East African Bryophytes, XXIII.
Three new species of *Diplasiolejeuna* (Lejeuneaceae, Jungermanniopsida) from Madagascar

Tamás PÓCSa* & Alfons SCHÄFER-VERWIMPb

a Department of Botany, Eszterházy College, Eger, Pf. 43, H-3301, Hungary

b Mittlere Letten 11, D-88634 Herdvangen-Schönach, Germany, moos.alfons@herter.de

(Received 10 April 2006, accepted 20 May 2006)

Abstract – Three new species of *Diplasiolejeuna* are described from Madagascar, as new to science: *Diplasiolejeuna ornata* Pócs & Schäfer-Verwimp, distributed in north-east Madagascar, is characterised by its first lobule teeth with superposed cells and by its perianth with often umbonate auricles. *Diplasiolejeuna ranomafanae* Pócs occurs exclusively in the Ranomafana National Park, and is characterised by its shaped sigmoid lobule with three teeth. Finally, *Diplasiolejeuna andringitrae* Schäfer-Verwimp is scattered all along the forested eastern escarpment and is characterised also by the lobule having three teeth, of which the first is located near the junction of the lobule with the ventral margin of lobe, and the second appears T-shaped, a combination of characters unique in African species of *Diplasiolejeuna*.

Africa / *Diplasiolejeuna* / Lejeuneaceae / Madagascar

Résumé – Trois espèces nouvelles sont décrites de Madagascar : *Diplasiolejeuna ornata* Pócs & Schäfer-Verwimp, distribuée dans le NE de Madagascar, caractérisée par la première dent du lobule avec des cellules superposées et par un périanthe avec des auricules souvent umbonate ; *Diplasiolejeuna ranomafanae* Pócs est exclusivement présente dans le Parc National de Ranomafana, reconnaissable par son lobule sigmoidé avec trois dents ; *Diplasiolejeuna andringitrae* Schäfer-Verwimp est dispersée au long de l’escarpement boisé oriental, caractérisée aussi par un lobule à trois dents, dont la première est placée près de la jonction lobule-marge ventrale du lobe, tandis que la seconde a une forme de T, une combinaison de caractères unique dans les espèces africaines de *Diplasiolejeuna*.

Afrique / *Diplasiolejeuna* / Lejeuneaceae / Madagascar

INTRODUCTION

The diversity of the Madagascan *Diplasiolejeuna* flora became known by the work of Tixier (1977, 1979, 1980, 1984), who himself described 13 new taxa from the area, and dealt with the speciation and phytogeography of these species,
that are often endemic in limited areas (Tixier, 1978, 1986, 1987). To the 22 previously known species of Diplasiolejeunea from the island, we would like to add a further three from the collections of the senior author, his wife and his colleagues made in Madagascar during 1994, 1998 and 2004.

We are adopting here the terminology according to Mizutani (1961). The first tooth is the outermost one, closest to the junction of free margin with the keel. In most species of Diplasiolejeunea, it is the most prominent tooth and has the hyaline papilla at its proximal base. The second tooth is usually smaller and often positioned at the “apex” of the lobule. Rarely – as in two of our three new species – there is an additional tooth between the previously named “first” or distal tooth and the keel; in the species with three (or more) lobular teeth, this must now be called the first tooth.

**DESCRIPTIONS OF NEW DIPLASIOLEJEUNEA SPECIES**

*Diplasiolejeunea ornata* Pócs & Schäfer-Verwimp (Figs 1-19)

*Planta pallide viridis, epiphylla vel ramicola, coloniae 1-4 cm diametro formans, caulis 0.5-2 cm longae, cum foliis 1.5-1.8 mm latae, diametro 70-100 µm. Foliae imbricatae lobis obovatis vel cuneatis apicibus rotundatis. Ocelli loborum perianthiorumque numerosi. Lobuli elongato-lanceolatae dentibus primis conduplicatis, secundis obtusis, obsoletis. Amphigastriorum lobuli triangulares, ad basin 4-8 celluli latae. Perianthium clavatum quinquecarinatum auriculis unbonatis.*

**Type:** MADAGASCAR, Prov. Toamasina, Mananara Nord Biosphere Reserve. Lowland rain forest on the NW slope of BEHAFOTRA Hill, at 250-300 m alt., with 3500 mm annual rainfall. 16°27.2'S, 49°47.7'E. Coll. T. Pócs & A. Szabó, 9877/CH, 16 August 1998 (Holotype: EGR; Isotypes: G, GOET, MO, PC, TANA, Herb. Schäfer-Verwimp).

Plants pale green, densely and irregularly pinnately-branched, epiphyllous, forming colonies 1-4 cm in diameter, the shoots 1.5-1.8 mm wide and up to 20 mm long. Stems 70-100 µm in diameter. Leaves imbricate, obovate or cuneate with a rounded apex and smooth margins, 800-1200 µm long, 600-750 µm wide, lobe with 5-50 scattered or sometimes paired ocelli of same size and shape as average cells. Ocelli blackish brown, but completely vanishing with time, and unnoticeable in old specimens. Apical and median lobe cells isodiametric to slightly elongate, 18-25 × 18-32 µm, with medium-sized nodulous trigones and many cells with intermediate thickenings, basal cells elongate hexagonal, with more evenly thickened walls, 20-28 × 32-40 µm. Oil bodies small, *Bazzania* type; in ocelli large, brown, of *Diplasiolejeunea* type. Lobule ovate-lanceolate, boat-shaped, inflated, with slightly crenulate keel and with tapering distal apex, which almost straightly continues in the postical margin of the lobe. First lobule tooth 1-3 cells long, doubled, usually with 2 superposed cells in the second layer forming a rodlike structure, not fully overlapping the first layer of the tooth (see Fig. 9). Second lobule tooth obtuse, obsolete. Underleaves distant, 3-5 × as wide as the stem, with acute or blunt segments 4-8 cells wide and 6-14 cells long, ending in one cell. Sinus wide (90-120°), U or V shaped; underleaf base auriculate, with a sinus 2-3 cells deep.

Autoicous, in a few cases even paroicous. Male branches usually on the main stem, with 1-3 bilobed bracteoles at the base; androecia consisting of
Three new species of *Diplasiojeuna* from Madagascar

4-8 pairs of bracts. Gynoecium developing on short lateral branches, with one innovation. Bracts and bracteole bilobate. Perianth clavate, urn-shaped, with 5 flat auriculate or often umbonate carinae, the auriculate part 1/6 to 1/3 the length of the perianth. Instead of a beak, a small incision tips the perianth. Perianth cells isodiametric, polygonal, with evenly thickened walls. Scattered ocelli present and similar to those of the leaves. Gemmae not seen.


*Diplasiolejeuna ranomafanae Pócs* (Figs 20-33)

Planta pallide viridis, ramicola, repens caulis 0.5 cm longae, cum foliis 1.5-2.1 mm lata, diametro 70-120 μm. Foliae contigueae vel imbricatae lobis falcato-ovatis apicibus rotundatis. Ocelli loborum numerosi. Lobuli sigmoidoideo-lanceolatae dentibus secundis lanceolatis, primis et tertiiis obtusis. Lobuli amphigastriorum obtusus-lanceolati, ad basin 4-7 celluli latae. Perianthium obpyriforme qinquecarinatum alis decurrentibus.


Plants pale green, sparsely branched, creeping on twigs, the shoots 1.5-2.1 mm wide and up to 5 mm long when moist, shrivelling to 0.5-1 mm wide when dry. Stems 70-120 μm in diameter. Leaves contiguous to imbricate, falcate-ovate with rounded apex and smooth margin, ± 1 mm long and 600-750 (dry only 180-240) μm wide, lobe with 10-30 scattered ocelli the same size and shape as average cells. Ocelli coffee-brown when fresh, but vanishing with time. Marginal lobe cells quadrate, 12 × 16-22 μm, median cells slightly elongated polygonal, 16-20 × 22-32 μm, with small nodulose trigones and on longitudinal walls with intermediate thickenings, basal cells 14-20 × 32-36 μm, with ± sinuose walls with large, nodulose trigones and sometimes with confluent intermediate thickenings. Oil bodies small, *Bazzania* or *Calypogea* type; in ocelli large, brown, *Diplasiolejeuna* type. Lobule sigmoid-lanceolate, inflated along the smooth keel, with first and third teeth 1-2 celled, obtuse, and second tooth 2-3 celled, more elongate. Sometimes both the second and third teeth are falcately curved (Fig. 27). Cells in the lobule more elongated than in the lobe. Underleaves distant or contiguous, ± 4 × as wide as the stem, with obtusely lanceolate lobes 4-7 cells wide at their base and ending in an acute to rounded, in the latter case 1-3 cells wide apex. Underleaf base decurrent with a narrow sinus 3-4 cells deep.

Most known plants are sterile, and only one gynoecium was observed on a short side branch. Female bracts obtusely bilobate, up to half the length of the
perianth, bracteole swallow-tail shaped with a V incision, much shorter than the bracts. Perianth 2 × 1.5 mm, obpyriform, with 5 long decurrent wings and with a short and wide beak. Gemmae not seen.


**Diplasiolejeuna andringitae Schäfer-Verwimp**

(Figs 34-46)

Planta parva, pallide vel luteo-viridis, caulibus diametro 60-75 µm, 5-15 mm longis, cum foliis 1-1.2 mm latis. Lobus folii obovatus vel reniformis ocellis basalibus 1-2 et dispersis 5-15. Lobulus curte rectangularis, inflatus, tridentatus dentibus primis obtuse triangularibus, 1-3 cellularis, secundis T-formibus, tertii parvis, unicellularibus. Amphigastria distantes vel contigui caulis 2.5-3 latoribus. Gemmae circa 40 cellulares diametro 60-70 µm.


Plants small, 5-15 mm long and 1-1.2 mm wide, pale green to yellowish green, irregularly branched, epiphyllous, rarely ramiculous, the leaves usually ascending from substrate at an angle of 30°-60°. Stems 60-75 µm in diameter, in cross section with 3 medullary and 7 cortical cells. Leaves contiguous to slightly imbricate, obliquely spreading, obovate to reniform (best seen when dissected from stem), about as twice as long as wide, up to 600 µm long and 330 µm wide, lobe with one large suprabasal ocellus (rarely two), 30-40 × 80-90 µm, about twice as long and wide as surrounding cells, and 5-15 scattered ocelli the same size and shape as average cells, vanishing soon after collection and not recognizable in dead herbarium material. Marginal lobe cells ± quadrate to short rectangular, 12 × 14 to 14 × 16 µm, median cells elongated polygonal, 16-18(20) × 25-32 µm, with conspicuous knot-like trigones and intermediate thickenings (which are sometimes confluent), basal cells ± rectangular, 15-20 × 30-40 µm, with sinuose walls and nodulose thickenings. Oil bodies small, 5-12(-16) per cell, of Calypogeia or Bazzania type; in ocelli large, brown, of Diplasiolejeuna type. Lobule shortly oval to shortly rectangular, 1.2-1.6 × as long as wide, ca 250-280 µm long, 160-180 µm wide, reaching about 0.4 leaf length, strongly inflated, flat only in upper distal part. The first tooth of 1-3 cells, positioned at the junction of the lobule with the ventral leaf lobe, and forming an incision – the latter feature rarely seen in Diplasiolejeuna (see Figs 40-41, 44-45). The second tooth T-like, with one “vertical” cell (sometimes 3 “vertical” cells, two of which are basal side by side) and two (rarely one) very thin walled, elongated-oval cells perpendicular to the “vertical” cell(s), and forming the cross-piece of the “T”. These two thin-walled cells are partly ental behind the “vertical” cell (see Figs 40-41, 45), and seem to be fugacious, sometimes disappearing in older leaves. The third tooth small, one celled, sometimes inconspicuous, often with an attached hyaline cell. Cells in lobule somewhat less elongate than in central leaf lobe, ± quadrate to short rectangular to irregularly polygonal, 14 × 14 to 14 × 25 µm. Underleaves distant
to contiguous, (2)2.5-3(3.5) × stem width, up to 200 μm long and 160(180) μm wide, the lobes ± triangular, 3-4 cells wide at base (40-60 μm wide), 3-6 cells long, tipped by a single cell or two uniseriate cells, the sinus very broadly rounded and often truncate, rhizoid disc rounded-quadrat,e large.

Most plants are sterile. Only a few male plants have been seen in the type specimen. Androecia lateral or terminal on short branches, consisting of 3(-4) pairs of bilobed bracts and 3 bilobed bracteoles. The male branches are 520-530 μm long and do not overtop the surrounding leaves. Asexual reproduction by discoid gemmae which are produced on distal part of ventral surface of lobe, up to 60-70 μm in diameter and consisting of about 40 cells. The leaves that produce gemmae are not differentiated from normal leaves.


DISCUSSION

Africa with its now 31 Diplasiolejeuna species is the second richest continent after the Americas with their 38 species, but if we examine the species diversity of smaller natural units, Madagascar (including the neighbouring islands), with its now 25 species, becomes the most diverse in Diplasiolejeuna among the 21 areas of the humid tropics, exceeding the 22 species of the tropical Andes and the 21 of the Caribbean region (Grolle, 1995; Pócs, 1996; Schäfer-Verwimp, 2001, 2004, 2005; Wigginton et al. 1996; Wigginton 2004).

The three new species are endemic to limited areas of Madagascar (Fig. 47), with altitudinal ranges of Diplasiolejeuna ornata from sea level to 720 m, D. ranomafanae between only 1100 and 1230 m, and D. andringitrae from 450-1200 m. Diplasiolejeuna ornata and D. andringitrae are predominantly epiphyllous, whereas D. ranomafanae was found primarily on small branches. The other Madagascan endemics are Diplasiolejeuna auriculata Tixier, D. cobrensis

The section Utriculatae of subgenus Diplasiolejeunea as defined by Tixier (1985), to which our three new species belong, has its centre of evolution Madagascar. Many members of this section (D. andringitrae, D. auriculata, D. cobrensis incl. var. antsirananae, D. hamata, D. kraussiana, D. ornata, D. ramicola, D. ranomafanae, D. symoensii, D. utriculata and D. zakiae Tixier from Madagascar, the African D. deslooveri Vanden Berghen, D. onraedtii Grolle from Sri Lanka as well as D. buckii Grolle, the little known D. guadalupensis Steph., D. heimii Jovet-Ast and D. replicata (Spruce) Steph. from the Neotropics belong here) are at least superficially rather similar. Our three new species may be separated from closely related species as follows.

Diplasiolejeunea ornata is well characterized by the obovate or cuneate leaf lobes, the ovate-lanceolate leaf lobule with a doubled first tooth and the clavate perianth with conspicuously auriculate to umbonate carinae. There are only a few species with a doubled lobule tooth, including Diplasiolejeunea aulæ E.W. Jones, D. cyanguguensis Tixier and D. phyllarthonii Tixier. However, these
three species belong to section *Villaumeae*, having considerable larger underleaves with lobes at least 8 or more cells wide at base (4-8 cells wide in *D. ornata*), and a different shape of the lobule, never being ovate-lanceolate as in *D. ornata*. *Diplasiolejeuna symoeisii* Vanden Berghen, *D. hamata* Tixier (both with an occasionally doubled first tooth) and *D. zakiae* Tixier are readily distinguished by the smaller underleaves with lobes 2-4 cells wide at base and distally truncate leaf lobule. From all these and other superficially similar species, *D. ornata* is separated, too, by the conspicuous auriculate to umbonate carinae of the perianth.

*Diplasiolejeuna ranomafanae* is unmistakable in its sigmoid-lanceolate inflated lobule with three teeth, the third tooth usually longer than the second. The decurrent underleaf base with a narrow sinus 3-4 cells deep, seems to be another good character distinguishing *D. ranomafanae* from superficially similar species. The falcately curved first tooth which is occasionally present in *D. ranomafanae*, is also a rare feature in the genus; it is otherwise found only in *D. hamata* Tixier in which, however, the first tooth is often doubled, and the second tooth is small, one celled and straight. Furthermore, underleaves in the latter are smaller, the lobes only 3-4 cells wide at base, and the lobule is distally truncate.

*Diplasiolejeuna andringitrae* seems to be closely related only to *D. auriculata* Tixier, from which it differs 1) in the shape of the leaf lobe being oval in *D. auriculata*, widest near mid-leaf, but obovate to reniform in *D. andringitrae*, 2) by the conspicuous knot-like trigones with abundant intermediate thickenings in *D. andringitrae*; small trigones only at base of leaf lobe in *D. auriculata*, 3) by the flat hammer-shaped second tooth with two rounded-oval “horizontal” cells as thick walled as neighbouring cells in *D. auriculata* (see fig. 1: 5-7 and fig. 2: 5-7 in Tixier 1979), and thin-walled longy oval perpendicular (“horizontal”) cells in *D. andringitrae*, and 4) in the shape of the underleaves being usually V-shaped in *D. auriculata* but often with a broad truncate sinus in *D. andringitrae*. *Diplasiolejeuna kraussiana*, which is similar in its leaf cells having conspicuous knob-like trigones and intermediate thickenings, is readily distinguished by its dispersed ocelli that are larger than average cells and conspicuous also in dead herbarium material, by the oval to elongate-oval leaf lobe and by the frequent occurrence of perianths (autoious). In addition, the incision at the junction of the lobule with the ventral leaf lobe caused by the first tooth in *D. andringitrae* is very characteristic, and this species may be separated from all similar species by this feature alone. We know of only one unrelated African species, *Diplasiolejeuna runssorensis* Steph., which shows a similar incision caused by a first tooth. In *Diplasiolejeuna aulae* E.W. Jones (= *D. tridentata* Tixier), another species with three lobule teeth and a first tooth near the junction of the lobule with the ventral leaf lobe, the lobule is narrowly and shortly decurrent and lacks an incision. Both the latter species are immediately distinguished by their large underleaves typical of sect. *Villaumeae*, the lobes being 10 or more cells wide at base. Another unique feature of *D. andringitrae* in African *Diplasiolejeuna* species is the really T-like second tooth of the lobule (it is “hammer-shaped” in *D. auriculata* and sometimes also in *D. kraussiana* and *D. symoeisii* Vanden Berghen), though a T-like second tooth is also found in the Neotropical *D. buckii* Grolle and in the Asian *D. longifolia* Herzog. both species unrelated to *D. andringitrae*.

The little known *Diplasiolejeuna utriculata* Steph. is separated from all other members of sect. *Uriculatae* by the long tubular lobule and dispersed ocelli that are larger than average cells.
Acknowledgements. The authors are grateful to Martin J. Wigginton for his
careful revision of their English and for his other useful comments. The senior author
expresses his gratitude to Dr. Robert Magill (MO), to Prof. Zoltán Tuba (Gödöllő), to
Mr. Rolland Ranaivojona (TANA), to Mr. András Szabó and to his wife, Mrs. Sarolta
Pócs for their logistic help and participation in the collecting work, to the National
Geographic Society, USA (Grants No. 5201/94, 6248-98), to the Hungarian Academy of
Sciences and to the Hungarian Scientific Research Fund OTKA (Grant No. T 038319) for
sponsoring the expeditions.

REFERENCES


GROLLE R., 1995 — The Hepaticae and Anthocerotae of the East African Islands. An

laboratory 24: 115-302.

PÓCS T., 1996 — Epiphyllous liverwort diversity at worldwide level and its threat and
conservation. Anales del instituto de biológica de la Universidad nacional autónoma

SCHÄFER-VERWIMP A., 2001 — Diplasiolejeunea pluridentata (Lejeuneaceae,
Marchantioipsida), eine neue Art aus Costa Rica. Haussknechta 8: 71-78.

SCHÄFER-VERWIMP A., 2004 — The Genus Diplasiolejeunea in the tropical Andes,
with description of two new species. Cryptogamie, Bryologie 25: 3-17.

SCHÄFER-VERWIMP A., 2005 — Diplasiolejeunea richegrolleti (Lejeuneaceae, Junger-
manniopsida), a remarkable new species from Cuba. Cryptogamie, Bryologie 26:
37-40.

TIXIER P., 1977 — Espèces nouvelles malgaches du genre Diplasiolejeunea (Spruce)

TIXIER P., 1978 — La speciation lémurienne et les Lejeuneacées. Le cas du genre
13 : 621-645.

TIXIER P., 1979 — Nouvelles espèces malgaches de Diplasiolejeunea (Diplasiae). II. Revue

TIXIER P., 1980 — Diplasiolejeunea insignis P. Tx. à Angavokely (Tananarive,

TIXIER P., 1984 — Contribution à l’étude du genre Diplasiolejeunea (Spruce) Schiffn.,
4. La section Villaumeae P. Tx. (subgenus Diplasiolejeunea) sur la côte est de

TIXIER P., 1985 — Contribution à la connaissance des Cololejeunioideae. Bryophytorum

TIXIER P., 1986 — La notion d’espèce dans le genre Diplasiolejeunea. 3— Diplasiolejeunea
harpaphylla Steph., espèce palaeotropicale. Cryptogamie, Bryologie-Lichénologie
7: 141-147.

TIXIER P., 1987 — La notion d’espèce chez le genre Diplasiolejeunea. Diplasiolejeunea

of the Hepaticae and Anthocerotae of Sub-Saharan Africa. Bryophytorum

WIGGINTON M.J., 2004 — Checklist and distribution of the liverworts and hornworts of
sub-Saharan Africa, including the East African Islands. Tropical bryology
research reports 5: 1-102. http://www.tropicalbryologyresearch.co.uk