



# Plant Archives

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## CONTRIBUTION TO THE KNOWLEDGE OF THE BRYOPHYTIC FLORA OF THE IZARENE MASSIF (OUEZZANE REGION, NORTH-WEST MOROCCO)

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### ABSTRACT

In order to establish an inventory of bryophytes in the Izarène Massif, northeast of the town of Ouezzane in Morocco, we carried out a survey in the area from March 2014 to April 2019. Sampling was carried out on 54 surveys in 8 cantons. The identification process resulted in the determination of 83 species of bryophytes belonging to 67 mosses, 14 liverworts and 2 hornworts, then to 27 families and 52 genera with a predominance of the family Pottiaceae, Brachytheciaceae, Bryaceae, Ricciaceae, Orthotrichaceae, Funariaceae and Grimmiaceae. The main genera in the Massif are *Bryum*, *Tortula*, *Brachythecium*, *Barbula*, *Didymodon*, *Grimmia* and *Orthotrichum*. Also, bryological analysis reveals the presence of a new taxon for Morocco: *Gymnostomum aeruginosum* var. *aeruginosum* belonging to the family Pottiaceae. These 83 taxa come essentially from terrestrial biotopes (48 species, or 57.83%). According to the frequency classes (IES), rare and very rare taxa are few in number since they together account for only 10.84%. The taxa abundant on the sites studied are numerous, reaching a total of 32.53% of all the bryophytes identified. In addition, moderately abundant taxa represent 9.63% and dominant taxa 36.14% of the total species inventoried. All these results show the interest of the site, which already benefits from legislative protection but which must also cover its biodiversity.

**Keywords** : Inventory; Bryophytes; Massif Izarène; New species; Northern Morocco.

### Introduction

The Moroccan terrestrial flora is rich and diversified, with about 7000 species inventoried (Benabid, 2000), including 619 species of Bryophytes, the subject of our study, divided into 72 families and 182 genera (Ahayoun *et al.*, 2013). Also, Morocco is known for its privileged geographical situation, the diversity of its relief and its bioclimates, which allows it to occupy an important place at the level of the Mediterranean basin. It is among the richest countries in terms of plant diversity (Benabid, 2000).

Bryophytes appeared before vascular plants, comprising three major groups: Liverworts, Mosses and Anthocerote. They are primitive plants with no roots and no real conducting vessel. They depend on water for reproduction and regenerate vegetatively and with spores that have a very high dispersal potential (Frahm, 2008). They are reviving and photoautotrophic evergreen plants (Leblond, 2004; Chakraborty and Paratkar, 2006; Malandrino *et al.*, 2006), which can adapt to drought and different environmental pressures.

The Bryophytes of the Izarene Massif were poorly known, as evidenced by the lack of scientific data on this important biological group in this area.

Indeed, no previous studies on bryophytic flora have been recorded, with only a few botanists having harvested during brief visits to these regions (Maire and Werner, 1934; Gattefossé and Werner, 1935; Ahayoun *et al.*, 2007). The

preservation of a natural ecosystem requires knowledge of its biological diversity (Benabid, 2000). It is within this framework that we conducted a study on the bryophytic flora of the Izarène massif, in order to enrich the knowledge of bryology in this region. The purpose of this study is therefore to identify and inventory the species present, as well as the conditions of the environment where they are collected.



**Fig. 1:** Panoramic view of the Izarène Massif

## Materials and Methods

### Study area

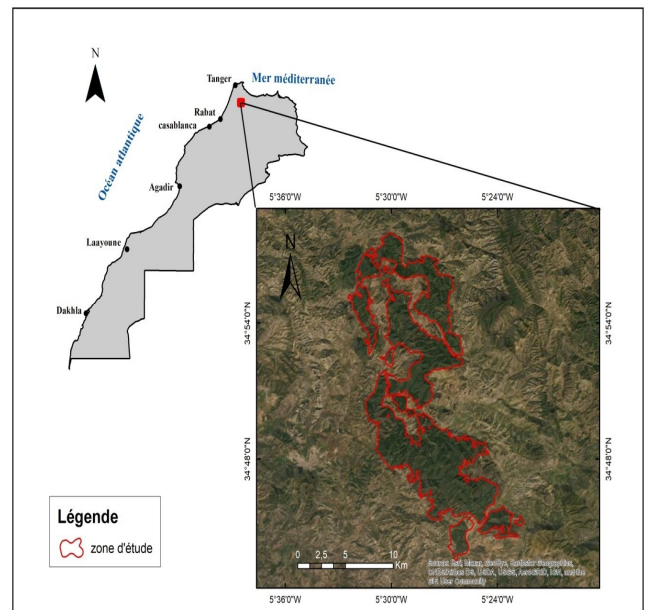
The territory studied corresponds to the Izarène massif. Geographically, it is located in the north-western part of Morocco on the Rif mountain range. It is limited to the Northwest by the town of Ouezzane and to the South by the secondary asphalt road linking Ouezzane to Zoumi (Figure 1). Administratively, this massif depends on the Tanger-Tetouan region, and is part of the Cercle of Mokrisset and of 'Ouezzane, rural Commune of Bni Kolla, Zoumi and Ain Beida (HCEFLPCD, 2016). From a forestry point of view, this territory is under the protection of the Provincial Directorate of EFLCD (=Water and Forestry and the Fight Against Desertification) in Ouezzane and the DREFLCD (=Regional Directorate of Water and Forestry and the Fight Against Desertification) of the Rif in Tetouan. The Izarène massif is made up of eight cantons, all of which have been prospected: Izarène (1), Jbel Karker (2), Bousaleh (3), Dhar Douira (4), Dhar Laaroussa (5), Oued Zandoula (6), Mokasseb (7) and Sidi Ali (8) (Figure 2), covering an approximate forest area of about 11855 Ha (HCEFLPCD, 2016), with an altitude varying approximately between 350 m and 680 m (DPA, 2017).

The soil is of the clay-schist or deep clay-marl type, reaching in some places more than 3 metres deep (Orch *et al.*, 2015). Furthermore, the climate of the study area is of the Mediterranean type with a variation from subhumid to temperate winter, characterised by rainfall that varies in time and space according to the season, altitude, continentality and exposure. Mean annual precipitation ranges from 450 mm to 950 mm, spread over approximately 70 days throughout the year (November to April) (Orch *et al.*, 2015). The temperature varies during the year from 6°C to 47°C (DPA, 2017) where the dry and hot season lasts from 3 to 4 months.

The forest stands in this massif are very dense and diversified and of high quality; they consist mainly of the formation of cork oak (*Quercus suber*) at different stages of degradation (Borgniet *et al.*, 2009 in Orch *et al.*, 2013), which covers most of the area of the site. The reforestation of the massif is based on eucalyptus, various pines (such as canary pine, maritime pine, brutia pine and Aleppo pine). The secondary species are diversified, we can mention: mastic grass, arbutus, rockroses, heather, phylaire, ect... (Orch *et al.*, 2013).

Episodes of forest fires have affected the massif since 2004, with a significant damaged area of nearly 4537.56 ha (HCEFLPCD, 2016). These fires are mostly concentrated during the months of June to September (Anonymous c, 2017) and constitute for the region one of the main factors of degradation and destruction of forest formations. This is due to the high fire sensitivity of forest species (pines, matorral plant species, etc.) and also to the strong anthropozoogenic pressure exerted on the forest estate.

Hydrologically, there are many temporary water sources and a permanent river called "Oued Zendoula". This allows the vegetation to be diversified and, in particular, the bryophytic flora to settle.

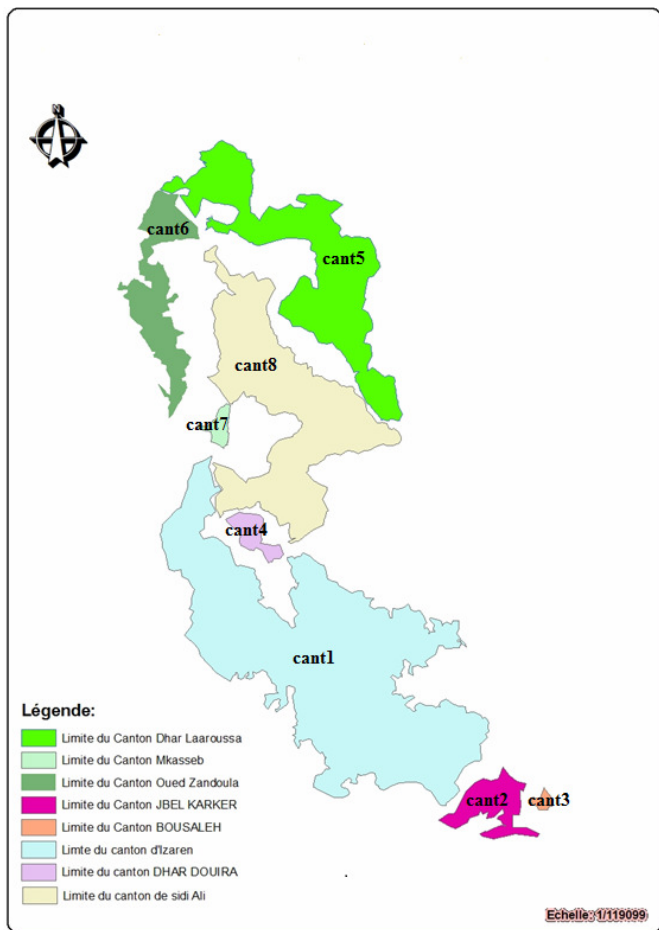


**Fig. 1:** Geographical location of the sampling area in the Massif d'Izarène (Ouezzane region, North-West Morocco).

### Methodology

The field surveys in the eight cantons were carried out after the heavy rain and cold winter for six consecutive years in March, April and May from 2014 to 2019. A systematic sampling method was adopted by following altitudes and tree formations in order to inventory and draw up an exhaustive list of possible bryophytic species present in our study site. These cantons have not been studied before, with the exception of the canton of Sidi Ali (Laouzazni *et al.*, 2018) and a region adjacent to the massif, the SIBE of Brikcha (Laouzazni *et al.*, 2020). The eight harvesting stations are shown in Figure 2; a total of 54 surveys were carried out. For each survey the geographical coordinates (longitude, latitude, altitude) were systematically recorded using GPS (GPS Essentials), and for each sample taken, the date, the precise location of the harvest and the type(s) of substrate on which the taxa collected were grown were recorded. Whenever possible, specimens are collected with their sporophytes to facilitate their identification. Samples are checked in the laboratory using optical instruments such as binocular loupe, microscope and digital camera; tissue sections are also made in some cases.

The complete bryological list was established after identification and verification of the samples collected in the field, thanks to the following main works: Boulay (1884), Augier (1966), Pierrot (1982) and Smith (2004) for Mosses and liverworts, Casas *et al.* (2006) for Mosses, then Boulay (1904) and Casas *et al.* (2009) for the determination of Liverworts and Hornworts. This determination is relatively facilitated by bryological glossaries on websites. Once identified, the samples were stored in the herbarium of the "Plants, Animals Productions and Agro-industry" laboratory of the Faculty of Sciences of Kenitra (Morocco). The nomenclature used is essentially based on that of North African bryophytes (Ros *et al.*, 1999) and (Ros *et al.*, 2013) (Table 1).



**Fig. 2:** The distribution of the prospected cantons of the Izarene massif (cant1 : canton Izarene, canton2 : canton Jbel Karker, canton3 : canton Bousaleh, canton4 : canton Dhar Douira, canton5 : canton Dhar Laaroussa, canton6 : canton Oued Zandoula, canton7 : canton Mokasseb, canton8 : canton Sidi Ali) (HCEFLPCD, 2017).

**Data analysis**

Species abundance was estimated in each township using the Ecological Significance Index (IES) (Lara & Mazimpaka, 1998; Albertos *et al.*, 2001), whose mathematical expression is as follows :

$$IES = F (1+C).$$

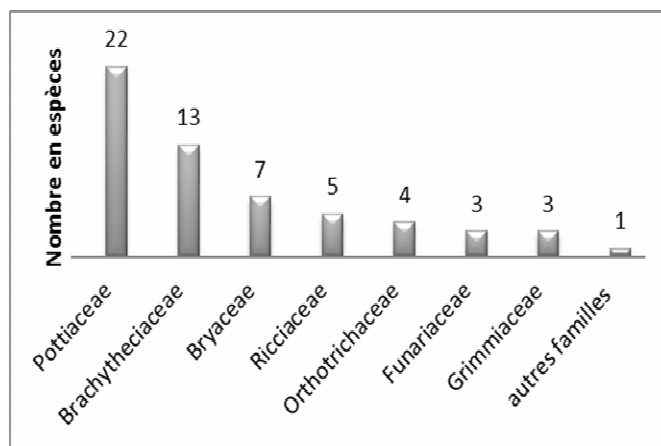
Where F is the relative frequency,  $F=100x/n$  and C is the mean coverage,  $C=\sum c_i/x$  where "x" is the number of samples containing the species, "n" is the total number of samples and "c<sub>i</sub>" is the coverage class assigned to the species in each sample (Ezer and Kara, 2013).

The coverage classes were classified according to the following scale: 0.5 (<1%); 1 (1%-5%); 2 (6%-25%); 3 (26%-50%); 4 (51%-75%); 5 (>75%). The IES values were combined into the following frequency classes: very rare (<25), rare (26-50), moderately abundant (51-100), abundant (101-200) and dominant (>200). (Ezer *et al.*, 2013).

**Results and Discussion**

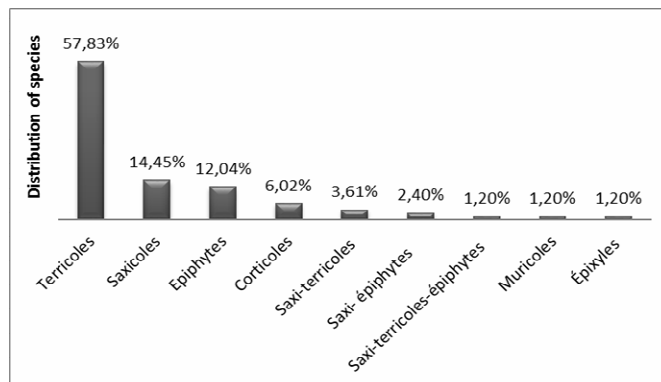
The inventory of the bryophytic flora carried out on the prospected sites identified 83 taxa recorded in table 1, of which 67 species (80.72%) are grouped within the Mosses and distributed in 40 genera and 16 families. Among the liverworts, 15 identified species (18.07%) are distributed in 10 families and 10 genera, while only two hornworts (2.40%) are present and are distributed in 2 genera and 1 family.

As for their taxonomic position, the inventoried species belong to 27 different families and 52 genera. The most represented families, dominating the bryological flora of the ecosystems of the Izarene Massif are the Pottiaceae (22 species), the Brachytheciaceae (13 species) and the Bryaceae (7 species) then the Ricciaceae (5 species), the Orthotrichaceae (4 species) and the Funariaceae as well as the Grimmiaceae with 3 species each. The remaining families have only one or two species each (Fig. 3). The main genera are *Bryum* and *Tortula* with 6 and 4 species respectively, followed by *Brachythecium*, *Barbula*, *Didymodon*, *Grimmia* and *Orthotrichum* with 3 species each.



**Fig. 3:** Species occurrence numbers by family

The procession of the terricoles is very largely dominant in the Izarene massif (48 species, or 57.83%), followed by the saxicoles (12 species, or 14.45%) and the epiphytes (10 species, or 12.04%), followed by the corticoles with 5 species, then the muricoles, the epixyls with one taxon each. Species found on more than one type of substrate are not numerous: saxi-terricoles-epiphytes, saxi-epiphytes and saxi-terricoles which are rare in this massif with 1, 2 and 3 taxa respectively in each of these categories (Fig. 4).



**Fig. 4:** Specific numbers according to the lifestyle of the bryophytes in the Izarene massif (Ouezzane region).

Among the 83 taxa recorded in the Izarene massif, species have been found in several surveys. Among them, *Pleurochaete squarrosa*, living on clayey soil under a plant formation of white-flowered rockrose, is widely distributed in the massif, followed by *Bryum capillare*, *Timmia barbuloidea*, *Funaria hygrometrica*, *Grimmia trichophylla*, *Pleuridium acuminatum* and *Riccia warnstorffii* which are all soil (clay) based except for *Bryum capillare* which is Saxi-terricolous and *Grimmia trichophylla* which is Saxicolous. Based on their IES values, these species can be said to be

abundant to dominant (Table 2) with IES values greater than 101. The total number of species harvested in the study site appears to be lower than in the SIBE of Brikcha, the area surrounding the massif, if one reports the number of bryophyte species (60 taxa) in relation to the area of the SIBE (670 Ha) (Laouzazni *et al.*, 2020). This can probably be due to the high summer temperatures in the study area that delay or limit the growth of certain species; whereas at the SIBE level, the environment presents a certain humidity and a pluristratified and diversified plant cover favouring the installation of bryophytes.

In comparison with the list of bryophytes of Morocco (Ahayoun *et al.*, 2013) and North Africa (Ros *et al.*, 1999), this study has led to the discovery of a new taxon for Morocco: *Gymnostomum aeruginosum* var. *aeruginosum* belonging to the family Pottiaceae. It was recorded for the first time in the centre of the Massif d'Izarène (canton Izarène) on 15 April 2017 on clay soil under various pine trees with an IES of 40 (Table 2), so it is classified as a rare species.

The family Pottiaceae, the most diverse in species in this site, grows mainly on clayey soils with the exception of *Dialytrichia mucronata* and *Tortella nitida* which are saxicolous, then *Tortula laevipila* which is an epiphyte and *Tortula muralis* which is a saxi-epiphyte. These are plants that have the capacity to adapt and survive in unstable biotopes, which helps the diversification and dominance of the species belonging to this family.

Of the species surveyed, 36.14% (or 30 species) are dominant in this massif, of which five have a greater dominance *Pleurochaete squarrosa*, *Dicranella varia*, *Homalothecium lutescens*, *Riccia warnstorffii* and *Timmiella barbulooides* with an IES of 300 to 350 (Table 2). Twenty-seven other bryophyte species with an IES of 102 to 200 are considered abundant (Table 2), such as two species (2.40%) that are found in only one survey, a Moss (*Bartramia stricta*) and a Hepatica (*Reboulia hemisphaerica*) for which IES values range from 125 to 150. On the other hand, nine species are very rare in this massif where they are

encountered only once and have an IES value ranging from 8 to 23: *Anomobryum filiforme*, *Anthoceros punctatus*, *Bryum pallescens*, *Bryum alpinum*, *Barbula convoluta*, *Orthotrichum diaphanum*, *Orthotrichum tenellum*, *Pterogonium gracile* and *Zygodon viridissimus* (Table 2). Two species, one terricolous and the other saxi-terricolous in the Izarène massif, with IES ranging mainly from 225 to 300 (Table 2), are marked as very abundant in the SIBE of Brikcha, and have been collected on other types of substrates: *Timmiella barbulooides* (saxicolous on limestone and shale) and *Bryum capillare* (epiphytic) (Laouzazni *et al.*, 2020). This indicates that these taxa are capable of adapting to the ecological conditions of the environment.

Rare species, detected using the IES value in Table 2, total nine species: *Tortella nitida*, *Riccia sorocarpa*, *Sphaerocarpos michelii*, *Tortula laevipila*, *Gymnostomum aeruginosum* var. *aeruginosum*, *Trichostomum crispulum*, *Didymodon tophaceus*, *Hypnum cupressiforme*, *Rhynchostegiella curviseta*. Among these species, *Sphaerocarpos michelii* is also rare in the Brikcha SIBE (Laouzazni *et al.*, 2020).

## Conclusion

The Izarène Forest Massif is home to a rich bryophytic flora due to the clayey soil and vascular vegetation, which favour microclimates with a certain humidity allowing these small plants to settle and spread. In fact, the most widespread way of life in the massif is the soil type represented by about 57.83% of the identified taxa. The bryological surveys we carried out in the eight cantons of the Izarene Massif allowed us to identify 83 species on the basis of the analysis of 54 surveys with Mosses representing 80.72%, liverworts 18.07% and hornworts 2.40%. Among the identified mosses, a new taxa *Gymnostomum aeruginosum* var. *aeruginosum* has enriched Moroccan bryoflora. The results of this work have the merit of filling gaps in the knowledge of the bryophytes of the Massif d'Izarène. Additional studies are needed to explore the distribution of terrestrial bryophytes in relation to epiphytes in relation to ecological changes, particularly edaphic and bioclimatic changes.

**Table 1:** Taxa listed, their families and substrate types, localities according to the cantons in which each taxon was found.

Species	Families	Cantons								Substrates
		1	2	3	4	5	6	7	8	
<b>MOSES</b>										
<b>Bartramiaceae</b>										
<i>Bartramia pomiformis</i> Hedw.		■							■	rock rock at the edge of the water ravine
<i>Bartramia stricta</i> Brid.								■		on rocks (layers of limestone and shale)
<b>Brachytheciaceae</b>										
<i>Amblystegium radical</i> (P.Beauv.) Schimp.					■	■				on cork oak bark
<i>Brachythecium glareosum</i> (Bruch ex Spruce).				■					■	on clay soil under <i>Cistus salviifolius</i>
<i>Brachythecium plumosum</i> (Hedw.) Schimp.	■			■						on the bark of phillyrea
<i>Brachythecium rivulare</i> Schimp.					■	■				on a rock on the edge of the water ravine
<i>Eurynchium speciosum</i> (Brid.) Warnst.		■								on the bark of phillyrea
<i>Eurynchium striatulum</i> (Spruce) M.Fleisch.		■		■						on the cork oak, and the holm oak
<i>Homalothecium lutescens</i> (Hedw.) H. Rob.				■	■					on the cork oak and on stone rock
<i>Homalothecium sericeum</i> (Hedw.) Schimp.	■								■	on cork oak and kermes oak
<i>Isothecium myosuroides</i> Brid.		■						■		on rocks, (layers of limestone and

									shale)	
<i>Plasteurhyncium meridionale</i> (Schimp.)	■				■				on the cork oak	
<i>Rhynchostegium confertum</i> (Dicks.) Schimp.			■					■	on clay soil at the edge of the water ravine	
<i>Rhynchostegiella curviseta</i> (Brid.) Limpr.								■	on sandy-clay soil under the arbutus tree	
<i>Scorpiurium circinatum</i> (Brid.) M.Fleisch. & Loeske.		■						■	on stony rock under dense mastic vegetation	
<b>Bryaceae</b>										
<i>Anomobryum filiforme</i> (Dicks.) Husn. Hom. Illeg.								■	on damp clay soil near a water source	
<i>Bryum alpinum</i> Huds.								■	on wet clay soil next to a water source	
<i>Bryum argenteum</i> Hedw.							■	■	on sunny walls	
<i>Bryum caespiticium</i> Hedw.	■								on clay soils	
<i>Bryum capillare</i> Hedw.					■			■	on clay soil under dense vegetation in the cork oak forest and on rocks (layers of limestone and shale)	
<i>Bryum dichotomum</i> Hedw.					■				On rocks (layers of limestone and shale)	
<i>Bryum pallescens</i> Schleich. ex Schwägr.								■	on wet clay soil under the masticum	
<b>Dicranaceae</b>										
<i>Dicranella varia</i> (Hedw.) Schimp.			■					■	■	on sandy-clay soil under tree heather
<i>Dicranella heteromalla</i> (Hedw.) Schimp.	■				■					wet clay soil
<b>Ditrichaceae</b>										
<i>Pleuridium acuminatum</i> Lindb.	■							■		on sunny sandy-clayey soil
<b>Encalyptaceae</b>										
<i>Encalypta vulgaris</i> Hedw.			■		■					on sandy-clayey soil
<b>Entodontaceae</b>										
<i>Pseudoscleropodium purum</i> (Hedw.) M. Fleisch.	■	■				■				on the cork oak, on very wet clay soil and rock
<i>Scleropodium touretii</i> (Brid.) L.F. Koch.								■	■	on clay soil under <i>Cistus salviifolius</i>
<b>Fissidentaceae</b>										
<i>Fissidens bryoides</i> Hedw.	■				■					on a very wet clayey slope
<i>Fissidens incurvus</i> Starke.		■								on a very wet clayey slope
<b>Funariaceae</b>										
<i>Entosthodon fascicularis</i> (Hedw.) Müll.Hal.		■						■		on clayey, sunny ground
<i>Funaria hygrometrica</i> Hedw.	■							■		on clayey, sunny ground
<i>Funaria microstoma</i> Bruch ex Schimp.					■	■				on wet clay soil
<b>Grimmiaceae</b>										
<i>Grimmia decipiens</i> (Schultz) Lindb.	■				■					on rocks (layers of limestone and shale)
<i>Grimmia ovalis</i> (Hedw.) Lindb.	■			■						on rocks (layers of limestone and shale)
<i>Grimmia trichophylla</i> Grev.						■		■		on rock with vegetation to <i>Phylleria angustifolia</i>
<b>Hypnaceae</b>										
<i>Hypnum cupressiforme</i> Hedw.								■		on the bark of the arbutus tree
<b>Leucodontaceae</b>										
<i>Leucodon sciuroides</i> (Hedw.) Schwaegr.								■		on the oleaster tree
<i>Pterogonium gracile</i> (Hedw.) Sm.								■		on a piece of dead wood
<b>Neckeraceae</b>										
<i>Leptodon smithii</i> (Hedw.) F.Weber & D.Mohr.			■					■		on the trunk of the olive tree
<b>Orthotrichaceae</b>										
<i>Orthotrichum cupulatum</i> Hoffm.				■		■				on the cork oak, and the holm oak
<i>Orthotrichum diaphanum</i> Brid								■		on the cork oak
<i>Orthotrichum tenellum</i> Bruch ex Brid.								■		on the cork oak
<i>Zygodon viridissimus</i> (Dicks.) Brid.								■		on clay soil under <i>Pistacia lentiscus</i>

<b>Pottiaceae</b>										
<i>Aloina aloides</i> Kindb.					■	■				on rocks (layers of limestone and shale)
<i>Barbula convoluta</i> Hedw.									■	on sandy-clayey, sunny ground
<i>Barbula hornschurchiana</i> Schultz.	■								■	on sandy-clayey, sunny ground
<i>Barbula unguiculata</i> (Huds.) Hedw.		■			■					on wet clayey soil
<i>Crossidium squamiferum</i> (Viv.) Jur.				■	■					on sandy-clay soil under tree heather
<i>Didymodon falax</i> (Hedw.) R.H.Zander.					■	■				on sandy-clay soil under tree heather
<i>Didymodon tophaceus</i> (Brid.) Lisa.									■	on sandy-clay soil under tree heather
<i>Didymodon vinealis</i> (Brid.) R.H. Zander.								■	■	on sandy-clay soil under tree heather
<i>Dialytrichia mucronata</i> (Brid.) Broth.			■						■	on a rocky outcrop near the water
* <i>Gymnostomum aeruginosum</i> var. <i>aeruginosum</i> Sm.	■									on the very wet ground under the pine
<i>Pottia davalliana</i> (Sm).C.E.O.Jensen.	■			■						on a very wet clayey slope
<i>Pottia truncata</i> (Hedw.) Bruch.		■							■	on wet sandy-clay soil near water
<i>Phascum cuspidatum</i> Hedw.	■								■	on sandy-clayey soil
<i>Pleurochaete squarrosa</i> (Brid.) Lindb.	■				■			■	■	on clay soil under dense vegetation of <i>Cistus salviifolius</i> and on rocks (layers of limestone and shale)
<i>Timmiella barbuloidea</i> (Brid.) Mönk.				■				■	■	on wet sandy-clay soil on the edge of the ravine
<i>Tortella nitida</i> (Lindb.) Broth.									■	on rocks (layers of limestone and shale)
<i>Tortula canescens</i> Mont.		■							■	on sandy-clayey soil under masticum
<i>Tortula cuneifolia</i> (Dicks.) Turner.			■					■		on a very wet clayey slope
<i>Tortula laevipila</i> (Brid.) Schwaegr.									■	on the cork oak
<i>Tortula muralis</i> Hedw.								■	■	on stone rock under a dense vegetation of cork oak and holm oak and on cork oak
<i>Trichostomum crispulum</i> Bruch.									■	on wet clay soil under the arbutus tree
<i>Weissia viridula</i> Hedw. ex Brid.								■	■	on clayey soil with dense tree heath vegetation
<b>Sematophyllaceae</b>										
<i>Sematophyllum substrumulosum</i> (Hampe) E. Britton.					■					on the bark of arbutus, phillyrea, heather
<b>LIVERWORTS</b>										
<b>Aytoniaceae</b>										
<i>Reboulia hemisphaerica</i> (L.) Raddi.									■	on clayey soil on slopes close to a water flow
<b>Cephaloziaceae</b>										
<i>Cephalozia bicuspidata</i> (L.) Dum.			■							on clayey soil on slopes close to a water flow
<b>Cephaloziellaceae</b>										
<i>Cephaloziella divaricata</i> (Sm.) Schiffln.	■				■					on Aleppo pine
<b>Corsiniaceae</b>										
<i>Corsinia coriandrina</i> (Spreng.) Lindb.			■						■	on moist clay soil under <i>Pistacia lentiscus</i>
<b>Fossombroniaceae</b>										
<i>Fossombronia angulosa</i> (Dicks.) Raddi.				■					■	on wet clay soil next to a water gully and on stony rock
<b>Lunulariaceae</b>										
<i>Lunularia cruciata</i> (L.) Dumort.								■	■	on clay soil under mastic
<b>Marchantiaceae</b>										
<i>Marchantia polymorpha</i> L.			■					■		on very wet clay soil
<b>Ricciaceae</b>										
<i>Riccia ciliifera</i> Link		■							■	on clayey soil
<i>Riccia gougetiana</i> Durieu et Mont								■	■	on clayey soil
<i>Riccia macrocarpa</i> Lev.	■							■	■	on clay soil under mastic
<i>Riccia sorocarpa</i> Bisch.									■	on clayey soil
<i>Riccia warnstorffii</i> Limpr. Ex Warnst	■	■			■					on wet clay soil

<b>Sphaerocarpacea</b>	
<i>Sphaerocarpos michelii</i> Bell.	■ on wet clay soil
<b>Targioniaceae</b>	
<i>Targionia hypophylla</i> L.	■ on clay soil under mastic
<b>HORNWORTS</b>	
<b>Anthocerotaceae</b>	
<i>Anthoceros punctatus</i> L.	■ on very wet clay soil under <i>Cistus salviifolius</i>
<i>Phaeoceroslaevis</i> (L.) Prosk.	■ on very wet clay soil under <i>Cistus salviifolius</i>

Where, ■: species present in the canton; \*: new species in Morocco

**Table 2:** Value of the IES of the bryophytic species inventoried in the eight cantons surveyed in the Massif d'Izarène.

Species	(IES)							
	Cantons							
	1	2	3	4	5	6	7	8
<i>Aloina aloides</i>					100	125		
<i>Amblystegium radical</i>					40	150		
<i>Anomobryum filiforme</i>								8
<i>Anthoceros punctatus</i>								8
<i>Bartramia pomiformis</i>		175						38
<i>Bartramia stricta</i>							125	
<i>Brachythecium glareosum</i>				300				13
<i>Brachythecium plumosum</i>	60			100				
<i>Brachythecium rivulare</i>					60	75		
<i>Bryum alpinum</i>								19
<i>Bryum argenteum</i>							100	35
<i>Bryum caespiticium</i>	100							
<i>Bryum capillare</i>						275		69
<i>Bryum dichotomum</i>						75		
<i>Bryum pallescens</i>								8
<i>Barbula convoluta</i>								19
<i>Barbula hornschuchiana</i>	100							19
<i>Barbula unguiculata</i>		125			80			
<i>Crossidium squamiferum</i>				200	120			
<i>Cephalozia bicuspidata</i>			150					
<i>Cephaloziella divaricata</i>	80				120			
<i>Corsinia coriandrina</i>			225					27
<i>Dicranella varia</i>			250				125	23
<i>Dicranella heteromalla</i>	140				200			
<i>Didymodon falax</i>					80	100		
<i>Didymodon tophaceus</i>								27
<i>Didymodon Vinealis</i>						200	75	
<i>Dialytrichia mucronata</i>			50					13
<i>Eurynchium speciosum</i>		100						
<i>Eurynchium striatulum</i>		100		250				
<i>Encalypta vulgaris</i>			100		140			
<i>Entosthodon fascicularis</i>		75						27
<i>Fissidens bryoides</i>	60				200			
<i>Fissidens incurvus</i>		75						
<i>Funaria hygrometrica</i>	160							58
<i>Funaria microstoma</i>					40	75		
<i>Fossombronia angulosa</i>				250				42
<i>Grimmia decipiens</i>	180				60			
<i>Grimmia ovalis</i>	80			100				
<i>Grimmia trichophylla</i>						275		50
<i>Gymnostomum aeruginosum</i> var. <i>aeruginosum</i>	40							
<i>Homalothecium lutescens</i>				350	140			
<i>Homalothecium sericeum</i>	120							27
<i>Hypnum cupressiforme</i>								27
<i>Isothecium myosuroides</i>		100				125		

<i>Leucodon sciuroides</i>						100	
<i>Leptodon smithii</i>			200				38
<i>Lunularia cruciata</i>					125		35
<i>Marchantia polymorpha</i>			50		50		
<i>Orthotrichum cupulatum</i>				250	100		
<i>Orthotrichum diaphanum</i>							19
<i>Orthotrichum tenellum</i>							23
<i>Plasteurhyncium meridionale</i>	160				140		
<i>Pleurochaete squarrosa</i>	120						62
<i>Pseudoscleropodium purum</i>	60	175			150		
<i>Pottia davalliana</i>	40			200			
<i>Pottia truncata</i>		175					19
<i>Phascum cuspidatum</i>	60					100	
<i>Pleurochaete squarrosa</i>	180				320	125	96
<i>Pterogonium gracile</i>							8
<i>Phaeoceros laevis</i>	120						50
<i>Rhynchostegium confertum</i>			125				27
<i>Rhynchostegiella curviseta</i>							27
<i>Reboulia hemisphaerica</i>						150	
<i>Riccia ciliifera</i>		50				75	
<i>Riccia gougetiana</i>					50	75	
<i>Riccia macrocarpa</i>	80				75	225	
<i>Riccia sorocarpa</i>						50	
<i>Riccia warnstorffii</i>	80	300			100		
<i>Scorpiurium circinatum</i>		225					46
<i>Scleropodium touretii</i>						175	23
<i>Sematophyllum substrumulosum</i>					200		
<i>Sphaerocarpos michelii</i>		50					
<i>Timmiella barbuloidea</i>				300		225	69
<i>Tortella nitida</i>						50	
<i>Tortula canescens</i>		50					31
<i>Tortula cuneifolia</i>			125			125	
<i>Tortula laevipila</i>							42
<i>Tortula muralis</i>						125	35
<i>Trichostomum crispulum</i>							31
<i>Targionia hypophylla</i>	120						27
<i>Weissia viridula</i>						125	19
<i>Zygodon viridissimus</i>							19

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