

SYSTEMATIC AND BIOGEOGRAPHIC STUDIES OF CHAROPHYTES IN YUGOSLAVIA

Jelena BLAZENCIC*, Zivojin BLAZENCIC**, Mirko CVIJAN*
and Branka STEVANOVIC*

*Institute of Botany, Faculty of Biology -
University of Belgrade, 11 000 Belgrade,
Takovska 43, Yugoslavia.

**Faculty Veterinary Medicine -
University of Belgrade, 11 000 Belgrade,
Bulevar JNA 18, Yugoslavia.

ABSTRACT - Charophytes are widespread and floristically abundant through the different regions of Yugoslavia. They inhabit fresh, salt, brackish, and mineral waters, with preference for stagnant water. The 37 so far recorded species include the following: 9 species of the genus *Nitella*, 5 species of the genus *Tolypella*, one species of each of the genera *Nitellopsis*, *Lamprothamnium* and *Lychnothamnus*, and 20 species of the genus *Chara*. The majority of charophytes in Yugoslavia belongs to the cosmopolitan and subcosmopolitan floristic group (nearly 50%) while all the other species have predominantly Mediterranean, Euroasian and European distribution.

RÉSUMÉ - Les charophytes sont répandues dans les différentes régions de la Yougoslavie. Elles peuplent les eaux douces, salées, saumâtres et minérales, de préférences stagnantes. Leur flore, riche actuellement de 37 espèces comprend 9 espèces du genre *Nitella*, 5 espèces du genre *Tolypella*, une espèce du genre *Nitellopsis*, une espèce du genre *Lamprothamnium*, une espèce du genre *Lychnothamnus* et 20 espèces du genre *Chara*. La majorité des charophytes en Yougoslavie appartient au cortège floristique cosmopolite et subcosmopolite (presque 50%), alors que toutes les autres espèces ont une distribution principalement méditerranéenne, euro-asiatique et européenne.

KEY WORDS : *Charophyta*, systematics, phytogeography, chorology, Yugoslavia.

INTRODUCTION

Charophytes of Yugoslavia territory are first mentioned in 1842 (Visiani, 1842). Since then, the data appear in the works of a great number of botanists and hydrobiologists. The most important sources on the flora, systematics, distributions and ecology of charophytes are the studies of Kosanin (1907), Vilhelm (1908, 1913, 1922), Filarszky (1931), Kostic (1936), Tortie-Njegovan (1956), Golubic (1960), Petrovska (1963), Blazencic (1980, 1984) and Blazencic *et al.* (1980, 1982, 1983a, 1983b, 1986). Charophytes

are widespread and very important elements of aquatic ecosystems in Yugoslavia. They inhabit fresh, salt, brackish and mineral waters. Their preference is for the stagnant or slowly running waters along the seashore and in aquatic localities at different altitudes, reaching the mountain lakes at 2000m.

These aquatic habitats are of neutral or weakly alkaline reaction as could be expected of the limestone bedrock setting.

This study represents the first complete survey of systematic, chorological and ecological characteristics of charophytes of the entire territory of Yugoslavia.

MATERIAL AND METHODS

Charophytes were collected throughout the entire Yugoslav territory. More than 250 localities were studied, and about 90 of them were mountain lakes. The studies were conducted using the methods of transects and/or transverse profiles. Specimens of algae were fixed in 4% formalin, and this plant material is included in the collection of the Botanical Institute and Garden in Belgrade. The data collected for each locality comprised: the air and water temperature, the depth of water of which charophytes extend, water transparency, chemical analysis of water, as well as the register of vascular plants found in associations with charophytes.

RESULTS AND DISCUSSION

Our own investigations and the literature data record 37 species of charophytes in Yugoslavia flora: 9 species of the genus *Nitella*, 5 species of the genus *Tolypella*, one species of each of the genera *Nitellopsis*, *Lamprothamnium* and *Lychnothamnus* and 20 species of the genus *Chara*:

- *Nitella syncarpa* (Thuill.) Chev., *N. capillaris* (Krock.) Gr. et B-W., *N. opaca* (Bruz.) Ag., *N. flexilis* (L.) Ag., *N. mucronata* (A.Br.) Miquel, *N. brachytelea* A. Br., *N. batrachosperma* (Reich.) A. Br., *N. gracilis* (Smith) Ag., *N. hyalina* (D.C.) Ag.*

- *Tolypella prolifera* (A.Br.) Leonh.*, *T. intricata* (Roth.) Leonh.*, *T. glomerata* (Desv.) Leonh., *T. nidifica* (O. Müll.) Leonh., *T. hispanica* Nordst.*

- *Nitellopsis obtusa* (Desv.) Gr.

- *Lamprothamnium papulosum* (Wallr.) Gr.

- *Lychnothamnus barbatus* (Meyen) Leonh.

- *Chara braunii* Gmel., *Ch. tomentosa* L., *Ch. denuda* A.Br.*, *Ch. contraria* (A.Br.) T.F. Allen, *Ch. strigosa* A. Br., *Ch. aculeolata* Kütz., *Ch. polycantha*, A.Br., *Ch. gymnophylla* A.Br., *Ch. vulgaris* L., *Ch. radix* A.Br., *Ch.*

* Species cited only in literature data.



Fig. 1-4: Distribution of charophytes in Yugoslavia. Fig. 1: *Tolypella prolifera* (c), *T. intricata* (r), *T. nidifica* (v), *T. hispanica* (o), *T. glomerata* (u). Fig. 2: *Nitellopsis obtusa* (c), *Lamprothamnium papulosum* (v), *Lychnothamnus barbatus* (s), *Chara imperfecta* (x), *Ch. kokeilii* (o). Fig. 3: *Nitella syncarpa* (v), *N. capillaris* (s), *N. opaca* (c), *N. flexilis* (o). Fig. 4: *N. mucronata* (c), *N. brachytelea* (s), *N. batrachosperma* (o), *N. gracilis* (v), *N. hyalina* (u), *Chara rohlenae* (z).

hispidula L., *Ch. aspera* Deth., *Ch. tenuispina*, A.Br., *Ch. connivers* Salzm., *Ch. globularis* Thuill., *Ch. delicatula* Ag., *Ch. rohlenae* Villh., *Ch. kokeilii* A. Br., *Ch. rubenhorstii* A.Br., *Ch. imperfecta* A. Br.*

The number of charophytic species in different european countries varies from 11 in Rumania to 35 species in France (Table I). In total, 42 species of charophytes are found to be present in the whole of Europa (Coril-

* Species cited only in literature data.

lion, 1975). In this respect, the 37 charophytes recorded so far in Yugoslavia represent a remarkably rich and heterogeneous charophytic flora in this country. A number of favourable conditions could account for the floristic richness of this flora: Yugoslavia lies on a calcareous bedrock, it is subject to different climatic conditions (mediterranean, continental, high mountain), and has, therefore, a number of varied aquatic ecosystems.

Country	Number of species	References
Rumania	11	Ionescu V., 1974
Bulgaria	18	Vodenicarov D., 1963
Norway	21	Langangen A., 1974
Great Britain and Ireland	25	Moore J. 1986
Poland	28	Dambaska I., 1964
Spain	30	Comelles M., 1982
France	35	Corillion R., 1975
Yugoslavia	37	Blazencic et al., 1989
Soviet Union (included European and Asian parts)	64	Gollerbah M.M., Krasavina L.K., 1963

Table 1 - Number of charophytes in different European countries

The widely distributed species are: *Chara vulgaris*, *Ch. contraria*, *Ch. globularis* (fig. 8), *Ch. delicatula*, *Ch. aspera* (fig. 7) and *Nitella opaca* (fig. 3). Among these, *Chara vulgaris* and *Ch. contraria* are found at more than 150 localities. Other species, as are *Ch. aculeolata* (fig. 5), *Nitellopsis obtusa* and some species of the genus *Tolypella*, are less numerous and present on fewer localities (figs. 1-2). The scarcity of these species could be due to two reasons: some of them are truly rare even in the floras of other countries, and, moreover, not all yugoslav regions are sufficiently investigated until now, in terms of charophytes distribution.

The very rare species are *Nitella brachytelea* (fig. 4), *Chara strigosa* (fig. 5), *Ch. kokeilii* (fig. 2) and endemic *Ch. rohlena* (fig. 4).

The analysis of floristic elements demonstrated, as expected, the prevalence of cosmopolitan and semi(sub)cosmopolitan species, accounting for nearly 50% of the entire flora: the additional 27% are northern and continental species (circumboreal, euroasian and middle-european). Together, these account for 77% of the entire charophytic flora of Yugoslavia (Fig. 9). Mediterranean and subatlantic species make nearly 20% of this flora, due to Yugoslavia mediterranean coast. One endemic species (*Chara rohlena*), present in the charophytic flora of Yugoslavia, points to the fact that Yugoslav territory and the Balkans in general were a refuge not only to terrestrial, but also to aquatic (freshwater) flora, being, at the same time, an important region of the glacial-postglacial speciation.

CONCLUSION

The study presents the inventory of charophytes in Yugoslavia together with their ecological characters. The inventory is based on the literature data



Fig. 5-8: Distribution of charophytes in Yugoslavia. Fig. 5: *Chara braunii* (s), *Ch. tomentosa* (v), *Ch. strigosa* (u), *Ch. aculeolata* (c), *Ch. rudis* (o), *Ch. rabenhorstii* (z). Fig. 6: *Ch. denudata* (u), *Ch. polyacantha* (c), *Ch. hispida* (o), *Ch. tenuispina* (v), *Ch. connivens* (s). Fig. 7: *Ch. aspera* (c), *Ch. delicatula* (o), *Ch. imperfecta* (v). Fig. 8: *Ch. globularis* (c), *Ch. gymnophila* (v).

and on our own field investigations. It brings the total number of charophytes in Yugoslavia to 37 species. The following 5 species: *Nitella brachytelea*, *Tolypella glomerata*, *Nitellopsis obtusa*, *Lamprothamnium papulosum* and *Chara strigosa* are for the first time included in such an inventory.

Charophytes were found in different aquatic habitats, in fresh, salt, brackish, and mineral waters, on the localities varying from cryptodepression to high mountain sites of 2000m altitude.

The majority of charophytes in Yugoslavia belongs to cosmopolitan floristic elements - nearly 50%.

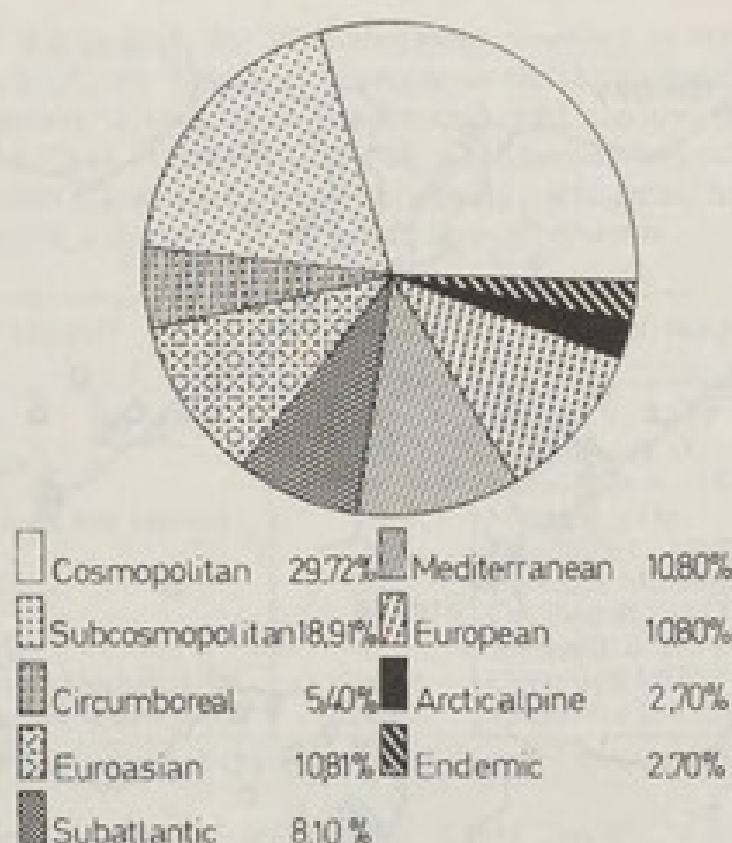


Fig. 9: Chorological spectrum of charophytes present in Yugoslav flora.

In shallow aquatic habitats, or near the lake shores, charophytes are usually found in mixed populations with vascular aquatic plants, predominantly with the species belonging to *Potamogeton* genus. Pure charophytic populations overgrow the bottom of the deeper lakes where they form the lower limit of macrophytes distribution. The deepest level to which charophytes grow is still at 36 m in the lake Vrana (island of Cres) as established by Golubic (1960).

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