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Seasonal and Spatial Variation of Epilithic Algal Community in Batlama Stream (Giresun, Turkey)

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ABSTRACT

Spatio-temporal changes in taxonomic composition and structure of epilithic algal community with some physicochemical features of the Batlama stream were assessed between June 2013 and May 2014 at the intertidal zone of the Batlama Stream, Giresun, Turkey. A total of 90 taxa were identified belonging to division of Bacillariophyta (80 taxa), Euglenophyta (3 taxa), Cyanobacteria (3 taxa) , Charophyta (2 taxa) and Chlorophyta (2 taxa) on epilitihic algae of Batlama Stream. Encyonema minutum, Ulnaria ulna, Cocconeis placentula, and Navicula cryptocephala species were the most abundant taxa among all samples of the four stations throughout the study.

The Shannon diversity index (H') values varied in the range from 0.5 to 1.2 and correlated with both species richness and relative species abundance (evenness). The results of the diversity analysis and the counting did not exactly match up with each other. Chlorophyll-a values of the stream and trophic classification (TDI, BDI) based on epilithic diatoms ascribed Batlama Stream to the mezotrophic range. Also, according to the calculated pollution index (PTI, S) values, all stations of the Batlama Stream were moderately polluted (β-mesosaprobity).

Keywords:
Stream; Epilithic algae; Seasonal variation; Diversity; Diatom index.

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INTRODUCTION

Diatoms, besides the role of environmental condition indicator, also determine the water quality and are as interesting and intriguing phytoplanktons, as snowflakes. They took a primary role in various studies, in terms of oxygen, nutritional value and pollution indicator. The main primary producers in undisturbed and shaded zones of the streams are epilithic algae and play major roles in controlling energy flow of food webs in stream ecosystems [1, 2]. However, the overgrowth of epilithic algae may deteriorate water quality [3]. The production and dynamics of an epilithic algal composition in stream ecosystems are also largely influenced by physical variables such as flow rate, light and water temperature [4, 5]. The variation of epilithic algal biomass may indirectly affect the distribution of the Batlama stream. Water quality variables (electrical conductivity, pH, total dissolved solids, chemical oxygen demand, biochemical oxygen demand, and nutrients such as phosphorus and nitrogen from the surrounding lands) also play major roles in regulating the production rate and species composition of epilithic algae in streams [6]. However, in complex stream ecosystems, the dynamics of epilithic algal biomass may nonlinearly interact with the combination of abiotic and biotic factors. Therefore, some index varieties may help to describe the nonlinear relationships between epilithic algal biomass and aforementioned factors.

In Turkey, studies of diatom were began by Yıldız in Meram stream [7] and followed by other researchers which mostly concentrated on various physicochemical factors affecting the development of diatoms in addition to their flora in cental anatolian [9, 10, 11, 12, 13, 14, 15, 16]. In recent years, some topics that determine trophic state and water quality level of a stream monitoring by means of diatom indices based on the variety and density of the diatoms in water or on the substrat have become popular [17, 18, 19].

The TDI was designed with the practical needs of busy water industry biologists in mind and, as a result, was designed to be robust and easily learnt. It uses the weighted average equation of Zelinka and Marvan [20] to interpret benthic diatom community structure in terms of the nutrient concentrations in the river.

Epilithic algal samples obtained in the present study comprised of mixed forms growing on silicate-rich stones and phytoplankton forms commonly living in littoral and pelajic zones of freshwaters, however, in this context this all community was termed as epilithon. The aims of the present study were to describe the species composition of diatom assemblages, to determine which environmental factors explain the composition of epilithic diatoms and to assess the response of common diatom taxa to these environmental variables..

MATERIALS AND METHODS

Samples analysed in this work were collected monthly between June 2013 and May 2014 from four stations (Fig. 1). Stones collected from the stations in the stream were brushed clean of algae and the samples fixed the formaldehyde solution (4%). The epilithic diatoms were then placed on permanent slides which had been prepared according to Round [21]. At least 300 diatom valves per slide were counted at 400x magnification on Olympus BX51 microscope. In the evaluations, the average of three countings from the station was used [22]. Species identifications were based primarily on the John *et al.* [23], Krammer and Lange-Bertalot [24, 25, 26, 27]. In addition, current systematic status of algae taxa is checked by way of AlgaeBase databases [28] and the author names are given in abbreviated form according to Brummit and Powel [29].

The Shannon diversity index, the evenness and species richness were applied on epilithic flora at different stations. The software used was PRIMER version 5.0 from Plymouth Marine Laboratory for Shannon-Wiener index [30]. Trophic diatom index (TDI) and Biological Diatom Index (BDI) were calculated by using the formula [31] and "IBD Calculate With Excel" programme [32], respectively. Also, the saprobic index (S) was evaluated based on the formula proposed by Pantle and Buck [33] and the diatom pollution tolerance index (PTI) was calculated based on the formula [34]. Water temperature (°C), pH, and dissolved oxygen concentration (mg/l) were measured in situ with WTW multi 340i/SET model pH meter. After filtering through GF/C and extracting in cold 90% acetone, chlorophyll-a (chl-a) was determined according to the equations of Strickland and Parsons [35].

RESULTS AND DISCUSSION

A total of 90 taxa belonging to division of Bacillariophyta (80), Euglenophyta (3), Cyanobacteria (3) , Charophyta (2) and Chlorophyta (2) were identified in this study (Table 1). Bacillariophyta members were rich in species diversity and intensity in the algal flora of Batlama Stream (Fig. 2).

Encyonema minutum, Ulnaria ulna, Cocconeis placentula, and *Navicula cryptocephala* were predominantly found species in all sampling stations in the study area (Fig. 3). Sienkiewicz [36] stated that *U. ulna* have wide trophy tolerance and can live in oligo-eutrophic water. So, to be dominant of *U. ulna* throughout the study period point to a mesotrophic environment. *Navicula cryptocephala* and *Ulnaria ulna* are known that broad to distribution in Turkey [37, 38].

Total organisms decreased their numbers during the months of high rainfall. Sıvacı and Dere [39] reached also a

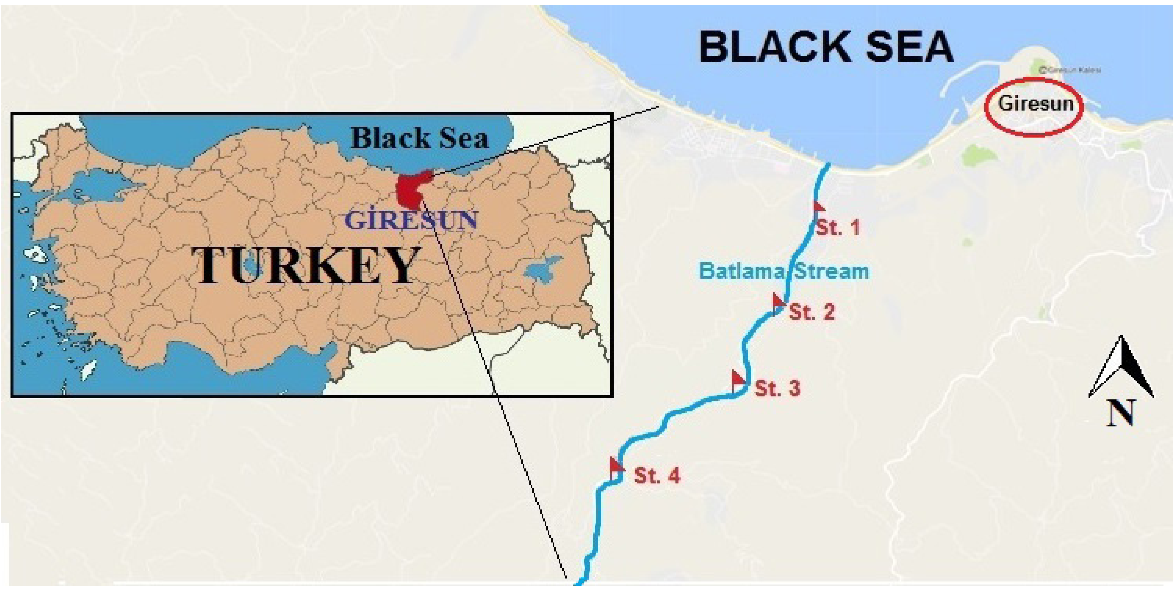

Figure 1. Locations of the sampling stations in Batlama Stream

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Table 1. The list of common taxa found in all four stations of the Batlama Stream

Division: Bacillariophyta	
Amphora ovalis (Kütz.) Kütz.	*Melosira varians* C. Agardh
Closterium navicula (Bréb.) Lütkem.	*Navicula cryptocephala* Kütz.
Cocconeis placentula Ehrenb.	*Navicula lanceolata* (C. Agardh) Kütz.
Cymatopleura solea (Bréb.) W. Sm.	*Navicula menisculus* Schum.
Cymbella affinis Kütz.	*Navicula rhynchocephala* Kütz.
Cymbella helvetica Kütz.	*Navicula tripunctata* (O.F.Müller) Bory
Cymbella tumida (Bréb.) Van Heurck	*Navicula viridula* var. *linearis* Hustedt
Diatoma vulgaris Bory	*Nitzschia acicularis* (Kütz.) W. Sm.
Didymosphenia geminata (Lyngb.) M.Schmidt	*Nitzschia palea* Kütz.
Encyonema caespitosum Kütz.	*Rhoicosphenia abbreviata* (C.Agardh) Lange-Bert.
Encyonema minutum (Hilse) D.G.Mann	*Surirella minuta* Bréb.
Encyonema silesiacum (Bleisch) D.G.Mann	*Ulnaria ulna* (Nitzsch) Compère
Eunotia minor (Kütz.) Grunov	**Division: Chlorophyta**
Fragilaria capucina Desmaz.	*Botryococcus braunii* Kütz.
Gomphonema augur Ehrenb.	**Division: Cyanobacteria**
Gomphonema minutum (C. Agardh) C. Agardh	*Oscillatoria tenuis* C. Agardh
Gomphonema olivaceum (Hornem.) Bréb.	**Division: Euglenophyta**
Gyrosigma scalproides (Rabenh.) Cleve	*Euglena gracilis* G.A.Klebs
Hannaea arcus (Ehrenb.) R.M.Patrick	*Euglena viridis* (O.F. Müll.) Ehrenb.

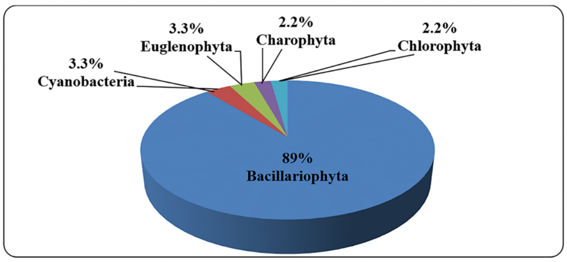

Figure 2. % Distribution of Epilithic Algal Composition in Batlama Stream

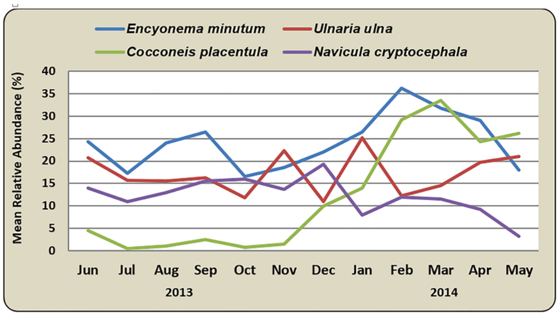

Figure 3. Seasonal variations of predominant species in the epilithon of the Batlama stream

very similar conclusion during their study. Species diversity increased in the months of which the water temperature rise. Yavuz and Çetin [40] had recorded that relationship between seasonal variation of algae and water temperature.

The all parameters are high during the study period except winter. Water temperature ranged between 5.2 and 24.3°C in the stream. The development of epilithic algae in the stream affected by water temperature. The epilithic algal density was lower in some months except February and November than the other months when the temperature was low. In the stream throughout the research period, whereas the maximum oxygen level was 14 mg/l, the minimum level was 2 mg/l. The solubility of oxygen in the water decreases with the increase in temperature [41]. The density of oxygen in a natural oligotrophic freshwater having a temperature around 20°C is about 10 mg/l [42]. The average pH value of 7.8 indicates that the stream is slightly alkaline. The abundance of Encyonema minutum, Ulnaria ulna and Navicula cryptocephala in present study supports the Round's idea [43] that these species are widespread in alkaline waters. When total cell numbers were found to be high in autumn and winter seasons the pH values also reached similarly high values in these months in the study area. This result did not support the Vinebrooke's view [44] that algal growth decreases with pH increase.

The amount of chlorophyll-a were calculated monthly and chlorophyll-a showed usually similar values at the sampling stations. Chl-a ranged from 0.2 to 15.2 mg/m^3 in Batlama stream. According to Moses [45] has stated that running water with chlorophyll-a values between 10 and 30 mg/m^3 was mesotrophic. In term of the values, Batlama stream has a mesotrophic character.

The seasonal variation of Shannon diversity and even-

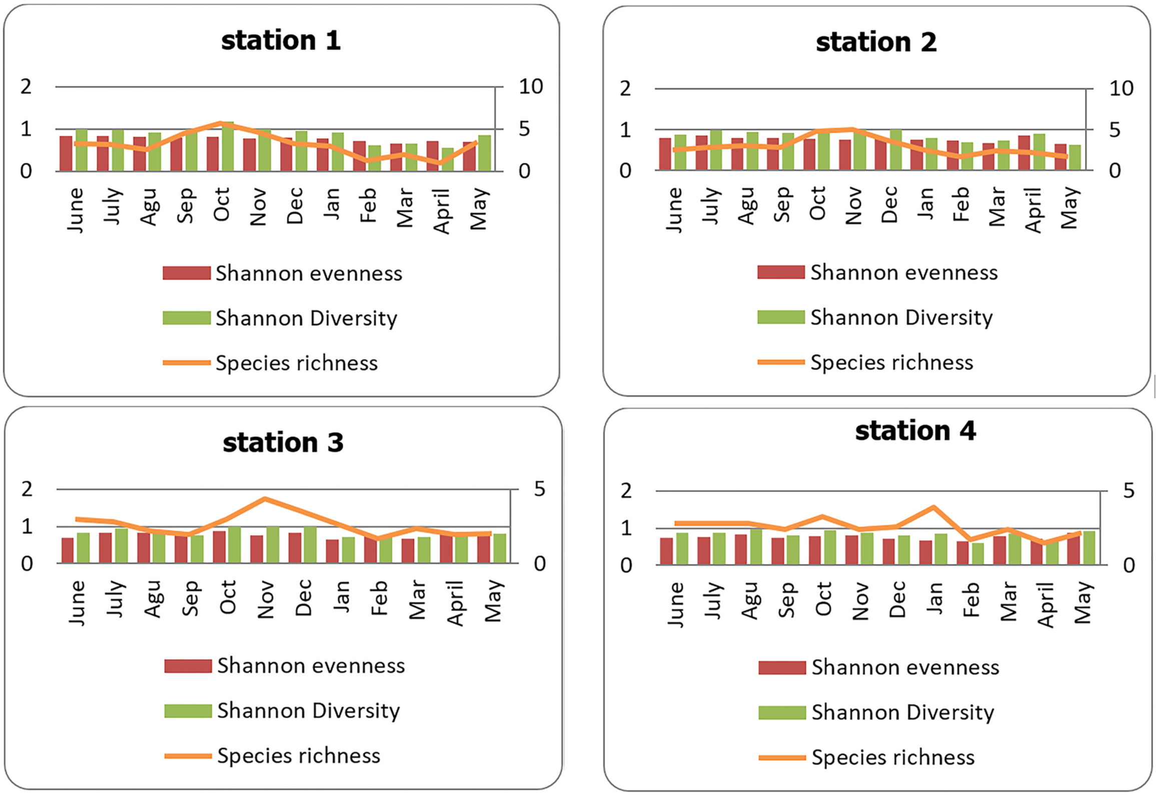

Figure 4. Shannnon diversity, evenness, and species richness of the Batlama stream

ness did not vary greatly during the study period. While the highest values of the H' during the year was usually recorded in October, the lowest value was recorded in April. Recording the low value of shannon diversity in April may be due to heavy rain mostly seen in Giresun in this month of the spring. In our study it was found that species diversity decreased in the spring and confirmed this with the Shannon diversity index. Species evenness index varied from 0.7–0.8. The lower species evenness values were often associated with the rainy season. Approaching the zero value of relative species abundance (evenness) indicates dominance of organism linked to single-species that Encyonema minutum and Cocconeis placentula comprised of more than 80% of the all organisms in April 2014. Recording a decrease of H' and J' values with being the result of the excessive increase of these species indicates that Batlama stream is under pressure in these months of the year. The seasonal variations of species richness presented a decrease especially in cold period, while the highest values of species richness were recorded in autumn period (Fig. 4).

BDI and TDI indices provide information about trophic states of the lotic ecosystems. In the study, taxa with an mean relative abundance (%) less than 5 throughout the year were not included in the index calculation. Accordingly, 22 diatom taxa were used in St.1 and 19 diatom taxa in the other three stations to calculate the diatom indice scores of the four stations to determine the trophic status and water quality of the Batlama Stream. While the lowest value of the TDI was recorded in station 3 as 49.8, the station has the lowest BDI value was station 4. Both values of the indices indicate oligo-mesotrophic features. TDI and BDI values of the four stations ranged between 50–55 and 14.7-15.4 respectively (Table 2). However, mean values of TDI (53.5) and BDI (15.1) indicated that the trophic structure of Batlama stream is mesotrophic. Similarly, according to PTI and S values, the studied site was moderately polluted (β-mesosaprobity). The present results coincide with the conclusions of Köster and Hübener [46], who suggested that the best method for monitoring freshwater by diatoms is the combined application of saprobity and trophic indices.

CONCLUSION

Agriculture, livestock activities and domestic waste water into the Batlama stream, are factors that increase of water pollution. The factors are decreased of density of epilithic algae. The present study results demonstrated that epilithic algal composition is distributed gradients of enviromental factors. Temperature and rain are more important factor in explaning the seasonial variation of epilithic algae of Batlama stream. More research is needed to analyse the causes of the observed variation in the nutrient status and biomass of benthic algae in Batlama stream.

According to the diversity values, one can conclude that Batlama stream is on eutrophic level, however, the species

Table 2. Diatom indice values of the four stations in Batlama Stream derived from TDI, BDI, PTI and S

	kind of index	Station 1	Station 2	Station 3	Station 4	Average
Trophic index	TDI	53.8	55.3	49.8	55.3	53.5
	BDI	15.3	15	15.4	14.7	15.1
Pollution index	PTI	2.5	2.5	2.4	2.4	2.5
	S	2.3	2.3	2.4	2.4	2.4

composition of the stream, TDI, BDI, and chl-a values indicate that the stream is mesotrophic. So, diversity indices calculated using epilithic diatoms did not exactly represent the trophic status of the stream. Consequently, based on all these results, it can be said that Batlama stream does not yet reach the level of pollution and having mesotrophic characteristics as a trophic structure.

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