18).

Basionym: *Coscinodiscus yabei* Kanaya (1959), p. 86, pl. 5, figs. 6–9; Ciesielski (1986), p. 876, pl. 4, figs. 7–10.

Thalassiosira spp. (no illustrations).

Thalassiothrix longissima Cleve et Grunow (1880), p. 108; Schrader (1976), p. 637, pl. 1, figs. 5, 6, 17; Fenner et al. (1976), p. 781; Akiba (1982a), p. 46, pl. 8, fig. 19; Akiba (1986), p. 447, pl. 21, fig. 18; Harwood and Maruyama (1992), p. 708, pl. 11, fig. 12; Suto et al. (2013), p. 35, pl. P3, figs. 75–78 (Pl. **P11,** figs. 19–22).

Triceratium spp. (Pl. **P11,** figs. 23–39).

Coastal upwelling indicator, resting spores of *Chaetoceros*

Coronodiscus collarius Suto (2004a), p. 96, figs. 2A, 5–35; Suto et al. (2013), p. 36, pl. P10, figs. 1, 2; pl. P12, fig. 1 (Pl. **P12,** figs. 1, 2).

Dicladia capreola Ehrenberg (1854), pl. 35A, fig. 8; Van Heurck (1880–1885), pl. 106, figs. 15, 16 (not fig. 14); Van Heurck (1896), p. 426, fig. 144; Kanaya (1959), p. 117, pl. 11, figs. 1, 2; Sheshukova-Poretzkaya (1967), p. 213, pl. 34, figs. 1a–1c; Hanna (1970), p. 188, fig. 63; Lohman (1974), p. 351, pl. 5, fig. 10; Abbott and Andrews (1979), p. 243, pl. 4, fig. 5; pl. 7, fig. 7; Suto (2003), pp. 337, 339, figs. 1B, 17–30, 124, 125; Suto (2005a), p. 359, fig. 2B; Suto et al. (2013), p. 36, pl. P10, figs. 3–6 (Pl. **P12,** figs. 3, 4).

Synonym: *Chaetoceros (Dicladia) lorenzianus* Grunow (1863), p. 157, pl. 5, fig. 13; Frenguelli (1949), p. 139, pl. 4, figs. 23, 24; Proschkina-Lavrenko (1949), p. 139, pl. 47, fig. 4b; Jousé (1977), pl. 24, fig. 17; Andrews (1980), p. 26, pl. 1, fig. 13; Gersonde (1980), p. 300, pl. 16, fig. 12; Harwood and Maruyama (1992), pl. 18, figs. 11, 18, 19; Lee (1993), p. 34, pl. 3, fig. 28; *Chaetoceros dicladia* Castracane (1886a), p. 82, pl. 8, fig. 1; pl. 19, figs. 7, 8; Barron (1975), p. 128, pl. 5, fig. 7; Lee (1993), p. 33, pl. 2, figs. 5, 6, 27?; pl. 3, fig. 29; *Dicladia mitra* Bailey of Van Heurck (1880–1885), pl. 106, fig. 13; *Dicladia pylea* Hanna et Grant (1926), p. 142, pl. 16, figs. 4, 5; Schrader (1973), pl. 17, figs. 1–3; Hasegawa (1977), p. 85, pl. 21, figs. 5a, 5b; pl. 12, figs. 12a, 12b; pl. 27, figs. 17a, 17b; *Chaetoceros mitra* (Bailey) Cleve of Winter (2001), p. 9, pl. P6, fig. 7.

Dispinodiscus pilusus var. *montanus* Suto (2004b), pp. 87, 89, figs. 1M–1R, 45–56; Suto et al. (2013), p. 36, pl. P10, figs. 11–16; pl. P12, fig. 2 (no illustrations).

Synonym: Resting spore 1 of Hasegawa (1977), p. 91, pl. 23, fig. 9; Resting spore of Stockwell (1991), pl. 1, figs. 3, 4; *Chaetoceros* cf. sp. 1 of Homann (1991), p. 76, pl. 9, figs. 1, 9; *Chaetoceros* sp. of Bohaty et al. (1998), pl. 5, fig. 7.

Dispinodiscus pilusus var. *pilusus* Suto (2004b), pp. 81, 87, figs. 1A–1I, 57–88; Suto et al. (2013), p. 36, pl. P10, figs. 17, 18 (Pl. **P12,** figs. 5, 6).

Synonym: *Chaetoceros debilis* Cleve of Jousé (1977), pl. 2, fig. 14; Resting spore 2 of Hasegawa (1977), p. 91, pl. 23, fig. 10; *Chaetoceros* sp. of Bohaty et al. (1998), pl. 5, fig. 6; *Xanthiopyxis* sp. of Fenner (1995), p. 79, pl. 4, fig. 8; Resting spore of Takahashi et al. (2003), figs. 7-26, 7-27.

Dispinodiscus stimulus Suto (2004b), pp. 80, 81, figs. 1J–1L, 6–31, 43, 44; Suto et al. (2013), p. 36, pl. P10, figs. 19–24e (no illustrations).

Synonym: *Chaetoceros* sp. of Fenner (1978), p. 513, pl. 34, figs. 7, 10.

Dispinodiscus sp. A (Pl. **P12,** figs. 7, 8).

Gemellodiscus bifurcus Suto (2004c), p. 269, figs. 2.F, 2.G, 10.1–10.25; Suto et al. (2013), p. 37, pl. P10, figs. 25–34; pl. P12, fig. 3 (Pl. **P12,** figs. 9, 10).

Synonym: *Chaetoceros furcellatus* Bailey of Sheshukova-Poretzkaya (1967), p. 205, pl. 33, fig. 8; Hajós (1968), p. 129, pl. 34, fig. 2; Gleser et al. (1974), pl. 58, fig. 3; pl. 88, fig. 4; Shirshov (1977), pl. 2, fig. 17; Sancetta (1982), pl. 2, figs. 7, 9; Lee (1993), p. 33, pl. 1, fig. 11; *Chaetoceros* sp. IV of Hajós (1968), p. 130, pl. 34, fig. 10; *Chaetoceros septentrionalis* Oestrup of Sancetta (1982), pl. 2, fig. 8; *Chaetoceros didymus* Ehrenberg of Whiting and Schrader (1985b), pl. 5, fig. 4.

Gemellodiscus cingulus var. *cingulus* Suto (2004c), p. 267, figs. 2.C, 2.D, 8.1–8.10, 8.15; Suto et al. (2013), p. 37, pl. P10, figs. 35, 36 (Pl. **P12,** figs. 11, 12).

Synonym: *Chaetoceros cinctus* Gran of Sheshukova-Poretzkaya (1967), p. 206, pl. 33, fig. 9; Gleser et al. (1974), pl. 54, figs. 1a, 1b; pl. 80, fig. 6 not pl. 48, fig. 7; *Chaetoceros incurvus* Bailey of Sheshukova-Poretzkaya (1967), p. 207, pl. 8, fig. 8; pl. 33, fig. 10; *Chaetoceros didymus* Ehrenberg of Hanna (1970), p. 182, figs. 62, 98 not fig. 97.

Gemellodiscus cingulus var. *longus* Suto (2004c), pp. 267, 269, figs. 2.E, 8.11–8.14; 9.1–9.15 (no illustrations).

Synonym: *Chaetoceros cinctus* Gran of Hajós (1968), p. 129, pl. 33, figs. 18, 19; pl. 34, fig. 1; Schrader (1973), pl. 17, figs. 14, 15; Gleser et al. (1974), pl. 48, fig. 7; pl. 80, fig. 6 not pl. 54, figs. 1a, 1b; Hasegawa (1977), p. 81, pl. 23, fig. 16; Jousé (1977), pl. 24, fig. 15; Lee (1993), p. 32, pl. 1, fig. 13; *Chaetoceros* spores (cf. *radicans*) of Whiting and Schrader (1985b), pl. 5, fig. 2 not fig. 3; *Chaetoceros* sp. B of Lee (1993), p. 37, pl. 1, fig. 10.

Gemellodiscus geminus Suto (2004c), p. 278, figs. 2.N, 14.5–14.9, 16.1–16.24 (Pl. **P12,** figs. 13, 14).

Synonym: *Chaetoceros didymus* Ehrenberg of Makarova (1962), p. 50, pl. 4, figs. 7–14; Hanna (1970), p. 182, fig. 97

not figs. 62, 98; Jousé (1977), pl. 24, figs. 10, 11; Harwood and Bohaty (2000), p. 91, pl. 2, figs. j, k; *Chaetoceros* sp. V of Hajós (1968), p. 131, pl. 34, fig. 14; *Chaetoceros debilis* Cleve of Schrader (1973), pl. 17, figs. 12, 13; *Chaetoceros* sp. of Schrader and Fenner (1976), p. 968, pl. 6, fig. 15; pl. 38, figs. 5, 7 not fig. 6; Barron and Mahood (1993), p. 38, pl. 6, figs. 3, 4.

Gemellodiscus hirtus Suto (2004c), p. 269, figs. 2.H, 10.26–10.31 (no illustrations).

Gemellodiscus micronodosus Suto (2004c), figs. 2.J–2.M, 12.1–12.14, 14.1 (no illustrations).

Hypovalves of *Gemellodiscus caveatus* and *Gemellodiscus micronodosus* of Suto (2004c), pp. 271, 278, figs. 2.M, 13.1–13.14, 14.4; Suto et al. (2013), p. 37, pl. P10, figs. 37, 38 (see also Suto, 2004d) (no illustrations).

Same type hypovalve: *Xanthiopyxis* sp. A of Lee (1993), p. 46, pl. 2, fig. 14.

Liradiscus castaneus var. *castaneus* Suto (2007), p. 146, figs. 2H–2J; pl. 2, figs. 1a–3c, 7a, 7b, 14a, 14b; Suto et al. (2013), p. 37, pl. P10, figs. 39–46; pl. P12, fig. 4 (Pl. P12, figs. 15–18).

Liradiscus castaneus? (Pl. P12, figs. 19–26)

Liradiscus japonicus Suto (2004e), pp. 69–70, figs. 2L, 2M; pl. 3, figs. 1a–10; Suto (2007), p. 150, figs. 3G, 3H; Suto et al. (2013), p. 37, pl. P10, figs. 47, 48 (Pl. P12, figs. 27, 28).

Liradiscus pacificus Suto (2004e), p. 70, figs. 2P, 2Q; pl. 3, figs. 11a–15; Suto (2007), p. 150, figs. 3O, 3P; Suto et al. (2013), p. 37, pl. P10, figs. 49, 50 (no illustrations).

Synonym: *Liradiscus ovalis* Greville of Andrews (1976), p. 16, pl. 5, figs. 6–7.

Liradiscus petasus Suto (2004e), p. 70, figs. 2N, 2O; pl. 2, figs. 26a-35; Suto (2007), p. 150, figs. 3I, 3J; pl. 3, figs. 10a–13b (Pl. P12, figs. 29, 30).

Liradiscus plicatulus Hajós (1968), p. 114, pl. 28, fig. 10; Suto (2004e), p. 66, figs. 2F, 2G; pl. 2, figs. 1a–20b; Suto (2007), p. 150, figs. 3A, 3B; Suto et al. (2013), p. 37, pl. P10, figs. 51–54; pl. P12, fig. 5 (Pl. P12, figs. 31–34).

Quadrocistella paliesa Suto (2006a), p. 17, fig. 2L; pl. 6, figs. 1–24 (Pl. P12, figs. 35, 36).

Synonym: *Chaetoceros*? sp. VI of Hajós (1968), p. 131, pl. 34, figs. 12, 13.

Quadrocistella palmesa Suto (2006a), p. 20, fig. 2N; pl. 5, figs. 18–23 (no illustrations).

Quadrocistella rectagonuma Suto (2006a), p. 17, fig. 2J; pl. 5, figs. 1–13; Suto et al. (2013), p. 37, pl. P10, figs. 57–62; pl. P12, fig. 6 (no illustrations).

Quadrocistella sp. A (Pl. P12, figs. 37–40).

Syndendrium altantemna Suto (2005a), p. 369, figs. 2M, 94–107, 117 (Pl. P13, figs. 1, 2).

Syndendrium diadema Ehrenberg (1854), pl. 35A, group 18, fig. 13; Van Heurck (1896), p. 427, fig. 146; Lohman (1974), p. 350, pl. 5, fig. 13; Suto (2003), pp. 342, 348, 349, figs. 1G, 76–93, 122; Suto (2005a), p. 365, fig. 2H; Suto et al. (2013), p. 37, pl. P10, figs. 63–74 (Pl. P13, figs. 3, 4).

Synonym: *Chaetoceros diadema* (Ehrenberg) Gran (1897), p. 20, pl. 2, figs. 16–18; Frenguelli (1949), p. 140, pl. 4, figs. 33–35; Barron (1975), p. 128, pl. 5, fig. 5; Gersonde (1980), p. 299, pl. 16, fig. 9; Winter (2001), p. 9, pl. P6, fig. 4; *Chaetoceros subsecundus* (Grunow) Hustedt (1927–1930), p. 790, fig. 404; Makarova (1962), p. 48, pl. 3, figs. 6–10; Schrader (1973), pl. 17, figs. 4, 8; Gleser et al. (1974), pl. 88, fig. 5; Jousé (1977), pl. 24, fig. 9; Sancetta (1982), p. 227, pl. 2, figs. 5, 6; Lee (1993), p. 36, pl. 1, figs. 2–4; pl. 3, fig. 18.

Truncatulus tortonicus (Hajós) Suto (2006c), p. 598, figs. 8, 108–140 (Pl. P13, figs. 5–10).

Basionym: *Chasea tortonica* Hajós (1968), p. 117, pl. 28, figs. 18, 19; Hajós (1986), pl. 49, figs. 6–8.

Vallodiscus chinchae (Mereschkowski) Suto (2005b), pp. 22, 24, figs. 2G–2I, 69–87 (Pl. P13, figs. 11, 12).

Basionym: *Chaetoceros chinchae* Mereschkowsky (1889), pp. 483, 484, pl. 16, figs. 3–7.

Synonym: *Chaetoceros chinchae* (Mereschkowsky) Frenguelli (1949), p. 142, pl. 4, figs. 25–27; *Liradiscus ellipticus* Greville of Barron (1975), p. 145, pl. 9, fig. 19; *Liradiscus* sp. of McCollum (1975), p. 535, pl. 9, figs. 5, 6; *Liradiscus asperulus* Andrews (1976), p. 16, pl. 5, figs. 3–5; Abbott and Andrews (1979), p. 245, pl. 4, fig. 18; Abbott and Ernissee (1983), p. 300, pl. 17, fig. 2; *Liradiscus* spp. of Jousé (1977), pl. 51, figs. 10, 11; genus and species indeterminate of Fenner (1978), pl. 34, figs. 16–19.

Vallodiscus complexus Suto (2005b), p. 22, figs. 2D–2F, 33–68; Suto et al. (2013), p. 37, pl. P10, figs. 75–78 (Pl. P13, figs. 13–16).

Synonym: *Liradiscus ovalis* Greville of Hajós (1968), p. 114, pl. 28, figs. 8, 9 not fig. 12; Hajós (1986), pl. 21, figs. 10, 11; pl. 48, fig. 6; Lee (1993), p. 42, pl. 2, fig. 23 not fig. 25; *Liradiscus asperulus* Andrews of Lee (1986), pl. 2, fig. 17; Lee (1993), p. 41, pl. 2, fig. 10.

Vallodiscus simplexus Suto (2005b), pp. 16, 20, 22, figs. 2A–2C, 5–18 (no illustrations).

Synonym: *Liradiscus ovalis* Greville of Hajós (1968), p. 114, pl. 28, fig. 12 not figs. 8, 9; Lee (1993), p. 42, pl. 2, fig. 25 not fig. 23; *Liradiscus* sp. 1 of Fenner (1978), p. 524, pl. 37, fig. 12; *Liradiscus asperulus* Andrews of Hajós (1986), pl. 4, fig. 5.

Vallodiscus spp. (no illustrations).

Xanthioisthmus biscoctiformis (Forti) Suto (2006a), pp. 9, 10, fig. 2A; pl. 1, figs. 1–8 (Pl. P13, figs. 17, 18).

Basionym: *Xanthiopyxis biscoctiformis* Forti (1913), p. 1553, pl. 2, figs. 6, 10, 21; Proschkina-Lavrenko (1949), p. 87, pl. 84, figs. 11a–11c.

Xanthioisthmus maculata (Hanna) Suto (2006a), pp. 13, 15, 16, figs. 2H, 2I; pl. 4, figs. 1–11 (Pl. P13, figs. 19, 20).

Basionym: *Xanthiopyxis maculata* Hanna (1932), p. 225, pl. 18, fig. 4.

Synonym: *Xanthiopyxis panduraeformis* Pantocsek of Schrader and Fenner (1976), p. 1003, pl. 45, fig. 7.

Xanthioisthmus sp. A (Pl. **P13,** figs. 21, 22).

Xanthiopyxis acrolopha Forti (1912), p. 84; Forti (1913), p. 1556, pl. 2, figs. 22, 24, 27, 28, 30–37; Hanna (1927), p. 124, pl. 21, figs. 10, 11; Hanna (1932), p. 224; Proschkina-Lavrenko (1949), p. 86, pl. 84, figs. 2a, 2b; Kanaya (1959), p. 121, pl. 11, figs. 8a, 8b; Fenner (1978), p. 536, pl. 35, figs. 25, 26; Hajós (1986), pl. 21, figs. 16, 17 not pl. 4, fig. 8; Desikachary and Sreelatha (1989), p. 286, pl. 139, fig. 3 (Pl. **P14,** figs. 1–7).

Synonym: *Xanthiopyxis cingulata* Ehrenberg of Forti (1913), pl. 2, fig. 29; *Xanthiopyxis* cf. *acrolopha* Forti of Hajós (1976), p. 826, pl. 11, fig. 6; pl. 17, figs. 4, 10, 12; pl. 21, fig. 5; *Xanthiopyxis oblonga* Ehrenberg of Schrader (1976), p. 637, pl. 14, fig. 4; *Xanthiopyxis* sp. of Sanfilippo and Fourtanier (2003), pl. P3, fig. 10.

Xanthiopyxis circulatus Suto (2004d), p. 297, figs. 1.F, 7.18–7.30 (no illustrations).

Xanthiopyxis globosa Ehrenberg (1844c [1845]), p. 273; Forti (1913), p. 1557, pl. 2, figs. 39–49; Hanna (1932), p. 224, pl. 18, fig. 3; Proschkina-Lavrenko (1949), p. 87, pl. 84, figs. 12a, 12b not pl. 32, figs. 5a, 5b; Jousé (1963), p. 117, fig. 105; McCollum (1975), p. 536, pl. 15, figs. 6–9; Schrader and Fenner (1976), pl. 40, figs. 15, 17; Jousé (1977), pl. 30, fig. 49; pl. 33, fig. 10 not figs. 9, 11; Dzinoridze et al. (1978), pl. 17, fig. 2; Fenner (1978), p. 536, pl. 37, figs. 1, 2; Jousé in Dzinoridze et al. (1979), p. 62, fig. 159; Hajós (1986), pl. 16, figs. 12, 13; pl. 43, fig. 7; Homann (1991), p. 142, pl. 57, figs. 8, 13; Suto (2004d), pp. 301, 303, figs. 1.K, 14.9–14.14 (no illustrations).

Synonym: *Xanthiopyxis oblonga* Ehrenberg of Kanaya (1959), p. 121, pl. 11, figs. 9, 10; Gleser et al. (1974), pl. 36, fig. 7; Lee (1993), p. 45, pl. 2, fig. 21; pl. 3, figs. 13, 17 not pl. 2, figs. 11, 26; pl. 3, fig. 23.

Xanthiopyxis hirsuta Hanna et Grant (1926), p. 170, pl. 21, fig. 10; Fenner (1978), p. 536, pl. 35, figs. 7, 8; Suto (2004d), pp. 297, 299, figs. 1.I1, 1.I2, 11.25–11.28, 13.8; Suto et al. (2013), p. 37, pl. P10, figs. 79–84 (no illustrations).

Synonym: *Xanthiopyxis micropunctatus* Hajós (1968), p. 117, pl. 28, figs. 1, 2; Indet. sp. of Hajós (1986), pl. 10, figs. 1–4; Porifera of Hajós (1986), pl. 34, figs. 17–19.

Xanthiopyxis oblonga Ehrenberg (1844c [1845]), p. 273 (no illustration); Ehrenberg (1854), pl. 33, group 17, fig. 17; Forti (1913), pl. 2, fig. 38; Hanna and Grant (1926), p. 170, pl. 21, fig. 11; Hanna (1927), p. 124; Hanna (1932), p. 226; Lohman (1948), p. 179; Proschkina-Lavrenko (1949), p. 86, pl. 84, fig. 3; Kanaya (1957), p. 116, pl. 8, figs. 12a, 12b; Kanaya (1959), p. 121, pl. 11, figs. 9, 10; Sheshukova-Poretzkaya (1967), p. 180, pl. 24, fig. 5; pl. 26, fig. 2; Wornardt (1967), p. 72, figs. 146–149; Hajós (1968), p. 115, pl. 28, figs. 16, 17, 20, 21; Lohman (1974), p. 349, pl. 5, fig. 7; Gleser et al. (1974), pl. 31, fig. 11; pl. 36, fig. 7; pl. 40, fig. 2; Hajós (1976), p. 826, pl. 17, fig. 11; Schrader and Fenner (1976), p. 1003, pl. 39, figs. 9, 10; pl. 40, fig. 5; Hasegawa (1977), p. 90, pl. 25, figs. 22a–22c; Jousé in Dzinoridze et al. (1979), p. 62, fig. 158; Hajós (1986), pl. 21, figs. 21, 22; Lee (1993), p. 45, pl. 2, figs. 11, 26; pl. 3, fig. 23 not pl. 2, fig. 21; pl. 3, figs. 13, 17; Harwood and Bohaty (2000), p. 94, pl. 9, figs. v, w; Suto (2004d), pp. 299, 301, figs. 1.J, 13.10, 13.11, 14.1–14.8 (Pl. **P14,** figs. 8, 9).

Synonym: *Xanthiopyxis hystrix* Forti (1913), p. 1553, pl. 2, figs. 7–9; Proschkina-Lavrenko (1949), p. 86, pl. 84, figs. 5a, 5b; Fenner (1978), p. 536, pl. 36, figs. 1, 2; Hajós (1986), pl. 4, fig. 9; pl. 16, fig. 7; *Xanthiopyxis globosa* Ehrenberg of Proschkina-Lavrenko (1949), p. 87, pl. 32, figs. 5a, 5b not pl. 84, figs. 12a, 12b; Jousé (1977), pl. 33, figs. 9, 11 not pl. 30, fig. 49; pl. 33, fig. 10; Schrader and Schuette (1981), p. 1192, figs. 9, 10; *Stephanopyxis*? *limbata* Ehrenberg var. *crista-galli* of Kanaya (1959), p. 70, pl. 30, figs. 1a, 1b; *Xanthiopyxis acrolopha* Forti of McCollum (1975), p. 536, pl. 15, figs. 4, 5; Dzinoridze et al. (1978), pl. 17, fig. 13; Hajós (1986), pl. 4, fig. 8; Lee (1993), p. 44, pl. 1, fig. 24; *Xanthiopyxis oblonga*? of Fenner (1978), pl. 35, fig. 18; *Pyxidicula oblonga* (Ehrenberg) Kuetzing of Desikachary and Sreelatha (1989), p. 219, pl. 142, figs. 7, 8; pl. 139, fig. 7; *Xanthiopyxis* Ehrenberg of Hargraves (1986), p. 72, figs. 21–23.

Xanthiopyxis polaris Gran (1904), pp. 51, 52, pl. 3, figs. 16–19; Suto (2004d), figs. 1.A, 7.1–7.17; Suto et al. (2013), p. 37, pl. P10, figs. 85, 86 (no illustrations).

Synonym: *Chaetoceros* spp. of Jousé (1977), pl. 15, fig. 15; Spora of Dzinoridze et al. (1978), pl. 15, fig. 18.

Xanthiopyxis type A (knobbly type) of Suto (2004d), p. 303, figs. 1.L1, 1.L2, 7.32–7.35, 10.1–10.28; Suto et al. (2013), p. 37, pl. P9, figs. 57–62; pl. P12, fig. 7 (Pl. **P14,** figs. 10, 11).

Synonym: See Suto (2004d).

Xanthiopyxis type B (short spiny type) of Suto (2004d), pp. 303, 307, figs. 1.M1, 1.M2, 12.1–12.32, 13.1–13.7; Suto et al. (2013), p. 37, pl. P9, figs. 63–78; pl. P12, fig. 8 (Pl. **P14,** figs. 12, 13).

Synonym: See Suto (2004d).

Xanthiopyxis type C (long spiny type) of Suto (2004d), p. 307, figs. 1.N, 12.33–12.40; Suto et al. (2013), p. 37, pl. P9, figs. 79–84 (no illustrations).

Synonym: See Suto (2004d).

Hyaline type valves of resting spores of Suto et al. (2013), p. 37, pl. P9, figs. 85–96 (no illustrations).