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Conservation of Velidab, the Biodiversity Hotspot in Lake Ohrid: Species Inventory and Site Valuation

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Abstract: The Velidab locality in Lake Ohrid has been recognised as the most important hotspot of biodiversity, at the same time harbouring many endemic species, among which is the snail *Gocea ohridana*, whose range of distribution is strictly limited to this locality. The aim of our study was to make an inventory of species of benthic diatoms, macrophytes and benthic macroinvertebrates at this locality and based on the results to assess the current ecological state and evaluate the ecosystem services. We studied two alternatives: 1) the Velidab locality is not managed and/or protected in any way (the current situation), and 2) the site is designated as a Strict Nature Reserve and appropriate conservation measures are taken. Twenty-three species of benthic diatoms, 11 macrophytes and 33 benthic invertebrates were recorded in May and July 2017. Of them 28 species were endemic, the highest percentage of endemism was in Gastropoda (95%). The ecological state based on water physical, chemical and biological parameters varied in a wide range from oligothrophic to euthrophic conditions, showing a decrease in some parameters and unstable conditions compared to previous study periods. The results demonstrated the urgent need of proper management and protection of the site. The designation of Velidab as a Strict Nature Reserve was proposed and appropriate conservation measures were recommended.

Key words: Velidab locality, Lake Ohrid, inventory of species, benthic diatoms, macrophytes, benthic macroinvertebrates, economic valuation

Introduction

For centuries Lake Ohrid has been famous for its specific flora and fauna, their origin, diversity and relic character created by the synergic action of the general lake's conditions, such as its long-term isolation and continuous existence under undisturbed conditions and the process of intralacustrine speciation which still occurs. With its enormous biodiversity and more than 212 endemic species Lake Ohrid has been designated as an aquatic ecosystem with the highest endemism per unit square among the other worldwide ancient lakes (Albrecht & Wilke 2008). Following the shoreline from west to east the level of both biodiversity and endemism vary and reach their highest values in the area of the sloppy terrain on the south-eastern part. In this area, the Velidab locality has been considered as the most important hotspot of biodiversity, at the same time harbouring many endemics, among which is the snail *Gocea ohridana*, whose range of distribution is strictly limited to this locality (Albrecht & Wilke 2008, Budzakoska Gjoreska et al. 2019). Here, in an area of a few hundred square meters, during the previous studies, a high number of species of benthic diatoms, macrophytes and benthic macroinvertebrates have

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been registered giving the place a mark of a hotspot of biodiversity (Trajanovski 2005, Levkov et al. 2006, Budzakoska Gjoreska 2012). More recent studies in 2010–2011 at 20 localities along the littoral of the lake once again have contributed to designating Velidab as one of the most remarkable hotspot of diversity and endemism in Lake Ohrid (Schneider et al. 2014).

In the past few decades there has been an international recognition that generally, mostly in the developing countries, the contribution of nature to human well-being is often undervalued or not adequately valued and/or integrated and taken into consideration in the decision-making processes (Zdraveski et al. 2015). Therefore, the ecosystem services due to this notion are often eroded, hence generating substantial cost to the society as a whole, instead of financial or non-market benefit whatsoever (Zdraveski et al. 2015). Lake Ohrid as an ancient aquatic ecosystem has been intensively studied from biological, geological and water physical and chemical perspective in the past. However, as it is the case with most of the developing countries, the ecosystem services have not been fully and correctly evaluated. Some of the first attempts for ecosystem services valuation in this region have been conducted in the period after 2014 and related to evaluation of the biodiversity of Lake Ohrid as a whole along with a valuation of the possibility of protecting certain endemic species in the lake (Zdraveski et al. 2015, 2016, 2019).

The aim of our study in 2017 was to make an inventory of species of benthic diatoms, macrophytes and benthic macroinvertebrates at the Velidab locality and based on the results to assess water quality and to evaluate the ecosystem services.

Materials and Methods

The samplings were performed twice during 2017 (in May and July).

The **water samples** were collected from 2 m depth, using standard limnological methods in accordance with the EU Water Framework Directive 2000/60/EC (EU WFD) (EU 2000). Several basic physical and chemical parameters as well as nutrients were examined: water temperature, pH, conductivity, dissolved oxygen (DO), biochemical oxygen demand (BOD), total nitrogen (TN), and total phosphorous (TP). The trophic state of the water was assessed according to OECD (1982). The ecological state was evaluated according to the EU WFD (EU 2000) and UK Environmental standards and conditions (WFD UKTAG 2008).

The **benthic diatom algae** were sampled by removal of the specimens from the substratum by vigorous brushing of the upper surface and preserved in formalin (3–4%). Then, the samples were cleaned off from organic and inorganic materials based on the acid method by Krammer & Lange-Bertalot (1986–1991). The benthic diatoms cleaned of cell contents and mounted in Naphrax were identified and counted with an optic microscope. The identification was made using different determination keys, such as Krammer & Lange-Bertalot (1986–1991) and other available literature for benthic diatom algae. The Trophic Diatom Index (TI_{DIA}) and the Saprobic Index (SI) were calculated by the formula of Zelinka & Marvan (1961). The water quality was classified according to Rott et al. (1997, 1999, 2003).

The **macrophyte vegetation** was sampled using the WISER method of transects (CEN 2002, 2003, Birk et al. 2010). The transects were approximately 10 meters wide, perpendicular to the shoreline, from the upper littoral to the lower vegetation limit. Each transect was divided into depth zones: 0–2 m, 2–4 m, 4–10 m, and >10 m depth. In deeper water, plants were collected by a Van Veen grab, while in shallow water by snorkeling. The collected material was identified to species level, using different floras and keys for vascular macrophytes (Hayek 1924–1933, Jordanov 1963–1970, Josifović 1970–1977, Tutin et al. 1964–1980), and charophytes (Corillion 1957, 1975, Wood & Imahori 1964, 1965, Golerbah & Krasavina 1983, Krause 1997, Schubert & Blindow 2004). The macrophyte index was calculated according to the formula described by Melzer (1999), with updated indicator values and class boundaries as described by Melzer & Schneider (2001).

The **benthic macroinvertebrate samples** were collected using the methods of transects (Plafkin et al. 1989) along the depth gradient starting from 0.2 to 20 m, i.e. along the whole littoral zone of the lake at the Velidab locality, using a Van Veen sampler (400 cm^3). The lake's bottom was examined using an echo sounder from the research vessel of the Hydrobiological Institute Ohrid so the samples were collected taking into consideration the heterogeneity of the bottom facies as one of the primary factors affecting the distribution of the benthic fauna (Parsons & Norris 1996). Therefore, the samples were taken from at least six different habitat types such as: stony, stony and sandy, sandy, sandy and muddy, muddy and sandy, and muddy (shell zone). The presence of vegetation at 2, 5, 10 and 15 m additionally increased the habitat diversity, with the presence of habitat forming species at 5, 10, 15 and 20 m, directly contributing to the enhanced

biodiversity of the locality. Based on the structure of the benthic macroinvertebrates, the ASPT (Average Score per Taxon) index was calculated as a tool for assessing the ecological state of the water ecosystems (Mandaville 2002).

The **ecosystem services** were evaluated using a methodological framework based on the Toolkit for Ecosystem Service Site-based Assessment (TESSA) (Peh et al. 2013). The toolkit has been designed to take advantage of the local knowledge and stakeholder engagement and is relatively accessible to those who do not possess the adequate technical knowledge. The toolkit aims to help 'non-experts' evaluate several ecosystem services 'quickly, cheaply, but robustly ... and estimate the difference between current state and plausible alternatives' (Peh et al. 2013). The framework used while applying the TESSA evaluation comprised six consecutive steps: 1) preliminary work; 2) rapid appraisal; 3) identification of plausible alternative state; 4) method selection; 5) data acquisition; and 6) analysis and communication.

Results and Discussion

Water quality

In both seasons, the quality of water based on the following parameters: total phosphorous (TP), dissolved oxygen (DO) and biochemical oxygen demand (BOD) was within the range of oligotrophic waters, with a low concentration of nutrients and a high concentration of dissolved oxygen (Table 1). The ecological state based on the WFD referent values for the same parameters (TP, DO and BOD) was assessed as high. The differences in the concentrations of nutrients in the two different seasons could be a result of the increased release of these two nutrients due to the intensified decomposition of the organic matter originated in the process of disintegration of some macrophytes and phytoplankton organisms.

Benthic diatoms

A total of 23 benthic diatom species were identified at the Velidab locality during both sampling periods (Table 2). Of them, only three species (13%) have been considered as endemic. The number of species varied in different seasons, in spring (May) it was higher than in summer (July). None of the species of diatoms from the list obtained during the study of Levkov et al. (2006) were recorded. The diversity of the benthic diatom algae was noticeably higher in comparison with the diatoms registered in the study period 2010–2011 (Schneider et al. 2014).

The values of the Trophic Diatom Index (TI_{DIA}) and the Saprobic Index (SI) have not changed significantly since the previous study period (Schneider et al. 2014). The TI_{DIA} value was 1.8 and indicated mesotrophic character of the water, the same as the SI value, which was 1.8 and indicated β-mesosaprobic conditions.

Comparing the results of different study periods and of different consecutive sampling periods during our study points out to the conclusion that the benthic diatoms composition is not persistent throughout the year. Taking into consideration the size, the short period of generation and ecological adaptability of the benthic diatoms, it is easy to understand the changes and succession in the composition of their community. The water level, water currents and waves, temperature and food availability are the major factors influencing the changes in species composition of benthic diatoms (Göthe et al. 2013). In fact, the whole spectra of environmental factors could influence the benthic diatom algae structuring (Whittaker 1970). The water currents, waves and water level are of primarily importance in their distribution and factors that could easily relocate the substrates the benthic diatom algae are attached to. Both the environmental and the biological factors, such as interspecies relationships (especially food competition), have certainly played a role in the algal distribution, diversity and abundance.

Macrophyte vegetation

Totally, 11 macrophyte species were identified in the samples in both field campaigns during the study period (Table 3). Ten of the species were native and one (*Elodea canadensis*) was alien. All 11 species were present in the spring period, while nine species were found in July. The only endemic species was *Chara ohridana* (9% endemism) and it was registered only during the spring period. The fact that it was not found in July does not mean it was not present at the spot. The dense and more competitive species, such as *Chara tomentosa* and *Potamogeton perfoliatus* could simply prevent *C. ohridana* from reaching to the samples.

Unlike the benthic diatom algae, the diversity of macrophytes was the same as in the previous study periods (Schneider et al. 2014). This was expected taking into consideration that macrophytes are a wide group of vascular plants that are sessile, i.e. rooted to the bottom of the lake, hence, their distribution is more stable. This distribution, as well as their abundance and diversity depend on various environmental factors, such as: light, water temperature, substrate composition, disturbance, competitive interactions,

Table 1. Physical and chemical parameters at the Velidab locality in May and July 2017. TN – total nitrogen; TP – total phosphorous; DO – dissolved oxygen; BOD – biochemical oxygen demand

Velidab locality	TN (µg l^{-1})	TP (µg l^{-1})	Temperature (°C)	Conductivity (mS cm^{-1})	pH	DO (mg l^{-1} O_2)	BOD (mg l^{-1} O_2)	Transparency (m)
May 2017 (spring)	248	6.0	10.9	205	8.17	12.8	1.42	11
July 2017 (summer)	556	9.1	23.6	219	8.46	9.1	1.30	12

Table 2. Benthic diatoms recorded at the Velidab locality in May and July 2017. * – endemic species

	Species	May	July
1	*Amphora ovalis* Kützing	+	–
2	*Amphora aequalis* Krammer	+	+
3	**Amphora sancti-naumii* Levkov et Metzeltin	+	+
4	*Cavinula scutelloides* (W. Smith) Lange-Bertalot	+	+
5	*Cocconeis pediculus* Ehrenberg	+	+
6	*Cocconeis placentula* Ehrenberg	+	+
7	*Cocconeis placentula* var. *euglypta* (Ehrenberg) Grunow	+	–
8	*Cyclotella ocellata* Pantocsek	+	+
9	**Cymbella ohridana* Levkov et Krstic	+	+
10	*Diploneis alpina* Meister	+	+
11	*Diploneis domblitensis* Cleve	+	–
12	*Encyonema prostratum* (Berkeley) Kützing	+	+
13	**Epithemia ohridana* Levkov et Metzeltin	+	+
14	*Epithemia sorex* Kützing	+	+
15	*Epithemia adnata* (Kützing) Brebisson	+	–
16	*Gomphonema minutum* (Agardh) Agardh	+	+
17	*Gomphonema olivaceum* (Hornemann) Brébisson	+	+
18	*Gomphonema angustum* Agardh	+	–
19	*Hantzschia abundans* Lange-Bertalot	+	–
20	*Navicula tripunctata* (O. F. Müller) Bory	+	+
21	*Navicula radiosa* Kützing	+	–
22	*Rhoicosphenia abbreviata* (C. Agardh) Lange-Bertalot	+	+
23	*Planothidium lanceolatum* (Brébisson) Lange-Bertalot	+	+

herbivory, epiphyte loading, water level, quality of the lake water, and sediment nutrients (Barko & Smart 1981, Duarte & Kalff 1987, Wetzel 2001, Trajanovska 2009, Capers et al. 2010). In addition, the composition and properties of sediments also seem to have a significant effect on the diversity and distribution of certain macrophyte species (Dawson & Szoszkiewicz 1999, Heegaard et al. 2004, Makela et al. 2004, Trajanovski et al. 2016a, b).

The relatively stable water conditions without any disturbances caused by anthropogenic activities have enabled normal phenological change in the composition of the macrophytes at this locality. Thus, in spring, as a result of the increase in the water temperature and spring circulation, more nutrients are included in the turnover cycle and cause 'waking up' of the macrophytes, especially in the shallower part of the transect. During this period, the biomass of macrophytes is still low, enabling almost equal portion of insulation and dissolved matters to the plant, which is a reason why both *Cladophora* sp. and *C. ohridana* are present. In summer, the biomass of macrophytes increases and suppresses the presence of some species, such as *C. ohridana,* which cannot

Table 3. Macrophyte species recorded at the Velidab locality in May and July 2017. * – endemic species

	Species	May	July
1	*Chara globularis* Thuillier	+	+
2	* *Chara ohridana (*Kostic) Krause	+	+
3	*Chara tomentosa* L.	+	–
4	*Cladophora* sp.	+	–
5	*Elodea canadensis* Rich & Michx.	+	+
6	*Myriophyllum spicatum* L.	+	+
7	*Potamogeton perfoliatus* L.	+	+
8	*Potamogeton pussilus* L.	+	+
9	*Ranunculus trichophyllus* Chaix	+	+
10	*Vallisneria spiralis* L.	+	+
11	*Zannichelia palustris* L.	+	+

compete successfully with the other macrophytes that form dense meadows on the lake`s bottom (e.g. *C. tomentosa*). Similarly, after the period of summer stagnation and depletion of dissolved resources in the shallow littoral, *Cladophora* sp. disappears.

The values of the macrophyte index varied in different depth transects in the range from oligotrophic to eutrophic 3. The shallowest point of the transect was assessed as eutrophic 1, while with the increase in the depth, the trophic state deteriorated, reaching a level of high pollution (eutrophic 3) at a depth of 2–4 m. Further, in the deeper zone (below 4 m depth) the water quality enhanced and was assessed as oligotrophic. Based on the values of the macrophyte index, the overall trophic state at the Velidab profile was assessed as eutrophic 1.

The results of the metrics (indices) based on the structure and health of the biotic components (benthic diatoms, macrophytes), which indicated a mesotrophic and eutrophic state of the water were not consistent with the results of the water physical and chemical parameters, which showed a high ecological state, i.e. oligotrophic character. Such inconsistency can be explained with the intake of the nutrients, especially total phosphorus, from the water by the macrophytes and other primary producers, which results in higher production (biomass, diversity of species indicative of lower trophic state), apparently with a decreased concentration of the nutrients, which gives a distort picture regarding the real trophic state of the water (Schneider et al. 2014).

Benthic macroinvertebrates

The community of macroinvertebrates was assessed with the highest diversity and endemism in comparison with the macrophyte vegetation and flora of the diatom algae. A total of 33 species were registered, of which 26 were identified during the spring period and 33 during the summer period (Table 4). Species from eight different taxonomic groups of macroinvertebrates were identified, of which the most diverse was the fauna of Gastropoda with 18 species. The groups Turbellaria, Hirudinea and Insecta shared the second position, each presented by three species, while the least diverse were Oligochaeta and Bivalvia with one species each.

The endemism among all benthic macroinvertebrate groups at the Velidab locality was 73% (24 species) (Table 4). As expected, the highest level of endemism was found in the group of Gastropoda: 17 species were identified as endemic vs. one cosmopolite (attaining 95% level of endemism). Furthermore, 16 of all endemic species were the same as those recorded during the inventory in 2010-2011 (Schneider et al. 2014). Two endemic species were not registered in the earlier period: *Ancylus scalariformis* and *Gyraulus lychnidicus*. Three of the recorded endemic species (*Acroloxus macedonicus*, *Gocea ohridana*, and *Lychnidia hadzii*) have been listed as critically endangered and one species (*Ancylus lapicidus*) as endangered by the IUCN Red List of Threatened Species (IUCN 2018).

The most abundant benthic macroinvertebrates at the Velidab locality during our inventory were *Dreissena carinata* and *Chilopyrgula sturanyi*.

Most of the species were distributed evenly, i.e. they were present from 0.5 to 10 m depth, while only a few species inhabited the deeper littoral zone (Table 4). The most specific endemic species with the smallest range was *G. ohridana.* It was found only

Table 4. Benthic macroinvertebrate species recorded at different depths (from 0.5 to 20 m) and substrates (from stony to muddy) at the Velidab locality in May and July 2017. * – endemic species

Depth and substrate	Taxonomic group	Species	May	July
0.5 m; stony	Turbellaria	*Crenobia alpina montenegrina* Mrázek, 1904	+	+
		**Dendrocoelum maculatum* Stankovic and Komarek, 1927	+	+
	Gastropoda	**Gocea ohridana* Hadžišce, 1956	+	+
		**Radix relicta* Polinski, 1929	+	+
		**Ochridopyrgula macedonica* Brusina, 1896	+	+
		**Ohridohoratia sturanyi* Westerlund, 1902	–	+
		**Acroloxus macedonicus* Hadžišce, 1959	+	+
		**Lychnidia hadzii* Hadžišce, 1959	+	+
		**Ancylus lapicidus* Hubendick, 1960	–	+
		Theodoxus fluviatilis Linnaeus, 1758	+	+
	Amphipoda	**Gammarus ochridensis* Schäferna, 1926	+	+
	Isopoda	*Asellus aquaticus* Linnaeus, 1758	+	+
	Insecta	*Polypedilum pedestre* Kieffer, 1912	+	+
2 m; stony and sandy	Hirudinea	*Erpobdella octoculata* Linnaeus, 1758	+	+
	Gastropoda	**Radix relicta* Polinski, 1929	+	+
		**Valvata relicta* Polinski, 1929	–	+
		Theodoxus fluviatilis Linnaeus, 1758	+	+
		**Ancylus scalariformis* Stankovic & Radoman, 1953	+	+
		**Ochridopyrgula macedonica* Brusina, 1896	+	+
		**Gyraulus albidus* Radoman, 1953	–	+
		**Gyraulus lychnidicus* Hesse, 1928	–	+
		**Ohridohoratia sturanyi* Westerlund, 1902	+	+
	Bivalvia	*Dreissena carinata* (Dunker, 1853)	+	+
	Amphipoda	*Gammarus roeseli tetracanthus* Gervais, 1835	+	+
	Insecta	*Gomphus vulgatissimus* Linnaeus, 1758	+	+
5 m; sandy	Oligochaeta	**Rhynchelmis komareki* Hoffmeister, 1843	+	+
	Gastropoda	**Chilopyrgula sturanyi* Brusina, 1896	+	+
		**Valvata rhabdota* Sturany, 1894	–	+
		**Ohridohortia sturanyi* Westerlund, 1902	+	+
		**Lychnidia hadzii* Hadžišce, 1959	+	+
	Amphipoda	*Gammarus roeseli tetracanthus* Gervais, 1835	+	+
	Isopoda	*Asellus aquaticus* Linnaeus, 1758	+	+
10 m; sandy and muddy	Turbellaria	*Crenobia alpina montenegrina* Mrázek, 1904	+	+
	Gastropoda	**Radix relicta* Polinski, 1929	+	+
		**Valvata stenotrema* Polinski, 1929	+	+
		**Ohridohoratia sturanyi* Westerlund, 1902	+	+
		**Ochridopyrgula macedonica* Brusina, 1896	+	+
		**Ancylus scalariformis* Stankovic & Radoman, 1953	+	+
		**Chilopyrgula sturanyi* Brusina, 1896	+	+
		**Lyhnidia hadzii* Hadžišce, 1959	+	+
		**Stankovicia pavlovici* Polinski, 1929	+	+
	Amphipoda	**Gammarus ochridensis* Schäferna, 1926	+	+
	Insecta	*Chironomus plumosus* Linnaeus, 1758	+	+

Table 4. Continuation

Depth and substrate	Taxonomic group	Species	May	July
15 m; muddy and sandy	Turbellaria	**Dendrocoelum magnum* Stankovic, 1969	+	+
	Hirudinea	**Dina krilata* Sket, 1989	+	+
		**Dina kuzmani* Sapkarev, 1990	+	+
		**Neofossarulus stankovici* Polinski, 1929	–	+
	Gastropoda	**Ginaia munda* Sturany, 1894	+	+
	Bivalvia	*Dreissena carinata* (Dunker, 1853)	+	+
	Amphipoda	*Gammarus roeseli tetracanthus* Gervais, 1835	+	+
	Isopoda	*Asellus aquaticus* Linnaeus, 1758	+	+
20 m; muddy (shells)	Hirudinea	**Dina krilata* Sket, 1989	+	+
	Gastropoda	**Chilopyrgula sturanyi* Brusina, 1896	+	+
		**Ancylus scalariformis* Stankovic & Radoman, 1953	+	+
	Bivalvia	*Dreissena carinata* (Dunker, 1853)	+	+
	Amphipoda	*Gammarus roeseli tetracanthus* Gervais, 1835	+	+
	Isopoda	**Asellus remyi acutangulus* Karaman, 1953	+	+

at 0.5 m, in a very small density (25 ind./m^2). There were a few other species with low densities but all of them were widely distributed along the shoreline of the lake. The limited range of *G. ohridana* and its low density appeal for immediate conservation measures for this species together with its habitat, which would collaterally result in conservation of all species inhabiting this place.

Regarding the abundance, there was a decreasing trend along the depth gradient, with an exemption of *D. carinata*, which reached its highest abundance at the highest depth point. All other species showed a positive trend in their abundance levels going from 0.5 to 10 m depth, and then, the abundance drastically dropped. The same trend was observed with regard to the diversity in all species, without any exemptions. The number of species was the highest at the shallowest point (0.5 m), while at 10 m this number dropped to only 6 species (20 m).

On comparing our results with the previous study (Schneider et al. 2014), there were nine species less in our list. Fluctuations in species diversity and abundance are natural phenomena in the benthic macroinvertebrate fauna and they are affected by the periodicity of the environmental factors and species ecological adaptive capacity (Wetzel 2001, Trajanovski 2005, Barnes & Mann 2009, Trajanovski et al. 2016a, b). There were also some slight differences in the methodology used in the previous study (2010–2011) and the present one (2017). During our study, only the transect method along the depth gradient was applied, while in 2010–2011, several samples were collected perpendicularly to the shore, on the left and right of the main transect. This can be one of the reasons for the lower diversity of the benthic macroinvertebrate fauna recorded at the Velidab locality during our study.

According to the values of the ASPT index calculated based on the structure of the benthic macroinvertebrate community, the ecological state of the water varied within the range from 4.1 (moderate) to 5.7 (good). In fact, the depth point of 0.5 m was assessed as good ecological state, while the depth points of 2 and 5 m were assessed as moderate. Generally, the deeper points were all with good ecological state. The overall ecological state was assessed as good.

Evaluation of ecosystem services at the Velidab locality

We studied two alternatives: 1) the Velidab locality is not managed and/or protected in any way (the current situation), and 2) the site is designated as a Strict Nature Reserve and appropriate conservation measures are taken.

Under the current conditions (first alternative), our results showed fluctuations and changes in water quality and in diversity and quantitative composition of communities of benthic diatom algae, macrophytes, and benthic macroinvertebrates, when comparing two main periods of study 2010–2011 (Schneider et al. 2014) and 2017 (our study). These changes may be a result of natural processes but also may imply negative trends due to increased anthropogenic impact. In the latter case, some of the negative consequences may have been avoided if the site has been properly managed and protected by a responsible and professional management body.

Under the second alternative, the site is proclaimed as a Strict Nature Reserve, it is allowed to be used only for scientific purposes, and thus, the negative anthropogenic impact on the site would be reduced to a minimum.

In terms of the benthic diatoms, the reduced negative impact from the humans, the proper management and physical protection of the site during stormy periods would ensure stabilisation of the species composition. The stable conditions would eventually transform the site to its natural characteristics that may attract the species, which used to inhabit the site to come back. The diversity of the benthic diatoms would be enhanced, ensuring better monitoring conditions and results to scientists that may also generate positive financial figures for the management body of the locality.

The analysis of the second alternative (the site is proclaimed as a Strict Nature Reserve) related to macrophytes showed that the number of species would not change. However, there was one alien species (*E. canadensis*) recorded during our study, which may cause economic and/or environmental harm on the ecosystem. The protection and proper management of the site would definitely result in control of its spreading and reduction of its negative impact. This control may include elimination of certain quantities of the alien species at a given point in time in order to avoid its domination over the native species. The eliminated biomass generated by these plants could be used as a raw material for the production of biodiesel and/or bricks for heating, for whose production there are companies in the region and in the country. What is more, a portion of the other species detached from the ground naturally could also be used for the same purpose. Selling the 'green waste' would definitely bring financial benefit for the management of the site, which, at the same time, would assist in the financial sustainability of the reserve.

With respect to benthic macroinvertebrates, the direct anthropogenic influence as a factor of changes in the structure and dynamics of their community at the Velidab locality is excluded. Indeed, due to its geographical position (very sloppy karstic area) access from the ground to this locality is impossible. Also, the mountainous configuration of the terrain excludes agricultural activities in its surroundings. However, Velidab is around 650 m far from the very famous historical site Bay of the Bones, which in recent years has become a place of the highest interest for the tourists that come there by commercial cruising boats, especially during summer. Dozens of boat lines per day certainly impact the Velidab locality and its benthic fauna due to the fact that the cruising line is only 300 m far from the shore where Velidab is located. Noise and water disturbances caused from the waves generated by the boats and fuel exhausting gases can be considered as factors that could or have contributed to the changes in the distribution and abundance of the benthic macroinvertebrates. Under the second alternative state, the living conditions for these species would be enhanced by decreasing the noise and pollution from tourists, and by ensuring a regular scientific monitoring. The proclamation of the site as a Strict Nature Reserve would result in stabilisation of the state of the benthic communities, and eventually, in attracting the representatives that do not inhabit the place any longer. In addition, the management body of the reserve would be able to undertake contemporary methods of conservation through DNA barcoding and meso-cosmos establishment. Likewise, the creation of the meso-cosmos and potential aquarium displaying of the species living at this site would ensure financial benefits for the management body (tickets sold), which would assist in the sustainability of the reserve.

The proclamation of the Velidab locality as a Strict Nature Reserve would enable scientists from all around the world to conduct research and monitoring of the unique flora and fauna at this site. Currently, the locality does not generate any financial benefit neither for the municipality, nor for any individual person (the land is public). This means that the evaluation of the ecosystem services at the current state is impossible, since there is no actual market value which can be evaluated. However, based on the non-market values of the ecosystem services in the alternative state, we may assume that the proclamation of the site as a Strict Nature Reserve, besides protection of the environment, would generate financial benefits for the potential management body of the locality and for the economy. The financial inflows would be generated from visits for education, research and wildlife viewing.

Conclusions

Our results on the assessment of ecological state based on water physical and chemical parameters, benthic diatoms, macrophyte vegetation and benthic macroinvertebrates showed a decrease in some parameters and unstable conditions. These changes should be carefully considered as one of the factors that could impact the health of biological communities and influence the appearance/disappearance of certain species at the Velidab

locality. Having in mind the level of endemism as well as the presence of one of the most unique species at this locality, the gastropod *Gocea ohridana*, a further extensive analysis should be immediately undertaken in order to track the factors/ variables that has resulted in changes in the environmental/ water conditions. However, what would not be neglected is the fact that we have identified the species *G. ohridana* again in a very low density and at only one depth point. The question is when, from the scientific point of view, and under which chemical and physical conditions the already assessed as critically endangered *G. ohridana* will stop resist the surrounding pressure and become extinct.

Based on our results and the review of the two alternatives, we may conclude that there are needed changes in the form of protection of the site. Therefore, we initiated a proposal for designation of Velidab as a Strict Nature Reserve and for its inclusion in local development planning and budget allocation. Furthermore, the following measures for urgent protection and conservation are recommended: 1) extensive chemical and biological monitoring to detect the origin of pollution and other potential threats; 2) immediate conservation methods: DNA barcoding and in-vitro cultivation; 3) physical protection by setting up a visual barrier at 200 m from the shore; and 4) public awareness raising.

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