Bulgarian Journal of Agricultural Science, 21 (Supplement 1) 2015, 90–99
Agricultural Academy

PHYTOPLANKTON TAXONOMY IN THE BULGARIAN COASTAL WATERS (2008–2010)

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Abstract

PETROVA, D. and D. GERDZHIKOV, 2015. Phytoplankton taxonomy in the Bulgarian coastal waters (2008–2010). *Bulg. J. Agric. Sci.,* Supplement 1, 21: 90–99

The purpose of the study was to explore the dynamics of phytoplankton taxonomic composition in the Bulgarian coastal waters (2008–2010). In the analyzed total of 389 samples were identified 204 species and forms of microalgae distributed into 14 classes.The largest share belonged to classes *Dinophyceae* (40.20%) and *Bacillariophyceae* (31.86%). The remaining microalgae were distributed into the other 27.94%. The change in dominance between peridineas and diatoms during the hydrobiological seasons demonstrated well-defined cyclic recurrence. Throughout the study period the highest diversity of species was registered in June and September; the poorest species composition – in April, July and December.

Key words: Black sea, coastal waters, pelagial, phytoplankton, taxonomical composition, biodiversity

Introduction

Species composition of hydro-biocoenoses carries information about the nature and amount of the elements that make up the system. They are distinguished by their belonging to one or other systematic, taxonomic category. Depending on the adaptive capacity of individual species and the environmental state, in the composition of the communities are involved different species which aggregation is most often referred to as biological (species) diversity (Uzunov and Kovachev, 2002).

Phytoplankton taxonomic composition globally includes about 4000–5000 species (Sournia et al., 1991; Tett and Barton, 1995). Species richness of vegetating in the Black Sea phytoplankton species in the last decade has grown more than twice (up to 1621 confirmed and 48 unconfirmed species on the list of the Black Sea Phytoplankton Checklist (BSPC Editorial Board, 2013) compared to 80s (700 species identified to 1978), (Black Sea, 1978).

According to the latest published data for a 25-year period (1980–2005) in the Bulgarian part of the Black Sea were observed 544 species, distributed into 8 classes, two times more than the 230 species identified for the period 1954-1980. Although a part of this change is associated with a better strategy for collection of samples, quality of the microscopic technique, frequency and regions of sampling, a share also hold the changing environmental conditions and the introduction of new exotic species of microalgae (Moncheva and Kamburska, 2002).

Material and Methods

The study was carried out within the period 2008 – 2010 in the Bulgarian coastal aquatory of the Black Sea. The scientific expeditions were conducted on board the R/V *Prof. Al. Valkanov*. 389 phytoplankton samples were collected from 71 stations at standard horizons (0, 10, 25, 50, 75 and 100 m) by bathometers type Niskin-5L or in shallow water (up to 15 m depth) at surface – bottom horizons. The samples were fixed onboard the ship in 2% formalin solution and concentrated by the sedimentary method (Morozova-Vodyanitskaya, 1954).

The qualitative and quantitative analyses of the samples were performed with a light microscope Nikon E400 in

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counting cells *Sedgewick Rafter* – 1 ml and *Palmer – Maloney* – 0.05 ml, using standard methods (Moncheva and Parr, 2010). Software Phytomar 2.0 (IFR – Varna 2008) and Excel 12 (Microsoft Office 2007) were used for calculations and graphs.

Classification of phyla and classes of phytoplankton microalgae is based on Temniskova and Stoyneva (Temniskova and Stoyneva, 2011). This distribution of species in classes is according to electronic databases "WoRMS" (WoRMS, 2013) and "Algaebase" (Guiry and Guiry, 2013).

Results and Discussion

In the aquatic environment of the Bulgarian coast in 2008 were identified 133 species and forms of phytoplankton algae from 12 classes (Guiry and Guiry, 2013; WoRMS, 2013). According to the trend observed after 1970 (Temniskova et al., 2005) dominated representatives of class *Dinophyceae* 45.11%, *Bacillariophyceae* 31.58%, *Euglenophyceae* 5.26%, *Chlorophyceae* 4.51%, *Cyanophyceae* 3.01%, *Prymnesiophyceae* 3.01%, *Cryptophyceae* 2.26%, *Trebouxiophyceae* 2.26%, *Chlorophyta incertae sedis* 0.75%, *Craspedophyceae* 0.75%, *Dictyochophyceae* 0.75%, *Prasinophyceae* 0.75% (Figure 1). The main phytoplankton taxa *Bacillariophyceae/ Dinophyceae* dominated with total of 76.69%.

Taxonomic dynamics in 2008 was characterized by a maximum of class *Dinophyceae* in June (58.54%) and a maximum of class *Bacillariophyceae* in October (38.82%). The group „Other" was with prominent peaks in June and December, 26.83% and 31.82%, respectively (Figure 2).

In the aquatic environment of the Bulgarian coast in 2009 were identified 145 species and forms of phytoplankton algae from 14 classes (Guiry and Guiry, 2013; WoRMS, 2013). According to the trend observed after 1970 (Temniskova et al., 2005) dominated representatives of class *Dinophyceae*

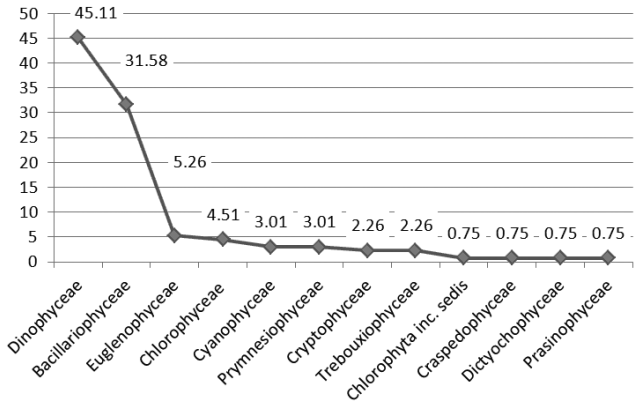

Fig. 1. Phytoplankton taxonomic composition (%) in coastal waters by classes in 2008

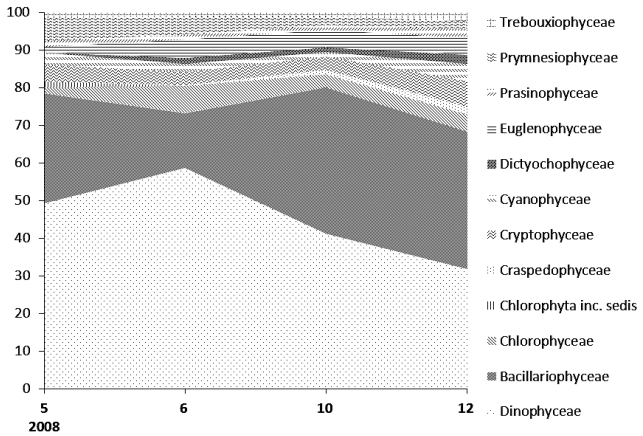

Fig. 2. Dynamics of phytoplankton taxonomic composition in coastal waters by classes and months, 2008

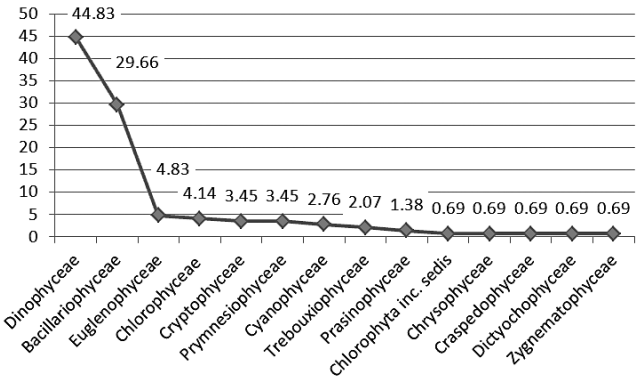

Fig. 3. Phytoplankton taxonomic composition (%) in coastal waters by classes in 2009

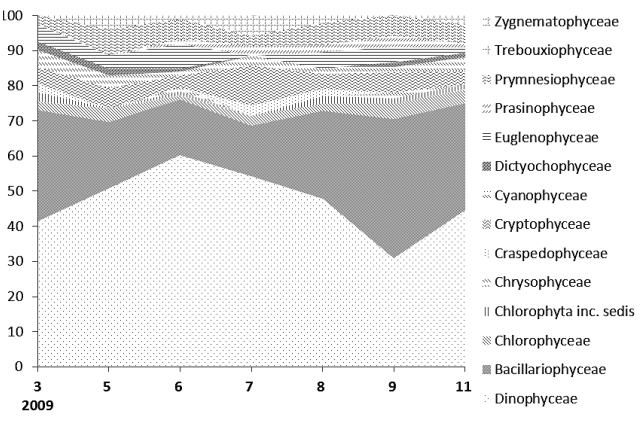

Fig. 4. Dynamics of phytoplankton taxonomic composition in coastal waters by classes and months, 2009

44.83%, *Bacillariophyceae* 29.66%, *Euglenophyceae* 4.83%, *Chlorophyceae* 4.14%, *Cryptophyceae* 3.45%, *Prymnesiophyceae* 3.45%, *Cyanophyceae* 2.76%, *Trebouxiophyceae* 2.07%, *Prasinophyceae* 1.38%, *Chlorophyta incertae sedis* 0.69%, *Chrysophyceae* 0.69%, *Craspedophyceae* 0.69%, *Dictyochophyceae* 0.69% and *Zygnematophyceae* 0.69% (Figure 3). The main phytoplankton taxa *Bacillariophyceae/ Dinophyceae* dominated with total of 74.48% (Figure 3).

Taxonomic dynamics in 2009 was characterized by a maximum of class *Dinophyceae* in June (60.23%) and two maxima of class *Bacillariophyceae* in March and September, 31.71% and 39.71%, respectively. The group "other" was with prominent peaks in May, July and September, 30.19%, 31.43% and 29.41%, respectively (Figure 4).

In the aquatic environment of the Bulgarian coast in 2010 were identified a total of 138 species and forms of phytoplankton algae from 13 classes (Guiry and Guiry, 2013; WoRMS, 2013). According to the trend observed after 1970 (Temniskova et al., 2005) dominated representatives of class *Dinophyceae* 36.96%. From 2009 towards 2010 there was a tendency for reducing the annual percentage (%) of peridineas in the taxonomic composition. *Bacillariophyceae* 31.88%, *Chlorophyceae* vegetate with high value 8.70%, *Euglenophyceae* 5.07%, *Cryptophyceae* 5.07%, *Cyanophyceae* 3.62%, *Prymnesiophyceae* 3.62%, *Trebouxiophyceae* 1.45%, *Prasinophyceae* 1.45%, *Dictyochophyceae* 1.45%, *Chlorophyta incertae sedis* 1.45%, *Craspedophyceae* 0.72%, and *Zygnematophyceae* 0.72% (Figure 5). The main phytoplankton taxa *Bacillariophyceae/ Dinophyceae* dominated with total of 68.84%.

Taxonomic dynamics in 2010 was characterized by a maximum of class *Dinophyceae* in April (53.23%) and a maximum of class *Bacillariophyceae* in July (36.96%). The group of "other" was with a pronounced maximum in May (36.62%) (Figure 6).

In the analyzed 389 quantitative phytoplankton samples were identified 204 species and forms of microalgae distributed into 14 classes (Guiry and Guiry, 2013; WoRMS, 2013). Most important in marine phytoplankton were the groups of *Dinophyceae* 40.20% and *Bacillariophyceae* 31.86%, dominating with 72.06% of the taxonomic composition. The established percentage was in line with the trend of increasing species diversity of phytoplankton communities in direction of the representatives of "other" taxonomic classes identified for the entire Black Sea basin after 2000 (Moncheva et al., 2010, 2012; Nesterova et al., 2008). The remaining microalgae were distributed into the other 27.94% as "green" algae (sub-kingdom *Chlorobionta*, Kozhuharova et al., 2011) reached 13.24%. The small taxonomic groups were represented by a limited number of species (Figure 7).

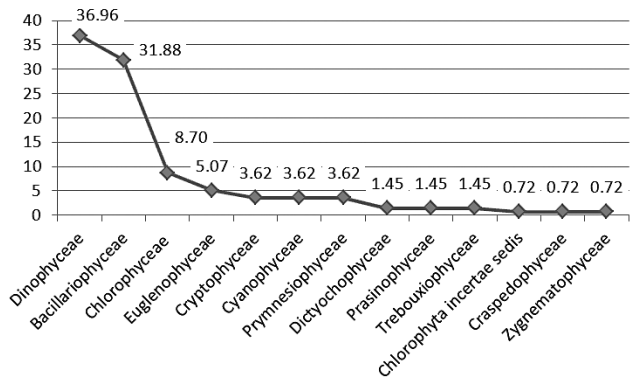

Fig. 5. Phytoplankton taxonomic composition (%) in coastal waters by classes in 2010

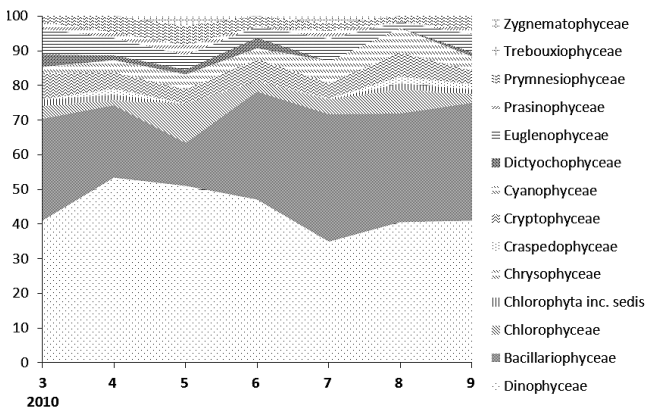

Fig. 6. Dynamics of phytoplankton taxonomic composition in coastal waters by classes and months, 2010

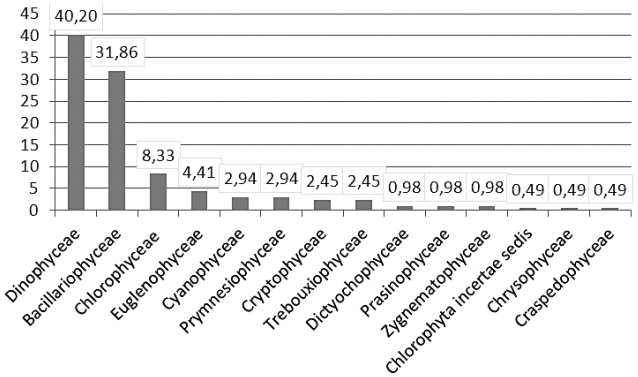

Fig. 7. Percentage shares of microalgae taxonomic classes in phytoplankton qualitative composition in coastal waters (2008–2010)

Phylum *Ochrophyta* include class *Bacillariophyceae*, presented with 29 genera and 65 species and taxons (genus *Achnanthes, Amphora, Bacillariophyceae, Cerataulina, Chaetoceros, Cocconeis, Coscinodiscus, Coscinosira, Cyclotella, Dactyliosolen, Ditylum, Eunotia, Grammatophora, Halamphora, Leptocylindrus, Licmophora, Melosira, Navicula, Nitzschia, Paralia, Petrodictyon, Pleurosigma, Proboscia, Pseudo-nitzschia, Pseudosolenia, Skeletonema, Synedra, Thalassionema, Thalassiosira*). Class Chrysophyceae (1 species) 0.49% (genus *Dinobryon*); class *Dictyochophyceae* (2 species) 0.98% (genus *Apedinella* и *Distephanus*); class *Craspedophyceae* – 1 species 0.49% (*Bicosta spinifera* Leadbeater, 1978) (Christensen, 1966; Hibberd, 1975).

Phylum *Pyrrhophyta* include class *Dinophyceae* with 27 genera and 82 species and taxons (genus *Akashiwo, Alexandrium, Amphidinium, Cladopyxis, Cochlodinium, Dinophysis, Diplopsalis, Durinskia, Exuviaella, Glenodinium, Gonyaulax, Gymnodinium, Gyrodinium, Hemidinium, Heterocapsa, Lingulodinium, Minuscula, Neoceratium, Oblea, Peridinium, Phalacroma, Polykrikos, Pronoctiluca, Prorocentrum, Protoperidinium, Scrippsiella, Tryblionella*).

Phylum *Euglenophyta* – *Euglenophyceae* (9 species and taxons; 4.41%) is presented with genera *Eutreptiella, Euglena, Eutreptia, Phacus*.

Phylum *Haptophyta* – *Coccolithophyceae* (=*Prymnesiophyceae*) (6 species) 2.94% is presented with genera *Acanthoica, Coccolithus, Emiliania, Phaeocystis, Syracosphaera*.

Phylum *Cryptophyta* – *Cryptophyceae* (5 species) 2.45% (genus *Chroomonas,Cryptomonas, Leucocryptos, Rhodomonas* and several representatives from the group of *small Flagellates* – unspecified to genus and species with a light microscope).

Phylum *Cyanopropkaryota* – *Cyanophyceae* (6 species) 2.94% with genera *Merismopedia, Oscillatoria, Phormidium u Spirulina*.

From subkingdom *Chlorobionta* (13.24%), (green algae) Phylum *Chlorophyta* (12.25%) – class *Chlorophyceae* (8.33%) is presented with 10 genera (*Ankistrodesmus, Chlamydomonas, Eudorina, Golenkinia, Hypnomonas, Monoraphidium, Platymonas, Scenedesmus, Tetrastrum, Treubaria*); class *Trebouxiophyceae* (2.45%) with 3 genera (*Dictiyosphaerium, Oocystis, Trochiscia*); class *Prasinophyceae*, 0.98% (*Pachysphaera* and *Pyramimonas*); class *Chlorophyta incertae sedis* (по WoRMS) (0.49%) is represented by *Poropila dubia* Schiller, 1925 – the exact taxonomic position of this common species has not yet been verified in the electronic database WoRMS. Two genera (*Closterium* and *Mesotaenium*) of the order Streptophyta (0.98%) were met.

Over the years, the months with the greatest number of species were May, June, September, October and November.

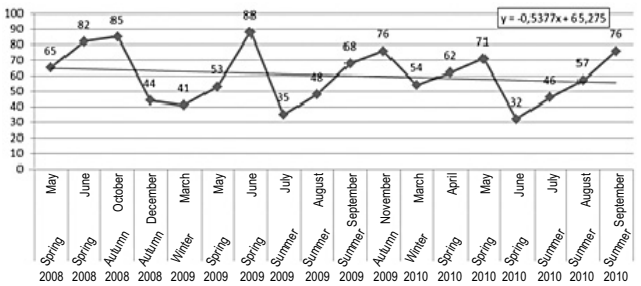

Fig. 8. Dynamics of species composition in the Bulgarian coastal waters in the different months within the period 2008–2010

The number of observed species showed a trend for reduction from 2008 towards 2010 (according to the linear regression dependence: y = –0.5377x + 65.275) (Figure 8).

Summarizing the average values of the number of phytoplankton microalgae for the entire period of research (2008–2010) we found that the most species-rich were the months of June and September (it corresponded with the high species diversity at the end of the seasonal succession cycle, Petrova et al., 2014). April, July and December were with the poorest species composition. The basic pattern in the summarized annual dynamics of phytoplankton biodiversity was reduction in the number of species during hydro-biological year (from March to December inclusive), (according to regression dependence: y = –1.6303x + 87.867). In that general trend stood out three seasonal cycles of phytoplankton development – increasing the number of microalgae from March towards June, from July towards September and gradually decreasing towards the end of the year (Figure 9 and Table 1).

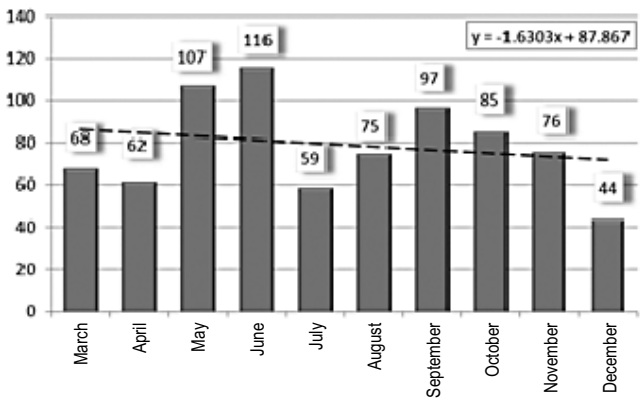

Fig. 9. Average monthly dynamics in the number of identified species in the Bulgarian coastal waters, total for the period 2008–2010

Table 1

Full taxonomic list of the registered phytoplankton algae (name, discoverer, year, synonyms) for all studied marine and brackish water areas (lakes and coast) 2008-2010

№	Taxon	Species	
1	*Dinophyceae*	*Akashiwo sanguinea* (K.Hirasaka) G.Hansen & Ø.Moestrup, 2000 (Syn. *Gymnodinium splendens* Lebour, 1925; *Gymnodinium sanguineum* Hirasaka, 1922)	1
2	*Dinophyceae*	*Alexandrium monilatum* (J.F.Howell,1953) Balech, 1995	2
3	*Dinophyceae*	*Amphidinium crassum* Lohmann, 1908	3
4	*Dinophyceae*	*Amphidinium extensum* Wulff, 1916	4
5	*Dinophyceae*	*Amphidinium lacustre* Stein, 1883	5
6	*Dinophyceae*	*Amphidinium longum* Lohmann, 1908	6
7	*Dinophyceae*	*Amphidinium sp.* Claperède & Lachmann, 1859	7
8	*Dinophyceae*	*Cladopyxis sp.* Stein, 1883	8
9	*Dinophyceae*	*Cochlodinium sp.* Schütt, 1896	9
10	*Dinophyceae*	*Cochlodinium adriaticum* Schiller, 1933 (Syn. Gyrodinium adriaticum Schiller, 1928)	10
11	*Dinophyceae*	*Cochlodinium citron* Kofoid et Swezy, 1921	11
12	*Dinophyceae*	*Dinophysis acuminata* Claparède & Lachmann, 1859	12
13	*Dinophyceae*	*Dinophysis acuta* Ehrenberg, 1841	13
14	*Dinophyceae*	*Dinophysis caudata* Saville-Kent, 1881	14
15	*Dinophyceae*	*Dinophysis hastata* Stein, 1883	15
16	*Dinophyceae*	*Dinophysis rotundata* Claparède & Lachmann, 1859 (syn.*Phalacroma rotundatum* Kofoid and Michener, 1911)	16
17	*Dinophyceae*	*Dinophysis sacculus* Stein, 1883	17
18	*Dinophyceae*	*Diplopsalis lenticula* Bergh 1882 (Syn. *Glenodinium lenticula* Pouchet 1883; *Peridiniopsis lenticula* (Bergh) Starmach)	18
19	*Dinophyceae*	*Durinskia agilis* (Kofoid & Swezy) Saburova, Chomérat & Hoppenrath, 2012 (Syn. *Gymnodinium agile* Kofoid & Swezy, 1921)	19
20	*Dinophyceae*	*Exuviaella sp.* Cienkowski, 1881 (syn. Accepted in WoRMS (2013) is *Prorocentrum* Ehrenberg, 1834)	20
21	*Dinophyceae*	*Glenodinium dinobryonis* (Woloszynska) Schiller 1937 (syn. Accepted in Algae Base as *Peridiniopsis dinobryonis* (Woloszynska) Bourrelly 1968)	21
22	*Dinophyceae*	*Glenodinium foliaceum* F.Stein 1883	22
23	*Dinophyceae*	*Glenodinium oculatum* Stein, 1883 (syn. Accepted in AlgaeBase is *Peridiniopsis oculatum* (F.Stein) Bourrelly, 1968)	23
24	*Dinophyceae*	*Glenodinium paululum* Lindemann, 1928	24
25	*Dinophyceae*	*Glenodinium sp.* Ehrenberg, 1836	25
26	*Dinophyceae*	*Gonyaulax apiculata* (Pénard,1891) Entz, 1904	26
27	*Dinophyceae*	*Gonyaulax grindleyi* Reinecke, 1967 (Syn. *Protoceratium reti*culatum (Claparède & Lachmann, 1859) Bütschli, 1885)	27
28	*Dinophyceae*	*Gonyaulax minima* Matzenauer, 1933	28
29	*Dinophyceae*	*Gonyaulax sp.* Diesing, 1866	29
30	*Dinophyceae*	*Gonyaulax spinifera* (Claparède & Lachmann, 1859) Diesing, 1866	30
31	*Dinophyceae*	*Gymnodinium adriaticum* (Schmarda) Kofoid & Swezy, 1921	31
32	*Dinophyceae*	*Gymnodinium agiliforme* Schiller, 1928	32
33	*Dinophyceae*	*Gymnodinium catenatum* L.W.Graham, 1943	33
34	*Dinophyceae*	*Gymnodinium elongatum* Hope, 1954	34
35	*Dinophyceae*	*Gymnodinium flavum* Kofoid & Swezy, 1921	35
36	*Dinophyceae*	*Gymnodinium fuscum* (Ehrenberg, 1834) Stein, 1883	36
37	*Dinophyceae*	*Gymnodinium grammaticum* (Pouchet) Kofoid & Swezy, 1921	37
38	*Dinophyceae*	*Gymnodinium najadeum* Schiller, 1928	38
39	*Dinophyceae*	*Gymnodinium neapolitanum* Schiller, 1928	39
40	*Dinophyceae*	*Gymnodinium simplex* (Lohmann) Kofoid & Swezy, 1921	40
41	*Dinophyceae*	*Gymnodinium sp.* Stein, 1878	41
42	*Dinophyceae*	*Gymnodinium uberrimum* (G.J.Allman) Kofoid & Swezy, 1921	42

Table 1 Continued

№	Taxon	Species	
43	*Dinophyceae*	*Gymnodinium variabile* Herdman, 1924	43
44	*Dinophyceae*	*Gymnodinium wulffii* Schiller, 1933	44
45	*Dinophyceae*	*Gyrodinium fusiforme* Koifoid & Swezy, 1921(syn. Accepted as *Gyrodinium fusus* (Meunier, 1910) Akselman, 1985)	45
46	*Dinophyceae*	*Gyrodinium lachryma* (Meunier, 1910) Kofoid et Swezy, 1921	46
47	*Dinophyceae*	*Gyrodinium pellucidum* (Wulff) Schiller, 1933	47
48	*Dinophyceae*	*Gyrodinium sp.* Kofoid & Swezy, 1921	48
49	*Dinophyceae*	*Gyrodinium spirale* (Bergh, 1881) Kofoid & Swezy, 1921	49
50	*Dinophyceae*	*Hemidinium nasutum* F.Stein, 1883	50
51	*Dinophyceae*	*Heterocapsa rotundata* (Lohmann, 1908) G.Hansen, 1995 (Syn. *Massartia rotundata* (Lohmann) Schiller, 1933; *Katodinium rotundatum* (Lohmann) Loeblich III, 1965)	51
52	*Dinophyceae*	*Heterocapsa triquetra* (Ehrenberg, 1840) Stein, 1883	52
53	*Dinophyceae*	*Lingulodinium polyedrum* (F. Stein) J.D. Dodge, 1989 (Syn. *Gonyaulax polyedra* F. Stein, 1883)	53
54	*Dinophyceae*	*Minuscula bipes* (Paulsen) Lebour, 1925	54
55	*Dinophyceae*	*Neoceratium furca* (Ehrenberg) F.Gomez, D.Moreira & P.Lopez-Garcia, 2009 (*Ceratium furca* (Ehrenberg) Claparède & Lachmann, 1859)	55
56	*Dinophyceae*	*Neoceratium fusus* (Ehrenberg) F.Gomez, D.Moreira & P.Lopez-Garcia, 2009 (*Ceratium fusus* (Ehrenberg, 1834) Dujardin, 1841)	56
57	*Dinophyceae*	*Neoceratium tripos* (O.F.Müller) F.Gomez, D.Moreira & P.Lopez-Garcia (*Ceratium tripos* (O.F.Müller) Nitzsch, 1817)	57
58	*Dinophyceae*	*Oblea rotunda* (Lebour) Balech ex Sournia, 1973	58
59	*Dinophyceae*	*Oxyrrhis marina* Dujardin, 1841	59
60	*Dinophyceae*	*Peridinium breve* Paulsen, 1907 (syn. Accepted in Gomez as *Protoperidinium pyriforme* (Paulsen 1907) Balech, 1974; *Protoperidinium breve* (Paulsen 1907) Balech)	60
61	*Dinophyceae*	*Peridinium bulla* Meunier, 1910 (!!! in Gomez have only as *Protoperidinium bulla* (Meunier 1910) Balech 1974)	61
62	*Dinophyceae*	*Peridinium quinquecorne* Abe, 1927 (syn. *Protoperidinium quinquecorne* (Abé) Balech, 1974)	62
63	*Dinophyceae*	*Peridinium sp.* Ehrenberg, 1832	63
64	*Dinophyceae*	*Peridinium umbonatum* F.Stein, 1883 (Syn. *Peridinium pusillum* (Pénard, 1891) Lemmermann, 1901)	64
65	*Dinophyceae*	*Phalacroma minutum* Cleve, 1900 (syn. *Dinophysis elongata* (Jørgensen, 1923) Abé vel Balech, 1967; *Dinophysis minuta* (Cleve, 1900) Balech, 1967)	65
66	*Dinophyceae*	*Polykrikos schwarzii* Bütschli, 1873	66
67	*Dinophyceae*	*Pronoctiluca pelagica* Fabre-Domergue, 1889	67
68	*Dinophyceae*	*Prorocentrum balticum* (Lohmann) Loeblich, 1970 (Syn. *Exuviaella baltica* Lohmann, 1908; *Prorocentrum pomoideum* Bursa, 1959)	68
69	*Dinophyceae*	*Prorocentrum cordatum* (Ostenfeld, 1901) Dodge, 1975 (syn. (from Gomez, 2005) =*Exuviaella cordata* Ostenfeld, *E. pyriformis* Schiller 1928, ?*P. minimum* (Pavillard 1916) Schiller 1931)	69
70	*Dinophyceae*	*Prorocentrum micans* Ehrenberg, 1833	70
71	*Dinophyceae*	*Prorocentrum scutellum* Schröder, 1900	71
72	*Dinophyceae*	*Protoperidinium abei* (Paulsen) Balech, 1974	72
73	*Dinophyceae*	*Protoperidinium achromaticum* (Levander 1902) Balech, 1974 (Syn. *Peridinium achromaticum* Levander, 1902)	73
74	*Dinophyceae*	*Protoperidinium brevipes* (Paulsen, 1908) Balech, 1974 (Syn. *Peridinium brevipes* Paulsen, 1908)	74
75	*Dinophyceae*	*Protoperidinium bulla* (Meunier ,1910) Balech 1974 (Syn. *Peridinium bulla* A.F.Meunier)	75
76	*Dinophyceae*	*Protoperidinium conicoides* (Paulsen 1905) Balech, 1973 (syn. *Peridinium conicoides* Paulsen, 1905)	76
77	*Dinophyceae*	*Protoperidinium conicum* (Gran) Balech, 1974 (Syn. *Peridinium conicum* (Gran) Ostenfeld & Schmidt, 1902)	77
78	*Dinophyceae*	*Protoperidinium crassipes* (Kofoid, 1907) Balech, 1974	78
79	*Dinophyceae*	*Protoperidinium depressum* (Bailey) Balech, 1974 (Syn. *Peridinium depressum*, Bailey, 1855)	79
80	*Dinophyceae*	*Protoperidinium divergens* (Ehrenberg, 1840) Balech, 1974	80
81	*Dinophyceae*	*Protoperidinium granii* (Ostenfield, 1906) Balech, 1974	81
82	*Dinophyceae*	*Protoperidinium marie-lebouriae* (Paulsen) Balech 1974 (Syn. *Peridinium marielebourae* - in Kiselev, 1950; *Peridinium marie-lebouriae* Paulsen 1930)	82

Table 1 Continued

№	Taxon	Species	
83	*Dinophyceae*	*Protoperidinium pellucidum* Bergh, 1882 (*Peridinium pellucidum* (Bergh,1881) Schütt, 1895)	83
84	*Dinophyceae*	*Protoperidinium steinii* (Jørgensen, 1899) Balech, 1974 (Syn. *Peridinium steinii* Jørgensen, 1899)	84
85	*Dinophyceae*	*Protoperidinium subinerme* (Paulsen) Loeblich III, 1969 (Syn. *Peridinium subinerme* Paulsen, 1908)	85
86	*Dinophyceae*	*Scrippsiella hangoei* (J.Schiller) J.Larsen, 1995 (Syn. *Peridinium hangoei* J.Schiller, 1935; *Peridinium gracile* E.Lindemann, 1924)	86
87	*Dinophyceae*	*Scrippsiella trochoidea* (Stein, 1883) Balech ex Loeblich III, 1965 (syn. *Peridinium trochoideum* (Stein, 1883) Lemmermann, 1910)	87
88	*Dinophyceae*	*Tryblionella compressa* (J.W.Bailey) M.Poulin, 1990 accepted in WoRMS (Syn. *Prorocentrum compressum* (Bailey, 1850) Abé ex Dodge, 1975; syn *Exuviaella compressa* (Bailey) Ostenfeld, 1899)	88
89	*Bacillariophyceae*	*Achnanthes brevipes* C.A. Agardh, 1824	1
90	*Bacillariophyceae*	*Achnanthes longipes* C.Agardh, 1824	2
91	*Bacillariophyceae*	*Amphora inflexa* (Brébisson ex Kützing) H.L. Smith	3
92	*Bacillariophyceae*	*Amphora sp.* Ehrenberg ex Kützing, 1844	4
93	*Bacillariophyceae*	*Bacillariophyceae spp.* (forma konus)	5
94	*Bacillariophyceae*	*Campylodiscus sp.* C. G. Ehrenberg ex F. T. Kützing, 1844	6
95	*Bacillariophyceae*	*Cerataulina pelagica* (Cleve) Hendey, 1937 (syn. *C. bergonii* H.Perag.)	7
96	*Bacillariophyceae*	*Chaetoceros affinis* Lauder, 1864	8
97	*Bacillariophyceae*	*Chaetoceros anastomosans* Grunov, 1885	9
98	*Bacillariophyceae*	*Chaetoceros borgei* Lemmerman, 1904 (accepted in WoRMS is syn. *Chaetoceros muelleri* Lemmermann, 1898)	10
99	*Bacillariophyceae*	*Chaetoceros compressus* Lauder, 1864	11
100	*Bacillariophyceae*	*Chaetoceros curvisetus* P.T. Cleve, 1889	12
101	*Bacillariophyceae*	*Chaetoceros danicus* Cleve, 1889	13
102	*Bacillariophyceae*	*Chaetoceros densus* (Cleve) Cleve, 1899	14
103	*Bacillariophyceae*	*Chaetoceros insignis* Proscкina-Lavrenko, 1955	15
104	*Bacillariophyceae*	*Chaetoceros lorenzianusv.solitarius* Proshkina-Lavrenko, 1955	16
105	*Bacillariophyceae*	*Chaetoceros peruvianus* Brightwell, 1856	17
106	*Bacillariophyceae*	*Chaetoceros rigidus* Ostenfeld, 1901	18
107	*Bacillariophyceae*	*Chaetoceros scabrosus* Proscкina-Lavrenko	19
108	*Bacillariophyceae*	*Chaetoceros septentrionalis* Oestrup, 1895	20
109	*Bacillariophyceae*	*Chaetoceros similis* Cleve, 1896	21
110	*Bacillariophyceae*	*Chaetoceros simplex* Ostenfeld, 1901	22
111	*Bacillariophyceae*	*Chaetoceros socialis* H.S.Lauder, 1864	23
112	*Bacillariophyceae*	*Chaetoceros sp.* Ehrenberg, 1844	24
113	*Bacillariophyceae*	*Chaetoceros subtilis* Cleve, 1896	25
114	*Bacillariophyceae*	*Chaetoceros teres* Cleve, 1896	26
115	*Bacillariophyceae*	*Chaetoceros wighamii* Brightwell, 1856	27
116	*Bacillariophyceae*	*Cocconeis scutellum* Ehrenberg, 1838	28
117	*Bacillariophyceae*	*Coscinodiscus granii* Gough, 1905	29
118	*Bacillariophyceae*	*Coscinodiscus sp.* Ehrenberg, 1839	30
119	*Bacillariophyceae*	*Coscinosira oestrupii* Ostenfeld, 1900 (syn. *Thalassiosira oestrupii* (Ostenfeld) Hasle)	31
120	*Bacillariophyceae*	*Cyclotella caspia* Grunow, 1878	32
121	*Bacillariophyceae*	*Cyclotella meneghiniana* Kützing, 1844	33
122	*Bacillariophyceae*	*Dactyliosolen fragilissimus* (Bergon) Hasle in Hasle & Syvertsen, 1996 (syn. *Rhizosolenia fragilissima* Bergon, 1903)	34
123	*Bacillariophyceae*	*Detonula confervacea* (Cleve) Gran, 1900 (syn. *Detonula cystifera* Gran., 1900; *Lauderia confervacea* P.T. Cleve, 1896)	35
124	*Bacillariophyceae*	*Ditylum brightwellii* (T.West) Grunow, 1885	36
125	*Bacillariophyceae*	*Eunotia sp.* Ehrenberg, 1837	37
126	*Bacillariophyceae*	*Grammatophora marina* (Lyngbye) Kützing, 1844	38

Table 1 Continued

№	Taxon	Species	
127	*Bacillariophyceae*	*Halamphora coffeaeformis* (Agardh) Levkov, 2009 (Syn. *Amphora coffeaeformis* (C.Agardh) Kützing, 1844)	39
128	*Bacillariophyceae*	*Leptocylindrus danicus* P.T. Cleve, 1889	40
129	*Bacillariophyceae*	*Leptocylindrus minimus* Gran, 1915	41
130	*Bacillariophyceae*	*Licmophorasp.*C. Agardh, 1827	42
131	*Bacillariophyceae*	*Licmophora Ehrenbergii* (Kutz.)Grun., 1867	43
132	*Bacillariophyceae*	*Melosira moniliformis* (O.F.Müller) C.Agardh, 1824	44
133	*Bacillariophyceae*	*Navicula cancellata* Donkin, 1872	45
134	*Bacillariophyceae*	*Navicula sp.* Bory de Saint-Vincent, 1822	46
135	*Bacillariophyceae*	*Nitzschia closterium* (Ehrenberg) W. Smith, 1853	47
136	*Bacillariophyceae*	*Nitzschia closterium* (Ehrenberg) W. Smith, 1853 (syn. *Cylindrotheca closterium* (Ehrenberg) Reimann & J.C.Lewin)	48
137	*Bacillariophyceae*	*Nitzschia incerta* (Grunow) M.Peragallo, 1903 (Syn. *Nitzschia reversa* W.Smith, 1853; *Nitzschia lorenziana var. incerta* Grunow)	49
138	*Bacillariophyceae*	*Nitzschia longissima* (Brébisson) Ralfs, 1861	50
139	*Bacillariophyceae*	*Nitzschia sp.* Hassall, 1845	51
140	*Bacillariophyceae*	*Nitzschia tenuirostris* Mer., 1902	52
141	*Bacillariophyceae*	*Paralia sulcata* (Ehrenberg) P.T. Cleve, 1873 (Syn. *Melosira sulcata* (Ehrenberg) Kützing, 1844)	53
142	*Bacillariophyceae*	*Pleurosigma elongatum* W. Smith, 1852	54
143	*Bacillariophyceae*	*Pleurosigma sp.* W.Smith, 1852	55
144	*Bacillariophyceae*	*Proboscia alata* (Brightwell) Sundström, 1986 (syn. *Rhizosolenia alata* Brightwell, 1858)	56
145	*Bacillariophyceae*	*Pseudo-nitzschia delicatissima* (P.T. Cleve, 1897) Heiden, 1928 (syn. *Nitzschia delicatissima* Cleve, 1897)	57
146	*Bacillariophyceae*	*Pseudo-nitzschia seriata* (P.T. Cleve, 1883) H. Peragallo in H. & M. Peragallo, 1900 (syn. *Nitzschia seriata* P.T. Cleve, 1883)	58
147	*Bacillariophyceae*	*Pseudosolenia calcar-avis* (Schultze, 1858) Sundström, 1986 (syn. *Rhizosolenia calcar-avis* Schultze, 1858)	59
148	*Bacillariophyceae*	*Rhoicosphenia marina* (W. Sm.) M. Schmidt (Syn. *Rhoicosphenia curvata var. marina* Grun)	60
149	*Bacillariophyceae*	*Skeletonema costatum* (Greville) Cleve, 1873	61
150	*Bacillariophyceae*	*Skeletonema subsalsum* (Cleve-Euler) Bethge, 1928	62
151	*Bacillariophyceae*	*Surirella gemma* Ehrenberg, 1839 (syn. Accepted in WoRMS as *Petrodictyon gemma* (Ehrenberg) D.G. Mann in Round, Crawford & Mann, 1990)	63
152	*Bacillariophyceae*	*Synedra sp.* Ehrenberg, 1830	64
153	*Bacillariophyceae*	*Thalassionema nitzschioides* (Grunow) Mereschkowsky, 1902 (Syn. *Thalassionema nitzschioides* (Grunow, 1862) Van Heurck, 1896)	65
154	*Bacillariophyceae*	*Thalassiosira angulata* (W.Gregory) Hasle, 1978 (Syn. *Thalassiosira decipiens* (Grunow) E.G.Jørgensen, 1905)	66
155	*Bacillariophyceae*	*Thalassiosira anguste-lineata* (A.Schmidt) G.Fryxell & Hasle, 1977	67
156	*Bacillariophyceae*	*Thalassiosira antarctica* Comber, 1896 (Syn. Thalassiosira fallax Meunier, 1910)	68
157	*Bacillariophyceae*	*Thalassiosira antiqua* (Grunow) Cleve *var. septata* Pr.-Lavr., 1955(syn. Accepted in AlgaeBase as Thalassiosira oestrupii (Ostenfeld) Hasle 1972)	69
158	*Bacillariophyceae*	*Thalassiosira baltica* (Grunow) Ostenfeld, 1901	70
159	*Bacillariophyceae*	*Thalassiosira nana* Lohmann, 1908	71
160	*Bacillariophyceae*	*Thalassiosira parva* Proshkina-Lavrenko, 1955	72
161	*Bacillariophyceae*	*Thalassiosira rotula* Meunier, 1910	73
162	*Chlorophyceae*	*Ankistrodesmus longissimus* (Lemmermann) Wille	1
163	*Chlorophyceae*	*Ankistrodesmus sp.* Corda, 1838	2
164	*Chlorophyceae*	*Chlamydomonas sp.* Ehrenberg, 1833	3
165	*Chlorophyceae*	*Chlorophyceae sp.* Wille, 1884	4
166	*Chlorophyceae*	*Eudorina sp.* Ehrenberg ex Ralfs, 1832	5
167	*Chlorophyceae*	*Golenkinia radiata* Chodat, 1894	6
168	*Chlorophyceae*	*Hypnomonas sp.* Korshikov, 1926	7
169	*Chlorophyceae*	*Monoraphidium arcuatum* (Korshikov) Hindák, 1970 (Syn. *Ankistrodesmusarcuatus* Korshikov)	8

Table 1 Continued

№	Taxon	Species	
170	*Chlorophyceae*	*Monoraphidium convolutum* (Corda) Komárková-Legnerová, 1969 (Syn. *Ankistrodesmus convolutus* Corda, 1838)	9
171	*Chlorophyceae*	*Monoraphidium griffithii* (Berkeley) Komárková-Legnerová (syn. *Ankistrodesmus acicularis* (A. Braun) Korshikov, 1953)	10
172	*Chlorophyceae*	*Phacotus sp.* Perty, 1852	11
173	*Chlorophyceae*	*Platymonas sp.* G.S.West, 1916	12
174	*Chlorophyceae*	*Scenedesmus incrassatulus* Bohlin, 1897	13
175	*Chlorophyceae*	*Scenedesmus obliquus* (Turpin) Kützing, 1833 (Syn. Accepted in Algaebase is *Acutodesmus obliquus* (Turpin) Hegewald & Hanagata 2000)	14
176	*Chlorophyceae*	*Scenedesmus protuberans* F.E.Fritsch & M.F.Rich 1929 (Syn. Accepted in Algaebase is *Desmodesmus protuberans* (F.E.Fritsch & M.F.Rich) E.Hegewald 2000)	15
177	*Chlorophyceae*	*Scenedesmus quadricauda* (Turpin) Brébisson in Brébisson & Godey 1835 (Syn. Accepted in Algaebase is *Desmodesmus quadricaudatus* (Turpin) Hegewald)	16
178	*Chlorophyceae*	*Scenedesmus sp.* Meyen, 1829	17
179	*Chlorophyceae*	*Tetrastrum heteracanthum* (Nordstedt) Chodat 1895	18
180	*Chlorophyceae*	*Treubaria schmidlei* (Schröder) Fott & Kovácik, 1975 (Syn. *Treubaria varia* Tiffany & Ahlstrom, 1931)	19
181	*Chlorophyta incertae sedis*	*Poropila dubia* Schiller, 1925	1
182	*Chrysophyceae*	*Dinobryon balticum* (Schütt) Lemmermann, 1900 (Syn. *Dinobryon pellucidum* Levander, 1894)	1
183	*Chrysophyceae*	*Dinobryon sp.* Ehrenberg, 1834	2
184	*Craspedophyceae*	*Bicosta spinifera* (Throndsen) Leadbeater, 1978 (*Salpingoeca spinifera* Throndsen, 1970)	1
185	*Cryptophyceae*	*Chroomonas sp.* Hansgirg, 1885	1
186	*Cryptophyceae*	*Cryptomonas sp.* Ehrenberg, 1831	2
187	*Cryptophyceae*	*Leucocryptos marina* (Braarud) Butcher, 1967 (syn. *Bodo marina* Braarud, 1935; *Chilomonas marina* (Braarud, 1935) Halldal, 1953)	3
188	*Cryptophyceae*	*Microflagellates (small Flagellathes)*	4
189	*Cryptophyceae*	*Rhodomonas sp.* Karsten, 1898	5
190	*Cyanophyceae*	*Spirulina subsalsa* Oerstedt ex Gomont, 1892	1
191	*Cyanophyceae*	*Cyanophyceae sp.* Schaffner, 1909	2
192	*Cyanophyceae*	*Merismopedia elegans* A.Braun ex Kützing, 1849	3
193	*Cyanophyceae*	*Merismopedia sp.* Meyen, 1839	4
194	*Cyanophyceae*	*Oscillatoria sp.* Vaucher ex Gomont, 1892	5
195	*Cyanophyceae*	*Phormidium bulgaricum* (Komárek) Anagnostidis & Komárek 1988 (Syn. *Oscillatoria bulgarica* Komárek, 1956)	6
196	*Cyanophyceae*	*Phormidium sp.* Kutzing ex Gomont, 1892	7
197	*Dictyochophyceae*	*Apedinella radians* (Lohmann) Campbell, 1973 (Syn. *Apedinella spinifera* (Throndsen) Throndsen, 1971)	1
198	*Dictyochophyceae*	*Distephanus speculum* (Ehrenberg) Haeckel, 1887	2
199	*Euglenophyceae*	*Euglena sp.* Ehrenberg, 1830	1
200	*Euglenophyceae*	*Euglena viridis* (O.F.Muller) Ehrenberg, 1832	2
201	*Euglenophyceae*	*Eutreptia lanowii* Steuer, 1904	3
202	*Euglenophyceae*	*Eutreptia sp.* Perty, 1852	4
203	*Euglenophyceae*	*Eutreptia viridis* Perty, 1852	5
204	*Euglenophyceae*	*Eutreptiella gymnastica*	6
205	*Euglenophyceae*	*Eutreptiella sp.* A.da Cunha, 1914	7
206	*Euglenophyceae*	*Phacus longicauda* (Ehrenberg) Dujardin, 1841	8
207	*Euglenophyceae*	*Phacus sp.* Dujardin, 1841	9
208	*Prasinophyceae*	*Pachysphaera sp.* Ostenfeld, 1899	1
209	*Prasinophyceae*	*Pyramimonas sp.* Schmarda, 1849	2
210	*Prymnesiophyceae*	*Acanthoica quattrospina* Lohmann, 1903	1
211	*Prymnesiophyceae*	*Coccolithus sp.* E.H.L.Schwarz, 1894	2
212	*Prymnesiophyceae*	*Emiliania huxleyi* (Lohmann) Hay & Mohler, 1967	3

Table 1 Continued

№	Taxon	Species	
213	*Prymnesiophyceae*	*Phaeocystis globosa* Scherffel, 1899	4
214	*Prymnesiophyceae*	*Phaeocystis pouchetii* (M.P. Hariot, 1892) G. Lagerheim, 1896	5
215	*Prymnesiophyceae*	*Syracosphaera sp.* Lohmann, 1902	6
216	*Trebouxiophyceae*	*Dictyosphaerium chlorelloides* (Nauman) Komárek & Perman, 1978 (Syn. *Dictyosphaerium simplex* Korschikov)	1
217	*Trebouxiophyceae*	*Dictyosphaerium pulchellum* H.C.Wood, 1873	2
218	*Trebouxiophyceae*	*Oocystis sp.* Nägeli ex A.Braun, 1855	3
219	*Trebouxiophyceae*	*Trochiscia multispinosa* (Möbius) Lemmermann	4
220	*Trebouxiophyceae*	*Trochiscia sp.* Kützing, 1834	5
221	*Zygnematophyceae*	*Closterium sp.* Nitzsch ex Ralfs, 1848	1
222	*Zygnematophyceae*	*Mesotaenium sp.* Nägeli, 1849	2

Conclusions

In 2008–2010, phytoplankton taxonomic structure in the coastal waters was made up of 204 species and forms of microalgae distributed into 14 classes. The largest share belonged to classes *Dinophyceae* (40.20%) and *Bacillariophyceae* (31.86%). The remaining microalgae were distributed into the other 27.94%.

The change in dominance between peridineas and diatoms during the hydro-biological seasons demonstrated well-defined cyclic recurrence. That indicated a predominant impact of the natural processes over the anthropogenic ones.

For the period 2008-2010 the range of dominance of class *Dinophyceae* was within the limits of 30.88 ÷ 60.23%, and for class *Bacillariophyceae* between12.68 ÷ 39.71%. The highest species diversity of phytoplankton was registered at the end of the seasonal succession cycles.

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