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PRELIMINARY RESULTS FROM THE STUDY OF FLORA AND VEGETATION OF SHKODRA LAKE

Përmbledhje: Me qëllim dhënien e një informacioni të plotë të diversitetit floristik të vegjetacionit, materiali bimor u mblodh në pika të ndryshme përgjatë Liqenit të Shkodrës. Nomeklatura taksonomike është e sinkronizuar me Florën Evropiane 1–5. Informacioni për bimët e kërcënuara është marrë nga libri i Kuq i të dhënave të Shqipërisë. Bazuar në vlerën e treguesit S/A (0.8752), mund të thuhet se biodiversiteti i Liqenit të Shkodrës mund të konsiderohet si një rezervë biogjenetike e rëndësishme në nivel Evropian. Gajtë gjithë historisë evolutive të ekosistemit, një sërë ndyshimesh ndodhën si rezultat i faktorëve natyrorë dhe aktivitetit njerëzor, i cili kishte gjithashtu kontribut të rëndësishëm.

Fjalë kyçe: *Liqeni i Shkodrës, diversiteti floristik, bimët enëzore*

Abstract: Aiming to get full information of the floristic diversity of vegetation the material was collected in several localities along Shkodra Lake. Nomenclature of taxa is synchronized with Flora Europaea l–5. Information as to whether the plants are known to be threatened was taken from Red data book of Albania. Based on the value of S/A index (0.8752), it can be said that Shkodra Lake's biodiversity can be considered a biogenetic reserve significant on the European level. Throughout the evolutionary history of the ecosystem, changes caused by natural factors took place where human activities contributed significantly.

Key words: *Shkodra Lake, floristic diversity, vascular plants*

INTRODUCTION

Shkodra Lake is the largest lake on the Balkan Peninsula in terms of water surface. The drainage area of the lake is about 5,500 km^2 (4,470 km^2 in Montenegro and

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1,030 km^2 in Albania). The lake area varies between 353 km^2 in dry periods and 500 km^2 in wet periods (at maximum level, 335 km^2 is in Montenegro and 165 km^2 in Albania). The distance between the mouth of the Crnojevica River (north-western lake edge) and the lake's outlet (Buna River) is 44 km (maximum length); its greatest width is 13 km. It is a relatively shallow lake with a maximum depth of 9 meters, situated at an average height 4.5 m above the sea level (Bekteshi, 2000).

Plant inventory was made due to the literature references, some unpublished notes and own investigations. Major information about the study area was obtained from current survey (Beka *et al.*, 2001). The botanical material collected in several localities along the Shkodra's Lake was identified during the field work from a dense network of transects „covering" vegetation of the littoral, aiming to get a full picture of the floristic diversity of vegetation and distribution of populations of the recorded species. The phytosociological characters like frequency, density, abundance, and dominance were also analyzed.

MATERIAL AND METHODS

Collection and identification of plant components: Field investigations investigation of the flora and vegetation was conducted by means of observation from the shore and from a light boat by the method of transects and transverse profiles. Plant components were identified during the field visit from a dense network of transects „covering" vegetation of the littoral aimed to get a full picture of the floristic diversity of vegetation and the distribution of populations of the recorded species. The botanical material is collected in several localities along the Shore of Shkodra Lake. Plant inventory was made due to the literature references and own investigations (Kashta *et al.*, 2001).

Photographic documentation was also done. For the fieldwork we have got the assistance from the local people. Experts from different backgrounds were also consulted.

Identification of vascular plants was performed on the basis of the following literature: Flora of Albania, Vol. 1–4 (Paparisto *et al.*, 1984–2000), Flora Europaea, Vol. 1–5 (1964–1980) and (Kashta *et al.*, 2001).

Nomenclature of taxa is synchronized with Flora Europaea.

The information was collected from various sources (Literature survey, works of and some unpublished notes). Major information about the study area was obtained from current survey (Kashta *et al.*, 2001). The study area has been divided into various zones for convenience and each zone was surveyed by walking along the lake shore and assistance of local people, forest guards.

Information as to whether the plants are known to be threatened was taken from Red data book of Albania (Vangjeli *et al.*, 1995); categories and abbreviations: Ex (extinct), E (endangered), V (vulnerable) are taken from this book (Table 2)

Phytosociological analysis: For the analysis, quadrate method was employed. 10 m wide and 10 m long quadrates were laid on the areas along an altitudinal gradient. Minimum size of the quadrate was determined by species area curve method. In

the forest areas the dominant communities i. e the trees and shrubs were given importance. Hence the 10 x 10 m quadrates were found to be most suitable. The phytosociological characters like Frequency, Density, Abundance, and Dominance were analyzed.

RESULTS AND DISCUSSION

Flora, aquatic macrophytes of the Shkodra Lake

Aquatic plants do not belong to one distinct taxonomic group but rather form a collection of many plant taxa. On the basis of their emergence or submergence and the manner of attachment or rooting in the bottom sediment, two main groups, with 3 subdivisions are commonly distinguished (Wetzel, 1975).

A) Aquatic macrophytes rooting in sediment

i. *Emergent aquatic macrophytes*

Reed is often found in monospecific stands, but also mixed with Typha spp., *Scirpus lacustris, Butomus umbellatus* and *Sagittaria sagittifolia.* Emergent macrophytes are rooted in the sediment and may grow to a water depth of ca. 1 m. During the growing season all members of this group produce aerial leaves and flowers. These plants are abundant in north-eastern shore of the lake, especially in the marshy areas.

Emergent vegetation of *Scoenoplectus lacustris* from the northeastern part of the lake.

Rich aquatic vegetation of floating-lived and emergent macrophytes composed from *Nuphar lutea, Schoenoplectus lacustris, Phragmites australis* and *Salix alba* (in the background).

ii. *Floating-leaved aquatic macrophytes*

The floating-leaved plant communities are often predominated by *Nymphaea alba*, *Nuphar lutea* and *Nymphoides peltata. Potamogeton natans Trapa natans, Caldesia parnassifolia and Polygonum hydropiper* also belong to this group. The floating-leaved plants may root in water depths up to 3 m. and have floating or aerial flowers (reproductive organs).

The vegetation of floating-leaved macrophytes is composed from plants solidly rooted in the muddy bottom extending their elongated petioles up to the water surface. These communities are present in shallower waters of the littoral zone and in water ponds among reedbeds (*Phragmites australis*, *Scirpus lacustris*) as well as in marshy zones especially in north-eastern shore of the lake. From this group *Caldesia parnassifolia* grow only in a small area in the northeastern part of the lake.

iii. Submersed macrophytes

This group includes the stoneworts (charophytes) *Chara* and *Nitella*, a few moss species like *Fontinalis antipyretica* and many flowering plants e. g. *Myriophyllum*

spicatum, Potamogeton pectinatus, Ceratophyllum demersum, Najas marina, N. minor, Vallisneria spiralis and *P. perfoliatus*. The submersed macrophytes (most abundant in north-eastern part of the lake) complete their life cycle under the water surface. Some species cause „nuisance growth". The degree of nuisance depends on the pursued management aims (water transport, recreation, and fishery management or nature conservation) in the water body.

Submersed vegetation of *Myriophyllum sp.* from the southwestern part of the lake.

B) Freely floating macrophytes

These macrophytes are not rooted in the sediment, but live unattached in the water. The life forms within this group range from macrophytes with floating or aerial leaves and well developed submersed roots *(Hydrocharis morsus-ranae)* to very small surface floating or submersed plants with few or no roots (*Lemna trisulca*). Some plants in this group have aerial flowers *(Utricularia vulgaris)* others complete their life cycle under the water surface *(Ceratophyllum demersum.)*.

All aquatic macrophyte species mentioned in this review are listed in Table 1.

CONCLUSIONS

About 144 macrophyte species, the communities formed whereby are grouped into 8 classes, 13 orders, 24 alliances and 84 syntaxa (77 associations and 7 rankles communities). The most widely spread were the communities of *Phragmiti–Magnocaricetea elatae* and *Potamotea,* which often occupied large areas of the eulittoral and littoral and formed the main part of the annual biomass in the lake ecosystem. However, macrophyte phytocenoses in Shkodra Lake were relatively poor – most communities being formed of 1–3 dominating species.

The amount of biogenic substances in lake was highly favorable for the development of most macrophyte species of wide ecological amplitude. However, due to the low water clarity this lake is not suitable for deepwater species of narrow ecological amplitude. Rarer were the communities of Utricularietalia.

The highest syntaxa diversity in Shkodra Lake was found in the classes *Phragmiti-Magnocaricetea elatae* (31 syntaxa) and *Potamotea* (26 syntaxa). However, most of these syntaxa are of minor constancy (classes I–II), or rare (+).

Their distribution, the diversity of species and communities are closely related to the trophic level.

Based on the fact that the value of S/A index is 0.8752, it can be said that Shkoder Lake's biodiversity can be considered a biogenetic reserve significant on the European level.

Similar to the situation elsewhere, the biodiversity of Shkoder Lake is different today than in the past. Throughout the evolutionary history of the ecosystem, changes caused by natural factors took place. During the last half century, human activities contributed significantly to these changes. With the increase of eutrophication, the eulittoral and littoral of the lake are getting overgrown by monodominant ma-

crophyte stands, so the species of narrow ecological amplitude use to be eliminated from the communities.

The decrease in the number of species is an especially worrying consequence of these changes. Even though there is no specific research that confirms the extinction of some species during this biogeological evolution, there are ever more frequent arguments that a few economically and scientifically significant species must have become extinct due to increased pressures on this ecosystem.

Some rare and endangered botanical species are threatened due to pollution and variations in the hydrological regime. Besides the threatening factors already known (such as pollution, grazing, transformation of natural habitats into agricultural land), new ones are emerging, including peat exploitation (all vegetation would be removed from the territories in the exploitation fields), increased construction of various facilities (hotels, marines, ports etc.), and major infrastructure projects.

Forest vegetation has been affected for a number of years, mainly due to the tendency of converting forested areas into agricultural land. During past years, this has been connected to social and economic changes in Albania. Part of the lake's shore area in the zone between Vraka and Dobri Spring, for example, has recently been completely cleared. Conservation of natural habitats of the lake and its surroundings into cultivable agricultural land has posed yet another threat to the lake – the use of chemical substances from artificial fertilisers, insecticides, pesticides and so on.

The impact of human activities can be seen on vegetation in the areas around the lake, such as in Ragam, Kastrat, Bajze, the stone regions Shegan-Hani and Hotit, including the forests of the Vukpalaj-Hot region. In the Ragam forests, major degradations have been observed, as well as a consequent decrease in diversity and the number of wild fauna species.

Damages to the forests along the lake's shore (especially of those that are closest to the lake), which have been observed in the northern part, have lead to the clearing of almost the whole area (except for the small woods in the Dobrac – Kamenice area).

Changes in the species composition and biomass of aquatic macrophytes in Shkodra Lake have dramatic impact on the physic-chemical and biological conditions. They strongly influence the aquatic macrophytes, which have a central position in the network of ecological relations between nutrients, plankton and macro-invertebrates. Extinctions of species in many cases reduce the capacity of an ecosystem to respond to additional changes and thus may jeopardize the future ability of the system to provide useful services to human populations.

Table 1. List of aquatic macrophytes of Shkodra Lake

CHLOROPHYTA
1. *Chaetophora elegans* (Roth) Ag.
2. *C. incrassata* Hazen.
3. *Draparnaldia glomerata* (Vauch.) Agardh

CHAROPHYCEAE
4. *Chara fragilis* Desv
5. *C. fragifera* Durieu
6. *C. vulgaris* L.
7. *C. vulgaris* L. f. *longibracheata*
8. *Nitella confervaceae* A. Br.
9. *N. opaca* (Bruz) Agardh
10. *N. syncarpa* (Thuilll) Kutz.
11. *N. tenuissima* (Desv) Kutz

BRYOPHYTA
12. *Fontinalis antipyretica* L.

PTERIDOPHYTA

EQUISETACEAE
13. *Equisetum ramosissimum* Desf.
14. *Equisetum palustre* L.
15. *Equisetum fluviatile* L.
16. *Equisetum arvense* L.

THELYPTERIDACEAE
17. *Thelypteris palustris* Schott

ADIANTACEAE
18. *Adiantum capillus veneris* L.

MARSILEACEAE
19. *Marsilea quadrifolia* L.

SPERMATOPHYTA

BETULACEAE
20. Alnus glutinosa *(L.) Gaertner*

SALICACEAE
21. Populus alba *L.*
22. *Salix fragilis* L.
23. *Salix alba* L.
24. *Salix purpurea* L.
25. *Salix elaeagnos* Scop.
26. *Salix pentandra* L.

ULMACEAE
27. *Ulmus minor* Miller

POLYGONACEAE
28. *Polygonum amphibium* L.
29. *Polygonum lapathifolium* L.
30. *Polygonum hidropiper* L.
31. *Polygonum salicifolium* Brouss.
32. *Polygonum aviculare* L.
33. *Polygonum persicaria* L.

EUPHORBIACEAE
34. *Euphorbia palustris* L.

CARYOPHYLLACEAE
35. *Myosoton aquaticum* (L.) Moench)

NYMPHAEACEAE
36. *Nymphaea alba* L.
37. *Nuphar lutea* (L.) Sibth. & Sm.

CERATOPHYLLACEAE
38. *Ceratophyllum demersum* L.
39. *Ceratophyllum submersum* L.

RANUNCULACEAE
40. *Ranunculus trichophyllus* Chaix in Villars
41. *Ranunculus aquatilis* L.
42. *Ranunculus flammula* L.
43. *Ranunculus lingua* L.
44. *Ranunculus ophioglossifolius* Vill.

BRASSICACEAE
45. *Nasturtium officinale* R. Brown
46. *Rorippa amphibia* (L.) Besser
47. *Rorippa silvestris* (L.) Besser

TAMARICACEAE
48. *Tamarix parviflora* DC.

HYPERICACEAE
49. *Hypericum tetrapterum* Fries.

LYTHRACEAE
50. *Lythrum salicaria* L.
51. *Lythrum hyssopifolia* L.
52. *Lythrum flexuosum* Lag.
53. *Lythrum virgatum* L.

OENOTHERACEAE
54. *Ludwigia palustris* (l.) Elliott
55. *Epilobium hirsutum* L.
56. *Epilobium palustre* L.

TRAPACEAE
57. *Trapa natans* L.

HALORAGACEAE
58. *Myriophyllum spicatum* L.
59. *Myriophyllum verticillatum* L.

APIACEAE
60. *Oenanthe aquatica* (L.) Poiret.
61. *Oenanthe fistulosa* L.
62. *Hydrocotyle vulgaris* L.
63. *Sium latifoilium* L.

PRIMULACEAE
64. *Lysimachia nummularia* L.
65. *Lysimachia vulgaris* L.
66. *Samolus valerandi* L.

BORAGINACEAE
67. *Myosotis sicula* Guss.
68. *Lycopus europaeus* L.

SCROPHULARIACEAE
69. *Veronica beccabunga* L.
70. *Veronica anagallis aquatica* L.
71. *Veronica anagalloides* Guss.
72. *Gratiola officinalis* L.

VERBENACEAE
73. *Lippia nodiflora* (L.) Michx

LAMIACEAE
74. *Stachys palustris* L.
75. *Lycopus europaeus* L.
76. *Mentha piperita* L.

77. *Mentha aquatica* L.

PLANTAGINACEAE
78. *Plantago lanceolata* L.
79. *Plantago major* L.
80. *Scutellaria galericulata* L.

GENTIANACEAE
81. *Blackstonia perfoliata* (L.) Hudson

MENYANTHACEAE
82. *Nymphoides peltata* (S. G. Gmelin) O. Kuntze

APOCYNACEAE
83. *Periploca graeca* L.

OLEACEAE
84. *Fraxinus angustifolia* Vahl.

RUBIACEAE
85. *Galium palustre* L.

ASTERACEAE
86. *Pulicaria dysenterica* (L.) Bernh.
87. *Bidens cernua* L.
88. *Bidens tripartita* L.
89. *Eupatorium cannabinum* L.

POACEAE
90. *Glyceria maxima* (Hartman) Holmberg
91. *Beckmannia eruciformis* (L.) Host.

CYPERACEAE
92. *Cyperus longus* L.
93. Cyperus flavescens *L.*
94. *Cyperus rotundus* L.
95. *Cyperus fuscus* L.
96. *Scirpus lacustris* L.
97. *Eleocharis palustris* (L.) R. et. Sch.
98. *Eleocharis acicularis* (L.) Roemer & Schultes
99. *Cladium mariscus* (L.) Pohl.
100. *Carex hirta* L.
101. *Carex distans* L.
102. *Carex pseudocyperus* L.
103. *Carex riparia* Curtis
104. *Carex acuta* L
105. *Carex paniculata* L.

SCHEUCHZERIACEAE
106. *Triglochin palustre* L.

LEMNACEAE
107. *Lemna gibba* L.
108. *Lemna minor* L.
109. *Spirodela polyrrhiza* L.

JUNCACEAE
110. *Juncus articulatus* L.
111. *Juncus acutus* L.
112. *Juncus effusus* L.
113. *Juncus conglomeratus* L.
114. *Juncus glaucus* Ehrh.

AMARYLIDACEAE
115. *Leucojum aestivum* L.

IRIDACEAE
116. *Iris pseudacorus* L.
117. *Gladiolus paluster* Gaud.

ORCHIDACEAE
118. *Orchis palustris* Jacq.
119. *Serapis vomeracea* (Burm.) Briq.

TYPHACEAE
120. *Typha angustifolia* L.
121. *Typha latifolia* L.

SPARGANIACEAE
122. *Sparganium erectum* L. subsp. *erectum*
123. *Sparganium erectum* L. subsp. *neglectum* (Beeby) Schinz & Thell.

POTAMOGETONACEAE
124. *Potamogeton natans* L.
125. *Potamogeton pusillus* L.
126. *Potamogeton lucens* L.
127. *Potamogeton nodosus* Poiret
128. *Potamogeton perfoliatus* L. *Potamogeton crispus* L.
129. *Potamogeton gramineus* L.
130. *Potamogeton pectinatus* L.
131. *Groenlandia densa* (L.) Foureau

ZANNICHELIACEAE
132. *Zannichellia palustris* L.

NAJADACEAE
133. *Najas marina* L.
134. *Najas minor* All.

ALISMATACEAE
135. *Alisma plantago-aquatica* L.
136. *Alisma lanceolatum* L.
137. *Caldesia parnassifolia*
138. *Sagittaria sagittifolia* L.

BUTOMACEAE
139. *Butomus umbellatus* L.

HYDROCHARITACEAE
140. *Vallisneria spiralis* L.
141. *Hydrocharis morsus – ranae* L.

LENTIBULARIACEAE
142. *Urticularia vulgaris* L.
143. *Utricularia minor* L.

Table 2. List of rare and threatened species

Shkodra Lake represents one of the few refuges in Albania for many rare and endangered plant species. 16 rare or endangered aquatic and hygrophilous plant species of Albania are found in this area.

MARSILEACEAE

1. Marsilea quadrifolia L.

It is reported from Shkodra Lake (Shütt, 1945) and according to the Red Data Book distribution map, this species grow in Shkodra and Lezha, although for many years it has not been found in the reported areas. This is why its presence we consider doubtful.

POTAMOGETONIACEAE

2. Groenlandia densa (L) Foureau

Found in some localities of Shkodra Lake. In Albania is mentioned related to Prespa Lake (Paparisto & Qosja, 1981; Mersinllari, 1997). Not mentioned in the Red Data Book.

3. Potamogeton gramineus L.

This species is found only in the northeastern part of the lake. Not mentioned in the Red Data Book.

BUTOMACEAE

4. Butomus umbellatus L.

The species is distributed throughout Shkodra Lake and channels of the area; widespread in Low West Albania, in channels and wetlands. Vulnerable (V) according Red Data Book.

ALISMATACEAE

5. Caldesia parnassifolia (Bassi) Parlatore

The presence of *Caldesia parnassifolia* is reported only from northeastern shore of Shkodra Lake as a new species for the Albanian flora (Kashta & Rakaj, 2003).

6. Sagittaria sagittifolia L.

Found in some localities in Shkodra Lake. Rare species in Albania: Prespa Lake and Shkodra Lake (Vangjeli *et al*., 1995). In the Red Data Book is considered as vulnerable (V).

HYDROCHARITACEAE

7. Hydrocharis morsus-ranae L.

Found in channels and ditches near the lake. According Red Data Book (V), found only in Prespa Lake.

8. Hydrocotyle vulgaris L.

Found along the northeastern shore of the lake. It is considered as extinct (Ex) in the Red Data Book. According to Buzo *et al*. (1997) it is rarely found in several localities of the low coastal area, while according to Mullaj (1988) it is found in Lagoon of Kune-Vain.

LEMNACEAE

9. Spirodela polyrhiza (L.) Schleiden

Found in upper part of Buna River accompanied with *Trapa natans* and *Hydrocharis morsus-ranae* (Kashta & Rakaj, 1999). Not included in Flora of Albania.

NYMPHAEACEAE

10. Nymphaea alba L.

Found in Shkodra Lake, Domni and Velipoja marshes. Vulnerable (V) according Red Data Book.

11. Nuphar lutea (L.) Sibth. Et Sm.

This species is widespread in the Lake, especially around the north-eastern lakeshore. Vulnerable (V) according Red Data Book.

TRAPACEAE

12. Trapa natans L.

Found in some localities in the Shkodra Lake, often in dense community or accompanied by *Nuphar lutea* and *Nymphaea alba*. It is also found in the upper flow of Buna River. Vulnerable (V) according Red Data Book, it is found in Shkodra Lake and Lezha. Mersinllari (1997) report it for Prespa Lake.

HIPPURIDACEAE

13. Hippuris vulgaris L.

Found in marshy area of the northeastern part of the lake. This species is found

also in Prespa Lake. It is not mentioned in the Red Data Book.

MENYANTHACEAE

14. Nymphoides peltata (S. Gmelin) Kuntze.

Found in several localities of the Shkodra Lake as well as in the upper flow of Buna River. Vulnerable (V) according Red Data Book, with sparse distribution in Shkodra Lake, Lezha and Prespa Lake.

CYPERACEAE

15. Cladium mariscus (L.) Pohl.

Sparsely found along the eastern shore of Shkodra Lake. Vulnerable (V) according Red Data Book.

AMARYLLIDACEAE

16. Leucojum aestivum L.

Found in wet meadows surrounding Shkodra Lake. In Albania is reported from a few other localities: Ohrid Lake (Markgraf, 1927; 1930), Mamurras (MARKGRAF, 1931) and near Korça, in 1300 m a. s. l. (L. Shuka, personal communication). It is not mentioned in the Red Data Book.

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