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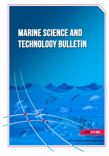

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RESEARCH ARTICLE

Phytoplankton species composition in the Turkish coast of the Aegean Sea between 2014 and 2016

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ABSTRACT

The research was carried out between 2014 and 2016, within the scope of the 'National Integrated Marine Pollution Monitoring Program,' in a total of five seasonal cruises at 22 stations along the Turkish coast of the Aegean Sea. A total of 296 phytoplankton species and one subspecies belonging to 12 classes were identified from samples collected during the five seasonal cruises. The highest diversity was observed in the summer of 2015, with 204 species recorded, while the lowest was 137 species in the summer of 2016. Dinoflagellates dominated the species composition, accounting for 51% of the species, followed by diatoms (44%), and other groups (5%). At the genus level, *Chaetoceros*, *Thalassiosira*, *Bacteriastrum*, and *Coscinodiscus* were the most dominant diatom genus, whereas *Protoperidinium*, *Tripos*, *Dinophysis*, *Oxytoxum*, and *Prorocentrum* were dominant among dinoflagellates. *Amphisolenia schauinslandii* Lemmermann 1899 and *Ceratoperidinium margalefii* A.R. Loeblich III 1980 were recorded for the first time along the Turkish coast of the Aegean Sea. This study provides a comprehensive assessment of the phytoplankton taxonomic diversity in the region from to 2014-2016.

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Introduction

The Aegean Sea, located between Greece and Turkey, is an intricate marine ecosystem with dynamic ecological interactions that significantly contribute to regional and global biodiversity. Phytoplankton, as primary producers, play a vital role in this ecosystem, influencing nutrient cycling and carbon sequestration, and supporting diverse marine life. The initiation of phytoplankton studies along the Turkish coast of the Aegean Sea in the 1950s marked an important milestone in understanding the ecological dynamics of this maritime region.

Traditionally, phytoplankton studies in this area have been characterized by short-term and regionally confined scopes. While these studies have provided valuable insights into local

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dynamics, a comprehensive understanding of the entire Turkish coast of the Aegean Sea necessitates a paradigm shift towards regular, systematic, and extensive monitoring initiatives. This shift is vital for several reasons rooted in the intricate nature of phytoplankton's role in marine ecosystems.

The Aegean Sea has significant economic importance for fisheries, tourism, and aquaculture. Regular phytoplankton monitoring is crucial for anticipating and mitigating potentially harmful algal blooms (HABs) that may pose threats to marine life, seafood safety, and economic activities dependent on the marine environment.

This study, which forms part of the "National Integrated Marine Pollution Monitoring Program," encompasses the entirety of the Turkish coast along the Aegean Sea. It presents the initial findings of a three-year taxonomic study conducted within the framework of the national monitoring initiative. The primary objective of this study was to lay the groundwork for a comprehensive reassessment, which was achieved by formulating a checklist that adheres to established taxonomic protocols. In particular, the study aimed to provide insights into the state of phytoplankton taxonomic composition between 2014 and 2016.

Materials and Method

Study Area

The Aegean Sea is separated from the Mediterranean by the islands of Crete, Karpatos, Kasos, and Rhodes to the south. The total surface area of the Aegean Sea, which has a rectangular appearance with indented coasts, a length of 660 km in the north-south direction, a width of 270 km in the east-west direction in the north, 150 km in the central part, and 400 km in the south, is approximately 214,000 km^2. The Aegean Sea is located within the borders of Turkey. The coastal length was determined to be 2833 km, and the average depth was 350 m (Senirkentli, 2003).

The research was carried out between 2014 and 2016, within the scope of the "National Integrated Marine Pollution Monitoring Program," in a total of five cruises (2014: Summer, 2015: Winter-Summer, 2016: Winter-Summer) implemented with R/V TÜBİTAK MARMARA at 22 stations along the Turkish coast of the Aegean Sea (Figure 1).

Figure 1. Sampling stations

Sampling and Identification

A total 268 phytoplankton samples were collected using 10-liter Teflon Niskin type bottles attached to a CTD (SeaBird SBE 25Plus/SBE 27 pH Sensor) Rosette System in sampling stations. 1-liter samples were fixed onboard in 3 ml L-1 alkaline Lugol's solution and concentrated by the sedimentary method. Qualitative analyses of the samples were performed with a light microscope (Nikon Eclipse Ni with DS-Fi2 cam-NIS Imaging System) in the counting cell Sedgewick Rafter using standard methods (Moncheva & Parr, 2010).

The species identified in the literature were taxonomically updated by examining both the AlgaeBase (Guiry & Guiry, 2023) and the World Register of Marine Species (WoRMS Editorial Board, 2023) online databases.

For the identification of species, printed and digital sources were used, including Kiselev (1950), Proshkina-Lavienko (1955), Trégouboff & Rose (1957a, 1957b), Cupp (1977), Sournia (1978), Rampi & Bernhard (1980), Sournia (1986), Balech et al. (1988), Tomas (1997), Faust & Gulledge (2002), Hoppenrath et al. (2009), and Kraberg et al. (2010), as well as online databases such as "AlgaeBase", "nordicmicroalgae.org", "planktonnet.avi.de", and "WoRMS". The species obtained in this study were classified using the AlgaeBase database (Guiry & Guiry, 2023).

Results

In total, 296 species and one subspecies belonging to 12 phytoplankton classes were identified. Their distribution in phytoplankton classes: 25 genus and 46 species belonging to the Bacillariophyceae, 10 genus and 23 species belonging to the Coscinodiscophyceae, 17 genus and 62 species belonging to the Mediophyceae, 38 genus, 149 species and 1 subspecies belonging to the Dinophyceae, 4 genus and 4 species belonging to the Cyanophyceae, 1 genus and 1 species belonging to the Thecofilosea, 2 genus and 2 species belonging to the Cryptophyceae, 1 genus and 1 species belonging to the Noctilucophyceae, 2 genus and 3 species belonging to the Dictyochophyceae, 1 genus and 1 species belonging to the Coccolithophyceae, 1 genus and 1 species belonging to the Chlorophyceae, two genus and two species belonging to the Euglenophyceae were identified (Table 1).

Table 1. Taxonomic list of the phytoplankton species

Cyanobacteria
Cyanophyceae
Anabaena* sp.**; ***Merismopedia glauca (Ehrenberg) Kützing 1845; ***Trichormus variabilis*** (Kützing ex Bornet & Flahault) Komárek & Anagnostidis 1989; ***Oscillatoria* sp.**
Cercozoa
Thecofilosea
Ebria tripartita (Schumann) Lemmermann 1899
Cryptista
Cryptophyceae
Chroomonas* sp.**; ***Hillea fusiformis (J.Schiller) J.Schiller 1926
Dinoflagellata
Dinophyceae
Akashiwo sanguinea (K.Hirasaka) Gert Hansen & Moestrup 2000; ***Alexandrium minutum*** Halim 1960; ***Amphidinium* sp.**; ***Amphisolenia bidentata*** B.Schröder 1900; ***Amphisolenia schauinslandii*** Lemmermann 1899; ***Brachidinium capitatum*** F.J.R.Taylor 1963; ***Blixaea quinquecornis*** (T.H.Abé) Gottschling 2017; ***Ceratocorys armata*** (Schütt) Kofoid 1910; ***Ceratocorys gourretii*** Paulsen 1937; ***Ceratocorys horrida*** Stein 1883; ***Ceratoperidinium margalefii*** A.R.Loeblich III 1980; ***Cochlodinium* sp.**; ***Corythodinium constrictum*** (F.Stein) F.J.R.Taylor 1976; ***Corythodinium diploconus*** (F.Stein) F.J.R.Taylor 1976; ***Corythodinium milneri*** (G.Murray & Whitting) F.Gómez 2017; ***Corythodinium tesselatum*** (F.Stein) Loeblich Jr. & Loeblich III 1966; ***Dinophysis acuta*** Ehrenberg 1839; ***Dinophysis acuminata*** Claparède & Lachmann 1859; ***Dinophysis amandula*** (Balech) Sournia 1973; ***Dinophysis caudata*** Kent 1881; ***Dinophysis fortii*** Pavillard 1924; ***Dinophysis hastata*** F.Stein 1883; ***Dinophysis odiosa*** (Pavillard) Tai & Skogsberg 1934; ***Dinophysis ovum*** F.Schütt 1895; ***Dinophysis sacculus*** F.Stein 1883; ***Dinophysis schuettii*** G.Murray & Whitting 1899; ***Dinophysis tripos*** Gourret 1883; ***Dinophysis* sp. 1**; ***Dinophysis* sp. 2**; ***Diplopsalis lenticula*** Bergh 1882; ***Gonyaulax digitale*** (Pouchet) Kofoid 1911; ***Gonyaulax monacantha*** Pavillard 1916; ***Gonyaulax polygramma*** F.Stein 1883; ***Gonyaulax scrippsae*** Kofoid 1911; ***Gonyaulax spinifera*** (Claparède & Lachmann) Diesing 1866; ***Gymnodinium* sp.**; ***Gyrodinium fusiforme*** Kofoid & Swezy 1921; ***Gyrodinium fusus*** (Meunier) Akselman 1985; ***Gyrodinium lacryma*** (Meunier) Kofoid & Swezy 1921; ***Gyrodinium spirale*** (Bergh) Kofoid & Swezy 1921; ***Gyrodinium* sp.**; ***Heterocapsa rotundata*** (Lohmann) Gert Hansen 1995; ***Histioneis elongata*** Kofoid & J.R.Michener 1911; ***Histioneis* sp.**; ***Karenia brevis*** (C.C.Davis) Gert Hansen & Moestrup 2000; ***Karenia mikimotoi*** (Miyake & Kominami ex Oda) Gert Hansen & Moestrup 2000; ***Karenia* sp.**; ***Kapelodinium vestifici*** (Schütt) Boutrup, Moestrup & Daugbjerg 2016; ***Kryptoperidinium triquetrum*** (Ehrenberg) Tillmann, Gottschling, Elbrächter, Kusber & Hoppenrath 2019; ***Lebouridinium glaucum*** (Lebour) F.Gómez, H.Takayam, D.Moreira & P.López-García 2016; ***Lingulodinium polyedra*** (F.Stein) J.D.Dodge 1989; ***Margalefidinium polykrikoides*** (Margalef) F.Gómez, Richlen & D.M.Anderson 2017; ***Oblea rotunda*** (Lebour) Balech 1964; ***Ornithocercus magnificus*** F.Stein 1883; ***Ornithocercus quadratus*** Schütt 1900; ***Oxytoxum curvatum*** (Kofoid) Kofoid & J.R.Michener 1911; ***Oxytoxum longiceps*** Schiller 1937; ***Oxytoxum longum*** J.Schiller 1937; ***Oxytoxum minutum*** Rampi 1941; ***Oxytoxum rampii*** Sournia 1973; ***Oxytoxum reticulatum*** (Stein) Schütt 1899; ***Oxytoxum scolopax*** F.Stein 1883; ***Oxytoxum viride*** Schiller 1937; ***Oxytoxum* sp.**; ***Phalacroma doryphorum*** F.Stein 1883;

Table 1 (continued)

Dinophyceae
Phalacroma favus Kofoid & J.R.Michener 1911; ***Phalacroma mitra*** F.Schütt 1895; ***Phalacroma ovatum*** (Claparède & Lachmann) Jørgensen 1923; ***Phalacroma rapa*** F.Stein 1883; ***Phalacroma rotundatum*** (Claparéde & Lachmann) Kofoid & J.R.Michener 1911; ***Podolampas bipes*** F.Stein 1883; ***Podolampas curvatus*** Schiller 1937; ***Podolampas elegans*** F.Schütt 1895; ***Podolampas palmipes*** Stein 1883; ***Podolampas spinifera*** Okamura 1912; ***Polykrikos kofoidii*** Chatton 1914; ***Polykrikos schwartzii*** Bütschli 1873; ***Prorocentrum balticum*** (Lohmann) Loeblich III 1970; ***Prorocentrum cordatum*** (Ostenfeld) J.D.Dodge 1976; ***Prorocentrum gracile*** F.Schütt 1895; ***Prorocentrum lima*** (Ehrenberg) F.Stein 1878; ***Prorocentrum micans*** Ehrenberg 1834; ***Prorocentrum redfieldii*** Bursa 1959; ***Prorocentrum scutellum*** B.Schröder 1900; ***Prorocentrum triestinum*** J.Schiller 1918; ***Protoperidinium bipes*** (Paulsen) Balech 1974; ***Protoperidinium brevipes*** (Paulsen) Balech 1974; ***Protoperidinium brochii*** (Kofoid & Swezy) Balech 1974; ***Protoperidinium cerasus*** (Paulsen) Balech 1973; ***Protoperidinium claudicans*** (Paulsen) Balech 1974; ***Protoperidinium conicoides*** (Paulsen) Balech 1973; ***Protoperidinium conicum*** (Gran) Balech 1974; ***Protoperidinium crassipes*** (Kofoid) Balech 1974; ***Protoperidinium curtipes*** (Jørgensen) Balech 1974; ***Protoperidinium depressum*** (Bailey) Balech 1974; ***Protoperidinium diabolus*** (Cleve) Balech 1974; ***Protoperidinium divergens*** (Ehrenberg) Balech 1974; ***Protoperidinium elegans*** (Cleve) Balech 1974; ***Protoperidinium grande*** (Kofoid) Balech 1974; ***Protoperidinium granii*** (Ostenfeld) Balech 1974; ***Protoperidinium latidorsale*** (P.J.L.Dangeard) Balech 1974; ***Protoperidinium leonis*** (Pavillard) Balech 1974; ***Protoperidinium oblongum*** (Aurivillius) Parke & Dodge 1976; ***Protoperidinium obtusum*** (Karsten) Parke & J.D.Dodge 1976; ***Protoperidinium oceanicum*** (Vanhöffen) Balech 1974; Protoperidinium pallidum (Ostenfeld) Balech 1973; ***Protoperidinium pellucidum*** Bergh 1882; ***Protoperidinium pentagonum*** (Gran) Balech 1974; ***Protoperidinium pyriforme*** (Paulsen) Balech 1974; ***Protoperidinium pyriforme* subsp. *breve*** (Paulsen) Balech 1988; ***Protoperidinium solidicorne*** (Mangin) Balech 1974; ***Protoperidinium steinii*** (Jørgensen) Balech 1974; ***Protoperidinium* sp.**; ***Pseliodinium fusus*** (F.Schütt) F.Gómez 2018; ***Pyrocystis fusiformis*** C.W.Thomson 1876; ***Pyrocystis lunula*** (F.Schütt) F.Schütt 1896; ***Pyrocystis obtusa*** Pavillard 1931; ***Pyrocystis robusta*** Kofoid 1907; ***Pyrocystis* sp.**; ***Pyrophacus horologium*** F.Stein 1883; ***Pyrophacus steinii*** (Schiller) Wall & Dale 1971; ***Scrippsiella acuminata*** (Ehrenberg) Kretschmann, Elbrächter, Zinssmeister, S.Soehner, Kirsch, Kusber & Gottschling 2015; ***Sourniaea diacantha*** (Meunier) H.Gu., K.N.Mertens, Zhun Li & H.H.Shin 2020; ***Torodinium robustum*** Kofoid & Swezy 1921; ***Tripos arcuatus*** (Gourret) F.Gómez 2021; ***Tripos arietinus*** (Cleve) F.Gómez 2021; ***Tripos brevis*** (Ostenfeld & Johannes Schmidt) F.Gómez 2021; ***Tripos candelabrum*** (Ehrenberg) F.Gómez 2013; ***Tripos carriensis*** (Gourret) Hallegraeff & Huisman 2013; ***Tripos extensus*** (Gourret) F.Gómez 2021; ***Tripos furca*** (Ehrenberg) F.Gómez 2013; ***Tripos fusus*** (Ehrenberg) F.Gómez 2013; ***Tripos gibberus*** (Gourret) F.Gómez 2021; ***Tripos gracilis*** (Pavillard) F.Gómez 2013; ***Tripos hexacanthus*** (Gourret) F.Gómez 2013; ***Tripos limulus*** (Pouchet) F.Gómez 2021; ***Tripos lineatus*** (Ehrenberg) F.Gómez 2021; ***Tripos longipes*** (Bailey) F.Gómez 2021; ***Tripos longissimus*** (Schröder) F.Gómez 2013; ***Tripos macroceros*** (Ehrenberg) Hallegraeff & Huisman 2020; ***Tripos massiliensis*** (Gourret) F.Gómez 2021; ***Tripos muelleri*** Bory 1826; ***Tripos pavillardii*** (Jørgensen) F.Gómez 2021; ***Tripos pentagonus*** (Gourret) F.Gómez 2021; ***Tripos pulchellus*** (Schröder) F.Gómez 2021; ***Tripos setaceus*** (Jørgesen) F.Gómez 2013; ***Tripos symmetricus*** (Pavillard) F.Gómez 2021; ***Tripos teres*** (Kofoid) F.Gómez 2013; ***Tripos trichoceros*** (Ehrenberg) Gómez 2013; ***Tripos vultur*** (Cleve) Hallegraeff & Huisman 2020
Noctilucophyceae
Pronoctiluca pelagica Fabre-Domergue 1889
Heterokontophyta
Bacillariophyceae
Achnanthes adnata Bory 1822; ***Achnanthes armillaris*** (O.F.Müller) Guiry 2019; ***Amphora marina*** W.Smith 1857; ***Amphora ovalis*** (Kützing) Kützing 1844; ***Amphora* sp. 1**; ***Amphora* sp. 2**; ***Asterionella formosa*** Hassall 1850; ***Asterionellopsis glacialis*** (Castracane) Round 1990; ***Bacillaria paxillifera*** (O.F.Müller) T.Marsson 1901; ***Cocconeis scutellum*** Ehrenberg 1838; ***Cocconeis* sp.**; ***Coronia decora*** (Brébisson) Ruck & Guiry 2016; ***Cylindrotheca closterium*** (Ehrenberg) Reimann & J.C.Lewin 1964; ***Diploneis bombus*** (Ehrenberg) Ehrenberg 1853; ***Diploneis crabro*** (Ehrenberg) Ehrenberg 1854; ***Diploneis* sp. 1**; ***Diploneis* sp. 2**; ***Entomoneis alata*** (Ehrenberg) Ehrenberg 1845; ***Entomoneis gigantea*** (Grunow) Nizamuddin 1983; ***Entomoneis* sp.**; ***Fragilaria crotonensis*** Kitton 1869;

Table 1 (continued)

Bacillariophyceae
Fragilaria* sp.**; ***Grammatophora marina (Lyngbye) Kützing 1844; ***Gyrosigma balticum*** (Ehrenberg) Rabenhorst 1853; ***Gyrosigma fasciola*** (Ehrenberg) J.W.Griffith & Henfrey 1856; ***Gyrosigma* sp.**; ***Licmophora abbreviata*** C.Agardh 1831; ***Licmophora flabellata*** (Greville) C.Agardh 1831; ***Licmophora gracilis*** (Ehrenberg) Grunow 1867; ***Navicula* sp. 1**; ***Navicula* sp. 2**; ***Nitzschia longissima*** (Brébisson ex Kützing) Grunow 1862; ***Nitzschia tenuirostris*** Manguin 1952; ***Pinnularia* sp.**; ***Pleurosigma angulatum*** (J.T.Quekett) W.Smith 1852; ***Pleurosigma elongatum*** W.Smith 1852; ***Pleurosigma formosum*** W.Smith 1852; ***Pseudo-nitzschia delicatissima*** (Cleve) Heiden, 1928; ***Pseudo-nitzschia pungens*** (Grunow ex Cleve) Hasle 1993; ***Striatella unipunctata*** (Lyngbye) C.Agardh 1832; ***Surirella* sp.**; ***Synedra* sp.**; ***Thalassionema frauenfeldii*** (Grunow) Tempère & Peragallo 1910; ***Thalassionema nitzschioides*** (Grunow) Mereschkowsky 1902; ***Tryblionella compressa*** (Bailey) Poulin 1990; ***Ulnaria ulna*** (Nitzsch) Compère 2001
Coscinodiscophyceae
Actinoptychus splendens (Shadbolt) Ralfs 1861; ***Actinoptychus* sp.**; ***Asterolampra marylandica*** Ehrenberg 1844; ***Asterolampra* sp.**; ***Coscinodiscus centralis*** Ehrenberg 1839; ***Coscinodiscus granii*** L.F.Gough 1905; ***Coscinodiscus janischii*** A.W.F.Schmidt 1878; ***Coscinodiscus perforatus*** Ehrenberg 1844; ***Coscinodiscus radiatus*** Ehrenberg 1840; ***Coscinodiscus wailesii*** Gran & Angst 1931; ***Dactyliosolen fragilissimus*** (Bergon) Hasle 1996; ***Guinardia flaccida*** (Castracane) H.Peragallo 1892; ***Guinardia striata*** (Stolterfoth) Hasle 1996; ***Melosira moniliformis*** C.Agardh 1824; ***Melosira varians*** C.Agardh 1827; ***Neocalyptrella robusta*** (G.Norman ex Ralfs) Hernández-Becerril & Meave 1997; ***Pseudosolenia calcar-avis*** (Schultze) B.G.Sundström 1986; ***Rhizosolenia castracanei*** H.Peragallo 1888; ***Rhizosolenia hebetata*** J.W.Bailey 1856; ***Rhizosolenia imbricata*** Brightwell 1858; ***Rhizosolenia styliformis*** T.Brightwell 1858; ***Sundstroemia pungens*** (Cleve-Euler) Medlin, Lundholm, Boonprakob & Moestrup 2021; ***Sundstroemia setigera*** (Brightwell) Medlin 2021
Dictyochophyceae
Dictyocha fibula Ehrenberg 1839; ***Octactis octonaria*** (Ehrenberg) Hovasse 1946; ***Octactis speculum*** (Ehrenberg) F.H.Chang, J.M.Grieve & J.E.Sutherland 2017
Mediophyceae
Bacteriastrum biconicum Pavillard 1916; ***Bacteriastrum comosum*** Pavillard 1916; ***Bacteriastrum delicatulum*** Cleve 1897; ***Bacteriastrum elongatum*** Cleve 1897; ***Bacteriastrum furcatum*** Shadbolt 1853; ***Bacteriastrum hyalinum*** Lauder 1864; ***Biddulphia biddulphiana*** (J.E.Smith) Boyer 1900; ***Cerataulina pelagica*** (Cleve) Hendey 1937; ***Chaetoceros affinis*** Lauder 1864; ***Chaetoceros anastomosans*** Grunow 1882; ***Chaetoceros atlanticus*** Cleve 1873; ***Chaetoceros borealis*** Bailey 1854; ***Chaetoceros brevis*** F.Schütt 1895; ***Chaetoceros coarctatus*** Lauder 1864; ***Chaetoceros compressus*** Lauder 1864; ***Chaetoceros constrictus*** Gran 1897; ***Chaetoceros costatus*** Pavillard 1911; ***Chaetoceros curvisetus*** Cleve 1889; ***Chaetoceros dadayi*** Pavillard 1913; ***Chaetoceros danicus*** Cleve 1889; ***Chaetoceros debilis*** Cleve 1894; ***Chaetoceros decipiens*** Cleve 1873; ***Chaetoceros densus*** (Cleve) Cleve 1899; ***Chaetoceros diadema*** (Ehrenberg) Gran 1897; ***Chaetoceros didymus*** Ehrenberg 1845; ***Chaetoceros diversus*** Cleve 1873; ***Chaetoceros insignis*** Müller Melchers 1955; ***Chaetoceros laciniosus*** F.Schütt 1895; ***Chaetoceros lorenzianus*** Grunow 1863; ***Chaetoceros messanensis*** Castracane 1875; ***Chaetoceros peruvianus*** Brightwell 1856; ***Chaetoceros pseudocurvisetus*** Mangin 1910; ***Chaetoceros radicans*** F.Schütt 1895; ***Chaetoceros similis*** Cleve 1896; ***Chaetoceros simplex*** Ostenfeld 1902; ***Chaetoceros socialis*** H.S.Lauder 1864; ***Chaetoceros tenuissimus*** Meunier 1913; ***Chaetoceros teres*** Cleve 1896; ***Chaetoceros tetrastichon*** Cleve 1897; ***Chaetoceros* sp.**; ***Climacosphenia moniligera*** Ehrenberg 1843; ***Detonula confervacea*** (Cleve) Gran 1900; ***Detonula pumila*** (Castracane) Gran 1900; ***Detonula* sp.**; ***Ditylum brightwellii*** (T.West) Grunow 1885; ***Eucampia zodiacus*** Ehrenberg 1839; ***Hemiaulus chinensis*** Greville 1865; ***Hemiaulus hauckii*** Grunow ex Van Heurck 1882; ***Lauderia annulata*** Cleve 1873; ***Lennoxia faveolata*** H.A.Thomsen & K.R.Buck 1993; ***Leptocylindrus danicus*** Cleve 1889; ***Planktoniella sol*** (G.C.Wallich) Schütt 1892; ***Proboscia alata*** (Brightwell) Sundström 1986; ***Skeletonema costatum*** (Greville) Cleve 1873; ***Thalassiosira allenii*** H.Takano 1965; ***Thalassiosira angustelineata*** (A.W.F.Schmidt) G.Fryxell & Hasle 1977; ***Thalassiosira eccentrica*** (Ehrenberg) Cleve 1904; ***Thalassiosira gravida*** Cleve 1896; ***Thalassiosira subtilis*** (Ostenfeld) Gran 1900; ***Thalassiosira* sp. 1**; ***Thalassiosira* sp. 2**; ***Trieres mobiliensis*** (Bailey) Ashworth & E.C.Theriot 2013

Table 1 (continued)

Haptophyta
Coccolithophyceae
Gephyrocapsa huxleyi (Lohmann) P.Reinhardt 1972
Chlorophyta
Chlorophyceae
***Scenedesmus* sp.**
Euglenophyta
Euglenophyceae
Euglena viridis (O.F.Müller) Ehrenberg 1830; ***Eutreptia lanowii*** Steuer 1904

The research study found that the highest number of species was recorded in the summer of 2015 with 204 species, while the lowest number was recorded in the summer of 2016 with 137 species. The average number of species recorded annually throughout the entire study period was 173.

When the study period from 2014 to 2016 was examined, the number of diatom species identified was 131, the number of dinoflagellate species was 150, and 14 species belonged to other phytoplankton groups. Throughout the entire research period, dinoflagellate species constituted 51% of the total number of species, diatom species constituted 44%, and other groups constituted 5%. Dinoflagellates were always dominant in the species composition, making up 50-55% of the species during the sampling periods. Diatoms were the second most important group, making up 39-45% of the species composition.

The study found that diatoms were represented by 52 genera, with *Chaetoceros*, *Thalassiosira*, *Bacteriastrum*, and *Coscinodiscus* making the biggest contribution to the number of species in the diatom group. These genera dominated 39% of the total species composition. In addition, 52% of the genus belonging to the diatom group were represented by a single species.

Dinoflagellates were represented by 39 species, with *Protoperidinium*, *Tripos*, *Dinophysis*, *Oxytoxum*, and *Prorocentrum* making the biggest contribution to the species composition. These genera dominated 56% of the total number of dinoflagellate species. 54% of the genus belonging to the dinoflagellate group were represented by only a single species.

Other groups, apart from dinoflagellates and diatoms, were represented by only 13 genus and made up 13% of the total number of genera.

Amphisolenia schauinslandii Lemmermann 1899, sampled in the summer of 2016, and *Ceratoperidinium margalefii* A.R.Loeblich III 1980, sampled in the summer of 2014, were reported for the first record species in the Turkish coast of Aegean Sea.

Discussion

The Turkish coast of the Aegean Sea was studied for the first time in the Gulf of Izmir. The first scientific investigations into the phytoplankton of the Izmir Bay, which encompasses the research area, were conducted by Numann (1955) and Acara & Nalbantoğlu (1960). Ergen (1967) carried out an initial qualitative examination of microplankton species in Izmir Bay, and Geldiay & Ergen (1968) subsequently built on this research.

Türkoğlu (2015) reported that a total of 88 studies were conducted along the Turkish coast of the Aegean Sea between 1950 and 2015. The majority of these studies were carried out in the Izmir Gulf region. Koray (2001) reported a list of 491 phytoplankton species found on the Turkish coast, while Koray et al. (2000) identified 243 phytoplankton species in the Turkish Aegean Sea. Türkoğlu (2015) examined the studies conducted in the Turkish seas, it was reported that the highest species diversity was in the Aegean Sea. According to the findings of the studies, dinoflagellates accounted for 54.7% of the dominant group, while diatoms accounted for 42%. Other phytoplankton groups made up 3.3% of the total phytoplankton composition. Although dinoflagellates were dominant over diatoms in studies conducted in the south of the Aegean Sea, the composition of phytoplankton groups varied in studies conducted in the north, with diatoms being the dominant group (Turkoglu & Yenici, 2007; Güreşen & Aktan-Turan, 2014). Furthermore, Altuğ et al. (2011) reported in their study that in the northern Aegean Sea, dinoflagellates accounted for 51% of the species composition and diatoms accounted for 37%. Aglaç & Balkis (2014) reported in their study in Edremit Bay that dinoflagellates (53.7%) were more dominant than diatoms (43.9%). This study is consistent with other research in terms of high species diversity and dominant phytoplankton groups.

As in this study, it has been revealed in studies that *Dinophysis*, *Prorocentrum*, *Protoperidinium*, and *Tripos* genera are dominant in the dinoflagellate species composition, and *Chaetoceros*, *Thalassiosira*, and *Bacteriastrum* genera dominate the diatom group (Koray et al., 2000; Senirkentli, 2003; Turkoglu & Yenici, 2007; Altuğ et al., 2011).

Conclusion

The importance of the Aegean Sea as an important corridor in the wider Mediterranean system linking the Mediterranean Sea to the Marmara-Black Sea highlights the need for ongoing monitoring and assessment. The dynamic nature of Aegean phytoplankton species composition requires continued taxonomic research to understand its ecological complexity. Traditional classification methods, while valuable, can be improved by incorporating advanced methods such as DNA barcoding (molecular methods). Furthermore, recognizing the ecological role of picoplankton and understanding their contribution to the overall phytoplankton composition is crucial for a comprehensive understanding of Turkish coast of the Aegean marine ecosystem.

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Compliance With Ethical Standards

Conflict of Interest

The author declares that there is no conflict of interest.

Ethical Approval

For this type of study, formal consent is not required.

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Data Availability Statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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