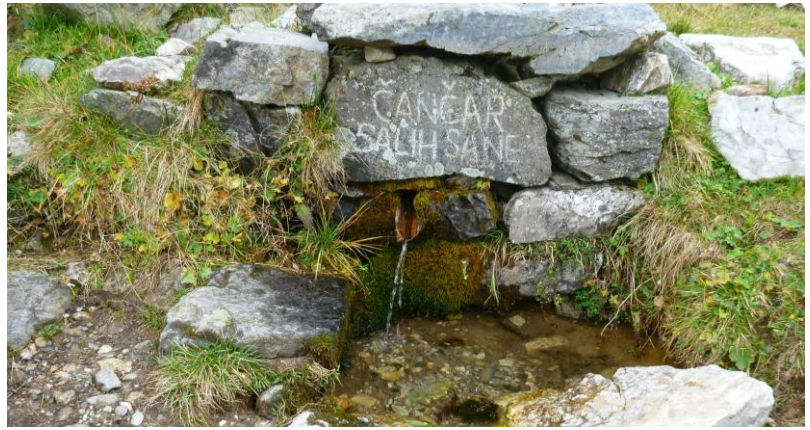

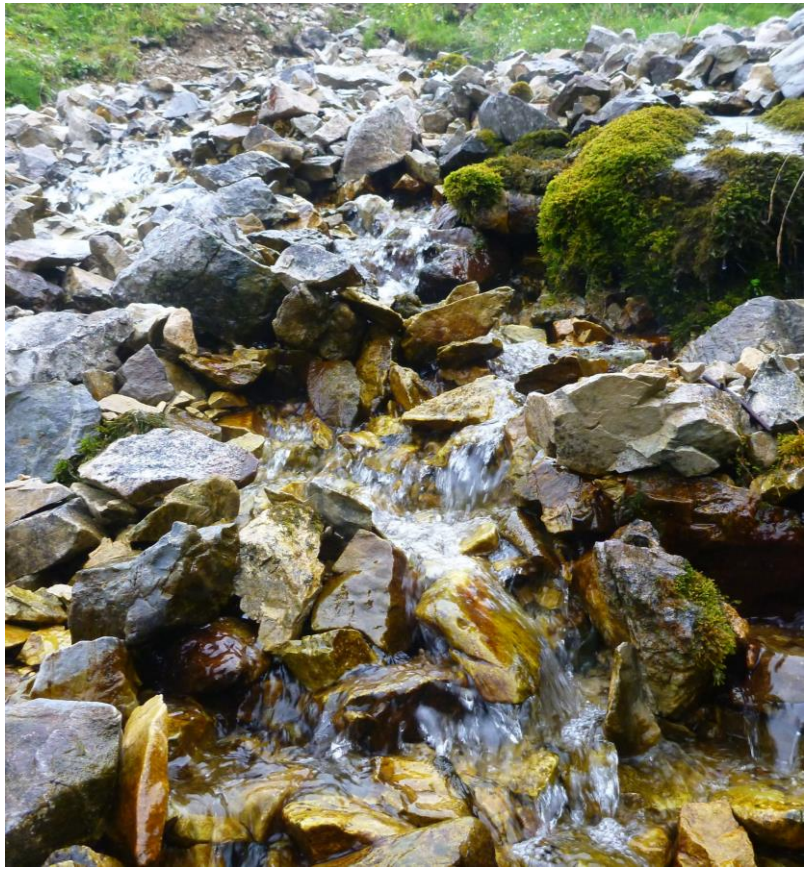

Conservation of Freshwater Oligotrophic Habitats on Vranica Mountain and Establishment of Long-Term Monitoring of Biodiversity

MOUNTAIN SPRINGS

MOUNTAIN SPRINGS

Springs are places where groundwater is exposed, often flowing from the Earth's surface. Emerging in many forms, springs are said to be the windows into the Earth. They are also some of the most sensitive indicators of global climate change. Until recently, very little research has focused on springs ecosystems or their dependent species.

According to recent literature, springs support a wide array of flora and fauna. They are the most biologically diverse ecosystems in the world. Springs have been used for a variety of human needs including drinking water, domestic water supply, irrigation, mills etc. Other modern uses include recreational activities such as fishing, swimming, water for livestock, fish hatcheries and supply for bottled mineral water. Unfortunately, springs are today under negative human influences and their restoration and conservation are necessary.

Due to specific geological characteristics, Vranica Mountain abounds with springs. Although they occupy a small area, they support and provide habitat for a lot of plant and animal species.

Cyanobacteria and algae are the most numerous groups of organisms which inhabit springs ecosystems.

A total of 90 species of cyanobacteria and algae were found during our investigation. The species identified belong to the following classes: Cyanophyceae (3), Chrysophyceae (1), Xanthophyceae (1), Bacillariophyceae (82) and Conjugatophyceae (3).

Dominant taxa were recorded in the mountain springs as follows:

- *Achnanthidium minutissimum* (Kützing) Czarnecki 1994,
- *Diploneis krammeri* Lange-Bertalot et Reichardt 2004,
- *Encyonema ventricosum* (C.Agardh) Grunow in A. Schmidt et al. 1885,
- *Meridion circulare* (Gréville) C. Agardh 1831,
- *Nitzschia fonticola* Grunow in Cleve & Möller 1879,
- *Odontidium mesodon* (Ehrenberg) Kützing 1844,
- *Pinnularia viridis* (Nitzsch) Ehrenberg 1843,
- *Planothidium lanceolatum* (Brébisson ex Kützing) Lange-Bertalot 1999,
- *Staurosirella pinnata* (Ehrenberg) D.M. Willams et Round 1988 and
- *Tetracyclus rupestris* (Braun) Grunow in Van Heurck 1881.

In these freshwater oligotrophic habitat types, 33 rare and endangered species of diatoms (Lange-Bertalot and Steinfdorf, 1996) were found. The most prominent were: *Aulacoseira crenulata* (Ehrenberg) Thwaites 1848, *Eunotia soleirolii* (Kützing) Rabenhorst 1864, *Eunotia tetraedon* Ehrenberg 1838, *Neidium longiceps* (Gregory) Ross 1947 and *Surirella spiralis* Kützing 1844.

In order to protect mountain springs in the future, it is necessary to establish long-term monitoring of biodiversity, as well as their condition.

The aim of this monitoring is to create a plan for the future restoration and conservation activities of these very unique and sensitive habitats and to protect a high degree of species diversity.

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Conservation of Freshwater Oligotrophic Habitats on Vranica Mountain and Establishment of Long-Term Monitoring of Biodiversity

MOUNTAIN CREEKS

MOUNTAIN CREEKS

Numerous small creeks which are active through the year give Vranica Mountain special uniqueness and beauty. Immediately after coming out under the Earth's surface, the water flows very fast along with various obstacles and later downstream forms waterfalls of high landscape values.

Mountain creeks represent specific habitat types and they are characterized by a high degree of biodiversity. They are inhabited by extremely rare and endangered plant and animal species. Similar to mountain springs, mountain creeks are also extremely sensitive to global climate change.

In mountain regions, creeks are most often used for water supply. Despite the fact that mountain creeks are inhabited by high number of sensitive plant and animal species, today they are under different anthropogenic influences. Due to their exceptional importance for conservation of biodiversity, in the future, it is necessary to adequately protect this type of habitat in mountain area.

Mountain creeks represent an ideal habitat for cyanobacteria and algae. A total of 78 species of cyanobacteria and algae were found during our investigation. The species identified belong to the following classes: Cyanophyceae (5), Bangiophyceae (1), Chrysophyceae (1), Xanthophyceae (1), Bacillariophyceae (61) and Conjugatophyceae (9).

Dominant taxa were recorded in the mountain creeks as follows:

- *Achnanthidium minutissimum* (Kützing) Czarnecki 1994,
- *Cocconeis lineata* Ehrenberg 1849,
- *Cocconeis placentula* Ehrenberg 1838,
- *Diatoma ehrenbergii* Kützing 1844,
- *Encyonema minutum* (Hilse) D.G. Mann 1990,
- *Encyonema silesiacum* (Bleisch) D.G. Mann 1990,
- *Gomphonema minusculum* Krasske 1932,
- *Hannea arcus* (Ehrenberg) R.M.Patrick in Patrick & Reimer 1966.
- *Meridion circulare* (Gréville) C. Agardh 1831 and
- *Odontidium mesodon* (Ehrenberg) Kützing 1844.

In the mountain creeks, 16 rare and endangered species of diatoms (Lange-Bertalot and Steinfdorf, 1996) were found. The most prominent were: *Aulacoseira crenulata* (Ehrenberg) Thwaites 1848, *Caloneis alpestris* (Grunow) Cleve 1894, *Cymbopleura amphicephala* (Nägeli) Krammer 2003, *Diploneis krammeri* Lange-Bertalot et Reichardt 2004 and *Pinnularia rupestris* Hantzsch in Rabenhorst 1861.

In addition to rare and endangered diatom taxa, algae from the other classes have been identified in the mountain creeks as follows: Bangiophyceae (*Bangia atropurpurea* (Mertens ex Roth) C. Agardh) and Chrysophyceae (*Hydrurus foetidus* (Villars) Trevisan).

In order to protect mountain creeks in the future, it is necessary to establish long-term monitoring of biodiversity, as well as their condition.

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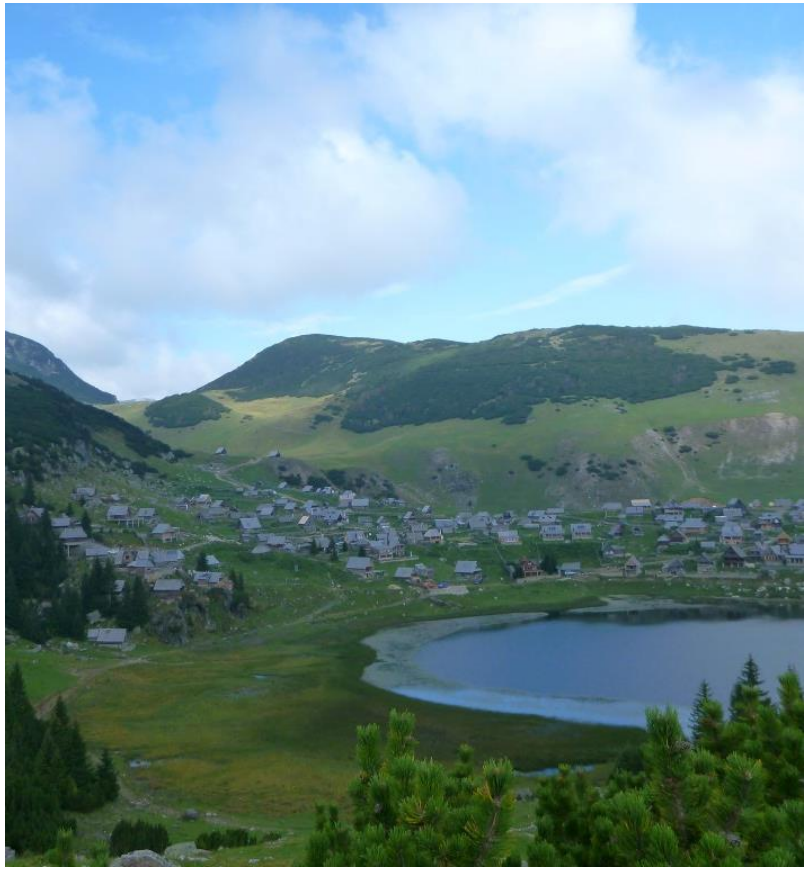

Conservation of Freshwater Oligotrophic Habitat on Vranica Mountain and Establishment of Long-Term Monitoring of Biodiversity

MOUNTAIN LAKES

MOUNTAIN LAKES

Lakes are complex ecosystems, playing vital roles in regulating the global hydrological and biogeochemical cycles and acting as important parts of the global biosphere. Unfortunately, mountain lakes are today endangered especially due to the effects of global climate change and strong anthropogenic influences.

In addition to numerous springs and streams, the well-known Prokoško Lake, which has a glacial origin, gives an extraordinary value to Vranica Mountain. Unfortunately, in recent years due to urbanization and unplanned construction, ecological state of the lake has changed.

Since Prokoško lake gives an extraordinary value to Vranica Mountain, and also because of its unique biodiversity, this area was protected as regional natural park in 1954. Later, in 2005 Prokoško lake got the status of Nature Monument.

The Lake Basin of Prokoško Lake is located at an altitude of 1,635 meters above the sea level and is the highest of its kind in Bosnia and Herzegovina. The maximum depth of the lake is 13 meters.

The first data about the geology of Vranica Mountain, as well as Prokoško lake can be found in works of Katzer (1902), and first hydrobiological data about Prokoško lake are presented in works of Protić (1924-1926).

A total of 121 species of cyanobacteria and algae were found during our investigation. The species identified belong to the following classes: Cyanophyceae (13), Chrysophyceae (2), Bacillariophyceae (52), Dinophyceae (1) , Euglenophyceae (7), Chlorophyceae (19), Trebouxiophyceae (4), Conjugatophyceae (22) and Charophyceae (1).

Dominant taxa were recorded in mountain lake as follows:

- *Achnanthidium minutissimum* (Kützing) Czarnecki 1994,
- *Cocconeis placentula* Ehrenberg 1838,
- *Encyonema ventricosum* (C.Agardh) Grunow in A. Schmidt et al. 1885,
- *Epithemia sorex* Kützing 1844,
- *Fragilaria vaucheriae* (Kützing) Petersen 1938,
- *Gomphonema acuminatum* Ehrenberg 1836,
- *Navicula radiosa* Kützing 1844,
- *Nitzschia fonticola* Grunow in Cleve & Möller 1879,
- *Staurosirella pinnata* (Ehrenberg) D.M. Willams et Round 1988 and
- *Tabellaria ventricosa* Kützing 1844.

In the Prokoško lake, 16 rare and endangered species of diatoms (Lange-Bertalot and Steinfdorf, 1996) were found. The most prominent were: *Cavinula cocconeiformis* (Gregory) D.G. Mann et Stickle 1990, *Craticula cuspidata* (Kützing) D.G. Mann in Round et al. 1990, *Cymbopleura inaequalis* (Ehrenberg) Krammer 2003, *Eunotia arcubus* Nörpel et Lange-Bertalot 1993 *and Stauroneis gracilis* Ehrenberg 1841.

In order to protect glacial Prokoško lake, in the future, it is necessary to establish long-term monitoring of biodiversity, as well as its condition.

The aim of this monitoring is to create a plan for the future restoration and conservation activities of this very unique and sensitive habitats and to protect a high degree of species diversity.

The Rufford Foundation

Conservation of Freshwater Oligotrophic Habitats on Vranica Mountain and Establishment of Long-Term Monitoring of Biodiversity

MOUNTAIN PEATLANDS

MOUNTAIN PEATLANDS

Peatlands are considered both important habitats and biodiversity hotspots worldwide. These types of ecosystems are characterized by extreme environmental conditions not found in other wetland ecosystems. Cold, anaerobic, and nutrient-poor conditions limit decay of organic matter. Because the rate of organic matter accumulation exceeds the rate of decomposition, peatlands are autogenic or "*self-creating*" habitats. Peatlands are important to the global C cycle because they store a large component of the world's soil C stocks and supply most of the dissolved organic C (DOC) entering boreal lakes and streams.

They are also major sinks for atmospheric carbon and may disappear with future climatic warming. However, many peatlands have been destroyed by human activities, such as peat extraction, land reclamation or drainage of groundwater for development purposes.

The necessity of biodiversity studies in peatlands today is underlined by the fact that these small, oligotrophic and mountain habitats of glacial relic origin are very sensitive to anthropogenic impacts and have become threatened in the last decades. The colonisation by specifically adapted organisms makes them very important habitats for nature conservation. Algae play vital roles in biodiversity conservation and the biogeochemical cycles of peatlands.

A total of 98 species of cyanobacteria and algae were found during our investigation. The species identified belong to the following classes: Cyanophyceae (5), Xanthophyceae (1), Bacillariophyceae (78) and Conjugatophyceae (14).

Dominant taxa were recorded in mountain peatlands as follows:

- *Eunotia paludosa* Grunow 1862,
- *Eunotia rhomboidea* Hustedt 1950,
- *Eunotia tetraodon* Ehrenberg 1838,
- *Eunotia valida* Hustedt 1930,
- *Frustulia crassinervia* (Brébisson) Lange-Bertalot et Krammer in Lange-Bertalot & Metzeltin 1996,
- *Pinnularia borealis* Ehrenberg 1843,
- *Pinnularia microstauron* (Ehrenberg) Cleve 1891,
- *Pinnularia perirrorata* Krammer 2000,
- *Pinnularia rupestris* Hantzsch in Rabenhorst 1861 and
- *Pinnularia subcapitata* var. *elongata* Krammer 1992.

In these freshwater oligotrophic habitat types, 44 rare and endangered species of diatoms (Lange-Bertalot and Steinfdorf, 1996) were found. The most prominent were: *Aulacoseira alpigena* (Grunow) Krammer 1991, *Chamaepinnularia mediocris* (Krasske) Lange-Bertalot 1996, *Eunotia tetraodon* Ehrenberg 1838, *Eunotia triodon* Ehrenberg 1837 and *Neidium bisulcatum* (Lagerstedt) Cleve 1894.

In order to protect mountain peatlands in the future, it is necessary to establish long-term monitoring of biodiversity, as well as their condition.

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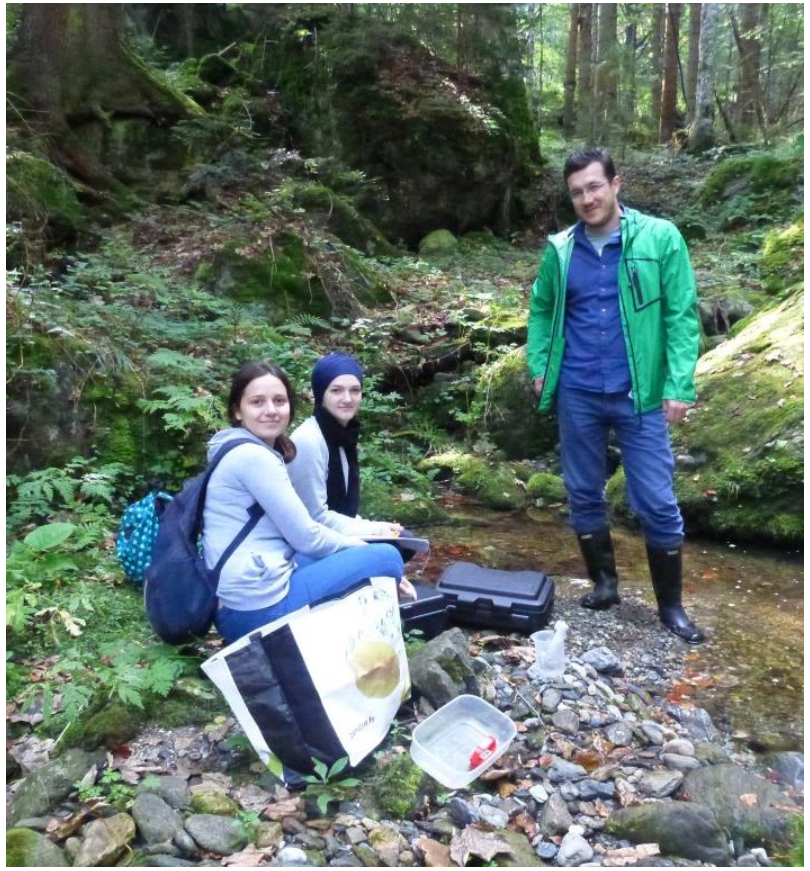
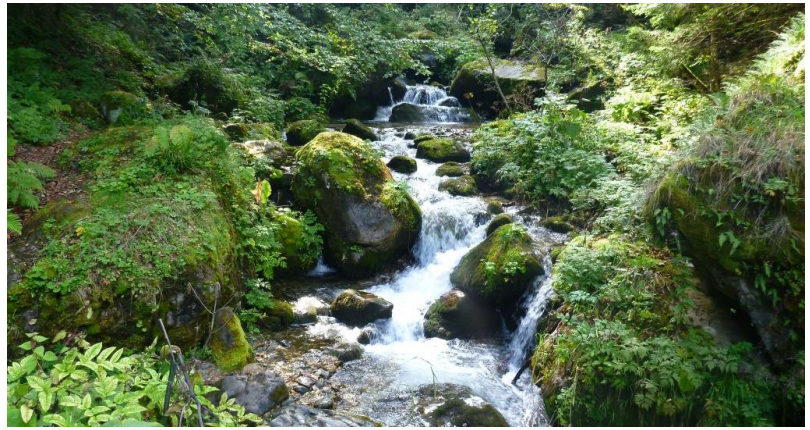
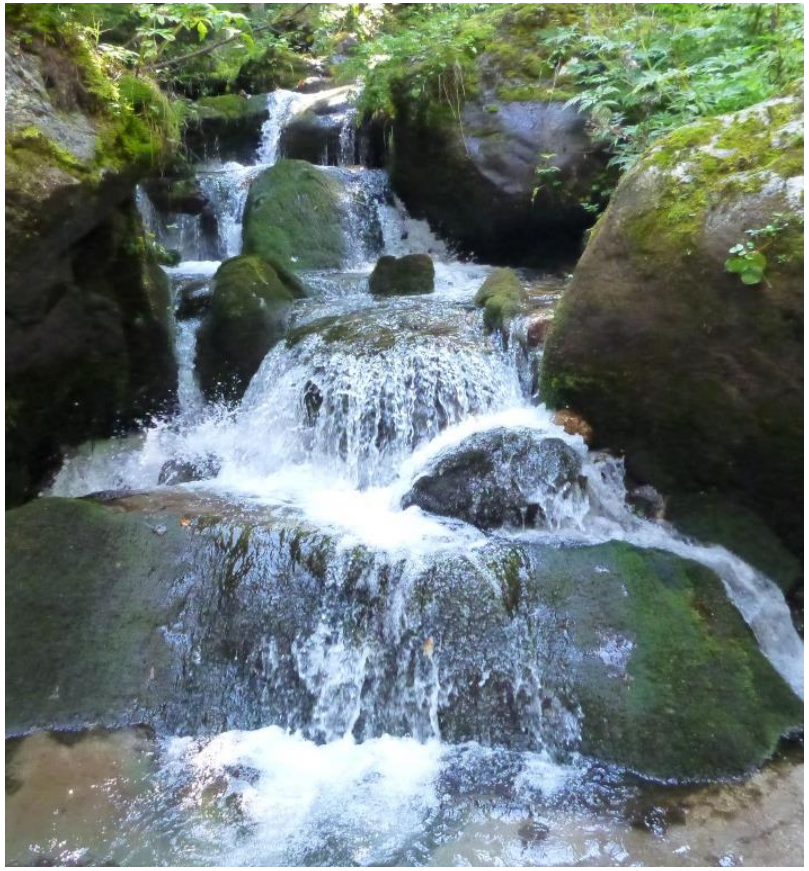
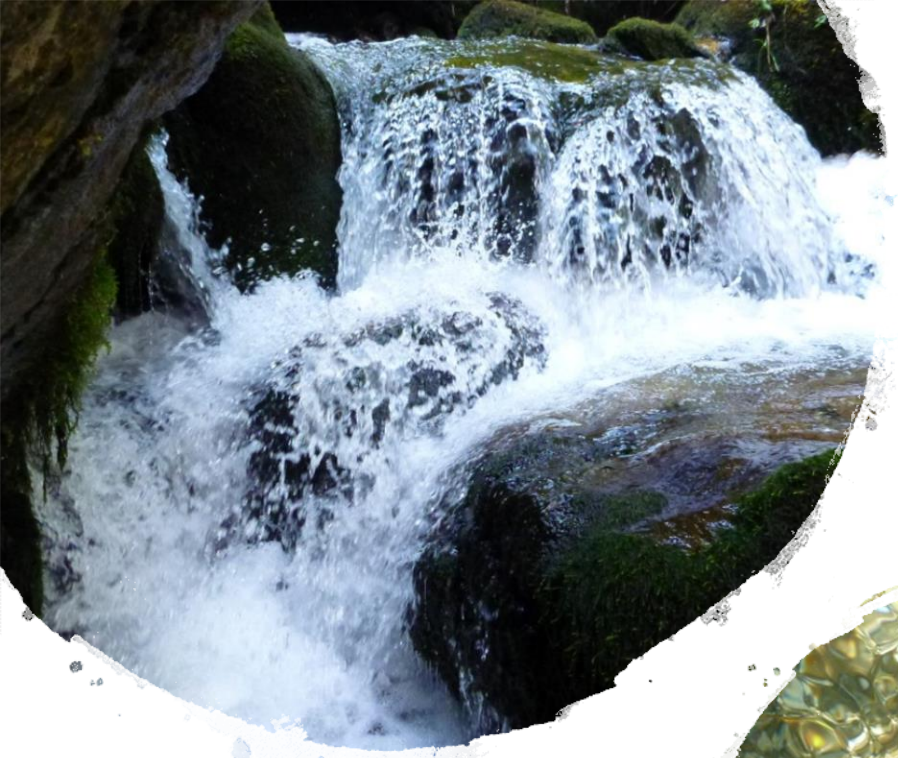






Conservation of Freshwater Oligotrophic Habitats on Vranica Mountain and Establishment of Long-Term Monitoring of Biodiversity

MOUNTAIN STREAMS



MOUNTAIN STREAMS

Mountain streams are very unique and fascinating habitat types. They represent the main sink for groundwater from surrounding small creeks which flows from the mountains. Mountain streams are usually with a steep gradient, flowing down a mountainside, their swift flow rate transporting large quantities of rock, gravel, soil, wood or even entire logs with them. The main characteristic of mountain streams is their steep gradient and sharply varying rates of flow within a short period of time, as a result of snowmelt and sudden storms.

In general, mountain stream is a body of water with surface water flowing within the bed and banks of a channel. The stream encompasses surface and groundwater fluxes that respond to geological, geomorphological, hydrological and biotic controls.

Streams are important as conduits in the water cycle, instruments in groundwater recharge, and corridors for fish and wildlife migration. Unfortunately, mountain streams are today under strong influences as follows: building infrastructure, Hydropower Plant, waste disposal, uncontrolled tourism activities, deforestation, spring capture and climate change.

Due to the peculiar configuration of the ground, mountain streams offer specific habitat for unique biodiversity. Streams play an important corridor role in connecting fragmented habitats and thus in conserving biodiversity. The biological habitat in the immediate vicinity of a stream is called a riparian zone.

A total of 61 taxa of cyanobacteria and algae were found during our investigation. The species identified belong to the following classes: Cyanophyceae (1), Xanthophyceae (1) and Bacillariophyceae (59).

Dominant taxa were recorded in mountain streams as follows:

- *Cocconeis placentula* Ehrenberg 1838,
- *Cocconeis lineata* Ehrenberg 1849,
- *Diatoma ehrenbergii* Kützing 1844,
- *Gomphonema minusculum* Krasske 1932,
- *Meridion circulare* (Gréville) C. Agardh 1831,
- *Navicula tripunctata* (O.F. Müller) Bory 1822,
- *Rhoicosphaenia abbreviata* (C.Agardh) Lange-Bertalot 1980,
- *Odontidium mesodon* (Ehrenberg) Kützing 1844,
- *Planothidium lanceolatum* (Brébisson ex Kützing) Lange-Bertalot 2000 and
- *Ellerbeckia arenaria* (Moore ex Ralfs) Crawford 1988.

In the mountain streams, 16 rare and endangered species of diatoms (Lange-Bertalot and Steinfdorf, 1996) were found. The most prominent were: *Achnanthidium kranzii* (Lange-Bertalot) Round et Bukhtiyarova 1996, *Eunotia praerupta* Ehrenberg 1843, *Eunotia rhomboidea* Hustedt 1950, *Orthoseira roeseana* (Rabenhorst) O'Meara 1876 and *Surirella spiralis* Kützing 1844.

In order to protect mountain streams, in the future it is necessary to establish long-term monitoring of biodiversity, as well as their condition.

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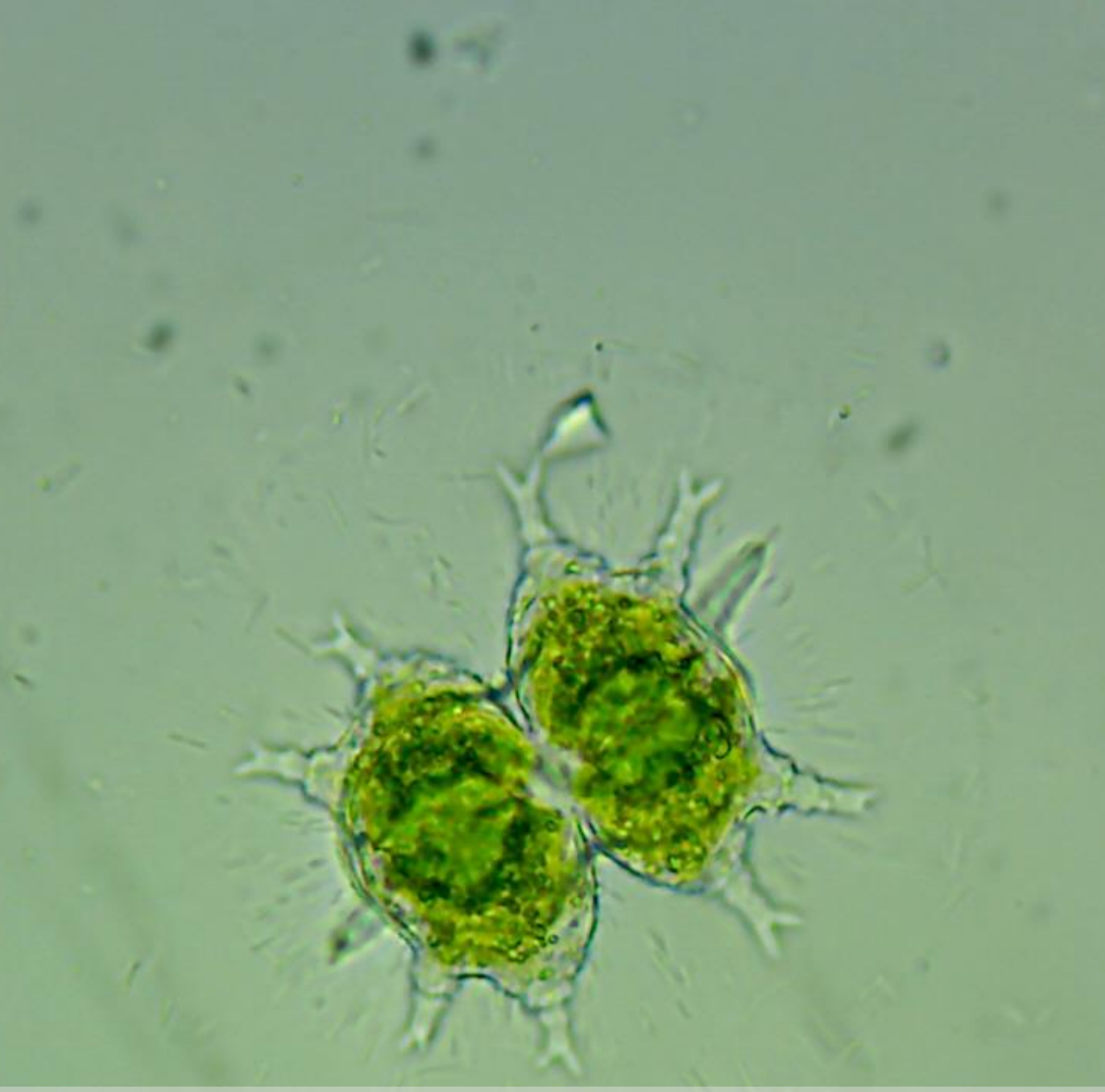

Conservation of Freshwater Oligotrophic Habitats on Vranica Mountain and Establishment of Long-Term Monitoring of Biodiversity

DID YOU KNOW

DID YOU KNOW?

Conservation of Freshwater Oligotrophic Habitats on Vranica Mountain and Establishment of Long-Term Monitoring of Biodiversity

► Did you know that peatland ecosystems only cover around 3% of the world's surface but contain more carbon than all of the world's rainforests.

► In the Hydrobiological and Plankton studies of the lakes of Bosnia and Herzegovina, Protić (1924-1926) presents extremely important scientific results of the Prokoško Lake.

► Mountain springs may be the most pristine remaining aquatic habitats. Near-natural springs often host on a small spatial scale a high species richness, offering a range of microhabitats for many organisms, such as diatoms, invertebrates and macrophytes.

► Numerous springs and creeks of the Vranica Mountain are the habitats of the rare and endangered golden algae *Hydrurus foetidus* (Villars) Trevisan 1848.

► In mountain streams and rivers it is possible to determine seasonal changes of cyanobacteria and algae. Thus, during the early spring, the blue-green algae *Phormidium autumnale* appear. During the cold months, the golden algae *Hydrurus foetidus* grow, and in the early autumn, the red algae *Bangia atropurpurea* grow.

► Diatoms have been used extensively in freshwater systems as indicators of ecosystem change. Diatom-based indices have been developed as indicators of nutrient enrichment, organic pollution, acidification and climate change.

► Oligotrophy refers to »poor food«, a situation where nutrients are in low quantity. The term has been used to describe a wide range of environments, including soils and other terrestrial environments, as well as almost all aquatic ecosystems.

► Peatland ecosystems represent an excellent habitat for a large number of rare and endangered microalgae. The most numerous are diatoms and desmids.

► Peatlands can be found on all continents from tropical to boreal and Arctic zones, from the coasts to the high mountains.

► In the peatland ecosystems of the European continent, there are several carnivorous plants, among them the most famous are *Drosera rotundifolia* L. and *Pinguicola vulgaris* L.

► Peatland ecosystems in Bosnia and Herzegovina represent the remains of vegetation from the time when a much colder climate prevailed in our area.

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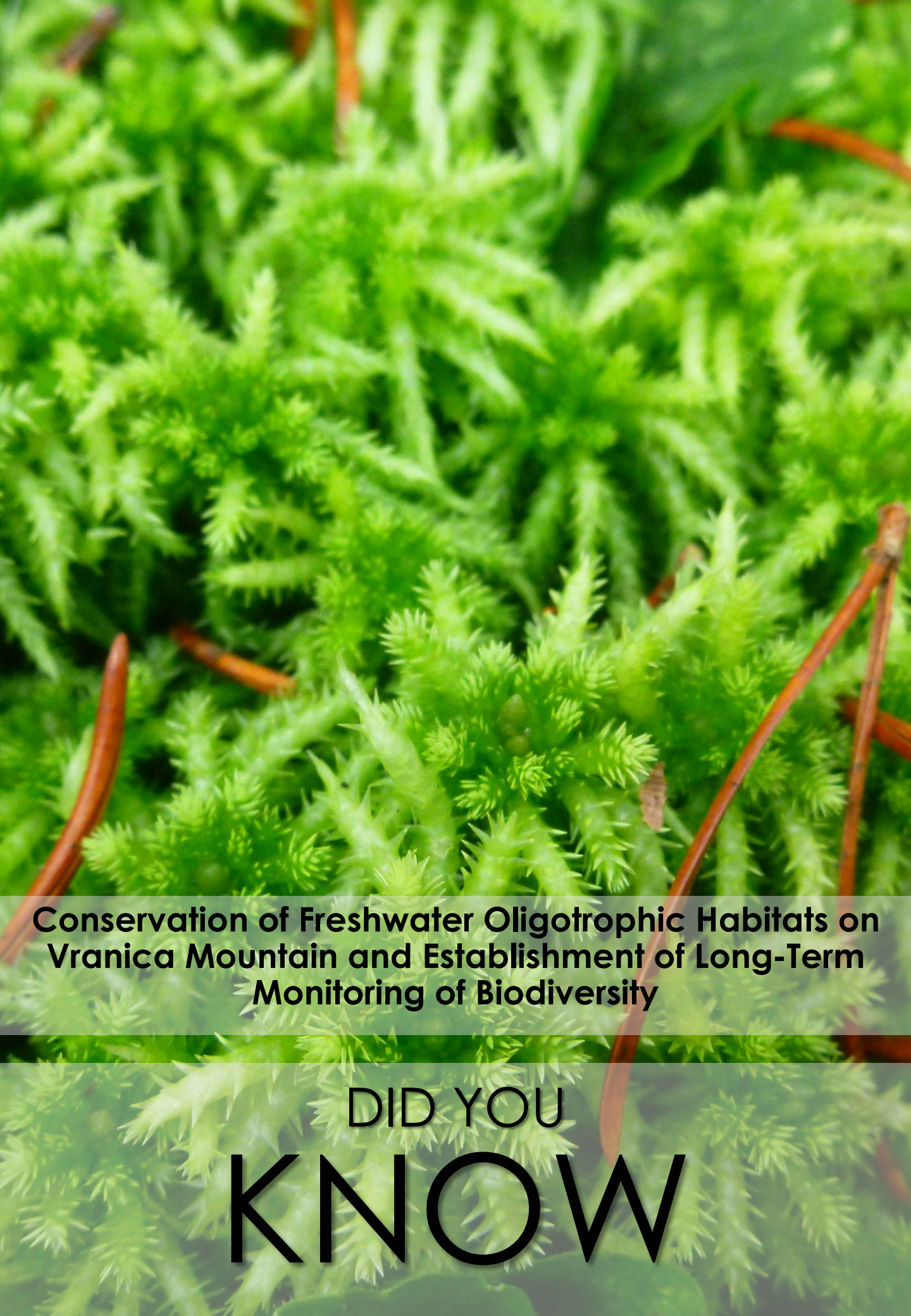

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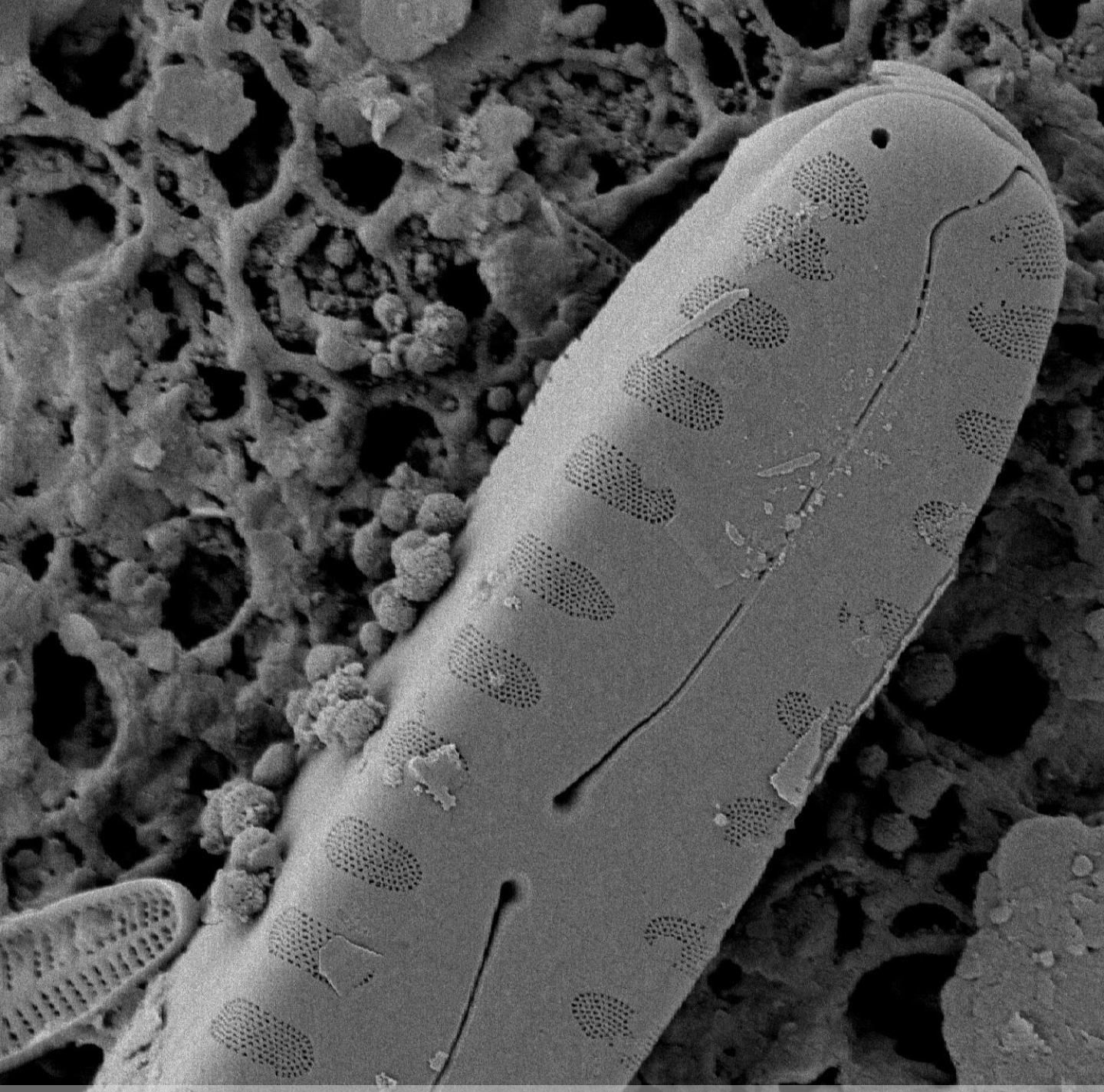

Conservation of Freshwater Oligotrophic Habitats on Vranica Mountain and Establishment of Long-Term Monitoring of Biodiversity

INTERESTING FACTS ABOUT DIATOMS

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Conservation of Freshwater Oligotrophic Habitats on Vranica Mountain and Establishment of Long-Term Monitoring of Biodiversity

Fact 1: Diatoms vary greatly in size, with the largest measuring only one millimeter across.

Fact 2: Diatoms are also impressive shell builders. They transform dissolved silicon into a silica almost identical to the gemstone opal. Diatoms contribute enormous amounts of oxygen to our atmosphere and even offer various functions when dead, as diatomaceous earth.

Fact 3: Diatomaceous earth is made up of tiny, single-celled organisms known as diatoms. Diatoms have been studied for hundreds of years and have proved to be amazing organisms, serving various functions in both life and death.

Fact 4: Diatoms are an important group in water ecosystems. They form a large part of the benthos (often 90%-95%) and that is why they could become an important part of water quality monitoring.

Fact 5. There has been found to be more than twenty-five thousand species of diatoms, none of which have the same shell. They exist in large numbers in most bodies of water throughout the world. In fact, just one liter of seawater can contain as many as ten million diatoms! Diatoms are the most abundant type of phytoplankton, with the greatest numbers existing in cold oceans.

Fact 6. Diatoms can thrive wherever there is light, water, carbon dioxide, and necessary nutrients.

Fact 7. In some cases diatoms can even live out of the water. In moist conditions, they are able to live in topsoil, or attached to moss, tree trunks and even brick walls.

Fact 8. Huge numbers of diatoms die and sink to the bottom of river, lake and ocean beds. Over many years these layers of dead diatoms fossilize and become rich deposits of diatomaceous earth, or diatomite.

Fact 9. Studies on pristine alpine environments refer to mountain springs as sources for diatom biodiversity and niches for rare species. Some species survive only in densely populated and intensively exploited areas in springs not affected by humans.

Fact 10. The authors Lange-Bertalot and Steindorf (1996) developed a red list of diatoms that are rare and which indicate the oligotrophic state of aquatic ecosystems. Following the same principle as in the higher plants and animals, the representation of species from the red list indicates high sensitivity, but also the value of the habitat for conservation.

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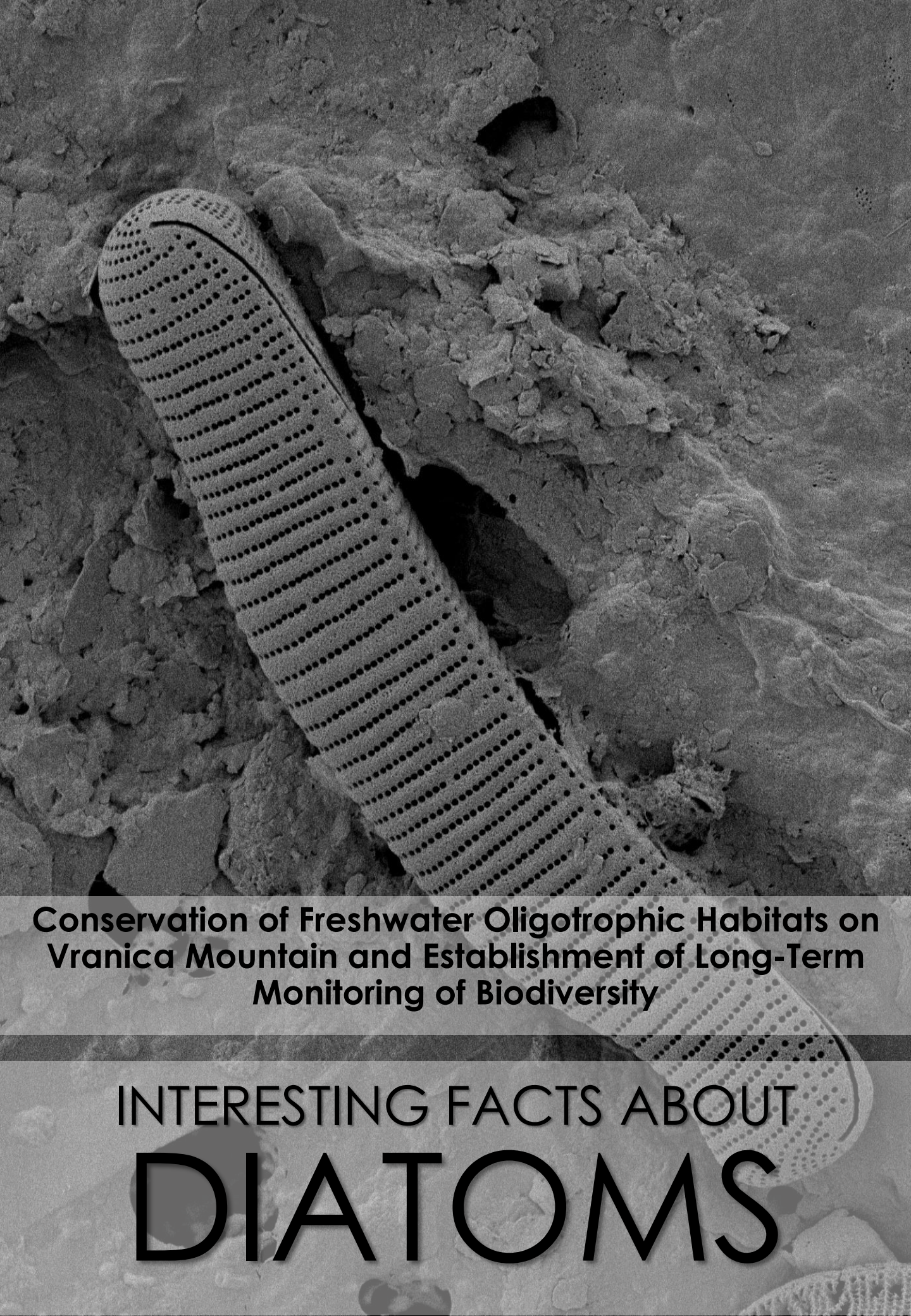

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