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Use of Epilithic Diatoms to Evaluate Water Quality of Murat Stream (Sakarya River Basin, Kütahya): Different Saprobity Levels and pH Status

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Abstract

In this study, the epilithic diatoms were monthly investigated from five stations between September 2007 and April 2008 along the Murat Stream and 75 diatom taxa were totally identified. Among the stations, *Cymbella affinis* in M1, *Gomphonema truncatum* in M2, *Diatoma moniliformis* in M3, *Gomphonema olivaceum* in M4 and *Fragilaria ulna* in M5 were the most dominant species. Also, water quality of the Murat Stream was determined according to diatom taxa by using Håkansson, Lange-Bertalot, Hoffman, Van Dam and Watanabe Indices. The results show that, according to Håkansson's Index, most of the species were alkaline characteristics; according to RoteListe of Lange-Bertalot Index approximately 51% of indicator species were described as "eutrophent"; according to Hoffman Index, the most of the indicator species were in the range of alfa- > beta- > βαmesosaprob; accrding to Van Dam Index, the most of the indicator species were the main groups of beta- than alphamesosaprobionts; and finally according to Watanabe Index, approximately 76% of indicator species were described as "indifferent."

Keywords: Epilithic diatoms, Kütahya, Murat Stream, Water quality.

INTRODUCTION

Diatoms are an important group of water ecosystems, they form a large part of the benthos (often 90 – 95%) and therefore they are an important part of water quality monitoring. They indicate water quality level of many aquatic environments. A huge advantage of the benthic diatoms is that they can be found in every surface waters at any time. Furthermore, in the form of preserved preparates or acid digested sample slides, the collected diatom samples can be preserved for an unlimited period of time and they can be reinvestigated whenever necessary. It is also incomplicated to decide what to consider an individual. However, a disadvantage of investigating diatoms is that it requires thorough taxonomic knowledge [1]. Diatoms have been used in a number of countries as indicators of river pollution [2, 3, 4, 5, 6, 1, 7, 8, 9, 10, 11, 12]. Although some similar studies have been made in our country [13, 14, 15, 16], the water quality monitoring, based on diatom indices, is a rather new topic for Turkey; and this topic is getting more important with each day.

The aim of this study was to investigate epilithic diatom composition and to reveal the ecologial characteristics and saprobity of Murat Stream by using epilthic diatoms.

MATERIALS AND METHODS

Study Area

Murat Stream, rises from the north of Murat Mountain and mixes with Kokar Stream approximately 11 km north of the district of Altintaş (Kütahya). Its length is 35 km and average flow is 2.5 m^3/sec [17].

Five stations were determined on study area by taking into consideration of source region, depth, flow rate, ease of transportation and waste water discharge zones. 1. station (M1) was the source of Murat Stream and located approximately 3 km away from Oysu village, 2. station (M2) was located on the Yeşilyurt village, 3. station (M3) was located on the Pınarcık village, 4. station (M4) was located on the district of Altıntaş, 5. station (M5) was located near the Alibey village just before mixing with Kokar Stream (Figure 1).

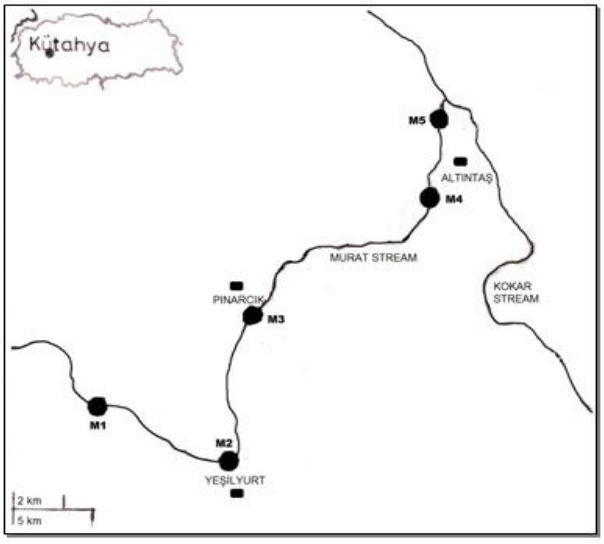


Figure 1. Study Area

Table 1. Ecological chracteristics of diatoms of Murat Stream

INDICES	Häkansson İndex	Lange-Bertalot İndex	Hoffmann İndex	Van Dam İndex	Watanabe İndex
BACILLARIOPHYTA					
CENTRALES					
Cyclotella meneghiniana Kützing	AKF	EU	--	α-p	sp
C. ocellata Pantocsek	AKF/NTR	--	--	o	ind
C. striata Grunow	NTR	HAL	--	--	ind
Melosira varians Agardh	AKF	--	--	α	ind
Meridion circulare (Greville) C.A.Agardh	AKF	AE	β-α	β	sx
PENNALES					
Achnanthes hungarica (Grunow) Grunow	AKF	EU	α	α	ind
Achnanthidium minutissimum (Kützing) Czanecki	AKF/NTR	TOL	β-α	β	sx
Amphipleura pellucida (Kützing) Kützing	--	TOL	β	α-p	ind
Amphora ovalis (Kützing) Kützing	AKF	TOL	β	β	ind
A. pediculus (Kützing) Grunow	AKF	--	β-α	β	ind
A. veneta Kützing	AKF	EU	p	α-p	ind
Anomoeneis sphaerophora (Ehrenberg) Pfitzer	AKB	EU	α	α	ind
Caloneis silicula (Ehrenberg) Cleve	AKF	TOL	o-β	o	ind
Cocconeis pediculus Ehrenberg	AKF	EU	β-α	β	sx
C. placentula var. *lineata* (Ehrenberg) Cleve	AKF	--	--	β	sx
Craticula ambigua (Ehrenberg) DG Mann	AKF	EU	--	--	sp
C. cuspidata (Kützing) D.G.Mann	AKF	O	α	α	sp
Cymatopleura elliptica (Brebisson) W.Smith	AKF	TOL	β	β	ind
C. solea (Brebisson) W.Smith	AKF	EU	α	β	ind
C. solea var. *apiculata* (W.Smith) Ralfs	AKF	--	α	β	ind
Cymbella affinis Kützing	AKF	--	o-β	β	ind
C. aspera (Ehrenberg) H.Peragallo	AKF	--	--	o	sx
C. helvetica Kützing	AKF	OC	o	o	ind
C. hungarica (Grunow) Pantocsek	--	--	--	--	--
C. hustedtii Krasske	AKF	--	--	o	ind
C. tumidula (Brebisson) Van Heurck	--	OC	o	o	ind
Denticula elegans Kützing	--	O	--	--	--
Diatoma moniliformis Kützing	NTR	--	β-α	--	ind
Diatoma vulgaris Morphotype *linearis* Bory	--	EU	--	β	ind
D. vulgaris Morphotype *ovalis* Bory	--	EU	--	--	--
D. vulgaris Morphotype *producta* Bory	--	--	--	β	sx
Fallacia pygmaea (Kützing) Stickle andD.G.Mann	AKB	--	α	α	ind
Fragilaria capucina var. *rumpens* (Kützing) Lange-Bertalot	NTR	--	β	β	ind
F. parasitica (W.Smith) Grunow	AKF	EU	β-α	β	İnd

F. ulna (Nitzsch) Lange-Bertalot	AKF	--	α-p	α-p	İnd
F. ulna var. *acus* (Kützing) Lange-Bertalot	AKF	--	β	α	Sx
Gomphonema affine Kützing	AKF	--	--	β	ind
G. augur Ehrenberg	AKF	EU	β-α	β	ind
G. gracile Ehrenberg	NTR	--	o-β	o	ind
G. olivaceum (Hornemann) Brebisson	AKF/AKB	EU	β-α	β	ind
G. parvulum Kützing	NTR	TOL	p	α-p	ind
G. truncatum Ehrenberg	AKF/NTR	TOL	β	β	sx
Gyrosigma acuminatum (Kützing) Robenhorst	AKB	EU	β-α	β	ind
G. spencerii (Quekett) Griffith andHenfrey	--	--	--	--	ind
Hantzschia amphioxys (Ehrenberg) W.Smith	NTR	AE	--	α	ind
Navicula angusta Grunow	ASF	OD	o	o	ind
N. cari Ehrenberg	AKF/NTR	EU	β	--	ind
N. cincta (Ehrenberg) Ralfs	AKF	EU	α	α	ind
N. lanceolata (Agardh) Ehrenberg	AKF	EU	α	α	ind
N. menisculus Schumann	AKF	--	α-βα	α	ind
N. menisculus var. *upsaliensis* Grunow	--	--	--	--	sx
N. radiosa Kützing	AKF/NTR	TOL	β	β	ind
N. tripuctata (O.F.Müller) Bory	AKF	EU	β-βα	β	ind
Nitzschia amphibia Grunow	AKF	TOL	α	α	ind
N. angustata (W.Smith) Grunow	AKF	TOL	o-β	o	ind
N. capitellata Hustedt	NTR	--	p	α-p	ind
N. commutata Grunow	--	HAL	--	--	ind
N. dissipata (Kützing) Grunow	AKF	EU	β	β	sx
N. dissipata var. *media* (Hantzsch) Grunow	--	TOL	o-β	--	ind
N. fonticola Grunow in CleandandMöller	AKF	EU	β-βα	β	sx
N. frustulum Kützing (Grunow)	AKF	EU	β-α	α-p	ind
N. gracilis Hantzsch	AKF/NTR	TOL	β	β	sp
N. linearis (Agardh) W.Smith	--	EU	β-α	β	ind
N. palea (Kützing) W.Smith	NTR	EU	p	p	sp
N. vermicularis (Kützing) Hantzsch	--	EU	--	β	ind
Pinnularia viridis (Nitzsch) Ehrenberg	NTR	--	β	β	ind
Planothidium lanceolatum (Bréb. ex Kütz.) Lange-Bertalot	AKF	--	α	α	ind
Sellophora pupula (Kützing) Mereschkowsky	NTR	--	α	α	sp
Stauroneis smithii Grunow	AKF	EU	β	β	ind
Surirella ovalis Brebisson	NTR	HAL	--	α	ind
S. subsalsa W.Smith	--	--	--	--	ind
S. tenera Gregory	AKF	O	--	β	ind
Tryblionella apiculata Gregory	--	--	α	α	ind
T. gracilis Hantzsch	--	--	α	α	ind
T. hungarica (Grunow) D.G.Mann	AKF	--	α	α	ind

Sampling and Analysis

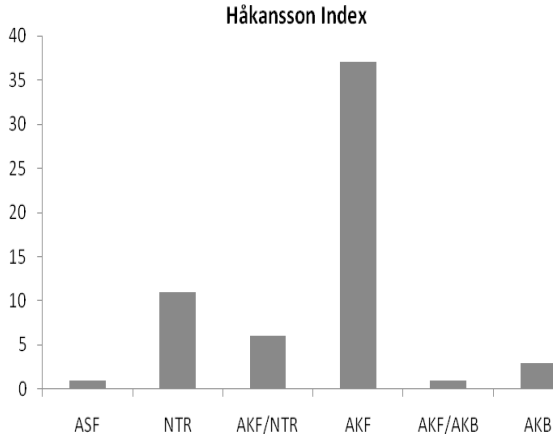
In this study, the epilithic diatom samples were collected monthly from five stations, between September 2007 and April 2008. Diatoms were collected by scraping 20 cm^2 area stones. They were cleaned with acid (HNO_3) and mounted on microscopie for observation with a magnification of 1000X. Three slides were prepared for each site and minimum 100 valves enumerated in each slide to determine the relation and abundance of each taxa [18, 19]. Diatoms were identified according to Krammer and Lange-Bertalot [20, 21, 22, 23] and then the dominat species of streem and Håkansson, Van Dam, Watanabe, Hoffmann and Lange-Bertalot indices were calculated.

Autoecologic Diatome Indices

In this study, the autoecological characteristics of the species were elaborated by using Håkansson Index, Hoffmann Index, Lange-Bertalot Index, Van Dam Index and Watanabe Index. Håkansson Index includes 9 classes (ASB = Acidobiontic, ASB/ASF = Acidofilik/Asidobiontic, ASF = Asidophilic, ASF/NTR = Asidophilic/Notral, NTR = Notral, AKF/NTR = Notral/Alkaliphil, AKF = Alkaliphil, AKF/AKB = Alkaliphil/Alkalibiontic, AKB = Alkalibiontic); Lange-Bertalot Index includes 7 classes (O = Oligotroph, OC = Oligotroph (alkaliphil), OD = Oligotroph (acidophil), EU = Mesotrophic-eutrophic, TOL = Tolerant, AE = Aerophil, HAL = Halophil); Van Dam Index includes 5 classes (o = oligosaprobic, β = βmesosaprobic, α = αmesosaprobic, α-p = αmesosaprobic/Polysaprobic, p = Polysaprobic); Watanabe Index includes 3 classes (sp = saprophil, sx = saproxene, ind = indifferent) and Hoffmann Index includes 9 classes (o=Oligosapob, o-β=Oligo/βmesosaprob, β=βmesosaprob, β-βα=β-βαmesosaprob, βα=βαmesosaprob, α-βα=α-βαmesosaprob, α=αmesosaprob, α-p=αmesosaprob/Polysaprob, p=Polysaprob; and also "--" was used for unknown species.

RESULTS

During the present study, a total of 75 diatom taxa were identified from Murat Stream (Table 1). *Cymbella affinis* (26.6%) in M1, *Gomphonema truncatum* (17.3%) in M2, *Diatoma moniliformis* (22.4%) in M3, *Gomphonema olivaceum* (16.4%) in M4 and *Fragilaria ulna* (16.3%) in M5 were the most dominant species among the stations.



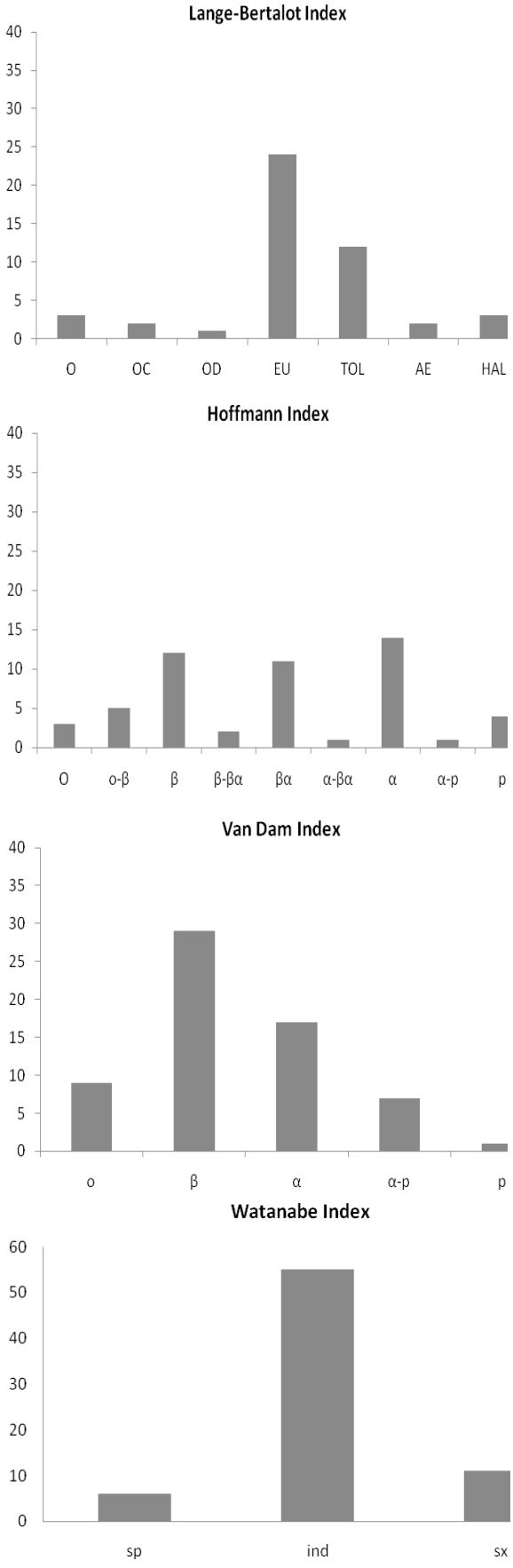


Figure 2. Diversity of indicator species of murat stream belonging to ecological groups

Water quality of the Murat Stream was determined according to diatom taxa by using Håkansson, Lange-Bertalot, Hoffman, Van Dam and Watanabe Indices. According to Håkansson's Index, 62.7% of all indicator species were alkaline charateristics; while, 18.6% were notral form. There is no acidobiontic form and only 1 taxa (1.7%) was acidophilic. According to Lange-Bertalot Index, 24 indicator species (51.1%) were described as "eutrophent" while, only 5 indicator species (12.8%) were "oligotrophic" characteristics. According to Van Dam Index, the most representing groups were beta- and alphamesosaprobionts (29 and 17 species, respectively). The assessment of organic pollution level based on Watanabe's Index, revealed 55 indicator species (76.4%) were described as "indifferent", 11 indicator species (15.3%) as "saproxene" and only 6 ones (8.3%) as "saprophile". According to Hoffmann Index, the most representing groups were alfamesosaprob (14 species; 26.4%), betamesosaprob (12 species; 22.6%) and beta-alfamesosaprob (11 species; 20.8%). 5.7% of all indicator species were oligosaprob while, 7.5% of them were polisaprob (Figure 2).

DISCUSSION

In this study, the epilithic diatoms were monthly investigated from five stations between September 2007 and April 2008 along the Murat Stream. As a result, 75 diatom taxa were totally identified. Also some autoecological diatom indices were evaluated for monitoring water quality of the Murat Stream.

As shown in Figure 3, *Cymbella affinis* have been identified as the most dominant taxon in M1 (26.6%). According to the indices used in the present study, it has Oligo/βmesosaprob characteristic. In M2, *Gomphonema truncatum* (17.3%) was most dominant taxon. According to the indices, it has βmesosaprob characteristic. In M3, *Diatoma moniliformis* (22.4%) was the most dominant taxon and it has βαmesosaprob characteristic. *Gomphonema olivaceum* have been identified as the most dominant taxon in M4 (16.4%). According to the indices, *G. olivaceum* has βαmesosaprob and eutrophic characteristic. Finally, the most dominant taxon of M5 was *Fragilaria ulna*, (16.3%) and it has αmesosaprob/Polysaprob characteristic. Dominant taxa, considered in terms of ecological characteristics; according to Krammer and Lange-Bertalot [20], *G. olivaceum* lives in different trophy levels when *G. truncatum* can be found in high conductivity and up to β-mesosaprob waters. *Cymbella affinis* shows dominance in I-II. water quality (less polluted) [24]. Also most taxa belonging to the genus Cymbella are indicators of the oxygen-rich waters [25]. When *D. moniliformis* can be found in high conductivity water, a cosmopolitan species of *F. ulna* has been adapted to different ecological conditions [22]. According to Van Dam et al. [25], *G. olivaceum*, *G. truncatum* and *F. ulna* are alkalibiontik and live in light saltwaters. But *G. olivaceum* and *G. truncatum* can be found in β-mesosaprob waters also *F. ulna* can be found from α-mesosaprob up to polysaprob waters. Also according to Potapova and Charles [26], the genus of Gomphonema includes alkali species.

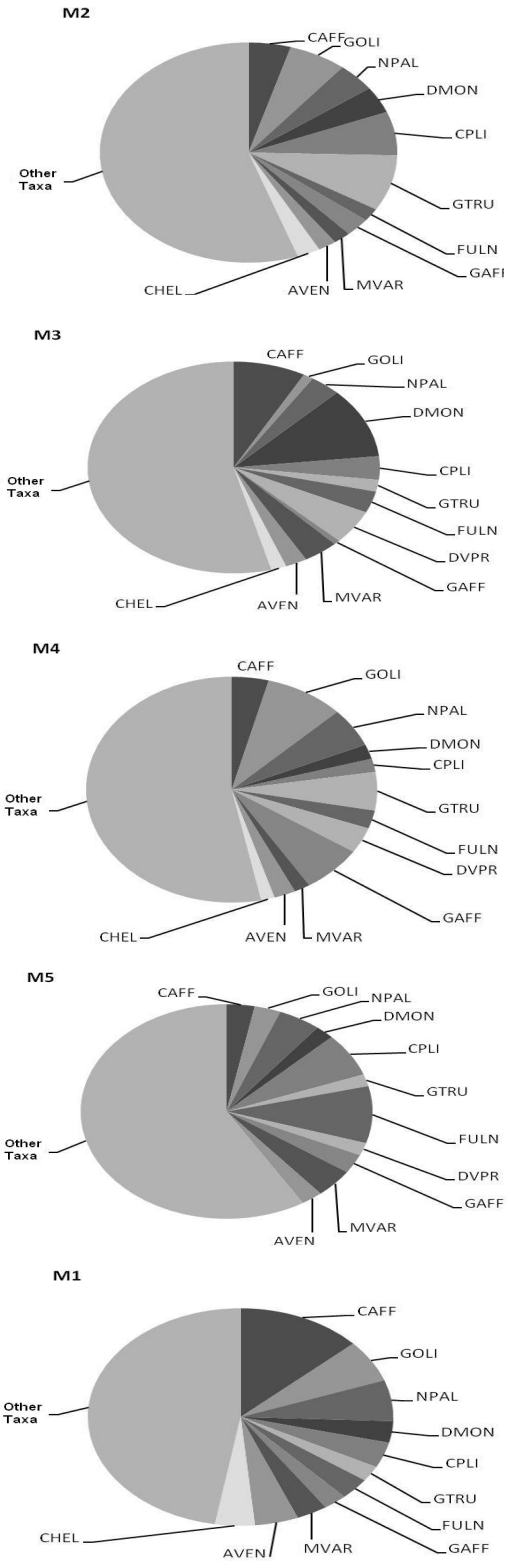


Figure 3. According to the stations, dominance status of dominant taxa in Murat Stream. AVEN: *Amphora veneta* Kützing, CAFF: *Cymbella affinis* Kützing, CPLI: *Cocconeis placentula* var. *lineata* (Ehrenberg) Cleve, DMON: *Diatoma moniliformis* Kützing, DVPR: *Diatoma vulgare* monotype *producta* Bory, FULN: *Fragilaria ulna* (Nitzsch) Lange-Bertalot, GAFF: *Gomhonema afine* Kützing, GOLI: *Gomphonema olivaceum* (Hornemann) Brebisson, GPAR: *Gomphonema parvulum* Kützing, GTRU: *Gomphonema truncatum* Ehrenberg, MVAR: *Melosira varians* Agardh, NPAL: *Nitzschia palea* (Kützing) W.Smith

M1 and M2 stations close to the source of Murat Stream and remote areas from pollution. Although there are no industry close to the M3, M4 and M5 stations, these regions exposure to organic pollution because of the settling areas. The dominant taxa that we identifed in M1, M2, M3, M4 and M5 and the data of indices that we use prove this information. According to the data obtained, there is a gradual pollution in the Murat Stream and this situation is highly effective on distribution and density of diatoms.

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