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CONTRIBUTION TO THE INVENTORY OF BRYOPHYTES FLORA OF TALASSEMTANE NATIONAL PARK, NORTH OF MOROCCO

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ABSTRACT

In order to contribute to the elaboration of an inventory of the bryophytic flora of Morocco, we were interested in the present study in the bryoflora of the National Park of Talassemtane (PNTS). It is an original site by its rich biodiversity, located in the Western Rif near the town of Chefchaouen. The inventory was carried out with the help of 72 surveys in 8 different stations following a sampling of bryophytes carried out during five years, from 2014 to 2019, when periods are favourable for harvesting. A total of 132 taxa were recorded, including 123 Mosses, 8 Liverworts and a unique Anthocerote, grouping 27 families and 60 genera. Thus, the moss class is the most represented in all the stations surveyed, either 93%, including 18 families and 51 genera. The bryophytic species are either harvested on a single type of substrate, or they are both saxicolous and/or terricolous and/or epiphytic; as there are those that are aquatic or supra-aquatic.Saxicolous bryophytes seem to be the most represented (54 taxa), followed by epiphytes and terricoles, then supra-aquatic, aquatic, epixyles and muricoles. *Timmiella barbiloides* and *Lunularia cruciata* are widely distributed in the study area with varying abundance classes. *Antitrichia californica* is dominant (IES=300) but is more widely distributed in the park fir forest. Thus we noted 39.4% of the taxa listed as very scarce in the study site. Among the inventoried bryophytes, 30 species are newly observed in the study region; among them, three were identified for the first time in Morocco, *Didymodon sinuosus, Didymodon umbrosus* and *Scleropodium obtusifolium*, where the first two belong to the family Pottiaceae and the last one to the family Brachyteciaceae. *Scleropodium obtusifolium* is new to North African countries. Thus, this study has enriched the bryological flora of Morocco and even that of North Africa.

***Keywords*:** Bryophytes, Inventory, Talassemtane National Park, New species, Rif, Morocco.

Introduction

The Talassemtane National Park (PNTS) was created in 2004 for its rich flora and landscape architecture (Benabid, 2000). This biodiversity has been the subject of various research studies (Benabid, 1994; Meda, 2008; Benyahia *et al*., 2015; Otero *et al*., 2017), particularly on fauna, flora, ecology, etc... No research has focused on the bryophytes of the PNTS, apart from a few temporary surveys (Ahayoun *et al*., 2013; Ros *et al*., 2013). In terms of species richness, Bryophytes (mosses, liverworts, anthoceroses) are the second largest phylum after Angiosperms, with about 23,000 species. Morocco currently has a bryophytic flora of about 619 species.This number has been deduced from the samples kept in the herbarium of "The Scientific Institute of Rabat" and from relatively old or recent studies, by Ahayoun *et al*. in 2013. Bryophytes are small plants that go unnoticed but colonize different habitats in various ecosystems. Byophytes play a considerable role in forest ecosystems. When they form a continuous mat, they regulate the thermal environment of the soil (case of the terricolous) and are therefore able to filter nutrients efficiently for the benefit of the forest trees (Oechel and Van Cleve, 1986). They are used as bio-indicators of air pollution. (Govindapyari *et al*., 2010), especially epiphytes (Authelet, 2019), and, also, that of the water thanks to aquatic bryophytes (Empain, 1973). Mosses play an important role in soil formation by colonizing inorganic substrates such as boulders. They then contribute to the formation of humus (Ozenda, 2000) and have a water retention medium that allows the seeds of higher plants to germinate (Ah-Peng, 2007). Thus, given the importance that these plants can play in the ecosystems they occupy, this study was undertaken with the aim of developing an inventory of bryophytic species in Talassemtane National Park, and to describe their distribution according to their ecological preferences in this site. This is within the framework of completing and enriching the bryoflora of Morocco.

Materials and Methods

Study area

Talassemtane National Park (PNTS) covers an area of 64,601 ha in an altitudinal fringe ranging from 600 m (city of Chefchaouen) to 2,159 m (Jbel Lakraâ) and is located in the provinces of Chefchaouen (2/3) and Tetouan (1/3). (Fig. 1). It covers the eastern end of the great limestone ridge that forms most of the Rif, with a calcairo-dolomitic lithology. (El Gharbaoui, 1981). With its very rugged relief, the park is characterized by the highest peaks of the Western Rif, such as Jbel Lekraa (2159 m), Jbel Tissouka (2122 m), Jbel Taloussiste (2005), Jbel Kelti (1926 m) et Jbel Tazaout (1791 m) (HCEFLCD, 2010 ; Ater *et al*., 2014 ; Benyahia *et al*.,

2016). It also has a very special hydrological feature: cascade. (Akchour, Ras-El-Ma), barrage (Talambote), the oueds, and also gorges with impressive cliffs and deep, narrow caves. The climate of the PNTS is characterized by the fact that it is the wettest zone in North Africa with diversified bioclimates: temperate subhumid at low altitude, cool humid, cold to very cold perhumid. (Benabid, 2000).Annual precipitation ranges from 500 mm in the eastern valleys to over 2000 mm on the mountain tops with little snow cover.This ecosystem diversity is reflected in the high specific richness of the flora and fauna, which qualifies the PNTS as a biodiversity hotspot in the Mediterranean basin. Thus, The park hosts about 190 animal species (mammals, birds, reptiles, amphibians) of which 35% are endemic and more than 750 plant species belonging to 103 families of which 56 are endemic (ATECMA & ECOTONO, 2012). It is characterized by three fir plantations (Jbel Talassemtane, Jbel Lekraa and Tissouka) with a surface area of 2219 ha. (ATECMA & ECOTONO, 2012); they are climatic forest formations, organized by an endemic and relict species of fir tree, *Abies maroccana* Trab. There are 11 major forest species:*Abies marocana*, *Pinus sp.*, *Cedrus atlantica*, *Quercus faginea*, *Quercus rotundifolia*, *Tetraclinis articulata*, *Olea silvestris*, etc… (Benabid, 1984). The park is also home to an important biodiversity of aromatic and medicinal plants, of which 184 species have recently been inventoried. (Rattass *et al*., 2017).

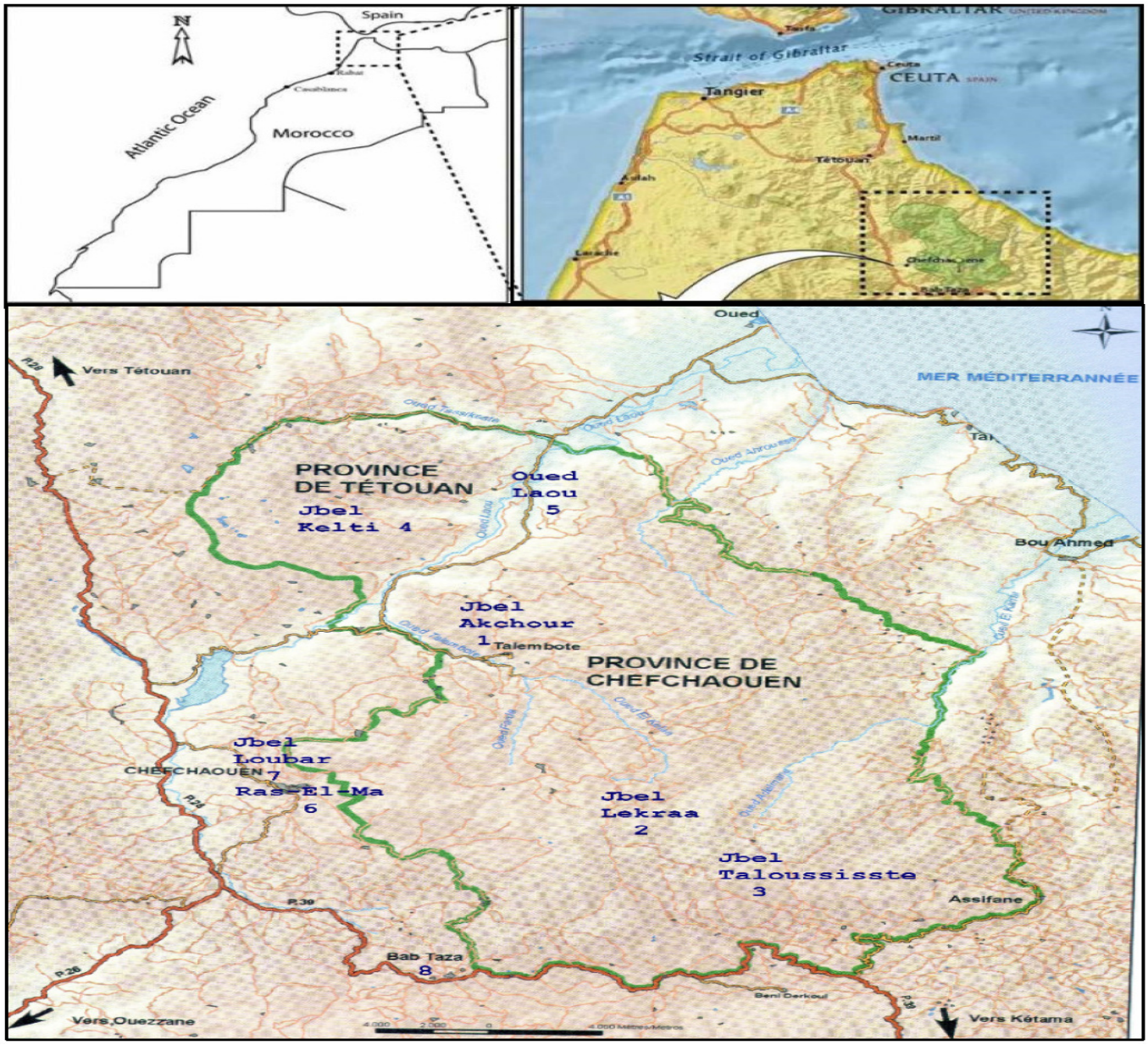

Fig. 1: Location of the study area and prospected stations (Talassemtane National Park, Northern Morocco).

Data collection

The PNTS bryoflora study was carried out using systematic sampling according to the forest areas of the site: Ain Rami, Bab Taza, Bni Hassane, Talambote, Assifane, Bouhmed, Sidi Abdelhamid, Talassemtane. Our choice focused on these eight stations, which were deemed to be representative of the park's ecosystem diversity (Fig. 1).These stations combined 72 readings (Table 1).

The inventory of the bryological species of the PNTS was carried out over a period of 5 years, from October 2014 to March 2019, taking care to program the prospection during different seasons in order to be able to follow the vegetative

cycle of the species. Spring is generally the season for bryophyte sporulation. Thus, we have made a point of making several passes per year in order to harvest the maximum number of species on the different types of substrates and in different possible natural habitat environments (rocky areas, wetlands, forests, matorrals, lawns).

The identification of the harvested species was based on the following determination keys: Smith (2014), Pierrot (1982), Boulay (1904), Augier(1966), (Coudreuse *et al.,* 2005), Casas *et al*.(2006), Casas et al. (2009). Verification of species nomenclature is based on the list of North African bryophytes (Ros *et al*., 1999). The species new to the region are marked with one asterisk (*), for Morocco with two asterisks (**) and for North Africa with three asterisks (***). The morphological state under which the plant was encountered is noted by "G" (=gametophyte) for species harvested only in the sterile state or by "GS" (=gametophyte+sporophyte) for species harvested in the fertile state.

Data analysis

The abundance of species in the different substrates in the study area was expressed using the Ecological Significance Index "IES", where frequency and overlap are two parameters of abundance, (Lara & Mazimpaka, 1998; Albertos *et al.,* 2001), whose mathematical expression is as follows: IES=F (1+C).

With,F (relative frequency) = 100 x /n andC (mean cover) =Σ c_i / x, where xrepresents the number of samples containing the species, n the total number of samples and c_i the cover class attributed to the species in each sample.

The recover classes have been classified according to the following values: 0,5 (<1%), 1 (1%-5%), 2 (6%-25%), 3 (26%-50%), 4 (51%-75%), 5 (>75%).For a better understanding, the values of this index have been delineated into frequency classes as follows: very scarce (≤25), scarce (26-50), moderately abundant (51-100), abundant (101-200) and dominant (>200).

Results and Discussion

Sampling to date has identified 132 bryophytic taxa in PNTS, belonging to 27 families and 60 genera, and divided into 123 mosses, 8 liverworts and one anthocerote. The families are presented in the catalogue by grouping the species in alphabetical order and by phylum. For each species, the stations where it was collected, the altitude and the type of substrate on which it lived are noted, including terrestrial species and aquatic or supra-aquatic species.

PNTS Bryophyte Inventory (2014-2019):

ANTHOCEROPHYTA

Anthocerotaceae

Anthocerote punctatus L. Douin: (G), Jbel Lekraa, terricolous (clay soil), slope NW.Alt : 1205 m.green oakMatorral, forest of *Abies marocana*.

MARCHANTIOPHYTA

Frunalliaceae

Frunallia sp.: (G), Jbel Kelti, terricolous, (on clay soil), found in combination with *Homalothecium lutecens*.

Fossombroniaceae

Fossombronia sp.: (G), Jbel Kelti, terricolous, (iron-rich clay soil).

Lunulariaceae

Lunularia cruciate (L.) Dum: (GS), Bab taza, terricolous (clay soil), slope NW. Alt: 887 m, on lawn.Jbel Akchouron wet clay soil at the edge of the big cascade, on the banks of the Oued Ferda, on the banks of the Oued Kelâa (supra-aquatic species), on limestone rock, Alt: 618 m. Ras-El-Maon the wall (artificial substrate), Alt:564m. Jbel Taloussiste on clay soil and at the edge of a water source, in combination with *Dicranella*, slope Est, Alt: 1105 m. Oued Law in a water source (sagia).

Marchantiaceae

**Marchantia polymorpha* L.: (GS), Jbel Akchour, terricolous (clay soil), muricolous and saxicolous (calcareous rock) at the edge of the cascade, Alt: 369 m (supra-aquatic species).

Pelliaceae

Pellia endiviifolia (Dicks.) Dumort.= [*Pellia* fabbroniana Raddi,*Peliia calycina* (Taylor) Nees.]: (GS), Jbel Lekraa, saxicolous (limestone rock) sope NW, Alt: between 1205 m et 1634 m.Holm oak matorral, *Abies marocana +Quercus faginea, Abies marocana*. Jbel Kelti on clay soil (terricolous).

Porellaceae

Porella platyphylla (L.) Pleiff.: (GS), Jbel Lekraa, saxicolous (on siliceous rock), slope Est, Alt: between 1635 m et 1638 m.

Sphaerocarpaceae

**Sphaerocarpos michelii* Bellardi: (G), Jbel Akchour, terricolous (very wet clay soil) on the verge of Oued Kelâa, Alt: 374 m (supra-aquatic species).

Targoniaceae

Targonia hypophylla L.:(GS), Jbel Akchour, terricolous and saxicolous, harvested on very wet clay soil at the edge of the big cascade (supraaquatic species), Alt: 613 m.Jbel Taloussisteon siliceous soil, slope Est, Alt: 1105 m. Jbel kelti on limestone rock.

BRYOPHYTA

Amblystegiaceae

**Amblystegium tenax* (Hedw.): (G), Jbel Akchour, saxicolous, fixed on pebbles immersed in the running water of the middle cascade (aquatic species), Alt: 376 m.Jbel Kelti, on calcareous rock, in the meadow.

**Amblystegium varium* (Hedw.) Lindb.: (G), Jbel Taloussiste, saxicolos (siliceous rock), slope Est, Alt: 1106 m.

Cratoneuron filicinum (Hedw.) =[*Cratoneuron filicinum* (Hedw.) Spruce, *Hygroamblystegium filicinum* (L.) Loesk., *Hygroamblystegium fallax* (Brid.) Loesk., *Hypnum filicinum* Hedw., *Cratoneuron filicinum* var. *crassinervium* (Renauld) Podp.]: (G), Ras-El-Ma, saxicolous, fixed on pebbles of the cascade (supraaquatic species), Alt: 564m.Jbel Loubar on limestone soil, Alt: 622 m.

**Cratoneuron commutatum* (Hedw.)= *Palustriellacommutata* (Hedw.): (G),Jbel Akchour, saxicolous,on the verge of Oued Kelâa (supraaquatic species)on pebbles, Alt: 373 m.

Hygroamblystegium tenax (Hedw.) Jenn.:(G),Ras-El-Ma, saxicolous, fixed onpebbles of the cascade (supraaquatic species), Alt:564m.

**Leptodictyum riparium* (Hedw.) Warnst = *Amblystegium riparium* (Hedw.) Schimp.:(G), Jbel Loubar, terricolous (on sandy-clay soil), Alt: 630 m.

Bartramiaceae

Bartramia pomiformis (Hedw.):(GS), Jbel Kelti, saxicolous (on limestone rock), lives in association with *Trichostomum crispulum*.

Brachytheciaceae

Brachythecium dieckei Roll.: (G), Jbel Lekraa, epiphyte, on the trunk of *Abies marocana,* Alt : 1600m.

Brachythecium rutabulum (Hedw) Schimp:(G), Jbel Kelti, epiphyte, on the trunk of *Quercus rotundifolia,* Alt: 1200 m. Jbel Loubar, terricolous (on sandy-clay soil), Alt: 630 m.

Brachythecium plumosum (Hedw):(G), Jbel Akchour, saxicolous, fixed on pebble on the edge of a large cascade, (supra-aquatic species), Alt: 613m.

Brachythecium velutinum (Hedw.)Ignatov & Huttunen=*Chamberlainia velutina* (Hedw.)H.Rob.: (G),Jbel Lekraa, terricolous (on clay soil), slope N, Alt: betwen 1112m et 1634m, found in association with *Didymodon sinuosus et Bryum caespiticium* at an altitude of 1634 m, in lawn and et forest of*Abies marocana*.

Cirriphyllum crassinervium (Tayl.)Loeske& M. Fleischb. =*Eurhynchiumcrassinervium*:(G), Jebl Akchour, saxicolous(on limstone rock), Alt: 376m.

Eurhynchium hians (Hedw) =*Eurhynchiumswartzii* var. *rigidum* (Boulay):(G), Jbel Akchour, terricolous (on claysoil) on the verge of OuedFerda, Alt: 376 m.

Eurhynchium praelongum (Hedw) Schimp.=*Kindbergia praelonga* (Hedw) Schimp.: (G), Jbel Lekraa, terricolous (on clay soil), slope North-west, Alt: betwen 1163m et 1634m, found in association with*Didymodon sinuosun, Brachytechium velutinum* and*Bryum caespiticium*at analtitude of 1634m. Forest of*Abies marocana+Quercus faginea,* forest of *Abies marocana*.

Eurhynchium pulchellum (Wils.) Schimp:(G),Jbel Akchour, saxicolous (on a pebble in the big cascade), Alt: 613 m (aquatic species).

Eurhynchium striatum (Schreb.) Schimp= *Eurhynchiummagnusii* (H. Winter) Pilous:(GS), Jbel Akchour, epiphyte (on the trunk of *Quercus rotundifolia*), Alt : 523 m.

**Homalothecium lutescens* (Hedw.) H.Rob= *Comptothecium lutescens* (Hedw.) Schimp.:(G),Jbel Lekraa, epiphyte (on the trunk of *Abies marocana*), slope North-west, Alt: betwen 1112m et 1714 m, found in association with*Pterigonium gracile* at an altitude of 1500m. In lawn, forest of *Abies marocana+Quercus faginea, Abies marocana*.Jbel Keltiwhere she sometimes lives in association with *Frunallia*. Jbel Taloussisteon the slope East, Alt:1105 m.

**Homalothecium philippeanum* (Spruce) Schimp : (GS), Jbel Lekraa, epiphyte (on trunk, exposed roots and branches of *Abies marocana*), slopeNorth andNorth-west, Alt: betwen 1500m and 1714m.Forest of *Abies marocana+Quercus faginea*, forest of *Abies marocana*.

Homalotheium sericeum (Hedw.) Schimp = *Camptothecium sericeum* (Hedw)Kindb: (G), Jbel Lekraa, epiphyte (on trunk of *Abies marocana*), North-western slope,Alt: between 1500m and 1646m.Forest of *Abies moroccana+Quercus faginea*, forest of *Abies moroccana*. Jbel Loubar, saxicolous (limestone rock), Alt: 626 m.

Isothecium alopecuroides (Lam.ex Dubois) Isov: (G), Jbel Lekraa, epiphyte (on the trunk of *Abies marocana*), North-western slope, Alt: betwen 1712m and 1714m. Forest of *Abies marocana*.

Isothecium myosuroides Brid. =*Eurhynchium myosuroides* (Brid) Schimp:(G), Jbel Akchour, epiphyte (on the trunk of *Quercusrotundifolia)*, Alt: 516m.

Platyhypnidium riparoides (Hedw) Cardot = [*Rhynchostegium riparoides* (Hedw.) Cardot, *Platyhypnidium rusciforme* (Neck.) M. Fleisch., *Rhynchostegium rusciforme* (Weiss ex Brid) Schimp., *Oxyrrhynchium rusciforme* (Neck.) Warnst., *Eurhynchium rusciforme* Milde.]: (G), Jbel Akchour, saxicolous (on limestone rock), Alt: 614 m.

Rhynchostegium confertum (Dicks.) Schimp.:(G), Jbel Taloussiste, saxicolous (on siliseous rock), versant Est, Alt: 1106m.

Sciuro-hypnum plumosum Hedw Ignatov & Huttunen=*Brachythecium plumosum*:(G), Jbel Taloussiste, saxicolous(on limestone rock), slope East, Alt: 1106 m.

**Sciuro–hypnum reflexum* (Starke) (Brid) Ignatov &Huttenen=*Brachythecium reflexum* (Starke) Schimp.:(G), Jbel Lekraa, epiphyte and saxicolousrespectively on the trunk of *Abies marocana* and on limestone rock, slope North-west; Alt: betwen 1294m and 1714m. Forest of *Abies marocana+Quercus faginea*, forest of *Abies marocana*.Jbel Akchouron the verge of OuedKelâa fixed on the pebbles (supra-aquatic species), Alt: 373 m.

****Scleropodium obtusifolium*(Bruch.) Schimp:(G),Jbel Lekraa, epiphyte (on the branches of *Abies marocana*), slope North, Alt: 1638m. Forest of *Abies marocana*.

Scleropodium touretii (Brid), L.F. Koch. =*S. illecebrum* (Vail.) B.E:(G),Jbel Lekraa,epiphyte (on the trunk of*Abies marocana*), slope North-west, Alt: betwen 1635m and 1638m.Forest of *Abies marocana.*Jbel Kelti, saxicolous (on limestone rock).

Scorpiurium circinatum (Brid.) M. Fleisch. & Loeske =[*Eurhynchiunm circinatum* (Brid.) Schimp., *Thamnium circinatum* (Brid). Kindb]:(G), Jbel Akchour, epiphyte (on the trunk of *Quercus rotundifolia*), Alt: 523m.

Bryaceae

Bryum caespiticium (Hedw.): (G), Jbel Lekraa, terricolous (clay soil), Alt: 1500m and 1634m, found in association with *Eurhynchium pralongium* and *Orthotrichum affine*atan altitude of 1500m. Forest of *Abiesmarocana*. Jbel

Kelti, on limesone rockin association with *Barbula unguculata*.

Bryum capillare Hedw.:(GS), Jbel Lekraa, terricolous (claysoil), Alt: 887m and 1634m.Lawn and forest of *Abies marocana*.Jbel Akchour, epiphyte (on the trunk of *Quercus rotundifolia*) and saxicolous (limestone rock), Alt: 614 m. Jbel Taloussiste, slope East, Alt: 1105 m.

Bryum donianum Grev.:(GS), Jbel Taloussiste, saxicolous (on limestone rock), Alt :1105m.

Bryum gemmilucens R. Wilczek & Demaret:(G), Bab Taza, terricolous(sandy soil), Alt: 887m.

Bryumpallescens Schleich.*ex* Schwägr.: (GS), Jbel Lekraa, saxicolous (on limestone rock), Alt: 887m.Lawn.

Bryum pseudotriquetrum (Hedw.) P. Gaertn., B. Mey. & Scherb:(G), Jbel Kelti, terricolous (on iron rich clay soil).

**Bryum rubens* Mitt.: (GS),Ras-El-Ma, terricolous (sandy soil) andmuricolous, Alt:564m.

Bryum sp.: (G), Ras-El-Ma, muricolous, Alt:564m.

Bryum torquescens Bruch ex De Not.:(GS),Bab Taza, terricolous(sandy soil), Alt : 887m.

**Ptychostomum moravicum* (Podp.) Ros & Mazimpaka:(G), Jbel Lekraa, terricolous (clay soil), Alt: betwen 887m and 1634m. Lawn and forest of *Abies marocana*.

Dicranaceae*

Ceratodon purpureus (Hedw.) Brid.:(G),Jbel Lekraa, terricolous (clay soil), Alt: 1500m and 1632m.Forest of *Abies marocana+Quercus faginea* and forest of *Abies marocana*.

Dicranella varia (Hedw.) Schimp (Hedw.) Schimp. =*Anisothecium rubrum* Lindb.): (G), Jbel Taloussiste, terricolous (clay soil), lives inassiciation with *Lunularia cruciata*, East exposition, Alt: 1106m.

Dicranowesia cirrata (Hew.) Lindb:(G), Jbel Lekraa, saxicolous (on limestone rock), North exposition, Alt: 1635 m. Forest of *Abies marocana*.

Fissidentaceae*

Fissidens dubius P. Beauv. =*Fissidens cristatus* Wilson ex Mitt.: (GS), Jbel Akchour, saxicolous (on limestone rock) shaded, on the verge of OuedKelâa, Alt: 376m (aquatic species).

Fissidens grandifrons (Brid.): (G), Jbel Akchour, saxicolous (on limestone rock), in the big cascade, Alt: 613 m (aquatic species).

Fissidens incurvus Starke ex Rohl:(G), Oued Laou, Oued Ifrtan, terricolous (on clay soil) (supraaquatic species).

Fontinalaceae*

**Fontinalis Antipyretica* (Hedw):(G),Ras-El-Ma, saxicolous(on the pebbles in the big cascade) (aquatic species), Alt:564 m.

Funariaceae*

Enthostodon muhlenbergii (Turner) lndb. =[*Funaria dentata* Crome., *Funaria hibernica* Hook., *Funaria calcarea* Wahlenb, *Funaria mediterranea* Lindb., *Funaria muhlenbergii* Turner) Lindb.]:(GS), Ras-El-Ma, terricolous (limestone soil) and saxicolous(siliceouse rock), Alt: 614 m.

**Entosthodon attenuates*(Dicks.) Bryhn =[*Entosthodon templetonii* (Sm.) Schwagr.,*Funaria attenuata* (Dicks.) Lindb.]:(GS), Jbel Taloussite, terricolous (on clay soil), Alt: 1106m.

Funaria hygrometrica (Hedw.):(GS), Jbel Lekraa, terricolous (on clay soil), North-western exposition, Alt: 1294m.Forest of*Quercus faginea*. Jbel Akchour on the trunk of *Quercus rotundifolia* and limestone soil, Alt: 500 m.

**Funaria pulchella* H. Philib.=*Enthostodon pulchellus* (H.Philib.) Brogues:(GS),Jbel Akchour, terricolous (on limestone soil), Alt: 500m.

Grimmiaceae*

Grimmia arenaria Hampe: (G), Jbel Taloussiste on clay soil, eastern exposition, Alt : 1106m.

**Grimmia decipiens*(Schultz) Lindb:(GS),Jbel Lekraa, saxicolous (limestone rock), slope North-west, Alt: 1112m and 1205m. Lawn, green oak matorral, forest of *Abies marocana.*

**Grimmia funalis* (Schwaegr.) Bruch & Schimp:(GS), Jbel Akchour, saxicolous (limestone rock), Alt: 500m.

**Grimmia longirostrie* (Hook):(G), Jbel Lekraa, epiphyte (on the trunk of*Abies marocana*), exposition North-west, Alt: 1294m.Forest of *Quercus faginea*.

**Grimmia muhlenbeckii* Schimp. =*Dryptodon muhlenbeckii* (Schimp.) Loeske.: (G), Jbel Taloussiste, saxicolous (limestone rock), eastern exposition, Alt: 1105 m.

Grimmia orbicularis Bruchex Wilson =*Dryptodon orbicularis* (Bruchex Wilson) Ochyra & Zarnowiec:(G), Jbel Lekraa, saxicolous (limestone rock), North-western exposition, Alt: 1634m. Forest of *Abies marocana*.

Grimmia pulvinata (Hedw.) Sm., Engl. Bot.= *G.pulvinata* var.*africana* (Hedw.)Hook.f. & Wilson:(GS), Jbel Lekraa, epiphyte(on the trunk and exposed roots of *Abies marocana*), slope North, Alt: betwen 1500m and 1712m.Forest of *Abies marocana+Quercus faginea* and forest of *Abies marocana*.

Grimmia trichophyla Grev Fl, Edinensis=*Grimmia ausrtofunalis* auct:(GS), Jbel Lekraa, saxicolous (siliceous rock), North-western slope, Alt : betwen 1113m and 1714m.Lawn, green oak matorral, forest of *Abies marocana+Quercus faginea* and forest of *Abies marocana*.

Racomitrium aciculare (Hedw.):(GS), Ras-El-Ma, muricolous, Alt:564m.

Schistidium crassipilum H.H. Blom: (GS), Jbel Lekraa, epiphyte (on the trunk of *Quercus faginea*), Alt: 1294m. Forest of *Quercus faginea+Abies marocana*.

Hypnaceae*

Hypnum cupressiform Hedw (Timm ex Hedw.) Brid:(G), Jbel Lekraa, epiphyte (on trunk, branches and apparent rootsof *Abies marocana*), exposition Nort-west, Alt: betwen 1634m and 1714m, also lives in association with *Antitrichia californica* and *Syntrichia ruralis*. Forest of *Abies marocana.*

**Hypnum cupressiforme* var. *lacunosum* (Brid.): (G),Jbel Lekraa, epiphyte (on the trunk of *Abies marocana*), exposition North, Alt: around 1635m, found in association with *Tortella tortuosa*. Forest of *Abies marocana*.

Leskeaceae

Leskea gracilescens Hedwig: (GS), Jbel Loubar, terricolouson sandy-clay soil, Alt: 588 m.

Leucodontaceae

Antitrichia californica Sull: (G), Jbel Lekraa, epiphyte (on the trunk, branches and apparent roots of *Abies marocana*) and saxicolous (on limestone rock), slopes North andNorth-west, Alt: between 1500m and 1712m. Forest of *Abies marocana+Quercus faginea* and forest of *Abies marocana*.

Antitrichia curtipendila (Hedw.) Brid:(G),Jbel Lekraa, epiphyte (on the trunk of *Abies marocana*), slope North-west, Alt: betwen 1500m and 1714m, found in association with *Syntrichia ruralis*at an altitude of 1634m. Forest of *Abies marocana+Quercus faginea*, forest of *Abies* marocana. Jbel Taloussiste on branche of green oak, slope East, Alt: 1105 m. Forest of *Quercus rotundifolia*.

Leucodon sciuroides (Hedw) Schwagr: (G), Jbel Lekraa, epiphyte(on the trunk, branches of*Abies* marocana), northern slope, Alt: 1714m.Forest of *Abies marocana*. Jbel Taloussiste, slope East, Alt: 1106 m. Forest of *Quercus rotundifolia*.

Pterogonium gracile(Hedw):(G), Jbel Lekraa, epiphyte (on the trunk of *Abies marocana*), slopes North and North-west, Alt: betwen 1500m and 1635m,lives in association with *Homalothecium lutecens* at an altitude of 1500m. Forest of *Abies marocana+ Quercus faginea*and forest of *Abies marocana*.

Mniaceae

Mnium sp.:(G), Oued Laou, terricolous (clay soil)in the verge of Oued (supra-aquatic species).

Mnium spinosum(Voit.), Schwagr:(GS), Jbel Akchour, saxicolous (limestone rock), Alt: 618 m.

Mnium spinulosum Bruch & Schimp: (G), Ras-El-Ma, saxicolous, fixed on the pebbles in the cascade (aquatic species), Alt:564m.

Rhizomnium punctatum (Hedw) T.j Kop:(G),Ras-El-Ma, saxicolous, fixed on the pebbles in cascade (aquatic species), Alt:564 m.

Neckeraceae

Homalia lusitanica (Hedw) Brid =[*Homalia lusitanica* var. *subrecta* (Mitt.) Dull-Herm., *Homalia subrecta* (Mitt.) A. Jaeger, *Neckera subrecta* Mitt.)]: (G), Jbel Akchour, epiphyte (on the trunk of *Quercus rotundifolia*), Alt: 516m.

Leptodon smithii F Weber & D.Mohr =*Hypnum smithii* Hedw:(G), Jbel Akchour, epiphyte (on the trunk of *Quercus rotundifolia*), Alt: 523m. Jbel Lekraa, on *Quercus rotundifolia,*slope North-west, Alt: 1294m.Forest of*Quercus faginea*.Jbel Kelti, epiphyteon the trunk of green oak, mattoral of*Quercus rotundifolia*.

Thamnium alopecurum (Hedw.) Schimp. =*Thamnobryum alopecurum* (Hedw.) Gangulee: (G), Jbel Akchour, epiphyte (on the trunk of *Quercus rotundifolia*), Alt: 369m.

Orthotrichaceae

*Orthotrichum affine*Schrad. Ex Brid. =*O. affine* var.*fastigiatum*(Brid):(GS),Jbel Lekraa, epiphyte (on the trunk of *Abies marocana*), slope North, Alt: betwen 1500 m and 1638m.Forest of *Abies marocana+Quercus faginea* and forest of *Abies marocana*.Jbel Loubar on limestone rock, Alt: 626 m.

**Orthotrichum anomalum* Hedw.=*O. anomalum* var. *saxatile* Milde:(GS), Jbel Lekraa, epiphyte (on the trunk of *Abies marocana)*, slope North, Alt: 1500m.Forest of *Abies marocana+Quercus faginea*.

Orthotrichum cupulatum Brid. =*O. cupulatum* var. *nudum* (Dicks.) Braith:(GS),Jbel Lekraa, epiphyte (on the trunk of *Quercus faginea*), slope North-west, Alt: 1294m. Forest of*Quercus faginea*.

Orthotrichum diaphanum Schrad. Ex Brid:(GS), Jbel Lekraa, epiphyte (on branches of *Quercus faginea*),slope North-west, Alt: 1294m. Forest of *Quercus faginea*.

Orthotrichum ibericum F. Lara, (Garilleti & Mazimpaka): (G), Jbel Taloussiste, saxicolous (limestone rock), slope East, Alt: 1105 m.

*Orthotrichum lyelii*Hook. & Taylor: (G),JbelLekraa, epiphyte (on branches and trunk of *Quercus faginea*), slopes North and North-west, Alt: betwen 1294m and 1712m.Forest of *Quercus faginea*, *Abies marocana*.

Orthotrichum pallens Bruch ex Brid: (G),Jbel Lekraa, epiphyte (on the branches of *Quecus faginea*), slope North-west, Alt: 1294m.Forest of *Quecus faginea*.

Orthotrichumrupestre Schleich. ex Schwägr: (GS), Jbel Lekraa, epiphyte, (on branches of *Quercus faginea*), North-western exposition, Alt: 1294m.Forest of *Quercus faginea+Abies marocana.* Jbel Taloussiste, eastern exposition, Alt: 1106 m.

Orthotrichumscanicum Grönvall=*Ortotrichum lewinskyae* Lara, Garilleti & Mazimpaka:(GS), Jbel Lekraa, epiphyte (on the trunk of*Abies marocana*andof *Quercus faginea*), Alt: 1294m and 1500m. Forests of *Quercus faginea*and *Abies marocana+Quercus faginea*.

Orthotrichum schawii Wilson:(G), Jbel Lekraa, epiphyte (on the branches of *Quercus faginea*), Alt: 1294m. Forest of *Quercus faginea*.

Orthotrichum speciosum var. *speciosum* Nees:(GS),Jbel Lekraa, epiphyte (on the trunk of *Quercus faginea*), slope North-west, Alt: betwen 1294m and 1500m.Forests of *Quercus faginea* and *Quecus faginea+Abies marocana*.

Orthotrichum tenellum Bruch ex. Brid:(G), Jbel Lekraa, epiphyte (on he trunk of *Abies marocana*), Alt: 1714m. Forest of *Abies marocana*.

Plagiomniacea

**Plagiomnium rostratum* (Schrad.) T.J. Kop Kop =*Mnium rostratum* Schrad.:(G), Ras-El-Ma, saxicolouson the pebbles of the cascade (aquatic species), Alt: 564 m.

Plagiomnium undulatum (Hedw.) T.J. Kop. =*Mnium undulatum* Hedw: (G), Ras-El-Ma, saxicolouson the pebbles of cascade (aquatic species), Alt: 564 m.

Polytrichaceae

Polytrichum strictum Menzies exBrid. (Schrader)= [*Polytrichum alpestre* Hoppe, *Polytrichum juniperium* ssp. *Strictum*]: (G), Jbel Taloussiste, saxicolous(limestone rock), slope east, Alt: 1106 m.

Pottiaceae

Barbula convoluta (Hedw.)Frond: (GS), Jbel Lekraa, epiphyte (on the trunk of *Abies marocana*), Alt: 1712m. Forest of *Abies marocana*. Jbel Akchour, terricolous (sandy soil), Alt: 516 m.

Barbula sp.:(G), Jbel Taloussiste, saxicolous (limestone rock), slope east, Alt: 1106m.

Barbula unguiculata Hedw=*Barbula apiculata* Hedw: (GS), Jbel Akchour, saxicolous (limestone rock), Alt: 613 m. Jbel Kelti on limestone rock,lives in association with *Bryumcaespiticium.*

Dialytrichia mucronata (Brid.) Broth. =*Dialytrichia brebissonii* (Brid.) Limpr: (GS),Jbel Akchour, terricolous (limestone soil), Alt: 516m. Jbel Taloussiste on sandy soil, Alt: 1106m.

Didymodon acutus(Brid.) K, Saito=[*Barbula acuta* (Brid.) Brid., *Barbula gracilis* (Schleich.) Schwagr., *Didymodon rigidulus* var. *gracilis* (Schleich.) R.H. Zander]: (G), Jbel Lekraa, epiphyte (on the trunk of *Abies marocana*), slope North-west, Alt: 1646m. Forest of *Abies marocana*. Jbel Kelti on iron riche clay soil, in association with *Timmiella barbiloides.*

Didymodon fallax (Hedw.) R.H. Zander= [*Barbula fallax* Hedw., *Barubua ariatica* Baumgartner]: (G), Jbel Lekraa, epiphyte, (on the branches of *Abies marocana*), Alt: 1646m. Forest of *Abies marocana*.

Didymodon luridus Hornsc: (G), Jbel Taloussiste, saxicolous (limestone rock), slope East, Alt: 1106m.

**Didymodon nicholsonii* Culm. =[*Barbula nicholsonii* Culm., *Didymodon luridus* var. *nicholsonii* (Culm.) Loesk, *Didymodon vinealis* var. *nicholsonii* (culm) R.H Zander]: (GS), Jbel Lekraa, terricolous (limestonesoil), slope North-west, Alt: betwen 1500 m and 1635m. Forestsof *Abies marocana*+ *Quercus faginea* and *Abies marocana.*

**Didymodon rigidulus* Hedw. =[*Barbula rigidula* (Hedw.) Mitt, *Didymodon mamillosus* (Crundw.) M.O. Hill, *Trichostomum rigidulum*]: (G), Jbel Lekraa, saxicolous (limestone rock), slope North-west, Alt: 1634m. Forest of *Abies marocana*. Jbel Akchour, terricolous (siliceous soil). Alt: 516m. Jbel Loubar, terricolous (sandy-clay soil), Alt: 590 m.

***Didymodon sinuosus* (Mitt.) Delogne=[*Barbula sinuosa* (Mitt.) Gravet, *Oxystegus sinuosus* (Mitt.) Hilp., *Trichostomum sinuosum* (Mitt.) Mull.Hal]:(G), Jbel Lekraa, terricolous (clay soil), slope North-west, Alt: 1633m. Forest of *Abies marocana.*

Didymodon vinealis (Brid) R.H. Zander.=*Barbula vinealis* Brid:(G), Jbel Lekraa, terricolous (sandy soil), saxicolous, slope North-west, Alt: betwen 1112m and 1294m. Forest of *Quercus faginea+Abies marocana*, lawn. Jbel Akchour, saxicolous (on siliceous soil and limestone rock), Alt: 614m. Jbel Taloussiste on limestone rockslope East, Alt: 1105 m. Jbel Kelti on limestone soil.

***Didymodon umbrosus* (Müll.Hal.) R.H. Zander: (G), Jbel Taloussiste, saxicolous (limestone rock), slope East, Alt : 1105 m.

Physcomitrium pyriforme (Hedw.) Bruch & Schimp =*Physcomitrium pyriforme* var. *langloisii* Renauld & Cardot: (GS), Jbel Akchour, terricolous (clay soil), Alt: 383 m.

Pleurochaete squarrosa (Brid.) Lindb.=*Tortella squarrosa* (Brid.) Limpr: (G), Jbel Akchour, terricolous (siliceous soil), Alt: 516m.

**Stegonia latifolia* (Schwagr.): (GS), Jbel Kelti, saxicolous (limestone rock).

Syntrichia calcicola J.J Amann:(G), Jbel Lekraa, terricolous(clay soil), northern exposition, Alt: betwen 1501m and 1646m. Forest of *Abies marocana+Quercus faginea*.

Syntrichia laevipila (Brid.):(G), Jbel Lekraa, epiphyte (onapparent roots of *Abies marocana*), saxicolous (limestone rock) and terricolous (sandy-clay soil), slope North-west, Alt: 1633m. Forest of *Abies* marocana. Jbel Loubar on limestone rock, Alt: 642 m.

Syntrichia mantana (Nees) =[*Barbula intermedia* (Brid., A.W.H. Walther & Molendo, *Syntrichia intermedia* (Brid.) A.W.H. Wather & Molendo, *Tortula intermedia* (Brid.) Berk., *Tortula mantana* (Nees.) Lindb., *Tortula crinita* (De Not), *Syntrichia mantana* (Nees)]: (G), Jbel Lekraa, saxicolous (siliceous rock), Alt : 1634m, lives in association with *Tortella tortuosa*. Forest of *Abies marocana.*

Syntrichia princeps (De Not.) Mitt. =*Tortula princeps* De Not: (G), Jbel Lekraa, saxicolous (limestone rock), Alt: 1634m, lives in association with *Syntrichia ruralis* and *Eurhynchium pralongium*. Forest of *Abies marocana*.

Syntrichia ruralis (Hedw)F. Weber & D. Mohr. =[*Tortula ruralis* (Hedw.) P.Gaertn., B. Mey. &. Scherb, *Tortula ruralis* var. *epilosa* (Hedw.) F. Weber & D. Mohr]: (GS), Jbel Lekraa, saxicolous (limestone rock), slope North-west, Alt: 1163m and 1646 m. lawn, holm oak matorral, Forest of *Abies marocana+Quercus faginea*, Forest of *Abies marocana*.

Timmiellabarbuloides (Brid.) Mönk:(G),Jbel Lekraa, saxicolous (limestone rock), Alt: 1000 m. Bab taza, terricolous (clay soil), Alt: 887m.Lawn. Jbel Akchour on siliceous-clay rock, (GS), Alt: 613 m. Ras-El-Ma, terricolous (clay soil), Alt:564m. Jbel Kelti on iron rich clay soil, in association with *Didymodon acutus*andon the barley's field in the verge of Oued Laou, Alt:30m.

Tortella flavovirens (Bruch.) Broth=[*Tortella flavovirens* var. *glareicola* (A.chr.) Crundw, & Nyholm, *Trichostomum flavovirens* Bruch]: (GS), Jbel Lekraa, terricolous (clay soil), Alt: betwen 887m and 1163m. Lawn.

**Tortella fragilis* (Hook. & Wilson) Limpr.= *Trichostomum fragile* (Hook. & Wilson)Mull. Hal:(GS), Jbel Akchour, terricolous (wet clay soil), Alt: 516m.

Tortella humilis (Hedw.)Jenn =*Tortella caespitosa* (Schwägr.) Limpr.: (GS), Jbel Akchour, terricolous (limestone soil), Alt: 516m.

Tortella tortuosa(Hedw.) Limpr.=*Trichostomum tortuosum* (Hedw.) Dixon:(G), Jbel Lekraa, saxicolous

(siliceous rock), slope North and North-west, Alt: betwen 1163m and 1634m.Lawn, green oak matorral, forest of *Quercus faginea*, forest of *Abies marocana*+*Quercus faginea,* Forest of *Abies marocana*. Jbel Kelti on limestone rock.

Tortula inermis (brid.) Mont =[*Barbula inermis* (Brid.) Garov., *Syntrichia inermis* (Brid.) Bruch.]: (GS), Jbel Taloussiste, saxicolous (limestone rock), slope East, Alt: 1105 m.

Tortula muralis (Hedw):(GS), Jbel Akchour, saxicolous (limestone rock), epiphyte (on the trunk of *Quercus rotundifolia*), Alt: 613m. Jbel Loubar on clay-sandy soil, Alt: 636 m.

Tortula sp:(GS), Jbel Taloussiste, saxicolous on limestone rock, slipe East, Alt: 1105 m.

Tortula subulata(Hedw) =*Tortula subulata* var. *subinermis* (Bruch & Schimp.) Wilson.):(GS), Jbel Lekraa, saxicolous(limestone rock), slope North-west, Alt: betwen 1207m and 1634m. Holm oak matorral, forest of *Abies marocana*.

Tortula marginata (Bruche & Schimp.) Spruce =*Desmatodon meridionalis* Luisier: (GS),Ras-El-Ma, terricolous (clay soil), Alt:564m.

**Trichostomum brachydontium* Bruch=[*Trichostomum mutabile* Bruch., *Trichostomum littorale* Mitt.]: (G), Jbel Kelti, saxicolous (limestone rock).

Trichostomum crispulum (Bruch): (G), Jbel Akchour, terricolous (sandy soil), Alt : 523m. Jbel Kelti on limestone rockin association with *Bartramia pomiformis*.

Trichostomum sp.: (G), Jbel Kelti on limestone rock, Alt: 1600m.

**Trichostomumtenuistre* (Hook. & Taylor) Lindb. =*Trichostomum cylindricum* (Bruch ex Brid.) Mull. Hal.: (G), Jbel Lekraa, terricolous (clay soil), Alt: 1633m, Forest of *Abies marocana*.

Pterigynandraceae

Pterigyrandium filiforme (Hedw):(G),Jbel Lekraa, epiphyte (on apparent roots of *Abies marocana*), slope North-west,Alt: betwen 1500m and 1633m. Forests of *Abies marocana*+*Quercus faginea*, and of*Abies marocana*.

Among the species in this catalogue, we noted a clear dominance of acrocarpal mosses (79 species) over pleurocarps (44 species).Most of the taxa inventoried belong to the family Pottiaceaed of which the totality of the representatives is made up of acrocarpic mosses affectionate with the luminous places.This family is already known as species-rich in the world with nearly 1500 taxa, some of which tolerate severe drought and strong sun exposure. The Pottiaceae of the PNTS are represented by 34 species and 14 genera including *Didymodon* (8 taxa) and *Syntrichia* (5 taxa), followed by the family Brachytheciaceae (21 species and 11 genera), Orthotrichaceae (12 species and 1 genus) and Grimmiaceae (10 species and 3 genera) (Fig. 2).These four families thus present a specific richness in the site. Ten other families such as Amblystegiaceae, Grimmiaceae, Bryaceae, Funariaceae, Fissidentaceae, etc. have a specific number that varies from two to seven. Thirteen families are monospecific, among them all the hepatic and the only anthocerote.Indeed, the class Anthocerote is represented only by one species *Anthocerote punctatos*(=*Anthoceros crispulus*).

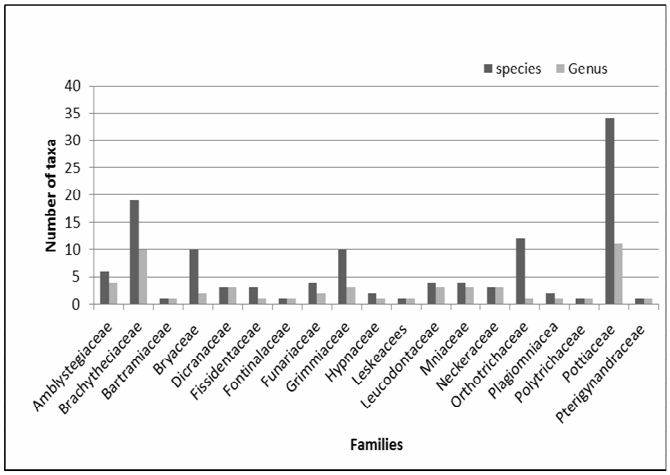

Fig. 2: Specific and generic richess of families.

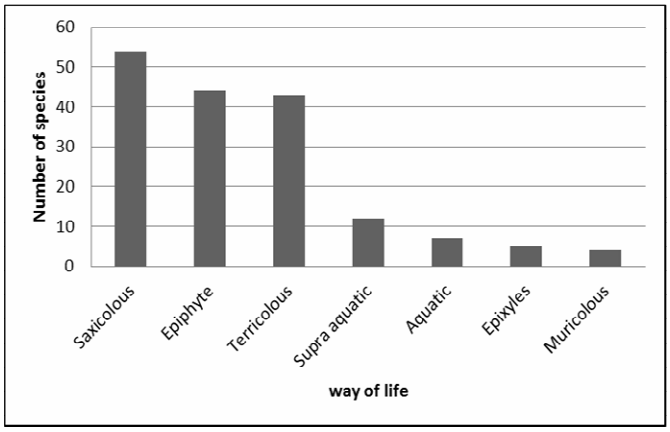

Fig. 3: Specific richness according to the way of life of Bryophytes.

The ecological conditions of the PNTS offer an extremely diverse biotope. Bryophytes are harvested from different types of substrates. Saxicoles seem to be the most represented with 54 taxa, followed by epiphytes and terricoles with 33.33% and 32.57% respectively, then supra-aquatic and aquatic with 9.09% and 5.30% respectively, and finally some epixyls and muricolous (Fig. 3). There are species that are found on several types of substrate, such as *Antitrichia californica* and *Sciuro-hypnum reflexum* which are epiphytic and saxicolous, *Timmiella barbiloides* which is terricolous and saxicolous and also *Syntrichia laevipela* which is both epiphytic, saxicolous and terricolous, as well as *Marchantia polymorpha* which is both terricolous, muricolous and saxicolous in the same station (Jbel Akchour).In the aquatic to sub-aquatic environment, 22 species have been recorded, including *Cratoneuron filicinum* and *Cratoneuron commutatum* forming mats on the pebbles respectively in the cascade of Ras-El-Ma and at Akchour where they are moderately abundant with IES of 100 and 92 respectively. Among these aquatic species are two taxa, *Fontinalis antipyretica* and *Platyhypnidium riparoides*, capable of accumulating heavy metals, which are used as bioindicators of water pollution (Empain, 1973).As far as the soil is concerned, most of them grow on clay or limestone soils. The epiphytic bryophytes are mainly installed on horizontal branches because they retain rainwater or fog or morning dew water longer, and also on the part of the trunks that is exposed to the north.

Despite the richness of the park in bryophytes, only *Timmiella barbiloides* and *Lunularia cruciata*, respectively a moss and a liverwort, show significant overlaps in the study area with variable abundance classes. (Table 2).The dominance of certain taxa in one station does not mean that they are dominant throughout the study area, as in the case of *Antitrichia californica*, which is widely distributed in the fir forest of Jbel Lekraa stand where it forms mats on the trunks, branches and apparent roots of trees, and also on rocks; the value of the index of abundance is very high (IES=333).This moss seems to be linked to the forest atmosphere of the fir forest. On the other hand, the number of very rare species of bryophytes (IES≤25) has been estimated at nearly 39%, of which 46 taxa are found in a single station of the site, where *Didymodon sinuosus, Polytrichum strictum, Sphaerocarpos michelii* and *Tortula subulata* var. *graffi* are the very scarce ones (IES=8).

The specific diversity of bryophytes in the stations of Talassemtane National Park varies from 3 to 62 taxa (Table 2). Jbel Lekraa, which hosts the fir forest, and Jbel akchour, where the cascade are located, are the two stations where the most bryophytic species have been observed, 62 and 40 taxa respectively. This may be due to the humid and cool conditions maintained by the fir forest and the cascades, which contribute to the installation of bryophytes on different types of substrate.In the Oued Laou sation, only three species were observed, *Fissidens incurvus, Mnium sp*. and *Timmiella barbiloides*, which grow on water-soaked land. The first two species are moderately abundant with IES=100 and 67 respectively, while *Timmiella barbiloides* is very rare (IES=25) (Table 2).At the Jbel Taloussiste station, 28 species of bryophytes have been inventoried, a number that remains relatively low. This may be due, firstly, to the station's bioclimatic conditions, which are relatively dry because it is exposed to the east, and secondly, to the plant formations that are mattoralised there, with a dominance of *Quercus rotundifolia* and *Pistacia lentiscus*. It is therefore an environment that has not favoured the proliferation of bryophytes. The Ras-Al-Ma station is a frequently visited place throughout the year. It is subject to strong anthropic pressure, since the developments that have been carried out have destroyed a large part of the natural aquatic biotopes. A low number of bryophytes (17 taxa) have been recorded there, but their abundance remains moderately abundant to abundant (Table 2).

The genus *Orthotrichum* is mainly related to the fir forest and zeeland of Jbel Lekraa, where 12 species have been recorded. It is of great ecological importance in the Mediterranean area, having morpho-functional adaptations related to the bioclimatic conditions of the area (Lara and Mazimpaka, 2001). It is an epiphytic-dominant genus, with the exception of *Orthotrichum ibericum*, which is saxicolous and endemic to the Ibero-North African region (Garilleti *et al*., 1997a). This species is assigned as a scarce moss in most of its range (Lara & Mazimpaka, 2001), which was also proven in this study as *Orthotrichum ibericum* is only present in Jbel Taloussiste with an IES of 33. It should also be noted that *O. scanicum* (= O. lewinskyae) is endemic to northern Morocco (Garilleti *et al.,*1997b) but its abundance is scarce (IES=42) and is only found in Jbel Lekraa on a few branches of Zen oak and fir.

The present study highlighted 30 species newly observed in the Rif region compared to other bryophytic prospecting work carried out in this area of northern Morocco (Cano *et al.,* 2000; Draper *et al.,* 2006; Ahayoun *et al*., 2013; Laouzazni *et al.,* 2018; Laouzazni *et al.,* 2020).Also, two new species are identified for the first time in Morocco compared to the work of Ros *et al.* (2007), Ahyoune *et al.* (2013) and Ros *et al.* (2013) : *Didymodon sinuosus* and *Scleropodium obtusifolium* belonging respectively to the family Pottiaceae and Brachyteciaceae. *Scleropodium obtusifolium* is a remarkable species as it is reported for the first time in North Africa compared to the list of North African bryophytes (Ros *et al.,* 1999; Ros *et al*., 2013) and has been identified usingNorth American bryoflora (FNA). *Scleropodium obtusifolium*is not a Mediterranean species and *Didymodon sinuosus* is only mentioned in Egypt (Ros *et al*., 2013). These two species are very scarce (Table 1) and collected only in the Jbel Lekraa station at high altitude (1638 m).

Conclusion

The study of bryoflora in Talassemtane National Park provided interesting ecological data. The species inventoried were encountered on different types of substrates, of which saxicolous seem to be the most represented; epiphytes are dominant in forest environments such as fir stands. It is an area rich in species belonging to the genus Orthotricum and the family Pottiaceae.This first contribution to the PNTS inventory has made it possible to identify new taxa enriching the bryophyte flora of Morocco and even that of North Africa. Most of the species listed are Western Mediterranean species. It is clear that such a small exhaustiveness of the plant inventory in the PNTS can only be achieved with more surveys, given its large surface area and its ecosystem and plant biodiversity. Thus, new bryophytic inventories should cover all habitats and territories of the site.

Table 1: Study stations with the main forest formations.

Forest area	Study stations	Statements	Frange altitudinale (m)	Main forest formations
Talambote	Akchour	12	350 at700	(Cascade) *Quercus rotundifolia, Pinus halepensis, Arbutus unedo, Pistacia lentiscus*
Talassemtane	Jbel Lekraa	14	858 at2159	*Abies maroccana, Quercus faginea*
Sidi Abdelhamide	Jbel Taloussiste	14	1000 at 2005	*Matorral ofQuercus rotundifolia*
Bni Hassane	Jbel Kelti	10	1000 at 1926	*Quercus rotundifolia*
	Oued Laou	6	131	(River)
Ain Rami	Ras-El-Ma	6	564	(Cascade)
	Jbel Loubar	6	630 at 780	(Village with cultures)

Table 2: IES values of the taxa inventoried according to the different study stations of the PNTS.

Stations	J.Lek	J.Akc	J.Tal	J.Kel	J.Lou	R.Ma	O.Lao	B.Taz
Amblystegium tenax	0	100	17	17	0	0	0	0
Amblystegium varium	0	0	67	0	0	0	0	0
Anthocerote punctatos	42	0	0	0	0	0	0	0
Antitrichia californica	333	0	0	0	0	0	0	0
Antitrichia curtipendila	67	0	33	0	0	0	0	0
Barbula convoluta	17	25	0	0	0	0	0	0
Barbula sp.	0	0	17	0	0	0	0	0
Barbula unguiculata	0	25	0	83	0	0	0	0
Bartramia pomiformis	0	0	0	17	0	0	0	0
Brachythecium dieckei	50	0	0	0	0	0	0	0
Brachythecium plumosum	0	92	33	0	0	0	0	0
Brachythecium rutabulum	0	0	0	50	133	0	0	0
Brachythecium velutinum	50	0	0	0	0	0	0	0
Bryum caespiticium	42	0	0	50	0	0	0	67
Bryum donianum	0	0	50	0	0	0	0	0
Bryum gemmilucens	0	0	0	0	0	0	0	50
Bryum pseudotriquetrum	0	0	0	17	0	83	0	0
Bryum torquescens	0	0	0	0	0	0	0	67
Bryum rubens	0	0	0	0	0	133	0	0
Bryum sp.	0	0	0	0	0	33	0	0
Bryum capillare	33	42	83	0	0	0	0	0
Bryum pallescens	17	0	0	0	0	0	0	50
Ceratodon purpureus	33	0	0	0	0	0	0	0
Cratoneuron commutatum	0	92	0	0	0	0	0	0
Cirriphyllum crassinervium	0	25	0	0	0	0	0	0
Cratoneuron filicinum	0	50	0	0	33	100	0	0
Dialytrichia mucronata	0	17	50	0	0	0	0	0
Dicranella varia	0	0	8	0	0	0	0	0
Dicranoweisia cirrata	33	0	0	0	0	0	0	0
Didymodon acutus	17	0	0	50	0	0	0	0
Didymodon fallax	17	0	0	0	0	0	0	0
Didymodon luridus	0	0	17	0	0	0	0	0
Didymodon nicholsonii	50	0	0	0	0	0	0	0
Didymodon rigidulus	25	17	0	0	67	0	0	0
Didymodon sinuosus	8	0	0	0	0	0	0	0
Didymodon vinealis	83	67	75	75	0	0	0	0
Didymoon umbrosus	0	0	42	0	0	0	0	0
Enthostodon muhlenbergii	0	17	0	0	0	50	0	0
Entosthodon attenuates	0	0	33	0	0	0	0	0
Eurhynchium hians	0	25	0	0	0	0	0	0
Eurhynchium praelongum	50	0	0	0	0	0	0	0
Eurhynchium pulchellum	0	50	0	0	0	0	0	0
Eurhynchium striatum	0	42	0	0	0	0	0	0
Fissidens dubius	0	33	0	0	0	0	0	0
Fissidens grandifrons	0	42	0	0	0	0	0	0
Fissidens incurvus	0	0	0	17	0	0	100	0
Fontinalis antipyrineca	0	0	0	0	0	83	0	0
Frunallia sp	0	0	0	42	0	0	0	0
Funaria hygrometrica	17	25	0	0	0	0	0	0
Funaria pulchella	0	17	0	0	0	0	0	0
Fossombronia sp.	0	0	0	67	0	0	0	0
Grimmia arenaria	0	0	50	0	0	0	0	0
Grimmia decipiens	50	0	0	0	0	0	0	0
Grimmia funalis	0	17	0	0	0	0	0	0
Grimmia longirostrie	17	0	0	0	0	0	0	0
Grimmia muhlenbeckii	0	0	42	0	0	0	0	0
Grimmia orbicularis	17	0	0	0	0	0	0	0
Grimmia pulvinata	108	0	0	0	0	0	0	0

Grimmia trichophyla	150	0	0	0	0	0	0	0
Homalia lusitanica	0	25	0	0	0	0	0	0
Homalothecium lutescens	50	0	100	33	0	0	0	0
Homalothecium philippeanum	83	0	0	0	0	0	0	0
Homalotheium cericeum	83	0	0	0	133	0	0	0
Hygroamblystegium. tenax	0	0	50	0	0	100	0	0
Hypnum cuprissiforme	83	0	0	0	0	0	0	0
Hypnum cupressiforme var. *lacunosum*	33	0	0	0	0	0	0	0
Isothecium alopecuroides	33	0	0	0	0	0	0	0
Isothecium myosuroides	0	33	0	0	0	100	0	0
Leptodictyum riparium	0	0	0	0	133	0	0	50
Leptodon smithii	33	42	0	58	0	0	0	0
Leskea gracilescens	0	0	0	0	33	0	0	0
Leucodon sciuroies	42	0	75	0	33	0	0	0
Lunularia cruciata	42	167	75	75	0	133	0	67
Marchantia polymorpha	0	75	0	0	0	0	0	0
Mnium sp.	0	0	0	0	0	0	67	0
Mnium spinosum	0	50	0	0	0	0	0	0
Mnium spinulosum	0	0	0	0	0	83	0	0
Orthotrichum affine	75	0	0	0	100	0	0	0
Orthotrichum anomalum	17	0	0	0	0	0	0	0
Orthotrichum cupulatum	25	0	0	0	0	0	0	0
Orthotrichum diaphanum	25	0	0	0	0	0	0	0
Orthotrichum ibericum	0	0	33	0	0	0	0	0
Orthotrichum lyelii	125	0	0	0	0	0	0	0
Orthotrichum pallens	25	0	0	0	0	0	0	0
Orthotrichum rupestre	33	0	50	0	0	0	0	0
Orthotrichum scanicum	42	0	0	0	0	0	0	0
Orthotrichum schawii	17	0	0	0	0	0	0	0
*Orthotrichum speciosum*var. *speciosum*	33	0	0	0	0	0	0	0
Orthotrichum tenellum	17	0	0	0	0	0	0	0
Pellia endiviifolia	108	0	0	42	0	0	0	0
Porella platyphylla	50	0	0	0	0	0	0	0
Physcomitrium pyriforme	0	25	0	0	0	0	0	0
Plagiomnium. Rostratum	0	0	0	0	0	83	0	0
Plagiomnium. undulatum	0	0	0	0	0	83	0	0
Platyhypnidium riparoides	0	25	0	0	0	0	0	0
Pleurochaete squarrosa	0	58	0	0	0	0	0	0
Polytrichum strictum	0	0	8	0	0	0	0	0
Pterigyrandium filiforme	75	0	0	0	0	0	0	0
Pterogonium gracile	83	0	0	33	0	0	0	0
Ptychostomum moravicum	17	0	0	0	0	0	0	0
Racomitrium aciculare	0	0	0	0	0	33	0	0
Rhizomnium punctatum	0	0	0	0	0	17	0	0
Rhynchostegium confertum	0	0	33	0	0	0	0	0
Schistidium crassipilum	17	0	0	0	0	0	0	0
Sciuro-hypnum plumosum	0	0	100	0	0	0	0	0
Sciuro–hypnum reflexum	83	0	0	0	0	0	0	0
Scleropodium obtusifolium	17	0	0	0	0	0	0	0
Scleropodium tourtii	58	0	0	25	0	0	0	0
Scorpiurium circinatum	0	33	0	17	0	100	0	0
Sphaerocarpos michelii	0	8	0	0	0	0	0	0
Stegonia latifolia	0	0	0	17	0	0	0	0
Syntrichia calcicola	33	0	0	0	0	0	0	0
Syntrichia laevipela	17	0	0	0	100	0	0	0
Syntrichia mantana	17	0	0	0	0	0	0	0
Syntrichia princeps	17	17	33	0	0	0	0	0
Syntrichia ruralis	83	0	0	0	0	0	0	0
Targonia hypophylla	0	42	125	100	117	0	0	0
Thamnium alopecurum	0	42	0	0	0	0	0	0
Timmiella barbiloides	25	67	0	108	0	300	25	83

Tortella flavovirens	0	0	0	0	0	0	0	17
Tortella fragilis	0	17	0	0	0	0	0	0
Tortella humilis	0	25	0	0	0	0	0	0
Tortella tortuosa	125	0	0	17	0	0	0	0
Tortula inermis	0	0	42	0	0	0	0	0
Tortula muralis	0	42	0	0	100	0	0	0
Tortula subulata var *graffi*	0	0	8	0	0	0	0	0
Tortula. marginata	0	0	0	0	0	150	0	0
Tortula subulata	33	0	0	0	0	0	0	0
Trichostomum brachydontium	0	0	0	17	0	0	0	0
Trichostomum crispulum	0	25	0	58	0	0	0	0
Trichostomum sp.	0	0	0	33	0	0	0	0
Trichostomum tenuistre	75	17	0	0	0	0	0	0
Number of species/station	**62**	**40**	**28**	**25**	**11**	**17**	**3**	**8**

Where, J. Lek: Jbel Lekraa; J. Akc: Jbel Akchour; J. Tal: Jbel Taloussiste; J. Kel: Jbel Kelti; J. Lou: Jbel Loubar; R-M: Ras-El-Ma; O. Lao: Oued Laou; B. Taz: Bab Taza.

References

Ahayoun, K., A. Ouazzani Touhami, R. Benkirane and A. Douira (2013). Catalogue bibliographique des Bryophytes du Maroc (1913-2011). *Journal of Animal & Plant Sciences*,17 (1): 2433-2513.

Ah-Peng, C., (2007). Diversité, distribution et biogéographie des bryophytes des coulées de lave du Piton de la Fournaise (La réunion). Mémoire de Thèse de Doctorat, Université de la Réunion. 420 pp.

Albertos, B., R. Garilleti, I. Draper, F. Lara and V. Mazimpaka (2001). Index of ecological significance (IES), a useful tool for the estimate of relative abundance of bryophyte populations. *Novitates Botanicae Universitatis Carolinae* 15: 69–76.

Ater, M., Y. Hmimsa (2014). Guide des ressources naturelles et culturelles du Jbel Kelti & régions voisines. https://www.researchgate.net/publication/259580589.

Augier, J., (1966). Flore des Bryophytes, morphologie, anatomie, écologie, distribution géographique. Editions Paul Lechevalier, Paris, 702 pp.

Authelet, C. (2019). Analyse diachronique des communautés de bryophytes épiphytes en Wallonie et leur réponse aux polluants atmosphériques. Mémoire de Master en Biologie des Organismes et Ecologie, Université de Liège, Belgique. 33 pp. https://matheo.uliege.be/handle/2268.2/6878

Benabid, A., (1984). Étude phytoécologique des peuplements forestiers et pré forestiers du Rif centro occidental (Maroc). *Travaux de l'Institut Scientifique, Série Botanique*,Rabat, 34.

Benabid, A., (1994). Milieu physique et valeurs biologiques et écologiques des Parcs Nationaux de Talassemtane, Tazekka, Ifrane, Toubkal, Haut Atlas oriental et Dakhla. In"Etude des Aires Protégées duMaroc". Administration des Eaux et Forêts et de la Conservation des Sols/BC EOM-SECA, Rabat.

Benabid, A. (2000).Flore et écosystèmes du Maroc: évaluation et préservation de la biodiversité. Ed. Ibis Press, Paris, 359 pp.

Benyahia, Y., F. Soldati, L. Rohi, L. Valladarès, N. Maatouf, O. Courtin, S. El Antry and H. Brustel (2015). First survey of darkling beetles (Coleoptera, Tenebrionidae) ofTalassemtane National Park, Western Rif, Morocco.*Check List, the journal of biodiversity data*, 11(5), 1778: 1-9.

Boulay, M. l'Abbé (1904). Muscinées de la France, Deuxième partie: Hépatiques. Paris. 225 pp.

Cano, M.J., R.M. Ros and J. Guerra(2000). Identity of North African endemic bryophytes. *Journal of bryology*,22: 269-272.

Casas, C., M. brugnés, R.M. Cros and Sérgio C., (2006). Handbook of Mosses of the Iberian Peninsula and the Balearic Islands, illustrated keys to genera and species. Ed, Institut d'EstudisCatalanus, Barcelona.349 pp.

Casas, C., M. Brugnés, R.M. Cros, C. Sérgio and M. Infante (2009). Handbook of Liverworts and Hornworts of the Iberian Peninsula and the Balearic Islands, illustrated keys to genera and species. Ed, Institut d'Estudis Catalanus, Barcelona: 177 pp.

Draper, I., F. Lara, B. Albertos, R. Garilleti and V. Mazimpaka (2006). Epiphytic of the Atlas and Antiatlas Mountains, including a synthesis of the distribution of epiphytic bryophytes in Morocco. *Journal of bryology*, 28: 312-330.

El Gharbaoui, A. (1981). La terre et l´homme dans la péninsule tingitane. Étude sur le Rif et le milieu naturel dans le Rif occidental. Travaux de l´institut scientifique. Série géologie et géographie physique Nº 15, Rabat, Maroc.

Empain, A. (1973). La vegetation bryophytique aquatique et subaquatique de la Sambre belge, son déterminisme écologique et ses relations avec la pollution des eaux. *Lejeunia*, 69: 58 pp.

FNA- Flora of North America. Vols 27 & 28: Web site1:http://www.efloras.org/consulted on 10/06/2017.

Garilleti, R., F. Lara and V. Mazimpaka (1997a). *Orthotriehum iberieum* and *O. maeroeephalum* new for Northern Africa. *Lindbergia*,22(1): 33-35.

Garilleti, R., F. Lara and V. Mazimpaka (1997b). *Orthotrichum lewinskyae* sp. nov. (*Orthotrichaceae*, Musci), a Moroccan epiphytic moss related to *O. scanicum* Grónv. And*O. holmenii* Lew.Haap. *Journal of. Bryology*,19(3): 457-464.

Govindapyari, H., M. Leleeka, M. Nivedita and P.L. Uniyal (2010). Bryophytes: indicators and monitoring agents of pollution. *NeBio*,1,1: 35-41.

HCEFLCD, (2010). Rapport « Ressources Naturelles Et Ecologiques du Parc National de Talassemtane » Projet MEDA-Chefchaouen, 39 pp.

Laouzazni, H., J. Dahmani, A. Adoudou and N. Belahbib (2018). Contribution to the inventory of bryophytes of

Jbel Ali in the Izaren massif (Ouazzane region, north of Morocco). *American Journal of Innovative Research and AppliedSciences*,6(4):170-179.

Laouzazni, H., J. Dahmani, J. Zaza and N. Belahbib (2020).Contribution to the elaboration of the Brikcha SIBE bryoflora inventory in the central western Rif of Morocco. *Plant* Archives, 20(1): 2027-2032.

Lara F & V. Mazimpaka (1998). Succession of epiphytic bryophytes in a *Quercus pyrenaica* forest from the Spanish Central Range (Iberian Peninsula). *Nova Hedwigia*,67: 125–138.

Lara, F and V. Mazimpaka (2001). Diversity and originality of the genus *Orthotrichum* Hedw. *(Orthotrichaceae)* in West Mediterranean basin (Middle East). – Bocconea,13: 101-106.

Coudreuse, J., J. Haury, J. Bardat, J.P. Rebillard (2005). Les bryophytes aquatiques et supra-aquatiques: clé d'identification pour la mise en œuvre de l'indice Biologique Macrophytique en Rivière. Ed. Agence de l'Eau Adour Garonne, 133 pp.

Meda (2008). Parc National de Talassemtane: Evaluation de la biodiversité et suivi des habitats. 208 pp.

Oechel, W.C. and K. Van Clevel (1986). The role of bryophytes in nutrient cycling in the Taiga. *In*: Van Clevel K., Chapin F.S., Flanagan P.W., Viereck L.A., Dyrness C.T. (eds) "Forest Ecosystem in Alaska". *Ecologia Studies (Analysis an Synthesis)*, 57: 121-137.

Otero, J.C., Y. Benyahia and H. Brustel (2017). Faunistic notes on Cryptophagidae and Latridiidae of Talassemtane National Park, Western Rif, Morocco, with the description of a new species (Coleoptera, Cucujoidea). *ZooKeys*, 668: 69-82.

Ozenda, P. (2000). Les végétaux: organisation et diversité biologique. Ed. Dunod (2e édition). 516 pp.

Pierrot, R. B. (1982). Les Bryophytes du Centre-Ouest: classification, détermi-nation, répartition. *Bulletin de la Société Bototanique Centre-Ouest*,5:123pp.

ATECMA & ECOTONO(2012). Diagnostic Parc national Talassemtane, Plan stratégique de l'écotourisme. Ed. Caecid - CUICN, 112pp.

Rhatasse, M. (2017). Valorisation des potentialiés floristique, écotouristique du parc national de talassemtane (Province de chefchaouen) Maroc. Thése de Doctorat d'Etat, Université Ibn Tofaïl, Kénitra, Maroc.

Ros, R. M., V. Mazimpaka, U. Abou- Salama, M. Aleffi, T. L. Blockeel, V. Hugonnot, K. Khalil, H. Kurschner, A. Losada-Lima, L. Luis, S. Mifsud, M. Privitera, M. Puglisi, M. Sabovljevic, C. Sergio, H.M. Shabbara, M. Sim-Sim, A. Sotiaux, R. Tacchi, A. Vanderpoorten and O. Werner (2013). Mosses of the Méditerranéen, an annoted checklist. *Cryptogamie Bryologie Lichénologie*, 34 (2): 99 – 283.

Ros, R. M., V. Mazimpaka, U. Abou-Salama, M. Aleffi, T. L. Blockeel, M. Brugues, M. J. Cano, R. M. Cros, M. G. Dia, G. M. Dkse, W. Elsaadawi, A. Erdag, A. Ganeva, J. M. Gonzalez-Mancebo, I. Herrnstadt, K. Khlil, H. Kurschner, E. Lanfranco, A. Losada-Lima, M. S. Refai, S. Podriguez-Nunez, M. Sabovljevic, C. Sergio, H. Shabbara, M. Sim-Sim, L. Soderstrom (2007). Hepatics and anthocerotes of the Mediterranean an annotated checklist. Cryptogamie Bryologie, 28 (4): 351 – 437.

Ros, M.R., M.J. Cano and J. Guerra (1999). Bryological Monograph, Bryophyte checklist of Northern Africa, *Journal of Bryology.*, 21: 207-244.

Smith, A.J.E. (2004).The Moss Flora of Britain and Ireland. 2nd Ed. Cambridge University Press. 1012 pp.