

## A checklist of marine phytoplankton species of Northeast Brazil

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### ABSTRACT

The oceanic zone of Northeast Brazil in the southwestern tropical Atlantic Ocean is characterised by the presence of a variety of current systems. Thus, it has the potential to host a large diversity of phytoplankton species. In this context, we propose a comprehensive checklist of documented marine phytoplankton species in this region. To this end, we have compiled all the published material and supplemented it with original data from two comprehensive surveys, the ABRAÇOS surveys, covering the shelf, slope, and offshore areas of Northeast Brazil. Even if few articles were retrieved from our review research, a total of 719 phytoplankton taxa are reported, including 98 new records plus 45 potential new records from the ABRACOS data. Most taxa are accompanied by a comprehensive library of illustrations. The two major phytoplankton groups, dinoflagellates and diatoms, contributed similarly to the total checklist richness, which is consistent with the global phytoplankton diversity. The contribution of nano- and microphytoplankton varies between areas. The shelf displays a greater diversity of pennate and small/medium-sized diatoms. This may be attributed to the inputs from estuarine rivers as well as the resuspension of benthic diatoms. Conversely, dinoflagellates are more prevalent offshore, demonstrating their adaptability to changing nutritional conditions, by employing numerous metabolic and growth strategies to survive. This checklist, which reveals an remarkable diversity of nano- and microphytoplankton in Northeast Brazil, provides a valuable reference for scientists and managers to monitor community evolution under global change.

### 1. Introduction

Phytoplankton plays a fundamental role in marine ecosystems, influencing various biogeochemical cycles through significant contributions to oxygen production and carbon fixation. Responsible for 45 % of global photosynthesis, they are likened to the 'second global lung' (Field et al., 1998; Naselli-Flores and Padišák, 2023). Moreover, these microorganisms are vital components of marine food webs, producing organic biomass via primary production to sustain higher trophic levels. This biomass constitutes crucial environmental and economic resources in marine systems (Pierella Karlusich et al., 2020; Clementson et al., 2022). Furthermore, phytoplankton species serve as sensitive indicators of environmental changes, highlighting the need for comprehensive

checklists and distribution descriptions to study their ecology and contributions to ecosystem functioning (D'Elbée, 2016).

Assessing and accurately estimating phytoplankton diversity is challenging, primarily due to their diminutive size (D'Elbée, 2016) and the high level of taxonomic expertise required to identify species (McQuatters-Gollop et al., 2017). Approximately, 5000 marine species have been described to date using traditional methods (Sournia et al., 1991; Not et al., 2012; D'Elbée, 2016; Pierella Karlusich et al., 2020). However, the true number is likely to have been significantly underestimated (de Vargas et al., 2015; Righetti et al., 2020; Guiry, 2024). Within the realm of eukaryotes, Bacillariophyceae and Dinophyceae exhibit the highest diversity, each reaching about 1800 species, followed by Haptophyceae (~500 species) and Prasinophyceae (~300 species). In

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contrast, Cryptophyceae and Euglenophyceae display markedly less diversity, with ~80 species each (D'Elbée, 2016; Pierella Karlusich et al., 2020). Another major component of marine phytoplankton originates from the Cyanobacteria phylum, encompassing about 600 species (Pierella Karlusich et al., 2020; Guiry and Guiry, 2023; Editorial Board, 2023), including both benthic and planktonic lifestyles. The taxonomic diversity of the free-living Cyanobacteria is very low with few major genera, including *Prochlorococcus*, *Synechococcus* and *Crocospaera* (three picoplanktonic size-class taxa, 0.22–3 µm), and *Trichodesmium* (a microplanktonic size-class, over 20 µm). Notably both *Crocospaera* and *Trichodesmium* are diazotrophic cyanobacteria (Pierella Karlusich et al., 2020).

The oceanic zone of Northeast Brazil in the southwestern tropical Atlantic is characterised by a diversity of current systems (Stramma and England, 1999; Costa da Silva et al., 2021; Dossa et al., 2021). It thus has the potential to host a wide diversity of phytoplankton species. In this context, the objective of this study is to propose a comprehensive checklist of all documented phytoplankton species in this region. To do this, we have collated all the published material and supplemented it with original data from two comprehensive surveys, ABRACOS 1 and 2, spanning the shelf, slope, and offshore areas of Northeast Brazil (Bertrand, 2015, 2017). Moreover, we evaluate new records observed during the ABRACOS surveys, thereby extending the diversity previously observed. Encompassing a size spectrum ranging from a few microns to over a millimetre, this checklist focuses on the nano- and micrometre fractions, typically ranging between about 10 and 200 µm, within the phytoplankton communities of Northeast Brazil.

## 2. Material and methods

### 2.1. Study area

Northeast Brazil (Figs. 1a and 1b) comprises 9 Brazilian states: Alagoas, Bahia, Ceará, Maranhão, Paraíba, Piauí, Pernambuco, Rio Grande do Norte and Sergipe. Their coasts are characterized by a narrow continental shelf (~35 km) with a shelf break between 40 and 80 m depth and a steep slope down to ~3600 m depth (Knoppers et al., 1999). Offshore lies the Fernando de Noronha Ridge, which comprises a chain of seamounts along 4°S, stretching almost 500 km and including Rocas Atoll and the Fernando de Noronha Archipelago (Mabesoone and

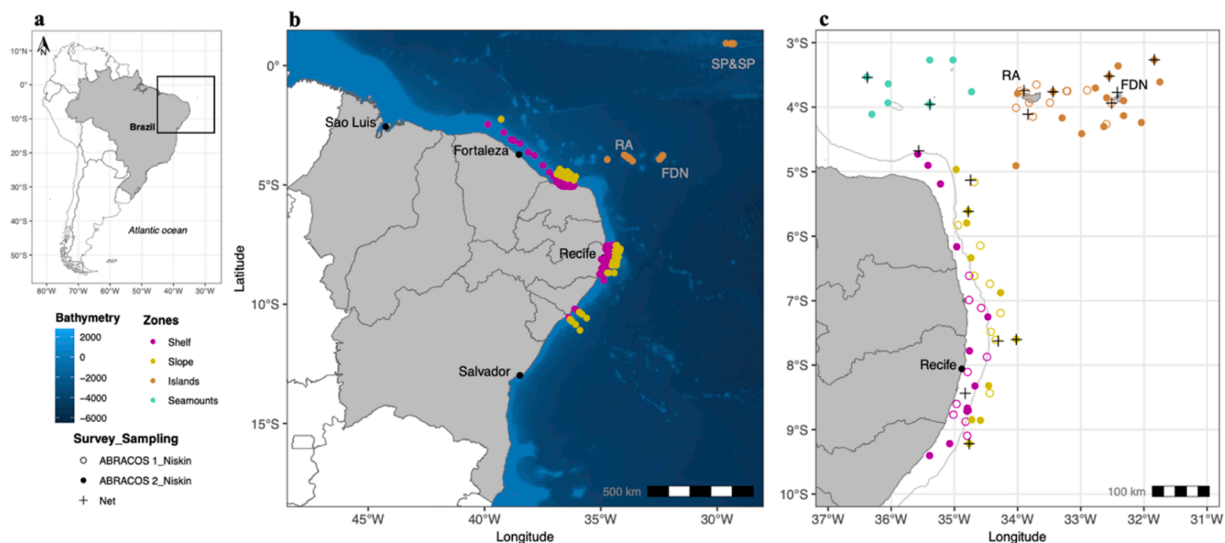
Coutinho, 1970; Kikuchi et al., 2002). Furthermore, historically, the São Pedro and São Paulo archipelagos have been part of the special "state district" of Fernando de Noronha in the state of Pernambuco, despite the very large distance between the two island groups and the even greater distance to the state mainland.

### 2.2. Data review

The aim of this study was twofold: first, to provide a comprehensive floristic checklist of the southwestern tropical Atlantic Ocean, off Northeast Brazil, including the Rocas Atoll and the Fernando de Noronha and São Pedro and São Paulo archipelagos and second, to document new records from the ABRACOS surveys. To this end, we conducted a comprehensive review of all published articles and theses, as well as reports and repositories describing phytoplankton communities. These were sourced from online resources (e.g., Google Scholar, ResearchGate) as well as exchanges within our networks of co-authors (Table 1). Online searches were conducted using combinations of the following descriptors: diversity, checklist, species, taxonomy, phytoplankton, dinoflagellates, diatoms, marine, coastal, shelf, slope, islands, archipelagos, Northeast Brazil; results were sorted by the most relevant. This published information was supplemented with new data from the ABRACOS observations. Studies describing very coastal ecosystems such as estuaries, mangroves or ports, were excluded from the analysis. The checklist also provides information on some functional traits, such as the trophic mode of Dinophyceae and the shape and size of diatoms (Table 2, Table S1).

### 2.3. ABRACOS surveys

The "Acoustics along the BRAZilian COast (ABRACOS)" surveys were carried out aboard the French R/V ANTEA in Austral spring (30 August - 20 September 2015 - ABRACOS 1; Bertrand, 2015) and fall (9 April - 9 May 2017 - ABRACOS 2; Bertrand, 2017). A total of 72 stations were studied off the Northeast Brazil region (Fig. 1c). Phytoplankton was collected using Niskin bottles mounted in a rosette in the mixed-layer (~40 m, 25–53 m, depending on the station), at the deep chlorophyll maximum (DCM, ~100 m, 50–123 m) and at 200 m (where fluorescence was no longer measured) at stations with a bottom depth greater than 200 m or near the bottom (between 10 and 63 m) at stations located over the shelf. In total, 20, 48, 68 and 24 samples were collected



**Fig. 1.** Study area of the position of (a-b) the published references stations in the Northeast Brazil region and (c) the position of ABRACOS 1 (coloured outline) and ABRACOS 2 (full coloured) Niskin (circles) and phytoplankton net (stars) sampling stations. The shelf limit is represented by the isobath of 200 m (solid line). RA stands for Rocas Atoll, FNA for Fernando de Noronha archipelago, SP&SP for São Pedro and São Paulo archipelagos. Stations have been organized into four ecological areas (shelf in magenta, slope in yellow-green, oceanic islands in brown and seamounts in cyan).

**Table 1**  
Review of phytoplankton communities' studies in Northeast Brazil. DCM= deep chlorophyll maximum.

Source number	Source	Period and Project	Sampling area and design	Sampling tool	Taxonomic scope	Taxa richness
1	Eskinazi-Leça and Passavante (1972)	1965 monthly sampling	Shelf station in Pernambuco	Horizontal "Kitahara" quantitative net (65 µm mesh size) in sub-surface	Total flora	74
2	Passavante (1979)	1965 monthly sampling and June 1965 (R/V Canopus, England)	Pernambuco shelf: 1 fixed station sampled each month and 9 stations	Horizontal "Kitahara" quantitative net (65 µm mesh size) in sub-surface	Dinophyceae	41
3	Passavante et al. (1982)	June 1965 (R/V Canopus, England)	Ceará shelf (11 stations)	Horizontal "Kitahara" quantitative net (65 µm mesh size) in sub-surface	Dinophyceae	24
4	Eskinazi-Leça et al. (1989)	Brasilian ALGAS Project, 1978 (SUDENE/CIRM)	Pernambuco shelf (15 stations)	Van Dorn bottle and horizontal qualitative 65 µm mesh size net in sub-surface	Total flora	68
5	Silva-Cunha and Eskinazi-Leça (1990)	Between June 1965 and February 1967 (R/V Canopus, England)	Pernambuco shelf (9 stations), south Paraíba (1 station), north Alagoas (1 station)	Horizontal qualitative 65 µm mesh size net in sub-surface	Diatoms	119
6	Koening and Macêdo (1999)	JOPS II-5 cruise, 1-2/03/1995 (R/V Victor Hensen, Germany)	Itamaracá-Pernambuco (10 stations along 2 profiles)	Van Dorn bottle in sub-surface and oblique qualitative 64 µm mesh size net (14-0 m in shelf stations, 160-0 m in slope stations)	Total flora	101
7	Koening and Lira (2005)	JOPS II-5 cruise, 25/02-3/03/1995 (R/V Victor Hensen, Germany)	Pernambuco shelf and slope (34 stations along 7 profiles)	Oblique qualitative 64 µm mesh size net (14-0 m in shelf stations, 160-0 m in slope stations)	<i>Ceratium</i> spp.	57
8	Koening et al. (2009)	JOPS II-5 cruise, 25/02-3/03/1995 (R/V Victor Hensen, Germany)	Pernambuco shelf and slope (34 stations along 7 profiles)	Oblique qualitative 64 µm mesh size net (14-0 m in shelf stations, 160-0 m in slope stations)	Total flora	173
9	Santos et al. (2010)	Servemar-X (May-July 2005) and Servemar-I (November and December 2005, January 2006) projects	Pernambuco shelf Servemar-X and Servemar-I shipwrecks as artificial reefs (12 dives - 6 for each shipwreck)	Vertical qualitative 20 µm mesh size net	Total flora	76
10	Tiburcio et al. (2011)	CNPq project, 12-16/05/2008	São Pedro and São Paulo archipelagos (2 stations: Cabeço da Tartaruga and Enseada)	Horizontal quantitative 45 µm mesh size net in sub-surface	Total flora	129
11	Queiroz et al. (2014)	March 2008	São Pedro and São Paulo archipelagos (16 stations along 4 profiles)	Horizontal quantitative 45 µm mesh size net in sub-surface	Total flora	110
12	Queiroz et al. (2015)	21-23/07/2010 and 29/09-01/10/2011 (R/V Cruzeiro do Sul, Brazil)	São Pedro and São Paulo archipelagos (6 stations along 2 profiles)	Niskin bottle (surface, 25, 50 m, DCM+10, DCM, DCM-10 m, 100 m) and vertical qualitative 20 µm mesh size net (75-105-0 m)	Total flora/ Cyanophyceae	129
13	Jales et al. (2015)	July 2010 (R/V NH 38, Brazil)	Rocas Atoll (6 stations along 2 profiles)	Niskin bottle (surface, 25, 50 m, DCM+10, DCM, DCM-10 m, 100 m) and vertical qualitative 20 µm mesh size net (DCM-10m up to the surface)	Total flora	150
14	Aquino (2016)	08/2010 and 10/2012 (R/V Cruzeiro do Sul, Brazil)	Fernando de Noronha archipelago (6 stations along 2 profiles)	Niskin bottle (surface, 25, 50 m, DCM+10, DCM, DCM-10 m, 100 m) and vertical qualitative 20 µm mesh size net (130-0 m)	Total flora	115
15	Silva-Cunha, Leça, et al. (2019)	Brazilian-Petrobras Marseal project, AGUA 1 and 2 cruises, June 2014 and December 2014 (R/V Seward Johnson, Panama)	Bacia de Sergipe-Alagoas: shelf and slope/ocean (14 stations along 2 profiles)	Niskin bottle (surface, about 50 m, DCM) and oblique qualitative 20 µm mesh size net (near bottom or 200-0 m)	Total flora	331
16	Silva-Cunha, Koening, et al., (2019)	Petrobras monitoring during 3 periods in 2002-2004, 2009-2011 and 2014: (i) Piracicaba, Pegasus I and R/V Astro Garouba, (ii) Corenav II, Marimar XII, Titanic IX, R/V Seward Johnson, Panama and R/V Luke Thomas, USA, and (iii) R/V Seward Johnson, Panama and R/V Luke Thomas, USA	Bacia Potiguar shelf and slope, Rio Grande do Norte and Ceará (i) 70 stations, (ii) 23 stations, and (iii) 20 stations	Niskin bottle in sub-surface and oblique vertical 20 µm mesh size net (near bottom or 200-0 m)	Diatoms/ Dinophyceae	93
17	Jales et al. (2022)	03-15/12/2012 and 26/08-3/09/13	Five natural pools - 3 collections per pool	20 µm mesh size filtration (200 L)	Total flora	109
18	ABRACOS observations	ABRACOS 1 and 2 cruises, October-November 2015 and April-May 2017 (R/V Antea, France)	Northeast Brazil coast: Rio Grande do Norte, Paraíba, Pernambuco, Ceara, Alagoas shelf and slope/ ocean, Rocas Atoll and Fernando de Noronha (72 stations)	Niskin bottle (about 50 m, DCM, 200 m) and oblique qualitative 20 µm mesh size net (200-0 m)	Total flora	321

Table 2

List of phytoplankton species or taxa observed in the Brazilian Northeast region at shelf, slope, around the oceanic islands and in the seamounts area since 1970. \* indicates ABRACOS new records and \* ? the potential new records. We mentioned if taxa illustrations are available in the checklist sources we studied or in the Abraços pictures online database. <sup>m</sup> indicates mixotrophic and <sup>h</sup> heterotrophic taxa.

	Sources	Illustration availability (picture, draw)	Shelf	Slope	Oceanic islands	Seamounts
MYZOOA						
<b>Dinophyceae</b>						
<i>Spiniferites</i> sp. G.A. Mantell, 1850	10				X	
<i>Alexandrium minutum</i> Halim, 1960 *	18	X		X	X	
<i>Alexandrium</i> sp1 Halim, 1960 *	18	X			X	
<i>Alexandrium</i> sp2 Halim, 1960 *	18	X	X	X	X	
<i>Amphidinium</i> sp. Claperède & Lachmann, 1859	15		X			
<i>Amphidoma nucula</i> Stein, 1883 *	18	X			X	
<i>Amphisolenia bidentata</i> Schröder, 1900	2, 3, 6, 8, 12, 13, 15, 16	X (16)	X	X	X	
<i>Amphisolenia bifurcata</i> Murray & Whitting, 1899	2, 3, 15		X	X		
<i>Amphisolenia globifera</i> Stein, 1883 <sup>m</sup>	16, 18	X (16, 18)		X		X
<i>Amphisolenia schauinslandii</i> Lemmermann, 1899 <sup>m</sup>	15		X	X		
<i>Amphisolenia schroederi</i> Kofoid, 1907 <sup>m*</sup>	18			X		
<i>Amphisolenia</i> sp. Stein, 1883 <sup>m</sup>	15	X		X		
<i>Archaeoperidinium minutum</i> (Kofoid) Jørgensen, 1912 *	18	X			X	
<i>Azadinium caudatum</i> (Halldal) Nézan & Chomérat, 2012 *	18	X			X	
<i>Azadinium</i> sp. Elbrächter & Tillmann, 2009 *	18	X		X		
<i>Blepharocysta</i> sp. Ehrenberg, 1873 <sup>h*</sup>	18	X	X	X	X	
<i>Ceratium carriense</i> var. <i>carriense</i> Gourret, 1883	15			X		
<i>Ceratium contortum</i> var. <i>robustum</i> (Karsten) Sournia, 1966	7					
<i>Ceratium gibberum</i> var. <i>dispar</i> (Pouchet) Sournia, 1966	8			X		
<i>Ceratium macroceros</i> var. <i>gallicum</i> (Kofoid) Sournia, 1966	1, 7, 8		X	X		
<i>Ceratium pentagonum</i> var. <i>longisetum</i> (Ostenfeld & J. Schmidt) Jørgensen, 1911	10, 11, 15		X		X	
<i>Ceratium pentagonum</i> var. <i>tenerum</i> Jørgensen, 1920	7, 8, 10, 11		X	X	X	
<i>Ceratium platycorne</i> Daday, 1888	7, 18			X		
<i>Ceratium porrectum</i> Karsten, 1907	9, 16	X (16)	X	X		
<i>Ceratium</i> sp. F. Schrank, 1793	10, 15		X		X	
<i>Ceratium symmetricum</i> var. <i>coarctatum</i> (Pavillard) Graham & Bronnikovskiy, 1944	7					
<i>Ceratium symmetricum</i> var. <i>orthoceras</i> (Jørgensen) Graham & Bronnikovskiy, 1944 *	18	X				X
<i>Ceratium symmetricum</i> var. <i>symmetricum</i> Pavillard, 1905	7, 10				X	
<i>Ceratium tenue</i> Ostenfeld & Schmidt, 1901	7, 15, 16, 18	X (16)	X	X		
<i>Ceratium tenue</i> var. <i>buceros</i> Balech, (1988) *	18			X		
<i>Ceratium tenue</i> var. <i>tenissimum</i> (Kofoid) Graham & Bronnikovskiy, 1944	7, 8			X		
<i>Ceratium tripos</i> f. <i>ponticum</i> (Jørgensen) Schiller, 1937	3		X			
<i>Ceratium tripos</i> var. <i>atlanticum</i> (Ostenfeld) Paulsen, 1908	8, 18	X		X	X	
<i>Ceratium vultur</i> f. <i>japonicum</i> (Schröder) Wood, 1954	2, 3, 7		X			
<i>Ceratocorys armata</i> (Schütt) Kofoid, 1910	6, 8, 12, 13, 15, 16	X (16)	X	X	X	
<i>Ceratocorys gourretii</i> Paulsen, 1937	6			X		
<i>Ceratocorys horrida</i> Stein, 1883	2, 3, 6, 8, 10, 11, 12, 13, 14, 15, 16, 17, 18	X (16, 18)	X	X	X	X
<i>Ceratocorys</i> sp. Stein, 1883	6, 10, 15		X	X	X	
<i>Cladopyxis brachiolata</i> Stein, 1883	6, 8, 15, 18		X	X		X
<i>Cladopyxis hemibrachiata</i> Balech, 1964	6, 15, 18			X		X
<i>Cochlodinium</i> sp. Schütt, 1896	15		X			
<i>Corythodinium belgicæ</i> (Meunier) F.J.R. Taylor, (1976)	10				X	
<i>Corythodinium constrictum</i> (F. Stein) F.J.R. Taylor, (1976)	6, 10, 12, 13, 14, 15, 18		X	X	X	X
<i>Corythodinium curvicaudatum</i> (Kofoid) F.J.R. Taylor, (1976) *	18			X	X	
<i>Corythodinium diploconus</i> (F. Stein) F.J.R. Taylor, (1976)	12, 15, 18	X	X	X	X	X
<i>Corythodinium elegans</i> (Pavillard) F.J.R. Taylor	10, 12, 13, 18			X	X	X
<i>Corythodinium frenguelli</i> (Rampi) F.J.R. Taylor, (1976) *	18			X	X	
<i>Corythodinium milneri</i> (G. Murray & Whitting) F. Gómez, 2017	10, 14, 15, 18	X		X	X	X
<i>Corythodinium</i> sp. Loeblich Jr. & Loeblich III, 1966	10, 15, 18	X (15)	X	X	X	X
<i>Corythodinium tessellatum</i> (F. Stein) Loeblich Jr. & Loeblich III, 1966	10, 12, 13, 18	X	X	X	X	
Dinophyceae 1 (cf Gymnodiniales) Lemmermann, 1910 *?	18	X			X	
Dinophyceae 2 (cf Peridinales) Haeckel, 1894 *?	18	X			X	
Dinophyceae 3 Fritsch, 1927 *?	18	X			X	
Dinophyceae 4 (cf Dinophysiales) Lindemann 1928 *?	18	X	X	X	X	
Dinophyceae 5 (cf Thoracosphaerales) Tangen in Tangen, Brand, Blackwelder & Guillard, 1982 *?	18	X			X	
Dinophyceae 6 Fritsch, 1927 *?	18	X			X	
Dinophyceae 7 (cf Gonyaulacales) Taylor, 1980 *?	18	X			X	
Dinophyceae 8 (cf Peridinales) Haeckel, 1894 *?	18	X		X		
Dinophyceae 9 Fritsch, 1927 *?	18	X		X		
Dinophyceae 10 Fritsch, 1927 *?	18	X		X		
<i>Dinophysis argus</i> (Stein) Abé <sup>m</sup>	10, 12, 13, 15, 18		X	X	X	
<i>Dinophysis bibulba</i> Balech, 1971 <sup>m*</sup>	18	X			X	
<i>Dinophysis caudata</i> Saville-Kent, 1881 <sup>m</sup>	1, 2, 9, 15, 16, 17	X (15, 16)	X	X	X	

(continued on next page)



Table 2 (continued)

	Sources	Illustration availability (picture, draw)	Shelf	Slope	Oceanic islands	Seamounts
<i>Dinophysis dubia</i> Balech, 1978 <sup>m</sup>	14				X	
<i>Dinophysis exigua</i> Kofoid & Skogsberg, 1928 <sup>m</sup>	13, 14, 15, 18	X	X	X	X	
<i>Dinophysis hastata</i> F. Stein, 1883 <sup>m</sup>	6, 10, 12, 13, 14, 18			X	X	
<i>Dinophysis minuta</i> (Cleve) Balech <sup>m</sup>	13				X	
<i>Dinophysis ovata</i> Claparède & Lachmann, 1859 <sup>m</sup>	14, 15		X	X	X	
<i>Dinophysis parvula</i> (Schütt) Balech, 1967 <sup>m</sup>	15, 18	X	X	X	X	
<i>Dinophysis pusilla</i> Jørgensen, 1923 <sup>m</sup>	14				X	
<i>Dinophysis schuettii</i> Murray & Whitting, 1899 <sup>m</sup>	10, 12, 13, 14, 15, 18	X	X	X	X	X
<i>Dinophysis</i> sp1 Ehrenberg, 1839 <sup>m*?</sup>	18	X		X		X
<i>Dinophysis</i> spp. Ehrenberg, 1839 <sup>m</sup>	10, 13, 14, 15, 17		X	X	X	
<i>Dinophysis uracantha</i> Stein, 1883 <sup>m</sup>	12, 18	X			X	
Diplopsalid 1 <sup>h*</sup>	18	X		X		
Diplopsalid 2 <sup>h*</sup>	18	X	X			X
Diplopsalid 3 <sup>h*</sup>	18	X		X	X	
Diplopsalid 4 <sup>h*</sup>	18	X				X
Diplopsalid 5 <sup>h*</sup>	18	X		X	X	
<i>Dissodinium pseudolumula</i> Swift ex Elbrächter & Drebes, 1978	12				X	
<i>Gonyaulax birostris</i> Stein, 1883	10, 12, 13, 15, 17, 18	X	X	X	X	X
<i>Gonyaulax digitalis</i> (C.H.G. Pouchet) Kofoid, 1911	12, 13				X	
<i>Gonyaulax fusiformis</i> H.W. Graham, 1942 *	18			X		
<i>Gonyaulax gracilis</i> Schiller, 1935	14				X	
<i>Gonyaulax minuta</i> Kofoid & Michener 1911	17				X	
<i>Gonyaulax pacifica</i> Kofoid, 1907	10				X	
<i>Gonyaulax polygramma</i> F. Stein, 1883 <sup>m*</sup>	10, 11, 12, 13, 15, 17, 18	X	X	X	X	X
<i>Gonyaulax</i> sp1 Diesing, 1866 *	18	X			X	
<i>Gonyaulax</i> sp2 Diesing, 1866 *	18	X		X	X	
<i>Gonyaulax</i> sp3 Diesing, 1866 *	18	X			X	
<i>Gonyaulax</i> sp4 Diesing, 1866 *	18	X			X	
<i>Gonyaulax spinifera</i> (Claparède & Lachmann) Diesing, 1866 <sup>m</sup>	10, 12, 13, 14, 17, 18	X (15, 18)	X	X	X	
<i>Gonyaulax</i> spp. Diesing, 1866	6, 10, 14, 15	X (15)	X	X	X	
<i>Gymnodinium catenatum</i> H.W. Graham 1943 <sup>m</sup>	17				X	
<i>Gymnodinium</i> sp1 F. Stein, 1878 <sup>*?</sup>	18	X			X	
<i>Gymnodinium</i> sp2 F. Stein, 1878 <sup>*?</sup>	18	X			X	
<i>Gymnodinium</i> sp3 F. Stein, 1878 <sup>*?</sup>	18	X			X	
<i>Gymnodinium</i> sp4 F. Stein, 1878 <sup>*?</sup>	18	X			X	
<i>Gymnodinium</i> spp. F. Stein, 1878	12, 13, 14, 15, 17, 18	X	X	X	X	
<i>Gyrodinium biconicum</i> Kofoid & Swezy, 1921 <sup>h</sup>	15		X			
<i>Gyrodinium spirale</i> (Bergh) Kofoid & Swezy, 1921 <sup>h</sup>	15		X			
<i>Gyrodinium</i> spp. Kofoid & Swezy, 1921 <sup>h</sup>	12, 15, 18	X	X	X	X	X
<i>Heterocapsa minima</i> A.J. Pomroy, 1989 *	18	X	X	X	X	X
<i>Heterocapsa niei</i> (Loeblich III) Morrill & Loeblich III, 1981 *	18	X	X	X	X	
<i>Heterocapsa</i> sp. Stein, 1883 *	18	X			X	
<i>Heterodinium minutum</i> Kofoid & Michener, 1911	13				X	
<i>Histioneis crateriformis</i> Stein, 1883	10, 13, 14				X	
<i>Histioneis cymbalaria</i> Stein, 1883 <sup>h*</sup>	18			X		
<i>Histioneis elongata</i> Kofoid & Michener, 1911 <sup>h</sup>	15		X			
<i>Histioneis hyalina</i> Kofoid & Michener, 1911 <sup>h</sup>	12, 14, 15, 18	X	X	X	X	
<i>Histioneis megalocapa</i> Stein, 1883 <sup>h</sup>	12, 13, 14, 15		X	X	X	
<i>Histioneis milneri</i> Murray & Whitting, 1899 <sup>h</sup>	10, 11, 12, 15, 18	X		X	X	X
<i>Histioneis mitchellana</i> Murray & Whitting, 1899 <sup>h</sup>	12, 14				X	
<i>Histioneis panaria</i> Kofoid & Skogsberg, 1928 <sup>h</sup>	13				X	
<i>Histioneis rotundata</i> Kofoid & Michener, 1911 <sup>h</sup>	13				X	
<i>Histioneis</i> sp. Stein, 1883 <sup>h</sup>	12, 13, 14, 15	X		X	X	
<i>Histioneis</i> sp1 Stein, 1883 <sup>h*?</sup>	18	X			X	
<i>Histioneis</i> sp2 Stein, 1883 <sup>h*?</sup>	18	X			X	
<i>Histioneis striata</i> Kofoid & Michener, 1911 <sup>h</sup>	13				X	
<i>Karenia papilionacea</i> A.J. Haywood & K.A. Steidinger, 2004 *	18	X				X
<i>Kryptoperidinium triquetrum</i> (Ehrenberg) U. Tillmann, M. Gottschling, M. Elbrächter, W.-H. Kusber & M. Hoppenrath, 2019 <sup>m*</sup>	18	X		X	X	X
<i>Lessardia elongata</i> Saldarriaga & F.J.R. Taylor, 2003 <sup>h*</sup>	18	X	X	X	X	X
<i>Lingulodinium polyedra</i> (F. Stein) J.D. Dodge, 1989 <sup>m</sup>	10, 12, 13, 14, 15, 17, 18	X	X	X	X	
<i>Metaphalacroma skogsbergii</i> L.-S. Tai, 1934 *	18	X			X	
<i>Noctiluca scintillans</i> (Macartney) Kofoid & Swezy, 1921	12, 18	X		X	X	X
<i>Noctiluca</i> sp. Suriray, 1836	15		X			
<i>Ornithocercus heteroporus</i> Kofoid, 1907 <sup>h</sup>	15, 18	X		X		X
<i>Ornithocercus magnificus</i> Stein, 1883 <sup>h</sup>	3, 6, 8, 10, 11, 12, 13, 14, 15, 16, 17, 18	X (16, 18)	X	X	X	X
<i>Ornithocercus quadratus</i> Schütt, 1900 <sup>h</sup>	2, 6, 10, 11, 12, 13, 14, 15, 17, 18	X	X	X	X	
<i>Ornithocercus</i> sp. Stein, 1883 <sup>h</sup>	12, 13, 15, 17		X		X	
<i>Ornithocercus splendidus</i> Schütt, 1895 <sup>h</sup>	6, 8, 12, 15, 18	X	X	X	X	
<i>Ornithocercus steinii</i> Schütt, 1900 <sup>h</sup>	2, 6, 8, 10, 12, 13, 15, 18	X	X	X	X	X
<i>Ornithocercus thumii</i> (Schmidt) Kofoid & Skogsberg, 1928 <sup>h</sup>	8, 10, 12, 13, 14			X	X	
<i>Ostreopsis ovata</i> Fukuyo, 1981 <sup>m</sup>	17				X	
<i>Oxytoxum caudatum</i> Schiller, 1937 *	18	X	X	X	X	X

(continued on next page)

Table 2 (continued)

	Sources	Illustration availability (picture, draw)	Shelf	Slope	Oceanic islands	Seamounts
<i>Oxytoxum cf. challengeroides</i> Stein, 1883 *	18	X		X	X	
<i>Oxytoxum crassum</i> J. Schiller, 1937	10, 13, 18	X		X	X	X
<i>Oxytoxum curvatum</i> (Kofoid) Kofoid & J.R. Michener, 1911	14, 18		X	X	X	X
<i>Oxytoxum elegans</i> Pavillard, 1916	6, 18	X	X		X	
<i>Oxytoxum globosum</i> Schiller *	18		X		X	
<i>Oxytoxum gracile</i> Schiller, 1937	12, 13, 14, 15		X	X	X	
<i>Oxytoxum laticeps</i> Schiller, 1937	13, 14, 15, 18	X	X	X	X	X
<i>Oxytoxum longiceps</i> Schiller	12, 18				X	
<i>Oxytoxum mediterraneum</i> Schiller	13, 15, 18		X	X	X	X
<i>Oxytoxum obliquum</i> Schiller, 1937	12, 13, 14, 15, 18		X	X	X	X
<i>Oxytoxum parvum</i> Schiller, 1937 *	18	X	X	X	X	X
<i>Oxytoxum sceptrum</i> (F. Stein) Schröder, 1906	14, 15, 17			X	X	
<i>Oxytoxum scolopax</i> Stein, 1883	10, 12, 13, 14, 15, 16, 17, 18	X (15, 16, 18)	X	X	X	X
<i>Oxytoxum sphaeroideum</i> Stein, 1883 *	18				X	
<i>Oxytoxum</i> spp. Stein, 1883	13, 15		X	X	X	
<i>Oxytoxum subulatum</i> Kofoid, 1907	13, 18	X		X	X	
<i>Oxytoxum tessellatum</i> (F. Stein) Schütt, 1895	14, 15, 18		X	X	X	X
<i>Oxytoxum turbo</i> Kofoid, 1907 *	18	X		X	X	X
<i>Oxytoxum variabile</i> Schiller, 1937 *	18	X	X	X	X	X
<i>Oxytoxum viride</i> Schiller, 1937	13				X	
<i>Phalacroma circumcinctum</i> Kofoid & Michener, 1911 <sup>h</sup>	6, 14			X	X	
<i>Phalacroma cuneus</i> F. Schütt, 1895 <sup>h</sup>	6, 8, 10, 12, 13, 14		X	X	X	
<i>Phalacroma doryphorum</i> Stein, 1883 <sup>h</sup>	10, 11, 12, 13, 15, 18	X	X	X	X	
<i>Phalacroma favus</i> Kofoid & Michener, 1911 <sup>h</sup>	12, 13				X	
<i>Phalacroma mitra</i> F. Schütt, 1895 <sup>h</sup>	12, 14, 18	X		X	X	
<i>Phalacroma porodictyum</i> Stein, 1883 <sup>h*</sup>	18	X				X
<i>Phalacroma rapa</i> Jorgensen, 1923 <sup>h</sup>	6, 10, 12, 13, 14, 15, 18	X		X	X	
<i>Phalacroma rotundatum</i> (Claparède & Lachmann) Kofoid & J.R. Michener, 1911 <sup>h</sup>	10, 12, 13, 14, 15, 17, 18	X	X	X	X	X
<i>Phalacroma scrobiculatum</i> (Balech) Díaz-Ramos & G.J. Estrella 2000 <sup>h</sup>	14				X	
<i>Phalacroma</i> sp. Stein, 1883 <sup>h</sup>	6, 15		X	X		
<i>Podolampas bipes</i> Stein, 1883 <sup>h</sup>	10, 12, 13, 15		X	X	X	
<i>Podolampas bipes</i> var. <i>reticulata</i> (Kofoid) Taylor <sup>h</sup>	13				X	
<i>Podolampas elegans</i> Schütt, 1895 <sup>h</sup>	6, 10, 13, 15, 16, 18	X (15, 16)	X	X	X	
<i>Podolampas palmipes</i> Stein, 1883 <sup>h</sup>	10, 12, 13, 14, 15, 16, 17, 18	X (16, 18)	X	X	X	X
<i>Podolampas</i> sp. Stein, 1883 <sup>h</sup>	15		X			
<i>Podolampas spinifera</i> Okamura, 1912 <sup>h</sup>	10, 13, 15, 17, 18	X	X	X	X	X
<i>Polykrikos kofoidii</i> Chatton, 1914 <sup>h</sup>	12				X	
<i>Preperidinium meunieri</i> (Pavillard) Elbrächter, 1993 <sup>h</sup>	12				X	
<i>Pronoctiluca rostrata</i> F.J.R. Taylor, (1976) <sup>h*</sup>	18	X			X	
<i>Pronoctiluca spinifera</i> (Lohmann) Schiller, 1932 <sup>h*</sup>	18	X		X	X	
<i>Prorocentrum balticum</i> (Lohmann) Loeblich III, 1970 <sup>m</sup>	10, 12, 13, 14, 17, 18	X	X	X	X	
<i>Prorocentrum compressum</i> (Bailey) T.H. Abé ex J.D. Dodge, 1980	5, 10, 12, 13, 14, 15, 17		X	X	X	
<i>Prorocentrum cordatum</i> (Ostenfeld) J.D. Dodge, 1975 <sup>m</sup>	12, 18	X	X	X	X	X
<i>Prorocentrum dactylus</i> (Stein) Dodge, 1975 *	18	X	X	X	X	X
<i>Prorocentrum emarginatum</i> Fukuyo 1981	17, 18				X	
<i>Prorocentrum gracile</i> F. Schütt, 1895	10, 12, 13, 14, 15, 16, 17, 18	X (16, 18)	X	X	X	X
<i>Prorocentrum hoffmannianum</i> M.A. Faust, 1990 <sup>m</sup>	13, 14, 17				X	
<i>Prorocentrum lenticulatum</i> (Matzenauer) F.J.R. Taylor, (1976) *	18	X			X	
<i>Prorocentrum lima</i> (Ehrenberg) F. Stein 1878	17, 18	X			X	
<i>Prorocentrum mexicanum</i> Osorio-Tafall 1942	17, 18	X	X	X	X	
<i>Prorocentrum micans</i> Ehrenberg, 1834 <sup>m</sup>	6, 10, 12, 13, 15, 16, 17, 18	X (16, 18)	X	X	X	
<i>Prorocentrum rostratum</i> F. Stein, 1883	12, 14, 18	X	X	X	X	X
<i>Prorocentrum shikokuense</i> Hada, 1975 *	18	X	X	X	X	
<i>Prorocentrum</i> sp1 Ehrenberg, 1834 <sup>?</sup>	18	X	X	X	X	X
<i>Prorocentrum</i> sp2 Ehrenberg, 1834 <sup>?</sup>	18	X			X	
<i>Prorocentrum</i> spp. Ehrenberg, 1834	10, 13, 14, 15		X	X		
<i>Prorocentrum triestinum</i> J. Schiller, 1918 <sup>m*</sup>	18	X		X	X	
<i>Prorocentrum vaginula</i> (F. Stein) J.D. Dodge, 1975	12, 13, 18	X	X	X	X	X
<i>Protoceratium reticulatum</i> (Claparède & Lachmann) Bütschli, 1885 <sup>h</sup>	13, 18	X	X	X	X	X
<i>Protoceratium spinulosum</i> (Murray & Whitting) Schiller, 1937 <sup>h*</sup>	18	X	X	X	X	
<i>Protoperidinium acutipes</i> (P.-A. Dangeard, 1927) Balech, 1974 <sup>h*</sup>	18	X			X	
<i>Protoperidinium brevipes</i> (Paulsen, 1908) Balech, 1974 <sup>h</sup>	6, 18	X	X	X	X	
<i>Protoperidinium brochii</i> (Kofoid & Swezy, 1921) Balech, 1974 <sup>h</sup>	14				X	
<i>Protoperidinium cassum</i> (Balech, 1971) Balech, 1974 <sup>h</sup>	14, 15, 18	X	X	X	X	
<i>Protoperidinium cerasus</i> (Paulsen, 1907) Balech, 1973 <sup>h</sup>	10, 12				X	
<i>Protoperidinium conicum</i> (Gran) Balech, 1974 <sup>h</sup>	13				X	
<i>Protoperidinium crassipes</i> (Kofoid, 1907) Balech, 1974 <sup>h</sup>	12				X	
<i>Protoperidinium curvipes</i> (Ostenfeld) Balech, 1974 <sup>h*</sup>	18	X			X	
<i>Protoperidinium deficiens</i> (Meunier, 1919) Balech, 1974 <sup>h*</sup>	18	X		X	X	
<i>Protoperidinium depressum</i> (Bailey, 1854) Balech, 1974 <sup>h</sup>	10, 11, 12, 13, 15		X	X	X	
<i>Protoperidinium divergens</i> (Ehrenberg) Balech, 1974 <sup>h</sup>	10, 14, 18	X	X	X	X	

(continued on next page)

Table 2 (continued)

	Sources	Illustration availability (picture, draw)	Shelf	Slope	Oceanic islands	Seamounts
<i>Protoperidinium elegans</i> (Cleve, 1900) Balech, 1974 <sup>h</sup>	8, 15		X	X		
<i>Protoperidinium grande</i> (Kofoid, 1907) Balech, 1974 <sup>h</sup>	6			X		
<i>Protoperidinium latispinum</i> (Mangin, 1926) Balech, 1974 <sup>h</sup>	10				X	
<i>Protoperidinium longipes</i> Balech, 1974 <sup>h</sup>	14				X	
<i>Protoperidinium oblongum</i> (Aurivillius) Parke & Dodge, 1976 <sup>h</sup>	9		X			
<i>Protoperidinium obtusum</i> (Karsten) Parke & J.D. Dodge, 1976 <sup>h</sup>	10, 14, 17, 18	X			X	X
<i>Protoperidinium oceanicum</i> (VanHöffen, 1897) Balech, 1974 <sup>h</sup>	12				X	
<i>Protoperidinium ovatum</i> Pouchet, 1883 <sup>h</sup>	12				X	
<i>Protoperidinium ovum</i> (Schiller, 1911) Balech, 1974 <sup>h</sup>	11, 12, 15		X		X	
<i>Protoperidinium parvum</i> (Balech, 1971) Balech, 1974 <sup>h*</sup>	18	X	X	X	X	
<i>Protoperidinium pedunculatum</i> (Schütt, 1895) Balech, 1974 <sup>h</sup>	6			X		
<i>Protoperidinium pentagonum</i> (Gran, 1902) Balech, 1974 <sup>h</sup>	12				X	
<i>Protoperidinium pyriforme</i> (Paulsen, 1905) Balech, 1974 <sup>h</sup>	17, 18	X	X	X	X	
<i>Protoperidinium quarnerense</i> (B. Schröder, 1900) Balech, 1974 <sup>h*</sup>	18	X			X	
<i>Protoperidinium rectum</i> (Kofoid, 1907) Balech, 1974 <sup>h</sup>	15		X			
<i>Protoperidinium simulum</i> (Paulsen, 1931) Balech, 1974 <sup>h*</sup>	18	X			X	
<i>Protoperidinium</i> sp1 Bergh, 1881 <sup>h*,7</sup>	18	X			X	
<i>Protoperidinium</i> spp. Bergh, 1881 <sup>h</sup>	6, 10, 12, 13, 14, 15, 17	X	X	X	X	
<i>Protoperidinium steinii</i> (Jørgensen, 1899) Balech, 1974 <sup>h</sup>	12, 18	X		X	X	X
<i>Protoperidinium subpyriforme</i> (P.-A. Dangeard, 1927) Balech, 1974 <sup>h</sup>	10, 18	X			X	
<i>Protoperidinium venustum</i> (Matzenauer, 1933) Balech, 1974 <sup>h</sup>	15, 16	X (16)	X	X		
<i>Pyrocystis elegans</i> Pavillard, 1931	2		X			
<i>Pyrocystis fusiformis</i> C.W. Thomson, 1876	1, 2, 3, 6, 8, 10, 11, 12, 13, 15, 16, 18	X (16, 18)	X	X	X	
<i>Pyrocystis hamulus</i> var. <i>inaequalis</i> Schröder, 1900	2		X			
<i>Pyrocystis hamulus</i> var. <i>semicircularis</i> Schröder, 1900	2		X			
<i>Pyrocystis lumula</i> (Schütt) Schütt, 1896	6, 10, 13, 18		X	X	X	X
<i>Pyrocystis obtusa</i> Pavillard, 1931	13				X	
<i>Pyrocystis pseudonocitiluca</i> Wyville-Thompson, 1876	1, 2, 3, 6, 8, 11, 12, 14, 15, 16	X (16)	X	X	X	
<i>Pyrocystis robusta</i> Kofoid, 1907	6, 8, 10, 13, 14, 15, 16, 18	X (16, 18)	X	X	X	X
<i>Pyrocystis</i> sp. J. Murray ex Haeckel, 1890	15, 18	X		X		
<i>Pyrophacus horologium</i> F. Stein, 1883	1, 2, 3, 6, 10, 16	X (16)	X	X	X	
<i>Pyrophacus</i> sp. Stein, 1883	13, 17, 18				X	X
<i>Pyrophacus steinii</i> (Schiller) Wall & Dale, 1971	10, 15, 16	X (16)	X	X	X	
<i>Schuetziella mitra</i> (Schütt) Balech, (1988)	14, 18				X	X
<i>Scrippsiella acuminata</i> (Ehrenberg) Kretschmann, Elbrächter, Zinssmeister, S. Soehner, Kirsch, Kusber & Gottschling, 2015 <sup>m</sup>	12, 18	X	X	X	X	
<i>Scrippsiella</i> sp. Balech ex A.R. Loeblich III, 1965	15, 18	X	X	X	X	X
<i>Scrippsiella spinifera</i> G. Honsell & M. Cabrini, 1991 *	18	X		X		
<i>Spatulodinium pseudonocitiluca</i> (Pouchet) J. Cachon & M. Cachon, 1968 *	18	X		X	X	
<i>Spiraulax kofoidii</i> H.W. Graham, 1942	11, 12, 18	X			X	
<i>Triadinium polyedricum</i> (Pouchet) Dodge, 1981	8, 10, 11, 12, 13, 14, 18	X	X	X	X	X
<i>Tripes angusticornis</i> (N. Peters) F. Gómez, 2013 <sup>m</sup>	10, 15			X	X	
<i>Tripes arietinus</i> (Cleve) F. Gómez, 2013 <sup>m</sup>	3, 7, 10, 12, 13, 15, 18	X	X	X	X	X
<i>Tripes arietinus</i> f. <i>gracilentus</i> (Jørgensen) F. Gómez, 2013 <sup>m</sup>	7					
<i>Tripes azoricus</i> (Cleve) F. Gómez, 2013 <sup>m</sup>	13, 15, 18		X	X	X	
<i>Tripes belone</i> (Cleve) F. Gómez, 2013 <sup>m</sup>	11, 12, 18			X	X	
<i>Tripes bigelowii</i> (Kofoid) F. Gómez, 2013 <sup>m</sup>	15			X		
<i>Tripes brevis</i> (Ostenfeld & Johannes Schmidt) F. Gómez, 2013 <sup>m</sup>	1, 2, 3, 4, 7		X			
<i>Tripes buceros</i> (Zacharias) F. Gómez, 2013 <sup>m</sup>	7					
<i>Tripes candelabrum</i> (Ehrenberg) F. Gómez, 2013 <sup>m</sup>	1, 2, 3, 6, 7, 8, 10, 11, 12, 13, 15, 16, 18	X (16, 18)	X	X	X	X
<i>Tripes candelabrum</i> var. <i>depressus</i> (Pouchet) F. Gómez, 2013 <sup>m</sup>	1, 2, 7		X			
<i>Tripes carriensis</i> (Gourret) F. Gómez, 2013 <sup>m</sup>	1, 2, 3, 7, 8, 15, 18	X	X	X		X
<i>Tripes cephalotus</i> (Lemmermann) F. Gómez, 2013 <sup>m</sup>	2, 6, 7, 8		X	X		
<i>Tripes concilians</i> (Jørgensen) F. Gómez, 2013 <sup>m</sup>	7					
<i>Tripes contortus</i> (Gourret) F. Gómez, 2013 <sup>m</sup>	1, 2, 3, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18	X (16, 18)	X	X	X	
<i>Tripes contrarius</i> (Gourret) F. Gómez, 2013 <sup>m</sup>	2, 8, 15		X	X		
<i>Tripes declinatus</i> (G. Karsten) F. Gómez, 2013 <sup>m</sup>	9, 10, 11, 12, 13, 14, 15, 16, 17, 18	X (16, 18)	X	X	X	X
<i>Tripes declinatus</i> var. <i>major</i> (Jørgensen) F. Gómez, 2013 <sup>m*</sup>	18	X		X		X
<i>Tripes deflexus</i> (Kofoid) F. Gómez, 2013 <sup>m</sup>	7, 9		X			
<i>Tripes dens</i> (Ostenfeld & Johannes Schmidt) F. Gómez, 2013 <sup>m</sup>	6		X			
<i>Tripes digitatus</i> (F. Schütt) F. Gómez, 2013 <sup>m</sup>	7, 11, 12				X	
<i>Tripes euarquatus</i> (Jørgensen) F. Gómez, 2013 <sup>m</sup>	7, 8, 9, 15	X (15)	X	X		
<i>Tripes eugrammus</i> (Ehrenberg) F. Gómez, 2013 <sup>m</sup>	8			X		
<i>Tripes extensus</i> (Gourret) F. Gómez, 2013 <sup>m</sup>	2, 7, 9, 10, 12, 13, 14, 15, 16, 18	X (16, 18)	X	X	X	
<i>Tripes falcatifomis</i> (Jørgensen) F. Gómez, 2013 <sup>m</sup>	7, 12, 14, 15			X	X	
<i>Tripes falcatus</i> (Kofoid) F. Gómez, 2013 <sup>m</sup>	16, 18	X (16)	X	X	X	
<i>Tripes furca</i> (Ehrenberg) F. Gómez, 2013 <sup>m</sup>	1, 2, 4, 6, 7, 9, 15, 16, 18	X (16, 18)	X	X		

(continued on next page)

Table 2 (continued)

	Sources	Illustration availability (picture, draw)	Shelf	Slope	Oceanic islands	Seamounts
<i>Tripes fustus</i> (Ehrenberg) F. Gómez, 2013 <sup>m</sup>	1, 2, 3, 4, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18	X (16, 18)	X	X	X	
<i>Tripes geniculatus</i> (Lemmermann) F. Gómez, 2013 <sup>m</sup>	6, 7, 10, 18			X	X	
<i>Tripes gibberus</i> (Gourret) F. Gómez, 2013 <sup>m</sup>	2, 3, 6, 7, 10, 11, 12, 13, 14, 15, 18	X	X	X	X	
<i>Tripes gravidus</i> (Gourret) F. Gómez, 2013 <sup>m</sup>	2, 3, 6		X	X		
<i>Tripes hexacanthus</i> (Gourret) F. Gómez, 2013 <sup>m</sup>	2, 3, 6, 7, 8, 10, 15, 18	X	X	X	X	X
<i>Tripes hexacanthus f. spiralis</i> (Kofoid) F. Gómez, 2013 <sup>m</sup>	2		X			
<i>Tripes horridus</i> (Cleve) F. Gómez, 2013 <sup>m</sup>	6, 7, 10, 13, 15, 16, 17, 18	X (16, 18)	X	X	X	X
<i>Tripes incisus</i> (Karsten) F. Gómez, 2013 <sup>m</sup>	7, 10, 18				X	X
<i>Tripes karstenii</i> (Pavillard) F. Gómez, 2013 <sup>m</sup>	7, 8, 12, 16	X (16)	X	X	X	
<i>Tripes kofoidii</i> (Jørgensen) F. Gómez, 2013 <sup>m</sup>	7, 15, 18	X	X	X		X
<i>Tripes limulus</i> (Pouchet) F. Gómez, 2013 <sup>m</sup>	6, 7, 12, 15, 18			X	X	X
<i>Tripes lineatus</i> (Ehrenberg) F. Gómez, 2013 <sup>m</sup>	6, 7, 10, 11, 12, 13, 15, 17, 18		X	X	X	
<i>Tripes longirostris</i> (Gourret) F. Gómez, 2013 <sup>m</sup>	1, 2, 7, 10, 12, 13, 14, 15, 16	X (16)	X	X	X	
<i>Tripes lunula</i> (Schimper ex Karsten) F. Gómez, 2013 <sup>m</sup>	3, 7, 10		X		X	
<i>Tripes macroceros</i> (Ehrenberg) F. Gómez, 2013 <sup>m</sup>	1, 2, 3, 6, 7, 8, 10, 11, 12, 13, 14, 15, 16, 17, 18	X (16, 18)	X	X	X	X
<i>Tripes massiliensis</i> (Gourret) F. Gómez, 2013 <sup>m</sup>	1, 2, 3, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18	X (16, 18)	X	X	X	X
<i>Tripes massiliensis f. armatus</i> (Karsten) F. Gómez, 2013 <sup>m</sup>	1, 2, 7, 10, 15		X	X	X	
<i>Tripes minutus</i> (Jørgensen) F. Gómez, 2013 <sup>m</sup>	15		X			
<i>Tripes mollis</i> (Kofoid) F. Gómez, 2013 <sup>m</sup>	10				X	
<i>Tripes muelleri</i> Bory de Saint-Vincent, 1827 <sup>m</sup>	1, 2, 3, 4, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18	X (15, 16, 18)	X	X	X	X
<i>Tripes muelleri f. parallelus</i> (Schmidt) F. Gómez, 2013 <sup>m</sup>	7					
<i>Tripes paradoxides</i> (Cleve) F. Gómez, 2013 <sup>m</sup>	7, 10				X	
<i>Tripes pavillardii</i> (Jørgensen) F. Gómez, 2013 <sup>m</sup>	7, 15		X			
<i>Tripes pentagonus</i> (Gourret) F. Gómez, 2013 <sup>m</sup>	1, 2, 6, 7, 12, 13, 14, 15, 16, 17, 18	X (16, 18)	X	X	X	X
<i>Tripes praelongus</i> (Lemmermann) F. Gómez, 2013 <sup>m</sup>	7					
<i>Tripes pulchellus</i> (Schröder) F. Gómez, 2013 <sup>m</sup>	6, 7, 10, 15, 18		X	X	X	X
<i>Tripes ranipes</i> (Cleve) F. Gómez, 2013 <sup>m</sup>	7, 15		X			
<i>Tripes recurvus</i> (Jørgesen) F. Gómez <sup>m</sup>	7, 8			X		
<i>Tripes reflexus</i> (Cleve) F. Gómez, 2013 <sup>m</sup>	2, 6, 7, 10, 12, 14		X	X	X	
<i>Tripes seta</i> (Ehrenberg) F. Gómez, 2013 <sup>m</sup>	7, 10, 15, 18		X	X	X	
<i>Tripes setaceus</i> (Jørgesen) F. Gómez, 2013 <sup>m</sup>	15, 14		X	X	X	
<i>Tripes strictus</i> (Okamura & Nishikawa) F. Gómez, 2013 <sup>m</sup>	10				X	
<i>Tripes subrobustus</i> (Jørgesen) F. Gómez, 2013 <sup>m</sup>	7					
<i>Tripes sumatranus</i> (Karsten) F. Gómez, 2013 <sup>m</sup>	3, 7, 8		X	X		
<i>Tripes teres</i> (Kofoid) F. Gómez, 2013 <sup>m</sup>	2, 7, 8, 10, 11, 12, 13, 14, 15, 16, 17, 18	X (16, 18)	X	X	X	X
<i>Tripes trichoceros</i> (Ehrenberg) F. Gómez, 2013 <sup>m</sup>	1, 2, 3, 7, 8, 9, 11, 15, 16, 18	X (16, 18)	X	X	X	X
<i>Tripes tripodioides</i> (Jørgesen) F. Gómez, 2013 <sup>m</sup>	7, 8, 15		X	X		
<i>Tripes volans</i> (Cleve) F. Gómez, 2013 <sup>m</sup>	2		X			
<i>Tripes vultur</i> (Cleve) F. Gómez, 2013 <sup>m</sup>	2, 6, 7, 10, 11, 12, 13, 14, 15, 16	X (16)	X	X	X	
<i>Tripesolenia depressa</i> Kofoid, 1906 *	18			X		
<b>OCHROPHYTA</b>						
<b>Bacillariophyceae</b>						
<b>Centric form</b>						
<b>&gt; 50 µm size</b>						
<i>Actinocyclus kützingii</i> (A. Schmidt) Simonsen	14, 15			X	X	
<i>Actinocyclus senarius</i> Ehrenberg, 1838	5	X (5)	X			
<i>Actinocyclus</i> sp. C.G. Ehrenberg, 1843	10, 13, 18				X	X
<i>Actinocyclus splendens</i> (Shadbolt) Ralfs ex Pritchard, 1861	5, 15	X (5)	X			
<i>Amphitetras antediluviana</i> Ehrenberg, 1840	17				X	
<i>Arachnoidiscus ehrenbergii</i> J.W. Bailey ex Ehrenberg	15		X			
<i>Asterolampra marylandica</i> Ehrenberg, 1844	15, 17			X	X	
<i>Asteromphalus heptactis</i> (Brébisson) Ralfs, 1861	15, 16	X (16)	X	X		
<i>Auliscus pruinosus</i> Bailey	5	X (5)	X			
<i>Auliscus sculptus</i> (W. Smith) Brightwell, 1860	5, 16	X (5, 16)	X			
<i>Bacteriastrium delicatulum</i> Cleve, 1897	1, 4, 5, 15	X (5)	X	X		
<i>Bacteriastrium furcatum</i> Shadbolt, 1854	15, 18		X	X		
<i>Bacteriastrium hyalinum</i> Lauder, 1864	1, 4, 5, 12, 15, 16, 18	X (5, 16, 18)	X	X	X	
<i>Bacteriastrium</i> sp. G. Shadbolt, 1854	15		X	X		
<i>Bacteriastrium</i> sp1 G. Shadbolt, 1854 *?	18	X		X	X	X
<i>Bellerochea malleus</i> (Brightwell) Van Heurck, 1885	1, 4, 5, 13, 16, 17	X (5, 16)	X		X	
<i>Biddulphia antediluviana</i> (Ehrenberg) Van Heurck, 1885	4, 5, 10, 17	X (5)	X		X	
<i>Biddulphia biddulphiana</i> (J.E. Smith) Boyer, 1900	1, 4, 5, 10, 12, 15, 16, 17	X (5, 16)	X	X	X	
<i>Biddulphia</i> sp. S.F. Gray, 1821	15		X			
<i>Biddulphia surella</i> (Ehrenberg) Rabenhorst, 1864	5		X			

(continued on next page)

Table 2 (continued)

	Sources	Illustration availability (picture, draw)	Shelf	Slope	Oceanic islands	Seamounts
<i>Biddulphia titiana</i> Grunow in Van Heurck, 1883	1, 4, 5	X (5)	X			
<i>Biddulphia tridens</i> (Ehrenberg) Ehrenberg, 1841	5, 15, 16	X (5, 16)	X			
<i>Biddulphia tuomeyi</i> (J.W. Bailey) Roper, 1859	1, 4, 15	X	X			
Centrics spp. Round & Crawford, 1990	18	X	X	X		X
<i>Cerataulina bergonii</i> Ostenfeld, 1903	1, 4, 5, 15, 18	X (5, 18)	X	X	X	
<i>Cerataulina</i> sp1H. Peragallo ex F. Schütt in Engler & Prantl, 1896 *	18	X				X
<i>Chaetoceros affinis</i> Lauder, 1864	1, 5, 9, 12, 15, 18	X (5, 18)	X	X	X	
<i>Chaetoceros anglicus</i> Grunow in Van Heurck, 1882	1, 5	X (5)	X			
<i>Chaetoceros atlanticus</i> Cleve, 1873	5, 10, 15	X (5)	X	X	X	
<i>Chaetoceros borealis</i> Bailey, 1854	15	X	X	X		
<i>Chaetoceros brevis</i> F. Schütt, 1895	5, 9, 15	X (5)	X			
<i>Chaetoceros coarctatus</i> Lauder, 1864	1, 5, 6, 8, 9, 10, 14, 15, 16, 18	X (5, 15, 16, 18)	X	X	X	X
<i>Chaetoceros compressus</i> Lauder, 1864	1, 5, 15	X (5)	X			
<i>Chaetoceros concavicornis</i> Mangin, 1917	15	X	X			
<i>Chaetoceros curvisetus</i> Cleve, 1889	1, 4, 5, 15, 16	X (5, 16)	X	X		
<i>Chaetoceros decipiens</i> Cleve, 1873	15, 18	X		X	X	
<i>Chaetoceros densus</i> (Cleve) Cleve, 1899	15	X	X			
<i>Chaetoceros didymus</i> Ehrenberg, 1845	1, 5, 9, 15	X (5)	X	X		
<i>Chaetoceros difficilis</i> Cleve, 1900	15	X	X			
<i>Chaetoceros distans</i> Cleve, 1873	15	X	X			
<i>Chaetoceros diversus</i> Cleve, 1873	1, 4, 5, 12, 15	X (5)	X	X	X	
<i>Chaetoceros holsaticus</i> F. Schütt, 1895	4, 18	X	X		X	
<i>Chaetoceros laciniosus</i> F. Schütt, 1895	15, 18	X	X	X	X	
<i>Chaetoceros levis</i> Schutt, 1896	4	X	X			
<i>Chaetoceros lorenzianus</i> Grunow, 1863	4, 5, 6, 10, 12, 13, 15, 16	X (5, 16)	X	X	X	
<i>Chaetoceros mitra</i> (Bailey) Cleve, 1896	5	X (5)	X			
<i>Chaetoceros pelagicus</i> Cleve *	18	X			X	
<i>Chaetoceros perpusillus</i> Cleve, 1897	15	X	X			
<i>Chaetoceros peruvianus</i> Brightwell, 1856	5, 10, 12, 13, 14, 15, 16, 18	X (5, 16, 18)	X	X	X	
<i>Chaetoceros pseudocurvisetus</i> Mangin, 1910	5, 12	X (5)	X		X	
<i>Chaetoceros saltans</i> Cleve, 1897	15	X	X			
<i>Chaetoceros septentrionalis</i> Cleve, 1896	15	X		X		
<i>Chaetoceros simplex</i> Ostenfeld, 1902 *	18	X			X	
<i>Chaetoceros</i> sp1C.G. Ehrenberg, 1844 *?	18	X			X	
<i>Chaetoceros</i> sp2C.G. Ehrenberg, 1844 *?	18	X			X	
<i>Chaetoceros</i> sp3C.G. Ehrenberg, 1844 *?	18	X			X	X
<i>Chaetoceros</i> spp. C.G. Ehrenberg, 1844	9, 10, 13, 15, 17, 18	X	X	X	X	
<i>Chaetoceros teres</i> Cleve, 1896	1, 5, 15	X (5)	X			
<i>Chaetoceros tetrastichon</i> Cleve, 1897	1, 5, 6, 15	X (5)	X	X		
<i>Chrysanthemodiscus floriatus</i> A. Mann, 1925	15, 16	X (15, 16)	X	X		
<i>Climacodium frauenfeldianum</i> Grunow, 1868	5, 6, 8, 15	X (5)	X	X		
<i>Corethron criophilum</i> Castracane, 1886	15	X	X			
<i>Corethron hystrix</i> Hensen, 1887	5, 6, 15	X (5)	X	X		
<i>Coscinodiscus asteromphalus</i> Ehrenberg, 1844	4	X	X			
<i>Coscinodiscus centralis</i> Ehrenberg, 1844	10	X (5, 16)	X	X	X	
<i>Coscinodiscus concavus</i> Ehrenberg, 1854	15	X	X			
<i>Coscinodiscus curvatulus</i> Grunow ex A. Schmidt, 1878	4	X	X			
<i>Coscinodiscus granii</i> Gough, 1905	1, 5, 14	X (5)	X		X	
<i>Coscinodiscus lineatus</i> Ehrenberg, 1841	5, 18	X (5)	X		X	
<i>Coscinodiscus marginatus</i> Ehrenberg, 1844	15	X		X		
<i>Coscinodiscus oculus-iridis</i> (Ehrenberg) Ehrenberg, 1840	5, 6, 10	X (5)	X	X	X	
<i>Coscinodiscus radiatus</i> Ehrenberg, 1840	15	X	X			
<i>Coscinodiscus radiolatus</i> Ehrenberg, 1854	15	X		X		
<i>Coscinodiscus</i> spp. C.G. Ehrenberg, 1839	6, 10, 13, 15, 18	X	X	X	X	X
<i>Ditylum brightwellii</i> (T. West) Grunow, 1885	4, 5, 6, 15, 16	X (5, 16)	X	X		
<i>Ethmodiscus gazellae</i> (C. Janisch ex Grunow) Hustedt, 1928	5, 6	X (5)	X	X		
<i>Gossleriella tropica</i> Schütt, 1892	15, 16, 18	X (16, 18)	X	X	X	
<i>Guinardia flaccida</i> (Castracane) H. Peragallo, 1892 *	18	X				X
<i>Guinardia</i> spp. H. Peragallo, 1892	9, 15	X	X	X		
<i>Guinardia striata</i> (Stolterfoth) Hasle, 1996	15, 16	X (15, 16)	X	X		
<i>Haslea wawriake</i> (Hustedt) Simonsen, 1974 *	18	X			X	X
<i>Helicotheca tamesis</i> (Shrubsole) M. Ricard, 1987	1, 4, 5, 9, 15, 17, 18	X	X	X	X	X
<i>Hemiaulus hauckii</i> Grunow ex Van Heurck, 1882	12, 15, 18	X	X	X	X	
<i>Hemiaulus indicus</i> Karsten, 1907	5, 18	X (5, 18)	X		X	
<i>Hemiaulus membranaceus</i> Cleve	1, 4, 5, 8, 9, 10, 11, 12, 15, 16, 18	X (5, 15, 16, 18)	X	X	X	X
<i>Hemiaulus sinensis</i> Greville, 1865	5, 6, 11, 12, 16	X (5, 16)	X	X	X	
<i>Hemiaulus</i> sp. P.A.C. Heiberg, 1863	9, 13, 15	X	X		X	
<i>Hemidiscus</i> sp. G.C. Wallich, 1860	13	X		X		
<i>Hobaniella longicuris</i> (Greville) P.A. Sims & D.M. Williams in Sims et al., 2018	4, 5	X (5)	X			
<i>Isthmia enervis</i> Ehrenberg, 1838	1, 4, 5, 6, 8, 9, 13, 15, 16, 17, 18	X (5, 16, 18)	X	X	X	X
<i>Isthmia</i> sp. C.A. Agardh, 1832	13	X			X	

(continued on next page)



Table 2 (continued)

	Sources	Illustration availability (picture, draw)	Shelf	Slope	Oceanic islands	Seamounts
<i>Lampriscus orbiculatum</i> (Shadbolt) Peragallo & Peragallo, 1902	13,14		X		X	
<i>Lampriscus shadboldianum</i> (Greville) H.Peragallo & M.Peragallo, 1902	10,18		X	X	X	
<i>Lampriscus</i> sp. A. Schmidt 1882	17				X	
<i>Lauderia borealis</i> Gran, 1900	5	X (5)	X			
<i>Lioloma pacificum</i> (Cupp) Hasle, 1996 *	18	X		X	X	X
<i>Lithodesmium</i> sp. C.G. Ehrenberg, 1839	9, 15		X	X		
<i>Lithodesmium undulatum</i> Ehrenberg, 1839	1, 4, 5, 6, 15, 17	X (5)	X	X	X	
<i>Melchersiela hexagonalis</i> Teixeira, 1958	4, 5, 6, 8, 9, 13, 14, 17, 18	X (5)	X	X	X	X
<i>Melosira borneri</i> Greville, 1833	15		X	X		
<i>Melosira</i> spp. C.A. Agardh, 1824	15, 18		X	X	X	
<i>Melosira sulcata</i> (Ehrenberg) Kützing, 1844	5		X			
<i>Odontella aurita</i> (Lyngbye) C. Agardh, 1832	4, 5, 9, 13	X (5)	X		X	
<i>Odontella regia</i> (Schultze) Simonsen, 1974	16	X (16)	X			
<i>Odontella</i> sp. C.A. Agardh, 1832	9		X			
<i>Odontella turgida</i> (Ehrenberg) Kützing, 1844	4, 5, 16	X (5, 16)	X			
<i>Palmeria hardmanniana</i> Greville, 1865	5, 6	X (5)	X	X		
<i>Paralia</i> sp. P.A.C. Heiberg, 1863	15		X			
<i>Paralia sulcata</i> (Ehrenberg) Cleve, 1873	6, 13, 15, 16, 17, 18	X (5, 15, 16, 18)	X	X	X	
<i>Planktoniella sol</i> (C.G. Wallich) Schütt, 1892	6, 8, 12, 13, 14, 15, 18	X	X	X	X	X
<i>Pleurosira laevis</i> (Ehrenberg) Compère, 1982	10				X	
<i>Proboscia alata</i> (Brightwell) Sundström, 1986	1, 5, 9, 14, 15, 16, 18	X (5, 16, 18)	X	X	X	X
<i>Proboscia indica</i> (H. Peragallo) Hernández-Becerril, 1995	16	X (5, 16)	X	X		
<i>Rhizosolenia acuminata</i> (H. Peragallo) H. Peragallo, 1907	5, 6, 15, 16	X (5, 16)	X	X		
<i>Rhizosolenia alata</i> var. <i>corpulenta</i> Cleve, 1897	15		X			
<i>Rhizosolenia bergonii</i> H. Peragallo, 1892	5, 6, 8, 14, 15	X (5)	X	X	X	
<i>Rhizosolenia calcar-avis</i> Schultze, 1858	1, 4, 5, 14, 15	X (5)	X		X	
<i>Rhizosolenia castracanei</i> H. Peragallo, 1888	5, 6, 8, 15, 18	X (5, 18)	X	X		X
<i>Rhizosolenia clevei</i> Ostefeld, 1902	12				X	
<i>Rhizosolenia cylindrus</i> Cleve, 1897	1, 5, 16, 18	X (5, 16, 18)	X	X		X
<i>Rhizosolenia delicatula</i> Cleve, 1900	12, 15		X	X	X	
<i>Rhizosolenia flaccida</i> Castracane, 1886	15		X	X		
<i>Rhizosolenia formosa</i> H. Peragallo, 1888	5, 6	X (5)	X			
<i>Rhizosolenia fragilissima</i> f. <i>fragilissima</i> Bergon, 1903	15		X	X		
<i>Rhizosolenia hebetata</i> Bailey, 1856	9, 14, 18	X	X		X	
<i>Rhizosolenia imbricata</i> Brightwell, 1858	4, 5, 6, 12, 14, 15, 16, 17, 18	X (5, 16, 18)	X	X	X	
<i>Rhizosolenia indica</i> H. Peragallo, 1892	5		X			
<i>Rhizosolenia robusta</i> G. Norman ex Ralfs, 1861	1, 5, 15	X (5, 15)	X	X		
<i>Rhizosolenia semispina</i> Hensen, 1887	1, 5, 15	X (5)	X	X		
<i>Rhizosolenia setigera</i> Brightwell, 1858	1, 4, 5, 9, 13, 15, 16	X (5, 16)	X	X	X	
<i>Rhizosolenia shrubsolei</i> Cleve, 1881	1, 5	X (5)	X			
<i>Rhizosolenia</i> spp. T. Brightwell, 1858	9, 12, 15	X	X	X	X	
<i>Rhizosolenia stouterfothii</i> H. Peragallo, 1888	1, 4, 5, 6, 15	X (5)	X	X		
<i>Rhizosolenia styliformis</i> T. Brightwell, 1858	1, 5, 6, 8, 9, 10, 14, 15, 16, 17, 18	X (5, 15, 16, 18)	X	X	X	X
<i>Skeletonema costatum</i> (Greville) Cleve, 1873	1, 4, 5, 9, 13, 15, 18	X (5, 18)	X	X	X	
<i>Spatangidium arachne</i> Brébisson, 1857	14, 15, 18	X	X	X	X	X
<i>Thalassiosira eccentrica</i> (Ehrenberg) Cleve, 1904	5, 15, 16	X (5, 16)	X	X		
<i>Triceratium alternans</i> f. <i>alternans</i> J.W. Bailey, 1851	5, 10	X (5)	X		X	
<i>Triceratium contortum</i> Shadbolt, 1854	4, 5	X (5)	X			
<i>Triceratium elongatum</i> Grunow, 1867	1, 4, 10		X		X	
<i>Triceratium favus</i> Ehrenberg, 1839	5, 12, 16	X (5, 16)	X		X	
<i>Triceratium formosum</i> f. <i>formosum</i> Brightwell, 1856	4		X			
<i>Triceratium orbiculatum</i> Schibkova in Krotov & Schibkova, 1959	1, 10		X		X	
<i>Triceratium pentacrinus</i> (Ehrenberg) Wallich, 1858	1, 4, 5, 13, 16, 17, 18	X (5, 16)	X		X	X
<i>Triceratium repletum</i> Greville	13, 15			X	X	
<i>Triceratium</i> sp. C.G. Ehrenberg, 1839	12				X	
<i>Triceratium</i> sp1.C.G. Ehrenberg, 1839 * <sup>2</sup>	18	X			X	X
<i>Trieres mobiliensis</i> (J.W. Bailey) Ashworth & E.C. Theriot in Ashworth, Nakov & E.C. Theriot, 2013	1, 4, 5, 6, 16, 18	X (5, 16, 18)	X	X		
<i>Trieres regia</i> (M. Schultze) M.P. Ashworth & E.C. Theriot, 2013 < 50 µm size	1, 4, 5, 15, 17	X (5)	X		X	
<i>Asteromphalus flabellatus</i> (Brébisson) Greville, 1859	15, 18		X	X	X	
<i>Auricula</i> sp. A.F. Castracane, 1873	1, 17		X		X	
<i>Chaetoceros cinctus</i> Gran, 1897	15			X		
<i>Chaetoceros danicus</i> Cleve, 1889	15		X	X		
<i>Chaetoceros rostratus</i> Ralfs, 1864	1, 5	X (5)	X			
<i>Chaetoceros socialis</i> H.S. Lauder, 1864	4, 12		X		X	
<i>Chaetoceros subtilis</i> Cleve, 1896	15		X	X		
<i>Coscinodiscus nitidus</i> Schmidt in Schmidt et al., 1878	15		X	X		
<i>Coscinodiscus scintillans</i> Greville, 1863	15		X	X		
<i>Cyclotella</i> sp1 (F.T. Kützing) A. de Brébisson, 1838 *	18	X		X	X	
<i>Lauderia confervacea</i> Cleve, 1896	15		X	X		
<i>Lauderia pumila</i> Castracane, 1886	15		X	X		

(continued on next page)

Table 2 (continued)

	Sources	Illustration availability (picture, draw)	Shelf	Slope	Oceanic islands	Seamounts
<i>Endictya oceanica</i> Ehrenberg, 1845	4		X			
<i>Eupodiscus radiatus</i> var. <i>antiqua</i> Cox in Kain & Schultze, 1889	4, 5	X (5)	X			
<i>Leptocyclus danicus</i> Cleve, 1889	4, 5, 6, 8, 9, 10, 15	X (5)	X	X	X	
<i>Leptocyclus</i> sp. P.T. Cleve in C.G.J. Petersen, 1889	15		X	X		
<i>Thalassiosira leptopus</i> (Grunow ex Van Heurck) Hasle & G. Fryxell, 1977	6, 15		X	X		
<i>Thalassiosira</i> sp. P.T. Cleve, 1873 emend. Hasle, 1973	12, 13, 14, 15, 17, 18		X	X	X	
<i>Thalassiosira subtilis</i> (Ostenfeld) Gran, 1900	15, 16	X (16)	X	X		
<b>Pennate form</b>						
<b>&gt; 50 µm size</b>						
<i>Achnanthes brevipes</i> C. Agardh, 1824	5, 6	X (5)	X			
<i>Achnanthes longipes</i> C. Agardh, 1824	5	X (5)	X			
<i>Achnanthes</i> sp. Bory, 1822	14				X	
<i>Amphiprora complexa</i> Gregory, 1857	9		X			
<i>Amphiprora</i> sp. C.G. Ehrenberg, 1843	1, 15, 17, 18		X		X	
<i>Ardissonea formosa</i> (Hantzsch) Grunow	13, 17				X	
<i>Asterionella bleakeleyi</i> var. <i>notata</i> Grunow, 1867	1, 4, 5, 6, 6, 9, 15, 18	X (5, 18)	X	X	X	
<i>Asterionella glacialis</i> Castracane, 1886	6, 9, 13, 14, 15, 16, 17, 18	X (15, 16, 18)	X	X	X	X
<i>Asterionella japonica</i> Cleve, 1882	1, 4, 5, 15	X (5)	X	X		
<i>Asterionella</i> sp. A.H. Hassall, 1850	15			X		
<i>Asterionella</i> sp1 A.H. Hassall, 1850 * <sup>2</sup>	18	X		X	X	
<i>Bacillaria paxillifera</i> (O.F. Müller) T. Marsson, 1901	4, 5, 6, 9, 15, 16, 17, 18	X (5, 16, 18)	X	X	X	
<i>Bacillaria ulna</i> Nitzsch, 1817	5	X (5)	X			
<i>Campylodiscus clypeus</i> (Ehrenberg) Ehrenberg ex Kützing, 1844	1, 5, 6, 13, 15, 17	X (5)	X	X	X	
<i>Campylodiscus ecclesianus</i> Greville	5	X (5)	X			
<i>Campylodiscus fastuosus</i> Ehrenberg, 1845	5	X (5)	X			
<i>Campylodiscus grevillii</i> Leuduger-Fortmorel, 1879	5		X			
<i>Campylodiscus</i> sp. C.G. Ehrenberg ex F.T. Kützing, 1844	4, 14		X		X	
<i>Campyloneis grevillei</i> (W. Smith) Grunow & Eulenstein in Grunow 1868	17	X (5)			X	
<i>Climaconeis mirifica</i> (W. Smith) Kuntze, 1898	1		X			
<i>Climacosphenia elongata</i> J.W. Bailey, 1854	10, 13, 17				X	
<i>Climacosphenia monilifera</i> Ehrenberg, 1843	1, 4, 5, 6, 10	X (5)	X		X	
<i>Cylindrotheca closterium</i> (Ehrenberg) Reimann & J.C. Lewin, 1964	4, 5, 6, 9, 10, 15, 17, 18	X (5, 15, 18)	X	X	X	X
<i>Diploneis bombus</i> (Ehrenberg) Ehrenberg, 1853	6, 9, 15, 17		X	X	X	
<i>Diploneis</i> spp. (C. G. Ehrenberg) P.T. Cleve, 1894	12, 13, 15, 17, 18		X	X	X	
<i>Epithemia</i> sp. F.T. Kützing, 1844	15		X			
<i>Frustulia rhomboides</i> (Ehrenberg) De Toni, 1891	5, 14	X (5)	X		X	
<i>Gyrosigma balticum</i> (Ehrenberg) Rabenhorst, 1853	4, 5, 6, 9, 16	X (5, 16)	X	X		
<i>Gyrosigma</i> sp. A.H. Hassall, 1845	15		X			
<i>Licmophora abbreviata</i> C. Agardh, 1831	6, 10, 15		X	X	X	
<i>Licmophora ehrenbergii</i> (Kützing) Grunow, 1867	10				X	
<i>Licmophora gracilis</i> (Ehrenberg) Grunow, 1867	10, 15		X		X	
<i>Licmophora lyngbyei</i> (Kützing) Grunow ex Van Heurck, 1867	13				X	
<i>Licmophora remulus</i> Grunow, 1867	13, 14, 15		X		X	
<i>Licmophora</i> sp. C.A. Agardh, 1827	9, 10, 12, 13, 15, 17		X		X	
<i>Lyrella lyra</i> (Ehrenberg) Karajeva, 1978	5, 6, 9, 13, 15, 16, 17, 18	X (5, 16, 18)	X	X	X	
<i>Navicula humerosa</i> f. <i>humerosa</i> Brébisson ex W. Smith, 1856	5, 14	X (5)	X		X	
<i>Nitzschia longissima</i> (Brébisson) Ralfs, 1861	6, 9, 10, 12, 13, 15, 17, 18	X	X	X	X	X
<i>Nitzschia longissima</i> var. <i>reversa</i> Grunow, 1880	15		X	X		
<i>Nitzschia lorenziana</i> Grunow, 1879	15, 18	X	X	X	X	
<i>Nitzschia lorenziana</i> var. <i>incerta</i> Grunow in Cleve & Grunow, 1880	13				X	
<i>Nitzschia pungens</i> Grunow ex Cleve, 1897	15		X			
<i>Nitzschia pungens</i> var. <i>atlantica</i> Cleve, 1897	4, 5	X (5)	X			
<i>Nitzschia sigma</i> (Kützing) W. Smith, 1853	4, 6, 9, 13, 15, 17, 18	X	X		X	
<i>Nitzschia sigma</i> var. <i>intercedens</i> Grunow, 1878	15		X			
<i>Nitzschia spathulata</i> W. Smith, 1853	17, 18	X			X	
Pennate 1 Mann, 1990 * <sup>2</sup>	18	X	X			
<i>Pinnularia crabro</i> Ehrenberg, 1844	15		X			
<i>Pinnularia</i> sp. C.G. Ehrenberg, 1843 *	18	X			X	
<i>Plagiotropis lepidoptera</i> (Gregory) Kuntze, 1898	15, 18	X	X		X	
<i>Plagiotropis</i> sp1 E. Pfitzer, 1871 *	18	X	X	X	X	X
<i>Pleuro/Gyrosigma</i> sp. Haeckel, 1878	9, 17		X		X	
<i>Pleurosigma affine</i> Grunow, 1880	15		X	X		
<i>Pleurosigma angulatum</i> (Queckett) W. Smith, 1852	15		X			
<i>Pleurosigma scalprum</i> var. <i>gallicum</i> Grunow in Van Heurck, 1880–1885	15		X			
<i>Pleurosigma</i> spp. W. Smith, 1852	9, 12, 14, 15		X	X	X	
<i>Pleurosigma virginicum</i> H.L. Smith, 1877 *	18	X	X			
<i>Podocystis adriatica</i> (Kützing) Ralfs, 1861	4, 5, 9, 13, 14, 16, 17, 18	X (5, 16, 18)	X	X	X	
<i>Podocystis americana</i> Bailey, 1854	10				X	
<i>Podocystis</i> sp. J.W. Bailey, 1854	14				X	
<i>Podosphenia ovata</i> W. Smith, 1853	10				X	
<i>Pseudo-nitzschia delicatissima</i> (Cleve) Heiden, 1928	9		X			
<i>Pseudo-nitzschia pungens</i> (Grunow ex Cleve) G.R. Hasle, 1993	9, 15, 18		X		X	

(continued on next page)

Table 2 (continued)

	Sources	Illustration availability (picture, draw)	Shelf	Slope	Oceanic islands	Seamounts
<i>Pseudo-nitzschia seriata complex</i> H. Peragallo in H. Peragallo & M. Peragallo, 1900 *	18	X	X	X		
<i>Pseudo-nitzschia</i> sp. H. Peragallo in H. Peragallo & M. Peragallo, 1900	10, 15	X	X	X	X	
<i>Pseudo-nitzschia</i> sp1H. Peragallo in H. Peragallo & M. Peragallo, 1900 *	18	X		X	X	
<i>Pseudosolenia calcar-avis</i> (Schultze) B.G. Sundström, 1986	6, 12, 16, 18	X (16, 18)	X	X	X	X
<i>Rhabdonema adriaticum</i> Kützing, 1844	1, 4, 5, 9, 10, 13, 14, 15, 16, 17, 18	X (5, 16, 18)	X	X	X	
<i>Rhabdonema punctatum</i> (Harvey & Bailey) Stodder, 1880	4, 5, 9, 10, 15	X (5)	X		X	
<i>Rhabdonema</i> sp. F.T. Kützing, 1844	9, 13	X	X		X	
<i>Schizonema smithii</i> var. <i>smithii</i> Agardh, 1824	15	X	X			
<i>Streptotheca thamesis</i> var. <i>thamesis</i> Shrubsole, 1890	6	X (5)	X	X		
<i>Striatella interrupta</i> (Ehrenberg) Heiberger, 1863	1, 4, 5, 13, 15, 16	X (5, 16)	X		X	
<i>Striatella</i> sp. C.A. Agardh, 1832	9, 18	X	X			
<i>Striatella unipunctata</i> (Lyngbye) C. Agardh, 1832	1, 5, 6, 9, 13, 16, 18	X (5, 16, 18)	X	X	X	
<i>Surirella fastuosa</i> (Ehrenberg) Ehrenberg, 1843	13, 14, 17	X (5)			X	
<i>Surirella febrigerii</i> F.W. Lewis, 1861	4, 5, 16	X (5, 15, 16)	X			
<i>Surirella gemma</i> f. <i>gemma</i> Ehrenberg, 1840	4	X	X			
<i>Surirella nervata</i> (Grunow) Mereschkowsky, 1902	5	X (5)	X			
<i>Surirella recedens</i> var. <i>recedens</i> Schmidt in Schmidt et al., 1875	5	X (5)	X			
<i>Surirella</i> sp. P.J.F. Turpin, 1828	14	X			X	
<i>Surirella</i> sp1 P.J.F. Turpin, 1828 * <sup>?</sup>	18	X	X	X		
<i>Synedra acus</i> var. <i>acus</i> Kützing, 1844	18	X			X	
<i>Synedra crystallina</i> (C. Agardh) Kützing, 1844	18	X			X	
<i>Synedra doliolus</i> Wallich, 1860	14				X	
<i>Synedra</i> sp. C.G. Ehrenberg, 1830	10, 13, 15, 17		X	X	X	
<i>Synedra</i> sp1 C.G. Ehrenberg, 1830 * <sup>?</sup>	18	X	X	X	X	
<i>Tabularia fasciculata</i> (C. Agardh) D.M. Williams & Round, 1986 *	18	X			X	
<i>Terpsinoë musica</i> Ehrenberg, 1843	1, 5, 15	X (5)	X			
<i>Thalassionema frauenfeldii</i> (Grunow) Tempère & Peragallo, 1910	1, 5, 9, 15, 16	X (5, 16)	X			
<i>Thalassionema nitzschioides</i> (Grunow) Mereschkowsky, 1902	1, 4, 5, 9, 15, 16, 18	X (5, 16, 18)	X	X	X	X
<i>Thalassiothrix longissima</i> Cleve & Grunow, 1880 *	18	X			X	
<i>Thalassiothrix</i> sp. P.T. Cleve & A. Grunow, 1880	15		X			
<i>Thalassiothrix</i> sp1 P.T. Cleve & A. Grunow, 1880 * <sup>?</sup>	18	X		X		X
<i>Toxarium undulatum</i> Bailey, 1854	4, 5, 10, 13, 15, 17		X		X	
<i>Trachyneis aspera</i> (Ehrenberg) Cleve, 1894	13, 17, 18		X	X	X	
<i>Tropidoneis seriata</i> Cleve, 1892	5, 6, 15	X (5)	X			
<i>Tropidoneis</i> sp. P.T. Cleve, 1891	17				X	
<i>Tryblionella gracilis</i> W. Smith, 1853	15		X			
<i>Tryblionella punctata</i> W. Smith, 1853	17				X	
<b>&lt; 50 µm size</b>						
<i>Amphora arenaria</i> Donkin, 1858	5, 6, 13, 17	X (5)	X		X	
<i>Amphora egregia</i> Ehrenberg, 1861	9		X			
<i>Amphora fluminensis</i> Grunow 1863	13				X	
<i>Amphora ostrearia</i> Brébisson, 1849	9		X			
<i>Amphora</i> sp. C.G. Ehrenberg ex F.T. Kützing, 1844	9, 10, 13, 14, 15, 17, 18	X	X		X	
<i>Amphora</i> sp1 C.G. Ehrenberg ex F.T. Kützing, 1844 * <sup>?</sup>	18					X
<i>Amphora</i> sp2 C.G. Ehrenberg ex F.T. Kützing, 1844 * <sup>?</sup>	18			X		
<i>Amphora turgida</i> var. <i>turgida</i> Gregory, 1857 *	18		X			
<i>Campyloneis</i> sp. A. Grunow, 1862	18		X			
<i>Campylotira</i> sp. A. Grunow ex H. Van Heurck, 1885 *	18	X		X	X	X
<i>Cocconeis regalis</i> Greville, 1859	4		X			
<i>Cocconeis scutellum</i> Ehrenberg, 1838	4, 5, 6, 13, 17, 18	X (5, 18)	X	X	X	
<i>Cocconeis</i> sp. C.G. Ehrenberg, 1837	13	X			X	
<i>Dimeregramma dubium</i> (Grunow) Grunow in Van Heurck, 1881	9		X	X		X
<i>Dimeregramma</i> sp. J. Ralfs in A. Pritchard, 1861	17				X	
<i>Entomoneis alata</i> (Ehrenberg) Ehrenberg, 1845	4, 6, 17, 18	X	X	X	X	X
<i>Fragilaria capucina</i> Desmazières, 1830	9, 15		X	X		
<i>Fragilaria hyalina</i> (Kützing) Grunow ex Van Heurck, 1880	15		X			
<i>Fragilaria</i> sp. H.C. Lyngbye, 1819	1, 15		X			
<i>Fragilariopsis</i> sp. F. Hustedt in A. Schmidt et al., 1913	12				X	
<i>Grammatophora flexuosa</i> Grunow, 1881	5	X (5)	X			
<i>Grammatophora hamulifera</i> Kützing, 1844	5	X (5)	X			
<i>Grammatophora marina</i> (Lyngbye) Kützing, 1844	4, 5, 15, 16	X (5, 16)	X			
<i>Grammatophora oceanica</i> Ehrenberg, 1840	5, 15, 16, 17	X (5, 16)	X	X	X	
<i>Grammatophora serpentina</i> Ehrenberg, 1844	13, 15		X		X	
<i>Grammatophora</i> sp. C.G. Ehrenberg, 1840	10, 15, 17, 18		X	X	X	
<i>Mastogloia fimbriata</i> (T. Brightwell) Grunow, 1863	5	X (5)	X			
<i>Mastogloia</i> sp1 G.H.K. Thwaites in W. Smith, 1856 *	18	X	X		X	
<i>Mastogloia splendida</i> (Gregory) H. Pergallo, 1888	16	X (5, 16)	X	X		
<i>Navicula fastuosa</i> Ehrenberg, 1840	5		X			
<i>Navicula incurvata</i> Gregory, 1856	14				X	
<i>Navicula lewistana</i> Greville, 1863	4		X			
<i>Navicula marina</i> var. <i>marina</i> Ralfs in Pritchard, 1861	5, 14, 15	X (5)	X		X	

(continued on next page)

Table 2 (continued)

	Sources	Illustration availability (picture, draw)	Shelf	Slope	Oceanic islands	Seamounts
<i>Navicula membranacea</i> Cleve, 1897	15, 18	X	X	X		X
<i>Navicula powellii</i> sensu H. Peragallo, 1888	15		X			
<i>Navicula cf trevelyana</i> J.B.M. Bory de Saint-Vincent, 1822	15		X			
<i>Navicula</i> sp1 J.B.M. Bory de Saint-Vincent, 1822 * <sup>?</sup>	18	X	X			
<i>Navicula</i> sp3 J.B.M. Bory de Saint-Vincent, 1822 * <sup>?</sup>	18	X	X		X	
<i>Navicula</i> sp4 J.B.M. Bory de Saint-Vincent, 1822 * <sup>?</sup>	18	X		X	X	X
<i>Navicula</i> sp2 J.B.M. Bory de Saint-Vincent, 1822 * <sup>?</sup>	18	X	X			
<i>Navicula</i> sp5 J.B.M. Bory de Saint-Vincent, 1822 * <sup>?</sup>	18	X		X		
<i>Navicula splendida</i> var. <i>splendida</i> Gregory, 1856	13				X	
<i>Navicula</i> spp. J.B.M. Bory de Saint-Vincent, 1822	6, 9, 10, 12, 13, 14, 15, 17, 18	X	X	X	X	
<i>Nitzschia distans</i> sensu Brockmann, 1950	17				X	
<i>Nitzschia granulata</i> Grunow, 1880	5	X (5)	X			
<i>Nitzschia pacifica</i> Cupp, 1943	13, 15, 17			X	X	
<i>Nitzschia panduriformis f. panduriformis</i> Gregory, 1857	15, 17		X		X	
<i>Nitzschia</i> sp1 A.H. Hassall, 1845 * <sup>?</sup>	18	X			X	
<i>Nitzschia</i> sp2 A.H. Hassall, 1845 * <sup>?</sup>	18	X			X	X
<i>Nitzschia</i> sp3 A.H. Hassall, 1845 * <sup>?</sup>	18	X	X		X	
<i>Nitzschia</i> spp. A.H. Hassall, 1845	6, 9, 10, 13, 15, 17		X	X	X	
<i>Nitzschia tryblionella</i> Hantzsch, 1860	1, 5	X (5)	X			
<i>Plagiogramma</i> sp. R.K. Greville, 1859	15, 18		X	X		
<i>Rhaphoneis amphicerus</i> (Ehrenberg) Ehrenberg, 1844	5	X (5)	X			
<i>Rhaphoneis discoides</i> Subrahmanyam, 1946	5	X (5)	X			
<i>Stauroneis</i> sp. C.G. Ehrenberg, 1843 *	18	X				X
<b>Dictyochophyceae</b>						
<i>Dictyocha fibula</i> Ehrenberg 1839	12, 13, 14, 15, 17, 18	X (15, 18)	X	X	X	X
<i>Octactis octonaria</i> (Ehrenberg) Hovasse, 1946 *	18	X			X	
<i>Octactis speculum</i> (Ehrenberg) F.H. Chang, J.M. Grieve & J.E. Sutherland, 2017	13, 15, 18	X (15)	X	X	X	
<b>CYANOBACTERIA</b>						
<b>Cyanophyceae</b>						
<i>Anabaena</i> sp. Bory de Saint-Vincent ex Bornet & Flahault, 1886	17				X	
<i>Anabaena</i> sp1 Bory de Saint-Vincent ex Bornet & Flahault, 1886 * <sup>?</sup>	18	X		X		
<i>Aphanocapsa</i> sp1C. Nägeli, 1849 *	18	X				X
<i>Aphanocapsa</i> sp2 C. Nägeli, 1849 *	18	X		X		X
<i>Arthrospira</i> sp1 Sitzenberger ex Gomont, 1892 *	18	X		X		
<i>Chroococcus</i> sp. Nägeli, 1849	15		X			
<i>Chroococcus turgidus</i> (Kützing) Nägeli, 1849	15			X		
Cyanophyceae spp. Schaffner, 1909	13, 17				X	
<i>Jaaginema</i> sp1 Anagnostidis & Komárek, 1988 *	18	X		X	X	
<i>Katagnymene pelagica</i> Lemmermann, 1899	11, 12				X	
<i>Katagnymene spiralis</i> Lemmermann, 1899	12				X	
<i>Lyngbya anomala</i> (C.B. Rao) Umezaki & Watanabe, 1994	9		X			
<i>Lyngbya</i> sp. C. Agardh ex Gomont, 1892	9, 14, 15, 17		X		X	
<i>Lyngbya</i> sp1C. Agardh ex Gomont, 1892 * <sup>?</sup>	18	X		X	X	X
<i>Merismopedia</i> sp. Meyen, 1839	15		X			
<i>Microcystis</i> sp. Lemmermann, 1907	15		X			
<i>Oscillatoria perornata</i> Skuja, 1949	9		X			
<i>Oscillatoria princeps</i> Vaucher ex Gomont, 1892	6, 8		X	X		
<i>Oscillatoria cf. margaritifera</i> Vaucher ex Gomont, 1892 *	18	X	X	X	X	
<i>Oscillatoria</i> sp1 Vaucher ex Gomont, 1892 * <sup>?</sup>	18	X			X	
<i>Oscillatoria</i> spp. Vaucher ex Gomont, 1892	6, 8, 9, 10, 13, 15, 17		X	X	X	
<i>Phormidium retzii</i> Kützing ex Gomont, 1892	9		X			
<i>Phormidium</i> sp. Kützing ex Gomont, 1892	9, 15		X	X		
<i>Phormidium</i> sp1 Kützing ex Gomont, 1892 * <sup>?</sup> (=Katagnymene?)	18	X			X	
<i>Phormidium</i> sp2 Kützing ex Gomont, 1892 * <sup>?</sup> (=Katagnymene?)	18	X	X		X	
<i>Planktolynghya</i> sp. Anagnostidis & Komárek, 1988	14				X	
<i>Planktolynghya cf. limnetica</i> Anagnostidis & Komárek, 1988 *	18	X		X	X	X
<i>Pseudanabaena</i> sp1 Lauterborn, 191 *	18	X				
<i>Richelia intracellularis</i> J.A. Schmidt, 1901	1, 12, 13, 14, 18	X (12, 18)	X	X	X	X
<i>Rivularia</i> sp. C. Agardh ex Bornet & Flahault, 1886	15		X			
<i>Scytonematopsis crustacea</i> (Thuret ex Bornet & Flahault) Koválik & Komárek, 1988	15	X (15)	X	X		
<i>Spirulina</i> sp. Turpin ex Gomont, 1892	4, 9, 18		X			
<i>Stichosiphon sansibaricus</i> (Hieronymus) F.E. Drouet & W.A. Daily, 1956	9		X			
<i>Trichodesmium clevei</i> (J. Schmidt) Anagnostidis & Komárek, 1988 *	18	X			X	
<i>Trichodesmium erythraeum</i> Ehrenberg ex Gomont, 1892	4, 6, 8, 11, 12, 14, 15	X (12, 15)	X	X	X	
<i>Trichodesmium hildebrandtii</i> Gomont, 1892	12	X (12)			X	
<i>Trichodesmium radicans</i> (Wille ex Kirchner) Golubic, 1978	12				X	
<i>Trichodesmium</i> sp. Ehrenberg ex Gomont, 1892	1		X			
<i>Trichodesmium thiebautii</i> Gomont ex Gomont, 1890	9, 10, 11, 12, 13, 14, 15, 17, 18	X	X	X	X	X
<b>HAPTOPHYTA</b>						
<b>Prymnesiophyceae</b>						

(continued on next page)

Table 2 (continued)

	Sources	Illustration availability (picture, draw)	Shelf	Slope	Oceanic islands	Seamounts
<i>Emiliania huxleyi</i> (Lohmann) W.W. Hay & H.P. Mohler, 1967	13, 17, 18	X		X	X	X
<i>Calciosolenia brasiliensis</i> (Lohmann) J.R. Young, 2003	15			X		
<i>Calciosolenia murrayi</i> Gran, 1912	15	X (15)		X		
Coccolithophorid 1 (cf Rhabdosphaeraeace Lemmermann, 1908) *	18	X			X	
Coccolithophorid 2 *	18	X		X	X	
Coccolithophorid 3 *	18	X			X	
Coccolithophorid 4 *	18	X		X		X
<i>Coccolithus</i> sp1 E.H.L. Schwarz, 1894	17				X	
<i>Coccolithus</i> sp2 E.H.L. Schwarz, 1894	17				X	
<i>Discosphaera tubifer</i> (Murray & Blackman) Ostenfeld, 1900	15			X		
<i>Papposphaera lepida</i> Tangen, 1972	15			X		
<i>Phaeocystis</i> sp. Lagerheim, 1893 *	18	X		X		
<i>Pontosphaera discopora</i> Schiller, 1930	12				X	
<i>Pontosphaera</i> sp. Lohmann, 1902 *	18	X				X
<i>Scyphosphaera apsteinii</i> Lohmann, 1902	13, 18	X (15, 18)			X	X
<i>Syracosphaera pulchra</i> Lohmann, 1902 *	18	X			X	
<i>Syracosphaera</i> sp. Lohmann, 1902	13				X	
PLANTAE						
<b>Charophyta</b>						
<i>Closterium setaceum</i> Ehrenberg ex Ralfs, 1848	15		X	X		
<i>Closterium</i> sp. Nitzsch ex Ralfs, 1848	15		X			
<b>Chlorophyta</b>						
<i>Ankistrodesmus</i> sp. Corda, 1838	15		X			
<i>Characium</i> sp. A. Braun, 1849	15			X		
Chlorophyceae 1 Wille, 1884 *	18					X
Chlorophyceae 2 Wille, 1884 *	18				X	X
Chlorophyceae 3 Wille, 1884 *	18					X
Chlorophyceae 4 Wille, 1884 *	18		X			
<i>Korshikovella</i> sp. P.C. Silva, 1959	15, 18	X (15)	X	X		X
<i>Pterosperma marginatum</i> Gaarder, 1954 *	18	X			X	
<i>Pterosperma moebii</i> (Jørgensen) Ostenfeld, 1901 *	18	X		X		
<i>Pterosperma</i> sp. Pouchet, 1893	15			X		
<i>Cladophora</i> sp. Kützing, 1843	15		X			
<i>Echinospaerella limnetica</i> G.M. Smith, 1920	15		X			
<i>Monactinus simplex</i> (Meyen) Corda, 1839	15		X			
<i>Scenedesmus</i> sp. Meyen, 1829	15		X			
<i>Rhizoclonium</i> sp. Kützing, 1843	9		X			
<b>Cryptophyta</b>						
<i>Plagioselmis prolunga</i> Butcher ex G. Novarino, I.A.N. Lucas & S. Morrall, 1994 *	18	X			X	
EUGLENOZOA						
<b>Euglenoida</b>						
Euglenophyceae sp. Cavalier-Smith, 1981	9, 18		X		X	
<i>Eutreptia</i> sp. Perty, 1852	15		X			
<i>Eutreptiella</i> sp. A. da Cunha, 1914	15		X	X		
<i>Lepocinclis acus</i> (O.F. Müller) B. Marin & Melkonian, 2003	6	X (15)		X		
<i>Euglena</i> sp. Ehrenberg, 1830	4	X (15)	X			
<i>Phacus</i> sp. Dujardin, 1841	15		X	X		

over the shelf, the slope, the oceanic islands and the seamounts of the region, respectively (Fig. 1c). For each sample, approximately 2 L was concentrated by filtration on 5 µm filters (47 mm diameter, PC) and resuspended in 30 mL of 0.2 µm seawater, fixed with lugol at 4 % final concentration and stored in the dark at 4°C. To complement these observations, in 15 stations representative of each area, samples were collected using an oblique plankton net with a 20 µm mesh-size (Fig. 1c). These oblique tows were achieved from 200 m to the surface at offshore stations and from the bottom to the surface at shelf stations. These net samples were concentrated in 250 mL bottles, fixed with buffered formaldehyde at 4 % final concentration and stored at room temperature in the dark until analysis.

For Niskin samples, taxonomic identification was performed from observations and pictures taken with 20X or 40X objectives using an inverted microscope (TCM 400 Labomed) equipped with an iVu 5000 Labomed camera (operating with the Jenoptik's application), using Utermöhl chambers where at least 400 cells were counted. Phytoplankton net samples were observed between slides and coverslips (about ten slides for each concentrated sample) with 20X, 40X (DIC or not) and 100X objectives using an upright microscope (AxioScope 1 Zeiss) equipped with an AxioCam MRC Zeiss camera. Formol fixation of

the net samples allowed us to detect cells morphological details that might have been obscured by the lugol staining, and to verify the identifications made during the counting of lugol-stained samples. Taxa were identified at the lowest possible taxonomic level (class, genus or species) according to the literature, in particular Taylor (1976), Balech (1988), Licea et al. (1995), Tomas et al. (1997), Tenenbaum (2006), Gomez et al. (2008) and Hoppenrath et al. (2009), and verified using WoRMS « World Register of Marine Species » (<http://www.marinespecies.org>). Taxa identified at the genus level for which we could not identify the species were designated as ".spx". Whenever possible, photographs were taken and identifying characteristics documented. All high-quality species pictures were included in an open-access global phytoplankton recognition and identification database (Carré and Fabre, 2021 - [https://data.oreme.org/plankton/plankton\\_gallery/index/phyto](https://data.oreme.org/plankton/plankton_gallery/index/phyto)), which is linked to standard diversity databases such as WoRMS and GBIF.

#### 2.4. New records

The identification of new records depends on the accuracy of the taxonomic identification in both the reviewed literature and the



ABRACOS data. When taxonomic identification to species level was not possible, we used the available images from publications to differentiate between taxa, and assigned a unique ".spx" to each taxon. However, when no images were available, we were unable to differentiate undetermined species from the literature, which hindered the identification of potential new records. The ABRACOS taxa that were not identified at the specific level and/or for which we had no images but the genus was already recorded in the literature, were recorded as potential new records. These taxa were grouped based on their lowest identified level and named accordingly, with the addition of ".sp" (or ".spp" when several species were differentiated for the same genus, as indicated in the checklist, Table 2).

### 3. Results

#### 3.1. Review

The online bibliographic search showed that most of the articles retrieved related to research on marine phytoplankton biodiversity further south in Brazil, or described ecosystems at the interface or very

close to the coast. Very few described communities of the northeastern shelf and oceanic ecosystems. This search, supplemented by the exchanges within our working group, identified 17 publications describing phytoplankton communities in Northeast Brazil, covering the period from 1972 to 2022 (publication years) (Table 1). These works were primarily authored by the phytoplankton group of the Department of Oceanography at the UFPE, and were conducted in collaboration with local fishers boats, the Brazilian Navy, and research vessels through international partnerships with England, Germany, Panama, the USA, and more recently, France through the ABRACOS surveys. Until 2010, these studies focused on the coastal regions, specifically the continental shelf and slope of the states of Pernambuco, Ceará, Paraíba and Alagoas (Eskinazi-Leça and Passavante, 1972; Passavante, 1979; Passavante et al., 1982; Eskinazi-Leça et al., 1989; Silva-Cunha and Eskinazi-Leça, 1990; Koenig and Macêdo, 1999; Koenig and Lira, 2005; Koenig et al., 2009; Santos et al., 2010). Phytoplankton organisms were typically sampled with a 64 µm mesh size plankton net, enabling the observation of the largest species. From 2011–2016 (with the latest Jales et al.; 2022 publication), the focus shifted to the description of phytoplankton communities around oceanic archipelagos/islands (Fernando

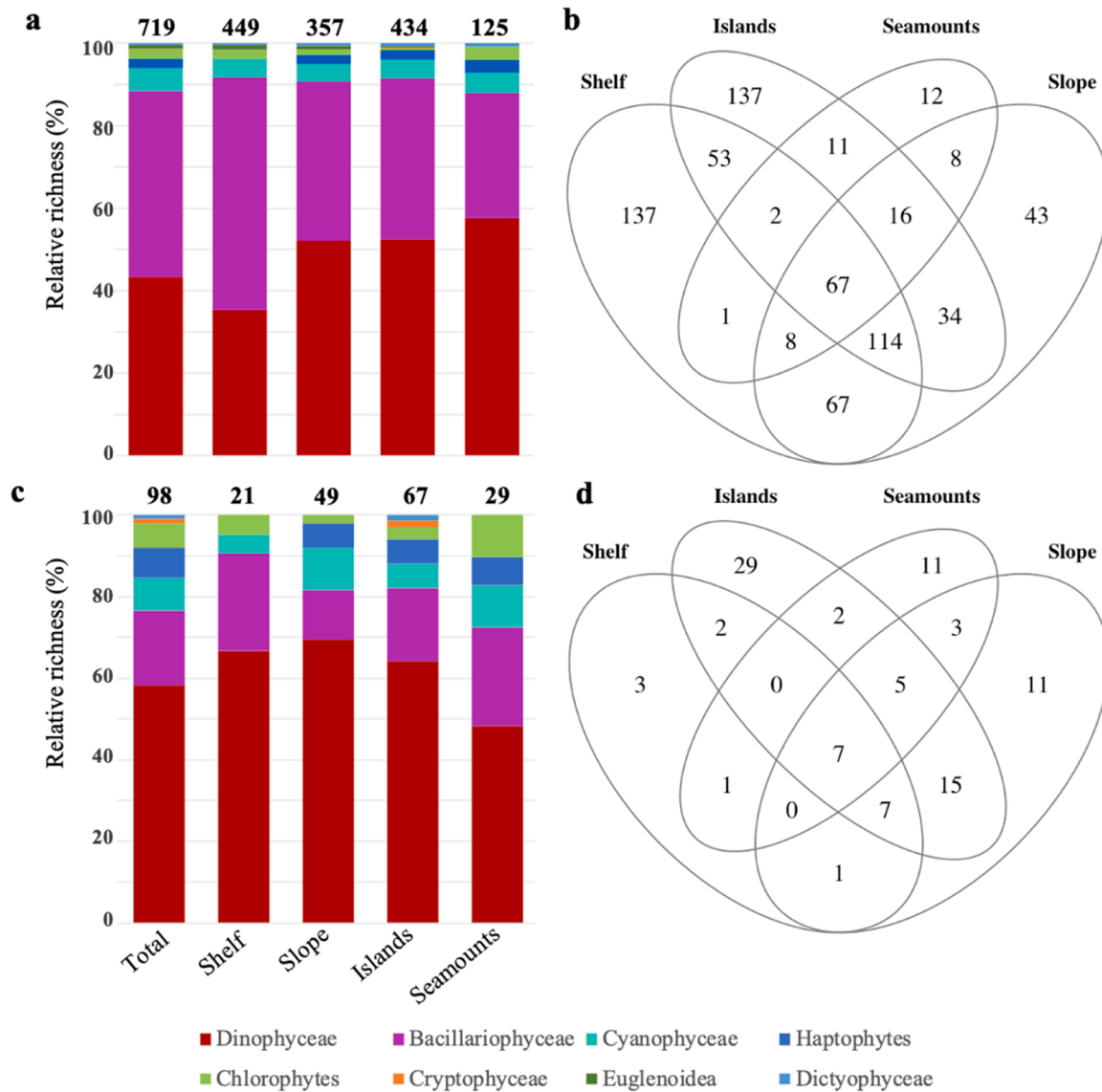


Fig. 2. Relative phytoplankton richness by group and area, for the complete checklist (a) and the ABRACOS new records (c). The bold numbers above each bar indicate the number of taxa recorded. Venn diagrams representing the number of exclusive and common taxa in the four areas for the complete checklist (b) and the ABRACOS new records (d).

de Noronha, São Pedro and São Paulo) and the Rocas Atoll (Tiburcio et al., 2011; Queiroz et al., 2014, 2015; Jales et al., 2015; Aquino, 2016). During this phase, the sampling protocols were refined by incorporating the use of nets with smaller mesh-size and Niskin bottles for sampling at different depths. This refinement enabled a greater richness of taxa to be observed at each location. Subsequently, in 2019, two comprehensive studies focused on the Brazilian Northeast coastal region (Silva-Cunha, Koenig, et al., 2019; Silva-Cunha, Leça, et al., 2019). Silva-Cunha, Koenig, et al. (2019) described diatoms and dinoflagellates observed in the Bacia Potiguar. Meanwhile, Silva-Cunha, Leça, et al. (2019) identified a total of 331 taxa in the total phytoplankton flora observed in the Bacia de Sergipe-Alagoas.

### 3.2. Checklist

A total of 719 phytoplankton taxa were observed from the literature and ABRAÇOS data (Table 2), with varying distribution patterns in different areas, including the shelf, slope, islands and seamounts areas, with 449, 357, 434 and 125 taxa documented, respectively (Fig. 2a). Bacillariophyceae (diatoms, 45.1 % of the total number of species, 325 taxa) and Dinophyceae (dinoflagellates, 43.3 %, 312 taxa) contributed most to this richness (Fig. 2a). Cyanophyceae (39 taxa), Haptophytes (Prymnesiophyceae and silicoflagellates, 17 taxa) and Chlorophytes (17 taxa) together accounted for 10.2 % of the total richness. Euglenoidea (6 taxa), Dictyophyceae (3 taxa), and Cryptophyceae (1 taxon) represented only 1.3 % of the total richness (Fig. 2a).

The shelf and islands areas exhibited higher exclusive richness, with 137 taxa each, followed by the slope with 43 taxa and the seamounts with 12 taxa (Fig. 2b). Notably, 53 taxa were common to both the shelf and islands areas. Moreover, a large number of taxa observed on the slope were common to the shelf and islands areas (114 taxa), the islands and seamounts areas (16 taxa), or exclusively with the shelf (67 taxa) or the islands areas (34 taxa). The seamounts area shared few taxa with the other areas, 11 taxa with the islands, 8 with the slope and 1 with the shelf. A total of 67 taxa were found to be common to all four areas (Fig. 2b).

The study identified 100 different genera of diatoms, including 246 identified to the species level and 2 unidentified taxa referred to as morpho-like group (one centric and one pennate, with available images) (Table 2; Carré and Fabre, 2021). The shelf had the highest number of taxa (253), followed by the islands (168) and the slope (137) (Fig. 3a). Ninety-four taxa were exclusive to the shelf, and 42 exclusive to the islands. Most of the slope taxa were shared with the shelf (45 taxa) and with both the shelf and the islands areas (49 taxa). A total of 42 taxa were shared between the islands and the shelf, and 18 taxa were shared between all four areas (Fig. 3a). The diatoms identified were

predominantly centric (165) or pennate (159); 76.9 % were large cells or colonies (over 50 µm size) (Table S1). The pennate group contained the majority of the smallest diatoms (56 taxa, 17.3 % of the global diatom community) (Table S1), and they were mainly observed in the shelf area (Table 2).

Dinophyceae comprised 47 genera, with 255 taxa (81.7 % of the total richness) identified at the species level, 15 unidentified taxa, 10 were named with their family affiliation, and 5 with their morphological group affiliation, each with available pictures in the online database. While the relative richness of dinoflagellate species was higher in the seamounts area, the greatest diversity was observed around the islands, on the slope and shelf areas, with 229, 187 and 159 different taxa, respectively (Table 2, Fig. 3b). A total of 76 taxa (24.3 %) were exclusive to the islands, while 23 taxa were observed over the shelf and slope, and only 4 on the seamounts (Fig. 3b). Most of the commonly observed taxa were shared between the shelf, slope and islands areas (61 taxa), across all four areas (46 taxa), between the slope and islands areas (24 taxa) and between the shelf and slope areas (16 taxa) (Fig. 3b). Notably, 95 taxa were described in the literature as having mixotrophic behaviours, and 83 taxa were heterotrophic. The mixotrophic group consisted mainly of genera such as *Amphisolenia*, *Dinophysis*, *Gonyaulax*, *Gymnodinium*, *Prorocentrum*, *Scrippsiella* and *Triplos*, while the heterotrophic group consisted of *Gyrodinium*, *Histioneis*, *Ornithocercus*, *Phalacroma*, *Podolampas*, *Pronoclituella* and *Protoperidinium* (Table 2). These functional characteristics were observed in all four areas studied.

The Cyanophyceae included 4 Chroococcales, 13 Oscillatoriales, and 2 Nostocales taxa from 19 different genera. Among them, 15 taxa were identified at the species level (Table 2). Haptophytes were represented by 9 different genera, including 8 taxa identified at the species level and 4 unidentified taxa. These coccolithophorids were primarily observed in offshore areas (Table 2). Dictyophyceae silicoflagellates were represented by 2 genera (*Dictyochoa* and *Octactis*), of which 3 taxa were identified. Cryptophytes were represented by one species, the nanoflagellate *Plagioselmis prolonga*. The Plantae phylum comprised 2 taxa, the genus *Closterium* in Charophyta and Chlorophytes comprised 9 genera. Among Chlorophytes, 4 taxa were identified at the species level, while 4 taxa were not identified but differentiated by their form and organisation (colonial and isolated flagellate, colonial coccoid) (Table 2).

### 3.3. ABRACOS list

A total of 321 phytoplankton taxa were identified from the ABRAÇOS data (Table 2, Fig. S1). Pictures are available for 198 taxa (Carré and Fabre, 2021), some examples are shown in Fig. 4. Within the 321 taxa observed, the richness was primarily composed of Dinophyceae (55.8 %, 179 taxa), followed by Bacillariophyceae (43.2 %, 142 taxa), and other groups (10.0 %, 30 taxa).

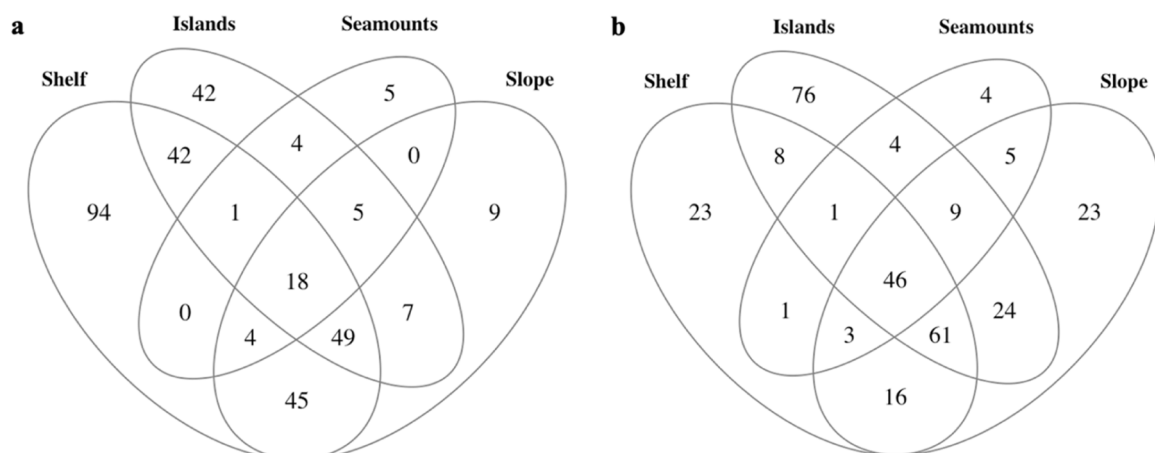
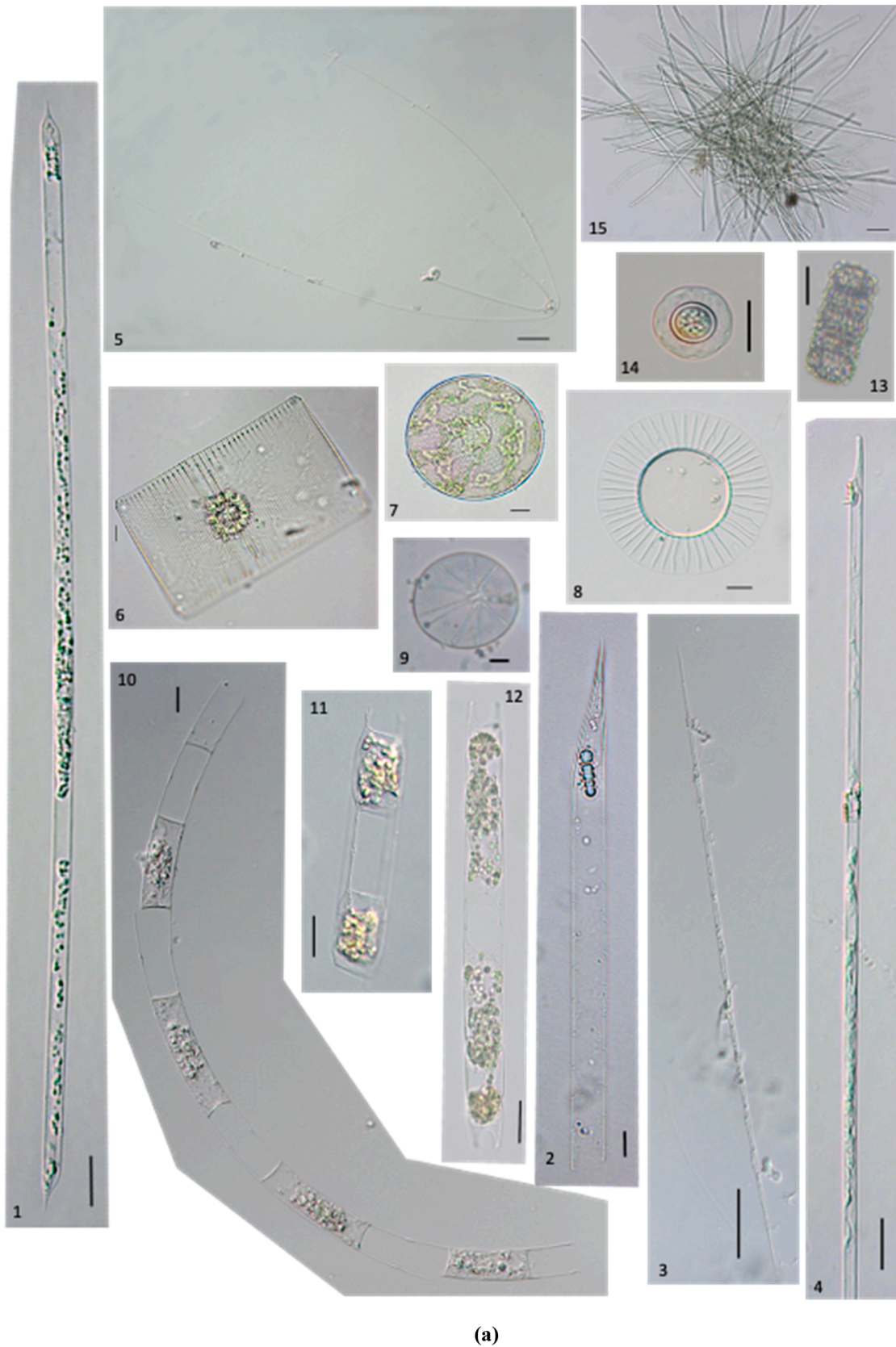


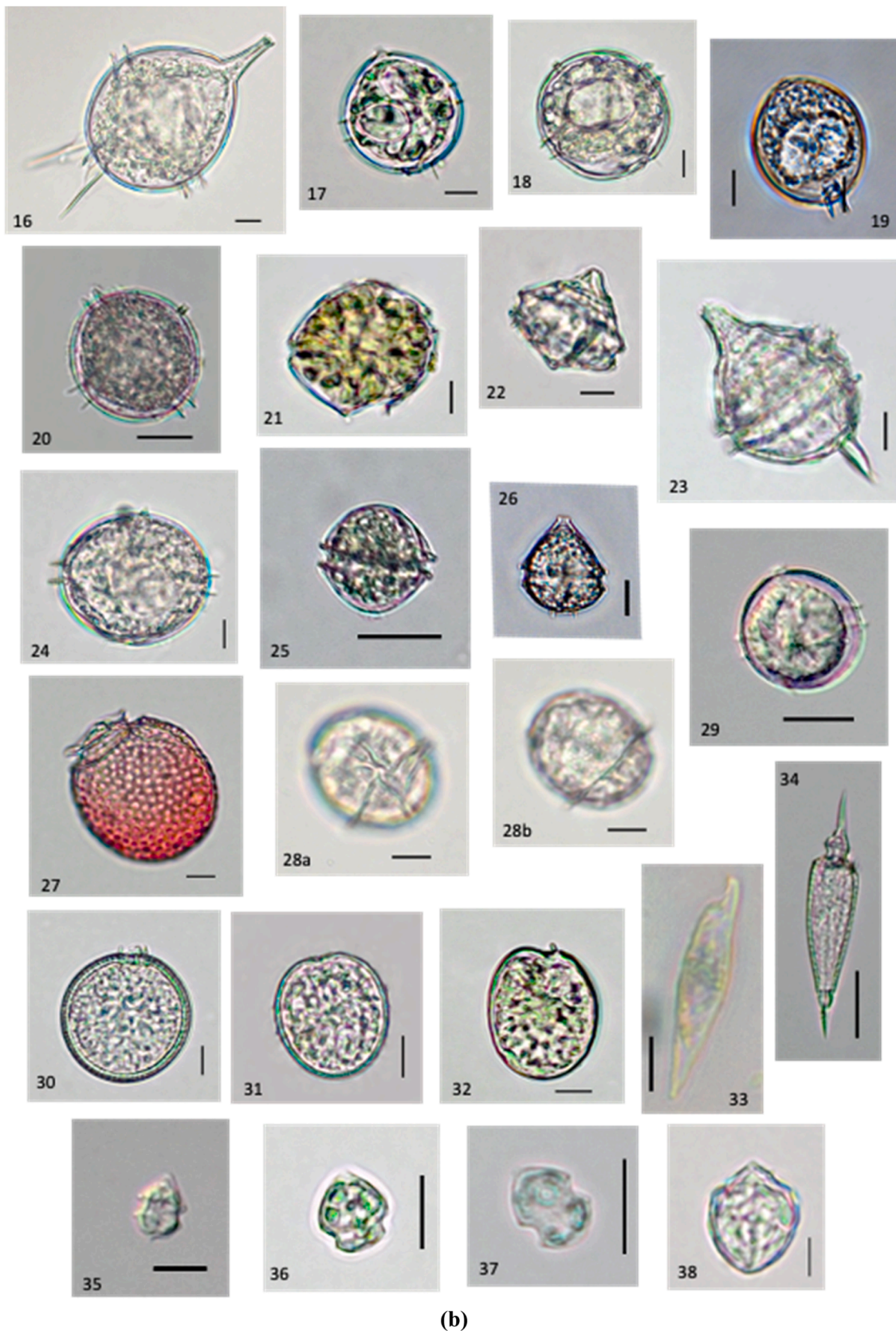
Fig. 3. Venn diagrams of Bacillariophyceae (a) and Dinophyceae (b) richness in the four areas considered in the checklist.



(a)

**Fig. 4.** Illustrations of phytoplankton richness found in nets and rosette samples collected during the Abraços (not exhaustive list): 62 species/taxa composed by 13 Diatoms (1–13), 1 Prasinophyceae (14) and 1 Cyanophyceae (15) and 48 Dinoflagellates (16–62). Scale bar = 10 µm for pictures 2, 6–9, 16–19, 21–24, 26–33, 35–38, 42, 44–49, 57; 20 µm for pictures 1, 4, 10–14, 20, 25, 34, 39–41, 43, 50–54, 56, 58 and 62; 50 µm for pictures 3, 15, 55, 59–61 and 100 µm for picture 5.



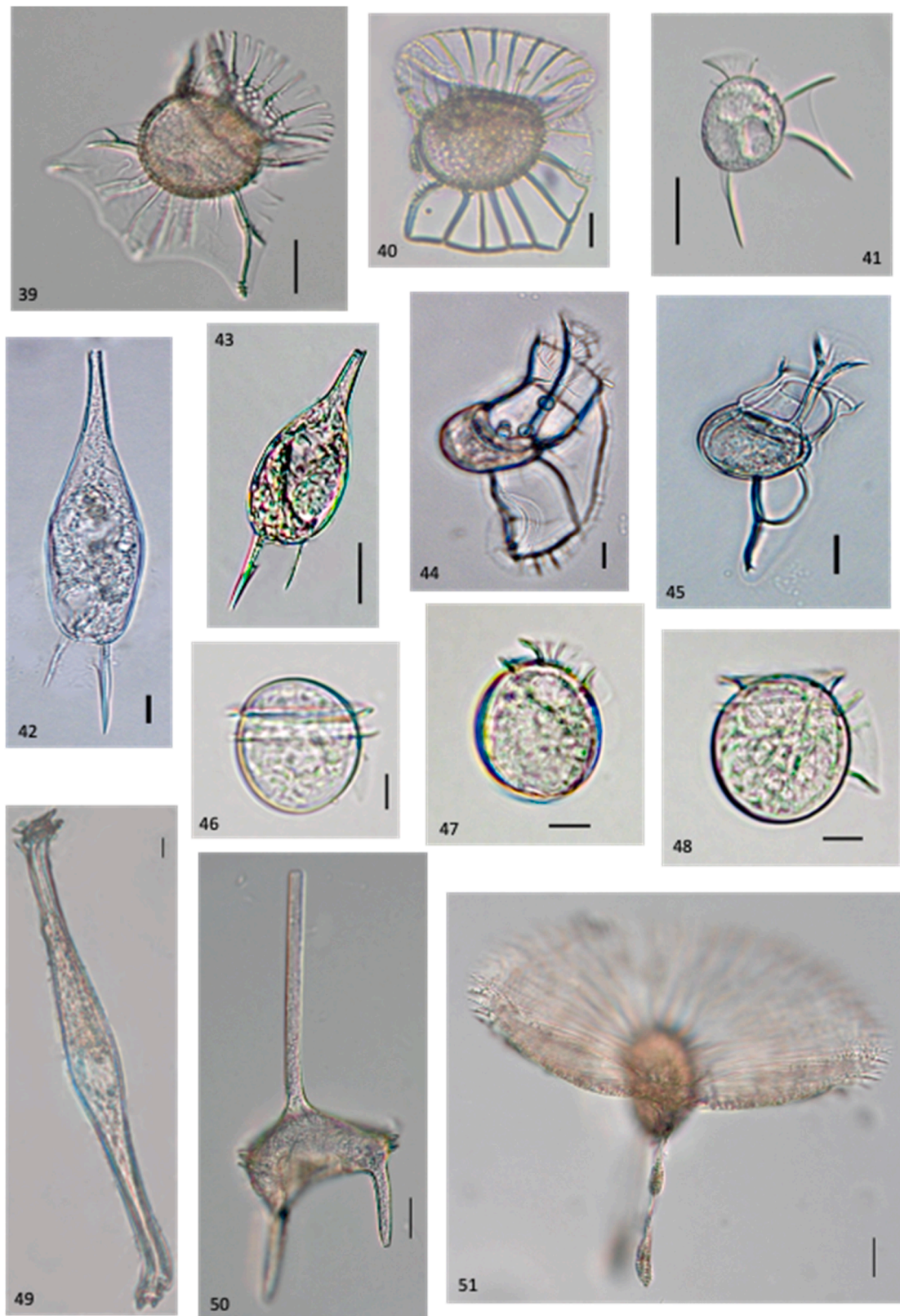


(b)

Fig. 4. (continued).

179 taxa) and Bacillariophyceae (32.7 %, 105 taxa). Cyanophyceae (16 taxa), Haptophytes (Prymnesiophyceae, 9 taxa), Chlorophytes (7 taxa) collectively represented 10 % of this richness diversity. In contrast,

Dictyophyceae (3 taxa) and Cryptophyceae and Euglenoidea (1 taxon each) collectively represented only 1.6 % of the richness (Fig. S1a). The spatial distribution of these taxa was as follows: 110 on the shelf, 178 on



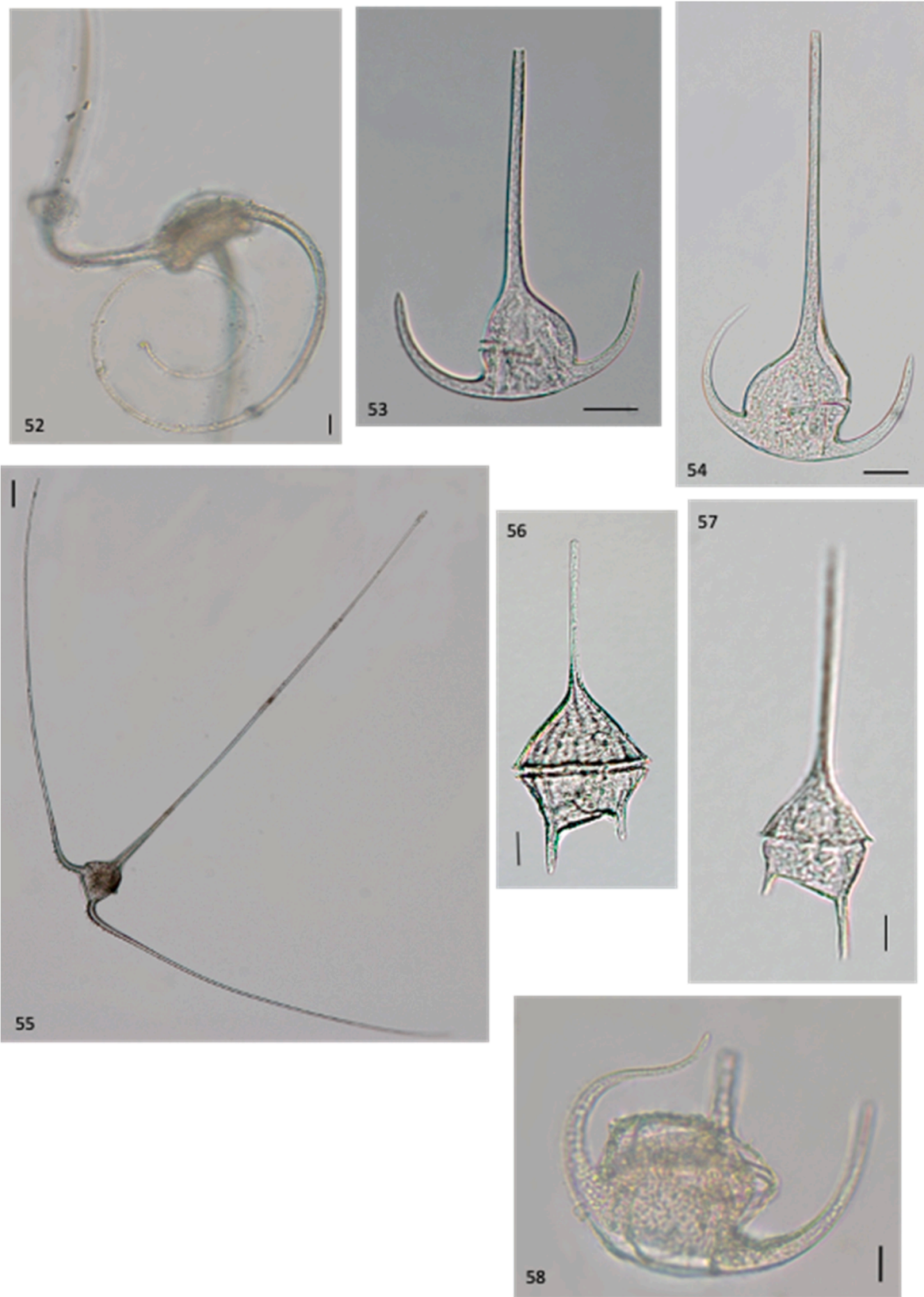
(c)

Fig. 4. (continued).

the slope, 211 around the islands and 125 in the seamounts area (Fig. S1a). Specific area richness was higher around the islands (79 taxa) than on the slope (29 taxa), the seamounts (23 taxa) and the shelf (15

taxa) (Fig. S1b), while 38 taxa were common to all areas. Although the shelf area shared 14 taxa with the slope and 21 with the islands areas, the majority of common taxa of the ABRACOS list were observed on the





(d)

Fig. 4. (continued).

slope, islands, and seamounts areas (Fig. S1b).

This review identified 98 new taxa records plus 45 potential new records in the ABRACOS samples (Table 2). The majority of the new

records richness belonged to Dinophyceae (57 taxa; 58.2 %) (Fig. 2c). Of these, 43 taxa were identified at the species level, 9 at the genus level and 5 were classified into morphological groups. Additionally, 18 taxa

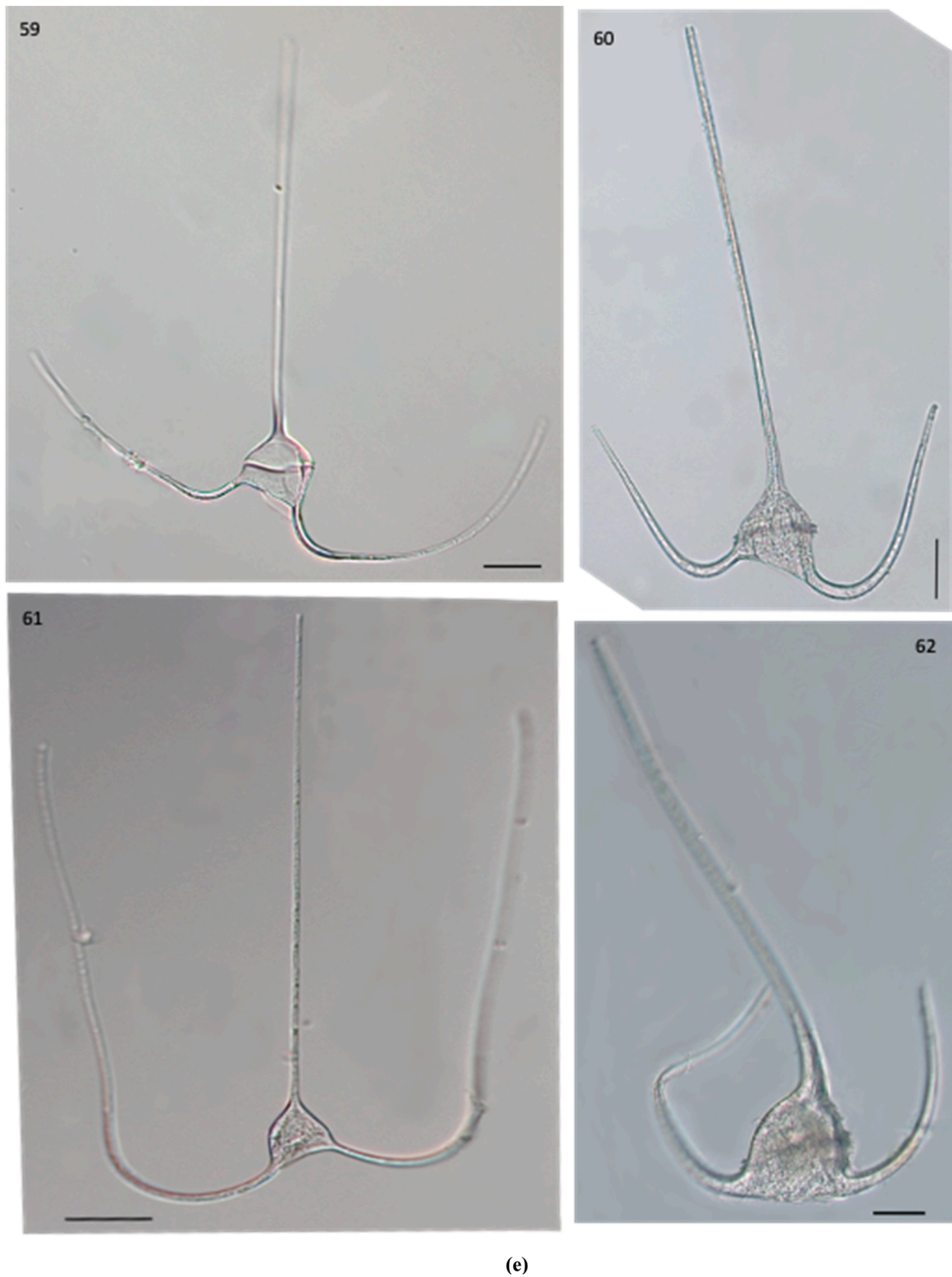


Fig. 4. (continued).

(18.4 %) belonged to Bacillariophyceae, including 9 taxa identified at the species level and the remaining 9 at the genus level (Fig. 2c). Furthermore, 8 new taxa (8.2 %) were Cyanophyceae including four

new genera and one identified at the species level. Moreover, 7 taxa (7.1 %) were new records of Haptophytes, 1 identified at the species level, the others at the genus or class level. Finally, 6 taxa (6.1 %) were

new records of Chlorophytes, including *Pterosperma marginatum* and *P. moebii*. The Cryptophyceae nanoflagellate, *Plagioselmis prolonga*, and one of the three Dictyophyceae taxa, *Octactis octonari*, were documented for the first time in the region, both observed in the vicinity of the oceanic islands. However, there were no new records of Euglenoidea (Fig. 2c).

Spatially, the new records were distributed as follows: 21 taxa over the shelf, 49 taxa on the slope, 67 taxa around the islands and 29 taxa in the seamounts area. The slope exhibited new records of Dinophyceae and fewer new records of Bacillariophyceae, while the shelf lacked new Haptophytes. In contrast, the seamounts area differed from other areas by having a few new records of Dinophyceae but a notable presence of Chlorophytes. Most new records were area-exclusive, with 29 around the islands, 11 over the slope and 11 in the seamounts areas. Additionally, 7 new records were common to four areas (Fig. 2d).

#### 4. Discussion

This study examines the nano- and microphytoplankton fractions, revealing a remarkably diverse ocean in Northeast Brazil. In total, we listed 719 different taxa, accompanied by a comprehensive library of illustrations. These images can be found in this article, in the online database, or in the reviewed papers to facilitate further identification. This checklist includes almost 15 % of all known marine phytoplankton species worldwide, exceeding the Australian Ocean Data Network (AODN) database which records 541 phytoplankton taxa (286 species) (Davies et al., 2016; Eriksen et al., 2019). It also represents 42 % of the species listed in PhytoBase, the global synthesis of open ocean phytoplankton (Righetti et al., 2020).

This high richness occurs in a region characterised by low biomass, with average abundances of over 80 % of pico- and nanophytoplankton dominated by *Prochlorococcus* (Farias et al., 2022). These observations may seem contradictory, but such a feature has already been observed in other oligotrophic open-ocean tropical regions at the same low latitude with the same ecological characteristics (Bouvy et al., 2016; Ibarbalz et al., 2019; Pierella Karlusich et al., 2020; Righetti et al., 2020).

The comprehensive checklist shows that the two major phytoplankton groups, dinoflagellates and diatoms, contribute similarly to total richness, which is consistent with the global phytoplankton diversity (Pierella Karlusich et al., 2020; Vincent et al., 2022). Our study also provides comprehensive spatial coverage, including both coastal and oceanic areas, which is rare on a global scale, as most studies focus on more localised communities, particularly those near the coast. Comparable group repartition has been observed in other subtropical regions with similar ecological configurations such as the Australian coast (Davies et al., 2016), the Western Pacific Ocean (Chen et al., 2021), and around the Scattered islands in the Indian Ocean (Bouvy et al., 2016).

Locally, the richness of nano- and microphytoplankton varies between areas. The shelf area exhibited a greater diversity of pennate and small to medium-sized diatoms. This may be due to the inputs from estuarine rivers as well as the resuspension of benthic diatoms (Taffs et al., 2017). In contrast, dinoflagellates species were more prevalent offshore, demonstrating their adaptability to changing nutritional conditions, by employing multiple metabolic and growth strategies to survive (Reynolds, 2007; Cohen et al., 2021). These spatial patterns of diversity mirror the results of other studies at similar latitudes (Malviya et al., 2016; Vincent et al., 2022).

The ABRACOS surveys covered shelf, slope, and offshore areas, resulting in the recording of 319 taxa and the identification of nearly 100 new records (plus 45 potential new records), primarily dinoflagellates. These surveys provide a comprehensive view of the marine phytoplankton communities richness, which is consistent with the observations of other surveys with similar spatial coverage conducted in the Atlantic Ocean (Sal et al., 2013; Silva-Cunha, Leça, et al., 2019). It has been acknowledged that expanded regional sampling increases the

likelihood of discovering new species (D'Elbée, 2016). Thus, the extensive sampling effort conducted offshore, coupled with the higher richness of dinoflagellates in this region (in contrast to the shelf area), could explain the predominance of this group in the new records documented during the ABRACOS surveys.

It is difficult to determine whether these new records are introduced, invasive, or characteristic of these ecosystem types, and therefore responsive to environmental change. The potential for misidentification or oversight by analysts over time due to changes in sampling methods, microscopes, and expertise, complicates such assessments (Zingone et al., 2015).

Moreover, identifying species-level proved to be challenging for some specimens. The taxa listed in the checklist or specifically observed during the ABRACOS surveys were often identified at the genus, family, or generic group level (e.g. combining several species or genera of similar morphology), which sometimes hindered the identification of new records. This limitation is partly due to the difficulty to identifying diatom species (both pennate and centric) using light microscopy. Detailed examination by electron microscopy is required. For example, genera such as *Amphora*, *Navicula*, *Nitzschia* and *Pseudo-nitzschia* for pennates, and *Chaetoceros*, *Coscinodiscus* and *Thalassiosira* for centric diatoms, often require higher-resolution imaging. As an example, Kra-berg et al. (2010) recommend using *Pseudo-nitzschia* "seriata complex" Hasle & Syvertsen, 1997, as species of this genus with cell widths greater than 3 µm (e.g., *P. pungens* and *P. seriata*) are difficult to differentiate. Fixation with lugol iodine solution can cause dinoflagellates to lose their distinctive features, especially naked cells, making identification difficult, even at the genus level. Similarly, fixation with acidic lugol and acidic formaldehyde can damage calcified coccolithophorids. These are then often very small, and their identification may require electron microscopy for genus or species confirmation. This review includes many unidentified Cyanophyceae taxa due to the paucity of articles on the taxonomy of planktonic Cyanophyceae in tropical marine coastal environments. Furthermore, traditional morphological observations are often insufficient to differentiate species within genera, necessitating the use of additional methods such as culture and genetic analysis (Komárek, 2016; Brito et al., 2017; Willis and Woodhouse, 2020). Finally, the equipment used to observe Chlorophyceae, Prasinophyceae, Euglenoideae and other nanoflagellates (about 10 µm size) was unsuitable for their identification and detection. Future taxonomic studies in this region should focus on these communities and plan specific sampling and observations. For instance, using epifluorescence microscopy with 40X and 60X objectives can improve detection, confirm identification, and differentiate their trophic mode, heterotrophic or autotrophic. These aspects are often crucial in determining species-level classification.

Despite its limitations, this checklist reveals an incredible diversity of nano- and microphytoplankton in the oceanic zone of Northeast Brazil. It provides a useful reference for scientists and managers to monitor community evolution under global change. This work emphasises the importance of ensuring data continuity, for example through programmes such as the Peld TAMS observatory in Tamandaré, Brazil (Cordeiro et al., 2022). Such programmes provide valuable opportunities to conduct time series analyses and assess the adaptation of these communities and their response to changing environmental conditions, detect unusual episodes as efflorescences potentially toxic due to rising temperatures and sewage emissions. Blooms have been known locally since 1943 (Barbosa, 1944) and also by Satô et al. (1963), but in sporadic events. However, in recent years, these events have intensified in frequency and intensity, with almost 300 people poisoned in the last event (personal communication).

#### Ethical approval

No animal testing was performed during this study.



## Sampling and field studies

All necessary permits for sampling and observational field studies have been obtained by the authors from the competent authorities and are mentioned in the acknowledgements, if applicable. The study is compliant with CBD and Nagoya protocols.

## CRedit authorship contribution statement

**Marina Cavalcanti Jales:** Data curation. **Sírleis Rodrigues Lacerda:** Data curation. **Isis Amália Cordeiro:** Data curation. **Gabriel Bittencourt Farias:** Writing – review & editing. **Béatrice Bec:** Writing – review & editing, Methodology, Conceptualization. **Leandro Ferreira Cabanez:** Resources, Data curation. **Arnaud Bertrand:** Writing – review & editing, Writing – original draft, Methodology, Funding acquisition, Conceptualization. **Claire Carré:** Writing – review & editing, Writing – original draft, Resources, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Pedro Augusto Mendes de Castro Melo:** Writing – review & editing, Resources. **Monique Simier:** Writing – review & editing. **Maria da Glória Gonçalves Silva-Cunha:** Writing – review & editing, Resources, Methodology, Data curation, Conceptualization. **Nayana Buarque Antao Silva:** Data curation.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.rmsa.2024.103887](https://doi.org/10.1016/j.rmsa.2024.103887).

## Data availability

Data will be made available on request.

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