cryptogamie
Bryologie
2019 • 40 • 14

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art. 40 (14) — Published on 2 October 2019
www.cryptogamie.com/bryologie

MUSÉUM
NATIONAL D'HISTOIRE NATURELLE
PUBLICATIONS SCIENTIFIQUES

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Mise en page / *Page layout* : Marianne SALAÜN

Couverture / *Cover* :
Gorges de la Restonica, Corte ; localité d'*Orthotrichum laevigatum*

Cryptogamie, Bryologie est indexé dans / Cryptogamie, Bryologie *is indexed in:*
– Biological Abstracts
– Current Contents
– Science Citation Index
– Publications bibliographiques du CNRS (Pascal).

Cryptogamie, Bryologie est distribué en version électronique par / Cryptogamie, Bryologie *is distributed electronically by:*
– BioOne® (http://www.bioone.org)

Cryptogamie, Bryologie est une revue en flux continu publiée par les Publications scientifiques du Muséum, Paris
***Cryptogamie, Bryologie** is a fast track journal published by the Museum Science Press, Paris*

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Adansonia, Geodiversitas, Zoosystema*, *Anthropozoologica, European Journal of Taxonomy, Naturae,* Cryptogamie sous-sections *Algologie, Mycologie.

Diffusion – Publications scientifiques Muséum national d'Histoire naturelle
CP 41 – 57 rue Cuvier F-75231 Paris cedex 05 (France)
Tél. : 33 (0)1 40 79 48 05 / Fax : 33 (0)1 40 79 38 40
diff.pub@mnhn.fr / http://sciencepress.mnhn.fr

ISSN (imprimé / *print*) : 1290-0796 / ISSN (électronique / *electronic*) : 1776-0992

New records for the bryophyte flora of Corsica

Vincent HUGONNOT
Le bourg, 43380 Blassac (France)
vincent.hugonnot@wanadoo.fr

Submitted on 16 July 2018 | Accepted on 6 March 2019 | Published on 2 October 2019

Hugonnot V. 2019. — New records for bryophyte flora of Corsica. *Cryptogamie, Bryologie* 40 (14): 153-158. https://doi.org/10.5252/cryptogamie-bryologie2019v40a14. http://cryptogamie.com/bryologie/40/14

ABSTRACT
As a result of recent field work, three liverworts (*Myriocoleopsis minutissima* subsp. *minutissima* (Sm.) R.L. Zhu, Y. Yu & Pócs, *Riccia cavernosa* Hoffm. *emend*. Raddi, *Riella notarisii* (Mont.) Mont.) and five mosses (*Brachytheciastrum dieckei* (Röll) Ignatov & Huttunen, *Hedwigia striata* (Wilson) Bosw., *Orthotrichum laevigatum* J.E. Zetterst., *Tortula schimperi* M.J. Cano, O. Werner & J. Guerra, and *Zygodon forsteri* (Dicks.) Mitt.) were newly recorded for Corsica. The new localities are briefly described. As a result, the bryophyte flora of Corsica now comprises 587 species, among which 424 mosses, 160 liverworts and three hornworts.

KEYWORDS
Chorology,
mosses,
liverworts,
floristics,
Europe,
France,
Mediterranean Basin.

RÉSUMÉ
Nouveaux signalements pour la bryophyte floral de Corse.
Suite à des prospections de terrain, trois hépatiques (*Myriocoleopsis minutissima* subsp. *minutissima* (Sm.) R.L. Zhu, Y. Yu & Pócs, *Riccia cavernosa* Hoffm. *emend.* Raddi, *Riella notarisii* (Mont.) Mont.) et cinq mousses (*Brachytheciastrum dieckei* (Röll) Ignatov & Huttunen, *Hedwigia striata* (Wilson) Bosw., *Orthotrichum laevigatum* J.E. Zetterst., *Tortula schimperi* M.J. Cano, O. Werner & J. Guerra, *Zygodon forsteri* (Dicks.) Mitt.) sont nouvellement signalées en Corse. Les nouvelles localités sont brièvement décrites. La flore bryophytique corse compte désormais 587 espèces, parmi lesquelles 424 mousses, 160 hépatiques et trois anthocérotes.

MOTS CLÉS
Chorologie,
mousses,
hépatiques,
floristique,
Europe,
France,
Bassin méditerranéen.

INTRODUCTION

Corsica is the fourth largest Mediterranean island with 8741 km² (Gauthier & Cubells 2018). The central and western parts of the island are made of a Palaeozoic massives; mesozoic schists are encountered in the northern part whereas extreme south is made of Tertiary deposits; acidic substrates are found in the western part whereas more bas-rich substrates are encountered in the eastern one (Gauthier 2015).

The island is mostly mountainous, being the highest elevation the Monte Cinto with 2706 m a.s.l. (Gauthier 1998); the strong altitudinal gradation accounts for a considerable climatic zonation (Reymann *et al.* 2016). According to Gamisans (1999), the island is divided into five major ecological zones by altitude that are described in the following. Below 100 m is the coastal zone, characterized by Thermomediterranean climate, with hot, dry summers and mild winters. Between 100-800 m the Mesomediterranean belt is much more developed that Thermomediterranean one. The natural climax is Mediterranean evergreen *Quercus ilex* L. forest. Much of these woodlands have been cleared for agriculture, grazing and logging so that maquis dominates largely nowadays. The Supramediterranean belt, between 800-1200 m is dominated by broadleaved *Quercus* species (*Quercus petraea* Liebl. and *Q. pubescens* Willd.). Between 1200-1700 m, *Abies alba* Mill. and- *Fagus sylvatica* L. forests are dominant, with large extents of *Pinus nigra* J.F. Arnold subsp. *laricio* Maire on hottest slopes. Above 1700 m, shrubby subalpine and alpine vegetations are found.

Corsica represents an important area in terms of bryophyte diversity (Sotiaux *et al.* 2007). The extremely diverse geologic settlement combined with a wide variety of microclimate, owing to heterogeneous topography, together contribute to account for this richness (Hébrard 1986). Putative tertiary relicts, *Anacolia webbi* (Mont.) Schimp., *Claopodium wippleanum* (Sull.) Renauld & Cardot, etc. are well represented because of limited extension of glaciers during the Quaternary Era (Hébrard 1986). Extensive gene flow between Corsican and continental populations may explain the near complete absence of endemics (Sotiaux *et al.* 2007), *Leptodon corsicus* Enroth, A. Sotiaux, D. Quandt & Vanderp. being the unique exception (Sotiaux *et al.* 2009).

Bryophytes of Corsica have been thoroughly studied in recent years. Sotiaux *et al.* (2007) published a modern checklist which makes mention of 540 species. Subsequently, significant additions have been made in Sotiaux *et al.* (2008) and Sotiaux *et al.* (2009), that were included in Ros *et al.* (2013) list of Corsica. Also Pioli (2015) and Hugonnot & Simont (2018) published new records. As a result, 579 species (419 mosses, 157 liverworts and three hornworts) were confidently recorded in Corsica.

Corsica is nonetheless largely under-explored from a bryofloristic point of view. In this context, the aim of this paper was to provide further additions to the bryophyte flora of Corsica and to investigate variability of well-known taxa and their morphological response to Mediterranean climate.

MATERIAL AND METHODS

Bryological surveys in some natural regions of Corsica were carried out. No systematic recording method was applied. Hence, the new taxa recorded here were randomly spotted the following natural regions of Corsica: South- and Center-Corsica and Cap Corse.

Liverworts and mosses are presented in alphabetical order. Locality details are provided with altitude of the station and date of field observation. Habitat characteristics are given and commented taking into account relevant continental records. The phytosociology is briefly described with the help of Gamisans (1999) and the recent phytosociological checklist of Corsica (Reymann *et al.* 2016). Distribution data were mainly obtained from Dierβen (2001). Bischler (2004), Ros *et al.* (2007, 2013) and Hodgetts (2015). Ecological preferences of species were obtained from Bischler (2004) and Dierβen (2001). Nomenclature follows Ros *et al.* (2013) for mosses and Söderström *et al.* (2016) for liverworts. The delimitation of the Mediterranean Region has been done according to Conservation International Biodiversity Hotspots (2019).

The specimens are kept in the private herbarium of Vincent Hugonnot and duplicates deposited in PC.

RESULTS AND DISCUSSION

Here, we report the occurrence of eight species never previously mentioned in Corsica: three liverworts and five mosses. Some of them are newly reported due to the fact that they were either recently reinstated, or their taxonomy has changed in the last 20 years, since Sotiaux *et al.* published their Corsica's checklist. For each species information related to ecological background, fertility and distribution at world, European, Mediterranean Region and Mediterranean France scales is given. In some cases also taxonomy and important diagnostic characteristics for identification are mentioned.

As a result, the bryophyte flora of Corsica now comprises 587 species (424 mosses, 160 liverworts and three hornworts).

LIVERWORTS

Myriocoleopsis minutissima subsp. ***minutissima***
(Sm.) R.L. Zhu, Y. Yu & Pócs

SPECIMEN EXAMINED. — **France**. Corse-du-Sud, Suartone, Natural Reserve of Tre Padule, Campu Celi, on bark of living *Quercus ilex*, 24.IV.2017, 80 m a.s.l., *V. Hugonnot s.n.*

Remarks

It was observed on bark of living *Quercus ilex* in a dense Mesomediterranean woodland. The vegetation stand was referable to *Quercus ilex*-maquis (*Erico arboreae-Arbutetum unedonis* Allier & Lacoste, 1980, *Quercetosum ilicis* Allier & Lacoste, 1980). Hébrard & Roux (1991) described the habitat of the species in the French Port-Cros Island and stated to be

comparable to that of Corsica. Sporophytes were produced abundantly in the Corsican locality.

Myriocoleopsis minutissima has a Mediterranean-oceanic character in Europe (Düll 1983). Its distribution includes western and central Europe, tropical and southern Africa, the South Indian Ocean islands, central and eastern Asia, North, Central and South America, and Oceania (Bischler 2004). It is a species of rare occurrence in the Mediterranean Region, recorded from the Azores, Canary Islands, Cape Verde Islands and Madeira in Macaronesia; Croatia, France, Greece, Italy, Montenegro, Portugal, Sicily, Serbia and Spain in southern Europe; Algeria and Tunisia in northern Africa; and Lebanon in south-western Asia (Bischler 2004; Patiño Llorente & González Mancebo 2005; Ros *et al.* 2007; Gabriel *et al.* 2010). In Mediterranean France it is recorded locally in Var and Alpes-Maritimes Departments (Hébrard & Roux 1991).

Riccia cavernosa Hoffm. emend. Raddi

Specimen examined. — **France**. Corse-du-Sud, Bonifacio, mare temporaire de Musella, 26 IV.2017, 54 m a.s.l., *V. Hugonnot s.n.*

Remarks

It was observed within a mediterranean temporary pond of great floristic interest (Lorenzoni & Paradis 1998), in which *Eryngium pusillum* L. was also found. Both species may share comparable ecological requirements. The associated vegetation is considered to be part of *Trifolio-Cynodontion* Br.-Bl. & O. Bolòs, 1957. *Riccia cavernosa* grew directly on wet mud. It seems to suffer from overgrazing of the site which causes severe trampling and direct destruction of vegetation. In the Mediterranean, it was recorded in occasionally to periodically flooded ditch banks, soils depressions and margins of temporary ponds (Jovet-Ast 1986). The thalli observed in Corsica were poorly developed and sterile.

Riccia cavernosa is a Circumpolar-temperate taxon (Düll 1983). At a world scale it is recorded in northern, western, central and eastern Europe, northern and central Asia, tropical and southern Africa, North, Central and South America and Australasia (Bischler 2004). In the Mediterranean Region its distribution includes Canary Islands, Cape Verde Islands and Madeira in Macaronesia; Balearic Islands, Croatia, France, Italy, Portugal, Sicily and Spain in southern Europe; as well as Algeria, Egypt, Libya, Morocco and Tunisia in northern Africa (Bischler 2004; Patiño Llorente & González Mancebo 2005; Ros *et al.* 2007). In Mediterranean France, the species is known in the Departments of Pyrénées-Orientales (Hugonnot *et al*. 2017), Hérault (Crozals 1903) and Bouches-du-Rhône (Hébrard *et al.* 2014).

Riella notarisii (Mont.) Mont.

Specimen examined. — **France**. Haute-Corse, Barcaggio, temporary ponds d'A Cala, 30.IV.2017, 5 m a.s.l., *V. Hugonnot s.n.*

Remarks

It was found in great abundance in the Corsican locality in a brackish Mediterranean pond with mix water supply (sea water and meteoric water). *Riella notarisi*, as most of species of the genus, is a typical species of clean, shallow temporary ponds (Segarra-Moragues *et al.* 2014). It is a halotolerant subneutrophilous-basiphilous species (Dierβen 2001).

The determination of the sexual condition may offer special difficulties since antheridia are difficult to locate; they are hidden in a profusion of vegetative appendages very close to the growing point at the margin of the developing wing. The accurate determination of *Riella notarisi* relies heavily on its monoecy (Casas *et al.* 2009).

Riella notarisi is an European-Mediterranean species, which distribution includes Central Europe (Bischler 2004). In the Mediterranean Region it is recorded from the Canary Islands in Macaronesia; the Balearic Islands, Crete, Croatia, France, Greece, Portugal, Sardinia, Sicily and Spain in southern Europe; Algeria, Morocco and Tunisia in northern Africa (Bischler 2004; Ros *et al.* 2007). In Southern France, it is recorded patchily in Hérault, Bouche-du-Rhône, and Var Departments (Crozals 1903; Skrzypczak 2001, erroneously *sub Riella parisii* Gottsche (specimen N° 1048 from French Groupe d'Échange des bryophytes, *leg. Renée Skrzypczaky*, duplicate at Vincent Hugonnot private herbarium revised by Benoît Offerhaus).

Mosses

Brachytheciastrum dieckei (Röll) Ignatov & Huttunen

Specimen examined. — **France**. Corse-du-Sud, Quenza, plateau de Cusciunu, on rock outcrops, in 7.V.2017, 1540 m, *V. Hugonnot s.n.*

Remarks

It was observed on granitic rock outcrops in *Alnetum suaveolentis* Litard. & Malcuit, 1926 vegetation but this does not necessarily reflect a particular preference for this type of habitat. The species seems rather unspecialized as regards its ecological preferences as it is recorded to grow on alkaline and acidic grounds, rocks in forests or scrublands, or as an epiphyte on trees and bushes, from 550-3250 m a.s.l. (Orgaz *et al.* 2013). This should be confirmed by additional field observations. The species is fully fertile in Corsica, with abundant production of spore capsules. It is very likely that *B. dieckei* was confused with the very common *B. velutinum* (Hedw.) Ignatov & Huttunen.

Brachytheciastrum dieckei is a Mediterranean species, known from Africa, Asia and Europe (Orgaz *et al.* 2013). It is recorded from the Canary Islands in Macaronesia; Albania, Croatia, Cyprus, France, Greece, Italy, Montenegro, Portugal and Spain in southern Europe; Morocco in northern Africa; and Israel, Lebanon and Turkey in south-western Asia (Orgaz *et al.* 2010, 2013; Ros *et al.* 2013; Hodgetts 2015). In France it was recorded from Hautes-Alpes Department (Orgaz *et al.* 2013) and is most probably more widespread in Mediterranean France.

This species is characterized by a set of characters of difficult interpretation without experience; the leaves are shorter and more ovate than that of *B. velutinum*, margins are more commonly distinctly recurved, alar group is much more apparent with marginal cells ascending up margin, the laminal cells are dorsally prorate and the seta is rough (Orgaz *et al.* 2013). The abaxial proration of leaf-cells is subject to variation and is not always easy to observe in the Corsican specimens. Corsican *Brachytheciastrum* specimens housed in herbaria should be re-examined taking into account the revision of Orgaz *et al.* (2013).

Hedwigia striata (Wilson) Bosw.

Specimens examined. — **France**. Corse-du-Sud, Quenza, aiguilles de Bavella, on acidic rock outcrops, 4.V.2017, 1420 m a.s.l., *V. Hugonnot s.n.*; plateau de Cusciunu, on acidic rock outcrops, 4.V.2017, 1420 m, *V. Hugonnot s.n.*; Evisa, forêt d'Aitone, on acidic rock outcrops, 4.V.2017, 1320 m a.s.l., *V. Hugonnot s.n.*

Remarks
It was observed on siliceous rocks fully exposed or semi-shaded, in mixed stands with *H. ciliata* (Hedw.) P. Beauv. or *H. stellata* Hedenäs on the same rock and did not seems to differ much ecologically. The forest stands were attributable to *Pinus nigra* subsp. *laricio* forest of the *Galio rotundifolii-Fagenion sylvaticae* Gamisans (1977) 1979.

Until now, *H. striata* could be considered as an Oceanic species (Blockeel & Bosanquet 2016). For now, it is only recorded in Europe (Belgium, France, Great Britain, Norway, Ireland, Portugal, Spain and Sweden) and northwest Africa (Morocco) (Buchbender *et al.* 2014; Gallego *et al.* 2014; Blockeel & Bosanquet 2016; Ellis *et al.* 2016). It was previously recorded in continental France in Lot Department by Ellis *et al.* (2016), where it is probably much more widespread.

Hedwigia striata belongs to the *H. ciliata*-complex together with two other species *H. ciliata* and *H. stellata*; and used to be neglected until the phylogenetic reconstruction of the genus (Buchbender *et al.* 2014). The identification offers no special difficulties owing to a set of clear-cut morphological characters from which only the first can be appreciated in the field: the leaves are more or less longitudinally plicate, the decurrent basal margins of the leaves are provided with papillae and double teeth and the cilia of mature perichaetial leaves are less numerous and straighter than those of *H. ciliata* or *H. stellata* (Gallego *et al.* 2014).

Orthotrichum laevigatum J.E. Zetterst.

Specimen examined. — **France**. Haute-Corse, Corte, gorges de la Restonica, Source de Triggione, on acidic rock outcrops, 4.V.2017, 1650 m a.s.l., *V. Hugonnot s.n.*

Remarks
It was growing on granitic vertical rock walls in cold environment with no directly associated bryophytes. It is known from alpine comparable habitats in Western Europe (Maier & Schäfer-Verwimp 1999; Bardat *et al.* 2013). The Corsican material was fully fertile (presence of mature sporophytes).

Orthotrichum laevigatum is a Boreo-Alpine species (Lara & Garilleti 2014) with a disjunct distribution, including western North America, western Europe, and Asia (Ellis *et al.* 2014). In Europe, it occurs in Italian, French and Swiss Alps, Greece, Iceland, Norway, Sardinia, Spain and Turkey (Lara *et al.* 2002; Blockeel 2010; Ros *et al.* 2013; Ellis *et al.* 2014; Erdag & Kürscher 2017).

The species was thoroughly studied in France (Savoie Department) by Bardat *et al.* (2013). Unfortunately, after revision of the plant described in their publication, we verify that it is to be referred to a high-altitude morph of *Orthotrichum speciosum* Nees (specimens N° 8006, 8327, 8371 from Pierre Boudier private herbarium, revised by Vincent Hugonnot). The diagnostic characters of *O. laevigatum* are: exserted capsules, smooth exothecium and exostome teeth that remain erect when dry (Lara & Garilleti 2014).

Tortula schimperi M.J. Cano, O. Werner & J. Guerra

Specimen examined. — **France**. Haute-Corse, Saliceto, Monte San Petrone, on acidic banks, 2.V.2017, 1620 m a.s.l., *V. Hugonnot s.n.*

Remarks
It was growing on an acidic and eroded bank with *Brachytheciastrum velutinum* and *Oxyrrhynchium schleicheri* (R. Hedw.) Röll in grazed Beech wood of the *Poo balbisii-Fagetum sylvaticae* Gamisans (1977) 1979 association. Very few ecological data are available in the Mediterranean basin. It had abundant sporophyte production.

Tortula schimperi distribution is not fully documented because of taxonomic uncertainties. It is a European-Temperate taxon (Blockeel *et al.* 2014). At a global scale, it is recorded in Europe, northern Africa, western Asia and North America (Blockeel *et al.* 2014). In Europe it is widespread distributed (Hodgetts 2015). In the Mediterranean Region, it is recorded from Andorra, France, Greece, Italy, Macedonia, Montenegro, Sardinia, Serbia, Sicily, Slovenia and Spain in southern Europe; Algeria in northern Africa; and Turkey in south-western Asia (Ros *et al.* 2013; Hodgetts 2015) but it is certainly still under-recorded. In Mediterranean France it is a poorly known taxon with very few mentions (Hugonnot *et al.* 2017).

This is a poorly known and somehow critical taxon since it has often been confused with various species in the complex *Tortula subulata-mucronifolia* (Cano *et al.* 2005). All previous Corsican records of *Tortula subulata* Hedw., especially of the var. *angustata* (Schimp.) Limpr., should be checked to verify their identity. It is possible that some of them correspond in fact to *Tortula schimperi*. It differs from the closely related *T. subulata* and from all the members of the complex (*T. inermis* (Brid.) Mont. and *T. mucronifolia* Schwägr.) by the occurrence of a bistratose leaf-margin whereas it is constantly unistratose in all the other species (Cano *et al.* 2005).

Zygodon forsteri (Dicks.) Mitt.

SPECIMEN EXAMINED. — **France**. Haute-Corse, Saliceto, Monte San Petrone, on *Fagus sylvatica*, 2.V.2017, 1380 m a.s.l., *V. Hugonnot s.n.*

Remarks

It grew on the bark of medium-age *Fagus sylvatica* individuals (Beechwood) in grazed *Poo balbisii-Fagetum sylvaticae* Gamisans (1977) 1979 association. Here, the species thrives only at the margins of dripping cavities (dendrotelms) of natural origin. Only two cavities bearing *Z. forsteri* could be spotted in spite of targeted research and innumerable available cavities. Sporophytes full of mature spores could be seen at one of the cavities. Abundant propaguliferous protonemata with immature gametophores were colonizing the other cavity. The species was reported to grow in dendrotelm in the Mediterranean basin, however, it generally favours *Quercus* phorophytes and is only casually observed on *Fagus* in the Mediterranean (Hugonnot 2010).

Zygodon forsteri is a Suboceanic-southern-Temperate element (Blockeel *et al.* 2014). It is known from western, central and southern Europe, northern Africa and south-western Asia (Ros *et al.* 2013; Hodgetts 2015). In the Mediterranean Region its distribution includes Madeira in Macaronesia; Bulgaria, Croatia, France, Greece, Italy, Montenegro, Portugal, Sardinia, Serbia, Sicily, Slovenia and Spain in southern Europe; Algeria and Morocco in northern Africa; and Turkey in south-western Asia (Blockeel *et al.* 2009; Ros *et al.* 2013). In Mediterranean France, numerous localities were recorded in all the Departments (Pyrénées-Orientales, Aude, Hérault, Tarn, Averyon, Lozère, Gard, Ardèche, Vaucluse, Drôme, Bouche-du-Rhône, Alpes-de-Haute-Provence, Var, Alpes-Maritimes) (Hugonnot 2010).

Acknowledgements

The two reviewers are thanked for their useful comments. Our gratitude is extented toward Rosa Maria Ros for her help.

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Submitted on 16 July 2018;
accepted on 6 March 2019;
published on 2 October 2019.