Study on Microscopic Algae in the Iranian waters of the Caspian Sea during 2010-2011

Fatemeh Sadat Tahami[1,*], Aboulghasem Roohi[1], Alireza Keihan Sani[1], and Mojgan Rowshan Tabari[1]

[1]Caspian Sea Ecological Institute, Iranian Fisheries Science Research Organization, Sari, Iran

Received: 2017-06-03 *Accepted: 2017-09-09*

Abstract

Ongoing study of the Caspian Sea ecology is necessary, particularly identifying the distribution of species, density of biomass, and regional variations in Microscopic Algae. Due to various physical and chemical factors of rivers ended to the sea, and different topography, the initial productions in different seasons are different. The study was conducted during 2010-2011 through spring, summer, autumn and winter, in 32 stations from 8 transects (Astara, Anzali, Sefidrood, Tonekabon, Noshahr, Babolsar and BandarTurkman). In each transect 5 stations in different depths of 5 m, 10 m, 20 m, 50 m and 100 m were defined that the seasonal sampling were performed from the depth of zero (surface), 10 m, 20 m, 50 m and 100 m by Ruttner Water Sampler. Based on the results, 7 branches of Bacillariophyta, Pyrrophyta, Cyanophyta, Chlorophyta, Euglenophyta, Xantophyta, and Chrysophyta and 137 Microscopic Algae species were identified. Among them, 72 species belonged to the Bacillariophyta, 21 species to the Pyrrophyta, 20 species to Cyanophyta, 15 species to Chlorophyta, 7 species of Euglenophyta, 1 species of Chrysophyta, and 1 species of the Xantophyta. The dominant branches of Microscopic Algae were Pyrrophyta, Cyanophyta, and Bacillariophyta, and Shannon index was different for the seasons.

Keywords: Microscopic Algae; Caspian Sea; Ecology; Seasonal Diversity; Shannon Index.

1. Introduction

The southern Caspian Sea adjacent to the three provinces of Iran; Golestan, Mazandaran, and Gilan, is located in the northern part of the Alborz Mountains. The rivers such as Sefidrood, Gorganrood, Tajan, Haraz, Shirood, Sarabrood, Talar, Babolroodare ended in this sea. Since Microscopic Algae is the base of production in aquatic ecosystems, continuous ecological study of Caspian Sea is necessary, especially in species identification, biomass density, regional

* Corresponding Author: farnaz_tahami@yahoo.com

alternation, and various factors effect on this ecosystem. The Microscopic Algae flora of the Caspian Sea is divided into three groups of marine, salty and freshwater species that the salty group being the largest group includes of most Microscopic Algae species. Most of the freshwater species are in the northern Caspian Sea, and marine and salty species gradually increase with salinity rising from the north toward the middle and south of Caspian Sea (Plotnikov *et al.,* 2006).The different conditions of the Caspian Sea and the existence of diverse biological conditions provide the conditions for the growth of different species of Microscopic Algae. Different conditions of the Caspian Sea and the existence of biological diversity provide suitable environment for the growth of different species of Microscopic Algae (Salmanov, 1987). Nowadays, there are many problems in the Caspian Sea as ecological threats for its sensitive and vulnerable ecosystem. In fact, population growth in the cities adjacent to the Caspian Sea, increasing the entry of various types of wastewater (industrial, agricultural and urban), the expansion of oil extraction and connection of the Caspian Sea with open water through the Volga Canal have created many problems (Shams and Afsharzadeh, 2008). So, at the end of the 20th century, with increasing water temperature, entering Eutrophication, and the excessive nutrients into the Caspian Sea, can be mentioned (WHO, 1999).Hydrological and hydro-biological studies in aquatic environments in Iran and the world have a relatively long history, and planktonic study is part of these studies (Fallahi, 1999). In the studies in the hydrological and hydrobiological project in the south of Caspian Sea, during 1991-1996, five species of Microscopic Algae including Bacillariophyta, Euglenophyta, and Chlorophyta were observed. Ganjian *et al.* (2008a) identified 163 species of Microscopic Algae from 5 branches that the most diversity of 43% and the concentration of 47% were assigned to the Bacillariophyta species. Investigation on Microscopic Algae in the southern basin of Caspian Sea during 1994-2008 identified 334 species in 6 types of Microscopic Algae which the Bacillariophyta was predominant (Fazli and Ganjian, 2009).

A study in 2012 showed that the Bacillariophyta had the most abundance of 51.5% with the amount of 14390833.33±2023487.35. These values were different in different seasons (Gol Aghaei *et al.,* 2012). Considering the fact that Microscopic Algae plays an important role in the productivity and the conditions in the southern Caspian Sea basin, this research investigates the identification of different species of Microscopic Algae and their temporal and spatial variations in the area.

2. Material and methods

This study was conducted in the southern Caspian Sea basin, which the sampling at different stations and depths was performed for one year and by the Gilan research vessel in spring, summer, autumn and winter, 2010, and with Rottner sampler (maximum volume of 2 liters).Sampling areas were selected at the 8 transects between Astara and Hasangholi border. Transects were located in Astara, Bandar Anzali, Sefidrood entrance, Tonekabon, Noshahr, Babolsar, Amir Abad port, Bandar Turkman where are on the southern coast of the Caspian Sea (Figure 1).

In each transect, 5 stations at the depths of 5 m, 10 m, 20 m, 50 m and 100 m were considered and the sampling was conducted by a research

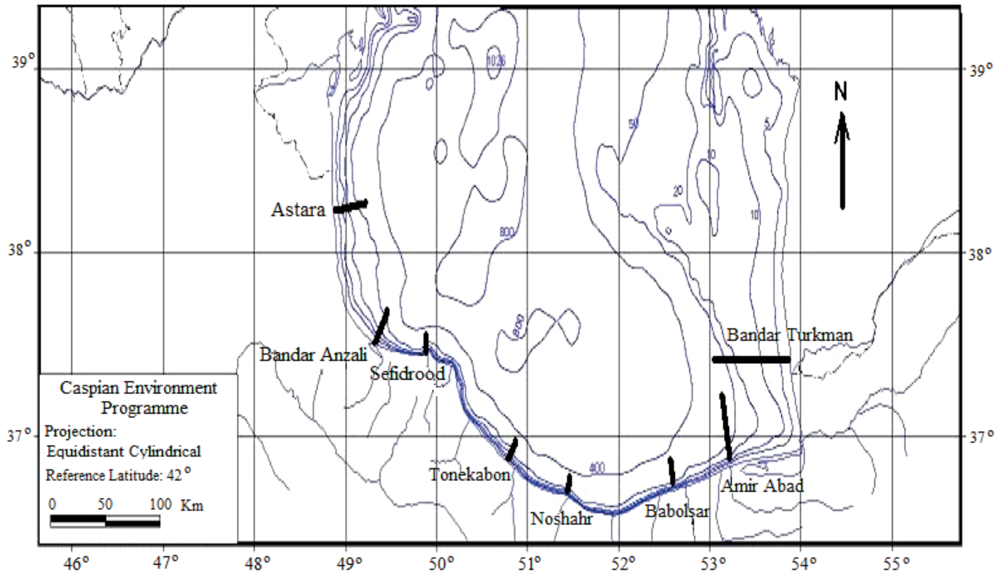

Figure 1. Microscopic Algae sampling stations in the southern basin of Caspian Sea, 2010

ship, Guilan. Laboratory work was performed according to the APHA method (2005). In this method, the samples are updated in the darkness to be completely precipitated. Then, drain it with a special siphon, and the remaining sample is centrifuged at a speed of 3,000 rpm for several minutes to reach a volume of 20-25 ml.

In the laboratory, the samples were investigated and counted in two qualitative steps and one quantitative step by the slabs and lamellas of 24×24mm, and a microscope with magnification of 10X, 20X, and 40X (WHO, 1999; Laloei *et al.,* 2002).The physicochemical factors were sampled during Microscopic Algae factor sampling by the chemistry laboratory of the Caspian Sea Ecology Research Center and then analyzed. Calculations of mean and standard deviations and preparation of their figures were performed by Excel 2007 software. Frequency data and the Microscopic Algae biomass showed a normal distribution. Comparisons of the mean data were performed by multiple analysis of variance (ANOVA) and Duncan test. In variance analysis, the density and biomass of different branches were considered as dependent variables and the season, half-line and depth were independent variables. The species diversity index was calculated according to the Shannon-Weaver formula (Shannon and Weaver, 1963) and by following formula:

$$H' = -\sum P_i \ln P_i$$

H' is the Shannon-Weaver index (nits per individual), and is the relative abundance of species.

3. Results

3.1. Abiotic factors

The results obtained in 2010 showed that the maximum average water temperature in summer was 20.4 ±10.1 °C, and then the values were14±5.34 °C in spring, 13.99±4.20 °C in autumn, and 9.66± 1.36 °C in winter. The highest mean salinity was 11.32±2.08ppt in summer. Then, the salinity reduced during autumn and winter, and the lowest mean water salinity was

Table 1. Mean values of temperature, salinity, and transparency in different seasons in 2010

Season	Mean Temperature (ºC)	Mean Salinity (ppt)	Mean Transparency (m)
Spring	14±5.34	9.77±2.44	6.2±2.9
Summer	20.4±10.1	11.32±2.08	5.5±1.9
Autumn	13.99±4.20	10.64±2.42	6.1±2
Winter	9.66±1.36	10.52±2.34	3.6±2.4

measured in spring with the value of 9.77±2.44 ppt. In addition, the highest mean value of water transparency happened in the spring 6.2 ±2.9 m and then in summer with the value of 5.5±1.9 m. The lowest average of water transparency was 3.6±2.4 m in the winter (Table 1).

3.2. Microscopic Algae

In this study, a total of 137 species of Microscopic Algae of Bacillariophyta, Chlorophyta, Cyanophyta, Pyrrophyta, Euglenophyta, Chrysophyta, and Xantophyta were identified, which 72 species belonged to Bacillariophyta, 21 species of Pyrrophyta, 20 species of Cyanophyta,15 species of Chlorophyta, 7 species of Euglenophyta,1 species of Chrysophyta, and 1 species of the Xantophyta.

The studies have indicated that the majorities of Microscopic Algae in the southern Caspian Sea are Bacillariophyta (Diatom), Pyrrophyta, and Cyanophyta, which had an essential role in the primary production in the ecosystem according to the environmental conditions. In 2010, the highest number of Microscopic Algae species was observed in the autumn (114 species), followed by spring (103 species) and winter (104 species), and the lowest number of species was observed in summer (93 species), which in all seasons the Bacillariophyta was the highest species.

As is in Table 3a, the highest and lowest amounts of Microscopic Algae were observed in autumn and summer, respectively. In all seasons, the Bacillariophyta had the highest number of species. In contrast to the spring season, the Chlorophyta was ranked in second in terms of number of Microscopic Algae species. In the seasons of summer, autumn and winter, the number of species of Pyrrophyta branch was ranked after the Bacillariophyta branch. The lowest and the highest number of species of Bacillariophyta were respectively observed in summer (42 species) and in autumn (61 species). The number of species of Cyanophyta reached to its maximum value (18 species) in autumn. The number of species of Pyrrophyta in different seasons did not show significantly variation, while, these variations were significant in the Chlorophyta branch, and dropped from its maximum value in spring to its minimum value in summer (Table 3a).

Table 2. Observed Microscopic Algae in different seasons in the south Caspian Sea water environment

Phytoplankton	Spring	Summer	Autumn	Winter
Bacillariophyta				
Amphora ovalis	-	-	+	-
Örtaulina pelagica	+	+	+	+
Chaetoceros convolutus	-	+	+	+
Chaetoceros peruvianus	+	+	+	+
Chaetoceros throndsenii	-	-	+	+
Chaetoceros simplex	+	-	-	-
Chetoserus diversicurvatus	-	-	-	+
Chaetoceros mirabilis	-	+	+	+
Chetoserus mueelleri	-	-	+	+
Chetoserus rigidus	-	+	+	+
Chaetoceros socialis	+	+	+	+
Chaetoceros subtilis	-	-	+	-
Coscinodiscus gigas	+	+	+	+
Coscinodiscus granii	+	-	+	-
Coscinodiscus jonesianus	+	+	-	+
Coscinodiscus perforatus	+	-	-	+
Cyclotella caspica	-	-	+	-
Cyclotella menenghiniana	+	+	+	+
Cymbella sp	-	-	+	-
Cymbella ventricosa	-	-	+	-
Cymatopleura solea	-	+	-	-
Diatoma vulgar	-	-	+	-
Diatoma ochki	-	-	+	-
Gyrosigma acuminatum	-	+	+	+
Gyrosigma attennuatum	-	+	+	+
Gyrosigma strigile	-	-	+	-
Gyrosigma peisone	-	+	-	-
Melosira sp	-	+	+	-
Melosira granulata	-	-	+	-
Meiosira varians	-	-	-	+
Melosira moniliformis	+	+	+	+
Navicula bombus	+	+	-	-
Navicula cryptocephala	-	+	+	+
Navicula sp	-	+	+	+
Nitzschia sp	+	+	+	+
Nitzschia SP2	-	-	+	-
Nitzschia acicularis	+	+	+	+
Pyrophyta				
Exuviaella cordata	+	+	+	+
Exuviaella marina	+	+	+	+
Glenodinium behningii	+	+	+	+
Glenudinium danicum	-	+	-	-
Glenodinium lenticula	+	-	+	+
Glenodinium penardii	+	+	+	-
Goniaulax sp	-	-	-	+
Goniaulax monacantha	-	+	-	-
Goniaulax digitale	+	+	+	+
Goniaulax polyedra	+	+	+	+
Goniaulax spinifera	+	-	+	-
Gymnodinium SP	+	+	+	+
Gymnodinium variabile	+	+	+	+
Peridinium achromaticum	+	+	+	+
Peridinium latum	+	+	+	+
Peridinium sp	+	-	+	+
Peridinium thricoidum	-	-	+	-
Prorocentrum micans	+	-	+	-
Prorocentrum obtusum	-	-	+	+
Prorocentrum praximum	+	+	+	+
Prorocentrum scutllum	+	+	+	+
Cyanophyta				
Anabaena bergii	-	+	-	-
Anabaena aphanizomenides	-	+	+	+
Anabaena spiroides	-	+	-	+
Anabaena hisselevii	-	+	-	-
Aphanizominon flos-aqua	-	+	-	-
Aphanizominon sp	-	+	-	-
Aphanotece sp.	-	-	+	-
chroococcus sp	-	-	+	-
cyanococus sp	-	-	-	+
Lyngbya limnetica	+	+	+	+
Lyngbya SP	+	+	+	+
Merismopedia minima	-	+	+	+
Nodollaria spumgina	+	+	+	-
Oscillatoria limosa	+	+	+	-
Oscillatoria agardhii	+	-	-	-
Oscillatoria sp	+	+	+	+

Table 2- continued

Oscillatoria tennuis	-	-	+	-
Spirulina sp	-	-	+	-
Spirulina laxissma	+	+	+	+
Gloeacapsa Limnetica	+	-	-	-
Chlorophyta				
Actinastrum hartzachii	+	-	-	-
Ankistrodesmus SP	-	-	+	-
Binuclearia lauterbornii	+	+	+	+
Binuclearia SP	-	-	+	-
Clamidomonas SP	+	-	-	+
Coelastrum microporum	+	+	-	-
Golenkinia Paucispina	-	-	+	-
Oocystis borgi	+	-	-	-
Oocystis solitaria	+	-	-	+
Oocystis parva	-	+	-	-
Pandorina morum	-	-	+	-
Scenedesmus bijuga	-	-	-	+
Scenedesmus quadricauda	-	-	-	+
Schroderia sp	-	-	+	+
tetrastrum sp	-	-	+	-
Euglenophyta				
Euglena SP	-	+	+	+
Euglena acus	-	+	+	+
Euglena caudata	-	+	-	-
Trachelomonas planctoniea	+	+	-	-
Trachelomonas SP1	+	+	+	-
Trachelomonas spiculifera	+	+	-	+
Trachelomonas verrucosa	+	-	-	-
Chrysophyta				
Chrysochromalina sp	-	-	-	+
Xantophyta				
Tribonema volgar	-	-	+	+

Nitzschia parva	+	-	-	+
Nitzschia reversa	-	+	+	+
Nitzschia sigma	-	-	+	-
Nitzschia sigmoidea	-	-	+	-
Nitzschia sp.1	-	-	+	-
Nitzschia tenirustris	+	+	+	+
Nitzschia sublinearis	-	-	+	-
Nitzschia closterium	+	+	+	-
Nitzschia sp.	+	-	+	+
Nitzschia sp2	-	-	+	-
Nitzschia tennuis	+	-	-	-
Nitzschia longgisma	+	+	+	+
Pleurosigma elongatum	-	+	+	-
Pseudonitzschia sp	-	-	+	-
Pseudonitzschia seriata	+	+	+	+
Rhicosphenia curvata	-	-	+	-
Rhizosolenia calcaravis	+	-	+	+
Rhizosolenia fragilissima	+	+	+	+
Scletonema costata	+	-	-	-
Scletonema costatum	+	+	+	+
Scletonema subsalsum	-	+	+	+
Stephanodiscos hantzschii	+	-	-	-
Stephanodiscos sp	+	-	-	-
Synedra amphirhynchus	-	-	+	-
Thalassionema nitzschoide	+	+	+	+
Thalassiosira caspica	+	+	-	-
Thalassiosira variabilis		-	+	-

As shown in Figure 2 and Table 3b, the highest Shannon index (H') was observed in the spring and it gradually decreased during the summer, autumn and winter. The highest Shannon index was in the west area in spring (0.96), and the lowest Shannon index was in the East region in the autumn season (0.47).

In the seasonal study of different branches of Microscopic Algae, the highest density and biomass belonged to the Bacillariophyta, with the highest density in the winter, 878.6±683.6 (m^3×106) and the maximum biomass in the spring, 20640±57222 mg/m^3. The highest density of Pyrrophyta was observed in spring with amount of 88.2±36.4 (m^3×106) and the maximum density of Cyanophyta was in autumn with amount of 285.7±137.1 m^3×106. The branches of Chlorophyta and Euglenophyta were observed in all seasons with lower density and less biomass, while the branches of Xantophyta and Chrysophyta were observed only a few in autumn and winter seasons (Table 3b).

Table 3a. The number of species of Microscopic Algae branches in different seasons

Microscopic Algae branches	Spring	Summer	Autumn	Winter
Bacillariophyta	46	42	61	48
Pyrrophyta	18	19	19	19
Cyanophyta	10	15	18	16
Chlorophyta	21	8	11	11
Euglenophyta	7	9	4	5
Xantophyta	1	_	1	1
Chrysophyta	0	0	0	1
Total	103	93	114	101

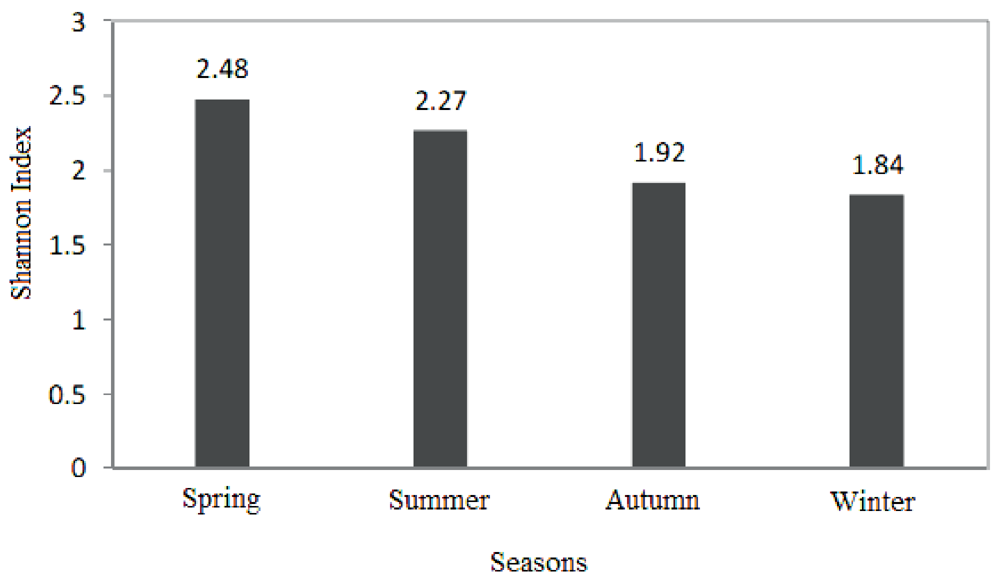

Figure 2. Shannon index (H') for Microscopic Algae in different seasons in 2010

Table 3b. Density (number in $m^3 \times 10^6$) and biomass (mg/m^3) of Microscopic Algae branches in different seasons in 2010

Season	Spring		Summer		Autumn		Winter	
Factor	Density (m^3)	Biomass (mg/m^3)	Density (m^3)	Biomass (mg/m^3)	Density (m^3)	Biomass (mg/m^3)	Density (m^3)	Biomass (mg/m^3)
Bacillariophyta	28.2±19.2	20640±57222	35.3±34.7	128.5±76	51.2±41.7	225±252	878.6±683.6	3273±1264
Pyrrophyta	88.2±36.4	1075±473	4.7±2.5	351±13	5.4±1.6	130±50	12.5±13.9	129.7±50
Cyanophyta	13.6±7.4	7.5±10	158.2±134.4	105.81±38	285.7±137.1	95±54	10.4±2.4	5±2.2
Chlorophyta	5.6±6	2±2.5	46.2±24.1	1±0.5	9.9±6.9	0.34±0.158	13.7±7	0.4±0.189
Euglenophyta	0.2±0.2	3.4±2.9	0.5±0.5	3.6±3.5	0.07±0.05	1±0.83	0.2±0.1	9±0.818
Chrysophyta	0	0	0	0	0	0	0.05±0.05	0.196±0.2
Xantophyta	0	0	0	0	0.04±0.04	0.013±0.01	0.03±0.04	0.01±0.01
Total	135.8±69.9	21727.9±57710.4	244.9±196.2	892.3±131	352.31±187.4	451.43±357	915.5±83529.8	3417.3±1317.4

4. Discussion

The production of Microscopic Algae in different regions of the Caspian Sea is quite different because of different Physico-Chemical conditions of the Caspian Sea and the existence of diverse biological conditions for the growth of Microscopic Algae (Salmanov, 1987).Seasonal variations including various effects on air temperature, river inflow and consequent increase in nutrients, the formation of water flows, as well as salinity changes in river entrances and salinity decrease can have important impacts on changes in population of zooplanktons (Vollenweider, 1974; Kosarev and Yablonskaya, 1994).

According to the results, 7 branches of Bacillariophyta, Chlorophyta, Cyanophyta, Pyrrophyta, Xantophyta, Euglenophyta, and Chrysophyta, and 137 species of Microscopic Algae were identified. At the end of spring, with the beginning of summer when the temperature raised to the values of 20.4 ± 10.1 ºC, the density, biomass and the number of Cyanophyta species increased (Gol Aghaei *et al.,* 2012).

In winter, with a decrease in mean temperature to 9.66 ± 1.36 °C, and upwelling, the clarity was about3.6± 2.4 meters. Upwelling caused the nutrients to come from the bottom to the water column, and it provided conditions for the growth and propagation of different species of Bacillariophyta (Makaremi *et al.,* 2006), so that at all levels, more than 90% of the plankton density was formed (Mirzajani *et al.,* 2012), and on the other hand, while the density of Microscopic Algae was high, the Shannon index was low.

Barnett *et al.* (2007) stated that the Shannon index reduced in the winter due to the flood because of precipitation over the rivers, which increased the suspended particles in the water column that practically caused no light penetration and influenced the diversity and density of the Microscopic Algae. In winter, autumn and spring, two branches of Microscopic Algae, Xantophyta and Chrysophyta were observed, of which only one species was present. The Shannon-Weaver index is between 1 and 3.5 (Mason, 2002). Theoretically, among the applications for describing biological communities, the high value of the biodiversity index is a symptom of a healthier ecosystem.

In the study of Fazli and Ganjian (2009), the Shannon-Weaver index in the Caspian Sea has fluctuated between 1.39 (during 1999-2000) and 3.02 (in 2004), so that the biodiversity index of Microscopic Algae during the years of 1994 to 2006 showed an increasing trend.

Pyrrophyta is an important group of Microscopic Algae and the main food source in warmer waters, and the number of species in Pyrrophyta was ranked in second. Salmanov in 1987 and Hoseini *et al.* in 2005 also identified two branches of Bacillariophyta and Pyrrophyta as the main groups of Microscopic Algae in the middle and the south of Caspian Sea. In this study, the branches of Pyrrophyta, Bacillariophyta were also the main groups of Microscopic Algae in the southernbasin of Caspian Sea. The branches of Euglenophyta and Chlorophyta had the lowest population in the southern Caspian Sea. The low percentage of Euglenophyta, which is the symbol of pollution, indicated that there was little or no factor in the Caspian Sea basin for the growth and propagation of this branch.

Khodaparast (2008) showed that the low percentage of Euglenophyta in the Anzali wetland represented insignificant pollution. Tahami (2012) also indicated that the Bacillariophyta branch played an essential role in the biodiversity of Microscopic Algae (Ganjian *et al.,* 2008b; Tahami *et al.,* 2012; Tahami, 2012).

Foggin1975 stated that the level of nutrients in the South Caspian Sea was lower than the average and was considered as an oligo-mesotrophic ecosystem with high biodiversity, while the study conducted by Tahami in 2012 indicated that more species of Microscopic Algae were present in the years after entry of Mnemiopsis leidyi, than in the years before the M. leidyi entrance, which indicating changes in the ecosystem toward the Mesotrophic and could be due to variation of water condition in the Caspian Sea (Ganjian *et al.,* 2008b).

In recent years and after the arrival of M. leidyi in the Caspian Sea, although many changes occurred in the Microscopic Algae population, the dominant group of Microscopic Algae was Bacillariophyta (Tahami *et al.,* 2011). Although the statistical results indicated that the Bacillariophyta species played an important role in biodiversity of Microscopic Algae, a study in 2012 showed that the biodiversity of the Bacillariophyta decreased in comparison with the years prior to the M. leidyi entering to the Caspian Sea, while the biodiversity of Pyrrophyta, Chlorophyta, and Cyanophyta increased (Tahami, 2012).

In 2006, Finenko's study revealed that M. leidyi's hunting was lonely sufficient to reduce zooplankton in the summer, and therefore, due to reduction of Microscopic Algae feeding by zooplankton; the density, biomass, and the number of different branches of Microscopic Algae increased.

Comparison of the density of different branches of Microscopic Algae showed a remarkable change in recent years, so that the Bacillariophyta gradually increased from 35.8% in during 1995-1996 to 60.26% in 2010. While, the Pyrrophyta branch increased to 13.45% in 1998, and decreased to 6.7% during 2009, and the Cyanophyta branch showed an increasing trend during these years. The maximum percentage of Chlorophyta population was 13.2% during 2006-2007, while it decreased to 4.57% in 2010, and there were no significant changes in the Euglenophyta branch (Table 4).

Table 4. Percentage of different branches of Microscopic Algae during study periods

Microscopic Algae branch	1995-1996	1998	2006-2007	2009	2010
Bacillariophyta	35.8	51.49	48.4	58.3	60.26
Pyrrophyta	11.9	13.45	11.9	6.7	6.72
Cyanophyta	13.8	26.49	20.8	29.3	28.38
Chlorophyta	11.9	8.18	13.2	0.6	4.57
Euglenophyta	5.7	0.39	5.7	0.02	0.05

Table 5. Number of different species of Microscopic Algae during study periods

Microscopic Algae branch	1995-1996	2006-2007	1998	2009	2010
Bacillariophyta	57	77	51	81	72
Pyrrophyta	19	19	14	33	21
Cyanophyta	22	33	13	28	20
Chlorophyta	19	21	15	38	15
Euglenophyta	9	9	8	11	7
Other	-	-	-	4	2
Total	126	159	191	195	137

Comparison of the number of Microscopic Algae species in different branches showed an increasing trend in the number of different branches and the least species diversity was observed during 1995-1996 and the most species diversity was reported in 2009 (Table 5).

Temperature is one of the important factors that effects on zooplankton organisms, which in 2009 had the highest amount of 23-29.5 °C in the southern basin of Caspian Sea (RoshanTabari *et al.,* 2009).As the temperature increased in the summer, the number of Cyanophyta branches raised as well, these variations in summer and autumn could be an alarm of Eutrophication and bloom of Cyanophyta in the region, because the Cyanophyta, which grew in an environment with turbidity and nutrient were able to create bloom in high temperature conditions (WHO, 1999; Laloei *et al.,* 2002).

In the years after entering the M. leidyi, more species of Bacillariophyta were present in the ecosystem in comparison with earlier years, and the Microscopic Algae branches were changing, so that some species such as Pseudonitzschia seriata were increased in the recent years and were observed in all seasons. Moreover, some Microscopic Algae species such as Rhizosolenia-calcar-avis, which were dominant in the recent years, showed a significant reduction. In the studies carried out in 2010, significant changes were observed in the number of Microscopic Algae species, which varied in different seasons and in different areas of southern Caspian Sea. The excess nutrition of Microscopic Algae by zooplankton could also effect on overall health of the Caspian Sea (Kosarev and Yablonskaya, 1994; Kideys *et al.,* 2005).

Conclusion

A biological study in each ecosystem plays an important role in the amount of aquatic resources. The study of phytoplankton is essential to indicate primary production, as algae are really vital in water environment. The results showed that throughout the Southern Caspian Sea, where has different environment and morphological conditions, seasonal slopes and specified temperatures determine the distribution of bulk phytoplankton to layers and seasons, while the maximum depth and heterogeneity individual phytoplankton groups vary by habitat structure. The structure of phytoplankton habitat varied in different seasons.

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