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A Study on the Epipelic Diatom Flora of Tunca River and Evaluation of Water Quality by Using Biological Diatom Index

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ABSTRACT

In this study, epipelic (EPP) diatom flora of Tunca River was investigated and Biological Diatom Index (BDI) was used to determine the trophic status of the river. Diatom samples were collected in autumn season of 2018 from the downstream of Tunca River (before emptying into Meriç River) and some limnological parameters were measured during the field studies. Cluster Analysis (CA) was also applied to detected biological data in order to classify the identified taxa in terms of their dominance grades in the system. According to the results of chemical analysis, Tunca River has I. – II. Class water quality in terms of almost all the investigated parameters and has III. Class water quality in terms of NO2 parameter. According to the results of biological researches, a total of 19 diatom species were identified by counting a total of 409 diatom valves and Navicula erifuga Lange-Bertalot, Navicula gregaria Donkin and Navicula rostellata Kützing were recorded as the most dominant taxa. According to result of BDI, the investigated river was found in meso-eutrophic state and according to results of CA, three statistical clusters were formed, which were named as “dominant taxa”, “moderate dominant taxa” and “rare taxa”.

INTRODUCTION

Diatoms, which are known to be a large part of the benthos (often 90 – 95%), can be found in all surface waters all the time. They are also one of the most important aquatic producer groups and have quick reactions to the changes in environmental variables. Therefore, diatoms, which are accepted as an important part of bio-indicator organisms, have been used to evaluate environmental conditions in many countries as indicators of water pollution. Diatom indices developed for different conditions in different habitats are one of the most widely used water quality assessment techniques and the Biological Diatom Index (IBD) is one of the most convenient indexes for evaluating the water quality by using diatom communities.

The Meriç River is one of the most significant lotic ecosystems for the Balkans and it is well documented that they are being exposed to intensive anthropogenic pressure – especially from agricultural and domestic applications conducted on their watersheds (Erkmen and Kolankaya, 2006; Tokatlı and Başţatlı, 2016; Tokatlı, 2017). The aim of this study was to determine the epipelic diatoms of Tunca River and to evaluate/compare the water quality by using certain limnologic parameters and the Biological Diatom Index (IBD).

MATERIAL AND METHOD

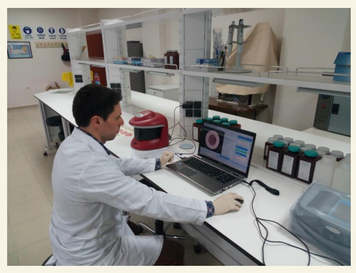
Water and epipelic (EPP) diatom samples were collected from Tunca River in autumn (November) season of 2018. A map of the study area and the selected station is shown in Figure.

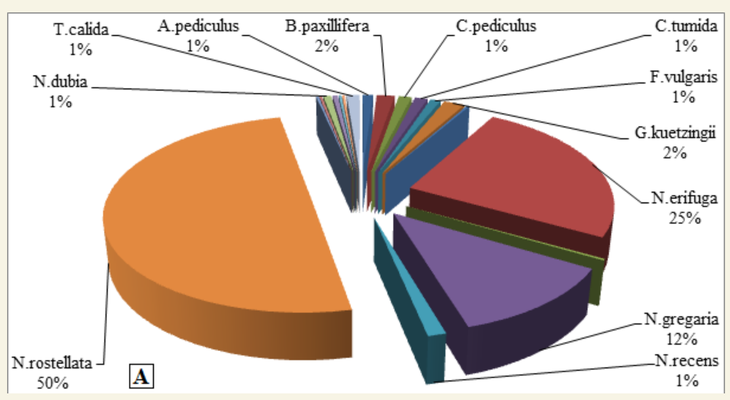
The dissolved oxygen, oxygen saturation, pH, EC, TDS, salinity and oxidation - reduction potential (ORP) parameters were determined using a Hach Lange branded "HQ40D Multiparameter” device during the field studies; the turbidity parameter was determined using a Hach Lange branded "2100Q Portable Turbiditymeter” device during the field studies; the nitrate, nitrite, ammonium, phosphate, sulphate and chemical oxygen demand (COD) parameters were determined using a Hach Lange branded "DR3900 Spectrophotometer” device during the laboratory studies.

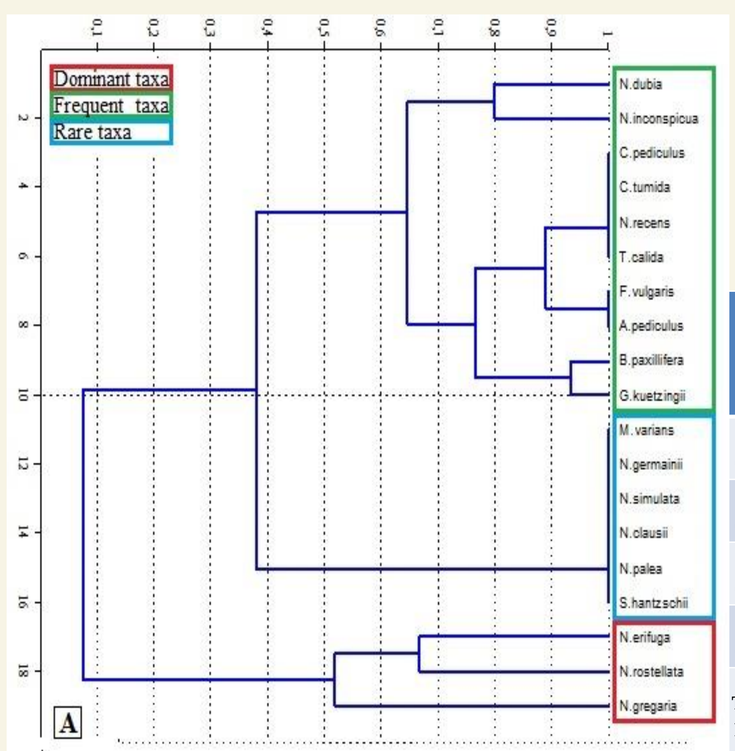
A glass pipe with a diameter of 0.8 cm and 100 – 150 cm long was used for capturing EPP diatom samples. Then the diatom samples collected from the field were cleaned with acid (98% H_2SO_4 and 35% HNO_3) and mounted on a microscope for observation at a magnification of 1000X. Slides were prepared and approximately 400 valves were enumerated on each slide to determine the relation and abundance of each taxa. Diatoms were identified according to Cox (1996) and Krammer and Lange-Bertalot (1986; 1988; 1991a; 1991b).

The Biological Diatom Index (IBD) values of the Meriç River were automatically calculated using the "Calculate IBD with Excel" program.

Cluster Analysis (CA) according to Bray Curtis was applied to the results using the "Past" package program in order to classify the diatom species in terms of their relative abundances.







RESULTS AND DISCUSSION

Physical and Chemical Data

The results of the physicochemical data detected in the Tunca River and some national limit values are given in Table. According to the criteria of the Water Pollution Control Regulation in Turkey, the Tunca River has I. – II. Class water quality in terms of dissolved oxygen, oxygen saturation, pH, EC, TDS, nitrate, ammonium, sulphate and COD parameters; and have III. – IV. Class water quality in terms of nitrite and phosphate parameters.

Biological Data

During the present study, a total of 36 diatom species were identified from the epipelic (EPP) habitats of the Tunca River by counting a total of more than 400 valves in the Tunca River. A list of identified diatom taxa with the frequency values of the investigated stations is given in Table and the relative abundance values of the detected EPP diatom species, which have relative abundance values higher than 1% for the Tunca River, is given in Figure.

Cluster Analysis (CA)

Cluster Analysis (CA), which classifies the objects, is one of widely used multivariate statistical techniques and hierarchical agglomerative clustering is the most common approach in CA applications. In the present study, CA was applied to the results in order to classify the EPP diatoms of the Tunca River according to their relative abundance values. According to the results of CA, three statistically significant clusters were formed and these detected clusters were named as “dominant taxa”, “frequent taxa” and “rare taxa”.

The Biological Diatom Index (IBD)

The Biological Diatom Index (BDI) is a standardized biologically water quality assessment method. The BDI, the formula of which was developed by Zelinka and Marvan (1961), is based on a total of 209 diatom taxa and provides information about trophic levels of the investigated aquatic ecosystems. In the present study, a total of 36 diatom taxa were identified and 34 of them were used to calculate the Biological Diatom Index (BDI) scores of the Tunca River in order to determine the trophic statuses. The BDI index values of the investigated rivers are given in Figure. According to the calculated BDI values for the EPP habitats of the investigated aquatic ecosystems, the Tunca River was in “meso – eutrophic state” and had “low water quality” (score range of 9 – 12) in general.

Parameters	DO (mg/L)	OS (%)	pH	EC (mS/cm)	TDS (mg/L)	Sal (‰)	Tur (NTU)	NO_3 (mg/L)	NO_2 (mg/L)	NH_4 (mg/L)	$*PO_4$ (mg/L)	SO_4 (mg/L)	COD (mg/L)	ORP (mV)
I. Class	8	90	6.5-8.5	400	500	-	-	5	0.002	0.2	0.02	200	25	-
II. Class	6	70	6.5-8.5	1000	1500	-	-	10	0.01	1	0.16	200	50	-
III. Class	3	40	6.0-9.0	3000	5000	-	-	20	0.05	2	0.65	400	70	-
IV. Class	<3	<40	Out of 6.0-9.0	>3000	>5000	-	-	>20	>0.05	>2	>0.65	>400	>70	-
Tunca River	**8.98** I. Class	**96.9** I. Class	**8.07** I. Class	**777** II. Class	**426** I. Class	**0.43**	**2.46**	**2.230** I. Class	**0.072** IV. Class	**0.249** II. Class	**1.960** IV. Class	**69.6** I. Class	**39.1** II. Class	**196.4**

Diatom Taxa	Tunca River
Amphora pediculus (Kützing) Grunow	+
Bacillaria paxillifera (O.F.Müller) T.Marsson	+
Cocconeis pediculus Ehrenberg	+
Craticula subminuscula (Manguin) Wetzel & Ector	-
Cyclotella atomus Hustedt	-
Cyclotella meneghiniana Kützing	-
Cymbella tumida (Brébisson) Van Heurck	+
Diatoma vulgaris Bory	-
Encyonema minutum (Hilse) D.G.Mann	-
Frustulia vulgaris (Thwaites) De Toni	+
Geissleria decussis (Østrup) Lange-Bertalot & Metzeltin	-
Gyrosigma kuetzingii (Grunow) Cleve	+
Melosira varians C.Agardh	+
Navicula amphiceropsis Lange-Bertalot & U.Rumrich	-
Navicula capitatoradiata H.Germain ex Gasse	-
Navicula erifuga Lange-Bertalot	+
Navicula germainii J.H.Wallace	+
Navicula gregaria Donkin	+
Navicula perminuta Grunow	-
Navicula radiosa Kützing	-
Navicula recens (Lange-Bertalot) Lange-Bertalot	+
Navicula rostellata Kützing	+
Navicula simulata Manguin	+
Nitzschia amphibia Grunow	-
Nitzschia clausii Hantzsch	+
Nitzschia dissipata (Kützing) Rabenhorst	-
Nitzschia dubia W.Smith	+
Nitzschia inconspicua Grunow	+
Nitzschia linearis W.Smith	-
Nitzschia palea (Kützing) W.Smith	+
Nitzschia sociabilis Hustedt	-
Nitzschia subacicularis Hustedt. nom. inval.	-
Pantocsekiella ocellata (Pantocsek) K.T.Kiss & Ács	-
Reimeria sinuata (W.Gregory) Kociolek & Stoermer	-
Stephanodiscus hantzschii Grunow	+
Tryblionella calida (Grunow) D.G.Mann	+