Bol. Soc. Esp. Briol. 29: 25-33 (2006)

A NEW IMPORTANT MEDITERRANEAN AREA FOR BRYOPHYTES IN PORTUGAL: BARRANCOS (BAIXO ALENTEJO)

Cecília Sérgio[1], Monserrat Brugués[2], Rosa Maria Cros [2], César Garcia[1] & Teresa Louro[1]

1. Jardim Botânico, Museu Nacional de História Natural, Universidade de Lisboa / Centro de Ecologia e Biologia Vegetal. Rua da Escola Politécnica, 58, 1269-170, Lisboa, Portugal.
E-mail: csergio@fc.ul.pt
2. Botànica. Facultat de Ciències. Universitat Autònoma de Barcelona, 08193 Bellaterra, España.

Abstract: As a result of field works conducted in Barrancos region, in the Guadiana river basin, near the border with Spain, the bryophyte flora is reported. The census includes 128 taxa (29 liverworts, 96 mosses and 3 hornworts). Some species of mosses are new to the country or correspond to the first locality (*Bryum cyclophyllum, Entosthodon mouretii, Microbryum fosbergii*, *Pyramidula tetragona*). Several others species of phytogeographic interest are reported and some aspects of their distribution and ecology are discussed.

INTRODUCTION

The Iberian Peninsula is recognized as a world hotspot of biodiversity (Myers *et al.* 2000). Hotspots of richness and endemicity are biologically important for vascular plants (Williams *et al.,* 1998) and certainly for bryophytes. Also the knowledge of biodiversity hotspots for bryophytes can be important for the general biodiversity diagnosis in Portugal (Sérgio *et al.* 2000). Therefore, a first study based on predictive tools for the functional classification of Portuguese bryophytes diversity was presented by Sérgio & Draper (2002).

In this perspective, a project is now in progress at the Botanical Garden of Lisbon University. The main purpose of this project is to develop a predictive tool for biological diversity based on ecological modelling of bryophyte distribution. From this point of view and to validate the methodology, we surveyed an area in Portugal which had never been studied, to confirm the bryophyte richness and the possible presence of endemic species. One not studied region, where less than 5 species were reported to that moment, corresponds to the eastern boundary of Portugal, in Baixo Alentejo, along or adjacent to the Guadiana river basin.

STUDIED AREA

This studied area is situated in Barrancos area, southeast of Portugal, Baixo Alentejo province (lat. 37º45'N to 38º13'N and 8º40'W to 7º55'W), within the Guadiana river basin, near the Portuguese border with Spain (Fig.1). In the southern border of the river catchments, the northern slopes at Perímetro da Contenda can reach 500 m of altitude and the main heights of the northern region are Castelo de Noudar (about 300 m). The depth of the Guadiana valley is variable due to decreasing heights towards the south at Pulo do Lobo (about 35 m high). Tributaries of the Guadiana river include ribeira de Lima and ribeira de Murtega that corresponds to the boundary with Spain.

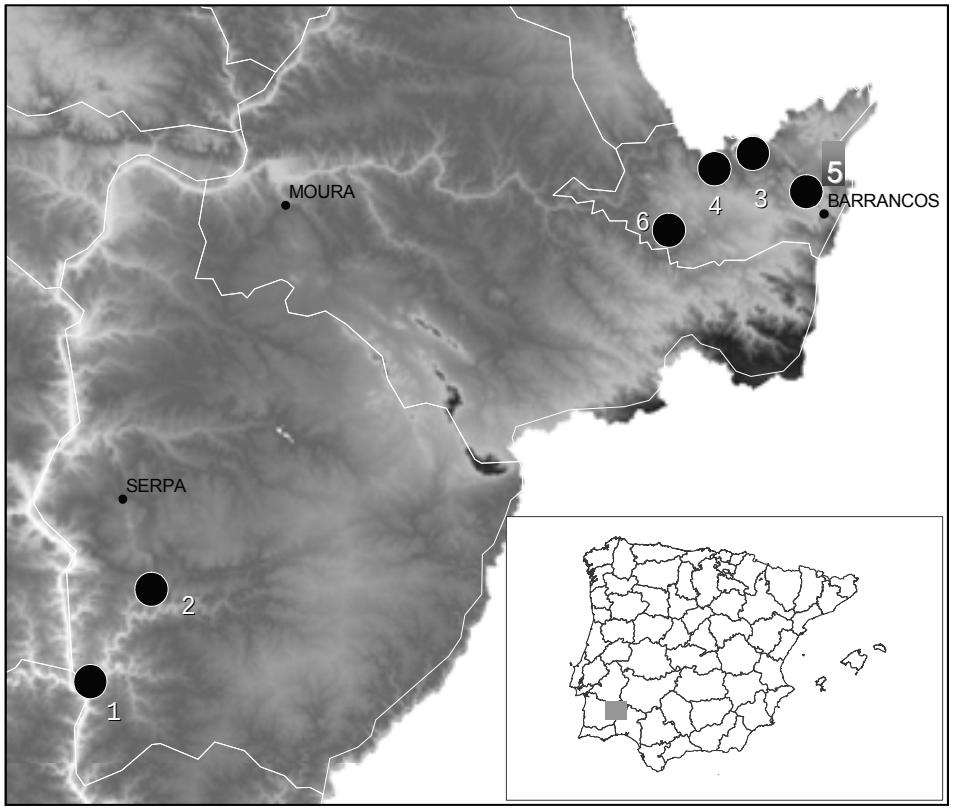

Figure 1. The studied area, a part of the Guadiana basin in Portugal (Baixo Alentejo province). Numbers indicate the studied localities.

Climatic features of the area are typically Mediterranean, and can be summarized as follows: average annual temperature in the area between 16º and 17.5º C or more, with the average summer temperature reaching 26-34º C. The winters are mild and frosts are very infrequent. Average minimum temperatures vary from 4.5ºC to 9ºC. The mean annual rainfall ranges from 400 to 800 mm (in the highest regions).

Depending on the locality and the ecological conditions of habitats, Mediterranean shrubs and forest stands are the dominant formations in the region, mainly «*montados*» of *Quercus rotundifolia* Lam. as well as some *Q. suber* L. woodlands. In some localities olive orchards can be found, as well as cereal crops in some restricted areas. The geological character of the

area may cause some differences in the species composition of these formations and the dominant rocks in the studied area are quartzite and clay schist and some greywackes.

1	Serpa, Rio Guadiana, Pulo do Lobo, 39 m, 29SPB2085, 25-03-2000, Sérgio; Pulo do Lobo, 11-02-2004, *C. Garcia.*
2	Serpa, Ribeira da Lima, 100 m, 29SPB2187, 11-02-2004, *C. Sérgio, M. Brugués & R.M. Cros.*
3	Barrancos, próximo do Castelo de Noudar, 185 m, 29SPC7027, 10-02-2004, *C. Garcia, P. Carvalho, J. Calaím.*
4	Barrancos, Castelo de Noudar, 390 m, 29SPC6927, 12-02-2004, *C. Sérgio, M. Brugués & R.M. Cros.*
5	Barrancos, Fonte da Pipa, Ribeira da Murtega, 186 m, 29SPC7624, 12-02-2004, *C. Sérgio, M. Brugués & R.M. Cros*; Fonte da Pipa, 13-04-2004, *C. Garcia.*
6	Barrancos, Mina de Aparis, 230 m, 29SPC6821, 12-02-2004, *C. Sérgio, M. Brugués & R.M. Cros.*

Table 1. List identifying the studied localities, data and collectors).

MATERIALS AND METHODS

Bryophyte specimens were collected throughout the Guadiana valley in 6 distinct areas (Table 1) from different substrata and habitats, during short field surveys in 2000 and 2004. Identification of specimens was carried out by using appropriate European and Iberian floras for bryophytes. The taxonomic and nomenclatural arrangement follows Sérgio & Carvalho (2003) with some more recent taxonomic criteria and the author's names are based mainly in Hill *et al.* (2006). An asterisk (*) indicates that the taxon is a new record for Baixo Alentejo and two asterisks (**) indicate that it is a new record to Portugal or the first locality to the country. The only Iberian endemic is indicated with a diamond.

The different chorological types, which were grouped into six main categories for statistical and graphical purposes, follow Düll (1983, 1984 and 1985), and are stated as: temperate, oceanic and suboceanic, oceanic-mediterranean and mediterranean-oceanic, submediterranean and mediterranean, boreal and subalpine. All specimens are deposited in the herbarium of LISU and some also in BCB.

RESULTS

MOSSES

***Aloina ambigua* (Bruch & Schimp.) Limpr.** – 2, 4.
***Archidium alternifolium* (Hedw.) Mitt.** – 1, 6.
***Aschisma carniolicum* (F. Weber & D. Mohr) Lindb.** – 6.
***Barbula convoluta* Hedw.** – 4, 5, 6.
***Bartramia stricta* Brid.** – 2, 4, 5.
***Bryum alpinum* Huds. ex With.** – 6.
***Bryum argenteum* Hedw.** – 1, 2, 4, 6.
***Bryum caespiticium* Hedw.** – 5.
***Bryum capillare* Hedw.** – 1, 4, 5, 6.
***Bryum cyclophyllum* (Schwägr.) Bruch & Schimp.** – 5.

***Bryum dichotomum* Hedw.** – 2, 4, 5.
***Bryum donianum* Grev.** – 5.
****Bryum gemmiferum* R. Wilczek & Demaret** – 5.
****Bryum gemmiparum* De Not.** – 1, 2, 5.
****Bryum minii* Podp.** – 1, 2.
****Bryum muehlenbeckii* Bruch & Schimp.** – 6.
***Bryum torquescens* Bruch & Schimp.** – 2.
***Cheilothela chloropus* (Brid.) Broth.** – 6.
****Cinclidotus riparius* (Brid.) Arn.** – 5.
****Crossidium crassinerve* (De Not.) Jur.** – 4.
***Cynodontium bruntonii* (Sm.) Bruch & Schimp.** – 4.
***Dialytrichia mucronata* (Brid.) Broth.** – 5.
****Dicranella howei* Renauld & Cardot** – 2.
****Didymodon acutus* (Brid.) K. Saito** – 4, 5, 6.
****Didymodon bistratosus* Hebr. & R.B. Pierrot** – 1.
***Didymodon insulanus* (De Not.) M.O. Hill** – 1, 2, 5.
***Didymodon luridus* Hornsch.** – 4.
***Didymodon nicholsonii* Culm.** – 2.
****Ditrichum cylindricum* (Hedw.) Grout** – 2, 6.
***Encalypta vulgaris* Hedw.** – 2, 4, 5.
****Entosthodon convexus* (Spruce) Brugués** – 1, 2, 4, 5, 6.
***Entosthodon fascicularis* (Hedw.) Müll.Hal.** – 2, 6.
*****Entosthodon mouretii* (Corb.) Jelenc** – 2, 6.
***Entosthodon pulchellus* (H. Philib.) Brugués** – 4, 5. –
***Ephemerum sessile* (Bruch) Müll. Hal.** – 2, 6.
***Epipterygium tozeri* (Grev.) Lindb.** – 1, 2.
***Eurhynchium hians* (Hedw.) Sande Lac.** – 5.
***Eurhynchium pumilum* (Wilson) Schimp.** – 5.
***Fabronia pusilla* Raddi** – 6.
****Fissidens crassipes*. subsp. *warnstorffi* (Fleisch.) Brugg.- Nann.** – 5.
***Fissidens limbatus* Sull.** – 2.
***Fissidens viridulus* (Sw.) Wahlenb.** – 5.
***Fissidens viridulus* (Sw.) var. *incurvus* (Starke ex Röhl.) Waldh.** – 2.
****Fissidens viridulus* (Sw.) var. *intralimbatus* (R. Ruthe) Düll** – 6.
***Fontinalis hypnoides* Hartm. var. *duriaei* (Schimp.) Kindb.** – 6.
***Funaria hygrometrica* Hedw.** – 2, 6.
****Grimmia decipiens* (Schultz) Lindb.** – 5, 6.
***Grimmia laevigata* (Brid.) Brid.** – 4, 5.
****Grimmia lisae* De Not.** – 2, 4, 5.
***Grimmia pulvinata* (Hedw.) Sm.** – 1.
***Gymnostomum calcareum* Nees & Hornsch.** – 5.
****Homalothecium aureum* (Spruce) H. Rob.** – 4, 5, 6.
***Homalothecium sericeum* (Hedw.) Schimp.** – 4, 6.
***Hypnum cupressiforme* Hedw.** – 5.
***Leptodictyum riparium* (Hedw.) Warnst.** – 4.
****Leptophascum leptophyllum* (Müll. Hal.) J. Guerra & M.J. Cano** – 2.
***Leucodon sciuroides* (Hedw.) Schwägr.** – 6.
****Microbryum davallianum* (Sm.) R.H. Zander** – 2.
*****Microbryum fosbergii* (E.B. Bartram) Ros, O. Werner & Rams** – 6.
***Microbryum starckeanum* (Hedw.) R.H. Zander** – 1, 4, 6.
***Orthotrichum diaphanum* Schrad. ex Brid.** – 1, 3, 5, 6.
****Orthotrichum lyellii* Hook. & Tayl.** – 3.
****Orthotrichum rupestre* Schleich. ex Schwägr.** – 3.
***Orthotrichum tenellum* Bruch ex Brid.** – 1, 3, 5.
****Phascum cuspidatum* subsp. *papillosum* (Lindb.) J. Guerra & Ros** – 6.
****Philonotis arnelli* Husn.** – 5, 6.
****Philonotis tomentella* Molendo** – 5, 6.
****Platyhypnidium lusitanicum* (Schimp.) Ochyra & Bednarek-Ochyra** – 5.
***Pleuridium acuminatum* Lindb.** – 2, 4, 6.
***Pleurochaete squarrosa* (Brid.) Lindb.** – 2, 3, 5, 6.
***Polytrichum juniperinum* Hedw.** – 5, 6.
****Polytrichum piliferum* Hedw.** – 4.
****Pottia truncata* (Hedw.) Bruch & Schimp.** – 2, 4.
****Pseudocrossidium hornschuchianum* (Schultz) R.H. Zander** – 2.
***Pterogonium gracile* (Hedw.) Sm.** – 1, 3, 5.
*****Pyramidula tetragona* (Brid.) Brid.** – 6.
***Rhynchostegium megapolitanum* (F. Weber & D. Mohr) Schimp.** – 4.
***Scleropodium touretii* (Brid.) L.F. Koch** – 2, 3, 6.
***Scorpiurium circinatum* (Bruch) M. Fleisch. & Loeske** – 3, 4.
***Scorpiurium deflexifolium* (Solms) M. Fleisch. & Loeske** – 2, 3, 5, 6.

***Syntrichia laevipila* Brid.** – 1, 3, 5, 6.
****Syntrichia latifolia* (Bruch ex Hartm.) Huebener** – 5.
****Syntrichia papillosa* (Wilson) Jur.** – 3.
****Syntrichia ruralis* (Hedw.) F. Weber & D. Mohr var. *ruralis*** – 6.
****Timmiella barbuloides* (Brid.) Mönk.** – 4.
****Tortella nitida* (Lindb.) Broth.** – 1, 6.
****Tortula atrovirens* (Sm.) Lindb.** – 2, 4, 5, 6.
****Tortula canescens* Mont.** – 6.
***Tortula cuneifolia* (Dicks.) Turner** – 2.
****Tortula guepinii* (Bruch & Schimp.) Broth.** – 6.
***Tortula muralis* Hedw.** – 1, 2, 4, 6.
***Trichostomum brachydontium* Bruch.** – 2, 3, 6.
♦ – ***Triquetrella arapilensis* Luisier** – 6.
***Weissia controversa* Hedw.** – 2.
*****Zygodon catarinoi* C. Garcia, F. Lara, Sérgio & Sim-Sim** – 3.
***Zygodon rupestris* Schimp. ex Lorentz.** – 3.
Zygodon rupestris* fo. *mediterraneum – 3.

HEPATICS

****Conocephalum conicum* (L.) Dumort.** – 5.
***Corsinia coriandrina* (Spreng.) Lindb.** – 1, 2, 5.
***Fossombronia angulosa* (Dicks.) Raddi** – 2, 5.
***Fossombronia echinata* Macvicar** – 2.
***Fossombronia husnotii* Corb.** – 1, 2, 6.
***Fossombronia pusilla* (L.) Nees** – 2.
****Fossombronia wondraczekii* (Corda) Lindb.** – 4.
***Frullania dilatata* (L.) Dumort.** – 1, 3, 5, 6.
***Gongylanthus ericetorum* (Raddi) Nees** – 2, 5.
***Lunularia cruciata* (L.) Lindb.** – 2, 4, 5.
***Mannia androgyna* (L.) A. Evans** – 2, 6.
***Oxymitra incrassata* (Brot.) Sérgio & Sim-Sim** – 1, 2, 6.
****Plagiochasma rupestre* (J.R. Forst. & G. Forst.) Steph.** – 1.
****Reboulia hemisphaerica* (L.) Raddi** – 3.
***Riccia bicarinata* Lindb.** – 5.
***Riccia bifurca* Hoffm.** – 2.
***Riccia crystallina* L. emend. Raddi** – 4.
***Riccia gougetiana* Durieu & Mont.** – 1, 2, 6.
***Riccia gougetiana* var. *armatissima* Müll.Hal.** – 2.
***Riccia macrocarpa* Levier** – 2, 6.
****Riccia michelii* Raddi** – 2.
***Riccia nigrella* DC.** – 1, 2, 6.
***Riccia papillosa* Moris** – 6.
***Riccia perennis* Steph.** – 2, 6.
***Riccia sorocarpa* Bisch.** – 1, 2, 6.
****Riccia subbifurca* Warnst. ex Croz.** – 2.
***Sphaerocarpos texanus* Austin** – 2, 4, 6.
***Targionia hypophylla* L.** – 1, 2, 6.
***Targionia lorbeeriana* Müll.Frib.** – 4, 5.

HORNWORTS

***Anthoceros punctatus* L.** – 3.
***Phymathoceros bulbiculosus* (Brot.) Stotler, W. Doyle & Crand.-Stotl.** – 2, 3, 4, 6.
***Phaeoceros laevis* (L.) Prosk.** – 2, 5.

COMMENTS AND ANALYSIS OF THE CATALOGUE

One hundred and twenty-eight bryophyte taxa were found in the area in the present study. The list includes 97 mosses, 29 liverworts and 3 hornworts. Fifty-one species are new records for Baixo Alentejo province and 5 species are new to the country or correspond to their first locality there. Some species correspond to the second area to Portugal.

The presence and abundance of the species vary greatly, depending on the zones and site conditions and habitats considered, but mosses are the dominant element in the bryoflora of the area. The more representative group of the hepatics are the *Riccia* species (12 taxa). The xeric nature of the area causes evident dominance of acrocarpous moss species (80).

Pleurocarpous mosses (16) generally cover rocks or tree trunks and some are also aquatic, such as *Scorpiurium deflexifolium* and *Platyhypnidium lusitanicum*. Funariaceae are represented by 6 species in the area and Pottiaceae include more than 33% of the total number of mosses.

The more interesting locality corresponds to an old mine area, Mina de Aparis, where we found more than 50 species of bryophytes, from which three species of mosses are new reports for Portugal.

Microbryum fosbergii, a minute member of the family Pottiaceae, was found on bare soil in a natural grassland and has a restricted distribution: three regions of southwestern Spain (Badajoz, Córdoba and Sevilla), and a disjunct area in California (Ros *et al,* 2005). *Entosthodon mouretii* occurred on the margins of periodically flooded depressions, on acidic soils, near small lagoons. This species was only found in one locality in the northeast of the Iberian Peninsula and in Morocco (Brugués *et al.,* 1999). *Pyramidula tetragona* has been cited for many European countries, in some of which being classified as threatened according to ECCB (2006); in the Iberian Peninsula it has been reported from several sites in southern Spain (Albacete, Almería, Córdoba and Cádiz).

In Aparis one endemic species to the Iberian Peninsula was found, *Triquetrella arapilensis*, and some taxa correspond to the second record to Portugal, such as *Phascum cuspidatum* subsp. *papillosum* and *Tortula guepinii*.

Another species, *Bryum minii,* collected at Ribeira de Lima and Pulo do Lobo, presents a very restricted occurrence. This moss is only present in Portugal and Italy (Sérgio *et al*. 1999).

We found a very interesting aquatic community in Ribeira da Murtega with *Cinclidotus riparius*, an abundant species in the area and new to Baixo Alentejo and *Bryum cyclophyllum*, a new taxon to the country and the second locality to the Iberian Peninsula (Sérgio *et al. in press*).

In Castelo de Noudar, *Zygodon catarinoi* was collected. This recently described species (Garcia *et al.* 2006) is distributed in several localities over the Mediterranean region of the Iberian Peninsula, western and mainly southern Spain, as well as southern Portugal (Baixo Alentejo and Algarve) and also in Morocco (Rif and Middle Atlas).

Another interesting finding was *Didymodon bistratosus*, a moss described in the Iberian Peninsula, also a Mediterranean element, reported recently to Turkey (Erdag & Kürschner 2005) and Santa Monica Mountains, California (Zander *et al,* 2005).

A biogeographical analysis of the main chorological elements represented in the investigated area was performed by calculating the approximate percentages of different categories. The biogeographic considerations of the main chorological elements represented in the studied area (Fig. 2) were made through the percentage of the different chorological types. There is a relatively high percentage of oceanic-mediterranean and mediterranean-oceanic elements (37%) and submediterranean and mediterranean (34%). A small number of species with temperate (19%) and oceanic (6%) distribution are found, but boreal and

subalpine distribution types have lower percentage (1-3%). In general, these results are to be expected, considering the typical mediterranean bioclimatic condition of the area.

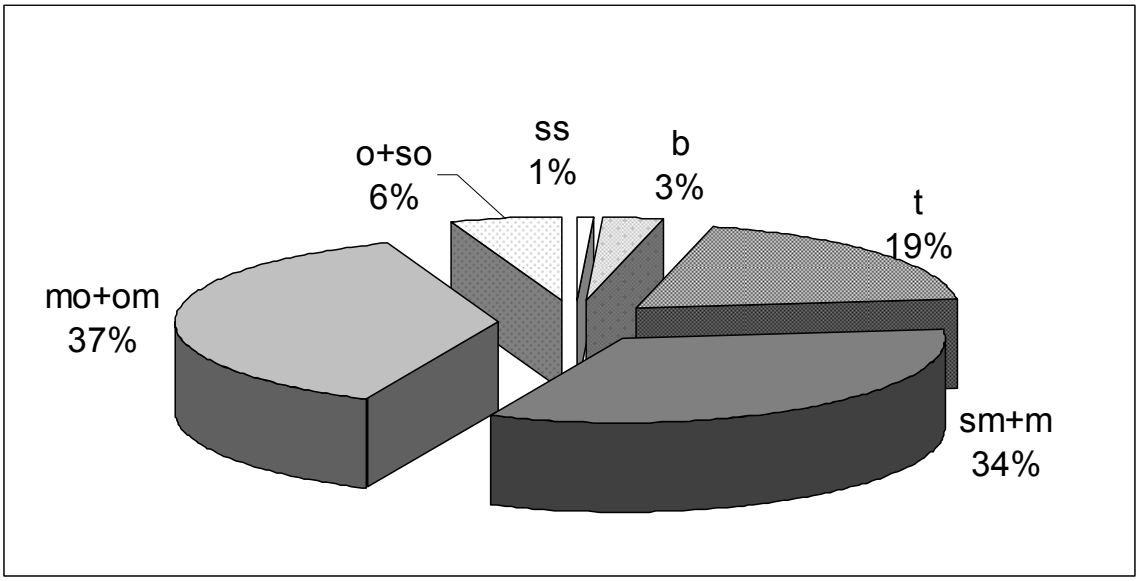

Figure 2. Percentage of the different chorological types of the bryophytes of Barrancos. (t = temperate; o+so = oceanic and suboceanic; mo+om = mediterranean-oceanic and oceanic-mediterranean; sm+m = submediterranean and mediterranean; b = boreal and ss = subarctic-subalpin).

CONCLUSION

To address both the conservation of bryophytes and their role in ecosystem protection, we need more data about the habitat, geographic distribution and abundance of the particular species over all the Iberian Peninsula. One major barrier to assess the status of conservation of bryophyte species is the variation in the intensity of sampling of different regions. So, the first recommendation is to do bryophyte surveys in selected areas that are predicted to have a larger number of species (Sérgio & Draper 2002) or incidence of endemics (Sérgio & Draper 2001).

On the other hand, the studied area is near a recent dam, and the bottom and the middle zones of the valley were completely lost. However, this upper area was preserved and classified as a Natura 2000 site, containing a high biodiversity, and actually it seems to be very important in biological terms.

So, this region should be recognized as a relevant unit among the Iberian bryophyte diversity hotspots, and it also contributes significantly to the overall biodiversity of the whole Guadiana basin. With this study, we assume that this area acts as a refuge for many species that present a disjunct distribution (Iberian Peninsula, North Africa, East Mediterranean and California).

Consequently, the site is very important for biological conservation but the ecological data suggest that the ecosystem is extremely fragile and must be protected from future disturbance. On the other hand, urgent survey of more sites is required and remedial measures should be considered for at least some of them, such as the small lagoon area near Mina de Aparis.

The present study is also part of the ongoing research on the bryophytes of the stream areas in the south-east of Alentejo which in the near future will contribute to the knowledge of the important bryophyte flora of temporary Mediterranean streams in Portugal.

ACKNOWLEDGEMENTS

This study was supported by FCT project POCTI/MGS/45325/2002 and Luso-Espanhola Actions CRUP – Nº E-21/04. We thank Graça Oliveira for improving the style of the language.

REFERENCES

BRUGUÉS, M., C. CASAS, R. M.CROS & C. SÉRGIO (1999). *Entosthodon mouretii* (Corb.) Jelenc new to Europe. *Cryptogamie, Bryol.* 29(1). 72-75.

DÜLL, R. (1983). Distribution of the European and Macaronesian liverworts (Hepaticophytina). *Bryol. Beitr.* 2: 1-114.

DÜLL, R. (1984). Distribution of the European and Macaronesian mosses (Bryophytina). *Bryol. Beitr.* 4: 1-113.

DÜLL, R. (1985). Distribution of the European and Macaronesian mosses (Bryophytina). *Bryol. Beitr.* 5: 1-112.

ECCB (2006). http://www.nt.ntnu.no/users/soder/ECCB/Red/RedMoss.htm

ERDAG, A. & H. KÜRSCHNER (2005). *Didymodon bistratosus* Hébrard & Pierrot (Pottiaceae, Bryopsida), a new record to the bryophyte flora of Turkey. *Cryptogamie, Bryol.* 26: 233-236.

GARCIA, C., F. LARA, C. SÉRGIO, M. SIM-SIM, R.GARILLETI & V. MAZIMPAKA (2006). *Zygodon catarinoi* (Orthotrichaceae, Bryopsida), a new epiphytic species from the Western Mediterranean Basin. *Nova Hedwigia* 82: 247-256.

HILL, M. O., N. BELL, M. A. BRUGGEMAN-NANNENGA, M. BRUGUÉS, M. J. CANO, J. ENROTH, K. I. FLATBERG, J.-P. FRAHM, M. T. GALLEGO, R. GARILLETI, J. GUERRA, L. HEDENÄS, D. T. HOLYOAK, J. HYVÖNEN, M. S. IGNATOV, F. LARA, V. MAZIMPAKA, J. MUÑOZ & L. SÖDERSTRÖM (2006). An annotated checklist of the mosses of Europe and Macaronesia. *J. Bryol.* 28: 198-267.

MYERS, N., R. A. MITTERMEIER, C. G. MITTERMEIER, G. A. B. da FONSECA & J. KENT (2000). Biodiversity hotspots for conservation priorities. *Nature* 403: 853-858.

ROS, R. M., O. WERNER & S. RAMS (2005). New taxonomical data on the genus *Microbryum* Schimp. (Pottiaceae, Musci). *Cryptogamie, Bryol.* 26(2). 167-172.

SÉRGIO, C. & S. CARVALHO (2003). Annotated catalogue of Portuguese bryophytes. *Portugaliae Acta Biol.* 21: 5-230.

SÉRGIO, C. & D. DRAPER (2001). Bryophyte survey as a basis for the validity of the Mediterranean isoclimatic areas in Portugal. *Bocconea* 13: 89-99.

SÉRGIO, C. & D. DRAPER (2002). How to evaluate species when distribution is poorly understood. The use of predictive studies for Iberian bryophytes. *Portugaliae Acta Biol.* 20: 37-48.

SÉRGIO, C., M. ARAÚJO & D. DRAPER (2000). Portuguese bryophytes diversity and priority areas for conservation. *Lindbergia* 25: 116-123.

SÉRGIO, C., C. CASAS, M. BRUGUÉS, R. M CROS & T. LOURO, (*submited*). New localities for *Bryum cyclophyllum* (Hedw.) Schimp. in Iberian Peninsula, a species found here over more than 90 years.

SÉRGIO, C., R. B. PIERROT, R. M. CROS & M. BRUGUÉS, (1999). Re-evaluation of *Bryum minii* Podp. (Bryaceae) and remarks about new discoveries in Portugal. *J. Bryol.* 21(4): 299-303.

WILLIAMS, P. H., C. J. HUMPHRIES, M. B. ARAÚJO, T. LAHTI, R. LAMPINEN, P. UOTILA & R. I. VANE-WRIGHT (1998). Important Plant Areas of Europe: exploring the consequences of selection criteria. *Planta Europa*, Workshop on Important Plant Areas of Europe. Uppsala.

ZANDER, R. H., J. A. JIMÉNEZ & T. SAGAR (2005). *Didymodon bistratosus* (Pottiaceae) in the New World. *Bryologist* 108(4). 540-543.