

List of Phytoplankton of the Sea of Marmara

Marmara Denizi Fitoplankton Tür Listesi

Neslihan Balkıs

Istanbul University, Faculty of Science, Department of Biology, 34118
Vezneciler 34118, Istanbul, Turkey

Abstract

In this work, a list of the phytoplankton species in the Sea of Marmara is presented in the light of the previously conducted research. It was seen that totally 168 species, eight at the generic level, had been recorded from this region. Diatoms and Dinoflagellates were dominant in terms of species number, with 76 and 73 species, respectively. Diatoms represented the majority of the population (45.2%), followed by dinoflagellates (43.5%).

Key words: Phytoplankton, Species list, Sea of Marmara.

Introduction

The Sea of Marmara is a semi-enclosed basin located between the continents of Europe and Asia. It is connected to the Black Sea through the Bosphorus in the north-east and to the Aegean Sea via the Dardanelles in the south-west. The chemical oceanography of the Sea of Marmara is significantly influenced by the biochemistry of the Black Sea and the Aegean Sea. Because of the large volume of water inflow from the adjacent Black Sea (about 600 km³) into the relatively small upper layer volume (about 225 km³) of the Sea of Marmara, the upper layer ecosystem of the latter has been influenced to a large extent (Ünlüata *et al.*, 1990; Tuğrul and Polat, 1995). In particular, the basin is affected by the brackish water coming from the Black Sea. Phytoplankton composition, which possibly can be exposed to changes because of water flow, should be observed by new studies.

The list includes phytoplankton species found in the Sea of Marmara from 1974 to 2004. There are few data on phytoplankton (Kocataş *et al.*, 1993; Aubert *et al.*, 1990; Uysal, 1996; Uysal and Ünsal, 1996; Balkıs, 2000, 2003 and Balkıs *et al.*, 2004). The oldest data belong to Artüz (1974) and Bingel *et al.* (1986) according to Kocataş *et al.* (1993) and the most detailed studies were reported by Balkıs (2003) and Balkıs *et al.* (2004).

The main goal of this work is to list the phytoplankton species recorded up to this date and to provide species, of which taxonomy was changed according to modern system.

Material and Methods

According to present literature, phytoplankton samples were collected with plankton nets or oceanographic bottles and preserved with lugol's iodine or neutralized formalin. The recent revisions of phytoplankton species are based on the studies of Huber-Pestalozzi (1983), Hasle and Syvertsen (1997), Steidinger and Tangen (1997), Throndsen (1997) and Heimdal (1997). The list of species within each Genus was organized in alphabetical order. In addition, synonyms in the references for the Sea of Marmara were noted in the list and authors were given under the species.

Results

A total of 168 species, eight at the generic level, were identified: 2 Cyanophyceae, 73 Dinophyceae, 3 Prymnesiophyceae, 2 Chrysophyceae, 3 Dictyochophyceae, 76 Bacillariophyceae, 2 Euglenophyceae, 3 Prasinophyceae and 4 Chlorophyceae. Diatoms represented the majority of the population (45.2%), followed by dinoflagellates (43.5%). The genera *Chaetoceros* (diatom) and *Protoperdinium* (dinoflagellate) were dominant in terms of diversity.

Abbreviations used: L1, Aubert, *et al.* (1990); L2, Kocataş *et al.* (1993); L3, Uysal (1996); L4, Uysal and Ünsal (1996); L5, Balkıs (2000); L6, Balkıs (2003); L7, Balkıs *et al.* (2004).

PROCARYOTA
CYANOPHYTA

Classis: CYANOPHYCEAE Schaffner

Order: Hormogonales Atkinson

Family: Oscillatoriaceae Engler

Genus: *Oscillatoria* Vaucher

Oscillatoria sp.

(L6).

Family: Nostocaceae Kützing

Genus: *Anabaena* (Bory) Bornet and Flahault

Anabaena sp. (Fresh water algae)

(L7).

EUCARYOTA

CHROMOPHYTA

Classis: DINOPHYCEAE G.S. West and Fritsch

Order: Prorocentrales Lemmermann

Family: Prorocentraceae Stein

Genus: *Mesoporos* Lillick

Mesoporos perforatus (Gran) Lillick

[=*Porella perforata* (Gran) Schiller]

(L1).

Genus: *Prorocentrum* Ehrenberg

Prorocentrum compressum (Bailey) Abé

(L6, L7).

Prorocentrum cordatum (Ostenfeld) Dodge

(L6, L7).

Prorocentrum micans Ehrenberg

(L1, L6, L7).

Prorocentrum scutellum Schröder

(L1, L6, L7).

Prorocentrum triestinum Schiller

(L6, L7).

Order: Dinophysiales Lindemann

Family: Dinophysiaceae Stein

Genus: *Dinophysis* Ehrenberg

Dinophysis acuminata Claparède and Lachmann
(L6).

Dinophysis acuta Ehrenberg
(L6).

Dinophysis caudata Saville-Kent
(L1, L6, L7).

Dinophysis fortii Pavillard
(L6).

Dinophysis hastata Stein
(L6, L7).

Dinophysis odiosa (Pavillard) Tai and Skogsberg
(L5, L6).

Dinophysis ovata Claparède and Lachmann
(L6).

Dinophysis ovum Schütt
(L1, L6).

Dinophysis punctata Jorgensen
(L6).

Dinophysis sacculus Stein
(L6).

Genus: *Ornithocercus* Stein

Ornithocercus quadratus Schütt
(L6).

Genus: *Phalacroma* Stein

Phalacroma rotundatum (Claparède and Lachmann) Kofoid
and Michener
(L6, L7).

Family: Oxyphysaceae Sournia

Genus: *Oxyphysis* Kofoid

Oxyphysis oxytoxoides Kofoid
(L5, L6).

Order: Gymnodiniales Lemmermann

Family: Gymnodiniaceae Lankester

Genus: *Gymnodinium* Stein

Gymnodinium sanguineum Hirasaka

(L6, L7).

Gymnodinium simplex (Lohmann) Kofoid and Swezy

(L6).

Genus: *Gyrodinium* Kofoid and Swezy

Gyrodinium spirale (Bergh) Kofoid and Swezy

(L1, L6, L7).

Genus: *Torodinium* Kofoid and Swezy

Torodinium sp.

(L6).

Family: Polykrikaceae Kofoid and Swezy

Genus: *Polykrikos* Bütschli

Polykrikos schwartzii Bütschli

(L6).

Order: Noctilucales Haeckel

Family: Kofoidiniaceae F.J.R. Taylor

Genus: *Kofoidinium* Pavillard

Kofoidinium velleloides Pavillard

(L6, L7).

Family: Noctilucaceae Kent

Genus: *Noctiluca* Suriray

Noctiluca scintillans (Macartney) Kofoid and Swezy

(=*N. miliaris* Suriray)

(L1, L2, L6, L7).

Genus: *Scaphodinium* Margalef

Scaphodinium mirabile Margalef

(L5, L6).

Order: Gonyaulacales F. J. R. Taylor

Family: Ceratiaceae Lindemann

Genus: *Ceratium* Schrank

Ceratium candelabrum (Ehrenberg) Stein

(L6).

- Ceratium contortum* var. *karstenii* (Pavillard) Sournia
 (= *C. karstenii* Pavillard)
 (L2).
- Ceratium furca* (Ehrenberg) Claparède and Lachmann
 (L2, L6, L7).
- Ceratium fusus* (Ehrenberg) Dujardin
 (L2, L6, L7).
- Ceratium gibberum* Gourret
 (L7).
- Ceratium inflatum* (Kofoid) Jörgensen
 (L7).
- Ceratium lineatum* (Ehrenberg) Cleve
 (L2).
- Ceratium longirostrum* Gourret
 (L6, L7).
- Ceratium macroceros* (Ehrenberg) Vanhöffen
 (L6, L7).
- Ceratium minutum* Jörgensen
 (L5, L6, L7).
- Ceratium pentagonum* Gourret
 (L1, L6, L7).
- Ceratium trichoceros* (Ehrenberg) Kofoid
 (L6, L7).
- Ceratium tripos* (O. F. Müller) Nitzsch
 (L1, L2, L6, L7).
- Family: Ceratocoryaceae Lindemann
 Genus: ***Ceratocorys*** Stein
 Ceratocorys armata (Schütt) Kofoid
 (L6).
- Family: Cladopyxidaceae Stein
 Genus: ***Cladopyxis*** Stein
 Cladopyxis caryophyllum (Kofoid) Pavillard
 (L6).
- Family: Goniodomataceae Lindemann
 Genus: ***Alexandrium*** Halim
 Alexandrium minutum Halim
 (L6, L7).
- Family: Gonyaulacaceae Lindemann
 Genus: ***Gonyaulax*** Diesing

Gonyaulax diegensis Kofoid
(L7).

Gonyaulax grindleyi Reinecke
(L6, L7).

Gonyaulax monacantha Pavillard
(L1, L6).

Genus: *Lingulodinium* Wall

Lingulodinium polyedrum (Stein) Dodge
(L6).

Family: Oxytoxaceae Lindemann

Genus: *Oxytoxum* Stein

Oxytoxum scolopax Stein
(L1, L6).

Family: Pyrophacaceae Lindemann

Genus: *Pyrophacus* Stein

Pyrophacus horologium Stein
(L6, L7).

Order: Peridinales Haeckel

Family: Calciodinellaceae F. J. R. Taylor

Genus: *Scrippsiella* Balech ex Loeblich III

Scrippsiella trochoidea (Stein) Loeblich III
(L6, L7).

Family: Kolkwitziellaceae Lindemann

Genus: *Diplopsalis* Bergh

Diplopsalis lenticula Bergh
(L6, L7).

Family: Peridiniaceae Ehrenberg

Genus: *Heterocapsa* Stein

Heterocapsa triquetra (Ehrenberg) Stein
(L6, L7).

Family: Podolampaceae Lindemann

Genus: *Podolampas* Stein

Podolampas palmipes Stein
(L5, L6).

Family: Protopteridiniaceae F. J. R. Taylor

Genus: *Protopteridinium* Bergh

Protopteridinium bipes (Paulsen) Balech
(L6).

Protopteridinium brevipes (Paulsen) Balech
(L7).
Protopteridinium brochi (Kofoid and Swezy) Balech
(L6, L7).
Protopteridinium claudicans (Paulsen) Balech
(L6, L7).
Protopteridinium conicum (Gran) Balech
(L6).
Protopteridinium crassipes (Kofoid) Balech
(L1, L6, L7).
Protopteridinium depressum (Bailey) Balech
(L1, L6, L7).
Protopteridinium diabolus (Cleve) Balech
(L7).

Protopteridinium divergens (Ehrenberg) Balech
(L1, L6, L7).
Protopteridinium globulum (Stein) Balech
(L6).
Protopteridinium granii (Ostenfeld *in* Paulsen) Balech
(L6).
Protopteridinium leonis (Pavillard) Balech
(L6, L7).
Protopteridinium mediterraneum (Kofoid) Balech
(L6).
Protopteridinium oceanicum (Vanhöffen) Balech
(L6, L7).
Protopteridinium paulseni Pavillard
(L6, L7).
Protopteridinium pellucidum Bergh
(L6, L7).
Protopteridinium pentagonum (Gran) Balech
(L6, L7).
Protopteridinium pyriforme (Paulsen) Balech
(L6).
Protopteridinium steinii (Jørgensen) Balech
(L1, L6, L7).
Protopteridinium subinerme (Paulsen) Loeblich III
(L6, L7).

Classis: PRYMNESIOPHYCEAE Hibberd

Order: Isochrysidales Pascher

Family: Gephyrocapsaceae Black

Genus: *Emiliana* Hay and Mohler

Emiliana huxleyi (Lohmann) Hay and Mohler

(L1).

Order: Coccochaerales Haeckel

Family: Coccolithaceae Poche

Genus: *Coccolithus* Schwarz

Coccolithus pelagicus (Wallich) Schiller

(L1).

Family: Syracosphaeraceae Lemmermann

Genus: *Syracosphaera* Lohmann

Syracosphaera pulchra Lohmann

(L1).

Classis: CHRYSOPHYCEAE *sensu* Christensen

Order: Bicosoecales Grassé

Family: Bicosoecaceae Stein

Genus: *Bicosoeca* James-Clark

Bicosoeca mediterranea Pavillard

(L6, L7).

Order: Ochromonadales Pascher

Family: Dinobryaceae Ehrenberg

Genus: *Dinobryon* Ehrenberg

Dinobryon balticum (Schütt) Lemmermann

(L6).

Classis: DICTYOPHYCEAE Silva

Order: Dictyochales Haeckel

Family: Dictyochaceae Lemmermann

Genus: *Dictyocha* Ehrenberg

Dictyocha fibula Ehrenberg

(L6).

Dictyocha speculum Ehrenberg

(L6).

Genus: *Octactis* Schiller

Octactis octonaria (Ehrenberg) Hovasse

(L6).

Classis: BACILLARIOPHYCEAE

Order: Biddulphiales Krieger (Centric diatoms)

Suborder: Coscinodiscineae

Family: Thalassiosiraceae Lebour

Genus: **Lauderia** Cleve

Lauderia annulata Cleve

(= *L. borealis* Gran)

(L2, L3, L6).

Genus: **Detonula** Schütt *ex De Toni*

Detonula pumila (Castracane) Gran

(= *Schroederella delicatula* Pavillard)

(L2, L3).

Genus: **Skeletonema** Greville

Skeletonema costatum (Greville) Cleve

(L2, L3, L6, L7).

Genus: **Thalassiosira** Cleve

Thalassiosira allenii Takano

(L6).

Thalassiosira angulata (Gregory) Hasle

[= *T. decipiens* (Grunow) Jörgensen]

(L2, L3, L6).

Thalassiosira anguste-lineata (A.Schmidt) G.Fryxell and

Hasle

(L6).

Thalassiosira eccentrica (Ehrenberg) Cleve

(= *Coscinodiscus exentricus* Ehrenberg)

(L2, L3).

Thalassiosira gravida Cleve

(L2, L3).

Thalassiosira nordenskiöldii Cleve

(L2, L3, L6).

Thalassiosira rotula Meunier

(L3, L6).

Family: Melosiraceae Kützing

Genus: **Melosira** C. A. Agardh

Melosira moniliformis (Müller) Agardh

(L6, L7).

Genus: *Stephanopyxis* (Ehrenberg) Ehrenberg
Stephanopyxis turris (Arnott in Greville) Ralfs in Pritchard
(L7).

Family: Leptocylindraceae Lebour

Genus: *Leptocylindrus* Cleve
Leptocylindrus danicus Cleve
(L1, L2, L3, L6, L7).
Leptocylindrus minimus Gran
(L3, L7).

Family: Coscinodiscaceae Kützing

Genus: *Coscinodiscus* Ehrenberg
Coscinodiscus centralis Ehrenberg
(L2, L3).
Coscinodiscus granii Gough
(L2, L3, L6).
Coscinodiscus lineatus Ehrenberg
(L2, L3).
Coscinodiscus perforatus Ehrenberg
(L6, L7).
Coscinodiscus radiatus Ehrenberg
(L2, L3, L6, L7).

Suborder: Rhizosoleniineae

Family: Rhizosoleniaceae Petit

Genus: *Rhizosolenia* Brightwell
Rhizosolenia hebetata Bailey
(L2, L3, L7).
Rhizosolenia setigera Brightwell
(L2, L3, L4, L6, L7).
Rhizosolenia styliformis Brightwell
(L2, L3, L7).

Genus: *Proboscia* Sundström
Proboscia alata (Brightwell) Sundström
(= *Rhizosolenia alata* Brightwell)
(L2, L3, L6, L7).

Genus: *Pseudosolenia* Sundström
Pseudosolenia calcar-avis (Schultze) Sundström
(= *Rhizosolenia calcar-avis* Schultze)
(L2, L3, L6, L7).

- Genus: **Guinardia** H. Peragallo
Guinardia cylindrus (Cleve) Hasle
(L6).
Guinardia delicatula (Cleve) Hasle
(= *Rhizosolenia delicatula* Cleve)
(L2, L3).
Guinardia flaccida (Castracane) Peragallo
(L2, L3, L6, L7).
Guinardia striata (Stolterfoth) Hasle
(= *Rhizosolenia stolterfothii* H. Peragallo)
(L2, L3).
- Genus: **Dactyliosolen** Castracane
Dactyliosolen fragilissimus (Bergon) Hasle
(= *Rhizosolenia fragilissima* Bergon)
(L2, L3, L6, L7).
- Suborder: Biddulphiineae
Family: Hemiaulaceae Jousé, Kisselev and Poretsky
Genus: **Cerataulina** H. Peragallo
Cerataulina pelagica (Cleve) Hendey
(L2, L3, L6, L7).
- Genus: **Hemiaulus** Ehrenberg
Hemiaulus hauckii Grunow in Van Heurck
(L1, L3, L6).
Hemiaulus sinensis Greville
(L3).
- Family: Chaetocerotaceae Ralfs in Prichard
Genus: **Bacteriastrum** Shadbolt
Bacteriastrum delicatulum Cleve
(L7).
Bacteriastrum hyalinum Lauder
(L2, L3).
- Genus: **Chaetoceros** Ehrenberg
Chaetoceros affinis Lauder
(L2, L3, L6, L7).
Chaetoceros brevis Schütt
(L7).
Chaetoceros constrictus Gran
(L6).

Chaetoceros costatus Pavillard
(L6).
Chaetoceros curvisetus Cleve
(L4, L6, L7).
Chaetoceros danicus Cleve
(L6).
Chaetoceros debilis Cleve
(L6, L7).
Chaetoceros decipiens Cleve
(L2, L3, L4, L6, L7).
Chaetoceros densus (Cleve) Cleve
(L3).
Chaetoceros diadema (Ehrenberg) Gran
(L4, L6).
Chaetoceros didymus Ehrenberg
(L2, L3, L7).
Chaetoceros diversus Cleve
(L2, L3).
Chaetoceros holsaticus Schütt
(L6).
Chaetoceros lacinosus Schütt
(L6, L7).

Chaetoceros lauderi Ralfs *in* Lauder
(L2, L3, L4).

Chaetoceros lorenzianus Grunow
(L6, L7).

Chaetoceros peruvianus Brightwell
(L6, L7).

Chaetoceros rostratus Lauder
(L3).

Chaetoceros socialis Lauder
(L7).

Family: Lithodesmiaceae H. and M. Peragallo

Genus: *Ditylum* J. W. Bailey *ex* L. W. Bailey

Ditylum brightwellii (T. West) Grunow *in* Van Heurck
(L2, L3, L6, L7).

Genus: *Helicotheca* Ricard

Helicotheca tamesis (Shrubsole) Ricard
(L6).

Order: Bacillariales (Pennate diatoms)
Suborder: Fragilariineae (Araphid pennate diatoms)
Family: Fragilariaceae Greville
Genus: *Asterionella* Hassall
 Asterionella bleakeleyii W. Smith
 (L2, L3).
Genus: *Asterionellopsis* Round *in* Round et al.
 Asterionellopsis glacialis (Castracane) Round
 (L7).
Genus: *Climacosphenia* Ehrenberg
 Climacosphenia sp.
 (L6, L7).
Genus: *Striatella* Agardh
 Striatella unipunctata (Lyngbye) Agardh
 (L6, L7).
Genus: *Grammatophora* Ehrenberg
 Grammatophora marina (Lyngbye) Kützing
 (L6).
Genus: *Licmophora* Agardh
 Licmophora abbreviata Agardh
 (L1, L6, L7).
 Licmophora flabellata (Greville) Agardh
 (L7).
Family: Thalassionemataceae Round
Genus: *Thalassionema* Grunow *in* Mereschkowsky
 Thalassionema nitzschioides (Grunow) Mereschkowsky
 (L2, L3, L6, L7).

Suborder: Bacillariineae (Raphid pennate diatoms)
Family: Achnantheaceae Kützing
Genus: *Achnanthes* Bory
 Achnanthes brevipes Agardh
 (L6).
Family: Naviculaceae Kützing
Genus: *Navicula* Bory
 Navicula sp.
 (L6, L7).

- Genus: *Diploneis* Ehrenberg
Diploneis bombus (Ehrenberg) Cleve
(L6).
- Genus: *Pleurosigma* W. Smith
Pleurosigma normanii Ralfs in Pritchard
(L6, L7).
- Genus: *Gyrosigma* Hassall
Gyrosigma fasciola (Ehrenberg) Cleve
(L6).
- Family: Bacillariaceae Ehrenberg
- Genus: *Bacillaria* J. F. Gmelin
Bacillaria paxillifera (O. F. Müller) Hendey
(L7).
- Genus: *Cylindrotheca* Rabenhorst
Cylindrotheca closterium (Ehrenberg) Reimann and Lewin
(L2, L3, L6, L7).
- Genus: *Pseudo-nitzschia* H. Peragallo in H. and M. Peragallo
Pseudo-nitzschia delicatissima (Cleve) Heiden in Heiden
and Kolbe
(L2, L3, L4, L7).
Pseudo-nitzschia fraudulenta (Cleve) Hasle
(L7).
Pseudo-nitzschia pseudodelicatissima (Hasle) Hasle
(L6, L7).
Pseudo-nitzschia pungens (Grunow ex P.T.Cleve) Hasle
(L2, L3, L6, L7).
Pseudo-nitzschia seriata (Cleve) H. Peragallo
(L2, L3, L4).
- Genus: *Nitzschia* Hassall
Nitzschia longissima (Brébisson in Kützing) Ralfs in
Pritchard
(L2, L3, L4, L6, L7).

CHLOROPHYTA

Classis: EUGLENOPHYCEAE

Order: Euglenales Engler

Family: Eutreptiaceae Hollande

Genus: *Eutreptiella* de Cunha

Eutreptiella sp.

(L6, L7).

Family: Euglenaceae Dujardin
Genus: *Euglena* Ehrenberg
Euglena viridis Ehrenberg (Fresh water algae)
(L7).

Classis: PRASINOPHYCEAE
Order: Chlorodendrales Fritsch
Family: Halosphaeraceae Haeckel
Genus: *Halosphaera* Schmitz
Halosphaera viridis Schmitz
(L6, L7).

Genus: *Pyramimonas* Schmarda
Pyramimonas grossii Parke
(L6).
Family: Chlorodendraceae Oltmanns
Genus: *Tetraselmis* Stein
Tetraselmis sp.
(L6).

Classis: CHLOROPHYCEAE
Order: Chlorococcales Marchand
Family: Hydrodictyaceae Cohn
Genus: *Pediastrum* Meyen
Pediastrum boryanum (Turpin) Meneghini (Fresh water algae)
(L7).
Pediastrum simplex (Meyen) Lemm. (Fresh water algae)
(L7).
Family: Oocystaceae Bohlin
Genus: *Monoraphidium* Komarkova-Legnerova
Monoraphidium sp. (Fresh water algae)
(L7).
Family: Scenedesmaceae
Genus: *Scenedesmus* Meyen
Scenedesmus quadricauda (Turpin) Brébisson (Fresh water algae)
(L7).

Discussion

A total of 168 species have been identified from the Sea of Marmara as a result of previous studies. Kocataş *et al.* (1993) reported 42 species, four at the generic level. Aubert *et al.* (1990) mentioned 23 species, two at the generic level; Uysal (1986) 46 species, five at the generic level; Uysal and Ünsal (1996) 8 species and Balkıs (2000) 5 species new to Turkish coastal waters from this region. The works of Uysal (1986) and Uysal and Ünsal (1996) are focused on the diatoms. The most detailed studies about phytoplankton in the Sea of Marmara were performed by Balkıs (2003) and Balkıs *et al.* (2004). Balkıs (2003) reported 125 phytoplankton species, eight at the generic level, and Balkıs *et al.* (2004) recorded 102 species, 13 at the generic level.

Taxa in the generic level were included in the list if the genera did not possess another species. Therefore, species number in the list differs from that in original papers of the authors.

Some fresh water algae reported by Balkıs *et al.* (2004) were included in the list since they were indicators of less saline waters of different origins on the shelf. Balkıs *et al.* (2004) reported that these species had been obtained in the area where Kocasu river flows to the sea.

This study has shown that a moderate number of phytoplankton species live in the Sea of Marmara and phytoplankton composition should be observed by new studies.

Özet

Bu çalışmanın amacı, Marmara Denizi'ndeki fitoplankton türlerini, daha önce yapılmış araştırmaların ışığı altında bir liste halinde sunmaktır. Bu bölgeden sekizi cins seviyesinde toplam 168 tür bildirilmektedir. Tür sayısı bakımından diatomlar (76 tür) ve dinoflagellatlar (73 tür) baskındır. Diatomlar popülasyonunun %45.2'sini, dinoflagellatlar ise %43.5'ini oluşturmaktadır.

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