

Epiphyllous liverworts (Marchantiophyta) from Batanta Island (Indonesia, West Papua)

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ABSTRACT: Epiphyllous liverworts were collected in 2017, 2018 and 2019 in the tropical rainforest at low elevation of Batanta Island by the entomologist Tibor Kovács and his colleagues, which were identified by Tamás Pócs. From the 28 species collected at least 14 are new to the western half of New Guinea. These are mostly widespread Indomalesian-Pacific species, but two are endemics, i.e. *Cololejeunea streimannii* Pócs and *Cololejeunea touwii* Pócs, which were previously known only from their type localities in Papua New Guinea. Further collections from the higher elevations of the island should be very promising.

Introduction

The name of Raja Ampat (Four Kings) Archipelago belonging to Western Papua refers to the four larger islands of Batanta, Misool, Salawati and Waigeo. They are located on the west side of Vogelkop Peninsula of New Guinea (Fig. 1b). The research was done on Batanta Island (Fig. 1a), the smallest among them, with an area of 453 km², 60 km length and 7,5 km width, with its highest point of 1184 m. The relative high elevation compared to the size of the island makes it difficult to access by humans. Combined with the high precipitation, in the almost intact rainforest cover there are many watercourses of different type and in addition several larger water bodies (bogs, swamps and open lakes) can be found.

The exploration of the area with almost unknown biodiversity was started by Hungarian entomologists with the caddisflies (Trichoptera) in 2010, then continued by the search of other aquatic and terrestrial taxa as Auchenorrhyncha, Coleoptera, Hymenoptera, Diptera, Odonata, Ephemeroptera, Dermaptera, Blattoptera, Phasmatoda, Ensifera, Caelifera, Heteroptera and Diptera (KOVÁCS et al. 2015a). Till now 151 from the 156 collected species of Trichoptera, and 5 of the 47 species of Odonata were described as new to science (OLÁH 2012, 2013, 2014, 2015, 2016a,b, OLÁH & KOVÁCS 2015, 2018, KOVÁCS et al. 2015b, 2016).

Liverwort records were previously unknown from the island, therefore their collecting was also started at a small scale in 2017.

Material and methods

In 2017 and 2018 only one leaf sample from each year was taken. Interesting species were found on them, so we were encouraged to make more regular collection. In 2019 from each collecting site 8–15 leaves were taken, mainly from broadleaved shrubs and trees, but also from ferns. The material collected by Tibor Kovács with his colleagues and identified by Tamás Pócs are deposited in the Herbarium of Botany Department at Eszterházy Károly University in Eger (EGR) and the duplicates of a number of species in the Mátra Museum of the Hungarian Natural History Museum in Gyöngyös (Heves County).

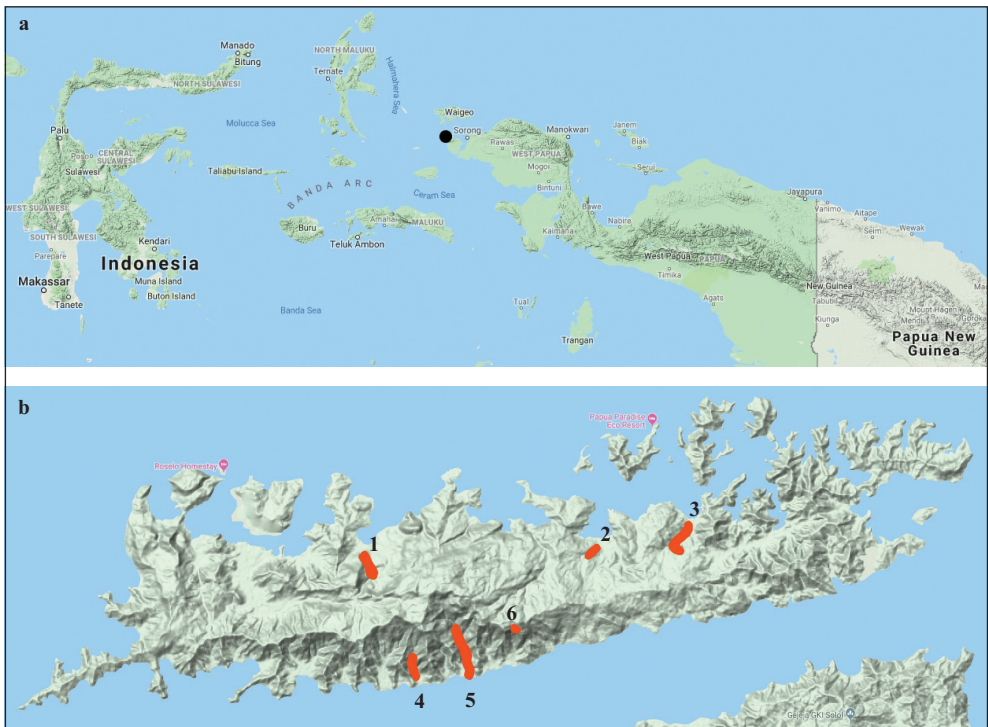


Fig. 1 a, b. a = Location of Batanta (black dot) in Australasia (www.maps.google.com);
 b = Collecting sites of epiphyllous liverworts in Batanta (www.maps.google.com): 1 = valley of Warai Stream,
 2 = valley of Warmon Stream, 3 = valley of Waibin River, 4 = valley of Tanjung Lampu River,
 5 = valley of Kalijakut River, 6 = Wailebet, stream

The localities (Fig. 1b) where epiphyllous liverworts were collected

2017-6. = Indonesia, West Papua, Batanta Island, valley of Warmon Stream, between the lower and upper waterfall, S00°50'04.50", E130°42'54.01" and S00°50'23.25", E130°42'35.18", 20.02.2017, T. Kovács, R. Horváth, P. Juhász.

2017-14. = Indonesia, West Papua, Batanta Island, valley of Tanjung Lampu River, S00°54'24.03", 130°36'47.64", 27.02.2017, T. Kovács, R. Horváth, P. Juhász, K. Sauyai (Fig. 5).

2018-10. = Indonesia, West Papua, Batanta Island, Wailebet, stream, S00°52'47.10", E130°40'08.57", 20.02.2018, T. Kovács, R. Horváth, P. Juhász, K. Sauyai, R. Sauyai.

2019-9. = Indonesia, West Papua, Batanta Island, valley of Warmon Stream, between the lower and upper waterfall, S00°50'04.50", E130°42'54.01" and S00°50'23.25", E130°42'35.18", 09.02.2019, T. Kovács, R. Horváth, P. Juhász, E. Kondorosy (Fig. 4).

2019-12. = Indonesia, West Papua, Batanta Island, valley of Tanjung Lampu River, between S00°54'18.6", E130°36'48.6", and S00°53'43.0", E130°36'38.5", 12.02.2019, T. Kovács, R. Horváth, P. Juhász, E. Kondorosy.

2019-14. = Indonesia, West Papua, Batanta Island, valley of Kalijakut River, between S00°54'20.59", E130°38'31.7" and S00°52'49.10", E130°38'4.9", 14.02.2019, T. Kovács, R. Horváth, P. Juhász, E. Kondorosy (Fig. 6).

2019-18. = Indonesia, West Papua, Batanta Island, valley of Waibin River, between S00°49'20.8", 130°45'56.9" and S00°50'01.9", E130°45'24.8", 17.02.2019, T. Kovács, R. Horváth, P. Juhász, E. Kondorosy (Fig. 3).

2019-21. = Indonesia, West Papua, Batanta Island, valley of Warai Stream, between S00°50'25.19", E130°34'59.19" and S00°50'59.3", E130°35'18.0", 22.02.2019, T. Kovács, R. Horváth, P. Juhász, E. Kondorosy (Fig. 7).



Fig. 2. Landscape of Batanta (photo by R. Horváth)



Fig. 3. Valley of Waibin River (photo by T. Kovács)



Fig. 4. Valley of Warmon Stream
(photo by T. Kovács)

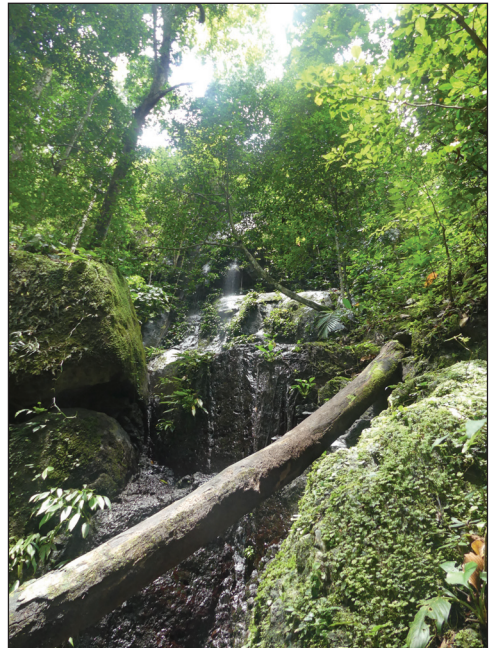


Fig. 5. Valley of Tanjung Lampu River
(photo by T. Kovács)

Enumeration of the collected epiphyllous liverwort species

After the name of each species (only selected synonyms mentioned) the collecting data from Batanta Island (see “Material and methods”) are given. After their occurrence in West Irian (Irian Jaya) and Papua New Guinea the worldwide distribution is discussed. This is followed by the description of distinguishing character states of the species.



Fig. 6. Valley of Kalijakut River (photo by T. Kovács)



Fig. 7. Valley of Warai Stream (photo by T. Kovács)

Caudalejeunea recurvistipula (Gottsche) Schiffn. Syn.: *Caudalejeunea reniloba* (Gottsche) Steph. – 2017-6, 2019-12, 2019-14, 2019-18, 2019-21.

Widespread in the whole of New Guinea, mostly epiphyllous at low altitudes from the sea level but rarely reaching even 2000 m elevation (GRADSTEIN et al. 2002). Indomalasian-Pacific species distributed from India to Fiji and Micronesia (ZHU & SO 2001, SINGH et al. 2016). Important generic character is the presence of discoid leaf-gemmae born at the apex of circinate branches.

Cololejeunea* cf. *angustiflora (Steph.) Mizut. Syn.: *Cololejeunea crenulata* (Herzog) Benedix – 2019-9.

West Irian: only one record from the mountains of Manokwari Prov., Cyclops Mountains, but widely known from Papua New Guinea (PÓCS et al. 1994, PÓCS & PIIPPO 2011). Total range: Southern China, Kalimantan, Sabah, New Guinea, New Caledonia, Solomon Islands, Fiji (ZHU & SO 2001, PÓCS & PIIPPO 2011, PÓCS et al. 2011). The specimen from Batanta is atypical but it is difficult to classify elsewhere. Typical specimens have more spatulate leaves with crenulate margin.

Cololejeunea appressa (Horik.) Benedix – 2019-12.

Unknown in West Irian. There is only one record from Papua New Guinea (GROLLE & PIIPPO 1984). A widespread pantropical species which is surprisingly rare in Western Melanesia. The uniseriate lobe vitta consisting of 4 ocelli combined with two short lobule teeth not crossing each other are the characteristics of this species.

Cololejeunea cordiflora Steph. Syn.: *Cololejeunea trichomanis* (Gottsche) Steph. ssp. *cordiflora* (Steph.) Pócs – 2019-14.

West Irian: only one record known from the Star Mountains but many localities in Papua New Guinea (PÓCS & PIIPPO 2011). Indomalaysian-Pacific species widespread from India to Samoa (MILLER et al. 1983). It is distinguished from *Cololejeunea trichomanis* by its unicellular stylus.

Cololejeunea equialbi Tixier (Figs 8–9) – 2017-6, 2017-14, 2019-14.

New to West Irian. Scattered records known from the montane forests of Papua New Guinea (PÓCS & PIIPPO 2011). Indomalaysian-Pacific species occurring from the Nicobar Islands through Southeast Asia to Fiji (ZHU & SO 2001, SINGH et al. 2016). The roundish, retrorsed leaves with smooth lobe margin and relatively small, unidentate lobule are typical for the species.

Cololejeunea floccosa (Lehm. et Lindenb.) Schiffn. var. *aurita* Benedix (Figs 10–11) – 2019-12.

The species is new to West Irian. Both var. *floccosa* and var. *aurita* known from a few localities in Papua New Guinea. A Paleotropical species distributed from West Africa through Indomalaya and Southeast Asia to the Pacific: Ryukyu and Fiji Islands (MILLER et al. 1983, PÓCS & PIIPPO 2011, PÓCS et al. 2011). The 1–3 seriate lobe vitta is slightly curved at its apex. The first falcate and the second obsolete lobule teeth distinguish it from *Cololejeunea appressa*. Var. *aurita* differs from the typical variety by the very wide, subrotundate auricles of the perianth.

Cololejeunea haskarliana (Lehm. et Lindenb.) Schiffn. (Figs 12–13) – 2017-6, 2019-14.

In West Irian known only from the Manokwari Prov.: Arfak Mountains (EGGERS et al. 1998). Papua New Guinea has several localities in the montane forest belt (PÓCS & PIIPPO 2011). Paleotropical species widespread from the Seychelles through Indomalaya and Australia to Ryukyu and Fiji Islands (PÓCS et al. 2011). A species with dentate lobe margin and acutely papillose outer leaf surface and with two short lobule teeth usually crossing each other.

Cololejeunea lanciloba Steph. – 2019-9.

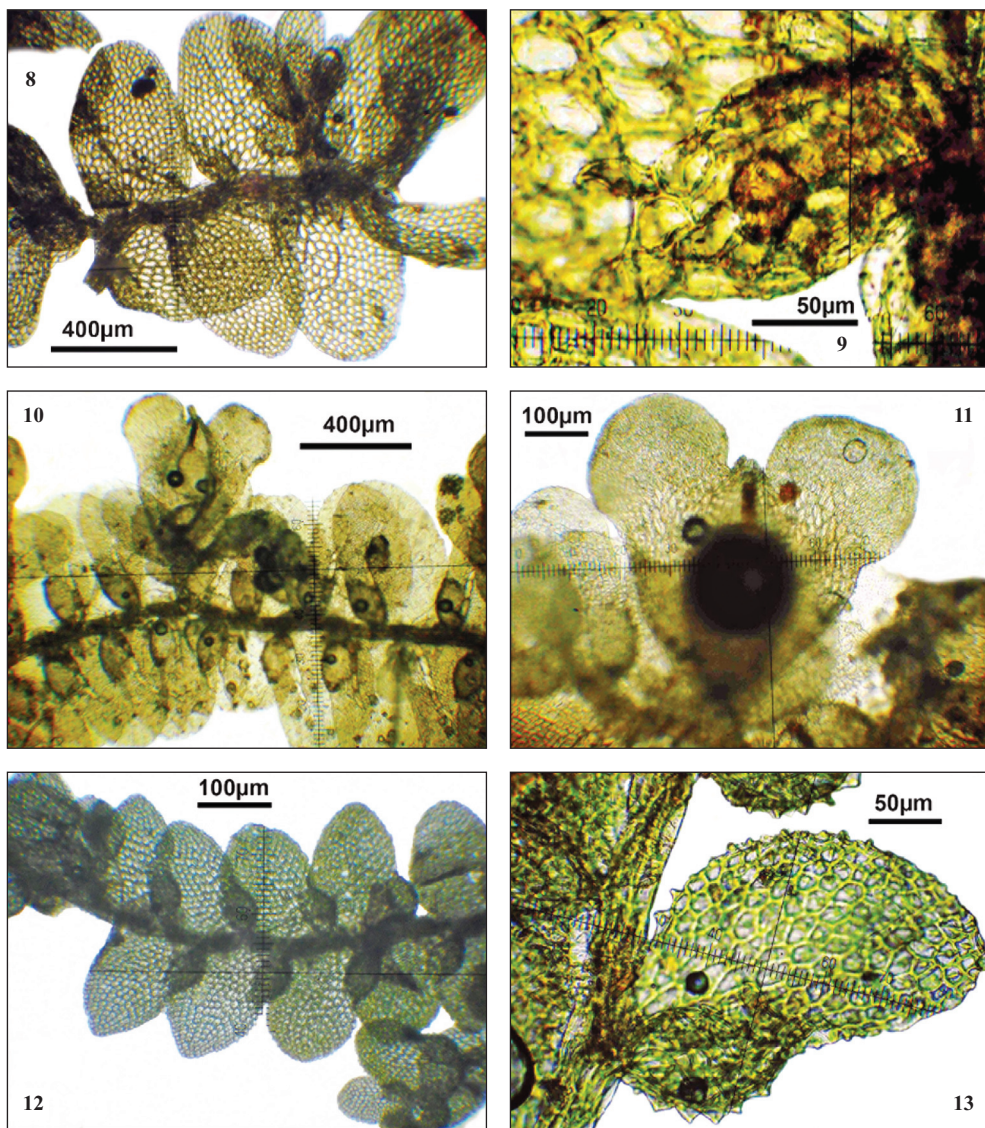
New to West Irian. Many localities known from Papua New Guinea, from the sea level to 1500 m elevation (PÓCS & PIIPPO 2011). Widespread pantropical species rare in South America (PÓCS et al. 2014). Pluricellular hyaline margin all around the lobe. Lobule usually lanceolate with 1–2 teeth at its proximal edge.

Cololejeunea obliqua (Nees et Mont.) Schiffn. Syn.: *Cololejeunea scabriflora* Gottsche ex Steph. – 2019-12.

Unknown in West Irian. It has many localities in Papua New Guinea from 300 to 2900 m elevation (PÓCS & PIIPPO 2011). Widespread pantropical species (ZHU & SO 2001). Characterised by the greater part of lobe covered by short conical papillae and by its cordate perianth with small auriculate wings.

Cololejeunea planissima (Mitt.) Abeyw. – 2019-12.

Unknown from West Irian and known only from one locality in Papua New Guinea (PÓCS & PIIPPO 2011). Pantropical species common in Indomalaya but rare in Africa and South America (PÓCS et al. 2014). Differs from *C. lanciloba* by its hyaline lobe margin discontinued at the ventral edge and by its mostly triangular and only rarely ligulate lobules.



Figs 8–9. *Cololejeunea equialbi* Tixier.: 8 = habit, ventral view; 9 = lobule. **Figs 10–11.** *Cololejeunea floccosa* (Lehm. et Lindenb.) Schiffn. var. *aurita* Benedix: 10 = habit, ventral view; 11 = perianth. **Figs 12–13.** *Cololejeunea haskarliana* (Lehm. et Lindenb.) Schiffn.: 12 = habit, ventral view; 13 = leaf, ventral view

Cololejeunea streimannii* Pócs var. *streimannii (Figs 14–17) – 2018-10, 2019-14.
 Rare New Guinean endemic, hitherto known only from its type locality in Papua New Guinea, Morobe Province, lowland rainforest of Mt. Hagen. Its ssp. *solomonensis* Pócs is endemic to the Solomon Islands (PÓCS & PIIPPO 2011). Therefore the new occurrence of this species in West Irian has great significance. A very characteristic species distinguished by *Allorgella* type

lobe margin teeth (combined by two prorate cells adjoining each other with their protrusions) and by the auriculate, wider than long perianth wings.

Cololejeunea* cf. *touwii Pócs – 2019-18.

Like the previous species, it was formerly known only from its type locality in Papua New Guinea's West Sepik Prov.: Star Mountains at 2300 m altitude. As the Batanta specimen is sterile, although the denticulate leaf margin suggests the presence of *Cololejeunea towunii*, the typical dioecious habit and flat, bialate, cordate perianth should be seen in a later collection to prove its identity (Pócs 2012). Otherwise it could be only an unusual modification of *C. equalbi* Tixier.

Colura conica (Sande Lac.) K. I. Goebel – 2019-14, 2019-21.

From West Irian is known from the Star Mountains, Mt. Antares. There are many localities in Papua New Guinea (Pócs 2013). Widespread Indomalesian-Oceanian species known from India and Sri Lanka to the Philippines, Australia and New Caledonia, the Carolines, Fiji and to Samoa (ZHU & SO 2001, PÓCS et al. 2011, SINGH et al. 2016). It is characterised by the conical sac with pluricellular crest like apex and by its well-developed lobe with dentate margin.

Colura imperfecta Steph. – 2019-12.

From West Irian known only in Arfak Mountains at 1350 m altitude. In Papua New Guinea is widespread almost from sea level to 1500 m elevation (Pócs 2013). It is an Malesian-Pacific species spreading from Java to the Solomon and Fiji Islands (JOVET-AST 1954, SÖDERSTRÖM et al. 2011). Specific characters are the short sac apex ending in a 2–3 toothed crest but most leaves are without sac. Valve very reduced, consisting only of 3–7 cells.

Dendroceros javanicus (Nees) Gottsche et al. – 2019-12.

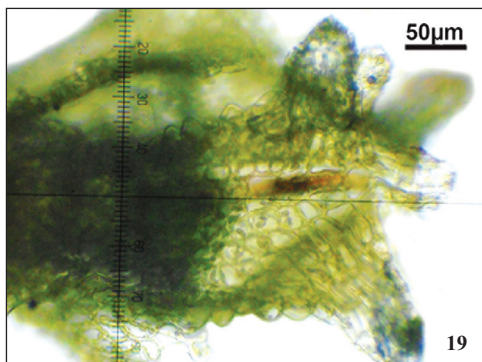
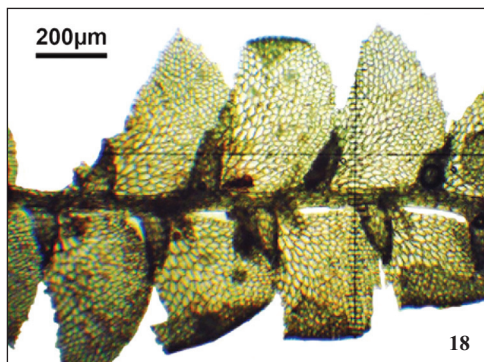
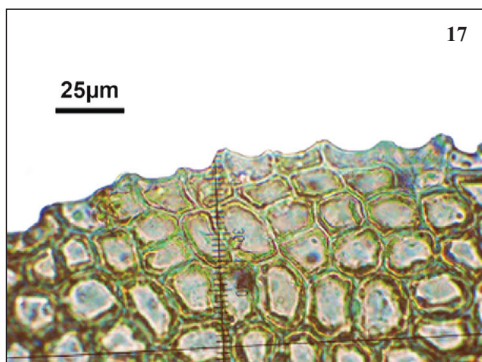
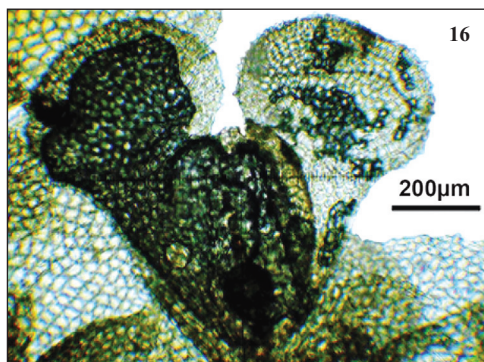
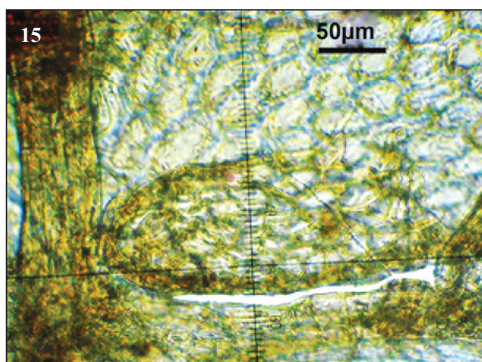
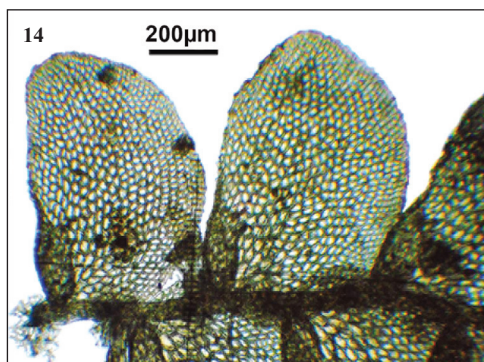
The occurrence of *D. javanicus* was not specified from New Guinea and not confirmed in West Irian. (GROLLE & PIIPPO 1984). More localities known from Papua New Guinea (PIIPPO 1993). Malesian-Pacific species known from Sumatra to Fiji and Samoa (HASEGAWA 1993). It is characterised by the strongly convex, well-distinguished, solid costa and dorsally inflated alar lamina with numerous large perforations.

Drepanolejeunea levicornua Steph. (Figs 18–19) – 2019-21.

Not known from West Irian. There are several records from Papua New Guinea (Pócs et al. 2019). An uncommon Malesian species distributed from Java to New Guinea (MIZUTANI 1990). Among the related species is distinct by the absence of median ocelli in the lobe without and by the highly mamilllose perianth body.

Drepanolejeunea longicruris (Steph.) Grolle & R. L. Zhu Syn.: *Rhaphidolejeunea longicruris* Steph. – 2019-14.

In West Irian known from the Arfak Mountains in Manokwari Prov. (GROLLE & ZHU 2000). In Papua New Guinea recorded from several localities, mostly in lowland forests (Pócs et al. 2019). Malesian species distributed from Borneo to the Solomon Islands (GROLLE & ZHU 2000). Apart from the linear, widely divergent underleaf lobes typical for subgenus *Rhaphidolejeunea* the species is characterised by its acute lobe with 3–4 ocelli in a longitudinal row and by its free lobule margin bordered by 7–8 longitudinal cells.



Figs 14–17. *Cololejeunea streimannii* Pócs var. *streimannii*: 14 = habit, ventral view; 15 = lobule; 16 = perianth; 17 = lobe margin.
 Figs 18–19. *Drepanolejeunea levicornua* Steph.: 18 = habit, ventral view; 19 = mamilllose perianth

Drepanolejeunea pentadactyla (Mont.) Steph. Syn.: *Drepanolejeunea cambouena* Steph., *Drepanolejeunea micholitzii* Steph. – 2017-14, 2019-14.

In West Irian known only from Manokwari Prov. in the Arfak Mountains (GROLLE & PIPPO 1984). Widespread in Papua New Guinea from the sea level to the tree limit (PÓCS et al. 2019). A Paleotropical species known from Bioko and Madagascar in Africa (MIZUTANI 1975,

MÜLLER & PÓCS 2007, PÓCS 2011). In Asia and in the Pacific is more common, from India and Sri Lanka through Indonesia, China, Australia and Melanesia to Hawaii (SINGH et al. 2016).). It is well-distinguished by the acute lobe with 2–4 large side teeth, large median ocelli and by its 5 horned perianth with smooth wall. Reduced forms occur also with shorter, acute lobe but without teeth.

Lejeunea adpressa Nees Syn.: *Lejeunea anisophylla* Mont., *Lejeunea borneensis* Steph., *Lejeunea caespitosa* auct. – 2019-9.

The distribution of this common species is very poorly known from New Guinea. There are no records from West Irian and only one published from Papua New Guinea under the name of *Lejeunea caespitosa* (GROLLE & PIIPPO 1984), although the species seems to be very widespread according to the herbarium records. Pantropical, known under the different synonym names, distributed all over the tropics (ZHU & SO 2001, REINER-DREHWALD 2009, GRADSTEIN 2019). The main characteristics of the autoecious species are the widely spreading underleaf lobes often with a blunt tooth at its outer margin.

Lejeunea micholitzii Mizut. Syn.: *Lejeunea parvisaccata* (Steph.) Steph. – 2019-14.

No record from West Irian. Indicated only in general from New Guinea (GROLLE & PIIPPO 1984, HÜRLIMANN 1993 under *Lejeunea parvisaccata* (Steph.) Steph. Malesian-Pacific species known from Sri Lanka to Fiji and Tonga (LEE 2013, PÓCS & WEI 2017). It is characterised by the lobe cells with well-developed trigones and intermediate thickenings and by its reniform, deeply bifid underleaves with acute lobes.

Leptolejeunea elliptica (Mitt.) Steph. – 2017-6, 2019-12.

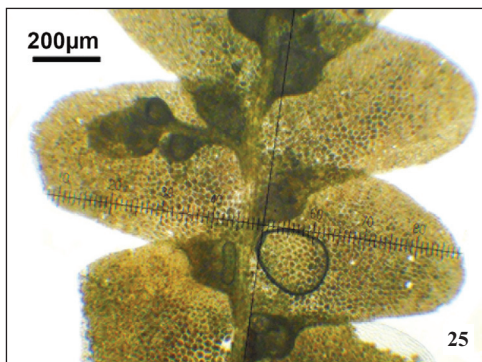
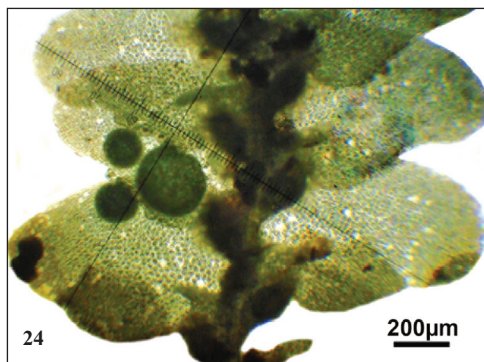
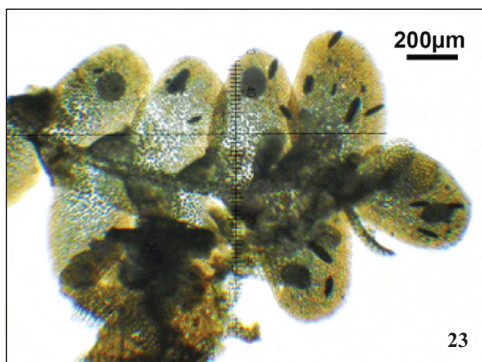
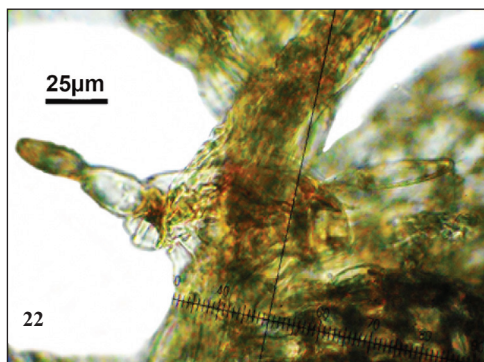
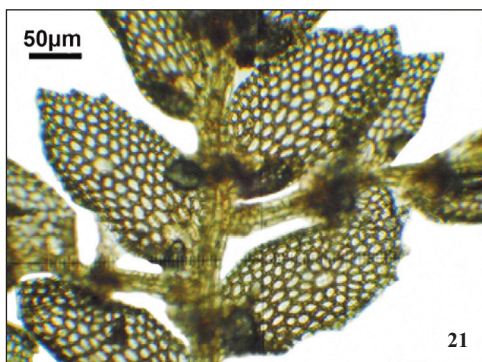
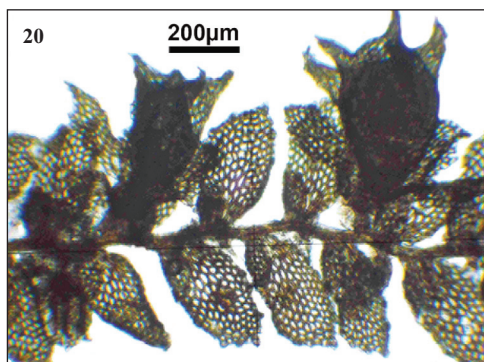
New for West Irian. Previously known from Papua New Guinea in the Central Prov.: Imila Riv. 26 km from Kapiano (STREIMANN 1991). A common pantropical species well-known from the neighbouring Indonesian archipelago, New Caledonia and Australia. Small plants with leaves ovate or elliptic with rounded apex, lobule often reduced. In fresh state vivid green with a special scent but dark brown in dry condition.

Leptolejeunea epiphylla (Mitt.) Steph. – 2017-6, 2017-14, 2019-21.

Previously unknown from West Irian. Only a few records from Papua New Guinea (GROLLE & PIIPPO 1984). A Palearctic species widespread from Africa through India, Indonesia and Southeast Asia to the Pacific islands (Solomon, Tonga and Fiji). Interestingly unknown in Australia (MILLER et al. 1983, HÜRLIMANN 1995, SÖDERSTRÖM et al. 2011). It has rhomboid leaves with parallel sides and often reduced lobule. The underleaves have widely spreading, linear lobes.

Leptolejeunea tripuncta (Mitt.) Steph. (Figs 20–22) Syn.: *Leptolejeunea serrulata* Herz. – 2017-6, 2019-10, 2017-14, 2019-14, 2019-21.

Leptolejeunea tripuncta is known from West Irian, published by GROLLE (1967) from Arfak Mountains, under the name of *L. serrulata*. Not known from Papua New Guinea. Otherwise the species is known from Peninsular Malaysia (Pahang) and from Fiji Islands (HERZOG 1942). The small size with acute, dentate lobes with large median ocelli and the narrow lanceolate, dentate perichaetial leaves bilobed to their half length are typical for the species.



Figs 20–22. *Leptolejeunea tripuncta* (Mitt.) Steph.: 20 = habit, ventral view; 21 = shoot, ventral view; 22 = underleaf, ventral view. Fig. 23. *Radula acuminata* Steph.: habit, ventral view.

Fig. 24. *Radula nymanii* Steph.: habit, ventral view. Fig. 25. *Radula tjibodensis* K. I. Goebel: habit, ventral view

Metalejeunea cucullata (Reinw. et al.) Grolle – 2019-12.

The old records in GROLLE & PIIPPO (1984), under *Lejeunea cucullata* (Reinw. et al.) Nees, did not specify from which part of New Guinea was it collected. Apparently there are no new records from the area. A widespread, pantropical species common in the lowland forests of Indomalaysia and the Pacific (GROLLE 1995). Its appearance is similar to a larger *Microlejeunea*,

but the leaves have no ocelli and the subfloral innovation is of *Pycnolejeunea* type, that is, the first leaflike appendage on it is an underleaf.

Radula acuminata Steph. (Fig. 23) – 2017-14, 2019-18.

The species is recorded both from West Irian: Arfak Mountains (YAMADA 1979) and from several localities Papua New Guinea from the mainland (GROLLE & PIIPPO 1984) and from New Britain (STREIMANN & GROLLE 1993). Indomalesian-Pacific species widespread from India to Fiji (YAMADA 1979, 1984). It has discoid gemmae perpendicular to the ventral lobe surface and subquadrate lobule.

Radula nymanii Steph. (Fig. 24) – 2019-21.

The species is recorded from two localities in West Irian and from several localities of Papua New Guinea (YAMADA 1979). Malesian-Pacific species distributed from Sri Lanka and Nicobar Islands to Tahiti and Micronesia (SINGH et al. 2016). Its discoid gemmae are marginal, parallel to the lobe surface and the lobules are directed sideway with their acute apex.

Radula protensa Lindenb. – 2017-6, 2017-14, 2019-14, 2019-18, 2019-21.

It is known from Sattelberg in West Irian and from several localities in Papua New Guinea (GROLLE & PIIPPO 1984). Indomalesian-Pacific species (MILLER et al. 1983, PÓCS et al. 2011). Its lobule apexes also turn sideway but the discoid gemmae are perpendicular to the lobe surface.

Radula tjibodensis K. I. Goebel (Fig. 25) – 2019-21.

Known from West Irian from the Arfak and from the Mt. Antares (YAMADA 1979, GROLLE & PIIPPO 1984), while from several localities in the main island of Papua New Guinea (GROLLE & PIIPPO 1984) and from one in New Britain (STREIMANN & GROLLE 1993). Indomalesian-Pacific species widespread from India to Samoa. It also has marginal gemmae but the lobule is subquadrate with bluntly protruding apex and its base strongly mammiformly inflated.

Concluding remarks

Our knowledge on the bryophyte flora of West Irian (Irian Jaya, West Papua, Papua Barat), the western part of New Guinea belonging to Indonesia, is much less complete than that of Papua New Guinea. Apart from old German collections and a few Dutch and one Japanese expeditions (HATTORI 1951) to the area, very few bryologists collected there and only for a short time, like Marianne Lenz from Hamburg (EGGERS 2006, PÓCS & EGGERS 2006). As a consequence, half of the above species were hitherto unknown from western New Guinea, and any further collecting might yield a lot of new information.

As it is seen from the above enumeration, the composition of the epiphyllous flora in the lowland rainforests of the islands consists mostly of Malesian, Indomalesian and Indo-malesian-Pacific elements, which is also typical for the great island of New Guinea and can be explained according to SCHUSTER (1972) by the fact, that only the species of elevation above 2000 m are mostly of Gondwanan origin. The lower part of the area was earlier submerged and later interconnected through land bridges with Malaysia. During Tertiary and Pleistocene a great number of Malesian elements spread to New Guinea, mostly to the lower

elevations (PIIPPO 1994). Anyway, even in the lowland are evolved a few species endemic to New Guinea or Western Melanesia, like *Cololejeunea streimannii* or *Cololejeunea touwii*. We expect much from the next collecting trip of the entomologists if they can climb higher in the very difficult terrain and can reach the cloud forest belt which in smaller islands can be lower than on the big land masses.

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