

Revision and checklist of the moss families Bartramiaceae and Mniaceae in Vietnam

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Abstract The genera *Fleischerobryum* Loeske and *Philonotis* Brid. of the Bartramiaceae and the family Mniaceae (excluding *Pohlia* Hedw.) are revised for Vietnam, based on specimens studied and literature reports. Four species are added to the flora: *Orthomnion javense* (M.Fleisch.) T.J.Kop., *Philonotis asperifolia* Mitt., *P. laii* T.J.Kop., *P. speciosa* (Griff.) Mitt. *syn. nov.* (based on *P. mercieri* Paris & Broth.), and *Plagiomnium wui* (T.J.Kop.) Y.J.Yi & S.He. Eight species are excluded from the flora. Two taxa are considered doubtful. The flora now includes one species of *Fleischerobryum*, eight species of *Philonotis*, one species of *Mnium* Hedw. (doubtful), three species of *Orthomnion* Wills. and five species of *Plagiomnium* (one doubtful). The 15 species are divided into phytogeographical elements. Eight belong to the Southeast Asiatic temperate to meridional element, and seven to the Southeast Asiatic meridional to subtropical element. One species is pantropical and one is pansubtropical. The new finds widen the distribution range of several species that were previously known only from North or South Vietnam.

Introduction

Vietnam is located in the tropical region at the easternmost portion of continental SE Asia and the Indochina Peninsula. The heterogeneity in climate, topography and landscape support a rich flora, together with a high level of biodiversity and diversity in vegetation types. The vascular plant flora includes nearly 2,010 genera comprising approximately 12,000 species (Averyanov *et al.* 2003), a remarkably high number for a relatively small country. About

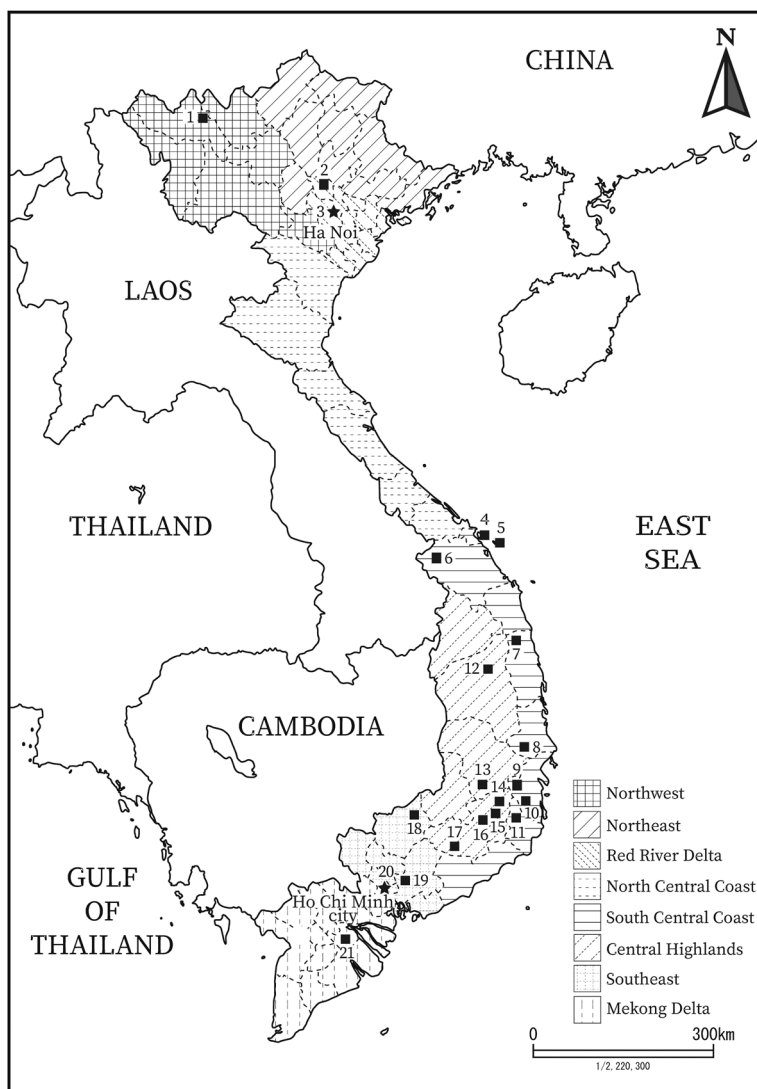


Figure 1. Map of all collecting areas in Vietnam. 1. Pu Ta Leng Mountain. 2. Tam Đảo N.P. 3. Hà Nội City. 4. Sơn Trà N.R. 5. Cù Lao Chàm Island. 6. Tây Giang. 7. An Toàn N.R. 8. Sông Hình P.F. 9. Sơn Thái. 10. Hòn Bà N.R. 11. Phước Bình N.P. 12. Kon Ka Kinh N.P. 13. Chư Yang Sin N.P. 14. Bidoup-Núi Bà N.P. 15. Đà Lạt City. 16. Nam Ban P.F. 17. Linh Quy Pháp Ấn Pagoda. 18. Bù Gia Mập N.P. 19. Biên Hòa City. 20. Hồ Chí Minh City. 21. Trà Ôn District.

three-quarters of Vietnam is hilly or mountainous, with highest peaks reaching up to 3,143 m. The mountain areas are important reserves for the tropical evergreen montane forests, and they can be divided into three distinct ecological regions. 1. North-eastern, 2. North-western, and 3.

Annamite Range (Central Highlands), along the western border of Vietnam (Fig. 1; Averyanov *et al.* 2003). Even though not mountainous, other regions such as the Red River Delta, North Central Coast, South Central Coast, Southeast and Mekong Delta, also hold a high biodiversity because of their complex topography.

Compared to vascular plants, the bryophyte flora of Vietnam is still poorly studied in many areas. Investigations are biased towards the northern part of the country, while the flora in the southern provinces is less surveyed and studied. For example, among five provinces of the Central Highland only two, Lâm Đồng and Đắk Lắk, have been studied due to the intensive collecting activity of the late Pierre Tixier prior to 1975 (Jovet-Ast & Schmid 1958; Jovet-Ast & Tixier 1959, 1962; Tixier 1962, 1966, 1968, 1970, 1974) and a few recent excursions by researchers from the University of Science, Ho Chi Minh City (Tan *et al.* 2003; Pocs *et al.* 2013; Ho *et al.* 2015; Akiyama *et al.* 2018). According to Zhang *et al.* (2016) the moss flora of Vietnam includes 766 species in 227 genera and 61 families. 103 taxa (species or intraspecific taxa, about 13%) are endemic to the country. However, taxonomic assessments, especially older reports, need verification.

The latest checklist for Vietnam (He & Nguyen 2012) includes eight species of *Philonotis* and thirteen species of Mniaceae. Based on their field work in North Vietnam, Zhang *et al.* (2016) added five species to Vietnamese moss flora including *Fleischerobryum longicolle* (Hampe) Loeske, *Rhizomnium magnifolium* (Horik.) T.J.Kop. and three species of *Plagiomnium*, but some of these new records are doubtful. In this paper, we revise the two families Bartramiaceae and Mniaceae (excluding *Pohlia* Hedw.) based mainly on our own collections. This paper forms part of a series of new and noteworthy bryophyte records for Vietnam and a comprehensive list of the specimens studied during this and ongoing projects is published and available on GBIF database (Luong *et al.* 2019).

Materials and Methods

Specimens reported here have been collected from twenty-one areas in Vietnam (Fig. 1). Material was collected as part of field studies by the University of Science, Vietnam National University Ho Chi Minh City, and the Southern Institute of Ecology, Ho Chi Minh, in 2010–2019. Collecting localities in Vietnam are listed in the order of geographical areas and the year when the area was visited.

Northwest

1. Pu Ta Leng Mountain, Lai Châu Province (2019).
Location 1. Along stream near the trail to peak. Moist evergreen forest. 2°25'7.70"N, 103°35'29.44"E, elev. ca. 2,256 m.

Red River Delta

2. Tam Đảo National Park, Vĩnh Phúc Province (2014).
Location 2.1. Along trail to Rừng Rinh peak. Mixed bamboo forest. 21°28'6.29"N, 105°37'9.83"E, elev. 950–1,300 m.
Location 2.2. On stairs toward television tower. Mixed forest. 21°27'6.26"N, 105°38'8.98"E, elev. 1,000 m.

3. Hà Nội City (2019).
Location 3. Ngọc Sơn Temple in Hoàn Kiếm Lake. Urban area, on rock in bonsai pot.
21°1'49.48"N, 105°51'8.99"E, elev. 12 m.

South Central Coast

4. Sơn Trà Nature Reserve, Đà Nẵng City (2016–2018).
Location 4.1. Along trail to Bàn Cờ peak. Dry, exposed rocks. 16°8'54.16"N, 108°14'32.98"E, elev. ca. 65–589 m.
Location 4.2. Along Suối Ôm (Om stream). Moist, exposed evergreen forest. 16°8'54.74"N, 108°14'39.48"E, elev. 65 m.
5. Cù Lao Chàm Island, Quảng Nam Province (2018).
Location 5. Along concrete drain, open, moist habitats. 15°57'40.78"N, 108°30'23.75"E, elev. 26 m.
6. Tây Giang, Quảng Nam Province (2017–2018).
Location 6.1. Partly open, moist evergreen forest and along stream near Abanh 2 village. 15°50'50.22"N, 107°20'58.99"E, elev. ca. 956–1,212 m.
Location 6.2. Stream near Lim forest, semi-dry forest. 15°46'1.17"N, 107°29'56.5"E, elev. 252 m.
7. An Toàn Nature Reserve, Bình Định Province (2015).
Location 7. Moist evergreen forest. 14°32'13.23"N, 108°41'30.62"E, elev. ca. 800–1,000 m.
8. Sông Hình Protective Forest, Phú Yên Province (2014, 2018).
Location 8.1. Overcome Đông's camping ground. Semi-dry evergreen forest. 12°47'10.71"N, 109°2'10.44"E, elev. ca. 300–700 m.
Location 8.2. At Suối Máng waterfall. 12°48'5.04"N, 109°0'42.20"E, elev. 365 m.
9. Sơn Thái, Khánh Hòa Province (2012).
Location 9. Khánh Lê mountain pass. Moist evergreen forest with high canopy coverage. 12°10'41.80"N, 108°43'32.59"E, elev. ca. 980–1,450 m.
10. Hòn Bà Nature Reserve & Thành Sơn, Khánh Hòa Province (2015, 2018).
Location 10.1. Along stream behind Yersin's house. Moist evergreen forest with many large rocks. 12°07'08.5"N, 108°56'51.5"E, elev. ca. 1,500 m.
Location 10.2. Along big stream near a research plot at Thành Sơn. Moist, exposed area with many large rocks. 12°4'20.69"N, 108°48'5.95"E, elev. 405 m.
Location 10.3. Open, semi-dry area with many large rocks at surroundings of Tà Gù waterfall. 12°2'56.79"N, 108°55'16.28"E, elev. 432 m.
11. Phước Bình National Park, Ninh Thuận Province (2018).
Location 11. Partly open, moist habitat along Sông Cái river. 11°58'30.97"N, 108°45'40.33"E, elev. 241 m.

Central Highlands

12. Kon Ka Kinh National Park, Gia Lai Province (2016).
Location 12.1. Sub-area 18. Wet habitats with many large rocks along stream. 14°26'35.22"N, 108°22'34.13"E, elev. 1,101 m.
Location 12.2. Sub-area 104. Along trekking trail on the right side of stream near camping site. Evergreen forest with high canopy coverage and thick litter

- layer. 14°13'42.89"N, 108°20'25.23"E, elev. 1,477 m.
- Location 12.3. Headquarters of Kon Ka Kinh National Park, under Orchid garden. 14°11'11.62"N, 108°17'42.57"E, elev. 813 m.
13. Chur Yang Sin National Park, Đắk Lắk Province (2015).
Location 13. Sub-area 1195. Internal road of Krong K'mar hydroelectric power station toward Suối Xanh. Evergreen forest varying from open to high canopy coverage along small stream. On concrete drain. 12°28'7.76"N, 108°20'45.38"E, elev. 700–750 m.
14. Bidoup-Núi Bà National Park, Lâm Đồng Province (2010–2015, 2018).
Location 14.1. Sub-area 75B. Near Cổng Trời forest station. Montane evergreen forest. 12°05'46.73"N, 108°22'39.86"E, elev. 1,700–1,800 m.
Location 14.2. Along stream at K'Long K'Lanh station. Đung K'Si community village, Đa Chais. Montane evergreen forest. 12°10'7.68"N, 108°42'0.76"E, elev. ca. 1,500 m.
Location 14.3. Langbiang hiking trail. Pine forest and broadleaved forest. 12°02'51.36"N, 108°26'14.5"E, elev. 1,700–2,000 m.
Location 14.4. Hòn Giao forest station. Mixed conifer-broadleaved forest along stream. 12°11'10.75"N, 108°42'54.66"E, elev. ca. 1,600 m.
Location 14.5. Đung K'Nớh. Partly open evergreen forest. 12°9'52.84"N, 108°23'30"E, elev. 1,492 m.
Location 14.6. Sturgeon farm hiking trail near Hòn Giao. Mixed conifer-broadleaved forest and on soil along brook bank. 12°10'24.0"N, 108°41'59.9"E, elev. 1,500 m.
15. Đà Lạt City (2018).
Location 15. Lâm Đồng Museum. Open urban area in front yard, on rock in bonsai pot. 11°56'26.6"N, 108°27'35.1"E, elev. 1,530 m.
16. Nam Ban Protective Forest, Lâm Đồng Province (2018).
Location 16. Open, dry habitats at surroundings of Coffee farm near stream at Nam Ban P.F. 11°54'49.35"N, 108°15'32.81"E, elev. 1,240 m.
17. Linh Quy Pháp Ấn Pagoda, Lâm Đồng Province (2018).
Location 17. Along trail to peak. Partly open, dry *Camellia* sp. plantation. 11°25'6.85"N, 107°49'22.39"E, elev. 884–890 m.

Southeast

18. Bù Gia Mập National Park, Bình Phước Province (2012).
Location 18. Đăk Ca stream. Open, semi dry forest. 12°12'22.79"N, 107°12'13.72"E, elev. ca. 350 m.
19. Biên Hòa City, Đồng Nai Province (2019).
Location 19. Urban area, on rock in bonsai pot in front yard of local house. 10°55'17.4"N, 106°48'10.4"E, elev. 3 m.
20. Hồ Chí Minh City (2016).
Location 20.1. Lê Thị Riêng Park. Partly open, semi-dry urban area. 10°47'6.10"N, 106°39'53.57"E, elev. 7–9 m.
Location 20.2. Gia Định Park. Partly open, semi-dry urban area. 10°48'37.60"N, 106°40'27.06"E, elev. 7–9 m.

Mekong Delta

21. Trà Ôn District, Vĩnh Long Province (2019).

Location 21. Exposed, semi-moist surroundings of domestic house. 9°59'39.31"N, 106°0'11.14"E, elev. 6 m.

Specimens were identified in connection with the project, with the aim of confirming identifications and digitizing bryophyte and lichen specimens held in the Herbarium of the University of Science, Vietnam National University Ho Chi Minh City (PHH) and to publish observations in the Global Biodiversity Information Facility (GBIF) database (Luong *et al.* 2019). Identifications of *Philonotis* and Mniaceae were checked and confirmed by Thành-Lực Nguyễn, Thiện-Tâm Lương and Timo Koponen. All specimens listed below are stored in two herbaria in Ho Chi Minh City, Herbarium of the Southern Institute of Ecology (SGN) and Herbarium of the University of Science, Vietnam National University Ho Chi Minh City (PHH), with duplicates in the Finnish Museum of Natural History, Helsinki (H). Names of collectors are abbreviated as Bích-Hà Dương (Duong), Nhật-Lâm Đình (Dinh), Sanna Huttunen (Huttunen), Mỹ-Nhàn Lê (Le), Thiện-Tâm Lương (Luong), Thành-Lực Nguyễn (Nguyen), Hiếu-Cường Nguyễn (H.C.Nguyen) and Nguyễn-Khánh-Trình Trâm (Tram). Some specimens were obtained as loans from the Herbarium of East China Normal University, Shanghai (HSNU) to facilitate verification of identifications (Zhang *et al.* 2016).

In addition to our new material, we review and estimate the previous records of Bartramiaceae and Mniaceae from Vietnam, based on the references in He & Nguyen (2012) and literature reports published since then. The basionyms are cited and nomenclature given when relevant. More complete lists of synonyms, typifications, discussion on ranges and citations of published illustrations are to be found in several previous papers by Koponen (see below Chapters A. Bartramiaceae and B. Mniaceae). New locations are marked with asterisk (*).

Results

I. TAXA

Five species are reported here for the first time from Vietnam: *Orthomnion javense*, *Philonotis asperifolia*, *P. laii*, *P. speciosa* and *P. wui*. As a result of revising the specimens and evaluating the status of published records, eight species, *Philonotis lancifolia*, *P. turneriana*, *Plagiomnium cuspidatum*, *P. integrum*, *P. maximoviczii*, *P. rostratum*, *P. undulatum* and *Rhizomnium magnifolium* are excluded from the flora. Records of two species, *Mnium lycopodioides* and *Plagiomnium tezukae* are considered here as doubtful.

A. Bartramiaceae Schwägr., Spec. Musc. 90. 1830.

In this study, two genera of the Bartramiaceae, *Fleischerobryum* Loeske (one species) and *Philonotis* Brid. with eight species are confirmed to Vietnam. The taxonomy, nomenclature, typifications and ranges of these taxa have been dealt with in a number of papers, including several preliminary regional revisions (Koponen 1998, 2009, 2010a, 2010b, 2019a, 2019b, 2019c; Koponen & Norris 1996; Koponen & Virtanen 1998; Koponen *et al.* 2012).

Key to Bartramiaceae in Vietnam

1. Capsule erect, cylindrical or ovoid, constricted below mouth and striate in upper half when dry; peristome reduced *Philonotis bartramioides*
1. Capsule long cylindrical, globose or gibbous, pendent or horizontal; peristome complete; or capsule lacking 2
2. Large species, stems up to 10 cm long; capsule long-cylindric, horizontal or pendulous with a long neck; leaves from broad ovate base tapering quickly to falcato-secund, setaceous, apical part; leaf margin involute; basal leaf cells wide; mid-leaf laminal cells often with central papilla *Fleischerobryum longicolle*
2. Smaller species, stems 1–5 cm long; capsule \pm globose, or gibbous, pendent or horizontal with a short neck; leaves \pm ovate with acute apex or lanceolate, tapering gradually to erect, falcato-secund or spreading apical part; leaf margin smooth or revolute; basal leaf cells wide or narrow, mid-leaf laminal cells smooth or with mammilla/papilla at distal cell end 3
3. Basal leaf cells distinctly wider than apical leaf cells; basal leaf cell areolation translucent 4
3. Basal leaf cells not much wider than apical leaf cells; basal leaf areolation \pm dense 7
4. Costa not reaching apex or percurrent on innovation leaves, often shortly excurrent on stem leaves; marginal teeth blunt, in two rows *Philonotis hastata*
4. Costa percurrent or excurrent, marginal teeth sharp, serrate or bi- to triseriate 5
5. Basal leaf cells linear, rectangular with only low mammillae/papillae at distal cell end *P. mollis*
5. Basal leaf cells subquadrate or shortly rectangular, bulging or mammillate at proximal cell end 6
6. Leaves tightly imbricate when dry, stiff, shortly acute (especially in fertile female stem leaves) The leaves in sterile shoots may be with longer apices, especially if grown in flowing water *P. bartramioides*
6. Leaves erect-spreading to spreading when dry, falcato-secund and acuminate *P. asperifolia*
7. Leaves distinctly in five rows (best seen when wetted, and on innovations), strongly carinate and falcate; costa bending *P. falcata*
7. Leaves not in rows, plane, plicate or concave; costa straight 8
8. Tiny plants; adult plants erect with numerous propagules at apex of innovations; later stems and innovations grow to slender, creeping shoots with miniature leaves and propagules; leaf base very narrow, usually less than 15 cells between costa and margin *P. laii*
8. Larger; propagules not present or a few inside tomentum; no elongated creeping shoots with propagules present; leaf base broader, more than 15 cells between costa and margin 9
9. Leaves hook-like when dry, plicate, ovate with shortly acute or acuminate apex, or apex twisted (rarely piliferous, the piliferous part cut off in old leaves, the apex then truncate); basal leaf cells narrow elongate; leaf borders smooth or revolute only at base; leaf margin serrate *P. speciosa*
9. Leaves erect spreading when dry, not plicate, stiff, ovate with acute or acuminate apex; basal leaf cells subquadrate to short rectangular; both leaf borders revolute from base to near apex; leaf margin bi- to triseriate *P. thwaitesii*

1. *Fleischerobryum* Loeske, Stud. Morph. Syst. Laubm. 127. 1910.
Philonotis sect. *Pseudo-Philonotis* M.Fleisch., Musci Fl. Buitenzorg 2: 612. 1904.

1.1 *Fleischerobryum longicolle* (Hampe) Loeske, Morph. Syst. Stud. Laubm. 127. 1910.
Bartramia longicollis Hampe in Müll.Hal., Syn. Musc. Frond. 1: 478. 1848.
Philonotis longicollis (Hampe) Mitt., J. Proc. Linn. Soc., Bot., Suppl. 1: 64. 1859.

Zhang *et al.* (2016) reported *Fleischerobryum longicolle* from Cao Bang, Nguyen Binh District. We have not seen the specimen, but the diagnostic characters, the central leaf cells with central mammilla and the shape of leaf, are shown in the illustrations (Zhang *et al.* 2016; Figs. 4–5).

RANGE IN VIETNAM. Northeast. Cao Bang (Zhang *et al.* 2016).

TOTAL RANGE. (Koponen 2019a). As 1: Chi Ja Ko; As 3: Bhu In Ne Vi; As 4: Ind Phi PNG. Range map: Koponen & Virtanen (1998).

2. *Philonotis* Brid., Bryol. Univ. 2: 15. 1827.
Bartramidula Bruch & Schimp., Bryol. Eur. 4: 55. 1846 (fasc. 29–30).
Philonotis sect. *Bartramidula* (Bruch & Schimp.) Mitt., Linn. Soc. Bot. 7: 153. 1863.

Eight species of *Philonotis* are recognized for Vietnam in this paper. *Philonotis laii* T.J.Kop. and *P. asperifolia* Mitt. are added to the flora, and *P. speciosa* (Griff.) Mitt. is accepted when *P. mercieri* Paris & Broth. is synonymized with it. *Philonotis turneriana* (Schwägr.) Mitt. is excluded from the flora.

2.1 *Philonotis asperifolia* Mitt., J. Linn. Soc. Bot. 10: 185. 1868. Fig. 2A, G–I; Fig. 13A–B.
Philonotula vescoana Besch., Ann. Sci. Nat. Bot. sér. 7, 20: 29. 1894 (“*Vescoana*”).
Synonymized by Koponen (2019a).

The diagnostic characters of *Philonotis asperifolia* are: (1) The second leaves are distant on the stem so that the red stem is visible between leaves, (2) leaves taper gradually from an ovate base to an acuminate apex, (3) the basal leaf cells are distinctly wider than the apical leaf cells and are broadly mammillate at the proximal cell end; cells of mid- and apical leaf have the papilla at the distal cell end, (4) leaf borders are strongly revolute from the leaf base to mid-leaf, (5) teeth of the leaf margin are large and the margin is bi- to triseriate to mid-leaf; apical margin is serrate.

The wide basal leaf cells have mammillae at the proximal cell end are similar to those of *P. bartramoides*, which has smooth or only slightly revolute leaf border and more shortly acute leaves, in addition to the imbricate leaf arrangement and erect capsule. *Philonotis thwaitesii* has similar leaf shape and revolute leaf border to *P. asperifolia*, but the basal leaf cells there are nearly as narrow hardly wider than the apical leaf cells, and all leaf cells are papillate at the distal cell end. *Philonotis asperifolia* can be misidentified as *P. falcata* but the latter species has leaves usually not revolute at the margins and all leaf cell are papillate at the distal cell end.

Philonotis asperifolia is a new record to Vietnam. The species has a wide range in the Pacific area from New Guinea through Indonesia and the Philippines to Japan, but the range is not yet known in detail.

RANGE IN VIETNAM. South Central Coast. Khanh Hoa* (loc. 10.2. *Nguyen HB-161*).

TOTAL RANGE. As 2: Ja As 3: Vi: As 4: Ind Phi PNG. Oc: Fiji Samoa.

2.2 *Philonotis bartramioides* (Griff.) D.G.Griffin & W.R.Buck, *Bryologist* 92: 376. 1989. Fig. 2B–F, J.

Bartramidula bartramioides (Griff.) Wijk & Margad., *Taxon* 7: 289. 1958.

Weissia bartramioides Griff., *Calcutta J. Nat. Hist.* 2: 489. 1842.

The species is now reported again after a lapse of almost a century since the report of Henry (1928).

RANGE IN VIETNAM. Northwest. Lao Cai (Henry 1928). Northeast. Cao Bang (Henry 1928). However, the specimens reported by Henry (1928) have not been revised. Central Highlands. Dak Lak* (loc. 13. *Luong & Duong 15872*).

TOTAL RANGE. *Philonotis bartramioides* has a temperate range from Himalaya to Japan.

2.3 *Philonotis falcata* (Hook.) Mitt., *J. Proc. Proc. Linn. Soc., Bot., Suppl.* 1: 62. 1859. Fig. 3J–N; Fig. 13H.

Bartramia falcata Hook., *Trans. Linn. Soc. London* 9: 317, 27, Fig. 4. 1808.

Philonotis fontana var. *falcata* (Hook.) Brid., *Bryol. Univ.* 2: 21. 1827.

Philonotis falcata has previously been reported only from North Vietnam (He & Nguyen 2012). The first find in Vietnam was made at Lao Cai (Henry 1928), and He & Nguyen collected it again at Nghe An in 2012. Our specimens extend the distribution area in Vietnam further South to Da Nang city and Lam Dong province.

RANGE IN VIETNAM. Northwest. Lao Cai (Henry 1928). North Central Coast. Nghe An (He & Nguyen 2012), Ha Tinh* (*Tan 02-278*, misidentified as *P. lancifolia* in Tan & Ninh 2003). South Central Coast. Da Nang* (loc. 4.1. *Dinh ST-038, Nguyen & Luong 18269, 18271*), Lam Dong* (loc. 14.3. *Duong & Luong LB 02042*).

TOTAL RANGE. Africa (Koponen 2003); Europe (Ignatov *et al.* 2010); As 1. (Koponen *et al.* 2012; Koponen & Ignatova 2018a); As 2. Chi, Ja, Ko; As 3. Bhu, Ind, Ne; As 4. Phi; As 5. Iran (Koponen 2012), Yemen (Kürschner & Ochyra 1999). Records from the Pacific area need to be confirmed. Range maps are in Koponen (1996, 2003).

2.4 *Philonotis hastata* (Duby) Wijk. & Margad., *Taxon* 8: 74. 1959. Fig. 3A–I; Fig. 13C–D. *Hypnum hastatum* Duby in Moritzi, *Syst. Verz. Zoll. Pfl.* 132. 1846.

Philonotis hastata is a widespread species in Southeast Asia but it had been recorded only twice in Vietnam, from Ha Tinh (Tan & Ninh 2003) and Lam Dong (Tixier 1970). Our observations show that it is a common species in Vietnam by more than doubling the number

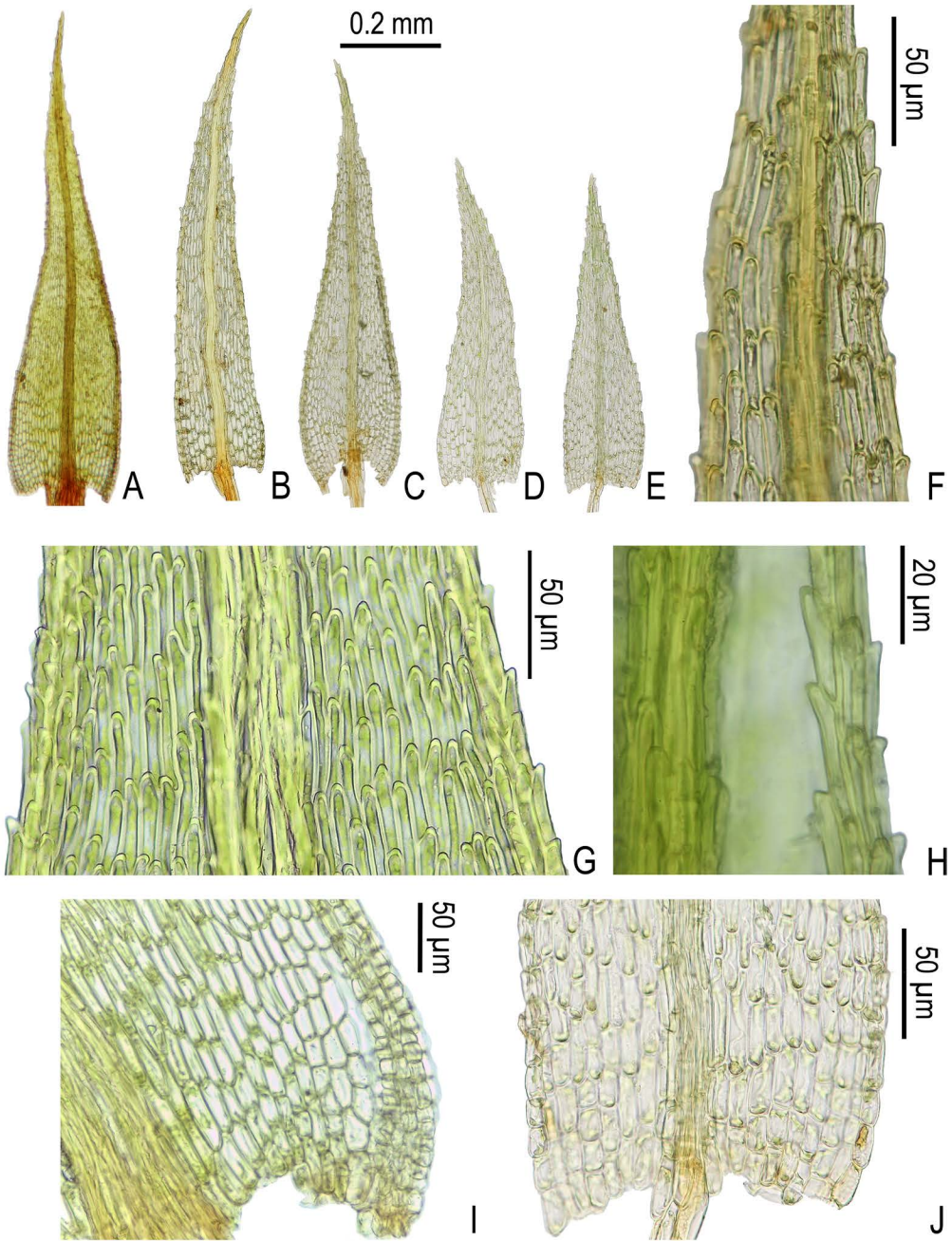


Figure 2. *Philonotis asperifolia* Mitt. (A, G–I) & *P. bartramioides* (Griff.) D.G.Griffin & W.R.Buck (B–F, J). A–E. Leaves. F. Upper leaf cells with distal papillae. G. Mid-leaf cells with papillae at distal cell end. H. Leaf borders strongly revolute, margin bi- to triseriate with large teeth. I & J. Basal leaf cells with papillae at proximal cell end. A, G–I from *Nguyen HB-161*; B–F, J, from *Luong & Duong 15872*.

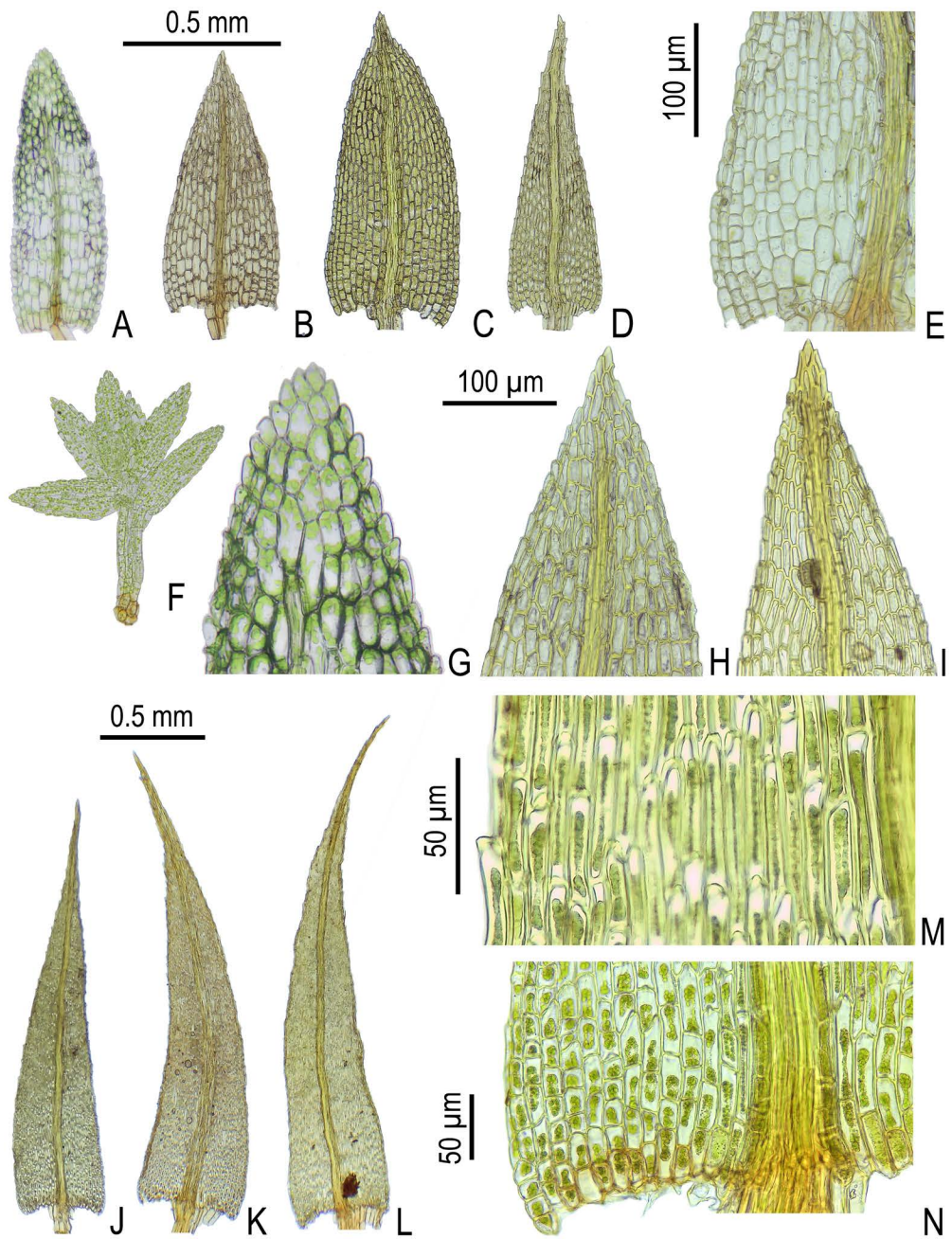


Figure 3. *Philonotis hastata* (Duby) Wijk. & Margad. (A–I) & *P. falcata* (Hook.) Mitt. (J–N). A–D & J–L. Leaves. E & N. Basal leaf cells. F. Propagule. G–I. Leaf acumens. M. Mid-leaf cells with papillae at distal cell end. A, F, G from *Nguyen 19018*; B–C & H–I from *Nguyen HB-112*; D from *Nguyen HB-127*; E from *Nguyen 19093*; J–N from *Dinh ST-038*.

of known localities and by extending its further south to the Mekong Delta and north to the Red River Delta. At Lam Dong, since Tixier's first collection in 1970, the species has been found again. The species usually grows on man-made habitats, such as bonsai pots or ornamental objects in gardens.

RANGE IN VIETNAM. Red River Delta. Ha Noi* (loc. 3. *Nguyen 19018*). North Central Coast. Ha Tinh (*Tan 02-286* in Tan & Ninh 2003). South Central Coast. Quang Nam* (loc. 6.1. *Nguyen & Luong 18174*), Phu Yen* (loc. 8.2. *Nguyen 19093*), Khanh Hoa* (loc. 10.2. *Nguyen HB-112, HB-127*; loc. 10.3. *Nguyen HB-128a*), Ninh Thuan* (loc. 11. *Nguyen PB-003*). Central Highlands. Gia Lai* (loc. 12.1. *Dinh & Nguyen KKK-643A*; loc. 12.3. *Dinh & Nguyen KKK-679*), Dak Lak* (loc. 13. *Luong & Duong 15871*), Lam Dong (Tixier 1970; loc. 14.2. *Luong & Duong 15671*; loc. 14.4. *Nguyen & Luong 18714*, loc. 15. *Huttunen 24112018-2*). Southeast. Binh Phuoc* (loc. 18. *Dinh BGM-Br-033*), Dong Nai* (loc. 19. *Nguyen 19019; 19020, 19021*), Ho Chi Minh City* (loc. 20.1. *Le 16059*; loc. 20.2. *Le 16116*). Mekong Delta. Vinh Long* (loc. 21. *Tram TO-19001*).

TOTAL RANGE. Widely distributed in SE Asia, the Pacific to Australia, Africa; possibly pantropical.

2.5 *Philonotis laii* T.J.Kop., Acta Bryolichenol. Asiat. 3: 137. 2010. Fig. 4; Fig. 13E–G.

Philonotis laii, described as new in 2010 (Koponen 2010c), is reported as new to Vietnam. It seems to be common in Central Vietnam.

Philonotis laii has been confused with *P. hastata* and *P. mollis*, and the distinguishing characters have been discussed in connection with the description of *P. laii* (Koponen 2010c) and again by Koponen (2019b). It is also possible to misidentify *P. laii* as *P. runcinata* Müll. Hal. ex Ångström. Our material has been compared with the original material of *P. laii* from Hunan Province of China and with specimens of *P. runcinata* from New Guinea (Koponen & Norris 1996; Koponen 2019b).

The characters distinguishing *Philonotis laii* from *P. runcinata* are: (1) a wider leaf base in *P. runcinata* than *P. laii* and the number of cells between costa and margin, less than 15 cells in *P. laii* and more than 15 cells in *P. runcinata*. (2) Leaf borders in *P. laii* are not revolute, in *P. runcinata* at least one leaf border is revolute from leaf base to mid-leaf or even higher. (3) Basal leaf marginal cells are short and crenulate in *P. runcinata*, while in *P. laii* they are often elongate and entire. (4) Mid-leaf marginal teeth are sharp and small in *P. runcinata*, in contrast to \pm blunt and larger teeth in *P. laii*. (5) Unlike *P. laii*, the leaf is often shortly piliferous in *P. runcinata*. (6) Our specimens have abundant propagules at some shoots apices, a distinctive character of *P. laii*.

One of the Vietnamese specimens (*Dinh ST-02*) has old sporophytes (Fig. 4E–F). When described (Koponen 2010c), the sporophyte of *P. laii* was not known, and since then only one specimen of *P. laii* with capsules has been seen from Yunnan Province of China. The capsule is very small, less than 1 mm long. *Philonotis runcinata* has capsules to 2 mm long.

RANGE IN VIETNAM. North Central Coast. Ha Tinh* (*Tan 02-299*, misidentified as *P. turneriana* in Tan & Ninh 2003). South Central Coast. Da Nang* (loc. 4.1. *Dinh ST-02, ST-041*; *Nguyen & Luong 18314, 18331; Nguyen 18472*; loc. 4.2. *Nguyen & Luong 18261*),

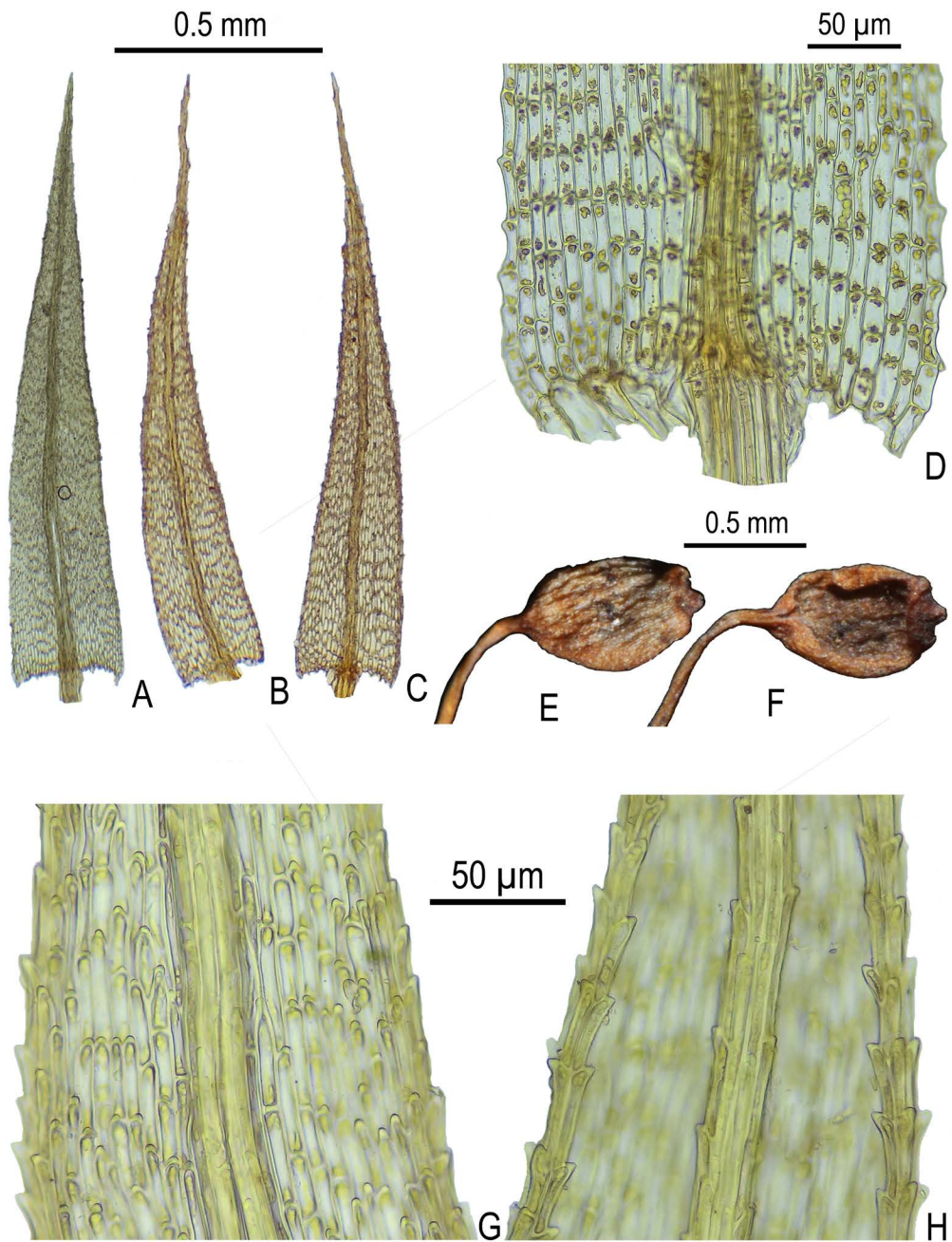


Figure 4. *Philonotis laii* T.J.Kop. A–C. Leaves. D. Leaf base with narrow cells, the number of cells between costa and margin less than fifteen. E & F. Sporophytes. G & H. Mid-leaf marginal teeth. A & D from *Nguyen 18612*; B–C, G–H from *Nguyen 18654*; E & F from *Dinh ST-02*.

Quang Nam* (loc. 6.1. *Nguyen 17341*; loc. 6.2. *Nguyen & Luong 18242*), Phu Yen* (loc. 8.1. *Dinh PY-Br-019*). Central Highlands. Gia Lai* (loc. 12.3. *Dinh & Nguyen KKK-678*), Lam Dong* (loc. 17. *Nguyen 18603, 18612*; loc. 16. *Nguyen 18654*).

TOTAL RANGE. As 2: Chi, Ja (Koponen 2018); As 3: In, Myan, Ne, Tha, Vi; As 4: Ind, Phi (Koponen 2018), PNG (Koponen 2019b).—Range map: Koponen (2010c; Fig. 1).

2.6 *Philonotis mollis* (Dozy & Molk.) Mitt., J. Proc. Linn. Soc., Bot., Suppl. 1: 60. 1859.
Bartramia mollis Dozy & Molk., Ann. Sci. Nat. Bot., sér. 3, 2: 300. 1844.

RANGE IN VIETNAM. Northwest. Lao Cai (Paris 1902). Red River Delta. Vinh Phuc (Ninh 1980). North Central Coast. Ha Tinh (Tan & Ninh 2003), Thua Thien-Hue (Potier de la Varde 1917). South Central Coast. Da Nang (He & Nguyen 2012), Khanh Hoa (Potier de la Varde 1923). Specimens of this species in Vietnam have not been revised in this study.

TOTAL RANGE. *Philonotis mollis* ranges from the Himalayas to Japan in east and to New Guinea in south.

2.7 *Philonotis speciosa* (Griff.) Mitt., J. Proc. Linn. Soc. Bot., Suppl. 1: 64. 1859.
Bartramia speciosa Griff., Calcutta J. Nat. Hist. 2: 513. 1842.

Philonotis mercieri Broth. & Paris in Paris, Rev. Bryol. 29: 95. 1902 ("*Mercieri*"). **syn. nov.** Lectotype (designated here): From the label of the specimen: "Tonkin super., Mgai Pio, inlet Muong Ham u n. le Col des Nuages (1,200 m alt.), ad arboret, 5.XII.1901, *Mercier*" (H-BR, ex Herb. E. G. Paris., "*Philonotis Mercieri* n.sp.", manu V. F. Brotherus, see below). Syntype: From the protologue: Rochers humides dans la vallée de Nam Pou Ho, affluent du Ngoi Phat Hao, près Muong Hum (650 m alt.), 3 décembre 1901, *Mercier*" (MNHN-PC-PC0133473, voucher not seen).

Koponen (1998) tentatively synonymized *Philonotis speciosa* with *P. turneriana* (Schwägr.) Mitt. The study of more material and comparison of the type specimens (Koponen 2010b, see the discussion there) confirmed that these taxa are distinctly different species (see also Eddy 1996).

The lectotype of *Philonotis mercieri* is typical *P. speciosa*. Two characters separate *P. speciosa* from most other species of *Philonotis*: (1) The leaves end with a shortly acute apex, not acuminate or piliferous (but plants with acuminate leaf apices and even piliferous plants occur in the Himalayas), and (2) the marginal teeth are distinctly serrate lacking a double serrate, or more accurately, biseriate, margin (see Koponen 2019b). The costa is percurrent and the leaf cells are narrow from the apex to the base and have a prominent papilla at the distal cell end. At the basal leaf angles is a small group of subquadrate to roundish cells. The special habitus character, the leaves diverging from the stem at a wide angle and making the leaf hook-like (Koponen 2010b), confirms the identification.

The typification of *Philonotis mercieri* is problematic. The name and "n.sp." appears on the label in Brotherus's hand, but the locality data given on the label of the lectotype and in the protologue are different (see above). Possibly J.E.G.N Paris had two specimens (collected at 1,200 and 1,650 m) with one being sent to Brotherus while Paris retained the second. When

Brotherus sent the description, Paris copied to the manuscript the data of the specimen he had in his possession and it was published (Paris 1902). Since Brotherus's name is given first in the protologue it means that he made the description from the specimen in his herbarium, and we select that specimen as the lectotype. However, the altitude on the syntype in PC, 1,650 m, differs from the protologue where it is 650 m, a probable typographical error. The confusion of the data between Brotherus and Paris can be confirmed only by studying the specimen in Paris's herbarium (in REN, or PC). The locality on the label in H-BR is the same as that given for *Racopilum schmidii* Müll.Hal. in Paris (1902).

RANGE IN VIETNAM. Northwest. Lao Cai Province, the lectotype of *P. mercieri*.

TOTAL RANGE. Kabiersch (1937) and Eddy (1996) recorded *Philonotis speciosa* from India, Nepal and Philippines only. The range is still insufficiently known.

2.8 *Philonotis thwaitesii* Mitt., J. Proc. Linn. Soc., Bot., Suppl. 1: 60. 1859 ("Thwaitesii").
Fig. 5; Fig. 14A.

Philonotis revoluta Bosch & Sande Lac., Bryol. Jav. 1. 158, pl. 128. 1861.
Synonymized by Ochi (1970).

Philonotis socia Mitt., J. Linn. Soc., Bot. 8: 151. 1864. Synonymized by Ochi (1970).

Philonotis angusta Mitt. var. *tonkinensis* Besch., Bull. Soc. Bot. France 34. 96. 1887.
Type. Vietnam. Prov. de Ninh-binh: Yen-moi, maison de campagne du college Phuc-nhae, sur les talus sablonneux, frais, 1.IV.1881, *Bon 406* (PC; not seen).
Synonymized by Fleischer (1904).

Philonotis thwaitesii can be found intermixed with *P. lancifolia*. These species have both leaf margins revolute to near the acuminate leaf apex (in *P. thwaitesii*), or to an acute or shortly acuminate apex (in *P. lancifolia*). The leaves are ovate, but *P. lancifolia* has the leaves broadest above the insertion v.s. the leaves are broadest at the insertion in *P. thwaitesii*. The safest distinguishing character is the wide area of quadrate cells in basal angle of the leaf of *P. thwaitesii*, separated from costa with only a few rectangular cells, while *P. lancifolia* has a smaller group of \pm quadrate cells at the basal angles, separated from costa by many elongated cells. *Philonotis lancifolia* also has creeping stems while *P. thwaitesii* has erect stems.

RANGE IN VIETNAM. Northwest. Lao Cai (Paris 1901). Northeast. Cao Bang (He & Nguyen 2012). Red River Delta. Ninh Binh (Bescherelle 1887). North Central Coast. Ha Tinh (Pócs *et al.* 1967). South Central Coast. Quang Nam* (loc. 5. Nguyen & Luong 18473). Central Highlands. Lam Dong* (loc. 14.3. Nguyen & Luong 18776)

TOTAL RANGE. In temperate and warm temperate zones from Himalaya to Japan in east and New Guinea in south. Range maps. Japan (Ochi 1963: pl. 25, as *Philonotis socia*); China (Zang & He 2007: 180, Fig. 15).

Excluded taxa

Philonotis lancifolia Mitt., J. Proc. Linn. Soc., Bot. 8: 148. 1864.

The record of *Philonotis lancifolia* in Vietnam, Ha Tinh Province, is based on misidentification. The specimen *Tan 02-278*, reported by Tan & Ninh (2003) as *P. lancifolia*, is

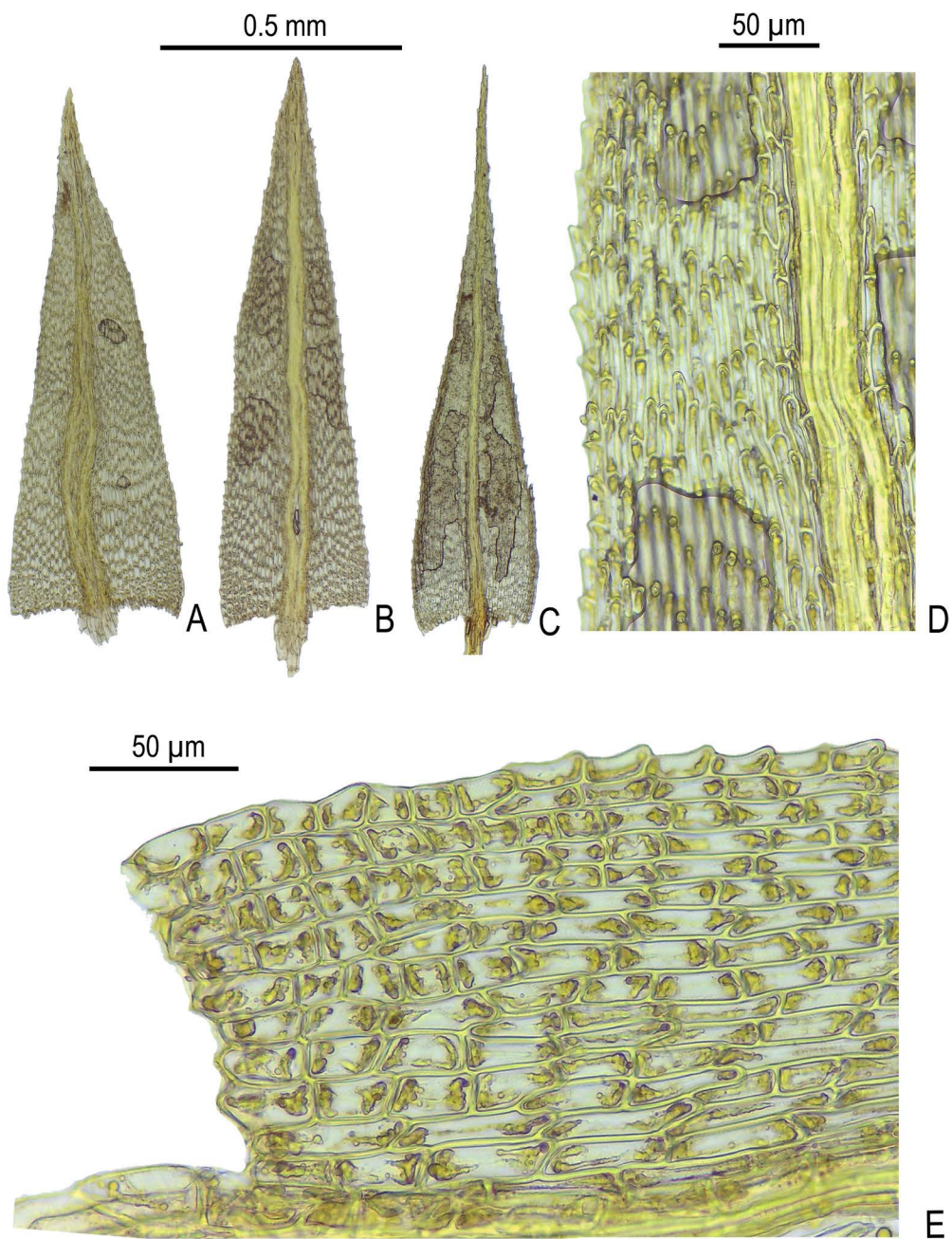


Figure 5. *Philonotis thwaitesii* Mitt. A–C. Leaves. D. Mid-leaf cells with papillae at distal cell end. E. Quadrate cells in leaf base separated from costa by only a few rectangular cells. A–B & D–E from Nguyen & Luong 18473; C from Nguyen & Luong 18776.

referable to *P. falcata*.

Philonotis turneriana (Schwägr.) Mitt., J. Proc. Linn. Soc., Bot., Suppl. 1: 62. 1859.

Bartramia turneriana Schwägr., Spec. Musc. Suppl. 3(1): 238. 1828 (“*Turneriana*”).

The taxonomy of *Philonotis* species with long, gradually tapering acuminate and often piliferous leaves [*P. asperifolia* Mitt., *P. falcata*, *P. mollis*, *P. nitida* Mitt., *P. secunda* (Dozy & Molk.) Bosch & Sande Lac., and *P. turneriana*], is confusing. Of these species, *P. turneriana* seems to be strictly a Himalayan taxon. All the Japanese specimens we have examined and named as *P. turneriana* represent other taxa (Koponen 2009). Neither has *P. turneriana* been found in Hunan Province of China (Koponen 2019c). The problem has been discussed by Koponen (2009, 2010b, 2019b).

The specimen *Tan 02-299* previously reported as *P. turneriana* (Tan & Ninh 2003) is renamed as *P. laii*. The identity of other Vietnamese specimens listed as *P. turneriana* by He & Nguyen (2012), Paris (1911) and Jovest-Ast & Schmid (1958) need to be confirmed.

B. Mniaceae Schwägr. in Willd., Sp. Pl., ed. 4. 5(2): 25. 1830.

The taxonomy, nomenclature, typification and ranges of the species of Mniaceae in SE Asia were dealt with in a series of papers (Koponen 1972, 1973a, 1974, 1980, 1981; Koponen & Norris 1983; Koponen 1994, 2014a, 2014b), the latest most relevant being Koponen & Sun (2017) and Koponen (2017, 2019d).

He & Nguyen (2012) recorded three genera of Mniaceae for Vietnam: *Mnium* Hedw. with one species, *Orthomnion* Wils. with two species, and *Plagiomnium* T.J.Kop. with six species. Zhang *et al.* (2016) added *Rhizomnium* (Broth.) T.J.Kop. to the flora.

Key to Mniaceae in Vietnam

1. Leaf margin serrate; capsule horizontal or pendulous; peristome complete 2
1. Leaf margin entire; capsule erect; peristome reduced 8
2. Teeth of leaf margin double *Mnium lycopodioides*
2. Teeth of leaf margin single 3
3. Leaves serrate from apex to mid-leaf; leaf apex acute *Plagiomnium acutum*
3. Leaves serrate to base (on reduced stolons often entire); leaf apex acute, obtuse or emarginate 4
4. Mid-leaf cells 50–120 μm long 5
4. Mid leaf cells shorter than 62 μm long 6
5. Leaf border with \pm thin-walled rectangular cells; teeth of leaf margin formed by 1–2 cells; leaves not decurrent; mid-leaf cells 33–70 \times 55–120 μm *P. succulentum*
5. Leaf border with thick-walled, narrow elongated cells; teeth of leaf margin formed by 1–3(–4) cells; leaves decurrent; mid-leaf cells 17–57 \times 30–107 μm *P. tezukae*
6. Leaf cells isodiametric to short elongate, with very thin, pitted walls and distinct small trigones; synoicous *P. wui*
6. Leaf cells \pm rectangular to oblong-hexagonal, thick-walled, not pitted; synoicous or dioicous 7

7. Synoicous, often with sporophytes; leaves linear, undulate; rectangular juxtacostal cells clearly visible, much larger than adjoining laminal cells; leaf cells less than 40 μm long *P. rhynchophorum*
7. Dioicous, sporophytes rare; leaves elliptic, plane; juxtacostal cells not larger than adjoining laminal cells; mid-leaf cells 45–62 μm long *P. integrum*
8. Leaf border at mid-leaf 2–3 cells wide, partly bistratose; border cells thick-walled, narrow and elongated *Orthomnion bryoides*
8. Leaf hardly bordered or bordered by 1(–2) rows of elongated, thin-walled cells, at mid-leaf unistratose 9
9. Leaf not bordered at apex; leaves fragile, in old leaves only remnants of lamina or only costa remaining; when wetted creeping stolons remain in spiral position *O. javense*
9. Leaf bordered at apex by 1 row of elongated, thin-walled cells; leaves remain entire; when wetted creeping stolons arranged in flat position *O. dilatatum*

1. *Orthomnion* Wils., in Mitt., Kew J. Bot. 9: 368. 1857.

Mnium sect. *Orthomnion* (Wils.) Mitt., J. Proc. Linn. Soc., Bot., Suppl. 1: 142. 1859.
For nomenclatural details, see Ochyra *et al.* (2017).

1.1 *Orthomnion bryoides* (Griff.) Nork., Trans. Brit. Bryol. Soc. 3: 445. 1958. Fig. 6; Fig. 14B.

Orthotrichum? *bryoides* Griff., Calcutta J. Nat. Hist. 2: 486. 1842.

Orthodon bryoides (Griff.) Mitt. & Wils., Hook. J. Bot. Kew Gard. Misc. 9: 368. 1857.
nom. inval.

The juxtacostal cells of Vietnamese specimens are clearly larger than adjoining laminal cells only at the upper part of costa, and similar in size with adjoining laminal cells toward leaf base.

RANGE IN VIETNAM. Red River Delta. Ninh Binh (He & Nguyen 2012), Vinh Phuc (He & Nguyen 2012). Central Highlands. Gia Lai* (loc. 12.2. *Dinh & Nguyen KKK-412*), Lam Dong (Koponen 1980; loc. 14.3. *Nguyen & Luong 18790, Tram LB-19010*).

TOTAL RANGE. As 2: Chi; As 3: Bu, In, La, Ne, Tha, Vi.—Range maps. Total range (Koponen 1980: 48, Fig. 42); China (Li *et al.* 2007: 105, Fig. 1).

1.2 *Orthomnion dilatatum* (Mitt.) P.C.Chen, Feddes Repert. 58: 25. 1955 (“*Orthomnium*”). Fig. 7; Fig. 14E.

Mnium dilatatum Wils. ex Mitt., J. Proc. Linn. Soc., Bot., Suppl. 1: 143. 1859.

Mnium dilatatum Wils. in Mitt. & Wils., Hook. J. Bot. Kew Gard. Misc. 9: 368. 1857.
nom. nud.

Orthomniopsis dilatata (Mitt.) Nog. in Hara, Fl. Eastern Himalaya 563. 1966.

Orthomnion dilatatum has thus far been reported only from North Vietnam.

RANGE IN VIETNAM. Northwest. Lao Cai (Pócs 1966), Son La (Ninh & Lan 1999). Northeast. Cao Bang (He & Nguyen 2012; *Zhu et al. 20131026-79 & Zhu et al.*

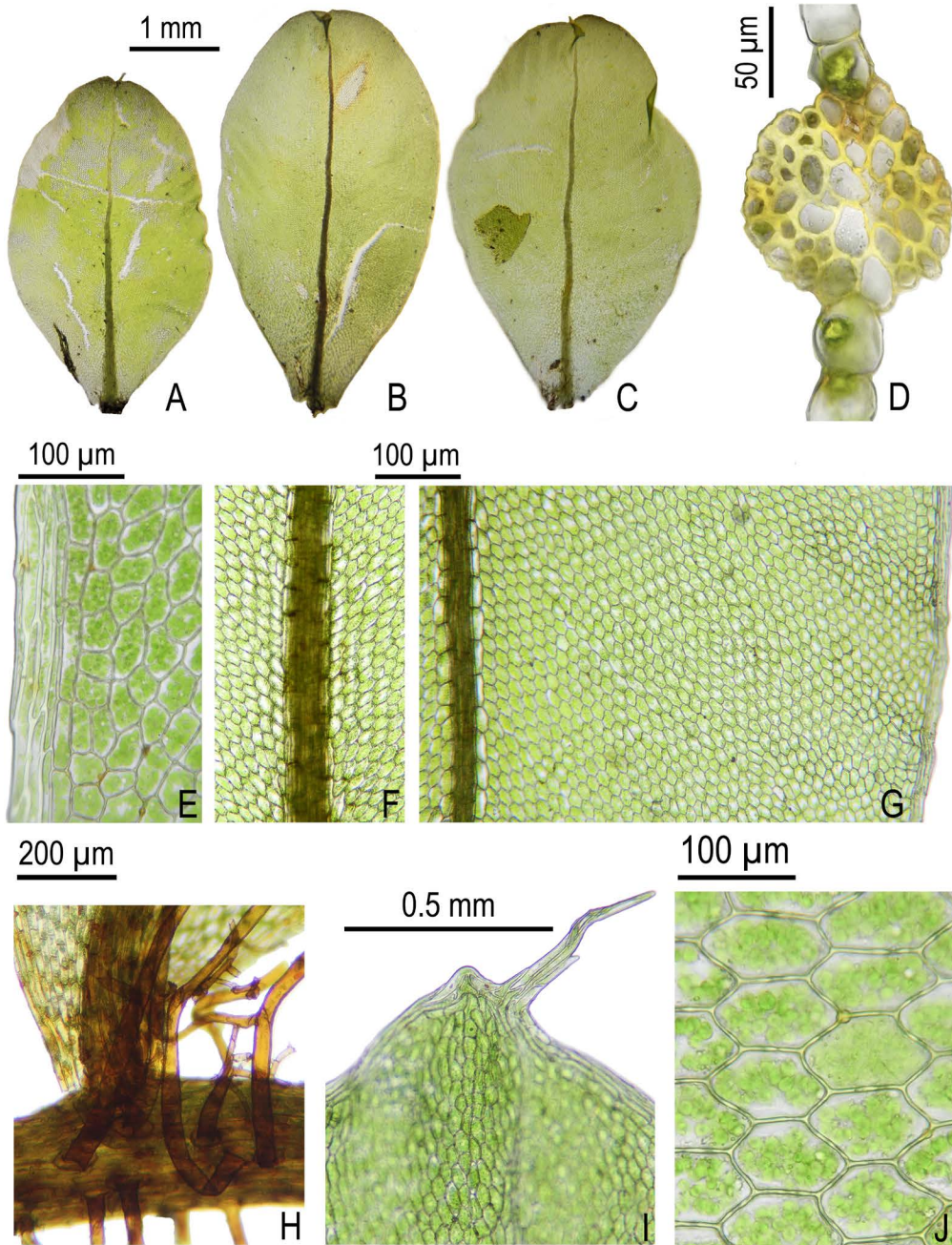


Figure 6. *Orthomnion bryoides* (Griff.) Nork. A–C. Leaves from stolons. D. Cross-section of costa. E. Leaf border at mid-leaf with 2–3 cells broad. F. Juxtacostal cells at leaf base that are similar in size with adjoining laminal cells. G. Juxtacostal cells at the upper part of costa that are clearly larger than adjoining laminal cells. H. Leaf base without decurrencies. I. Leaf tip. J. Mid-leaf cells. A–D from *Dinh & Nguyen KKK-412*; E–J from *Tram LB-19010*.

20131027-102, HSNU, misidentified as *Rhizomnium magnifolium* in Zhang *et al.* 2016), Ha Giang* (Zhu *et al.* 20131103-54, HSNU, misidentified as *Plagiomnium integrum* in Zhang *et al.* 2016), Thua Thien-Hue (He & Nguyen 2012). Red River Delta. Vinh Phuc (He & Nguyen 2012; Pócs 1966; Luong & Dinh 14597).

TOTAL RANGE. As 2: Chi, Ja; As 3: In, Ne, Sri, Vi; As 4: Ind, Ma, Phi. Range maps: Total range (Koponen 1980: 39, Fig. 2; 40, Fig. 3); China (Li *et al.* 2007: 105, Fig. 2).

1.3 *Orthomnion javense* (M.Fleisch.) T.J.Kop., Ann. Bot. Fennici 17: 53. 1980. Fig. 8; Fig. 14C, D.

Mnium javense M.Fleisch., Musci Fl. Buitenzorg 2: 585. 1904.

Orthomnion loheri Broth., Öfv. Finska Vetensk. Soc. Förh. 47(14): 6. 1905.

Orthomnion javense is reported here for the first time from Vietnam. Previously known only from Java Island, until Yi & He (2015) discovered that some Chinese specimens named as *Plagiomnium elimbatum* (M.Fleisch.) T.J.Kop. are referable to *Orthomnion javense* and as also identical to *O. loheri*, a species known from Japan, Philippines and New Guinea (Koponen & Norris 1983). According to Koponen (2017) the range is rather wide but there are few collections. This may be due to its epiphytic habitat and special growth habit. The leaves appear very fragile and fragmentation begins as soon as the leaves are fully grown and continues until all laminal cells are destroyed, so that on the old stem only the costa remains.

RANGE IN VIETNAM. Red River Delta. Vinh Phuc* (loc. 2.2. Luong & Dinh 14647). South Central Coast. Binh Dinh* (loc. 7. Dinh BD-Br-002, BD-Br-003). Central Highlands. Lam Dong* (loc. 14.5. Nguyen 18646).

TOTAL RANGE. As 2: Chi, Ja; As 3: Ind, Laos, PNG, Phi. Range map: Koponen (2017).

2. *Mnium* Hedw., Spec. Mucs. 188. 1801.

2.1 *Mnium lycopodioides* Schwägr., Spec. Musc. Suppl. 2(2): 24, pl. 160, Figs. 1–9. 1826.

Ninh (1981) reported *Mnium lycopodioides* from Vietnam but we have not seen the voucher specimen.

RANGE IN VIETNAM. Red River Delta. Vinh Phuc (Ninh 1981).

TOTAL RANGE. Am 1; Eur; As 1; As 2: Chi, Ja, Ko; As 3: In, Ne, Bhu; As 4: PNG (Koponen & Norris 1983); As 5.—Range maps: North America (Koponen 1979 as *M. ambiguum*), Fennoscandia (Hallingbäck 2008), Sakhalin (Bakalin *et al.* 2012).

3. *Plagiomnium* T.J.Kop., Ann. Bot. Fennici 5. 145. 1968.

3.1 *Plagiomnium acutum* (Lindb.) T.J.Kop., Ann. Bot. Fennici 12: 57. 1975. Fig. 9.

Mnium acutum Lindb., Contr. Fl. Crypt. As. 227. 1872.

Mnium remotifolium Besch., Rev. Bryol. 25: 74. 1898. Isotype: Vietnam. Rochers calcaires et sees de Dong-Si, 2.I.1894, *Bollet 12* (PC). Synonymized by Koponen (1981).

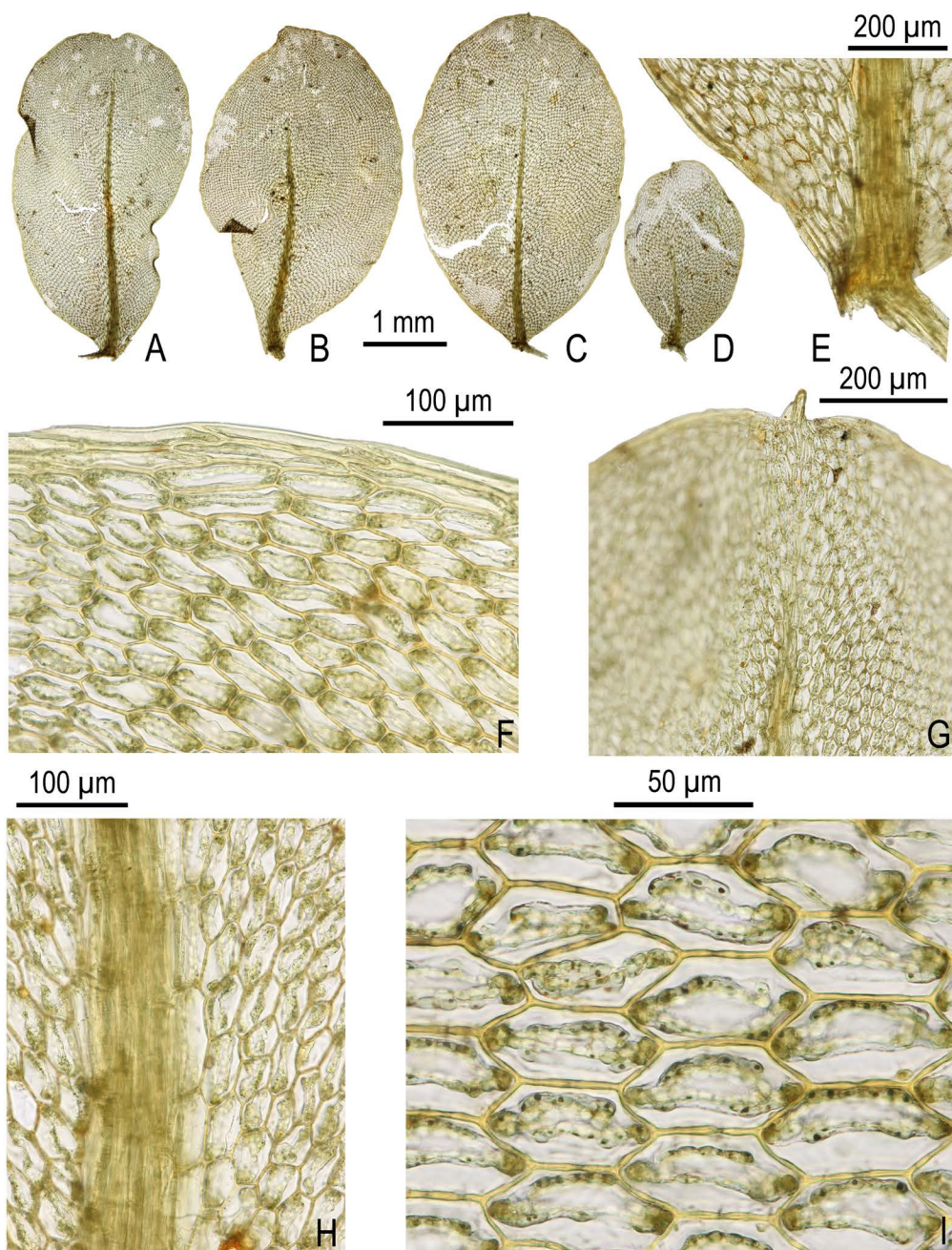


Figure 7. *Orthomnion dilatatum* (Mitt.) P.C.Chen. A–D. Leaves from stolons. E. Leaf base without decurrencies. F. Leaf bordered at near apex by one row of elongated, thin-walled cells. G. Leaf tip. H. Juxtacostal cells at mid-leaf. I. Mid-leaf cells. A–I from *Luong & Dinh 14597*.

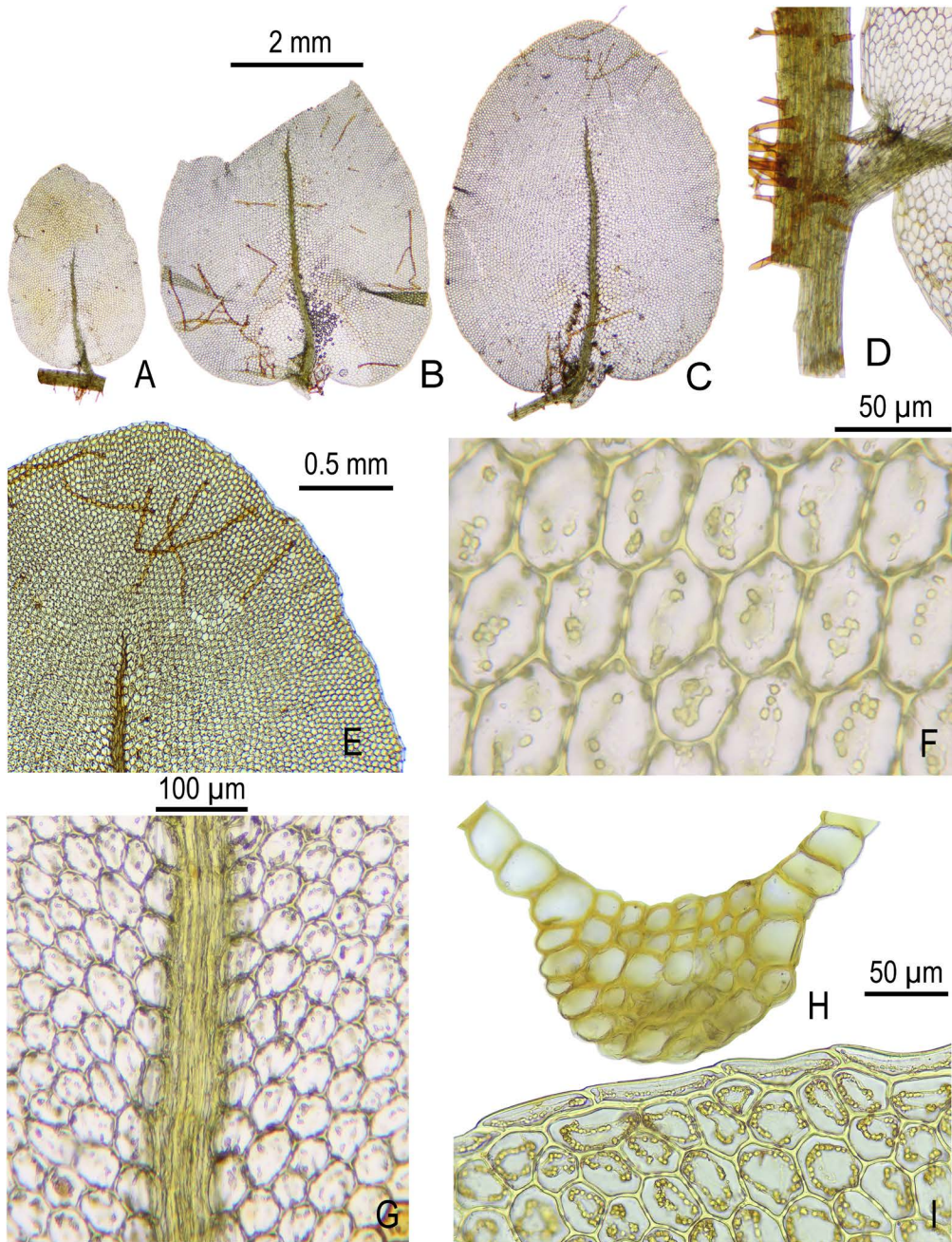


Figure 8. *Orthomnion javense* (M.Fleisch.) T.J.Kop. A–C. Fragmenting leaves from stolons. D. Leaf base without decurrencies. E. Leaf without bordered at apex. F. Mid-leaf cells. G. Juxtacostal cells at mid-leaf. H. Cross-section of costa. I. Leaf bordered by one row of elongated, thin-walled cells. A–E, G & H from *Nguyen 18646*; F & I from *Dinh BD-Br-003*.

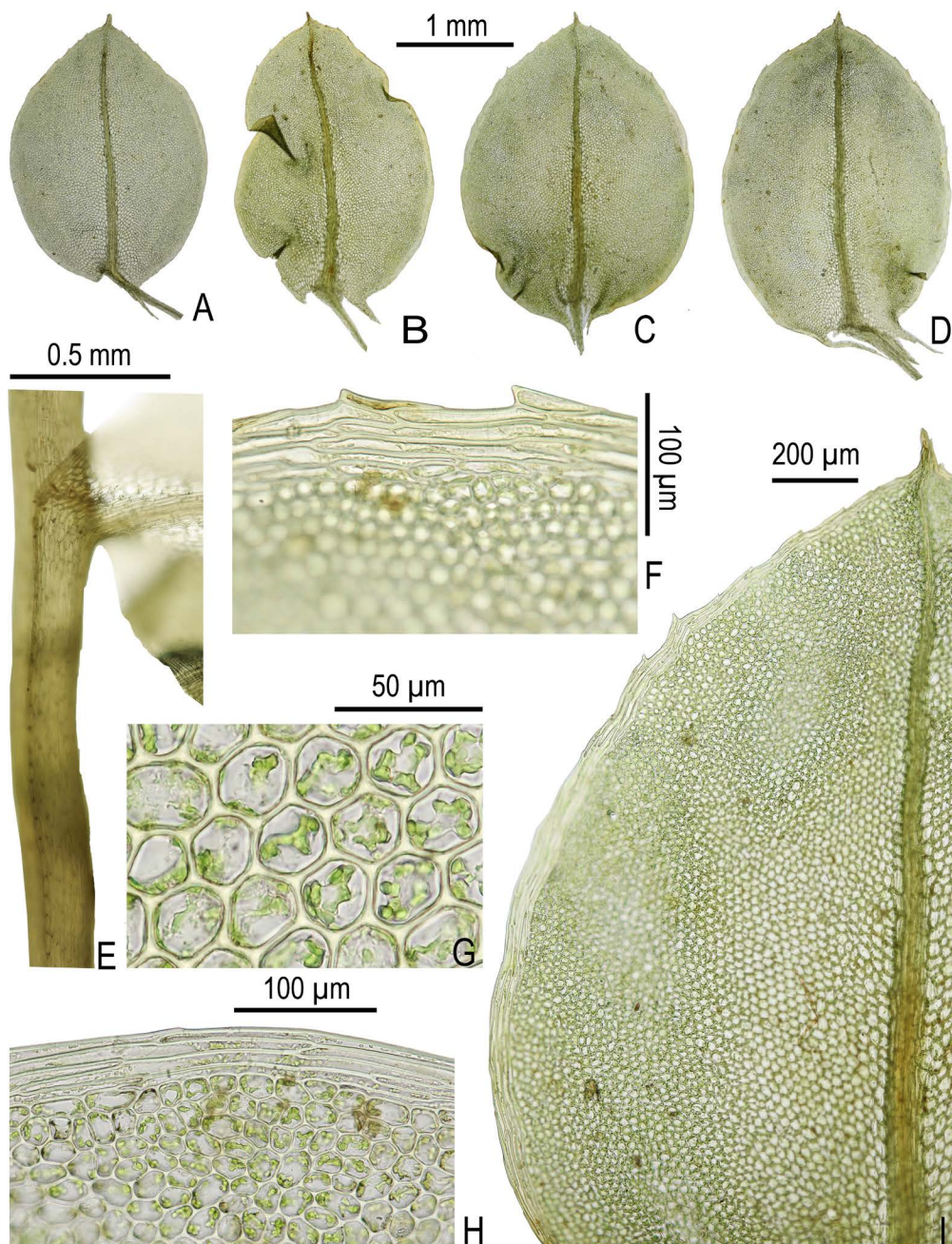


Figure 9. *Plagiomnium acutum* (Lindb.) T.J.Kop. A–D. Leaves from stolons. E. Leaf base with long decurrencies. F. Leaf border with serration from apex to mid-leaf. G. Mid-leaf cells. H. Marginal border entire from mid-leaf to base. I. Leaves serrate from apex to mid-leaf, leaf apex acute. A–I from *Zhu et al. 2013*1107-170.

As explained under excluded species below, specimens *Zhu et al. 20131022-10A*, *Zhu et al. 20131022-28A* and *Zhu et al. 20131022-80* collected from Cao Bang and a specimen *Zhu et al. 20131107-170* from Ha Giang (all specimens in HSNU) were misidentified as *Plagiomnium cuspidatum* in Zhang *et al.* (2016).

RANGE IN VIETNAM. Northwest. Hoa Binh (Koponen 2014c: 123), Lao Cai (Ninh 1981). Northeast. Cao Bang (Bescherelle 1898 as *Mnium remotifolium*; He & Nguyen 2012; Zhang *et al.* 2016 as *Plagiomnium cuspidatum*), Ha Giang (He & Nguyen 2012; Zhang *et al.* 2016 as *Plagiomnium cuspidatum*). Red River Delta. Vinh Phuc (Ninh 1981, Koponen 2014c: 123).

TOTAL RANGE. *Plagiomnium acutum* has a wide range from Western Himalaya through China and its neighboring countries to Japan and the Russian Far east. A selection of specimens from that area is listed in Koponen (2014c). As 1: Russia (Koponen & Ignatova 2018b); As 2: Chi, Ja, Ko, Mo; As 3: Bhu, In, Ne, Vi.

3.2 *Plagiomnium rhynchophorum* (Hook.) T.J.Kop., Hikobia 6: 57. 1972 (“1971”). Fig. 10; Fig. 14F, G.

Mnium rhynchophorum Hook. Icon. Pl. Rar. 1, tab. 20, Fig. 3. 1836 (figures only); Hook. ex Harvey in Hook., J. Bot. 2: 11. 1840. (detailed description)

Plagiomnium rhynchophorum is reported here for the first time from South Vietnam. The species usually grows on soil near brooks.

In addition, specimens *Zhu et al. 20131101-66* & *Zhu et al. 20131107-67A* (HSNU) were misidentified as *Plagiomnium maximoviczii* in Zhang *et al.* (2016).

RANGE IN VIETNAM. Northwest. Lao Cai (He & Nguyen 2012; Koponen 2014c: 124). Northeast. Ha Giang (He & Nguyen 2012; Zhang *et al.* 2016). Red River Delta. Ninh Binh (He & Nguyen 2012), Vinh Phuc (Ninh 1981, 1993; Koponen 2014c: 124). South Central Coast. Khanh Hoa* (loc. 9. *Dinh KH-Br-092*, *KH-Br-102*). Central Highlands. Lam Dong* (loc. 14.3. *Luong 15223*, *Luong & Duong LB 02175*; loc. 14.1. *Luong & Duong 15542*, *15544*, *15388*, *15559*, *15586*; loc. 14.6. *Huttunen 23112018-48*).

TOTAL RANGE. Am 1: (*Plagiomnium rhynchophorum* var. *carolinianum*); Am 2–5; Afr 2–4; As 2: Chi; As 3: Bhu, In (NW, NE, S) Ne, Sri, Tha, Vi; As 4. Ind, Phi, Sab; Oc: Hawaii. Range map: Koponen (1982a. 80, Fig. 4).

3.3 *Plagiomnium succulentum* (Mitt.) T.J.Kop., Ann. Bot. Fenn. 5: 147. 1968. Fig. 11; Fig. 14H.

Mnium succulentum Mitt., J. Proc. Linn. Soc., Bot., Suppl. 1: 143. 1859.

Mnium voxense Besch., Bull. Soc. Bot. France 41: 82. 1894. Province de Ha-Noi, Vo-Xa, adherent aux troncs d'arbres sur les monts Thung-Gang, 21.X. 1886, *Bon 3242* (PC; not seen). Synonymized by Kabiersch (1936).

Mnium subvesicatum Broth. & Paris, Rev. Bryol. 35: 44. 1908. Lectotype (designated by Koponen 1981): Vietnam. Tonkin, prov. de Vinhien, in catena Tam Duo, 9–1,100 m, V.1907. *Eberhardt* (H-BR). Synonymized by Kabiersch (1936).

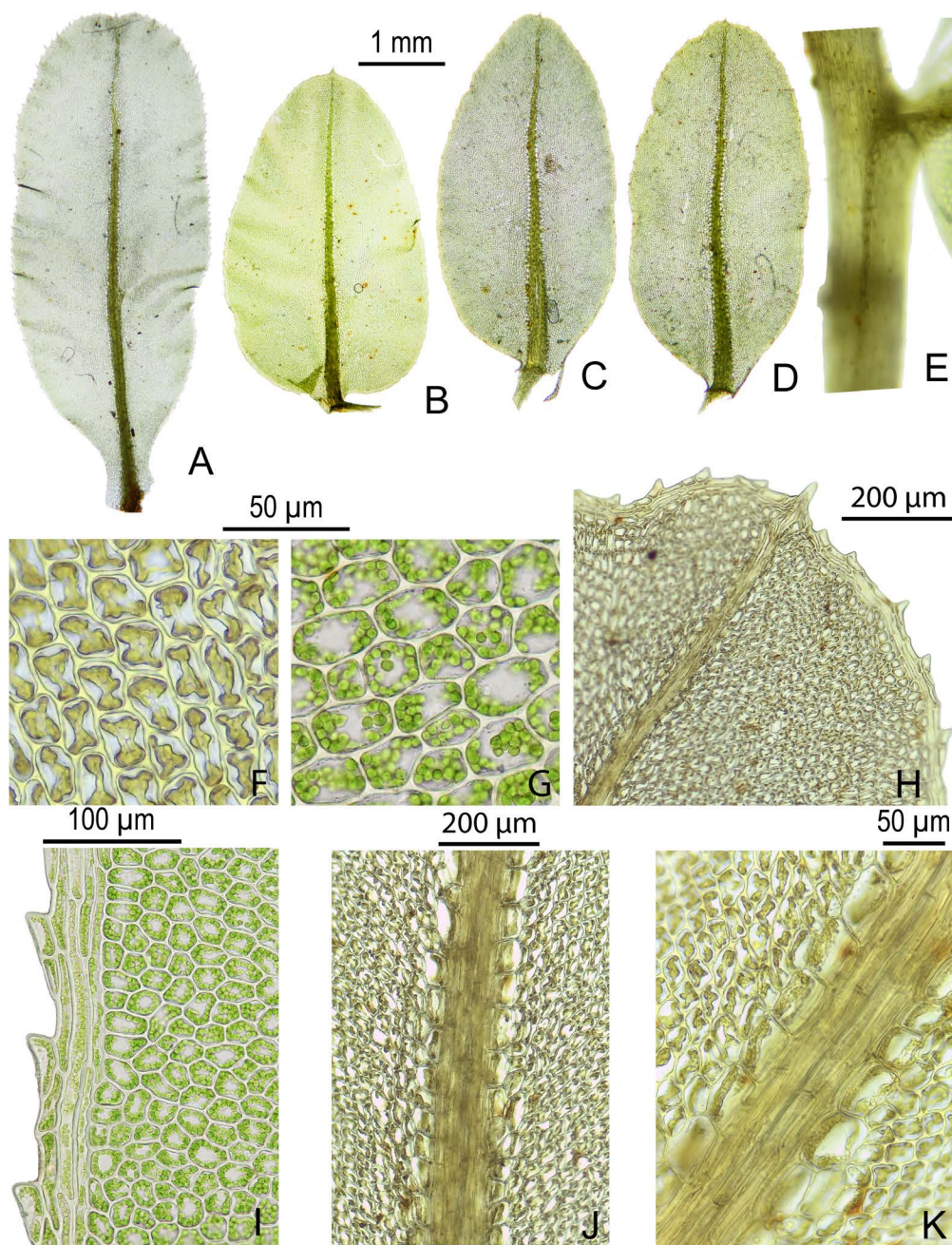


Figure 10. *Plagiomnium rhynchophorum* (Hook.) T.J.Kop. A. Leaf from fertile stem. B–D. Leaves from stolons. E. Leaf base with long decurrencies. F & G. Mid-leaf cells. H. Leaf apex with strong border. I. Leaf border with teeth. J & K. Juxtacostal cells that are much larger than adjoining laminal cells. A, C–E from *Dinh KH-Br-102*; B, G & I from *Huttunen 23112018-48*; F, H, J & K from *Dinh KH-Br-092*.

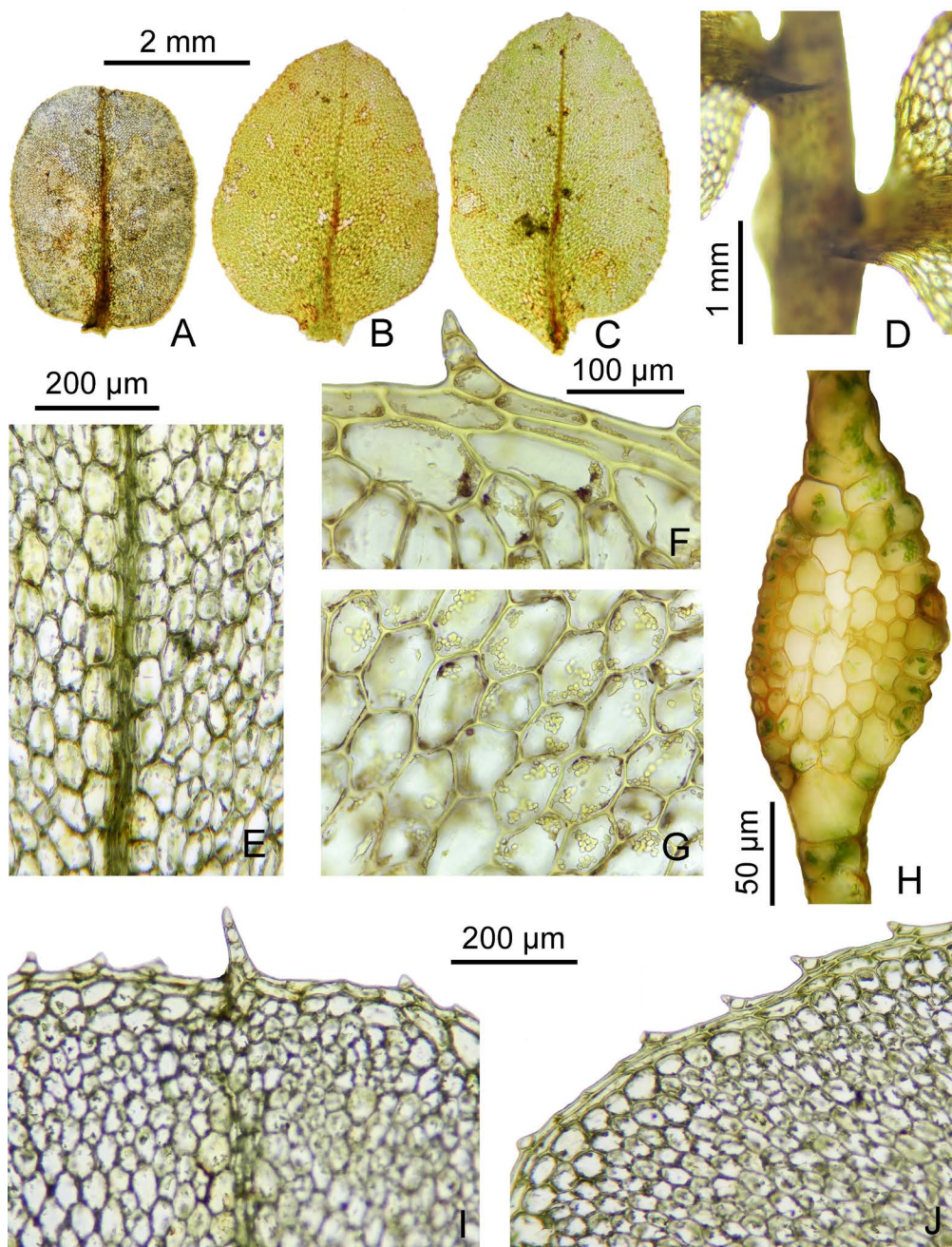


Figure 11. *Plagiomnium succulentum* (Mitt.) T.J.Kop. A–C. Leaves from stolons. D. Leaf base without decurrencies. E. Juxtacostal cells. F. Teeth at leaf margin formed by 1–2 cells. G. Mid-leaf cells. H. Cross-section of costa. I. leaf apex. J. Leaf border with \pm thin-walled rectangular cells. A–C, H from *Dinh & Nguyen KKK-646*; D–G, I & J from *Dinh PY-Br-037*.

Plagiomnium succulentum is a new record for Quang Nam and Gia Lai provinces. It seems to be quite widely distributed in Vietnam, from North to South.

RANGE IN VIETNAM. Northwest. Lao Cai (Paris 1902), Son La (Ninh & Lan 1999). Northeast. Lai Chau* (loc. 1. *H.C.Nguyen 19010*). Red River Delta. Ha Noi (Bescherelle 1894), Ninh Binh (Pócs 1966), Vinh Phuc (Paris 1908, as *Mnium subvesicatum*; Pócs 1966; Ninh 1981, 1993; loc. 2.2. *Luong & Dinh 14657*). North Central Coast. Ha Tinh (Tan & Ninh 2003). South Central Coast. Quang Nam* (loc. 6.1. *Nguyen 17343*, *Nguyen & Luong 18182*), Phu Yen* (loc. 8.1. *Dinh PY-Br-037*), Khanh Hoa (Thériot 1919; loc. 9. *Dinh KH-Br-080*; loc. 10.1. *Luong & Duong 15790, 15795, 15796*). Central Highlands. Gia Lai* (loc. 12.1. *Dinh & Nguyen KKK-646*), Lam Dong (Tixier 1984; loc 14.1. *Luong & Duong 15540*; loc. 14.4. *Luong BD 1210-080*).

TOTAL RANGE. As 2: Chi, Ja, Ko; As 3: Bhu, In (NE, S) Myan, Ne, Tha, Vi; As 4: Ind, Ma, Phi, PNG.—Range map: Koponen (2017).

3.4 *Plagiomnium tezukae* (Sakurai) T.J.Kop., Ann. Bot. Fennici 5: 146. 1968.

Mnium tezukae Sakurai, J. Jap. Bot. 29(4): 114, 1954.

Tan & Ninh (1998) recorded *Plagiomnium tezukae* from Hoa Binh. The voucher specimen needs re-examination, since *P. tezukae* is found mainly in nemoral temperate (= cool temperate) and oroboreal areas in Japan and China (Koponen 1974, 1994).

RANGE IN VIETNAM. Northwest. Hoa Binh (Tan & Ninh 1998).

TOTAL RANGE. As 1: Russia (Koponen & Ignatova 2018b); As 2: Chi, Ja.

3.5 *Plagiomnium wui* (T.J.Kop.) Y.J.Yi & S.He, Novon 23: 294. 2015. Fig. 12.

Orthomnion wui T.J.Kop., Ann. Bot. Fennici 44: 376, Fig. 1. 2007.

Described as *Orthomnion wui* (Koponen 2007) mainly on its laminal cells which have very thin, unthickened walls with pittings and small trigones. However, the leaf margin is serrulate, while in most *Orthomnion* species the margin is entire. Also, *O. wui* has stereids in the costa, another character of the genus *Plagiomnium*. Accordingly, Yi & He (2015) removed it to *Plagiomnium*. This is only the third report of the species worldwide. In addition to the type from Hubei, it was known only from Jiangsu Province of China (Koponen 2017: 210). The present fertile specimen fits well with *P. wui*. In addition to the size of leaf cells with thin, pitted cell walls and serrulate leaf margins, it is synoicous and the leaves are decurrent. The second specimen is composed of sterile shoots and is identified based on the characters of the leaf margin and thin-walled leaf cells with pittings. The mid-lamina cells in our specimens are about 30–40 µm long.

This species is first recorded in this paper from the specimens cited in Zhang *et al.* 2016: *Zhu et al. 20131023-154* (HSNU), synoicous, misidentified as *Plagiomnium integrum* & *Zhu et al. 20131025-80A* (HSNU), sterile, misidentified as *Plagiomnium maximoviczii*.

RANGE IN VIETNAM. Northeast. Cao Bang* (Zhang *et al.* 2016).

TOTAL RANGE. As 2: Chi; As 3: Vi.

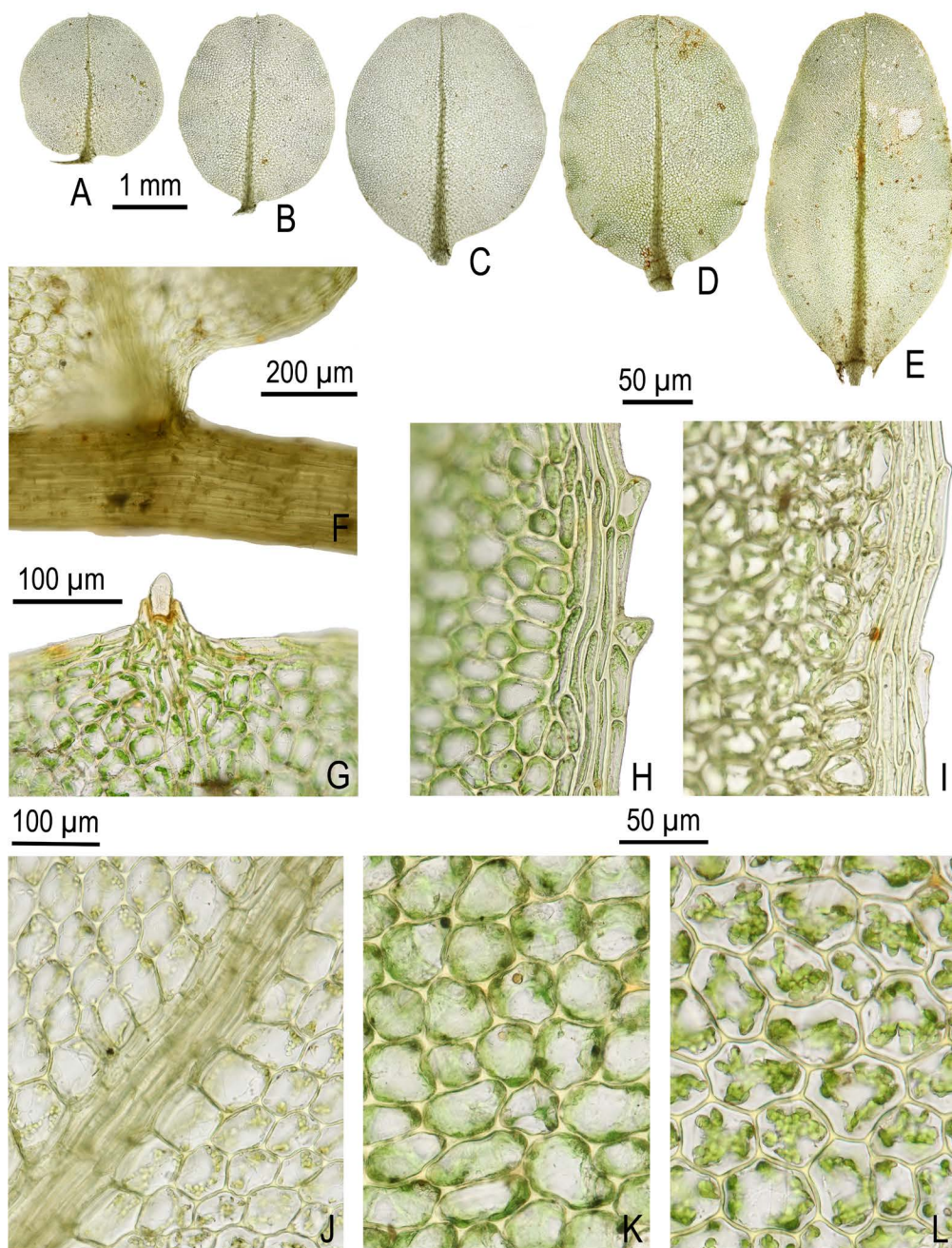


Figure 12. *Plagiomnium wui* (T.J.Kop.) Y.J.Yi & S.He. A–D. Leaves from stolons. E. Leaf from fertile shoot. F. Leaf base with short decurrencies. G. Leaf tip. H. Marginal border with large teeth on leaf from fertile shoot. I. Marginal border with small teeth on leaf from stolon. J. Juxtacostal cells. K. Mid-leaf laminal cells from fertile shoot leaf. L. Mid-leaf laminal cells from stolon leaf. A–L from *Zhu et al. 20131023-154*.

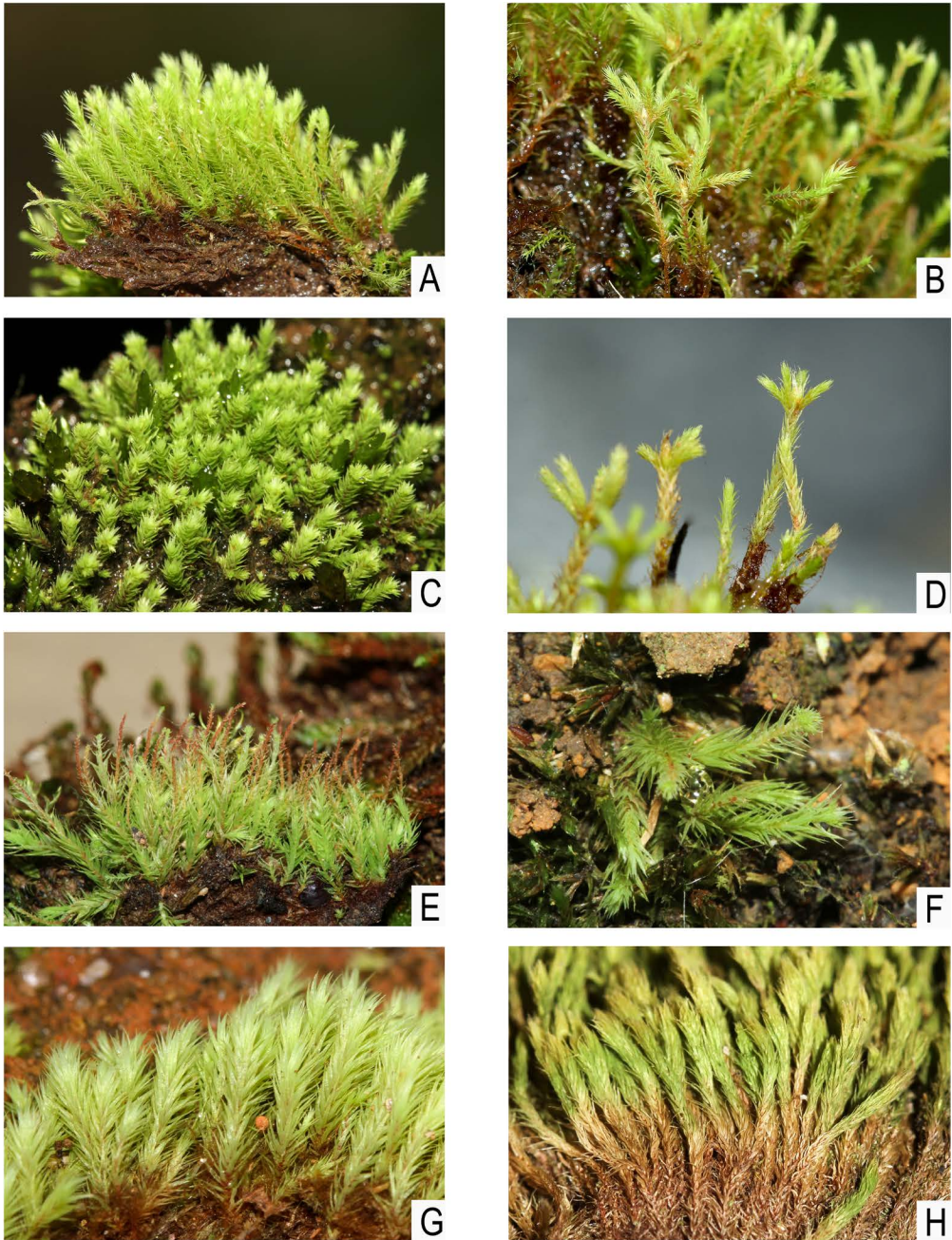


Figure 13. Plant in nature. *Philonotis asperifolia* (A & B); *Philonotis hastata* (C & D); *Philonotis laii* (E–G); *Philonotis falcata* (H). A & B from Nguyen HB-161; C from Dinh & Nguyen KKK-643 (photo by Nhật-Lâm Đình); D from Nguyen HB-127; E from Nguyen 17341; F from Nguyen 18603; G from Nguyen & Luong 18331; H from Dinh ST-038.

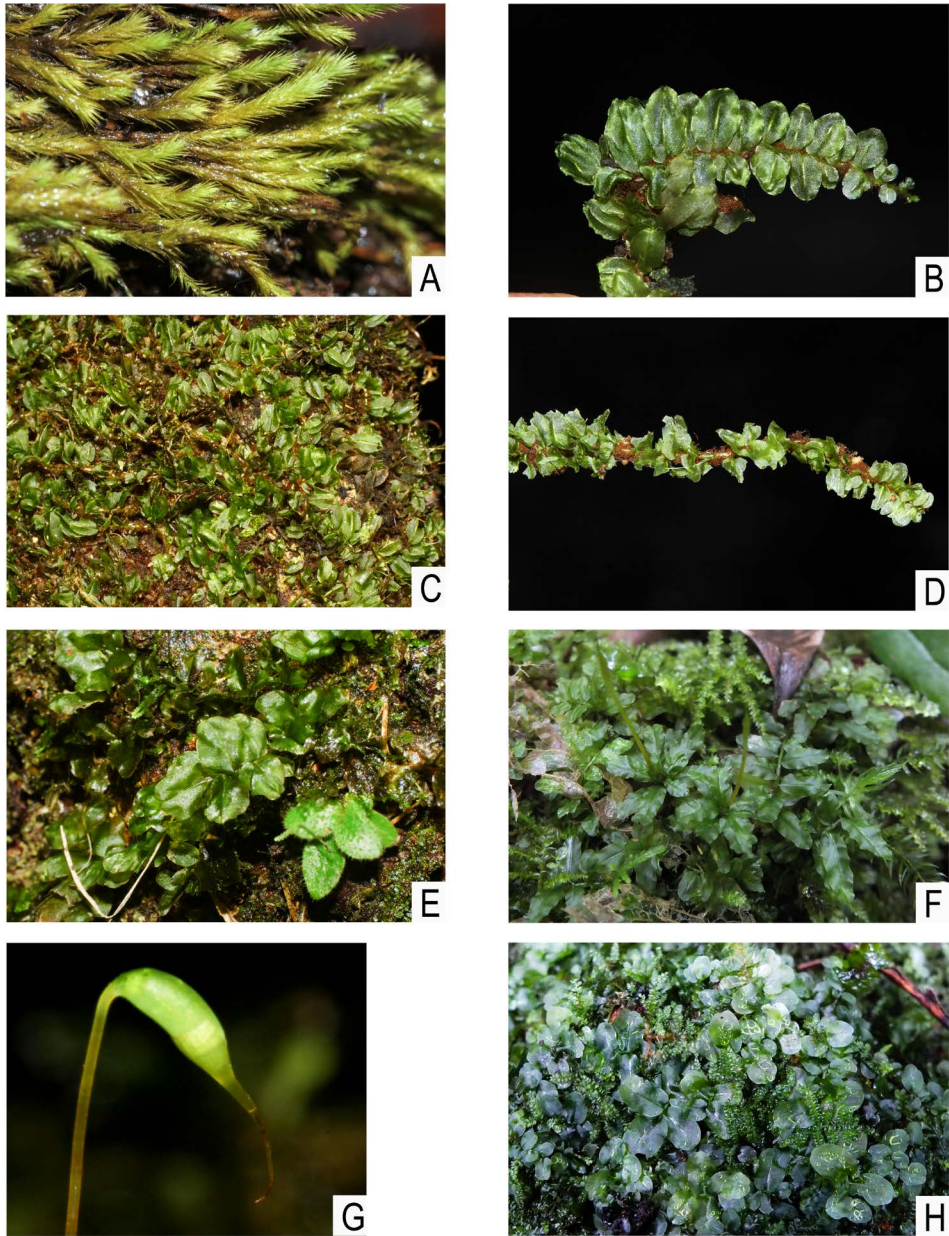


Figure 14. Plant in nature. *Philonotis thwaitesii* (A); *Orthomnion bryoides* (B); *Orthomnion javense* (C & D); *Orthomnion dilatatum* (E); *Plagiomnium rhynchophorum* (F–G); *Plagiomnium succulentum* (H). A from Nguyen & Luong 18776; B from Nguyen & Luong 18790; C from Luong & Dinh 14647; D from Nguyen 18646; E from Luong & Dinh 14597; F from Nguyen Luong & Duong 15388; G from Dinh KH-Br-092 (photo by Nhật-Lâm Đình); H from Luong & Duong 15540.

Excluded taxa

Plagiomnium cuspidatum (Hedw.) T.J.Kop., Ann. Bot. Fennici 5: 148. 1968.

Mnium cuspidatum Hedw., Sp. Musc. 192, tab. 45, Figs. 5–6. 1801.

Zhang *et al.* (2016) reported four specimens of *Plagiomnium cuspidatum* from Vietnam. They all are *P. acutum* (see above). *Plagiomnium cuspidatum* is a holarctic species found in the boreal and nemoral (cool temperate) bioclimatic vegetation zones. In East Asia, Koponen (2014c) identified *P. cuspidatum* specimens only from Japan, the Russian Far East, the Himalayan area, and from Taiwan and Xinjiang Yugur provinces, with one specimen, without locality data, from NE China. The large material from Hunan Province of China Koponen (2014a) contained only *P. acutum*.

Plagiomnium integrum (Bosch & Sande Lac.) T.J.Kop., Hikobia 6: 57. 1972 (“1971”).

Mnium integrum Bosch & Sande Lac. in Dozy & Molk., Bryol. Javanica 1: 153, pl. 122, Figs. 1–15. 1861.

Zhang *et al.* (2016) reported two specimens as *Plagiomnium integrum* from Vietnam. The country is well within the range of *P. integrum* (range map in Koponen 2017, Fig. 4), but the specimens cited are referable to *Othomnion dilatatum* or *Plagiomnium wui*.

Plagiomnium maximoviczii (Lindb.) T.J.Kop., Ann. Bot. Fennici 5: 147. 1968.

Mnium maximoviczii Lindb., Linn. Soc. J. Bot. 13: 201. 1872; Acta Soc. Sci. Fennicae 10: 244. 1873.

Zhang *et al.* (2016) reported *Plagiomnium maximoviczii* as new to Vietnam. However, two of the specimens sent on loan from HSNU are referable to *P. rhynchophorum* and the third specimen is *P. wui* (see above under these taxa). *Plagiomnium maximoviczii* and *P. rhynchophorum* have similar oblong, decurrent leaves, rectangular transparent juxtacostal cells and, in well-developed plants, and projecting leaf marginal teeth are often formed of 2(–3) cells. There are few distinguishing characters. The plants and laminal cells are larger, in *P. rhynchophorum* (10–25 × 15–42 μm), and 7–17 × 12–27 μm in *P. maximoviczii* (Koponen 1972). The leaf cells in *P. rhynchophorum* are more clearly rectangular and the oblique cell rows from the costa to the border are more regular. The herbarium specimens of *P. rhynchophorum* also have a light yellowish colour and the leaves are undulate, while in *P. maximoviczii* the greenish color remains and the well-developed leaves are undulate. Fertile specimens can always be distinguished. *Plagiomnium maximoviczii* is dioicous and *P. rhynchophorum* is synoicous, and they form a dioicous–monoicous species pair (Koponen 2019d). They also have different but overlapping ranges. *Plagiomnium maximoviczii* is a Himalayan–Japanese species while the distribution of *P. rhynchophorum* is warm temperate–pansubtropical.

Plagiomnium rostratum (Schrad.) T.J.Kop., Ann. Bot. Fennici 5: 147. 1968.

Mnium rostratum Schrad., Bot. Zeit. Regensb. 1: 79. 1802.

Mnium longirostre Brid., Musc. Rec. 2(3): 1106. 1803.

He & Nguyen (2012) gave numerous literature references under the name *Plagiomnium rostratum*. However, it is mainly a North American and European species with disjunct localities in western Asia in the Lake Baikal area of Siberia, the Himalayas and a few localities in Northwest China (range map in Koponen 1982a. 80, Fig. 4, 1982b. 78, Fig. 2; see also the discussion in Koponen 2014c). Nearly all the specimens of *P. rhynchophorum* from Indonesia we have examined (loan from L) were named either *Mnium rostratum* or *M. longirostre* (Koponen 2017). The old Vietnamese records (below) given as *P. rostratum* need to be confirmed. For the present, we exclude *P. rostratum* from the flora of Vietnam on the basis of its general phytogeographical range.

Doubtful old records after He & Nguyen (2012): Dong Nai (Jovet-Ast & Schmid 1958), Lam Dong (Jovet-Ast & Tixier 1959), Lao Cai (Pócs 1966), Ninh Binh (Thin 1992), Son La (Ninh & Lan 1999), Vinh Phuc (Ninh 1981).

Plagiomnium undulatum (Hedw.) T.J.Kop., Ann. Bot. Fennici 5: 146. 1968.

Mnium undulatum Hedw., Sp. Musc. 195. 1801.

Tixier (1984) recorded *Plagiomnium undulatum* from Lam Dong. Since *P. undulatum* is mainly an European species, with extensions to the neighboring areas (range map in Koponen 1993), the voucher specimen should be studied. In Asia, two species of *Plagiomnium* sect. *Undulata* occur. *Plagiomnium arbuscula* (Müll.Hal.) T.J.Kop. ranges from the Himalayas to central China with a disjunction in Taiwan, and *P. confertidens* has a northern distribution area from Japan via Siberia to Ural Mts. in Russia.

Rhizomnium magnifolium (Horik.) T.J.Kop., Ann. Bot. Fennici 10: 14. 1973.

Mnium magnifolium Horik., J. Jap. Bot. 11: 503, Figs. 4–5. 1935.

Zhang *et al.* (2016) reported two specimens of *Rhizomnium magnifolium* from Vietnam, Zhu *et al.* 20131026-79 ♀, from tree trunk, and Zhu *et al.* 20131027-102, from rotten tree (both in HSNU). Both are referable to *Orthomnium dilatatum*.

Rhizomnium magnifolium is a species of the boreal vegetation zone (range maps in Koponen 1971b, 1973b; Koponen & Afonina 1992) and it grows in wet habitats such as swamp forests and along creeks, and around springs and in seepage areas; never as an epiphyte.

II. RANGES IN VIETNAM & FLORISTIC ELEMENTS

The species of Bartramiaceae and Mniaceae can be divided into floristic elements based mainly on the bioclimatic vegetation system (Hämet-Ahti *et al.* 1974). Division of the species in these elements is given in Table 1.

Holarctic, continuously or discontinuously circumpolar, boreal to temperate element

Mnium lycopodioides is the only taxon belonging to this element. However, its presence

Table 1. Altitudinal (in meters) and geographical ranges of studied species in Vietnam and their division into biogeographical elements.

Biogeographical regions	Northwest	Northeast	Red River Delta	North Central Coast	South Central Coast	Central Highlands	Southeast	Mekong Delta
Holarctic, continuously or discontinuously circum-polar, boreal to temperate element								
<i>Mnium lycopodioides</i>			950					
Southeast Asiatic temperate–meridional element								
<i>Orthomnion bryoides</i>			335–1213			900–1996		
<i>Orthomnion dilatatum</i>	800–2200	515–1587	950–1300	1386–1450				
<i>Philonotis bartramiooides</i>	1500–1600	1500				700–750		
<i>Philonotis falcata</i>	1500–1600			130–270	67	1500–1900		
<i>Philonotis speciosa</i>	650							
<i>Plagiomnium acutum</i>	250–1750	500–915	1000					
<i>Plagiomnium tezukaе</i>		850						
<i>Plagiomnium wui</i>		585–1907						
Southeast Asiatic meridional to subtropical element								
<i>Fleischerobryum longicolle</i>		1157					1492	
<i>Orthomnion javense</i>			1055	925–935				
<i>Philonotis asperifolia</i>					405			
<i>Philonotis lai</i>	123			110–200		813–1240		
<i>Philonotis mollis</i>			950	100–400	20–700			
<i>Philonotis thwaitesii</i>	80	463	3	300	26	1856		
<i>Plagiomnium succulentum</i>	650–900	2256	9–1100	50	300–1400	1000–2000		
Pantropical and pansubtropical elements								
<i>Philonotis hastata</i>			12	220–270	26–1006	700–1500	7–348	6
<i>Plagiomnium rhynchophorum</i>	1933–1991	915–949	360–1000		983–1372	1500–1981		

in Vietnam needs to be confirmed.

Southeast Asiatic temperate—meridional element

This includes eight species, *Orthomnion bryoides*, *O. dilatatum*, *Philonotis bartramioides*, *P. falcata*, *P. speciosa*, *Plagiomnium acutum*, *P. wui* and *P. tezukae*. These taxa occur in the cool temperate (nemoral) and meridional (warm temperate) zones in continental Asia from the Himalayas to Japan, and in the corresponding oro-zones in the more southerly areas, but not in New Guinea. Ranges of *Philonotis speciosa* and *Plagiomnium wui* are insufficiently known. In Vietnam, the eight taxa occur at higher elevations than those of the taxa included in the Southeast Asiatic meridional to subtropical element, and they have not been collected near sea level (Table 1). More noteworthy is that they occur almost entirely in the northern regions, in the Northeast, Northwest and Red River Delta. The disjunctive record in the Central Highlands agrees with their general ranges in SE Asia.

Southeast Asiatic meridional to subtropical element

Seven taxa, *Fleischerobryum longicolle*, *Orthomnion javense*, *Philonotis asperifolia*, *P. laii*, *P. mollis*, *P. thwaitesii* and *Plagiomnium succulentum* have a wide range in SE Asia extending from the Himalayas to Japan in east and New Guinea in south. In Vietnam, they occur both in northern, central and southern regions, and some have been collected near sea level (Table 1).

Pantropical and pansubtropical elements

Pantropical *Philonotis hastata* is one of the few species studied here thriving in tropical lowland areas (Koponen 2019b). *Plagiomnium rhynchophorum* can be included in the group of pansubtropical taxa. They both have a wide range in Vietnam (Table 1).

Discussion

The division of species into these floristic elements for Viet Name is also shown in many moss families studied from Hunan Province of China and New Guinea (Koponen & Piippo 2004; Enroth & Koponen 2017; Sollman & Koponen 2017; Tan & Koponen 2017; Koponen 2019c; see also Piippo & Koponen 2003). The biogeographical pattern provides the basis for exclusion of eight taxa from the Vietnamese moss flora. Koponen *et al.* (2014) presented the question: “How to deal with records of taxa which are highly doubtful on the basis of the general distribution of the taxon”. The known and confirmed ranges of all the excluded species are remote from Vietnam, making their occurrence in country very unlikely. Two species marked as “Doubtful” require further taxonomic verification. For instance, specimens stored in herbaria under the name *Plagiomnium rostratum* probably belong to several taxa, such as *P. rhynchophorum*, *P. integrum* and *P. wui*.

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