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COMPARISON OF DIATOMS IN WELL AND DRENOVAČA SWAMP IN VELINO SELO VILLAGE, IN BOSNIA AND HERZEGOVINA

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ABSTRACT:

Parallel with the research of Bacillariophyta flora in the well with shadoof on the area of Semberija was researched Bacillariophyta flora of other freshwater systems that are located in the near or distant environment from the researched wells, such as Drenovača swamp, Sava river, Jelaz canal, artesian wells and ephemeral swamps. It is very interesting to compare Bacillariophyta flora that inhabits wells and Bacillariophyta flora of Drenovača swamp that is only a dozen meters away from the researched well of Lazić Mijo, a local in the village Velino Selo.

All identified Bacillariophyta in researched well belong to aerophile, which indicates on certain ecology of the well, that is a specific life conditions that are present in wells as anthropogenic creations. Contrary to the well flora, Bacillariophyta flora of Drenovača swamp is composed party of algae belonging to benthos. In Lazić Mijo well were identified 33Bacillariophyta, all aerophile, while in Drenovača swamp were identified 57 Bacillariophyta, from which only 18 are aerophile and others belong to benthos.

Considering that Bacillariophyta is a component of aeroplankton, and that via air currents can be transmitted over long distances, it is assumed that similarly aerophile Bacillariophyta were transmitted on mosses associations on the well wall, manifested their adaptive attributes in such biotopes, and by that became autochthonous flora of the well. Large qualitative differences in Bacillariophyta flora in wells with shadoof and in Bacillariophyta flora of Drenovača swamp also indicate on autochthony of Bacillariophyta flora of the well, which means that species were not transmitted from the neighborhood.

Key words: *aerophile, swamp, benthos, well, diatoms*

INTRODUCTION

Floristic researches of Bacillariophyta in wells with shadoof are poor in world literature. In the area of former Yugoslavia, the first researches of this algae were conducted in the period from 1981 to 1993 [1,2,3,4,5,6,7].

Our research included several wells and other freshwater ecosystems on the area of Semberija, and the subject of this paper is a comparison of identified Bacillariophyta flora of a well that is located near Drenovača swamp and Bacillariophyta flora of the same swamp. The collection of researches showed that there is no large similarity in the number of prominent Bacillariophyta in the well and the swamp even though they are only ten meters away from each other. Of course, the physical – chemical factors

and environmental factors determine the presence or absence of particular species in the researched ecosystem.

That fact proves that wells with shadoof are inhabited with autochthonous Bacillariophyta flora. In contrast to the autochthonous flora of diatoms, Drenovača swamp is inhabited mostly with benthos periphyton diatoms whose presence is determined by the depth of water, meaning physical and chemical factors of the environment in which they live [8,9,10,11,12,13,14]. Drenovača swamp is located in Velino Selo village. The total area of the swamp is around 1000 m². The maximum depth is approximately 1 m. On the edges of the swamp are places different objects of metal, glass and plastic origin (figure 1).



Figure 1. Drenovača swamp

Open Mijo Lazić well is located only 10m from the swamp. It is bounded with a wooden fence that is worn out. Inside of the well, it is built of bricks. Well walls are overgrown with mosses, especially to 1.5 m depth from the surface where aerophile diatoms live as epiphytes. Depth of the well is approximately 5 m, and the diameter is about 1 m. Bucket of water abstraction is partly overgrown with mosses. The bottom of the well is muddy with admixtures of clay and moss (figure 2).



Figure 2. Mijo Lazić well

MATERIALS AND METHODS

Considering the nature of the location, character of the research and comparative analysis of diatomaceous flora of well with diatomaceous flora of Drenovača swamp, sampling of the material was conducted in different ways. Special difficulties were present during sampling of the material from well wall and sediments from the bottom of the well. It demanded specific equipment. Taking sediments from the well bottom was performed with a mini excavator that is normally used for hydrobiological research. After the extraction of the excavator from the well, sediments were placed in labeled bottles. Samples of mosses from the well wall were taken from the surface of 10 cm² on every 50 cm starting from the surface of the well (0 cm) to 200 cm depth.

Sampling was conducted with a special “spoon” for the abstraction of mosses (figure 3). Phycology material from mentioned biotopes was collected during all twelve months in 2016. After the extraction from the well, mosses were placed in plastic bags that were immediately labeled. Phycology material from Drenovača swamp was collected as benthos on rocks in swamp water, from other solid bases in water or with the extraction of swamp water.

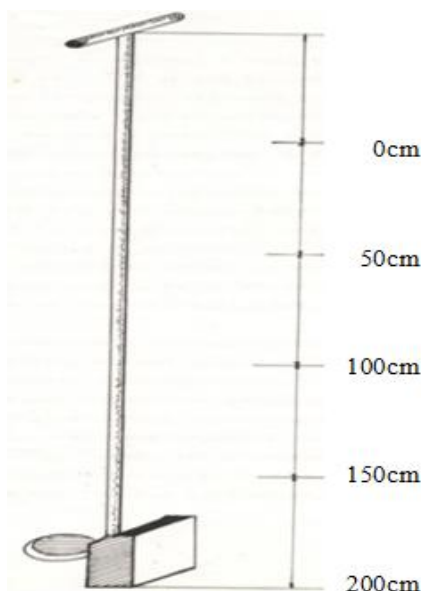


Figure 3. “Spoon” for moss extraction

Samples were placed in labeled bottles and preserved with 4% formaldehyde. In laboratory, material was tested with a method according to Hustedt [15] and modified with a method according to Jerković [16], and obtained suspension was used for making of the permanent product. Determination and counting of individuals per area unit were conducted under the binocular microscope “ZEISS” with an immersion lens with magnification of 1.500 times.

Number calculation of individuals on area unit was conducted according to equation (Ćurčić mscr):

$$x^{jed} / cm^2 = \frac{S \cdot n \cdot F}{N \cdot S_1}$$

where:

S – is a surface of the cover tile;

n – is a number of individuals of one taxon;

N – is a number of visible a field on which counting was conducted;

S₁ – is a surface area of one visible field;

F – is a factor (ratio of concentrate volume in ml/surface area of substrate for sample x volume of subsample in ml).

RESULTS AND DISCUSSION

It is generally known that Bacillariophyta inhabits all aquatic ecosystems. However, they can be found also in ground and air (aerophile). According to Jerković [17] diatoms that can be found in the air are integral parts of aeroplankton. Diatoms that are part of aeroplankton inhabit mosses of the well wall leading epiphytic life in those microhabitats. Such microhabitats of the well wall are characterized with special ecological conditions like extreme humidity, reduced light, variable temperature, and other physical – chemical factors.

A relatively large number of aerophile Bacillariophyta was identified during research in 1981 [1], then in wells in the area near Bosanski Šamac [18] and in wells near Bijeljina, as well as during researching of Bacillariophyta in the Mijo Lazić well in village Velino Selo, that are the subject of this paper.

During the research of diatoms in Mijo Lazić well were identified 33 species and infraspecies taxa of aerophile Bacillariophyta on mosses of the well wall. In buckets for extraction of the well water were identified 20 species and infraspecies taxa of Bacillariophyta and in the sediment of well bottom 9 species and infraspecies taxa of Bacillariophyta. A large number of species and infraspecies taxa that live on mosses of the well wall in relation to the number of species that are identified in buckets for extraction of well water and sediments of well bottom show that well water is not a natural habitat for diatoms. Their natural habitats are mosses of the well wall that they constantly or periodically inhabited. Foundings of Bacillariophyta in well sediments are the result of long term “falling” from well wall and buckets for extraction of well water.

Sampling of phycology material, ie mosses from the well wall was conducted on every 50 cm to 200 cm of well depth, starting from the surface of the well (0 cm). This microhabitat is characterized by the dominance of aerophile species and infraspecies taxa Bacillariophyta of *Navicula*, *Nitzschia*, *Achnanthes* and *Amphora* genera. The most dominant populations are *Navicula contenta* and *Achnanthes lanceolata* ssp. *lanceolata* var. *lanceolata* on all well levels. Other species and infraspecies taxa are less dominant, meaning they are less abundant. The exceptions are populations of *Amphora normanii* and *Nitzschia debilis* that are the most abundant on well levels of 150 cm and 200 cm during all seasons of the year.

The total number of individuals of Bacillariophyta on different levels in researched well was the highest on the level of 100 cm and it was 423965 of individuals. On well level of 0 cm number of individuals was 168574, on level of 50 cm number of individuals was 301801, on level of 150 cm number of individuals was 386637 and on level of 200 cm number of individuals was 183703.

The number of individual diatoms was in the function of several factors such as light intensity, humidity, well depth, but also it depended from the coverage of mosses on well levels. In researched well was identified moss association of *Oxyrrynchio-Platyhypnidietum rusciformis*. This moss association was first described in well near Bosanski Šamac [18]. Walls of the researched well had high general coverage of association of algae and mosses.

Identified species and infraspecies taxa of aerophile Bacillariophyta in the Mijo Lazić well in the village Velino Selo are the following:

- *Achnanthes lanceolata* (Brebisson) Grunow ssp. *lanceolata* var. *lanceolata*
- *Achnanthes conspicua* A. Mayer
- *Achnanthes coarctata* (Brebisson) Grunow in Cleve et Grunow
- *Aulacoseira granulata* var. *granulata* (Ehrenberg) Simonsen
- *Amphora montana* Krasske
- *Amphora normanii* Rabenhorst
- *Amphora pediculus* (Kiitzing) Grunow
- *Caloneis bacillum* (Grunow) Cleve
- *Cocconeis placentula* var. *lineata* (Ehrenberg) Van Heurck

- Eunotia soleirolii (Kiitzing) Rabenhorst
- Gomphonema micropus Kiitzing
- Hantzschia amphioxys (Ehrenberg) Grunow in Cleve et Grunow
- Navicula atomus var. atomus (Kiitzing) Grunow
- Navicula contenta Grunow in Van Heurck
- Navicula mutica var. mutica Kiitzing
- Navicula mutica var. ventricosa (Kiitzing) Cleve et Grunow
- Navicula nivalis Ehrenberg
- Navicula seminulum Grunow
- Navicula veneta Kiitzing
- Navicula goepertiana var. goepertiana (Bleisch) H. L. Smith
- Navicula atomus var. excelsa (Krasske) Lange-Bertalot
- Navicula elginensis var. elginensis (Gregory) Ralfs in Pritchard
- Navicula cincta (Ehrenberg) Ralfs in Pritchard
- Navicula gallica var. gallica (W. Smith) Lagerstedt
- Navicula suecorum var. dismutica (Hustedt) Lange-Bertalot
- Nitzschia communis Rabenhorst
- Nitzschia amphibia f. amphibia Grunow
- Nitzschia debilis (Arnott) Grunow in Cleve et Grunow
- Nitzschia hantzschiana Rabenhorst
- Nitzschia fonticola Grunow in Cleve et Moller
- Nitzschia inconspicua Grunow
- Nitzschia palea (Kiitzing) W. Smith
- Pinnularia microstauron var. brebissonii (Kiitzing) Mayer

In Drenovača swamp that is located in the immediate surroundings, next to Mijo Lazić well in Velino Selo village were identified 57 species and infraspecies taxa of Bacillariophyta that mostly belong to benthos algae. Of the total number of identified, only 18 are aerophile Bacillariophyta, or 31.58%, while 39 species and infraspecies taxa or 68.42% belong to benthos algae. These data show a very low level of cenological similarity in the structure of Bacillariophyta between well and Drenovača swamp.

If we compare the structure of Bacillariophyta in Mijo Lazić well with the structure of Bacillariophyta in previously researched wells on the area of Semberija that are around 15 km distant from each other, we can conclude that cenological similarity between these wells is present with over 72%. According to that, wells show one homogeneity in the view of high level of cenological similarity in the structure of Bacillariophyta regardless of the distance.

All of this points out the autochthony of Bacillariophyta flora of the well. Very low level of cenological, ie qualitative similarity in the structure of Bacillariophyta of well and Drenovača swamp is a consequence of large ecological differences in those biotopes that are followed during the whole year, as they suggest physical and chemical characteristics of the biotope.

Identified species and infraspecies taxa of Bacillariophyta in Dranovača swamp are the following:

- Achnanthes lanceolata (Brebisson) Grunow ssp. lanceolata var. lanceolata
- Achnanthes lanceolata ssp. Rostrata (Oestrup) Lange-Bertalot
- Amphora aequalis Krammer
- Amphora montana Krasske
- Amphora libyca Ehrenberg
- Amphora pediculus (Kiitzing) Grunow
- Amphora ovalis (Kiitzing) Kiitzing
- Caloneis bacillum (Grunow) Cleve
- Cocconeis pediculus (Ehrenberg)
- Cocconeis placentula var. euglipta (Ehrenberg) Grunow
- Cocconeis placentula var. lineata (Ehrenberg) Van Heurck
- Anomoeneis sphaerophora f. sphaerophora (Ehrenberg) Pfitzer

- Diploneis oblongella (Naegeli) Cleve-Euler
- Diploneis ovalis (Hilse) Cleve
- Diploneis elliptica var. elliptica (Kiitzing) Cleve
- Diatoma vulgare Bory
- Diatoma ehrenbergii Kiitzing
- Diatoma mesodon (Ehrenberg) Kiitzing
- Aulacoseira granulata var. granulata (Ehrenberg) Simonsen
- Aulacoseira ambigua (Grunow) Simonsen
- Cyclotella meneghiniana Kiitzing
- Cyclotella bodanica var. afinis (Grunow) Cleve-Euler
- Cymatopleura solea var. solea (Brebisson) W. Smith
- Cymbella silesiaca Bleisch in Rabenhorst
- Cymbella affinis Kiitzing
- Cymbella sinuata Gregory
- Cymbella lanceolata (Ehrenberg) Kirchner
- Fragilaria capucina var. capucina Desmazieres
- Fragilaria ulna var. ulna (Nitzsch) Lange-Bertalot
- Fragilaria ulna var. acus (Kiitzing) Lange-Bertalot
- Fragilaria pinata var. pinata Ehrenberg
- Fragilaria brevistriata Grunow in Van Heurck
- Fragilaria elliptica Schuman
- Fragilaria tenera (W. Smith) Lange-Bertalot
- Gomphonema micropus Kiitzing
- Gomphonema angustum Agardh
- Gomphonema clavatum Ehrenberg
- Gomphonema tergestinum Fricke
- Gomphonema parvulum var. parvulum f. parvulum Kiitzing
- Gomphonema grovei var. lingulatum (Hustedt) Lange-Bertalot
- Gomphonema truncatum Ehrenberg
- Gomphonema olivaceum var. olivaceum (Hornemann) Brebisson
- Gyrosigma scalproides (Rabenhorst) Cleve
- Gyrosigma nodiferum (Grunow) Reimer
- Gyrosigma acuminatum (Kiitzing) Rabenhorst
- Gyrosigma spencerii (Quekett) Griffith et Heufrey
- Frustulia vulgaris (Thwaites) De Toni
- Hantzschia amphioxys (Ehrenberg) Grunow in Cleve et Grunow
- Meridion circulare var. circulare (Greville) C. A. Agardh
- Meridion circulare var. constrictum (Ralfs) Van Heurck
- Navicula capitata var. capitata Ehrenberg
- Navicula cuspidata (Kiitzing) Kiitzing
- Navicula cryptosephala Kiitzingž
- Navicula cincta (Ehrenberg) Ralfs in Pritchard
- Navicula trivialis Lange-Bertalot
- Navicula mutica var. mutica Kiitzing
- Navicula mutica var. ventricosa (Kiitzing) Cleve et Grunow
- Navicula elginensis var. elginensis (Gregory) Ralfs in Pritchard
- Navicula menisculus var. menisculus Schumann
- Navicula pigmaea Kiitzing
- Navicula goepertiana var. goepertiana (Bleisch) H. L. Smith
- Navicula contenta Grunow in Van Heurck
- Navicula placentula (Ehrenberg) Kiitzing
- Navicula viridula var. viridula (Kiitzing) Ehrenberg

CONCLUSION

Our researches included the comparison of identified Bacillariophyta in one well with shadoof on the area of Semberija (Velino Selo village) and in Drenovača swamp (located also in Velino Selo village). Expected differences in the presence of certain taxa on researched localities are confirmed. Meaning, on well mosses were identified only aerophile epiphytic Bacillariophyta, while in Drenovača swamp were mostly identified benthos Bacillariophyta, even though their habitats are about ten meters away from each other. Different ecological conditions that are present in these habitats such as light, humidity, temperature, pH of the environment define the presence or absence of certain species, varieties and forms in well and Drenovača swamp.

In well were identified 33 species and infraspecies taxa of Bacillariophyta on well mosses, buckets for water extraction and on well sediments that belong to aerofiles, while in Drenovača swamp were identified 57 species and infraspecies taxa that belong to benthos diatoms. Only 18 species and infraspecies taxa belong to aerofiles in Drenovača swamp, while 39 species and infraspecies taxa of Bacillariophyta are determined as benthos. In researched well were not identified benthos diatoms which confirm the fact that well Bacillariophyta flora is an autochthonous flora. On well mosses the most dominant species of diatoms belong to Navicula, Nitzschia and Achnanthes genera, while in Drenovača swamp the most dominant species are from Amphora, Cymbella, Fragilaria, Gomphonema, Navicula and Nitzschia genera.

Considering that material was sampled from the well wall on different levels from 0 cm to 200 cm of depth, with numerical analysis were obtained the data that the largest number of individuals per area unit is registered on the depth of 100 cm and it is 423965 of individuals of diatoms. The smallest number is on the depth of 0 cm (surface) and it is 168574 of individuals per area unit. The number of individuals is in the function of environmental factors that are present in researched biotopes, such as light, humidity, temperature but also the general coverage of the well wall with mosses flora.

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