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## - Short communication -

# Aberrant haplostichous cortication of *Chara tomentosa* – another argument for matrix keys

## Abstract

A population of *Chara tomentosa* with haplostichous cortication was found in Sardinia (Italy). Correct identification by means of the characters used by common keys would be impossible, the specimens would have been regarded as *C. canescens* irrespective of the fact that *C. tomentosa* exhibit a unique character (two celled rows of branchlet cortex at the lowermost section). This note is a plea for keys allowing for identification by means of all characters in parallel instead of the commonly used hierarchical ones at least as an addition for the determination of untypical or non-fertile specimen.

**Keywords:** Charophytes, cortication, determination key, aberrant morphology, brackish water

## Observation and conclusions

*Chara tomentosa* L. 1753 is regarded as one of the few charophyte species, which can be identified easily by its habitus already (e. g. TORN 2024). Experienced botanists will recognise this species already from distance by its typical reddish colour of the top sections of the tall and robust plant (e. g. MIGULA 1889-1897) and just check for the typical swollen and segments of branchlets (for a full description of the species see TORN 2024; TORN et al. 2004). Variability of the taxon known so far is rather restricted to spine density and length; non-fertile and deep-water specimen may appear greenish and/or elongated (TORN 2024).

Consequently, the species is keyed out in all hierarchical determination keys of the genus *Chara* along a rather simple path of characters: diplostephanous – completely corticated – diplostichous – dioecious with just slight variations in the order of characters or respecting also for size and color as additional hints (e. g. KRAUSE 1997; VAN DE WEYER et al. 2024). Also MIGULA (1889-1897), describing a large number of morphological variants, distinguishes them mainly by size of plant, spines and bract-cells and bracteoles.

During fieldwork in Sardinia, the authors found specimens largely deviating from the known range of morphological variability of *C. tomentosa*. The investigation was conducted in a temporary brackish endorheic pond called Pauli Murtas (Fig. 1) (Province of Oristano, 40.0030°N, 8.4640°E (WGS 84)), on 14 May 2024. The basin is located 7 meters above sea level. The maximum extension exceeds the 25 ha; the internal part, free of helophytic vegetation, occupies more than half of this surface. At the time of the inspection, due to the low rainy season and the natural drying out in spring, the surface occupied by water did not exceed 6 ha. A small population of charophytes extended over approximately one sixth of the submerged surface, with plant cover less than 1 %. The pond water conditions were extreme in terms of conductivity (63 mS cm<sup>-1</sup>, which is about 43 PSU), maximum depth (10 cm) and temperature (29.6°C at 3 p.m.) and the individuals were abundantly covered in filamentous algae.



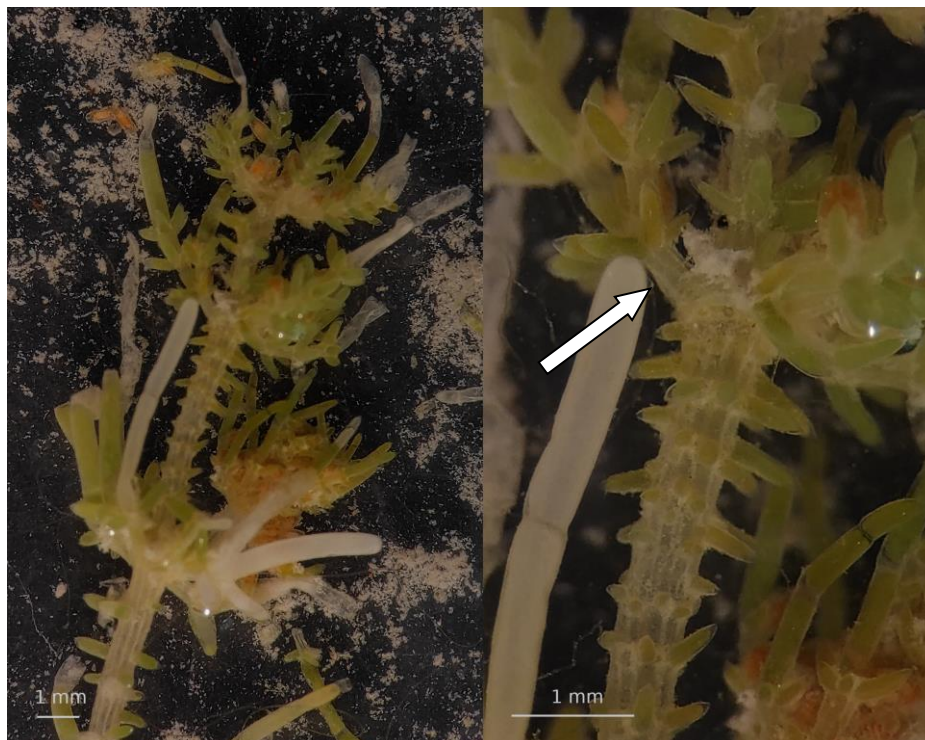
**Fig. 1** Pauli Murtas pond (Oristano, Sardinia) close to drying up mid-May 2024.

Despite all this, populations of *C. aspera* and *C. canescens* were found in this basin, together with *Chara* sp. individuals which could not be identified by their habitus in the field. Microscopic identification revealed clearly haplostichous cortication of diplostephaneous, dioecious individuals (Fig. 2) which, by means of all European keys in use known to the authors (HOLLERBACH & KRASAVINA 1983; KRAUSE 1997; VAN DE WEYER et al. 2024), would guide to *C. canescens*. Moreover, a check by the description of *C. canescens* (MIGULA 1889-1897; KRAUSE 1997; BLINDOW & SCHUBERT 2004; SCHUBERT et al. 2016a, 2024a) would not result in serious doubts about the correctness because large variability is described with respect to size as well as spine, stipulode and bract-cell/bracteole appearance; the combination of being dioecious and having haplostichous cortication highlighted as a unique set of characters allowing for reliable identification.

Only the extremely swollen end segments of the branchlets, and the fact that male individuals were observed, raised some concerns about the identification of the specimens. Male specimens of *C. canescens* are very rarely found, an overview about the recently published bisexual populations is given by SCHUBERT et al. (2024). On the other hand, NOWAK et al. (2019) found such a bisexual pop in Sardinia, so this

occurrence would have been possible. Swollen end segments are a common feature for brackish water stands of halotolerant species (SCHUBERT & BLINDOW 2004). Consequently, the fact that a description of this feature for *C. canescens* is lacking would not raise major concerns.

Here it was a character ignored so far for determination which allowed correct identification of the specimen as *C. tomentosa*: double-celled cortication of the lowermost branchlet sections (Fig. 2, right panel). This character is unique for *C. tomentosa* and not found in any other *Chara*-species so far (SCHUBERT et al. 2016, 2024). First described by WITT (1906), its ontogenetic relevance is not yet understood and deserves further investigation. However, it can (and should) be taken as a distinctive character for future determination keys allowing for correct identification in case of aberrant cortication.



**Fig. 2** *Chara tomentosa* with haplostichous cortication. The specimen shown here was sampled in Sardinia, Italy, in May 2024 and resembles by its habitus *C. tomentosa* (left panel). Being clearly haplostichous (right panel) it would have been misidentified by all recent keys. However, the two-celled rows of branchlet cortication at the lowermost section (arrow in right panel) in combination with the extremely swollen end-segments identifies them as *C. tomentosa*.

Cortication is used as a prominent character still, irrespective of the many examples found in the past years where intermediate forms were described. Both, diplo-triplostichous as well as haplo-diplostichous cortication appear, hampering the use of cortication-based keys (see, e. g. BLINDOW et al. 2024). In fact, all corticated *Chara*-species develop secondary cortex rows, the appearance (including tyla-/aulacanthous) just depends on the degree these secondary rows are developing further (SCHUBERT et al. 2016b, 2024b). Consequently, the haplostichous cortication observed here may just reflect stalled development of the secondary rows due to the

environmental conditions (salinity and/or ion composition), known to modulate morphology of charophytes (MARTIN et al. 2004; SCHUBERT et al. 2004).

Moreover, *C. tomentosa* is known for variability of cortication; MIGULA (1889-1897) already describes diplo-triplostichous appearances with variability even within individuals along internode sections. The haplostichous cortication found here would just extend the range of variability to the opposite edge.

As a consequence, the authors would advocate for determination tools allowing for non-hierarchical attendance of all characters in parallel as exemplified by, e. g. VAN RAAM (2009) and BLINDOW et al. (2024). Such “matrix keys” are useful tools for identification of field material where not all characters are available (e. g. non-fertile material – e. g. distinction between *Nitella opaca* and *N. flexilis* as the most notorious problem) but especially to overcome problems with respect to cortication, as found here. We also advocate to include the character of cortication of the lowermost branchlet section not only for the case shown here, but also to increase attention to potential occurrences of species of the Willdenowia-group in Europe, a group just recently described for the first time on this continent (BECKER et al. 2021).

Incidentally, *C. tomentosa* is new to the charophyte flora of Sardinia (BECKER 2019).

## Acknowledgement

The investigations described here were conducted in the context of the project “ProParts” (Developing strategies for the protection of taxa consisting of interconnected sexual and parthenogenetic reproducing strains), funded by Biodiversa+, the European Biodiversity Partnership under the 2021-2022 BiodivProtect joint call for research proposals, co-funded by the European Commission (GA N°101052342) and with the funding organisations Deutsche Forschungsgemeinschaft e. V. (Germany), Agencia Estatal de Investigación, Fundación Biodiversidad (Spain), Ministry of Universities and Research (Italy), Österreichischer Wissenschaftsfonds FWF (Austria). All partners of the proparts project who are not among the authors are warmly acknowledged.

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