

Studies on Asian Species of *Bazzania*, Hepaticae, I

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Bazzania, a large genus of the Hepaticae, achieved a remarkable speciation in Asia, especially in the tropical region, and Meijer (1960) noted, "the centre of the genus seems to lie in the Malaysian region". The *Bazzania* flora is relatively well-known only in a few restricted areas in Asia—Japan (Hattori & Mizutani 1958), the Himalayas (Mizutani 1967), Thailand (Kitagawa 1967) and North Vietnam (Pócs 1969). Meijer (1960) dealt with many Malaysian species and framed a very useful key for them but unfortunately his description of each species is too brief for a full understanding and accompanied by no illustration. Despite these contributions, a large number of species still remain little-known and it is often difficult to identify even the species occurring commonly in the region. As the genus represents one of the most conspicuous and abundant Hepaticae from the lowlands to the high mountains, especially in the mossy forests in tropical Asia, it is highly desirable to redescribe and illustrate those little-known species and clarify their taxonomy which has been in confusion.

Through the fieldworks in Thailand and Malaya in 1965–66 and 1967, I became acquainted with the ecology of many tropical species of *Bazzania*, and I could examine the type specimens of many Asian species of *Bazzania* in some European herbaria, chiefly in the Stephani Herbarium in Geneva, when I was in Europe in 1969–70. This facilitates greatly to identify a number of specimens accumulated for the present studies; they were collected by myself and by my colleagues in various localities in the region.

1. Some common species of Sumatra and Borneo

I describe below five species which are common in Sumatra and Borneo. Material of Sumatra was collected by Dr. M. Hirano and Mr. G. Murata in 1971, and that of Borneo by Mr. T. Kodama in 1970. All the specimens cited are kept in the Herbarium of Kyoto University (KYO).

Bazzania erosa (Reinw., Bl. et Nees) Trev., Mem. Istit. Lombardo, ser. 3, 4: 415 (1877).—*Jungermannia erosa* Reinw., Bl. et Nees, Nova Acta Acad. Leop.-Carol. 12: 230 (1824).

Plants robust, rigid, yellowish brown, ascending, 3.8–5.0 mm wide when moist, in dense, deep mats. Stems stout, often more than 4 cm long, 350–500 μ thick, sparsely furcate at angles of 50–80 degrees; ventral branches rather numerous, mostly flagelliform, occasionally becoming normal leafy shoots; rhizoids scarce, on flagella. Leaves densely imbricate, strongly deflexed and postically connivent when dry, widely spreading (at 80–100 degrees with the

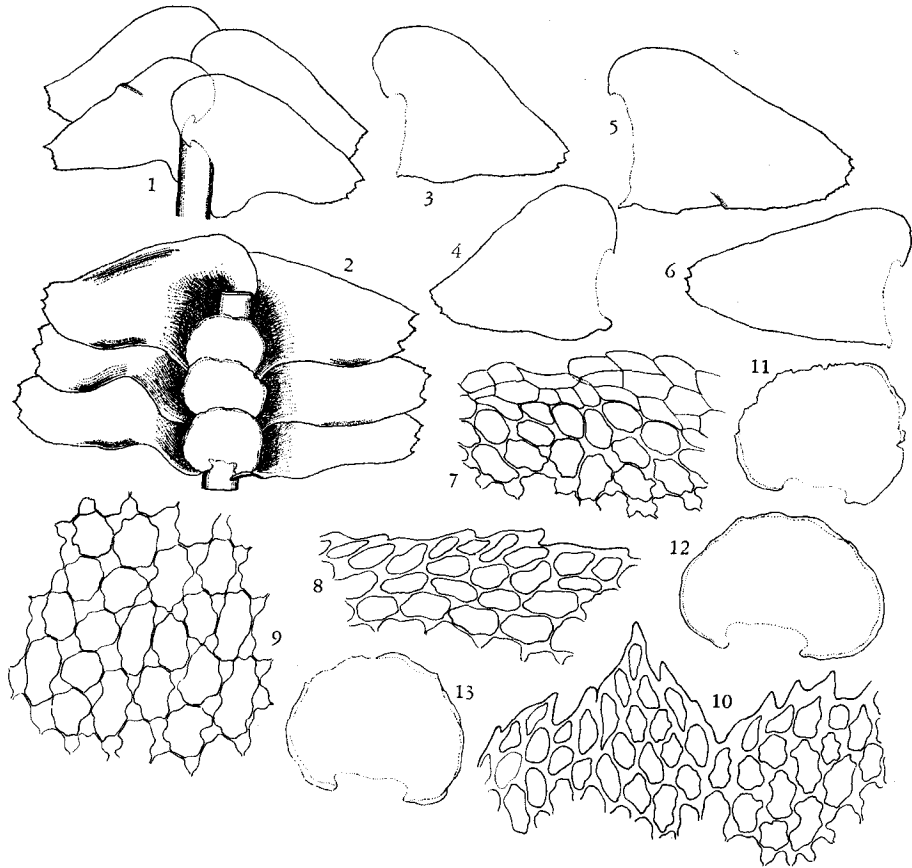


Fig. 1. *Bazzania erosa* (Reinw., Bl. et Nees) Trev.

1. Portion of shoot, dorsal view, $\times 10$. 2. Ditto, ventral view, $\times 20$. 3-6. Leaves, $\times 10$. 7. Marginal cells of underleaf, $\times 200$. 8. Cells of leaf-margin, $\times 200$. 9. Cells of leaf-middle, $\times 200$. 10. Cells of leaf-apex, $\times 200$. 11-12. Underleaves, $\times 20$. All drawn from T. Kodama 41219.

stem), adaxially concave and embracing the stem basally but rather plane distally, strongly asymmetrical, triangular-ovate to ligulate-ovate, mostly 2.5-3.5 mm long, 1.8-2.2 mm wide near the base (at the widest portion), the apex shallowly and indistinctly tridentate with accessory minute denticulations, the margin somewhat undulate, minutely serrulate, the dorsal base cordate, arching across the stem, the ventral base inflated and sometimes with a small auricle. Cells of the leaf-middle $27-37 \times 15-24 \mu$, of the base $30-48 \times 25-35 \mu$; walls thin, the trigones very large, nodulose, often confluent; cuticle faintly verrucose. Underleaves imbricate, nearly transversely inserted, plane or somewhat adaxially convex but not reflexed at apex, broadly orbicular, 0.6-1.0 mm long (measured from the insertion-line to the apex), 1.0-1.4 mm wide, the margin subentire, bordered by hyaline, thin-walled cells which are often eroded, the base cordate to auriculate; intramarginal cells similar to those of leaves.

Specimens examined. Borneo. Sabah: Mt. Kinabalu, near Mamut Mine, ca. 1300 m alt.,

T. Kodama 41219. Sumatra. Atjeh : higher elevation of Gunong Kemiri, 1800-2500 m alt., in evergreen mossy forest, M. Hirano & G. Murata S 2013.

Lindenberg and Gottsche (1851) described and figured *Bazzania erosa* but their specific conception was so broad as to include *B. spiralis* (Reinw., Bl. et Nees) Meij. and *B. desciscens* (Steph.) Meij. (only var. α is now referable to *B. erosa*). Evans (1933) has made a full description and illustrations under the name of *Bazzania erosa*, but he has misunderstood the species and his description points to *B. longicaulis* as noted by Meijer (1960).

This species is widely distributed in southern Asia and shows a great range of variation, especially in the size of plants, and the above description is made on the basis of robust plants which correspond with the type specimen. The species is characterized by the densely imbricate leaves whose apices are dentate-serrulate, the large leaf-cells with nodulose trigones, and the large underleaves bordered by hyaline, thin-walled cells.

Bazzania spiralis, another common species of southern Asia, agrees well with *B. erosa* in the characters of leaves but differs in the underleaves which are distant, much shorter (thus relatively broader), and strongly reflexed at apex. *B. serrulata* (Mitt.) Herz. known from Samoa, Borneo and the Philippines also possesses the dentate-serrulate leaves and the hyaline-bordered underleaves but the leaves are shorter (in the type specimen, they are ca. 1.4 mm long and 1.2 mm wide), not so densely imbricate, and the underleaves are distant. *B. insignis* (De Not.) Trev. from Borneo is also closely related to *B. erosa*. In the former, the numerous small serrulations of the leaf apex make the three apical teeth almost imperceptible and the hyaline border of underleaves is poorly developed—although Meijer (1960) has described that underleaves are not bordered by hyaline cells, in the type material I examined (Borneo, Tiang-laggi, leg. Beccari 1867, in herb. G), the outermost one-cell row of the underleaf margin is often hyaline. I have found that both *Bazzania semperi* (Steph.) Inoue from the Philippines and *Mastigobryum tamiense* Steph. from New Guinea are conspecific with *B. erosa*.

Bazzania longicaulis (Sde. Lac.) Schiffn., Consp. Hepat. Archip. Indici, 165 (1898).—*Mastigobryum longicaule* Sde. Lac., Ann. Mus. Bot. Lugd. Bat. 1: 303 (1864).

Plants robust, rigid, olive-brown, ascending to suberect, 3.5-5.0 mm wide when moist, in dense, deep mats. Stems stout, very long, often more than 10 cm long, sparsely furcate (pseudodichotomies as much as 8 cm apart) at angles of 30-70 degrees; flagella numerous, very long (often more than 3 cm long) and often branched; rhizoids scarce, on flagella. Leaves imbricate to approximate, more or less deflexed (strongly so when dry) or nearly horizontal, widely spreading (at 70-100 degrees with the stem), asymmetrical, narrowly oblong-ovate, often somewhat falcate, 2.0-3.0 mm long, 1.0-1.3 mm wide subbasally, 0.6-0.8 mm wide subapically, the apex shallowly and indistinctly tridentate with accessory minute denticulations, the margin minutely and remotely serrulate, the dorsal base subcordate, arching across the stem, the ventral base inflated, sometimes with an auricle. Leaf cells variable in size, the apical cells irregular in shape, 20-30 \times 10-15 μ , thick-walled with indistinct trigones, the medium cells subrectangular, regularly arranged forming a somewhat vitta-like cell net, 25

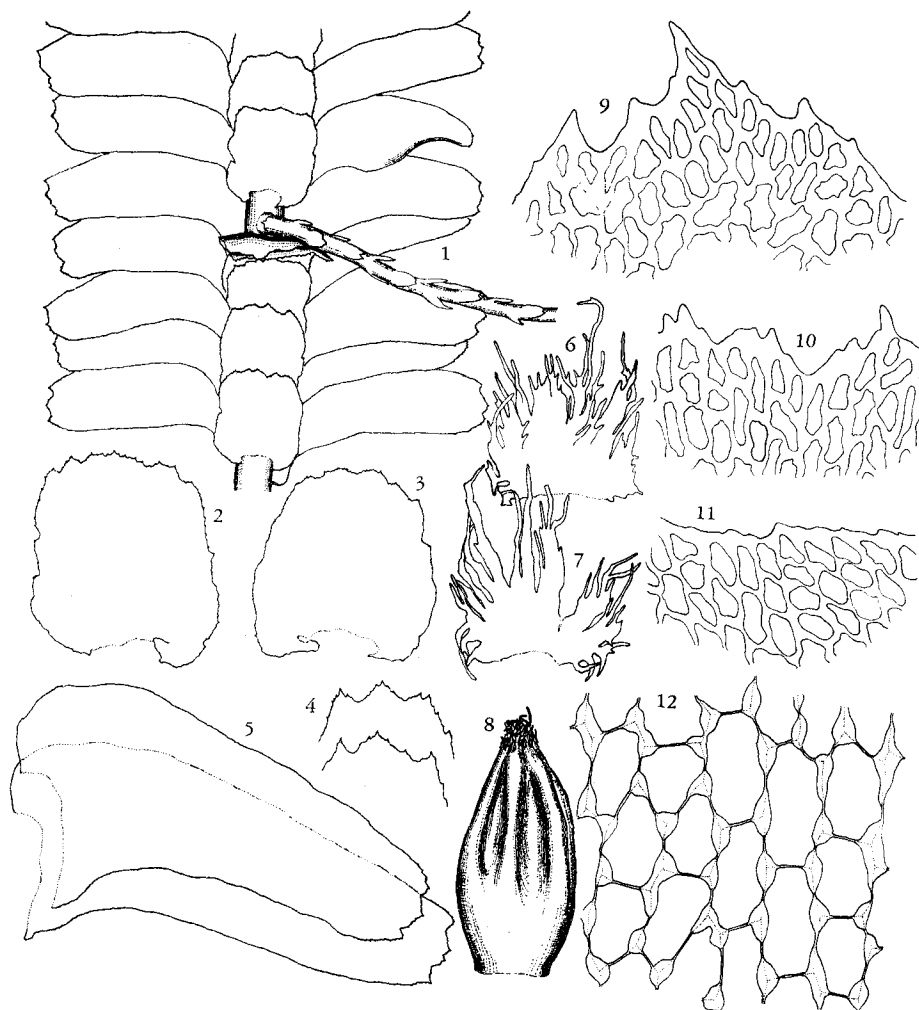


Fig. 2. *Bazzania longicaulis* (Sde. Lac.) Schiffn.

1. Portion of shoot, ventral view, $\times 10$. 2-3. Underleaves, $\times 20$. 4. Leaf-apices, $\times 25$. 5. Leaves, $\times 20$. 6. Female bract, $\times 25$. 7. Female bracteole, $\times 25$. 8. Perianth, $\times 25$. 9. Cells of leaf-apex, $\times 300$. 10. Cells of underleaf-apex, $\times 300$. 11. Cells of leaf-margin, $\times 300$. 12. Cells of leaf-middle, $\times 300$. All drawn from M. Hirano & G. Murata S 2004.

$-50 \times 18-25 \mu$, bearing large nodulose and often confluent trigones with intervening thin walls, the marginal and submarginal cells much smaller, thick-walled; cuticle smooth. Underleaves very large, imbricate to approximate, nearly transversely inserted, plane and appressed to the stem, subquadrate, 0.8-1.2 mm long, 0.8-1.2 mm wide, the margin vaguely sinuate and with minute, irregular serrulations, the base usually with a distinct auricle on each side; cells similar to those of leaves. Gynoecia frequent, abundant and in a series along a stem, occurring in the underleaf axil; bracts (of the gynoecia not fully developed) up to 1.0 mm long and wide, very deeply laciniate-ciliate; bracteole similar to bracts; perianth ovoid, up

to 1.2 mm long, terete below, obscurely trigonous and deeply pluriplicate above, the mouth long ciliate (cilia developed not only along the mouth but also on the outer surface near the mouth).

Specimens examined. Sumatra. Atjeh: higher elevation of Gunong Kemiri, 1800–2500 m alt., in evergreen mossy forest, M. Hirano & G. Murata S 1975, 2004. Borneo. Sabah: Mt. Kinabalu, near Mamut Mine, ca. 1300 m alt., on tree trunks, T. Kodama 41204. Malaya. Pahang: Gunong Beremban, Cameron Highlands, 1800 m alt., on tree trunk in dense evergreen forest, N. Kitagawa M 14591.

The diagnostic characters of this species are found in the stout, sparsely branched plants, the long leaves with the margins minutely serrulated, the very large, subquadrate underleaves which are not patent nor reflexed and whose margins are also minutely serrulated, and the deeply laciniate-ciliate female bracts and bracteoles.

Mastigobryum fruhstorferi Steph. from Celebes resembles very closely *B. longicaulis* and may be conspecific with it. *Bazzania minutiserra* (Steph.) N. Kitag., comb. nov. (*Mastigobryum minutiserrum* Steph., Spec. Hepat. 6: 474, 1924) is also closely related *B. longicaulis*, differing in the leaves whose marginal serrulations are less distinct (the lateral margin is almost entire) as well as in the shorter, rounded-quadrate underleaves with several large marginal teeth. Another related species is New Guinean *Bazzania aterrima* (Steph.) N. Kitag., comb. nov. (*Mastigobryum aterrimum* Steph., Spec. Hepat. 6: 454, 1924). This species is different from *B. longicaulis* in the underleaves which are much smaller, often reflexed, with the margin nearly entire or bearing a few small teeth, and having no basal auricles.

Plants of Sabah are often atypical, as noted by Kitagawa & Kodama (1973). They are epiphytes, occurring pendulous on tree trunks and the shoots are strangulated at intervals of 6–8 cm, because of a distinct dimorphism of leaves (long, widely spreading and short, erect-spreading) which occurs in a single shoot. However, the long leaves and the underleaves agree well with those of the typical form and I have no hesitation to identify them as *B. longicaulis*.

Bazzania serpentina (Nees) Trev., Mem. Istit. Lombardo, ser. 3, 4: 415 (1877). — *Jungermannia serpentina* Nees, Enum. Plant. Cryptog. Javae et Insul. Adiac. 1: 62 (1830).

Plants medium-sized, rigid, deep brown, suberect, 1.4–2.3 mm wide, in rather dense mats. Stems up to 35 mm long, 250–400 μ thick, sparsely furcate at angles of 60–90 degrees; flagella rather numerous; rhizoids scarce, on flagella. Leaves rather densely imbricate to approximate, strongly deflexed and often postically connivent to embrace the stem even in moist condition, widely spreading and extremely falcate, forming angles of 40–60 degrees proximally but more than 120 degrees (sometimes nearly parallel) with the stem distally, strongly asymmetrical, narrowly ovate-falcate to triangular-ovate-falcate, 1.5–1.8 mm long, 0.9–1.4 mm wide basally and 0.2–0.3 mm wide subapically, the apex very obliquely tridentate, the teeth acute, finger-like, the anterior tooth usually larger than the others, the margin entire, the dorsal base cordate, arching across the stem, the ventral base dilated and subau-

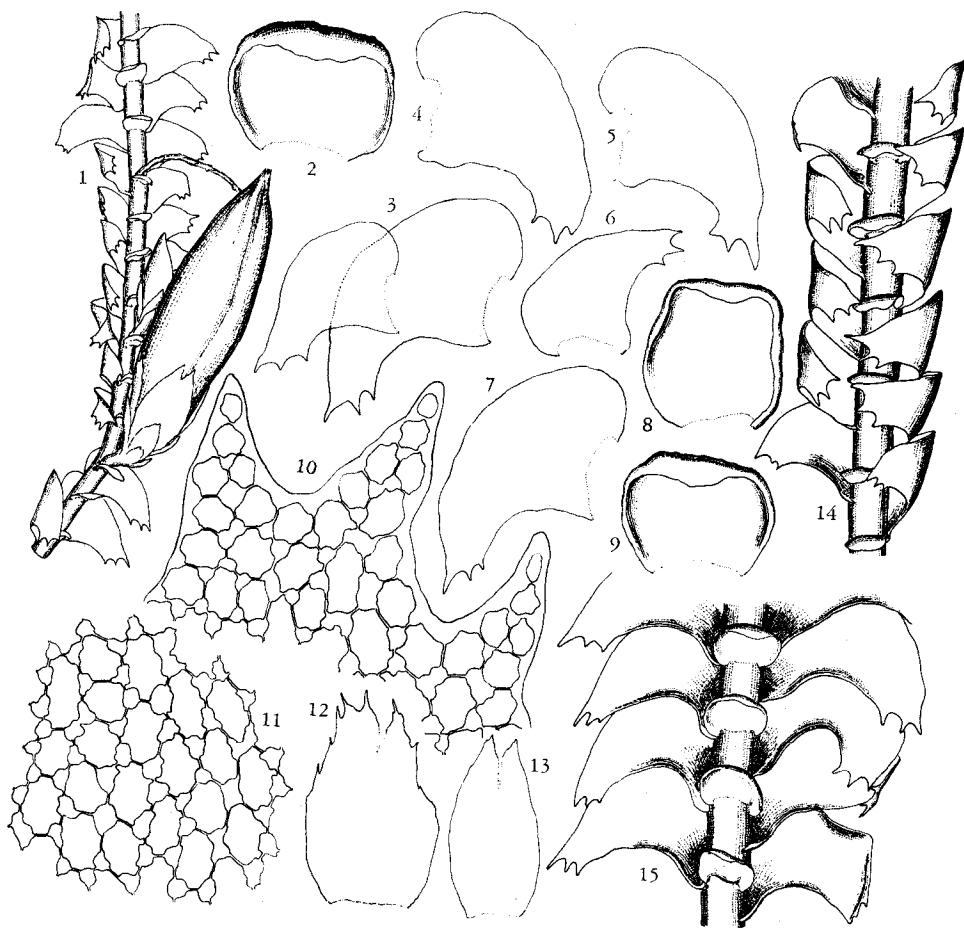


Fig. 3. *Bazzania serpentina* (Nees) Trev.

1. Portion of shoot with gynoecia, ventral view, $\times 10$. 2, 8-9. Underleaves, $\times 50$. 3-7. Leaves, $\times 20$. 10. Cells of leaf-apex, $\times 200$. 12. Female bract, $\times 20$. 13. Female bracteole, $\times 20$. 14-15. Portions of shoots, ventral view, $\times 20$. All drawn from M. Hirano & G. Murata S 2097.

reticulate. Leaf cells large, rather invariable in size, $34-44 \times 28-38 \mu$ near the apex, $38-56 \times 30-38 \mu$ in the middle, $42-58 \times 28-38 \mu$ in the base; walls thin, the trigones very large and nodulose; cuticle smooth. Underleaves distant, nearly transversely inserted, adaxially convex and reflexed at apex, quadrate-orbicular to transversely oblong-orbicular, $280-320 \mu$ long (when the reflexed apex is not expanded), $430-480 \mu$ wide, the margin subentire, the base connate or in contact with leaves on one side; cells of the apical reflexed portion thin-walled and hyaline, cells of other portion similar to those of leaves. Gynoecia frequent, abundant and in a series along a stem, occurring in the underleaf axil; the innermost bracts tightly sheathing the perianth, narrowly ovate, strongly concave, $1.1-1.4 \text{ mm}$ long, $0.7-1.0 \text{ mm}$ wide, the apex shallowly bi- or trilobed, the margin entire to sparsely lacinate-ciliate; bracteole similar to bracts; perianth very large, ovoid-cylindrical, fusiform above, up to 4 mm long, 1.5 mm

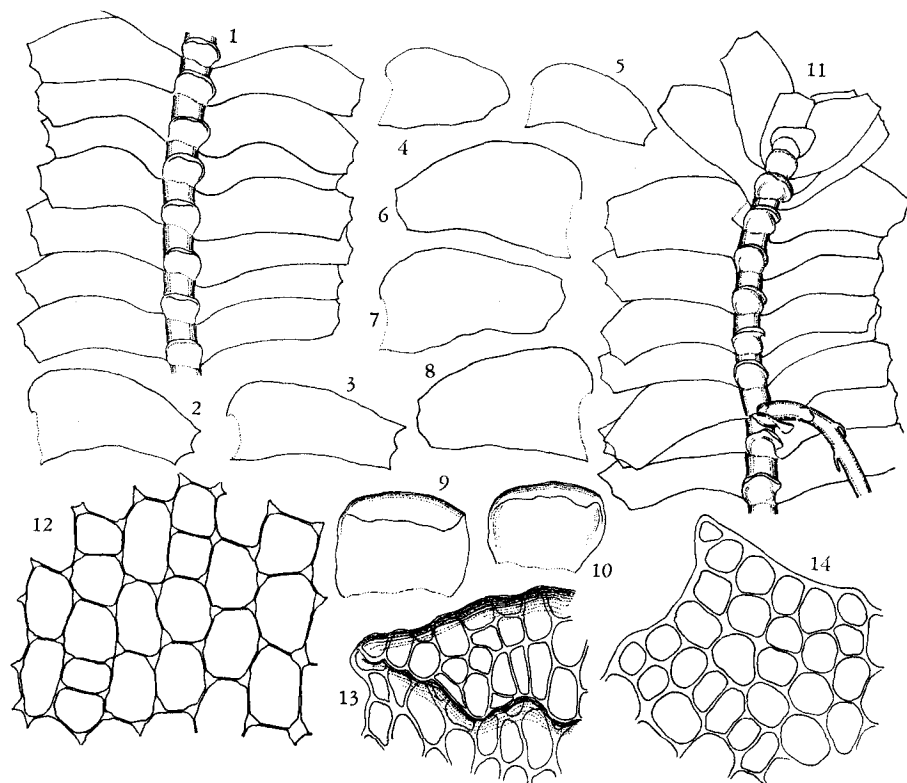


Fig. 4. *Bazzania densa* (Sde. Lac.) Schiffn.

1, 11. Portions of shoots, ventral view, $\times 20$. 2-8. Leaves, $\times 20$. 9-10. Underleaves, $\times 75$. 12. Cells of leaf-middle, $\times 300$. 13. Cells of underleaf-apex, $\times 300$. 14. Cells of leaf-apex, $\times 300$. All drawn from M. Hirano & G. Murata S 1894.

in diam., gradually contracted to the mouth, 3-stratose below.

Specimens examined. Sumatra. Atjeh: higher elevation of Gunong Kemiri, 2600-2900 m alt., in ericoid forest on mountain ridge, M. Hirano & G. Murata S 2097, 2102.

This species is easy to recognize by its strongly deflexed and falcate leaves, the large leaf-cells with large, knot-like trigones and the rather small, orbicular underleaves with reflexed apices where the cells are hyaline and thin-walled. *Bazzania praeurupta* (Reinw., Bl. et Nees) Trev., a common species in southern Asia, somewhat resembles *B. serpentina*, but the leaves are less falcate and the underleaves are larger, with the apices not reflexed nor hyaline-bordered and the bases strongly cordate.

Bazzania densa (Sde. Lac.) Schiffn., Consp. Hepat. Archip. Indici, 151 (1898).—*Mastigobryum densum* Sde. Lac., Nederl. Kruidk. Arch. 3: 418 (1854).

Plants medium-sized, not rigid, olive-green, prostrate, 1.8-2.8 mm wide, in thin, dense mats. Stems up to 20 mm long, 150-250 μ thick, rather frequently furcate widely (at 80-120 degrees with the stem), extremely variable in shape, usually oblong-ovate to sublinear-ovate, 0.75-1.25 mm long, 0.50-0.75 mm wide basally, 0.20-0.45 mm wide apically, the apex usually

truncate (rarely rounded), shallowly tridentate (occasionally rounded and entire or merely truncate without the median tooth), the teeth low and often indistinct, acute to obtuse, the margin entire, the dorsal base rounded, the ventral base somewhat dilated and often connate with the underleaf base. Leaf cells variable in size, of the apex $16-25 \times 13-20 \mu$, of the middle $23-35 \times 15-24 \mu$, of the base $30-50 \times 25-33 \mu$, of the dorsal margin $9-22 \times 12-20 \mu$, the apical and marginal cells rather thick-walled with indistinct trigones, the median cells thin-walled, with distinct, more or less bulging trigones. Underleaves distant, nearly transversely inserted, adaxially concave basally with strongly reflexed apices, quadrate-orbicular to transversely oblong-orbicular, $170-250 \mu$ long (when the reflexed apex is not expanded), $270-320 \mu$ wide, connate or in contact with leaves on both sides, the margin entire; cells of apical, reflexed portion thin-walled and hyaline, the median cells elongated, rectangular, $16-32 \times 12-20 \mu$, rather thick-walled with indistinct trigones.

Specimens examined. Sumatra. Sumatera Utara : Sikundar Nature Conservations, interior of Besting, NW of Tandjungpura, 100-250 m alt., M. Hirano & G. Murata S 1874, 1882, 1883, 1887, 1892, 1894. Atjeh : Gunong Kemiri, 1600-1800 m alt., S 2138, 1800-2500 m alt., S 2010.

This species is rather difficult to identify, because the leaves are very variable (even on a single shoot, they vary greatly in shape and size) and because there are many species described from southern Asia that may be subject to confusion with this species. Although leaf apices are very variable (this great variability itself seems to offer a diagnostic character), they are most frequently truncate with indistinct low teeth and not deeply tridentate. Another diagnostic feature is found in the small underleaves which are slightly broader than the stem and strongly reflexed at apex. *Bazzania zollingeri* (Lindenb. et Gott.) Trev. known from Java, Borneo and Sumatra is distinguished in the strongly falcate and deflexed leaves, the thick, somewhat fleshy stem and the very small underleaves which are apparently narrower than the stem. Although the typical forms of both species can easily be separated by these features, there occur sometimes intermediate, puzzling forms. *B. borneensis* (Steph.) N. Kitag. from Borneo and *B. squamulistipula* Steph. from Sumatra are closely related to *B. densa* but the underleaves are much broader (nearly twice as broad as the stem). *B. crassitexta* Steph. from Ambon has also small reflexed underleaves but the plants are rigid and the leaf-cells bear large, nodulose trigones. In *B. pectinata* (Lindenb. et Gott.) Schiffn. widely distributed in southeastern Asia, the underleaves are typically flat (not reflexed) and appressed to the stem but sometimes their apices are somewhat reflexed—in this case, the long sublinear leaves with three sharp teeth and the rather distinct vittae of leaves will serve to distinguish from *B. densa*. *B. cincinnata* (De Not.) Trev. known from Borneo, Sumatra and Thailand is also closely related to *B. densa*, differing in the leaf apices bearing many irregular denticulations. *Mastigobryum rigidum* Steph. from Great Natuna and *M. evansii* Steph. from the Philippines were placed under the synonym of *B. densa* (Kitagawa 1973).

Bazzania subtilis (Sde. Lac.) Trev., Mem. Istit. Lombardo, ser. 3, 4: 414 (1877). — *Mastigobryum subtile* Sde. Lac., Ann. Mus. Bot. Lugd. Bat. 1: 302 (1864).

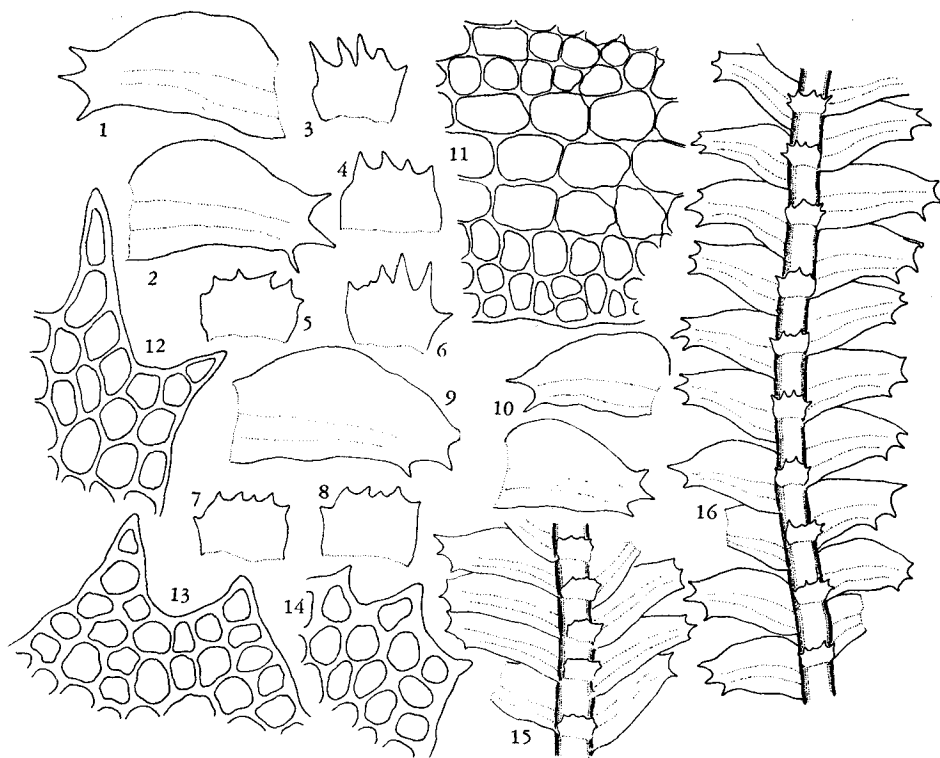


Fig. 5. *Bazzania subtilis* (Sde. Lac.) Trev.

1-2, 9-10. Leaves, $\times 50$. 3-8. Underleaves, $\times 75$. 11. Cells of leaf-middle; median three cell-rows forming a vitta, $\times 300$. 12, 14. Cells of underleaf-margins, $\times 300$. 13. Cells of leaf-apex, $\times 300$. 15-16. Portions of shoots, ventral view, $\times 30$. 1, 2, 9, 12, 16 drawn from T. Kodama 40906, others from T. K. 40664.

Plants small, rigid and fragile, pale brown to pale olive-brown, prostrate, less than 3 mm wide, in loose thin mats. Stems filiform, up to 10 mm long, $150-200\ \mu$ thick, furcate at angles of $80-110$ degrees; ventral branches mostly flagelliform, occasionally becoming normal leafy shoots; rhizoids scarce, on flagella. Leaves often caducous or ragged, remote to subimbricate, nearly plane, spreading at angle of $50-70$ degrees with the stem, variable in shape, usually oblong-ovate to ovate, mostly $400-700\ \mu$ long, $250-300\ \mu$ wide, the apex tridentate (occasionally bidentate), the teeth acute, divergent, 1-4 cells long, the dorsal base not arched nor crossing the stem. Vittae of leaves distinct, extending to the subapex, mostly of 3-4 cell-rows; cells of the vitta $27-32 \times 20-24\ \mu$, with large, somewhat bulging trigones; cells outside the vitta much smaller, $15-18 \times 9-15\ \mu$ in the leaf-middle, thick-walled with indistinct trigones; cuticle faintly verrucose or smooth. Underleaves distant, transversely inserted, plane and somewhat patent, nearly as wide as the stem, subquadrate to transversely oblong-quadrate, $130-150\ \mu$ long, $160-190\ \mu$ wide, the apex irregularly dentate, the teeth sharp or blunt, mostly 1-3 cells long; cells similar to those of leaves.

Specimens examined. Borneo. Sabah : Mt. Kinabalu, between Radio Station and Carson's Camp, 2250-2650 m alt., T. Kodama 40664, near Mamut Mine, on tree base, ca. 1300 m alt., T. Kodama 40906.

This species is easily recognized by the small plants, the acute and divergent leaf-teeth, the distinct vittae of leaves and the small underleaves which are not or slightly wider than the stem and bearing several divergent teeth. *Bazzania indigenara* (Steph.) N. Kitag., comb. nov. (*Mastigobryum indigenarum* Steph., Spec. Hepat. 6: 469, 1924) from New Hebrides (Watts no. 73, type in herb. G) is most closely related to *B. subtilis* but differs in the larger underleaves which are nearly twice as broad as the stem and in the leaf-apices whose three main teeth are obscured by the smaller and irregular denticulations.

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