Microscopic algae from karst lakes of Dumre region  
(Central Albania)

Lirika Kupe1*, Arensa Poçi2, Aleko Miho2 and Thomas Hübener3

1 Faculty of Agronomy, Agricultural University of Tirana, Albania  
2 Department of Biology, Faculty of Natural Sciences, University of Tirana, Albania  
3 Universität Rostock, Fachbereich Biowissenschaften, Institut für Biodiversitätsforschung, Allgemeine und Spezielle Botanik, Wismarsche Str. 8, D-18051 Rostock, Germany

ABSTRACT: More than 90 karst lakes, often smaller than 1ha, and shallower than 10m, can be found sparse over limestone or gypsum in Albanian territory. The most famous are the lakes of Dumre, a zone that extends between Shkumbini and Devolli valleys (Elbasani district). These lakes do not have nor inflows or outflows, and are often filled by the rainfall; therefore, their water level oscillates drastically during the year. Sporadic samples of peryphyton or phytoplankton were collected in some of Dumre lakes (Belshi, Merhoja, Mulleza, Cepi). Moreover, one sediment core (ca. 38cm) was taken in Belshi lake, in June 2005; based on Pb210 and Cs137, the sediments were the well laminated, dating only to the last 20 years (between 2005-1984), where alternated yellow and black layers might belong to one year. The calculated sedimentation rate was 1.76 cm/yr, considered relatively high, due to the strong erosion form the surrounding watershed. The diversity of diatoms found in Dumre lakes can be considered high, despite the limited number of samples examined. About 220 taxa of microscopic algae, diatoms (Bacillariophyta), were found in all the collected samples, represented mainly from the genera Navicula (28 species), Nitzschia (23) and Cyclotella (17). More than 170 species were found in the littoral samples of different lakes, where the sample from Cepi, a shallow eutrophic pond was the richest with diatoms, more than 90 species. About 140 species were found in the core sample from Belshi lake, represented mainly from Achnanthes minutissima, Cyclotella ocellata, C. stelligera, Gyrosigma acuminatum, Cymbella affinis, Gomphonema olivaceum or Hantzschia amphioxys. Centric diatoms Cyclotella ocellata and C. stelligera, and the pennate Achnanthes minutissima were found also relatively abundant in the population community of each sediment layer. The calculated Trophic Index of Diatoms (TIDIA) in each sediment layer oscillated from 1.2 (oligotroph) to 3.4 (polytroph), showing a moderate pollution with nutrients (phosphorous and nitrogen). Saprobic index seems to be more stable, oscillating from 1.5 (oligosaprob) to 2 (beta-mesosaprob), corresponding to scarcely polluted (I-II class) to moderately polluted water quality (II class). From the rare and interesting species of the karst lakes here were mentionioned Caloneis cf. aerophila, Gomphonema augur, Neidium bisulcatum var. subampliatum, Nitzschia geitleri, N. lorenziana, Placoneis elginensis, P. clementioides, Sellaphora levissima, Surirella venusta, Surirella cf. tenera. Caloneis sp. and Surirella sp. represent interesting or new species. The terrigenous hilly relief, the typical Mediterranean climate characteristics combined also with poor land use activities (land denuding), can be the principal causes of the relatively high rate of sedimentation observed in Belshi lake. The decentralized management of wastewater is recommended to prevent the eutrophication processes, and protect the water quality of the lakes. Moreover, forestation activities especially in denuded area would restore the vegetation cover and decrease the erosion.

Key words: Albanian karst lakes; Belshi lake; sediment core sampling; Albanian diatoms

Received 11 September 2009   Revision accepted 30 June 2010

UDK 582.261.1(496.5)

*correspondence: lirika_kupe@yahoo.com © 2010 Institute of Botany and Botanical Garden Jevremovac, Belgrade
INTRODUCTION

In most cases there is little or no reliable long-term data about the natural history of lakes. Paleoeological studies offer a way to address how a lake’s water quality has changed through time as a result of watershed disturbances. It depends upon the fact that lakes act as partial sediment traps for particles that are created within the lake or washed from the watershed. The sediments of the lake preserve fossil remains that are more or less resistant to bacterial decay or chemical dissolution; it includes diatom frustules, cell walls of certain algal species and subfossils from aquatic plants, pollen grains and chironomids (Lowe et al. 1996; Little et al. 2000; Garrison & La Liberte 2007). The chemical characteristics of the sediments may indicate the composition of particles entering the lake as well as the past chemical environment of the lake itself. Using the fossil remains found in the sediment, one can reconstruct changes in the lake ecosystem over any period of time since the establishment of the lake. It plays an important role in reconstructing when the condition of the lake has changed, when did this occur, what were the causes, and what were the historical conditions of the lake.

Siliceous microscopic algae, diatoms (Bacillariophyceae), which were taken into consideration by us, are known to be very sensitive to changes in environmental variables such as trophic conditions and pH (Vos & De Wolf 1988).

About 90 karst lakes can be found sparse over limestone or gypsum in Albanian territory (Kabo 1990-1991). The most famous are the lakes of Dumre zone that extends between Shkumbini and Devolli valleys (Elbasani district, Central Albania; Fig. 1); their total surface is about 770 ha, where the most important are Cestija (98.6 ha), Seferani (87.5 ha), Merhoja (65.5 ha), Dega (37.4 ha), Rashta (29.9 ha), Paraska (27.4 ha), Belshi (26.9 ha) and Cerraga (18.8 ha); the others are often smaller than 1 ha. The karst lakes are generally shallow (to 10m); the biggest depth is measured in Merhoja (61 m). They do not have nor inflows or outflows, and are often filled by the rainfall; therefore, their water level oscillates drastically during the year. Scarce data were published related with their biodiversity especially aquatic flora and vegetation.

Palaeolimnological studies in the Albanian natural lakes are missing, despite of interest. The first approach was given by Kupe et al. (2008) for sediment cores taken in Shkodra Lake, a trans-boundary lake between Albania and Montenegro. Data about diatoms in Dumre lakes were reported for the first time by this preliminary approach, completing further the biodiversity of Albanian aquatic habitats. Belshi Lake, close to Belshi town, ca. 30 km southwest of Elbasani, will be taken as the most representative (Fig.1). Rough indications about the sedimentation rates of the last decades and human impact will be discussed, as precondition to their protection and restoration.

MATERIAL AND METHOD

One sediment core (ca. 38cm; Fig. 2a) was taken in Belshi lake, in June 2005. The core was taken at the highest depth (11m) with the aid of a manual core sampler. The sediment core was evidently laminated with alternated white and dark layers, which are drawn up in the Fig. 2b.

One diatom sample was collected in each sub-layer, 43 samples in total; moreover, 6 representative samples, respectively in 0-1, 1-5, 5-10, 10-20, 20-30 and 30-38cm, were collected for dating. In order to determine when the various sediment layers were deposited, the samples were analyzed for lead-210 ($^{210}\text{Pb}$), a naturally occurring radionuclide. Lead-210 is the result of natural decay of uranium-238 to radium-226 to radon-222. Since radon-222 is a gas it moves into the atmosphere where it decays to lead-210, which is deposited on the lake during precipitation and with dust particles. After Pb-210 enters the lake and it is in the lake sediments, it slowly decays, with the half-life of 22.6 years. It means that it can be detected for about 130-150 years (Garrison & La Liberte 2007).
Table 1: Composition of diatom samples taken from the sediment core in Belshi lake, Dumre, Albania (date 12.06.2005; depth 11 m); B, black; W, white; S, spring; A, autumn

<table>
<thead>
<tr>
<th>Diatom sample</th>
<th>Core depth, cm</th>
<th>Colour of layer</th>
<th>Core thickness, cm</th>
<th>Suspected year and season</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>B</td>
<td>2</td>
<td>2005 S</td>
</tr>
<tr>
<td>2</td>
<td>0.5</td>
<td>W</td>
<td>0.5</td>
<td>2004 A</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>B</td>
<td>0.5</td>
<td>2004 S</td>
</tr>
<tr>
<td>4</td>
<td>1.5</td>
<td>W</td>
<td>1.5</td>
<td>2003 A</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>B</td>
<td>0.3</td>
<td>2003 S</td>
</tr>
<tr>
<td>6</td>
<td>3.5</td>
<td>W</td>
<td>0.2</td>
<td>2002 A</td>
</tr>
<tr>
<td>7</td>
<td>3.8</td>
<td>B</td>
<td>0.3</td>
<td>2002 S</td>
</tr>
<tr>
<td>8</td>
<td>4</td>
<td>W</td>
<td>0.2</td>
<td>2001 A</td>
</tr>
<tr>
<td>9</td>
<td>4.5</td>
<td>B</td>
<td>0.5</td>
<td>2001 S</td>
</tr>
<tr>
<td>10</td>
<td>5</td>
<td>W</td>
<td>0.5</td>
<td>2000 A</td>
</tr>
<tr>
<td>11</td>
<td>6</td>
<td>B</td>
<td>1.5</td>
<td>2000 S</td>
</tr>
<tr>
<td>12</td>
<td>7.5</td>
<td>W</td>
<td>1</td>
<td>1999 A</td>
</tr>
<tr>
<td>13</td>
<td>8.5</td>
<td>B</td>
<td>0.8</td>
<td>1999 S</td>
</tr>
<tr>
<td>14</td>
<td>9.3</td>
<td>W</td>
<td>1.7</td>
<td>1998 A</td>
</tr>
<tr>
<td>15</td>
<td>11</td>
<td>B</td>
<td>0.5</td>
<td>1998 S</td>
</tr>
<tr>
<td>16</td>
<td>11.5</td>
<td>W</td>
<td>1.3</td>
<td>1997 A</td>
</tr>
<tr>
<td>17</td>
<td>12.8</td>
<td>B</td>
<td>0.2</td>
<td>1997 S</td>
</tr>
<tr>
<td>18</td>
<td>13</td>
<td>W</td>
<td>0.5</td>
<td>1996 A</td>
</tr>
<tr>
<td>19</td>
<td>13.5</td>
<td>B</td>
<td>1</td>
<td>1996 S</td>
</tr>
<tr>
<td>20</td>
<td>14.5</td>
<td>W</td>
<td>0.5</td>
<td>1995 A</td>
</tr>
<tr>
<td>21</td>
<td>15</td>
<td>B</td>
<td>0.5</td>
<td>1995 S</td>
</tr>
<tr>
<td>22</td>
<td>15.5</td>
<td>W</td>
<td>1</td>
<td>1994 A</td>
</tr>
<tr>
<td>23</td>
<td>16.5</td>
<td>B</td>
<td>0.5</td>
<td>1994 S</td>
</tr>
<tr>
<td>24</td>
<td>17</td>
<td>W</td>
<td>0.8</td>
<td>1993 A</td>
</tr>
<tr>
<td>25</td>
<td>17.8</td>
<td>B</td>
<td>0.2</td>
<td>1993 S</td>
</tr>
<tr>
<td>26</td>
<td>18</td>
<td>W</td>
<td>0.5</td>
<td>1992 A</td>
</tr>
<tr>
<td>27</td>
<td>18.5</td>
<td>B</td>
<td>1</td>
<td>1992 S</td>
</tr>
<tr>
<td>28</td>
<td>19.5</td>
<td>W</td>
<td>1</td>
<td>1991 A</td>
</tr>
<tr>
<td>29</td>
<td>20.5</td>
<td>B</td>
<td>0.5</td>
<td>1991 S</td>
</tr>
<tr>
<td>30</td>
<td>21</td>
<td>W</td>
<td>0.5</td>
<td>1990 A</td>
</tr>
<tr>
<td>31</td>
<td>21.5</td>
<td>B</td>
<td>0.5</td>
<td>1990 S</td>
</tr>
<tr>
<td>32</td>
<td>22</td>
<td>W</td>
<td>3</td>
<td>1989 A</td>
</tr>
<tr>
<td>33</td>
<td>25</td>
<td>B</td>
<td>2</td>
<td>1989 S</td>
</tr>
<tr>
<td>34</td>
<td>27</td>
<td>W</td>
<td>1</td>
<td>1988 A</td>
</tr>
<tr>
<td>35</td>
<td>28</td>
<td>B</td>
<td>1</td>
<td>1988 S</td>
</tr>
<tr>
<td>36</td>
<td>29</td>
<td>W</td>
<td>1</td>
<td>1987 A</td>
</tr>
<tr>
<td>37</td>
<td>30</td>
<td>B</td>
<td>1.5</td>
<td>1987 S</td>
</tr>
<tr>
<td>38</td>
<td>31.5</td>
<td>W</td>
<td>1</td>
<td>1986 A</td>
</tr>
<tr>
<td>39</td>
<td>32.5</td>
<td>B</td>
<td>1.5</td>
<td>1986 S</td>
</tr>
<tr>
<td>40</td>
<td>34</td>
<td>W</td>
<td>2</td>
<td>1985 A</td>
</tr>
<tr>
<td>41</td>
<td>36</td>
<td>B</td>
<td>1</td>
<td>1985 S</td>
</tr>
<tr>
<td>42</td>
<td>37</td>
<td>W</td>
<td>1</td>
<td>1984 A</td>
</tr>
<tr>
<td>43</td>
<td>38</td>
<td>B</td>
<td>1</td>
<td>1984 S</td>
</tr>
</tbody>
</table>
Sediment age for the various depths of sediment was determined by the ‘Constant-Fraction-Model’ (Appleby et al. 1992) (Fig. 2c).

Moreover, five samples of peryphyton or littoral phytoplankton were collected sporadically in some of Dumre lakes, in Cepi, Merhoja, Mulleza (in June 1993), in Belshi (June 2006) and Merhoja (September 2006).

The diatom communities in each sublayer were examined microscopically. Diatom frustules were cleaned by boiling the material in HCl conc followed by boiling in H2SO4 conc with addition of a few crystals of KNO3 (Krammer & Lange-Bertalot 2005). Microscopic slides were prepared using Naphrax (index 1.69) and examined with a LEICA DML microscope (objective 100x). Microscopic photos were done using a Leitz-Diaplan Leica optivc microscope, using an 63x objective. Species determinations were made following the keys of Krammer & Lange-Bertalot (1986-2005). To get reliable data (confidence 95%) more than 400 valves were counted. The Trophic Index of Diatoms (TIDIA; Rott et al., 1999; 2003) and Saprobic Index (SI; Rott et al. 1997) was calculated using the formula of Zelinka & Marvan (1961). In addition, the Diversity Index (H'; Shannon & Weaver 1949) was calculated. Permanent slides and photos were deposited in the Lab of Botany, Tirana University.

RESULTS AND DISCUSSIONS

From the dating model reported in the Fig. 2c, it was concluded that the core might belong to the last 20 years; alternated yellow and black layers might represent one year: the black layer might represent the late summer season, probably with high content of organic matter, from the intense growth of phytoplankton, and the white one might belong to rainy season: late autumn-winter. The measured layers reported in Fig. 2b and Tab. 1 show that there are differences on the sedimentation rate, oscillating from 0.5cm to 1.7cm (autumn 1998) in each layer, or from 1cm to 2.3cm per year (in autumn 1998). The calculated sedimentation rate (line a in Fig. 2c) is the linear regression, 1.76±0.43cm/yr, which can be considered relatively high, showing relatively strong erosion form the surrounding watershed.

About 140 species of diatoms were found in all examined core layers (43 subalayers); only about 10 species belong to centrics, the rest were pennate. Achmnnathes minutissima was the most frequent species, found in 93% of the layers, followed by the centric diatoms Cyclotella ocellata (76.7%), C. stelligera (62.8) and Asterionella formosa (46.5%), then by other pennate species, like Amphora lybica (34.9%), A. montana (32.6%), A. ovalis (27.9), Cymatopleura
solea (48.8%), Cymbella affinis (51.2%), C. amphicephala (20.9%), C. minuta (20.9), C. silesiaca (27.9%), Diatoma tenuis (60.5%), Fragilaria acus (41.9%), F. capucina sp. diverse (16.3-27.9%), Gomphonema olivaceum (51.2%), G. parvulum var. exilissimum (32.6%), Gyrosigma acuminatum (74.4%), Hantzschia amphioxys (62.8%), Fallacia pygmaea (37.2%), Navicula oligotraphenta (25.6%), N. reichardtiana (27.9%), N. trivalis (20.9) and Nitzschia palea (46.5%).

Number of the species oscillated evidently between layers (Fig. 3), from 3 in 1991 (autumn) to 46 in 1986 and 1987. Slight decrease of species number and diversity was observed from the past years (1984) to the most recent years (2005). Generally, the white layers seem to be richer in species than black ones. Centric diatoms Cyclotella ocellata and C. stelligera were found also relatively abundant in the population community of each layer, respectively up to 86% (year 1993, C. ocellata) and up to 57% (1987, C. stelligera). From the pennatae diatoms, Achnanthes minutissima was found the most abundant in population community, up to 94% in year 2005, 90% in 1991 and 85% in 2004.

The population structure of diatoms help to give a better view of the average quality of the water. The Trophic Index of Diatoms (TI\textsubscript{DIA}), calculated by us, classify the environment quality in seven classes, from ultra-oligotroph (TI\textsubscript{DIA} ≤1) to poly-hypertroph (TI\textsubscript{DIA} >3.4); to these classes would match up an increasing quantity of nutrients, especially phosphor and nitrogen (Rott et al. 1999). Where as the Saprobic Index (SI) takes into consideration the organic pollution, classifying the environment in 7 classes, from oligosaprob (SI, 1-1.5) to polisaprob (SI, 3.5-4) (Rott et al. 1997). It is worth to evidence that the TI\textsubscript{DIA} and SI were drawn up for the periphyton communities, and are not well significant in diatoms found in core sediment layers, which are mainly of plankton origin. Therefore, our calculations have only an indicative value. Nevertheless, the TI\textsubscript{DIA} oscillate from 1.2 (oligotroph, in years 1991, 1992, 2002) to 3.4 (polytroph, in year 1985) (Fig. 4). Saprobic index seems to be more stable, oscillating from 1.5 (oligosaprob) to 2 (beta-mesosaprob). The calculated indexes correspond to the water quality scarcely polluted (I-II class of quality) to moderately polluted (II class).

More than 170 species of diatoms were determined in the littoral samples of different lakes, where 14 species belong to centricae the others were pennatea. The sample from Cepi, a shallow eutrophic pond was the richest with diatoms, more than 90 species, followed by that in Mulleza (87) and in Merhoja (62). The diversity index was also high in Cepi sample (4.5). The most widespread species among the centric diatoms were Cyclotella stelligera and C. ocellata; among the pennate diatoms, the most widespread among the examined samples were Cymbella

Fig. 3: Profiles of species number (N) and the related diversity index (H') in Belshi lake
microcephala, Rhopalodia gibba, Cymbella minuta, Achnanthes minutissima, Navicula oligotraphenta, Nitzschia fonticola, Sellaphora pupula, followed then by Achnanthes lanceolata, Cymatopleura solea, Cymbella affinis, C. silesiaca, Fragilaria acus, F. crotonensis, F. tenera, F. ulna, Gomphonema parvulum, G. sarcophagus, G. truncaturn, G. acuminatum, N. cryptcephala, Nitzchia palea, Pinnularia microstaurn and Stauroneis smithii. The most abundant species in their respective communities were Achnanthes minutissima (up to 58.7% in Belshi lake, June 2006) and Cyclotella ocellata (up to 33.3% in Merhoja, June 1993).

CONCLUSIONS
The results of this first tentative with the palaeoecological studies in Albania confirm that high diversity of diatoms were found in Dumre lakes, despite the limited number of samples examined. About 220 taxa of microscopic algae were found altogether, diatoms (Bacillariophyta), were found in all the collected samples, represented mainly from the genera Navicula (28 species), Nitzschia (23) and Cyclotella (17). In Plates I and II are reported 26 microscopic photos that represent 23 species, which are the most common and/or rare and interesting species. From the rare and interesting species of the karst lakes we can mention Caloneis cf. aerophila Bock (Plate I: Fig. 8), Gomphonema augur Ehrenberg (Plate I: Fig. 1), Neidium bisulcaturn var. subampliaturn Krammer (Plate I: Fig. 14), Nitzschia geitleri Hustedt (Plate II: Fig. 5), N. lorenziana Grunow (Plate II: Fig. 6), Placoneis elginensis (Gregory) Ralfs (Plate I: Figs. 3-5), P. clementioides (Hustedt) E.J. Cox (Plate I: Fig. 6), Sellaphora levissima (Kuetzing) D.G. Mann (Plate I: Fig. 11), Surirella venusta Østrup (Plate II: Fig. 2), S. gracilis (Plate II: Fig. 3). Grunow Surirella ft. tenera W. Gregory (Plate II: Fig. 4). The small Caloneis sp. (Plate I: Fig. 7), found in the small karst pond of Cepi, represents an interesting or even new species that requires further information; it was found also in Borshi spring (Southern Albania). Surirella sp. (Plate II: Fig. 1), a rare specimen found in Mulleza lake represents also an interesting or possibly new species, too.

Almost all the lakes are situated in an agricultural area, where in several villages spread out through their watersheds the main activity is the traditional agriculture and livestock. The zone is hilly, with typical undulated relief, shaped by karst topography. Nevertheless, soft erosive formations build up their slopes; the original forests have been drastically disappeared so far, and the natural vegetation is represented mainly from Mediterranean shrubs that grow up nowadays only in limited areas. Those characteristics combined also with poor land use activities, more evident during past decades, are the cause...
PLATE I: Fig. 1. Gomphonema augur Ehrenberg var. ?; Fig. 2. Gomphonema olivaceum (Hornemann) Brebisson var. olivaceum; Figs. 3-5. Placoneis elginensis (Gregory) Ralfs; Fig. 6. Placoneis clementiioides (Hustedt) Cox; Fig. 7. Caloneis sp.; Fig. 8. Caloneis cf. aerophila Bock; Fig. 9. Craticula accomoda (Hustedt) Mann; Fig. 10. Amphora montana Krasske; Fig. 11. Sellaphora levissima (Kuetzing) Mann; Fig. 12. Sellaphora pupula (Kuetzing) Meteschkovsky; Fig. 13. Gyrosigma acuminatum (Kuetzing) Rabenhorst; Fig. 14. Neidium bisulcatum var. subampliatum Krammer; Fig. 15. Anomoneis sphaerophora (Ehrenberg) Pfitzer; Figs. 15-16. Luticola kotschyi (Grunow) Mann; Fig. 17. Luticola muticopsis (Van Heurck) Mann; Figs. 19-21. Achnanthes catenata Bily & Marvan.
PLATE II: Fig. 1. *Surirella* sp.; Fig. 2. *Surirella venusta* Østrup; Fig. 3. *Surirella gracilis* Grunow; Fig. 4. *Surirella cl. tenera* W. Gregory; Fig. 5. *Nitzschia geitleri* Hustedt; Fig. 6. *Nitzschia lorenziana* Grunow.
of the relatively high rate of sedimentation observed even form our preliminary sampling in Belushi lake, phenomena observed even elsewhere in Albania (Miho et al. 2005, 2009). Moreover, poor management of waste was evident in the zone. The poor management of wastewater discharge, especially in Belushi lake, close with Belushi town can enhance the eutrophication processes. Also, other lakes suffer from the surrounding villages and their livestock, that decrease the beauty values of the zone, but they may cause health disturbances as well. The decentralized management of wastewater is recommended in each case. The erosion and as the consequence the sedimentation in the lakes could be prevented restoring the vegetation cover, through forestation activities, especially in denuded spots, i.e. in abandoned fields.

Acknowledgements – The core was taken with the aid of a manual core sampler, brought in Albania from Prof. B.W. Scharf, Muenster University, Germany. Dating was carried on in cooperation with Dr. H. Erlenkeuser, University of Kiel, Germany. The preparation of diatom samples was carried on by the former student of Biology B. Hoxha, under the assistance of Prof. A. Witkowski, using the facilities of the Department of Paleoceanology, Institute of Marine Sciences, University of Szczecin, Poland. To all of them the authors express the highest gratitude.

REFERENCES


Микроскопске алге крашских језера региона Думре (Централна Албанија)

Лирка Купе, Аренса Поћи, Алекси Миho, Томас Хубенер

Више од 90 крашских језера, често површине мање од 1ха, и дубине мање од 10м налази се распретено на прењаку и гипсу широм Албаније. Најпознатија су језера области Думре, регије која се простире између долина Шкунбини и Деволли (Елбасан region). У ова језера вода нити притичешт нити отице, тако да њихов ниво драстично варира током године. Спорадичан узоркоvanje перифитона и фотопланктона сакупљено је на језерима области Думре (Белши, Мерхоja, Муллеza, Цепи). Такоде je уукорован и један седиментни низ (око 38cm) на Белши језеру, Јун 2005; на основу Pb210 i Cs137, седименти се лепо раслажу поседњих 20 година (2005-1984). Израчуната вредност седиментације je 1.76 cm/годишњe, и relativno je visoka pre svega zbog intenzivnог erozивног спирanja.

Диверзитет дијатомова језера области Думре može se smatratи visokim i pored malog бroja studiranih uzoraka. Око 220 таксона микроскопских алги, дијатомова (Бацилариплитиа), регистровано je u sakupljenim узорцама и најзаступљенији родови су били Navicula (28 врста), Nitzschia (23) и Cyclotella (17). Више од 170 врста je надено на литоралним деловима језера, а više од 90 врста језеро Цепи има najbogatiju литорал зону. Око 140 врста je надено у дубинском узорку Белши језера, где су углавном доминирале Achnanthes minutissima, Cyclotella ocellata, C. stelligera, Gyrosigma acuminatum, Cymbella affinis, Gomphonema olivaceum или Hantzschia amphioxys. Центричне дијатоме Cyclorella ocellata и C. stelligera, и pentane Achnanthes minutissima se такоде ubrajaju u чešće vrste zajednica сedimentних slojeva. Pronadjeni трофички indeks дијатомова (TIDIA) u svakom сedimentном sloju oscilovao je од 1.2 (олиготрофнi) до 3.4 (политрофнi), ukazujući на умерено zagadjivanje nutrijentima (fosforom и azotom прe свих). Сapробни индекс био je стабилниji, и oscilovao je од 1.5 (олигосапробнi) до 2 (beta-mezosaprobni), što одговара слабо загаденим водама (I-II klasa) до до умерено загаденим водама (II klasa). Од retkiх и интересантних vrsta крашских језера естику се Caloneis cf. aerophila, Gomphonema augur, Neidium bisulcatum var. subampliatum, Nitzschia getleri, N. lorenziana, Placoneis elginensis, P. clementoides, Selaphora levissima, Surirella venusta, Surirella cf. tenera, Caloneis sp. и Surirella sp.

Брдски reljef, tipična mediteransка клима, kombinovana sa slabim korišćenjem земљишта, су вероватно осnovni razlozi visoke stope sedimentacije на језеру Белши. Preporučuje се decentralizovano upravljanje otpadnim водаjdа se spreče процес еутрофикације, и заштити kвалитет vode. Такоде, preporučuje се обновa vegetatione da bi se sprečila erozija.

Кljučne реčи: Кршћа jezera Albanije, jezero Belshi, седименти, дијатомеје Albanije
APPENDIX

Checklist of diatoms found in Dumre lakes (Central Albania)

**Centrales (18 species)**
- *Actinocyclus normanii* (W. Gregory) Hustedt
- *Asterionella formosa* Hassall
- *Aulacoseira granulata* (Ehrenberg) Simonsen
- *Aulacoseira italica* (Ehrenberg) Simonsen
- *Cyclotella antiqua* W. Smith
- *Cyclotella commersonis* Hustedt
- *Cyclotella cyclopuncta* Hakansson & Carter
- *Cyclotella krammeri* (Grunow) Lemmermann
- *Cyclotella stelligera* (Cleve & Grunow) Krammer
- *Cyclotella meneghiniana* Kützing
- *Cyclotella ocellata* Kuetzing
- *Cyclotella radiosa* (Ehrenberg) Cleve
- *Cyclotella praetermissa* (O.F. Müller) C. Agardh
- *Cyclotella krammeri var.* (Ehrenberg) Grunow
- *Cyclotella meneghiniana* Kützing
- *Cyclotella ehrenbergii* C. Agardh
- *Cyclotella norvegica* Grunow
- *Cyclotella tumida* (Brebisson) Van Heurck

**Pennales (193 species)**
- *Achnanthes catenata* Bily & Marvan
- *Achnanthes clevei* Grunow var. clevei
- *Achnanthes delicatula* (Kuetzing) Grunow
- *Achnanthes exilis* (Gregory) Ralfs
- *Achnanthes lanceolata* (Brebisson) Grunow agg.
- *Achnanthes ploenensis* Hustedt
- *Achnanthes minutissima* Kuetzing
- *Amphora pellucida* (Kuetzing) Kuetzing
- *Amphora cf. acqualis* Krammer
- *Amphora copulata* (Kuetzing) Schoeman & Archibald
- *Amphora flegeliana* Krammer
- *Amphora inariensis* Krammer
- *Amphora lybica* Ehrenberg
- *Amphora montana* Krasske
- *Amphora ovalis* Kuetzing
- *Amphora pediculus* (Kuetzing) Grunow
- *Amphora veneta* Kuetzing
- *Aneamastus minor* (Hustedt) Lange-Bertalot
- *Aneamastus tuscula* (Ehrenberg) Mann & Stickle
- *Anonomeis sphaerophora* (Ehrenberg) Pfitzer
- *Bacillaria paradoxa* J.F. Gmelin
- *Brachysira vitrea* (Grunow) Ross
- *Caloneis cf. aerophila* Bock
- *Caloneis alpestris* (Grunow) Cleve
- *Caloneis cf. hendeyi* Lange-Bertalot
- *Caloneis macedonica* Hustedt
- *Caloneis silicula* (Ehrenberg) Cleve
- *Caloneis thermalis* (Grunow) Krammer
- *Caloneis sp.*
- *Cocconeis neodiminuta* Krammer
- *Cocconeis placenta* Ehrenberg agg.
- *Cocconeis placenta* var. euglypta (Ehrenberg) Grunow
- *Cocconeis placenta* var. lineata (Ehrenberg) Van Heurck
- *Cricrta accommoda* (Hustedt) D. G. Mann
- *Cricrta ambigua* (Ehrenberg) D. G. Mann
- *Cricrta cuspidata* (Kuetzing) D.G.Mann
- *Cymatopleura elliptica* Geissler & Gerloff
- *Cymatopleura solae* (Brebisson) W. Smith
- *Cymbella affinis* Kuetzing agg.
- *Cymbella amphicephala* Naegeli
- *Cymbella caespitosa* (Kuetzing) Brun
- *Cymbella cistula* (Ehrenberg) Kirchner
- *Cymbella cymbiformis* C.A. Agardh
- *Cymbella ehrenbergii* C. Agardh
- *Cymbella fenticula* Hustedt
- *Cymbella helvetica* Kuetzing
- *Cymbella lanceolata* Ehrenberg
- *Cymbella lange-bertalotii* Krammer
- *Cymbella microcphala* Grunow gr.
- *Cymbella minuta* Hilde
- *Cymbella norvegica* Grunow
- *Cymbella prostrata* (Berkeley) Cleve
- *Cymbella silesia* Bleisch
- *Cymbella sinuata* Gregory
- *Cymbella tumida* (Brebbisson) Van Heurck
- *Cymbella tumidula* Grunow
- *Diatoma ehrenbergii* Kuetzing
- *Diatoma mesodon* (Ehrenberg) Kuetzing
- *Diatoma moniliformis* Kuetzing
- *Diatoma tenuis* Kuetzing
- *Diatoma vulgaris* Bory
- *Diploneis cf. modica* Hustedt
- *Diploneis maulerii* (Brun) Cleve
- *Diploneis oblongella* (Nägeli) Cleve-Euler
- *Epithemia abhata* (Kuetzing) Brebisson
- *Epithemia smithii* Carruthers
- *Epithemia sorex* Kuetzing
- *Epithemia turgida* (Ehrenberg) Kuetzing
- *Eunotia bidens* Ehrenberg
- *Fallacia pygmaea* Kuetzing
- *Fragilaria acus* (Kuetzing) Lange-Bertalot
- *Fragilaria biceps* (Kuetzing) Lange-Bertalot
- *Fragilaria bidens* Heiberg
- *Fragilaria brevistriata* Grunow
- *Fragilaria capitellata* (Grunow) J. B. Petersen
- *Fragilaria capucina* Desmaidsiers var. capucina
- *Fragilaria capucina* var. mesolepta (Rabenhorst) Rabenhorst
- *Fragilaria capucina* var. rumpens (Kützing) Lange-Bertalot
- *Fragilaria construens* (Ehrenberg) Grunow agg. (fo. construens)
- *Fragilaria construens* fo. binodis (Ehrenberg) Hustedt
- *Fragilaria crotonensis* Kitton
- *Fragilaria dilatata* (Brebisson) Lange-Bertalot
- *Fragilaria fasciculata* (Agardh) Lange-Bertalot
- *Fragilaria tenera* (W. Smith) Lange-Bertalot
- *Fragilaria ulna* (Nitzsch) Lange-Bertalot agg.
- *Fragilaria virens* Ralfs
Frustulia spicula Amosse
Frustulia vulgaris (Thwaites) DeToni
Gomphonema angustatum (Kuetzing) Rabenhorst
Gomphonema augur Ehrenberg
Gomphonema clavatum Ehrenberg
Gomphonema micropus Kuetzing var. micropus
Gomphonema minutum (Agardh) Agardh agg.
Gomphonema olivaceum (Hornemann) Brebisson gr.
Gomphonema parvulum (Kuetzing) Kuetzing var. parvulum
Gomphonema parvulum var. exilissimum Grunow
Gomphonema punulum (Grunow) Reichardt & Lange-Bertalot
Gomphonema sarcophagus
Gomphonema augur Lange-Bertalot
Gomphonema angustatum
Frustulia spicula
Navicula capitatoradiata
Luticola mutica
Luticola kotschyi
Hantzschia amphioxys
Gomphonema sarcophagus
Gomphonema pumilum
Frustulia vulgaris
Navicula reinhardtii
Navicula cryptofallax
Navicula cryptocephala
Navicula caterva
Navicula atomus
Luticola muticopsis
Gyrosigma scalproides
Gyrosigma acuminatum
Gomphonema truncatum
Navicula subminuscula
Navicula seibigii
Navicula radiosafallax
Navicula reichardtiana Lange-Bertalot
Navicula reinhardtii Grunow
Navicula seibigii Lange-Bertalot
Navicula subminuscula Manguin
Navicula tenelloides Hustedt
Navicula trivialis Lange-Bertalot
Navicula veneta Kuetzing
Navicula viridula (Kuetzing) Kuetzing,
Navicula viridula var. germanii (J. H. Wallace) Lange-Bertalot
Navicula viridula var. linearis Hustedt
Navicula viridula var. subamphitactum var. subamphitactum Kramer
Neidium affine (Ehrenberg) Pfitzer
Neidium ampliatum (Ehrenberg) Krammer
Neidium bisulcatum var. subampliatum Kramer
Neidium dubium (Ehrenberg) Cleve
Nitzschia alpina Hustedt
Nitzschia amphibia Grunow
Nitzschia angustata Grunow
Nitzschia bacilliformis Hustedt
Nitzschia brunnii Lange-Bertalot
Nitzschia calida Grunow
Nitzschia constricta (Gregory) Grunow
Nitzschia denticula Grunow
Nitzschia dissipata (Kuetzing) Grunow
Nitzschia fonticola Grunow
Nitzschia geilleri Hustedt
Nitzschia graciliformis Lange-Bertalot & Simonsen
Nitzschia hangarica Grunow
Nitzschia incopicia Grunow
Nitzschia lacuam Lange-Bertalot
Nitzschia linearis (Agardh) W. Smith var. linearis
Nitzschia lorenziana Grunow
Nitzschia palea (Kuetzing) W. Smith var. palea
Nitzschia recta Hantzsch
Nitzschia scalpelliformis (Grunow) Grunow
Nitzschia sigma (Kuetzing) Smith
Nitzschia signoides (Ehrenberg) W. Smith
Nitzschia solita Hustedt
Nitzschia vernicularis (Kuetzing) Hantzsch
Opephora Olsenii M. Møller
Pinnularia microstauron (Ehrenberg) Cleve
Pinnularia microutastauron var. brebissonii (Kuetzing) A. Mayer
Pinnularia nobilis (Ehrenberg) Ehrenberg
Pinnularia rupestris Hantzsch
Pinnularia viridiformis Krammer
Pinnularia viridis (Nitzsch) Ehrenberg
Placoneis clementoides (Hustedt) E.J. Cox
Placoneis elginensis (Gregory) Ralfs
Placoneis paraelginensis Lange-Bertalot
Placoneis pseudoanglica Lange-Bertalot var. pseudoanglica
Pleurosigma elongatum W. Smith
Rhiocephalina abbreviata (Agardh) Lange-Bertalot
Rhopalodia gibba (Ehrenberg) O. Mueller
Rhopalodia musculus (Kuetzing) O.M. Mueller
Sellophoria bacillum (Ehrenberg) D.G. Mann
Sellophoria levissima (Kuetzing) D.G. Mann
Sellophoria papula (Kuetzing) Merschikovsky
Stauroneis aciceps Ehrenberg
Stauroneis poenicenteron (Nitzsch) Ehrenberg
Stauroneis smitthii Grunow
Surirella angusta Kuetzing
Surirella bifrons Ehrenberg
Surirella brebissonii Krammer & Lange-Bertalot
Surirella cf. splendida Kuetzing
Surirella gracilis Grunow
Surirella linearis W. Smith
Surirella minuta Brébisson
Surirella cf. tenera W. Gregory
Surirella terricola Lange-Bertalot et Alles
Surirella venusta Østrup
Tabellaria flocculosa (Roth) Kuetzing
Tetracyclus rupestris (Braun) Grunow