



(RESEARCH ARTICLE)



## Contribution to the biosystematic study of liverworts (Marchantiophyta) of Senegal: Case of Senegaleses herbaria and check-lists

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### Abstract

The aim of this work is to contribute to a better knowledge of liverworts in the herbaria of Senegal in order to provide basic knowledge for a better sustainable management.

This study is carried out in the firstly in the herbaria of the University Cheikh Anta Diop of Dakar/Senegal: the herbarium of the Herbarium of the Institut Fondamental d'Afrique Noire (IFAN UCAD) and the herbarium DAKAR of the Department of Plant Biology of the Faculty of Sciences and Techniques. Secondly, a consultation of different checklists and databases was conducted to collect more information. This research work on the flora of liverworts is rich with nearly 39 species divided into 24 genera and 13 families. The order *Jungermanniales* is dominant in terms of families and the *Porellales Jubulineae* in terms of genera and species. The family *Lejeuneaceae* is in the majority in this flora before the families *Ricciaceae*, *Plagiochilaceae* and *Metzgeriaceae*.

These results are important for the conservation of the environment and the development of the plant biodiversity of Senegal.

**Keywords:** Liverworts; IFAN herbarium; DAKAR herbarium; Biodiversity; Senegal

### 1. Introduction

The *Marchantiophyta* comprise about 5000-6000 species in 391 genera [26, 7, 14, 19, 20, 15, 8, 9, 35] sometimes even reaching 7500 species [37, 38] of which 80% are leafy liverworts. According to the results of recent monographic work, these species show a cosmopolitan distribution [33, 34, 32, 7, 13]. The *Marchantiophyta* are the earliest diverging lineage in terrestrial plants, probably dating from the Silurian period [25, 31, 36, 39, 17, 18]. In Senegal, studies on the specific diversity of liverworts are still at an embryonic stage, despite the presence of samples in the Dakar and IFAN herbaria.

The present work aims to contribute to a better knowledge of the diversity of liverworts in the herbaria of Senegal in order to provide a data base for a sustainable management.

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## 2. Material and methods

### 2.1. Study sites

#### 2.1.1. The Herbarium of the Institut Fondamental d'Afrique Noire (IFAN)

The Herbarium of the Institut Fondamental d'Afrique Noire (IFAN UCAD) created in 1941 by Professor Paul JAEGER is the oldest herbarium in French-speaking Africa. Indeed, it centralized most of the botanical activities in the former French metropolis. Its main objective was to create a bank of all the plant species of French-speaking Africa, then of all continental and insular Africa with nearly 60,000 specimens.

#### 2.1.2. The Herbarium of the Department of Plant Biology: DAKAR Herbarium

Created in 1960 by Professor J. MIEGE and rehabilitated in 1994, the DAKAR herbarium is the second herbarium of Senegal. The main objective is to constitute a collection of good quality and representative of the flora of Senegal and a remarkable knowledge base in the fields of research, training, knowledge, conservation of plant resources and African and international collaboration. The herbarium houses about 13000 samples.

### 2.2. Material

The material consisted of samples from the DAKAR and IFAN herbaria and samples reported in the Checklist and distribution of the liverworts and hornworts of Sub-Saharan Africa, including the East African Islands [41]. Consultations of herbarium collections and databases were carried out to establish the floristic list of liverworts.

### 2.3. Methods

Scientific names were verified via *Tropicos*, *Plant List* and *eFloras*. The classification of [35]; was used for liverworts. African identification keys: for liverworts [40], from [22, 23], the flora of Kenyan mosses and liverworts [4]; volume 14 of the Rwandan Liverworts and Hornworts [11] and Catalogue of the Hepaticae and Anthocerotae of sub-Saharan Africa [42] were used to facilitate identification as well as Augier's [2, 3] flora of Bryophytes and many other articles.

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## 3. Results

### 3.1. Specific composition

Table 1 represents the global list of species and families encountered during this study. Thus 39 species of liverworts were recorded in these herbaria and check-list belonging to 7 orders, 24 genera and 13 families.

### 3.2. Taxonomic spectrum

Table 2 gives indications on the structure of the *Marchantiophyta* flora. These results show a great specific diversity of these herbarium collections.

The order *Jungermanniales* are dominant in terms of families with 38.5% and the *Porellales Jubulineae* in terms of genera with 54.2% and species with 43.6%. Except for the order *Metzgeriales* with 2 families; all other orders are represented by a single family.

The analysis of Table 3 of the distribution of genera and species in the families shows an important diversity. This flora is dominated by species of the family *Lejeuneaceae* occupying 50% of the genera and 41% of the species of the total number. All other remaining families are represented by only one genus. In terms of species, after the *Lejeuneaceae* come the species of the families *Ricciaceae*, *Plagiochilaceae* and *Metzgeriaceae* with 15%, 13% and 7.7% respectively. It appears from this analysis that the remaining families are represented by only one species.

**Table 1** List of species of *Marchantiophyta* surveyed

Orders	Families	Species
<i>Metzgeriales</i> Roseuv.	<i>Aneuraceae</i> H. Klinggr.	* <i>Riccardia limbata</i> (Stephani) E.W. Jones
	<i>Metzgeriaceae</i> H. Klinggr.	* <i>Metzgeria australis</i> Stephani
		* <i>Metzgeria camerunensis</i> Stephani
		* <i>Metzgeria hamata</i> Lindb.
<i>Marchantiales</i> Limpr.	<i>Dumortieraceae</i> D.G. Long	* <i>Dumortiera hirsuta</i> (Sw.) Nees
<i>Ricciales</i> L.	<i>Ricciaceae</i> Rchb.	* <i>Riccia discolor</i> Lehm. & Lindenb. ≡ <i>R. intermedia</i> E.W. Jones
		* <i>Riccia frostii</i> Austin
		* <i>Riccia fluitans</i> L.
		* <i>Riccia cavernosa</i> Hoffm. ≡ <i>R. rautanenii</i> (Steph.) Steph.
		*** <i>Riccia sp1</i>
		*** <i>Riccia sp2</i>
		<i>Jungermanniales</i> H. Klinggr. - <i>Lophocoleineae</i> Schljakov.
<i>Lepidoziaceae</i> Limpr.	* <i>Bazzania herminieri</i> (Gottsche ex Steph.) Pagán ≡ <i>Bazzania herminieri</i> (Gottsche)	
<i>Lophocoleaceae</i> Müll. Frib. ex Vanden Berghen	* <i>Lophocolea difformis</i> Nees	
<i>Plagiochilaceae</i> Müll. Frib.	* <i>Plagiochila barteri</i> Mitt.	
	* <i>Plagiochila pectinata</i> Lindenb. ≡ <i>P. pectinata</i> Wild ex Lindenb	
	* <i>Plagiochila lastii</i> Mitt. ≡ <i>Plagiochila terebrans</i> Nees et Mont. Lindenb.	
	* <i>Plagiochila sp1</i>	
	*** <i>Plagiochila sp 2</i>	
<i>Trichocoleaceae</i> Nakai	* <i>Trichocolea tomentosa</i> (Sw.) Nees	
<i>Porellales</i> Schljakov. <i>Jubulineae</i> Müll. Frib.	<i>Jubulaceae</i> H. Klingger.	* <i>Frullania serrata</i> Gottsche.
	<i>Lejeuneaceae</i> Casares-Gil	* <i>Odontolejeunea tortuosa</i> (Lelm. et Lindenb.) Stephani
		* <i>Cololejeunea obliqua</i> (Nees et Mont.) Schiffner
		* <i>Cololejeunea leloutrei</i> (E.W. Jones) R.M. Schust.
		* <i>Diplasiolejeunea cavifolia</i> Stephani
		* <i>Hygrolejeunea acuta</i> (Mitt.) Vander Bergham
		* <i>Leptocolea cuneifolia</i> (Stephani) A. Evans
		* <i>Leptocolea sp</i>
		** <i>Acrolejeunea emergens</i> (Mitt.) Steph. var. <i>confertissima</i> (Steph.) Gradst.
		** <i>Acrolejeunea emergens</i> (Mitt.) Steph. var. <i>emergens</i>
		* <i>Ceratolejeunea cornuta</i> (Lindenb.) Steph. ≡ <i>C. jungneri</i> Steph.
		* <i>Drepanolejeunea physifolia</i> (Gottsche) Steph. ≡ <i>D. clavicornis</i> Steph.)
		* <i>Drepanolejeunea cultrella</i> (Mitt.) Stephani

		* <i>Lejeunea flava</i> (Sw.) Nees
		* <i>Leptolejeunea truncatiflora</i> Steph.
		* <i>Prionolejeunea grata</i> (Gottsche) Schiffn ≡ <i>P. serrula</i> (Mitt.) Stephani; ≡ <i>P. kindbergii</i> (Steph.) Schiffn
		** <i>Thysananthus auriculatus</i> (Wilson et Hook.) Sukkharak et Gradst. ≡ <i>Mastigolejeunea auriculata</i> (Wilson et Hook.) Steph. ≡ <i>Mastigolejeunea auriculata</i> (Wilson) Schiffn. (Steph.) Gradst.)
<i>Porellales</i> Schljakov. <i>Radulineae</i> R.M. Schust.	<i>Radulaceae</i> Müll. Frib.	* <i>Radula flaccida</i> Lindenb. & Gottsche.
<i>Pleuroziales</i> Schljakov.	<i>Pleuroziaceae</i> Müll. Frib.	* <i>Pleurozia gigantea</i> (F. Weber) Lindb.

\*= IFAN Herbarium, \*\*= Check-List of Wigginton, \*\*\*= DAKAR Herbarium

**Table 2** Structure of the *Marchantiophyta* Flora

Ordres	Families		Genera		Species	
	Number	%	Number	%	Number	%
<i>Porellales Jubulineae</i>	2	15,4	13	54,2	17	43,6
<i>Jungermanniales</i>	5	38,5	5	20,8	9	23,1
<i>Metzgeriales</i>	2	15,4	2	8,3	4	10,3
<i>Marchantiales</i>	1	7,7	1	4,2	1	2,6
<i>Ricciales</i>	1	7,7	1	4,2	6	15,4
<i>Porellales Radulineae</i>	1	7,7	1	4,2	1	2,6
<i>Pleuroziales</i>	1	7,7	1	4,2	1	2,6
Total	13	100	24	100	39	100

**Table 3** Distribution of species in the different taxonomic groups

Families	Genera		Species	
	Number	%	Number	%
<i>Lejeuneaceae</i>	12	50	16	41
<i>Ricciaceae</i>	1	4,2	6	15
<i>Plagiochilaceae</i>	1	4,2	5	13
<i>Metzgeriaceae</i>	1	4,2	3	7,7
<i>Aneuraceae</i>	1	4,2	1	2,6
<i>Dumortieraceae</i>	1	4,2	1	2,6
<i>Herbertaceae</i>	1	4,2	1	2,6
<i>Lepidoziaceae</i>	1	4,2	1	2,6
<i>Lophocoleaceae</i>	1	4,2	1	2,6
<i>Trichocoleaceae</i>	1	4,2	1	2,6
<i>Jubulaceae</i>	1	4,2	1	2,6
<i>Radulaceae</i>	1	4,2	1	2,6
<i>Pleuroziaceae</i>	1	4,2	1	2,6
<b>Total</b>	<b>24</b>	<b>100</b>	<b>39</b>	<b>100</b>

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#### 4. Discussion

This study shows that the flora of liverworts in the herbaria and checklists is rich with nearly 39 species distributed in 24 genera and 13 families. This richness is explained by the fact that Senegal was a strategic point in the management of herbarium collections in Black Africa and the world. The IFAN's herbarium has hosted during missions collections of bryophytes and phanerogams of several authors.

Moreover, the collections of Marchantiophytes of this herbarium represent almost a great part of this flora. Compared to the liverwort flora of Madagascar [28] or the Reunion Islands [1], the latter is less diversified because there are very few field studies, contrary to other countries where many investigations have been conducted for the knowledge of the bryological flora.

At the level of families, the dominance of the family *Lejeuneaceae* is a characteristic of the flora of liverworts in the tropical zone. The *Lejeuneaceae* are the largest family of the liverworts (Hepaticae), with almost a thousand species in 91 currently accepted genera. They abound in humid tropical forests where they inhabit a large variety of niches, including tree trunks, branches, saplings, twigs and the surfaces of living leaves. In an average tropical lowland rain forest, more than three-quarters of the hepatic species are *Lejeuneaceae* [12, 16].

The *Ricciaceae* form a cosmopolitan family with two genera (*Riccia*, *Ricciocarpos*). The genus *Riccia* is represented by about 200 species worldwide [43], including 88 for sub-Saharan Africa, with the Indian Ocean [40]. Only the *Riccia* of Mediterranean North Africa [24] and South Africa have been explored and described in some detail [29]. *Riccia* are very diverse in South Africa (about 80 species), and they show a high rate of endemism, rare for bryophytes.

Compared to other African floras, this one is similar with a strong representation of mosses on liverworts: Guinea Conakry [27, 41] and African floras: Reunion Island [1], Mauritius [21, 10], South Africa [30], the Kenyan mosses and liverworts flora [5, 6].

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#### 5. Conclusion

The aim of the present work is to contribute to a better knowledge of liverworts in the Senegalese herbaria in order to provide basic knowledge for a better sustainable management. This study shows that the flora of liverworts in the herbaria and check-list is rich with nearly 39 species distributed in 24 genera and 13 families. The order *Jungermanniales* is dominant in terms of families and the *Porellales Jubulineae* in terms of genera and species. This flora is dominated by species of the family *Lejeuneaceae* occupying 50% of the genera and 41% of the species of the total number. In terms of species, after the *Lejeuneaceae* come the species of the family *Ricciaceae*, *Plagiochilaceae* and *Metzgeriaceae*. It also appears from this analysis that the remaining families are represented by only one species.

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#### Compliance with ethical standards

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##### *Disclosure of conflict of interest*

The authors declare no conflict of interest.

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