

Check-list of the bryophytes of the Serra de Sintra (Portugal)

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Abstract – An annotated check-list of the bryophytes of the Serra de Sintra is presented, based on a compendium of bibliographic records, on the revision of the material stored in Lisbon University herbarium (LISU) and Coimbra University herbarium (COI), as well as on the collections made by the authors during field work in 2011, 2013 and 2014. A total number of 279 taxa were recorded, out of which 5 taxa belong to Anthocerotophyta, 87 to Marchantiophyta and 187 to Bryophyta. Threat status in Portugal for taxa subject to conservation concern is also provided. The dominance of oceanic species on the other chorological types, as well as a remarkably high density of taxa per km² compared to other mountain regions in the Iberian Peninsula, is highlighted.

Hornworts / liverworts / mosses / biodiversity / European bryophyte

INTRODUCTION

Study area

The Serra de Sintra (Sintra Mountain) represents a remarkable site in Europe from the point of view of the richness and variety of its flora (Pinto da Silva *et al.*, 1991).

Its geographic position, at the furthest edge of the European Continent, near the Atlantic Ocean, and the peculiar climatic conditions resulting from such a location, a mixture of Atlantic and Mediterranean features, enable the occurrence of species, both of vascular plants and cryptogams, from different biogeographical regions.

As a result of the high humidity rate, ensuring constant water supply all year around (Azevedo Gomes, 1957), and the thickness of the forest mantle in most of the region, a huge variety of bryophytes, among which some Macaronesian species as well as several species of conservation concern for continental Portugal (Sérgio *et al.*, 2013a), found here a suitable habitat.

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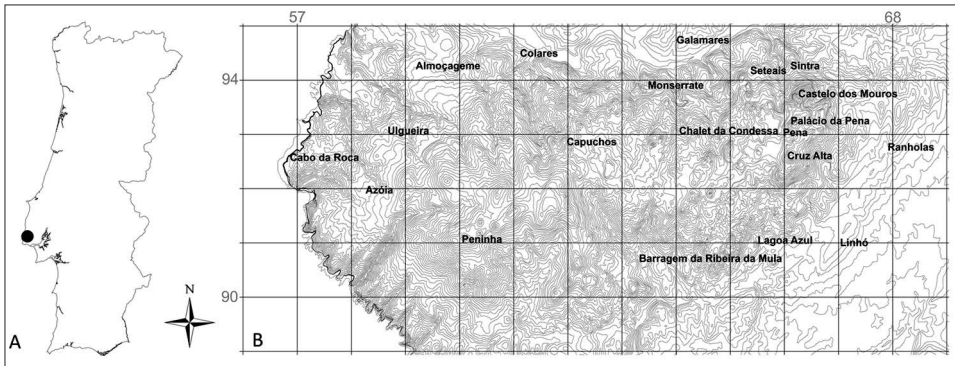


Fig. 1. A: Localization of the Serra de Sintra in Portugal. B: Serra de Sintra with the overlaying UTM grid and main locations. Each UTM value corresponds to a square 1×1 km.

The Serra de Sintra lies about 25 km northwest of Lisbon, marking the most western edge of the European Continent (Fig. 1) and is encompassed just by one 10×10 km square (29SMC69). It stretches around 10 km from East to West and 5 km from North to South, covering approximately 30 km^2 and reaching up to 528 m above sea level. The highest peaks, Cruz Alta and Peninha, both 528 m high, lie in the eastern part of the Serra. The western side of the Serra slopes down to a jagged coastline which is shaped by a series of high cliffs and gullies, reaching their most spectacular expression in the Cabo de Roca promontory, the most westerly point of continental Europe (Pinto da Silva *et al.*, 1991).

The Serra de Sintra is a subvolcanic massif made up of eruptive rocks resulting from the intrusion of magmatic material from the mantle into areas of conjugate faults (Pinto da Silva *et al.*, 1991; Kulberg & Kulberg, 2000). Such an intrusion is made up by a core of syenitic rocks surrounded by a large ring of granites and a discontinuous ring of gabbro-diorites. The granite occupies more than half of the eruptive area, which is included in calcareous sediments cropping out in the north-eastern part of the Serra and it makes up the highest peaks of the massif (Kulberg & Kulberg, 2000). The dominant type of soil is thus derived from eruptive rocks and is classified as humic cambisols (Pinto da Silva *et al.*, 1991).

The Serra de Sintra is characterized by both Mediterranean and Atlantic climatic features (Ribeiro *et al.*, 1987; Pinto da Silva *et al.*, 1991). Temperatures are, on average around 3-4 degrees lower than in the surrounding region, especially in the inner part of the Serra. Rainfalls occur mainly in autumn and winter, as is typical of a Mediterranean climate, however the Serra keeps a high rate of humidity all year around, due to the winds coming from the Ocean, bringing along thick fogs, which almost constantly wrap the top of the Serra and, by condensation against the slopes of the massif, duplicate the amount of water available for plants, even during the summer (Azevedo Gomes, 1957).

The climate of the Serra is regarded as generally belonging to the Mediterranean Humid Climate type, with areas mostly affected by the Atlantic microclimatic features and others showing typical Mediterranean character, also owing to the exposure of the slopes (Alcoforado, 1994).

The forest area of the Serra de Sintra covers approximately 5000 ha, 26% of which, corresponding to around 1300 ha, is managed by the State Forest Service (Ribeiro, 1996). The north-eastern part of the Serra is occupied by the vast estates that form the magnificent parks of the castles and palaces built by royalty and

nobility during the 19th century and the very beginning of the 20th. The largest estates are those of the Park of Monserrate, the Pena Park and the Capuchos Hermitage Park, all of them characterized by luxuriant vegetation, with a strong presence of Macaronesian species and tropical ferns.

Owing to the heavy alteration of the native flora by the hand of man, through the afforestation of bare areas with non-native species, such as *Acacia melanoxylon* R.Br., *Eucalyptus globulus* Labill. and *Pinus pinaster* Aiton, which soon grew invasive, as well as through the introduction, mainly during the 19th century and the first half of the 20th century, of exotic species from all over the world, destined to adorn the estates of Portuguese royalty and nobility, thickly dotting the Serra, the current vegetation of the region turned out to be quite artificial and in most sites no longer shows any features of the original species composition and vegetation patterns (Pinto da Silva *et al.*, 1991).

Another factor that has contributed to modify the native vegetation of the Serra is fire. During the last decades the Serra de Sintra has been affected by a series of fires that destroyed most of its original vegetation and led it to be gradually substituted by poorer communities made up mainly of competitive invasive plants and dominated by various species of *Acacia* Mill (Ribeiro, 1996).

The forests of the Serra are made up mainly of *Cupressus lusitanica* Mill., *Quercus faginea* Lam., *Q. pyrenaica* Willd., *Q. suber* L., with a significant amount of the invasives *Acacia melanoxylon* and *Eucalyptus globulus*, which in most sites have replaced the natural oak vegetation (Pinto da Silva *et al.*, 1991).

Bryophyte flora

The first bryophyte record for Serra de Sintra region dates back to the very beginning of the 19th century and is due to Brotero (1804), who reported it in his *Flora Lusitânica*. It was followed, in the next decades of the century, by those of Schimper (1836-1851, 1876), Mitten (1853), Levier (1880), Bottini (1886), Henriques (1886, 1889) and Warnstorf (1899). Both Mitten and Schimper identified material collected by Welwitsch between 1839 and 1853. Since the beginning of 20th century and up to 1950 several contributions to Sintra bryoflora were based on explorations by important bryologists such as Luisier (1907, 1910a, 1910b, 1916), Dixon (1912), Nicholson (1913), Machado (1917, 1920, 1925, 1928, 1930, 1932), Mendes (1948), Pereira Coutinho (1917a, 1917b), Casares Gil (1919, 1932), Allorge (1931a, 1931b, 1931c, 1935), Buch (1937), Ade & Koppe (1942), Sabino de Freitas (1944, 1948), Potier de la Varde (1945), as well as Portuguese botanists such as Tavares & Tavares (1946, 1948), Mendes (1948) and Sá Nogueira (1950). The latter's collections are reported in her publication "Briófitos da Serra de Sintra", in which she organized the records of the specimens gathered and previously referred under the name of Barros (1942a, 1942b, 1943).

From the second half of the 20th century until now the studies carried out on bryophytes in the Serra de Sintra region have essentially served as a preparatory stage in the drawing up of floras, catalogues, red-lists and works on individual species at national level or describing the biodiversity of the bryoflora of the Iberian Peninsula or Portugal (Tavares & Tavares, 1952; Müller, 1951-1958, 1953; Podpra, 1954; Pais, 1964, 1966; Sérgio, 1966, 1974, 1984, 1985, 1987, 1991, 2002, 2006; Grolle, 1970; Koponen, 1971; Sérgio & Mendes, 1971a, 1971b; Sérgio & Queiróz Lopes, 1972; Sérgio & Viana, 1973; Allorge, 1974; Jovet-Ast & Bischler, 1976; Grolle & Schumacker, 1982; Casas *et al.*, 1985, 1989, 1992, 1996; Düll-Hermans, 1986; Dirkse, 1987; Bisang *et al.*, 1986, 1989; Schumacker *et al.*, 1988;

Séneca-Cardoso, 1989; Sérgio & Sim-Sim, 1989; Sim-Sim, 1989, 1999; Zamora *et al.*, 1990; Schuster, 1992; Boisselier-Dubayle *et al.*, 1995, 1998; He, 1997; Fuertes *et al.*, 1997; Boisselier-Dubayle & Bischler, 1999; Fuertes & Acón, 1999; Gómez-Menor *et al.*, 1999; Jones, 1999; Sérgio & Carvalho, 2003; Sim-Sim *et al.*, 2003; Garcia 2006; Guerra *et al.*, 2006, 2010; Sérgio *et al.*, 2001, 2007a, 2007b, 2011a, 2011b, 2013a, 2013b; Garcia *et al.*, 2009; Ellis *et al.*, 2014).

As a matter of fact, despite the undoubted scientific interest held by the Serra de Sintra since the 17th century and the many important contributions to the knowledge of its flora from botanists, amateurs, and even occasional travelers (Pinto da Silva *et al.*, 1991), so far a complete catalogue of the bryophyte species occurring in such a remarkable site had not yet been produced.

Therefore, considering such an unaccountable shortage of information, as well as the more and more pressing demands for an all-encompassing knowledge of the biodiversity of biological hotspots in Europe, we felt that a revision of the state of the art about the bryoflora of such a unique site as the Serra de Sintra, protected as a Natural Park since 1994, belonging to the Natura 2000 network, and included in the list of the UNESCO World Heritage Sites since 1995, was more urgent than ever.

The aim of this work is thus to provide a list of both taxa occurring in the Serra de Sintra at the present time and those reported in bibliographic references, with hints about their conservation status, as well as to present a summary of the history of bryological investigation in this region.

MATERIAL AND METHODS

The following catalogue is based on all the published papers on the bryophytes occurring in the Serra de Sintra, on the material stored in the herbaria of the National Museum of Natural History and Science of Lisbon University (LISU, 312 specimens) and of Coimbra University (COI, 5 specimens), as well as on 886 samples gathered during fieldwork carried out by the authors of this work in 2011, 2013 and 2014, also kept at LISU. The total number of studied samples is around 1200. No additional bryophyte material from herbaria of other national and foreign institutions (e.g. BM, NY, PC, PO and S), was considered for the preparation of this work.

All the herbarium material from LISU which was included in this work, was thoroughly revised by the authors, in order to know which taxa from Serra de Sintra are represented and stored in LISU, whether or not if they were included in published papers or not. A small part had already been checked for other projects, such as Cartography of bryophytes of the Iberian Peninsula and the Balearic Islands, Canary Islands, Azores and Madeira (Casas *et al.*, 1985, 1989, 1992, 1996), Iberian Bryophyte Flora (Guerra *et al.*, 2006, 2010, 2014; Brugués *et al.*, 2007) and the Atlas and Red Data Book of Endangered Bryophytes of Portugal (Sérgio *et al.*, 2013a).

Among the specimens stored in LISU we chose to include in this work only those collected after 1980, excepting the specimens belonging to taxa regarded as new for the Serra de Sintra, all of which are reported in this checklist, independently from the year of collection. As new we meant those taxa never referred for the Serra de Sintra in any bibliographic reference and whose

occurrence in the area was assessed only thanks to herbarium material, whether collected in recent field work or stored in LISU or COI. The herbarium code numbers are reported only for specimens belonging to such taxa, which are marked with an asterisk (*). We chose 1980 as a threshold date for selecting the material to be included in the check-list as it also represents the threshold for the studies and distribution maps of endangered species in Portugal, which were used by Sérgio *et al.* (2013a).

No quantitative method was used during the fieldwork, as specimens were randomly collected, with the purpose of updating the knowledge on the bryophyte diversity of the studied area. The areas in which bryophyte specimens were collected were selected according to an altitudinal and ecological criteria, ranging from 200 m a.s.l. up to the highest elevations of the Serra and corresponding to its forested area, thus excluding the coastal zones such as Cabo de Roca as well as the most anthropized sites that lie just outside the perimeter of the Serra (eg. Colares, Galamares, Azóia, Portela). The 1 × 1 km square UTM coordinates for the sites in which specimens were collected are provided in Table 1.

Table 1. Collection sites of the Serra de Sintra and their UTM coordinates for the specimens in LISU herbarium (each UTM value corresponds to a square 1 × 1 km)

<i>Locality number</i>	<i>Locality name</i>	<i>UTM</i>
1	Sintra (general)	MC69
2	Capuchos	MC6192; MC6193; MC6292
3	Castelo dos Mouros	MC6595; MC6693; MC6694
4	Cruz Alta (Pena)	MC6593; MC6692
5	Estátua do Gigante (Pena)	MC6693
6	Fonte da Mata Alva	MC6393
7	Fonte dos Amores	MC6494
8	<i>Inter</i> Capuchos and Azóia	MC6192
9	<i>Inter</i> Capuchos and Lagoa da Mula	MC6190
10	<i>Inter</i> Capuchos and Urca	MC6192
11	<i>Inter</i> Castelo dos Mouros and Pena	MC6693
12	<i>Inter</i> Pena and Capuchos	MC6292; MC6492; MC6492
13	<i>Inter</i> Peninha and apuchos	MC6191; MC6292
14	Lagoa Azul	MC6591
15	Lagoa da Mula	MC6390
16	Monge	MC6191
17	Monserrate	MC6394; MC6493
18	Parque da Vila	MC6694
19	Parque das Merendas	MC6593; MC6694
20	Pena	MC6592; MC6593; MC6693
21	Penha Verde	MC6593
22	Peninha	MC5991; MC6091; MC6092
23	Pinhal do Duque	MC6592
24	Tapada D. Fernando	MC6292
25	Quinta da Regaleira	MC6594
26	Saldanha	MC6491; MC6492
27	São Pedro	MC6693; MC6793
28	Tapada do Mouco	MC6492

Whenever the local of collection of a given specimen and/or species was recorded as lying between two sites, one of which belonging to the study area while the other not, the choice of whether the sample should be considered for the work or not was made on the basis of a standard criterion. When on the sample the name of a local belonging to the study area was reported in first position (e.g. “between Capuchos and Azóia”), the sample was included, while when was in second position (e.g. “between Azóia and Capuchos”), it was left out of account. The locality data were cross-referenced with the bibliographic references and the available herbarium material.

Chorological types for the each taxa of the Serra de Sintra, were assigned based on Düll (1983, 1984, 1985) and adapted by the authors (Fig. 2).

The taxonomic classification adopted in this check-list is based on Goffinet *et al.*, (2008) for mosses and Crandall-Stotler *et al.* (2008) for liverworts and Renzaglia *et al.* (2008), for hornworts. The nomenclature of taxa was revised according to the two recently published check-lists of Mediterranean bryophytes (Ros *et al.*, 2007, 2013), and exceptions are given as notes. The main chorological data that served as a basis for the assessment of the occurrence of the species in the Serra de Sintra were provided by Sérgio & Carvalho (2003).

In the check-list the name of the taxa is followed by: 1) the numbers corresponding to the localities of collection of the samples gathered during field work and of the specimens stored in LISU and COI, according to Table 1 (the locality number 1 was reported just as “Sintra”, since the labels of the samples with such a note didn’t provide any further information as to the exact site of collection); 2) the bibliographic references from original records; 3) the IUCN threat category in Portugal for species included in Sérgio *et al.* (2013a), and when deemed meaningful, a comparison with the threat status in Spain, according to Brugués & González-Mancebo (2012); 4) when regarded as necessary, notes relative to taxonomic questions and/or other problems observed in the studied specimens, as well as information related to specimens collected by Wellwitsch because of their historical interest.

Species lacking herbarium voucher, and whose occurrence in the region is regarded as doubtful or whose identification resulted to be wrong, are included in the check-list in not bold font and are excluded in the overall species count for the Serra de Sintra.

RESULTS

Anthocerotophyta

***Anthoceros caucasicus* Steph.** – 4, 17, 18, 19, 20. Müller (1951-1958), Sérgio (1987), Casas *et al.* (1989), Sérgio *et al.* (2013a). VU (Portugal), NT (Spain).

***Anthoceros punctatus* L.** – 17. Nicholson (1913), Pereira Coutinho (1917a), Casares Gil (1919), Machado (1925).

****Phaeoceros carolinianus* (Michx.) Prosk.** – 17 (LISU232685).

***Phaeoceros laevis* (L.) Prosk.** – 2, 8, 17. Nicholson (1913), Pereira Coutinho (1917a), Machado (1925), Allorge (1974), Jovet-Ast & Bischler (1976).

***Phymatoceros bulbiculosus* (Brot.) Stotler, W.T. Doyle & Crand.-Stotl.** – 17. Casas *et al.* (1996).

Marchantiophyta

- Aneura pinguis* (L.) Dumort. – Mendes (1948), Jovet-Ast & Bischler (1976).
- Calypogeia arguta* Nees & Mont. – 6, 24. Mendes (1948), Jovet-Ast & Bischler (1976), Casas *et al.* (1992).
- Calypogeia fissa* (L.) Raddi – 2, 6, 10. Jovet-Ast & Bischler (1976).
- Cephalozia bicuspidata* (L.) Dumort. – 17. Jovet-Ast & Bischler (1976).
- Cephaloziella baumgartneri* Schiffn. – Allorge (1931a, 1931b), Müller (1951-1958), Jovet-Ast & Bischler (1976).
- Cephaloziella divaricata* (Sm.) Schiffn. – Jovet-Ast & Bischler (1976).
- Cephaloziella stellulifera* (Taylor ex Spruce) Schiffn. – 2, 16. Jovet-Ast & Bischler (1976).
- Cephaloziella turneri* (Hook.) Müll. Frib. – 4. Allorge (1931a), Jovet-Ast & Bischler (1976).
- **Chiloscyphus polyanthos* (L.) Corda – 1 (LISU255700), 15 (LISU255699), 22 (LISU53084).
- Cololejeunea minutissima* (Sm.) Schiffn. – 3, 12, 19, 22. Müller (1951-1958), Casas *et al.* (1985).
- Cololejeunea rossettiana* (C. Massal.) Schiffn. – 2, 3, 17, 19. Henriques (1886), Pereira Coutinho (1917a), Casares Gil (1919), Machado (1925), Müller (1951-1958), Allorge (1974), Casas *et al.* (1996).
- Conocephalum conicum* (L.) Dumort. – 2, 17. Henriques (1886), Pereira Coutinho (1917a), Machado (1925), Barros (1943), Sá-Nogueira (1950), Jovet-Ast & Bischler (1976).
- Conocephalum salebrosum* Szweykowski, Buczkowska & Odrzykoski – 1, 3. Sérgio *et al.* (2011a). This species was first reported for Portugal only recently (Sérgio *et al.*, *l.c.*).
- Corsinia coriandrina* (Spreng.) Lindb. – Henriques (1886), Casares Gil (1919), Machado (1925), Jovet-Ast & Bischler (1976), Casas *et al.* (1992).
- Diplophyllum albicans* (L.) Dumort. – 4. Allorge (1931a, 1974), Sabino de Freitas (1948), Tavares & Tavares (1948), Jovet-Ast & Bischler (1976).
- Drepanolejeunea hamatifolia* (Hook.) Schiffn. – 4. Tavares & Tavares (1952), Sérgio *et al.* (2013a). CR for Portugal and LC-att for Spain. Sintra is the only known site for this taxon in Portugal.
- Dumortiera hirsuta* (Sw.) Nees – Allorge (1931c), Sabino de Freitas (1944). VU for Portugal and NT for Spain.
- Fossombronia angulosa* (Dicks.) Raddi – 4, 17, 22. Henriques (1886), Pereira Coutinho (1917a) Casares Gil (1919), Machado (1925), Mendes (1948), Jovet-Ast & Bischler (1976).
- Fossombronia caespitiformis* De Not. ex Rabenh. – Mendes (1948).
- **Fossombronia caespitiformis* subsp. *multispira* (Schiffn.) J.R. Bray & D.C. Cargill – 22 (LISU256842).
- Fossombronia pusilla* (L.) Nees – 1. Pereira Coutinho (1917a), Sérgio (1974, 2002).

- **Fossombronia wondraczekii* (Corda) Lindb. – 15 (LISU147694).
- Frullania dilatata* (L.) Dumort. – 2, 4, 12, 19, 22, 26. Allorge (1931a), Mendes (1948), Jovet-Ast & Bischler (1976), Casas *et al.* (1985), Jones (1999).
- Frullania fragilifolia* (Taylor) Gottsche, Lindenb. & Nees – 22, 24, 26. Tavares & Tavares (1948), Casas *et al.* (1996).
- Frullania microphylla* (Gottsche) Pearson – 4, 19, 20, 22. Tavares & Tavares (1946), Müller (1951-1958), Bisang *et al.* (1989), Casas *et al.* (1996), Sim-Sim (1999), Sérgio *et al.* (2013a). VU for Portugal.
- **Frullania tamarisci* var. *mediterranea* (De Not.) Nees – 14 (LISU147732), 15 (LISU147777), 16 (LISU147778), 21 (LISU53216), 28 (LISU147772).
- Frullania tamarisci* (L.) Dumort. – 2, 3, 4, 5, 16, 17, 19, 20, 22, 26. Henriques (1886), Luisier (1910a, 1910b), Pereira Coutinho (1917a), Machado (1925), Sá-Nogueira (1950), Müller (1951-1958, 1953), Grolle (1970), Jovet-Ast & Bischler (1976). The first specimen of this taxon collected in Sintra by Welwitsch was described by Stephani in Henriques (*l.c.*) as *Frullania calcarifera* Steph., whose syntype is stored in LISU. More recently Heinrichs *et al.* (2010) considered this taxon as an independent species, but in our opinion its taxonomic placement should still be studied. For the infraspecific taxa of *Frullania tamarisci* we follow the taxonomic treatment of Sim-Sim (1999) for Portugal and Madeira.
- **Frullania tamarisci* var. *sardoa* (De Not.) De Not. – 1 (LISU53212), 3 (LISU147743), 20 (LISU202446), 22 (LISU53217).
- **Frullania tamarisci* var. *schiffnerii* Nicholson – 1 (LISU53219) (LISU53231) (LISU147773), 2 (LISU163214), 4 (LISU160648) (LISU163217) (LISU163218), 8 (LISU163212), 9 (LISU147775), 17 (LISU160647) (LISU160649), 22 (LISU147763).
- Frullania teneriffae* (F. Weber) Nees – 2, 3, 4, 12, 22. Henriques (1886), Machado (1925), Müller (1951-1958), Grolle (1970), Schumacker *et al.* (1988), Sim-Sim (1999), Sérgio *et al.* (2013a). VU for Portugal and NT for Spain.
- Gongylanthus ericetorum* (Raddi) Nees – Mendes (1948).
- Harpalejeunea molleri* (Steph.) Grolle – 2, 4, 17, 22. Henriques (1886), Casares Gil (1919), Machado (1925), Jovet-Ast & Bischler (1976), Bisang *et al.* (1986), Casas *et al.* (1992). EN for Portugal.
- **Jungermannia gracillima* Sm. – 2 (LISU156174) (LISU156175), 16 (LISU255721).
- **Jungermannia hyalina* Lyell – 16 (LISU190522) (LISU255711) (LISU255712).
- **Leiocollea turbinata* (Raddi) H. Buch – 2 (LISU255786) (LISU257097).
- Lejeunea cavifolia* (Ehrh.) Lindb. – 2, 3, 5, 8, 17, 19, 22, 25. Warnstorf (1899), Pereira Coutinho (1917a), Casares Gil (1919), Machado (1925), Mendes (1948), Allorge (1974), Jovet-Ast & Bischler (1976).
- Lejeunea eckloniana* Lindenb. – 2, 17, 22. Garcia (2006), Garcia *et al.* (2009).
- Lejeunea lamacerina* (Steph.) Schiffn. – 4, 6, 17, 20, 22. Jovet-Ast & Bischler (1976).
- Lejeunea mandonii* (Steph.) Müll. Frib. – 3, 2, 17, 18, 24. Tavares & Tavares (1946), Müller (1951-1958), Sérgio *et al.* (2013a). CR for Portugal and VU for Spain.

- Lejeunea patens* Lindb. – 2, 20. Jovet-Ast & Bischler (1976), Sérgio *et al.* (2013a). VU for Portugal.
- Lophocolea bidentata* (L.) Dumort. – 2, 4, 17, 19, 20, 22. Henriques (1886), Pereira Coutinho (1917a), Machado (1925), Casares Gil (1919), Sérgio & Mendes (1971a), Jovet-Ast & Bischler (1976).
- Lophocolea fragrans* (Moris & De Not.) Gottsche, Lindenb. & Nees – 17. Jovet-Ast & Bischler (1976), Sérgio *et al.* (2013a). EN for Portugal and VU for Spain.
- Lophocolea heterophylla* (Schrad.) Dumort. – 17, 20, 22. Jovet-Ast & Bischler (1976).
- Lunularia cruciata* (L.) Lindb. – 17. Henriques (1886), Pereira Coutinho (1917a), Machado (1925), Mendes (1948), Sá-Nogueira (1950), Sérgio & Viana (1973), Jovet-Ast & Bischler (1976), Boisselier-Dubayle *et al.* (1995).
- Mannia androgyna* (L.) A. Evans – Sabino de Freitas (1948), Casas *et al.* (1996).
- Marchesinia mackaii* (Hook.) Gray – 2, 5, 17, 20, 22. Pereira Coutinho (1917a), Machado (1925), Allorge (1931a), Müller (1951-1958), Jovet-Ast & Bischler (1976), Casas *et al.* (1989), Sérgio *et al.* (2013a). EN for Portugal. Sintra is the only known site for this taxon in Portugal.
- **Marsupella emarginata* (Ehrh.) Dumort. – 2 (LISU147870), 3 (LISU147861), 11 (LISU147831), (LISU147875).
- Metzgeria conjugata* Lindb. – 2, 4, 5, 19, 20. Buch (1937), Sérgio (1966). VU for Portugal and LC for Spain.
- Metzgeria furcata* (L.) Dumort. – 2, 3, 4, 5, 19, 20, 22, 25, 26. Henriques (1886), Pereira Coutinho (1917a), Machado (1925), Jovet-Ast & Bischler (1976), Jones (1999).
- Microlejeunea ulicina* (Taylor) A. Evans – 3, 4, 22. Sá-Nogueira (1950), Sérgio *et al.* (2013a). VU for Portugal.
- Oxymitra incrassata* (Brot.) Sérgio & Sim-Sim – Henriques (1886), Casares Gil (1919), Machado (1925), Casas *et al.* (1989), Sérgio & Sim-Sim (1989). The only specimen available was collected by Welwitsch in 1842.
- Pallavicinia lyellii* (Hook.) Carruth. – Sabino de Freitas (1948), Sérgio *et al.* (2013a). VU for Portugal.
- Pellia endiviifolia* (Dicks.) Dumort. – 17. Sérgio *et al.* (2007a).
- Pellia epiphylla* (L.) Corda – 17. Pereira Coutinho (1917a), Machado (1925), Jovet-Ast & Bischler (1976).
- Plagiochila bifaria* (Sw.) Lindenb. – 2, 3, 4, 17, 20, 24. Henriques (1886), Pereira Coutinho (1917a), Casares Gil (1919), Machado (1925), Buch (1937), Jovet-Ast & Bischler (1976), Grolle & Schumacker (1982), Sérgio *et al.* (2013a). EN for Portugal and LC-att for Spain.
- Plagiochila porelloides* (Torrey ex Nees) Lindenb. – Casares Gil (1919), Machado (1925), Sim-Sim *et al.* (2003).
- Porella arboris-vitae* (With.) Grolle – Nicholson (1913), Pereira Coutinho (1917a), Casares Gil (1919), Machado (1925), Sim-Sim (1989). The material studied by Sim-Sim (1989) from the Serra de Sintra (Machado's collections) corresponds to *P. canariensis*. The other reports from Sintra need thus to be confirmed.

- Porella canariensis* (F. Weber) Underw.** – 2, 3, 4, 5, 19, 22. Machado (1920, 1925), Allorge (1931a), Sérgio *et al.* (2013a). VU for Portugal.
- Porella obtusata* (Taylor) Trevis.** – 2, 20. Henriques (1886), Pereira Coutinho (1917a), Machado (1925), Sabino de Freitas (1948), Sá-Nogueira (1950), Allorge (1974).
- Porella platyphylla* (L.) Pfeiff.** – 22. Luisier (1910b), Machado (1925). VU for Portugal.
- Radula complanata* (L.) Dumort.** – 2, 22, 17. Pereira Coutinho (1917a), Allorge (1931a, 1974), Sabino de Freitas (1948), Sá-Nogueira (1950), Jovet-Ast & Bischler (1976), Jones (1999).
- Radula lindenbergiana* Gottsche ex C. Hartm.** – 2, 16, 17, 19, 22. Henriques (1886), Casares Gil (1919), Machado (1925), Mendes (1948), Sabino de Freitas (1948), Jovet-Ast & Bischler (1976).
- Reboulia hemisphaerica* (L.) Raddi** – 2, 17, 24. Henriques (1886), Pereira Coutinho (1917a), Machado (1925), Mendes (1948), Allorge (1974), Schuster (1992), Boisselier-Dubayle *et al.* (1998).
- Riccardia chamedryfolia* (With.) Grolle** – 17, 20. Sabino de Freitas (1948), Sérgio *et al.* (2013a). VU for Portugal and LC for Spain.
- Riccardia multifida* (L.) Gray** – 17, 24. Jovet-Ast & Bischler (1976).
- Riccia beyrichiana* Hampe ex Lehm.** – Jovet-Ast & Bischler (1976).
- Riccia bicarinata* Lindb.** – Pereira Coutinho (1917a), Casares Gil (1919), Machado (1925), Sabino de Freitas (1944), Casas *et al.* (1996).
- ****Riccia ciliata* Hoffm.** – 2 (LISU255856), 17 (LISU256407).
- Riccia crozalsii* Levier** – Jovet-Ast & Bischler (1976).
- ****Riccia crystallina* L. emend. Raddi** – 2 (LISU255857), 17 (LISU256408)
- Riccia fluitans* L.** – Sabino de Freitas (1948), Sérgio *et al.* (2013a). CR for Portugal and VU for Spain.
- Riccia gougetiana* Durieu & Mont.** – Sérgio & Mendes (1971b).
- Riccia macrocarpa* Levier** – Casas *et al.* (1992). This species was not found any more in the Serra de Sintra after being collected by Welwitsch in 19th century.
- ****Riccia michelii* Raddi** – 22 (LISU256409).
- ****Riccia nigrella* DC.** – 2 (LISU255858), 17 (LISU256410).
- ****Riccia sommieri* Levier** – 4 (LISU219638).
- Riccia sorocarpa* Bisch.** – 2, 17. Jovet-Ast & Bischler (1976).
- ****Riccia warnstorffii* Limpr. ex Warnst.** – 21 (LISU219647).
- Saccogyna viticulosa* (L.) Dumort.** – 2, 4, 17, 20, 25. Luisier (1910a), Pereira Coutinho (1917a), Machado (1925), Buch (1937), Jovet-Ast & Bischler (1976), Sérgio *et al.* (2013a). LC-att- for Portugal.
- Scapania compacta* (A. Roth) Dumort.** – Pereira Coutinho (1917a), Casares Gil (1919), Machado (1925), Allorge (1931a, 1974), Jovet-Ast & Bischler (1976).

- Scapania curta* (Mart.) Dumort. – According to Sérgio *et al.* (2001), the material reported under this name corresponds to *Scapania nemorea*.
- Scapania gracilis* Lindb. – Luisier (1910b), Pereira Coutinho (1917a), Casares Gil (1919), Machado (1925).
- Scapania nemorea* (L.) Grolle – 2, 4, 17. Henriques (1886), Pereira Coutinho, (1917a) Casares Gil (1919), Machado (1925), Sabino de Freitas (1944).
- Scapania undulata* (L.) Dumort. – Mendes (1948).
- Southbya nigrella* (De Not.) Henriq. – 2, 17. Allorge (1931a).
- **Southbya tophacea* (Spruce) Spruce – 7 (LISU53055).
- **Sphaerocarpos texanus* Austin – 17 (LISU256900).
- Targionia hypophylla* L. – 17. Henriques (1886), Luisier (1910b), Pereira Coutinho (1917a), Machado (1925), Mendes (1948), Jovet-Ast & Bischler (1976), Boisselier-Dubayle & Bischler (1999). Although the specimen present in the herbarium collection was confirmed as *T. hypophylla*, some of the references reported for this species can actually refer to *T. lorbeeriana*.
- Targionia lorbeeriana* Müll. Frib. – 1, 2, 17, 22, 26. Müller (1951-1958), Sérgio & Queiróz Lopes (1972), Zamora *et al.* (1990).

Bryophyta

- Alleniella complanata* (Hedw.) S. Olsson, Enroth & D. Quandt – 2, 3, 4, 5, 17, 19, 22, 24, 25. Luisier (1907, 1916), Pereira Coutinho (1917b), Allorge (1931a, 1974), Machado (1932), Ade & Koppe (1942), Barros, (1942b), Sá-Nogueira (1950).
- **Aloina aloides* (Koch ex Schultz) Kindb. – 22 (LISU256902).
- Antitrichia curtipendula* (Hedw.) Brid. – Brotero (1804).
- Archidium alternifolium* (Hedw.) Mitt. – Pereira Coutinho (1917b), Sérgio (1991), Casas *et al.* (1992). This species was collected in the Serra de Sintra only by Welwitsch in 1842 and never found again.
- **Atrichum angustatum* (Brid.) Bruch & Schimp. – 4 (LISU256903), (LISU256904).
- Atrichum undulatum* (Hedw.) P. Beauv. – 2. Henriques (1889).
- Barbula convoluta* Hedw. – 2. Ade & Koppe (1942), Allorge (1974).
- **Barbula convoluta* var. *sardoa* Schimp. – 17 (LISU256906), 22 (LISU256907).
- **Barbula unguiculata* Hedw. – 20 (LISU196300).
- Bartramia pomiformis* Hedw. – 3, 20, 22. Mitten (1853), Henriques (1889), Pereira Coutinho (1917b), Casas *et al.* (1992).
- Bartramia stricta* Brid. – 20. Pereira Coutinho (1917b), Barros (1942b), Allorge (1974), Casas *et al.* (1992).
- Brachytheciastrum velutinum* (Hedw.) Ignatov & Huttunen – Machado (1932), Allorge (1974).
- **Brachythecium albicans* (Hedw.) Schimp. – 0 (LISU160407).

- Brachythecium glareosum* (Bruch ex Spruce) Schimp. – 2, 4, 20, 26. Machado (1917, 1932), Pereira Coutinho (1917b).
- Brachythecium rutabulum* (Hedw.) Schimp. – 2, 20, 4, 22. Warnstorf (1899), Pereira Coutinho (1917b), Machado (1932), Allorge (1974).
- **Bryum argenteum* Hedw. – 4 (LISU256927).
- Bryum dichotomum* Hedw. – Ade & Koppe (1942), Sá-Nogueira (1950), Allorge (1974).
- **Bryum radiculosum* Brid. – 26 (LISU256938).
- Calliergonella cuspidata* (Hedw.) Loeske – Luisier (1910b, 1916), Machado (1932), Allorge (1974).
- Campylopus fragilis* (Brid.) Bruch & Schimp. – 1, 2, 24. Levier (1880), Pereira Coutinho (1917b), Machado (1928), Casares Gil (1932), Ade & Koppe (1942), Allorge (1974), Sérgio *et al.* (2013b).
- **Campylopus introflexus* (Hedw.) Brid. – 2 (LISU255881), 6 (LISU256942), 20 (LISU255882), 16 (LISU256950) (LISU256951), 22 (LISU256948), 26 (LISU256941), (LISU256949).
- Campylopus pilifer* Brid. – 2, 20, 22, 26. Henriques (1889), Luisier (1916), Casares Gil (1932), Casas *et al.* (1989).
- **Campylopus pyriformis* (Schultz) Brid. – 26 (LISU256959).
- Ceratodon purpureus* (Hedw.) Brid. – 22, 26. Ade & Koppe (1942), Allorge (1974).
- Cheilothela chloropus* (Brid.) Broth. – Levier (1880), Casas *et al.* (1985).
- Cirriphyllum crassinervium* (Taylor) Loeske & M. Fleisch. – 2, 3, 4, 5, 16, 17, 19, 24. Levier (1880), Henriques (1889), Allorge (1931a), Machado (1932), Sá-Nogueira (1950), Allorge (1974), Sérgio *et al.* (2007b).
- **Cinclidotus fontinaloides* (Hedw.) P. Beauv. – 1 (COI10001522). The only specimen available was collected by Welwitsch in 1839.
- Cryphaea heteromalla* (Hedw.) D. Mohr – 3, 5, 19, 22. Mitten (1853), Henriques (1889), Dixon (1912), Pereira Coutinho (1917b), Allorge (1931a, 1974), Machado (1932), Sá-Nogueira (1950), Pais (1966), Casas *et al.* (1992).
- Dialytrichia mucronata* (Brid.) Broth. – 2. Casas *et al.* (1985).
- **Dialytrichia saxicola* (Lamy) M.J. Cano – 3 (LISU148351) (LISU256971), 17 (LISU256972). According to Cano (2007) *D. fragilifolia* (Bizot & J. Roux) F. Lara is a synonym of *D. saxicola* but in our opinion *Dialytrichia* genus needs further studies.
- Dicranella heteromalla* (Hedw.) Schimp. – 20, 4. Machado (1928), Casares Gil (1932), Allorge (1974).
- **Dicranella howei* Renauld & Cardot – 1 (LISU239424).
- **Dicranella subulata* (Hedw.) Schimp. – 17 (LISU148372).
- Dicranoweisia cirrata* (Hedw.) Lindb. – 2, 20, 22, 26. Allorge (1974).
- Dicranum scoparium* Hedw. – 2, 3, 4, 5, 20, 22. Mitten (1853), Henriques (1889), Pereira Coutinho (1917b), Ade & Koppe (1942), Sá-Nogueira (1950), Allorge (1974).

- **Didymodon eckeliae* R.H. Zander – 2 (LISU255895). This species was reported from Portugal by Sérgio *et al.* (2013a). VU for Spain, while the assessment of its threat status is not yet available in Portugal.
- Didymodon fallax* (Hedw.) R.H. Zander – 22. Ade & Koppe (1942), Allorge (1974).
- Didymodon insulanus* (De Not.) M.O. Hill – 2, 17, 20. Warnstorf (1899), Allorge (1935, 1974).
- Didymodon luridus* Hornsch. – 2, 3. Ade & Koppe (1942), Allorge (1974).
- Didymodon rigidulus* Hedw. – Levier (1880), Machado (1928), Casares Gil (1932).
- Didymodon sinuosus* (Mitt.) Delogne – 2, 4, 17, 19. Sérgio *et al.* (2013a), Ellis *et al.* (2014).
- **Didymodon tophaceus* (Brid.) Lisa – 2 (LISU256988).
- Diphyscium foliosum* (Hedw.) D. Mohr – Allorge (1931a, 1974), Casas *et al.* (1989).
- Ditrichum subulatum* Hampe – 20. Levier (1880), Allorge (1931a).
- Entosthodon attenuatus* (Dicks.) Bryhn – 17, 20, 24. Mitten (1853), Levier (1880), Henriques, (1889), Pereira Coutinho (1917b), Casas *et al.* (1996).
- Entosthodon convexus* (Spruce) Brugués – 27. Casas *et al.* (1996).
- Entosthodon fascicularis* (Hedw.) Müll. Hal. – 6, 24. Pereira Coutinho (1917b), Machado (1930), Casas *et al.* (1996).
- Entosthodon obtusus* (Hedw.) Lindb. – Mitten (1853), Henriques (1889), Pereira Coutinho (1917b), Casas *et al.* (1996).
- Entosthodon pulchellus* (H. Philib.) Brugués – 19. Pereira Coutinho (1917b), Casas *et al.* (1996).
- Epipterygium tozeri* (Grev.) Lindb. – 17, 20, 22, 26. Casas *et al.* (1996).
- Eucladium verticillatum* (With.) Bruch & Schimp. – 2, 17, 19. Schimper (1876), Henriques (1889), Pereira Coutinho (1917b), Casares Gil (1932). The material collected by Welwitsch in “Cintra” in 1849 and stored in LISU (53571) is the isotype of *Weissia welwitschii* Schimp.
- Eurhynchiastrum pulchellum* (Hedw.) Ignatov & Huttunen – 4. Levier (1880), Machado (1932).
- Eurhynchium striatum* (Hedw.) Schimp. – Machado (1932), Allorge (1974).
- Exsertotheca crispa* (Hedw.) S. Olsson, Enroth & D. Quandt – 20. Sá-Nogueira (1950).
- Fissidens bryoides* Hedw. – 17, 20. Henriques (1889), Machado (1928), Sá-Nogueira (1950), Allorge (1974).
- **Fissidens crassipes* subsp. *warnstorffii* (M. Fleisch.) Brugg.-Nann. – 15 (LISU148440).
- **Fissidens crispus* Mont. – 6 (LISU257004), 20 (LISU232586).
- Fissidens dubius* P. Beauv. – 2, 6, 17, 18, 22. Levier (1880), Luisier (1916), Pereira Coutinho (1917b), Casares Gil (1932), Allorge (1935, 1974), Ade & Koppe (1942), Potier de la Varde (1945), Sá-Nogueira (1950).

- Fissidens fontanus* (Bach. Pyl.) Steud. – Henriques (1889), Dixon (1912), Luisier (1916), Pereira Coutinho (1917b), Machado (1928), Barros (1942b), Casas *et al.* (1989).
- Fissidens serrulatus* Brid. – 4, 17. Schimper (1836-1851), Mitten (1853), Levier (1880), Bottini (1886), Henriques (1889), Luisier (1916), Pereira Coutinho (1917b), Machado, (1928), Casares Gil (1932), Allorge (1974).
- Fissidens taxifolius* Hedw. – 16, 17, 20. Potier de la Varde (1945), Allorge (1974).
- Fissidens viridulus* (Sw. ex anon.) Wahlenb. – 17, 22. Potier de la Varde (1945), Allorge (1974).
- Fissidens viridulus* var. *incurvus* (Starke ex Röhl.) Waldh. – 17. Warnstorf (1899).
- **Fontinalis antipyretica* Hedw. – 1 (LISU54491).
- Fontinalis hypnoides* var. *duriaei* (Schimp.) Kindb. – Henriques (1889), Machado (1932), Sá-Nogueira (1950), Allorge (1974).
- Funaria hygrometrica* Hedw. – 17, 20. Henriques (1889), Pereira Coutinho (1917b), Ade & Koppe (1942), Barros (1942b), Sá-Nogueira (1950).
- Grimmia decipiens* (Schultz) Lindb. – 4, 5, 22, 26, 28. Mitten (1853), Henriques (1889), Luisier (1916), Pereira Coutinho (1917b), Ade & Koppe (1942), Allorge (1974).
- Grimmia laevigata* (Brid.) Brid. – 22, 24, 26. Pereira Coutinho (1917b).
- Grimmia lisae* De Not. – 3, 4, 5, 17, 28. Machado (1930).
- Grimmia pulvinata* (Hedw.) Sm. – 2, 3. Ade & Koppe (1942).
- **Grimmia trichophylla* Grev. – 2 (LISU260661), 13 (LISU156284), 20 (LISU260659), 22 (LISU53899), 24 (LISU260660).
- Gymnostomum calcareum* Nees & Hornsch. – 2, 3, 18, 19, 27. Levier (1880), Warnstorf (1899), Luisier (1910b, 1916), Machado (1928), Allorge (1931a, 1974).
- Gymnostomum calcareum* var. *atlanticum* Sérgio – 2, 18, 19, 22. Sérgio (2006). This taxon was not included in the accepted taxa list of Ros *et al.* (2013), but it is nonetheless reported here as such, following the revision of *G. calcareum* complex by Sérgio (*l.c.*).
- Gymnostomum viridulum* Brid. – 20, 23. Henriques (1889), Sérgio (1984), Casas *et al.* (1985).
- Gyroweisia reflexa* (Brid.) Schimp. – Ade & Koppe (1942). CR for Portugal.
- Hedwigia ciliata* (Hedw.) P. Beauv. – 26. Mitten (1853), Henriques (1889), Pereira Coutinho (1917b), Machado (1932), Allorge (1974).
- **Hedwigia ciliata* var. *leucophaea* Bruch & Schimp. – 22 (LISU257031) (LISU257032).
- Hedwigia stellata* Hedenäs – 2, 22. Casas *et al.* (1996).
- **Heterocladium heteropterum* (Brid.) Schimp. – 2 (LISU255920) (LISU257035), 4 (LISU255921).
- Homalia lusitanica* Schimp. – 2, 3, 17. Schimper (1836-1851), Mitten (1853), Levier (1880), Henriques (1889), Dixon (1912), Luisier (1916), Pereira Coutinho (1917b), Machado (1920, 1932), Allorge (1931a), Düll-Hermans (1986), Dirkse (1987), Casas *et al.* (1992), He (1997), Sérgio *et al.* (2013a).

The material collected by Welwitsch in 1847 and stored in LISU (54641) is an isotype of this name. The holotype (*Welwitsch 24*, “Cintra, W of Lisbon”) is stored in BM (He, 1997). VU for Portugal.

**Homalothecium aureum* (Spruce) H. Rob. – 4 (LISU255926) (LISU257039).

Homalothecium lutescens (Hedw.) H. Rob. – Allorge (1931a, 1974). The specimens collected in Sintra need to be checked and their identity confirmed. This species is typical of calcareous substrates and is quite rare in mountain areas of Portugal. Therefore its occurrence in Sintra is doubtful. EN for Portugal.

Homalothecium sericeum (Hedw.) Schimp. – 2, 3, 4, 16, 17, 19, 22. Mitten (1853), Henriques (1889), Luisier (1916), Pereira Coutinho (1917b), Machado (1932), Ade & Koppe (1942), Allorge (1974), Jones (1999).

Homomallium incurvatum (Schrad. ex Brid.) Loeske – 3, 4, 22. Pereira Coutinho (1917b), Machado (1932), Sérgio *et al.* (2013a). EN for Portugal.

Hookeria lucens (Hedw.) Sm. – Casas *et al.* (1992).

Hypnum andoi A.J.E. Sm. – 2, 17, 22, 26. Pereira Coutinho (1917b), Machado (1932), Allorge (1974).

Hypnum cupressiforme Hedw. – 2, 17, 20, 22, 26. Mitten (1853), Levier (1880), Henriques (1889), Warnstorf (1899), Ade & Koppe (1942), Sá-Nogueira (1950), Jones (1999). See *Hypnum imponens*.

**Hypnum cupressiforme* var. *filiforme* Brid. – 2 (LISU255930) (LISU257055).

**Hypnum cupressiforme* var. *lacunosum* Brid. – 22 (LISU257056).

Hypnum cupressiforme var. *resupinatum* (Taylor) Schimp. – 4, 19, 22, 2, 26, 17, 24. Machado (1932), Sá-Nogueira (1950), Allorge (1974). The taxonomic placement of this variety is doubtful, being regarded by some authors as a species of its own (Frey *et al.*, 2006).

**Hypnum cupressiforme* var. *subjulaceum* Molendo – 2 (LISU257065), 17 (LISU260644) (LISU260645), 22 (LISU260643). This variety was first reported from Portugal by Machado (1930), having been found yet only in Minho region, in the north of the country. The specimens here referred represent thus the first records of this taxon in central Portugal, as during the last years this variety had not been regarded as distinctive and is thus likely that more samples identified as *Hypnum cupressiforme sensu lato* actually belong to the var. *subjulaceum*.

Hypnum imponens Hedw. – Pereira Coutinho (1917b), Machado (1932). The specimens collected by Welwitsch in Sintra and reported by Pereira Coutinho and Machado were reviewed and identified as *Hypnum cupressiforme*. NT for Portugal and CR for Spain.

**Hypnum jutlandicum* Holmen & E. Warncke – 4 (LISU257066), 22 (LISU257067).

**Hypnum uncinulatum* Jur. – 20 (LISU55084), 22 (LISU257070), 26 (LISU257069). VU for Portugal and NT for Spain.

**Imbriobryum alpinum* (Huds. ex With.) N. Pedersen – 1 (COI10001271). The only specimen available was collected by Welwitsch in 1839.

Isoetecium algarvicum W.E. Nicholson & Dixon – 2, 3, 4, 17, 25. Sérgio *et al.* (2013a). The distribution of this species in Portugal needs to be assessed. VU for both Portugal and Spain.

- **Isothecium holtii* Kindb. – 20 (LISU255939) (LISU260662). LC for Portugal and VU for Spain.
- Isothecium alopecuroides* (Lam. ex Dubois) Isov. – 2, 4, 20, 25. Mitten (1853), Henriques (1889), Luisier (1916), Pereira Coutinho (1917b), Pais (1964), Allorge (1974).
- Isothecium myosuroides* Brid. – 2, 4, 17, 20, 22. Henriques (1889), Luisier (1916), Machado (1932), Sá-Nogueira (1950), Allorge (1974). The material reported for Sintra by Allorge (*l.c.*) and stored in PC should be revised for confirmation.
- Kindbergia praelonga* (Hedw.) Ochyra – 2, 3, 17, 18, 22, 26. Luisier (1916), Pereira Coutinho (1917b), Sá-Nogueira (1950).
- **Leptobarbula berica* (De Not.) Schimp. – 17 (LISU257098). VU for Portugal.
- Leptodictyum riparium* (Hedw.) Warnst. – Luisier (1916), Pereira Coutinho (1917b), Machado (1932), Allorge (1974).
- Leptodon smithii* (Hedw.) F. Weber & D. Mohr – 2, 17, 19, 22, 25. Mitten (1853), Levier (1880), Henriques (1889), Luisier (1916), Pereira Coutinho (1917b), Allorge (1931a, 1974), Machado (1932), Ade & Koppe (1942), Sá-Nogueira (1950), Casas *et al.* (1992), Jones (1999).
- Leucobryum juniperoideum* (Brid.) Müll. Hal. – 2, 17, 19, 25. Luisier (1910b, 1916), Pereira Coutinho (1917b), Machado (1928), Allorge (1974), Casas *et al.* (1996), Sérgio *et al.* (2013a).
- Leucodon sciuroides* (Hedw.) Schwägr. – Pereira Coutinho (1917b), Machado (1932), Allorge (1974), Fuertes *et al.* (1997), Jones (1999). The only specimen available at LISU was collected by Welwitsch in 1845 and it can be identified as var. *morensis* (Schwägr.) De Not., although, according to Stech *et al.* (2011), this taxon should be considered as a synonym of *L. sciuroides* var. *sciuroides*.
- Microbryum starckeanum* (Hedw.) R.H. Zander – Pereira Coutinho (1917b), Casares Gil (1932).
- Microeurhynchium pumilum* (Wilson) Ignatov & Vanderpoorten – 2, 3, 4, 17, 19, 20, 22. Pereira Coutinho (1917b), Machado (1932), Allorge (1974).
- Micromitrium tenerum* (Bruch & Schimp.) Crosby – 17, 26. Guerra *et al.* (2010), Sérgio *et al.* (2013a).
- Mnium hornum* Hedw. – Pereira Coutinho (1917b), Fuertes & Acón (1999).
- Neckera pumila* Hedw. – 5, 19, 22. Allorge (1974), Jones (1999).
- Nogopterium gracile* (Hedw.) Sm. – 2, 3, 17, 19, 20, 22. Luisier (1916), Pereira Coutinho (1917b), Machado (1932), Allorge (1974), Jones (1999).
- Orthotrichum anomalum* Hedw. – Pereira Coutinho (1917b), Pais (1964).
- **Orthotrichum lyellii* Hook. & Taylor – 20 (LISU257130), 22 (LISU204728).
- Orthotrichum rupestre* Schleich. ex Schwägr. – 3. Pereira Coutinho (1917b).
- **Orthotrichum tenellum* Bruch ex Brid. – 19 (LISU206856), 22 (LISU204729).
- Oxyrrhynchium hians* (Hedw.) Loeske – 22, 4. Pereira Coutinho (1917b), Machado (1932), Allorge (1974).

- **Oxyrrhynchium schleicheri* (R. Hedw.) Röhl. – 2 (LISU257141), 4 (LISU257140), 22 (LISU257139). VU for Portugal.
- Oxyrrhynchium speciosum* (Brid.) Warnst. – Ade & Koppe (1942).
- **Philonotis capillaris* Lindb. – 21 (LISU255734).
- **Philonotis fontana* (Hedw.) Brid. – 22 (LISU54476).
- **Philonotis marchica* (Hedw.) Brid. – 22 (LISU54446).
- Philonotis rigida* Brid. – Pereira Coutinho (1917b), Casas *et al.* (1989), Guerra *et al.* (2010), Sérgio *et al.* (2013a).
- Plagiomnium affine* (Blandow ex Funck) T.J. Kop. – 4, 17, 22. Pereira Coutinho (1917b), Koponen (1971).
- **Plagiomnium rostratum* (Schrad.) T.J. Kop. – 20 (LISU172469).
- Plagiomnium undulatum* (Hedw.) T.J. Kop. – 17, 20. Sá-Nogueira (1950), Gómez-Menor *et al.* (1999). The specimens reported by Sá-Nogueira (1950) may belong to *P. undulatum* var. *madeirense*. The rest of the material from LISU was recently reviewed and confirmed as var. *undulatum*.
- Plagiomnium undulatum* var. *madeirense* T.J. Kop. & Sérgio – 4, 17, 20. Sérgio *et al.* (2011b).
- Plagiothecium nemorale* (Mitt.) A. Jaeger – 2, 3, 4, 19, 20. Sá-Nogueira (1950), Séneca-Cardoso (1989).
- Plasteurhynchium meridionale* (Schimp.) M. Fleisch. – 1, 2, 3, 4, 17. Mitten (1853), Levier (1880), Henriques (1889), Warnstorf (1899), Luisier (1916), Pereira Coutinho (1917b), Allorge (1935, 1974), Ade & Koppe (1942).
- Plasteurhynchium striatulum* (Spruce) M. Fleisch. – Machado (1932).
- Pleuridium subulatum* (Hedw.) Rabenh. – 17. Mitten (1853), Henriques (1889), Machado (1928), Casares Gil (1932), Allorge (1974).
- Pogonatum aloides* (Hedw.) P. Beauv. – 2, 17, 22. Mitten (1853), Henriques (1889), Barros (1942b), Allorge (1974), Casas *et al.* (1992).
- Pogonatum nanum* (Hedw.) P. Beauv. – 1. Mitten (1853). The only specimen available and revised was collected by Welwitsch in 1839 (COI1002562).
- **Polytrichastrum formosum* (Hedw.) G.L. Sm. – 20 (LISU256363).
- Polytrichum juniperinum* Hedw. – 22. Sá-Nogueira (1950).
- **Polytrichum piliferum* Hedw. – 22 (LISU257142).
- **Pseudocrossidium revolutum* (Brid.) R.H. Zander – 3 (LISU53700), 17 (LISU256372).
- Pseudoscleropodium purum* (Hedw.) M. Fleisch. – 20. Ade & Koppe (1942), Allorge (1974).
- **Pseudotaxiphyllum elegans* (Brid.) Z. Iwats. – 4 (LISU153334), 17 (LISU256373).
- Ptychostomum capillare* (Hedw.) D.T. Holyoak & N. Pedersen – 2, 3, 17, 19, 20, 22. Luisier (1916), Sá-Nogueira (1950).
- Ptychostomum donianum* (Grev.) D.T. Holyoak & N. Pedersen – 19, 26. Warnstorf (1899), Ade & Koppe (1942), Barros (1942a), Allorge (1974).
- Ptychostomum imbricatum* (Müll. Hal.) D.T. Holyoak & N. Pedersen – 20, 22. Ade & Koppe (1942).

- **Ptychostomum pseudotriquetrum* (Hedw.) J.R. Spence & H.P. Ramsay** – 6 (LISU256937), 17 (LISU54229).
- Ptychostomum rubens* (Mitt.) D.T. Holyoak & N. Pedersen** – Pereira Coutinho (1917b), Machado (1930), Allorge (1974).
- **Racomitrium affine* (F. Weber & D. Mohr) Lindb.** – 2 (LISU255983).
- **Racomitrium heterostichum* (Hedw.) Brid.** – 22 (LISU256379), 26 (LISU256380).
- Racomitrium lanuginosum* (Hedw.) Brid.** – Luisier (1907, 1916), Pereira Coutinho (1917b).
- **Rhizomnium punctatum* (Hedw.) T.J. Kop.** – 17 (LISU256397), 22 (LISU256389).
- Rhynchostegiella curviseta* (Brid.) Limpr.** – 17, 22. Henriques (1889), Pereira Coutinho (1917b), Machado (1932).
- Rhynchostegiella litorea* (De Not.) Limpr.** – 1, 6, 17, 22, 26. Pereira Coutinho (1917b).
- Rhynchostegiella tenella* (Dicks.) Limpr.** – 2, 3, 17, 18. Pereira Coutinho (1917b), Ade & Koppe (1942), Allorge (1974).
- **Rhynchostegiella teneriffae* (Mont.) Dirkse & Bouman** – 7 (LISU54870).
- Rhynchostegium confertum* (Dicks.) Schimp.** – 2, 4, 5, 17, 20, 22. Pereira Coutinho (1917b), Machado (1932), Ade & Koppe (1942), Allorge (1974).
- **Rhynchostegium megapolitanum* (Blandow ex F. Weber & D. Mohr) Schimp.** – 1 (LISU148810).
- Rhynchostegium riparioides* (Hedw.) Cardot** – Pereira Coutinho (1917b), Machado (1932), Allorge (1974).
- Schistidium apocarpum* (Hedw.) Bruch & Schimp.** – Ade & Koppe (1942).
- **Sciuro-hypnum plumosum* (Hedw.) Ignatov & Huttunen** – 4 (LISU257143).
- Scleropodium touretii* (Brid.) L.F. Koch** – Ade & Koppe (1942), Allorge (1974).
- Scorpiurium circinatum* (Bruch) M. Fleisch. & Loeske** – 2, 3, 17. Luisier (1916), Pereira Coutinho (1917b), Allorge (1931a, 1974), Machado (1932), Ade & Koppe (1942), Casas *et al.* (1989).
- Scorpiurium sendtneri* (Schimp.) M. Fleisch.** – 2, 17. Sérgio (1985).
- Sematophyllum substrumosum* (Hampe) E. Britton** – 2, 4, 6, 16, 22, 24, 25, 26. Henriques (1889), Machado (1932), Allorge (1974), Casas *et al.* (1985).
- Sphagnum capillifolium* (Ehrh.) Hedw.** – Mitten (1853), Henriques (1889), Machado (1932).
- Sphagnum subnitens* Russow & Warnst.** – Pereira Coutinho (1917b), Machado (1932). The two specimens available in LISU were both collected by Welwitsch in 1843 and 1845. Other specimen in COI (10002950), originally labelled *Sphagnum acutifolium* Ehrh., was also collected by Welwitsch in 1842.
- Syntrichia laevipila* Brid.** – 22. Allorge (1931a, 1974).
- **Syntrichia ruralis* var. *ruraliformis* (Besch.) Delogne** – 22 (LISU257159).
- Thamnobryum alopecurum* (Hedw.) Gangulee** – 3, 2, 17, 5. Levier (1880), Henriques (1889), Pereira Coutinho (1917b), Allorge (1931a, 1974), Machado (1932), Ade & Koppe (1942).

- **Thamnobryum alopecurum* var. *maderense* (Kindb.) M. Stech, Ros & O. Werner – 2 (LISU255997) (LISU257165) (LISU257170), 3 (LISU257166), 4 (LISU257168) (LISU257169), 17 (LISU255998) (LISU257164), 20 (LISU255999), 22 (LISU257167). According to Hedenäs (1992) this taxon should be regarded as a distinct species. However currently it is mostly considered to be a variety (Stech *et al.*, 2001).
- **Thuidium tamariscinum* (Hedw.) Schimp. – 4 (LISU257171), 20 (LISU256000).
- Timmiella barbuloides* (Brid.) Mönk. – 2, 17, 19. Mitten (1853), Levier (1880), Henriques (1889), Luisier (1907, 1916), Pereira Coutinho (1917b), Machado (1928), Allorge (1931a), Casares Gil (1932), Guerra *et al.* (2006).
- Tortella flavovirens* (Bruch) Broth. – 16. Warnstorf (1899).
- **Tortella inclinata* (R. Hedw.) Limpr. – 22 (LISU257174). VU for Portugal.
- Tortella inflexa* (Bruch) Broth. – 3, 4, 20, 22. Casas *et al.* (1989).
- Tortella nitida* (Lindb.) Broth. – 2, 4, 17, 20, 22. Ade & Koppe (1942), Allorge (1974).
- Tortella squarrosa* (Brid.) Limpr. – 20. Luisier (1907, 1916), Machado (1928).
- Tortella tortuosa* (Hedw.) Limpr. – Sá-Nogueira (1950).
- Tortula cuneifolia* (Dicks.) Turner – Henriques (1889), Guerra *et al.* (2006).
- Tortula marginata* (Bruch & Schimp.) Spruce – 2, 17. Levier (1880), Allorge (1931a, 1974), Ade & Koppe (1942).
- Tortula muralis* Hedw. – 22. Pereira Coutinho (1917b), Ade & Koppe (1942), Sá-Nogueira (1950), Allorge (1974).
- **Tortula truncata* (Hedw.) Mitt. – 17 (LISU148744).
- **Trichodon cylindricus* (Hedw.) Schimp. – 10 (LISU215348). VU for Portugal.
- Trichostomum brachydontium* Bruch – 2, 4, 6, 16, 17, 19, 20, 22. Mitten (1853), Levier (1880), Henriques (1889), Pereira Coutinho (1917b), Machado (1928), Casares Gil (1932), Allorge (1974).
- Trichostomum crispulum* Bruch – 16, 42. Warnstorf (1899), Luisier (1916), Pereira Coutinho (1917b), Machado (1928), Ade & Koppe (1942), Allorge (1974).
- Ulota bruchii* Hornsch. ex Brid. – 22. Sá-Nogueira (1950).
- **Ulota calvescens* Wilson – 4 (LISU153247). VU for Portugal.
- **Ulota crispa* (Hedw.) Brid. – 2 (LISU257202), 4 (LISU257200) (LISU257201), 22 (LISU204733) (LISU222040).
- Weissia condensata* (Voit) Lindb. – Mitten (1853), Pereira Coutinho (1917b), Machado (1928), Sá-Nogueira (1950).
- **Weissia controversa* Hedw. – 1 (LISU53531) (LISU53533), 20 (LISU53537).
- Weissia leptocarpa* Schwägr *hom. illeg.* – Casares Gil (1932), Levier (1880), Machado (1928), Podpra (1954). This is a doubtful and illegitimate name in Index Muscorum (Wijk *et al.*, 1969). For description see Levier (1880). The material collected in Sintra needs to be studied for identification (Sérgio & Carvalho, 2003), in order to know if it belongs to a species already known or to a different one.

Zygodon conoideus (Dicks.) Hook. & Taylor – 22. Ade & Koppe (1942). VU for Portugal.

**Zygodon rupestris* Schimp. ex Lorentz – 2 (LISU256014), 16 (LISU257208), 17 (LISU54078) (LISU257210), 20 (LISU257207), 22 (LISU257209) (LISU204734).

Zygodon viridissimus (Dicks.) Brid. – 2, 17, 19, 22. Mitten (1853), Henriques (1889), Pereira Coutinho (1917b), Allorge (1931a, 1974), Ade & Koppe (1942).

DISCUSSION

Overall, 279 taxa were recorded in the Serra de Sintra, out of which 5 belonging to Anthocerotophyta, 87 to Marchantiophyta and 187 to Bryophyta.

Seventy-eight taxa present in the LISU or COI herbaria had never been referred for the Serra de Sintra in published papers, and can thus be considered as new reports for the area, while 21 taxa reported in the bibliographic references have no longer been found in Sintra and most likely disappeared from the region. Among the latter ones, as taxa of particular ecological and phytogeographical relevance, as well as of conservational concern, there are: *Dumortiera hirsuta*, *Pallavicinia lyellii*, *Gyroweisia reflexa*, and *Sphagnum capillifolium*. Noteworthy is the case of *Antitrichia curtipendula*, which, while quite common in continental Portugal, after being recorded by Brotero at the beginning of the 19th century, was never found again in the Serra de Sintra.

Out of the 279 taxa reported for the Serra de Sintra, as summarized in the present work, 120 were recorded before the beginning of the 19th century, 99 during the first half of the 20th century, while just 60 from 1950 up to now.

Three species, *Homalothecium lutescens*, *Hypnum imponens* and *Porella arboris-vitae*, whose occurrence in the Serra de Sintra was regarded as doubtful, were reported but excluded from the species count, as well as the illegitimate name *Weissia leptocarpa*.

A total number of 64 families were recorded, out of which 3 belong to Anthocerotophyta, 28 to Marchantiophyta and 33 to Bryophyta. For some species, such as *Drepanolejeunea hamatifolia* and *Marchesinia mackaii* the Serra de Sintra represents the only locality in continental Portugal.

As for chorological types, it emerges from Fig. 2 a clear predominance of species with oceanic features (oceanic = 12%, suboceanic = 12%, oceanic-mediterranean + mediterranean-oceanic = 26%), which account altogether for 50% of the total, thus reflecting the Atlantic character of the Serra de Sintra. Another considerable share is represented by the species typical of temperate climates (27%), followed by mediterranean and submediterranean species (14%) and boreal species (8%). The Cosmopolite and Subcosmopolite species account only for 1% of the total.

Analyzing the richness of the bryoflora of region in relation to its surface (around 30 km²), it emerges that the Serra de Sintra hosts a remarkably high density of taxa, around 9,3 per km². In comparison, the Serra de Estrela in northern Portugal, with a surface of almost 1000 km², around thirty three times as large as the area of the Serra de Sintra, hosts around 383 taxa (Garcia *et al.*, 2008), with a density of taxa of just 0,43 per km², while the Sierra Nevada

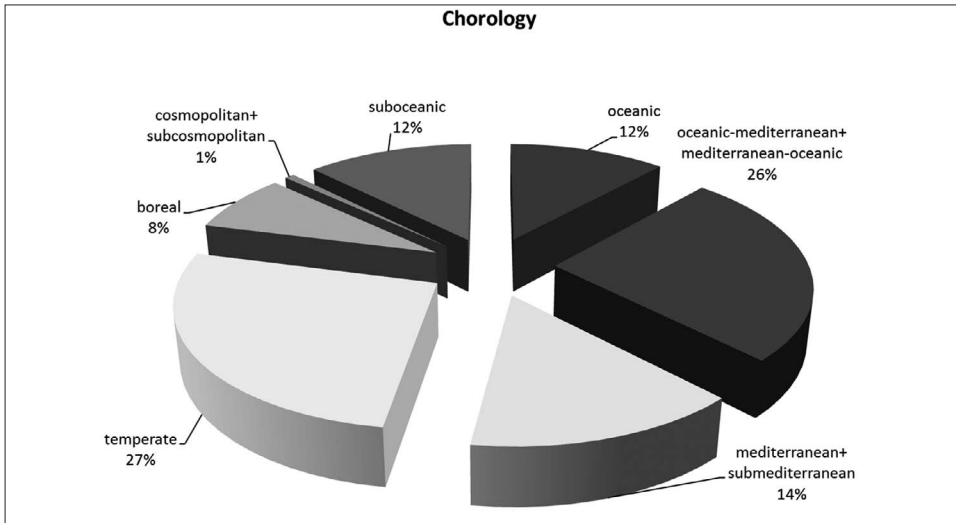


Fig. 2. Percentage of different chorological types of bryophytes in the Serra de Sintra based on Düll (1983, 1984, 1985) and adapted by the authors.

Mountains in Spain, covering around 2000 km², sixty six times as large as the Serra de Sintra, hosts around 395 taxa (Rams *et al.*, 2014), with a density of 0,19 taxa per km². One more example is represented by the Serra do Gerês in northern Portugal, whose core area, represented by the Peneda-Gerês National Park, covering approximately 700 km², hosts around 374 taxa (Sérgio *et al.*, 2012), with a density of 0,53 taxa per km².

The Serra de Sintra represents a relevant site also from the conservational point of view, hosting around 30 taxa which are regarded as threatened at national level (Sergio *et al.*, 2013a).

Thus, the exceptionally high number of taxa recorded in a such a relatively small area as the Serra de Sintra, which represents more than one third of all the taxa known for Portugal, as well as the occurrence of taxa present nowhere else in continental Portugal and threatened at national level, clearly proves the unique character of this region and confirms the necessity of the conservation of its biodiversity by long-term measures aimed to preserve the ecosystem features which account for the bryophyte richness of the area.

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