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NEW RECORDS FOR THE LIVERWORT AND HORNWORT FLORA OF VIETNAM, 3
Epiphyllous collections of Pierre Tixier in the Natural History Museum, Paris

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Pierre Tixier deposited a large amount of bryophyte collections, including epiphylls, in the Cryptogamic Herbarium of the Natural History Museum in Paris (PC). A very large part of his valuable epiphyllous specimens collected between 1957 and 1965 in the southern half of Vietnam remained unidentified. Based on study of a small portion of these collections, 44 species are reported including six new to the country (*Dendroceros subplanus*, *Ceratolejeunea singapurensis*, *Cheilolejeunea rigidula*, *Cololejeunea angulata*, *C. stephanii* and *Thysananthus aculeatus*). *Ceratolejeunea* and *Dendroceros* are genera new to Vietnam.

Key words: *Ceratolejeunea*, *Dendroceros*, endemism, Indochina, new records, Paris Cryptogamic Herbarium

INTRODUCTION

The history of the bryological exploration of Vietnam was discussed in detail in a previous paper (Pócs 2023*a*). The rôle of Dr Pierre Tixier (1918–1997) who had grown up and worked part of his life in Vietnam and Cambodia, is unquestionable in this field. He described or renamed 75 species (17.4%) of the known Vietnamese liverwort flora (Shu *et al*. 2017). At the beginning of his bryologist career, Dr Susanne Jovet-Ast, bryologist at the Cryptogamic Laboratory of Herbarium PC, encouraged and helped him a lot. He was a careful collector and had good eyes to discover meticulous differences between taxa (although, maybe sometimes he distinguished species hardly different from each other). I have known him and maintained good relations with him during the last 33 years of his life. As it happens to many bryologists (including myself), he collected much more than being able to identify and describe.

MATERIAL AND METHODS

A large amount of unidentified epiphyllous bryophyte collections made by Tixier is kept in high quality paper envelopes of 27 × 21 and 19 × 15 cm size

in the Cryptogamic Herbarium of the Natural History Museum in Paris (PC). On the envelopes and inside on a small piece of paper is the short (sometimes old, colonial) locality name with the collecting date. Each envelope bears its own inventory number starting with PC, with a title of "Herbier Muséum Paris Cryptogamie". In each envelope 3–12 (depending on their size), well pressed host leaves, covered by epiphylls, are deposited. Specimens from the same locality are usually divided into 2–4 envelopes to avoid congestion, with different inventory numbers. In this way the epiphyllous flora of each locality is fairly well represented. Groups of 20–50 envelopes are put in large zipped plastic bags and stored in big cardboard boxes.

During my work, I identified the content of 16 envelopes collected at six different localities. Whenever it was possible, I tried to put the scattered specimens of each species from the different leaves in separate convolutes with the species name, or if there were only a few shoots, in very small paper bags or marked by ball pen on the host leaf surface, then returned all in their original envelope. On each envelope I wrote the full list of species found inside. From the more interesting species I kept microslides for our herbarium (EGR) and the majority of species were photographed by a PZO compound microscope and RS 500 microphoto adapter or by OptitekScope macrophoto apparatus.

ANNOTATED ENUMERATION OF SPECIES

This list of epiphyllous collections examined contains 44 species (Table 1), almost exclusively liverworts with exception of one hornwort and three mosses of which one, *Ephemeropsis tjibodensis* K. I. Goebel, occurs exclusively on living leaves. The taxa new to the Vietnamese flora are according to the checklist of Shu *et al.* (2017) and our later publications (Pócs 2023*a*, *b*, Pócs *et al.* 2019).

Tixier's collecing localities and dates – The locality name given by Tixier is written in quotation marks, followed by its abbreviation used in this paper, and if necessary, some explanation of the modern name or the whereabouts of the locality, and finally the PC inventory numbers of the envelopes.

"Benom da Treu" – Abbreviated: BT. A 1,781 m high mountain summit in Lâm Đồng province, covered mostly by natural pine forests, NNE of the provincial capital, Đà Lạt. Collection date: Paques 1959. PC0764766, PC0764770 and PC0764771.

"Blao" – Abbreviated: BL. B'lao was the last name of present-day Bảo Lộc town in Lâm Đồng province. Date: 8 Jan. 1960. PC0764772, PC0764773, PC0764777.

"Col de Bananiers" – Abbreviated: CB. Now called Đèo Chuối (Banana Mountain pass), in Đạ Huoai, Lâm Đồng province, about 350 m above sea level. Coordinates from Google Maps: 11.401865°, 107.569382° (information by Ms Thiện Tâm Lương).

"Da Pampei, ravine 8" – Abbreviated: DP. A place probably in Lâm Đồng province. Date: 14 Sept. 1959. PC0764769, 0467774.

"Forêt E.N.A.E.S." – Abbreviated: FE. Most probably the study forest of former École Nationale d'Agriculture Superieure (present Faculty of Agriculture and Forestry, Đà Lạt University) in Lâm Đồng province. Date: 19 Febr. 1960. PC0764775, 0764776, 0764780.

Piste de "Dalao" – Abbreviated: DL. Is also called as B'Su Dalao, or nowadays as Đại Lào, in Lâm Đồng province, at about 780 m above sea level. Coordinates from Google Maps: 11.5135°, 107.75142° (information by Ms Thiện Tâm Lương). Date: 22 March 1961. PC0764781, PC0764782, PC0764786.

The majority of species were already known from Vietnam, part of them having been published by Tixier. The results of the identifications are presented in Table 1. Names of species new to Vietnam are marked by asterisk. Taxa new to the country or previously known only from 1–2 localities, are enumerated, annotated and illustrated.

Table 1

Enumeration of the identified species according to their presence at the different localities.

Species/Locality	BT	DP	BL	FE	DL	CB
Number of species	18	8	11	7	19	14
ANTHOCEROTOPHYTA						
**Dendroceros subplanus* Steph.	–	–	–	–	–	+
MARCHANTIOPHYTA						
**Ceratolejeunea singapurensis* (Lindenb.) Schiffn.	–	–	–	–	–	+
**Cheilolejeunea rigidula* (Mont.) R. M. Schust.	–	–	–	+		–
Cheilolejeunea trapezia (Nees) R. M. Schust. et Kachroo	–	–	–	–	+	–
**Cololejeunea angulata* Steph.	–	–	+	+	+	–
Cololejeunea appressa (A. Evans) Benedix	–	–	+	–	–	–
Cololejeunea floccosa (Lehm. et Lindenb.) Steph.	+	–	+	+	+	–
Cololejeunea floccosa var. *amoena* (Benedix) Pócs	–	–	+	+	+	–
Cololejeunea haskarliana (Lehm. et Lindenb.) Schiffn.	–	+	–	–	+	–
Cololejeunea inflata Steph.	+	–	–	–	–	–
Cololejeunea lanciloba Steph.	+	–	–	–	–	–
Cololejeunea latilobula (Herzog) Tixier	–	+	–	–	–	–
Cololejeunea obliqua (Nees et Mont.) Schiffn.	+	+	–	–	–	+
Cololejeunea planissima (Mitt.) Abeyw.	–	–	+	–	–	–
Cololejeunea platyneura (Spruce) A.Evans	–	–	–	–	–	+
Cololejeunea pseudoserrata Tixier	+	–	–	–	–	–

Table 1 (continued)

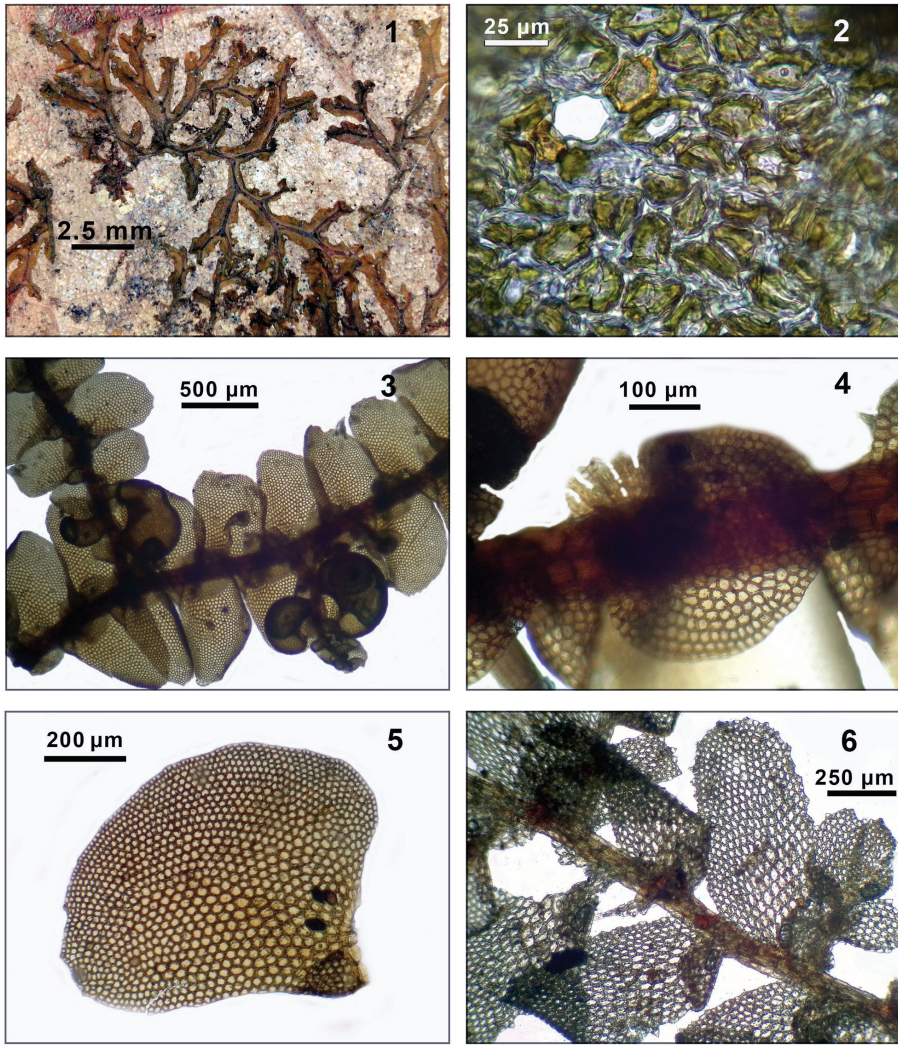
Species/Locality	BT	DP	BL	FE	DL	CB
Cololejeunea serrata (Steph.) Benedix	–	–	+	–	+	–
Cololejeunea sigmoidea Ast et Tixier	+	–	–	+	–	–
**Cololejeunea stephanii* Schiffn. ex Benedix	–	–	–	–	+	–
Cololejeunea tenella Benedix	+	–	–	–	–	–
Colura apiculata (Schiffn.) Steph. (Syn.: *C. leratii* Steph.)	–	–	+	–	–	–
Colura conica (Sande Lac.) K. I. Goebel	–	–	–	+	–	–
Colura corniantha Grolle (Syn.: *C.cornuta* Ast)	–	–	–	–	+	–
Drepanolejeunea commutata Grolle et R. L. Zhu	+	–	–	–	–	–
Drepanolejeunea erecta (Steph.) Mizut.	+	–	–	–	–	–
Drepanolejeunea levicornua Steph.	+	–	–	–	–	+
Drepanolejeunea pentadactyla (Mont.) Steph.	+	–	–	–	–	–
Drepanolejeunea spicata (Steph.) Grolle et R. L. Zhu	–	–	–	–	+	–
Drepanolejeunea vesiculosa (Mitt.) Steph.	–	–	–	–	+	–
Lejeunea apiculata Sande-Lac.	+	–	–	–	+	–
Lejeunea flava (Sw.) Nees subsp. *flava*	–	–	+	–	+	+
Lejeunea micholitzii Mizut.	–	+	–	–	–	+
Lejeunea sp. ster.	+	+	–	–	+	+
Leptolejeunea dapitana Steph.	–	–	–	–	+	–
Leptolejeunea maculata (Mitt.) Schiffn.	–	+	+	+	+	+
Leptolejeunea vitrea (Nees) Schiffn.	–	–	+	–	+	+
Metzgeria furcata (L.) Corda	+	–	–	–	–	–
Microlejeunea punctiformis (Taylor) Steph.	–	–	–	–	+	+
Radula acuminata Steph.	+	+	+	+	–	–
Radula tjibodensis K. I. Goebel	–	–	–	+	+	+
**Thysananthus aculeatus* Herzog	–	–	–	–	–	+
BRYOPHYTA						
Ephemeropsis tjibodensis K. I. Goebel	+	+	–	–	–	–
Floribundaria floribunda (Dozy et Molk.) Fleisch.	+	–	–	–	–	+
Trachypodopsis serrulata (P. Beauv.) M. Fleisch.	–	–	+	–	–	–

Names of species new to Vietnam are marked by asterisk (*); BT = Benom da Treu; DP = Da Pampei; BL = Bảo Lộc; FE = Forêt ENAES; DL = Đại Lào; CB = Đèo Chuối

Taxa new to the flora of Vietnam

Anthocerotopsida

Dendroceros subplanus Steph., Sitzungsb. Naturf. Ges. Leipzig 36: 20 (1909) (Figs 1–2) – CB (PC0764784, PC0864785) – The plant is well described



Figs 1–6. 1–2 = Dendroceros subplanus Steph., 1: Habit, on the leaf surface; 2: Lamina cells with small pori near the margin, ventral view. From PC0764784. *3–5 = Ceratolejeunea singapurensis* (Lindenb.) Schiffn., 3: Habit, with utricles; 4: Stem with underleaf; 5: Leaf with ocelli. Ventral views. From PC0764789. *6 = Leptolejeunea vitrea* (Nees) Schiffn., habit, ventral view, from PC0764781

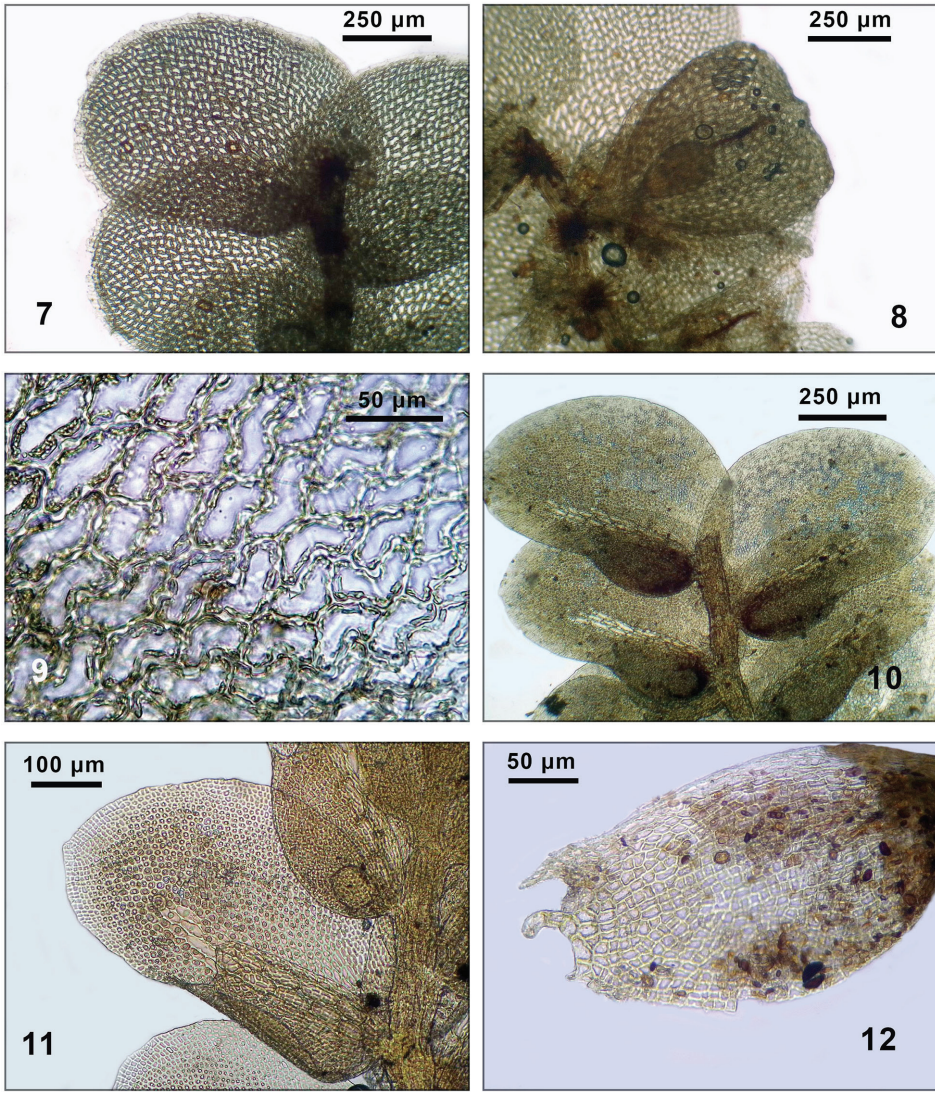
and illustrated by Hasegawa (1980), Piippo (1993) and Chantanaorrapint (2014). It can be characterised by its solid costa without schizogenous cavities, by its narrow, flat, strap shaped lamina with small perforations and nearly entire margin. The spinulous spore ornamentation could not be seen, as the Vietnam specimens are sterile. Piippo (1993) contrasted the species against the related *Dendroceros javanicus* (Nees) Gottsche *et al.*, and showed that the latter has wider, more lobed thalli with much more and larger perforations, which are well illustrated by Hasegawa (1993, fig. 5) and seen also in our macrophoto (Pócs and Kovács 2023, fig. 5). – It is known from Java, Sumatra, Thailand and Papua New Guinea (Chantanaorrapint 2014). From the 10 known hornwort genera, 4 were represented in the flora of Vietnam (Shu *et al.* 2017). The genus *Dendroceros* is new to Vietnam!

Marchantiopsida

Ceratolejeunea singapurensis (Lindenb.) Schiffn., Consp. Hepat. Archip. Indici 273 (1898) (Figs 3–5) – CB (PC0764784, PC0764785, PC0764789) – This seemingly rare species is related to *Ceratolejeunea cornuta* (Lindenb.) Schiffn. and *C. belangeriana* (Gottsche) Steph., but differs from them by its slightly falcate, oblong leaves with rounded apex, orbicular or longer than wide underleaves much smaller than leaf lobes and not exceeding the distal end of lobules. and by the shorter perianth horns. According to Mizutani (1981) the lack of utricles is also a differentiating character, but he had seen only the type from Singapore and the Vietnamese and Indian specimens have utricles. Piippo *et al.* (2002) suggested that the species maybe only an extreme form of *C. oceanica* (= *C. belangeriana*). This is possible, but needs molecular proof. Bonner (1953), Mizutani (1981), Udar and Shaheen (1985) and Sarimi *et al.* (2021) supplied illustrations of the species, but these do not agree in all aspects. – The species has been recorded from Singapore, the Western Ghats in India (Udar and Shaheen 1985) and quite recently from Peninsular Malaysia: Terengganu (Pesiu *et al.* 2021, Sarimi *et al.* 2021). The genus and species are new to the bryoflora of Vietnam.

Cheilolejeunea rigidula (Nees ex Mont.) R. M. Schust., Castanea 36(2):102 (1971) – CB (PC0764776) – Also being known under its synonym name *Cheilolejeunea serpentina* (Mitt.) Mizut., this is a widespread pantropical species. Earlier it was not well distinguished from the related *C. intertexta* (Lindenb.) Steph. (Grolle 1979) and probably this may be the reason why it was not observed by Tixier and lacked in earlier checklists from Vietnam. *Cheilolejeunea rigidula* is easily distinguished from its relatives by its rather rigid stature, by the lejeuneoid subgynoecial innovations and by the large trigones of the lobe cell walls.

Cololejeunea angulata (Steph.) Mizut., J. Hattori Bot. Lab. 28: 108 (1965) (Figs 7–9) – BL (PC0764777); FE (PC0764775, PC0764776, PC0764780); DL (PC0764781) – A very characteristic species due to its leaf lobes with *Allorgella*-type hyaline margin and sinuous cell walls with nodulose intermediate thickenings (similar to those of some *Frullania* and *Racomitrium* species)



Figs 7–9. Cololejeunea angulata (Steph.) Mizut., 7: Habit; 8: Gynoecium with perianth; 9: Median lobe cells. All ventral view. From PC0764775. – *Figs 10–12. Cololejeunea stephanii* Schiffn. ex Benedix, 10: Habit; 11: Leaf; 12: Lobule, all ventral view. From PC0764781

and smooth cuticle. The lobule has one erect tooth. The characteristic features are well illustrated by Mizutani (1965: 108 figs 8–13) and by Pócs and Piippo (2011: 110, fig. 17). – The species is known from Peninsular Malaysia, Borneo, Philippines and Papua New Guinea; new to Vietnam.

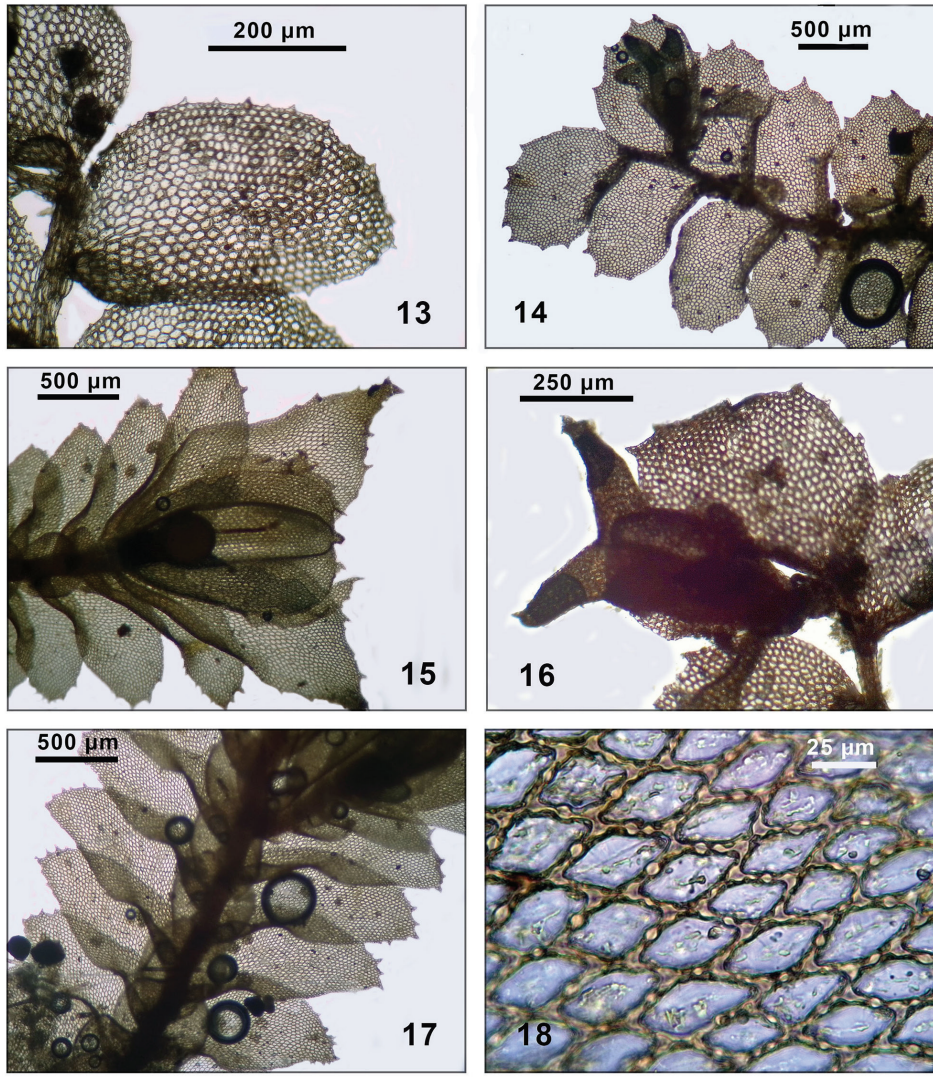


Fig. 13. Cololejeunea pseudoserrata Tixier, leaf, ventral view. From PC0764770. – *Figs 14, 16. Colura corniantha* Grolle, 14: Habit, dorsal view; 16: Gynoecium with perianth, ventral view. – *Figs 15, 17–18. Thysananthus aculeatus* Herzog, 15: Gynoecium with perianth, ventral view; 16: Habit; 17: Median lobe cells. All ventral views, from PC0764784

Cololejeunea stephanii Schiffn. ex Benedix, Beih. Feddes Repert. 134: 40 (1953) (Figs 10–12) – DL (PC0764781, PC0764782, PC0764786) – A relatively large, to the host leaves tightly adherent species, forming 1–2 cm wide, roundish colonies. Easy to recognise by its broad, shiny margin of hyaline cells combined with a large vitta and papillose lobe cells. The differences from the related, widespread Vietnamese endemic *C. pseudostephanii* Tixier are indicated in detail by Zhu (1995) and by Pócs *et al.* (2013). In this collection the hyaline cells of the margin are weakly differentiated, similarly to those of Hainan (Zhu 1995). This fact raises the question whether *C. pseudostephanii* Tixier can be separated at the species level or is it only an infraspecific taxon within *C. stephanii*. – Widespread in the Malesian Archipelago (including the south Chinese Hainan Island and Peninsular Malaysia) from Sumatra to Borneo, the Philippines and New Guinea (Benedix 1953, Zhu and So 2001).

Thysananthus aculeatus Herzog, Ann. Bryol. 4: 89 (1931) (Figs 15 and 17–18). – CB (PC0764784, PC0764785) – The species forms a dark brown, irregularly branched network on the host leaves. It is easy to distinguish from the related and more frequent *Thysananthus spathulistipus* by its truncate lobule and hollow underleaves (Wang *et al.* 2016), and also the much larger appendages on the perianth margin with aculeate teeth, and much more sharply dentate perichaetial leaves. – It is known only from southern Japan, China (Hainan, Taiwan) and Malaysia (Sabah); new to Indochina and Vietnam (Sukkharak 2014, Wang *et al.* 2016).

Taxa rare in Vietnam, recorded only from one locality until now

Cololejeunea pseudoserrata Tixier, Nova Hedwigia 31: 770 (1979) (Fig. 13) – BT (PC0764770, PC0764771) – A species from the sect. *Salebrosae* Benedix of subgenus *Leptocolea* (Spruce) Schiffn., characterised by its remotely spinulose margin and uniseriate ventral merophyte. – It was recorded and illustrated from northern Vietnam: Ha Giang Mts by Pócs (2023*a*: 5–6, figs 1 E, F). Distributed in New Guinea, Solomon Islands, New Caledonia and Fiji (Pócs and Piippo 2011). Probably more widespread and unrecognised.

Colura corniantha Grolle, J. Hattori Bot. Lab. 28: 44 (1965) (Figs 14 and 16) (Syn.: *Colura cornuta* Jov.-Ast, *nom. inval.*) – DL (PC0764786) – The specimen originates from the type locality and corresponds in all details to the protologue, including the tricornute perianths with dentate horn apices. The specimen might therefore be a duplicate of the type. – The species seems to be a strict Vietnamese endemic, related to *Colura siamensis* Jov.-Ast (Jovet-Ast 1967).

Leptolejeunea vitrea (Nees) Schiffn., Hepat. (Engl.-Prantl): 126 (1893) (Fig. 6) – BL (PC076477); DL (PC0764781, PC0764782); CB (PC0764784, PC0764789) – A very characteristic species with large, parallel-sided lobes with an obtuse apex, and with dentate underleaves. – Jovet-Ast and Tixier (1962) published it only from Bảo Lộc. A widely distributed Malesian species known from Sumatra to Papua New Guinea (Herzog 1942, Pócs *et al.* 2019).

DISCUSSION

As the above data suggest, the unidentified epiphyllous materials of Pierre Tixier from Vietnam may contain numerous liverwort species new to the country, possibly more than 10% of the species recorded. Many species were already published by Tixier himself, or by Mme S. Jovet-Ast, but only from one or very few localities. As can be seen from the example of *Colura corniantha*, Tixier had already started to deal with this material and had selected a few specimens for identification. I would like to continue this work as long as my health conditions permit. The material will be very useful in future for our knowledge of the flora and vegetation of the tropics, before its destruction.

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