

**NOTES ON SOME SPECIES OF *COLURA*
(LEJEUNEACEAE, JUNGERMANNIOPSIDA),
WITH DESCRIPTION OF *COLURA CATARACTARUM*
FROM MADAGASCAR**

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Examination of about one hundred unidentified *Colura* specimens resulted in new distributional data of eleven uncommon species, *C. australiensis*, *C. bicornis*, *C. calyptrifolia*, *C. crispiloba*, *C. cristata*, *C. heimii*, *C. humbertii*, *C. imperfecta*, *C. obesa*, *C. rhynchophora*, *C. saroltae* and a new species of sect. *Colura* from Madagascar, *C. cataractarum*.

Key words: Africa, Australia, endemism, Fiji, Madagascar, Mascarenes, new species, phylogeography

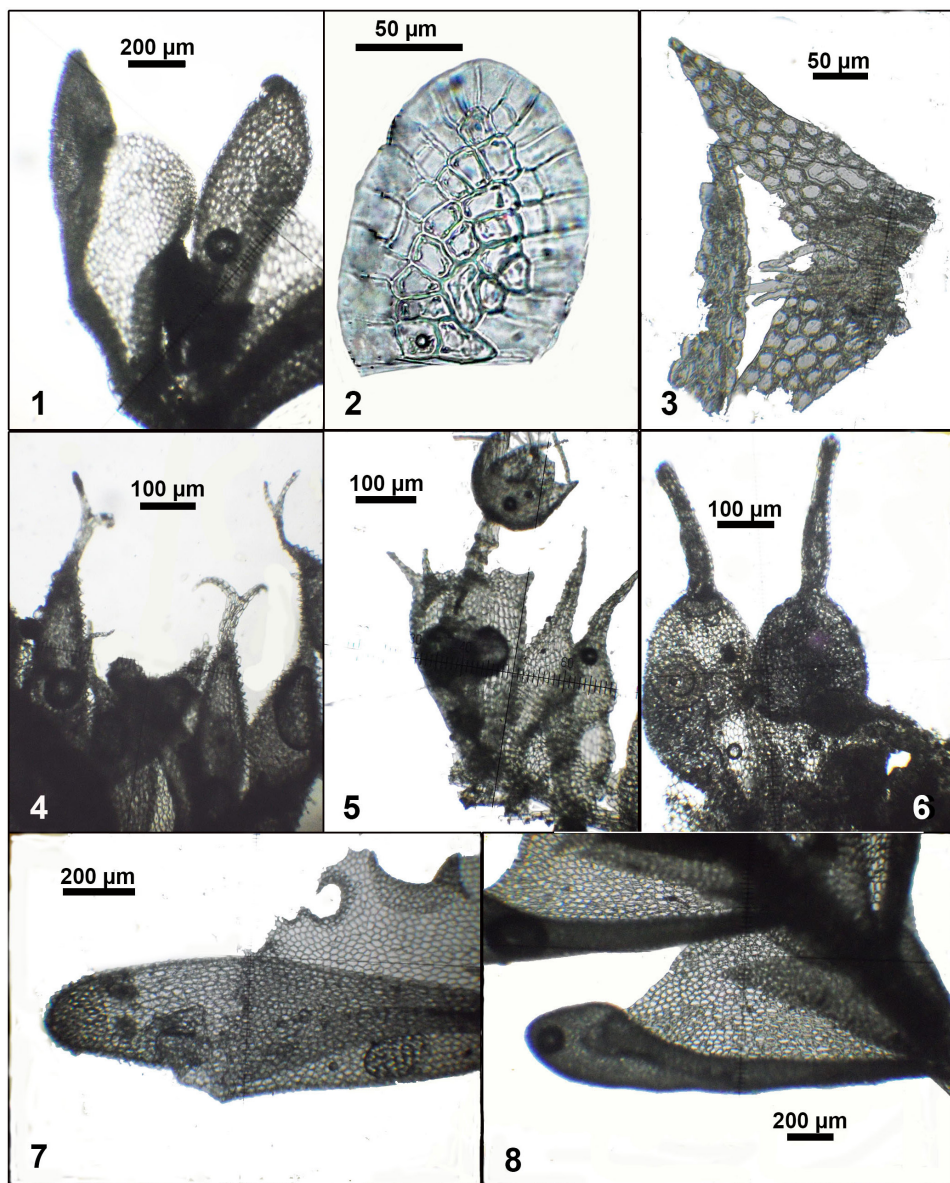
INTRODUCTION

During the past decades I accumulated nearly one hundred unidentified specimens of the liverwort genus *Colura* (Dumort.) Dumort. (Lejeuneaceae) from different parts of the world, mostly from East Africa, Australia and the Fiji Islands, collected by myself, my wife and my colleagues. The identification of the material resulted in a large number of range extensions and recognition of a new species of section *Colura*, *C. cataractarum* Pócs, from Madagascar. In this paper new localities and range extensions of eleven uncommon species as well as the description of the new species are presented.

RANGE EXTENSIONS

In the present enumeration the first two digits of locality numbers refer to the year of collection, while the letters mark the different species within the same locality. The novelty of the records was mostly established using Ah-Peng and Bardat (2005) and Ah-Peng *et al.* (2010a, b) for Réunion, Grolle (1995) and Marline *et al.* (2012) for Madagascar and the Mascarenes, McCarthy (2003) for Australia, Söderström *et al.* (2011) for Fiji and Wigginton (2018) for continental Africa.

Colura australiensis Ast, Rev. Bryol. Lichénol. 22: 260 (1954) (Figs 1–3, 24)
– Australia: Queensland, Cape Tribulation, Daintree National Park, ‘Botanical



Figs 1–8. – Figs 1–3. *Colura australiensis* Ast (from Pócs & Streimann 9990/C): 1 = habit, ventral view; 2 = valve; 3 = broken underleaf. – Fig. 4. *Colura bicornis* Ast, habit (from Pócs, Szabó & 9872/AA). – Fig. 5. *Colura calyptrifolia* (Hook.) Dumort., habit with sporophyte (from Pócs, Szabó & Ranaivojaona 9851/AE). – Fig. 6. *Colura humbertii* Ast, habit (from S. & T. Pócs 9890/DB). – Fig. 7. *Colura crispiloba* Ast, lobe apex with lobule sac (from S. & T. Pócs 03269/I). – Fig. 8. *Colura saroltae* Pócs, habit, ventral view (from Kis & Pócs 9124/S)

Circuit' along Noah Creek, on bark in mangrove forest at 1–2 m elevation, with *Colura streimannii* Pócs (Pócs 2015), *T. Pócs*, *H. Streimann* 9990/C (CANB, EGR). A species of sect. *Harmophyllum*, previously known only from the type locality on Mt Bellenden Ker in Queensland, from the Solomon Islands (Pócs 2013) and from New Caledonia (Hürlimann 1987).

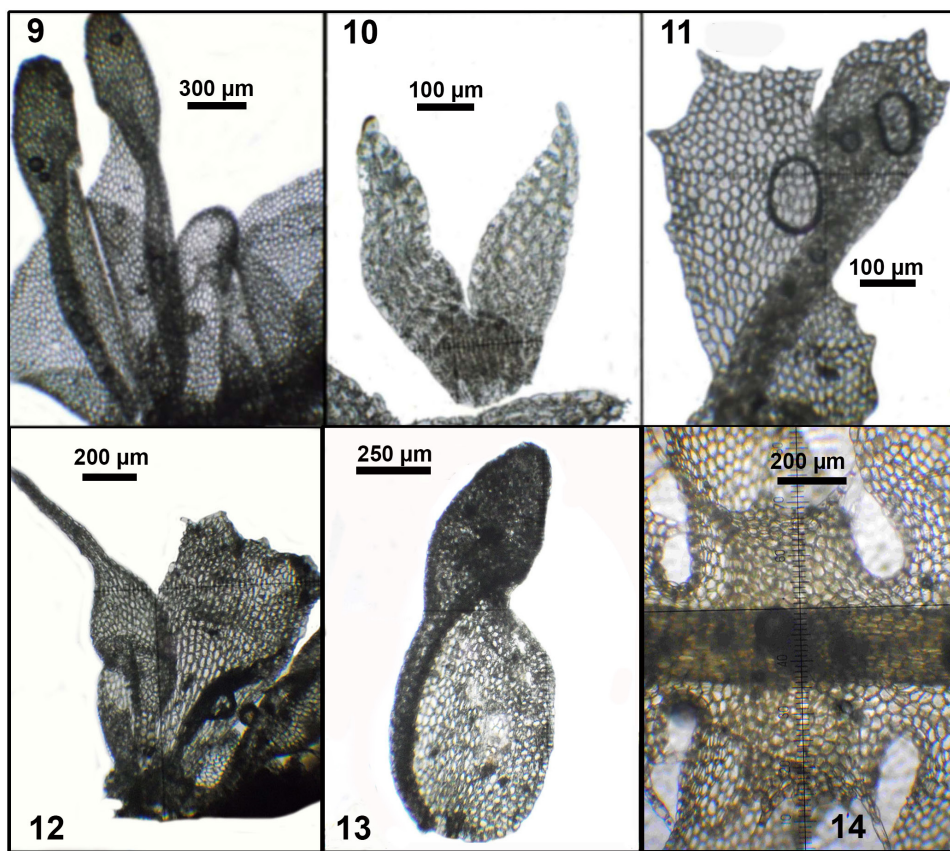
Colura bicornis Ast, Rev. Bryol. Lichénol. 25: 272 (1957) (Figs 4, 23) – Madagascar, Toamasina Prov., epiphyllous in lowland rainforest at the N side of Fandrazana River Estuary at 2–3 m elev., *S. & T. Pócs*, *A. Szabó* 9872/AA (EGR, TAN). Since the description of this peculiar Madagascan species of sect. *Glotta* with a forked sac apex (Jovet-Ast 1956) from the Moramanga-Andasibé road, only one further locality had become known, from Andringitra National Park (Pócs 1995). The species seems to prefer very wet, waterlogged rainforests.

Colura calyptrifolia (Hook.) Dumort., Recueil d'Observ. Jungerm., p. 12 (1835) (Fig. 5) – Madagascar, Antananarivo Prov., on *Erica* twig in a heath on the summit at the N end of Lake Mantasoa, near Anjoroza village, at 1,500 m elev., *T. Pócs*, *A. Szabó*, *R. Ranaivojaona* 9851/AE (EGR); Toamasina Prov. Maromizaha Forest S of Andasibe National Park. Epiphyllous in a mossy cloud forest on the summit ridge of Mt Maromizaha, at 1,080–1,214 m elev., *S. & T. Pócs* 9890/DB (EGR, TAN). This widespread, pantropical-oceanic temperate species of sect. *Colura* was not previously known from Madagascar (see map in Gradstein *et al.* 1984).

Colura crispiloba Ast, Cryptog. Bryol. Lichénol. 4(3): 205 (1983) (Figs 7, 24) – Australia, Queensland, there are several new localities: Atherton Tableland, Cardwell Range, E slope of Mt Fisher 9 km N of Ravenshoe, at 940–1,000 m elev. Epiphyllous in disturbed rainforest, *Pócs*, *Streimann* 99114/AK. This place is not far from its type locality in Kirrima State Forest. Paluma Range: McClelland's Lookout at the E side of the village and also in the garden of A. & W. Cairns in Paluma village, in the opening of a rainforest rich in epiphytes, at 900 m alt., on bark, *T. Pócs* 9976/A (CANB, EGR); *S. & T. Pócs* 01109/W (BRI, EGR). Main Coast Range, Mt Lewis W of Rumula, SW slope of the summit at 951 m elev., on decaying twigs, *S. & T. Pócs* 01085/F (EGR, BRI). A new Fiji locality: Viti Levu Island, SW ridge of Mt Tamanivi (Mt Victoria), at 800 m elev., epiphyllous in cloud forest, *S. & T. Pócs* 03269/J (EGR). According to our present knowledge this is an Australasian–Pacific species restricted to Queensland and to Viti Levu in the Fiji Islands (Jovet-Ast 1983, Pócs and Streimann 2006, Pócs and Eggers 2007).

Colura cristata Ast., Rev. Bryol. Lichénol. 22(3): 291 (1954) – Fiji Islands, Viti Levu Island, coral Coast, near Nabukavesi village 10 km N of Lombau, epiphyllous in wet lowland rainforest, *S. & T. Pócs* 03261/CD (EGR). A rare species of section *Harmophyllum*, known only from Borneo, Java and from the Kadavu Island of Fiji.

Colura heimii Ast, Rev. Bryol. Lichénol. 22(3): 275 (1954) (Fig. 9) – Two additions to the Réunion localities: SSW slope of Piton de la Fournaise volcano, along the trail from Gite Basse vallée to Puis Ramond and to Piton Larde, 720–1,250 m elev., on bark, G. Kis 9605/C, 9652/CQ (EGR, REU). In Mauritius the species was known from 1–2 localities only (Jovet-Ast 1976). Mauritius: Black River Gorges Nat. Park, N slope of Mt Cocotte, 710 m, on twig, D., S. & T. Pócs, D. Florins 9665/B (EGR, NAI). Tanzania, Morogoro District, Nguru Mts, which is part of the Crystalline Eastern Arc range: Watershed between Chogowale and Divue headwaters, 6 km SSE of Maskati Mission, at 1,960 m elev. On bamboo stems in montane rainforest dominated by *Schefflera volkensii*, *Afrocrania volkensii* and *Podocarpus*, T. Pócs, G. Kis 9129/W (EGR); Bamboo



Figs 9–14. – Figs 9–10. *Colura heimii* Ast (from Pócs & Kis 9129/W): 9 = habit, ventral view; 10 = underleaf. – Fig. 11. *Colura imperfecta* Steph., habit, dorsal view (from Pócs & Streimann 99117/AN). – Fig. 12. *Colura rhynchophora* Ast, habit with perianth (from S. & T. Pócs 03148/BB). – Fig. 13. *Colura obesa* Ast, leaf, ventral view (from Pócs 6889/CF). – Fig. 14. *Heteroscyphus grandistipus* (Steph.) Schiffn., underleaf, ventral view (from Pócs 9473/AF)

(*Sinarundinaria alpina*) forest with scattered *Ocotea usambarensis* trees, on the S slope of Mt Kwakungwi, 7 km SE of Maskati, at 1,970–2,000 m, on bamboo stem, *T. Pócs*, *G. Kis* 9135/AF and 9137/E (EGR); Dry elfin forest on the rocky top of Mt Kwakungwi, at 2,100 m, on tree bark, *G. Kis*, *T. Pócs* 9140/O and BQ (EGR). Jovet-Ast (1954, 1958, 1976) has published it and we also found it from several localities in Madagascar, where it seems to be widespread. Not so common in the island of Réunion, where it became known from 7 localities (Ah Peng *et al.* 2012) and was known only from 1–2 localities in Mauritius (Jovet-Ast 1976). It became known also from the Comoro Islands: Mayotte (Pócs 2010). More surprising is its discovery in continental Africa (Tanzania).

Colura humbertii Ast, Rev. Bryol. Lichénol. 22(3): 251 (1954) (Figs 6, 25) – Réunion: Le Grand Brule on the E slope of Piton de la Fournaise. On lava flow of the 1931 eruption above the “Vierge au Parasol”, at 50–350 m elev. On dead fern petiole in secondary *Agauria-Casuarina-Erica* bushes, *E. Kónya*, *T. Pócs* 9630/ZB (EGR). Tanzania: Nguru Mountains, on twigs in ericaceous heath of Kwasenjungu rock SE of Maskati Mission, at 2,010 m elev., *G. Kis*, *T. Pócs* 9111/AX (EGR, NAI). It differs from *C. tenuicornis* (A. Evans) Steph. not only by the short obtuse, conical perianth horns but also the much wider, inflated lower part of lobule very quickly tapering into the half leaf long, narrow sac in contrast to the gradually narrowing sac of *C. tenuicornis*. It was known as an endemic of Madagascar and the Mascarene Islands. Jovet-Ast (1954) described it from Madagascar but later (1958) published it also from 3 localities in Réunion and Jones (1979) from Mauritius, but new for continental Africa.

Colura imperfecta Steph., Sp. Hepat. 5: 938 (1916) (Fig. 11) – Australia, Queensland edge of Atherton Tableland, Wooroonooran Nat. Park, Henrietta Creek, 33 km WSW of Innisfail town, along the Palmerston Highway, epiphyllous in lowland rainforest with scattered *Agathis robusta* trees, at 375 m elev. *T. Pócs*, *H. Streimann* 99117/AN (CANB, EGR). A Malesian–Melanesian species distributed from the Malay Peninsula through New Guinea to the Solomon Islands. New to Australia.

Colura obesa Ast., Rev. Bryol. Lichénol. 22(2–3): 273 (1954) (Fig. 13) – New localities in Réunion: S slope of Piton de la Fournaise volcano from Basse Vallée at 930–1,300 m elevation, on twigs in mossy and in elfin forests, *T. Pócs* 9602/DD, 9612/DA (EGR). Tanzania, Uluguru Mts, summit and NE ridge of Bondwa Peak, 1,600–2,120 m elev. on leaves and on bark, *T. Pócs* 6889/CF, *T. Pócs*, *M. Crosby* 6844/GE (EGR, NAI). It is quite widespread in Madagascar (Jovet-Ast 1954), but had only one known locality in Réunion Island (Ah-Peng *et al.* 2012). After recording it from São Tomé and from Príncipe Island at very low altitudes, Pócs in Pócs *et al.* (2015: 57–59) discussed in details, supported by microphotos and a comparative table, its synonymy with the sympatric *C. benoistii* Ast. The present records are new to mainland Africa. The illustration of Jones (1979: 388, fig. 1/c) intends to depict *C. dusenii* Steph. This drawing

exactly matches the drawing of the type of *C. obesa* Ast, provided by Jovet-Ast (1954: 274, fig. 44/4) and Pócs *et al.* (2015: 57, figs 3C–D), but not the illustration of *C. dusenii* in Jones (1958: 62, fig. 3/D). The latter corresponds better to the figure of *C. dusenii* provided by Jovet-Ast (1954: 275, fig. 45). Therefore, I suppose that several records of *C. dusenii* of Jones from continental West Africa apply also to *C. obesa*.

Colura rhynchophora Ast, Rev. Bryol. Lichénol. 17(1–4): 27 (1948) (Fig. 12) – Dominican Republic, prov. La Vega. Cordillera Central, Constanza, between El Convento and Valle Nuovo, epiphyllous on fern leaves in wet, mossy *Pinus occidentalis* forest at 2,040 m elev. S. & T. Pócs 03148/BB (EGR). A Caribbean species known from Guadeloupe (Jovet-Ast 1954), Cuba (Mustelier Martínez 2005), Jamaica (Schäfer-Verwimp and van Melick 2016), Dominica (Schäfer-Verwimp 1999), Martinique, Guyana, Suriname (Gradstein 1997), and Costa Rica (Eggers in Eggers *et al.* 2004). New to the Island of Hispaniola.

Colura saroltae Pócs, J. Bryol. 14(3): 497 (1987) (Figs 8, 24) – Tanzania, we have found new localities in the western part of Nguru Mts: on *Erica* twigs in the summit bush of Mafulumula Ridge, at 2,050 m, on twigs in the elfin forest at our campsite NE from Divue headwaters at 2,090 m elevation, G. Kis, T. Pócs 9124/ S, 9130/AP (EGR, NAI). This large and spectacular species preferring ericaceous twigs was hitherto known in Tanzania from the Kilimanjaro Mts (type), West Usambara Mts, E part of Nguru Mts, Rungwe Mts (Jones and Pócs 1987, Pócs 1991, Pócs 1994, Pócs and Váňa 2015); Kenya (Enroth *et al.* 2019, Pócs and Váňa 2015) and from Rwanda (Fischer 2013).

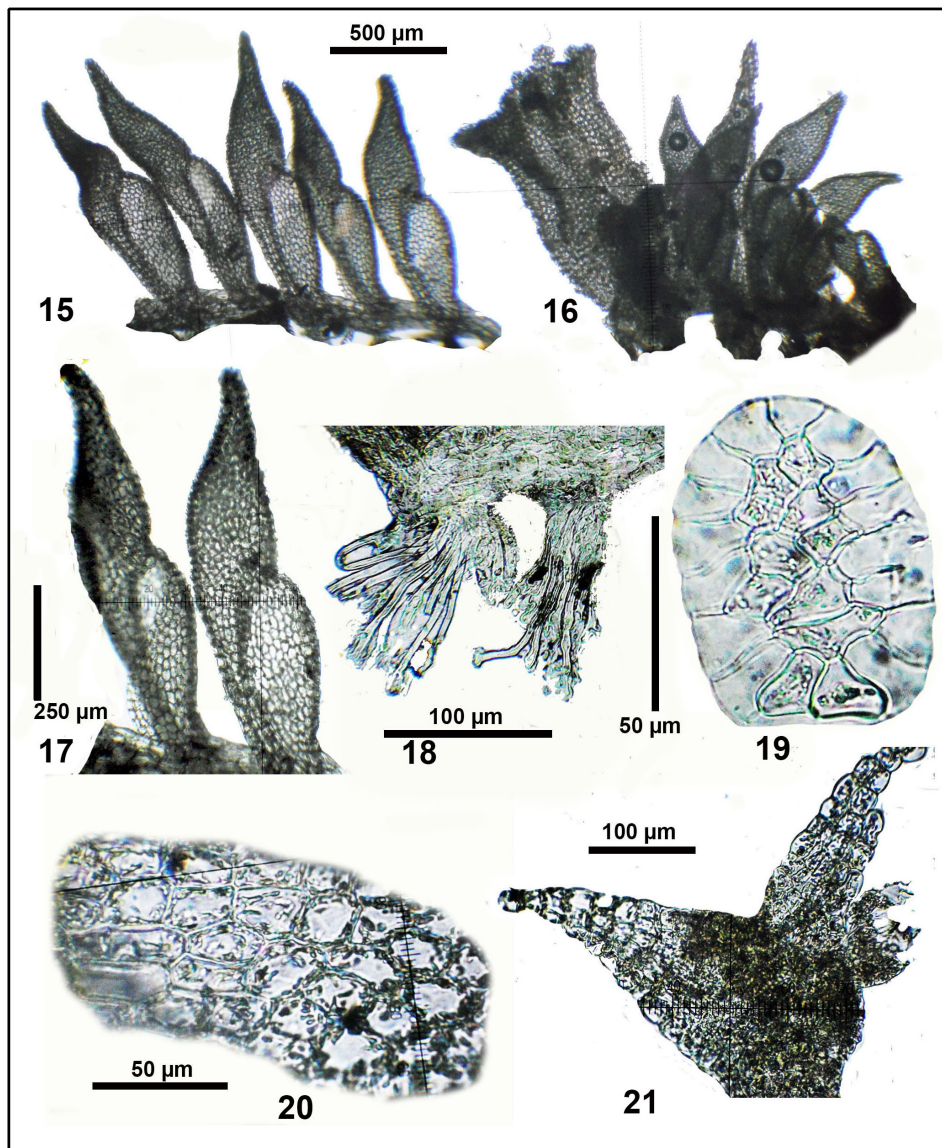
DESCRIPTION OF THE NEW SPECIES

Colura cataractarum Pócs, spec. nova (sect. *Colura*) (Figs 15–22)

Similar to Colura ochyrana Pócs from Peru (Pócs 2019) and *C. junghuhniana* Steph. from Java (Stephani 1916) in the hood-like lobule sac (other members of sect. *Colura* have narrowly elongate horns), but differing from both species in the wider (5–8 cells wide) underleaf lobes and short, triangular perianth horns (similar to those of *C. calyptrifolia*). The new species is furthermore separated from *C. ochyrana* by the obtuse apex of the lobular sac and from *C. junghuhniana* by the smooth leaf cells, without papillae.

Type: Madagascar, Prov. Fianarantsoa, Reg. Haute-Matsiatra, Andringitra Massif and National Park, on steadily irrigated granite rocks in the cataracts of the W tributary of Korokoro River, near Camp III, surrounded by mossy montane rainforest at 1,230 m elevation, 22° 12' 40" S, 47° 00' 00" E, T. Pócs, A. Szabó 9473/K, 22. Sept. 1994 (holotype: TAN; isotypes: G, GOET, EGR, MO, herb. Schäfer-Verwimp).

Plants in herbarium brownish yellow, creeping on the irrigated granite rock, forming a continuous mat. Stems *ca* 50 μm thick, adherent, irregularly branched, branches to 4 mm long. Leaves about 1 mm long, erecto-patent, spreading at an angle of 60–80° to the stem. Lobes about half of the lobule



Figs 15–21. *Colura cataractarum* Pócs, sp. nov. (all from the type): 15 = habit, side view; 16 = lant with perianth, side view; 17 = leaves, side view; 18 = rhizoid bundles, side view; 19 = valve; 20 = lobe cells; 21 = underleaf



Fig. 22. András Szabó collecting *Colura cataractarum* at its type locality, from the irrigated granite rocks

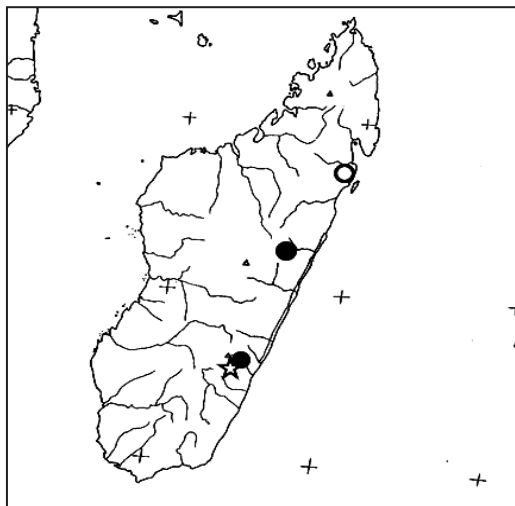


Fig. 23. Endemic species of Madagascar. Star: *Colura cataractarum*, ring: *Colura bicornis*. (Here and later: black: known data, white: new records)

length, inflated, convolute, about 250 μm wide, auriculate at base. Lobules gradually widening above into a hood shaped sac, ca 200 μm wide at base and 500–600 μm long, with obtuse apex. Leaf cells irregular polygonal, ca 20 μm in diameter, somewhat elongate near the lobe margin, to 40 μm long, walls thin, without trigones and intermediate thickenings, outer wall smooth, on the sac mamillose protruding. Valves ca $75 \times 65 \mu\text{m}$, with 16–17 hyaline marginal and 11–12 median cells, of which the two basal ones are more or less triangular in shape. Underleaves

V-shaped, to 500 μm wide, with triangular lobes, 5–8 cells wide at their base, ending in a row of 1–2 rounded cells. Rhizoids colourless, unicellular, often ending up in short dichotomy. Gynoecia on very short side branches; female bracts with rounded apex, about 1/3 of the length of the perianth; perianth urn-shaped, up to 1.2 mm long, without horns 0.5 mm wide, with 5 horns, the horns broadly triangular, 100–200 μm long, nearly horizontally spreading; beak 1–2 cells (up to 6 μm) high, not emerging. Androecia not seen. Vegetative reproduction by gemmae from the perianth mouth.

Etymology: named for its occurrence on regularly irrigated rock surfaces in a cataract (Fig. 22). This habitat is very rare in the genus *Colura* and is otherwise known in the morphologically highly unusual *C. irrorata* (Spruce) Heinrichs, Y. Yu, Schäff.-Verw. et Pócs (= *Myriocolea irrorata* Spruce) (Gradstein *et al.* 2004).

DISCUSSION

Since the publication of World checklist of hornworts and liverworts (Söderström *et al.* 2016) four new species of *Colura* have been described, hence the total number of species in this genus, according to our present knowledge, is 86. The number may change in the future with synonymization and description of further species. A notable feature of the genus is that the greater part of the species is endemic, while several species are worldwide distributed or at least pantropical. This can be the result partly of their quick and steady evolvement since the Cretaceous (Feldberg *et al.* 2014, Wilson *et al.* 2007), partly of the ability of many species for vegetative reproduction by mass production of disciform gemmae. These develop in endo- or exogenous ways (Pócs 2012), usually at the upper end of the sacciform lobule and sometimes on the perianth. The gemmae might be more successful in long range dispersal than the large, protonematic spores attaining sometimes 100 μm in length in many species (Weiss 2001). The fully developed gemmae of different *Colura* species have the same diameter (80–100 μm), but being lighter and having much larger specific surface due to their shape (Zanten and Pócs 1981) they have a good chance to float in the air. Their survival ability is not yet experimentally checked. It is notable that the autoicous, worldwide distributed *Colura calyptrifolia* has relatively small, unicellular spores (Jovet-Ast 1954).

Examples of endemic species are the Melanesian endemics (Fig. 23) *C. australiensis*, *C. crispiloba* and *C. vitiensis* Eggers et Pócs (the latter reaching westwards to the Solomon Islands; Pócs 2013), and *C. queenslandica* B. Thiers, a narrow endemic of Queensland (Thiers 1987). *Colura heimii* and *C. humbertii*, hitherto considered endemic to Madagascar and the Mascarene Islands, have become known also from the Nguru Mts of Tanzania (Fig. 24). These two species are joining the group of more than 50 “Lemurian” elements (Pócs 1975, 1982, 1999,



Fig. 24. Distribution of Melanesian species. Diamond: *Colura australiensis*. – Ring: *Colura crispiloba*

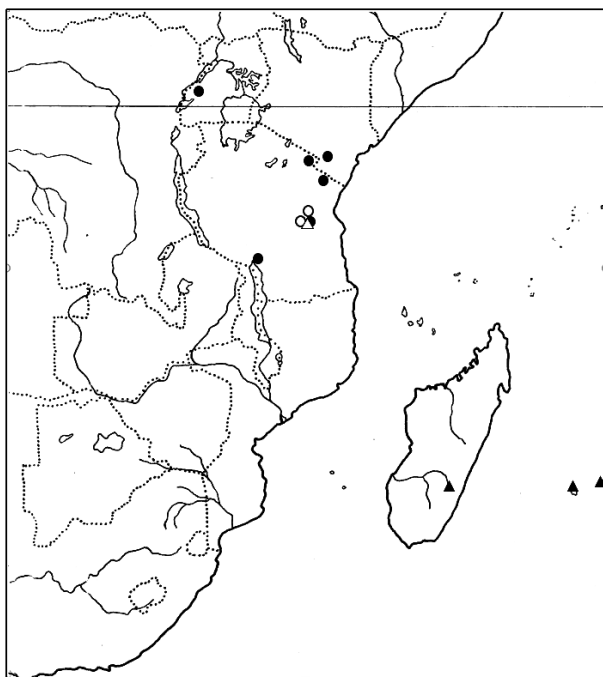


Fig. 25. Distribution of Lemurian (Indian Ocean–East African) species and endemic East African species. Triangle: *Colura humbertii*. – Ring: *Colura saroltae*

2000, Tixier 1978) occurring in Madagascar and the crystalline Eastern Arc mountain range of mainland Africa, extending from southern Kenya to southern Tanzania.

The new species, *C. cataractarum*, represents a small group within section *Colura* characterised by the hood-like, relatively wide conical sac, approaching morphologically the sect. *Oidocorys*. In fact, these two sections, characterised by their valves with 2 triangular basal-median cells (Grolle and Zhu 2002), represent related, sister lineages within the subgenus *Colura*, separated from the sect. *Harmophyllum* (Heinrichs *et al.* 2012). *Colura cataractarum* seems to be a narrow endemic of Madagascar, similarly in distribution to *C. bicornis* (Fig. 22).

The Andringitra Massif, where the new species was found, is particularly rich in endemics compared with other Madagascar localities, and several new bryophyte taxa have recently been described from this area. Examples of rare taxa of this area include *Amazoopsis diplopoda* (Pócs) J. J.

Engel et G. L. Merr., *Ceratolejeunea andringitiae* Pócs, *Cheilolejeunea cordigera* (Steph.) Grolle, *Colura bicornis* Ast, *Diplasiolejeunea andringitiae* Schäfer-Verw., *D. ornata* Pócs et Schäfer-Verw., *Otolejeunea moniliata* Grolle in Tixier, *Plagiochila angusta* Lindenb., *Serpotortella chenagonii* (Ren. et Card.) Vitt et Zander and *Heteroscyphus grandistipus* (Steph.) Schiffn. (Fig. 14), the latter growing on tree-fern stems and decaying logs in mossy montane rainforest (Pócs 9473/AF, EGR, TAN). This species is new to Madagascar, hitherto being known only from Zimbabwe (Sim 1926) and Réunion (Ah-Peng *et al.* 2012). A good illustration of the species is available in the Icones of Stephani (1985: 1833).

As the new records of the *Colura* species have demonstrated, the ranges of the species of this large genus are still very imperfectly known. To obtain a more precise picture, many more specimens have to be studied by morpho-taxonomic and molecular methods.

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