

## CONTRIBUTION TO THE STUDY OF AQUATIC MACROPHYTES FROM MUSURA BAY (DANUBE DELTA, ROMANIA)

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### ABSTRACT

The Romanian Danube Delta is situated in the eastern part of Europe, and it is the largest continuous marshland and the second largest delta on the continent (the Volga being the largest). Danube Delta, as a unique, as well as a young and continuing to grow region, is a favorable place for developing a unique flora and fauna in Europe, with many rare and protected species. The great biodiversity of Danube Delta is considered to be in a better state than in other deltas from Europe, and it contains a great range of lower and higher plants, invertebrates, vertebrates and habitat types.

All of these are arguments for the designation of the Danube Delta Biosphere Reserve (DDBR) by the Romanian Government in 1990, and from September 1990, the DDBR was listed as a wetland of international importance especially as waterfowl habitat under the Ramsar Convention. The universal natural heritage value of the reserve was recognised in December 1990 by the inclusion of the strictly protected areas in the World Heritage List under the World Heritage Convention.

Researchers consider that in an area of 3.466 km<sup>2</sup>, that represent 1.5,% of the Romanian territory, live around 1/3 of all species of the Romanian flora (around 1.000 species).

Many scientific papers present the flora of different types of habitats: sand dunes, salty areas, forests, swamps, fresh or salty water; also a great number of articles present the vegetation of the area, and the different vegetal associations. A great importance is now given to the alien species and on the other hand, to the rare and protected ones, in order to identify the endangered and periclitated species and to evaluate their status. Even though the terrestrial environment is present in the area, the predominance of the aquatic environment, led to the existence of a particular macrophytic flora. At the contact point of the sea-water and freshwater, it is understandable that particular physical, chemical and biological processes occur, and as a consequence researchers consider these coastal waters a special ecosystem, from which Musura Bay is one of the most representative.

In this context, the purpose of this paper is to contribute to the study of aquatic macrophytes, both submerged and floating flora that has been studied in previous years, and is a constant preoccupation of researchers. The present study took place over two years, between 2013-2014, and in each year a number of expeditions were made in different seasons, in order to observe the diverse flora and flora associations, because, due to seasonal variation in water quality, there might be a significantly seasonality of the vegetation also.

The importance of the studies regarding flora of the Danube Delta, consist in the fact that the plants of these area are of social and economical importance, but also are very important for environmental conservation.

**Keywords:** Danube Delta, Musura Bay, aquatic macrophytes

## 1. Introduction

Danube Delta, considered to be the Romania's youngest relief unit is a particular territory and a favorable place for developing a unique flora and fauna in Europe, with many rare and protected species. On an area of approximately 3.466 km<sup>2</sup>, representing 1,5,% of the Romanian territory, live around 1/3 of all species of the Romanian flora (around 1.000 species) (Ciocârlan, 2011).

The great biodiversity of Danube Delta is considered to be in a better state than in other deltas from Europe, and it contains a great range of lower and higher plants, invertebrates, vertebrates and habitat types. Many of these species that live here are unique. In this category plants as well as animals, are included (Gâștescu *et al.*, 2008). The particular and diverse conditions of the Danube Delta led to the establishment of rich and diversified vegetation.

There is a terrestrial vegetation on smaller surfaces, which encompasses the vegetation of riverside coppices or of sandbanks. Also, there is a vegetation specific to wet or dry sands, while the salty lands or marine sands developed a halophilic or subhalophilic flora (depending on the maximum salinity). A rich vegetation with aquatic or palustrine species develops on the lands with permanent water, excess humidity or, on the contrary, with low humidity.

Both the flora and the vegetation of the Danube Delta were studied by numerous botanists, being published in over 300 scientific articles beginning with the 1990s. According to the existing data, it is considered that approximately 955 species of spontaneous Cormophytes live in the delta and 157 vegetal associations have been identified so far (Ciocârlan, 2008; Popescu *et al.*, 1997). The study of the flora and vegetation of the Danube Delta represents an important component in the study of the biodiversity of the area in general and also a very important part of the issue regarding environmental protection.

The aquatic and palustrine vegetation of the delta is considered the most representative and, as a result, it was the most studied, and in this context, the purpose of this paper is to contribute to the study of aquatic macrophytes, both submerged and floating flora, that has been studied in previous years, and is a constant preoccupation of researchers.

According to the adaptation to water, there is a hydrophilic vegetation and a helophilic vegetation.

The hydrophilic vegetation is represented by aquatic plants and here are the following categories:

- flora of fresh running waters – represented by a few number of species, but numerically abundant; these species live on channels and streams with reduce water flow, or in small lakes with slow water circulation;
- flora of fresh stagnant waters – these species live in open-pools (with natural active water exchange), or in closed pools, which are smaller and with slow water circulation;
- flora of brackish and salty waters – this kind of flora is very poor, because mainly the water in inner Delta is fresh water (Ciocârlan, 2011).

The helophilic vegetation is the most distributed and it is represented by a large number of species and a large number of individuals This type of flora lives on lake shores, streams, channels and shallow pools.

## 2. Material and method

The present study took place over two years, between 2013-2014, and in each year a number of expeditions were made in different seasons, in order to observe the diverse flora and flora associations, because, due to seasonal variation in water quality, there might be a significantly seasonality of the vegetation also.

The present observations took place in Musura Bay (Fig.1 a, b).

Musura Bay or Northern Bay is situated north of Sulina distributary, between Sulina and the southernmost arm of the Chilia Distributary, Stary Stambul. It has a length of about 12 km, is crossed by the border between Romania and Ukraine and has a very low, marshy coast.



**Figure 1:** The location of Musura Bay in the eastern part of Romania (a) and in Danube Delta region (b)

Now, in the Romania Danube Delta Biosphere Reserve we have only two areas with brackish habitat: between the Sacalin Peninsula and the Danube Delta coast -Musura Bay. But both are now in the process of undergoing a change of status. The Sacalin Peninsula will disappear so that the habitat will become a marine one (Gâştescu *et al.*, 2008).

For the Musura Bay, as result of the sedimentation of sandy sediments derived from the Stary Stambul secondary mouth and transported by the longshore current from the north, a submerged littoral bar was formed in Ukrainian waters, near the Romanian–Ukrainian border. During the late 1970s through to the beginning of the 1980s, this became a lateral spit, with a length of about 3.5 km in 1985. At the beginning of the 1990s, the new island length was already sufficiently long to cross the border between the Ukraine and Romania. Subsequently, the island advanced to the south for about 3 km (Stanică *et al.*, 2007).

In its present position, the new spit (approximately 7 km in length and 80 m wide), has transformed the previous Musura Bay into a lagoon, with two inlets (north and south of the former bay).

### 3. Results and disscution

Due to the field trips that took place in spring, summer and autumn period, in year 2013 and 2014, the following taxa were identified in the study area.

Aquatic vegetation: emersed, attached or not attached to a substrate: Pteridophyta: *Salvinia natans* (L) All. T, Euras., Angiospermatophyta: *Hydrocharis morsus-ranae* L.,H, Euras., *Lemna minor* L. Hd, Cosm., *Lemna trisulca* L., Hd, Cosm., *Nuphar luteum* Sm., Hd, Euras., (Fig. 2) *Nymphaea alba* L., Hd, Eur.,(Fig.2), *Nymphoides peltata* Kuntze, Hd, Euras., *Potamogeton crispus* L., Hd, Cosm., *Potamogeton natans* L., Hd, Circ., *Potamogeton pectinatus* L., Hd Cosm., *Potamogeton perfoliatus* L., Hd, Cosm., *Stratiotes aloides* L., Hd, Euras., *Trapa natans* L., T, Euras. Cont (submedit.) (Fig.3), *Utricularia vulgaris* L., Hd, Circ.

This type of vegetation is characteristic to the basins with deposits of suspensions, with more or less oxygenized waters, and in some cases we encounter this vegetation in pools with stronger clogging. The flora that makes up this vegetation develops at the surface of still waters in sheltered pools, sometimes smaller, where the currents are weak, or along the channels with calm waters.

In the pools with stronger anthropogenic influence, *Lemna trisulca* develops abundantly. The species of *Potamogeton* are widely distributed in the Danube Delta, but the great occurrence of *Potamogeton crispus* indicates a stronger anthropogenic influence, which leads to an oxygen deficit and

accumulation of organic materials in the respective pools. The related species, *Potamogeton pectinatus*, develops well where oxygenation is scarce, accumulating a great amount of biomass and leading to the clogging of the pools.



**Figure 2:** *Nuphar luteum* and *Nyphaea alba*



**Figure 3:** *Trapa natans*

*Stratiotes aloides* is very distributed in aquatic basins with calm waters, vegetating in clogged places sheltered from strong winds. Sometimes, the species may invade the pools where fishing is practiced and it practically becomes harmful due to the amount of biomass it produces, which accumulates (leads to decreased water oxygen, which harms fish farming). The association of the species *Trapa natans* is one of the most distributed in the marshes and lakes of the Danube Delta. In the specialized literature, it is mentioned that *Trapa natans* is practically ever-present in the Danube Delta aquatic basins, producing phytocoenoses on considerable surfaces. However, it seems that the draining of certain lakes and marshes along the Danube, as well as the presence of toxic substances, led to the strong reduction of the populations of *Trapa natans*, the species being listed as “vulnerable” (VU) in the “Romanian Red List of Vascular Plants” (1994), according to the IUCN categories. *Utricularia vulgaris* is a plant with mixotrophic nutrition which develops in shallow waters, strongly clogged and rich in decomposing organic substances, its mass occurrence indicating a strong eutrophication of these pools. Its status in the “Romanian Red List of Vascular Plants” (1994) is “rare” (R), according to the IUCN categories.

Submerged vegetation Angiospermatophyta: *Ceratophyllum demersum* L., Hd, Cosm., *Ceratophyllum submersum* L., Hd, Eur., *Elodea canadensis* Michx., H, Adv., *Myriophyllum spicatum* L., H, Circ., *Myriophyllum verticillatum* L., H, Circ., *Najas marina* L.T, Subcosm.

Between the two species of *Ceratophyllum*, *C. demersum* seem to have a resistance to pollution, shown by its development in large quantities in some areas.

*Elodea canadensis* is an adventive plant, original from North America and introduced into Central and Western Europe in the 20<sup>th</sup> century, from where is found its way into our country, being first mentioned in the Danube Delta. Initially, it developed intensely, but now it is not very widely distributed. It even disappeared from certain places and where it still exists the populations are not numerous.

*Najas marina* is characteristic to still water lakes or very slow flowing waters, with a preference for open places and more demanding in terms of light.

Palustrine vegetation: Angiospermatophyta: *Alisma plantago-aquatica* L., Hd, Circ., *Buttomus umbellatus* L., Hd, Euras., *Carex riparia* Curtis, G, Euras, *Cicuta virosa* L., H, Euras., *Lythrum salicaria* L., H, Circ., *Oenanthe aquatica* (L.) Poir.,T, Euras., *Mentha aquatica* L., H, Eur., *Myosotis scorpioides* (L.), H, Euras., *Phragmites australis* (Cav.) Trin. ex Steud., G, Cosm., *Sagittaria sagitifolia* L., Hd, Euras., *Schoenoplectus lacustris* (L.) Palla., G, Cosm., *Sparganium erectum* L., G, Euras., *Rumex hydrolaphatum* Huds., H, Eur., *Typha angustifolia* L., G, Circ., *Typha latifolia* L., G, Cosm. Palustrine vegetation is the most distributed in the Danube Delta, the characteristic vegetal

formation being the reed plot, which occupies most of this territory. It is an association with durable consistency and which offers the characteristic aspect of most aquatic basins, developing both in clear waters and in waters with various clogging degree.

#### 4. Conclusions

This recent study of the aquatic vegetation of the Musura Bay, shows a notable diversity. An analysis of the floristic elements (geoelements) was made, that shows the predominance of Eurasian and European elements (48%), and also a large number of Cosmopolitan species (27%); Circumpolar species represent 18% and adventives species, only 3%.

Nevertheless, during the years, human actions can be observed in many ways, and this may lead to changes in floristic aspects as well as in ecosystems in general. Many studies showed that there was a drastic reduction in taxonomic diversity, because over 100 species mentioned once in the literature (in 1950s) were not recorded in recent studies and on the other hand adventives species appear (Ciocârlan, 2011). The research upon flora of the Danube Delta must be continued in the future, on more field trips, and an important part of this study must be the research on vulnerable and endangered species.

The protection and preservation of the flora and vegetation of the Danube Delta is and must remain in the future the most important part of the general preservation of the Delta ecosystems and of the environment.

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