



ORIGINAL RESEARCH PAPER

## CHAROPHYTES (Charales) OF ULCINJ AND VELIKA PLAŽA BEACH (MONTENEGRO)

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### Ključne riječi:

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### SYNOPSIS

The paper presents the results of a study of flora and ecology of Charophytes (Charales) from 7 localities in the area of Velika Plaža Beach near Ulcinj. The analysis of the collected samples and inspection of the collection of Charophytes at the Institute of Botany and "Jevremovac" Botanical Garden of the Belgrade University (Ch. BEOU) showed presence of: *Chara aspera* Deth. ex Willd., *C. contraria* A.Br., *C. contraria* f. *capillacea* Blatt. Vergr., *C. globularis* Thuill., *C. hispida* L., *C. tenuispina* A.Br., *C. virgata* Kutz., *C. vulgaris* L., *C. intermedia* A. Br. and *Nitella tenuissima* (Desv.) Kutz. *C. tenuispina*, and the species of *C. hispida*, *C. virgata*, and *C. vulgaris* were registered for the first time in puddles in the area of Velika Plaža in Ulcinj. The paper also includes a list of the types and characteristics of the habitats occupied by these algae, assessment of endangerment of the species found and proposal of protection measures.

### SINOPSIS

#### HAROFITE (Charales) ULCINJA I VELIKE ULCINJSKE PLAŽE (CRNA GORA)

U radu su prikazani rezultati proučavanja flore i ekologije harofita (Charales) sa 7 lokaliteta na području Velike plaže kod Ulcinja. Analizom sakupljenih uzoraka, kao i pregledom zbirke harofita u Institutu za botaniku i botaničke bašte „Jevremovac“ Univerziteta u Beogradu ( Ch. BEOU) konstatovano je prisustvo: *Chara aspera* Deth. ex Willd., *C. contraria* A.Br., *C. contraria* f. *capillacea* Blatt. Vergr., *C. globularis* Thuill., *C. hispida* L., *C. tenuispina* A.Br., *C. virgata* Kutz., *C. vulgaris* L., *C. intermedia* A. Br. i *Nitella tenuissima* (Desv.) Kutz. *C. tenuispina*, kao i vrste *C. hispida*, *C. virgata*, i *C. vulgaris* su prvi put zabeležene u lokvama na području Velike ulcinjske plaže. U radu su, takodje, navedeni tipovi i karakteristike staništa koje ove alge naseljavaju, ocijenjena je ugroženost konstatovanih vrsta i predložene su mere zaštite.

## INTRODUCTION

Velika Plaža Beach in Ulcinj, as a part of the Ulcinj field, is the longest beach (12 km) in the area of the eastern Adriatic coast. Along with the plains in the hinterland, this beach consists of fine sand originating from Skadar Lake. This beach is mostly a coastal habitat, with rather dynamic coastline created by accumulation processes. The beach encompasses a mosaic of habitats, contributing to great landscape value of this area. The habitats vary from littoral zone, beach, dunes, depressions with alkaloid and freshwater habitats, to the indigenous Skadar oak forest.

The area of Velika Plaža is characterised by many aquatic and swamp habitats where diverse and specific flora and fauna can often be found. Studies in various scientific fields have been carried out in this region, but data on algae, in particular from the order of Charales, are rare (Vasić, 1979; Mijović, 1994; Urbaniak et al., 2008; Jovanović, 2009). A part of the data on Charophytes from this area is located in the Collection of Charophytes at the Institute of Botany and "Jevremovac" Botanical Garden. The Collection includes samples of: *C. intermedia* (Leg. Z. Romčević, ? July 1998 and V. Stevanović 2<sup>nd</sup> June 2003), *Nitella tenuissima*, *C. aspera*, *C. contraria*, *C. globularis* (Leg. V. Stevanović 2<sup>nd</sup> June 2003), *C. contraria* f. *capillacea* (Leg. D. Lakušić, ? May 2007).

Our objective was to determine the presence, floristic composition, taxonomic diversity, ecological characteristics and distribution of Charophytes in this area, and also to supplement the knowledge on Charophyte flora of Montenegro.

## MATERIALS AND METHODS

The data presented in this paper are a result of our own researches, data from the literature and inspection of the Collection of Charophytes at the Institute of Botany and "Jevremovac" Botanical Garden of the Belgrade University (Ch. BEOU).

In the area of Velika Plaža in Ulcinj, within the project called "Monitoring of Biodiversity in Montenegro" (Karaman & Dragičević, 2013), the researches were carried out in the period from May to October 2012 in seven localities, with listed GPS coordinates. Sampling included use of the method of a network of transects and transverse profiles, and the sampling itself was done for that purpose by using specially made grabbers (such as rakes, wire grapnels and similar). Material was herbarized or conserved in 4 % formaldehyde and it is kept in the Collections of Algae and Flowering Plants at the Natural History Museum of Montenegro in Podgorica.

Identification of Charophytes included use of standard keys of Migula (1897), Corillion (1975), Wood & Imahori (1964, 1965), Gollerbah & Krasavina (1983),

Schubert & Blindow (2003), and for vascular macrophytes - Tutin et al. (1964-1980) and Josifović, M. (ed) (1970-1977);

Endangerment assessment of Charophytes is based on the principles and criteria for categorization of the International Union for Conservation of Nature - IUCN (Stevanović, V. 1999; IUCN, 2001), and it refers only to the territory of Montenegro.

The type of habitat is marked with code and name according to the criteria of NATURA 2000, Habitat Directive (Petrović et al., 2012).

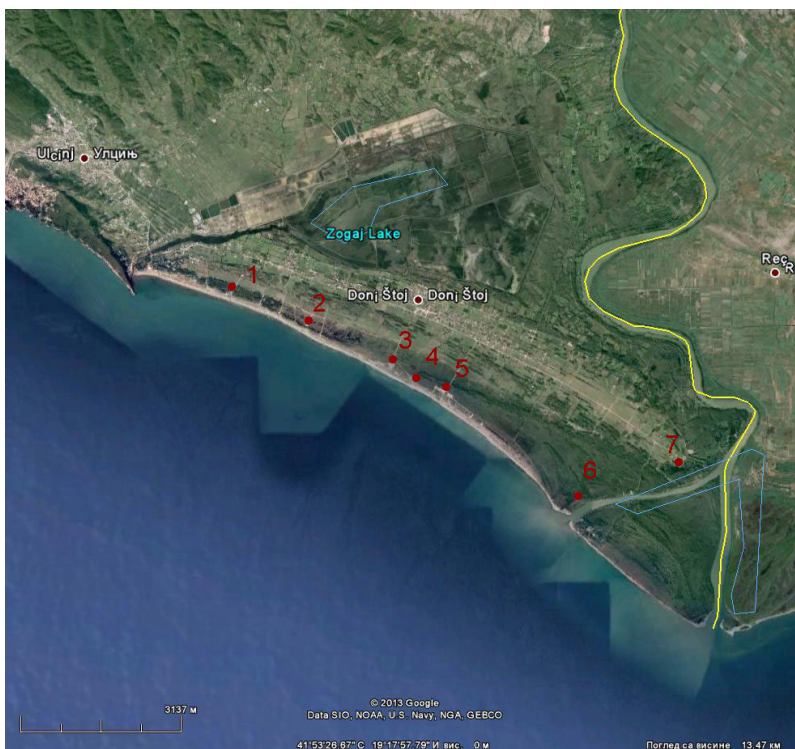


Figure 1 : Map of Velika Plaža beach with marked investigated localities.

## RESULTS AND DISCUSSION

### LOCALITIES

In the hinterland area of Velika Plaža in Ulcinj, research of the diversity and ecology of Charophytes was done in seven localities (Fig. 1). For each locality, GPS system coordinates were provided, the type of habitat was determined, the Charophytes found were identified, endangerment factors were registered, endangerment of each identified taxon was assessed and protection measures were proposed.

LOCALITY 1: (coordinates: N 41° 54.421' E 019° 15.552')

HABITAT TYPE: 91F0 Montenegrin flooded ash, oak and alder forests. This locality contains two shallow channels that are periodically filled with water. The water is with slightly alkaline reaction (water pH > 7.5). In the canals, apart from vascular aquatic macrophytes: *Phragmites australis* (Cav.) Trin.ex Steud, *Typha angustifolia* L., *Typha latifolia* L., *Alisma plantago-aquatica* L., *Gratiola officinalis* L., *Lycopus europaeus* L., *Mentha aquatic* L. and *Potamogeton lucens* L., we also found biofouling of the population of the species of

- *Chara hispida*

LOCALITY 2: (coordinates: N 41° 54,019' E 019° 16,557')

HABITAT TYPE: 2190 Humid dune slacks.

This type of habitat is a humid and swampy component of dune ecosystems. It is usually developed in the contact zone of salt water and fresh water: underground salt water come to the surface and mix with fresh water, so as to form brackish water. An important environmental factor for this type of habitat is the seasonal variation in water level. The vegetation is herbaceous type, but the height of the vegetation varies considerably - from a few centimeters to 2.5 m (*Cladium mariscus* (L.) Pohl.). In comparison to other habitats on the beach, this one is characterized by a greater floristic wealth and more coverage. Edificator species of this habitat are *Phragmites australis* and *Cladium mariscus*. The accompanying species are *Gratiola officinalis*, *Lythrum salicaria* L., *Lysimachia nummularia* L., *Alisma plantago-aquatica*, *Juncus articulatus* L., *Potamogeton lucens*, *Vallisneria spiralis* L., *Utricularia vulgaris* L.

The following species of *Charophytes* were identified:

- *Nitella tenuissima*
- *Chara contraria* f. *capillacea*
- *Chara contraria*
- *Chara aspera*
- *Chara globularis*
- *Chara hispida*

LOCALITY 3: (coordinates: N 41° 53,624' E 019° 17,808')

HABITAT TYPE: 2190 Humid dune slacks, with the same floristic composition as in the previous locality.

Apart from the aquatic plants characteristic for this type of habitat, the following one was also present

- *Chara aspera*

in communion with *Potamogeton lucens*, *Vallisneria spiralis*, and *Utricularia vulgaris*.

LOCALITY 4: (coordinates: N 41° 53.449' E 19° 18.091')

HABITAT TYPE: 2190 Humid dune slacks.

This locality includes a large number of smaller puddles. The water in the puddles is clean and shallow, only 50 cm deep, with water temperature 27°C and pH 7.6. Besides vascular aquatic plants typical for this type of habitats: *Phragmites australis*, *Cladium mariscus*, *Typha angustifolia*, *Gratiola officinalis*, *Lythrum salicaria*, *Alisma plantago-aquatica*, *Veronica anagallis-aquatica* L., *Potamogeton lucens*, *Lycopus europaeus*, *Vallisneria spiralis*, *Utricularia vulgaris*, the following species of Charophytes were also present:

- *Chara globularis*
- *Chara aspera*
- *Chara contraria*
- *Chara tenuispina*
- *Chara hispida*

LOCALITY 5: (coordinates: N 41° 53,495' E 019° 18, 648')

HABITAT TYPE: 2190 Humid dune slacks.

This locality includes two deep ponds (up to 1m deep) with edificator plants of this type of habitat: *Phragmites australis* and *Cladium mariscus*, as well as the following types of Charophytes:

- *Chara tenuispina* A. Br.
- *Nitella tenuissima* (Desv.) Kütz.

LOCALITY 6: (coordinates: N 41° 52,279' E 019° 20,299')

HABITAT TYPE: 2190 Humid dune slacks.

Here we have two canals over 1000m long with water depth up to 70 cm and fouling of *Zannichellia palustris* L. and the following *Charophytes*:

- *Chara aspera*
- *Chara vulgaris*

LOCALITY 7: (coordinates: N 41° 52,623 E 019° 21,431)

HABITAT TYPE: 2190 Humid dune slacks.

In this locality we identified a large number of permanent ponds over 1m deep, covering the area of about 1000m<sup>2</sup>. Edificator species are *Phragmites australis* and *Cladium mariscus*. The ponds include typical aquatic macrophytes: *Alisma plantago-aquatica*, *Nymphaea alba* L., *Myriophyllum spicatum* L., *Najas marina* L., *Najas minor* All., *Potamogeton fluitans* Roth., *Utricularia vulgaris* as well as algae from the division of *Charophytes*

- *Chara contraria* f. *capillacea*
- *Chara virgata*
- *Chara vulgaris*

• *Chara globularis*

**Endangerment assessment** of Charophytes, identified in Velika Plaža in Ulcinj (IUCN 2001), relating only to the territory of Montenegro, provided the following categorization:

*Nitella tenuissima* - **CR**. This species is highly endangered since it was identified in only three localities, one of which (Plavnica: Karuse: 1990: 712; Blaženčić et al., 1996: 43,44, 1998:121) was cleared of plants to such an extent that this species has not been found again in that locality in the recent period (2007). In the localities around Velika Plaža in Ulcinj this species is highly endangered and at risk of disappearing due to eutrophication, possible dehydration or fouling of habitat.

*Chara hispida* - **CR (A1c)**. The taxon is extremely endangered, since it was identified only in Otoci in Žabljak (on the mountain of Durmitor) and in three locations in Velika Plaža in Ulcinj, in an area of less than 100 m<sup>2</sup>, with obvious changes in the quality of habitat. It is estimated that the area inhabited by this taxon will gradually decrease over time.

The paper of Blaženčić & Blaženčić (1997) specified that this type has been extinct in Montenegro, however it was still identified afterwards (Leg. Rodrigo, 2007).

*Chara tenuispina* **CR (A1c, B1)**. The species is extremely endangered because its population has been reduced by decline of the occupied areas and its existence at only one place, because the site in Plavnica was completely destroyed.

*Chara virgata* - **VU (A1e, A2e)**. The species will be endangered in the near future due to reduction in its population caused by pollutants and fouling of macrophytes (A1e and A2e)

*Chara aspera* - **VU (B1, B3)**. The species is endangered because it is estimated that the population in the territory of Montenegro is extremely fragmented and that there are distinct variations of environmental factors in the habitats where it grows (temperature, water level fluctuation, drying up of ponds, salinization of habitat etc.).

*Chara globularis* - **LR (nt)**. The species is at low risk and its survival depends on the protection of the habitat against pollutants, fouling and drying up.

*Chara contraria* - **LR (lc)**. The species is at low risk and its survival depends on the protection of the habitat against pollutants, fouling and drying up.

*C. vulgaris* - **LR (cd)**. Low endangerment risk, but it should still be included in the preservation programme specific for Charophytes in order to preserve the species from any possible consequences of eutrophication, algal bloom, spreading of vascular aquatic macrophytes and similar.

In the region of Velika Plaža in Ulcinj Charophytes are found in brackish water of ponds or canals, appearing in the contact zone of fresh surface water and salty

groundwater. Water is with slightly alkaline reaction (pH is about 7.6). An important environmental factor in Charophytes habitats is the seasonal variation in water level.

In their habitats Charophytes are threatened by secondary eutrophization, which reduces water transparency, natural by macrophytes fouling, drying up of habitats, effect of agrochemical substances, uncontrolled tourism activities, etc.

The protection of endangered habitats can be achieved through control and prohibition of the use of water facilities as waste "containers", regulation of tourism activities, education of the population and sanctioning of those who do not comply with the regulations.

### SUMMARY

Within the framework of the biodiversity monitoring for 2012 in the area of Velika Plaža in Ulcinj, the diversity, types and characteristics of algae habitats from the order of *Charales* were studied, endangerment of the identified species was assessed and protection measures were proposed.

Based on the previously known data and the results obtained during the work on the Biodiversity Monitoring Programme in 2012, the following species were found: *Chara aspera*, *C. contraria*, *C. contraria* f. *capillace*, *C. globularis*, *C. hispida*, *C. tenuispina*, *C. virgata*, *C. vulgaris*, *C. intermedia* and *Nitella tenuissima*.

The species of *C. hispida*, *C. tenuispina*, *C. virgata* and *C. vulgaris* were identified for the first time in the puddles in the hinterland of Velika Plaža.

The species of *C. intermedia*, in the territory of Montenegro, was identified only in the puddles in the hinterland of Velika Plaža in Ulcinj.

The habitats where *Charophytes* are found are puddles with brackish and transparent water, with slightly alkaline reaction covered with herbaceous vegetation.

The factors compromising the survival of *Charophytes* and their habitats in the hinterland of Velika Plaža are: intense tourism, urbanization, land filling with waste, fouling, drying out.

Biotope protection can be achieved by installing water treatment devices in points where potential pollutants are discharged, prohibition of waste disposal, permitting tourist activities which do not compromise or threaten the aquatic ecosystems.

Based on the IUCN criteria the endangerment category of *Charophytes* in Montenegro is as follows: *C. tenuispina*, *C. hispida* *N. tenuissimasu* are extremely endangered (CR), *C. virgata* and *C. aspera* are vulnerable (VU), and *C. globularis*, *C. contraria* and *C. vulgaris* are exposed to a low endangerment risk (LR)

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