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New records for the liverwort and hornwort
flora of Vietnam 2. *Bazzania* Gray
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in the National Museum of Natural History, France

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COUVERTURE / *COVER*:

Vue ventrale de *Bazzania revoluta* (Steph.) N.Kitag (*Tixier 402*) / Ventral view of *Bazzania revoluta* (Steph.) N.Kitag (*Tixier 402*).

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New records for the liverwort and hornwort flora of Vietnam 2. *Bazzania* Gray and some other collections of Pierre Tixier in the National Museum of Natural History, France

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ABSTRACT

As a large part of the bryophyte collection of the late Pierre Tixier (1918-1997), deposited in the Cryptogamic Herbarium of the Muséum national d'Histoire naturelle, Paris (PC), was unidentified, the Author has started to study the rich collection of *Bazzania* Gray species as well as some other taxa. They were not identified by Tixier, because during his lifetime the genus had not been revised yet. Long ago, the Author himself recorded nine species from northern Vietnam, and a couple of studies were published on Vietnam and neighbouring areas. Today, by identifying Tixier's collection, the number of *Bazzania* species known in Vietnam has been increased to 28.

RÉSUMÉ

Nouveaux signalements pour la flore hépatique et anthocérotes du Vietnam 2. Bazzania Gray et quelques autres collections de Pierre Tixier au Muséum national d'Histoire naturelle, France.

Une grande partie de la collection de bryophytes de feu Pierre Tixier (1918-1997), déposée à l'Herbier cryptogamique du Muséum national d'Histoire naturelle, Paris (PC), n'étant pas identifiée, l'Auteur a commencé à étudier la riche collection d'espèces de *Bazzania* Gray avec quelques autres taxons. Elles n'ont pas été identifiées par Tixier, car de son vivant, le genre n'avait pas encore été révisé. Il y a longtemps, l'Auteur a lui-même enregistré neuf espèces du nord du Vietnam, et quelques études ont été publiées sur le Vietnam et les régions avoisinantes. Aujourd'hui, en identifiant la collection Tixier, le nombre d'espèces de *Bazzania* connues du Vietnam est passé à 28.

KEY WORDS

Indomalaya,
Sino-Himalaya,
endemism,
Lepidoziaceae,
new records.

MOTS CLÉS

Indomalaya,
Sino-Himalaya,
endémisme,
Lepidoziaceae,
signalements nouveaux.

INTRODUCTION

Pierre Paul Marie Tixier (1918-1997) was born in Bretagne, grown up partly in France, partly in Vietnam and in Madagascar (biographic data taken from Jovet-Ast & Lamy 1999). He took part in rubber research in Vietnam and by 1944 obtained diploma of Tropical Agriculture in Paris. He was teacher in secondary schools in Vientiane (Laos), and in Dalat (Vietnam). Later he became specialist of Indochinese orchids and, encouraged by Prof. Roger Heim – leader of the Cryptogam Laboratory of French National Museum of Natural History –, started to investigate the bryophytes of Indochina by 1957. He became a correspondent of the Museum and collected large amount of specimens all over southern Vietnam, in all countries of Indochina, and from the Philippines and Peninsular Malaysia. In 1966 he was appointed professor at Phnom Penh University, which he had to leave in 1972. He, apart from his early agricultural papers, published a PhD dissertation on epiphyte ecology and many floristic and taxonomic works, mostly on the cololejeuneoid liverworts of Asia, including a book (Tixier 1985). All his specimens, identified or unidentified, are deposited in the Paris Natural History Museum (PC). He did not deal in details with the collected Lepidoziaceae material due to their unrevised state at the time. Among the Tixier collections deposited in PC, were 46 specimens of *Bazzania* Gray, collected mostly in southern Vietnam between 1957 and 1965. Some of them were accompanied by other intermixed species or by taxa, which in the field looked like *Bazzania*.

The Author (Pócs 1969) recorded nine species of *Bazzania* from northern Vietnam. In the checklist of Bakalin & Nguyen (2016), 12 species were published from the whole country while in the enumeration of Shu *et al.* (2017) already 18 species were recorded, including their own new data. Bakalin *et al.* (2018) added two species, and Pócs *et al.* (2019) added one species to the Vietnam records. In the present study from 46 specimens of *Bazzania*, 15 species were identified, including seven taxa, *Bazzania adnexa* (Lehm. & Lindenb.) Trevis., *B. aff. friabilis* N.Kitag. & T.Kodama, *B. indica* (Gottsche & Lindenb.) Trevis., *B. loricata* (Reinw., Blume & Nees) Trevis., *B. pectinata* (Lindenb. & Gottsche) Schiffn., *B. sikkimensis* (Steph.) Herzog, and *B. spiralis* (Reinw., Blume & Nees) Meijer, that proved to be new for the bryoflora of Vietnam. With these, the number of *Bazzania* species known from Vietnam is raised to 28. Among other genera, *Acrolejeunea tjibodensis* (Verd.) Grolle & Gradstein, *Colura cylindrica* Herzog and *Lepidozia quadridens* (Nees) Gottsche *et al.* were not recorded yet from here. It seems that Tixier's collection from the southern half of Vietnam contains Indomalayan species in majority, while in northern Vietnam the Southeast Asian and Sino-Himalayan species predominate.

MATERIAL AND METHODS

There is still no modern taxonomic revision on the Asian *Bazzania* species, although the molecular investigation and

reclassification of the Lepidoziaceae family is in progress (Cooper *et al.* 2011, 2012; Cooper 2013). While the genus itself is easily recognizable, the delimitation of species is often difficult, due to their ecological plasticity and because the species concept is in many cases arbitrary, as it was stated by many authors since Spruce (1885). At the same time, as sexual reproduction is rare, many species are endemic in a certain continent or smaller area (Gradstein 2017) and only a small proportion has intercontinental distribution. The infrageneric classification of the genus into morphological groups, provided by Stephani (1907), was considered by himself to be artificial and was only used for practical purposes to distinguish the related species. Later, partly on this morphological base, Fulford (1946, 1963) established a more natural and nomenclaturally acceptable subdivision of two subgenera: *Bidentatae* with one section and *Tridentatae* with five sections: *Grandistipulae*, *Appendiculatae*, *Fissistipulae*, *Connatae* and *Vittatae*. According to Schuster (2000), the two subgenera were not tenable and he reduced subgenus *Bidentatae* to a sixth section, to which later Engel (2006, 2007) added sections *Exemptae*, *Protobazzania* and *Glaucobazzania*. The present Author, in the possession of old and recent area revisions (Evans 1933; Hattori & Mizutani 1958; Kitagawa 1967, 1978, 1979; Mizutani 1967; Pócs 1969; del Rosario 1977; Engel & Glenny 2008; Zhou *et al.* 2012; Cheah & Yong 2016; Khotimperwati *et al.* 2018; Siregar *et al.* 2018; Meagher 2019; Schwarz *et al.* 2023) tried to identify this material and has found 15 species of *Bazzania* and 13 other liverwort species, of which 7 taxa of *Bazzania* and 3 other species proved to be new for the Vietnamese flora.

RESULTS

Asterisks indicate new species recorded for the flora of Vietnam. Names of provinces and other geographic units, substrate and elevation in metres follow the label data given by Tixier. After the collection number, the inventory number of the cryptogam plant collection of the French National Museum of Natural History (PC) is given. Illustration references (other than Stephani's Icones) of the species are given at the end of annotations.

ANNOTATED LIST OF *BAZZANIA* SPECIES

Family LEPIDOZIACEAE Limpr.
Genus *Bazzania* Gray

**Bazzania adnexa* (Lehm. & Lindenb.) Trevis.
(Fig. 1A, B)

SPECIMEN EXAMINED. — Vietnam. Lâm Đồng, Dalao, sur bois en forêt, 900 m, Tixier 5256 (PC[PC0764718]).

ILLUSTRATIONS. — Engel & Glenny 2008: 423, fig. 94 and 426, fig. 95; Zhou *et al.* 2012: 12, fig. 2; Meagher 2019: 315, fig. 2.

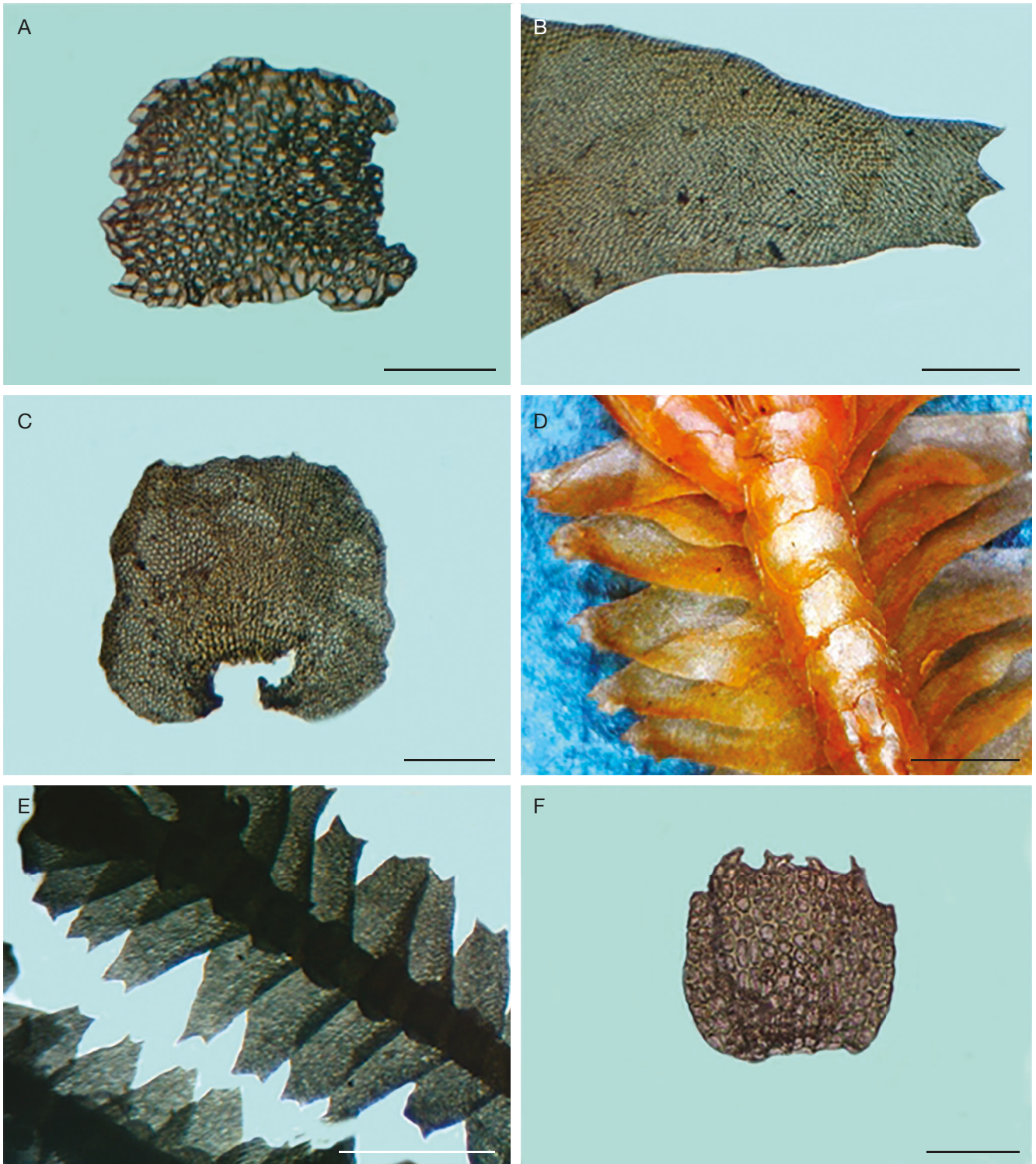


FIG. 1. — *Bazzania adnexa* (Lehm. & Lindenb.) Trevis.: **A**, underleaf; **B**, leaf distal half (Tixier 5256). *Bazzania asymmetrica* (Steph.) N.Kitag.: **C**, underleaf; **D**, habit, ventral view (Tixier s.n., PC0764741). *Bazzania bidentula* (Steph.) Steph. ex Yamada: **E**, habit, dorsal view; **F**, habit, ventral view (Tixier s.n., PC0764741). Scale bars: A, 125 µm; B, C, F, 250 µm; D, E, 500 µm.

NOTES

It occurs in south China and Thailand and widespread from Australia through Melanesia to the Society Islands (Miller *et al.* 1983; Zhou *et al.* 2012). New to Vietnam. It is a very

variable taxon with underleaves connate on both sides with the side leaves. *Bazzania adnexa* closely related to and vicariant of the African *Bazzania decrescens* (Lehm. & Lindenb.) Trevis. Their relationship should be clarified by molecular methods.

Bazzania asymmetrica (Steph.) N.Kitag.
(Fig. 1C, D)

SPECIMEN EXAMINED. — **Thailand**. Pitsanulok, Phu Nieng, sur tronc en forêt de montagne, 1300 m, *Tixier 1145* (PC[PC0764743]).

ILLUSTRATIONS. — Kitagawa 1979: 79, fig. 4; Zhou *et al.* 2012: 18, fig. 7.

NOTES

The species is characterized by its elongate side leaves tapering much to the trilobate apex. Its underleaf sinuate without hyaline cells and with auriculate base. Bakalin & Nguyen (2016) enumerates it from Vietnam, erroneously referring to Pócs (1971), where it is not mentioned and till now unknown from the country. *Bazzania asymmetrica* is a rare species with scattered distribution in New Guinea, Borneo and southern China and is new to Thailand (Lai *et al.* 2008).

**Bazzania aff. friabilis* N.Kitag. & Kodama
(Fig. 2A-D)

SPECIMEN EXAMINED. — **Vietnam**. Lâm Đồng, Dalat, Manline, sur bois en forêt Claire d'Ericacées, 1300 m, *Tixier 276* (PC[PC0764723]).

NOTES

Accompanied by *Bazzania tridens* (Reinw., Blume & Nees) Trevis., *B. tridens* var. *tridens*, *Frullania obscura* (Sw.) Mont. and *Plicanthus birmensis* (Steph.) R.M.Schust. A species maybe new to science, what needs confirmation. It has similarity by its always bidentate, caducous leaves with papillose cuticle to *B. friabilis* from Sabah (Kitagawa & Kodama 1975: 68, fig. 1) also found in peninsular Malaysia (Cheah & Yong 2016). But the leaves of Tixier's plant are more oval with margins less crenulate and the trigones of cell walls, although have midline, are much less bulging. Finally, the underleaves possess larger teeth, they are more lobate, almost star shaped.

**Bazzania indica* (Gottsche & Lindenb.) Trevis.
(Fig. 2E, F)

SPECIMENS EXAMINED. — **Vietnam**. Tuyên Duc (now Lâm Đồng), Manline, sur bois au sol, ravin n°6, 1300 m, *Tixier 185* (PC[PC0764738]); Tuyên Duc, Teurnom, fond de ravin sur bois au sol en forêt, 1300 m, *Tixier 417* (PC[PC07647747]).

NOTES

Identifiable by its densely imbricate, broad ovate leaves with shortly tridentate apex and serrulate margins. The underleaves reflexed, without hyaline border, variable in width. A Malesian species widespread in Indonesia and Thailand but with no occurrence in India (Kitagawa 1967; Siregar *et al.* 2018). New to Vietnam.

ILLUSTRATION. — del Rosario 1977: 150, fig. 61.

Bazzania japonica (Sande Lac.) Lindb.

SPECIMEN EXAMINED. — **Vietnam**. Lâm Đồng, piste de Dalao, sur bois en forêt dense, 900 m, together with *Denotarisia linguifolia* (De Not.) Grolle, *Tixier 403* (PC[PC0764733]).

ILLUSTRATIONS. — Hattori & Mizutani 1958: 98, fig. VI: 21-36; Pócs 1969: 84-85, figs III-IV: 19-20; Zhou *et al.* 2012: 31, fig. 18; Khotimperwati *et al.* 2018: 880, fig. 4.

NOTES

This species distinguished by its subquadrate, acutely dentate underleaves twice as wide as the stem, connate with the subopposite side leaves. It has Southeast Asian distribution, widespread from Japan and China, Vietnam, Thailand to Sumatra.

**Bazzania loricata* (Reinw., Blume & Nees) Trevis.
(Fig. 3A, B)

SPECIMEN EXAMINED. — **Vietnam**. Lâm Đồng, Dalao, épiphyte sur bois au sol, 900 m, *Tixier 260* (PC[PC0764729, PC0764730]).

ILLUSTRATION. — Meagher 2019: 343, fig. 23.

NOTES

Shoots 2-3 mm wide, leaves densely imbricate, broadly ovate, almost entire (Stephani's *Integrifolia* group), margins denticulate, at apical part with more projecting cells. Underleaves semicircular, wider than long, with 1-3 rows of hyaline margin. Malesian-Melanesian species, distribution known from Thailand and the Philippines through Indonesia and Australia to New Caledonia and the Solomon Islands. New to Vietnam.

**Bazzania pectinata* (Lindenb. & Gottsche) Schiffn.
(Fig. 3C, D)

SPECIMEN EXAMINED. — **Vietnam**. Lâm Đồng, Dalat, Manline, épiphyte en forêt dense, 1500 m, *Tixier 279* (PC[PC0764751]).

ILLUSTRATIONS. — Evans 1933: pl. XIV: 12-19; Khotimperwati *et al.* 2018: 883, fig. 6.

NOTES

Shoots 2-3 mm wide, leaves imbricate, linear-subfalcate lanceolate with tridentate apex and entire margin, length-width ratio more than 2.5. Underleaves distant to contiguous, quadrate, scarcely wider than the stem, in their middle appressed to it and do not have hyaline margin. Distribution: Malesian, widely distributed from Sumatra to Thailand, Luzon and Ambon (Kitagawa 1967; Khotimperwati *et al.* 2018). New to Vietnam.

Bazzania praerupta (Reinw., Blume & Nees) Trevis.
(Figs 3E, F; 6A, B)

SPECIMENS EXAMINED. — **Vietnam**. Tuyên Duc (now Lâm Đồng), Mts Lang Bian, sur écorce d'Ericacées, 1900 m, *Tixier 277* and

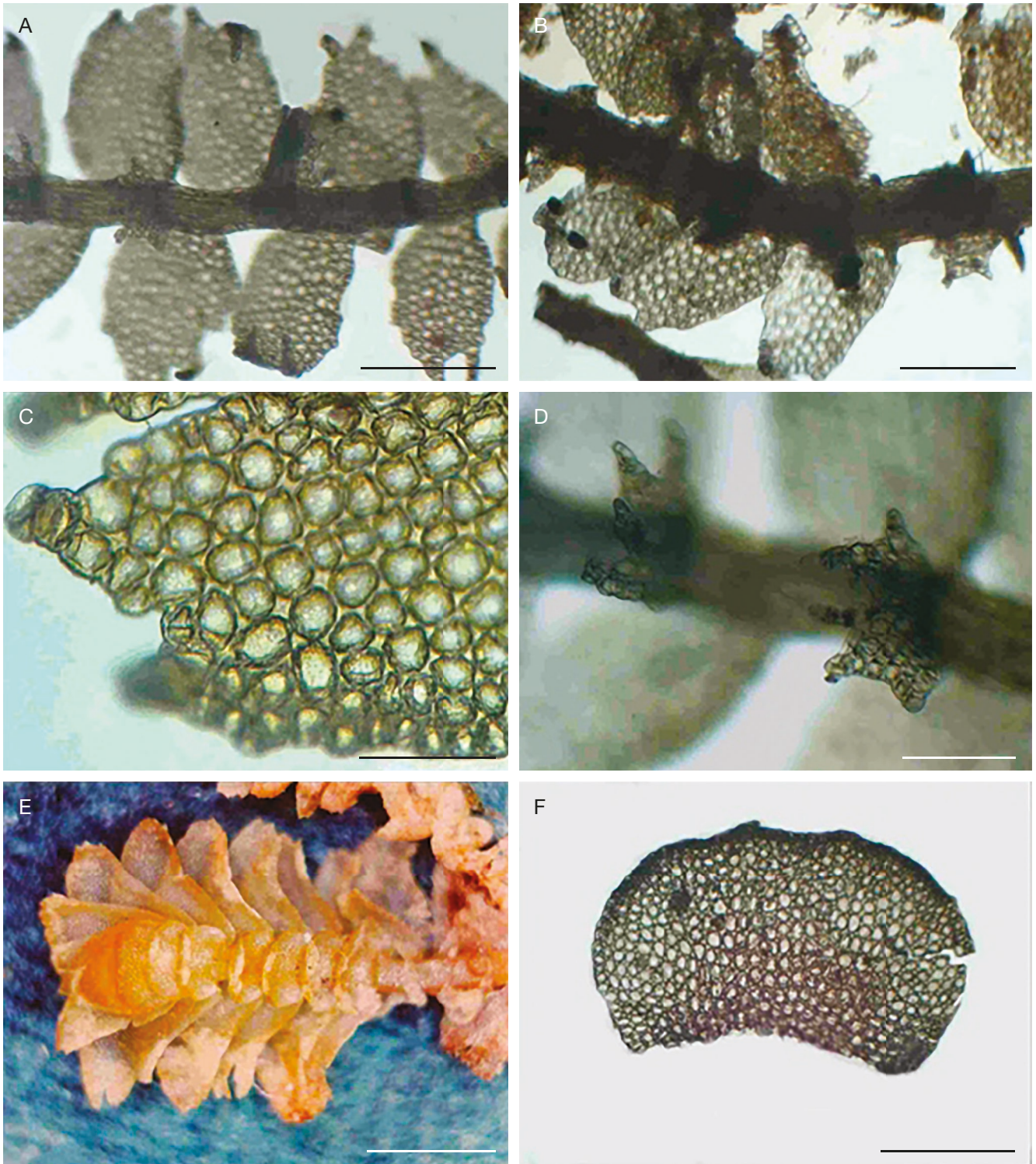


FIG. 2. *Bazzania friabilis* N.Kitag. & Kodama: **A**, habit, ventral view; **B**, shoot with caducous leaves; **C**, leaf apex; **D**, underleaves (*Tixier s.n.*, PC0764741). *Bazzania* cf. *indica* (Gottsche & Lindenb.) Trevis.: **E**, habit, ventral view; **F**, underleaf (*Tixier 185*). Scale bars: A, B, F, 200 μ m; C, 50 μ m; D, 100 μ m; E, 1 mm.

409 (PC[PC0764756, PC0764745]); Centre Vietnam, Nha Trang, corticole à 1000 m, 19.V.1922, *Poilane 3436* (PC[PC0764744]).

ILLUSTRATIONS. — Hattori & Mizutani 1958: 98, figs 1-20 (under *B. yakushimensis* Horik.); Pócs 1969: 84-85, figs III-IV: 14-16; Sharma & Srivastava 1993: 49-50; Zhou *et al.* 2012: 40, fig. 25; Khotimperwati *et al.* 2018: 883, fig. 8.

NOTES

Shoot 2-3 mm wide, in dry state more or less convolute. Leaves densely imbricate, broad triangular ovate, with tridentate to irregularly dentate apex. Underleaves orbicular or emarginate with auriculate base, without hyaline margin. Widespread Palaeotropical or Pantropical species (Gradstein 2017).

Bazzania recurva (Mont.) Trevis.
(Figs 4A, B; 6C, D)

SPECIMENS EXAMINED. — Vietnam. Lâm Đồng, Bao Loc, sur souche en forêt secondaire, 700 m, *Tixier 415* (PC[PC0764737]); Lâm Đồng, piste de Dalao, sur bois au sol en forêt, 900 m, *Tixier 410* (PC[PC0764739, PC0764739]).

ILLUSTRATION. — Piippo *et al.* 2002: 110, fig. 4.

NOTES

Bazzania recurva is a very characteristic species with its densely imbricate, triangularly suborbicular, entire leaves, finely and evenly denticulate at margin and slightly recurved, somewhat cucullate at apex. Underleaves densely imbricate, strongly concave in centre with reflexed margin, more or less auriculate at base, in situ U shaped, flattened semicircular-reniform, wider than long. Distributed in tropical Southeast Asia (Kitagawa 1979), also known from Vietnam (Jovet-Ast & Tixier 1958) and nearest in Thailand (Lai *et al.* 2008) and in Malaysia Chuah-Petiot (2011).

Bazzania revoluta (Steph.) N.Kitag.
(Figs 4C, D; 6E, F)

SPECIMENS EXAMINED. — Vietnam. Lâm Đồng, Dalat, Manline, épiphyte en forêt dense, 1300 m, *Tixier 274* (PC[PC0764725]); sur tronc en forêt d'Éricacées, 1400 m, *Tixier 401* (PC[PC0764748]); Tuyên Duc, Mts Lang Bian, sur tronc en forêt, 1850 m, *Tixier 402* (PC[PC0764753]).

ILLUSTRATIONS. — Under the synonym name of *Bazzania recurvolumbata* (Steph.) N.Kitag. in Kitagawa 1967: 266, fig. 6; Pócs 1969: 84-85, figs III-IV; and Zhou *et al.* 2012: 42, fig. 26.

NOTES

Shoot robust, 2-4 mm wide in wet state, 1-2 mm and convolute, when dry. The side leaves triangular-ovate, almost entire, very shortly tridentate or subentire at apex. The unic character of the species is that the hyaline margin of orbicular, often auriculate underleaves is strongly recurved, sometimes even saccate. Occurs from southern China to northern and central Thailand, in the whole Vietnam and in Sumatra (Zhou *et al.* 2012).

**Bazzania sikkimensis* (Steph.) Herzog
(Fig. 1E, F)

SPECIMEN EXAMINED. — “Benom da Treu” was the only locality indication on the envelope (PC[PC0464741]).

ILLUSTRATIONS. — Sharma & Srivastava 1993: 42-43; Zhou *et al.* 2012: 44.

NOTES

Benom da Treu is a mountain summit in southern Vietnam, approaching 1800 m altitude, covered mostly by pine forests. It lies north of Da Lat town in Lâm Đồng province. *Bazzania sikkimensis* has small, contiguous, ovate triangular, bilobate side

leaves with finely punctate cuticle. The underleaves distant, truncate orbicular with sinuously dentate apex, composed only of chlorophyllose cells. It differs from *B. bidentula* by its leaf and underleaf cells, which are only 18-25 µm in size, while in *B. bidentunla* they are 30 µm (Schwarz *et al.* 2023). It differs from the related *Bazzania mayebarae* by its underleaves consisting of only chlorophyllose cells. In this fragmentary specimen the underleaves are not reflexed, as used to be mostly by this species. It has Sino-Himalayan distribution, known also from India, Nepal, Bhutan, southern China, Philippines and Thailand (Sharma & Srivastava 1993; Zhou *et al.* 2012). New to Vietnam.

**Bazzania spiralis* (Reinw., Blume & Nees) Meijer
(Fig. 4E, F)

SPECIMENS EXAMINED. — Vietnam. Lâm Đồng, Bao Lộc, au sol en forêt de marais sur bois (E.N.A.E.S.), 700 m, *Tixier 418* (PC[PC0764750]); Lâm Đồng, piste de Dalao, sur tronc en forêt à 2 m, 900 m, *Tixier 411* (PC[PC0764752]); Thua Thien, Bach Ma, au sol sur talus, 1400 m, *s.n.* (PC[PC0764758]).

ILLUSTRATIONS. — Kitagawa 1967: 255, fig. 2; Khotimperwati *et al.* 2018: 885, fig. 10.

NOTES

Species distinguished from the other taxa with triangular-oblong leaves by its serrulate margin with larger teeth towards leaf apex and by the distant, reflexed semicircular underleaves convex near insertion, with hyaline margin (Kitagawa 1967).

Bazzania tridens (Reinw., Blume & Nees) Trevis.

NOTES

The most widespread species of Vietnam and of the whole Southeast Asia (Khotimperwati *et al.* 2018). The side leaves are elongate-ovate with tridentate apex. The most important character is the underleaf, consisting only of hyaline cells, except for a few green basal cell rows. According to their shape four varieties are distinguished. These have been described originally, as separate species, but they are interconnected with many transitional forms (Pócs 1969).

Bazzania tridens var. *tridens*

SPECIMENS EXAMINED. — Vietnam. Lâm Đồng, Bao Lộc, au sol, en forêt, confluent de la Dargna, 600 m, 26.I.1963, *s.n.* (PC[PC0764728]); Bao Lộc, E.N.A.E.S., épiphyte en forêt, 700 m, 14.X.1960, *s.n.* (PC[PC0764727]); Lâm Đồng, col du Da Troun, sur bois au sol en forêt, 1000 m, 19.I.1961, *s.n.* (PC[PC0764722]); Lâm Đồng, Da Lao, épiphyte en forêt, 900 m, *Tixier 288* (PC[PC0764721]); épiphyte sur bois au sol, 900 m, *Tixier 289* (PC[PC0764759]); Lâm Đồng, Mt. Lang Bian, épiphyte en forêt dense, 1900 m, *Tixier 278* (PC[PC0764724]); Lâm Đồng, Benom da Treu, sur touffe de *Paphiopedilum villosum*, 9.XII.1957, *s.n.* (PC[PC0764749]).

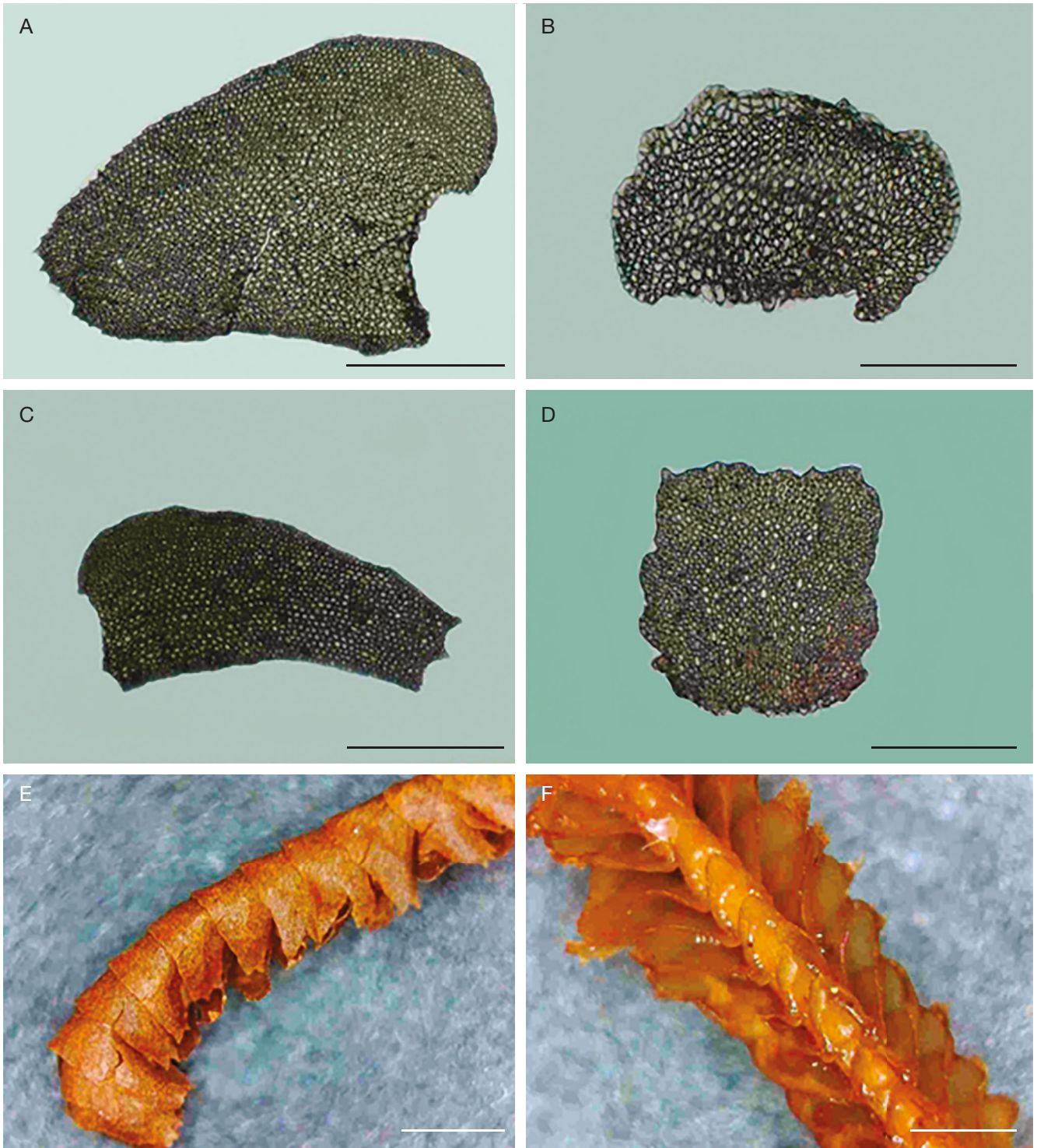


FIG. 3. — *Bazzania loricata* (Reinw., Blume & Nees) Trevis.: **A**, leaf; **B**, underleaf. *Bazzania pectinata* (Lindenb. & Gottsche) Trevis.: **C**, leaf; **D**, underleaf. *Bazzania praerupta* (Reinw., Blume & Nees) Trevis.: **E**, dry shoot, side view; **F**, wet shoot, ventral view. Scale bars: A, C, 500 μ m; B, D, 250 μ m; E, F, 1 mm.

ILLUSTRATIONS. — Pócs 1969: 84-85, figs III-IV; Zhou *et al.* 2012: 49-50, figs 33-34; Khotimperwati *et al.* 2018: 886, fig. 12.

NOTES

With underleaves subquadrate, as long as wide, entire or obtuse lobed.

Bazzania tridens var. *cornutistipula* (Steph.) Pócs

SPECIMENS EXAMINED. — **Vietnam**. Sud Vietnam, Bến Cát, *Pierre 36* (PC[PC0764719]); Thua Thien, Bach Ma, sur talus, 1400 m, 19.II.1962, *s.n.* (PC[PC0764726]).

ILLUSTRATION. — Pócs 1969: 84-85, figs III-IV.

NOTES

With underleaves as the previous var., but with truncate, cornuto-dentate apex. A variety rare in Vietnam.

Bazzania tridens var. *assamica* (Steph.) Pócs

NOTES

With underleaves wider than long, connate with side leaves on one or two sides. A variety rare in Vietnam.

Bazzania tridens var. *oshimensis* (Seph.) Pócs

SPECIMENS EXAMINED. — Vietnam. Annam, Nhatrang, vallée du Sông Mau, corticole, 400 m, *Poilane 3328* (PC[PC0764740]); Lâm Đông, *Manline s.n.* (PC[PC0764736]).

NOTES

With underleaves much longer than wide. The whole plant somewhat larger than that of var. *tridens*. It occurs in Vietnam only in the mountainous areas.

Bazzania vittata (Gottsche) Trevis.

SPECIMENS EXAMINED. — Vietnam. Tuyên Duc, piste de Kin-da, sur souche au sol, 600 m, *Tixier 202* (PC[PC0764754]); Lâm Đông, Bao Lộc, sur bois en forêt, 700 m, 6.II.1960, *s.n.* (PC[PC0724732]); Bao Lộc, E.N.A.E.S., sur bois au sol en forêt, *Tixier 275?* (PC[PC0764734]); Lâm Đông, Benom da Treu, *s.n.* (PC[PC0764741]).

ILLUSTRATIONS. — Zhou *et al.* 2012: 56, fig. 37; Meagher 2019: 357, fig. 33.

NOTES

In tropical Asia only this tiny species has a glaucous tint, due to the waxy particles on its opaque cuticle. Shoot 0.4–1.0 mm wide, with contiguous side leaves. The quadrangular, often emarginate underleaves consist of hyaline cells except for very few green basal cell rows, like in *B. tridens*, but its leaves have distinct vitta made up of 2–3(4) cell rows near the ventral margin. This character is shared with a few other tropical Asian species (Schwarz *et al.* 2023). It usually grows on rotting logs or on bark of trees. Distribution: Malesian-Pacific, from Java through Australia to Tahiti (Kitagawa 1967).

ANNOTATED LIST OF OTHER GENERA

Genus *Acrolejeunea* (Spruce) Steph.

**Acrolejeunea tjibodensis* (Verd.) Grolle & Gradstein (Fig. 5A, B)

SPECIMEN EXAMINED. — Vietnam. Tuyên Duc (now Lâm Đông), Mt. Lang Bian, épiphyte en forêt dense, intermixed among *Baz-*

zania tridens and *Lepidozia quadridens*, 1900 m, *Tixier 278 p.p.* (PC[PC0764724]).

NOTES

Relatively large, yellowish brown plants with about one millimeter wide main stem and *Lejeunea* type branching. Stem 100–140 µm thick, the brownish unistratose cortex with cells wider than the medullary ones. Ventral merophytes 4–6, more yellow pigmented than the rest. Leaves densely imbricate, undulate and convolute when dry, wrapping around the stem. In wet stage suborbicular, 0.7–0.9 mm long and 0.6 mm wide, with ventrally incurved apex and auriculate dorsal base. When the leaf flattened, the sinus between lobule keel and dorsal margin around 140°. Lobule about 2/5 of the lobe length, subrectangular, tapering to the truncate apex with two teeth. Underleaves imbricate, elliptic kidney shaped to suborbicular, twice as wide as long, with narrowly recurved margin. They are about five times wider than the stem, approaching in size the side leaves. Gynoecia on the tip of short side branches. The inner bracts are 1–1.12 mm long and 0.64 mm wide, with recurved apex and a lobule of 2/3–3/4 length. The innermost bracteole narrow oblong, with rounded and recurved apical part, reaching about two third of perianth length. The perianth 1.1–1.2 mm long, obpyriform, in our specimen with ten smooth or slightly wavy keels and a short beak of 2–3 cells long. Sporophyte on a 15 mm long, articulate seta, capsule valves widely spreading, 400 µm long, light brown, elaters 240–260 µm long with monospiral thickenings. Rare Malesian species, known from Sumatra, Java, Peninsular Malaysia and from West Irian (Gradstein 1975). New to Vietnam.

Genus *Colura* (Dumort.) Dumort.

**Colura cylindrica* Herzog

SPECIMEN EXAMINED. — Vietnam. Annam, Central Highlands Region, prov. Kon Tum, sur les feuilles d'un arbre haut de 10–11 m, 20.III.1941, *Poilane s.n.* (PC[PC0764720]).

ILLUSTRATION. — Herzog 1952: 196, fig. 26.

NOTES

The specimen is in bad state but still well identifiable. This species belongs to Sect. *Harmophyllum* Grolle, and was described from Ecuador, based on small fragments. Jovet-Ast (1954: 259) had already noted, that it is very close to the Asian *Colura mosenii* Steph. The only minor difference is in the shape of the fingerlike lobule sac, being cylindrical in *C. cylindrica* while narrow conical in *C. mosenii*. Pócs (1991) has found *C. cylindrica* also in East Africa, Tanzania. If the two taxa prove to be synonymous, then the earlier name: *C. mosenii* is to be used. *C. mosenii* was described from Java and has since been discovered in the Caroline Islands (Inoue & Miller 1965) and Malaysia (Pócs & Lee 2016), while *Colura cylindrica* in South America with the Caribbean and Tanzania in East Africa (see map in Pócs 1991). Now, it is new to Vietnam.

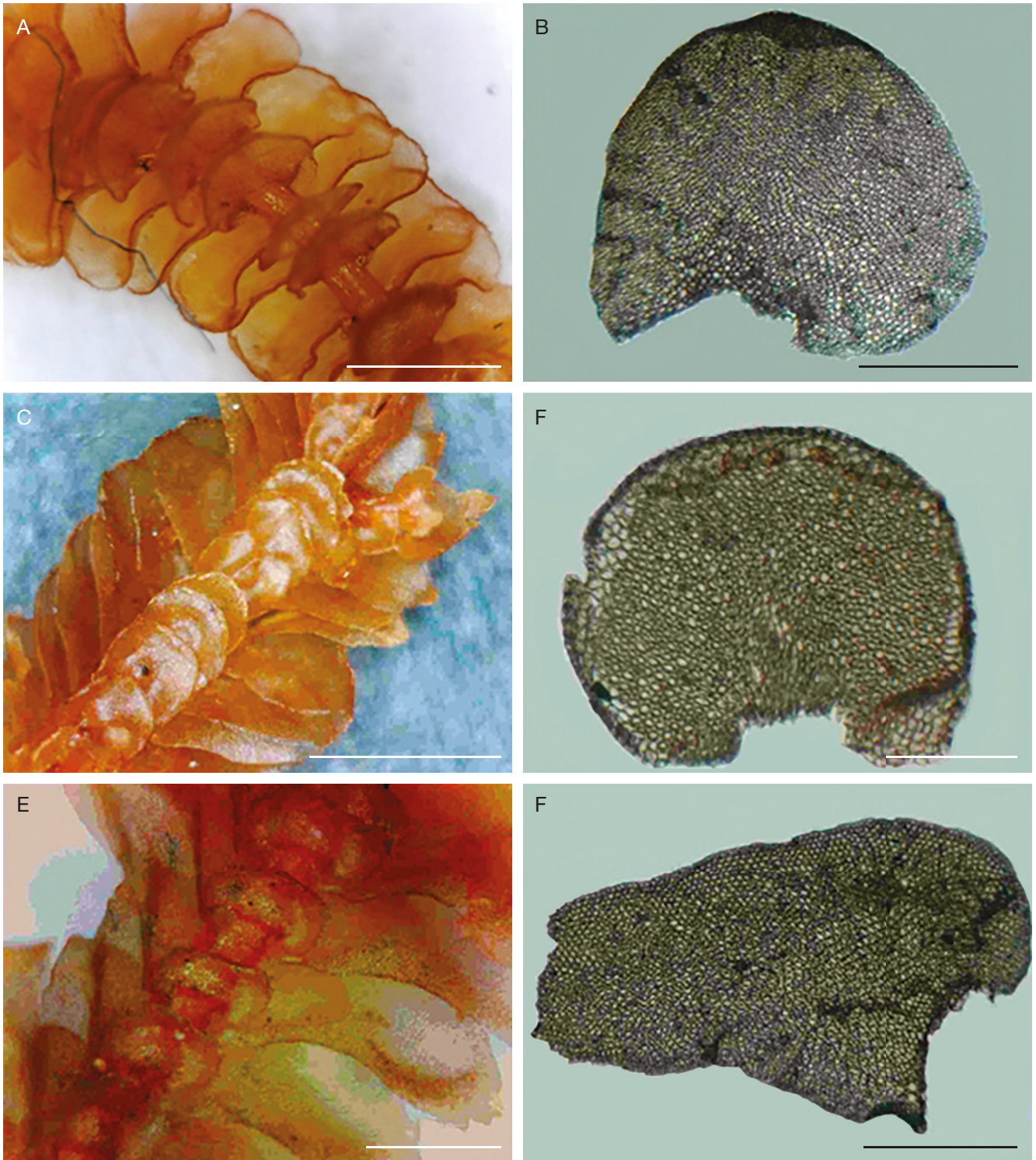


FIG. 4. — *Bazzania recurva* (Mont.) Trevis.: **A**, habit, ventral view; **B**, leaf. *Bazzania revoluta* (Steph.) N.Kitag.: **C**, habit, ventral view; **D**, underleaf. *Bazzania spiralis* (Reinw. et al.) Meijer: **E**, habit, ventral view; **F**, leaf. Scale bars: A, 2 mm; C, 1 mm; B, E, F, 500 µm.

Genus *Lepidozia* Limpr.

**Lepidozia quadridens* (Nees) Gottsche et al.
(Fig. 5E, F)

SPECIMEN EXAMINED. — Vietnam. Tuyên Duc (now Lâm Đồng),

Mt. Lang Bian, épiphyte en forêt dense, 1900 m, Tixier 278 p.p. (PC[PC0764724]).

ILLUSTRATIONS. — Mizutani 1968: 179, fig. II: 12-23; Piippo 1984: 312, fig. 2k-s.



FIG. 5. — *Acrolejeunea tjibodensis* Grolle & Gradstein: **A**, habit, ventral view; **B**, gynoecia, with perianth. *Denotarisia ligulifolia* (De Not.) Grolle: **C**, Habit, ventral and lateral view; **D**, leaf cells. *Lepidozia quadridens* (Nees) Gottsche *et al.*: **E**, habit, ventral view; **F**, underleaves. Scale bars: A-C, 1 mm; D, 50 μ m; E, 250 μ m; F, 100 μ m.

NOTES

It is a tiny, pale green epiphyte with shoot width of only 0.4-0.8 mm. Specific characters are narrowly triangular lobes of the concave leaves with long, setose apices and

with triangular, unicellular teeth on their side and also on the underleaves. It seems to be a rare Malesian species hitherto known only from Java and Papua New Guinea. New to Vietnam.

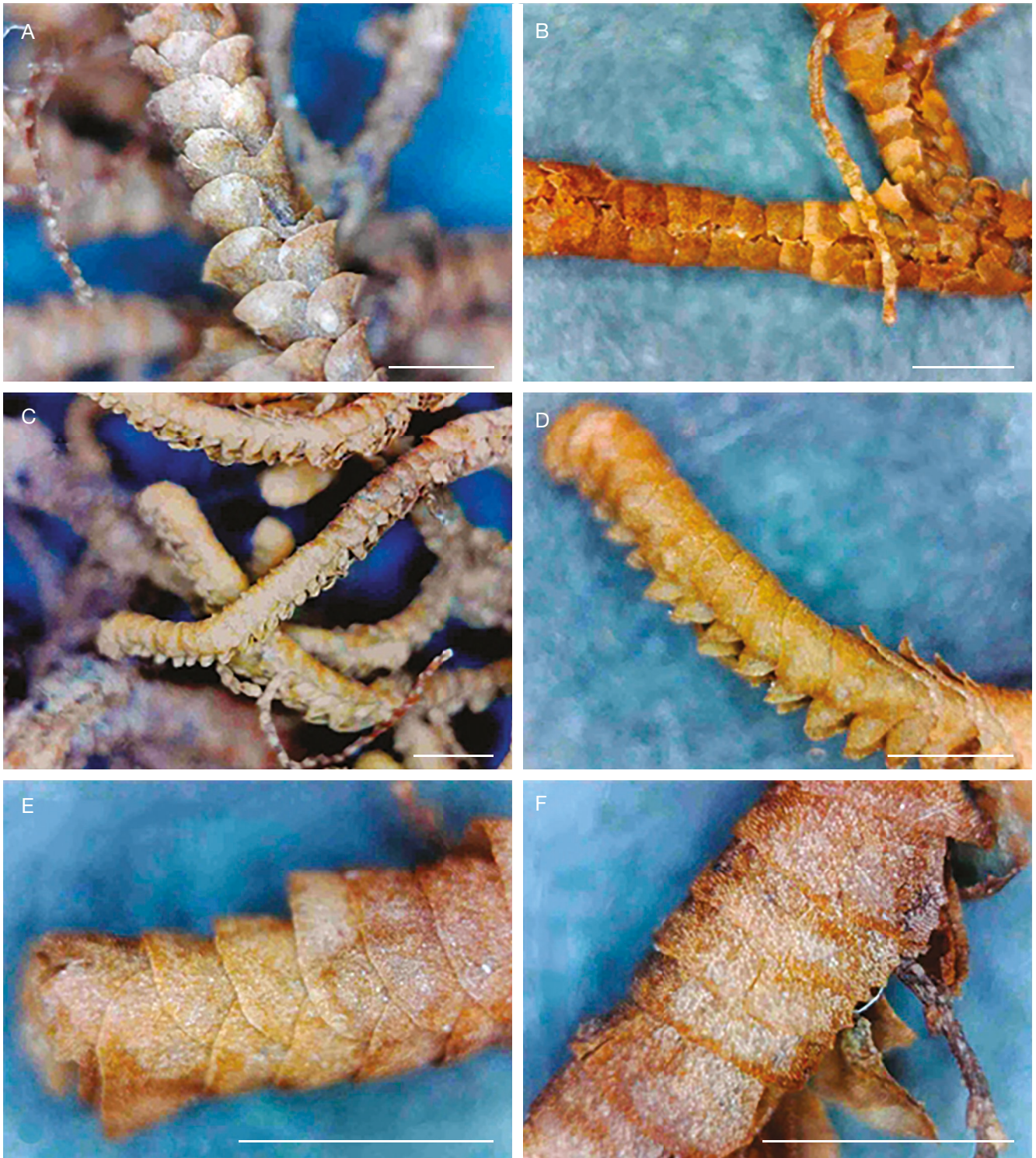


FIG. 6. — Species convolute in dry state. *Bazzania praerupta* (Reinw. *et al.*) Trevis.: **A**, habit, dorsal view; **B**, ventral view. *Bazzania recurva* (Mont.) Trevis.: **C**, **D**, habit, lateral view. *Bazzania revoluta* (Steph.) N.Kitag.: **E**, habit, dorsal view; **F**, habit, lateral view. Scale bars: A, B, 5 mm; C-F, 1 mm.

SPECIES PREVIOUSLY KNOWN FROM VIETNAM

Genus *Acromastigum* A.Evans

Acromastigum herzogii Grolle

SPECIMEN EXAMINED. — **Vietnam**. Lâm Đồng, Benom da Treu, *s.n.* (PC[PC0764741]).

NOTES

Known only from Sarawak and southern Vietnam (Pócs *et al.* 2019).

Genus *Colura* (Dumort.) Dumort.

Colura corynophora (Nees) Trevis.

SPECIMEN EXAMINED. — Vietnam. Lâm Đồng, Dalat, *Poilane 3432* (PC[PC744715]).

NOTES

Colura corynophora is a very widespread epiphyll of Indomalesian-Pacific distribution, occurring from India and Sri Lanka to Tahiti.

Genus *Denotarisia* Grolle

Denotarisia linguifolia (De Not.) Grolle
(Fig. 5C, D)

SPECIMEN EXAMINED. — Vietnam. Lâm Đồng, piste de Dalao, sur bois en forêt dense, 900 m, *Tixier 403* (PC[PC0764731, PC0764733]).

ILLUSTRATIONS. — Kitagawa 1970: 219, fig. 7 (under *Jamesoniella pulchra* Kitag.); Grolle 1971: 7, figs 1, 2a-d.

NOTES

This peculiar monotypic genus was separated from *Jungermannia* by Grolle (1971) on the base of its densely imbricate, strongly concave, succubous leaves. Its dorsal leaf bases very long decurrent. In addition its leaf cells have peculiar bulging trigones inside with a dark, star like pattern. An Indomalesian-Pacific species distributed from Sri Lanka to Tahiti. It grows on twigs and bark of trees in the mountain cloud forest belt. It was published only from one locality in Vietnam before (Pócs *et al.* 2019).

Genus *Herbertus* Gray

Herbertus armitanus (Steph.) H.A.Mill.

SPECIMEN EXAMINED. — Vietnam. Tuyên Duc (now Lâm Đồng), Mt. Lang Bian, sur bois en forêt dense, 1800 m, *Tixier 416 p.p.* (PC[PC0764742]); sur Éricacées vers 1900 m, *Tixier 277 p.p.* (PC[PC0764756]).

NOTES

A Malesian species occurring from Indonesia and Thailand and the Philippines to Papua New Guinea (Juslén 2006).

Genus *Plicanthus* R.M.Schust.

Plicanthus hirtellus (F.Weber) R.M.Schust

SPECIMEN EXAMINED. — Vietnam. Tuyên Duc (now Lâm Đồng), Mt. Lang Bian, sur Éricacées vers 1900 m, *Tixier 277 p.p.* (PC[PC0764756]).

NOTES

Palaeotropic in distribution, recorded from Africa to Fiji Islands (Miller *et al.* 1983).

Genus *Thysananthus* Lindenb.

Thysananthus spathulistipus
(Reinw., Blume & Nees) Lindenb.

SPECIMENS EXAMINED. — Vietnam. Lâm Đồng, Bao Lộc, E.N.A.E.S., épiphyte en forêt, 700 m, *Tixier 408 p.p.* (PC[PC0764735]); Tuyên Duc, Benom da Treu, sur bois en forêt dense, *Tixier 416 p.p.* (PC[PC0764742]).

NOTES

Palaeotropic species distributed from West Africa to Samoa (Sukkharak 2015; Wang *et al.* 2016).

DISCUSSION

According to our present knowledge, the following *Bazzania* species occur in Vietnam. Their distribution type is given after their binomial, finally whether they occur in the northern (N) or in the southern (S) half of Vietnam.

- | | |
|--|-----------------------------|
| 1. <i>Bazzania adnexa</i> | Malesian-Pacific (S) |
| 2. <i>Bazzania angustifolia</i> | Southeast Asian (N) |
| 3. <i>Bazzania angustistipula</i> | Sino-Himalayan (N) |
| 4. <i>Bazzania asperrima</i> | Indochinese (S) |
| 5. <i>Bazzania fauriana</i> | Southeast Asian (N) |
| 6. <i>Bazzania</i> aff. <i>friabilis</i> sp. nov.? | Endemic? (S) |
| 7. <i>Bazzania himalayana</i> | Sino-Himalayan (N) |
| 8. <i>Bazzania indica</i> | Malesian (S) |
| 9. <i>Bazzania intermedia</i> | Indomalesian (N, S) |
| 10. <i>Bazzania japonica</i> | Southeast Asian (S) |
| 11. <i>Bazzania loricata</i> | Malesian (S) |
| 12. <i>Bazzania magna</i> | Southeast Asian (N) |
| 13. <i>Bazzania ovistipula</i> | Sino-Himalayan (N) |
| 14. <i>Bazzania pectinata</i> | Malesian (S) |
| 15. <i>Bazzania pearsonii</i> | SE Asia, W Europe (N) |
| 16. <i>Bazzania praerupta</i> | Pantropical? (N, S) |
| 17. <i>Bazzania recurva</i> | SE-Asian-Malesian (S) |
| 18. <i>Bazzania revoluta</i> | SE-Asian-Malesian (N, S) |
| 19. <i>Bazzania sandei</i> | Malesian (S) |
| 20. <i>Bazzania serrulatoides</i> | Malesian (S) |
| 21. <i>Bazzania sikkimensis</i> | Sino-Himalayan (S) |
| 22. <i>Bazzania spiralis</i> | Malesian (S) |
| 23. <i>Bazzania tridens</i> var. <i>tridens</i> | Indomalesian-Pacific (N, S) |
| var. <i>cornutistipula</i> | |
| var. <i>oshimensis</i> | |
| var. <i>assamica</i> | |
| 24. <i>Bazzania uncigera</i> | Indomalesian-Pacific (N) |
| 25. <i>Bazzania vietnamica</i> | SE-Asian (N) |
| 26. <i>Bazzania vittata</i> | Malesian-Pacific (N) |

Of course, our knowledge is far from complete and a good number of species can be expected during further exploration in this country with a very rich and variable bryoflora.

As one can see, there is a great difference between the species composition of the southern and the northern half of Vietnam. Twelve species are only known from the southern part

of the country, ten only from the northern half, and only four widespread species occur in both parts. On the other hand, all species of strict Malesian distribution occur only in the south, while three Southeast Asian and five Sino-Himalayan taxa occur only in the north, and only one of each type in the south.

Another interesting observation is that certain *Bazzania* species in Asia are convolute in dry state (Fig. 6), similarly to many ptychanthoid Lejeuneaceae and to some xerotolerant mosses. This can happen in different ways. Either all leaves, including the underleaves, wrap around the stem (Fig. 6A, B, E, F), only the microphyllous ventral-intercalary branches stand out. In case of other species (e.g. *B. recurva*, Fig. 6C, D), only the side leaves wrap the stem and the underleaves protruding out of them. The phenomenon seems to have evolutionary significance, since in dry state, convolute *Bazzania* species are not rare in Asia, whereas they are barely present in Africa and in the Neotropics. This is clearly an adaptation to survive dry periods, as in the convolute stage, the species can retain a certain amount of moisture and are more resistant to desiccation. In tropical Asia it is a common phenomenon to see such wire like specimens in dry state on the bark of sole trees (e.g. on *Areca* L.) in relatively dry environment.

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