Mediterranean Marine Science

Vol 23, No 4 (2022)

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doi: [10.12681/mms.28075](https://doi.org/10.12681/mms.28075)

Research Article

Mediterranean Marine Science
Indexed in WoS (Web of Science, ISI Thomson) and SCOPUS
The journal is available on line at http://www.medit-mar-sc.net
www.hcmr.gr
DOI: http://doi.org/10.12681/mms.28075

Contributions to the Diatom Flora of the Aegean Sea and the Mediterranean Sea from the Turkish Coasts with Remarks on Rare Taxa

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Contributing Editor: Adriana ZINGONE

Received: 29 September 2021; Accepted: 26 October 2022; Published online: 09 December 2022

Abstract

This study reports on newly recorded and several rare marine benthic diatoms from the Turkish coasts of the Aegean Sea. Altogether 510 species were observed from 6 locations throughout the Aegean Sea, and taxonomic and biogeographic remarks concerning thirty-four new recorded species are presented. Amongst the represented taxa, *Amicula*, *Auricula*, *Cyclophora*, *Minidiscus*, *Oestrupia* and *Ralfsiella* were observed for the first time in Turkish coastal waters. *Biddulphia seychellensis*, *Cyclophora tabellariformis*, *Grammatophora maxima*, *G. gibberula*, *Amphicocconeis mascarenica*, *Cocconeis maxima*, *Amicula specululum*, *Caloneis egena*, *Diploneis dalmatica*, *D. droopii*, *Mastogloia affinis*, *M. linearis*, *M. mauritana* and *Oestrupia powelii* var. *vidovichii*, which were rarely recorded from the coasts of the oceans and the Mediterranean Sea, were examined by light microscopy (LM) and scanning electron microscopy (SEM). Also, the findings revealed that the geographic range of *A. mascarenica*, *B. seychellensis*, *C. tabellariformis* and *Psammodictyon corpulentum*, which were distributed in warmer marine waters, has expanded to the temperate waters of the Aegean Sea. Additionally, the recently described species *Hyalosira septata*, from the loggerhead sea turtle carapace and the Turkish Mediterranean Sea coast was observed in the Aegean Sea. This study contributes to the diatom knowledge of marine waters from the understudied Aegean Sea coasts of Türkiye, enhancing the biogeography of some rare and well-established taxa.

Keywords: Biogeography; marine benthic diatoms; new records; taxonomy; Aegean Sea; Mediterranean Sea.

Introduction

Benthic diatoms are important components of aquatic habitats (Falkowski *et al*., 1998). Diatoms contribute to both primary production and photosynthesis (Coelho *et al*., 2007). Diatoms are good bioindicators because their communities react quickly to environmental changes. Thus, the information about their taxonomic composition can be a tool to assess different ecological features and can be used during monitoring (throughout the year) (Desrosiers *et al*., 2013). These implications have increased the importance of determining the diatom flora in coastal areas. Nevertheless, location-specific studies have shown that, apart from several common taxa, differences can be observed in diatom composition in various geographic locations (Nevrova, 2016; Park *et al*., 2018).

Regarding marine benthic diatoms, several studies have been conducted especially on the Greek coasts of the Aegean Sea. Economou-Amilli (1980) investigated the marine diatoms of the Saronikos Gulf. Also, Foged (1986) investigated the Volo bay diatoms on Greek coasts. It was followed by detailed research conducted by Belegratis (2000) in marine sites of Evoikos Gulf and Louvrou (2007) in marine hydrothermal regions of Milos Island. Some studies included specific taxa from the Turkish coast of the Aegean Sea (De Stefano *et al*., 2008; Blanco & Blanco, 2014; Majewska *et al*., 2014), while other studies focused on lagoons and a few on coastal sites. Nevertheless, marine research on Turkish coasts was scanty and the diatom flora remained largely unknown. Çolak-Sabancı (2008; 2013) and Çolak-Sabancı & Witkowski *et al*. (2014) studied the benthic diatoms of Homa lagoon on the central Aegean coasts, followed by Kaleli (2019) and Kaleli *et al*. (2020) reporting on species from the Iztuzu coast and a coastal lake in the southern Aegean Sea. Çolak-Sabancı (2008) recorded a variety of *Mastogloia* species, while Kaleli (2019) observed a diatom flora in a coastal lake that was quite different from the coasts of the same location (Kaleli *et al*., 2020).

This study aimed to contribute to the knowledge of the diatom flora of the Aegean Sea and beyond in terms of taxonomic aspects and the biogeographic distribution of the taxa. Furthermore, the study focused on the rare and recently recorded taxa and provided evidence on whether species from different biogeographic areas were present on the coasts of the Turkish Aegean Sea. One of the aims of this study was to integrate and complement the checklist of marine diatoms of Turkish coastal waters (Kaleli & Akçaalan, 2021).

Materials and Methods

Diatom sampling was carried out from 6 sites on the coasts of the Aegean Sea in Türkiye in April 2015 (Fig. 1). The sampling sites are located in small towns which are favourable touristic destinations on the Aegean Sea coasts of Türkiye. Between spring and autumn, these locations are under high anthropogenic impact due to swimming and the overpopulation of the towns. Sampling was performed at public beaches. The beaches shared common characteristics being covered by stones and natural rocks on the shores. At the time of the sampling, no macroalgae suitable to host epiphytes were observed, therefore epilithic sampling was performed. Physicochemical parameters were measured by Hach HQ40 multiparameter (Table 1).

Samples were collected from the submerged stones and rocks by brushing ca. 10 cm^2 of the area. Samples were treated with HCl to remove carbonates followed by acid-cleaned boiling with H_2O_2 and then washed with distilled water several times. Diatom material was dropped on coverslips, then air-dried and mounted with Naphrax® to obtain permanent slides. Valves were observed at x1000 magnification using a Nikon Eclipse Ci-E (Nikon Corp., Tokyo, Japan) light microscope. Diatom material was dropped onto aluminum stubs and air-dried to perform scanning electron microscopy observations. Stubs were coated with gold-palladium and SEM observations were made using a Tescan Mira3 XMU (Tescan, Bruno, Czech Republic) at an accelerating voltage of 10 kV at Sivas Cumhuriyet University, Advanced Technology Application and Research Center.

Diatoms were identified mainly according to Peragallo & Peragallo (1897-1908), Hendey (1964), Hustedt & Jensen (1985), Witkowski *et al*. (2000) and Loir & Novarino (2013). Furthermore, several species-specific papers were consulted for identification (See Appendix). Slides and processed materials are deposited at the Department of Marine and Freshwater Resources Management, Istanbul University, Istanbul (Türkiye).

Fig. 1: Sampling stations along the Aegean Sea coasts of Türkiye.

Table 1. Physicochemical parameters of the sampling locations.

Sampling Sites	Salinity (PSU)	Water temperature (°C)	Dissolved Oxygen (mg/L)
Altınoluk	36.7	17.7	9.4
Ayvalık	36.9	13.1	8.7
Çeşme	37.2	19.7	9.1
Urla	37.2	18.4	9.6
Kuşadası	32.5	18.7	9.1
Datça	37.7	22	8.9

Results

A total of 510 taxa belonging to 115 genera were observed from the sampling locations (Table S1), with 6 genera and 34 species recorded for the first time from the Aegean Sea coasts of Türkiye (Table 2). Amongst the newly recorded taxa, one species belonged to the Coscinodiscophyceae whereas 3 and 30 belonged to the Mediophyceae and the Bacillariophyceae respectively. Among genera, *Amicula*, *Auricula*, *Cyclophora*, *Minidiscus*, *Oestrupia* and *Ralfsiella* were observed for the first time on Turkish coasts. Furthermore, species were investigated in terms of their morphology and biogeographical distribution. LM micrographs and, where possible, SEM micrographs were obtained (Figs. 2-6). The number of measured valves was indicated (n) in dimensions.

Table 2. Species distribution along with the sampling stations.

Taxa / Location	Altınoluk	Ayvalık	Çeşme	Urla	Kuşadası	Datça
Actinoptychus senarius (Ehrenberg) Ehrenberg		+	+			
Biddulphia seychellensis Grunow in Van Heurck					+	
Minidiscus trioculatus (F.J.R.Taylor) Hasle	+					
Thalassiosira mediterranea (Schröder) Hasle					+	
Ralfsiella smithii (Ralfs) P.A.Sims, D.M.Williams & M.Ashworth		+				
Cyclophora tabellariformis Ashworth & Lobban				+		
Grammatophora maxima Grunow	+				+	
Grammatophora gibberula Kützing	+				+	
Hyalosira septata Bosak, Van de Vijver & Bizsel	+					
Amphicocconeis mascarenica Riaux-Gobin & Compère						+
Cocconeis maxima (Grunow) H.Peragallo & M.Peragallo		+				
Amicula specululum (Witkowski) Witkowski	+					
Amphora ostrearia var. *lineata* Cleve			+	+	+	
Amphora proteus var. *contigua* Cleve	+					
Caloneis egena (A.W.F.Schmidt) Cleve						+
Caloneis elongata (Grunow) Boyer	+	+	+			
Caloneis excentrica (Grunow) Boyer		+				
Diploneis dalmatica (Grunow) Cleve			+	+		
Diploneis droopii Witkowski, Belegratis & Economu-Amilli			+			
Diploneis nitescens (W.Gregory) Cleve			+			+
Diploneis sejuncta (A.W.F.Schmidt) Jørgensen	+					
Diploneis suborbicularis (W.Gregory) Cleve					+	
Mastogloia affinis Cleve			+			
Mastogloia biocellata (Grunow) G.Novarino & A.R.Muftah			+			
Mastogloia corsicana (Grunow) H.Peragallo & M.Peragallo		+	+	+		+
Mastogloia fallax Cleve			+			
Mastogloia graciloides Hustedt			+			
Mastogloia linearis Simonsen			+			
Mastogloia mauritiana Brun			+			
Mastogloia ovata Grunow			+			
Oestrupia powelii var. *vidovichii* (Grunow) Heiden		+				
Psammodictyon corpulentum (Hendey) D.G.Mann					+	
Tryblionella lanceola Grunow	+	+				
Auricula intermedia (F.W.Lewis) Cleve		+	+			

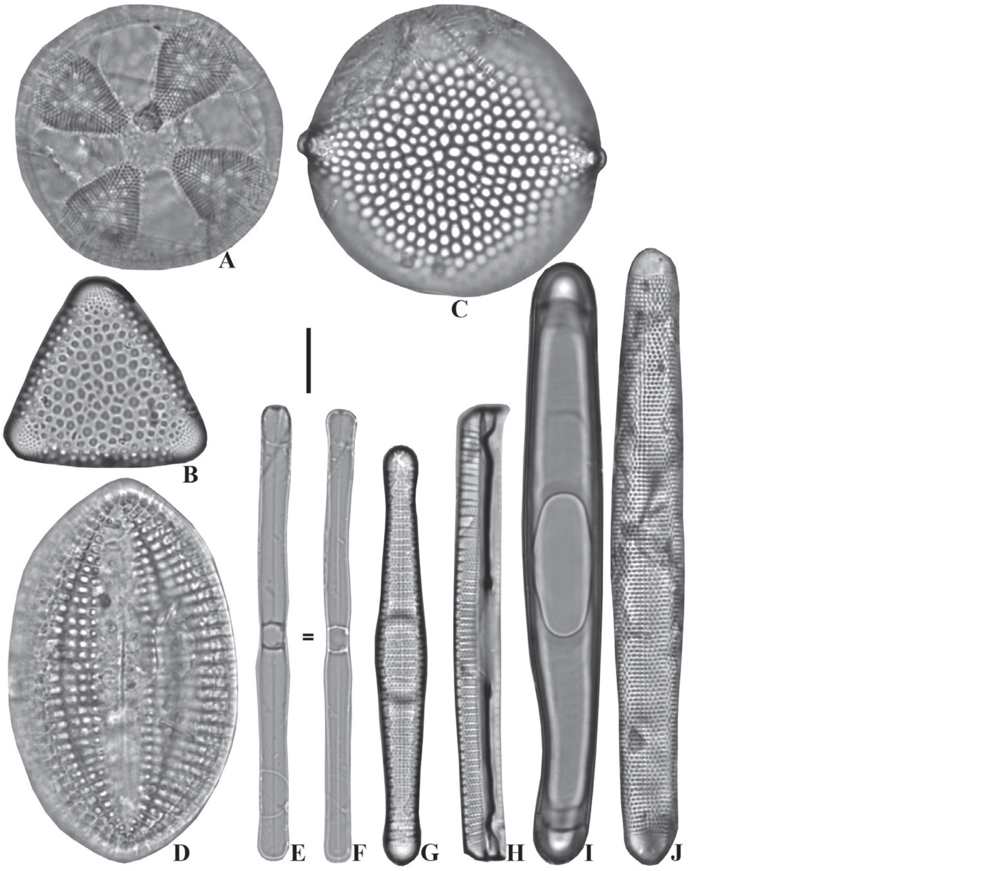

Fig. 2: A. *Actinoptychus senarius*, B. *Biddulphia seychellensis*, C. *Ralfsiella smithii*, D. *Cocconeis maxima*, E, F. *Cyclophora tabellariformis*, G, H. *Grammatophora gibberula*, I, J. *G. maxima*. Scale bar: 10 µm.

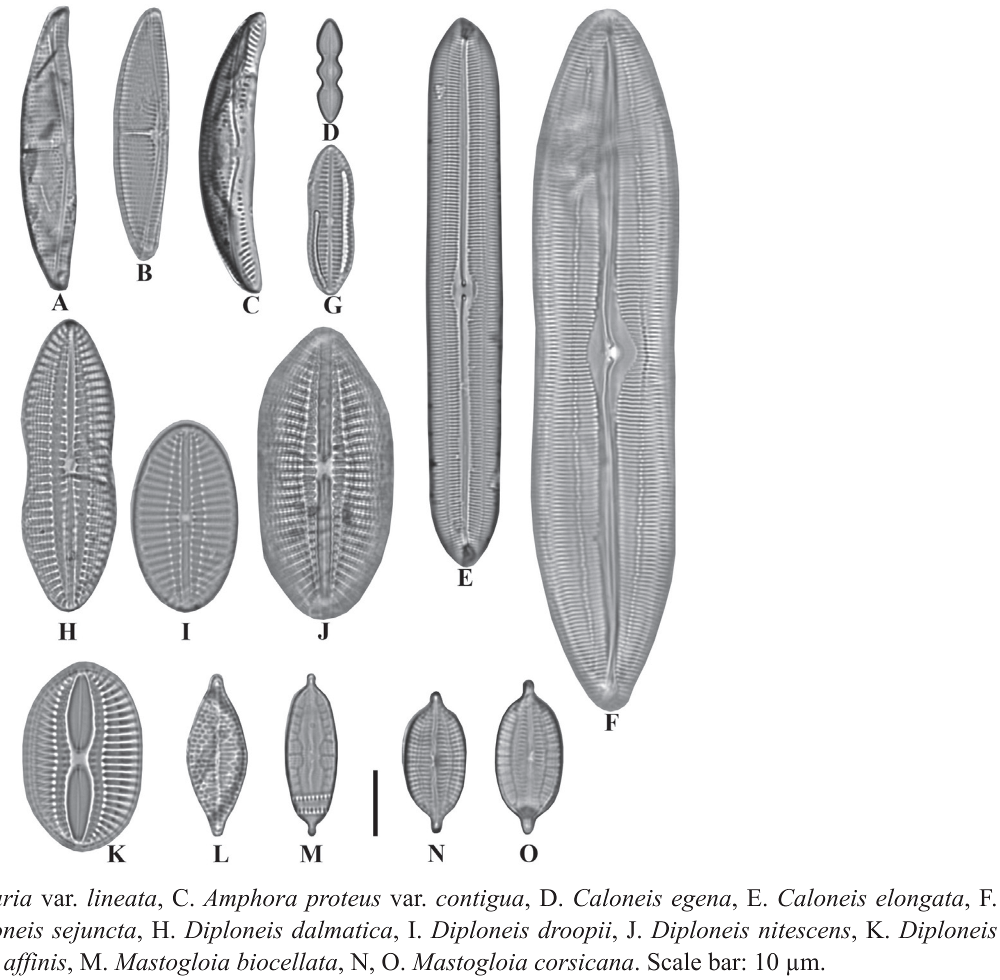

Fig. 3: A, B. *Amphora ostrearia* var. *lineata*, C. *Amphora proteus* var. *contigua*, D. *Caloneis egena*, E. *Caloneis elongata*, F. *Caloneis excentrica*, G. *Diploneis sejuncta*, H. *Diploneis dalmatica*, I. *Diploneis droopii*, J. *Diploneis nitescens*, K. *Diploneis suborbicularis*, L. *Mastogloia affinis*, M. *Mastogloia biocellata*, N, O. *Mastogloia corsicana*. Scale bar: 10 µm.

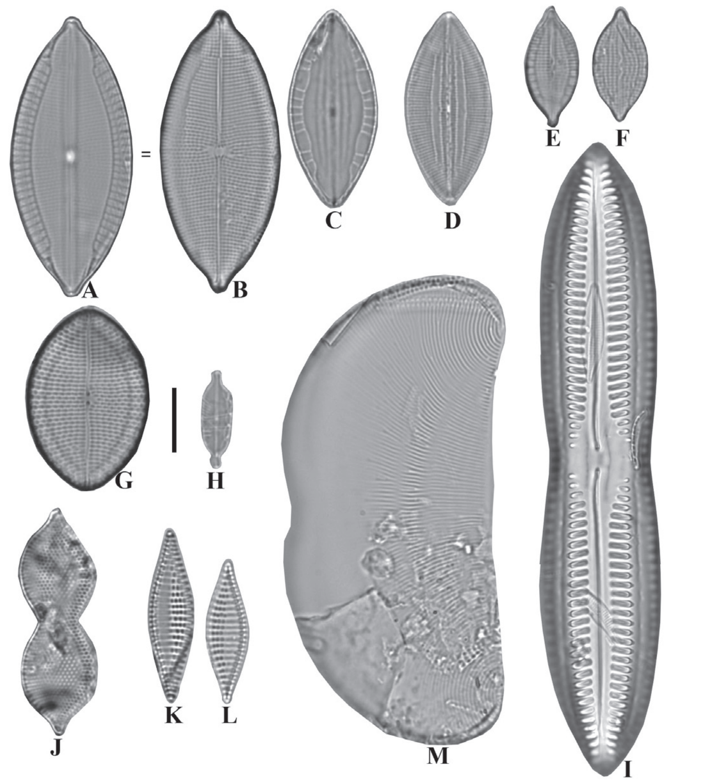

Fig. 4: A, B. *Mastogloia fallax*, C, D. *Mastogloia mauritiana*, E, F. *Mastogloia graciloides*, G. *Mastogloia ovata*, H. *Mastogloia linearis*, I. *Oestrupia powelii* var. *vidovichii*, J. *Psammodictyon corpulentum*, K, L. *Tryblionella lanceola*, M. *Auricula intermedia*. Scale bar: 10 µm.

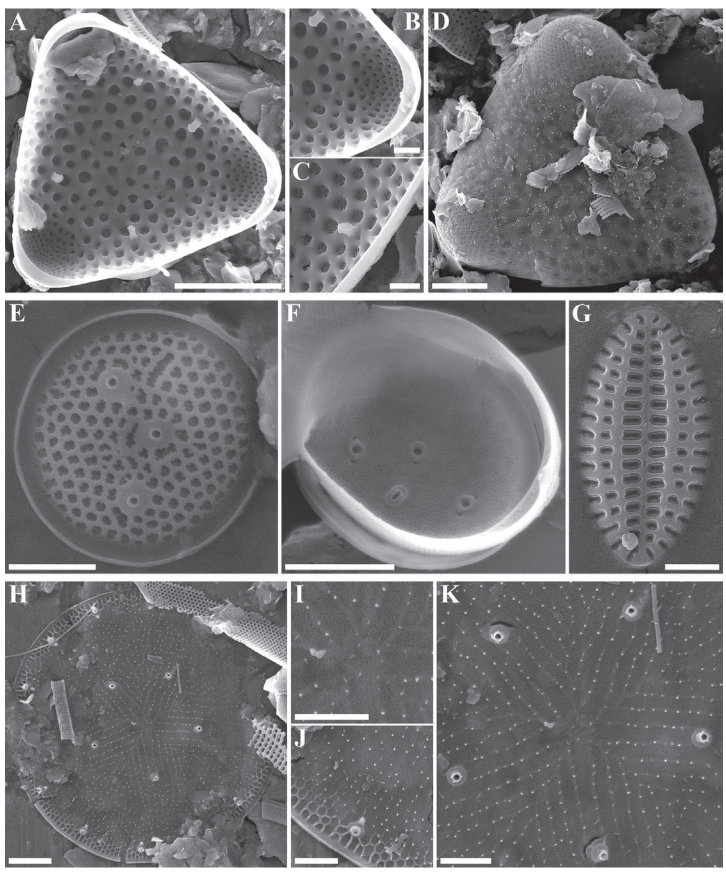

Fig. 5: A-D. *Biddulphia seychellensis* (A. internal overall valve view, B. pseudosepta view on the pole, C. rimoportula position on the valve mantle, D. external overall valve view); E, F. *Minidiscus trioculatus* (E. external overall valve view, F. internal overall valve view showing three fultoportulae and a rimoportula in the centre); G. *Amphicocconeis mascarenica*; H-K. *Thalassiosira mediterranea* (H. external overall valve view, I. view of the hyaline ring, J. view of rimoportula and fully developed areola, K. close-up view of star formation and spikes). Scale bars: Figs. (E, F, I-K): 1 µm; Figs. (B, C, G, H): 2 µm; Figs. (A, D): 10 µm.

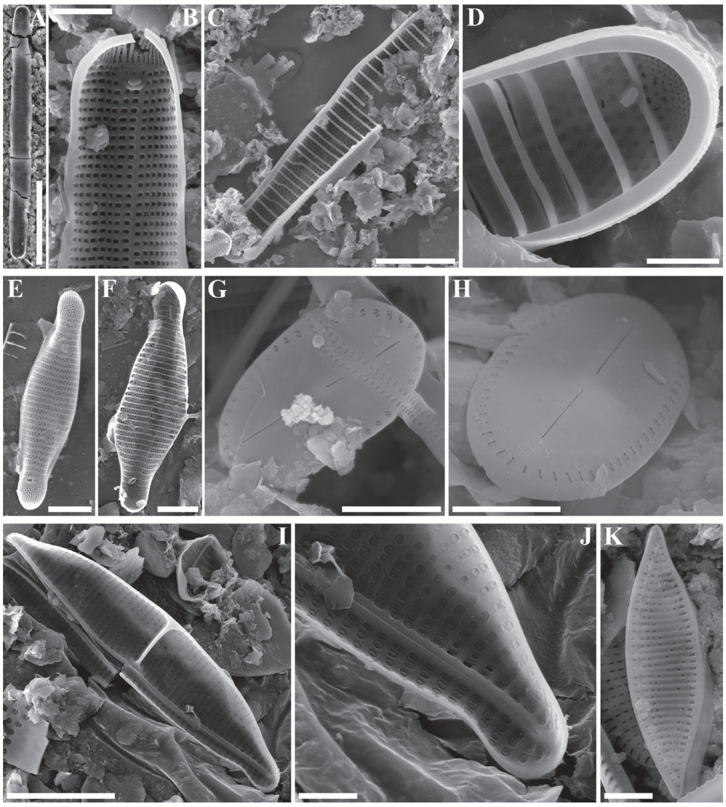

Fig. 6: A, B. *Cyclophora* cf. *tabellariformis* (A. internal overall valve view, B. close-up view of rimoportula); C, D. *Grammatophora gibberula* (C. internal overall valve view, D. close-up view of rimoportula and transapical ribs); E, F. *Hyalosira septata* (E. external overall valve view, F. internal overall valve view); G. *Amicula specululum*; H. *Amicula* sp.; I, J. *Amphora ostrearia* var. *lineata* (I. external overall valve view, J. close-up view of the valve ending); K. *Tryblionella* cf. *lanceola*. Scale bars: Figs. (B, D, E, F, G, H, J, K): 2 µm; Figs. (C, I): 10 µm. Fig. (A): 20 µm.

Coscinodiscophyceae

***Actinoptychus senarius* (Ehrenberg) Ehrenberg, 1843**
Fig. 2A

Basionym: *Actinocyclus senarius* Ehrenberg, 1838.
Synonyms: *Actinocyclus undulatus* Kützing, *Actinoptychus undulatus* (Kützing) Ralfs, *Actinoptychus undulatus* var. *typicus* Cleve-Euler.
References: Ehrenberg (1838), Hendey (1964), Al-Yamani & Saburova (2019).
Morphometry: Valve diameters are 28-41 µm (n=5).
Remarks: Valves are circular and divided into sectors. 8-10 sectors are observed with half of them elevated and composing a rounded, hyaline central area. Striae are small and punctate. Here, depressed sectors possess rimoportulae, however, they are barely visible. The taxon is cosmopolitan and widespread along different coasts of the oceans and is present on British coasts (Hendey, 1964), the Adriatic Sea (Car *et al*., 2019) and Kuwait (Al-Yamani & Saburova, 2019).

Mediophyceae

***Biddulphia seychellensis* Grunow in Van Heurck, 1883**
Fig. 2B; Fig. 5A-D

References: Van Heurck (1838-1909), Dąbek *et al*. (2015).
Morphometry: Apex to apex valve lengths are 21-35.5 µm (n=50).
Remarks: Valves are triangular with rounded poles (Fig. 5A, D). The external valve view shows granules placed irregularly whereas they surrounded the areola in Dąbek *et al*. (2015). Unoccluded pores are present on the valve face and poles bear pseudocellulus with small pores (Fig. 5D). Internally, 3-4 rimoportulae are observed located on the valve mantle (Fig. 5C). Pseudosepta are present on the poles (Fig. 5B). Even though no type of material was designated for *Biddulphia seychellensis*, valves observed from the Aegean Sea conform to the illustrations and descriptions by Dąbek *et al*. (2015), which followed the illustrations of Van Heurck (1838-1909). The taxon was rarely reported from the warm waters of the oceanic coasts of South Africa, Mozambique and Tanzania (Giffen, 1975; Riaux-Gobin *et al*., 2011a; Dąbek *et al*., 2015), associated with sand and seaweed habitats (Dąbek *et al*., 2015). In the temperate waters of the Aegean Sea *B. seychellensis* was found in material scraped from a rock.

***Minidiscus trioculatus* (F.J.R. Taylor) Hasle, 1973**
Fig. 5E-F

Basionym: *Coscinodiscus trioculatus* F.J.R. Taylor, 1966.
References: Taylor (1967), Kaczmarska *et al*. (2009), Fernandes & Da-Silva (2020).
Morphometry: Valve diameters are 2-3 µm (n=8).
Remarks: Valves are cylindrical and slightly domed. 3-4 fultoportulae and a rimoportula are present on the valve face (Fig. 5E). Rimoportula is internally labiate and located in the centre (Fig. 5F). Areolae are loculate (4-5 in

1 μm) and reach up to the margin. Copulae are composed of a hyaline ring, and valvocopulae form one or two rows of irregular small pores. *M. trioculatus* is reported as a planktonic species and is distributed along the oceans and the Mediterranean Sea (Kaczmarska *et al*., 2009; Leblanc *et al*., 2018; Fernandes & Da-Silva, 2020). Nevertheless, this is the first observation of cosmopolitan *M. trioculatus* on the Turkish coasts and the Aegean Sea.

***Thalassiosira mediterranea* (Schröder) Hasle, 1972**

Fig. 5H-K

Basionym: *Coscinosira mediterranea* J.L.B. Schröder, 1911.

Synonyms: *Coscinodiscus mediterranea* Schröder, *Thalassiosira stellaris* Hasle & Guillard.

References: Li *et al*. (2013), Park *et al*. (2016).

Morphometry: Diameter is 13 μm (n=1).

Remarks: The valve face is flat and weakly silicified. There are 5 simple fultoportulae in the valve centre, each located in the midway of star-like formation arms (Fig. 5H). The star-like ornamentation expands from a small hyaline ring (Fig. 5I) as radial rays with line-arranged spikes (Fig. 5K), becoming more scattered near the valve margin. Fully developed areola walls are seen in the marginal zone of the valve face (Fig. 5J). At the margins, not all the fultoportulae and rimoportula are observed due to debris and a broken part of the valve. The taxon was described from the plankton of the northern Adriatic Sea (Schröder, 1911) and later reported from the Saronicos Gulf (Greece) in the Mediterranean Sea (Fryxell & Hasle, 1977). It is widespread in warm to temperate waters (Hasle & Syvertsen, 1996), and has also been reported in Hong Kong and Korean coastal waters (Li *et al*., 2013; Park *et al*., 2016).

Bacillariophyceae

***Ralfsiella smithii* (Ralfs) P.A. Sims, D.M. Williams & M. Ashworth, 2018**

Fig. 2C

Basionym: *Cerataulus smithii* Ralfs in Pritchard, 1861.

Synonyms: *Biddulphia smithii* Van Heurck, *Eupodiscus radiatus* W. Smith, *Biddulphia hemitropa* L.W. Bailey.

References: Pritchard (1861), Sims *et al*. (2018).

Morphometry: Diameter is 45.5 μm. (n=1).

Remarks: The valve is circular and bears two raised ocelli close to the mantle. The species was reported from the northeastern Adriatic Sea (Viličić *et al*., 2009) and the Black Sea (Proshkina-Lavrenko, 1963).

***Cyclophora tabellariformis* Ashworth & Lobban, 2012**

Fig. 2E, F; Fig. 6A, B

References: Ashworth *et al*. (2012).

Morphometry: Length is 70 μm, breadth is 4.5 μm (n=1).

Remarks: The valve is linear and very slightly constricted in the middle. The pseudoseptum is circular. The specimen observed conforms to the description of Ashworth *et al*. (2012) in terms of dimensions and pseudoseptum. Apices are slightly expanded and rounded and differ from the capitate ends of *C. castracanei* Ashworth & Lobban. The broken valve of *Cyclophora* without pseudoseptum in SEM is somewhat linear, however, it is in line with the description of Ashworth *et al*. (2012) in terms of the rimoportula position and the linear arrangements of slits in the apical pore field (Fig. 6A, B). The taxon is rare and it was so far known only from the type locality (Florida), Guam and Palau Islands (Ashworth *et al*., 2012; Lobban *et al*., 2012).

***Grammatophora gibberula* Kützing, 1844**

Fig. 2G, H; Fig. 6C, D

References: Witkowski *et al*. (2000).

Morphometry: Valves are 18-70 μm long and 6.5-8 μm wide, and show 7-11 striae in 10 μm. (n=62).

Remarks: In girdle view, septa are undulated. Valves are linear with capitate endings and slightly expanded in the middle. Striae are composed of 2-3 rows of areolae and separated by transapical ribs (Fig. 6C). In the internal view, the rimoportula is apically located near the valve margin (Fig. 6D). The species has been rarely reported, and previously observed in the Adriatic Sea (Viličić *et al*., 2002; Hafner *et al*., 2018). Hustedt & Jensen (1985) reported that the species is widely distributed on the South European coasts and Witkowski *et al*. (2000) reported it as an epiphyte from the western Baltic Sea. This is the first record of the species from the coasts of the Aegean Sea.

***Grammatophora maxima* Grunow, 1862**

Fig. 2I, J

References: Hustedt & Jensen (1985), Witkowski *et al*. (2000).

Morphometry: Valves are 91-105 μm long, 10-12 μm wide, and have 18 striae in 10 μm (n=6).

Remarks: Valves are linear with rounded apices, slightly expanded in the middle. Striae are delicate and punctate. The taxon was rarely reported; Hustedt & Jensen (1985) and Witkowski *et al*. (2000) indicated that the species was widespread but not common and distributed along the south Mediterranean Sea and European Atlantic coasts.

***Hyalosira septata* Bosak, Van de Vijver & Bizsel, 2021**

Fig. 6E, F

References: Lobban *et al*. (2021).

Morphometry: Valves are 10.5-11.5 μm long, 2.5-3 μm wide, with 36-38 striae in 10 μm (n=2).

Remarks: Valves are linear with rostrate apices (Fig. 6E). Striae are biseriate and parallel throughout the valve face extending to the mantle. Internally, the rimoportula is close to apices and located near the pore fields (Fig. 6F). The species differs from the similar taxon *Hyalosira mixta* C.S. Lobban & Majewska by denser striation (Lobban *et al*., 2021; 24-30 in 10 μm). It was recently described from the carapace of loggerhead sea turtles and additionally found on the eastern Mediterranean Sea coast of Türkiye (Lobban *et al*., 2021).

***Amphicocconeis mascarenica* Riaux-Gobin & Compère, 2011**

Fig. 5 G

References: Riaux-Gobin *et al*. (2011b).

Morphometry: Valves are 9.5 µm long, 5 µm wide, with 20 striae in 10 µm (n=2).

Remarks: Valves are oblong-elliptical with rounded apices. Striae are monoseriate, slightly radiate and composed of 4 areolae on the valve face. Areolae are slightly depressed and quadrangular in the centre followed by smaller areolae. The remaining oblong areolae are extended to the margin. Species resemble *Amphicocconeis disculoides* (Hustedt) Stefano & Marino in valve outline, however, the areolae are larger in *A. mascarenica*. The species was described by Riaux-Gobin *et al*. (2011b) from the Mascarene Islands and later found on Rodrigues Island, also observed in Australia and New Zealand (John, 2016). This is the first record of *Amphicocconeis mascarenica* in the Aegean Sea and the Mediterranean Sea.

***Cocconeis maxima* (Grunow) H. Peragallo & M. Peragallo, 1897**

Fig. 2D

Basionym: *Mastogloia maxima* Grunow, 1863.

Synonym: *Orthoneis maxima* (Grunow) Grunow, *Cocconeis scutellum* var. *maxima* (Grunow) Cleve.

References: Peragallo & Peragallo (1897-1908), Hustedt & Jensen (1985).

Morphometry: Valves are 60-76.5 µm long, 35-48 µm wide, with 6 striae in 10 µm (n=5).

Remarks: Valves are widely elliptical. The sternum valve is composed of delicately punctate striae. The sternum is wide, crossed by longitudinal rows of areolae. Areolae are interrupted by a narrow hyaline area between the central rows of areolae and marginal areolae. Proshkina-Lavrenko (1963) reported the species from the Black Sea, and Hustedt & Jensen (1985) indicated the species is fairly common in the Mediterranean Sea reaching up to the Black Sea, which was confirmed by later reports from these areas (Viličić *et al*., 2002; Caraus, 2017). This is the first report of *Cocconeis maxima* from the coasts of the Aegean Sea.

***Amicula specululum* (Witkowski) Witkowski, 2000**

Fig. 6G, H

Basionym: *Navicula specululum* Witkowski, 1994.

References: Witkowski *et al*. (2000), Sunesen & Sar (2019).

Morphometry: The valve observed was 5 µm long and 3 µm wide, with 40 striae in 10 µm (n=1).

Remarks: The valve is elliptic with rounded apices (Fig. 6G). The axial area is narrow. The raphe is straight and terminates before apices. The central area is hyaline and areolae are restricted to the valve margin. In the samples, another similar *Amicula* sp. was observed which only differed by narrow linear areolae (Fig. 6H). *Amicula specululum* was first described from the Baltic Sea (Witkowski, 1994) and later observed from the coasts of Kenia of the Indian Ocean and Florida coasts of the Atlantic Ocean (Witkowski *et al*., 2000), the Black Sea (Nevrova, 2016; Nevrova & Petrov, 2019) and Argentinian coastal waters (Sunesen & Sar, 2019). So far, There was only one previous record of *A. specululum* from the Eastern Mediterranean Sea (Schmidt *et al.*, 2018), where however it was misidentified as *Diploneis* sp. (Gastineau *et al*., 2022). We hypothesize that it is common species for this area, yet very easy to omit during LM analysis, due to its small size.

***Amphora ostrearia* var. *lineata* Cleve, 1895**

Fig. 3A, B; Fig. 6I, J

References: Cleve (1895), Hendey (1964).

Morphometry: Valves are 35.5-43 µm long, 7.1-8.3 µm wide, with 14 striae in 10 µm (n=3).

Remarks: Valves are lunate, and dorsally slightly concave (Fig. 6I). The ventral side is slightly extended to straight. Valve endings are rounded to slightly protruding (Fig. 6J). The raphe is arched and bent towards the dorsal side on apices. The central area is crossed by a hyaline line. The taxon is different from *Amphora ostrearia* by the arcuate ventral valve, and *A. ostrearia* var. *vitrea* by the valve endings that bend towards the dorsal side of the valve. Species is possibly widespread along marine coasts, however, it is difficult to distinguish them from other varieties. The taxon was reported from the Aegean Sea (Louvrou, 2007), British coastal waters (Hendey, 1964) and American coasts (Eskinazi-Leça *et al*., 2010; López-Fuerte & Siqueiros-Beltrones, 2016).

***Amphora proteus* var. *contigua* Cleve, 1895**

Fig. 3C

References: Cleve (1895), Wachnicka & Gaiser (2007).

Morphometry: Valve length is 42.5 µm, breadth is 8.5 µm, 14 striae in 10 µm (n=1).

Remarks: The valve is lunate and ventrally straight and slightly expanded in the middle. Apices are rounded, slightly produced and bent towards the ventral side of the valve. The raphe is arched, the axial area is narrow. On the dorsal side of the valve, a hyaline area occurs in the middle and on the ventral side, a row of longer striae becomes shorter and interrupted in the middle composing a hyaline area. The species was recently reported from North America (Wachnicka & Gaiser, 2007), Mexico (López-Fuerte & Siqueiros-Beltrones, 2016) and the Aegean Sea (Louvrou, 2007).

***Caloneis egena* (A.W.F. Schmidt) Cleve, 1894**

Fig. 3D

Basionym: *Navicula egena* A.W.F. Schmidt in Schmidt *et al*., 1890.

Synonyms: *Schizonema egenum* (A.W.F. Schmidt) Kuntze.

References: Schmidt (1890), Witkowski *et al*. (2000), Lobban *et al*. (2012).

Morphometry: Valve length is 16 µm, breadth is 4 µm (n=1).

Remarks: Valve is biconstricted and apices are slightly produced. The raphe is straight, striae here are indiscernible in LM, and the central area is constricted and crossed by transapical lines. *Caloneis egena* was rarely reported from marine coasts. Recently the taxon was found in the Adriatic Sea (Witkowski *et al*., 2000; Viličić *et al*., 2002; Hafner *et al*., 2018), Guam (Lobban *et al*., 2012) and the Gulf of California (López-Fuerte *et al*., 2019). This is the first report of *Caloneis egena* from the Aegean and the eastern Mediterranean Sea.

***Caloneis elongata* (Grunow) Boyer, 1927**

Fig. 3E

Basionym: *Navicula elongata* Grunow in Schmidt, 1874.
Synonyms: *Caloneis liber* var. *elongata* (Grunow) Cleve.
References: Schmidt (1874-1959).
Morphometry: Valves are 78.5-83.5 µm long, 8-11.5 µm wide, with 19-20 striae in 10 µm (n=5).
Remarks: Valves are linear with rounded apices. The raphe is straight becoming bent in the same direction at the apices. The axial area is narrow, the central area has lunate markings on each side of the nodule. Striae are parallel becoming slightly radiated at the valve endings. Striae are crossed by longitudinal canals on both sides of the valve face becoming very slightly expanded. Species resemble *Caloneis liber* in terms of valve outline, however, in *C. liber* the raphe is slightly undulated and striae are less silicified compared to *C. elongata*. The species was reported from the southeastern Adriatic Sea coasts (Hafner *et al*., 2018).

***Caloneis excentrica* (Grunow) Boyer, 1927**

Fig. 3F

Basionym: *Navicula excentrica* f. *excentrica* Grunow, 1860.
Synonyms: *Caloneis liber* var. *excentrica* (Grunow) Cleve, *Navicula maxima* var. *excentrica* (Grunow) Peragallo & Peragallo, *Navicula liber* var. *excentrica* (Grunow) Fricke.
References: Grunow (1860), Louvrou (2007).
Morphometry: Valve length is 89.5 µm, breadth 22 µm; 16 striae in 10 µm (n=1).
Remarks: Valves are linear, apices are rounded and slightly produced. The raphe is straight, central raphe endings are bent on one side of the valve and the central area is excentric. Striae are parallel to slightly radiate, and crossed by longitudinal lines on both sides of the valve face. *Caloneis excentrica* was first described by Grunow from the Adriatic Sea (1860) and later reported from the Greek and Bosnia and Herzegovinian coasts (Louvrou, 2007; Hafner *et al*., 2018).

***Diploneis dalmatica* (Grunow) Cleve, 1894**

Fig. 3H

Basionym: *Navicula dalmatica* Grunow, 1860.
Synonyms: *Pinnularia dalmatica* (Grunow) Rabenhorst, *Schizonema dalmaticum* (Grunow) Kuntze.
References: Grunow (1860), Hustedt & Jensen (1985).
Morphometry: Valve length is 44.5 µm, breadth 14 µm; 8 striae in 10 µm (n=1).
Remarks: Valve linear-lanceolate and constricted in the middle, apices acutely rounded. The central nodule is small and circular. The raphe is straight and interrupted in the middle by longitudinal ribs. Areolae are crossed by transapical lines close to the margin. The taxon was described from the Adriatic Sea by Grunow (1860), and Hustedt & Jensen (1985) reported that the species is distributed in warm waters and present in the Mediterranean Sea.

***Diploneis droopii* Witkowski, Belegratis & Economu-Amilli, 2000**

Fig. 3I

References: Witkowski *et al*. (2000), Belegratis (2002).
Morphometry: Valve length is 29 µm, breadth is 16 µm; 8 striae in 10 µm (n=1).
Remarks: The valve is elliptical with rounded endings. The central nodule is small and the raphe is slightly undulated throughout the valve face. Striae are radiate and interrupted by ribs close to the central area. The taxon was rarely reported. Witkowski *et al*. (2000) described a specimen from the Mediterranean Sea (Majorca). Later Belegratis (2002) reported a specimen from the Aegean Sea as *Diploneis* sp.1 (their figure 172) and suggested it matched the specimen of *Diploneis droopii* shown in Witkowski *et al*. (2000). Furthermore *D. droopii* was documented by Loir (2010-2014) from Crete and Siqueiros-Beltrones *et al*. (2014) from the Californian Gulf. In the latter place, the specimen characteristics match the ones described by Belegratis (2002).

***Diploneis nitescens* (W. Gregory) Cleve, 1894**

Fig. 3J

Basionym: *Navicula smithii* var. *nitescens* W. Gregory, 1857.
Synonyms: *Navicula nitescens* (W. Gregory) Ralfs, *Schizonema nitescens* (Gregory) Kuntze.
References: Gregory (1857), Witkowski *et al*. (2000).
Morphometry: Valve length is 42.5 µm, breadth 20 µm; 7 striae in 10 µm (n=1).
Remarks: The valve is rhombic-elliptic with rounded apices. The central nodule is square and the raphe is straight. Striae are parallel in the middle and become radiate towards apices. The longitudinal canal is large and composed of a row of striae, followed by biseriate areolae. The species is widespread (Witkowski *et al*., 2000) and distributed from the Mediterranean Sea to the northern European coasts (Hustedt & Jensen, 1985), formerly reported from the Adriatic Sea (Hafner *et al*., 2018) and the Aegean Sea (Belegratis, 2002; Louvrou, 2007).

***Diploneis sejuncta* (A.W.F. Schmidt) Jørgensen, 1905**

Fig. 3G

Basionym: *Navicula sejuncta* A.W.F. Schmidt, 1874.
Synonyms: *Caloneis sejuncta* (A.W.F. Schmidt) Cleve, *Schizonema sejunctum* (Schmidt) Kuntze.
References: Schmidt (1874), Droop (1998).
Morphometry: Valve length is 23 µm, breadth 7.5 µm; 16 striae in 10 µm (n=1).
Remarks: The valve is linear and very slightly constricted in the middle, valve endings are rounded. The central nodule is small and the raphe is straight. Striae are parallel and crossed by the longitudinal canal near the valve margin. According to Witkowski *et al*. (2000), the taxon

is widespread but not common on oceanic coasts, however, it is common in the Mediterranean Sea.

***Diploneis suborbicularis* (W. Gregory) Cleve, 1894**

Fig. 3K

Basionym: *Navicula smithii* var. *suborbicularis* W. Gregory, 1857.
Synonyms: *Navicula suborbicularis* (W. Gregory) Donkin.
References: Gregory (1857), Witkowski *et al*. (2000), Lobban *et al*. (2012).
Morphometry: Valve length is 29 μm, breadth 18.3 μm; 10 striae in 10 μm (n=1).
Remarks: The valve is broadly elliptic with rounded apices. The raphe is slightly wavy and the sternum is wider in the middle of the valve face. The central nodule is large and quadrangular. Striae are radiated throughout the valve. The species is common in marine waters and was formerly reported from the northeastern Adriatic Sea (Viličić *et al*., 2002) and the Aegean Sea (Foged, 1986). According to Witkowski *et al*. (2000), the taxon is common in warm waters e.g., the Caribbean Sea and the European coasts of the Mediterranean Sea.

***Mastogloia affinis* Cleve, 1892**

Fig. 3L

References: Cleve (1892), Witkowski *et al*. (2000), Loir & Novarino (2013).
Morphometry: Valve length is 24.5 μm, breadth 9 μm; 14 striae in 10 μm (n=1).
Remarks: The valve is linear with rostrate apices. The raphe is straight and the axial area is very narrow. Striae are widened and slightly radiate throughout the valve. Here partecta and transapically widened central area are not observed. Partecta are hard or impossible to distinguish, which is in line with the literature. *M. affinis* possesses narrow partectal rings (only 1 μm width of each ring) usually positioned only close to apices (Witkowski *et al*., 2000; Loir & Novarino, 2013). The species was rarely reported and possibly common in coastal warm waters (Hustedt & Jensen, 1985; Navarro & Hernández-Becerril, 1997; Witkowski *et al*., 2000; Loir & Novarino, 2013). Recently it was reported from the Adriatic Sea (Car *et al*., 2019).

***Mastogloia biocellata* (Grunow) G. Novarino & A.R. Muftah, 1991**

Fig. 3M

Basionym: *Mastogloia erythraea* var. *biocellata* Grunow, 1877.
References: Grunow (1877), Novarino & Muftah (1991).
Morphometry: Valves are 19.5-25 μm long, 7-8 μm wide; 30 striae in 10 μm, 5-6 small partecta and 1-2 median partecta (n=3).
Remarks: Valves are lanceolate with strongly produced apices. The raphe is undulated and has expanded central endings. The axial area is narrow, the central area is slightly expanded on one side of the valve. Median partecta were 1 or 2, one in the small specimen. The species is common in the coastal waters and has been reported from the Albanian coastal wetlands, a marine lake in the eastern Adriatic Sea (Miho & Witkowski, 2005; Car *et al*., 2019) and the Aegean Sea (Belegratis, 2002; Louvrou, 2007).

***Mastogloia corsicana* (Grunow) H. Peragallo & M. Peragallo, 1897**

Fig. 3N, O

Basionym: *Mastogloia bisulcata* var. *corsicana* Grunow in Van Heurck, 1838-1909.
Synonyms: *Mastogloia corsicana* Grunow.
References: Van Heurck (1838-1909), Loir & Novarino (2013).
Morphometry: Valve lengths are 22-32 μm, breadth 9.5-12.5 μm; 14-16 striae in 10 μm and 7-8 partecta in 10 μm (n=6).
Remarks: Valves are elliptic with rostrate apices. The raphe is undulated and the axial area is narrow. The central area is expanded on one side of the valve and central raphe endings are expanded. Striae are radiated and crossed by one or two longitudinal ribs. Partecta terminate before reaching apices. The species was reported from the Bosnia and Herzegovina coasts (Hafner *et al*., 2018) and the Aegean Sea (Belegratis, 2002; Louvrou, 2007) and is also present in warm waters of the Caribbean Sea and Bahamas (Loir & Novarino, 2013; Lobban *et al*., 2012).

***Mastogloia fallax* Cleve, 1895**

Fig. 4A, B

References: Cleve (1895), Witkowski *et al*. (2000).
Morphometry: Valve length is 43.5 μm, breadth 19 μm; 19 striae in 10 μm and 10 partecta in 10 μm (n=1).
Remarks: The valve is broadly lanceolate with slightly produced apices. The raphe is straight to slightly wavy, distal raphe endings are bent on the same side of the valve and terminate before the apices. The axial area is narrow and the central area is transversely widened. Striae are radiate and areolae are punctate. Partecta are narrow, and uniform and terminate before reaching the apices. The taxon is possibly common in warm coastal waters (Hustedt & Jensen, 1985; Witkowski *et al*., 2000), although not commonly reported, and is also present in the Adriatic Sea and Greek coasts (Loir, 2010-2014; Car *et al*., 2020).

***Mastogloia graciloides* Hustedt, 1933**

Fig. 4E, F

References: Hustedt & Jensen (1985), Loir & Novarino (2013).
Morphometry: Valves are 15.5-18.5 μm long, 7.5-9 μm wide, and have 20 striae in 10 μm and 9 partecta in 10 μm (n=4).
Remarks: Valves are elliptic with produced apices. The raphe is slightly wavy and the axial area is narrow. Striae are straight to slightly radiate and crossed by wavy transapical lines close to the valve margin. Areolae are punctate. Partecta are uniform, however, one partectum becomes longer close to valve endings and terminates before the apices. The species was described from the tropic waters of Borneo (Hustedt & Jensen, 1985) and then reported from the warm waters of the oceans (Navarro

& Hernández-Becerril, 1997; Lobban *et al*., 2012; Loir & Novarino, 2013) and also from the Mediterranean Sea (Witkowski *et al*., 2000; Loir, 2010-2014).

***Mastogloia linearis* Simonsen, 1959**

Fig. 4H

References: Simonsen (1959), Witkowski *et al*. (2000).
Morphometry: Valve length is 15 µm, breadth is 4.5 µm; 5 partecta in 10 µm (n=1).
Remarks: The valve is linear with capitate endings. The raphe is straight and the axial area is narrow. Here striae are indistinct in LM. Partecta are uniform and transapically narrow and elongated. The specimen is slightly smaller than in the description to which however it conforms for the valve endings and partecta shape and formation (Simonsen, 1959; length: 21 µm). The species was described from the Baltic Sea (Simonsen, 1959) and reported from the Mediterranean Sea (Witkowski *et al*., 2000; Hafner *et al*., 2018). The taxon was also reported from Kuwait coasts (Al-Kandari *et al*., 2009), where however specimen differed from Simonsen's description by lanceolate valves and apiculate apices. This is the first record from the Aegean Sea.

***Mastogloia mauritiana* Brun, 1893**

Fig. 4C, D

References: Schmidt (1894), Hustedt & Jensen (1985), Loir & Novarino (2013).
Morphometry: Valve lengths are 30-30.5 µm, breadth 13-14 µm; 22 striae in 10 µm and 8 small partecta in 10 µm (n=2).
Remarks: Valves are broadly lanceolate with acute rounded apices. The raphe is slightly wavy and the axial area is narrow. Striae are parallel in the middle becoming radiate through the valve endings. Striae are crossed by two longitudinal lines near the central area composing furrows on both sides of the raphe. Partecta are small and rectangular in the middle followed by one large partectum and terminate before the apices with 2-3 smaller partecta. According to the drawings of Schmidt (1894), instead of a large partectum, a smaller, longer partectum exists, however in Hustedt & Jensen (1985), 4 rows of distinct, larger partecta were illustrated, which was similar to Witkowski *et al*. (2000) and Loir & Novarino (2013) specimens. The Aegean Sea specimens conform to those shown in Belegratis (2002) and Loir (2010-2014) with 1-2 larger partecta below the middle of the valve.

***Mastogloia ovata* Grunow, 1860**

Fig. 4G

References: Grunow (1860), Loir & Novarino (2013).
Morphometry: Valves are 26.5-36 µm long and 16-20.5 µm wide, with 16-20 striae in 10 µm and 5-6 partecta in 10 µm (n=6).
Remarks: Valves are broadly elliptic with rounded apices. The raphe is wavy, with a narrow axial area, a small and circular central area and slightly expanded proximal endings. Striae are radiate and areolae are punctate. Partecta are uniform, rectangular, and continue up to the apices. The taxon is widespread along the coasts of the Adriatic Sea, Caribbean Sea, Galapagos Islands, Philippines, Marie-Galante and Martinique (Loir & Novarino, 2013 and references therein).

***Oestrupia powelii* var. *vidovichii* (Grunow) Heiden, 1906**

Fig. 4I

Basionym: *Navicula vidovichii* Grunow, 1863.
Synonyms: *Navicula powelii* var. *vidovichii* (Grunow) Grove.
References: Grunow (1863), Schmidt (1874-1959), Peragallo & Peragallo (1897-1908).
Morphometry: Valve is 98.5 µm long, 17 µm wide, with 7 striae in 10 µm (n=1).
Remarks: The valve is linear and constricted in the middle with apiculate endings. The raphe is straight becoming curved on one side of the valve with slightly expanded proximal raphe endings. The axial area is narrow, and the central area is expanded and possesses a lunate marking. Striae are radiated and interrupted in the central area. The species was rarely reported and documentation is scarce in the literature. However, the specimen conforms well to the drawings of Schmidt (1874-1959, pl. 264: 8, 9), Peragallo & Peragallo (1897-1908, pl. 14: 9) and Stidolph *et al*. (2012, pl. 33: 25). The taxon was formerly reported by Hafner *et al*., (2018) in the Adriatic Sea.

***Psammodictyon corpulentum* (Hendey) D.G. Mann, 1990**

Fig. 4J

Basionym: *Nitzschia corpulenta* Hendey, 1958.
References: Hendey (1958).
Morphometry: Valve length is 35 µm and breadth is 12 µm; 17 striae in 10 µm (n=1).
Remarks: The valve is panduriform and strongly constricted in the middle. Apices are apiculate, the areolae are punctate and the constricted central area is wide (7 µm). Hendey (1958) described the species strongly constricted in the middle, which conforms to the specimen observed here. Striae density here is higher than in Hendey (1958, 14 in 10 µm) and Giffen (1963, 13-14 in 10 µm). Nevertheless, the dimensions, strong constriction in the middle and apiculate apices conform well to the description. The taxon was observed in Sierra Leone (Hendey, 1958) and South Africa (Giffen, 1963), and also reported in Far East Asia (Liu, 2008; Shao, 2003-2014). This is the first record of the taxon in the Mediterranean Sea.

***Tryblionella lanceola* Grunow, 1878**

Fig. 4K, L

Synonyms: *Nitzschia lanceola* (Grunow) Grunow.
References: Cleve (1878), Round & Basson (1997), Witkowski *et al*. (2000).
Morphometry: Valves are 27-32 µm long and 7-8 µm wide, with 10-12 striae in 10 µm (n=11).
Remarks: Valves are lanceolate and apices are apiculate. The valve face is depressed on one half and striae become indiscernible in LM. Striae are monoseriate and punctate. Witkowski *et al*. (2000) indicated that spines occur at their margins and Round & Basson (1997) observed

spines that were placed in one margin of the valve in SEM. Nevertheless, it is difficult to observe this feature in LM. In SEM, one valve with an outline that resembles that of *Tryblionella lanceola* was observed with areolae on the fibulae (Fig. 6K), but with no marginal spines nor any depression on the valve face. Areolae are irregularly interrupted by the hyaline area which prevents that specimen to be assigned to *T. lanceola*. The species is widespread and reported in warm waters by Foged (1975) and Witkowski *et al*. (2000) , while valve ultrastructure was documented by Round & Basson (1997) and Belegratis (2002) from the Aegean Sea.

Auricula intermedia **(F.W. Lewis) Cleve, 1894**

Fig. 4M

Basionym: *Amphora intermedia* F.W. Lewis, 1865.
References: Lewis (1865), Lobban *et al*. (2012).
Morphometry: Valves are 70-72.5 µm long and 31-32.5 µm wide, with 18 striae in 10 µm (n=2).
Remarks: Valves are biarcuate with rounded apices, dorsally constricted in the middle and ventrally almost straight. Striae are parallel in the middle becoming strongly radiate towards the apices. The specimens observed are slightly longer and have higher striae numbers than those observed from Guam Island (Lobban *et al*. 2012; length: 62-63 µm, 14-16 striae in 10 µm). The species also resembles *Auricula complexa*, from which it differs by size and striae numbers (Lobban *et al*., 2012, *A. complexa*: 26-28 in 10 µm). The taxon was reported from the Adriatic Sea (Cleve, 1894; Car *et al*., 2019); nevertheless, the species was not commonly documented in LM and SEM except for a few studies (Lobban *et al*., 2012; López-Fuerte *et al*., 2017).

Discussion

In this study 510 diatom species were observed in samples from the Aegean Sea coasts of Türkiye and detailed information was provided on 34 taxa representing interesting species or new records for these waters. The remaining diatoms of the study area were mainly common species or species recently recorded from surrounding areas (Kaleli & Akçaalan, 2021 and references therein). According to the results, the diatom composition of the Aegean Sea coasts of Türkiye is more diverse when compared to the former studies in the region (Kaleli *et al*., 2020). The genera represented with a higher number of species (*Navicula*, *Nitzschia* and *Amphora*) were the same as in the results from the Aegean Sea coasts of Greece (Belegratis, 2002; Louvrou, 2007). Amongst species, it was remarkable that some of them were common in marine waters while some taxa were reported rarely from the Mediterranean Sea and beyond. For instance, several species rarely reported from the coastal waters of the Mediterranean Sea and of the oceans were observed in this study: *Biddulphia seychellensis*, *Cyclophora tabellariformis*, *Grammatophora maxima*, *G. gibberula*, *Amphicocconeis mascarenica*, *Cocconeis maxima*, *Amicula specululum*, *Caloneis egena*, *Diploneis dalmatica*, *D. droopii*, *Mastogloia affinis*, *M. linearis*, *M. mauritana* and *Oestrupia powelii* var. *vidovichii*. Some of these species were described or distributed in warmer waters like *A. mascarenica* (Riaux-Gobin *et al*., 2011b), *B. seychellensis* (Dąbek *et al*., 2015), *C. tabellariformis* (Ashworth *et al*., 2012) and *Psammodictyon corpulentum* (Hendey, 1958; Giffen, 1963). These results confirm and extend the presence of several species formerly found in the Adriatic, Aegean or Mediterranean Sea and show that it is possibly the lack of studies on the Aegean coasts of Türkiye that limited the distribution of the taxa rather than species affinity to temperate conditions.

SEM analysis revealed the fine structure of taxa, although some of these species were rarely reported and poorly known. SEM observations made a smaller contribution than anticipated, possibly due to the rarity of most species in the samples. Nevertheless, SEM allowed us to identify species such as *Amicula specululum*, *Biddulphia seychellensis*, *Grammatophora gibberula*, *Minidiscus trioculatus*, and *Thalassiosira mediterranea*. Especially, the small-sized diatoms *M. trioculatus* and *A. specululum* may have easily been omitted in LM. Furthermore, SEM observations contributed to elucidate the fine structure of *Amphicocconeis mascarenica* after Riaux-Gobin *et al*. (2011b) and John (2016). Another rarely reported species, *Grammatophora gibberula* can be distinguished in LM by its valve shape and biseriate areolae. The fine structure of the species revealed the intercalary bands and rimoportula located in between the midway and the margins close to the apices. Both apices in SEM were not observed; however, in LM micrographs, some specimens have the opening-like field on both apices. Rimoportulae may be a common feature in *G. gibberula*, but no information on the fine structure of the species was found in the literature. Another contribution was the report of *Hyalosira septata*, which was recently described from the carapace of the loggerhead sea turtle in the Adriatic Sea and reported from the eastern Mediterranean Sea coasts of Türkiye (Lobban *et al*., 2021). The report of *H. septata* here allowed by the use of SEM extends the distribution of the species to the Aegean Sea.

Conclusions

This study provides new data on diatom species that were recorded from the Aegean coasts of Turkish coasts for the first time and contributes to the biogeography of several rare taxa. According to the results, it can be concluded that some marine diatom taxa, so far known from warm, tropical waters or other areas of the Mediterranean Sea also occur in the cooler waters of the Aegean Sea. Also, the finding of cosmopolitan species for the first time in Turkish waters shows a lack of research in these areas and indicates that further studies are needed to better understand species distribution on the Turkish coasts of the Aegean Sea. Additionally, SEM revealed several rare and possibly so far overlooked small-celled species that can be present in a wide range of environmental conditions and possibly be cosmopolitan.

Acknowledgements

Drs Seher Dirican and Ali Özer from Cumhuriyet University (Sivas, Türkiye) are acknowledged for SEM assistance. The author thanks Dr Przemysław Dąbek for help with the identification of *Biddulphia seychellensis*. The author expresses his gratitude to Prof. Reyhan Akçaalan and Prof. Andrzej Witkowski for the opportunity to work at the Department of Marine and Freshwater Resources Management (Istanbul University, Türkiye) and the Institute of Marine and Environmental Sciences (University of Szczecin, Poland). Finally, anonymous reviewers are acknowledged for their valuable comments which helped to improve the manuscript.

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Supplementary Data

The following supplementary information is available online for the article:

Table S1. Marine benthic diatom species list of the 6 sampling stations in the Turkish Aegean coasts.

Appendix. List of the species-specific references consulted for species descriptions.

References			
Ehrenberg, 1838	Van Heurck, 1880	Novarino & Muftah, 1991	Lobban *et al*., 2012
Gregory, 1857	Schmidt, 1890	Round & Basso 1997	Li *et al*., 2013
Grunow, 1860	Cleve, 1892	Droop, 1998	Dąbek *et al*., 2015
Pritchard, 1861	Schmidt, 1894	Belegratis, 2002	Park *et al*., 2016
Grunow, 1863	Cleve, 1895	Louvrou, 2007	Sims *et al*., 2018
Lewis, 1865	Hustedt, 1913-1959	Wachnicka & Gaiser, 2007	Sunesen & Sar, 2019
Schmidt, 1874	Hendey, 1958	Kaczmarska *et al*., 2009	Al-Yamani & Saburova, 2019
Schmidt,1874-1959	Simonsen, 1959	Riaux-Gobin *et al*., 2011b	Fernandes & Da-Silva, 2020
Grunow, 1877	Taylor, 1967	Ashworth *et al*., 2012	Lobban *et al*., 2021
Cleve, 1878			