www.biodicon.com Biological Diversity and Conservation

ISSN 1308-8084 Online; ISSN 1308-5301 Print 9/3 (2016) 84-90

Research article/Araştırma makalesi

Non – Silica Algae of Seydisuyu Stream basin and their relative abundances (Eskişehir/Turkey)

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Abstract

In the present study; non – silica algae of Seydisuyu Stream Basin were investigated and Cluster Analysis (CA) was applied to detected biological data in order to classify the stations in terms of algae floras. For this purpose, epipelic (EPP), epilithic (EPL), epifitic (EPF) and planktonic algae samples were collected seasonally from 12 stations in 2012 along the Seydisuyu Stream Basin. According to results of identified non – silica algae, a total of 17 Chlorophyta species, 12 Cyanobacteria species, 4 Euglenophyta species, 2 Dinoflagellata species and 1 Chrysophyta species were identified from benthic and planktonic samples of investigated freshwater ecosystem. According to results of CA, 5 statistically significant clusters were formed and different ecological zones of the Seydisuyu Stream Basin were presented according to the abundance of algae.

Key words: Seydisuyu stream basin, non – silica algae, relative abundances, cluster analysis

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Seydisuyu nehri havzası (Eskişehir/Türkiye) Silissiz Algleri ve bağıl bolluk seviyeleri

Özet

Bu çalışmada, Seydisuyu Nehri Havzası'nın silis ihtiva etmeyen algleri araştırılmış ve algal floraları açısından incelenen istasyonların sınıflandırılması için elde edilen biyolojik verilere Kümeleme Analizi uygulanmıştır. Bu amaç için, 2012 yılında, mevsimsel olarak, Seydisuyu Nehri Havzası'ndan epipelik (EPP), epilitik (EPL), epifitik (EPF) ve planktonik alg örnekleri toplanmıştır. Çalışmamız sonucunda, incelenen sucul ekosistemin bentik ve planktonik örneklerinden, 17 Chlorophyta türü, 12 Cyanobacteria türü, 4 Euglenophyta türü, 2 Dinoflagellat türü ve 1 Chrysophyta türü tespit edilmiştir. Elde edilen Kümeleme Analizi sonuçlarına göre, istatistiksel olarak anlamlı 5 küme tespit edilmiş ve Seydisuyu Nehri Havzası'nda alg bolluğuna göre farklı ekolojik bölgeler ortaya konulmuştur.

Anahtar kelimeler: Seydisuyu nehri havzası, silissiz algler, bağıl bollukları, kümeleme analizi

1. Introduction

Seydisuyu Stream is one of the most important branches of Sakarya River (third longest river in Turkey) and it has important agricultural lands on its basin. As it is known that Turkey has 70% of the total boron reserve of the globe. Kırka county of Eskişehir province is located in the border of Seydisuyu Stream Basin and it is one of the most important borate deposits of Turkey. In addition to the geological structure of the basin, agricultural activities, urban discharges and boron mines are the main pollution sources of the system (Çiçek et al., 2013; Köse et al., 2014; Tokatlı et al., 2014). Algal biodiversity can be easily affected by the environmental factors and may feedback quickly to different ecological status. Seydisuyu Stream Basin has a great potential of algal diversity, but the algal flora of system has not yet been investigated. The aim of this study was to determine the non – silica algae of Seydisuyu Stream Basin and classify the investigated lotic – lentic aquatic systems according to algal biodiversity.

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2. Materials and methods

2.1. Study area

Seydisuyu Stream Basin is located in the Central Anatolia Region between the locality of 38.0851 – 39.0361 north latitude and 30.0161 – 31.0071 east longitudes (Çiçek et al., 2016).

Non – silica algae samples were collected over a period of three months (seasonally) in 2012 from 12 selected stations on the Seydisuyu Stream Basin. The map of selected stations and study area are given in Figure 1.

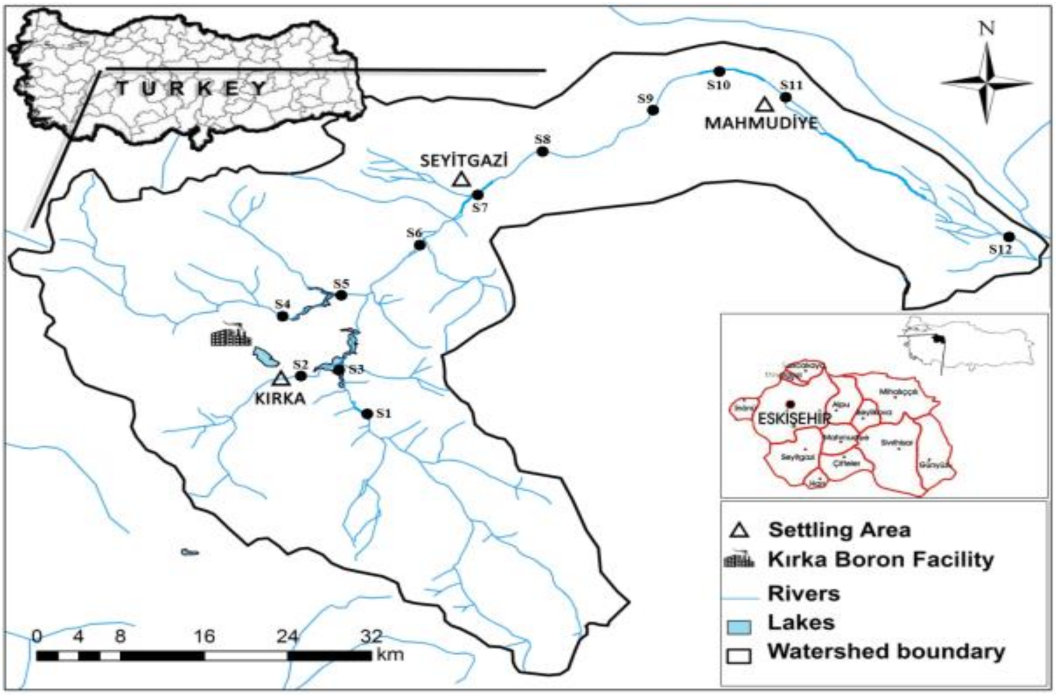

Figure 1. Seydisuyu Stream Basin and the selected stations

2.2. Collecting samples, identification and statistical data

Non – silica algae samples were taken from Seydisuyu Stream in sediment surface, stones and plants, also water surface with the period of 3 months at 12 stations. Gloss pipe with a diameter of 0.8 cm and 100 – 150 cm long, was used for capturing Epilitic samples. Epiphytic samples were collected from the stems and leaf of some plants, which are found in coastal water. Epilitic samples were taken from stone surface into water and planktonic ones from water surface using plankton net (Atıcı and Obalı, 2000).

Identification of algae samples was performed on a compound microscope, equipped with water immersion lenses and a phase contrast attachment. The non – silica algae were identified according to Round (1973) system and alphabetic order. Necessary sources were used for identification Bourrelly (1966), Huber (1969; 1972), Anagnostidis and Komarek (1988), Komarek and Anagnostidis (1989; 1999), Komarek et al. (1998), John et al. (2003) and Atıcı and Çalışkan (2007). Cluster Analysis (CA) according to Bray Curtis was applied to the results by using the "Past" package program.

3. Results

During the present study, a total of 17 Chlorophyta species, 12 Cyanobacteria species, 4 Euglenophyta species, 2 Dinoflagellata species and 1 Chrysophyta species were identified from benthic and planktonic samples of Seydisuyu Stream Basin. All detected non - silica algae species with the total relative abundance values in the Seydisuyu Stream Basin intra algae and species codes used in statistical assessment are given in Table 1. Relative abundance values of detected algae species according to stations are given in Table 2.

Table 1. Dominance values of detected algae

Species	Taxa Codes	Relative Abundance (intra – nonsilica algae)
Chlorophyta		
Ankistrodesmus falcatus (Corda) Ralfs	ch1	5.03
Chlorella vulgaris Beyerinck	ch2	4.80
Coelastrum microporum Nageli in A. Braun	ch3	4.15
Oocystis borgei J.Snow	ch4	4.36
Pediastrum boryanum (Turpin) Meneghini	ch5	4.15
Cladophora glomerata (L.) Kütz	ch6	4.34
Closterium littorale Gay.	ch7	4.58
Oedogonium sp.	ch8	4.46
Cosmarium botrytis Menegh.	ch9	4.70
Cosmarium morum Menegh.	ch10	3.81
Cosmarium sp.	ch11	4.40
Scenedesmus communis E. H. Hegevald	ch12	5.07
Scenedesmus bijuga (Turp) Lagerh	ch13	4.42
Spyrogyra varians (Hass.) Kütz.	ch14	3.81
Spyrogyra gratiana Kütz.	ch15	4.46
Spyrogyra sp.	ch16	3.97
Staurastrum gracile Ralf	ch17	3.70
Cyanophyta		
Anabaena flos-aqua G. S. West	cy1	2.25
Aphanizomenon sp.	cy2	1.03
Chroococcus disperus (Keissl) Lemmerman	cy3	1.19
Chroococcus minor (Kützing) Nageli	cy4	0.61
Chroococcus varius A. Braun	cy5	1.03
Merismopedia elegans A. Braun in Kützing	cy6	0.96
Microcystis punctata Meyen	cy7	1.41
Nostoc commune Vaucher	cy8	0.98
Oscillatoria tenuis (Agardh) Gomont	cy9	1.25
Oscillatoria granulata Gardner	cy10	2.59
Spirulina major (Kützing) Gomont	cy11	3.36
Spirulina pirinceps W. West & G. S. West	cy12	2.16
Dinophyta		
Ceratium hirundinella (O.F.Müller) Bergh	dn1	2.16
Peridinium sp.	dn2	0.49
Chrysophyta		
Dinobryon sertularia Ehrenberg	cr1	1.27
Euglenophyta		
Euglena elongata Schewiakoft	eu1	0.58
Euglena sp.	eu2	0.94
Trachelomonas volvocina Ehr.	eu3	0.90
Trachelomonas sp.	eu4	0.43

The most dominant groups were Chlorophyta and Cyanobacteria among the identified species in benthic and planktonic samples of investigated aquatic ecosystem. According to detected biological data, *Scenedesmus communis*, *Ankistrodesmus falcatus*, *Chlorella vulgaris*, *Cosmarium botrytis* and *Closterium littorale* were the dominant taxa in Chlorophyta group; *Spirulina* m*ajor*, *Oscillatoria granulata*, *Anabaena flos-aquae* and *Spirulina princeps* were the dominant taxa in Cyanobacteria group. Dinoflagellata genus represented only two species but one of them *Ceratium hirundinella* is important for dominance values. In a study performed in Tigris River, Chlorophyta and Cyanobacteria were found to be the most dominant non – silica algea group among the identified species in planktonic samples (Varol and Şen, 2014). In another study performed in Porsuk Stream, which is an element of Sakarya River Basin as the present study area, green algae (Chlorophyta) were found in low abundance in the system (Demir et al., 2011). In another study performed in Akçay Stream, as similar to the present investigation, total of 61 non - silica algae taxa were recorded and 26 of them were from Chlorophyta, 30 of them were from Cyanophyta, 1 of them was Chrysophyta and 4 of them were Euglenophyta (Solak et al., 2007).

Table 2. Dominance values of algae in the basin according to stations

Species	Taxa Codes	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
Chlorophyta													
A. falcatus	ch1	5.07	5.55	6.45	7.26	6.02	2.53	4.63	4.75	5.02	5.44	2.82	5.29
C. vulgaris	ch2	3.23	3.78	3.35	5.51	3.26	4.80	4.42	6.89	5.26	4.99	5.65	6.17
C. microporum	ch3	3.69	3.28	4.13	3.00	2.26	5.56	6.32	2.38	3.35	3.40	5.43	6.39
O. borgei	ch4	4.61	6.56	7.23	5.51	3.51	3.54	3.37	2.85	3.35	3.63	6.51	2.21
P. boryanum	ch5	5.07	6.31	7.48	6.01	2.51	3.03	5.05	3.09	5.74	2.95	1.52	1.76
C. glomerata	ch6	3.46	3.28	5.68	3.25	4.77	3.03	4.63	6.18	6.70	4.99	3.47	2.87
C. littorale	ch7	3.00	4.04	3.10	2.25	5.52	5.56	3.16	5.94	6.94	5.44	5.21	4.85
Oedogonium sp.	ch8	6.00	3.28	2.84	3.50	3.51	3.03	3.37	5.94	4.78	5.90	6.08	4.85
C. botrytis	ch9	5.77	3.53	3.35	3.50	5.27	4.04	4.63	3.33	5.26	5.67	6.30	5.29
C. morum	ch10	5.07	3.53	1.29	1.75	1.76	4.04	6.32	2.38	3.35	3.40	5.43	6.39
Cosmarium sp.	ch11	5.54	2.52	5.68	5.01	5.27	6.06	3.37	2.38	3.83	3.63	5.43	4.41
S. communis	ch12	3.00	4.79	5.42	7.26	5.52	5.56	4.21	6.18	6.70	4.99	3.04	4.85
S. bijuga	ch13	2.08	5.55	7.74	2.50	3.51	3.79	4.63	5.94	6.94	5.44	2.17	3.31
S. varians	ch14	5.07	3.53	1.29	1.75	1.76	4.04	6.32	2.38	3.35	3.40	5.43	6.39
S. gratiana	ch15	3.00	5.55	3.35	4.76	5.27	7.32	2.74	4.75	3.11	4.31	4.34	5.51
Spyrogyra sp.	ch16	3.69	3.03	2.32	5.51	7.53	2.53	3.37	2.85	2.15	4.99	6.51	3.09
S. gracile	ch17	6.46	5.55	3.61	3.50	4.02	3.03	2.74	4.04	2.39	2.72	4.13	2.43
Cyanophyta													
A. flos-aqua	cy1	3.69	1.26	0.39	7.26	4.52	2.27	1.26	1.19	0.96	0.23	1.52	2.87
Aphanizomenon sp.	cy2	1.27	1.89	2.32	0.63	1.25	0.51	1.05	2.61	0.24	0.23	0.33	0.33
C. disperus	cy3	1.61	0.50	0.26	1.50	0.50	0.76	1.58	1.43	0.24	2.27	1.52	1.76
C. minor	cy4	1.15	0.25	0.26	1.50	0.50	0.51	0.42	0.48	0.48	0.45	0.65	0.66
C. varius	cy5	1.61	0.50	0.52	1.50	3.14	1.77	1.26	0.48	0.48	0.45	0.43	0.44
M. elegans	cy6	1.38	1.51	0.52	0.50	0.50	0.51	1.05	1.66	0.48	1.36	0.22	1.76
M. punctata	cy7	1.61	1.77	1.29	0.25	0.25	1.26	1.05	1.19	2.63	2.95	1.52	1.10
N. commune	cy8	1.15	0.25	1.03	1.25	1.51	1.26	1.26	0.48	1.20	1.13	1.09	0.22
O. tenuis	cy9	0.46	1.77	2.06	0.50	2.01	0.51	1.89	2.38	1.20	0.91	0.65	0.88
O. granulata	cy10	0.92	3.53	3.10	1.00	1.76	3.28	1.68	3.80	2.87	2.27	3.91	3.09
S. major	cy11	2.77	4.04	3.10	1.00	5.02	5.56	4.42	5.46	2.87	2.04	2.17	2.21
S. pirinceps	cy12	0.92	2.02	1.81	3.25	0.75	4.29	3.79	1.43	1.67	2.27	1.30	2.43
Dinophyta													
C. hirundinella	dn1	2.77	2.27	2.06	2.50	2.51	0.76	1.68	2.14	2.15	3.40	1.95	1.76
Peridinium sp.	dn2	0.00	0.00	1.55	0.00	0.25	0.00	0.42	0.48	0.72	1.13	0.00	1.32
Chrysophyta													
D. sertularia	cr1	0.46	0.50	1.55	2.00	1.51	1.77	1.05	0.48	1.67	1.36	1.74	1.32
Euglenophyta													
E. elongata	eu1	0.69	1.01	0.26	1.00	0.50	0.51	0.53	0.24	0.72	0.45	0.22	0.88
Euglena sp.	eu2	2.08	1.77	1.03	1.25	0.75	1.26	1.05	0.71	0.24	0.68	0.43	0.22
T. volvocina	eu3	0.92	1.01	1.55	0.50	1.00	1.52	0.84	0.95	0.72	0.91	0.65	0.44
Trachelomonas sp.	eu4	0.69	0.50	1.03	0.75	0.50	0.25	0.42	0.24	0.24	0.23	0.22	0.22
Number of total identified algae		**867**	**793**	**775**	**799**	**797**	**792**	**950**	**842**	**836**	**882**	**921**	**907**

Cluster Analysis (CA) that is one of the most widely used multivariate statistical techniques to evaluate the surface water quality provides to facility in order to classify the objects according to similar characteristics (Yücel and Yücel, 2013; Tokatlı, 2013; Tokatlı et al., 2013; Tokatlı, 2014). In the present study CA was applied to the results to classify the stations according to biodiversities of non – silica algal floras. Tree dendogram of CA is given in Figure 2 and the similarity coefficients of stations are given in Table 3.

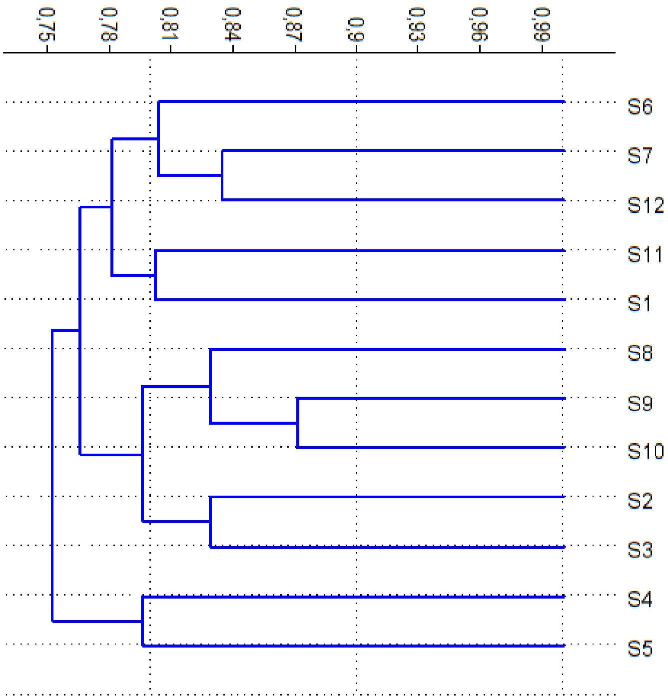

Figure 2. Tree dendrogram of CA

Table 3. Similarity coefficients of stations

St. *	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
S1	1											
S2	0.79	1										
S3	0.73	0.82	1									
S4	0.77	0.75	0.74	1								
S5	0.76	0.76	0.76	0.79	1							
S6	0.73	0.78	0.73	0.73	0.78	1						
S7	0.80	0.80	0.77	0.74	0.76	0.80	1					
S8	0.71	0.82	0.76	0.70	0.78	0.76	0.78	1				
S9	0.74	0.80	0.81	0.73	0.75	0.77	0.81	0.82	1			
S10	0.78	0.78	0.77	0.75	0.78	0.78	0.81	0.82	**0.87**	1		
S11	0.80	0.73	**0.68**	0.70	0.74	0.77	0.76	0.74	0.74	0.80	1	
S12	0.77	0.74	0.69	0.72	0.75	0.80	0.83	0.77	0.78	0.82	0.83	1

*: The most and least similarity coefficients were highlighted with bold

According to the results of CA, 5 statistically significant clusters were formed: Cluster 1 corresponded to the stations of S5 and S4 that were Kunduzlar Dam Lake side of the basin; Cluster 2 corresponded to the stations of S3 and S2 that were Çatören Dam Lake side of the basin; Cluster 3 corresponded to the stations of S10, S9 and S8 that were the downside of the basin; Cluster 4 corresponded to the stations of S1 and S11; Cluster 5 corresponded to the stations of S12, S7 and S6. As a result of CA, different ecological zones of the Seydisuyu Stream Basin including reservoirs and up – downstream sides were clearly presented as separately according to the abundance of non – silica algae. These results may reflect the availability of CA in determining ecological zones by using algae

According to a study performed in Ankara Stream, *Anabaena*, *Spirulina*, and *Oscillatoria* species from Cyanophyta were found to be dominant taxa and it was also reported that these species were adapted to pollution in Ankara Stream (Atıcı and Ahıska, 2005). Hellawell (1989) reported that *Oscillatoria* species are commonly found in highly polluted, nutrient – rich and ß – mesosaprob waters. According to a study performed in Tecer Stream, as similar to the present study, *Oscillatoria formosa* was found to be very abundant in especially organically contaminated areas (Kılınç, 1998). Also Gaur (1997) reported that *Microcystis* species are most commonly found in eutrophic waters. In the present study, *Anabaena*, *Spirulina*, *Oscillatoria* and *Microcystis* species from cyanophyta were found to be quite common in Seydisuyu Stream, where is known as an impacted area by anthropogenic pressures.

Verma and Munshi (1987), and Jindal and Vatsal (2005) reported that *Scenedesmus* species are found in quite abundant in sewage – polluted waters. It was also reported that *Chlorella* and *Scenedesmus* species form Chlorophyta are found in organically polluted waters and they can used to be as pollution indicators (Atıcı and Alaş, 2012). In the present study, *Chlorella* and *Scenedesmus* species were found to be the most dominant taxa in Seydisuyu Stream Basin, which contains many agricultural and urban areas. Also *Pediastrum boryanum* that is recorded as a quite common Chlorophyta species in the Seydisuyu Stream Basin was identified as the characteristic taxon in mesotrophic freshwater ecosystems (Dussart, 1956; Rawson, 1956).

Physical and chemical parameters used to determine the water quality may indicate just the current status of aquatic ecosystem. But algae, which are one of the most important groups used in water quality monitoring, may indicate the long – term effects on freshwater ecosystems (Torrisi and Dell'Uomo, 2006). Therefore the biotic components of aquatic habitats like algae have to be used in ecosystem quality assessment studies in order to make an objective and more reliable evaluation. The productivity of water bodies has been the subject of numerous studies, especially with an ecological focus on the transfer of matter and energy through the food chain (Kant and Kachroo, 1971). For a more practical approach, pragmatic alternatives have been proposed to relate productivity to easily accessible indicators, such as lakes and rivers. Algae are known as the most important element of primary productivity in the aquatic food chain. Therefore investigating the algae composition of freshwater ecosystems is a necessity and the first step to understand the system as a whole. In the present study, non – silica algae that can be used surveillance of freshwater quality were investigated and *Ankistrodesmus falcatus*, *Chlorella vulgaris*, *Pediastrum boryanum*, *Scenedesmus communis* and *Scenedesmus bijuga* from Chloropyta, *Anabaena flos-aqua*, *Microcystis punctata*, *Spirulina major*, *Oscillatoria tenuis* and *Oscillatoria granulata* from Cyanophyta and *Ceratium hirundinella* from Dinophyta were found to be the most dominant taxa in Seydisuyu Stream Basin, which are known as pollution indicators and to have wide ecological valences.

4. Conclusions and discussion

In the present study, the flora of non – silica algae in Seydisuyu Stream Basin were investigated and Cluster Analysis (CA) was applied to the results in order to classify the stations. As a result of the study, 17 Chlorophyta species, 12 Cyanophyta species, 4 Euglenophyta species, 2 Dinoflagellata species and 1 Chrysophyta species totally 36 non – silica algae taxa were identified and Cluster Analysis (CA) grouped 12 sampling seasons into 5 clusters of similar biodiversities of non – silica algal characteristics. According to biological data observed, Seydisuyu Stream Basin has a mesotrophic – oligotrophic state and quite polluted by organic contaminants thought to be originated from agricultural applications and rural areas located on the basin.

References

Anagnostidis, K. and Komarek, J. (1988). Modern approach to the classification system of Cyanophytes Oscillatoriales. Arch. Hydrobiol. (Suppl. 80), Algological Studies, 50(53), 327-472.

Atıcı, T., Ahiska, S. (2005). Pollution and algae of Ankara stream. Gazi University Journal of Science, 18(1), 51–59.

Atıcı, T., Çalışkan, H. (2007). Effect of Some Enviromental Variables on Bentic Shore Algae (Excluding Bacillariophyta) of Asartepe Dam (Ankara). International Journal of Natural and Engineering Sciences, 1 (2), pp. 9–22.

Atıcı, T., Obalı, O. (2000). Çoruh River's (Bayburt-Turkey) Algae (Excluding Bacillariophyta). The Herb Journal of Sistematic Botany, 7(1), pp. 231-247.

Atici, T., Alas, A. (2012). A study on the trophic status and phytoplanktonic algae of Mamasin Dam Lake (Aksaray-Turkey). Turkish Journal of Fisheries and Aquatic Sciences, 12, 595–601.

Bourrelly, P. (1966). Les algues d'eau douce. Tome I. Les algues vertes (Edn. N. Boubee and Cie), Paris.

Çiçek, A, Bakış, R, Uğurluoğlu, A, Köse, E, Tokatlı, C. (2013). The Effects of Large Borate Deposits on Groundwater Quality of Seydisuyu Basin (Turkey). Polish Journal of Environmental Studies, 22 (4): 1031-1037.

Demir, N., Pulatsu, S., Kirkagac, M. U., Topcu, A., Zencir, Ö., Fakioglu, Ö. (2011). Phytoplankton Composition Considering the Odor Occurrence in Porsuk River (Eskisehir-Turkey). Asian Journal of Chemistry, Vol. 23 (1): 247-250.

Dussart, B. (1956). Limnologie l'etude des eaux Continentales. Geobiologie, Ecologie, Amenagement Ed. Gautheir-Villards, Paris.

Gaur, R. K. (1997). Effects of *Microcystis aeruginosa* bloom on the density and diversity of cyanophycean population in a tropical pond. Proceedings of the 84th Indian Science Congress Part III, University of Delhi, New Delhi.

Hellawell, M. J. (1989). Biological Indicators of Freshwater Pollution and Environmental Management. Elsevier Applied Science, London and NewYork.

Huber P., G. (1969). Das Phytoplankton des Susswassers, systematik und biologie, Part 4: Euglenophyceen. Stuttgart, E. chweizerbart'sche Verlagsbuchhandlung (Nagele u. Obermiller).

Huber P., G. 1972. Das: Phytoplankton des Susswassers, systematik and biologie, Part 6, Fott. B. Chlorophyceae (Grunalgen), Ordnung Tetrasporales. Stuttgart, E. Schweizerbart'sche Verlagsbuchhandlung (Nagele u. Obermiller).

Jindal, R., Vatsal, P. (2005). Plankton as biomonitors of saprobity. Aquaculture, 6 (1), 1–16.

John, D. M., Whitton, B. A., Brook, A. (2003). The freshwater algal flora of the British Isles. An identification guide to freshwater and terrestrial algae. Cambridge University Press.

Kant, S., Kachroo, P. (1971). Phytoplankton population dynamics and distribution in two adjoining lakes in Srinagar. I . Macroflora in relation to phytoplankton. Proc. Ind . Natl . Sci . Acad ., 37 (4) : 163-188.

Kılınç, S. (1998). Tecer Irmağı Algleri. Süleyman Demirel Üniversitesi Eğirdir Su Ürünleri Fak. Dergisi, 6, 136-147.

Komarek, J., Anagnostidis, K. (1989). Modern approach to the classification system of cyanophytes. 4. Nostocales. Arch. fur Hydrobiol. (Suppl. 82), Algological Studies, 56, 247-345.

Komarek, J., Anagnostidis, K. (1999). Cyanoprokaryota, Chroococcales, Süßwasserflora von Mitteleuropa. Stuttgart, New York, Gustav Fisher Verlag, 19/1.

Komarek, J., Eloranta, P., Lhotski, P. (1998). Cyanophyta/Cyanophyta-14. Symposium Internat. Assoc. for Cyanophyte Research (IAC), Lammi (Finland) 1998 / Proceedings, Morphology, taxonomy, ecology. Archiv fur Hydrobiologie (Suppl. 129), Algological studies, 94.

Köse, E., Tokatlı, C., Çiçek, A. (2014). Monitoring Stream Water Quality: A Statistical Evaluation. Polish Journal of Environmental Studies, 23 (5): 1637-1647.

Rawson, D. S. (1956). Algal Indicators of trophic lake types. Limnol. Oceonogr. 1, 18-25.

Round, F. E. (1973). The Biology of the Algae, Second Edition. London.

Solak, C. N., Barlas, M., Pabuççu, K. (2007). Akçay'ın (Büyük Menderes-Muğla) Bacillariophyta Dışındaki Epilitik Algleri. Ekoloji, 16, 62, 16-22.

Tokatlı, C. (2013). Use of Statistical Methods in Water Quality Assessment: A Case Study of Balkan Arboretum Area in Trakya University (Edirne, Turkey). Journal of Applied Biological Sciences, 7 (3): 79-83.

Tokatlı, C. (2014). Drinking Water Quality of a Rice Land in Turkey by a Statistical and GIS Perspective: Ipsala District. Polish Journal of Environmental Studies, 23 (6): 2247-2258.

Tokatlı, C., Çiçek, A., Köse, E. (2013). Groundwater Quality of Türkmen Mountain (Turkey). Polish Journal of Environmental Studies, 22 (4): 1197-1208.

Tokatlı, C., Köse, E., Çiçek, A. (2014). Assessment of the Effects of Large Borate Deposits on Surface Water Quality by Multi Statistical Approaches: A Case Study of the Seydisuyu Stream (Turkey). Polish Journal of Environmental Studies, 23 (5): 1741-1751.

Torrisi, M., Dell'Uomo, A. (2006). Biological monitoring of some Apennine rivers (Central Italy) using the diatom-based Eutrophication/Pollution Index (EPI-D) compared to other European diatom indices. Diatom Research, 21, 159–174.

Varol, M., Şen, B. (2014). Flora of the Planktonic Algae of the Tigris River. Journal of FisheriesSciences.com, 8(4): 252-264.

Verma, P. K., Munshi, D. (1987). Plankton community structure of Badua reservoir, Bhagalpur (India). Tropical Ecology, 28, 200–207.

Yücel, M., Yücel, E. (2013). On the ecotoxicological effects of heavy metal pollution of industrial origin determination of wheat varieties. Biological Diversity and Conservation, 6/3: 6-11.

(Received for publication 31 May 2016; The date of publication 15 December 2016)