

## Rediscovering of *Chara braunii* (Characeae, Charophyta) in Madeira (Macaronesian region, Portugal)

Leopoldo Medina<sup>1</sup>, Pedro Nascimento<sup>2</sup>, Miguel Menezes de Sequeira<sup>3</sup>

**Abstract.** *Chara braunii* C.C. Gmelin (Characeae, Charophyta) was found in Madeira Island (Portugal) in a water channel in an agricultural area. This constitutes the first record of that species since 1944 in the Macaronesian region (Azores, Madeira and Canary archipelagos).

**Keywords:** Algae, Charophyta, *Chara braunii*, Madeira, Portugal, Macaronesia.

## [es] Redescubrimiento de *Chara braunii* (Characeae, Charophyta) en Madeira (Región Macaronésica, Portugal)

**Resumen.** *Chara braunii* C.C. Gmelin (Characeae, Charophyta) ha sido encontrado en un canal de riego de la isla de Madeira (Portugal) en una zona de intensa actividad agrícola. Se trata de la primera cita de esta especie desde 1944 en la región Macaronésica, formada por los archipiélagos de Azores, Madera y Canarias.

**Palabras clave:** Algae; Charophyta, *Chara braunii*, Madeira, Portugal, Macaronesia.

### Introduction

*Chara braunii* C.C. Gmelin (= *Charopsis braunii* (C.C. Gmelin) Kütz.; *Chara coronata* Ziz ex Bischoff) is a monoecious polymorphic (Kato et al. 2008) and cosmopolitan taxon (Krause 1997, Urbaniak, 2007), which occurs between 65°N and 35°S according to Wood (1965), although GBIF (2021) shows a wider distribution area. A European detailed map was published by Urbaniak (2007) and a more recent world map by Korsch (2018).

*Chara braunii* occurs scarcely in wild aquatic habitats being more frequent in secondary and anthropogenous habitats such as shallow fish-ponds, rice fields, man-made ponds and water channels, all of them corresponding to fresh or oligohaline to sub-saline (0,01- 1,12 mS/cm), alkaline or calcium rich waters, with medium to high eutrophication levels (Boira & Carretero 1985, Carretero 1993, Cirujano et al. 1999, Soulie-Märsche & Vautier 2004, Cirujano et al. 2007, Urbaniak 2007, Kato et al. 2008). Muller et al. (2017) refers that *Ch. braunii* tolerates desiccation of the water-bodies, periodical or even annual, recovering its populations from the underground deepest nodes of the oldest plants. Romanov et al.

(2019) found *Ch. braunii* in a karstic temporary pool of northern Sicily.

This macrophytic algae was first cited in mainland Portugal by Gonçalves da Cunha (1934) and later found in the Azorean archipelago, although identified as *Nitella ornithopoda* A. Braun, by Gonçalves da Cunha (1941). The distribution and ecology in the Iberian Peninsula of this taxon has been studied by Cirujano et al. (1999), and later additions to the Iberian distribution range are due to Ortega González et al. (2002) and Cirujano et al. (2007). No published references for both Madeira and the Canarian Archipelagos are known. However, Charophytes are not included in the biodiversity checklists of Canarias (Arechavaleta et al. 2010), Madeira (Borges et al. 2008) and Azores (Borges et al. 2010). In the African Atlantic region of Morocco Muller et al. (2017) refers to a unique locality of this taxon near Casablanca.

### Materials and methods

Plants collected in the field were preserved first in alcohol 70 °c and later in Copenhagen Mixture (Bridson & Forman 1998) to be studied under a binocu-

<sup>1</sup> Real Jardín Botánico, CSIC. Plaza de Murillo 2, 28014 Madrid, España.  
ORCID: <https://orcid.org/0000-0002-1675-4363>

<sup>2</sup> Faculty of Life Sciences, University of Madeira, Campus da Penteada, 9000-390 Funchal, Madeira, Portugal.  
E-mail: [pedrodiogo97@live.com.pt](mailto:pedrodiogo97@live.com.pt)  
ORCID: <https://orcid.org/0000-0002-4577-4267>

<sup>3</sup> Faculty of Life Sciences, University of Madeira, Campus da Penteada, 9000-390 Funchal, Madeira, Portugal. Madeira Botanical Group (GBM), Faculty of Life Sciences, University of Madeira, Funchal, Portugal. InBio, Research Network in Biodiversity and Evolutionary Biology, CIBIO-Azores, Portugal.  
E-mail: [sequeira@uma.pt](mailto:sequeira@uma.pt)  
ORCID: <https://orcid.org/0000-0001-9728-465X>

lar microscope and preserved as herbarium specimens. Collected plants are kept at MA, UMAD and UPS Herbaria. A Macaronesian distribution data set of *Ch. braunii* specimens from herbaria specimens were downloaded from GBIF (2021). JSTOR Global Plants database was consulted without success for Macaronesian specimens.

## RESULTS

### New localities

**PORTUGAL, MADEIRA:** Ilha da Madeira, Calheta, Estrada Regional 101 - Arco da Calheta, 32°42'34,6"N 17°08'58,0"W, 128 m, num canal de irrigação, 15 En. 2018, P. Nascimento (MA-*Algae* 11239, UMAD); Ilha da Madeira, Calheta, canal de rega num bananal ao sul e abaixo da estrada ER101 de Calheta para a Madalena do Mar, 32°42'35.95"N 17°09'1.38"W, 129 m, 13 May 2021, C. Gois-Marques, M. Gouveia, P. Jardim, P. Nascimento & M. Sequeira MS10553 (MA-*Algae* 11250, UMAD).

### Studied specimens

**PORTUGAL, MADEIRA:** Portugal, Madeira: Levada das Hortas, Funchal, Apr. 1892, s.c., MADJ -as *Tolypellopsis*; Levada, Jul. 1927, Barreto, MADJ -11 duplicates -as *Ch. coronata* Ziz; S. Roque do F.al [Funchal], num poço na Alegria, 14 Sept. 1944, s.c., MADJ; Madeira, 2000 fots höjd i bäckar [2000 feet high in brooks], Nov. 1890, J.R. Jungner, UPS A-001373 -as *Chara braunii*.

### Studied digitalized specimens

**PORTUGAL, MADEIRA:** Portugal, Madeira: Madeira, 18 Mar. 1882, G. Zander, LD 2104755 -as *Ch. Coronate*; Madeira, i bäckar. 2000 fot höjd [in brooks at 2000 feet altitude], Nov. 1890, J.R. Jungner, LD 2104819 -as *Chara braunii* Gmel. f. *microcarpa*;

The new Madeiran located populations of *Ch. braunii* (Fig. 1) occur in two nearby segments of a water irrigation channel located in the southwest of the island (Fig. 2), in a similar area of about 2 m<sup>2</sup> area and c. 50 cm wide channel section. This clear slow water flow channel is dominated by muddy substrates which allow the growth of aquatic plants from the seed bank in the remaining sediments.

The downstream *Ch. braunii* population was first found and collected in 2018, in a concrete water irrigation channel located on the side of the road to Calheta, but no plants were found along 2019 and 2020, this was possibly due to maintenance works that take place periodically that include removing the mud sediments of the bottom of the channel. A later visit in 2021 showed that a few small thalli were growing isolated along this part of the channel.

The second population, found first in 2018, but corresponding to material collected in 2021, was found c. 100 meters upstream in the same channel, however this part of the channel being simply dug out in the ground. In May 2020 the population was found reduced to a few thalli as a result of prolonged drying of the water channel caused by water diversion. In March 2021 this second population was visited again and found to be fully recovered, with mature thalli forming a dense bed in the water channel (Fig. 3). In this upper location *Ch. braunii* lives with other hygrophytes as *Apium nodiflorum* (L.) Lag., *Rorippa nasturtium-aquaticum* (L.) Hayek, *Callitriche stagnalis* Scop. and *Lemna* sp. Amphibious or hydrophytic plants in the channel slopes are *Ageratina adenophora* (Spreng.) R.M. King & H. Rob. (\*), *Adiantum capillus-veneris* L., *Polygonum capitatum* Buch.-Ham. ex D. Don (\*), *Parietaria judaica* L., *Rumex pulcher* subsp. *woodsii* (De Not.) Arcang., *Christella dentata* (Forssk.) Brownsey & Jermy, *Commelina diffusa* Burm. f. (\*), *Cardiospermum grandiflorum* Sw. (\*) and *Cyperus eragrostis* Lam. (\*), corresponding most of these plants to exotic taxa (\*) (Menezes de Sequeira et al. 2011) showing a high degree of hemeroby of these plant communities.

A long segment of about 250 m of the water channel, downstream, upstream and between both localities, has been surveyed in order to evaluate meta-population size, without success apart from the two already known locations.

Previous ancient and scarce references to this species are restricted to Madeira Island and correspond to herbarium specimens collected between 1882 and 1944. However only a few specimens include a detailed location, namely as “levada das Hortas”, “S. Roque de Funchal” and “Alegria”, all corresponding to localities close to the city of Funchal (Fig. 2), therefore about 22 km away of the recently found localities. All this peri-urban landscape has been deeply transformed due to the major increase in urban area that took place uphill along the second half of the XX<sup>th</sup> century, therefore reducing the surviving chances of these old populations.

## Discussion

The upstream population of *Ch. braunii* could derive from an original nucleus living in the upper hillside, where there is a permanent spring. However, no other populations have been found in the water line, both upstream and downstream. The downstream dispersion of black spores from the upstream population could explain the recovery of the downstream population in 2021 after the removal of sediments in 2019. Downstream diaspora has already been indicated as an important factor for the maintenance and dispersal of riparian species (Merrit & Whohl 2006, Hyslop & Trowsdale 2012) and for aquatic plants and charophytes in rivers (Bornette et al. 1998, Cellot et

al. 1998). Although there is no information of dispersal on man-made channels and even more for this reduced size of irrigation networks. This specific type of aquatic habitat does not allow water birds as a vector to facilitate long dispersal of the diaspora, as has been indicated for other types of wetlands (Proctor 1970). The unique estimated dispersal way could be the downstream flow along the channel and those through the local irrigation network that exchange water downstream between channels at different altitude. In addition, other even lesser important water bodies, and tanks for irrigation, are common in the nearest agriculture landscape, but they are subject to a strong level variation that could avoid the persistence of charophytes.

The transformation of the island landscape of Madeira has been progressively produced since XV<sup>th</sup> century, with the increase of the technical and mechanical resources for agriculture (Almeida et al. 2003, Kiesow & Bork 2017) and, in more recent years, for human infrastructures (Baioni 2011) related to tourism economy. This has led to the decline of the agricultural land use in Madeira since 1986 (Baioni 2011, Kiesow & Driesen 2017), what consequently has allowed recovery of a secondary forest and scrub vegetation in marginal agriculture areas, both in the upper limit and in the high slope low lands (Capelo et al. 2005, Kiesow & Driesen 2017).

This transformation has already affect to the scarce number and diversity of Madeiran wetlands, with the disappearance of the freshwater riverine and estuarine, and saline seaside water bodies, as Sequeira (2003 tab. 4.1) has related for the Madeiran “lagoas” of Porto Moniz, Paúl do Mar, Lugar de Baixo and Santo da Serra. This complete destruction of wetlands is directly related to the intensive human occupation of the low lands and seashore (Hughes 2005). As a consequence, the refugees of the wild aquatic flora in Madeira have been reduced to a few natural habitats, with different levels of disturbance, and to the more frequent man-made secondary habitats which are not management under the diversity and ecological criteria. Hughes & Malmqvist (2005) have pointed up, regarding to the aquatic invertebrate fauna but in the same way to the aquatic vegetation, that conservation and restoring strategies of the European Water Framework Directive should take into account for its implementation the rarity and diversity of the reduced types of wetlands placed in a high slope volcanic island, always in a synergy process with the Habitats Directive (Bolpagni et al. 2018).

Western Mediterranean (Spain and Portugal) fresh-water vegetation of *Charetum braunii* Corillion (*Charion vulgaris* (Krause ex Krause & Lang 1977) Krause 1981, *Charetea intermediae* F. Fukarek 1961) belongs to the charophyte pioneer and ephemeral communities of neutral, basophiles to saline fresh-water mainly colonized by *Chara* species, following Rivas Martínez et al. (2001, 2002) and Mucina et al. (2016). In the other hand Felzines &

Lambert (2012) include this association, for France, in the *Nitellion flexilis* W. Krause 1969 on neutral permanent waters, excluding it from the Atlantic and sub-Atlantic communities. The *Charetum braunii* is thus assigned to this alliance but with an exceptional ecology of pioneer, monospecific communities on oligo-mesotrophic and neutral waters, that seems to adjust better to these non-natural Madeiran communities due to water volcanic characteristics and the absence of the observed mineral encrustation on the thallus. These *Chara* communities are referred then to the EUR 3140 habitat “Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp” of lakes and pools (EUR 2013), that is not mentioned for the Macaronesian Biogeographical Region (EUR 2010). However, and as Guarino et al (2019) points out, the presence of a *Chara* stand is no enough to stablish the presence of this Habitat 3140. In the same way, we cannot consider the monospecific studied community as a representation on this habitat in the Macaronesian Biogeographical Region. However, conservation status of *Ch. braunii* in Madeira island should be evaluated in order to guarantee its conservation and to contribute to stablish a Charophyte Red List for this Biogeographical European Region, as has been consider as VU in the Baltic Countries (HELCOM 2013) under B2ab(iii) criteria, and in Norway (Langangen 2021). Portugal and Spain States have not included, to this time, these taxa under protection laws or national red lists.

## Acknowledgments

We are grateful to Patrik Frödén for providing us the digitalized images of the LD specimens during the pandemic and to UPS curators for providing us access to the *Ch. braunii* specimens.

## References

- Almeida, B. de, Vieira da Costa, J., Bisca, R., Conceição, J., Pires, M. & A.G. Castro (eds.). 2003. Plano Regional da Água Da Madeira. Relatório Técnico. Versão para Consulta Pública. Região Autónoma de Madeira. Funchal.
- Arechavaleta, M., Rodríguez, S., Zurita, N. & García, A. (coords.). 2010. Lista de especies silvestres de Canarias. Hongos, plantas y animales terrestres. 2009. Gobierno de Canarias. 579 pp.
- Baioni, D. 2011. Human activity and damaging landslides and floods on Madeira Island. *Nat. Hazards Earth Syst. Sci.* 11: 3035-3046. <https://doi.org/10.5194/nhess-11-3035-2011>
- Boira, H. & Carretero, J.L. 1985. Las carofíceas de las provincias de Castellón y Valencia. *Collect. Bot. (Barcelona)* 16: 13-19.
- Bolpagni, R., Laini A., Stanzani, C. & Chiarucci, A. 2018. Aquatic Plant Diversity in Italy: Distribution, Drivers

- and Strategic Conservation Actions. *Front. Plant Sci.* 9: 116. <https://doi.org/10.3389/fpls.2018.00116>
- Borges, P.A.V., Abreu, C., Aguiar, A.M.F., Carvalho, P., Jardim, R., Melo, I., Oliveira, P., Sérgio, C., Serrano, A.R.M. & Vieira, P. (eds.). 2008. A list of the terrestrial fungi, flora and fauna of Madeira and Selvagens archipelagos. Direcção Regional do Ambiente da Madeira and Universidade dos Açores, Funchal and Angra do Heroísmo, 440 pp.
- Borges, P.A.V., Costa, A., Cunha, R., Gabriel, R., Gonçalves, V., Martins, A.F., Melo, I., Parente, M., Raposo, P., Rodrigues, P., Santos, R.S., Silva, L., Vieira, P. & Vieira, V. (eds.). 2010. A list of the terrestrial and marine biota from the Azores. *Princípios, Cascais*, 432 pp. <https://doi.org/10.1046/j.1365-2427.1998.00273.x>
- Bornette, G., Amoros, C. & Lamourous, N. 1998. Aquatic plant diversity in riverine wetlands: the role of connectivity. *Freshw. Biol.* 39: 267-283. <https://doi.org/10.1046/j.1365-2427.1998.00273.x>
- Bridson, D. & Forman, L. 1998. The herbarium handbook, 3<sup>rd</sup> ed. Royal Botanic Gardens, Kew 346 pp.
- Capelo, J., Sequeira, M., Jardim, R., Mesquida, S. & Costa, J.C. 2005. The vegetation of Madeira Island (Portugal). A brief overview and excursion guide. *Quercetea* 7: 95-122.
- Carretero, J.L. 1993. Aportaciones a la distribución y ecología de las carofíceas de la provincia de Valencia. *Acta Bot. Malac.* 18: 31-36. <https://doi.org/10.24310/abm.v18i.8959>
- Cellot, B.; Mouillot, F.; Henry, C.P. 1998. Flood drift and propagule bank of aquatic macrophytes in a riverine wetland. *J. Veg. Sci.* 9: 631-640. <https://doi.org/10.2307/3237281>
- Cirujano, S., García Murillo, P., Meco, A. & Fernández Zamudio, R. 2007. Los carófitos ibéricos. *Anales Jard. Bot. Madrid* 64: 87-102. <http://dx.doi.org/10.3989/ajbm.2007.v64.i1.57>
- Cirujano, S., Medina, L., Sánchez Gullón, E. & García Murillo, P. 1999. *Chara braunii* (Charophyceae, Algae) en la Península Ibérica. *Anales Jard. Bot. Madrid* 57: 398-400.
- EUR. 2010. Terrestrial Macaronesian Region Reference List. Natura 2000. Available from: [https://ec.europa.eu/environment/nature/natura2000/sites\\_hab/biogeog\\_regions/docs/Macaronesia\\_ref\\_list.pdf](https://ec.europa.eu/environment/nature/natura2000/sites_hab/biogeog_regions/docs/Macaronesia_ref_list.pdf)
- EUR. 2013. Interpretation Manual of European Union Habitats, version EUR 28. European Commission, DG-ENV. Available from: [http://ec.europa.eu/environment/nature/legislation/habitatsdirective/docs/Int\\_Manual\\_EU28.pdf](http://ec.europa.eu/environment/nature/legislation/habitatsdirective/docs/Int_Manual_EU28.pdf)
- GBIF. 2021. GBIF *Chara braunii* Occurrences, Downloaded on 22 February 2021 from: <https://doi.org/10.15468/dl.fbb3mp> and <https://doi.org/10.15468/dl.8635gu>.
- Gonçalves da Cunha, A. 1934. Liste des Characées du Portugal. *Arq. Univ. Lisboa* 15: 5-18.
- Gonçalves da Cunha, A. 1941. Additions à la flore charologique du Portugal. *Bull. Soc. Portugaise Sci. Nat.* 13: 153-156.
- Guarino, R., Marcenò, C., Ilardi, V., Mannino, A.M. & Troia, A. 2019. One *Chara* does not make *Charetea* in the Mediterranean aquatic vegetation. *Webbia* 74: 139-147. <https://doi.org/10.1080/00837792.2019.1607142>
- HELCOM. 2013. *Chara braunii* Species Information sheet. Red List Macrophyte Expert Group 2013. Available from: <https://helcom.fi/media/red%20list%20species%20information%20sheet/HELCOM-Red-List-Chara-braunii.pdf>
- Hughes, S.J. & Malmqvist, B. 2005. Atlantic island freshwater ecosystems: challenges and considerations. Following the EU Water Framework Directive. *Hydrobiologia* 544:289–297. <https://doi.org/10.1007/s10750-005-1695-y>
- Hughes, S.J. 2005. Application of the Water Framework Directive to Macaronesian freshwater systems. *Biology & Environment. Proc. Roy. Irish Acad* 105b: 185-193. <https://doi.org/10.3318/BIOE.2005.105.3.185>
- Hyslop, J. & Trowsdale, S. 2012. A review of hydrochory (seed dispersal by water) with implications for riparian rehabilitation. *J. Hydrol.(N. Z.)*: 51: 137-152.
- Jean-Claude Felzines, J.-C. & Lambertz, E. 2012. Contribution au prodrome des végétations de France: les *Charetea fragilis* F. Fukarek 1961. *J. Bot. Soc. Bot. France* 59: 133-188.
- Kato, S., Sakayama, H., Sano, S., Kasai, F., watanabe, M., Tanaka, J. & Nozaki, H. 2008. Morphological variation and intraspecific phylogeny of the ubiquitous species *Chara braunii* (Charales, Charophyceae) in Japan. *Phycologia* 47: 191-202. <https://doi.org/10.2216/07-27.1>
- Kiesow, S. & Bork, H-R. 2017. Agricultural terraces as a proxy to landscape history of the Madeira Island, Portugal. *Ler História* 71: 127-152.
- Kiesow, S. & Dierssen, K. 2017. Vegetation analysis as a source of historic information. The case of Madeira Island. In: Vaz, E., Melo, C.J., de, & Pinto, L.C. (eds.). *Environmental History in the Making: Volume I: Explaining*. Basel.123-142. Springer International Publishing.
- Korsh, H. 2018. The worldwide range of the *Charophyte* species native to Germany. *Rostock. Meeresbiolog. Beitr.* 28: 45-96.
- Krause, W. 1997. *Charales (Charophyceae)*. Süßwasserflora von Mitteleuropa, vol. 18. Fischer Verlag, Stuttgart 208 pp.
- Langangen, A. 2021. Lokalitetsliste 2021 Status pr. 1. februar 2021. *Norges Kransalger Hefte* 13: 1-63.
- Menezes de Sequeira, M., Espírito-Santo, D., Aguiar, C., Capelo, J. & Honrado, J. (coords.). 2011. Checklist da Flora de Portugal (Continental, Açores e Madeira). Associação Lusitana de Fitossociologia. Lisboa.
- Merritt, D.M. & Wohl, E.E. 2006. Plant dispersal along rivers fragmented by dams. *River Res. Applic.* 22: 1-26. <https://doi.org/10.1002/rra.890>
- Mucina, L., Bültmann, H., Dierßen, K., Theurillat, J. -P., Raus, T., Čarni, A., Šumberová, K., Willner, W., Dengler, J., Gavilán García, R., Chytrý, M., Hájek, M., Di Pietro, R., Iakushenko, D., Pallas, J., Daniëls, F.J.A., Bergmeier, E., Santos Guerra, A., Ermakov, N., Valachovič, M., Schaminée, J.H.J., Lysenko, T., Didukh, Y.P., Pignatti, S., Rodwell, J.S., Capelo, J., Weber,

- H.E., Solomeshch, A., Dimopoulos, P., Aguiar, C., Hennekens, S.M. & Tichý, L. 2016. Vegetation of Europe: Hierarchical floristic classification system of vascular plant, bryophyte, lichen, and algal communities. *Appl. Veg. Sci.* 19, Supplement 1: 1-264. <https://doi.org/10.1111/avsc.12257>
- Muller, S.D., Rhazi, L., Soulie-Märsche, I., Benslama, M., Bottollier-Curtet, M., Daoud-Bouattour, A., De Belair, G., Ghrabi-Gammar, Z., Grillas, P., Paradis, L. & Zouaïdia-Abdelkassa, H. 2017. Diversity and distribution of *Characeae* in the Maghreb (Algeria, Morocco, Tunisia). *Cryptogam., Algol.* 38: 201-251. <https://doi.org/10.7872/crya/v38.iss3.2017.201>
- Ortega González, F., Parra Anguita, G. & Guerrero Ruiz, F.J. 2002. Nueva cita de *Chara braunii* Gmelin (*Characeae*) para la Península Ibérica. *Anales Jard. Bot. Madrid* 59: 335.
- Proctor, V.W. 1970. Taxonomy of *Chara braunii*: an experimental approach. *J. Phycol.* 6: 317-321.
- Rivas Martínez, S., Díaz, T.E., Fernández-González, F., Izco, J., Loidi, J., Lousã, M. & Penas, Á. 2002. Vascular plant communities of Spain and Portugal. Addenda to the Syntaxonomical checklist of 2001. *Itinera Geobot.* 15(1-2): 5-922.
- Rivas Martínez, S., Fernández-González, F., Loidi, J., Lousã, M. & Penas, Á. 2001. Syntaxonomical checklist of vascular plant communities of Spain and Portugal to association level. *Itinera Geobot.* 14: 5-341.
- Romanov, R., Napolitano, T., Van De Weyer, K. & Troia, A. 2019. New records and observations to the characean flora (*Charales*, *Charophyceae*) of Sicily (Italy). *Webbia* 74: 111-119. <https://doi.org/10.1080/00837792.2019.1609258>
- Sequeira, M., Matos, N.F., Jardim, R., Abreu, C., Huguet, S.J. & Meneses, D. 2003. Protecção da natureza e qualidade Ecológica. In: Almeida, B. de, Vieira da Costa, J., Bisca, R., Conceição, J., Pires, M. & A.G. Castro. (eds.. Plano Regional da Água Da Madeira. Relatório Técnico. Versão para Consulta Pública.: 73-74. Região Autónoma de Madeira, Funchal.
- Soulié-Märsche, I. & Vautier, J. 2004. Écologie et cycle de vie de *Chara braunii* (*Charales*) dans un habitat méditerranéen. *Vie Milieu* 54: 37-45.
- Urbaniak, J. 2007. Distribution of *Chara barunii* Gmelin 1826 (*Charophyta*) in Poland. *Acta Soc. Bot. Pol.* 76(4): 313-320. <https://doi.org/10.5586/asbp.2007.035>
- Wood, R.D. 1965. Monograph of the *Characeae*. J. Cramer. Weinheim.

## Captions



Figure 1. Landscape of the irrigation channel of the upper new population near Calheta.

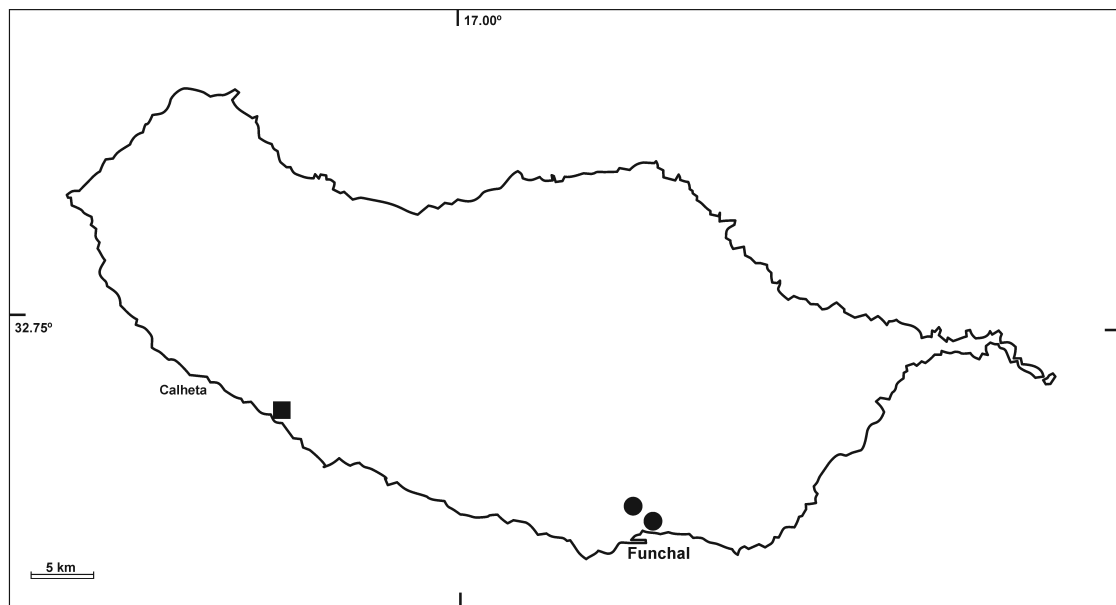


Figure 2. Georeferenced ancient herbarium specimens of *Chara braunii* in Funchal area (circle) at “Levada das Hortas”, “Sao Roque de Funchal” and “Alegria”, and new populations (square) in western Madeira Island.



Figure 3. *Chara braunii* stand on the upstream population near Calheta.