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*Original research***A new stonewort record for Turkey: *Chara polyacantha* A. Braun**Evren CABI^{1,*}, Fatoş ŞEKERCİLER¹, Burçin ÇİNGAY², Nesibe TURAN³¹Department of Biology, Faculty of Arts and Sciences, Namık Kemal University, Tekirdağ, Turkey²Nezahat Gökyiğit Botanic Garden, Science Departments, Atasehir, Istanbul³T.R. Ministry of Forestry and Water Affairs, Directorate General for Water Management, Ankara, Turkey

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Abstract: The charophyte flora of Turkey is poorly described and documented as lack of accurate and detailed documentation of collections as well as absence of voucher specimens proving its existence. During the project which is called as “Establishment of Reference Monitoring Network in Turkey” supported by Directorate General for Water Management of the Ministry of Forestry and Water Affairs, we carried out several field surveys to the West Mediterranean Region and collected several *Chara* and *Nitella* specimens from the various water bodies found in the region. Among the collected Charophyte populations, two unusual populations seem to be different than the ones we already met earlier. Careful morphological and microscopically examinations of the unusual populations proved that they were new for Turkey algal flora. Finally they were identified as *C. polyacantha* which was already known from Europe. The diagnostic morphological characters discriminating it from of *Chara hispida* *C. rubis* and *C. aspera* are pointed out. Notes are presented on its ecology and phenology. A distribution map of this species is also given.

Keywords: *Chara*, Characeae, Dalaman, Köyceğiz Lake, Muğla

Citing: Cabi, E., Şekerciler, F., Çingay, B., & Turan, N., 2019. A new stonewort record for Turkey: *Chara polyacantha* A. Braun. *Acta Biologica Turcica*, 32(4): 206-210.

Introduction

Charophytes are aquatic, cryptogamic, rooted plants with a macroscopic thallus. Characeae family of algae is characterized by the complexity of their morphological features, including the structure of their gametangia and their axis differentiated into nodes and internodes (Picelli-Vicentini et al. 2004). Many species in Characeae are similar to each other and they frequently misidentified without detailed microscopic examination (Urbaniak and Gabka 2014). These algae are considered the closest living relatives of land plants (Karol et al. 2001). They also have important ecological role in aquatic ecosystems. They are positively correlated with water transparency. They are important in nutrient cycling, supply nutrient for zooplankton and phytoplankton, and influence these organisms' biomasses (Coops 2002, Kufel & Kufel 2002,

Schwarz et al. 2002, van Donk & van de Bund 2002, Rodrigo et al. 2007, Meurer and Bueno 2012).

The genus *Chara* L. is represented about 188 species and is distinguished by erect corticated axes and a five-celled coronula at the apices of the female gametangia. They usually encrusted calcium and magnesium carbonate because they usually prefer hard fresh water, rich in organic matter and calcium. *Chara* species emit strong musky odor due to presence of sulphur compounds (Meurer and Bueno 2012, Duncan and Rouse-Miller 2017). In Turkey, Barinova et al. (2014) reported that there are 13 *Chara* species except *C. polyacantha* A. Braun.

Chara polyacantha A. Braun constitute extremely rare associations and its current distribution is restricted in Europe. It was recorded in Germany, Poland, Denmark, Sweden, France, Portugal, Czech Republic and the

Balkans. The species is more frequently recorded in central Ireland than Europe (John et al. 2002). The species usually grows in shallow zones of mesotrophic lakes or peat excavation ponds, rarely in rich fens. The depth range is limited up to 1.5 m, it is recorded from 6 m in Poland. *C. polyacantha* prefers waters rich in Ca⁺, Mg²⁺ and SO²⁻ or grows on mineral substratum and on calcareous bottom deposits with low concentrations of nutrients and high values of electrolytic conductivity (Zviedre and Grinberga 2012). In Norway, *C. polyacantha* is evaluated under threatened because of eutrophication and technical intervention of waters (Langangen & Asen 1996).

During the vegetation survey in the summer of 2017, a new charophyte species for Turkey *C. polyacantha* was recorded in Köyceğiz Coastal lake and Dalaman Wetlands. This is the first record of this species in Turkey, which is confirmed by herbarium material. Herbarium sample of *C. polyacantha* is stored at the Nezahat Gökyiğit Botanic Garden Herbarium (NGBB).

Materials and Methods

Description of the Study Site

Chara polyacantha was recorded in Köyceğiz Coastal lake and Dalaman Wetlands of the Muğla province located in southwestern Turkey. Both water bodies fed by fresh waters and they are released from slightly salty water with the rising tide.

Lake Köyceğiz, sixteenth biggest lake of Turkey, with a surface area of 55 km² is a meromictic lake. The lake comprises of two basin. The maximum depth in the northern part (Köyceğiz Basin) is 24 m and in the southern part (Sultaniye Basin) is 32 m. Totally, estimated volume of the lake is 826 million m³. According to Bayari et al. (1995), there is a thermocline layer at a depth of 10 m and oxygen-free, stagnant, dead water body at a deeper zone of the lake. The lake, having specific geological structure with impermeable ophiolitic rocks, groundwater bearing alluvium and karstified limestone is connected to the Mediterranean Sea with a 14 km long natural channel. Köyceğiz lake, fed mainly by rainfall and stream surface flow and ground water recharges from alluvial aquifer and discharges from sulphuric thermal springs located at the bottom of the lake (Kazancı and Girgin 2001, Bayari et al. 1995).

Dalaman Wetlands is one of the richest regions in Turkey in terms of both ecosystem and species diversity. The wetland, located in the southwest of Köyceğiz Lake,

is within natural site boundaries. In addition, it is classified as an Important Nature Area (INA) and Special Protected Area (SPA) due to ecological features, and the endemic and endangered species found in the region. The Dalaman wetland area (Muğla, Turkey) consists of 3 lakes (Kocagöl, Tersakan, and Kükürtlü), 3 rivers (Dalaman, Sarısu, and Tersakan) and the beaches of Dalaman and Sarıgerme (Aslan et al. 2011). The lakes and rivers of the wetland basin, that are habitat of *C. polyacantha* consist of reed bed, water drainage channels, marshes and saline-alkaline areas.

Typha latifolia L., *Arundo donax* L., *Juncus maritimus* Lam. emerged species and *Stuckenia pectinata* (L.) Börner and *Myriophyllum verticillatum* L. submerged macrophytes were identified in the aquatic vegetation of the Lake Köyceğiz and Dalaman Wetland besides *C. polyacantha* (Figure 1).

Sampling

Charophyte samples were collected by grapnel from the bottom of the Köyceğiz Lake and Dalaman wetland. First, collected plants were placed in plastic bags filled with water to protect against drying. Then the collected specimens pressed quickly. Some collected specimens were fixed in 5% alcohol solution for longer preservation. Field information including the date, locality, habitat type and the name of the collector were noted. Collected specimens transported to the Namık Kemal University for identification. Part of the samples studied under a Nikon light microscope and Leica stereomicroscope with digital cameras under magnification \times 100-1000. The certification type of the specimens were checked by cutting the plant across the plant axis diameter using a lancet.

Results

Chara polyacantha A. Braun, 1859

Synonyms: *C. hispida* var. *dasyacantha* A. Braun 1847, *C. hispida* var. *hispida* f. *polyacantha* (A. Braun) R.D. Wood 1962, *C. hispida* var. *polyacantha* (A. Braun) C.C. Babington 1874, *C. pedunculata* Kützing 1834, *C. polyacantha* f. *dasyacantha* W. Migula 1897, *C. pseudo-crinata* A. Braun 1935, *C. spondylophylla* Kützing 1843.

Type: Sweden (Silva 1996-to date). Notes: Salzsee bei Halle (Bulnheim) (INA).

The plants are 40-100 cm long, axis is 1.5-5 mm in diameter, and encrusted, robust, color varies from grey to

light green. Internodes 2-3 times longer than the branchlets. The branchlets are 8-10, each with 6-9 segments, the upper 2-3 are ecorticated (without cortex). The stem cortex is diplostichous, sometimes irregular: triplostichous or isostichous, the primary rows always prominent, strongly tylacanthous. The spine cells are commonly in bunches, same long or longer than the axis diameter. Prominent spine cells dense along the axis especially upper parts and younger internodes. The stipulodes are well developed in both rows, the cells in the upper and lower row are equal length, usually as long as the axis diameter. The bract cells are 5-7. The bracteoles are longer than the oogonium. The species is monoecious. Gametangia are conjoined at the lowest branchlet nodes. The oogonium is 900-1000 long 500-600 μm wide. The oospores are dark brown to black. Antheridia are solitary and 300-500 μm in diameter (Figure 2).

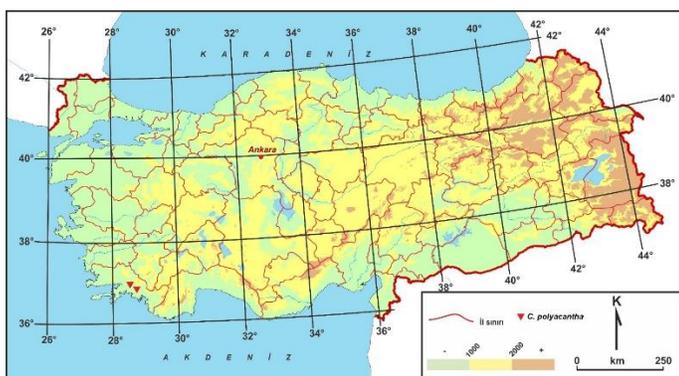


Figure 1. Distribution Map of *Chara polyacantha* in Turkey

Taxonomic Relationships: — *C. polyacantha* is morphologically different from all other Turkish *Chara* species. Its closest relative appears to be *C. rudis*, *C. hispida*, *C. aspera* from which the new record species differs by many remarkable morphological differences (Table 1).

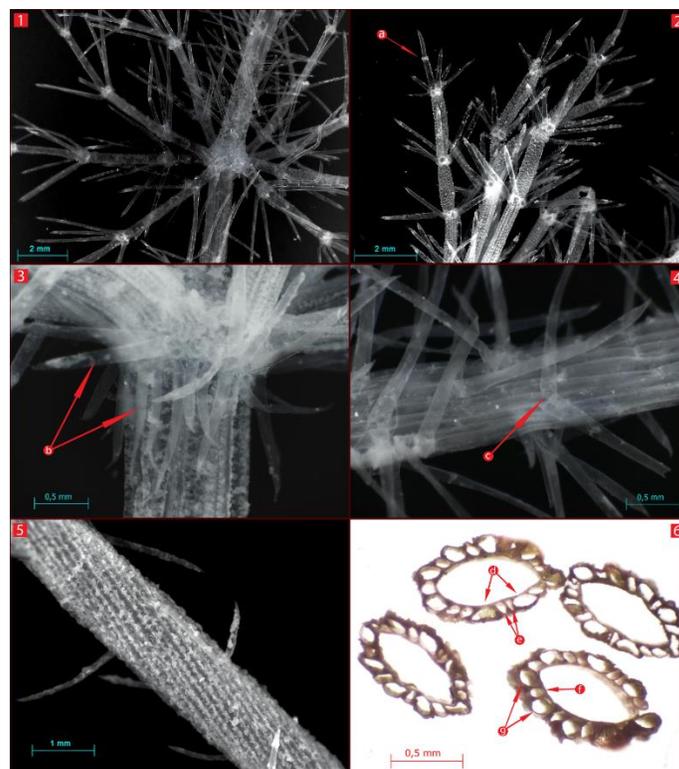


Figure 2. Morphology of *Chara polyacantha*: 1-whorl of branchlets, 2a-ecorticated last cells, 3b-stipulodes, 4c-spine cells in bunches and strongly tylacanthous, 5-corticated axis (diplostichous) 6-cortification: d, g-primary rows, e,f-secondary rows (cortification irregular, sometimes triplostichous or isostichous).

Discussion

In Turkey, Barinova et al. (2014) reported that there are 13 *Chara* species except *C. polyacantha*. This is the first record of *C. polyacantha* in Turkey, but possibly more localities may be recorded in future.

Acknowledgements

This study was supported by the Directorate General for Water Management of the Ministry of Forestry and Water Affairs. We would like to thank the executives and the staff of Çınar Engineering Ind. Trade. Co. Ltd who executed the project.

Table 1. Diagnostic morphological characteristics of *Chara polyacantha*, *C. rudis*, *C. hispida* and *C. aspera*

Characters	<i>C. polyacantha</i>	<i>C. rudis</i>	<i>C. hispida</i>	<i>C. aspera</i>
Length	30-70 cm	20-50 cm	15-80 cm	10-20 cm
Axis	1-5 mm in diam	1-3 mm in diam	1-5 mm in diam	0.5-2 mm in diam
Internodes	As long as or longer (up to 2 times) than branches	2-3 times longer than branches	As long as or longer (up to 2 times) than branches	Longer than branches
Branchlets	8-10 in a whorl	7-10 in a whorl	7-10 in a whorl	6-7 in a whorl
End segments	2-3 celled ecorticated	2-3 celled ecorticated	1-2 celled ecorticated	1-2 celled ecorticated
Cortex	Diplostichous, (usually irregularly triplostichous or isostichous)	Strongly Diplostichous	Diplostichous (sometimes isostichous)	Triplostichous (sometimes isostichous)
Spine cells	Thylacanthous Often in bunches	Aulacanthous in pairs sometimes in bunches	Aulacanthous Solitary or bunches (2-4 together)	Thylacanthous Solitary
Spine cells	Same long or longer than the axis diam. Dense along the axis	shorter than axis diam. Rare, more intense in upper parts	Same long, longer or shorter than axis diam. Rare or dense, more intense in upper parts	Same long the axis diam. Vary dense to sparse
Stipulodes	2 row, both similar length	2 row, both similar length	2 row, both similar length, (not exceed axis diam).	2 row upper longer than lower
Reproduction	Monoecious	Monoecious	Monoecious	Dioecious
Bract cells	5-7	5-6	5-7	5
Gametangia	At lowest branchlet nodes	On corticated branchlet nodes	At lowest branchlet nodes	At lowest branchlet nodes
Bract cells	Anteriors 2 times longer than mature oogonia, posteriors shorter than oogonia	Anteriors shorter than oogonium, posteriors often rudimentary	Anteriors as long as or longer than mature oogonium, posteriors rudimentary	Anteriors longer than mature oogonia, posteriors shorter
Oogonia	900-1000 µm long 500-600 µm wide	700-1010 µm long 400-860 µm wide	505-1100 µm long 420-875 µm wide	545-905 µm long 400-600 µm wide
Antheridia	300-500 µm in diam	360-470 µm in diam	390-630 in diam	355-570 µm diam

Key to the new record and related taxa

1. - Plant dioecious; Triplostichous; spine cells solitary.....*C. aspera*
- Plant Monoecious; Diplostichous (sometimes irregular corticated); spine cells usually in bunches sometimes solitary.....2
2. - Thylacanthous cortification; spine cells longer than axis diameter, dense along the axis especially upper parts.....*C. polyacantha*
- Aulacanthous cortification, spine cells in furrows.....3
3. - Anteriors bract cells shorter than oogonium.....*C. rudis*
- Anteriors bract cells as long as or longer than mature oogonium.....*C. hispida*

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