Benthic Diatom Algae in the watershed of River Black Drim and River Sateska

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Abstract

The Black Drim is a river that flows out of Lake Ohrid in Struga, Macedonia. After about 56 km it crosses the border to Albania and it merges with the White Drin in Kukes to form the Drin, which flows into the Adriatic Sea. Globochica is artificial lake on the River Black Drim located about 20 km northwest of Struga. Debar Lake - Spilje is artificial lake built in the valley of the river Black Drim located nearby town of Debar.

River Sateska is the largest tributary of Lake Ohrid but it is not a natural tributary of the Lake. In 1962 River Sateska was deliberately diverted into the lake to reduce siltation in downstream reservoirs.

Investigations for the diatom flora along the River Black Drim, Lakes Globochica and Debar and along the River Sateska were carried out during 2016 at 12 sampling sites to record the possible presence of invasive diatom species.

During the investigations a total of 78 taxa belonging to 19 genera were identified. Order Centrales was only represented by 4 species and order Penales 74 species. More species per site were identified along River Black Drim in comparison with River Sateska.

Based on the investigations, the sampling sites along the River Black Drim were characterized by the presence of species that dominate mesotrophic to eutrophic indicators.

Oligotrophic taxa predominated in the diatom assemblage at the sampling site Sini Viroj along the River Sateska. Presence of these diatom taxa indicated the best water trophic state at this sampling site.

Some poly-hypertrophic taxa were evidenced at sampling site St. Petka and more or less have been present in the other sampling sites downstream the River Sateska, with the exception of site Mesheishta. Visually, there have been noticed negative anthropogenic impact at the aforementioned sites.

During the investigations there were not registered invasive diatom species. All of the identified species are present in Lake Ohrid and its catchment area..

Keywords: diatoms, invasive species, trophic state.

Introduction

Invasive species are those that are not native to the ecosystem under consideration and that cause or are likely to cause economic or environmental harm or harm to human, animal, or plant health (ISAC 2006).

The factors enabling alien species to establish permanent populations cannot easily be identified because of the large number of factors determining the

ecological niche of a species. Besides chemical factors (e.g. shifts in nutrients), physical factors may be involved which are related to local or global climatic conditions (Nehring 1998).

It is evident that the history of introduction of nonindigenous aquatic species into Europe dates back to prehistoric times. Some of the human activities have facilitated the potential of alien species from all continents but Antarctica to became established in coastal and inland waters of Europe (Leppäkoski et al. 2002). The invasion and spread of non-native species of many different kinds of organisms is of increasing interest to researchers. Invasions by microscopic organisms, however, are poorly understood, and their impact on the environment is probably underestimated (Kaštovský et al. 2010).

The centric diatom *Coscinodiscus wailesii* is native to the Indian and Pacific Oceans. It was introduced to European waters and was first detected in the English Channel in 1977. Its tolerance to abiotic factors enabled it to become established and it spread rapidly (Laing & Gollasc 2002).

The diatoms *Coscinodiscus wailesii* and *Thalassiosira punctigera* were first reported in Norway in 1979. It is believed that the two species have arrived to Europe wind imported oysters (Jannson 1994).

According to Kilroy et al. (2008), in late 2004, an invasive freshwater diatom *Didymosphenia geminata* was detected in a New Zealand river. It was described a procedure used to rapidly develop a classification of suitability for all New Zealand's rivers, based on two sources of information. First, from a review of the limited available literature and unpublished data, it was determined that temperature, hydrological and substrate stability, light availability, and water pH were the most important environmental gradients determining *D.geminata*'s broad-scale distribution and capacity for establishing and forming blooms in rivers. The second information source was a GIS-based river network developed for a national classification of New Zealand's rivers, with associated data describing environmental characteristics of each section of the network.

Investigations for the diatom flora in the watershed of Lake Ohrid were carried out during 2016 at 12 sampling sites to record the possible presence of invasive diatom species.

Material and Methods

Investigations for the diatom flora along the River Black Drim, Lakes Globochica and Debar and along the River Sateska were carried out during 2016 at 12 sampling sites. Sampling was carried out according to the two standards: Standard EN 13946:2003, Water quality - Guidance standard for the routine sampling and pre-treatment of benthic diatoms from rivers and Standard EN 14407:2004, Water quality - Guidance standard for the identification, enumeration and interpretation of benthic diatom samples from running waters. Benthic diatoms were collected from at least 5 stones from each sampling site. The upper surface of stones was scratched with a stiff toothbrush and the resulting suspensions were collected and preserved in formalin (3-4%). The diatom valves were cleaned using HCl*cc* and H_2SO_4 *cc*, clean diatom frustules were mounted in Naphrax and identified using Krammer & Lange-Bertalot keys (1986-1991) and other available literature.

Results and Discussion

During the investigations a total of 78 taxa belonging to 19 genera were identified. Order Centrales was only represented by 4 species and order Penales 74 species (Tab 1). Genus Navicula have the largest number of species (15) following by Cymbella and Gomphonema. More species per site were identified along River Black Drim in comparison with River Sateska.

It is important to note that during the investigations there were not registered invasive diatom species. All of the identified species are present in Lake Ohrid and its catchment area.

The highest species number was recorded at DebarskoK RD4 – 27, followed by Moroiski Most RD1 – 24 and Globocica – RD3 – 24. At the same time the lowest species number were found at Sa sampling site, total 7. Also, low diversity was observed at Sini Viroj – S4, with 9 identified species, at sampling site Mesheishta – S2, 10 species and at Staro korito – S1 with total 12 species (Fig. 1).

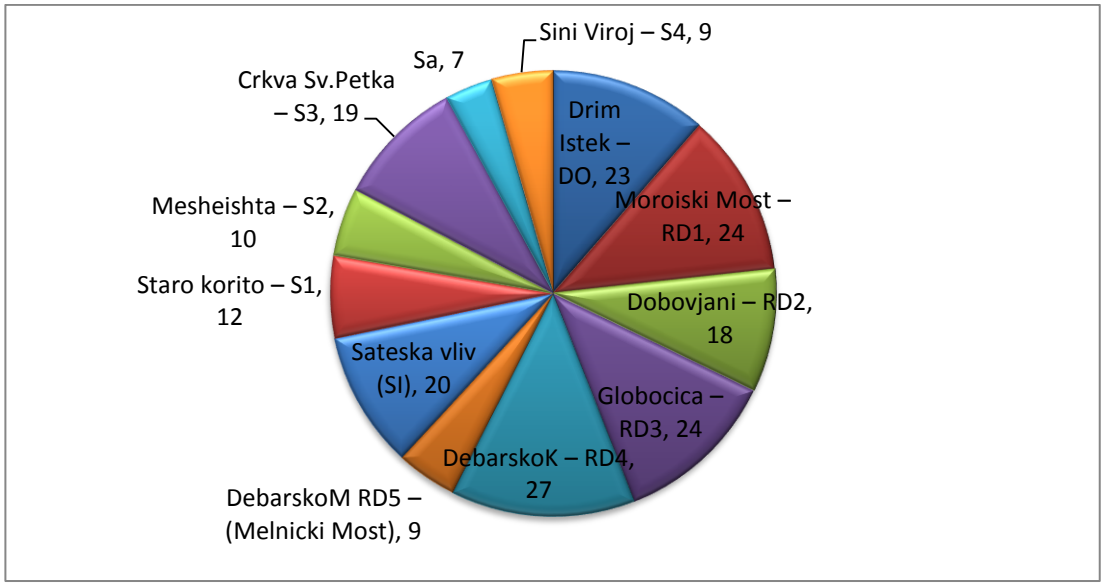

Figure 1. Species number at all of the sampling sites.

Based on the investigations, the sampling sites along the River Black Drim are characterized by the presence of species that dominate mesotrophic to eutrophic indicators such as: *Cocconeis placentula, Cymbella prostrata, Cymbella minuta, Diatoma vulgaris*, *Gomphonema olivaceum*.

There were registered some poly-hypertrophic taxa, but they haven't been wide spread. In regards to the sampling sites along the River Black Drim, *Gomphonema parvulum* have been founded among the most frequent species at the site RD4 (Debarsko K).

Also, there have been evidenced some oligotrophic species: *Achnanthes minutissima, Diatoma ehrenbergii, Diatoma mesodon, Navicula radiosa.*

Cocconeis placentula var. lineata and *Gomphonema pumilum* (oligotrophic taxa) predominate in the diatom assemblage at the sampling site S4 (Sini Viroj). During our investigations was registered *Meridion circulare* only at this site. This taxon is more or less confined to cool running waters and known as not tolerant of low pH or organic pollution. Presence of these diatom taxa indicated the best water trophic state at this sampling site.

Table 1. List of identified diatoms species.

Order Centrales
1. ***Cyclotella cyclopuncta (Håkansson& Carter)***
2. ***Cyclotella fottii (Hustedt)***
3. ***Cyclotella glomerata(Bachmann)***
4. ***Cyclotella ocellata (Pantocsek)***
Order Penales
5. ***Achnanthesexigua var. exigua (Grunow)***
6. ***Achnanthes minutissima (Kützing)***
7. ***Amphora ovalis (Kützing)***
8. ***Amphora pediculus (Kützing) Grunow***
9. ***Amphora veneta (Kützing)***
10. ***Cocconeis diminuta (Pantocsek)***
11. ***Cocconeis pediculus (Ehrenberg)***
12. ***Cocconeis placentula (Ehrenberg)***
13. ***Cocconeis placentula var. euglypta (Ehrenberg) Grunow***
14. ***Cocconeis placentula var. klinoraphis (Geitler)***
15. ***Cocconeis placentula var. lineata (Ehrenberg) Van Heurck***
16. ***Cymatopleura solea (Brebisson) W. Smith***
17. ***Cymatopleura solea var.apiculata (W.Smith) Ralfs***
18. ***Cymbella affinis (Kützing)***
19. ***Cymbella aspera (Ehrenberg)***
20. ***Cymbella caespitosa (Kützing) Brun***
21. ***Cymbella cistula (Ehrenberg) Kirchner***
22. ***Cymbella ehrenbergii (Kützing)***
23. ***Cymbella helvetica (Kützing)***
24. ***Cymbella lanceolata (Ehrenberg) V. H.***
25. ***Cymbella lata (Grunow)***
26. ***Cymbella minuta (Hilse)***
27. ***Cymbella prostrata (Berkeley) Cleve***
28. ***Cymbella silesiaca (Bleisch)***
29. ***Diatoma ehrenbergii (Kützing)***
30. ***Diatoma mesodon (Ehrenberg) Kützing***
31. ***Diatoma vulgaris (Bory)***
32. ***Diatoma vulgaris Morph. vulgaris (Bory)***
33. ***Diatoma vulgaris var. capitulatum (Grunow)***
34. ***Diploneis domblittensis (Cleve)***
35. ***Epithemia adnata(Kützing) Brebisson***
36. ***Fragilaria capucina (Desmazieres)***
37. ***Fragilaria capucina var. perminuta (Grunow) Lange – Bertalot***
38. ***Fragilaria capucina var. ruprens (Kützing) Lange – Bertalot***
39. ***Fragilaria parasitica (W.Smith) Grunow***
40. ***Fragilaria ulna (Nitzsch) Lange – Bertalot***
41. ***Fragilaria ulna var. acus (Kützing) Lange – Bertalot***
42. ***Fragilaria ulna var. danica (Kützing) Lange – Bertalot***
43. ***Gomphonema acuminatum var. coronatum (Ehrenberg) W. Smith***
44. ***Gomphonema angustatum (Kützing) Rabenhorst***
45. ***Gomphonema angustum (Agardh)***

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46. ***Gomphonema clavatum (Ehrenberg)***
47. ***Gomphonema minutum (Agardh)***
48. ***Gomphonema olivaceum (Hornemann) Brebisson***
49. ***Gomphonema olivaceum var. capitata (Jurilj)***
50. ***Gomphonema olivaceum var. minutissimum (Hustedt)***
51. ***Gomphonema parvulum (Kützing) agg.***
52. ***Gomphonema pumilum (Grunow) Reichardt & Lange-Bertalot***
53. ***Gomphonema truncatum (Ehrenberg)***
54. ***Gyrosigma acuminatum (Kützing) Rabenhorst***
55. ***Hantzschia amphioxys(Ehrenberg)Grunow***
56. ***Meridion circulare(Greville) Agardh***
57. ***Navicula anglica (Ralfs)***
58. ***Navicula angusta (Grunow)***
59. ***Navicula capitoradiata (Germain)***
60. ***Navicula clementis (Grunow)***
61. ***Navicula cryptocephala (Kützing)***
62. ***Navicula cryptotenella (Lange-Bertalot)***
63. ***Navicula kotschyi (Grunow)***
64. ***Navicula leptostriata (Jørgensen)***
65. ***Navicula perminuta (Grunow)***
66. ***Navicula placentula (Ehrenberg) Grunow***
67. ***Navicula radiosa (Kützing)***
68. ***Navicula rhynchocephala (Kützing)***
69. ***Navicula tripunctata (O. F. Müller)***
70. ***Navicula tuscula (Ehrenberg) Grunow***
71. ***Nitzschiadissipata(Kützing)Grunow***
72. ***Nitzschiadissipata var. dissipata(Kützing)Grunow***
73. ***Nitzschia linearis (Agardh) W. Smith***
74. ***Nitzschia palea (Kützing) W. Smith***
75. ***Nitzschia paleacea (Grunow)***
76. ***Neidium dubium (Ehrenberg)Cleve***
77. ***Rhoicosphaenia abbreviata (Ag)Lange – Bertalot***
78. ***Surirella ovalis (Brébisson)***

Some poly-hypertrophic taxa (*Cymatopleura solea, Gomphonema parvulum, Nitzschia palea* and *Surirella ovalis*) were evidenced at sampling site S3 (Crkva Sv. Petka) and more or less have been present in the other sampling sites downstream the River Sateska, with the exception of site S2 (Mesheishta). Visually, there have been noticed negative anthropogenic impact at the aforementioned sites.

Although there were not registered diatom invasive species, we should having in mind that anthropogenic changes (which were registered in the most of the sampling sites) may alter the environment in a way to favor the introduction of invasive species.

Conclusions

During the investigations were identified a total of 78 diatom taxa belonging to 19 genera. Genus Navicula have the largest number of species (15) following by Cymbella and Gomphonema.

Table 2. The most frequent and the rarest diatom species in the sampling sites.

River	Sampling site Code	Species	
		most frequent	rarest
Black Drim	DrimIstek DO	*Cocconeis placentula* *Fragilaria capucina*	*Neidium dubium*
	Moroiski Most RD1	*Cocconeisplacentulavar. klinoraphis* *Cymbella prostrata* *Diatoma vulgaris* *Gomphonemaolivaceum*	*Cymbellaaspera* *Fragilaria ulna* *Navicula placentula*
	Dobovjani RD2	*Diatoma vulgaris* *Gomphonema olivaceum*	*Fragilaria ulna* *Navicula cryptotenella* *Nitzschia palea* *Rhoicosphaeniaabbreviata*
	Globocica RD3	*Fragilaria capucina* *Fragilaria ulna var. acus* *Fragilaria ulna var. danica*	*Cymbella lanceolata* *Diatoma mesodon* *Gyrosigma acuminatum* *Hantzschia amphioxys*
	DebarskoK RD4	*Cymbella cistula* *Cymbella minuta* *Gomphonema parvulum* *Navicula capitoradiata*	*Cymatopleura solea* *Gomphonema truncatum* *Navicula gracilis*
	DebarskoMRD5	*Fragilaria capucina* *Fragilaria ulna var. danica*	*Cymatopleura solea* *Cymbella cistula*
	SateskaVlivSl	*Diatoma vulgaris* *Gomphonema angustatum*	*Nitzschia paleacea* *Neidium dubium* *Rhoicosphaeniaabbreviata*
Sateska	StarokoritoS1	*Cocconeis diminuta* *Cocconeis placentula* *Navicula cryptocephala* *Gomphonemaminutum*	*Diatoma vulgaris Morph. Vulgaris* *Surirella ovalis*
	MesheishtaS2	*Cocconeis placentula* *Navicula radiosa* *Gomphonema angustum* *Gomphonema pumilum*	*Nitzschiadissipata*
	CrkvaSv. Petka S3	*Cocconeis placentula*	*Cymatopleura solea* *Rhoicosphaeniaabbreviata*
	Sa	*Cocconeis placentula var. lineata*	*Rhoicosphaenia abbreviata*
	Sini Viroj S4	*Cocconeis placentula var. lineata* *Gomphonema pumilum*	*Diatoma vulgaris var. capitulatum*

The highest species number was recorded at DebarskoK RD4 – 27 and the lowest species number at Sa sampling site, total 7.

Along River Black Drim were identified more species per site in comparison with River Sateska.

During the investigations there were not registered invasive diatom species. All of the identified species are present in Lake Ohrid and its catchment area.

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