

**NEW DATA ON FOUR RARE AND THREATENED
CHAROPHYTE SPECIES (*CHARACEAE*,
CHAROPHYCEAE) FROM COASTAL WATERS OF
ALBANIA**

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Abstract

*The present paper provides data on the occurrence, distribution, and ecology of four characean species collected in the central and southern parts of Adriatic coastal area of Albania. The study area includes two of the most important wetland complexes in the country (Divjaka-Karavasta National Park and Pisha Poro-Narta Protected Landscape), known for their rich biodiversity. Fieldwork focused on saline and brackish habitats and was conducted in spring and early summer from 2013 to 2023. The plant material was collected by hand from eleven localities, five of which belong to permanent lagoons, while the other six are temporary wetlands. The most frequent species found in the study area was *Lamprothamnium papulosum* (Wallr.) J. Groves, recorded from seven localities; *Chara canescens* Loisel. and *Chara galioides* DC were recorded from three localities, whereas *Tolypella hispanica* Nordstedt ex T.F.Allen was found at only one locality. The occurrence of *L. papulosum* and *T. hispanica* is reported for the first time in Albania. The findings of *Chara canescens* and *C. galioides* represent new localities for the country. The distribution of all four species in the SE Europe region was summarised according to published records from each country and shown on separate maps.*

Key words: *Charophyceae, Chara, Lamprothamnium, Tolypella, brackish water, Albania.*

Përmbledhje

Punimi ofron të dhëna mbi praninë, përhapjen dhe ekologjinë e katër specieve harofite të mbledhura në pjesën qendrore dhe jugore të zonës bregdetare të

*Adriatikut të Shqipërisë. Zona e studimit përfshin dy nga komplekset ligatinore më të rëndësishme në vend (Parku Kombëtar Divjakë-Karavasta dhe peizazhi i mbrojtur Pishë Poro-Nartë), të njohur për biodiversitetin e pasur. Puna në terren, në habitatet e kripura dhe të njelmëta, u krye në pranverë dhe fillim të verës nga viti 2013 deri në 2023. Materiali bimor u mbledh me dorë në njëmbëdhjetë stacione, pesë prej të cilave u përkasin lagunave të përhershme, ndërsa gjashtë të tjerat janë ligatina të përkohshme. Lloji më i shpeshtë i gjetur në zonën e studimit ishte *Lamprothamnium papulosum* (Wallr.) J. Groves, i regjistruar në shtatë stacione; *Chara canescens* Loisel. dhe *Chara galioides* DC u regjistruan në tre stacione, ndërsa *Tolypella hispanica* Nordstedt ex T.F.Allen u gjet vetëm në një stacion. *L. papulosum* dhe *T. hispanica* raportohen për herë të parë në Shqipëri. Gjetjet e *Chara canescens* dhe *C. galioides* përfaqësojnë vendndodhje të reja për vendin. Përhapja e të katër specieve në rajonin e Evropës Juglindore jepet në harta të veçanta sipas të dhënave të publikuara për secilin vend.*

Fjalë kyçe: Charophyceae, Chara, Lamprothamnium, Tolypella, ujë i njelmët, Shqipëri

Introduction

Charophytes (Charophyceae, Charales) or stoneworts are a worldwide distributed group of benthic submerged macroscopic algae belonging to Streptophyta. Most of Charophytes occur in freshwater, but several species can be found in brackish water, where they can withstand large salinity fluctuations (Winter et al., 1996; Krause, 1997; Soulié-Märsche, 2008). Some of them are halo-tolerant and usually occurs in freshwater but are able to support low salinities, and some others are true halophiles, that need salinity to germinate and grow (Soulié-Märsche, 2008). *Chara canescens*, *Chara galioides*, *Lamprothamnium papulosum* and *Tolypella hispanica* are among charophyte species known as true halophiles (mesohaline or euryhaline) (Lambert et al., 2013).

Despite the results of research in the last two decades, knowledge about charophytes in Albania is still scarce and incomplete. Most of data come from freshwater, while records from brackish water habitats are relatively sparse (Zeneli & Kashta, 2016). To improve knowledge on the occurrence, distribution and ecology of charophytes related to brackish water habitats, we conducted a field study in the central and southern parts of the Adriatic coastal area of Albania in recent years. The main aim of this paper was to document the first record of the occurrence of *Lamprothamnium papulosum* and

Tolypella hispanica in Albania, their morphological characteristics as well as ecological conditions in which they were found, including associated species. In addition, new localities in Albania and ecological data on *Chara canescens* and *C. galioides* are also presented here.

Material and methods

Study area

The study was carried out on two protected areas: Divjaka-Karavasta National Park (40°55'17"N, 19°29'7"E) and Pisha Poro-Narta Protected Landscape (40°34'60"N, 19°24'60"E), located in the central and southern part of the Adriatic coast in Albania (Fig. 1).

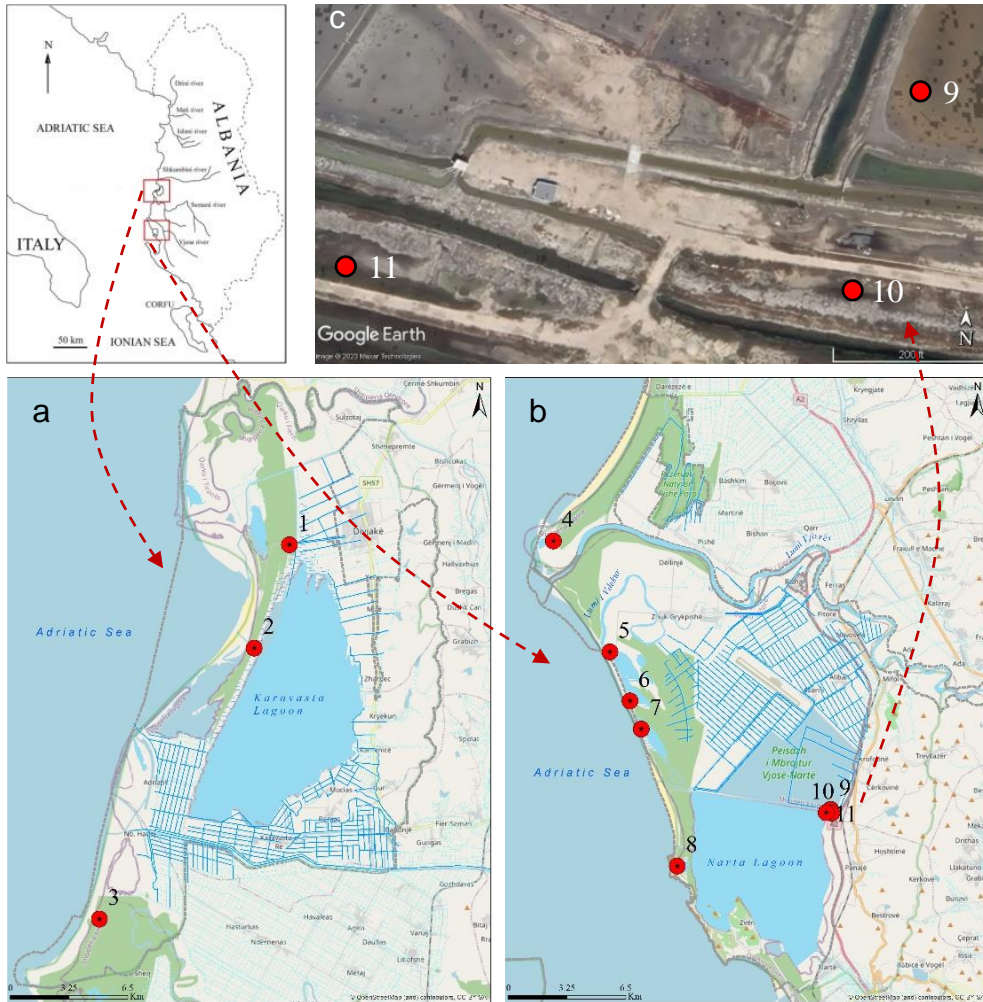


Figure 1. Location of Divjaka-Karavasta National Park (a) and Pishë Poronarta Protected Landscape (b); close view of localities 9, 10, 11 (c). Red dots represent numbered sampling localities: 1 Karavasta lagoon, brackish vernal pool at the entrance to the NP; 2. Karavasta lagoon, near the first channel; 3. Karavasta, temporary brackish water body, south of the lagoon; 4. shallow lagoon; 5. salt marsh north of Kallënga lagoon; 6. Kallënga lagoon; 7. Salty Lake; 8. Limopuo lagoon; 9. abandoned pond of Saltworks; 10. brackish vernal pool between lagoon and Saltworks; 11. temporary brackish waterbody with halophyte vegetation.

The Divjaka-Karavasta NP, spanning 22,230 hectares, includes the largest wetland in Albania. This wetland complex is a designated Ramsar Site, an Important Bird and Plant Area, and finally, a Natura 2000 Pilot Site. The lagoons are the most crucial habitats of the whole complex, comprising up to 6,000 ha, with two main parts, the large Karavasta lagoon (c. 4,200 ha) and the outer Godulla lagoon (850 ha) (Miho et al., 2013).

Pishe Poro-Narta, re-declared Protected Landscape (DCM 694/2022), comprises one of the largest and the most important coastal wetlands of Albania. Of the total area of 16,124.61 ha, 9,600 ha are wetlands, including the Narta lagoon and adjacent Saltworks (4200 ha), the Kallënga lagoon (450 ha), the Salty Lake (60 ha) and the Limopuo Lagoon (30 ha) (Miho et al., 2013). The area is also listed as an important Bird and Plant Area in Albania and is recently being considered among potential Natura 2000 sites as well.

Field and laboratory work

Fieldwork was performed mainly during the spring and early summer (March to June) in the period from 2013 to 2023, on permanent and temporary water bodies: coastal lagoons and peripheral vernal pools, salt marshes and brackish ponds. The plant material was collected by hand from eleven localities (Fig. 1) belonging to the protected areas mentioned above. For each locality, its GPS position was recorded.

Water quality parameters: temperature, pH, conductivity, total dissolved solids, salinity and dissolved oxygen were measured with the multiparametric probe AQUAREAD on the sampling localities during April 24th-26th, 2023 (Tab. 1). Maps of species distribution in SE Europe (Fig. 5) have been compiled using available literature data from each country.

Material identification and measurements were performed under a Motic (BA310) light microscope and a Motic stereomicroscope using fresh material. Specimens were identified using standard identification keys (Krause, 1997; Cirujano et al., 2008; Bazzichelli & Abdelahad, 2009). The scientific names of species follow AlgaeBase. Selected photographs are used to illustrate species and their habitat. Collected plants were preserved as dried specimens and deposited at the National Herbarium of the University of Tirana (TIR), Albania.

Results

Four species of charophytes were found occurring in eleven localities belonging to two types of habitats in relation to hydrological regime: permanent lagoons and temporary water bodies. According to measured environmental parameters (Tab. 1) the water was brackish to saline (salinity from 6.19 to 23.7 g/l) in permanent lagoons (location 2, 4, 6, 7, 8) and slightly brackish to brackish (salinity from 1.08 to 6.73 g/l) in temporary water bodies (location 1, 3, 5, 9, 10, 11).

Table 1. Average values of the physicochemical parameters measured on site during April 24th-26th 2023, with the multiparametric probe AQUAREAD (courtesy from A. Zhori and colleagues, AMBU). The analyses from locality 2 have been performed by Koto et al. (2014) in April 2013.

Locality /Parameter	Measured parameters variation (min-max. value)						
	Date	T (°C)	pH	DO (%)	DO (mg/l)	TDS (mg/l)	Salinity (‰)
Karavasta lagoon (location 2)	April 2013	22.1	8.8	-	8,6	21620	23.7
Small lagoons and ponds (location 4, 5, 6, 7, 8)	4/24/2023	18.2-19.4	8.8-9.6	112.6-124.4	10.26-10.32	7196-23686	6.28-22.99
Temporary ponds, Narta area (location 9, 10, 11)	4/26/2023	17.1-17.8	8.3-8.45	108.25-192.07	10.35-17.62	1386-7690	1.08-6.73

The most frequent species was *Lamprothamnium papulosum*, recorded from seven localities (location 1, 2, 4, 5, 6, 8, and 9). *Chara galioides* was recorded from three localities (location 3, 10 and 11), *Chara canescens* from three (location 3, 7 and 8), whereas *Tolypella hispanica* from only one locality (location 11). The species *L. papulosum* and *T. hispanica*, recorded for the first time in Albania, are briefly described and illustrated using plant material collected from the populations of the study area.

Lamprothamnium papulosum (Wallr.) J. Groves 1916: 337 (Fig. 2)

(new species for Albania)

Monoecious plant, (3)5-10 (14) cm high, usually bright green. Whorls of usually 6-8 branchlets; fertile branchlets are short, and consist of 3-4 segments; each node shows 3-5 verticillate bract cells, longer than the oogonium (Fig. 2c, e, f); sterile branchlets with 2-3 long segments and short bract-cells. The gametangia are conjoined at the two lowest branchlet nodes, with the oogonium pointing downward, below the antheridium; oogonia and antheridia are solitary, rarely geminate (Fig. 2f); oogonia with 9-10 spiral cells. The bulbils are white, spherical, up to 1 mm in diameter.

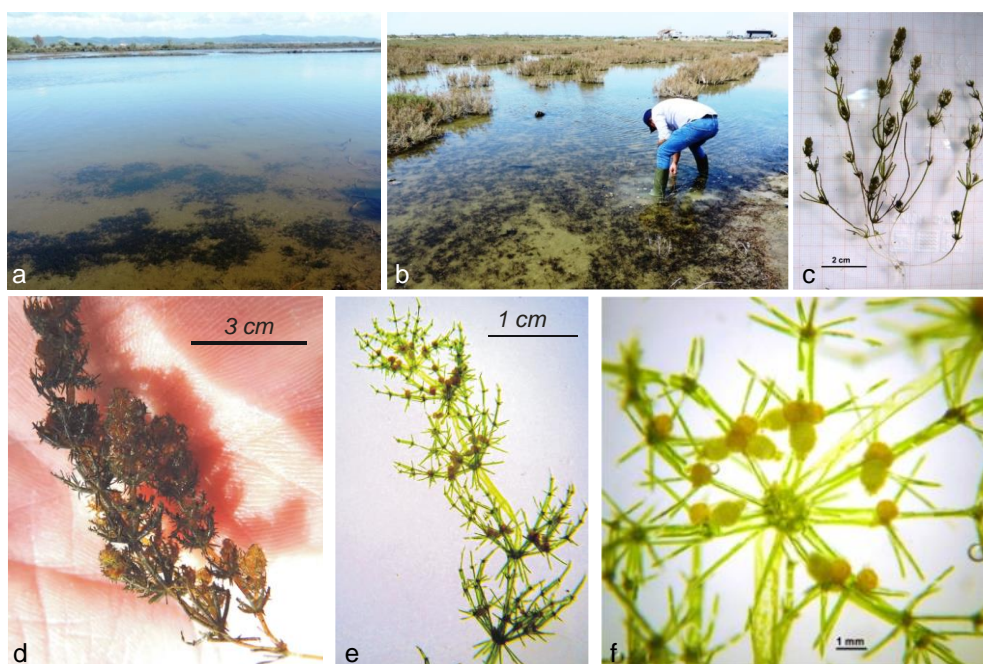


Figure 2. *L. papulosum* in Divjaka-Karavasta NP (a, c) and Pishe Poro-Narta PL (d, e, f): (a) Karavasta lagoon with dense population clusters; (b) salt marsh north of Kallenga lagoon, where *Lamprothamnium* occurs with *Ruppia* sp. and *Althenia filiformis* Petit; (c) whole plant from Karavasta lagoon; (d) fresh specimen brownish in color from salt marsh north of Kallenga lagoon; (e) upper whorls with branchlets and stipulodes; (f) view of a whorl showing conjoined gametangia, including solitary and geminate oogonia and antheridia.

Specimens: Divjaka-Karavasta NP, close to the northern channel of Karavasta lagoon, 40°57'3.75"N, 19°28'34.46"E, in 30-40 cm depth, 12 April 2016, L. Kashta (TIR: K20161, K20162, K20163, K20164); *ibidem*, 20 May 2016, L. Kashta (TIR: K20165, K20166); Divjaka-Karavasta NP, brackish vernal pool at the entrance to the NP, 40°59'24.37"N, 19°29'37.66"E, 7 May 2017, L. Kashta, M. Meço (TIR: K20171, K20172, K20173, K20174); Pisha Poro-Narta PL, shallow lagoon, 40°39'51.69"N, 19°19'23.29"E, 14 May 2020, M. Meço, E. Mahmutaj (TIR: PP 20201); Pisha Poro-Narta PL, salt marsh north of Kallenga lagoon, 40°37'3.53"N, 19°20'51.84"E, 10 May 2022, L. Kashta, M. Meço (TIR: PP20221); Pisha Poro-Narta PL, Kallenga lagoon, south of the Vjosa River estuary, 40°35'56.44"N, 19°21'27.75"E, 15 May 2020, M. Meço, E. Mahmutaj (TIR: Ka20201); Pisha Poro-Narta PL, Limopuo lagoon, 40°32'11.69"N, 19°22'53.13"E, 15 August 2019 (on dried up bottom), L. Kashta (TIR: L20191); *ibidem*, 15 June 2020, I. Nasto (TIR: L20201); Pisha Poro-Narta PL, close to Narta lagoon, abandoned pond of Saltworks, 40°33'25.24"N, 19°27'33.53"E, 7 May 2013, O. Saliaj (TIR: Na20131).

The species was found growing on sandy or sandy-silt bottoms, in the shallow (up to 30 cm) and clear waters of coastal lagoons or lagoon-like habitats (peripheral environments of lagoons, salt marshes and abandoned salt ponds), with a salinity ranging from 6.28 to 23.7‰, and pH value 8.8 to 9.6.

The plants were mostly short, 3-8 cm high; individuals from locality 1 (in shaded situation) were taller (up to 14cm). Specimens we collected in a very shallow salt marsh were brownish in color (Fig. 2d), probably due to high concentrations of carotenoids as an adaptation to excessive light intensity (Küster et al., 2004; Schneider et al., 2006; Wang et al., 2008; Bazzichelli & Abdelahad, 2009).

Tolypella hispanica Nordstedt ex T.F.Allen 1888: 51 (Fig. 3)

(new species for Albania)

Dioecious plant up to 10 (15) cm high, pale green to brownish-green. Axes 0.4 to 0.8 mm in diameter and quite branched, with short internodes, 1-3 times longer than branchlets. Sterile whorls with a few (5-7) undivided branchlets; fertile whorls of 6-10 short branchlets, which tend to form very dense fertile heads, especially on the male plant (Fig. 3c, d), once branched, with node bearing usually three rays, two lateral and one (longer) abaxial (Fig. 3e, f). All end cells are cylindrical and obtuse. Gametangia arranged at the branchlet nodes or at the base of whorls; antheridia big (0.7 - 0.8 mm), reddish, very

abundant and frequently pedunculated; oogonia small (0.4-0.5 mm), brown, visible as black clusters when ripe (Fig. 3f).

Specimens: Pische Poro-Narta PL, temporary waterbody with halophyte vegetation, 40°33'24.09"N, 19°27'17.14"E, male and female plants, 18 April 2015, L. Kashta (TIR: Na20151, Na20152, Na20153); *ibidem*, 19 April 2016, L. Kashta (TIR: Na20161, Na20162, Na20163); *ibidem*, male plant, 31 March 2018, L. Kashta (TIR: Na20181); *ibidem*, male plant, 16 April 2023, L. Kashta (TIR: Na20231).

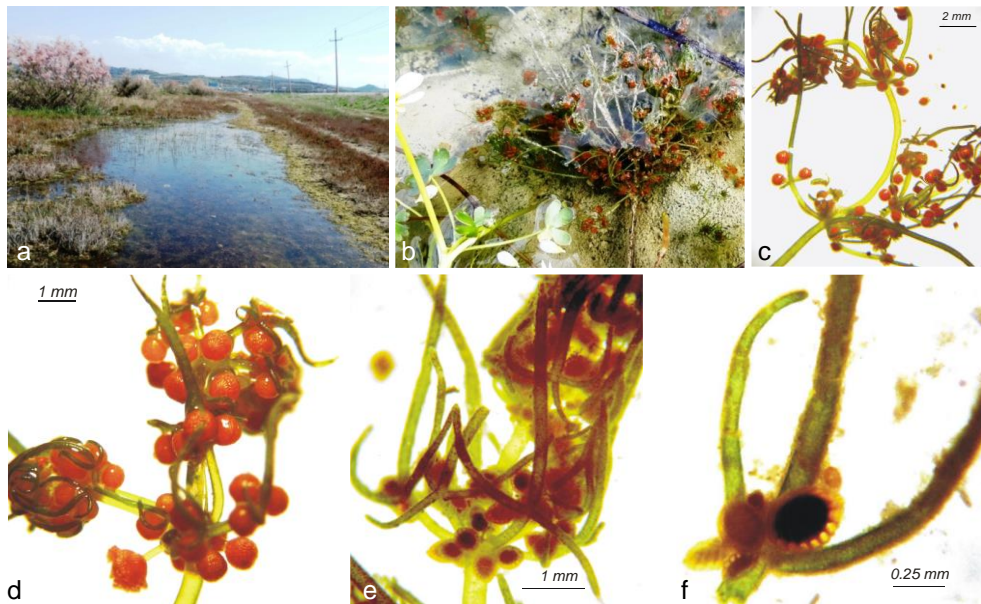


Figure 3. *T. hispanica* from Narta lagoon area: (a) the habitat, a temporary brackish waterbody; (b) male plant associated with *R. peltatus* subsp. *baudotii* (Godr.) Meikle ex C.D.K.Cook and *C. galioides*; (c) a part of male plant showing axis and nodes with fertile branches and branchlets; (d) apical part of a male plant with abundant big red antheridia at the base of whorls and at nodes of branchlets; (e) apical part of a female plant with oogonia at the branchlet nodes and at the base of whorls; (f) a branchlet of female plant with oogonia at different ripening stages.

Tolypella hispanica has only been detected in a small, shallow (5-15 cm depth) waterbody situated between the Narta Lagoon and Saltworks (location 11), surrounded by halophytic vegetation dominated by *Sarcocornia* sp.). The habitat represents a flooded depression that is maintained exclusively by

rainwater supply and usually dries up by the end of April. According to measurements performed in April 2023, the water was brackish (salinity 6.73 ‰ and pH value 8.32). All the plants we observed, both male and female individuals, were richly fertile, with numerous antheridia and oogonia (Fig. 3c, d, e).

Chara galioides De Candolle 1813: 93

(Fig. 4a, b, c, d)

(new records on species occurrence in Albania)

Specimens: Divjaka-Karavasta NP, temporary waterbody in the south of the lagoon, 40°50'54.77"N, 19°23'56.44"E, 10 June 2017, L. Kashta (TIR: K20175); Pische Poro-Narta PL, brackish vernal pool between lagoon and Saltworks, 40°33'23.08"N, 19°27'30.43"E, 27 April 2013, L. Kashta (TIR: Na20130); *ibidem*, 1 April 2015, L. Kashta (TIR: Na20150); *ibidem*, 20 April 2016, L. Kashta (TIR: Na20165); Pische Poro-Narta PL, temporary water body with halophyte vegetation, 40°33'24.09"N, 19°27'17.14"E, 30 March 2018, L. Kashta (TIR: Na20183).

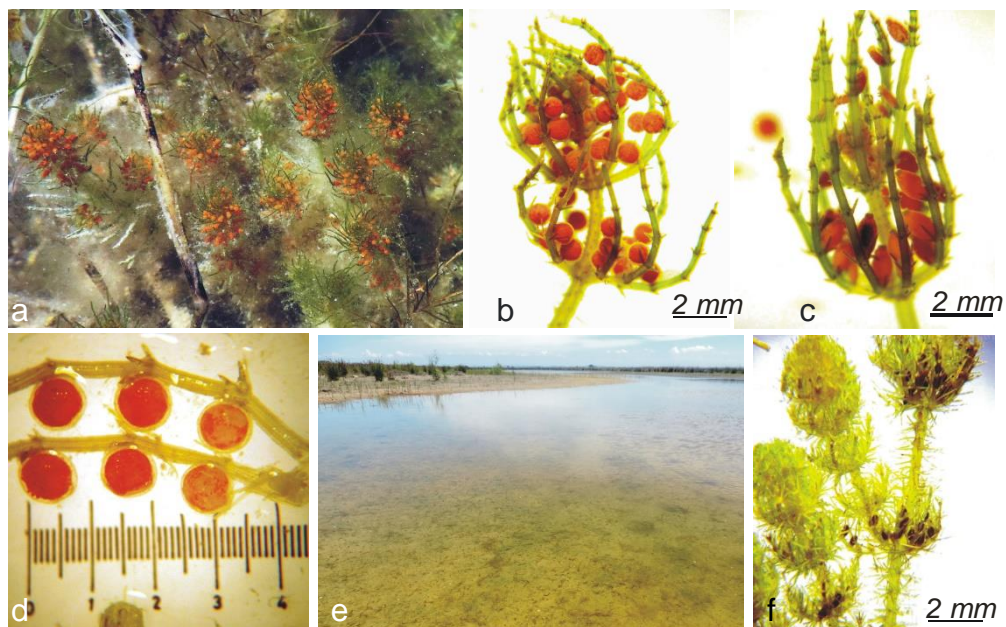


Figure 4. *Chara galioides* from Pische Poro-Narta PL (a, b, c, d) and *Chara canescens* from Divjaka-Karavasta NP (e, f): (a) view of the plant growing in a vernal pool; (b) apical part of a male plant showing strong curvature of branchlets and antheridia; (c) apical part of a female plant with oogonia; (d)

view of two branchlets with antheridia (800-900 μm); (e) the habitat, a temporary waterbody close to the sea; (f) apical part of a female plant with ripe oogonia.

C. galioides (both male and female individuals) was found in shallow (20 to 30 cm depth) brackish temporary waters with salinity ranging from 1.08 to 6.73‰ and pH value 8.32 to 8.45. The strong curvature of branchlets (Fig. 4b, c) seems to be an adaptative response to strong vertical light (Schneider et al., 2006; Muller et al., 2017).

Chara canescens Loisel. 1810: 139

(Fig. 4e, f)

(new records on species occurrence in Albania)

Specimens: Divjaka-Karavasta NP, temporary brackish waterbody on sandy coastal soils, 40°50'54.77"N, 19°23'56.44"E, 10 June 2017, L. Kashta (TIR: K20176, K20177); Pisha Poro-Narta PL, Salty lake, 40°35'18.06"N, 19°21'48.17"E, 16 May 2020, M. Meço, E. Mahmutaj (TIR: S20201); Pisha Poro-Narta PL, Limopuo lagoon, 40°32'11.69"N, 19°22'53.13"E, 15 August 2019 (on dried up bottom), L. Kashta (TIR: Na20193); *ibidem*, 12 June 2020, M. Meço, E Mahmutaj (TIR: L20201, L20202); *ibidem*, 15 June 2020, I. Nasto (TIR: Na 20200).

Only female plants, up to 20 cm high, were found. The specimens collected in early June were with ripe (black) oogonia (Fig. 4f).

Discussions

The study present data related to occurrence and ecology of four charophyte species closely linked to brackish habitats. *Lamprothamnium papulosum* is known as characteristic species for habitats with fluctuating salinity (Soulié-Märsche, 2008), occurring from oligohaline to polyhaline water, in coastal lagoons, small waterbodies, salt marshes, and in Spain also in inland brackish water lakes (Corillion, 1957; Guerlesquin, 1992; Krause, 1997). In our study area *L. papulosum* was found in shallow parts of permanent lagoons (four localities) and temporary water bodies (three localities). The best developed stands were observed in Karavasta lagoon, where the species grows associated with *Ruppia* sp.

Most often this species occurs together with other halophilic Characeae such as *Chara galioides*, *C. canescens*, *Tolypella hispanica* (Guerlesquin, 1992), and among the Angiosperms, with *Ruppia* sp., *Zannichellia pedunculata* Rchb. and *Althenia filiformis* (Corillion, 1975; Guerlesquin, 1992;

Mouronvalet et al., 2009). In the investigated area *L. papulosum* commonly appears together with *Ruppia* sp. and *Althenia filiformis*. Other accompanying species found in different localities were: *Chara canescens*, *Zannichellia pedunculata* and *Riella macrocarpa* (P. Allorge) Puche, Segarra-Moragues, Sabovlj., M. Infante et Heras. In the Mediterranean region, *L. papulosum* sometimes forms widespread mono-specific populations (Guerlesquin, 1992; Mouronval et al., 2009); similarly, we found it forming mono-specific stands at only one locality, a vernal pool in peripheral of Karavasta lagoon wetlands.

The only Albanian locality of *T. hispanica* is a temporary brackish wetland characterized by winter and spring flooding and complete drying by the end of April; these ecological conditions are consistent with the habitat preferences of the species; it is known as early-spring to spring species which grows in hypohaline and mesohaline waters (Cirujano et al., 2013) and colonizes the edges of lakes, salt marshes, ponds and other shallow endorheic seasonal wetlands (Corillion, 1957; Grillas, 1990; Krause, 1997; Muller et al., 2017).

The composition of the associated species we recorded (*Chara galioides*, *Ruppia* sp., *Ranunculus peltatus* subsp. *baudotii*, *Zannichellia pedunculata* and *Althenia filiformis*) seems to differ slightly from the literature data; for example, from a vernal pool of the Rhone delta (southern France), *T. hispanica* has been recorded together with *Chara aspera* / *galioides*, *Tolypella glomerata* (Desv.) Leonh., *Ranunculus peltatus* subsp. *baudotii* and *Zannichellia pedunculata* (Muller et al., 2008); in Spain, it can appear in association with *Tolypella salina* R. Cor. and *T. glomerata* (Cirujano et al., 2013).

Chara canescens is a heliophilous species growing in both seasonal and permanent brackish water habitats (Krause, 1997; Schaible & Schubert, 2008), usually shallow, due to its need for light (Küster et al., 2004). In our study area it was found in shallow brackish water, growing associated with *Ruppia* sp. and *L. papulosum* (Limopuo Lagoon), with *Althenia filiformis* and *C. galioides* (temporary waterbody in Divjaka-Karavasta NP), or *Chara aspera* and *Bolboschoenus maritimus* (L.) Palla (in Salty Lake). *C. canescens* has previously been recorded in slightly brackish water ponds, forming monospecific stands or associated with *Chara aspera* L., *Chara baltica* Bruz., and *Tolypella glomerata* (Zeneli & Kashta, 2016). Similar data have been reported from the Baltic Sea (Blindow & Schubert, 2004),

Chara galioides is a thermophilous brackish-water species and develops in shallow, often temporary wetlands that warm up very quickly (Corillion, 1975; Flor-Arnau et al., 2006). In our study area it grows on sandy and muddy-clay

substrate, in temporary ponds 20 to 30cm deep, together with other macrophytes: *Chara canescens*, *Tolypella hispanica*, *Althenia filiformis*, *Ruppia maritima*, *Riella macrocarpa*, *Ranunculus peltatus* subsp. *baudotii* and *Zannichellia pedunculata*. This species has already been recorded from the northern coastal area of Albania together with *Chara aspera*, *C. baltica*, *C. canescens*, and *Tolypella glomerata* (Zeneli & Kashta, 2016). A similar species composition has also been reported from other parts of the Mediterranean: in southern France *C. galioides* grows with *Chara baltica*, *Tolypella nidifica*, *T. hispanica*, *T. glomerata*, or with *L. papulosum* or *C. canescens* (Krause, 1997); in Greece it is reported together with *C. canescens* and *T. hispanica* (Raabe & Koumpli-Sovantzi, 2000), with *C. aspera* (Langangen, 2004), or with *Ruppia maritima* (Bergmeier & Abrahamczyk, 2008).

The four species reported in this study are currently rare throughout SE Europe and classified as threatened in this region: *C. galioides* and *T. hispanica* as critically endangered (CR), *L. papulosum* as endangered (EN) and *C. canescens* as vulnerable (VU) (Blaženčić et al., 2006).

Lamprothamnium papulosum has been recorded in Bulgaria (Temniskova et al., 2008), Croatia (Blaženčić et al., 1998) and Greece (Koumpli-Sovantzi, 1997; Raabe & Koumpli-Sovantzi, 2000; Christia et al., 2011; Langangen, 2004, 2007, 2008, 2010b, 2013, 2014) (Fig. 5).

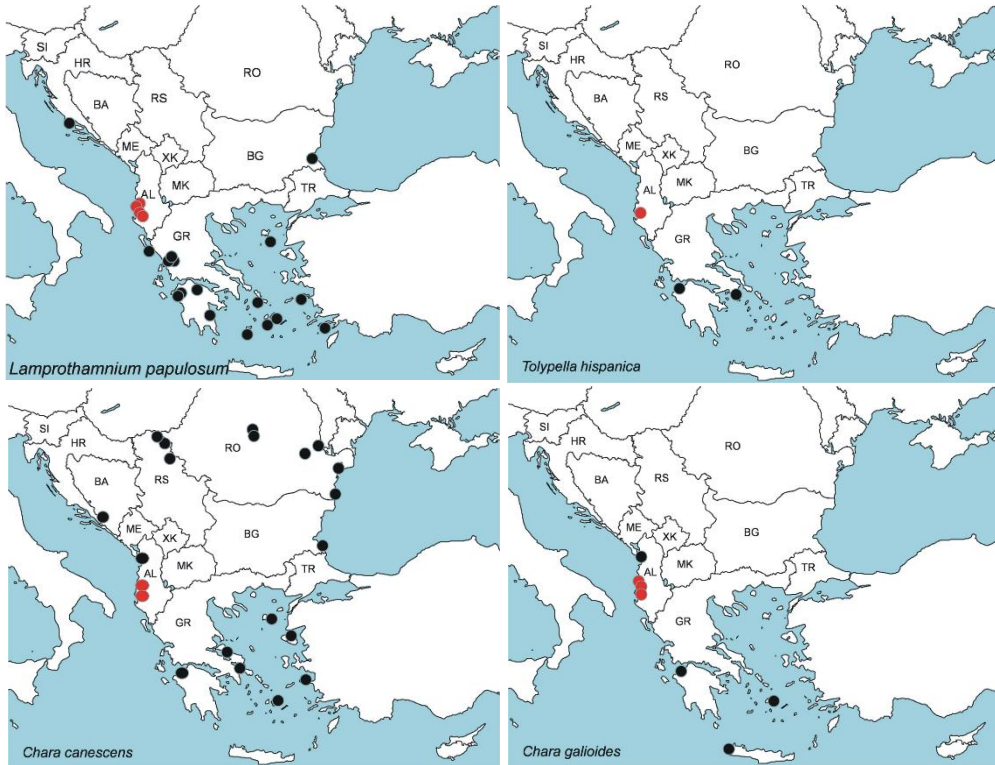


Figure 5. Distribution of *L. papulosum*, *T. hispanica*, *C. canescens* and *C. galioides* in SE Europe based on literature and our data. Black dots - previous records, red dots – new records (this paper). (Abbreviations according to Eurostat Country codes: AL - Albania, BG - Bulgaria, BA - Bosnia and Herzegovina, HR - Croatia, GR - Greece, ME - Montenegro, MK - North Macedonia, SI - Slovenia, RS - Serbia, RO - Romania, XK – Kosovo).

Tolypella hispanica is a rare species with range mainly restricted to the western Mediterranean region: Iberian Peninsula (Cirujano et al., 2008; Cirujano et al., 2013), France (Muller et al., 2008), Italy (Bazzichelli & Abdelahad, 2009), and NW Africa (Muller et al., 2017). In SE Europe it has only been recorded in Greece (Koumpli-Sovantzi, 1997; Raabe & Koumpli-Sovantzi, 2000; Blaženčić, 2006) (Fig. 5).

Chara galioides occurs mainly in Mediterranean region, with a few populations outside this area (Krause, 1997; Flor-Arnau et al., 2006; Cirujano et al., 2008). In SE Europe, it is recorded only in Greece (Blaženčić et al.,

2006) including Crete (Bergmeier & Abrahamczyk, 2008) and in northern coastal area of Albania (Zeneli & Kashta, 2016) (Fig. 5).

Chara canescens has a larger distribution area than the other three species in SE Europe; it has been recorded in Albania (Zeneli & Kashta, 2016), Bosnia and Herzegovina (Blaženčić et al., 1998), Bulgaria (Temniskova et al., 2008), Greece (Koumpli-Sovantzi, 1997; Raabe & Koumpli-Sovantzi, 2000; Langangen, 2004, 2008, 2010a, 2014; Christia et al., 2011), Romania (Blaženčić et al., 2006; Caraus, 2012) and Serbia (Trbojević et al., 2019; Marković, 2022) (Fig. 5). Albanian populations, like most of them in Europe (Küster et al., 2004; Schaible & Schubert, 2008), contain only parthenogenetic females. The first finding of male plants in the region was reported from Serbia recently (Marković, 2022).

Conclusions

The four species identified in this study occur in similar environmental conditions to those previously reported in the Mediterranean region. Two of them (*Lamprothamnium papulosum* and *Tolypella hispanica*) are new to Albania, while two others (*Chara canescens* and *Chara galioides*) are rare taxa in the country. Our findings of *L. papulosum* expand the knowledge about the geographical distribution of the species in SE Europe. Of particular interest from a biogeographical point of view is the discovery of *Tolypella hispanica* in Albania. In SE Europe it has only been recorded in Greece. Our findings of *C. canescens* and *C. galioides* represent new records for the country, extending its known distribution range southwards along the Adriatic coast.

Given the distribution range of the four species presented in this paper and their conservation status in SE Europe, we believe that our results are of interest to the characean flora beyond the national level. In addition to the need for further studies on the distribution and ecology of these rare and threatened species in other suitable coastal areas of Albania, their known habitats should be closely monitored.

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Author contribution statement

Lefter Kashta conducted the main field research and study of specimens. Ermelinda Mahmutaj and Marjol Meço performed additional collections. LK drafted the manuscript and all authors contributed to the writing of the final version.

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