

Botanical peculiarities of Dalmatian Lagoons in Neretva Delta

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RESUME : Singularités botaniques des lagunes dalmates du delta de la Neretva. Le delta de la Neretva est le plus grand et le plus diversifié du littoral yougoslave, compte tenu des étangs salés et lagunes typiques bien conservés. Les végétaux les plus intéressants sont *Botanus junceus*, *Typha australis*, *Fimbristylis illyrica*, *Taraxacum tenuifolium* et les communautés remarquables *Arundo-Typhetum australis*, *Taraxaco-Fimbristyletum illyricae*, *Limonio-Artemisietum caerulescentis* et *Batrachio-Potamogetum siculi*.

INTRODUCTION. The coastal Karst rivers of SW Yugoslavia have mostly the deep canyon estuaries with rocky shores, and it includes a considerable number of the Neretva delta in Middle Dalmatia. Although the western part of this delta is very degraded by the hydrotechnical regulations, agriculture and urbanizing, in its other parts persisted the most typical alluvial lagoons and salt marshes of Yugoslavia. It is of a considerable biogeographical and conservationist interest for its nesting sites of rare birds and of other threatened fauna, but also for its rich flora and vegetation so far few studied. Thus in the actual paper its neglected phytogeographical peculiarities are analysed. So far in the literature occurred only some marginal botanical indications on this delta e.g. Lovric and Rac (1987), and this is the first special contribution on its vegetation.

RESULTS. The swamp flora of Neretva delta is only partly comparable to the well known West Mediterranean estuaries, for it includes a considerable number of the interesting Oriental and Balkanic subendemic taxa, being rare or absent westwards. Among its lagunar algae the most remarkable are some rare halophilic Charophyta e.g. the W Mediterranean *Chara canescens* Lois. ssp. *salsa* M.G., and the subendemic Adriatic one *Ch. rabenhorstii* A.Br. The most interesting dicots there are *Bryonia cretica* L. s.str. in its northernmost site, then the rare *Nymphaea thermalis* DC. (*N. lotus* auct.), and the East Adriatic endemic *Taraxacum tenuifolium* Hoppe (*T. hercegovanicum* M.G.). The monocots there present the most diversified swamp plants, including a series of the striking rare taxa (the related vouchers are in Herbarium ADRZ):

Botanus junceus Turcz. (*B. scutariensis* auct.) is a SW Asian taxon with its westernmost sites in Neretva delta and Skadar lake.

Fimbristylis illyrica M.G. is endemic to coastal swamps of Eastern Adriatic.

Najas graminea Del. has here its northernmost native site.

Potamogeton siculus Ten. s.str. (*P. subflavus* Lor.) is a disjunctive halophyte of the Central Mediterranean lagoons, with its isolated NE outposts in Neretva, Cetina and Raša estuaries of Eastern Adriatic.

Triglochin laxiflorum Guss. has here also its northernmost site.

Typha australis Schum. & Thon. ssp. *angustata* (Bory & Chaub.) M.G. (*T. damingensis* auct. p.p.) is a relict palaeotropical taxon, with its NW outposts in Neretva and Krka estuaries of Dalmatia.

The original natural vegetation in this delta includes the next 8 remarkable phytocoenoses (symbols used for species presence: 1 = 1-20% samples ... V = 80-100% ones):

1. *Agropyro-Inuletum crithmoidis* Br.-Bl. (alliance *Euphorbion pepilis* Tx.) occurs in the shingle islets and undisturbed beaches of this delta.

2. *Juncetum maritimi-acuti* Hic. (all. *Juncion maritimi* Br.-Bl.) is frequent in the lagunar shores of Neretva delta.

3. *Bolboschoeno-Scirpetum littoralis* Br.-Bl. (all. *Bolboschoenion maritimi* Soo) is also frequent in the interior subsaline swamps within this delta.

4. *Arundino-Typhetum australis* Lov. (all. *Bolboschoenion*) is probably a most distinctive community in Dalmatian estuaries, covering extensive areas of the interior subsaline swamps in Neretva delta and being there a thermophilic swampy climax. It forms the robust dense reeds 3-5m tall, marked by *Arundo donax* IV, *Typha australis* V, *Botanus junceus* IV, *Baldellia ranunculoides* IV, and *Halochoenus australis* V.

5. *Taraxaco-Fimbristyletum illyricae* (Hic.) Lov. (all. *Fimbristylon* Hic.) is the endemic Dalmatian community of the subsaline or lime-saturated, periodical desiccating tarns, developed e.g. in the internal swamps of Neretva delta. Its indicators are *Fimbristylis illyrica* V, *Taraxacum tenuifolium* IV, *Bolboschoenus compactus* V, and *Heleocharis schoenoides* IV.

6. *Limonio-Artemisietum caerulescentis* Hic. (all. *Halo-Artemision* Pign.) is very characteristic of the desiccating hypersaline marshes in the seaward parts of delta.

7. *Coleogeto-Zannichellietum maritimae* (Hart.) Soo (all. *Ruppion cirrhosae* Lov.) is the main community of infralittoral benthos across the lagunar bottoms of delta, marked by *Coleogeton marinus* V, *Zannichellia maritima* (Z. major) V, *Ruppia cirrhosa* (R. spiralis) III, *Aithenia filiformis* II, *Chara canescens* IV, *Tolypella spec. div.* V.

8. *Batrachio-Potamogetum siculi* (Hic.) Lov. (all. *Ruppion maritimae* Br.-Bl.) occurs in the subsaline running waters of estuarine channels between the lagoons of this delta. It is marked by *Potamogeton siculus* V, *Pot. loeselii* IV, *Batrachium drouotii* IV, *Nymphaea thermalis* II, *Caldesia reniformis* II, etc.

In more disturbed western parts of this delta, the precedent vegetation is mostly eliminated, and there may persist only sporadically some isolated fragments of *Juncetum* and *Bolboschoeno-Scirpetum*. Other degraded habitats include the different secondary communities of a synanthropic lagunar vegetation, absent in E parts of delta: *Cynodonti-Plantaginietum coronopii* (Hic.) Tx. replacing *Agropyro-Inuletum* in shingle, then *Althaeo-Calyptegietum sepium* Beef. along the polluted lagunar shores, *Salicornietum europaeae* Tx. and *Suaedetum maritimae* Pign. instead of *Limonio-Artemisietum* in salt marshes, *Scirpo-Phragmitetum* Br.-Bl. instead of *Arundino-Typhetum*, and *Zosterelletum nottii* (Herm.) Giac. replacing the *Ruppia* in lagunar bottoms, etc. The most devastated and over-polluted westernmost lagoons closely to the Kardeljevo (Ploče) harbour include only *Salsolietum sodae* Slav. in salt marshes, then *Chaetomorpha-Valonietum aegagrophilae* (Feld.) Giac. on muddy bottom, and *Enteromorphetum proliferae-intestinalis* (Zal.) Hart. on the shingle one.

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Growth and reproduction of *Mytilus galloprovincialis* (LMK) in two greek districts (Kyparissi Lagoon and Elefsis Bay)

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SUMMARY

The growth and reproduction of *Mytilus galloprovincialis* was studied using a modified version of the von Bertalanffy equation. The difference in growth was attributed to the nutrient supply and pollution. Reproduction extended throughout the year, the main spawning occurring in the winter.

METHODS

The growth and reproduction of *Mytilus galloprovincialis* was studied for approximately one year in Kyparissi lagoon and Elefsis bay. In the first case the mussels were collected from a pole culture; the ones from Elefsis bay were kindly supplied by Dr. Panayotides of greek N.C.M.R. who was carrying out a settlement experiment in the area at the time.

Length (L) and total wet weight (TW) were used as indices of growth. The von Bertalanffy equation was used as applied by Gulland (1969) and Thiesen (1973). The L_{∞} is derived from the graphic method of Ford Walford (1946). Reproduction was studied by histochemical methods according to Griffiths (1977).

RESULTS AND DISCUSSION

The allometric equation $W=aL^b$ was estimated at every sampling period. The exponent b was always lower than 3.00 and ranged in Kyparissi from 0.82 in January to 2.89 in September. The low value is associated with gametogenesis and spawning. In Elefsis bay, ranged from 2.07 to 2.54. In Kyparissi, L_{∞} was estimated to $L_{\infty}=9.97$ and the von Bertalanffy was $L_t=9.97*(1-e^{-k(t-t_0)})$, $k=0.10*(t+0.10)$. In Elefsis bay $L_{\infty}=5.57$ and $L_t=5.57*(1-e^{-k(t-t_0)})$, $k=0.18*(t+0.20)$. The growth rate in Kyparissi is considerably faster than that in Elefsis. In fact it is higher than any other rate mentioned in the literature (Bayne 1976). The most likely explanation is the high concentration of nutrients in Kyparissi due to a nearby fresh water spring. The low growth rate in Elefsis may be due to the pollution of the area which receives the domestic sewage and industrial wastes of Athens.

The reproduction of *Mytilus galloprovincialis* was continuous throughout the year, but the main spawning occurred in winter, thus the larvae benefit from the abundance of food available at the beginning of spring. Whilst the gametogenesis and spawning in Mytilidae is documented in the Atlantic and other sea areas, there is very little information available regarding the populations in Greek waters. In addition, the advantage of this study is that the exact age of the mussels was known.

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