DIATOMS AND THEIR ROLE IN AQUATIC ECOSYSTEMS

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Abstract
The present article aimed to determine diversity and abundance of diatoms in the river basin of the Cerna River. In order to achieve the objective, samples were taken from the entire course of the river, from 9 specific points (I, II, III, IV, V, VI, VII, VIII, IX) in spring-summer of 2020. 53 species of diatoms classified in 21 genera were determined.

Introduction
Aquatic ecosystems are open to pollution due to population growth, technological development and increasing industrial activity [1]. Industrial activities are the main source of water pollution due to the generation of effluents with distinct characteristics. Pollutants commonly found in water include pesticides, organic contaminants, heavy metals, nitrogen compounds and sometimes even radionuclides [2]. A versatile and effective biological method in assessing the quality of aquatic environments is the use of diatoms, which are unicellular microscopic algae that live in all aquatic environments with sufficient light and are used worldwide as bioindicators due to their high sensitivity to certain chemical parameters of water, such as would be: mineralization of water, organic matter, nutrients, heavy metals, etc. [3]. Due to their wide distribution, species abundance, ease of storage and sensitivity to environmental changes, diatoms are effective as environmental indicators [4]. They are an important source of oxygen for planet Earth, producing about 25% of the oxygen released into the atmosphere [5]. They are photosynthesizing organisms, but there are some species that can survive in the dark if the environment contains sufficient amounts of organic carbon [6]. They are highly adaptable to different environmental conditions, such as temperature, pH, photoperiod and salinity, and can achieve higher growth rates compared to other groups of algae. Their size varies from 1 to 2000 μm and is known to contribute up to 45% to net primary productivity in the ocean due to their higher growth rate and competitive advantages over other groups of microalgae [7].

Experimental
Study area
For the study of diatoms in the Cerna River, 9 sampling stations were selected. The stations were chosen in such a way as to cover the entire course of the river and to be representative of the different areas through which it passes, and the samples were taken in the spring-summer period of 2020. A point with the highest altitude was chosen, being also the closest to the source of the southern channel - upstream of Gura Bordului. The following stations were selected according to the place of discharge of the tributaries - the stations were chosen before the area of discharge of the tributaries, and upstream of the locality. The only downstream station was represented by station VII - downstream of Hunedoara, because the upstream area of Hunedoara is dammed and arranged to avoid floods during rainfall, especially when the Hasdau stream, a tributary of Cerna, increases in flow.

Figure 1. Graphic representation of sampling points along the Cerna river

Sampling and preservation of samples

The samples were taken in the spring-summer of 2020. At each sampling 3 sub-samples were collected. The final samples for each point are obtained by mixing the 3 sub-samples. For diversity, we looked for three stones with different structure and size (figure 2), taken from places where the water depth remains relatively constant, both in periods of drought and in those with high rainfall.

Figure 2. The substrate from which the diatomic samples were taken

The samples of diatoms were taken by brushing and washing the stones with water. The aim was to brush on a large surface of the stone for the diversity of species. Where the stones were in the muddy substrate, only the accessible surfaces of the stone were brushed. The samples were placed in Falcon tubes and treated with 3 ml of formaldehyde, for preservation and maintenance until processing in the laboratory.

Sample processing

The processing of the diatom samples included several stages. The first of these was the removal of the remaining substrate particles in the samples. This operation was performed by washing and decanting repeatedly. In the second stage, the elimination of organic matter from the samples was followed by successive treatment with HCl (20%) 10 ml and HNO3 (37%) with a volume equal to that of the samples (nitric acid was added in two phases at an interval of 48 hours), respectively burning the samples on a metal plate at a temperature of 80-90 ° C, for 6-8 hours. The degreased lamella were placed on the plate, with a small amount of sample spread very well over its entire surface. The burned lamella were left to dry for 24 hours. In the third stage, the diatom frustules were mounted on microscopic slides using rosin. A thin start of rosin was spread on the heated lamella (at 60-70 ° C). After liquefying the rosin, the lamella was placed, obtaining the "microscopic preparation". After cooling the "microscopic preparations", the excess rosin was removed. Species identification was performed using the Olympus CX 43 optical microscope (2019), at the 40x objective and at the 100x immersion objective. Online determinants were used to identify the species: https://diatoms.org/species [8] https://www.biodiversitylibrary.org/item/23911#page/1/mode/1up [9].

Results and discussion

Composition of diatom communities in the Cerna river basin

During the Cerna River, 53 species of aquatic diatoms were identified and studied. The taxonomic analysis of the floristic list of diatoms highlights the following aspects, namely: the best represented genera with 6 species are Navicula and Nitzschia, followed by the genera Cymbella and Fragilaria with 5 species. The genus Surirella has 4 species, followed by the genera Cyclotella and Gomphoneis with 3 species, respectively the genera Achnanthes, Amphora, Cocconeis, Diatoma, Diploneis and Gyrosigma with 2 species each. The rest of the genera Aulacoseira, Eunotia, Frustulia, Hannaea, Melosira, Reimeria, Rhoicosphenia, Stauroneis and Synedra have only one species. The graphic representation of the genera is presented in figure 2.

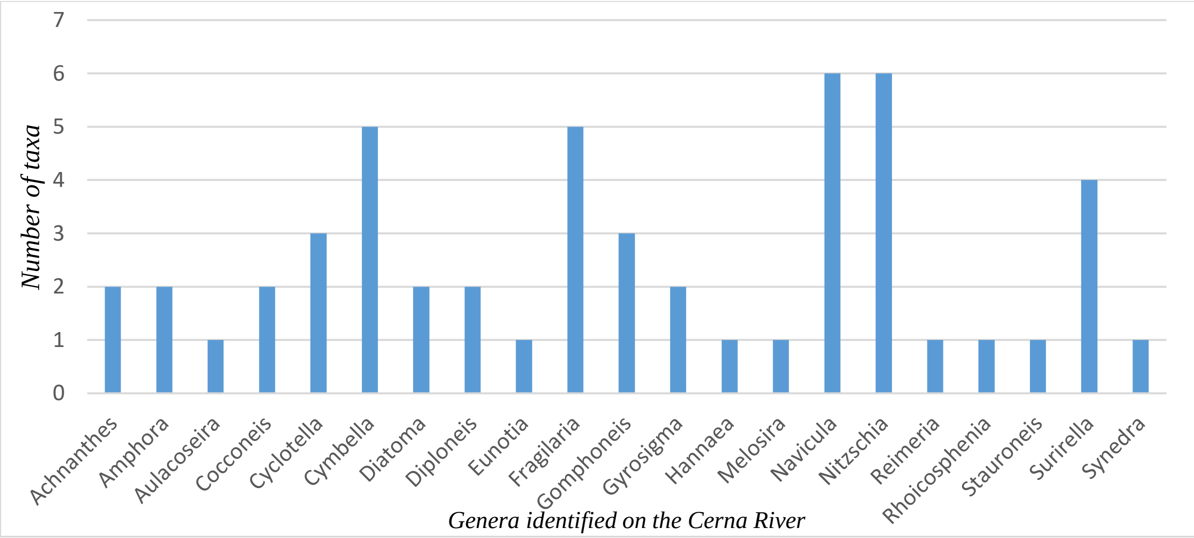

Figure 3. The main types of diatoms with the number of related taxa present in the Cerna river

Based on the absence / presence of the species in the sampling points, the diatoms were divided into four categories: dominant species (found in 7, 8 and 9 sampling points), sub-dominant species (found in 5 or 6 sampling points) , rare species (found in 3 or 4 sampling points) and very rare species, these being found in only 1 or 2 sampling points.

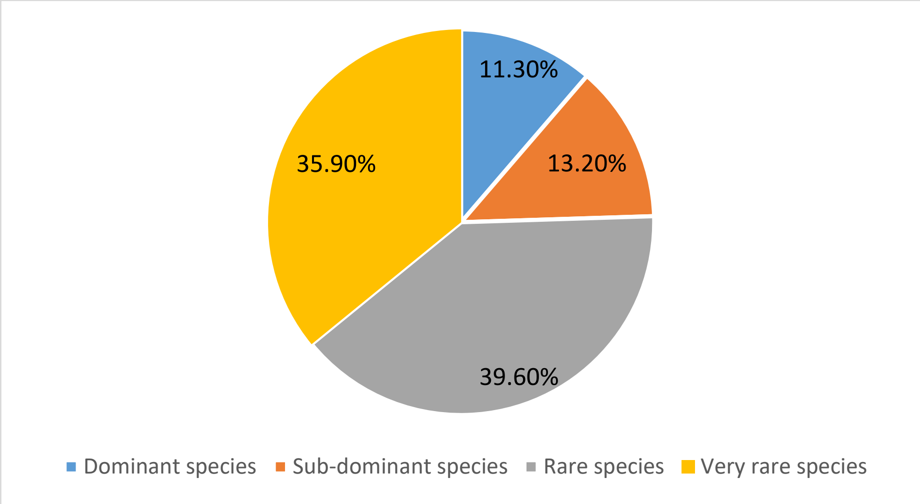

Figure 4. Classification of species in the four categories

The most abundant species present in the Cerna river basin are: *Achnanthes minutissima*, *Cymbella affinis*, *Cymbella minuta*, *Navicula radiosa*, *Reimeria sinuata* and *Synedra ulna*, and the least common species in the sampling points are: *Aulacoseira crassipunctata*, *Cymbella hantzschiana*, *Cymbella tumida*, *Diatoma moniliformis*, *Diploneis ovalis*, *Fragilaria famelica*, *Fragilaria vaucheriae*, *Frustulia vulgaris*, *Gomphoneis olivaceum*, *Gyrosigma acuminatum*, *Gyrosigma attenuatum*, *Melosira varians*, *Nitzschia brevissima*, *Nitzschia communis*, *Nitzschia minuta*, *Nitzschia palea*, *Rhoicosphenia abbreviate*, *Stauroneis obtusa* and *Surirella minuta*.

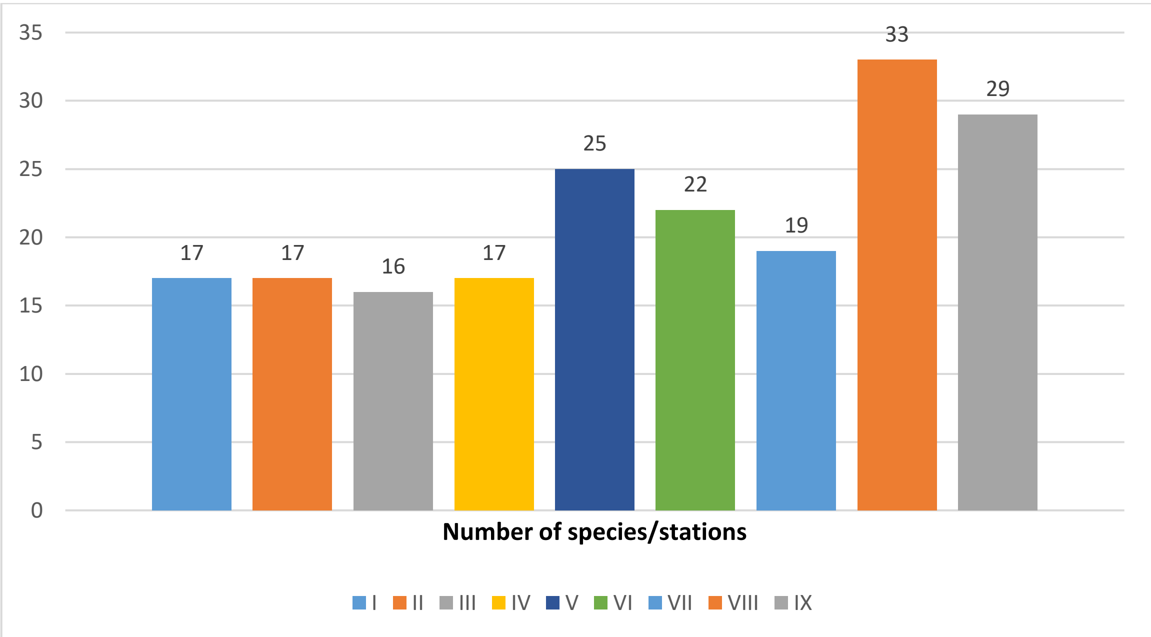

Figure 5. Number of diatomic species for each sampling station

Regarding the number of species from each sampling point, there is a uniformity of species in the first 4 stations, after which in the rest of the areas the abundance of species increases slightly reaching a maximum in the sampling point number VIII. We can attribute these differences to the depth and flow of water which is lower in the lower part of the river than in the upper area where the flow and depth increase with the discharge of tributaries. In addition, points VII, VIII

and IX are close to the cities of Hunedoara and Deva and it seems that the proximity to human communities affects to some extent the diatom communities.
Our relating and interpretations are also supported by Butiuc-Keul et al. 2012 [10], who studied the diatoms present in the Aries river basin and concluded that there are major differences between diatomic communities due in particular to anthropogenic factors and human intervention in the areas.

Conclusion

From the experimental study we can draw some interesting conclusions regarding the diatom communities present in the Cerna river basin. 53 species of diatoms classified in 21 genera were determined. The most abundant genera determined were the genera Navicula, Nitzschia, Fragilaria and Cymbela. The first two genera have 6 species in each component, and the next two genera have 5 species each. The stations where diatom species abound are stations VIII and IX with 33 and 29 taxa, respectively. .

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