

Biodiversity of phytoplankton in Duyen Hai town, Tra Vinh province

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Abstract

This study was conducted to enhance the understanding of phytoplankton diversity of Duyen Hai town, Tra Vinh province. We selected 12 representative sampling sites and investigated phytoplankton diversity in both dry and rainy seasons. The phytoplankton of this area were comprised of 134 species, belonging to 64 genera, 45 families, 31 orders, 8 classes and 5 divisions. Among those divisions, Bacillariophyta was the most dominant in species, accounting for 70% of the total number of species and Cyanobacteria commonly had high density at 12 surveyed sites. The average density of phytoplankton was 1,195 cells/l in the rainy season and 2,020 cells/l in the dry season, respectively. For water bodies with the exchange of freshwater and marine water, the diversity is typically higher than in water bodies with purely freshwater or marine conditions.

Keywords: Aquatic ecology, biodiversity, diatoms, phytoplankton, Tra Vinh.

INTRODUCTION

Duyen Hai town is located in the southeast of Tra Vinh province. It is bounded in the east and the south by the East Sea, in the west by Duyen Hai district, and in the north by Cau Ngang district. Duyen Hai aquatic system is influenced by the semi-diurnal tide (two high and two low tides each day), with the regime of high tidal amplitude and strong current. The systems of Thau Rau, Ba Dong, Long Toan rivers, and Tat channel control the entire network of rivers and distribute water throughout the town. In addition, there is a network of rivers, canals, and irrigation channels that distribute water sources to inland and aquaculture development areas.

Due to the characteristics of the region with dense river systems, the water resources of Duyen Hai town are plentiful and diverse. It is a favorable condition for the presence, living and diversification of aquatic species in the region. The appearance of phytoplankton is typically closely related to the ecological and environmental conditions, these species are production organisms in some food webs, capable of expediting material transition in the aquatic system and may be an indicator for water quality [1–4].

The studies of coastal phytoplankton for Vietnam started in 1926 since Maurice Rose reported 20 species of diatoms for the Nha Trang bay [5]. In 1966, Shirota described 213 species of diatoms along coastline from Thuan An (Thua Thien-Hue province) to Phu Quoc (Kien Giang province) [5]. In 1993, Truong Ngoc An described 244 species in the book “Taxonomy of Bacillariophyta plankton in marine water of Vietnam” [5]. Recently, some of the researches on coastal phytoplankton at local scale have contributed to the understanding of diversity of phytoplankton in Vietnam. At the Central coast Pham Thi My Hanh (2013) reported 144 species [6], at the West-Sea zone of Ca Mau peninsular Luong Van Thanh (2008) reported 216 species [7], and in the coastal areas from Soc Trang to Bac Lieu Mai Viet Van et al., (2012) reported 232 species [8]. Among these studies, diatom was the most abundant group of the species list.

So far, the studies on the diversity of phytoplankton in the coastal area of Tra Vinh

province have not been carried out yet. This research aims to explore phytoplankton diversity in Duyen Hai town for further works on the conservation, rational use, and sustainable development.

MATERIALS AND METHODS

Study area

This study selected 12 locations representative of the whole coastal zone and inland area of the Duyen Hai town, Tra Vinh province. Phytoplankton samples were collected during the rainy (July) and dry (December) seasons in 2017. The sampling sites are shown in figure 1 below.

Sample collection

Phytoplankton samples were taken by the method of Edward and David (2010) [9]. Qualitative samples of phytoplankton were collected from the surface waters by towing a plankton net (with a mesh size of 25 μm , mouth diameter of 40 cm, repeating 3–5 times/sample, and speed at 0.3 m/s). Quantitative samples of phytoplankton were collected by filtering 40 liters of water through the plankton net. The collected samples were stored in plastic jars with a volume of 250 ml and fixed with 5% formalin at the field.

Data analysis

Olympus BX51 optical microscope at 100–400X magnification was used to identify phytoplankton according to the morphological method based on the classification books such as Desikachary (1959) [10]; Hendeby (1964) [11]; Shirota (1966) [12]; Truong Ngoc An (1993) [5]; Duong Duc Tien and Vo Hanh (1997) [13]; Ton That Phap (2009) [14]. Quantitative samples were allowed to settle for 24 hours in the laboratory and then concentrated to 20 ml/sample. Phytoplankton density was counted in 1 ml in the Sedgewick-Rafter counting chamber by the method of Edward and David (2010) [9] and then converted to the number of cells in 1 liter. The phytoplankton taxa are searched and sorted according to AlgaeBase’s taxonomy system [15].

The samples of phytoplankton were analyzed at the laboratory of the Institute of Tropical Biology.

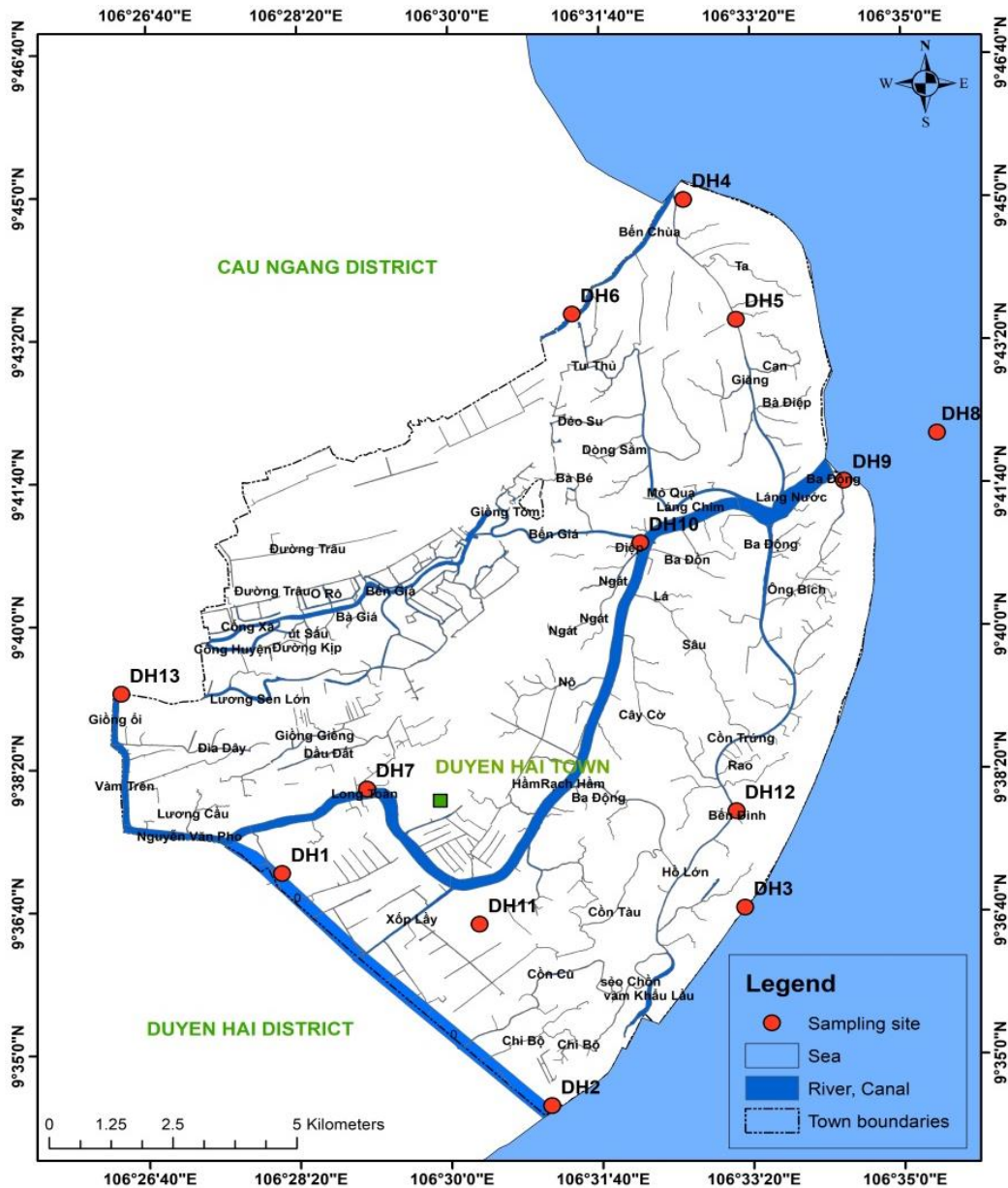


Figure 1. The map of sampling sites in Duyen Hai town, Tra Vinh province

RESULTS

Phytoplankton community structure

134 species of phytoplankton flora of Duyen Hai town, Tra Vinh province were recorded, which belong to 64 genera, 45 families, 31 orders, 8 classes, and 5 divisions, namely Cyanophyta, Bacillariophyta, Chlorophyta, Euglenophyta, and Dinophyta. Among those divisions, Bacillariophyta had the most diverse species composition with 98

species, occupying 73.1%; followed by Cyanophyta with 21 species, occupying 15.7%; Dinophyta with 8 species, occupying 6.0% and Chlorophyta with 5 species, occupying 3.7%; and the lowest species composition belonged to Euglenophyta with 2 species, occupying 1.5% (table 1, figure 2).

This phytoplankton flora is comprised of many species which are typical of the phytoplankton communities of the coastal

and estuarine regions. The *Biddulphia*, *Coscinodiscus*, *Chaetoceros*, *Ditylum*, *Gyrosigma*, *Nitzschia*, *Pleurosigma*, *Rhizosolenia*, and *Skeletonema* are representative genera in these groups. However, some of the species from freshwater were recorded as well, such as

Anabaena, *Microcystis*, *Oscillatoria*, *Pediastrum simplex*, *Scenedesmus quadricauda*, *Oedogonium* sp., and *Spirogyra ionia* (table 2). This proves that the aquatic environment in the study area was mainly co-affected by seawater via the tide and a part of freshwater from inland region.

Table 1. Structure of phytoplankton species composition in Duyen Hai town, Tra Vinh province

No.	Phylum	Class	Order	Family	Genus	Species	Ratio %
1	Cyanophyta	1	3	5	11	21	15,7
2	Bacillariophyta	3	20	30	42	98	73,1
3	Chlorophyta	2	4	5	5	5	3,7
4	Euglenophyta	1	1	1	2	2	1,5
5	Dinophyta	1	3	4	4	8	6,0
	Total	8	31	45	64	134	100

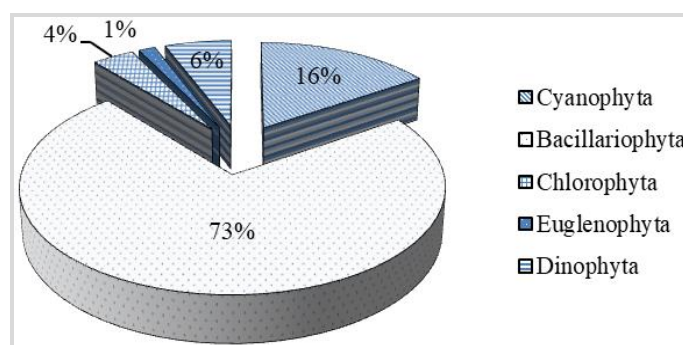


Figure 2. Composition structure of phytoplankton

Table 2. List of phytoplankton species from Duyen Hai town, Tra Vinh province

Taxon	Taxon
Phylum Cyanophyta	74. <i>Asteromphalus flabellatus</i> (Brébisson) Greville, 1859
Class Cyanophyceae	Order Thalassiosirales
Order Chroococcales	Family Skeletonemataceae
Family Microcystaceae	75. <i>Skeletonema costatum</i> (Greville) Cleve, 1873
1. <i>Microcystis aeruginosa</i> (Kützing) Kützing, 1846	Family Stephanodisceaceae
2. <i>Microcystis panniformis</i> Komárek, Komárková-Legnerová, Sant'Anna, M. T. P. Azevedo, & P. A. C. Senna, 2002	76. <i>Cyclotella comta</i> (Ehrenberg) Kützing, 1849
Order Oscillatoriales	77. <i>Cyclotella meneghiniana</i> Kützing, 1844
Family Pseudanabaenaceae	Ho Lauderiaceae
3. <i>Jaaginema</i> sp.	78. <i>Lauderia borealis</i> Gran, 1900
Family Phormidiaceae	Order Biddulphiales
4. <i>Arthrospira</i> sp.	Family Biddulphiaceae
5. <i>Phormidium tenue</i> Gomont, 1892	79. <i>Biddulphia aurita</i> (Lyngbye) Brébisson, 1838
6. <i>Planktothrix agardhii</i> Anagnostidis & Komárek, 1988	80. <i>Biddulphia mobiliensis</i> (J. W. Bailey) Grunow, 1882
Family Oscillatoriaceae	81. <i>Biddulphia regia</i> (Schultze) Ostenfeld, 1908
7. <i>Lyngbya majuscula</i> Harvey ex Gomont, 1892	82. <i>Biddulphia sinensis</i> Greville, 1866
8. <i>Lyngbya martensiana</i> Menegh. ex Gomont, 1892	83. <i>Hydrosera triquetra</i> G. C. Wallich
9. <i>Lyngbya</i> sp.	Order Triceratiales
10. <i>Oscillatoria acuta</i> Bruhl et Biswas, 1932	Family Triceratiaceae
11. <i>Oscillatoria curviceps</i> C. Agardh ex Gomont, 1892	84. <i>Triceratium favus</i> Ehrenberg, 1839

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| 12. <i>Oscillatoria limosa</i> C. Agardh ex Gomont, 1892 | Order Hemiaulales |
| 13. <i>Oscillatoria princeps</i> Vaucher ex Gamont, 1892 | Family Hemiaulaceae |
| 14. <i>Oscillatoria perornata</i> Skuja, 1949 | 85. <i>Hemiaulus membranaceus</i> Cleve, 1873 |
| 15. <i>Oscillatoria proboscidea</i> Gomont, 1892 | 86. <i>Hemiaulus sinensis</i> Greville, 1865 |
| 16. <i>Oscillatoria tenuis</i> Agardh, 1813 | 87. <i>Cerataulina pelagica</i> (Cleve) Hendey, 1937 |
| 17. <i>Oscillatoria</i> sp. | 88. <i>Climacodium biconcavum</i> Cleve, 1897 |
| 18. <i>Trichodesmium erythraeum</i> Ehrenberg ex Gomont, 1892 | Family Bellerocheaceae |
| Order Nostocales | 89. <i>Bellerochea horologicalis</i> Stosch, 1980 |
| Family Nostocaceae | 90. <i>Bellerochea indica</i> Karsten, 1907 |
| 19. <i>Anabaena</i> sp. | Family Streptothecaceae |
| 20. <i>Anabaenopsis circularis</i> Woloszynska & V. Miller, 1923 | 91. <i>Streptotheca thamesis</i> Shrubsole, 1891 |
| 21. <i>Aphanizomenon aphanizomenoides</i> (Forti) Horecká et Komárek, 1979 | Family Lithodesmiales |
| Phylum Bacillariophyta | Family Lithodesmiaceae |
| Class Bacillariophyceae | 92. <i>Ditylum brightwellii</i> (T. West) Grunow, 1885 |
| Order Achnanthes | 93. <i>Ditylum sol</i> (Grunow) De Toni, 1894 |
| Family Achnanthes | Order Chaetocerotales |
| 22. <i>Achnanthes brevipes</i> C. Agardh, 1824 | Family Chaetocerotaceae |
| Family Cocconeidaceae | 94. <i>Bacteriastrum hyalinum</i> Lauder, 1864 |
| 23. <i>Coccinella</i> sp. | 95. <i>Chaetoceros aequatorialis</i> Cleve, 1901 |
| Order Thalassiosiphysales | 96. <i>Chaetoceros affinis</i> Lauder, 1864 |
| Family Catenulaceae | 97. <i>Chaetoceros curvisetus</i> Cleve, 1889 |
| 24. <i>Amphora</i> sp. | 98. <i>Chaetoceros decipiens</i> Cleve, 1873 |
| Order Naviculales | 99. <i>Chaetoceros indicus</i> Karsten, 1907 |
| Family Naviculaceae | 100. <i>Chaetoceros lauderi</i> Ralfs ex Lauder, 1864 |
| 25. <i>Navicula membranacea</i> Cleve, 1897 | 101. <i>Chaetoceros lorenzianus</i> Grunow, 1863 |
| 26. <i>Navicula</i> sp. | 102. <i>Chaetoceros subtilis</i> Cleve, 1896 |
| 27. <i>Trachyneis aspera</i> (Ehrenberg) Cleve, 1894 | Order Rhizosoleniales |
| 28. <i>Trachyneis debyi</i> (Leuduger-Fortmorel) Cleve, 1894 | Family Rhizosoleniaceae |
| Family Pinnulariaceae | 103. <i>Guinardia flaccida</i> (Castracane) H. Peragallo, 1892 |
| 29. <i>Pinnularia major</i> (Kützing) Rabenhorst, 1853 | 104. <i>Dactyliosolen mediterraneus</i> H. Peragallo, 1892 |
| Family Pleurosigmaaceae | 105. <i>Rhizosolenia alata</i> f. <i>genuina</i> Gran, 1908 |
| 30. <i>Gyrosigma acuminatum</i> (Kützing) Rabenhorst, 1853 | 106. <i>Rhizosolenia alata</i> f. <i>indica</i> (H. Peragallo) Gran, 1905 |
| 31. <i>Gyrosigma attenuatum</i> (Kützing) Rabenhorst, 1853 | 107. <i>Rhizosolenia bergonii</i> H. Peragallo, 1892 |
| 32. <i>Gyrosigma balticum</i> (Ehrenberg) Rabenhorst, 1853 | 108. <i>Rhizosolenia calcar-avis</i> Schultze, 1858 |
| 33. <i>Gyrosigma scalproides</i> (Rabenhorst) Cleve 1894 | 109. <i>Rhizosolenia crassispina</i> J. L. B. Schröder, 1906 |
| 34. <i>Gyrosigma</i> sp. | 110. <i>Rhizosolenia imbricata</i> Brightwell, 1858 |
| 35. <i>Gyrosigma sinense</i> (Ehrenberg) Desikachary, 1988 | 111. <i>Rhizosolenia imbricata</i> var. <i>shrubsolei</i> Schröder, 1906 |
| 36. <i>Gyrosigma wormleyi</i> (Sullivant) Boyer, 1922 | 112. <i>Rhizosolenia robusta</i> G. Norman ex Ralfs, 1861 |
| 37. <i>Pleurosigma angulatum</i> (Queckett) W. Smith, 1852 | 113. <i>Rhizosolenia setigera</i> Brightwell, 1858 |
| 38. <i>Pleurosigma elongatum</i> W. Smith, 1852 | 114. <i>Rhizosolenia styliformis</i> T. Brightwell, 1858 |
| 39. <i>Pleurosigma naviculaceum</i> Brébisson, 1854 | Class Fragilariophyceae |
| 40. <i>Pleurosigma strigosum</i> W. Smith, 1852 | Order Climacospheniales |
| Order Bacillariales | Family Climacospheniaceae |
| Family Bacillariaceae | 115. <i>Climacosphenia moniligera</i> Ehrenberg, 1843 |
| 41. <i>Cylindrotheca closterium</i> Reimann & J. C. Lewin, 1964 | Order Thalassionematales |
| 42. <i>Nitzschia closterium</i> (Ehrenberg) W. Smith, 1853 | Family Thalassionemataceae |
| 43. <i>Nitzschia lorenziana</i> Grunow, 1880 | 116. <i>Lioloma pacificum</i> (Cupp) Hasle, 1996 |
| 44. <i>Nitzschia paradoxa</i> (J. F. Gmelin) Grunow, 1880 | 117. <i>Thalassionema nitzschioides</i> Mereschkowsky, 1902 |
| 45. <i>Nitzschia palea</i> (Kützing) W. Smith, 1856 | 118. <i>Thalassionema frauenfeldii</i> Hallegraeff, 1986 |
| 46. <i>Nitzschia plana</i> W. Smith, 1853 | Order Fragilariales |
| 47. <i>Nitzschia sigma</i> (Kützing) W. Smith, 1853 | Family Fragilariaceae |
| 48. <i>Pseudo-nitzschia seriata</i> (Cleve) H. Peragallo, 1899 | 119. <i>Synedra ulna</i> (Nitzsch) Ehrenberg, 1832 |
| Family Surirellaceae | Phylum Chlorophyta |
| 49. <i>Campylodiscus daemelianus</i> Grunow, 1874 | Class Chlorophyceae |
| 50. <i>Campylodiscus echeneis</i> Ehrenberg ex Kützing, 1844 | Order Chlorococcales |
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51. <i>Surirella fastuosa</i> (Ehrenberg) Ehrenberg, 1843	Family Hydrodictyaceae
52. <i>Surirella gemma</i> Ehrenberg, 1839	120. <i>Pediastrum simplex</i> Meyen, 1829
53. <i>Surirella ovata</i> Kützing, 1844	Family Scenedesmaceae
54. <i>Surirella ovalis</i> Brébisson, 1838	121. <i>Scenedesmus quadricauda</i> (Turpin) Brébisson, 1835
55. <i>Surirella robusta</i> Ehrenberg, 1840	Order Oedogoniales
Order Cymbellales	Family Oedogoniaceae
Family Cymbellaceae	122. <i>Oedogonium</i> sp.
56. <i>Cymbella lanceolata</i> (C. Agardh) Kirchner, 1878	Order Volvocales
57. <i>Cymbella tumida</i> (Brébisson) van Heurck, 1880	Family Volvocaceae
Order Plagiogrammales	123. <i>Volvox aureus</i> Ehrenberg, 1832
Family Plagiogrammaeae	Class Zygnematophyceae
58. <i>Plagiogramma vanheurckii</i> Grunow, 1881	Order Zygnematales
Class Coscinodiscophyceae	Family Zygnemataceae
Order Coscinodisciales	124. <i>Spirogyra ionia</i> Wade, 1949
Family Coscinodiscaceae	Phylum Euglenophyta
59. <i>Coscinodiscus asteromphalus</i> Ehrenberg, 1844	Class Euglenophyceae
60. <i>Coscinodiscus concinnus</i> W.Smith, 1856	Order Euglenales
61. <i>Coscinodiscus gigas</i> Ehrenberg, 1841	Family Euglenaceae
62. <i>Coscinodiscus jonesianus</i> (Greville) Ostenfeld, 1915	125. <i>Euglena acus</i> Ehrenberg, 1830
63. <i>Coscinodiscus bipartitus</i> Rattray, 1890	126. <i>Trachelomonas hispida</i> (Perty) F.Stein, 1878
64. <i>Coscinodiscus radiatus</i> Ehrenberg, 1841	Phylum Dinophyta
65. <i>Coscinodiscus rothii</i> (Ehrenberg) Grunow, 1878	Class Dinophyceae
66. <i>Coscinodiscus subtilis</i> Ehrenberg, 1841	Order Gonyaulales
67. <i>Coscinodiscus</i> sp.	Family Ceratiaceae
Family Heliopeltaceae	127. <i>Ceratium furca</i> Claparède & Lachmann, 1859
68. <i>Actinoptychus undulatus</i> (Kützing) Ralfs, 1861	128. <i>Ceratium fusus</i> (Ehrenberg) Dujardin, 1841
Family Hemiaulaceae	129. <i>Ceratium macroceros</i> (Ehrenberg) Vanhöffen, 1897
69. <i>Hemidiscus hardmannianus</i> (Greville) Kuntze, 1898	130. <i>Ceratium vultur</i> Cleve, 1900
Order Melosirales	Order Peridinales
Family Melosiraceae	Family Kolkwitzellaceae
70. <i>Melosira granulata</i> (Ehrenberg) Ralfs, 1861	131. <i>Diplopsalis lenticula</i> Bergh, 1882
71. <i>Melosira moniliformis</i> (O. F. Müller) C. Agardh, 1824	Family Protoperidiniaceae
72. <i>Melosira nummuloides</i> C. Agardh, 1824	132. <i>Protoperidinium divergens</i> (Ehrenberg) Balech, 1974
Order Paraliales	133. <i>Protoperidinium subinerme</i> (Paulsen) Loeblich III, 1969
Family Paraliaceae	Order Thoracosphaerales
73. <i>Paralia sulcata</i> (Ehrenberg) Cleve, 1873	Family Thoracosphaeraceae
Family Asterolampraceae	134. <i>Goniodoma sphaericum</i> Murray & Whitting, 1899

Phytoplankton densities and dominant species

The density and dominant species of phytoplankton in Duyen Hai town have shown a difference between seasons and locations.

In the rainy season, the density of phytoplankton between locations had a significant difference, ranging from 129 to 3,830 cells/l, with the maximum at the station DH08 and the minimum at the station DH11. The filamentous blue-green algae such as *Oscillatoria perornata*, *O. princeps*, *O. proboscidea*, and *Lyngbya* sp. grew well. These species dominated at ten of twelve sampling sites, at each station these species occupied from 35.3% to 77.2% of the total cells. Particularly, at two sampling sites of DH10 and

DH11, diatom species like *Coscinodiscus jonesianus* and *Melosira granulata* were dominant, occupying 24.8% and 54.3% of the total cells, respectively (table 3).

In the dry season, phytoplankton density was somewhat higher than in the rainy season, the cell number of phytoplankton ranged from 66–10,636 cells/l, with the highest at the station DH03 and the lowest at the station DH07. The dominant species in dry season were *Oscillatoria princeps*, *Lyngbya majuscula*, *Lyngbya* sp. belonging to blue-green algae which occupied from 19.4% to 93.9% of the total cells, except for two sampling sites of DH07 and DH09, the diatom *Skeletonema costatum* dominated, occupying 45.5% and 52.9% of the total cells, respectively (table 3).

Table 3. Density and dominant species of phytoplankton from Duyen Hai town, Tra Vinh province

Sampling sites	Dominant species	Total density (cells/l)	Density of dominant species (cells/l)	Ratio of dominant species (%)
Rainy season				
DH01	<i>Oscillatoria perornata</i>	2,225	814	36.6
DH02	<i>Oscillatoria princeps</i>	1,932	1,000	51.8
DH03	<i>Lyngbya</i> sp.	756	200	26.5
DH04	<i>Oscillatoria proboscidea</i>	486	375	77.2
DH05	<i>Lyngbya</i> sp.	2,590	1,214	46.9
DH06	<i>Lyngbya</i> sp.	279	200	71.7
DH07	<i>Lyngbya</i> sp.	177	86	48.6
DH08	<i>Oscillatoria perornata</i>	3,830	1,351	35.3
DH09	<i>Oscillatoria princeps</i>	342	150	43.9
DH10	<i>Coscinodiscus jonesianus</i>	137	34	24.8
DH11	<i>Melosira granulata</i>	129	70	54.3
DH12	<i>Oscillatoria princeps</i>	1,452	520	35.8
Dry season				
DH01	<i>Lyngbya majuscula</i>	693	200	28.9
DH02	<i>Oscillatoria princeps</i>	145	70	48.3
DH03	<i>Oscillatoria princeps</i>	10,636	5,720	53.8
DH04	<i>Lyngbya majuscula</i>	2,058	400	19.4
DH05	<i>Oscillatoria princeps</i>	4,873	1,764	36.2
DH06	<i>Lyngbya</i> sp.	391	367	93.9
DH07	<i>Skeletonema costatum</i>	66	30	45.5
DH08	<i>Oscillatoria princeps</i>	1,284	420	32.7
DH09	<i>Skeletonema costatum</i>	820	434	52.9
DH10	<i>Oscillatoria princeps</i>	204	166	81.4
DH11	<i>Oscillatoria princeps</i>	2,719	1,280	47.1
DH12	<i>Oscillatoria princeps</i>	353	220	62.3

DISCUSSION

In Vietnam, several studies on phytoplankton in some areas, which have environmental characteristic similarity to Duyen Hai, Tra Vinh province, have been conducted so far. In 2008, Luong Van Thanh [7] reported 16 species of phytoplankton belonging to seven algal divisions (Cyanophyta, Chrysophyta, Xanthophyta, Bacillariophyta, Chlorophyta, Euglenophyta, Dinophyta) in the estuaries of West-Sea zone of Ca Mau peninsula; in this research, Bacillariophyta was dominant with 53.7% of the total number of species. With similar environment condition in the coastal areas from Soc Trang to Bac Lieu province, the research of Mai Viet Van et al., (2012) [8] reported 232 algal species belonging to only four divisions (Bacillariophyta, Dinophyta, Cyanophyta, and Chlorophyta), however, Bacillariophyta randomly occupied 74.57% of the total number of species. In the other study, Pham Thi Minh Hanh (2013) [6] recorded 144 species

belonging to three divisions (Bacillariophyta, Dinophyta, and Cyanophyta), and confirmed that the Bacillariophyta was the dominant group in species number at the Central coastal region of Vietnam (Deo Ngang, Dong Hoi, Con Co, Thuan An, Da Nang, Dung Quat, Sa Huynh, Quy Nhon). The result of Huynh Thi Ngoc Duyen et al., (2018) [16] shown 238 species belonging to four divisions (Bacillariophyta, Dinophyta, Ochrophyta, and Cyanophyta) in the coastal waters of Ninh Thuan - Binh Thuan and Bacillariophyta played the main role in the structure of species composition. In comparison to the above researches, the phytoplankton flora of Duyen Hai town does not reflect diversity in species but show higher diversity in the division. Similar to other research, this research again confirms that Bacillariophyta plays the leading role in the structure of phytoplankton composition at the estuary and coastal waters.

The diversity of phytoplankton in the coastal area of Duyen Hai town has been

clearly shown at the diatom group. Among 98 species of diatom recorded for this area, many of them have been reported in a single genus. The number of species in the diatom genera was ordered as follows: *Rhizosolenia* (10 species) > *Coscinodiscus* (9 species) > *Chaetoceros* (8 species) > *Gyrosigma* (7 species) > *Nitzschia* (6 species) > *Surirella* (5 species) > *Biddulphia*, *Pleurosigma* (4 species). Only *Oscillatoria* genus of the blue-green algae group was recorded with eight species and only *Ceratium* genus of dinoflagellate group was recorded with four species. The other genera appeared with only 1 or 2 species. Phytoplankton are the primary producer in the aquatic food chain and play a significant role in the aquatic ecosystem. The density of phytoplankton in both rainy and dry seasons in Duyen Hai town ranged from 1,000 to 2,000 cells/l, this density is settled at medium level but contributes an important role in connecting the food web in this area.

CONCLUSION

134 species of phytoplankton flora in the coastal region of Duyen Hai town, Tra Vinh province were recorded, belonging to 64 genera, 45 families, 31 orders, 8 classes, and 8 divisions. The number of species in the flora list was arranged as follows: Bacillariophyta > Cyanophyta > Dinophyta > Chlorophyta > Euglenophyta. The species composition of phytoplankton was characteristic of the estuarine and coastal areas, however, there were some freshwater species that were widely environmentally distributed. These phytoplankton species are a primary food source for aquatic organisms. Bacillariophyta was dominant in the number of species and Cyanophyta was dominant in cell density. Moreover, the blue-green algae group (*Oscillatoria perornata*, *O. princeps*, *O. proboscides*, and *Lyngbya* sp.) and diatom group (*Coscinodiscus jonesianus*, *Melosira granulate*) were dominant at sampling sites in the rainy season. In dry season, species of *O. princeps*, *Lyngbya majuscula*, *Lyngbya* sp. (blue-green algae), and *Skeletonema costatum* (diatom) were dominant at sampling sites.

This research contributes to the understanding of species composition and density of phytoplankton in the coastal area of Duyen Hai town, Tra Vinh province. Further research on the management and conservation of aquatic ecosystem for sustainable development in this area needs to be conducted.

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