*Cryptogamie, Bryologie, 2007, 28 (3): 281-287*


# Some remarkable bryophytes from the aquatic habitats in northwestern Portugal

*Cristiana VIEIRA[a*], Cecília SÉRGIO[b] & Ana SÉNECA[a]*

*[a]Unidade de Genética e Ecologia Vegetal – CIBIO/ICETA e Departamento de Botânica Faculdade de Ciências, Universidade do Porto. Rua do Campo Alegre 1191. 4150-181 Porto. Portugal*

*[b]Museu Nacional de História Natural, Museu e Jardim Botânico da Universidade de Lisboa. Rua da Escola Politécnica, 58. 1269-170 Lisboa. Portugal*

*(Received 22 May 2006, Accepted 30 December 2006)*

**Abstract** – This paper presents information on the ecology and distribution of four species of Portuguese bryophyte flora. *Dichodontium pellucidum* (Hedw.) Schimp. and *Blindia acuta* (Hedw.) Bruch & Schimp. are recorded for the first time in Portugal. *Jungermannia obovata* Nees, is confirmed in two recently found localities, and *Climacium dendroides* (Hedw.) F. Weber & D. Mohr, a moss whose last records in the same area date 140 years, and which is currently considered to be extinct in Portugal, is confirmed.

**Iberian Peninsula / Portugal / mountain streams / mosses / liverworts / *Dichodontium* / *Blindia* / *Jungermannia* / *Climacium* / conservation**

**Résumé** – Cet article présente de nouvelles données sur l'écologie et la distribution de quatre espèces de bryophytes de la flore portugaise. *Dichodontium pellucidum* (Hedw.) Schimp. et *Blindia acuta* (Hedw.) Bruch & Schimp. sont récoltées pour la première fois au Portugal, la présence de *Jungermannia obovata* Nees est récemment confirmée dans deux localités. De plus, une mousse considérée disparue au Portugal, *Climacium dendroides* (Hedw.) F. Weber & D. Mohr, répertoriée il y a environ 140 ans, est confirmée.

**Péninsule Ibérienne / Portugal / jets de montagne / mousses / hépatiques / *Dichodontium* / *Blindia* / *Jungermannia* / *Climacium* / conservation**

## INTRODUCTION

Northwestern Portuguese territories are the most meridional of the Eurosiberian Region and represent a transition zone to the Mediterranean Region, which includes most of Portugal (Costa *et al.,* 1998). The climate is mainly temperate and rainy, but strongly influenced both by the smoothing effect of the Atlantic Ocean and the Mediterranean climate influence. Together with

*. Correspondence and reprints: ccvieira@fc.up.pt

tracheophyte communities, bryophyte distribution patterns also reflect this biogeographic transition, which is well illustrated by the distribution pattern of *Riccia* species and that of all *Sphagnum* species in the country (Séneca & Daniels, 1994; Sérgio & Draper, 2001). The northwestern area has a great phytogeographic significance, since it has a rich plant catalogue with species that occur only locally in the European Atlantic fringe, and show a subtropical bipolar distribution [*Cyclodictyon laetevirens* (Hook. & Taylor) Mitt.], or Micronesian distribution (*Rhamphidium purpuratum* Mitt. and *Fissidens polyphyllus* Wilson ex Bruch & Schimp). Other species occurring in the studied area present a relict occurrence, such as *Claopodium whippleanum* (Sull.) Renauld & Cardot, a species present only in Iberian Peninsula, Italy and California, with fossil records in Central Europe (Sérgio, 1990). Several of the migration routes and distribution patterns developed during quaternary glacial periods when the Iberian Peninsula acted as a refuge for many species (Bennet *et al.*, 1991).

Mountain stream ecosystems maintain unique and diverse assemblages of bryophyte species due to their high spatial and temporal heterogeneity. At a biogeographic scale bryophyte species richness depends mainly on biogeography and historic events, which are reflected in the diverse bryoflora of the Iberian Peninsula (Allorge, 1947; Sérgio, 2001). At a smaller scale, heterogeneity, stability, size and nature of the substrate, as well as local water level and velocity play major roles in the distribution of bryophyte species in mountain streams (Slack & Glime, 1985; Suren, 1996).

Streams in the mountains of northwestern Portugal show typical features of high slope bedrock rivers, with shifting currents and a succession of pools and riffles between waterfalls and rapids. Stream discharge is mainly dependent on the precipitation levels in the summer (1400-2000 mm annual precipitation with the maximum of 2 months of summer dryness), and thus most of them maintain a minimum water flow, which is crucial for the aquatic and rheophilous bryophyte populations. The distribution patterns of the Portuguese aquatic and semi-aquatic bryophytes are often underestimated due to poor field work and inherent difficulties in the process of sampling. Most of the species occur in waters with low levels of organic pollution, where aquatic species are segregated depending on the geomorphologic and hydrologic characteristics of the stream bed, but also on chemical characteristics of the flowing water (Vieira *et al.,* 2003; Vieira *et al.,* 2005).

Typical riparian vegetation of the studied area includes *Alnus glutinosa* (L.) Gaertn.*, Betula celtiberica* Rothm. et Vasc. and *Salix atrocinerea* Brot. The helophytic vegetation in bedrock streams is usually composed of *Carex elata* All. subsp. *reuteriana* (Boiss.) Luceño & Aedo, *Galium broterianum* Boiss. & Reuter, *Viola palustris* L. subsp. *palustris* and *Oenanthe crocata* L. (Costa *et al.,* 1998). The saxicolous stream bryophyte communities frequently include *Platyhypnidium lusitanicum* (Schimp.) Ochyra & Bednarek-Ochyra, *Scapania undulata* (L.) Dumort., *Fissidens polyphyllus* Wilson ex Bruch & Schimp., *Fontinalis squamosa* Hedw. var. *dixonii* (Cardot) A.J.E. Smith, *Racomitrium aciculare* (Hedw.) Brid. and *Racomitrium lamprocarpum* (Müll. Hal.) A. Jaeger (Vieira *et al.,* 2005).

Recent field work in northwestern Portuguese mountain streams (Fig. 1) integrated in a general survey and characterization of the bryophytes inhabiting them, revealed new information on interesting species for the National Catalogue (Sérgio & Carvalho. 2003). This paper aims to present new data on the distribution and ecology of these *taxa*, whose nomenclature is according to Sérgio & Carvalho (2003) [except for *Platyhypnidium* genus that follows Ochyra & Bednarek-Ochyra (1999)]. Authors' abbreviations are those proposed by Brummit & Powell (1992).

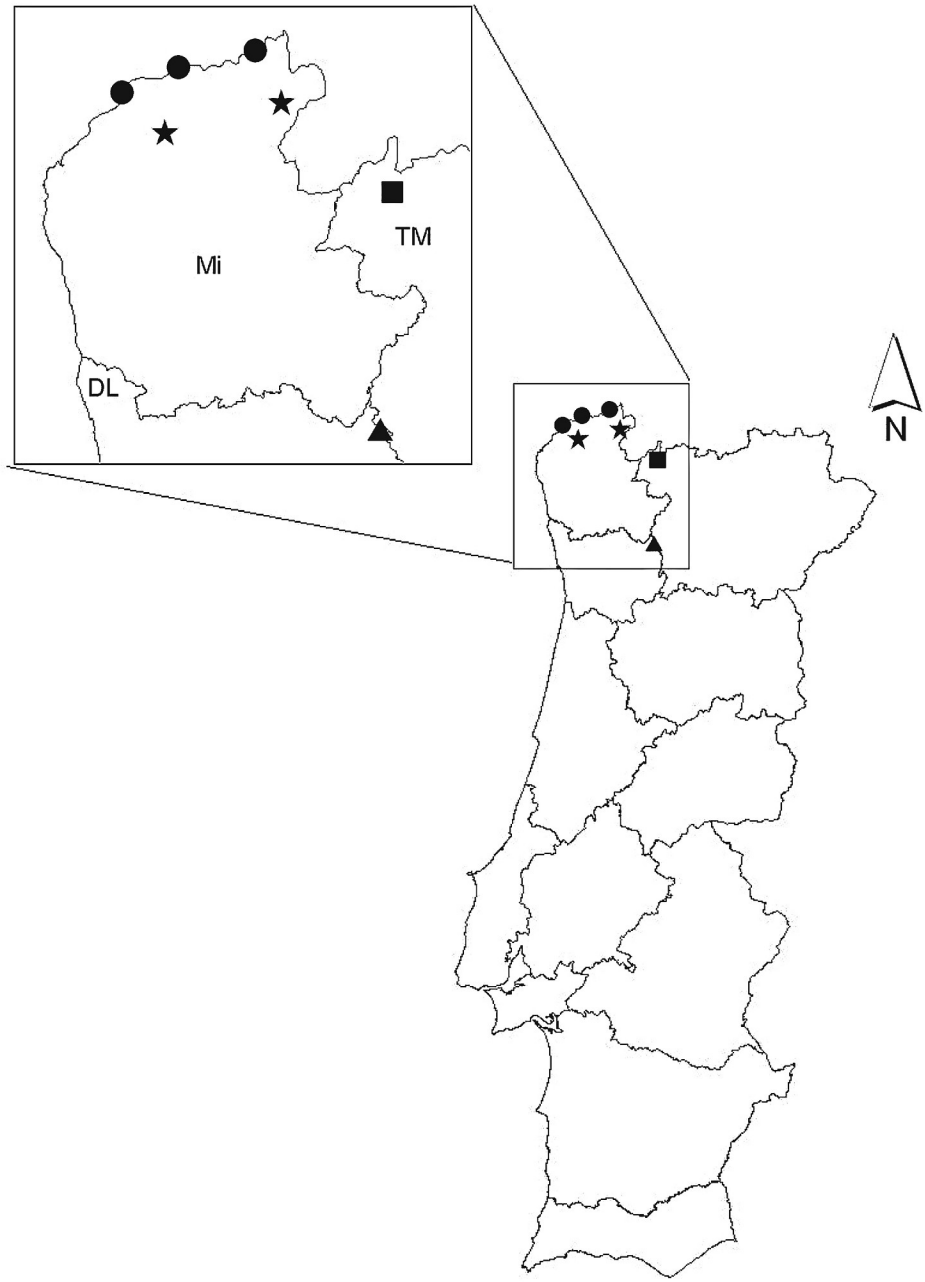


Fig. 1. *Dichodontium pellucidum* (Hedw.) Schimp. (▲), *Jungermannia obovata* Nees (★), *Blindia acuta* (Hedw.) Bruch & Schimp. (■) and *Climacium dendroides* (Hedw.) F. Weber & D. Mohr (●) records for Northwest Portugal. (Mi: Minho Province; DL: Douro Litoral Province and TM: Trás-os-Montes e Alto Douro Province).

## RESULTS AND DISCUSSION

The species mentioned in this paper are uncommon in northwest of Portugal, since after a survey of about 200 mountain stream and river segments, they were only found once or twice (Fig. 1).

***Dichodontium pellucidum* (Hedw.) Schimp. (Dicranaceae)**

**Studied specimen:** Portugal: Douro Litoral, Amarante, Sobrido, Ribeiro das Covas (Olo tributary river), 29TNF8874, 510 m, 3.06.2005, *Cristiana Vieira* (PO 9555-CIBIO).

This species had been previously reported for Portugal from Estremadura Province. However this record was considered dubious and not valid in the Portuguese bryophyte catalogue (Sérgio & Carvalho, 2003) because of labelling and problematic herbarium procedures associated with the inclusion of Estácio da Veigats collections in the Coimbra herbarium (COI). This, together with the site where it apparently was collected (Mafra), confirms the suspicion that it should be considered to be a foreign collection erroneously included in these bryophyte collections.

Although *D. pellucidum* is considered to be an occasional to rather common species in neutral to alkaline freshwater habitats of European mountains (Dierßen, 2001), in Portugal, this species was only recently found in one locality in Alvão-Marão Natura 2000 Site. This particular presence corresponds to a distinct situation because it is set in the only limestone area in the northwestern part of the country (Cândido de Medeiros *et al.*, 1954). The population was found growing on compact dark grey crystalline limestone (marble type) in a bedrock stream segment along with some other lime-loving bryophytes that were previously reported from this particular location (Pinto da Silva *et al.*, 1958). *Dichodontium pellucidum* was collected in a first order shaded stream on a steep hill facing northwest. The small (about 2 $cm^2$) and sterile population colonized a cobble vertical surface semi-immersed in neutral and weakly mineralized water (pH = 7.06; conductivity = 69 $\mu Scm^{-1}$).

Most of the associated species are typical of seasonally immersed, but common in more acidic conditions [*Eurhynchium praelongum* (Hedw.) Schimp. var. *stokesii* (Turner) Dixon, *Brachythecium rivulare* Schimp., *Bryum pseudotriquetrum* (Hedw.) P. Gaertn., B. Mey. & Scherb. and *Calliergonella cuspidata* (Hedw.) Loeske]. Some nitrophilous species were also found with *D. pellucidum*, which indicates some degree of organic pollution in this stream habitat, possibly due to the cattle presence in the stream margins (*Marchantia polymorpha* L., *Ceratodon purpureus* (Hedw.) Brid. and *Anomobryum julaceum* (P. Gaertn., B. Mey. & Scherb.) Schimp.).

*Dichodontium pellucidum* is considered to be frequent in Europe, though with a boreal montane distribution (Werner, 2002). In the Iberian Peninsula it is known to occur in northern Spain in the Pyrenees (Casas, 1986) and the Cantabrian range, Castellón and La Rioja, but there are also some confirmed localities south in Sierra Nevada (Rams *et al.,* 2001). The population here mentioned corresponds to the westernmost peninsular record for this species, as well as the first record confirmed for Portugal.

***Blindia acuta* (Hedw.) Bruch & Schimp. (Seligeriaceae)**

**Studied specimen:** Portugal: Trás-os-Montes e Alto Douro, Sezelhe, Ribeira do Rio Mau (Cávado tributary river), 29TNG9129, 904 m, 6.08.2004, *Cristiana Vieira* (PO 6899-CIBIO).

*B. acuta* was found for the first time in Portugal in a small valley stream facing southeast, deeply shaded by riparian tall vegetation. Some sterile gametophytes were found scattered among other rheophilous species in weakly

mineralized (conductivity = 17 $\mu Scm^{-1}$) and sub-neutral waters (pH = 6.77) colonizing bare granite vertical surfaces easily immersed after precipitation events. *Marsupella emarginata* (Ehrh.) Dumort., *Racomitrium hespericum* Sérgio, Muñoz & Ochyra and R. *aciculare* were found growing with *Blindia. acuta* and these pioneer colonist species (Dierßen, 2001) often occur in semi-immersed granite steep surfaces before *Brachythecium plumosum* (Hedw.) Schimp., *Heterocladium heteropterum* Bruch & Schimp. var. *wulfsbergii* I. Hagen and *Isothecium holtii* Kindb. mats dominate the substrate surface.

This species shows a fragmented distribution pattern, being relatively cosmopolite in alpine-oceanic areas (Dierßen, 2001). It is dispersed in the northern half of the Iberian Peninsula being also reported, in the south, from Sierra Nevada (Casas *et al.,* 1996; Lloret *et al.,* 1997, Rams *et al.,* 2001). To this moment it has only been found above 1000 m (Casas *et al.,* 1996). The recently found population corresponds to the first national record and it is located within the Peneda-Gerês National Park limits.

***Jungermannia obovata* Nees (Jungermanniaceae)**

**Studied specimens:** Portugal: Minho, Paredes de Coura, Insalde, Rio de Codeceda (Coura tributary river), 29TNG3843, 430 m, 30.08.2004 *Cristiana Vieira*; Arcos de Valdevez, Gavieira, Rio de Tieiras (Peneda river tributary), 29TNG6550, 865 m, 14.08.2004, *Cristiana Vieira* (PO 7646/7042-CIBIO).

*Jungermannia obovata* previous record in Portugal consisted of a literature reference in the Douro Litoral Province (Jovet-Ast & Bischler, 1976). The specimen, kept at PC, could not be confirmed and the species was considered as uncertain in the national catalogue (Sérgio & Carvalho, 2003). There was also the possibility that this previous reference corresponded to *J. sphaerocarpa* Hook., a much more frequent species. The recently found populations were submerged, but the morphological characters undoubtedly allowed its confirmation as belonging to *J. obovata.*

Two populations were found in moderately shaded small mountain streams in very similar micro-habitat conditions – granite blocks in the permanently splashed zone, just a few centimetres away from the main water flow, in weakly mineralized (maximum conductivity = 34 $\mu Scm^{-1}$) and sub-neutral waters (pH = 6.7). In both locations *Jungermannia obovata* was found growing in a mosaic with *Fissidens polyphyllus*, *Scapania undulata* and *Hyocomium armoricum* (Brid.) Wijk & Marg.

According to Hill & Preston (1998), *Jungermannia obovata* is spread throughout Europe, North Africa, Asia and North America, and can be considered as a boreal montane species. It has been reported, in the Iberian Peninsula, from the northern areas of Spain (Galicia, Asturias, Basque Country and Pyrenees). The Spanish reference closest to the Portuguese localities corresponds to Sierra de Cuarel (Lugo Province) (Reinoso *et al.,* 1994). The two populations here reported represent the westernmost confirmed records for *Jungermannia obovata* in the Iberian Peninsula.

***Climacium dendroides* (Hedw.) F. Weber & D. Mohr (Climaciaceae)**

**Studied specimens:** Portugal: Minho, Melgaço, Veigas de Remoães, Rio Minho, 30 m, 29TNG5962, 24.06.05 *Cristiana Vieira*; Monção, next to the international bridge, Lodeira, 10 m, 29TNG4158, 28.06.2005; Valença, Arão, Outeiro, 5m, 29TNG2852, 28.06.2005, *Cristiana Vieira* (PO 9899/9906/9914-CIBIO).

Although *Climacium dendroides* is a common species in Europe and a non-threatened species in the Iberian Peninsula because of its frequency in Spain (Casas *et al.,* 1985), in Portugal, it was considered as an extinct species (Sérgio *et al.,* 1994) since after a 1865 specimen collected by Ricardo da Cunha (LISU), in

river Minho margins, it had not been found again. A more recent record from the Serra da Estrela (Greven & Melick, 1994) could not be confirmed.

In recent surveys of the plant communities of the Minho river margins, *Climacium dendroides* was found in three different sections of the river, always growing in small crevices of the granite outcrops in the river margins along with some herbaceous vegetation. In the stony river margins where the water level fluctuates due to precipitation events and dam's releases, and where water is enriched with organic nutrients, *Climacium dendroides* has been found together with *Bryum gemmiparum* De Not., *Scleropodium touretii* (Brid.) L. Koch, *Leskea polycarpa* Hedw., *Calliergonella cuspidata* and *Marchantia polymorpha.* In steep substrates, such as granite walls in the river margins, it was found with *Dialytrichia mucronata* (Brid.) Broth., *Cinclidotus fontinaloides* (Hedw.) P. Beauv., *Porella pinnata* L. and *Radula holtii* Spruce.

In Spain the closest reference to the river Minho Portuguese location of *Climacium dendroides* is in Ourense (Allorge, 1934; Casas *et al.,* 1985).

## CONCLUSION

The species here reported are not frequent in Portugal and we think that the areas where they thrive should be considered important refuges since they contribute significantly to the overall biodiversity of Portugal. Therefore, these areas could be evaluated as Important Bryophyte Areas (IBrA) – using the adapted criteria for selecting Important Plant Areas (IPA) as defined by Planta Europa (http://www.plantaeuropa.org/html/important_plant_areas.htm).

**Acknowledgements.** The authors would like to thank Jiří Váňa for the identification of *Jungermannia obovata* specimens, and to Inês Silva for her helpful map. This work is part of a doctoral thesis ("Saxicolous rheophilous bryophytes of the Portuguese Northwest mountain streams"- PhD Grant SFRH/BD/6969/2001 by "Fundação para a Ciência e Tecnologia"). We would also like to acknowledge the financial support of the "European Commission's Research Infrastructure Action via the SYNTHESYS Project" for the study of "Aquatic and semi-aquatic Bryophytes from Europe, and interactions processes between bryophytes and water quality (bioindication and bioaccumulation)", at the Muséum National d'Histoire Naturelle (Paris-France), that allowed the comparison of aquatic specimens.

## REFERENCES

ALLORGE P., 1947 — *Essai de Bryogéographie de la Péninsule Ibérique*. Paris, Le Chevalier [*Encyclopédie Biogéographique et Écologique* 1], 105 p.

BENNET K.D., TZEDAKIS P.C. & WILLIS K.J., 1991 — Quaternary refugia of north European trees. *Journal of biogeography* 18: 103-115.

BRUMMIT R. K. & POWELL C. E., 1992 — *Authors of plant names*. Kew, Royal Botanic Gardens, 732 pp.

CÂNDIDO DE MEDEIROS A., LIMPO DE FARIA F. & DIAS DE CARVALHO A., 1954 — Calcários cristalinos da Serra do Marão. *Estudos, notas e trabalhos do serviço de Fomento Mineiro* 9: 1-19.

CASAS C., BRUGUÉS M. & CROS R. M. & SÉRGIO C., 1985 — *Cartografia de Briòfits. Península Ibèrica i les Illes Balears, Canarias, Açores i Madeira. I.* Barcelona, Institut d'Estudis Catalans, 50 p.

CASAS C., 1986 — Catálogo de los briófitos de la vertiente española del Pirineo Central y de Andorra. *Collectanea botanica* 16: 255-321.
CASAS C., BRUGUÉS M. & CROS R. M. & SÉRGIO C., 1996 — *Cartografia de Briòfits. Península Ibèrica i les Illes Balears, Canarias, Açores i Madeira.* 4. Barcelona, Institut d'Estudis Catalans, pp. 151-200.
COSTA J. C., AGUIAR C., CAPELO J. H., LOUSÃ M. & NETO C., 1998 — Biogeografia de Portugal Continental. *Quercetea* 0: 5-56.
DIERßEN K., 2001 — Distribution, ecological amplitude and phytosociological characterization of European bryophytes. *Bryophytorum bibliotheca* 56: 1-289.
GREVEN H. & VAN MELICK H., 1994 — Bryologische impressies uit het Sterrengebergte in Portugal. *Buxbaumiella* 35: 23-29.
HILL M. O. & PRESTON C. D., 1998 — The geographical relationships of British and Irish bryophytes. *Journal of bryology* 20: 127-226.
JOVET-AST S. & BISCHLER H., 1976 — Hépatiques de la Pénínsule Ibérique: Enumération, notes écologiques. *Revue bryologique et lichénologique* 42: 931-987.
LLORET F., CROS R. M., BRUGUÉS M. & GRANZOW de la CERDA I., 1997 — Aspectos biogeográficos y corológicos de los briófitos de la Sierra de Gredos (España). *Cryptogamie, Bryologie-Lichénologie* 18: 151-164.
OCHYRA R. & BEDNAREK-OCHYRA H., 1999 — *Platyhypnidium grolleanum* (Musci: Brachytheciaceae) a new species from the Sudetes (Central Europe). *Haussknechtia Beiheft* 9, 259-264.
PINTO DA SILVA A., TELES A. N. & ROZEIRA A., 1958 — First account of the limestone flora and vegetation of the North-Western Portugal - their climatic and ecological significance. *Boletim da sociedade Broteriana,* 2ª sér., 23: 267-297.
RAMS R., ROS R. M., CANO M. J. & GUERRA J., 2001 — Checklist de los briófitos de Sierra Nevada (Andalucía, España). *Boletín de la sociedad Española de briología* 18-19: 137-164.
REINOSO FRANCO J. & VIERA BENÍTEZ M. C., 1994 — Datos sobre la brioflora de la Sierra de Cuarel (Lugo, España). I Hepaticae. *Lazaroa* 14: 179-182.
SÉNECA A. & DANIELS R., 1994 — Four boreal sphagna new for the Portuguese mountains and *Sphagnum mole* in the coastal plane. *Journal of bryology* 18: 369-371.
SÉRGIO C., 1990 — Perspectiva biogeográfica da flora briológica Ibérica. *Anales del jardin botanico Madrid* 46: 371-392.
SÉRGIO C., CASAS C., BRUGUÉS M. & CROS R. M., 1994 — *Lista Vermelha dos Briófitos da Península Ibérica/Red List of Bryophytes of the Iberian Peninsula.* Lisboa, Instituto de Conservação da Natureza; Museu, Laboratório e Jardim Botânico & Universidade de Lisboa, 50 p.
SÉRGIO C., 2001 — L'influence Atlantique et Méditerranéenne dans la bryoflore Portugaise. *Braun-Blanquetia* 31: 15-17.
SÉRGIO C. & DRAPER D., 2001 — Bryophyte survey as a basis for the validity of the Mediterranean isoclimatic areas in Portugal. *Bocconea* 13: 89-99.
SÉRGIO C. & CARVALHO S., 2003 — Annotated catalogue of Portuguese bryophytes. *Portugaliae acta biologica* 21: 5-230.
SLACK N.G. & GLIME J. M., 1985 — Niche relationships of mountain stream bryophytes. *The bryologist* 88: 7-18.
SUREN A.M., 1996 — Bryophyte distribution patterns in relation to macro-, meso, and micro-scale variables in South Island, New Zealand streams. *New Zealand journal of marine and freshwater research* 30: 501-523.
VIEIRA C., HONRADO J. J., SÉNECA A. & CALDAS F. B., 2003 — Comunidades Higrófilas Herbáceas (Classes Isoeto-Littorelletea, Montio-Cardaminetea, Phragmito-Magnocaricetea e Potametea) no Parque Nacional da Peneda-Gerês (Nordeste de Portugal Continental). *Quercetea* 4: 93-112.
VIEIRA C., SÉNECA A. & SÉRGIO C., 2005 — Threatened bryophytes occurrence in Portuguese stream habitat. *Boletín de la sociedad Española de bríología* 26-27: 103-118.
WERNER J., 2002 — A comparison of *Dichodontium flavescens* (Dicks.) Lindb. and *D. pellucidum* (Hedw.) Lindb. (Bryopsida). *Journal of bryology* 24: 215-221.