

## NOTES ON THE BRYOPHYTES OF MADAGASCAR 6. EPIPHYLLOUS LIVERWORTS FROM ZAHAMENA NATIONAL PARK

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**Abstract:** Dr. Min Chuah-Petiot, together with staff of Missouri Botanical Garden-Antananarivo station, visited in 2002 the Zahamena National Park in the north-eastern part of central Madagascar. They collected epiphyllous liverworts, which are deposited in TAN and a set of small duplicates were sent to Tamás Pócs for identification, which are now kept in EGR in the form of microslides. The Zahamena National Park is notorious for its high diversity of animals and vascular plants, including several endemics. But hitherto, few liverworts were collected there. This enumeration contains 28 species. None of them is new to the island, but three were known before only from their type locality (*Allorgella rabenorii* Tixier, *Cololejeunea plagiochiliana* Tixier, *Cololejeunea subinflata* Tixier) and eight are endemics of Madagascar or the Indian Ocean islands.

**Keywords:** Allorgella, Atsinanana, Cololejeunea, endemics, types

### INTRODUCTION

Zahamena National Park was established in 1997, in an area of 423 square kilometres. In 2007, it became part of the "Rainforests of Atsinanana UNESCO World Heritage Site" (Wikipedia 2021). The park lies at 40 km distance of Ambatondrazaka town, at the border of Betsimaraha and Sihanaka Regions (Former Toamasina Province), on the eastern, windward slopes and mountain ranges of the plateau edge. The vertebrate animals and vascular plants are quite well known, including several strict endemics, but not many bryological records exist from the area as one endemic moss named *Isopterygium antsihanekense* Cardot. and a few thallose liverwort species as *Afroriccardia somosa*, *Riccardia martinii*,



*Riccardia ramosissima* and *Riccardia vohimanensis* (Reeb and Gradstein 2020); *Dumortiera hirsuta*, *Marchantia debilis* and *Marchantia pappeana* (Reeb *et al.* 2018). Therefore any bryological collection made from the area is of great value.

## MATERIAL AND METHODS

Min Chuah-Petiot, together with the staff of the Missouri Botanical Garden – Antananarivo station – Roger L. Andriamiarisoa, Hanta Ravololonanahary and Andriamalala Rakotondrafara made a collecting trip in the area, at 840–1010 m elevation, between 13 and 16 December 2002. They collected among others, epiphyllous liverworts and sent them for identification to the first author. The specimens are deposited in MBG (St. Louis) and TAN (Antananarivo) and some specimens of duplicates, in form of microslides, in EGR (Eger). As a result, 28 species of liverworts were identified by T. Pócs, of which three species were known before only from their type locality. The rest of species are also typical for the flora of Madagascar (Marline *et al.* 2012), containing several endemics. The 7 collecting localities, where epiphyllous liverworts occurred, are indicated in the enumeration in the form of the first two digits (the letters indicate more than one species from the same site).

They are all from Province de Toamasina, Préfecture Ambatondrazaka, Commune Antanandava. Environs du Parc National de Zahamena as follows:

**04:** Forêt ombrophile dégradée. Alt. 897 m.

**06:** Forêt ombrophile montagnarde. Ampelandrano. Alt. 1010 m, 17°28'47"S, 48°44'25"E.

**08:** Forêt ombrophile montagnarde avec fougères arborescentes près Ampelandrano. Alt. 1000 m, 17°28'S, 48°45'08"E.

**10:** Forêt ombrophile dégradée sur la terre brûlée et cultivé. Alt. 1000 m, 17°28'48"S, 48°44'51"E.

**11:** Forêt ombrophile montagnarde peu dégradée près Ampelandrano. Alt. 1000 m, 17°28'44"S, 48°44'21"E.

**12:** Forêt ombrophile montagnarde près Ambarihely. Alt. 900 m, 17°28'S, 48°4'E.

**13:** Forêt ombrophile dégradée près Rivière Antranoray. Alt. 820 m, 17°29'44"S, 48°45'35 "E.

## RESULTS

The enumeration below contains all species observed. Some of them (especially members of the genus *Lejeunea*) are not identified to the species level, either because they are in sterile state and also, because its Madagascar species are not yet taxonomically revised. The nomenclature follows Söderström *et al.* (2016).

***Allorgella rabenorii*** (Tixier) G.E.Lee, Schäf.-Verw. & Heinrichs

Basionym.: *Otolejeunea rabenorii* Tixier (Tixier 1988).

**08/151A, 09/158.** A Madagascar endemic, hitherto known only from its type locality in Toamasina region, route de Lakoto (Tixier 1988).

***Calypogeia annabonensis*** Steph.

**07/096.** Widespread, but uncommon tropical African species (Wigginton 2018).

***Calypogeia fissa*** (L.) Raddi

**07/107.** Northern temperate species widespread also in African mountains.

***Capillolejeunea mascarena*** S.W. Arnell (*Figures 1, 4*)

**11/257B.** Lemurian endemic known from Comoro Islands, Madagascar and Mauritius (He *et al.* 2014).

***Cheilolejeunea intertexta*** (Lindenb.) Steph.

**11/264.** Widespread Pantropical species.

***Cheilolejeunea rigidula*** (Nees & Mont.) R.M.Schust.

**12/291.** Widespread Pantropical species.

***Cololejeunea adnata*** Tixier (*Figure 5*)

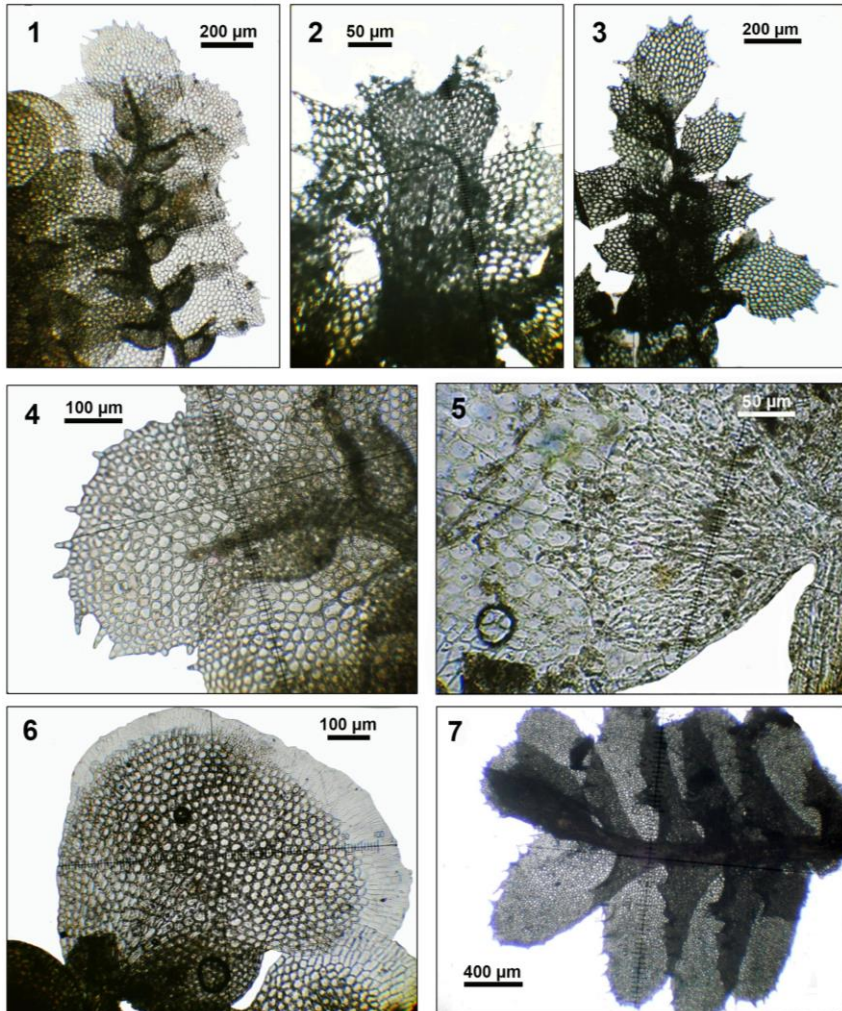
**06/309C, 06/310B, 08151/C, 09/240B, 13/336.** Madagascar endemic, not known from other Indian Ocean islands.

***Cololejeunea cuneata*** (Lehm. et Lindenb.) Herzog

**06/309B, 10/219.** A species with Asian links, scattered from all Indian Ocean islands to the Philippines and New Guinea (Tixier 1985).

***Cololejeunea leloutrei*** (E.W.Jones) R.M.Schust. var. ***microlobulata*** Tixier

**08/151B.** Endemic Madagascan variety of a widespread tropical African species.



**Figures 1 and 4.** *Capillolejeunea mascarena* S.W.Arnell, 1: habit, 4: leaf, ventral views (from M.Chuah-Petiot 11/257B). **Figures 2 and 3.** *Cololejeunea plagiochiliana* Tixier, 2: perichaetium, with mature perianth, 3: habit, ventral views (from M.Chuah-Petiot 8/151B). **Figure 5.** *Cololejeunea adnata* Tixier. Lobule with its distal end adnate to the lobe, ventral view (from M.Chuah-Petiot 8/151C). **Figure 6.** *Cololejeunea subinflata* Tixier, leaf with unusually wide hyaline margin, ventral view (from M.Chuah-Petiot 80/309). **Figure 7.** *Plagiochila boivinii* Steph. habit, ventral view (from P.Chuah-Petiot 6/166). (Microphotos by T. Pócs).

***Cololejeunea plagiochiliana*** Tixier (Figures 2, 3)

**08/151B.** A very characteristic central Madagascar endemic hitherto known only from its type locality in the Andasibe-Mantadia (former Périnet) National Park (Tixier 1975, 1977).

***Cololejeunea subinflata*** Tixier (Figure 6)

**06/309, 08/151C.** A central Madagascar endemic. Hitherto known only from its type locality in the Antananarivo region at Lake Mantasoa (Tixier 1977). The specimens seen in our collection has wider hyaline margin, than the type.

***Cololejeunea zenkeri*** (Steph.) E.W. Jones

**06/309A, 06/310A,B, 08/151A, 09240/A.** Very widespread tropical African species.

***Colura tenuicornis*** (A.Evans) Steph.

**13/352.** Widespread pantropical species.

***Diplasiolejeunea cavifolia*** Steph.

**06/310.** Widespread pantropical species.

***Drepanolejeunea madagascariensis*** (Steph.) Grolle

**13/336.** East African–Lemurian subendemic species, known from Kenya, Tanzania and from all East African islands (Grolle 1976).

***Frullania diptera*** (Lehm.) Drège

**11/269.** Tropical African species.

***Frullania spongiosa*** Steph.

**06/041.** Widespread tropical African species.

***Lejeunea cf. angulifolia*** Mitt.

**08/1518, 13/350B, 13/351A, 13/352, 13/354/C.** *L. angulifolia* is a rare Lemurian endemic, known only from Rodriguez Island and from the Chagos Archipelago (Seaward *et al.* 2006, Müller and Pócs 2002, Pócs 2011). The isotype has acuminate apex and the same lunular underleaf. Our and the later collected Chagos specimens somewhat differ, having rounded lobe apex, therefore their identity with the Indopacific *Lejeunea cocoes* Mitt. is also possible.

***Lejeunea anisophylla*** Mont.

**13/152, 13/350A, 13/351B, 352.** Widespread Palaeotropic species (Pócs 2010). Gradstein (2021) synonymised it with the Notropical *Lejeunea adpressa* Nees, which needs molecular confirmation. In this case the species proves to be pantropical.

- Lejeunea cf. isophylla*** E.W. Jones  
13/350A. Widespread tropical African species.
- Lejeunea leucosis*** Besch. & Spruce  
06/310A. East African-Lemurian species known from Kenya, Tanzania, Réunion Island and Madagascar (Pócs 2010).
- Lejeunea villaumei*** (Steph.) Grolle  
11/270. Uncommon tropical African species.
- Leptolejeunea maculata*** (Mitt.) Schiffn.  
13/268. Very widespread Palaeotropical species, common all over Asia and Africa and the other Indian Ocean islands, was reported only once from Madagascar before (Pócs 2020).
- Metzgeria furcata*** (L.) Dumort.  
08/158. A common cosmopolite species not rare in the Palaeotropics.
- Microlejeunea africana*** Steph.  
04/20E. Widespread tropical African species, only slightly differs in size from the northern temperate *Microlejeunea ulicina* (Taylor) Steph. (Vanden Berghen 1965, Jones 1969, Schuster 1980).
- Plagiochila boivinii*** Steph. (*Figure 7*)  
06/166. Rare Lemurian endemic, known only from Madagascar and Réunion Island. Morphologically close to *Plagiochila africana* Steph. (Vanden Berghen 1981).
- Pycnolejeunea contigua*** (Nees) Grolle  
11/257A. A widespread Pantropical sun epiphyte (He 1999).
- Radula flaccida*** Lindenb. & Gottsche  
06/310. A widespread tropical African lowland species well distinguishable by its reniform, stipitate, marginal gemmae (Jones 1977).

## DISCUSSION

Although the above enumeration consists only a limited number of species of a small sample, it reflects well the high diversity and peculiarity of the Madagascar flora, as more than a quarter of them are endemics, not occurring in continental Africa. Another ten are restricted to the African realm, of which only two reach the Precambrian crystalline arc of East Africa, not occurring in the interior area of the continent.

**Acknowledgements** – The second author wishes to thank the Madagascar National Park Service for providing authorization to collect specimens in Zahamena National Park, to Missouri Botanical Garden (MBG), in particular, to Chris Birkenshaw MBG Antananarivo station for facilitating the collecting trip to the National Park by the second author with participating staff, to Roger L. Andriamiarisoa, Hanta Ravololonanahary and Andriamalala Rakotondrifara and last but not least, to Tamás Pócs for his valuable contribution in the identification of the epiphyllous collection.

## REFERENCES

- GRADSTEIN, S.R. (2021). The liverworts and hornworts of Colombia and Ecuador. *Memoirs of the New York Botanical Garden* **121**: 1–723.  
<https://doi.org/10.1007/978-3-030-49450-6>
- GROLLE, R. (1976). *Drepanolejeunea* subgen. *Kolpolejeunea* – eine neue Untergattung aus der Palaeotropis. *Journal of the Hattori Botanical Laboratory* **40**: 191–216.
- HE, Q., WEI, Y-M., PÓCS, T. & ZHU, R-L. (2014). The reappraisal of *Capillolejeunea* S.W.Arnell (Marchantiophyta, Lejeuneaceae). *Phytotaxa* **175**(3): 166–170.  
<https://doi.org/10.11646/phytotaxa.175.3.7>
- HE, X-L. (1999). A taxonomic monograph of the genus *Pycnolejeunea* (Lejeuneaceae, Hepaticae). *Acta Botanica Fennica* **163**: 1–77.
- JONES, E.W. (1969). African Hepatics XXI. *Microlejeunea*, *Chaetolejeunea* and *Pleurolejeunea*. *Transactions of the British Bryological Society* **5**: 775–789.
- JONES, E.W. (1977). African Hepatics XX. The genus *Radula* Dumortier. *Journal of Bryology* **9**: 461–504. <https://doi.org/10.1179/jbr.1977.9.4.461>
- MARLINE, L., ANDRIAMIARISOA, R. L., BARDAT, J., CHUAH-PETIOT, M., HEDDERSON, T.A.J., REEB, C., STRASBERG, D., WILDING, N. & AH-PENG, C. (2012). Checklist of the bryophytes of Madagascar. *Cryptogamie, Bryologie* **33**(3): 199–255.  
<https://doi.org/10.7872/cryb.v33.iss3.2012.199>
- MÜLLER, F. & PÓCS, T. (2002). Contribution to the hepatic flora of Rodrigues (East African islands). *Tropical Bryology* **22**: 107–113.
- PÓCS, T. (2010). On some less known *Lejeunea* (Lejeuneaceae, Jungemanniopsida) species in tropical Africa. East African Bryophytes, XXVII (With 9 plates). *Nova Hedwigia, Beiheft* **138**: 99–116.
- PÓCS, T. (2011). Type studies of some African Lejeuneaceae. *Acta Botanica Hungarica* **53**(1–2): 181–192. <https://doi.org/10.1556/abot.53.2011.1-2.18>
- PÓCS, T. (2020). Notes on the bryophytes of Madagascar 2. New liverwort and hornwort records. *Acta Biologica Plantarum Agriensis* **8**: 69–84.  
<https://doi.org/10.21406/abpa.2020.8.1.69>
- REEB, C., MARLINE, L., RABEAU, L., ANDRIAMANANTENA, A., ANDRIAMIARISOA, R.L., RANARIJAONA, H-L. & PÓCS, T. (2018). A survey of Marchantiales from Madagascar. *Acta Biologica Plantarum Agriensis* **6**: 3–72.  
<https://doi.org/10.21406/abpa.2018.6.3>
- REEB, C. & GRADSTEIN, S.R. (2020). A taxonomic revision of Aneuraceae (Marchantiophyta) from eastern Africa with an interactive identification key. *Cryptogamie, Bryologie* **41**(2): 11–34.  
<https://doi.org/10.5252/cryptogamie-bryologie2020v41a2>

- SCHUSTER, R.M. (1980). *The Hepaticae and Anthocerotae of North America*. Volume IV. Columbia University Press, New York, 1334 pp.
- SEAWARD, M.R.D., ELLIS, L.T., PÓCS, T. & WIGGINTON, M.J. (2006). Bryophyte flora of the Chagos Archipelago. *Journal of Bryology* **28**: 11–19. <https://doi.org/10.1179/174328206X90440>
- SÖDERSTRÖM, L., HAGBORG, A., VON KONRAT, M., BARTHOLOMEW-BEGAN, SH., BELL, D., BRISCOE, L., BROWN, E.†, CARGILL, D.C., COSTA, D.P., CRANDALL-STOTLER, B.J., COOPER, E.D., DAUPHIN, G., ENGEL, J.J., FELDBERG, K., GLENNY, D., GRADSTEIN, S.R., HE, X., HEINRICH, J., HENTSCHEL, J., ILKIU-BORGES, A., KATAGIRI, T., KONSTANTINOVA, N.A., LARRAÍN, J., LONG, D.G., NEBEL, M., PÓCS, T., PUCHE, F., REINER-DREHWALD, E., RENNER, M.A.M., SASS-GYARMATI, A., SCHÄFER-VERWIMP, A., SEGARRA, J.G.M., STOTLER, R.E.†, SUKKHARAK, PH., THIERS, B.M., URIBE, J., VAÑA, J., VILLAREAL, J.C., WIGGINTON, M., ZHANG, L. & ZHU, R.L. (2016). World checklist of hornworts and liverworts. *PhytoKeys* **59**: 1–828. <https://doi.org/10.3897/phytokeys.59.6261>
- TIXIER, P. (1975). Contribution à l'étude du genre *Cololejeunea* V. Quelques espèces de la région indopacifique. *Botaniska Notiser* **128**: 425–431.
- TIXIER, P. (1977). La famille des *Cololejeunoideae* Grolle dans l'Océan Indien Occidental. Essai Monographique. *Bulletin De L'academie Malgache* **55**: 173–247.
- TIXIER, P. (1985). Contribution à la connaissance des *Cololejeunoideae*. *Bryophytorum Bibliotheca* **27**: 1–439.
- TIXIER, P. (1988). Le domaine lémuuro-australasien. Intérêt biogéographique de deux espèces nouvelles. *Nova Hedwigia* **46** (3–4): 373–383.
- VANDEN BERGHEM, C. (1965). Hépatiques récoltées par Dr J.-J. Symoens dans la région péri-tanganyikaise (Suite). *Bulletin de la Société Royale de Botanique de Belgique* **98**: 129–174.
- VANDEN BERGHEM, C. (1981). Le genre *Plagiochila* à Madagascar et aux Mascarenes. *Bulletin du Jardin Botanique National de Belgique* **51**: 41–103.
- WIGGINTON, M.J. (2018). Checklist and distribution of the liverworts and hornworts of sub-Saharan Africa, including the East African Islands. *Tropical Bryology Research Reports* **9**: 1–138.
- WIKIPEDIA (2020). Rainforests of the Atsinanana. (Accessed: 16 December 2020)

(submitted: 01.08.2021, accepted: 21.09.2021)