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Seasonal change of community structure and abundance of phytoplankton in Roudan River

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Key words: Roudan river, phytoplankton, abundance , Seasonal Change.

Abstract

A combination of environmental conditions affects the phytoplankton distribution and composition. This study analysed spatio-seasonal variation of phytoplankton in relationship to environmental variables in Roudan River (Iran) which has a good water quality and thus this research is important as a basis for future sustainable management. Phytoplankton and environmental variables were sampled monthly at 3 stations the upstream , intermediate and downstream zones from April 2013 to April 2014. Differences in the abundance, species diversity and dominant taxa of particular groups of phytoplankton between three sections of river were analyzed. River has a long and shallower depth and is susceptible to have different situation as ecological status. The results of the studies confirm that there are differences in the phytoplankton communities and physiochemical water parameters in the studied river. The abundance of diatoms dominated by *Nitzschia* and *Navicula*, noted in winter was almost 120-70 times higher than spring. Most of the sample was taken in autumn and winter and due to high water temperature the abundance was in colder water temperature. Both diatom phytoplankton was in highest frequency in two station, but very few plankton were selected in station one. The significant increasing of salinity ($P<0.05$) in the autumn and winter season also may provide increasing phytoplankton as well. Concluded that the species number and celldensity of phytoplankton could serve as biological water quality indicators, which would give overalldescriptions of water quality by combining with the physical and chemical indicators.

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Introduction

The study of biology of natural resources is essential for planning and management for proper utilization of these resources. In the study of biology of natural resources, much attention has been paid in the case of fish (Yousefian *et al.*, 2008 ; Yousefian and Mousavi, 2011) but very few for primary product e.g. phytoplankton.

To complete our knowledge about the taxonomical composition, quantitative relations, seasonal changes and long-term changes of phytoplankton in the central part of Iran the study of Roudan river one of the main rivers in this region was necessary. The river of Roudan is an example of a long water bodies with differing morphometry and phytoplankton status. There are not reported studies of qualitative and quantitative changes in phytoplankton status available of this main river.

To understand the nutrient supply of the river whether it is high or low, the potential trophic level is hypertrophic or eutrophic can be estimated but the community and density of phytoplankton of the river is affected by a variety of factors such as water temperature due to seasonal changes, salinity, alkalinity, intensity of solar radiation, and the resuspension of biogenic elements, including phosphorus. Planktonic algae are subject to ecological succession. Lampert and Sommer (1996) define succession as an orderly process of directional changes in the species structure of the biocenosis, which may proceed for several hundred, or even several thousand years, or which may be a regular and repeatable sequence of changes in the biocenosis, resulting from cyclical environmental changes (e.g., annual phytoplankton). This work focused on distribution, aboundance and dominant taxa in the river. Till now, no work had been carried out on seasonality of water quality and biodiversity of the river of Roudan in central part of Iran. The objective of the study is to provide a quantitative record of the seasonal changes of Phytoplankton status and to examine their distribution and diversity in relation to environment gradients in this river. The Roudan river is used for fishing activities and trip at weekend, especially in mid-part of the river. Discharges of municipal and rural sewage into surface waters, and inflows from the catchment area of waters rich in nutrients and other substances have effect in river. Excessive quantities of nutrients in water bodies might result in the mass occurrence of some planktonic algal species. One consequence of this is the decomposition of organic matter in the waters that often cause oxygen deficits, which, in turn, can resuspend nutrients from the sediments to the water and increasing the phytoplankton community. The effects of inputs on water quality and aquatic life have not been investigated. The Roudan river originated from the mountain in moderate temperature while pasing a hot area in south of Iran. One of the main factor affecting the community of phytoplankton and in water quality as reflected in the biodiversity, are generally shorter at higher temperature than at lower temperature. Species differ in their temperature tolerance during development but generally, there are temperatures which are too low and too high for physiological processes (Ezra and Nwankwo, 2001).This research study provide the knowledge of hydrological conditions of Roudan river that is not only useful in assessing its productivity but will also permit a better understanding of the population and life cycle of the phtoplankton community and the use of it for aquaculture activity.

However for aquaculture purpose it is necessary to have more investigation including: industries pollution, fertilizer effluents physic-chemical status of the river. In this study, phytoplankton community of Roudan river identified and counted undera microscope. The seasonal variation and spatial distribution of phytoplankton community structure were characterized. The critical environmental factors that strongly influence the distribution of phytoplankton were identified with a canonical correspondence analysis of phytoplankton community composition and aquatic environmental factors.

Materials and methods

Sites descriptions

The Roudan River located in West of Bandar Abbas city in South the of Iran between latitude 27°14´44"N and longitude 57°12´14"E. The length of the river is about 110 km. The area is warm and dry, the most raining season are in winter. The average five years raining is about 152 mm. Limnological parameters of river are listed as: Surface area (5670 km2), Volume of river (3123 thous. m3), Maximum depth (150 cm), Mean depth (98 cm), Maximum width (246 m), Mean Secchi disc transparency (90 cm).

The Roudan river is long river. According to present study of phytoplankton communities in a period of time it is classified as a trophic water body. For many decades the river received untreated municipal sewage and wastewater from the rural and country side. A considerable part of the bottom was covered in stones and gravel and about 10% of the littoral zone was overgrown by vascular plants, and weeds and at this time the bottom was muddy and covered with decompos Samples were taken from the river on a monthly basis during the period of one year. 3 sampling stations in the upstream, intermediate and downstream of the river were selected.

Environmental Parameters

Standard methods for the examination of water and wastewater were used for all measurements. Temperature values were recorded from a mercury in glass thermometer graduated in units of °C by immersing the thermometer slightly under the surface of water (2cm) for 5 minutes until mercury stood at one place. Digital pH meter after standardization with buffer solution at pH 4, 7 and 9 was used for pH. Dissolved oxygen concentration of the water samples was determined by winkler fixation though titration by $Na_2S_2O_4$ (Cleseri *et al.*, 1984). METROM electronic metre at 25°C was used for EC. Water transparency was measured by use of Secchi disc (Golterman, 1969). The disc was lowered into water and the depth at which it became invisible was recorded. It was then gradually withdrawn from the water and the depth at which it became visible was noted. The transparency of the water at that station was the mean of the two readings.

Total alkalinity, which is expressed in mg/L, is the total number of drops of sulphuric acid solution used multiplied by 17.1 (Fish Farmers' Water Quality Testing Kit Manual, 1990). Salinity was determined using Salino meter Hydrobios model Beckman (KielSERiE 69727).

Phytoplankton sampling,identification and counting

Samples were collected seasonally From April 2013 to April 2014. The samples were collected with a 5-liter plankton sampler in the middle of the river. The samples were poured through a 30 µm mesh plankton net, and then preserved with Lugol's solution and 4% formaldehyde solution. The sample kept in cold and dark place for 2-3 days to settle the organism in the sample. Then the upper clean water were removed from the top, the rest 100 ml were mixed and 1 ml were used for analyzing. A triplicate sample was scored in every sampling. A total of 28 samples were collected. The following physiochemical water parameters were determined: temperature (°C) and oxygen concentration (mg O_2 dm^{-3} with a HI-9143 DO meter (Hanna Instruments, Italy) and Secchi disc transparency (m).

Quantitative and qualitative determinations of phytoplankton were performed in a 1 ml plankton chamber with an invert microscope at a magnifications. Phytoplankton biomass was calculated for biovolume by comparing algae to their geometrical shapes (Rott 1981); abundance or biomass are given per 1 dm^3. For the analysis, abundance and biomass means of phytoplankton were used to represent the sum of the abundance or biomass respectively, divided by the number of samples. The Shannon-wiener species diversity index was analyzed based on the abundance of the phytoplankton community (Kawecka and Eloranta

1994).

Statistical analysis

Numerical composition of the specimens was estimated by direct count. Each quantitative sample was concentrated to 10ml and from this; 1ml of sample was taken and all individual taxa present were counted. Numerical composition was calculated as the number of individuals per liter of water filtered through the net.

Taxonomic keys used for proper identification include: Newell and Newell, 1997; Habit and Netal, 1976. Data analysis software SPSS version 19 and one-way analysis of variance was used at a level of 0.05 percent. Duncan test was used to compare the means.

Results

Physiochemical water parameters

Changes in water temperature and surface layer oxygenation were analyzed in different part of River and every season to provide a comparative background for the phytoplankton communities. Changes in River temperature are shown in table 1.

Table 1. Physico-chemical parameters scored at different station and seasons

Season	Station	Air temperature	Water temperature	Salinity psu	Total Hardness Mg(CaCo3)/l	Alkalinity ppm	DO mg/l	PH
Spring	S1	24±0.0	27.3±0.57	0.8±0.0	196.7±1.1	54±1.7	9±0.6	9.3±0.25
	S2	41.9±0.1	30.3±1.2	1.1±0.1	197.3±1.2	56.7±3.1	8.6±0.3	9±0.1
	S3	37.4±0.2	32.7±0.4	0.98±0.1	204±8	60±2	8.4±0.6	8.9±0.03
Summer	S1	24.4±0.0	28.4±0.2	0.8±0.1	188±3.5	68.7±8	10.1±1	8.1±0.0
	S2	24±0.2	29±0.3	1±0.2	173.3±4.2	61.3±4.9	8.7±0.1	8.3±0.1
	S3	34.1±0.1	35.8±0.3	0.84±0.1	203.3±8.3	69±3	9.4±0.7	8.2±0.07
Autumn	S1	12.5±0.0	15.3±0.06	0.8±0.07	230.7±1.2	61±1	9.9±0.3	8.2±0.01
	S2	21.8±0.2	21.4±0.4	1±0.1	231.3±3.1	56.9±0.2	9.9±0.6	8±0.1
	S3	22.1±0.1	21.5±0.8	0.95±0.05	241.3±8.1	60.3±2.1	10.3±0.7	7.9±0.11
Winter	S1	14±0.5	15.6±0.8	1.4±0.16	206.7±20.4	50±1	10.6±0.9	8.2±0.07
	S2	19.9±0.6	20.9±0.5	1.4±0.1	203±8.1	49.3±4	10.3±0.3	8.3±0.1
	S3	21.7±0.8	21.5±0.6	1.6±0.2	218.7±7.6	57.7±3.5	9.5±0.5	8.2±0.1

S= Station.

Mean water temperature in upper layer at downstream shows at least 6 degree higher temperature than upstream. Differences in other coefficients are also recorded. The trend of water temperature was to increase from the first station to the third station and it was significant ($P<0.05$). The highest temperature was in summer and autumn in third station (34.2± 1.7). The change in water temperature in spring and summer in the two other stations was equal and in average was 28±1.8. Water temperature in autumn and winter in first station was 15.4±0.5 while 21.4±0.5 in second and third station.

The oxygen content was higher than 7.8 in all three station and all seasons and the maximum was 11.2 mg/l. The PH also showed the same pattern. During the summer, autumn and winter it was in the range of 7.9-8.26, while in spring it was 9±0.2. About the salinity, the highest were observed in station 2 and minimum in station 1. In winter the highest salinity at significant level were scored comparing to other seasons. The alkalinity value was highest in station 3 and lowest in station 2. In summer and autumn the average alkalinity was 64.4±6 while in spring and winter lower 54.6±4.6. Total hardness was highest in autumn 234.4±6.8 and lowest in summer 188.2±13.9. In comparison between the stations it was higher in station number 3.

General characteristics of phytoplankton

The following taxonomic groups of phytoplankton were recorded in the water body of the river: Cyanophyta; Bacillariophyceae; Zygnematophyceae, Dinophyceae, Chlorophyceae. The mean total abundance of phytoplankton in downstream was four-times higher that of upstream.

The other groups contributing to the total phytoplankton abundance and biomass included: Siphanocladophyceae, Prasinophyta, Coscinodiscophyceae, Fragilariophyceae. The abundance of diatoms, more than 200,000 individual, dominated by *Nitzschia* and *Navicula*, noted in winter was almost 60 times higher than spring. Most of the sample was taken in autumn and winter and due to high water temperature the abundance was in colder water temperature. Both diatom phytoplankton was in highest frequent in two station, but very few plankton were selected in station 1. The significant increasing of salinity ($P<0.05$) in the autumn and winter season also may provoke increasing phytoplankton as well.

Table 2. Seasonal variation in the occurrence of Phytoplankton in Upstream of Roudan.

	Spring	Summer	Autumn	Winter	Total
Netrium				300	900
Nitzschia				50	150
Ankistrodesmu				533	1600
Surirella				50	150
Sprulina		148		0	445
*Halosphera**				33	100
*Cadophora**	50			83	400

*Refer to phytoplankton that have been observed only in this station.

Seasonal changes in the abundance and biomass of phytoplankton

Bacillariophyceae dominated the total abundance of phytoplankton from all around the year in three station except in station one which has very few phytoplankton number and diversity. Only at winter season the occurrence of *Nitzschia* is recorded in this station. The abundance and biomass of the algae group increased from spring to winter steadily and no sigmoid reproduction were observed. The decreased of phytoplankton is coincident with high temperature in late of spring and summer to early time in autumn. The abundance and biomass of phytoplankton was dominated by diatoms in the winter but it started to elevated in autumn. In spite of high frequency of phytoplankton in downstream, meanwhile less than 66 percent of them were observed in spring, summer and autumn and 34 present were observed only in winter. The *Chroococcus* and *Oscillatoria* were observed only in spring while *Anabeana*, *Oscillatoria*, *Biddulphia*, *Leptocylindrus*, *Thalassiosira*, *Ceratium* and *Sprulina* were occurred only in summer. *Cymatopleura*, *Tabellaria* and *Amphipora* were recorded only in fall.

Dominant taxa of the phytoplankton community

The genera of *Navicula* and *Nitzschia* were predominant and aboundance in the three station and in different time of sampling. With exception of these two plankton, the appearance and dominance was as follow: In the spring season, the highest abundance among the phytoplankton community was reached by the Cyanophyceae classes the genera *Chroococcus spp* and *Merismopedia*. The abundance of *Oscillatoria*, *Cymbella*, *Spirogyra* also were noticeable in this season. There was a rapid increase in the abundance of the *Merismopedia*, *Anabeana*, *Oscillatoria* belonging to Cyanophyceae classes in summer especially in mid-part of the river. During this period in mid-part of river significant increase in *Merismopedia* which peaked in August at 4000 indiv. dm^{-3} (Ave. 2000 in summer). The genus *Chroococcus* which appeared in sping was not recorded in summer and fall. The genera *Merismopedia* and *Coscinodiscus*, and *Thalassiosira* of Coscinodiscophyceae had the highest dominant phytoplankton. In winter the highest frequency of plankton was recorded and the dominant phyto were the genera of *Gomphonema*, *Cymbella* and *Synedra*.

Discussion

Usually phytoplankton abundance increases downstream in large rivers, associated to the corresponding increase in nutrients concentration and water residence time, and phytoplankton abundance decreases when the river deepens and water transparency lowers (Jones, 1984; Köhler, 1994). However, this longitudinal pattern of phytoplankton abundance (chlorophyll and phytoplankton density) is altered by large reservoirs and other infrastructures. This was the case in the Roudan River, where three reservoirs in the lower section of the river disrupted this predicted pattern by decreasing the water residence time, water conductivity (especially during dry periods), and nutrient concentration (nitrate) in the section downstream (Sabater and Tockner, 2010).

Table 3. Seasonal variation in the occurrence of Phytoplankton in Intermediate of Roudan.

Phytoplankton	Spring	Summer	Autumn	Winter	Total
Pleurosigma	141	21	321	1317	5451
Coconeis sp.	27	158	4	375	1692
Navicula	598	588	60	89992	273714
Nitzschia	257	1421	1616	45900	147583
Fragilaria	0	0	13440	450	41220
Cymbella	200	532	25	12192	38313
Gyrosigma	13	230	0	1167	4230
Leptocylindrus	0	158	0	0	475
Coscinodiscus	0	0	38	400	1314
Pinnularia	0	0	0	75	225
Synedra	0	21	0	32533	97664
Gomphonema	0	0	0	7900	23700
Cosmarium	0	0	0	917	2750
Ankistrodesmu	0	0	0	2050	6150
Chroococcus	27	0	0	0	80
Anabeana	0	1333	0	0	4000
Oscillatoria	0	438	0	0	875
Merismopedia	0	2000	2000	2533	19600
Sprulina	0	21	0	0	64
Pediastrum	0	0	0	250	750
Spirogye	320	0	0	233	1660
*Cymatopleura**	0	0	17	0	52
*Tabellaria**	0	0	0	50	150
*Biddulphia**	0	21	0	0	64
*Amphipora**	0	0	0	150	450

*Refer to phytoplankton that have been observed only in this station.

These differences between upstream and downstream sites were maximal during dry periods (spring and summer), when phytoplankton biomass was much higher in the meandering upstream section of the river. This was especially the case in September (summer) when the low discharge coincided with high water temperatures and light irradiance in the upstream sections and phytoplankton growth reached its maximum (Artigas *et al.*, 2012). In this section of the Roudan River phytoplankton abundance indicated the existence of eutrophication (Dodds *et al.*, 1998). However, water discharge and chemical conditions changed remarkably downstream of the river, accordingly decreased one order of magnitude, indicating oligotrophic to mesotrophic conditions. Higher river discharge significantly impacted the phytoplankton density, since dilution and fast speed waters affected phytoplankton growth (Salmaso and Zignin, 2010). The analysis on the phytoplankton communities determined that the river strongly affected the response of phytoplankton to seasonal variations. The temporal changes of phytoplankton communities differed between upstream, intermediate and downstream sites of the Roudan river. We could define the changes of the phytoplankton communities in the Roudan River as mostly corresponding to seasonal variations in the areas. In the upstream section a temporal replacement of diatoms and green algae occurred in the way it has been described elsewhere (Litchman *et al.*, 2010). The general pattern of seasonal succession of phytoplankton described in temperate large rivers starts with diatoms blooms mostly in spring and autumn, whereas green algae and diatoms dominate the summer and early autumn community.

Table 4. Seasonal variation in the occurrence of Phytoplankton in Downstream of Roudan.

Phytoplankton	Spring	Summer	Autumn	Winter	Total
Pleurosigma	26	0	531	550	3503
Coconeis sp.	55	84	75	275	1467
Navicula	2298	721	54	32558	106895
Nitzschia	258	700	11294	17100	88058
Fragilaria	0	0	12589	0	37768
Cymbella	268	0	50	4850	15278
Leptocylindrus	0	604	0	0	1814
Gyrosigma	0	159	38	608	2417
Coscinodiscus	0	0	1408	0	4225
Pinnularia	0	0	0	31	275
Synedra	83	0	0	25783	77600
Cosmarium	16	0	0	425	900
Gomphonema	0	0	0	2750	8250
Netrium	0	0	0	350	1050
Ankistrodesmu	0	0	0	400	400
Surirella	0	0	0	50	150
Oscillatoria	166	0	0	0	500
Merismopedia	933	6916	0	3066	32750
Chroococcus	4306	0	0	258	13695
Pediastrum	0	0	0	133	400
Spirogyra	0	241	0	558	2400
*Campylodiscus**	0	0	0	50	150
*Gonium**	66	666	0	0	2200
*Amphora**	16	0	0	50	200
*Thalassiosira**	0	0	1387	0	4163
*Scrippseilla**	0	0	0	8	25
*Nostoc**	0	0	0	366	1100
*Ceratium**	0	4	0	0	14
*Closterium**	0	0	0	16	50
*Scenedesmus**	0	0	0	175	525
*Cladophora**	0	208	0	175	1151

*Refer to phytoplankton that have been observed only in this station.

The increase in overall phytoplankton density in early spring corresponds to the onset of higher temperatures and high availability of nutrients, that mostly favours the dominance of diatoms. Green algae increase when temperature rises and light irradiances are higher. In autumn and winter lower temperature and light limit phytoplankton growth and high discharge prevents the accumulation of phytoplankton biomass, conditions that favour the occurrence of diatoms. This type of seasonal succession of phytoplankton communities has been observed in European (Gosselain *et al.*, 1994; Kiss, 1987; Stoyneva and Draganov, 1991), Asian (Ha *et al.*, 2002), American (del Giorgio *et al.*, 1991) and Australian rivers (Chan *et al.*, 2002). In the Roudan River, diatoms characterized the phytoplankton communities upstream of the reservoirs during high flow periods (autumn and winter). Wet periods were characterized by high turbulence and low water temperatures, conditions that favour diatom growth (Litchman *et al.*, 2010; Reynolds *et al.*, 2002).

The biological status of Roudan river is affected by morphometry and the character of the river in different places along of this river. Due to differences of the morphometric features and characters of the catchment basins of river the status of the river were differ. Station one located in upstream of the river has a smaller surface area, a deeper maximum depth, and a largely rocky catchment area, while intermediate and downstream has a large surface area, a shallow depth, and an rural catchment area.Rodrigo *et al.,* 2002 reported a large spatial heterogeneity was detected in La Safor, a coastal area with different kinds of small and shallow water bodies. The area exhibits a sharp gradient in eutrophication and varied water body features (morphology: size, depth; hydrology; vegetation, etc.). These factors result in a high diversity of aquatic habitats within the area.

Because of morphometric features, the waters of downstream warm more quickly than those of upstream as is confirmed by the higher water temperatures in all season, especially in the autumn and winter (Table.1).

The rapid increase in water temperature in spring in downstream might have indirectly influenced the spring oxygen deficit, but comparing the oxygen level in three station reviled the nearly the same pattern in different stations. In conclusion the stability of oxygen level in downstream and intermediate could have been related to increased sewage inflows during the summer tourist season or increasing the phytoplankton at these two areas. To identify the effect factors in deficiency of oxygeon, it is probable the best to be analyzed in close system. In a research study by Jana *et al.* (1980), there was a wide spatial and seasonal variation of population size and biomass of net plankton in two ponds studied. The seasonal changes of phytoplankton number in these ponds showed an inverse characteristic either with absolute concentration or with the rate of concentration changes of bicarbonate in the water, while the former and concentration of dissolved oxygen was positively correlated.

The seasonal change in phytoplankton aboundance in Roudan river are related to physical change that is illustrated in table 1 and table 4. This result is in agreement with the results of Christopher *et al.* (1989), who obtained data of physical/chemical and algal abundance from national Stream-Quality Accounting Network records of 10 river sites in Kentucky USA and analyzed how seasonal change in river phytoplankton related to changes in physical and chemical parameters. Phytoplankton assemblages were differed among rivers as a function of drainage basin characteristics, but exhibited common seasonal changes related to temporal variation in the physical/chemical environment. Distinct shifts in algal dominance were identified between spring, late summer, and transitional periods in the 10 systems. Nine common algal genera were found to differ in their response to changes in physical or chemical parameters. Abundances of *Anacystis*, Oscillatoria, *Scenedesmus*, and *Melosira* were strongly positively correlated with temperature while *Chlamydomonas* and *Navicula* abundances were inversely related to temperature. This result with exception of some phytoplankton was the same as we noted in this article.

One of morphometric status of the Roudan river is its shallow features. According to Barone and Naselli-Flores (2003), shallow lakes have a greater tendency to increase in tropic status than do large lakes. This is in case of downstream that has highest aboundant of phytoplankton. Phytoplankton is one of the crucial coefficients of trophic status in lakes. According to Spodniewska (1986), differences in the dynamics of phytoplankton development in shallow and deep lakes is partly because of different depths.The development of algae in downstream is due to high water temperature in all seasons, which was almost 5 °C higher than in upstream (Table 1). The abundance of Bacillariophyceae was more than five handered-times higher in downstream and intermediate compare to upstream (Table 2-4).

In case of roudan river, also the high oxygen level is related to the morphometry and the character of river in upstream. The weather is colder than the two other station and mixing of water with air is continually and constantly, while the oxygen supply in downstream is due to activity of phytoplankton.

In highly eutrophic pond type lakes, increased water turbidity can result from the mass occurrence of algae and the intense mixing of waters during spring and fall circulation, which leads to increased organic matter release from the sediments to the water column (Kawecka and Eloranta 1994).

The main algal recorded in present study are centric diatoms and Chlorophyceae. In the quantitative study of the phytoplankton of the River Avon, Bristol. Aykulua(2007) have been reported, Phytoplankton of the river comprised three main algal groups; centric diatoms, Chlorophyceae and Cryptophyceae. Centric diatoms increased in numbers in spring and autumn whilst Chlorophyceae were abundant in summer months. Total amount of phytoplankton increased downstream. In general, phytoplankton numbers were high in intermediate and summer, decreasing gradually towards the end of autumn. In winter, numbers were low. Nutrients did not appear to limit the algal growth in the river. The seasonal change and aboundance of phytoplankton in River Avon was differing from those Roudan river. Phytoplankton number and amount was highest in winter and at downstream. These results are due to difference in water temperature between the two rivers.

Discharges of municipal and rural sewage into surface waters, inflows from the catchment area of waters rich in nutrients and other substances have effect in river at downstream. In addition development of Bacillariophyceae and other species may cause increase turbidity.

Excessive quantities of nutrients in water bodies might result in the mass occurrence of some planktonic alga species such as *Campylodiscus*, *Thalassiosira*, *Scrippseilla*, *Nostoc*, *Scenedesmus* which have appeared only at downstream and increased turbidity. Species diversity is a measure of the fertility of a water body, and it is defined as the relative abun- dance of particular species (Kawecka and Eloranta 1994). In comparing the abundant algae in downstream there have observed almost 30 percent, new and particular species which have not been recorded in other station.

Conclusion

The difference in the density of phytoplankton populations in different seasons depends on various factors. The cause of this dispute requires extensive studies and detailed introduction of more precise analysis methods. It is too difficult to find the cause of all these differences, because the interaction between living and non-living elements in an ecosystem is very complex.

In total, according to investigations carried out on the Roudan river and phytoplankton diversity and density suitable than other similar ecosystems such as fisheries planning to release any fish-eating phytoplankton modest and aimed at optimal use of ecosystems and utilization of existing capacity should be more research and evaluation of all factors, including the recognition of native fish in the river and observe all laws to introduce new species to the aquatic ecosystems to be done. On the other hand before any action in this regard anthropogenic pollution under control and favorable environmental conditions for the aquatic environment will be provided.

References

Artigas J, Soley S, Pérez-Baliero MC, Romaní AM, Ruiz-González C, Sabater S. 2012. Phosphorus use by planktonic communities in a large regulated Mediterranean river. Sci Total Environ **426,** 180–7.

Aykulua G. 2007. A quantitative study of the phytoplankton of the River Avon, Bristol. British Phycological Journal **13(1),** 91-102.

Barone R, Naselli-Flores L. 2003. Distribution and seasonal dynamics of Cryptomonads in Silician water bodies. Hydrobiologia **502,** 325-329.

Chan TU, Hamilton DP, Robson BJ, Hodges BR, Dallimore C. 2002. Impacts of hydrological changes on phytoplankton succession in the Swan River, Western Australia. Estuaries Coasts **25,** 1406–15.

Christopher G, Peterson CG, Stevenson RJ. 1989. Seasonality in river phytoplankton: multivariate analyses of data from the Ohio River and six Kentucky tributaries. Hydrobiologia. **182(2),** 99-114.

Cleseri E, Berg G, Truss R. 1984. Standard methods for the examination of water & wast water. A pha (Am erican" public Health association).

Del Giorgio PA, Vinocur AL, Lombardo RJ, Tell HG. 1991. Progressive changes in the structure and dynamics of the phytoplankton community along a pollution gradient in a lowland river — a multivariate approach. Hydrobiologia **224,** 129–54.

Dodds WK, Jones JR, Welch EB. 1998. Suggested classification of stream trophic state: distributions of temperate stream types by chlorophyll, total nitrogen, and phosphorus. Water Res; **32,** 1455–62.

Ezra AG, Nwankwo DI. 2001. Composition of phytoplankton algae in Gubi reservoir, Bauchi. Nigerian Journal of Aquatic Science **16,** 115-118.

Golterman HI. 1969. Methods for chemical analysis of freshwater. Int. Biol. Program. Handbook & Oxford, Blackwell Scientific Publications.

Gosselain V, Descy JP, Everbecq E. 1994. The phytoplankton community of the River Meuse, Belgium: seasonal dynamics (year 1992) and the possible incidence of zooplankton grazing. Hydrobiologia. **289,** 179–91.

Ha K, Jang MH, Joo GJ. 2002. Spatial and temporal dynamics of phytoplankton communities along a regulated river system, the Nakdong River, Korea. Hydrobiologia. **470,** 235–45.

Jana BB, De UK, Das RN. 1980. Environmental factors affecting the seasonal changes of net plankton in two tropical fish ponds in India. Aquatic Sciences Research Across Boundaries **42(2),** 225-246.

Jones FH. 1984. The dynamics of suspended algal populations in the lower Wye catchment.Water Res. **8,** 25–35.

Kawecka B, Eloranta PV. 1994. An Outline of the Ecology of Freshwater and Inland Aquatic Habitats–Wydawnictwo Naukowe PWN, Warszawa, 256 p. (in Polish).

Kiss KT. 1987. Phytoplankton studies in the Szigetkoz section of the Danube during 1981–1982. Arch Hydrobiol. **78,** 247–73.

Köhler J. 1994. Origin and succession of phytoplankton in a river-lake-system (Spree, Germany). Hydrobiologia. **289,** 73–83.

Lampert W, Sommer U. 1996. The ecology of inland waters–PWN, Warszawa, 391p. (in Polish).

Litchman E, de Tezanos Pinto P, Klausmeier CA, Thomas MK, Yoshiyama K. 2010. Linking traits to species diversity and community structure in phytoplankton. Hydrobiologia. **65, 3**15–28.

Newell QC, Newell RC. 1997. Marin Plankton. Huteninsoh, London, 244 p.

Netal HR. 1976. Algen for a der ostsee, v: IIplankton verlag Jena pub., 496 p.

Reynolds CS, Huszar V, Kruk C, Naselli-Flores L, Melo S. 2002. Towards a functional classification of the freshwater phytoplankton. J Plankton Res. **24,** 417–28.

Rodrigo MA, Rojo C, Armengol X. 2002. Plankton biodiversity in a landscape of shallow water bodies (Mediterranean coast, Spain). Hydrobiologia. **506-509,** 1-3.

Rott E. 1981. Some results from phytoplankton counting intercalibrations- Schweiz. Z. Hydrol. **43,** 34-62.

Sabater S, Tockner K. 2010. Effects of hydrologic alterations on the ecological quality of river ecosystems. In: Sabater S, Barceló D, editors. Water scarcity in the Mediterranean.Berlin: Springer; 15–39 P.

Salmaso N, Zignin A. 2010. At the extreme of physical gradients: phytoplankton in highly flushed, large rivers. Hydrobiologia. **639,** 21–36.

Spodniewska I. 1986. Planktonic blue-green algae of lakes in north-eastern Poland – Ekol. pol. **34,** 151-183.

Stoyneva MP, Draganov SJ. 1991. Green algae in the phytoplankton of the Danube (Bulgarian sector)-species composition, distribution, cell numbers and biomass. Arch Protistenkd **139,** 243–60.

Yousefian M, Mousavi SE. 2011. A review of the control of reproduction and hormmanipulations in finfish species. African Journal of Agricultural Research **6(7),** 1643-1650.

Yousefian M, Gezel HG, Hedayatifard M. 2008. Induction of ovulation in endemic Chalcarburnus chalcoides, living in the Caspian Sea, using LRH-Aa. Combined with metoclopramide. African Journal of Biotechnology **7(22),** 4199-4201.