International Journal of Advanced Technology & Engineering Research (IJATER)
www.ijater.com

THE EFFECTS OF ENVIRONMENTAL PARAMETERS AND NUTRIENTS ON MICROALGAE COMMUNITIES AROUND THE SHRIMP FARM COMPLEXES IN BUSHEHR PROVINCE, IN PERSIAN GULF.

Khosrow Aein Jamshid[1], Fatemeh Mohsenizadeh[2] and Soheila Omidi[3]

Abstract

The aims of this work was to inform about the red tide condition before entering the algal bloomer in seawater supply canals of the shrimp farm and hatchery complexes in Bushehr province. Field investigation and monthly sampling have been carried out from April to December 2011. The Environmental parameters such as pH, salinity and water temperature and also meteorological conditions were measured and recorded on the field. The water sampling has been lunched for determination of nutrients and chlorophyll-a, phytoplanktons.

Keywords – Microalgae communities, Shrimp Culture, Nutrients, Environmental parameters, Bushehr province..

INTRODUCTION

The common term of "red tide" are used for a phenomenon that occurs by a sudden increase in the population of a phytoplankton and led to changes in water color. This term is not comprehensive and not scientific because in many cases a phytoplankton can bloom with low density and not included discoloration but may produce highly toxic products. The more scientific term for this phenomenon is “algal bloom” or “harmful algal bloom” [1].

The first outbreak of *Cochlodinium polykrikoides* was occurred in the coastal waters of Muscat, in Oman in August 2008. Its bloom spread to the southern and northern part of the Persian Gulf in United Arab Emirates (UAE) and Iranian waters in September 2008 [2 and 3]. The Cochlodinium bloom spread to the Bushehr province waters in December and reached to the Genaveh in northern part of Bushehr Province in February 2009. It caused to mortalities of tens ton of fishes included of grouper, sardines, sea scorpion, eel, and etc. in Iranian waters [4].

Coastal waters are used for supplying shrimp farm complexes. One of the most important factors which affected the production of farmed shrimp is phytoplankton quality and maintaining of plankton bloom [5]. By the addition of fertilizers the nutrient budget of shrimp ponds will increase and it enhance the phytoplankton growth. The bloom of certain species of phytoplankton, especially if a dinoflagellate bloomed, can seriously harm farmed shrimps [6].

The bloom of *dinoflagellates* and other phytoplankton groups such as diatoms, cyanobacteria and chlorophytes had serious harm to shrimp industry, in recent decades [6-9]. Occurrence of the extensive bloom of *Cochlodinium polykrikoides* in the Persian Gulf in 2008 and 2009 had considerable damage to the marine ecosystem. It led the Iranian Fisheries Science Research Institute to concerns about the serious impact of this phenomenon on aquaculture activities and its social consequences. The present study was aimed to investigate on microalgae communities and their relationship with environmental parameters and nutrients in the southern of shrimp farm and hatchery complexes in Bushehr province to aware about the red tide condition before entering the algal bloomer in seawater supply canals. Timely information about the structure of phytoplankton communities in the vicinity of the water intake canals of shrimp complexes, allow us to control and management the harmful algal blooms.

EXPERIMENTAL

By concern to the distribution of shrimp farms and hatcheries complexes along the coastal of Bushehr province, three stations were selected in the southern of water intake canal of Mond, Delvar and Heleh (Fig. 1).

Monthly sampling has been carried out from April 2011 to November 2011. Identification and abundance of phytoplankton specially the bloomer species and their relationship with environmental parameters (temperature, salinity and pH) and nutrients (silicate, phosphate, nitrate, nitrite and ammonia) situation in the vicinity of shrimp complexes were the goals of this work.

Date and time of sampling, geographic coordinates include of latitude and longitude, depth, transparency, meteorological conditions, color of the water and weather situation was recorded and measured in each station. The phytoplanktons were sampled by Ruttner bottle of Hydro-Bios Model, and identified using an inverted microscope of Nikon, Model Eclipse Tis.

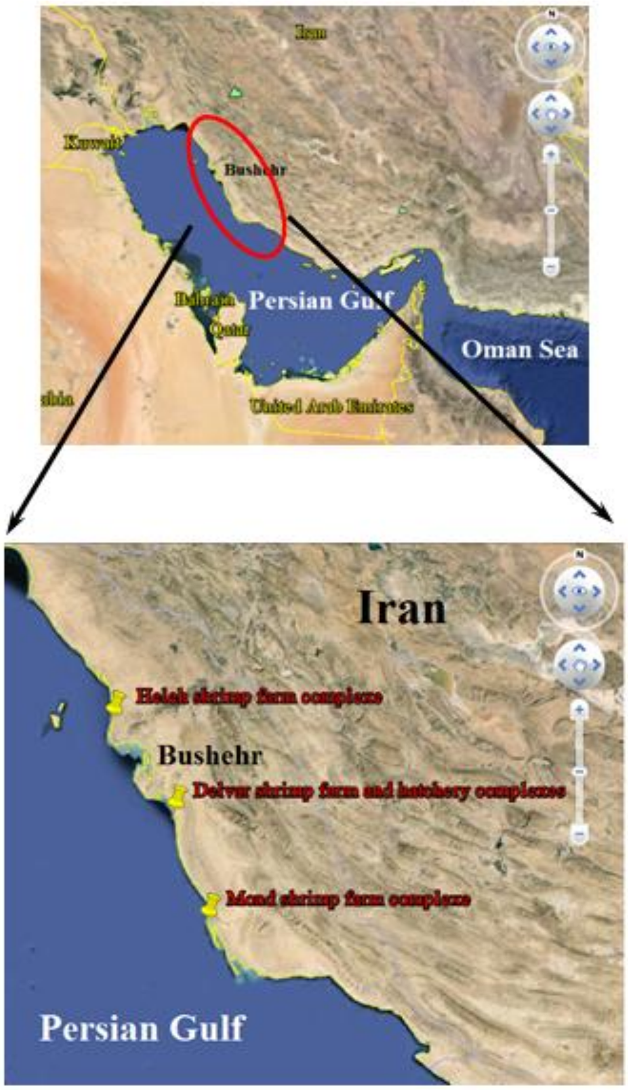

Fig. 1. The studied area and position of shrimp farm complexes in Bushehr province, Persian Gulf.

Water samples for measurement of chlorophyll-a and nutrients were sampled by Ruttner bottle of Hydro-Bios Model. The nutrients were analysed by using HACH spectrophotometer Model DR 4000. Water temperature and pH were recorded by the pH meter model WTW and salinity was recorded with an Atago S/Mill refractometer. All measurements were performed with three replicates. According to the objectives of the project, water samples were gathered monthly. Phytoplankton samples were fixed with Lugol's solution and transported to the National Shrimp Research Institute of Iran (NSRII) laboratories, located in Bushehr. Fixed specimens allowed be settling for two weeks and then identifying by using invert microscope. Phytoplankton sampling and laboratory methods have been done based on the references of [10-14].

Sampling and analysis of nutrients and chlorophyll-a were performed according to Methods of MOOPAM, 2010 and Clesceri, 1989 [14 and 15]. Recording and data processing and statistical analysis have been done by using EXCEL 2007 software.

RESULTS

The averages of air and water temperature in the studied station were 29.4 °C and 28.3 °C, respectively. The minimum of water temperature was 19.0 °C in April and its maximum value reached to 34.2 °C in July at Delvar station. The average of salinity was 41.2 ppt. The highest of salinity value was 45.2 ppt in July at Delvar station and its minimum value was 38.2 ppt in July at Mond station. Due to mixing of low salinity water of Mond river with seawater, the salinity of water at Mond station has the lowest values in Bushehr coastal waters. The average of pH was 8.46 in the studied waters. The highest level of pH was 8.88 which recorded in May at Mond station and the minimum level was 8.20 at Delvar station in September, and also was the same at Heleh in October.

Summary results of nutrient include of silicate (SiO_4^{-4}), nitrate (NO_3^-), nitrite (NO_2^-), ortho-phosphate (PO_4^{-3}), ammonia (NH_3) and chlorophyll-a are collected in TABLES 1 and 2. The identified phytoplankton were belong to three class of *Bacillariophyceae* (52.6%, 13,280 ± 7226 cell/lit), *Dinophyceae* (37.7%, 6302 ± 8268 cell/lit) and *Cyanophyceae* (9.7%, 1,955 ± 806 cell/lit) (Figure 2). The maximum density of total phytoplankton was 23,632 cell/lit and their temporal maximum density was 54623 ± 22569 cell/lit in August. The highest spatial density of phytoplanktons was 141,120 cell/lit at Delvar station in December (Fig. 2-4).

TABLE 1. Concentration of nutrients and chlorophyll-a in different station, Bushehr province waters, 2011.

	Mond	Delvar	Heleh	Average
SiO_4^{-4}	0.83 ± 0.07	1.04 ± 0.08	0.94 ± 0.09	0.94 ± 0.04
PO_4^{-3}	0.20 ± 0.02	0.10 ± 0.01	0.16 ± 0.02	0.15 ± 0.01
Chlorophyll-a	2.22 ± 0.18	2.31 ± 0.36	1.46 ± 0.11	1.99 ± 0.14
NO_3^-	0.04 ± 0.00	0.04 ± 0.00	0.03 ± 0.01	0.03 ± 0.01
NO_2^-	0.006 ± 0.000	0.011 ± 0.001	0.010 ± 0.001	0.009 ± 0.000
NH_3	0.83 ± 0.07	1.04 ± 0.08	0.94 ± 0.09	0.94 ± 0.04

TABLE 2. Concentration of nutrients and chlorophyll-a in different months, Bushehr province waters, 2011.

	SiO_4^{-4}	PO_4^{-3}	Chlorophyll-a
April	0.35 ± 0.06	0.12 ± 0.04	7.60 ± 1.06
May	2.78 ± 0.26	0.26 ± 0.05	1.25 ± 0.16
June	1.12 ± 0.07	0.14 ± 0.03	0.91 ± 0.10
July	1.29 ± 0.18	0.26 ± 0.03	1.39 ± 0.17
August	0.81 ± 0.12	0.05 ± 0.01	2.60 ± 0.24
September	0.47 ± 0.05	0.09 ± 0.01	0.88 ± 0.06
October	0.27 ± 0.02	0.16 ± 0.01	1.26 ± 0.13
November	0.39 ± 0.04	0.15 ± 0.01	0.07 ± 0.01
Average	0.94 ± 0.04	0.15 ± 0.01	1.99 ± 0.14
	NO3-	NO2-	NH3
April	0.04 ± 0.01	0.01 ± 0.001	0.19 ± 0.02
May	0.03 ± 0.00	0.01 ± 0.002	0.11 ± 0.01
June	0.05 ± 0.01	0.01 ± 0.002	0.22 ± 0.00
July	0.06 ± 0.01	0.00 ± 0.001	0.20 ± 0.02
August	0.01 ± 0.00	0.01 ± 0.001	0.11 ± 0.01
September	0.03 ± 0.00	0.01 ± 0.001	0.12 ± 0.01
October	0.02 ± 0.00	0.01 ± 0.001	0.11 ± 0.01
November	0.03 ± 0.00	0.01 ± 0.001	0.09 ± 0.01
Average	0.03 ± 0.01	0.01 ± 0.000	0.14 ± 0.00

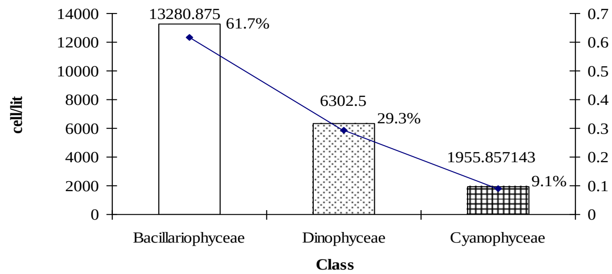

Fig. 2. Density and percentage of different classes of identified phytoplanktons, Bushehr province, 2011.

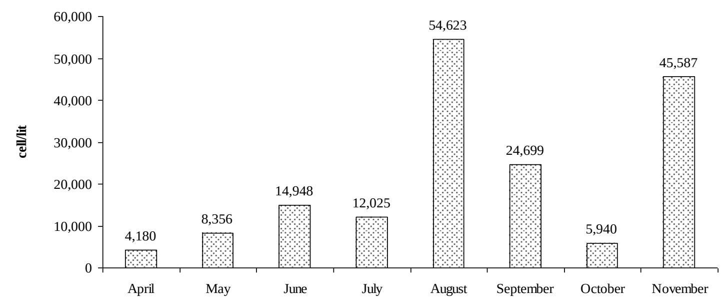

Fig. 3. Density of phytoplanktons in different months, Bushehr province, 2011.

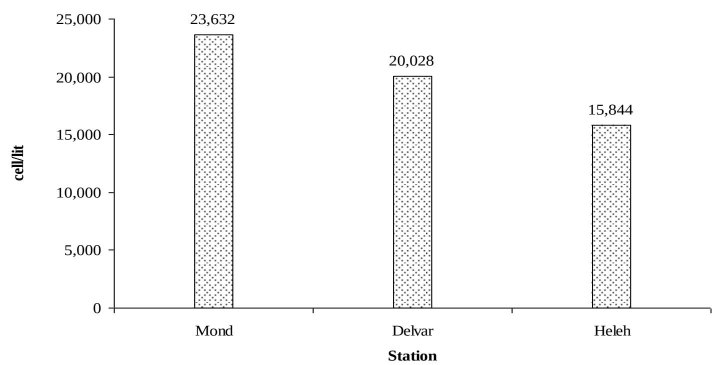

Fig. 4. Density of phytoplanktons in the studied stations, Bushehr province, 2011.

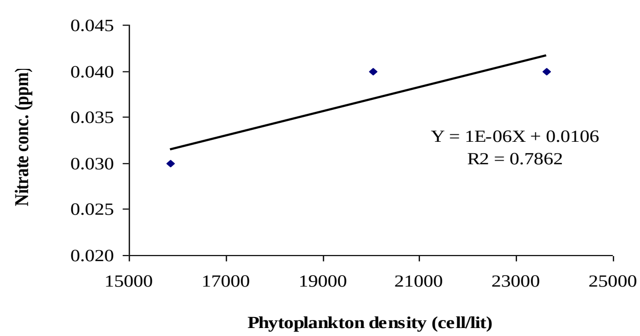

Fig. 5. Regression of nitrate vs. phytoplankton density in the studied stations, Bushehr province, 2011.

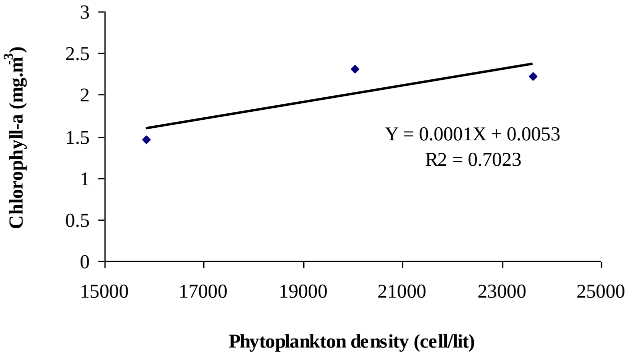

Fig. 6. Regression of chlorophyll-a vs. phytoplankton density in the studied stations, Bushehr province, 2011.

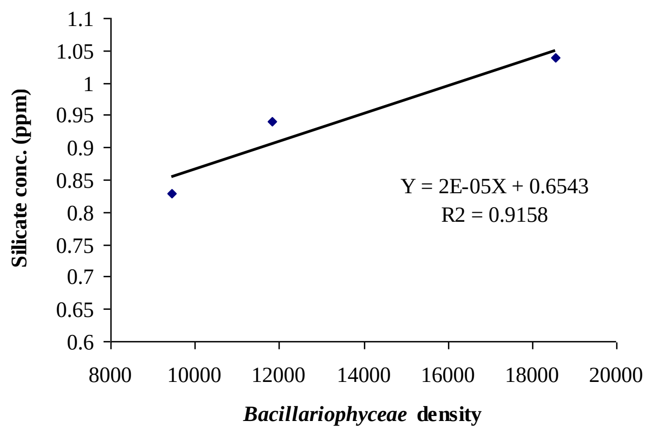

Fig. 7. Regression of silicate vs. *Bacillariophyceae* density in the studied stations, Bushehr province, 2011.

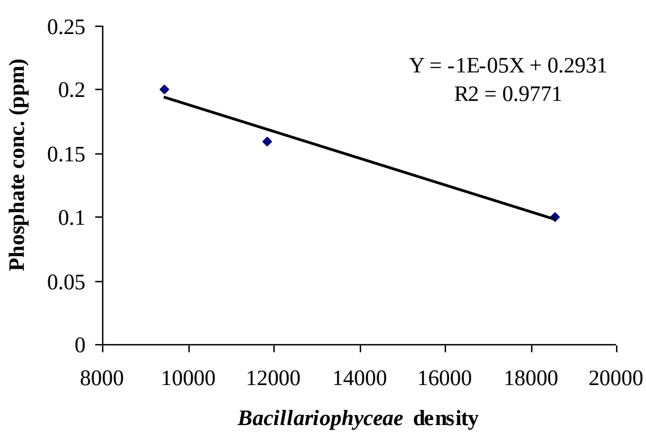

Fig. 8. Regression of phosphate vs. *Bacillariophyceae* density in the studied stations, Bushehr province, 2011.

DISCUSSION

Based on the results, the average of water temperature in studied stations increased from 22.0 °C in April to 33.6 °C in July and then decreased to 23.5 in November. The correlation coefficient of water temperature with density of *Bacillariophyceae*, *Dinophyceae* and *Cyanophyceae* were 0.99, -0.95 and -0.49, respectively. Strong positive correlation between Bacillariophyceae and water temperature implying that in surveyed area, when the water temperature increases, the density of *Bacillariophyceae* increases. The results revealed that the *Bacillariophyceae* are thermo-tolerant algae while *Dinophyceae* and *Cyanophyceae* are thermo-intolerant algae. This results are consistent with the findings of Izadpanahi, 2005 [16].

The salinity varied from its maximum value of 42 ppt in August and decreased to 39.7 in September and increased to 42.3 in November. The salinity in Bushehr coastal waters is affected by the general trend of salinity variation in Persian Gulf which is depended to the entering current from Indian Ocean and Oman Sea to the Persian Gulf, and mixing of low salinity freshwaters of Mond and Heleh rivers with high saline seawater [17]. The correlation coefficient between salinity and phytoplankton density at different stations was -0.99. High negative correlation between these data shows that in the surveyed area, by increasing the salinity, the density of phytoplankton decreases. The correlation coefficient of salinity with density of *Bacillariophyceae*, Dinophyceae and Cyanophyceae were 0.95, -0.88 and -0.64, respectively. The results revealed that the *Bacillariophyceae* are halotolerant algae while *Dinophyceae* and *Cyanophyceae* are halointolerant algae. These results are consistent with the findings of Izadpanahi, 2005 [16].

In the studied area, the main cause of nutrient variation is outflow of nutrient rich effluent from the shrimp complexes. Study on the variation of the silicate concentration showed that its average increased from 0.35 ppm in April to 2.78 ppm in May and then declining to 0.27 ppm in October (TABLE 2). The average concentration of silicate at Mond, Delavar and Heleh stations were 0.83, 1.04 and 0.94 ppm, respectively. The correlation coefficient of *Bacillariophyceae*, *Dinophyceae* and *Cyanophyceae* with silicate were 0.99, -0.94 and-0.51, respectively. Strong positive correlation between *Bacillariophyceae* and silicate is due to high affinity of these groups of phytoplanton to silicate. The *Bacillariophyceae* cell walls are consist of silica. They require the presence of bioavailable silicate or silicic acid in their growth environment [18]. In the studied area, the population of *Dinophyceae* have changed with variation of *Bacillariophyceae* population.

The correlation coefficient of phosphate with density of total phytoplankton, *Bacillariophyceae*, *Dinophyceae* and *Cyanophyceae* were 0.98, -0.97, 0.90 and 0.58, respectively. Negative correlation between *Bacillariophyceae* and phosphate is due to the relationship between the variation of silicate and phosphorus. Our results showed that by changing the balance of Si:P, when the SiO_4^{-4} concentration decreased, the density of *Bacillariophyceae* decreased and Dinophyceae were dominated groups in the area. The composition of nutrients in each area is depend on the sources of these nutrients, texture of sea bottom, construction of artificial islands, destruction of the coastal and seabed drying. Aein Jamshid reported that the correlation coefficient of phosphate and nitrate with *Cochlodinium polykrikoides* in the southern part of Bushehr province waters in 2009 were +0.90 and +0.59, respectively. Their results showed that the *Cochlodinium polykrikoides*,which is belong to *Dinophyceae* class, is a Phosphorus limited species [4].

The long-term investigation of Philippart and his co-worker showed that the phytoplankton production during the spring and summer blooms was Phosphorus limited. They reported that diatoms are Silicon limited and flagellates are Nitrogen limited [19]. Our results are consistent with these findings with an except that the *Dinophyceae* are Phosphorus limited not Nitrogen limited.

The correlation between the density of *Dinophyceae* with concentration of phosphate, silicate and nitrate were 0.83, -0.90 and 0.46, respectively. A reverse trend was observed between *Bacillariophyceae* with phosphate and silicate, which their correlation coefficients were -0.99 and 0.96, respectively.

The analysis of data resulted that the correlation coefficient of ammonia and nitrite with total phytoplankton were -0.99 and -0.83, respectively. The ammonia and nitrite are nitrogen waste released by aquatic animals which are toxic to aquatic life, so their relationship with phytoplankton is negative. The concentrations of these parameters are affected by some bacteria such as Nitrosomonas in nitrification or, and another groups of bacteria such as Pseudomonas in denitrification [20].

The Linear regression analysis of the density of phytoplankton with concentration chlorophyll-a and nitrate showed a strong positive relationship between these parameters and phytoplankton (Fig. 5 and 6). Correlations coefficient between chlorophyll-a and nitrate with phytoplankton density were 0.84 and 0.89, respectively. The analysis of linear regression between *Dinophyceae* and phosphate showed a strong positive relationship, whereas its regression with silicate had a strong negative relationship (Fig. 7 and 8).

Comparison of the phytoplankton density in the present study with the results of Eco Zist (in 1976) and Izadpanahi (in 2000) showed that total phytoplankton density has increased in the studied area [20]. Based on the above researches, the structure of phytoplankton community in Bushehr province waters are changed. The abundance percentage of high risk toxin producer and bloomer class of *Dinophyceae* increased from 7.5% in 1976 to 29.3% in 2011, whereas the percentage of *Bacillariophyceae* are decreased from 73.1% in 1976 to 61.7% in 2011 (TABLE 3).

TABLE 3. The abundance percentage and density of different class of phytoplanktons in Bushehr province waters.

	Total phytoplankton density (cell/lit)	Abundance percentage	
		Dinophyceae	*Bacillariophyceae*
Eco-Zist, 1976	4300	7.5	73.1
Izadpanahi, 2000	1312	20.3	26.2
The present work, 2011	21538	29.3	61.7

REFERENCES

[1] M. Maso and E. Garces, “Harmful microalgae blooms (HAB); problematic and conditions that induce them”, *Marine Pollution Bulletin*, Vol. 53, pp 620–630, 2006.

[2] M. L. Richlen, S. l. Morton, A. Jamali, and D. M. Rajan, The catastrophic 2008-2009 red tide in the Persian Gulf region, with observation on the identification and phylogeny of the fish-killing dinoflagellate *Cochlodinium polykricoides*, *Journal of harmful algae*, Vol. 9 (2), pp. 163-172, 2010.

[3] R. M. Kudela and C. J. Gobler, Harmful dinoflagellate blooms caused by Cochlodinium sp.: Global expansion and ecological strategies facilitating bloom formation Original Research Article, *Harmful Algae*, Vol. 14, pp. 71-86, 2012.

[4] K. Aein Jamshid, F. Mohsenizadeh, A. Haghshenas and S. Omidi, “Interactive effects of industrial activities and marine environment in Pars Special Economic Energy Zone”, *Second national conference on sustainable development perspective, and knowledge-based integrated of Pars Special Economic Energy Zone*, Mars 2010.

[5] W. Dall, B. J. Hill, P. C. Rothlisberg, D. J. Sharples, The Biology of the Peneidae, Advances in Marine Biology, Academic Press, New York, Vol. 27, pp. 315–330, 1990.

[6] F. P. Osuna and R. A. Rodrıgueza, Nutrients, phytoplankton and harmful algal blooms in shrimp ponds: a review with special reference to the situation in the Gulf of California, *Aquaculture*, Vol. 219, pp. 317–336, 2003.

[7] X. Jiasheng, Z. Mingyuan and L. Binchang, The formation and environmental characteristics of the largest red tide in North China, *Toxic Phytoplankton Blooms in the Sea*, Elsevier, New York, pp. 359– 362, 1993.

[8] R. Jime´nez, Ecological factors related to Gyrodinium instriatum bloom in the inner estuary of Gulf of Guayaquil, *Toxic Phytoplankton Blooms in the Sea*, Elsevier, New York, pp. 257–262, 1993.

[9] G. I. Lizarraga, J. J.Bustillos, R. Alonso, C. Hummert and B. Luckas, Comparacio ´n del perfil de toxinas de Gymnodinium catenatum y moluscos bivalvos en dos localidades del Golfo de California. *International Meeting of the Mexican Society of Planktology*, Veracruz, Mexico., Vol. 95, 2002.

[10] D. E Andrew, “ Standard Methods for Examination of Water & Wastewater”, 21ed, Washington DC., 2005.

[11] G. E. Newell and R. C. Newell, “ Marine Plankton (a practical guid)”, Hatchinson of London, UK, 1977.

[12] A. Sorina, “Phytoplankton Manual, United Nations Educational”, Scientific and Cultural Organization, Vol. 237, 1978.

[13] M. Hoppenrath, M. Elbrächter, and G. Drebes, “Marine Phytoplankton”, Kleine Senckenberg-Reihe 49. E. Schweizerbart Science Publishers, Stuttgart Germany, 2009.

[14] MOOPAM, ” Manual of Oceanographic Observation and Pollutant Analyses Methods”, ROPME Publishing, 4th ed., 2010.

[15] L. S. Clesceri, A. E. Greenberg and R. R. Trussell, Standard methods for the water examination of water and waste. Port city press, Baltimor, p. 1268, 1989.

[16] Gh.Izadpanahi et als. Hydrology and hydrobiological study of the Persian Gulf in the Bushehr region. Final project report (in Persian), Iranian Fisheries Research Organization, 2005.

[17] J. Kampf and M. Sadrinasab, “ The circulation of the Persian Gulf: a numerical study”, *Ocean Sci.*, Vol 2, pp 27–41, 2006.

[18] T. J.Smayda, What is a bloom? A commentary. *Limnology and Oceanography*, Vol. 42, pp. 1132-6, 1997.

[19] C. J. M. Philippart, J. J. Beukema, G. C. Cadée, R. Dekker, P. W. Goedhart, J. M. Van Iperen, M. F. Leopold, P. M. J. Herman, Impacts of nutrient reduction on coastal communities, *Ecosystems* Vol. 10, pp. 96-119, 2007.

[20] J. Simon and M. G. Klotz, Diversity and evolution of bioenergetic systems involved in microbial nitrogen compound transformations, *Biochimica et Biophysica Acta*, 1827, pp. 114–135, 2013.