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Some interesting bryophytes from the Adrar massif (Mauritania)

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Abstract – The bryophyte flora of Mauritania is poorly known, only five species of bryophytes having been cited previously. Based on field collections and diaspore bank studies, seven bryophyte species have been identified, two of which were reported previously for the country (*Gymnostomiella monodii* and *Riccia cavernosa*). Five are new to Mauritania (*Barbula indica*, *Eucladium verticillatum, Philonotis hastata, Splachnobryum obtusum* and *Leptophascum leptophyllum*); the last one is also a new record to Northern Africa.

Bryophyte flora / Northern Africa / Mauritania / Adrar region

Resumen – La flora briofítica de Mauritania es poco conocida, sólo cinco especies de briófitos habían sido citadas hasta ahora. Sobre la base de recolecciones de campo y estudios del banco de diásporas, se han encontrado siete especies. De ellas dos ya habían sido citadas en Mauritania (*Gymnostomiella monodii* y *Riccia cavernosa*) y cinco son nuevas citas para el país (*Barbula indica*, *Eucladium verticillatum, Philonotis hastata, Splachnobryum obtusum* y *Leptophascum leptophyllum*); la última es además nueva para África del Norte.

Flora briofítica / África del Norte / Mauritania / Región del Adrar

INTRODUCTION

Desert areas constitute one of the less favourable habitats for the growth of bryophytes. For that reason, in many cases, collections and new records are more related to fortuitous conditions than exhaustive studies. The discontinuity of the communities in time and space is an other reason for the scarcity of works on desert bryophytes (Scott, 1982).

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According to Archibold (1995), among the phanerogams, therophytes dominate the flora of most deserts. The same could be said of bryophytes. The spores of many species of desert bryophytes presumably remain viable for some time in the soil (Scott, 1982; Longton, 1988), however diaspore bank studies have been done mainly in temperate, arctic and antarctic ecosystems (During, 1997; During & Moyo, 1999). For these reasons, desert flora studies it seems to be advantageous to combine field prospecting with diaspore bank analysis, especially in very arid areas where annual and short lived species that grow only after rain might be common. Nevertheless, in these desert areas other humid conditions although rare are also present, adjacent to permanent springs or water courses that permit the existence of other bryophyte species with different life strategy.

Mauritania occupies a considerable portion of the Western Sahara desert (Fig. 1) with a fringe of the Sahel region. As far as we know, until now only four publications include data about the bryophytes of Mauritania (Ros *et al.*, 1999). In them five species have been reported for this country: four liverworts of the genus *Riccia* and a pottiaceous moss. The first paper was by Hariot (1913) dealing about some cryptogams in the Sahara desert and neighbouring areas, where *Riccia convexa* Steph. ex Har. *nom. inval.* and *R. exsulcata* Steph. ex Har. *nom. inval.* were cited, the first in Dhayet El-Tofla (Adrar) and the second in Agul Takeist Ahnet and Adrar. Later, Potier de la Varde (1953) discovered the moss *Gymnostomiella monodii* P. de la Varde in the oasis d'El Berbera (El Berbâra) in Adrar, which is the type locality. Jovet-Ast in her studies about some problematic species of the genus *Riccia* in the Mediterranean region reported from Adrar the liverworts *R. frostii* Austin, in Dhayet El-Tofla (Jovet-Ast, 1957) and *R. cavernosa* Hoffm. (Jovet-Ast, 1965).

During a study of vascular plants in the Adrar Region of Mauritania, some bryophyte species were found and studied. These species were growing in both diaspore banks and some oases with permanent flowing water.

STUDY SITES AND METHODS

The Adrar is a region located in the central part of Mauritania. It consists of a massif with noticeable cliffs that have two platforms at 300 m and 600 m a.s.l. Oases are common there, but only in a few of them water reach the surface of the terrain. Among the oases with permanent surface water, does among the more important are Tergit and El Berbâra (see Fig. 1), located at 280 m and 350 m a.s.l. respectively. In both, springs are present in deep straight ravines partially covered by palms (*Phoenix dactylifera* L.).

Arenic regosols (WRB, 1988) are dominant, especially the sands that constitute the large mobile dunes or *ergs*. The region has a summer rainfall climate, with the rain irregularly distributed in time and space. Following the data from Atar (see Fig.1), annual rainfall varies from 1 mm (min.) to 624 mm (max.) per year (average 106 mm). Mean temperature varies between 21 °C and 37 °C, with mean extreme temperatures of 49 °C (Griffiths & Soliman, 1972). The Adrar region is located in the Saharian zone, characterized by the abundance, among the perennial vascular plants, of *Stipagrostis pungens* (Desf.) De Winter in the ergs and *Acacia tortilis* (Forssk.) Hayne, *Maerua crassifolia* Forssk., *Balanites aegypti-*

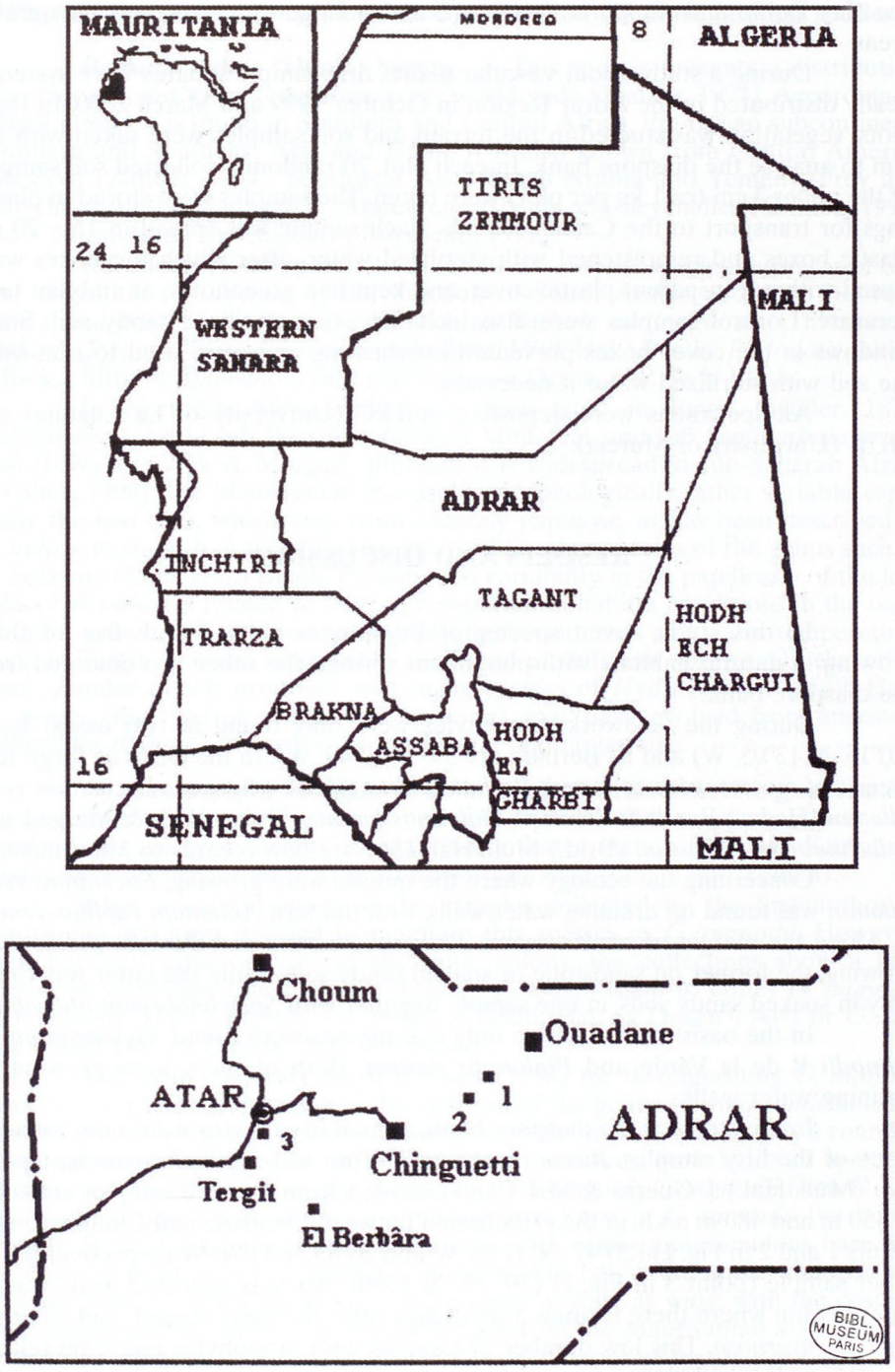

Fig.1. Map of Mauritania (above) with the regions. Below: location of the main oases and areas (1,2,3) where bryophytes were found in the diaspore bank samples collected in the Adrar region.

aca (L.) Delile and *Capparis decidua* (Forssk.) Edgew., in the more favourable areas.

During a study about vascular plants, fifty sample squares were systematically distributed in the Adrar Region in October 1999 and March 2000. In these plots, vegetation was studied in the terrain and soil samples were taken with the aim to analyse the diaspore bank. In each plot, 20 randomly collected soil samples of the upper 3 cm (ca 1 kg per plot) were taken. The samples were stored in plastic bags for transport to the Canary Islands. Each sample was spread in 15 × 20 cm plastic boxes and remoistened with sterilized water, after which the boxes were closed with a transparent plastic cover, and kept in a greenhouse at ambient temperature. Control samples were also included using sterilized sandy soil. Small windows in the cover boxes prevented overheating and were used to remoisten the soil with sterilized water if necessary.

All specimens were deposited at TFC (University of La Laguna) and MUB (University of Murcia).

RESULTS AND DISCUSSION

In this study, seven species of bryophytes were found, five of them growing in natural habitats with permanent springs, the other two emerged from the diaspore bank.

During the fieldwork, bryophytes were only found in two oases: Tergit (20°15´ N, 13°05´ W) and El Berbâra (19°59´ N, 12°49´ W). In the Oasis of Tergit four species of mosses were collected: *Barbula indica* (Hook.) Spreng., *Eucladium verticillatum* (Hedw.) Bruch & Schimp., *Philonotis hastata* (Duby) Wijk & Margad. and *Splachnobryum obtusum* (Brid.) Müll. Hal. They are new records to Mauritania.

Concerning the ecology where the mosses were growing, *Eucladium verticillatum* was found on draining water walls, with the fern *Adiantum capillus-veneris* L. Along the margin of small streams *Philonotis hastata* and *Barbula indica* were growing, the former on sandstone or soaked sandy soils, while the latter was found only in soaked sandy soils, in one sample together with *Splachnobryum obtusum*.

In the oasis of El Berbâra only two mosses were found: *Gymnostomiella monodii* P. de la Varde and *Philonotis hastata*. Both of them were growing on draining water walls.

In the study of the diaspore bank, annual bryophytes were only found in three of the fifty samples. *Riccia cavernosa* Hoffm. and *Leptophascum leptophyllum* (Müll. Hal.) J. Guerra & M.J. Cano emerged from two soil samples collected at 450 m and 480 m a.s.l., in the *erg* situated between Ouadane and Chinguetti (see points 1 and 2 in Fig. 1) (20°47´ N, 11°51´W and 20°43´N, 11°60´W respectively). The other sample (point 3 in Fig. 1) (20° 19´ N, 13°10´ W), was collected near Atar, in a depression where there is often a small lake after the rainy season, and emerged only *R. cavernosa*. This low number of samples with bryophytes might be related to the method that was used for culture, perhaps more appropriate for phanerogams than bryophytes.

Leptophascum leptophyllum represents the first record to Northern Africa.

Phytogeographical and taxonomical comments on the more relevant species

***Barbula indica* (Hook.) Spreng.** — This species presents a distribution over tropical and warm temperate areas world-wide (Zander, 1994). According to Magill (1981) it is found in Southern and Central Africa, the Indian subcontinent, Southern and Southeast Asia and Japan. It is also known from Central America (Mexico) (Zander, 1994), Southwest Asia (Saudi Arabia and Yemen) (Frey and Kürschner, 1991), Madagascar, Mascarene Islands and Seychelles (O'Shea, 1999) and Central Asia (Uzbekistan) (Townsend, 1991).

Kürschner (1986), pointed out that this is a relict species, indicator of former migration routes-man of the function of South Arabia as bridge between Africa and Asia, like other species such as *Barbula consanguinea* (Thwaites & Mitt.) A. Jaeger, *Claopodium prionophyllum* (Müll. Hal.) Broth., *Philonotis falcata* (Hook.) Mitt. or *Splachnobryum procerrimum* Dixon & P. de la Varde.

In Northern Africa only have been cited in Egypt (Müller, 1874; Sickenberger, 1901) sub *Weissia rohlfsiana* Müll. Hal. and sub *Semibarbula orientalis* (F.Weber) Wijk & Margad. although it is widespread in sub-Saharan Africa (O'Shea, 1999). The Mauritanian material is morphologically rather variable, especially the leaf cells, which vary from coarsely papillose, as has been described in *B. indica*, to smooth or nearly so as observed in other species of the genus such as *B. bolleana* (Müll. Hal.) Broth. Perhaps this variability in the papillosity of the leaf cells of *B. indica* is related to the large variation in habitat conditions in the oasis where it grows, such as water availability, light conditions and water temperature; since in Tergit, hot and cold water are found at different springs. On the other hand, Zander (1993) proposed that many species of *Hydrogonium* (Müll. Hal.) A. Jaeger (the type of which is *B. bolleana*), may have evolved from ancestors rather like *B. indica* towards a hygric habitat and larger size.

***Gymnostomiella monodii* P. de la Varde** — This interesting species has been considered for many years as endemic to North Africa, where it was only known from the type locality in Mauritania. Later, Arts (1998) and Kürschner (2000) have also reported it from southwestern Asia (Oman and Yemen).

After a careful study of the samples collected by the first author in Mauritania, we have decided to maintain this species as *G. monodii.* However, even between gametophytes of the same colony, the collections show a high degree of variability that makes it difficult to assign them to either *G. monodii*, *G. vernicosa* (Harv.) Fleisch. var. *tenerum* (Müll. Hal. ex Dusén) Arts or *G. erosula* (Müll. Hal. ex Dusén) Arts [*erosulum*].

The main character given by Arts (1998) for distinguishing *G. monodii* from *G. vernicosa* var. *tenerum,* in his revision of the genus *Gymnostomiella* is the broadly pointed, acute or apiculate leaf apex, while the latter taxon has a rounded never apiculate leaf apex. In the Mauritanian collections both kinds of apex can be observed. The most important characters to distinguish *G. monodii* from *G. erosula* (both of them with acute or apiculate apex) are, in *G. monodii* the leaves broadly ovate, 1.2-1.5 times as long as wide, with semi-amplexicaulous base and the costa in most of leaves ending 5 or more cells below the apex; while *G. erosula* has ovate to spatulate leaves, 1.8-2.2 times as long as wide, with the costa in most leaves ending within 3-5 cells of the apex. In the Mauritanian material, collected from different habitats in El Berbâra, both types of leaves were observed, and the length of the nerve was related to the shape and size of the leaves. Furthermore the margin of the leaves varied from crenulate to dentate, which also does not fit with Arts (1998) description of *G. monodii.*

From these observations we deduce that the variability of these taxa is not well known, because they are very rare and usually not abundant and consequently it is difficult to study this variability from the herbarium material. A more detailed study of these species would be desirable.

***Leptophascum leptophyllum* (Müll. Hal.) J. Guerra & M.J. Cano** — According to Arts & Sollman (1991) this seems to be a subcosmopolitan species of (sub)tropic, mediterranean and oceanic areas. These authors also assure that its anomalous distribution pattern reported by several other researches merely reflects poor taxonomy and inadequate collecting and that due to its weedy character and adaptation to man-made habitats, future expansion of the species seems probable. However, the designation of *Leptophascum leptophyllum* as a subcosmopolitan species does not seem to be very accurate. According to Ochyra (pers. comm.), the term "subcosmopolitan" itself is very imprecise and this species seems to be a widely disjunct pan-tropical species extending to the mediterranean and oceanic regions in Europe and East Asia. According to Zander (1993), it is apparently spread by human activities through rhizoid-borne propagula, Mischler (1994) also indicates that in Mexico it has probably been introduced on garden soils.

It is the first record in North Africa, but it has been cited in several countries of Central and Southern Africa (O'Shea, 1999) sub *Chenia leptophylla* (Müll. Hal.) R. H. Zander, *Tortula rhizophylla* (Sakurai) Z. Iwats. & K. Saito and *Phascum leptophyllum* Müll. Hal.

***Philonotis hastata* (Duby) Wijk & Margad.** — This is a pantropical species with a wide distribution area known from the whole African continent, Asia except the northern part, America except the eastern Brazilean part and Azores and Madeira (Düll, 1985, 1992). Probably the oases of the Adrar, in Mauritania, might be considered local refuges for this and other tropical species like *Splachnobryum obtusum*, and the presence of these species there could be considered as a relict.

According to Ros *et al.* (1999), in North Africa it is known from Chad and Egypt. In Chad it has been cited in the Tibesti Mountains by Jelenc (1955, 1958) and Bizot & Lauriol (1950) sub *Philonotis laxissima* Mitt. In Egypt it has been reported by El-Saadawi *et al.* (1986a) sub *Philonotis obtusata* Müll. Hal. ex Renauld & Cardot and by El-Saadawi *et al.* (1986b).

***Splachnobryum obtusum* (Brid.) Müll. Hal.** — This is a subcosmopolitan species from the tropical and subtropical regions, spread by human activities. It has been collected from all continents except Antarctica and has been introduced in glasshouses in temperate regions of North America and Europe (Arts, 2001). In the African continent it is much more common in central and southern parts than in the north, where it is only known from Chad (Arts, 1996). In desert countries such as Mauritania and Chad, it might probably be considered a relict confined to the habitats with permanent humid conditions just as *Philonotis hastata*. It has also been found associated with this last species in the Azores, in similar conditions to those of Mauritania (Düll, 1992).

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