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PROSPECTIVE FLORISTICS OF EPIPHYTIC DIATOMS ON RHODOPHYTA FROM THE SOUTHERN GULF OF MEXICO

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ABSTRACT. Studies on epiphytic diatoms can be considered somewhat lacking worldwide, mainly because of the enormous scientific research potential around them, and there is still much to do concerning floristics alone. Particularly for the Mexican coasts, mainly in the southern Gulf of Mexico. Thus, our objective was to determine the epiphytic diatom floristics for several species of Rhodophyta from the coast of Veracruz state (México). Diatoms sampled from specimens of six taxa of Rhodophyta were observed in permanent mountings, under light microscopy. A total 115 diatom taxa were identified, that support our expectancy of a potential species richness much higher on red algae hosts. A presence absence similarity measurement suggested that a single diatom assemblage was hosted in the six red algae taxa. The species composition is highly similar to epiphytic diatom assemblages from NW Mexico, albeit six taxa are new records for Mexican littorals. A photographic catalog of the identified epiphytic diatoms is provided.

Key words: Epiphytic diatoms, Florideophyceae, Floristics, Gulf of México, New records, Similarity.

Florística prospectiva de diatomeas epifitas sobre Rhodophyta en el Sur del Golfo de México

RESUMEN. Los estudios sobre diatomeas epifitas a nivel global se pueden considerar escasos, principalmente por el gran potencial científico que representan. Una consecuencia de ello es lo mucho que falta por hacer tan solo en florística a lo largo de las costas mexicanas, particularmente al sur del Golfo de México. Así, el objetivo de nuestro estudio fue determinar la florística de diatomeas epifitas en varias especies de Rhodophyta de la costa del Estado de Veracruz, México. Se identificaron diatomeas epifitas en talos de seis taxa en preparaciones permanentes bajo microscopía de luz. La lista florística de diatomeas reditúo 115 taxa, lo que respalda nuestra expectativa de una riqueza de especies potencial mucho mayor en Rhodophyta hospederos. La similitud (Bray-Curtis) con base en presencia/ausencia de taxa sugiere que una sola asociación de diatomeas epifitas se distribuye entre los seis taxa de algas rojas hospederos. La composición de especies es muy similar a la de asociaciones de diatomeas epifitas del NW de México, aunque seis taxa son nuevos registros para litorales mexicanos. Se incluye un catálogo fotográfico de los taxa de diatomeas epifitas identificadas.

Palabras clave: Diatomeas epifitas, Florideophyceae, Florística, Golfo de México, Nuevos registros, Similitud.

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INTRODUCTION

Studies on epiphytic diatoms can be considered somewhat lacking worldwide mainly because of the enormous scientific research potential around them. Either on their taxonomy, including floristics, their ecology, biogeography, or eco-physiological interaction with their hosts, etc. Thus, although sufficient theoretical basis may exist to pursue such diverse roles of epiphytic diatoms, there is still much to do concerning floristics alone.

The above scenario is stressed for the Mexican coasts, where few efforts to undertake such a challenge exist for benthic diatoms in general. Pioneer research on the subject may be traced to the first study on diatoms found living on blades of eel grass (*Zostera marina*) in NW México (Siqueiros Beltrones & Ibarra Obando, 1985; Siqueiros Beltrones *et al*., 1985) which refer to floristics and assemblage structure, respectively. This approach was continued much later focusing on macroalgae, considering monospecific hosts (Siqueiros Beltrones *et al*., 2001, 2005; Argumedo Hernández & Siqueiros Beltrones, 2008; López Fuerte *et al*., 2013; Siqueiros Beltrones *et al*., 2016), for which several studies showed that particularly structured assemblages of epiphytic diatoms occurred (Siqueiros Beltrones & Argumedo Hernández, 2005, 2014, 2014b). Whilst, studies on multispecies hosts lead to the conclusion that macroalgae represented more than just attaching surfaces for diatoms, and suggested also that differences in species composition of epiphytic diatom assemblages depended on the macroalga genus or division serving as substrate (Siqueiros Beltrones & Hernández Almeida, 2006; Hernández Almeida & Siqueiros Beltrones, 2008, 2012).

Most of the above publications were carried out in the NW region of Mexico, however, no studies on epiphytic diatoms of macroalgae have been published for the Mexican southeastern coasts. Our objective was to describe the epiphytic diatom floristics from several species of Rhodophyta from the

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coast of the state of Veracruz (México), to attain a first insight of the species richness, based on a prospective survey. Previously, a single specimen of *Ploclamium cartilagineum* (J.V. Lamoroux) Dixon (Rhodophyta) from NW Mexico was found to host 46 epiphytic diatom taxa (Siqueiros Beltrones & Argumedo-Hernández, 2104a), whilst several specimens of *Laurencia pacifica* Kylin (Rhodophyta) from five different seasons were observed to host 143 diatom taxa (Siqueiros Beltrones & Hernández Almeida, 2006). We thus proposed the hypothesis that the species richness for the collected Rhodophyta from Villa Rica would be similarly high, and including taxa that are new additions to the current floristic list (López-Fuerte & Siqueiros Beltrones, 2016) for Mexican littorals.

MATERIAL AND METHODS

Specimens of red algae were collected at Villa Rica, which is located north of Veracruz Port on the Gulf of México, at 19°40´45´´ N and 96° 23´ 30´´ W (Fig. 1). It is a rocky shore subject to intense wave action. Whole thalli of red algae were detached and collected from the rocky intertidal during January 2017. The specimens were transported fresh in plastic jars. The red algae were identified using Börgesen (1915-1920), Dawes (1974-1981), Joly (1957-1965), Germain (1981), Romero Zarco (2003), Taylor (1960), and following the classification by Guiry & Guiry (2017).

The diatoms were brushed off from one specimen of each red algae species while rinsing with purified water. The resulting sample was placed in a 150-ml test tube and left to settle. Then, the precipitate was collected and oxidized with a mixture of alcohol and nitric acid at a 1:2:5 ratio (Siqueiros Beltrones & Voltolina, 2000). The oxidized material was rinsed repeatedly with purified water until it reached a pH ≥ 6. For each sample 2 permanent slides were mounted using Pleurax (RI=1.7). Identification was done at 1000× under an Olympus CH-2 compound microscope with phase contrast.

Diatoms were identified following Hernández-Almeida and Siqueiros-Beltrones (2008, 2012), Hustedt (1955, 1959, 1961-66), López-Fuerte *et al*. (2010), Moreno *et al*. (1996), Peragallo and Peragallo (1908), Siqueiros-Beltrones (2002), Siqueiros-Beltrones and Hernández-Almeida (2006), Schmidt *et al*. (1874 -1959), Stidolph *et al*. (2012), Witkowski *et al.* (2000). A catalog of epiphytic diatoms was assembled with micrographs of specimens from the permanent mounts taken with a CMOS Konus digital ocular lens microscope at 1000×.

The similarity between the epiphytic diatom assemblages was measured on the basis of presence/absence of taxa using the Bray-Curtis index (Primer 5).

RESULTS

The collected macroalgal thalli comprised six Rhodophyta taxa (Table 1). Floristic analysis of the epiphytic diatom yielded 115 taxa distributed differentially among the examined red algae taxa, from 32 (*Digenea simplex*) to 63 (*Centroceras clavulatum*) taxa per host (Table 1). These values are evidence that support the proposed hypothesis.

Similarity measurement of red algae hosts based on the presence/absence of the epiphytic diatom taxa they harbor are relatively high. Although most val-

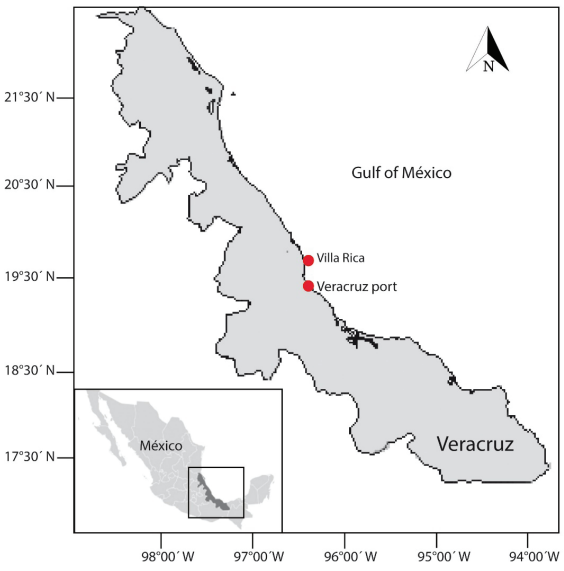

Figure. 1.- Location of study area and sampling site Villa Rica, State of Veracruz, Mexico.

Table 1.- Rhodophyta species collected at Villa Rica, Veracruz, Mexico, hosting epiphytic diatoms. Classification according to Guiry and Guiry (2017). **()** = number of diatom taxa.

Phylum Rhodophyta
Class Rhodophyceae
Sub-class Florideophycidae
Order Corallinales
Family Corallinaceae
Jania rubens (Linnaeus) J.V. Lamouroux (44)
Order Gigartinales
Family Cystocloniaceae
Hypnea cervicornis J. Agardh (46)
Order Ceramiales
Family Ceramiaceae
Centroceras clavulatum (C. Agardh) Montagne (63)
Family Rhodomelaceae
Bryothamnion triquetrum (S. Gmelin) Howe (49)
Digenea simplex (Wulfen) C. Agardh (32)
Laurencia microcladia Kützing (45)

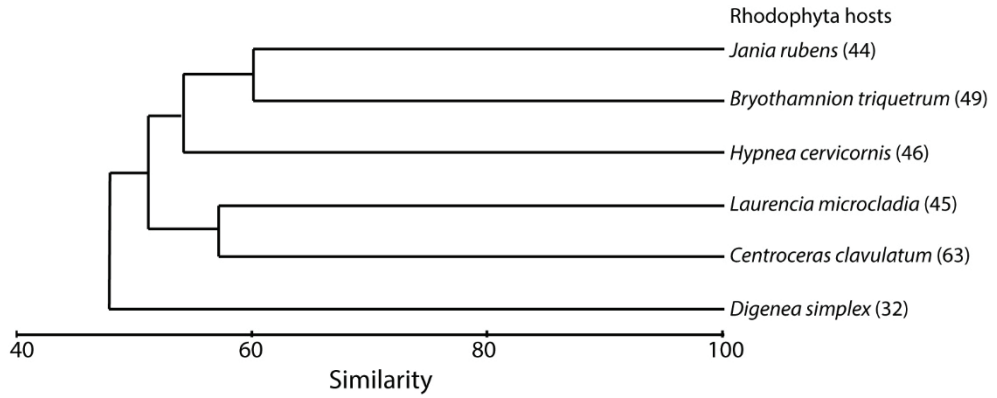

Figure. 2.- Similarity measurement of red algae hosts based on the presence/absence of the epiphytic diatom taxa they harbor. Most values are under 60% similarity. The isolation of *Digenea simplex* could relate to the lower number of epiphytic taxa. () = Number of diatom taxa on each host.

ues are under 60% similarity (Fig. 2), this relates to the differential number of taxa among hosts, which shows in the isolation of *Digenea simplex*. Nine of the most frequent diatom taxa were observed on the six rhodophyte hosts, while eight diatom taxa were found on five species hosts (Table 3).

All the identified diatom taxa are worldwide distributed, and most have been registered as common in the Mexican NW, except for: *Tabularia barbatula* (Kützing) D.M. Williams & Round, *Licmophora pfannkuckae* Giffen, *Amphiprora gigantea* Cleve, *Pleurosigma majus* (Grunow) Cleve, *Nitzschia dis-*

Table 2. Species list of epiphytic diatoms recorded from Rhodophyta hosts in the coasts of Villa Rica, Veracruz, Mexico. Classification according to Round *et al.* (1990). *Fresh-water taxa. ** New records for Mexican littorals.

BACILLARIOPHYTA
Class Coscinodiscophyceae
Order Thalassiosirales
Family Thalassiosiraceae
Ehrenbergiulvaa granulosa (Grunow) Witkowski, Lange-Bertalot & Metzeltin
Shionodiscus oestrupii A.J. Alverson, S.H. Kang & E.C. Theriot
Thalassiosira eccentrica (Ehrenberg) Cleve
Family Stephanodiscaceae
Cyclotella litoralis Lange & Syvertsen
Cyclotella stylorum Brightwell
Family Skeletonemataceae
Skeletonema sp. Greville
Order Melosirales
Family Hyalodiscaceae
Podosira stelligera (Bailey) A. Mann
Order Paraliales
Family Paraliaceae
Paralia sulcata (Ehrenberg) Cleve
Order Coscinodiscales
Family Heliopeltaceae
Actinoptychus senarius (Ehrenberg) Ehrenberg
Order Anaulales
Family Anaulaceae
Eunotogramma laeve Grunow
Order Triceratiales
Family Triceratiaceae
Odontella aurita (Lyngbye) C. Agardh
Odontella aurita var. *obtusa* (Kützing) Denys
Odontella mobiliensis (J.W. Bailey) Grunow
Family: Triceratiaceae
Cerataulus californicus A. Schmidt
Order Cymatosirales
Family Cymatosiraceae
Cymatosira belgica Grunow
Cymatosira sp. Grunow
Order Chaetocerotales
Family Chaetocerotaceae
Chaetoceros sp. Ehrenberg
Order Coscinodiscales
Family Coscinodiscaceae
Coscinodiscus centralis Ehrenberg
Coscinodiscus rothii (Ehrenberg) Grunow
Order Melosirales
Family Melosiraceae
Melosira montagnei (Kützing) Lagerstedt
Class Fragilariophyceae
Order Fragilariales
Family Fragilariaceae
**Fragilaria goulardii* (Brébisson ex Grunow) Lange-Bertalot
***Tabularia barbatula* (Kützing) D.M. Williams & Round
Tabularia fasciculata (C. Agardh) D.M. Williams & Round
Tabularia investiens (W. Smith) D.M. Williams & Round

Table 2. Continued.

Tabularia tabulata var. *fasciculata* (Lyngbye & Kützing) Hustedt
Order Climacospheniales
Family Climacospheniaceae
Climacosphenia moniligera Ehrenberg
Order Licmophorales
Family Licmophoraceae
Licmophora abbreviata Agardh
Licmophora ehrenbergii (Kützing) Grunow
Licmophora gracilis Grunow
***Licmophora pfannkuckae* Giffen
Order Rhaphoneidales
Family Rhaphoneidaceae
Delphineis surirella W. Smith
Delphineis surirelloides (Simonsen) G.W. Andrews
Rhaphoneis amphiceros (Ehrenberg) Ehrenberg
Order Striatellales
Family Striatellaceae
Grammatophora hamulifera Kützing
Grammatophora marina (Lyngbye) Kützing
Grammatophora oceanica Ehrenberg
Grammatophora undulata Ehrenberg
Order Thalassionematales
Family Thalassionemataceae
Thalassionema nitzschioides (Grunow) Mereschkowsky
Thalassiothrix longissima Cleve & Grunow
Class Bacillariophyceae
Order Lyrellales
Family Lyrellaceae
Lyrella abrupta (Gregory) D.G. Mann
Order Mastogloiales
Family Mastogloiaceae
Mastogloia binotata Grunow
Mastogloia crucicula (Grunow) Cleve
Mastogloia cuneata (Meister) R.Simonsen
Mastogloia sp. Thwaites ex W. Smith
Order Achnanthales
Family Achnanthaceae
Achnanthes brevipes Agardh
Achnanthes brevipes var. *angustata* (Greville) Cleve
Achnanthes longipes Agardh
Achnanthes manifera Brun
Family Cocconeidaceae
Cocconeis britannica Gregory
Cocconeis cf. *heteroidea* Hantzsch
Cocconeis convexa M.H. Giffen
Cocconeis dirupta Gregory
Cocconeis diruptoides Hustedt
Cocconeis krammerii Lange-Bertalot & Metzeltin
Cocconeis placentula var. *euglypta* (Ehrenberg) Cleve
Cocconeis scutellum Ehrenberg
Cocconeis scutellum var. *parva* (Grunow) Cleve
Order Cymbellales
Family Anomoeoneidaceae
Anomoeoneis sphaerophora (Ehrenberg) O. Müller
Family Rhoicospheniaceae
Campylopyxis garkeana (Grunow) Medlin
Family Cymbellaceae
**Cymbella hustedtii* Krasske
**Cymbella turgidula* Grunow
Family Gomphonemataceae
**Gomphonema subclavatum* (Grunow) Grunow
**Reimeria* cf. *sinuata* (Gregory) Kociolek & Stoermer
Order Naviculales
Family Amphipleuraceae
***Amphiprora gigantea* Cleve
Family Berkeleyaceae
Parlibellus rhombicula (Hustedt) Witkowski
Family Diploneidaceae
Diploneis chersonensis Cleve
Diploneis nitescens (W. Gregory) Cleve
Diploneis papula (A.W.F. Schmidt) Cleve
Diploneis papula var. *constricta* Hustedt
Diploneis smithii (Brébisson) Cleve
Diploneis weissflogii (A.W.F. Schmidt) Cleve
Diplones litoralis (Donkin) Cleve
Family Naviculaceae
Navicula cf. *transistantioides* Foged
Navicula johanrosii Giffen
Navicula longa Grunow
Navicula longa var. *irregularis* Hustedt
Navicula pennata A. Schmidt
Navicula sp. Bory
Trachyneis aspera (Ehrenberg) Cleve
Trachyneis velata A. Schmidt
Family Diadesmidaceae
Caloneis liber (W. Smith) Cleve
Caloneis linearis (Cleve) Boyer
Family Pleurosigmataceae
Pleurosigma aestuarii (Brébisson ex Kützing) W. Smith
Pleurosigma angulatum (J.T. Quekett) W. Smith
Pleurosigma cf. *diverse-striatum* F. Meister
Pleurosigma lanceolatum Donkin
***Pleurosigma majus* (Grunow) Cleve
Pleurosigma rigidum W. Smith
Pleurosigma salinarum (Grunow) Grunow
Family Plagiotropidaceae
Plagiotropis pusilla (Gregory) Kuntze
Family Amphipleuraceae
Halamphora coffeaeformis (C. Agardh) Levkov
Halamphora turgida Gregory

Table 2. Continued.

Family Pinnulariaceae	*Nitzschia microcephala* Grunow
**Pinnularia gibba* (Ehrenberg) Ehrenberg	*Nitzschia scalpeliformis* Grunow
Order Thalassiophysales	*Nitzschia sigma* (Kützing) W. Smith
Family Catenulaceae	*Nitzschia sigmatiformis* Hustedt
Amphora angusta W. Gregory	*Psammodictyon constrictum* (W. Gregory) D.G. Mann
Amphora bigibba Grunow	*Psammodictyon panduriforme* (W. Gregory) D.G. Mann
Amphora sp. Ehrenberg ex Kützing	*Tryblionella coarctata* (Grunow) D.G. Mann
Order Bacillariales	Order Rhopalodiales
Family Bacillariaceae	Family Rhopalodiaceae
Bacillaria socialis (Gregory) Ralfs	*Rhopalodia musculus* (Kützing) Otto Müller
Nitzschia bicapitata Cleve	*Rhopalodia musculus* var. *producta* (Kützing) Otto Müller
Nitzschia distans W. Gregory	Order Surirellales
Nitzschia distans var. *distans* W. Gregory	Family Surirellaceae
***Nitzschia distans* var. *tumescens* W. Gregory	***Surirella fastuosa* var. *recedens* (A. Schmidt) Cleve
Nitzschia longisima Brébisson	*Campylodiscus ralfsii* W. Smith
Nitzschia longissima f. *costata* Hustedt	
Nitzschia lorenziana var. *subtilis* Grunow	

tans var. *tumescens* W. Gregory, *Surirella fastuosa* var. *recedens* (A. Schmidt) Cleve, that are new records for Mexican littorals.

Several freshwater taxa were found in the samples: *Cymbella hustedtii* Krasske, *Cymbella turgidula* Grunow, *Gomphonema subclavatum* (Grunow) Grunow, *Pinnularia gibba* (Ehrenberg) Ehrenberg, *Reimeria* cf. *sinuata* (Gregory) Kociolek & Stoermer, *Fragilaria goulardii* (Brébisson ex Grunow) Lange-Bertalot. These are also widely distributed.

Representative taxa from the permanent slides are depicted in an iconographic reference (Figs. 3-97).

DISCUSSION

According to the similarity measurements, the distribution of epiphytic diatom taxa on the red algae species suggest that it is a single assemblage in accordance with the 17 taxa that were common on five or six of the Rhodophyta hosts. The detected variation among the different hosts reflects the patchy distribution typical of benthic diatom assemblages (Siqueiros Beltrones, 2002).

The occurrence of fresh-water diatom taxa in the samples may be explained by the input of numerous creeks, inasmuch no large rivers flow nearby into the sea, but may contribute seasonally to the species richness. The question is, however, are any of these taxa finding a favorable habitat on these hosts? Observations on fresh mounts of these samples should help to answer this question.

The species richness recorded in this study is similar to other carried out in the NW coasts of Mexico, where a single specimen of *Ploclamium cartilagineum* (J.V. Lamoroux) Dixon (Rhodophyta) yielded 46 epiphytic diatom taxa (Siqueiros Beltrones & Argumedo-Hernández, 2104a), and in *Macrocystis pyrifera* C. Agardh, where the overall species richness surpassed 150 taxa but varied monthly from 39 to 114 (Argumedo-Hernández & Siqueiros Beltrones, 2008). Whilst, in *Laurencia pacifica* from five different seasons, samples were observed to host 143 diatom taxa overall, but varying from 20 to 54 in different samples (Siqueiros Beltrones & Hernández Almeida, 2006). Thus, in

Table 3.- Epiphytic diatom taxa colonizing all or most rhodophyte species hosts in the coasts of Villa Rica, Veracruz, Mexico.

On six red algae host species	On five red algae host species
Campylopyxis garkeana (Grunow) Medlin	*Amphora bigibba* Grunow
Cerataulus californicus A. Schmidt	*Navicula longa* Grunow
Cocconeis britannica Gregory	*Odontella aurita* (Lyngbye) C. Agardh
Grammatophora hamulifera Kützing,	*Odontella aurita* var. *obtusa* (Kützing) Denys
Grammatophora marina (Lyngb.) Kützing	*Paralia sulcata* (Ehrenberg) Cleve
Mastogloia binotata Grunow	*Psammodictyon constrictum* (W. Gregory) D.G. Mann
Melosira montagnei (Kützing) Lagerstedt	*Shionodiscus oestrupii* A.J. Alverson, S.H. Kang & E.C. Theriot
Nitzschia longissima f. *costata* Hustedt	*Thalassiosira eccentrica* (Ehrenberg) Cleve
Tabularia tabulata var. *fasciculata* (Lyngbye & Kützing) Hustedt	

view of the overall number of diatom taxa and per host species in this study, derived from a discrete number of host red algae, the proposed hypothesis on the expected high number of taxa on the red algae from the southern part of the Gulf of Mexico is founded. Moreover, the species richness in the area is expected to increase significantly with a bigger sample size and other sampling seasons. And, although many more widely distributed taxa are, again, expected to be found, the six new records also indicate (López-Fuerte & Siqueiros Beltrones, 2016) that further surveys will also yield other new records of epiphytic diatom taxa from this part of the Mexican littorals. Whilst, the high number of identified diatom taxa that also occur in the Mexican NW poses questionings on the factors that determine the biogeographical distribution of epiphytic diatoms, whether it be latitudinal gradient, or a suitable host availability.

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REFERENCES

Argumedo Hernández, U. & D. A. Siqueiros Beltrones. 2008. Cambios en la estructura de la asociación de diatomeas epifitas de *Macrocystis pyrifera* (L.) C. Agardh. *Acta Botánica Mexicana*, 82: 43-66. https://doi.org/10.21829/abm82.2008.1134

Börgesen F. 1915. The marine algae of the Danish West Indies. Part 3. Rhodophyceae (1). *Dansk Botanisk Arkiv*., 3: 1-80.

Börgesen F. 1916. The marine algae of the Danish West Indies. Part 3. Rhodophyceae (2). *Dansk Botanisk Arkiv*., 3: 81-144.

Börgesen F. 1917. The marine algae of the Danish West Indies. Part 3. Rhodophyceae (3). *Dansk Botanisk Arkiv*., 3: 145-240.

Börgesen F. 1918. The marine algae of the Danish West Indies. Part 3. Rhodophyceae (4). *Dansk Botanisk Arkiv*., 3: 241-304.

Börgesen F. 1919. The marine algae of the Danish West Indies. Part 3. Rhodophyceae (5). *Dansk Botanisk Arkiv*., 3: 305-368.

Börgesen F. 1920. The marine algae of the Danish West Indies. Part 3. Rhodophyceae (6). With addenda to the Chlorophyceae, Phaeophyceae and Rhodophyceae. *Dansk Botanisk Arkiv*., 3: 305-368.

Dawes, C. J. 1981. *Marine Botany*. John Wiley & Sons Ltd. 628 p.

Hernández Almeida, O. U. & D. A. Siqueiros Beltrones. 2008. Variaciones en asociaciones de diatomeas epifitas de macroalgas en una zona subtropical. *Hidrobiológica*, 18 (1): 51-61.

Germain, H. 1981. Flore des diatomées, Boubée. Paris. 444.

Guiry, M. D. & G. M. Guiry, 2017. *Algaebase*. World-wide electronic publication. National University of Ireland, Galway: http://www.algaebase.org/, accessed August 2017.

Hernández Almeida, O.U. & D. A. Siqueiros Beltrones. 2012. Substrate dependent differences in the structure of epiphytic vs. epilithic diatom assemblages from the southwestern coast of the Gulf of California. *Botanica Marina*, 55: 149-159. https://doi.org/10.1515/bot.2011.103

Hustedt, F. 1955. *Marine littoral diatoms of Beaufort, North Carolina*. Marine Station Bulletin No. 6. Duke University Press. 67 p.

Hustedt, F. 1959. Die kieselalgen Deutschlands, Osterreichs and der Schweis. En L.Rabenhorts (Ed.), *Kryptogammen-Flora. VII Band, II Teil* (pp. 221, 356, 388, 409). Leipzig: Koeltz Scientific Book.

Hustedt, F. 1961-66. Die kieselalgen Deutschlands, Osterreichs and der Schweis. In Kryptogammen-Flora. L. Rabenhorst (Ed.). VII Band, III Teil. Koeltz Scientific Book (reprint 1991). Leipzig.

Joly, A.B. 1965. Flora marinha do litoral norte do Estado de Sao Paulo e regioes circunvizinhas. *Bol. Fac. Cienc. Let UPS. Botánica*, 21. 267. https://doi.org/10.11606/issn.2318-5988.v21i1p5-393

López Fuerte, F.O., D.A. Siqueiros Beltrones & O.U. Hernández Almeida. 2013. Epiphytic diatoms of *Thalassia testudinum* in Yalahau lagoon, Quintana Roo, México. *Marine Biodiversity Records.* 6: 1-11. doi:10.1017/S1755267213000857; e107. https://doi.org/10.1017/S1755267213000857

Moreno Ruíz, J.L., S. Licea Durán & H. Santoyo. 1996. Diatomeas del Golfo de California. Universidad Autónoma de Baja California Sur-SEP-FOMES-PROMARCO. 273 p.

Peragallo, H. & M. Peragallo. 1908. Diatomees marines de France et des districts marines voisins.

M. J. Tempere. Grez sur Loing. 491 p.

Romero Zarco, C. 2003. Red algae identification key (1998- 2003). Universidad de Sevilla. Last update July 24, 2003. www.aloj.us.es/carromzar/algas.

Siqueiros Beltrones, D. A. & S. E. Ibarra Obando. 1985. Lista florística de las diatomeas epifitas de *Zostera marina* en Bahía Falsa, San Quintín, BC. *Ciencias Marinas*. 11(3): 2167. https://doi.org/10.7773/cm.v11i3.479

Siqueiros Beltrones, D.A., S.E. Ibarra Obando & D.H. Loya Salinas. 1985. Una aproximación a la estructura florística de las diatomeas epifitas de *Zostera marina* y sus variaciones temporales en Bahía Falsa, San Quintín, B.C. *Ciencias Marinas*. 11(3): 6988. https://doi.org/10.7773/cm.v11i3.479

Siqueiros Beltrones, D.A., E. Serviere-Zaragoza & U. Argumedo Hernández. 2001. First record of the diatom *Cocconeis notata* Petit living inside the hydrotheca of a hydrozoan epiphyte of *Macrocystis pyrifera* (L) C. Ag. *Oceánides*. 16 (2): 135-138.

Siqueiros Beltrones, D.A. 2002. *Diatomeas bentónicas de la Península de Baja California; Diversidad y Potencial Ecológico*. Centro Interdisciplinario de Ciencias Marinas-Instituto Politécnico Nacional / Universidad Autónoma de Baja California Sur, México. 102.

Siqueiros Beltrones, D.A., F.O. López Fuerte & I. Gárate Lizárraga. 2005. Structure of diatom assemblages living on prop roots of the red mangrove *Rhizophora mangle* L. from the west coast of Baja California Sur, México. *Pacific Science,* 59 (1): 79-96. https://doi.org/10.1353/psc.2005.0014

Siqueiros Beltrones, D. A. & U. Argumedo Hernández. 2005. Florística de diatomeas epifitas en láminas apicales de *Macrocystis pyrifera* (L.) C. Ag. *CICIMAR Oceánides,* 20 (1, 2): 37-63. https://doi.org/10.37543/oceanides.v20i1-2.21

Siqueiros Beltrones, D. A. & O. U. Hernández Almeida. 2006. Florística de diatomeas epifitas en macroalgas de un manchón subtropical. *CICIMAR Oceánides,* 21 (1): 11-61. https://doi.org/10.37543/oceanides.v21i1-2.25

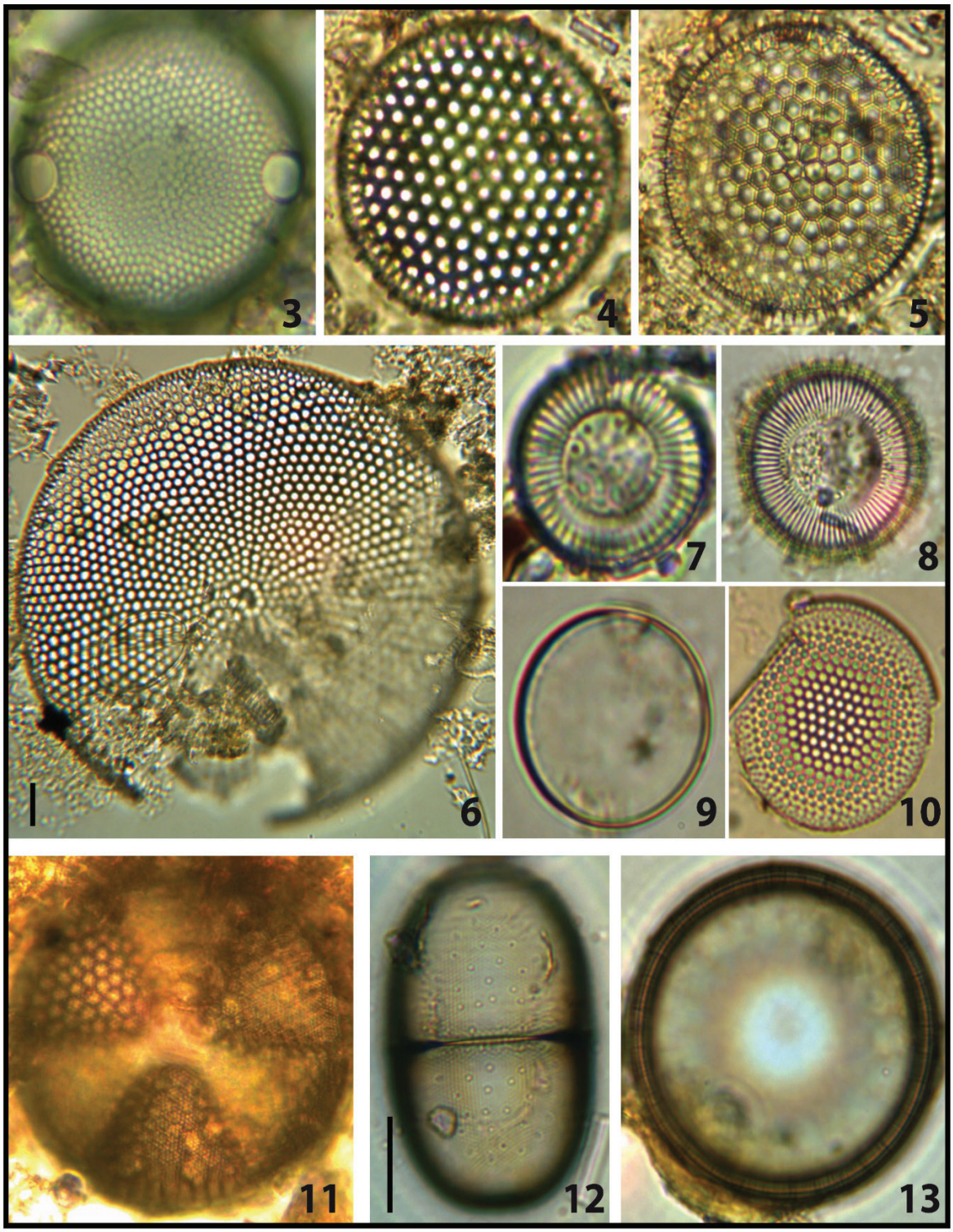
Siqueiros Beltrones, D. A. & U. Argumedo Hernández. 2014. Particular structure of an epiphytic diatom assemblage living on *Ploclamium cartilagineum* (Lamoroux) Dixon (Rhodophyceae: Gigartinales). *CICIMAR Oceánides*, 29(2): 11-24. https://doi.org/10.37543/oceanides.v29i2.136

Siqueiros Beltrones, D. A. & U. Argumedo Hernández. 2014b. Quasi monospecific proliferation of *Pteroncola inane* (Giffen) Round (Fragilariales; Bacillariophyceae) on blades of *Eisenia arborea* Areschoug. *CICIMAR Oceánides,* 29(2): 57-62. https://doi.org/10.37543/oceanides.v29i2.140

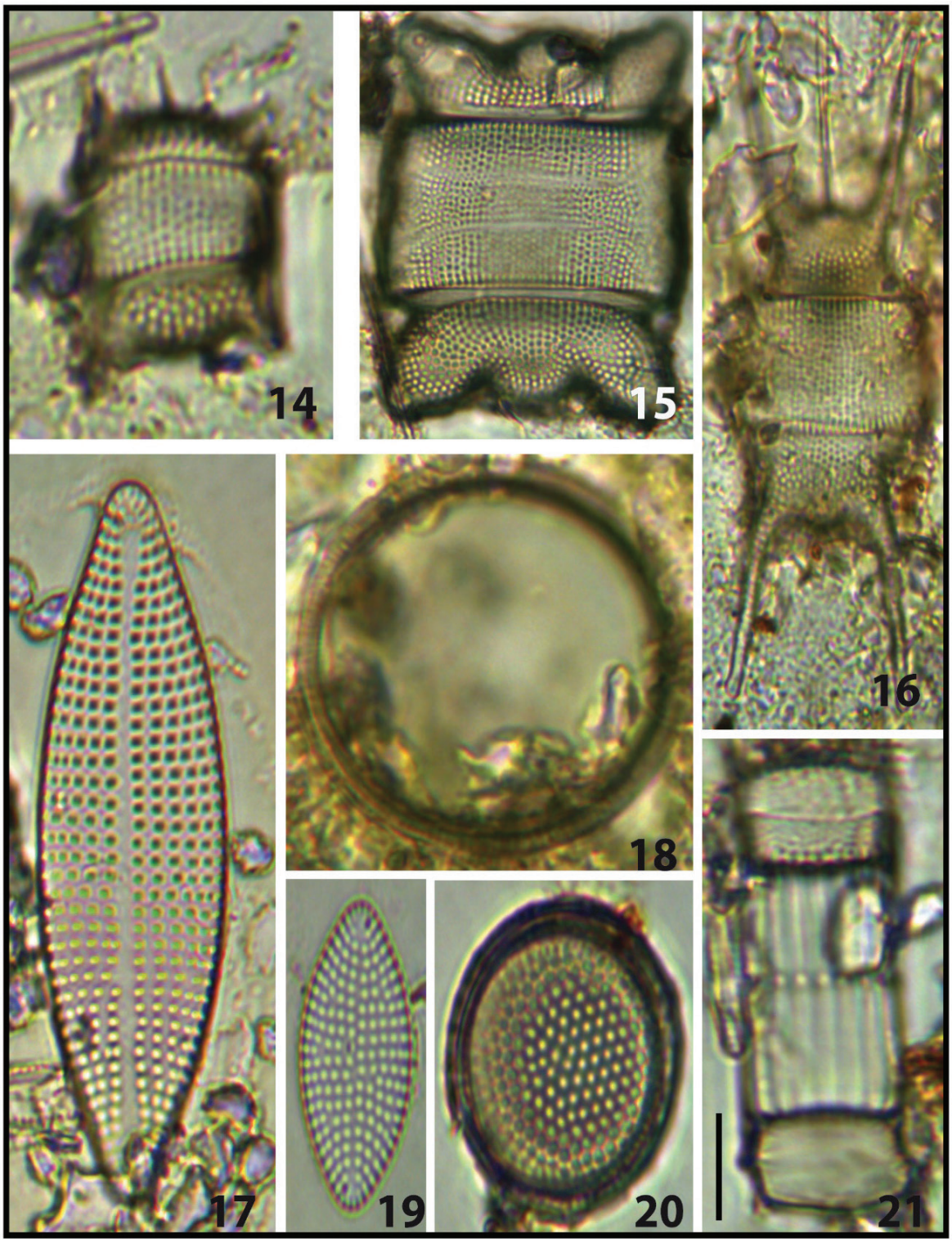
Siqueiros Beltrones, D. A., U. Argumedo Hernández & C. Landa Cansigno. 2016. Uncommon species diversity values in epiphytic diatom assemblages of the kelp *Eisenia arborea*. *Hidrobiológica*, 26(1): 61-76. https://doi.org/10.24275/uam/izt/dcbs/hidro/2016v26n1/Siqueiros

Stidolph, S. R., F. A. S. Sterrenburg, K. E. L. Smith & A. Kraberg. 2012. Stuart R. Stidolph Diatom Atlas, US Geological Survey Open-File Report. 2012-1163. https://doi.org/10.3133/ofr20121163

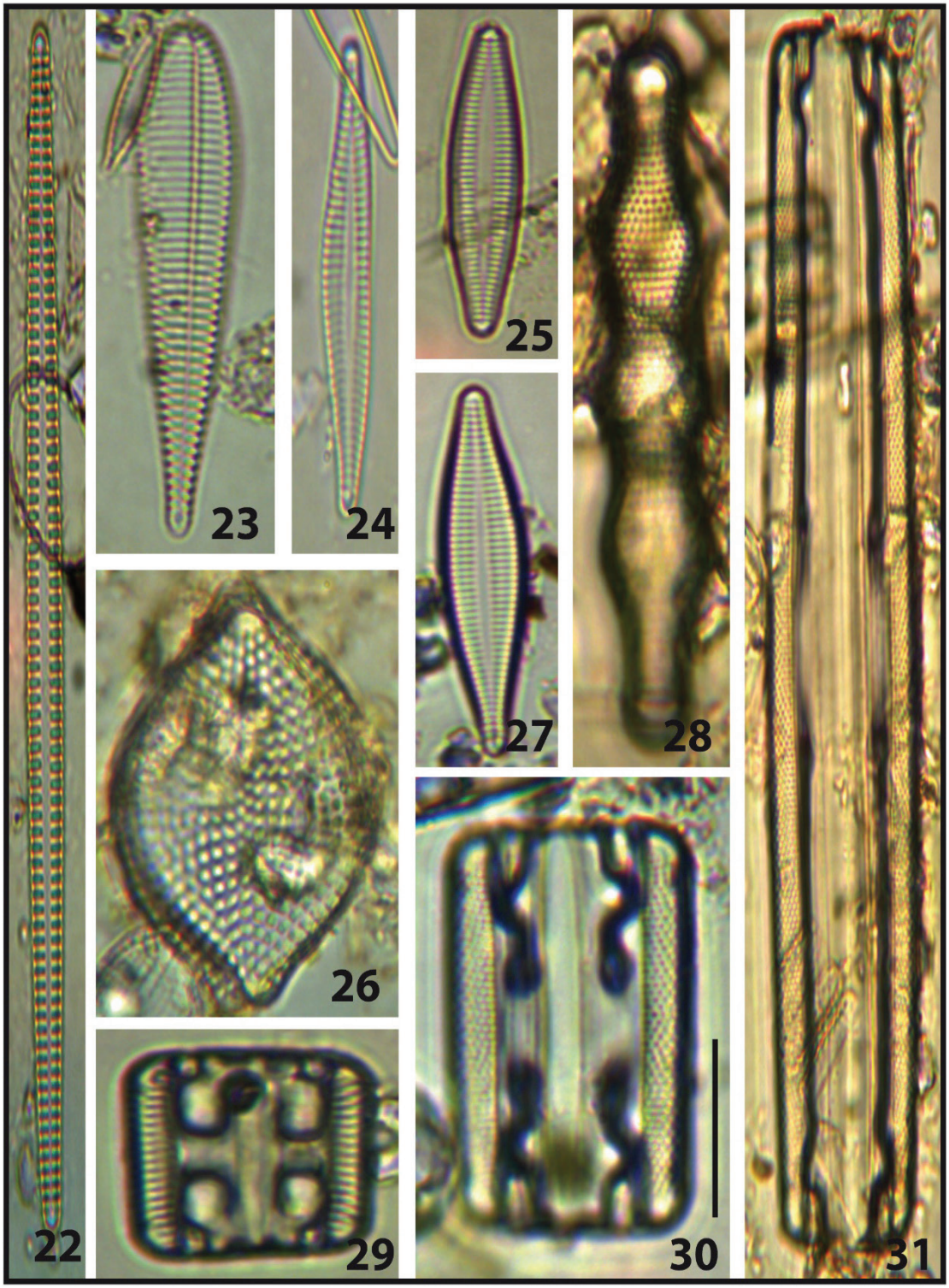
Witkowski, A., H. Lange-Bertalot & D. Metzeltin. 2000. Diatom flora of marine coasts I.A.R.G. Gantner Verlag K.G., Ruggell.



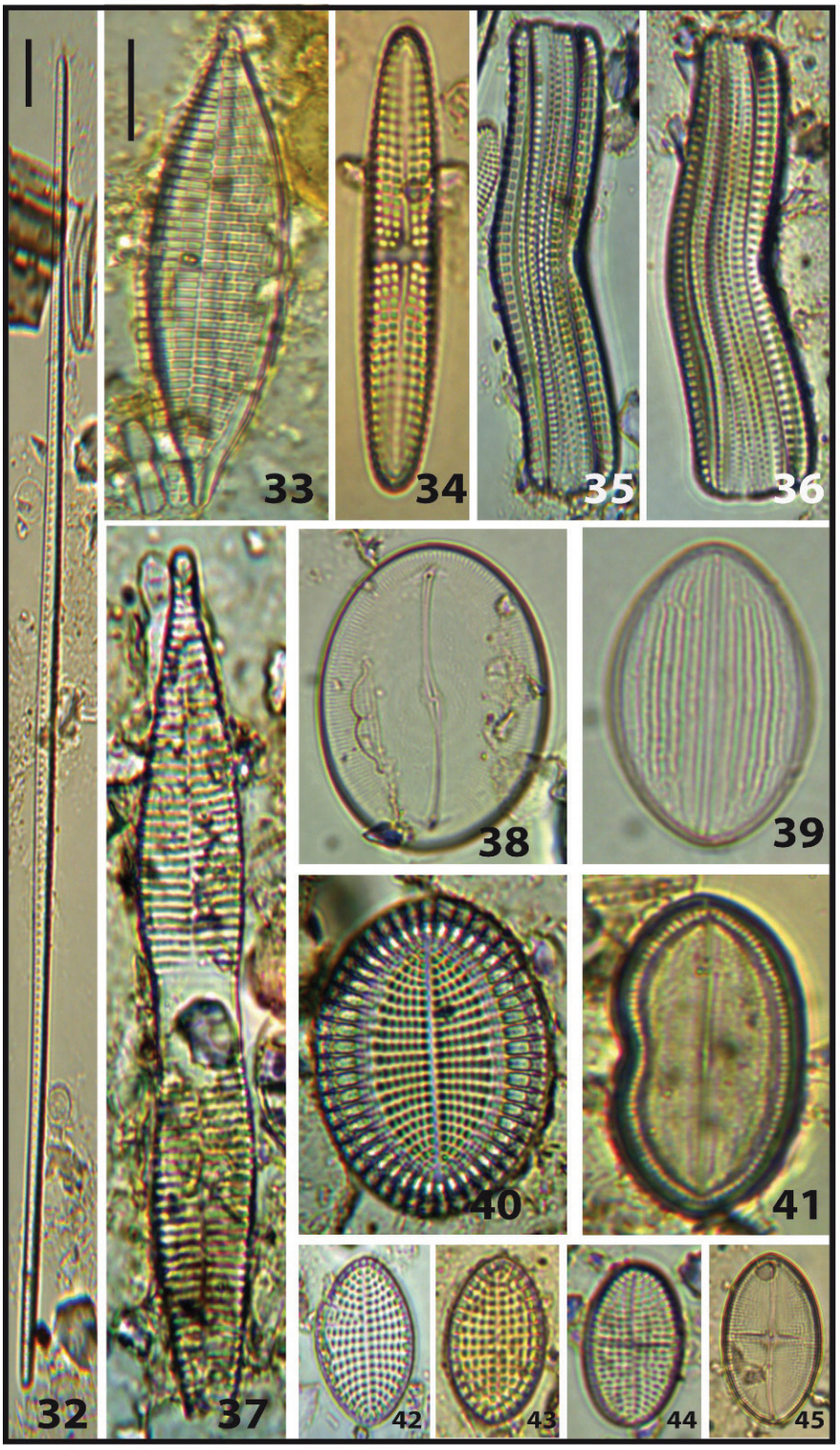
Figs. 3-13. At 630×: 6) *Coscinodiscus centralis*. At 1000×: 3) *Cerataulus californicus*; 4-5) *Coscinodiscus rothii*; 7) *Cyclotella litoralis*; 8) *Cyclotella stylorum*; 9) *Ehrenbergiulva granulosa*; 10) *Thalassiosira eccentrica*; 11) *Actinoptychus senarius*; 12) *Melosira montagnei*; 13) *Podosira stelligera.* Bar = 10 µm.



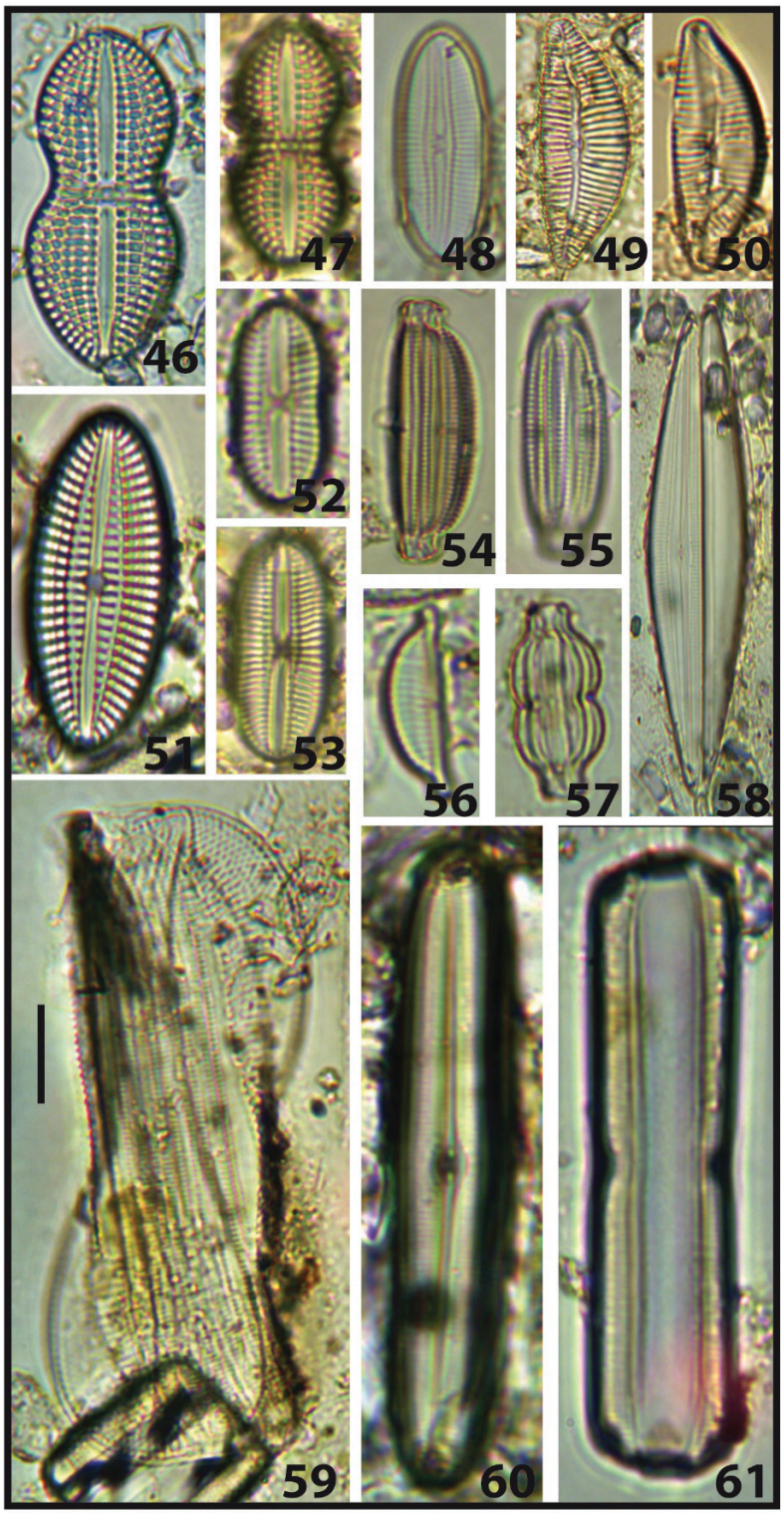
Figs. 14-21. At 1000×. 14) *Odontella aurita*; 15) *Odontella aurita* var. *obtusa*; 16) *Odontella mobiliensis*; 17) *Delphineis surirella*; 18) *Paralia sulcata*; 19) *Delphineis surirelloides*; 20) *Shionodiscus oestrupii*; 21) *Skeletonema* cf. *costatum*, Bar = 10 µm



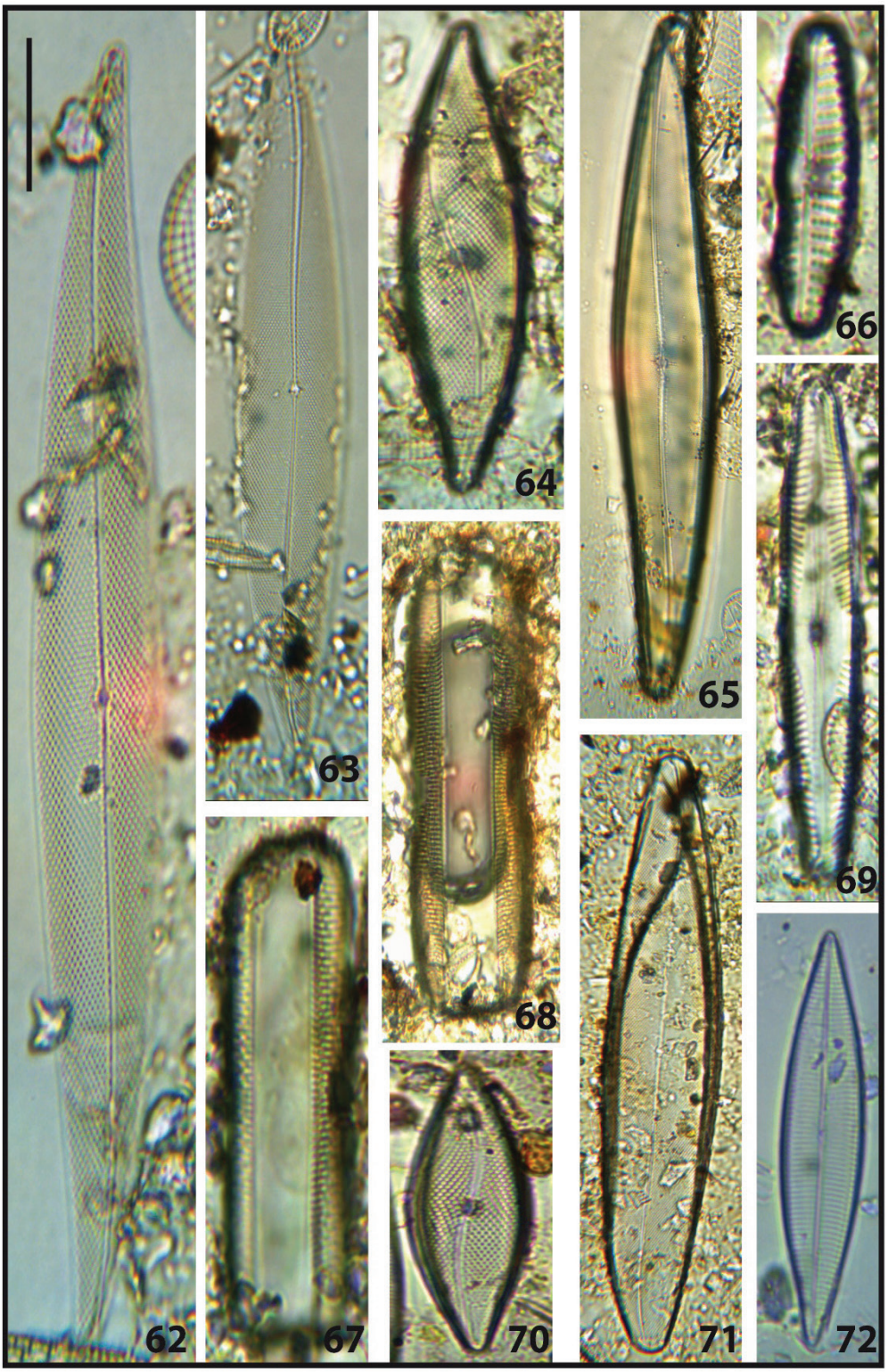
Figs. 22-31. At 1000×: 22) *Tabularia investiens*; 23) *Licmophora abreviata*; 24) *Tabularia fasciculata*; 25) *Tabularia tabulata* var. *fasciculata*; 26) *Raphoneis amphiceros*; 27) *Tabularia barbatula*; 28) *Grammatophora undulata*; 29) *Grammatophora hamulifera*; 30) *Grammatophora marina*; 31) *Grammatophora oceanica*. Bar = 10 µm.



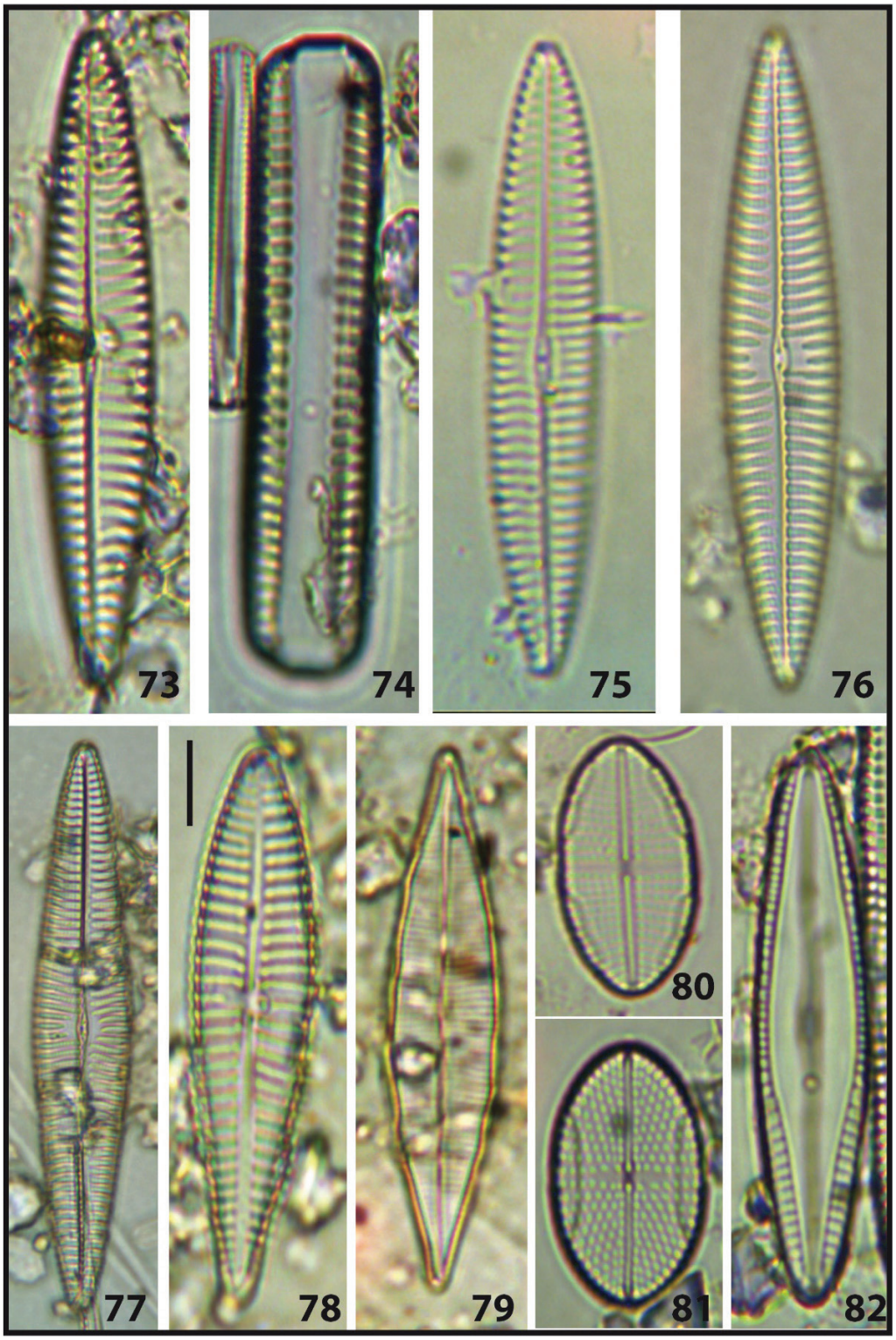
Figs. 32-45. At 630×: 32) *Thalassiothrix longissima*. At 1000×: 33) *Achnanthes manifera*; 34-35) *Achnanthes brevipes* var. *angustata*; 36) *Achnanthes longipes*; 37) *Synedra goulardi*; 38*)* *Cocconeis krammeri*; 39) *Cocconeis convexa*; 40) *Cocconeis britannica*; 41) *Cocconeis placentula* var. *euglypta*; 42-43) *Cocconeis scutellum* var. *parva*; 44) *Cocconeis diruptoides*; 45) *Cocconeis dirupta*. Bar = 10 μm.



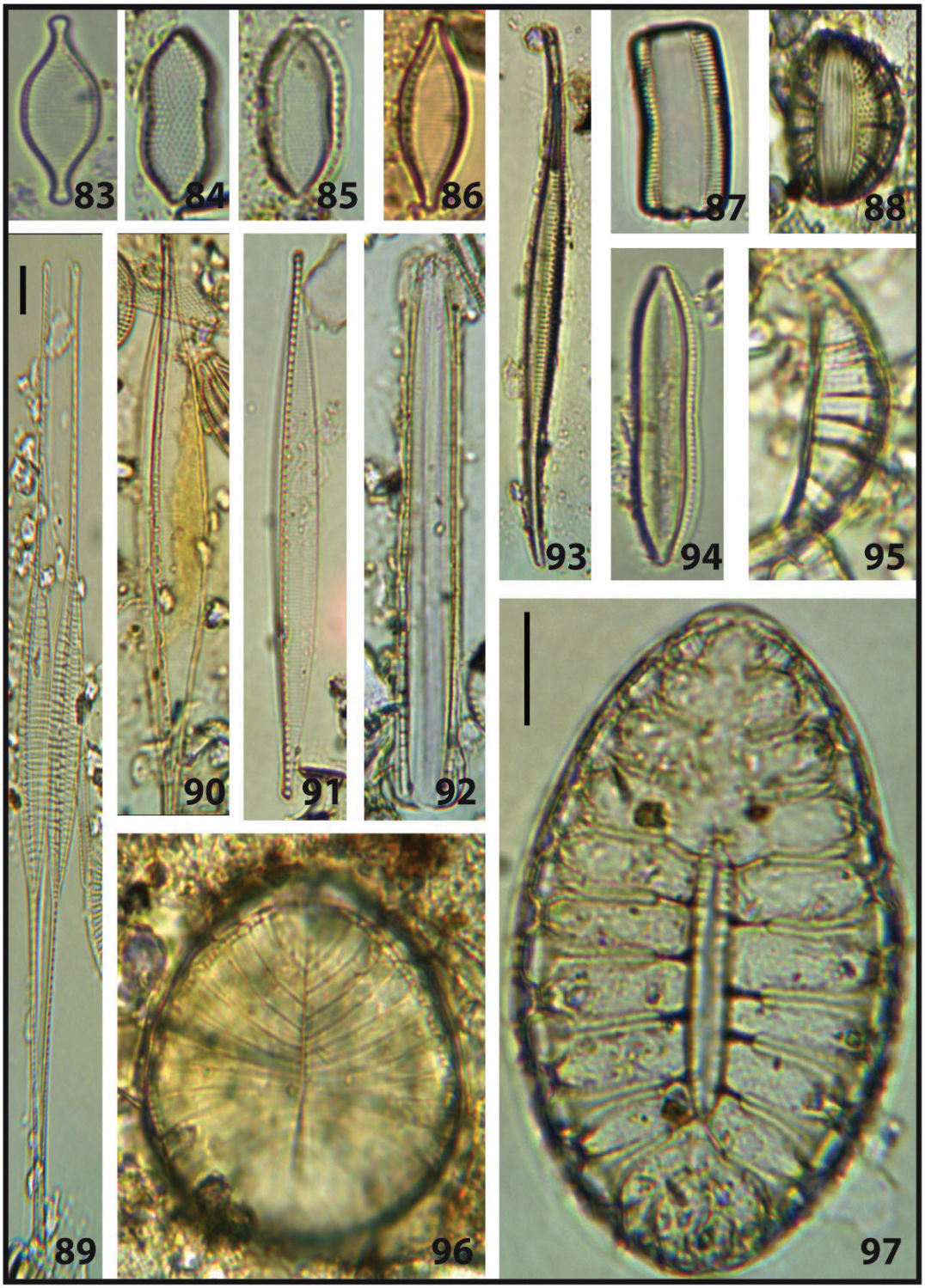
Figs. 46-61. At 1000×. 46) *Diploneis chersonensis*; 47) *Diploneis weiseflogii*; 48) *Diploneis litoralis*; 49) *Cymbella turgidula*; 50) *Cymbella hustedtii*; 51) *Diploneis nitescens*; 52-53) *Diploneis papula* var. *constricta*; 54) *Amphora turgida*; 55-56) *Halamphora coffeaeformis*; 57) *Amphora bigibba*; 58) *Amphora angusta*; 59) *Amphiprora gigantea*; 60) *Caloneis liber*; 61) *Caloneis linearis*. Bar = 10 µm



Figs. 62-72. At 1000×. 62) *Pleurosigma salinarum*; 63) *Pleurosigma majus*; 64) *Pleurosigma diverse striatum*; 65) *Pleurosigma angulatum*; 66) *Reimeria* cf. *sinuata*; 67) *Trachyneis aspera*; 68) *Trachyneis velata*; 69) *Pinnularia gibba;* 70) *Pleurosigma aestuarii*; 71) *Pleurosigma rigidum*; 72) *Parlibellus rhombicula*. Bar = 10 µm.



Figs. 73-82. At 1000×. 73-74) *Navicula pennata*; 75) *Navicula johanrosii*; 76) *Navicula longa*; 77) *Navicula longa* var. *irregularis*; 78) *Gomphonema subclavatum*; 79) *Navicula* cf. *transistantiodes*; 80) *Mastogloia crucicula*; 81) *Mastogloia binotata*; 82) *Mastogloia cuneata*. Bar = 10 µm.



Figs. 83-97. At 1000×: 83) *Nitzschia bicapitata*; 84-85) *Tryblionella coarctata*; 86) *Nitzschia microcephala*; 87) *Campylopyxis garkeana*; 88) *Rhopalodia musculus* var. *producta*; 89) *Nitzschia longissima* f. *costata* (630×); 90) *Nitzschia longissima*; 91) *Bacillaria socialis*; 92) *Nitzschia distans* var. *tumescens*; 93) *Nitzschia lorenziana* var. *subtilis*; 94) *Trybionella* sp. 95) *Rhopalodia musculus*; 96) *Campylodiscus ralfsii*; 97) *Surirella fastuosa* var. *recedens*. Bar = 10 μm.