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財 団 法 人

服 部 植 物 研 究 所

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MORPHOLOGY OF REBOULIACEAE

III. Development of sex organs, sporogonium and interrelationships of the various genera[1]

By P. KACHROO[2]

P. KACHROO: ヂンガサゴケ科の形態学的研究（其三）. 生殖器官の発生, 胞子体及び種々の属間の類縁

Introduction

Mehra and Kachroo (1951) in their detailed account of sporeling germination studies in the family found the spore structure built on a common plan and probably affording a feature of phylogenetic value. Kachroo (1954a) discussed the distribution of the family in India. He further (1954b) gave a morphological account of *Mannia indica*, a few species of *Asterella*, and *Plagiochasma appendiculatum*, and described a number of morphologically interesting forms in *Asterella*.

Since the present investigation gives an account of development of sex organs, sporogonium and interrelationships of the various genera it is thought desirable to give a concise historical account of work done so far on these.

Roboulia:—Cavers (1911) reported the presence of 2 archegonia in the same receptacular notch and a carpocephalum structure similar to *Sauteria*, formation of octants in the embryo (*c.f.* Cavers, 1904) and a well developed lid which falls off in frangments on opening of the capsule. Woodburn (1919) wrote a preliminary note on the embryology and a comprehensive account of the same was later given by Haupt (1921) who also discussed the affinities of *Reboulia* to other Marchantiaceae on the basis of development of air chambers, development of sex organs and the sporophyte; reporting antheridia developing intermittently without interrupting the activity of the apical cell. The latter is, however, involved in the formation of the archegonial receptacle. The reduction in the number of archegonia in Marchantiaceae reaches highest expression in *Reboulia*. The embryo is of the filamentous type and the potentially sporogenous tissue is diverted to form elaters later than in *Marchantia*, *viz.* both belong to the same cell generation. In this respect the sporophyte of *Reboulia* is primitive.

Mannia:—Leitgeb (1881) studied structure of the receptacle and the origin of archegonia. Kienitz-Gerloff (1874, 1875) found regular formation of octants in the sporogonium. Cavers regarded the genus as closely related to *Reboulia* except that the upper portion of the capsule wall forms a well-developed lid and the capsule shows the presence of an annulus. Campbell (1918) stated that the dehiscence of the capsule is by a lid.

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[1] Part I appeared in the Bryologist, **57**: 159-166, 1954; and Part II in the Journ. Hattori Bot. Lab. **12**: 34-52, 1954. The major portion of this work was completed at Panjab University, India, as a special Research Scholar during 1948-50; and some part at Gauhati University, India, where the author served as a Lecturer. Thanks are due to the authorities at both the places for laboratory facilities.

[2] Malaria Research Laboratory, Damodar Valley Corporn., Burdwan, India.

Asterella:—Leitgeb (1881) gave an account of structure and origin of the receptacles and Cavers (1911) regarded the perianth as nearest ally of that of the highest type of Marchantiaceae and that each involucre, in most of the species, contained more than one archegonium and that it resembles *Massalongoa* except for the absence of a perianth in the latter genus. Pierce (1902) investigated the discharge of spermatozoids in *A. californica*, which is explosive as in *Conocephalum conicum*. Campbell (1918) studied the morphology of *A. californica*, and reported a quadrant type of embryo. Peissel (1925) described the development of sex organs and sporogonium in *A. blumeana*. She found the growing point of the thallus consisting of a transverse row of 4 cells of which the apical cell seen in a median longitudinal section is but one member and that the carpocephalum arises as a dorsal outgrowth of the thallus as in *Plagiochasma*, that the marginal spical meristem remains at the base of the young receptacle and finally becomes lost in the formation of the stalk. Haupt (1929) reinvestigated *A. californica* and found the development of sex organs similar to other Marchantiaceae, absence of mucilage hairs in the antheridial pits (otherwise present in *Reboulia*), 2-3 archegonia in each group and neck canal cells numbering 8; after formation of archegonia there is development of new growing points beneath the posterior region of each wing to continue the growth of thallus but these were adventitious, having no relation to original apical cell; further that in *A. palmeri* the embryo was filamentous. Mahabale and Bhate (1945) in *A. angusta* reported the development of sex organs similar to those of other Marchantiaceae, a filamentous embryo and the presence of radical thickenings on the walls of cells on the upper part of capsule.

Cryptomitrium:—Abrams (1899) and Howe (1899) studied the life history of *C. tenerum*, the former describing the compound nature of carpocephalum and an embryo similar to that of *A. californica* (Campbell, 1918). Cavers found the involucre containing upto 5 archegonia with centrifugal development and carpocephalum of the composite type. Haupt (1942) in a reinvestigation of *C. tenerum* found the development of sex organs typical of Marchantiaceae, a filamentous embryo of 4 superimposed cells and remarked that early embryogeny resemles that of *Reboulia*, *Asterella* and *Plagiochasma*; further that 3-4 archegonia develop in each involucre. Chopra and Khosla (unpublished) reported a filamentous embryo in *C. himalayense* and development of sex organs as usual in Marchantiaceae.

Plagiochasma:—Leitgeb (1881) and Goebel (1930) gave a general account of the genus; the former as well as Cavers (1911), interpreted the archegoniophore as an adventitious branch arising on the dorsal surface of the thallus and whose apex is used in development of carpocephalum as in *Athalamia*. Cavers reported a definite lid breaking up into fragments on dehiscence of the capsule. Meyer (1916, vide Campbell, 1918) described a filamentous embryo in the genus. Kashyap (1914) discussed the nature of the horse-shoe shaped receptacle in *P. articulatum* and *P. appendiculatum* which is due to forking and (according to him) homologous with those of higher Marchantiales, representing a branch system. He further established a homology between the stalk of the female receptacle in this genus, as also in *Athalamia*, with a similar stalk of higher forms of Marchantiales and regarded the genus as a last stage in a series of reduced forms from the level of *Marchantia* through *Reboula*. Star (1916) in an investigation of a Mexican species reported that the main apical cell of the thallus was not involved in formation of the archegonial receptacle or the antheridial receptacle; the latter may follow the formation of the former; that the apical cell did not function while the antheridial group was active but later continued growth of the thallus and that the embryo was of the

filamentous type. Kapoor (1931) wrote a short morphological account on *P. articulatum*. Mahabale and Deshpande (1947) in a detailed study of the same species noted bisexual receptacles, gametogenesis similar to other Marchantiales and an embryo of the filamentous type.

Materials and methods

The present investigation includes the following species: *Mannia indica*, *Asterella blumeana*, *A. reticulata*, *A. mussuriensis*, *A. sanguinea*, *A. pathankotensis*, *A.* sps. (probably identical with *A. khasiana* (Griffith), referred to as *A.* "Manipur" in the following pages) and *Plagiochasma appendiculatum*. The life history has been studied in detail in all species except in *A.* "Manipur". *Mannia indica* is figured in detail and in others only those features are figured by which they differ from this species.

The species were collected at Pathankot, Hoshiarpur, Delhousie, Simla, Hardwar, Dehradun, Mussurie, Nainital (Western Himalayas); Gauhati, Jowai, Shillong and Manipur (Khasi Hills, Assam) in spring, summer and autumn during March 1948 - August 1952. All were fixed in the field and the simple suction pump (Kachroo, 1951) was employed to sink the material in the fixative. F.A.A., CRAF and Lewitsky's fixatives were used but CRAF proved best for cytological and morphological studies. Microtome sections were cut 8–12 μ thick; safranin and light green, and crystal-violet and erythrosin staining schedules were followed.

Nomenclature of the cited species[3]

All combinations proposed here as new under *Asterella* have actually been adopted by Kachroo (1954) and Pande *et al* (1954) but are there technically not valid under the current International Code as the authors unfortunately omitted the basionyms. The genera as well the species under them are arranged alphabetically in the following list.

Asterella angusta (St.) comb. nov., basionym *Fimbriaria angusta* St. Spec. Hepat. **1**: 104, 1899.

A. blumeana (Nees) comb. nov., basionym *Fimbriaria blumeana* Nees, in Gottsche *et al.*, Syn. Hep. p. 564, 1846.

A. bolanderi (Aust.) Underw., Bot. Gaz. **20**: 61, 1895.

A. lindenberghiana (Corda) Lindberg, Musc. Scand, 1, 1879.

A. ludwigii (Schwaegr.) Underw., Bot. Gaz. **20**: 61, 1895.

A. multiflora (St.) comb. nov., basionym *Fimbriaria multifloaa* St., Spec. Hepat. **1**: 124, 1899.

A. mussuriensis (Kashyap) comb. nov., basionym *Fimbriaria mussuriensis* Kashyap, J. Bombay Nat. Hist. Soc. **24**: 345, 1916.

A. nepalensis (Taylor) comb. nov., basionym *Fimbriaria nepalensis* Taylor, Trans. Linn. Soc. **17**: 387, 1837.

A. palmeri (Aust.) Underw., Bot. Gaz. **20**: 63, 1895.

[3] Thanks are due to Mr. V. Raghavan (Gauhati Univ.) for his assistance in collecting some of this information.

A. papulosa (St.) comb. nov., basionym *Fimbriaria papulosa* St., Spec. Hepat. **6:** 16, 1917.
A. parvipora (St.) comb. nov., basionym *Fimbriaria parvipora* St., Spec. Hepat. **1:** 116, 1899.
A. pathankotensis (Kashyap) comb. nov., basionym *Fimbriaria pathankotensis* Kashyap, J. Bombay Nat. Hist. Soc. **24:** 344, 1916.
A. reticulata (Kashyap) comb. nov., basionym *Fimbriaria reticulata* Kashyap, J. Bombay Nat. Hist. Soc. **25:** 279, 1917.
A. saccata (Wahl.) Evans, Contrib. U.S. Nat. Herb. **20:** 276, 1920.
A. sanguinea (L. et L.) comb. nov., basionym *Fimbriaria sanguinea* Lehm. et Lindenb., in Lehm., Pug. **4:** 5, 1832.
A. tenella (L.) Pal. de Beauv., in Cuvier ed., Dict. Sci. Nat. **3:** 258, 1805.
Cryptomitrium himalayense Kashyap, New Phytol. **14:** 2, 1915.
C. tenerum (Hook.) Aust. ex Underw., Bull. Ill. State Lab. Nat. Hist. **2:** 36, 1884.
Mannia californica (Gottsche) Wheeler, The Bryologist **37:** 88, 1934.
M. fragrans (Balbis) Frye & Clark, Univ. Washington Publ. Biol. **6:** 62, 1937.
M. indica (St.) comb. nov., basionym *Grimaldia indica* St., Spec. Hept. **6:** 10, 1917.
M. pilosa (Hornem.) Frye & Clark, Univ. Washington Publ. Biol. **6:** 67, 1937.
M. rupestris (Nees) Frye & Clark, Univ. Washington Publ. Biol. **6:** 64, 1937.
Plagiochasma appendiculatum Lehm. et Lindenb., Pug. **4:** 14, 1832.
P. articulatum Kashyap, New Phytol. **13:** 320, 1914.
P. cuneatum Evans, Amer. J. Bot. **19:** 627, 1932.
P. intermedium Lindenb. *et* G., in Gottsche *et al.*, Syn. Hep. p. 513, 1846.
P. rupestre (Forst.) St., Spec. Hepat. **1:** 80, 1898.
P. simlense Kashyap, J. Bombay Nat. Hist. Soc. **25:** 279, 1917.
Reboulia hemisphaerica (L.) Raddi, Opusc. Scient di Bologna **2:** 357, 1818.

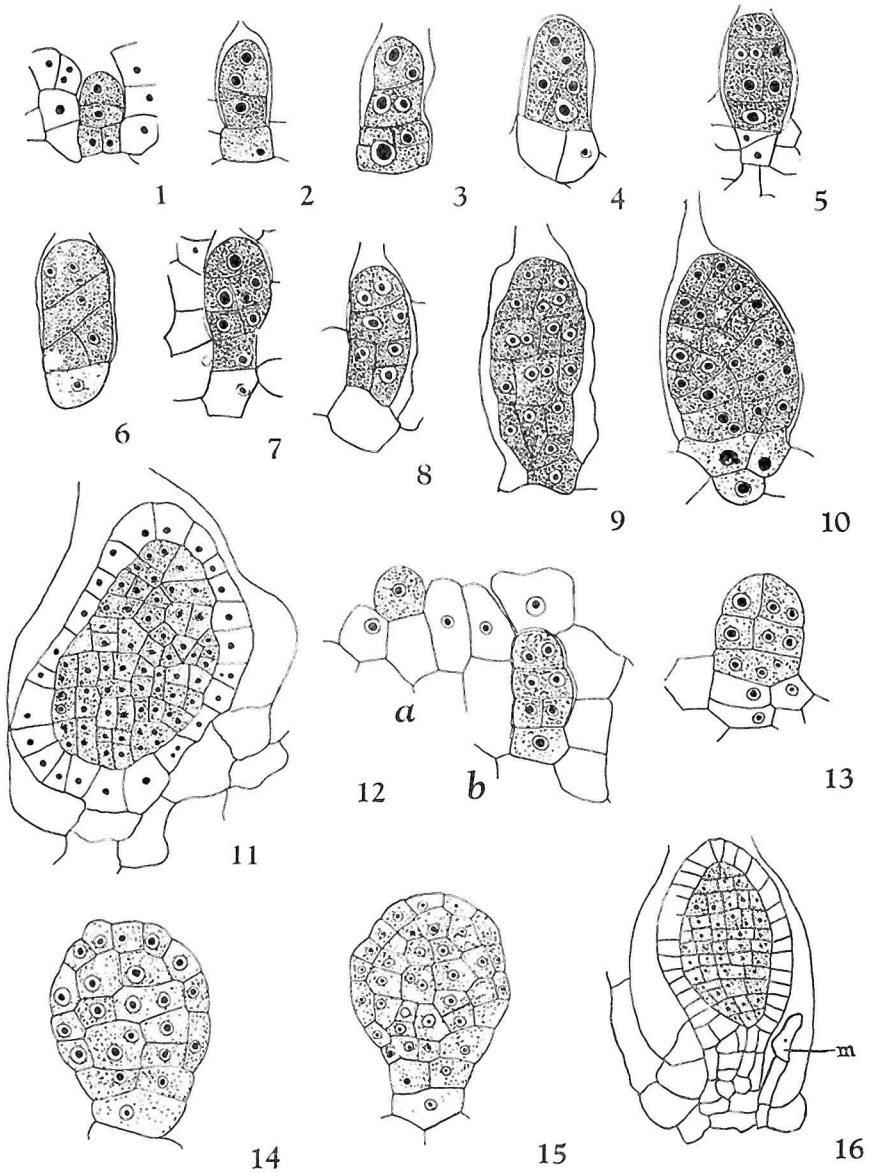
Receptacles and the development of sex organs

In *Marchantia* and other genera Marchantiaceae the growth of the thallus ceases with the development of archegoniophore while in *Plagiochasma* and *Athalamia* the apex of the thallus continues to grow in length after the differentiation of the archegoniophore.

All the species under consideration here are strictly protandrous in development and by the time the female receptacle becomes prominent most of the mature antheridia have released their spermatozoids. In *Asterella* the antheridia are aggregated into circular or oval cushions which project but slightly above the surface of the thallus; except occasionally in *A. sanguinea* where they are much raised-up forming false receptacles (*c.f.* Kachroo, 1954b), or in *A.* "Manipur" where they are in the form of receptacles—either more or less horse-shoe shaped or crescentic (Figs. 85, 90). In *A. blumeana* such cushions are borne just behind the stalk of the female receptacle; in *A. reticulata* on lateral shoots borne along the anterior or the posterior region of the thallus; in *A. pathankotensis* and *A. sanguinea* terminal on the main thallus and in *A. mussuriensis* on the lateral shoots. In *Mannia indica* they are linear in form, and situated either terminally or dorsally (as occasionally in *A. pathankotensis*) on the main thallus. *Plagiochasma appendiculatum* is characteristic in having sessile male receptacles dorsal in

position and variable in form; horse-shoe shaped to oval.

The formation of antheridia is acropetal and usually accompanies the apical growth of the thallus or lateral shoots. But in *A. californica* (Haupt, 1929) they



Figs. 1-16. Development of antheridium. 1-6, 10, 11, *Mannia indica*. 7-9, *Asterella blumeana*. 12-15, *A. reticulata*. 16, *Plagiochasma appendiculatum* (m—mucilage hair). Figs. 1-10, 12-15, ×510; 11, 16, ×390.

sometimes have an intermittent development resulting in formation of sterile patches in between. Usually they are in 1-2 rows. Each is separated from one another by septa which persist even after the antheridia discharge spermatozoids. Towards the dorsal surface air chambers in many layers are quite distinct in the space between the passages through which the antheridial chambers open to outside. It is interesting that mucilage hairs only arise within the antheridial cavities in *Plagiochasma*, (as also in *Reboulia* and *Cryptomitrium*) and not in *Mannia* and *Asterella*. The antheridial cavities open to outside through a pore which resembles the air pore in development except that the inner cells do not become so small and pointed.

The archegonia are borne on stalked receptacles which arise singly in the apical notch, making their appearance as knobs. In the development of receptacles the apical cell of the thallus undergoes two successive dichotomies forming 4 cells arranged in a cross-wise fasion, which ultimately form 4 archegonia. The dome-shaped receptacle is the result of the intercalary growth of the cells between these vegetative points. In this tissue later air chambers appear schizogenously. A vertical section of the receptacle at a later stage shows air chambers in more than one layer, the dorsal ones opening to outside through compound pores. Meantime, a short stalk develops with an anterior rhizoidal groove. The receptacle bears ventrally rhizoids and scales, the latter often showing degenerating chloroplasts. The stalks, when young, is composed of cells more or less the same size and shape but later the cells towards the base become more elongated and those towards the apex remain smaller, densely granular and with prominent nuclei. In *Mannia* and most species of *Asterella* the stalk is long, but in *A.* "Manipur" the stalk is always sub-sessile and rarely the carpocephalum is sessile (Figs. 88c, 89) as also in *A. sanguinea* (Fig. 92). The former species also exhibits abnormalities in the nature of the receptacle (Figs. 86-88). In *Plagiochasma appendiculatum* the stalk is often subsessile and always without rhizoidal groove.

Usually 4 archegonia are formed, one in each involucre; in contrast to usual 8 in *Marchantia* (Andersen, 1929; McNaught, 1929). In these species each of the original growing points undergoes dichotomy. In *Plagiochasma appendiculatum* occasionally 9 involucres are formed due to further dichotomy in one of the 8 lobes formmed due to a dichotomy in each of the 4 original growing points. It is not, however, uncommon to find more than one archegonium within an involucre (a feature of Compositae) in the various genera of this family: *Cryptomitrium* (Abrams, 1899), *Asterella californica* (Campbell, 1918; Haupt, 1929), *A. angusta* (Mahabale and Bhate, 1945), *A. mussuriensis*, *A. sanguinea* (author) and *Plagiochasma articulatum* (Mahabale and Deshpande. 1947). (See also Cavers, 1911; Kashyap, 1914 and Haupt, 1942).

The growth of the dorsal tissue of the carpocephalum is so quick that the growing points, from which archegonia arise, are pushed downwards close to the stalk and are later obscured.

After the formation of the female receptacle usually thallus stops growth. Leitgeb, however, reported that in *Asterella ludwigii* sometimes the female receptacle is abortive and does not limit the growth of the branch on which it is borne. He deduced from it that the limitation is secondary and receptacle dorsal in origin.

In *A. californica* Haupt (1929) reported that the receptacle may grow out from the bottom of the dichotomy, an ordinary branch appearing on each side. "This would seem to indicate dorsal origin, the apical region of the branch continuing it growth but undergoing dichotomy at once." The two lateral branches, thus, formed grow out and the receptacle then appears to grow out from the bottom of the dichotomy. Each or both of these branches may bear receptacles.

In *Mannia* and *Asterella* it is common to observe the development of apical, subapical or lateral ventral shoots, either arising anteriorly or on either side at the base of the receptacle; or from the ventral surface of the thallus. They usually arise from the surface of the midrib or from the region within the notch. A detailed study of the development of such shoots is in progress. At the moment the idea of dorsal nature of female receptacle is improbable as the apical cell is utilized in its formation. (In *Reboulia hemispharica* var. *pangiensis* Kashyap, and often in *Asterella* "Manipur" and rarely in *Mannia indica* and *Plagiochasma appendiculatum* the thallus forms apical innovations, as in *Preissia*, to facilitate continued elongation of thallus after formation of carpocephalum or antheridial cushion. Such ventral shoots grow out from beneath the receptacle and finally give the thallus a jointed appearance).

Antheridium: The antheridial initial is observed as a conspicuous cell (Fig. 12a) just behind the apex of the thallus. Later each becomes sunken in the antheridial pits formed by the outgrowth of the surrounding tissue. A transverse wall divides it into 2 cells—the primary antheridial cell and a lower stalk cell (Fig. 1). Transverse walls are formed in the former resulting in formation of a short filament of 3–4 cells (Figs. 2, 3, 12b) as in *Reboulia* (Haupt, 1921), *Asterella californica* (Haupt, 1929), *A. angusta* (Mahabale and Bhate, 1945), *Plagiochasma articulatum* (Mahabale and Deshpande, 1947), *Cryptomitrium tenerum* (Haupt, 1942) and *C. himalayense* (Chopra and Khosla, unpubl.) and other Marchantiaceae (see Durand, 1908; Andersen, 1929, McNaught, 1929; Ahmad, 1938; Mehra and Mehra, 1939). In *Asterella bolanderi* (Campbell, 1918) a row of 5 cells is produced before the first vertical walls are formed (although his figure shows only 3 transverse walls in the superficial portion of the antheridum) and the same is the case occasionally in *Reboulia* (Dupler, 1922). In *Mannia* rarely the first wall is oblique followed by another oblique wall at right angles to it, thus, delimiting something apparently like an apical cell as seen in a longitudinal section (Fig. 4) or the 3 cell filament organised has oblique instead of transverse walls (Fig. 6). Rarely in *Asterella reticulata* the initial after the first transverse division undergoes vertical divisions and remains 2 cell long (Fig. 13). The first vertical wall may appear in the cell next to the stalk cell (Figs. 5, 7). This is followed by vertical walls in other cells (Figs. 8, 12b, 13). Subsequently another serise of vertical walls at right angles to the first divide the filament into quadrants. This is followed by periclinal walls differentiating a single layered wall of the antheridium and primary spermatogenous cells (Figs. 9–11, 14, 15). The stalk cell divides a few times by transverse and verticals walls forming a very short stalk, which is 2 cells in length and 4 cells in thickness. The basal cell is usually the last to undergo a vertical division. A study of the antheridia that the form of the stalk is mainly conditioned by space and this results in great variation in size of the mature antheridium.

Similar conditions restrict the size of the sporogonium.

By this time the antheridium is sunk within the antheridial chamber which opens to out side by a simple pore. The antheridial wall grows by further formation of radial walls and is usually hyaline in adult condition (Fig. 11). In *P. appendiculatum* the antheridium is associated with unicellular hairs which arise near its base (Fig. 16) as in *C. tenerum* and *Reboulia*. They secrete mucilage in the antheridial chamber.

Mahabale and Bhate (1945) described that in *Asterella angusta* exist occasionally a triangular apical cell at the apex of the antheridium adding segments on 3 sides (though not clear from their figure in the text). Such a cell is not discernible in the present species. Spermatogenesis follows the normal course described for Marchantiales (Champbell, 1939; also Woodburn, 1922). The primary spermatogenous cell is with conspicuous nucleus and nucleolus. It divides diagonally in the usual fashion. 9 chromosomes are present in *Mannia indica*, *Asterella mussuriensis*, *A. pathankotensis* and *Plagiochasma appendiculatum*; and 18 in *A. blumeana* and *A. reticulata*.[4] Irregular spermatogenesis is observed in *P. appendiculatum* and *P. articulatum*. Each spermatozoid is biciliate and with a more or less twisted body. They were observed to be discharged explosively in *Mannia indica* and *Asterella pathankotensis* as in certain other Marchantiaceae (see Peirce, 1902; Cavers, 1903; Haupt, 1921).

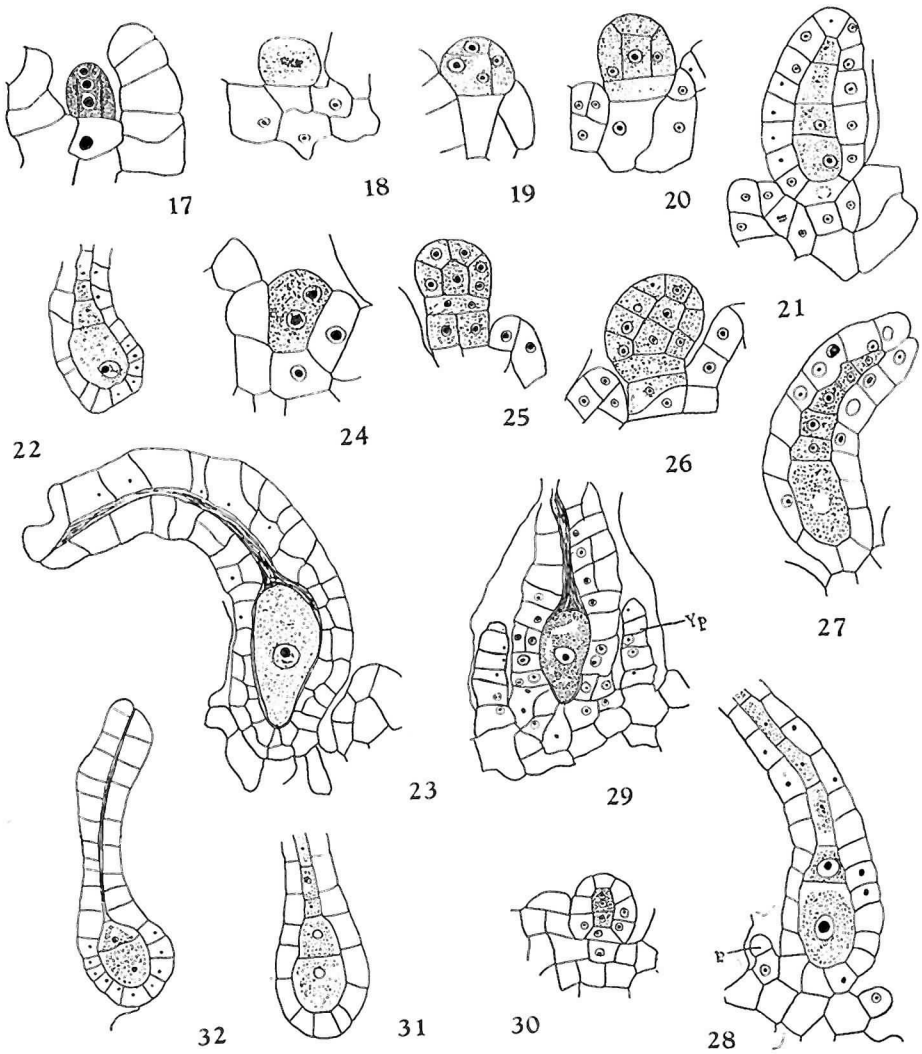
Campbell (1918) found the top of the antheridium in *A. californica* prolonged into a beak or tubular neck. Such a condition is not found in any of the species under consideration nor could Haupt (1929) locate it in the same species.

Archegonium: The archegonial initials are also superficial in origin and they arise in early stages of development of the carpocephalum but do not involve the growing points. However, the activity of the latter is checked by the growing archegonia. The development of the archegonium is of the usual type in Marchantiales (Leitgeb, 1881; Goebel, 1905; Star, 1916; Campbell, 1918; Haupt, 1921, 1926, 1929, 1942; Mahabale and Bhate, 1945; Mahabale and Deshpande, 1947; Mehra and Mehra, 1939). The initial (Fig. 24) either divides by a transverse wall forming an upper archegonial initial and a lower basal cell or directly behaves as an archegonial initial (Fig. 18). It is cut off by 3 intersecting walls into an axial cell and 3 peripheral cells (Fig. 17). The axial cell next divides to form a cover cell and a central cell (Figs. 19, 20, 25), the latter divides by a transverse wall into a primary neck canal cell and a lower ventral cell (Figs. 26, 30). The former undergoes three transverse divisions to form 4 neck canal cells, the ventral cell divides transversely to form a small ventral canal cell and a large basal egg (Figs. 22, 27, 32). In *A. blumeana* the ventral cell may divide simultaneously with the neck canal cell (Fig. 21) and in *A. mussuriensis* both the egg and the ventral canal cell may be nearly equal in size (Fig. 31). The peripheral cells undergo a few transverse divisions and elongate to form the neck, and the lid cell divides by 2 vertical walls at right angles to each other to form 4 lid cells. At maturity the archegonium has an elongated neck (Fig. 23) and is either lying more or less horizon-

[4] A detailed account of cytology of some North West Himalayan Marchantiales will appear jointly with Prof. P. N. Mehra.

tally or is nearly pendent. There are six vertical rows of neck cells in all species, with each row having 8 cells in *A. reticulata*, *A. blumeana* and *A. mussuriensis*. In *A. californica* Campbell (1918) reported 7 and Haupt (1929) 8; while in *Reboulia* Haupt (1921) reported 18–20 in each row.

In *Asterella* just before the fertilization there appears a perianth around the base of the archegonium (Figs. 28, 29) and after an archegonium is fertilized it grows over it as a conspicuous conical sheath projecting from the carpocephalum.



Figs. 17–32. Development of archegonium. 17, *M. indica*. 18–23, *A. blumeana*. 24–28, *A. reticulata*. 29, *A. sanguinea*. 30–32, *A. mussuriensis*. Figs. 17–29, ×425; 30–32, ×325. (*p*—perianth initial, *yp*—young perianth, both in *v.s.*).

Fertilization: Fertilization takes place during the first shower of rains and it is later that the stalk increases in length. Just before it occurs the neck opens along the lid cells due to hygroscopic pressure inside, which forces them apart to let in the spermatozoids. The latter wriggle their way down the neck till they reach the egg membrane. One fertilizes the egg. The zygote enlarges in size till it nearly fills the cavity of the venter (Figs. 23, 29). The latter is one layered before fertilization but afterwards its cells enlarge and divide to form a jacket of several layers around the young embryo. This is the calyptra, and it persists even after the spores lie freely within the capsule.

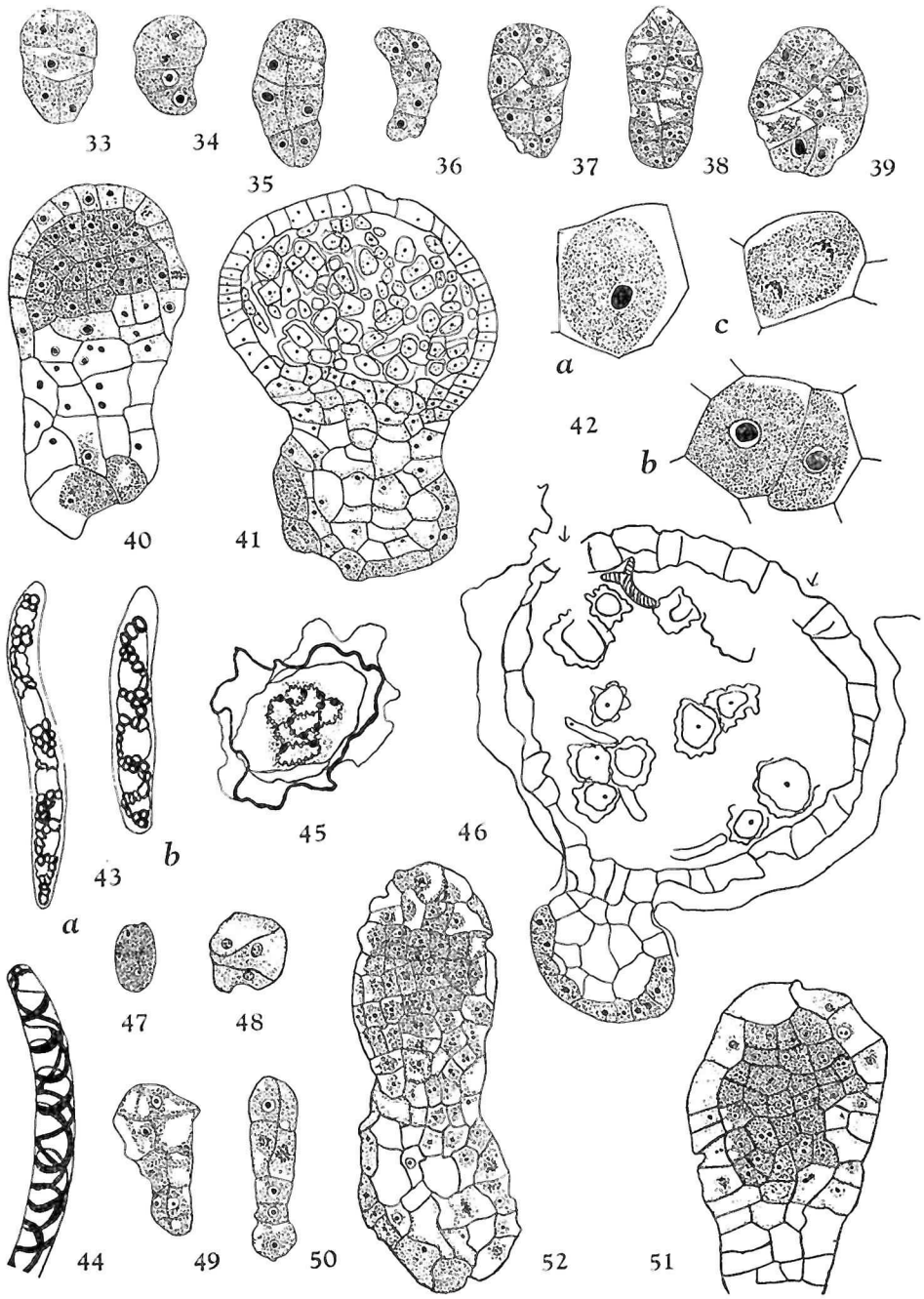
Sporogonium

Meyer (1931) described filamentous and quadrant types of embryos in Marchantiales and regarded the former as primitive and the latter as secondary. He included *Plagiochasma Mannia*, *Reboulia*, *Asterella* and *Fegatella* (and probably *Cyathodium* and *Cryptomirium* as well) in the filamentous type and *Marchantia*, *Preissia*, Astroporae, Corsiniacea and *Riccia* in the latter type. The embryos of the species investigated here are of the filamentous type, no exception having been observed.

The development of the embryo starts immediately after fertilization. The first division in the zygote is transverse dividing it more or less equally in *Asterella blumeana* and *A. sanguinea* (Figs. 47, 64, 65) or unequally in other species (Fig. 61), thus forming 2 cells—an epibasal cell and a hypobasal cell. In *A. mussuriensis* there is an indication that rarely the division may be oblique (Fig. 62). In *Asterella*, *Plagiochasma* and occasionally in *Mannia indica* next a transverse division appears in the epibasal cell dividing the embryo in a 3 celled filament (Figs. 33, 48, 53, 63, 66, 71, 77), in which the lower forms the foot, the middle seta and the upper capsule. A filamentous embryo is also described for *Reboulia*, *Asterella palmeri*, *Cryptomitrium tenerum* (Haupt, 1921, 1929, 1942), *A. blumeana* (Peissel, 1925), *A. angusta* (Mahabale & Bhate, 1945), *Plagiochasma articulatum* Mahabale & Deshpande, 1947), *Mannia* (Meyer, 1916) and *Cryptomitrum himalayensis* (Chopra & Khosla, unpubl.). Previously Campbell (1918) described a quadrant embryo for *A. californica* and Abrams (1899) described the same for *C. tenerum*. Usually in *Mannia indica* a 4 celled embryo is organised (Figs. 34–36) as in *A. californica* and *C. tenerum* (Haupt. 1929).

Though the early divisions in this filamentous embryo are more or less variable in different species they broadly follow the plan described for other Rebouliaceae. After the first division of the embryo one can easily detect the further divisions in the 3 (or 4 in case of *Mannia indica*) regions of the embryo (Figs. 34–36, 66–68, 71–73). Vertical walls first appear in the capsular region (Figs. 36, 37, 50, 63, 71) in contrast to *Reboulia* (Haupt, 1921) where they first appear in the lower tiers; or all tiers may undergo simultaneous divisions (Fig. 67), or often the terminal cell of

Figs. 33–52. Development of sporogonium. 33–46, *M. indica*. 47–52, *A. blumeana*. 42a, archesporial cell; b, c, division of the same into spore mother cell and elater cell. 43a, b, 44, stages in spiralization in elater. Figs. 33–40, 43, 47–52, ×325; 41, ×200; 42, 44, 45, ×425; 46, ×125.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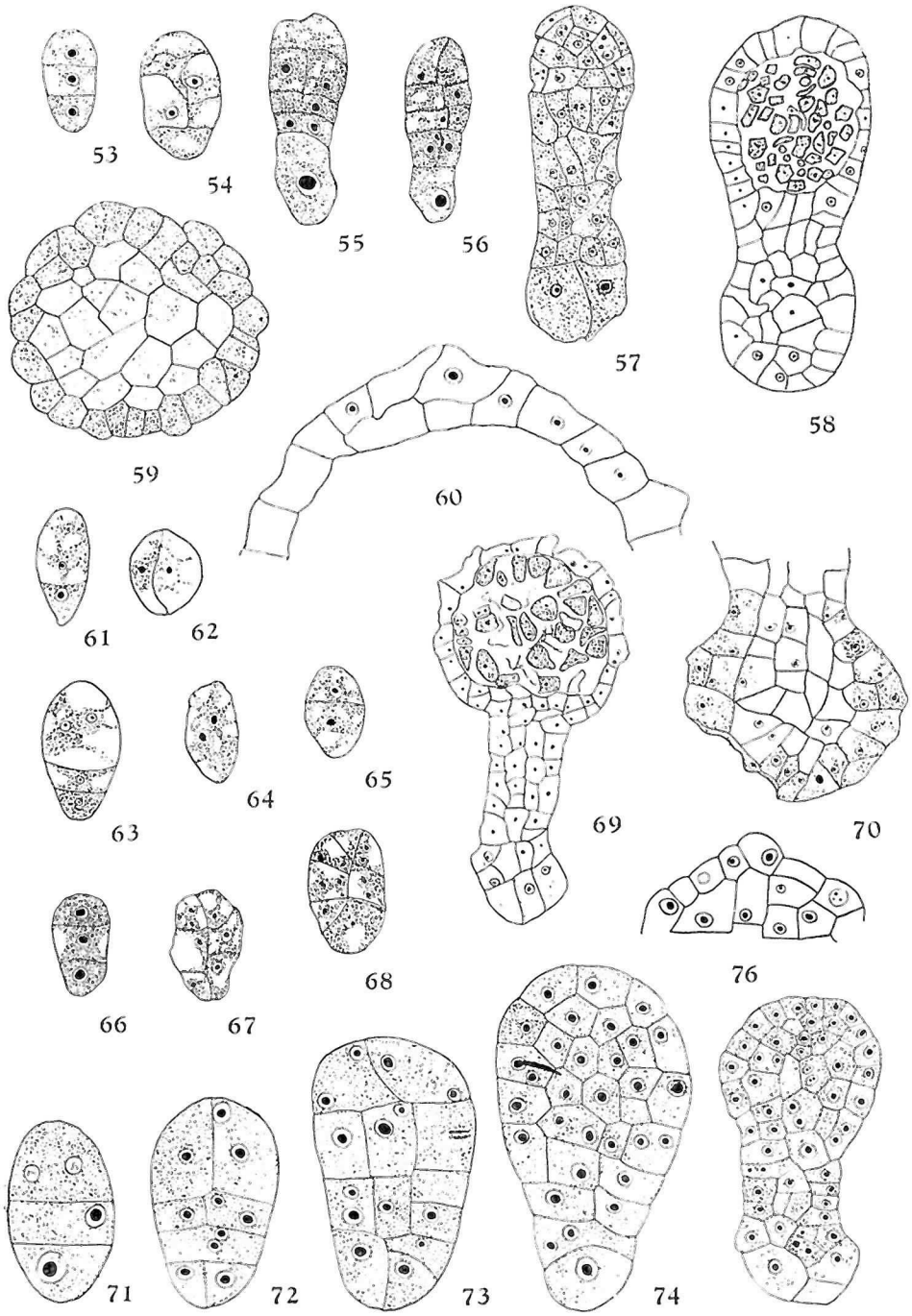
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the embryo is the last to undergo a vertical division (Figs. 35, 49, 54). Later more vertical walls are laid in nearly all the tiers (Figs. 38, 68, 72, 78). The cells of the seta are meristematic for some time and result in the formation of a short seta. In the mature sporogonium usually it remains short but in *Asterella sanguinea* it is somewhat elongated (Fig. 69) recalling to some extent the seta of *Marchantia*.

The basal cell of the embryo does not divide simultaneously with the capsular and the seta initials so that in *Asterella blumeana* and *A. reticulata* when the embryo is elongated and many cells long it is still a single cell, though enlarged and prominent (Figs. 49, 50, 55, 56). The later development of foot is quick and it soon assumes a bulbous shape with the peripheral cells highly granular and the central ones less so in the mature state (Figs. 59, 70). This character is persistent even after the spores are shed. It is believed to be haustorial in function though no particular processes are developed for this purpose.

By this time the sporogonium is elongated and now the cells in the capsular region divide in all directions (Figs. 39, 39, 51, 57, 74, 78–80). Later this mass of cells is differentiated into an outer one cell thick layer and a central archesporium (Figs. 40, 52, 58, 75, 81) and the capsule becomes globular in shape (Figs. 41, 69, 82). The parietal layer is persistent but loses its contents and becomes enlarged by the time the spores are shed (Figs. 46, 84), retaining the nuclei up to the last stage. The cells of the archesporium stain deeper due to their dense cytoplasmic contents and have prominent nucleoli. The sporogenous mass is formed from about 2/3 of this tissue and about 1/3 forms the belt separating the archesporium from the seta. There is no definite arrangement of sterile and fertile cells but they are readily distinguishable by their form. The elater mother cells and spore mother cells are sister cells (Fig. 42a–c) as in *Reboulia* and *Cryptomitrium tenerum* (Haupt, 1921, 1942). The sterile cells are more or less elongated and the fertile ones nearly rounded.

The sporogenesis is as usual for Marchantiaceae. The spore mother cells round off and form a tetrad after reduction division. When the spore mature the outer cell walls thicken and are later differentiated into 3 layers—the exine developing characteristic sculpturing and the perisporium is in form of a sac. The spore wall is already 3-layered even when the nucleus is still in the late telophase stage (Fig. 45) suggesting thereby that the differentiation of the walls starts just after the tetrad is formed. The spores do not remain in tetrads for a long time. The perisporium is variable in various species and a detailed account of the same has already been given (*c.f.* Mehra & Kachroo, 1951; Kachroo, 1954b).

The sterile cells are elongated, thin-walled, with distinct nucleus and finely granulated cytoplasm. These continue to elongate and the cytoplasm becomes less uniform and tends to form a spiral band (Figs. 43a–b, 44). When mature the elater has a thickening of usually 2, occasionally 3 (and rarely branched), spiral bands; and becomes brown.

Figs. 53–76. Development of sporogonium (contd.) 53–60, *A. reticulata*. 61–63, *A. mussuriensis*. 64–70, *A. sanguinea*. 71–76, *A. pathankotensis*. 59, *t.s.* foot. 60, 76, apices of capsules in *l.s.* 70, *t.s.* foot in *v.s.* Figs. 53–68, 70, 75, ×325; 69, ×125; 71–74, 76, ×425.

The apical region of the capsule-wall in vertical section shows 2 layers of cells in *Asterella blumeana*, *A. reticulata* (Fig. 60) and *A. mussuriensis*, while in *A. pathankotensis* (Fig. 76), *A. sanguinea*, *Mannia indica* and *Plagiochasma appendiculatum* (Fig. 83) it is very prominent and 3 cells in thickness.

An operculum is present in all the species. In *Mannia indica*, *Asterella pathankotensis*, *A. sanguinea* and *Plagiochasma appendiculatum* it is detached as a circular lid from the capsule. In other species it is detached in fragments. In either case the dehisced capsule is left as an urn-shaped structure. The cells of the operculum show radial thickenings which are more prominent where the lid detaches as a disc. Cavers (1911) described an annulus-like structure in capsules of *Mannia*, such a structure is not detected in *M. indica*.

The spores are liberated either singly, few at a time or in a mass, depending on the velocity of the currents of air or movements of insects. The elaters help in dispersal in rains or after the spores fall on moist ground.

Discussion

Individuality of Rebouliaceae:—The various genera included within the family justify their separation in a group on basis of their morphological characters: carpocephalum always stalked, terminal, with a single rhizoidal furrow; male receptacle or cushion truly dorsal. In *Plagiochasma* both are dorsal, and rhizoidal furrow is absent. (In *A.* "Manipur" the carpocephalum stalk has air-spaces as well). The thallus has usually air chambers in many layers. In all species there is uniformly a filamentous embryo (except for a report of quadrant embryo in *Asterella californica* and previous report of a similar embryo in *Reboulia* and *Cryptomitrium tenerum*). *Asterella* is unique in having a perianth. It is interesting to note that all genera have reticulate, winged spores with slight variation in *Asterella* where they are occasionally ridged. This is in contrast to the coarsely papillate spores of Sauteriaceae; to some extent resembbling those of *Targionia* (compare *e.g.* spores of *A. blumeana* with those of *T. hypophylla*). In the family Marchantiaceae the spores range from smooth to lamellate.

Cavers (1911) also while discussing their relationships with other genera of Marchantiaceae concluded that the "group may be regarded as forming an independent series showing some striking parallelisms with Astroporae on one hand and the Compositae on the otner." He (*l.c.* p. 195) used the family name Aytoniaceae since he regarded *Plagiochasma* (=*Aytonia*) as the most primitive member of this family. Evans (1923,[5] p. 9; 1939) chose Rebouliaceae.[6] *Plagiochasma*, though retaining the well developed carpocephalum, is specialized due to the dorsal nature of the reproductive branches and the consequent loss of the rhizoidal furrow.

[5] The correct citation for the name Rebouliaceae should be: Rebouliaceae (Reichenbach) Evans, 1923.—Proskauer (in litt., 1957).

[6] While the name Aytoniaceae Cavers, 1911, p. 195, is the correct name and has priority over Rebouliaceae Evans, 1923, in North American Flora **14**: pt. 1, p. 9, the latter is here employed. The name Aytoniaceae is based on a synonym rejected as a homonym and the case has been drawn to the attention of a member of the International Committee on Nomenclature of Bryophytes for further action.

The only character that might be regarded primitive in *Reboulia* is the aggregation of antheridia in receptacles, instead of a cushion, and compound pores on the same! *Asterella* might with justification be regarded as primitive since in a few species it has retained air chambers in one layer with assimilatory filaments, the perianth is present in all its species. Thus, with regards to primitiveness of any one of these genera one has to be cautious since the various genera show striking parallelisms with each other and the 'position of primitive genera should be based upon a combination of character rather than upon a single character (Evans, 1939)'.

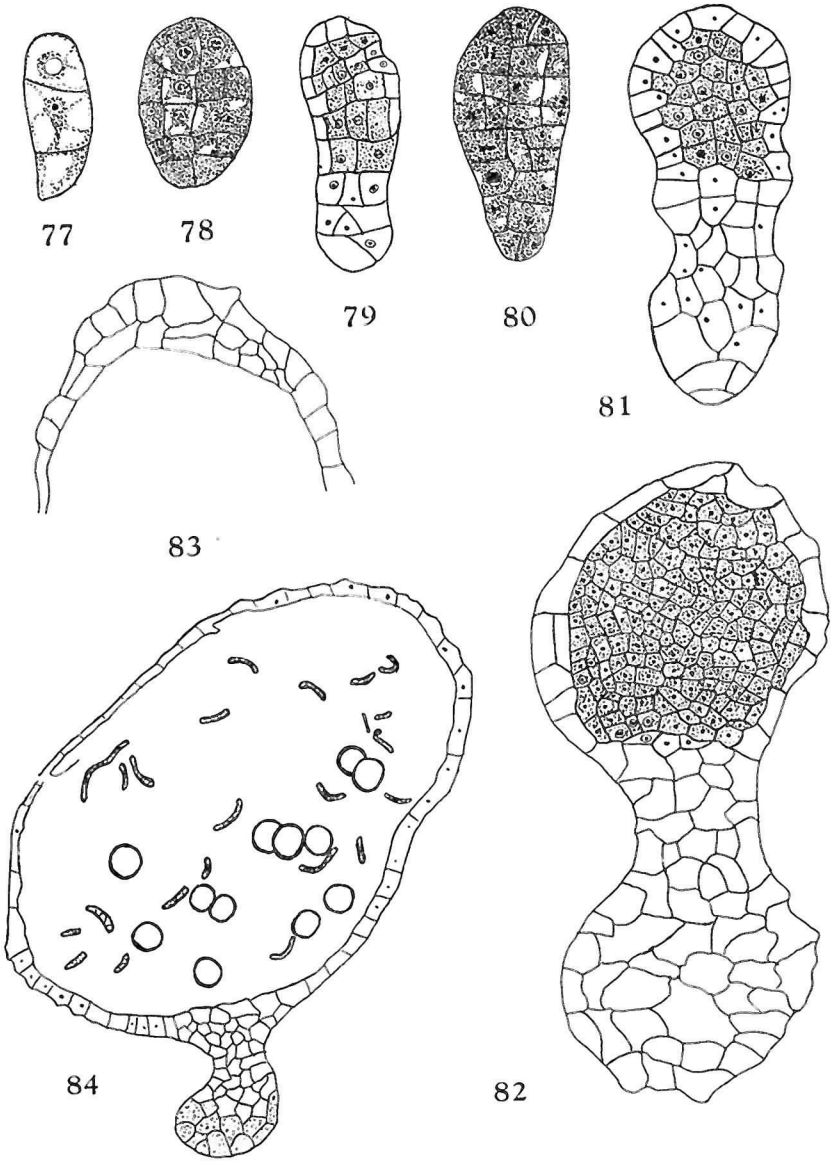
Position of sex organs:—The position of male and female receptacles/cushions on the thallus within the various genera and occasionally within the same species is variable as shown below. (The species marked with an asterisk were studied by the author for this feature).

Sex distribution	Position of sex organs	Species
Dioecious	♂ receptacle dorsal; ♀ stalked, terminal.	*A. angusta**
Monoecious	♀ stalked, terminal; ♂ dorsal, just behind it.	*A. blumeana**, *A.* "Manipur"*, *A. nepalensis*, *A. papulosa*, *A. ludwigii*, *A. saccata*, *A. lindenbergiana*, *A. tenella*, *A. palmeri*; *M. rupestris*; *C. tenerum*, *C. himalayense**.
〃	♀ stalked, terminal; ♂ on ventral shoots.	*A. reticulata**; *M. pilosa*; *R. hemisphaerica**.
〃	♀ stalked, on ventral shoots, ♂ apical-dorsal.	*A. pathankotensis**, *A. Sanguinea**, *A. parvipora*, *A. multiflora*; *M. indica**, *M. californica*.
〃	♀ stalked; ♀ and ♂ terminal on ventral shoots.	*A. mussuriensis**, *A. bolanderi*.
〃	♀ stalked, terminal on one lobe; ♂ dorsal-terminal on another lobe.	*M. fragrans*; *R. hemisphaerica**; *P. cuneatum*, *P. simlense*.
〃	♂ and ♀ dorsal on main thallus.	*P. appendiculatum**, *P. articulatum**, *P. rupestre*, *P. intermedium*.

A—Asterella, M—Mannia, C—Cryptomitrium, R—Reboulia, P—Plagiochasma.

In *A. mussuriensis* where the sex organs are restricted to the ventral shoots occasionally the stalked carpocephalum is borne apically on the apical continuation of the main thallus. *A. sanguinea* also exhibits this reversal in position of male and female receptacles. Here the carpocephalum is borne on the ventral shoots and the male cushion (occasionally a false receptacle) is apical on the main thallus. But there are cases where the male is borne on a lateral elongation of the apex and the apical-cell-region is continued as the stalk of the carpocephalum, which thus occupies a terminal position. It yet another case the carpocephalum was terminal and the male was borne on a small ventral shoot arising from the ventral side just near the region from where the carpocephalum arose. This interesting inter-

shifting of sex organs from their normal position points to the fact that probably the ancestoral feature was that both the sex organs were terminal on the thallus but later in the course of evolution they shifted to the ventral shoots. Thus, on this feature the species with both sex organs on the main thallus are primitive and those with either of these on the lateral shoots derived; those with both on the



Figs. 77-84. Development of sporogonium (contd.) *P. appendiculatum*. 83, apex of capsule in *l.s.* Figs. 77-80, 84, ×390; 81-83, ×240.

leteral shoots still more removed from the ancestoral type. In the latter group this specialization may have resulted in great morphological advantage over the other species, since the apical cell is free to undergo unlimited vegetative growth and may go on producing side by side numerous sexual shoots as well.

It is interesting to note that in the family Sauteriaceae (of Evans, 1939) *Sauteria* has similarity with *Asterella blumeana* in position of sex organs on the thallus, air chambers in many layers, stalk without green tissue and with a single rhizoidal groove. In *Peltolepis* the male and female receptacles are terminal on adjoining lobes and air chambers in many layers as in *Mannia fragrans*; but the stalk though without green tissue, has occasionally two rhizoid furrows. In *Athalamia*, though the female receptacle is dorsal without a groove in the stalk, as in *Plagiochasma*, the male receptacle is reduced, has become indistinct, irregular and is without surrounding bracteoles. These facts bring forth striking parallelisms between the two families rather than showing a merging of one into another.

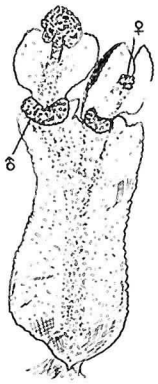
Receptacles:—The carpocephalum is conservative in having retained its stalked nature, compound pores, and probably in some species of *Asterella* the presence of air chambers in one layer with assimilatory filaments. It has undergone reduction in nature of air chambers in most of the species, reduction to one rhizoidal groove in *Mannia*, *Asterella*, *Cryptomitrium* and *Reboulia*; and to its total absence in *Plagiochasma*.

In *A.* "Manipur" (Figs. 88, 90) and *A. blumeana* (Pande *et al*, 1953) the stalk of the carpocephalum is occasionally branched into two, each branch bearing apically a female receptacle in the usual fashion. Often in most of the Rebouliaceae the number of involucres may be as great as 9, but the stalk remains always with a single furrow. However, *A. blumeana* (Pande & Srivastava, 1953) shows a double furrow in the stalk of the carpocephalum, which is a feature of Compositae; further a reduction from 2 to one furrow in the same stalk and in one case accompanied by a dichotomy of the stalk at its apex! *A.* "Manipur" also shows the various forms of this reduction from 2-1 furrow, but in different plants and without any correlation with the bifurcation of the stalk. Furthermore, this species shows the presence of air spaces (usually 3) towards the posterior region of the stalk (Fig. 91), these double in number in stalks with a double furrow. Such a feature is not reported so far, for any species of *Asterella*.[7]

Sex organs and embryo:—The development of sex organs is nearly uniform in the family and resembles other Marchantiales. It is significant that the embryo is filamentous in nearly all the species investigated so far.[8] In Marchatiaceae a similar type of embryo is reported for *Conocephalum*, *Targionia* and *Cyathodium*.

[7] While this paper was in Mss. form Pande *et al* (1953b) published an excellent account on some abnormal female receptacles of *Asterella khasiana*, which makes it un-necessary for me to append a similar account I wrote on the basis of abnormal female receptacles of *A.* "Manipur" (Figs. 86-90) and *A. sanguinea* (Fig. 92). Reference may also be made here of the fruitful discussion on the Reduktionen in den Geschlechtsständen in Marchantiales (Burgeff, 1943, pp. 244-253).

[8] *A. californica* (Campbell, 1918), *Reboulia* (Cavers, 1904) and *C. tenerum* (Abrams, (1899) were previously described with quadrant embryos; but on reinvestigation *Reloulia* and *C. tenerum* were found to have filamentous embryos.



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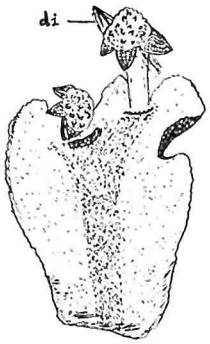

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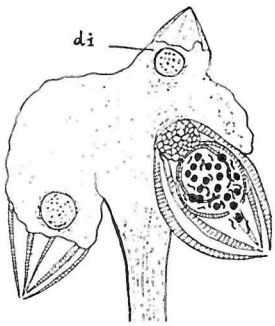

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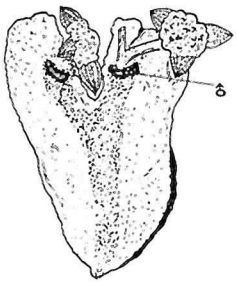

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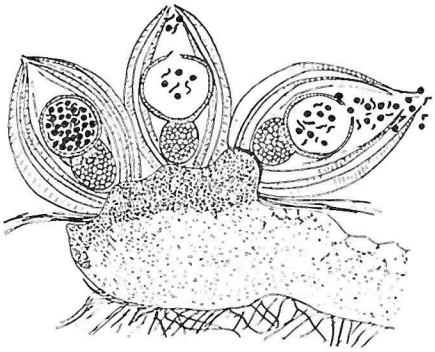

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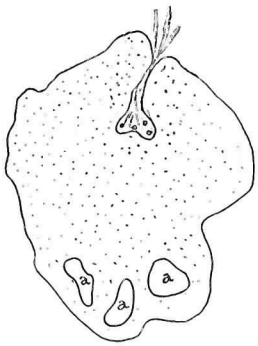

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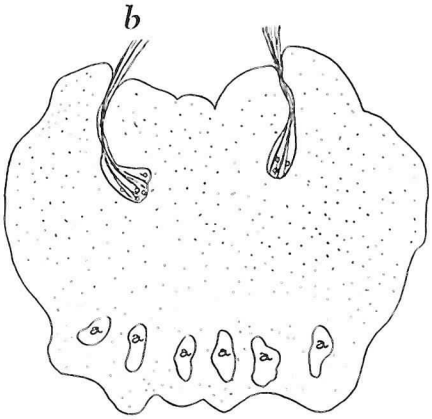

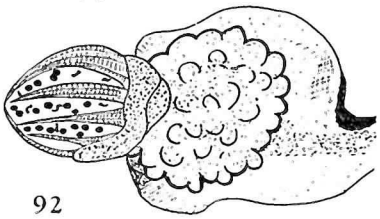

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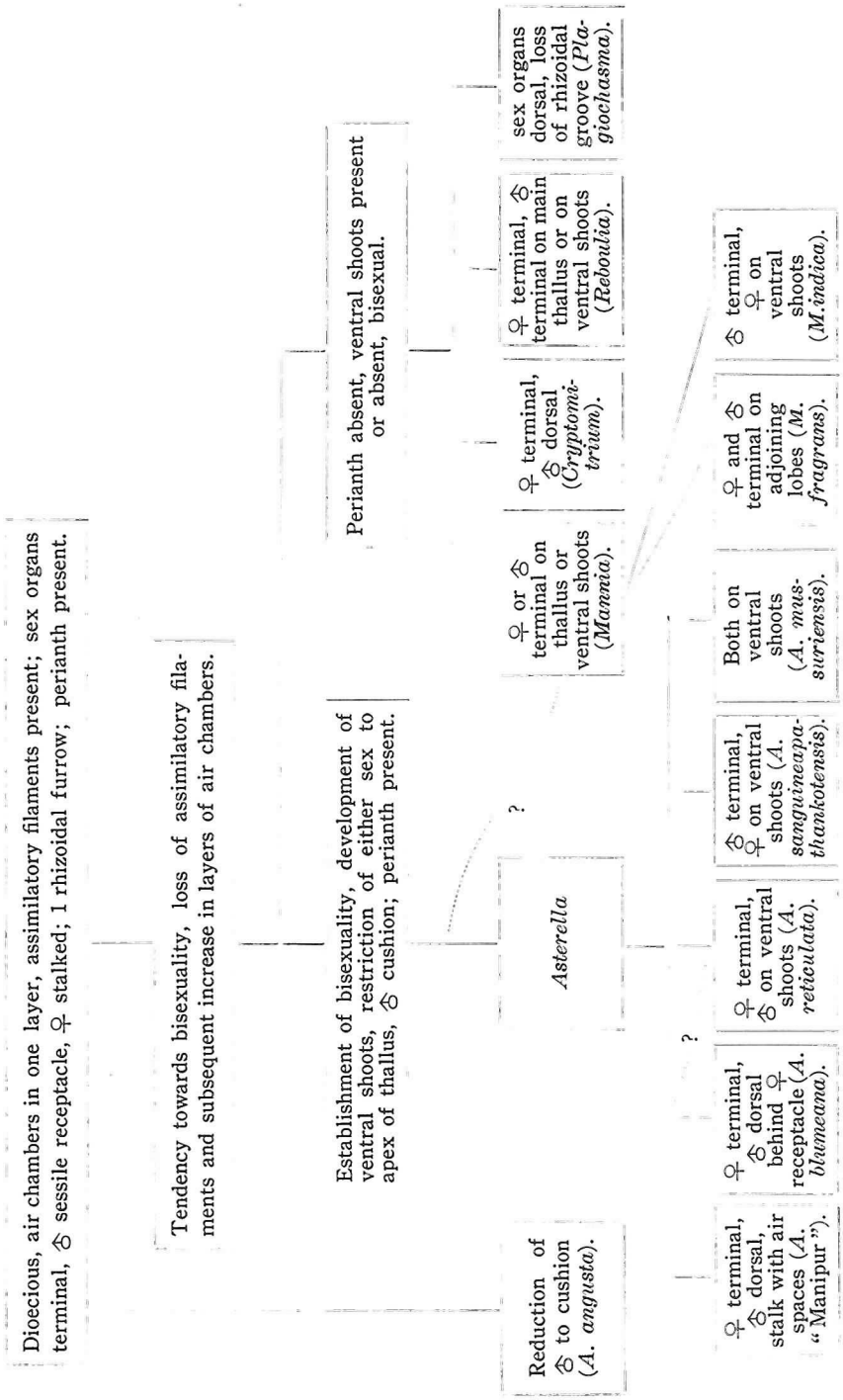
In *Corsinia*, *Sauteria*, *Exormotheca*, *Stephensoniella*, *Preissia* and *Marchantia* the embryo is of octant-type. Meyer (1931) regarded the filamentous embryo as primitive and the octant type advanced. (It appears that linear phylogeny of Marchantiales, ascending or descending, no longer deserves serious consideration). However, it may be noted that Corsiniaceae and Sauteriaceae have an octant embryo; Targionaceae and Rebouliaceae a filamentous type; and Marchantiaceae mostly an octant type and occasionally a filamentous one. Thus, a filamentous type can not be visualized to have been sandwiched between an octant and octant type. It would be best to visualize that in each group this development is independent of other features. Incidentally it may be noted here that in *Ricciocarpus* and *Riccia* both types are met with.

Concluding remarks:—According to Cavers (1911), Kashyap (1919) and Frye and Clark (1937) *Reboulia* and *Plagiochasma* are derived one from the other. The apparent relationship between the two is very great but it is to be noted that they differ a great deal in morphology. *Plagiochasma* is apt to be regarded as a derived genus or at least as 'later evolved' as shown by its thallus and position of sex organs. But the two might have descended from a common ancestor and followed parallel lines of evolution. *Asterella* in the presence of a perianth resembles *Marchantia* and *Preissia* and on this basis most clearly approaches the ancestoral form from which the Marchantiaceae have descended (Goebel, 1930). This suggests that *Asterella* is a comparatively primitive genus and could not have been derived from *Plagiochasma* through either *Massalongoa* or *Mannia* and *Cryptomitrium*. It may have ancestors similar to those of *Reboulia-Plagiochasma* group, even though it differs from them in spore structure, nature of germ disc and in many species in the structure of the thallus. Cavers (1911) derived *Mannia* also from *Plagiochasma* through *Reboulia* while Frye and Clark (1937) did so directly from *Plagiochasma*. This is unsound. It could not have evolved from a genus with dorsal sex organs and the usual absence of ventral shoots. It resembles *Asterella* in its plan of sporeling germination and in the range of vegetative structure as revealed by the various species of each genus. Resemblances between some species are so great that before a perianth appears it is difficult to differentiate one from the other (*c.f.* *A. pathankotensis* and *M. indica*). The two genera might have had a common ancestor or *Mannia* might represent a genetic mutation from a form like *Asterella* with the perianth becoming obsolete. More cytological research in such directions may reveal some interesting cases of mutations and hybrids in Hepaticae. *A.* "Manipur" might provide another case of similar mutation or hybridization. Frye and Clark (1937) provide an unconvincing phylogenetic table for the group. It is surprising how they account for the loss of the characteristic perianth and the

Figs. 85–92. *Asterella* "Manipur". 85, plant showing horse-shoe shaped male receptacle and continuation of apex into a heart-shaped lobe bearing carpocephalum. 86, same, note subsessile carpocephalum and dorsal involucre (*di*); the latter in *v.s.* in 87 (diagrammatic). 88, showing sessile carpocephalum on left side and a dorsal involucre in the one on the right side; the former in *v.s.* in 89 (diagram.). 90, showing concentric male receptacle and bifurcation of stalk (also in 88). 91, *t.s.* stalk showing air spaces (*a*) and rhizoidal groove, both double in *b*. 92, *A. sanguinea*, a small thallus with sessile carpocephalum. Figs. 85, 86, 88, 90, 92, ×4; 87, 89, ×10; 91, ×125.


Dioecious, air chambers in one layer, assimilatory filaments present; sex organs terminal, ♂ sessile receptacle, ♀ stalked; 1 rhizoidal furrow; perianth present.
Tendency towards bisexuality, loss of assimilatory filaments and subsequent increase in layers of air chambers.
Establishment of bisexuality, development of ventral shoots, restriction of either sex to apex of thallus, ♂ cushion; perianth present.
Reduction of ♂ to cushion (A. angusta).
Asterella
?
?
Perianth absent, ventral shoots present or absent, bisexual.
♀ or ♂ terminal on thallus or ventral shoots (Mannia).
♀ terminal, ♂ dorsal (Cryptomitrium).
♀ terminal, ♂ terminal on main thallus or on ventral shoots (Reboulia).
sex organs dorsal, loss of rhizoidal groove (Plagiochasma).
♀ terminal, ♂ dorsal, stalk with air spaces (A. "Manipur").
♀ terminal, ♂ dorsal behind ♀ receptacle (A. blumeana).
♀ terminal, ♂ on ventral shoots (A. reticulata).
♂ terminal, ♀ on ventral shoots (A. sanguineapathankotensis).
Both on ventral shoots (A. mussuriensis).
♀ and ♂ terminal on adjoining lobes (M. fragrans).
♂ terminal, ♀ on ventral shoots (M. indica).

occasional presence of air chambers in one layer with assimilatory filaments in *Asterella*. The removal of *Cryptomitrium* from Rebouliaceae to Marchantiaceae (Verdoorn, 1932) is also uncalled for, since this genus is so much like Rebouliaceae that such a doubt should not have arisen; *e.g.* in its filamentous embryo, a definite lid in the capsule, structure of male cushions and female receptacles and thallus morphology.

In conclusion the accompanying table is presented embodying these results and speculations.[9]

Summary

Life history is studied in *Mannia indica*, *Asterella blumeana*, *A. reticulata*, *A. mussuriensis*, *A. sanguinea*, *A. pathankotensis* and *Plagiochasma appendiculatum*. Development of sex organs is of the general type in Marchantiales. The embryo is filamentous: 4-celled in *M. indica* and 3-celled in other species. The various genera on basis of thallus morphology, nature of reproductive organs and spore character justify their inclusion under a single family. *Asterella* and *Mannia* show striking parallelisms in position of sex organs; and in the former genus variation and interchange in position of sex organs (receptacles) on the thallus, as shown by various species, suggest that in ancestoral form both were terminal on the main thallus.

A. sanguinea and *A.* "Manipur" have rarely sessile carpocephalum, the latter showing occasionally a branched stalk and usually abnormalities in the number of involucres. The inter-relationships of the various genera are discussed.

I am indebted to Prof. P. N. Mehra for having suggested this problem and for his keen interest in me in general and in this problem in particular; to Prof. J. Proskauer for his criticism and for suggesting a few modifications incorporated in the text; to Profs. W. C. Steere, A. J. Sharp and Dr. T. Herzog for encouragement; to Mr. T. N. Khoshoo for helping me in a number of ways; and to my wife for her appreciation, cooperation and encouragement.

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[9] Burgeff (1943) in his Genetical Studies in *Marchantia* presented a Schema der Marchantiales (p. 241, f. 213-reproduced here) in which he suggested a polyphyletic origin of most of the genera of the Marchantiales (Fig. 93). *Reboulia*, *Asterella* and *Mannia* are derived distantly from *Plagiochasma*; the latter genus shares its ancestory with *Clevea* and *Athalamia*. The genera *Peltolepis*, *Sauteria*, *Exormotheca*, *Plagiochasma*, *Clevea* and *Athalamia*, form a distinct 'line' in his scheme.

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APPENDIX

1. Notes on Aytoniaceae.

During my previous investigations on the morphology of this family I chose the family name Rebouliaceae. However, when the last of this series was sent to Dr. J. Proskauer for his kind criticism, he drew my attention to the impropriety of such a selection, since Aytoniaceae has priority over Rebouliaceae, as a family name, and ought to have been employed. This correspondence resulted in the following compilation, (mainly from Proskauer's letters to the writer), which gives the various names used for this group in the past.

Rebouilliariae H. G. L. Reichenbach, 1837.

Grimaldieae Reichenbach in Rabenhorstschen Kryptogamen-Flora, ed. I, 1848; (the original date in 1841—Proskauer *in lit.*)

Operculatae Leitgeb in Untersuchengen über die Lebermoose, VI. Die Marchantieen. Graz, 1881.

Aytoniaceae Cavers in New Phytol. repr. no. 4, p. 195, 1911.

Rebouliaceae Evans in North American Flora **15** (1): 9, 1923 (the correct citation should be Rebouliaceae (Reichenbach) Evans 1923—Proskauer *in lit.*).

Asterelleae Jörgensen in Norges Levermoser, Bergens Mus. Skrifter Nr. **16**: 1-343, *mit 25 Taf.* Bergen, 1934.

Grimaldiaceae (Reichenbach) Müller in Rabenhorst Kryptogamen-Flora **6**: Ergänzungsband: 220, 1940.

* Not seen in original.

2. On *Asterella evansii* Kachroo.

In 1917 Kashyap described *Asterella* (=*Fimbriaria*) *reticulata* with the following characters: the thallus monoecious with air chambers in many layers and with simple pores; the ventral scales with single appendages; the antheridial cushions on very short lateral shoots arising on both sides of the midrib; the stalked carpocephalum terminal on the main thallus, the stalk with a single rhizoidal groove; and the spores brown, reticulate-lamellate: reticulations obscure, and with narrowly finely punctate wing. However, Kachroo (1954) described the male cushion as often found on lateral shoots that are borne apically and the exine of the spore decidedly with larger fewer reticulations inclosing many smaller reticulation. The species is closely related to *A. blumeana* (Nees) Kachroo with which it agrees in its spore structure, thallus morhology and chromosome number (n=18 in both, Mehra and Kachroo in press). Further it is not uncommon to find specimens intermediate between them, and it is possible that *A. reticulata* is a derivative of *A. blumeana*.

Evans (1920), presumably unaware of *A. reticulata* Kashyap also described a new species of *Asterella* which he also named *A. reticulata*. Evans' "*A. reticulata*" is very close to *A. elegans* in the general appearance, in the thallus structure and the male inflorescence; the only difference between the two being spore structure, which in case of *A. elegans* has a regular reticulum and in case of "*A. reticulata*" larger regular reticulations including smaller irregular meshes (*c.f.* Evans, *l.c.*).

Since *A. reticulata* (Kashyap) Kachroo is described earlier, it has priority over "*A. reticulata*" Evans. Therefore, ***A. evansii*** sp. n. is proposed to accommodate the latter species. (Named after Prof. Alexander W. Evans). However, a study of the four species: *A. blumeana*, *A. reticulata*, *A. evansii* and *A. elegans* might be interesting from cytological and distributional points of view.

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Kachroo, P. 1954. Jour. Hattori Bot. Lab. **12**: 38-39, fig. 3, a-1.

Kashyap, S. E. 1917. Jour. Bombay Nat. Hist. Soc. **25**: 279; 1929—Liverworts of the Western Himalayas and Panjab Plain, I: **65**, pl. 14, figs. 1-3.

Mehra, P. N. and P. Kachroo. Cytology of West Himalayan Marchantiales (in press).

THE FAMILY PLAGIOCHILACEAE OF JAPAN AND FORMOSA. I.

By Hiroshi INOUE[1]

井上 浩: 日本及び台湾のハネゴケ科 (I)

Introduction and history

The history of the study of Japanese Hepaticae dates back nearly one hundred years. During this time numerous reports on Hepaticae of Japan have been published both at home and abroad. There are, however, many questionable species among those reported from Japan, especially by F. Stephani (1897, 1900, 1906–1917, 1924), who described many as new in his notorious "Species Hepaticarum". Recently critical study of those doubtful species has led to a series of monographic works on some groups of Hepaticae, mainly by Dr. S. Hattori and his coworkers. Nevertheless, the family Plagiochilaceae in Japan contains many species of dubious value. Except for Dr. S. Hattori's short review of the genus *Plagiochila* (S. Hattori 1949), in which he critically discussed the records of the species from Japan, there has been no important contribution to our knowledge of the family.

The family Plagiochilaceae is large, and includes the large genus *Plagiochila* of more than 1300 species and of cosmopolitan distribution. Except for those of Europe and North America, however, the great majority of them have not yet been critically studied by a monographer. Many new species are still described without a careful comparison with known allied species. Consequently, the recognition of species is very difficult without comprehensive study of the literature. For this reason a complete monographic work is needed for the present family.

The family Plagiochilaceae was first proposed by H. Buch (1936). He included only one genus *Plagiochila* in his work on the Hepaticae of Finland. Till then *Plagiochila* had been included in the classical family Jungermanniaceae ackrogynae (Epigonantheae) proposed by V. Schiffner (1909), or Epigonanthaceae as proposed by F. Verdoorn (1932). In the family Jungermanniaceae ackrogynae there were 28 genera including among them *Tylimanthus*, *Syzygiella*, *Plagiochila*, *Pedinophyllum*, and *Mylia*. F. Verdoorn's Epigonanthaceae consisted of not only *Plagiochila* and others cited above, but also *Chiastocaulon* establised by H. Carl (1932). E. Joergensen (1934) first grouped *Plagiochila*, *Pedinophyllum* and *Mylia* as Tribus Plagiochileae[2] of the large family Jungermanniaceae of Dumortier (1892). In 1938, Buch, Verdoorn and Evans published a check list of Hepaticae of N. America and Europe, in which they included a complete enumeration of all genera and families of Hepaticae. In their treatment *Plagiochila*, *Chiastocaulon*, *Syzygiella*, *Plagiochilidium*, *Wettsteinia* and *Tylimanthus* were included in the Plagiochilaceae. After that Evans (1939)

[1] Botanical Institute, Faculty of Science, Tokyo University of Education, also Hattori Botanical Laboratory.

[2] K. Müller (1956) noted this Tribus as Plagiochilaceae Joerg. But it is an illegitimate. E. Joergensen divided the Jungermanniaceae into five groups (Tribus), Marsupelleae, Nardiae, Lophoziae, Plagiochileae and Lophocoleae.

published 'The classification of Hepaticae', in which he arranged all genera and families of Hepaticae for the most part according to the list published in the previous year. K. Müller (1948) added the genus *Mylia* to this family.

In 1945, Frye and Clark published their 'Hepaticae of N. America' (part 3), in which they treated *Plagiochila* under Plagiochiloideae; in the previous part (2) they placed *Pedinophyllum* under the Nardioideae. S. Hattori (1952) published a list of Hepaticae of southern Japan, in which the Plagiochilaceae included genera as *Plagiochila*, *Chiastocaulon* and *Plagiochilion* (proposed by him in 1949),[3] and then added to them *Pedinophyllum* in 1953. R. M. Schuster (1953) newly proposed *Cryptocolea* in this family from Minnesota of N. America, including a solitary species.

After all, summarizing the history of the genera in this family, *Plagiochila*, *Plagiochilidium*, *Noguchia*,[3] *Chiastocaulon*, *Tylimanthus*, *Syzygiella*, *Wettsteinia*, *Pedinophyllum*, *Mylia* and *Cryptocolea* are counted. The genus *Mylia*, however, is placed by some authors in the family Jungermanniaceae.

The area under consideration includes all Japan (Hokkaido, Honshu, Shikoku, Kyushu and few islands belonging to Japan) and Formosa. Adjacent areas, such as Sakhalin, Korea, Manchuria, Micronesia, and Bonins, are omitted because so little material is available.

Most of the specimens examined in this study are in the herbarium of the Hattori Botanical Laboratory. Others are in the private herbaria of Mr. T. Amakawa (Syuyukan High School, Fukuoka), Mr. T. Kodama (Osaka Municipal Science Museum, Osaka), Mr. M. Hara (Kochi University, Kochi) and Mr. M. Kamimura (Marunouchi High School, Kochi), and the author himself. Fortunately the collections of U. Faurie, determined by F. Stephani, are preserved in good condition in the herbarium of the Kyoto University. The type specimens established by Prof. Y. Horikawa are in the herbarium of the Hiroshima University. The materials from Formosa are mainly those preserved in the herbarium of Tokyo National Science Museum.

The author should like to acknowledge the help and criticism of Prof. H. Ito of our University. He must also express his cordial thanks to Dr. S. Hattori of the Hattori Botanical Laboratory, for his useful suggestions and criticisms, and for his permission to examine the specimens of the present family in the herbarium of the Hattori Botanical Laboratory. The author also desires to express his gratitude to Dr. Y. Kobayashi of the Tokyo National Science Museum, Prof. Y. Horikawa of the Hiroshima University, Dr. S. Kitamura and Dr. M. Tagawa of the Kyoto University, for the examination of the specimens of the present family in those herbaria. Finally the author is indebted to those persons mentioned above for their kindness in lending or sharing their collections of Hepaticae of this family.

Taxonomical treatment

In the present area the following genera are recognized: *Plagiochila*, *Noguchia* (*Plagiochilion*)[3], *Syzygiella*, *Pedinophyllum*, and *Mylia*. *Chiastocaulon* is reduced to the subgeneric rank under *Plagiochila* in this study.

[3] The generic name of *Plagiochilion* was replaced with *Noguchia* (nom. nov.) by S. Hattori (1954).

Key to genera

1 { Stem prostrate; rhizoids usually numerous on ventral side of stem throughout; cortical cells of stem not differentiated from interior cells 2
  Stem ascending; rhizoids usually few or absent; cortical cells of stem clearly differentiated from interior cells (except for *Syzygiella*) 3

2 { Plants unisexual; antheridium more than 2 per bract; trigones of leaf cells conspicuously large ..... *Mylia*
  Plants bisexual; antheridium one per bract; trigones of leaf cells small or absent .... *Pedinophyllum*

3 { Leaves opposite, orbicular to ovate; flagella usually present ..... *Noguchia*
  Leaves nearly opposite or alternate, adherent at ventral end; flagella not present..... ..... *Syzygiella*
  Leaves alternate; flagella usually not present ..... *Plagiochila*

Mylia Gray

Nat. Arr. Brit. Pl. **1**: 693 (1821).——*Leptoscyphus* Mitt. London Jour. Bot. **3**: 358 (1851).——*Leioscyphus* Mitt. in Hooker, Handb. New Zealand Fl. **2**: 134 (1855).——*Coleochila* Dum. Hepat. Eur. 105 (1874).

This genus was first included in the Plagiochilaceae by K. Müller (1948), but E. Joergensen (1934) treated it as a member of the Plagiochileae of Jungermanniaceae Dum. Recently, R. M. Schuster (1951, 1953) and T. Amakawa (1955) assigned this genus to the present family, although other authors still included it in the Jungermanniaceae (S. Hattori 1953, 1955; M. Hara 1956), or Epigonanthaceae (S. Arnell 1956). The basis of K. Müller's treatment were the partially laterally compressed perianth, the capsule wall composed of 4 cell-layers, the botryoidal oil-bodies and convexed leaves. E. Joergensen's treatment was made on the basis of the leaf and perianth.

The position of the present genus in the Plagiochilaceae seems somewhat artificial. As K. Müller (1948) noted, the relationship of this genus to *Plagiochila* is not so close as to members of the Jungermanniaceae. But *Mylia* cannot be kept in that family because of its laterally compressed perianth, which is one of the unique characteristics of the Plagiochilaceae.

The perianth of *Mylia* is completely free from bracts as it is in other genera of the Plagiochilaceae. However, the bracts are usually strongly inflated at base and always entire throughout, and gemmae are usually produced. These facts and the presence of the bracteole, though it is very small, seems to indicate a close relationship to the Jungermanniaceae (especially to *Jungermannia*). The oil-bodies of *Mylia* are nearly the same as those of other genera in the Plagiochilaceae and also those of *Jungermannia*. The presence of a small bracteole and the characteristics of the sporophytes may indicate a relationship to *Jamesoniella*. But *Mylia* differs from *Jamesoniella* in having an entire bract and laterally compressed perianth.

Reasons for placing *Mylia* in the Plagiochilaceae are a perianth form, non-homogeneous and botryoidal oil-body, and characteristics of its sporophytes, as described by K. Müller. It may be appropriate to give *Mylia* the rank of sub-family in the Plagiochilaceae thereby separating it from the other genera.

In the diagnoses by European bryologists (Macvicar 1926; Frye and Clark 1943),

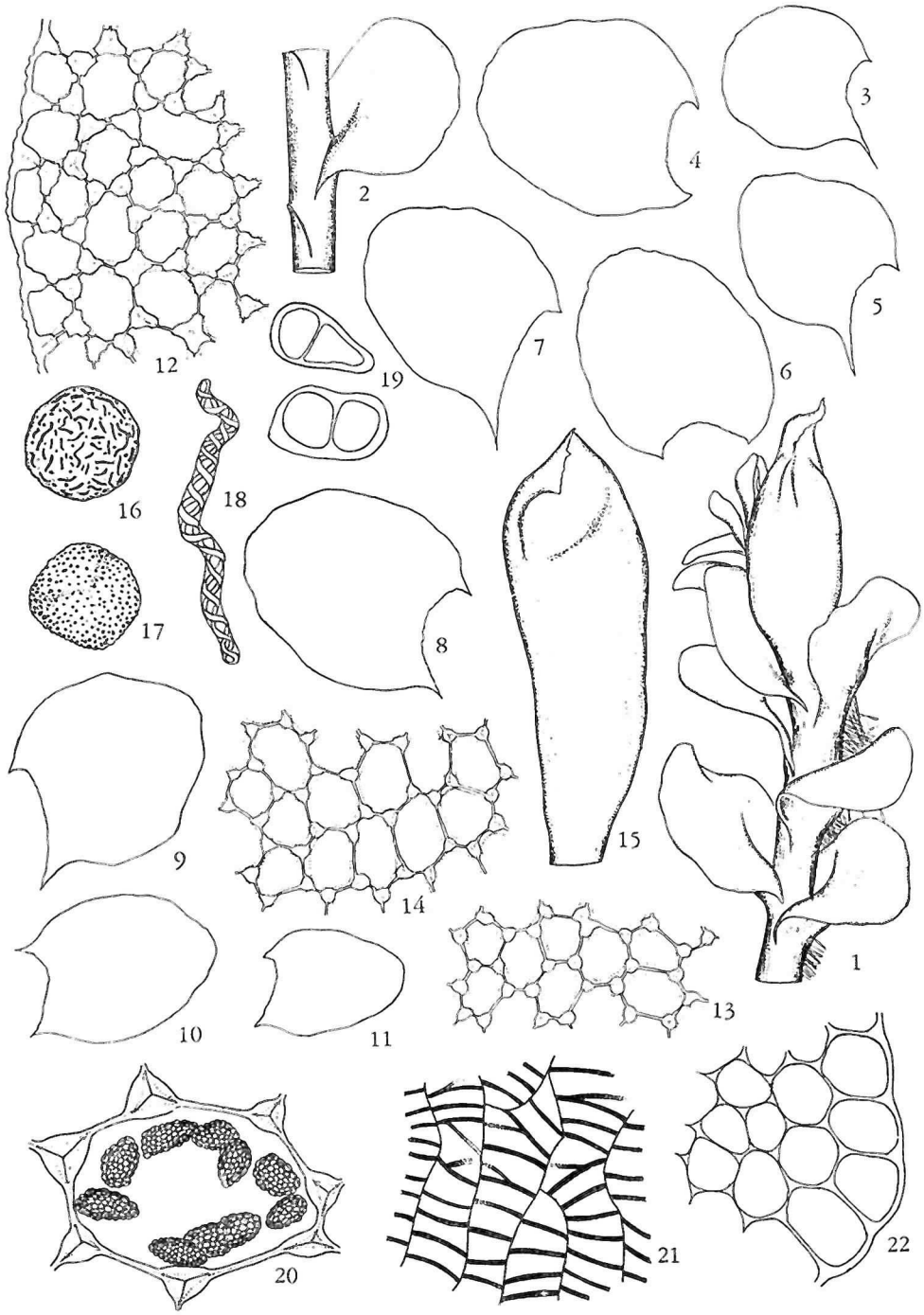

Fig. I.

the number of the antheridia was given as 1–2. This may be true of *M. taylori*, however, in *M. verrucosa* there are usually 3–5 antheridia per bract.

Key to species

- Leaves usally widely ovate; perianth without protuberances ..... *M. taylori*
- Leaves usually rectangular with strongly reflexed dorsal margin; perianth with many protuberances below ..... *M. verrucosa*

Mylia taylori (Hook.) Gray (Fig. I. 1–20)

Nat. Arr. Brit. Pl. **1**: 693 (1821).——*Jungermannia taylori* Hook. Brit. Jungerm. *pl. 57* (1816).——*Aplozia taylori* Dum. Rec. d'Obs. 16 (1835).——*Leptoscyphus taylori* Mitt. London Jour. Bot. **3**: 358 (1851).——*Leioscyphus taylori* Mitt. in Hooker Fl. Antarct. **2** (2): 134 (1855). ——*Jungermannia reticulatopapillata* Steph. Mem. Soc. Nat. Cherbourg **29**: 215 (1892).

Plants 5–8 cm. long, 3–4 mm. wide, yellowish green to reddish yellow, rarely green, in compact patches. Stem 0.3–0.4 mm. thick, yellowish green to brown, without rhizomatous stem, simple or occasionally dichotomously branching, ascending or prostrate; in cross-section no differentiation of cortical cells seen, cells variable in size, $24\times17\,\mu$ to $44\times34\,\mu$, walls more or less thickened, pale brown to pale yellow. Leaves imbricate to subdistant, succubously inserted, the line of insertion semicircularly curved upward ending nearly 1/2 of stem width, ventrally not decurrent, dorsally long decurrent, horizontally spreading, orbicular to widely ovate, or somewhat rectangular, 1.5–2.2 mm. long and wide, entire throughout, dorsal margin slightly reflexed. Cells of leaf apex and along margin $34–41\times41\,\mu$, of middle $51–55\times48–55\,\mu$, of base $68–82\times44–55\,\mu$, walls thin, white, trigones conspicuously large, bulging, sometimes confluent, culicule distinctly verrucose. Oil-bodies variable in number, mostly 9–17 per cell, fusiform, $10–20\times10–13\,\mu$, with numerous glanules. Rhizoids numerous, colorless, long. Underleaves mostly hidden among rhizoids, filiform to subulate. Plants unisexual. Male plants slightly smaller than female ones, male inflorescence terminal or intercalary, bracts in 4–6 pairs, densely imbricate; antheridia 1–2 or occasionally 3 per bract. Female inflorescence terminal, usually with 1–2 innovations; bracts similar to leaves but larger. Bracteole small, lanceolate. Perianth oblong, about 3 mm. long, 1.5 mm. wide, gradually narrowed to mouth, laterally compressed in upper 1/3, cylindrically inflated below, mouth truncate, ciliate, cilia composed of 2–4 cells, cells of perianth-wall same as those of leaves. Seta about 2 cm. long, 9–10 cells across with about 24 epidermal cells. Capsule oval-globose, blackish brown; spores $17–21\,\mu$, with minutely punctated coat, right brown; elaters $10–12\,\mu$ wide, about $250\,\mu$ long, bispiral, right brown. Gemmae rather few, 1–2 celled, oval, $42–25\times23\,\mu$.

Fig. I. ***Mylia taylori*** (Hook.) Gray (1–20) and ***M. verrucosa*** Lindb. (21–22).

1. Apical part of plant with perianth, dorsal view, ×12. 2. Part of plant, dorsal v., ×12. 3–11. Leaves, ×12. 12. Cells from leaf margin, ×190. 13. Cells from leaf middle, ×190. 14. Cells from leaf base, ×190. 15. Perianth, ×12. 16–17. Spores, ×900. 18. Elaster, ×360. 19. Gemmae, ×360. 20. Cells from leaf middle showing oil-bodies, ×900. 21. Inner layer of capsule wall, ×360. 22. Part of cross-section of seta, ×360. Figs. 1, 8–19 were based on *Inoue 3155*, figs. 2–7 on *Inoue 952*, fig. 20 on *Inoue 6189*, figs. 21–22 on *Inoue 7254*.

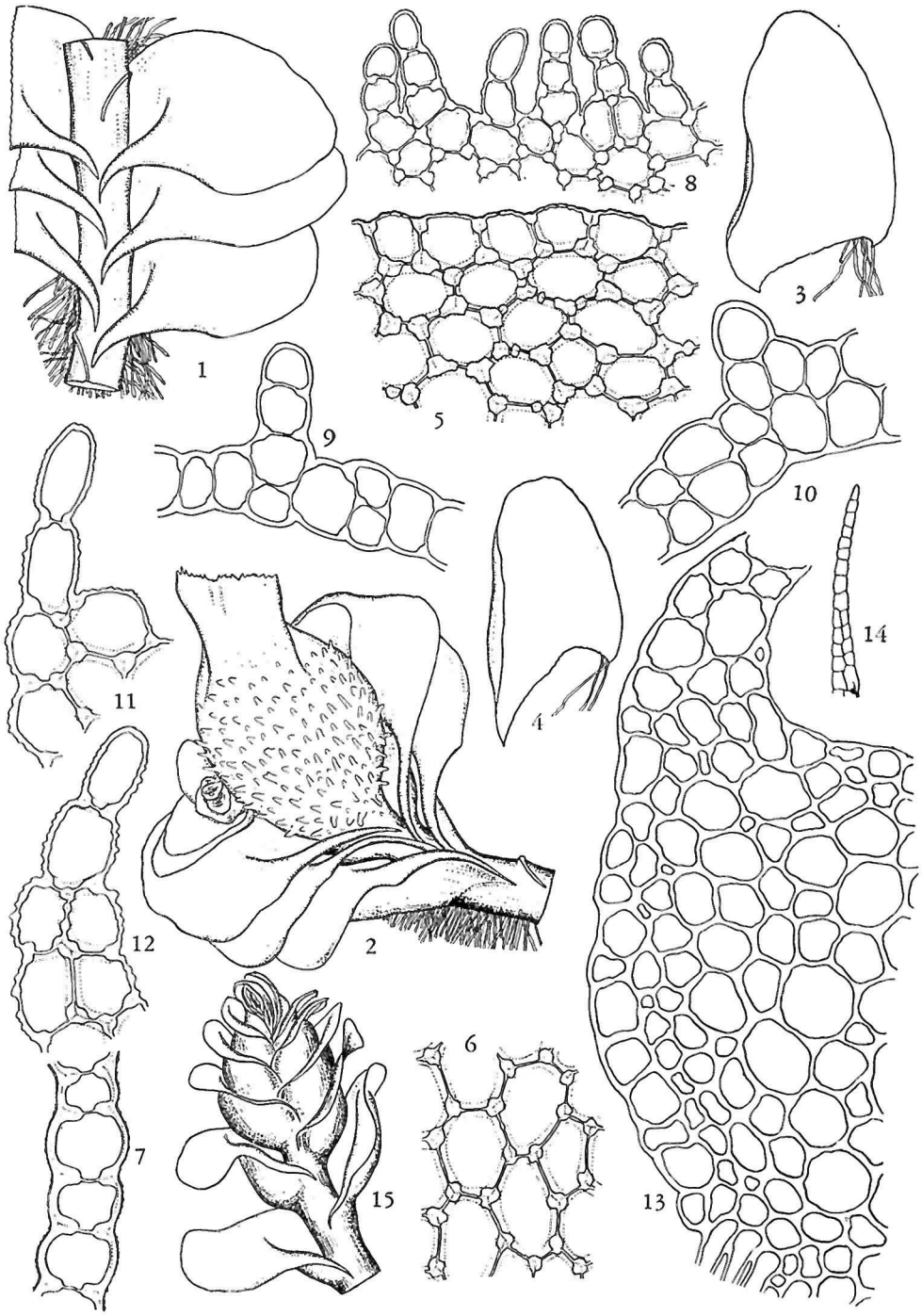

Fig. II.

Ecology.—Usually on humus or rocks covered with humus, occasionally on decaying logs or base of tree trunk, in humid and shady sites in the deciduous forest to the coniferous forest zone and occasionally the alpine zone, at an elevation of 700-2500 m. This species grows alone in patches, but occasionally with *Blepharostoma trichophyllum*, *Diplophyllum albicans*, *Bazzania albicans*, *B. ovifolia*, *Macrodiplophyllum plicatum*, *Scapania ampliata*, *S. ornithopodioides* (very rarely, at Mt. Kazigamori, Shikoku), *Nipponolejeunea pilifera* and *Herberta longifissa*, and rarely scattered among *Sphagnum* tufts. The species is acidophilic and is never found in calcareous regions. **Loc**.—Kyushu: Isl. Yakushima. Shikoku: Pref. Kochi, Mts. Shiraga and Kazigamori; Pref. Ehime, Mt. Higashiakaishi; Pref. Tokushima, Mt. Tsurugi. Honshu: Pref. Nagano, Mt. Shirouma; Pref. Yamanashi, Mt. Yatsugadake; Pref. Tokyo, Mt. Mitake; Pref. Saitama, Mt. Ryogami. **Range**.—Europe, N. America, India, China, Japan.

Compared with the European descriptions of this species, Japanese plants show differences in the number and size of oil-bodies, the diameter of spore and the width of elater. The difference of diameter of spore and of width of elater are both so small as to be insignificant, but the difference in oil-bodies may be taxonomically important. In European plants the number of oil-bodies is given as 5-12 per cell and the diameter as 7-10×14-20 μ (K. Müller 1934, 1956; Frye and Clark 1943; S. Arnell 1956). In Japanese plants, as already described by S. Hattori (1951, 1953), largest number of oil-bodies is more than 20, and their size is larger than it is in European plants.

The spores from one capsule, in some cases, show somewhat tetrahedral form. These are illustrated in Fig. I (16-17), in which 16 shows the linearly verrucosed face and 17 shows the punctate face.

Mylia verrucosa Lindb. (Fig. I, 21-22 and Fig. II)

Acta Soc. Sci. Fenn. **10**: 236 (1872).——*Leioscyphus verrucosus* Steph. Spec. Hepat. **3**: 18 (1906).——*Leptoscyphus verrucosus* K. Müll. in Rabenh. Krypt. Fl. **6**: 787 (1911).——*Plagiochila shinanoensis* Steph. l. c. **6**: 224 (1921).——*Solenostoma aspera* Steph. in sched.

Plants 2-3 cm. long, 3-4 mm. wide, yellowish to brownish green, sometimes reddish purple at apex, usually in compact mats. Stem about 0.5 mm. thick, yellowish green, prostrate with ascending apex, simple or poorly dichotomously branching; in cross-section cortical cells not clearly differentiated but comparatively smaller than inner cells, cells variable in size, 23×26 μ to 56×60 μ, walls thickened, pale brown to yellow. Leaves densely imbricate, horizontally spreading, widely inserted with the line of insertion curved upward ending 1/2 of stem width, ventrally not decurrent but dorsally long decurrent, rectangular to oblong-ovate, 1.8-2.5 mm. long and wide, dorsal margin strongly reflexed, margin entire throughout. Cells of leaf apex and along margin 33-40×37-50 μ, of middle 42-57×56-67 μ, of base

Fig. II. ***Mylia verrucosa*** Lindb.

1. Part of plant, dorsal view, ×12. 2. Apical part of plant with perianth, lateral v., ×12. 3-4. Leaves, ×12. 5. Cells from leaf margin, ×190. 6. Cells from leaf base, 190. 7. Part of cross-section of stem, ×190. 8. Part of mouth of perianth, ×190. 9-10. Parts of cross-section of perianth, ×190. 11-12. Protuberances of perianth, ×190. 13. Part of cross-section of stem, ×190. 14. Underleaf, ×48. 15. Male inflorescence, dorsal view, ×12. All figs. were based on *Inoue 6497*.

42–53×80–94 μ, walls thin, occasionally with intermedial thickning near base of leaf, trigones conspicuously large, bulging, cuticle smooth, verrucosed. Oil-bodies 10–16 per marginal cell, 12–23 per median to basal cell, elipsoid to spherical, 8–12×6–9 μ, up to 20×12 μ, with numerous globules, grayish. Rhizoids numerous, colorless, long. Underleaves mostly hidden among rhizoids, filiform, up to 3 cells wide at base. Plants unisexual. Male plants mostly in separate mats, slightly smaller than female ones; inflorescence terminal or intercalary, bracts 4–6 pairs, strongly saccate, densely imbricate; antheridia 3–5 (mostly 3) per bract. Female inflorescence terminal with 1–2 innovations, bracts similar to leaves but larger. Perianth oblong, occasionally reddish purple in lower portion, 4.0–4.6 mm long, 2.0–2.5 mm. wide, gradually narrowed to mouth, laterally composed in upper 1/3, cylindrically inflated below, with many multicellular protuberances in lower, inflated portion, mouth truncate, ciliate; archegonia usually 4–6 per perianth. Seta about 2.5 cm. long, about 10 cells across, with 24 cortical cells measuring approximately 67×80 μ, medular cells 40×40 μ to 63×67 μ, with distinct trigones; capsule oblong, about 0.8 mm. long; spores 17–20 μ, brown, with minutely punctate coat; elaters about 10 μ wide, bispiral. Gemmae not seen.

Ecology.—On humus, damp rocks covered with humus or soil, decaying logs, and trunk bases of trees, in places not so shady and humid as the habit of *M. taylori*, ascending to the elevation of 2000 m. Usually found with *Cephalozia nipponica*, *Blepharostoma trichophyllum*, *Bazzania ovifolia*, *Scapania ampliata*, *S. bolanderi*, *S. spinosa*, *Trichocoleopsis sacculata* and rarely with *Lophozia cornuta* in middle to western Honshu, Shikoku and Kyushu. But in northern Honshu and Hokkaido it usually occurs with *Diplophyllum albicans*, *Blepharostoma trichophyllum*, *Nardia scalaris*, *Pleuroclada albescens* and *Orthocaulis attenuatus*. Like *M. taylori* this species never occurs in calcareous regions and is rather abundant in granitic regions. On decaying logs it may occur with *Nowellia curvifolia*, *Cephalozia media*, *Blepharostoma trichophyllum*, *Bazzania bidentula*, *Microlepidozia makinoana*, *Odontoschisma denudata* and some mosses. **Loc.**—Formosa: Mt. Arisan (U. Ara without number). Shikoku: Pref. Kochi, Mts. Kazigamori and Shiraga; Pref. Ehime, Mts. Higashiakaishi and Omogo. Honshu: Pref. Hyogo, Mt. Koganegadake; Pref. Wakayama, Mt. Odaigahara; Pref. Mie, Mt. Higurashiyama; Pref. Gifu, Mt. Hirayu; Pref. Yamanashi, Mt. Kokushi; Pref. Saitama, Mts. Chichibu. Hokkaido: Mts. Daisetsu and Apoi. **Range.**—Sakhalin, Amure, Japan, Formosa, Himalaya.

S. O. Lindberg (1872) originally described the male plant as "Planta mascula feminis intermixta et simillima, sed superne constanter purpura et densius amphigastiata." His original collection was made on a decaying log in Sakhalin. The author has observed that the purple color of the plant is not restricted to the male plant, and also in *M. taylori* such color is occasionally observed at the apex of plant. Underleaves of male plants also are not so dense as described in the original description.

K. Müller (1911) regarded this species as "arktisch-xerophytischer Typus des weit verbreiteten *M. taylori*." Indeed the present species grows at more xerophytic sites than *M. taylori*. However, he overlooked the most significant feature of this species, that is the multicellular protuberances at the lower portion of perianth. When plants are sterile, this species is, eventually, much confusable with *M. taylori* in may ways. S. Hattori stated the difficult separation of this species from *M. taylori* in sterile condition. But, as remarked by M. Hara (1956) this species is

rather easily recognized by its rectangular leaves which are dorsally more strongly reflexed.

Pedinophyllum Lindb.

Bot. Not. 156 (1874).——*Plagiochila* subg. *Pedinophyllum* Lindb. Not. Soc. Fauna Fl. Fenn. **13**: 366 (1874).

The species of this genus were formerly placed in *Plagiochila*. But *Pedinophyllum* differs from *Plagiochila*, as already remarked by K. Müller (1911) and others, by being autoicous and not having a rhizomatous stem. Some authors included it in the Epigonanthaceae (Evans 1938, 1940) or in the Nardioideae (Frye and Clark 1943). But the genus should be excluded from those families because of its laterally compressed perianth. The genus was first placed in the Plagiochileae of Jungermanniaceae Dum. by E. Joergensen (1934). However, V. Schiffner (1909) and K. Müller (1911) noticed the closer relationship of the genus to *Plagiochila* and *Mylia*. Frye and Clark (1943) thought that the Nardioideae were related to Lophocoleoideae through *Pedinophyllum* and *Jamesoniella*. But this seems unnatural.

The close relationship between *Pedinophyllum* and *Jamesoniella* is not undeniable by the considerable agreements in the significant characteristics. The oil-body type, the leaf-insertion, a single antheridium per bract with biseriate stalk, and the 4-stratose structure of the capsule wall, may indicate the relationship.[4] However, *Pedinophyllum* is distinct from *Jamesoniella* by its perianth form which indicates for *Pedinophyllum* to belong to the Plagiochilaceae. The relationship to the Lophocoleaceae and to the Nardiaceae are not so close as Frye and Clark considered, though to the Lophocoleaceae *Pedinophyllum* has some allied characteristics in the male inflorescence.

Key to species

- Margin of female bract entire throughout; mouth of perianth entire or with slight dentations..... *P. interruptum* subsp. *truncatum* var. *truncatum*
- Margin of female bract slightly dentate; mouth of perianth distinctly dentate .... *P. interruptum* subsp. *trunctum* var. *jungermannioides*

Pedinophyllum interruptum Lindb. **subsp. *truncatum*** (Steph.) Inoue, comb. nov. (Fig. III, 1–14)

Plagiochila interruptum auct. quoad plant. Japon.——*Clasmatocolea truncata* Steph. Bull. Herb. Boiss. **5**: 87 (1897).——*Plagiochila integra* Steph. Spec. Hepat. **6**: 170 (1918).——*P. levicalyx* Steph. l. c. **6**: 176 (1918).——*Pedinophyllum interruptum* auct. quoad plant. Japon. ——*P. pyrenaicum* Lindb. var. *interruptum* auct. quoad plant. Japon.

Plants 1.0–1.5 cm. long, 2.0–3.0 mm. wide, green to yellowish green, sometimes brownish green, in depressed mats or occasionally scattered among other mosses. Stem 0.2–0.3 mm. thick, brown to yellowish green, prostrate with ascending apex, simply branched; in cross-section no differentiation of cortical cells seen, cells averaging $18 \times 24\,\mu$, walls pale brown, thin, trigones small. Rhizoids numerous, colorless, long. Leaves imbricate to subdistant, inserted with the line of insertion

[4] Furthermore, the female bract of *Pedinophyllum* has occasional dentation and a small bracteole is occasionally present. This features semm to indicate more practically that *Pedinophyllum* may be phylogenetically a derivative from the same ancestor with *Jamesoniella*, though *Pedinophyllum* has laterally compressed perianths.

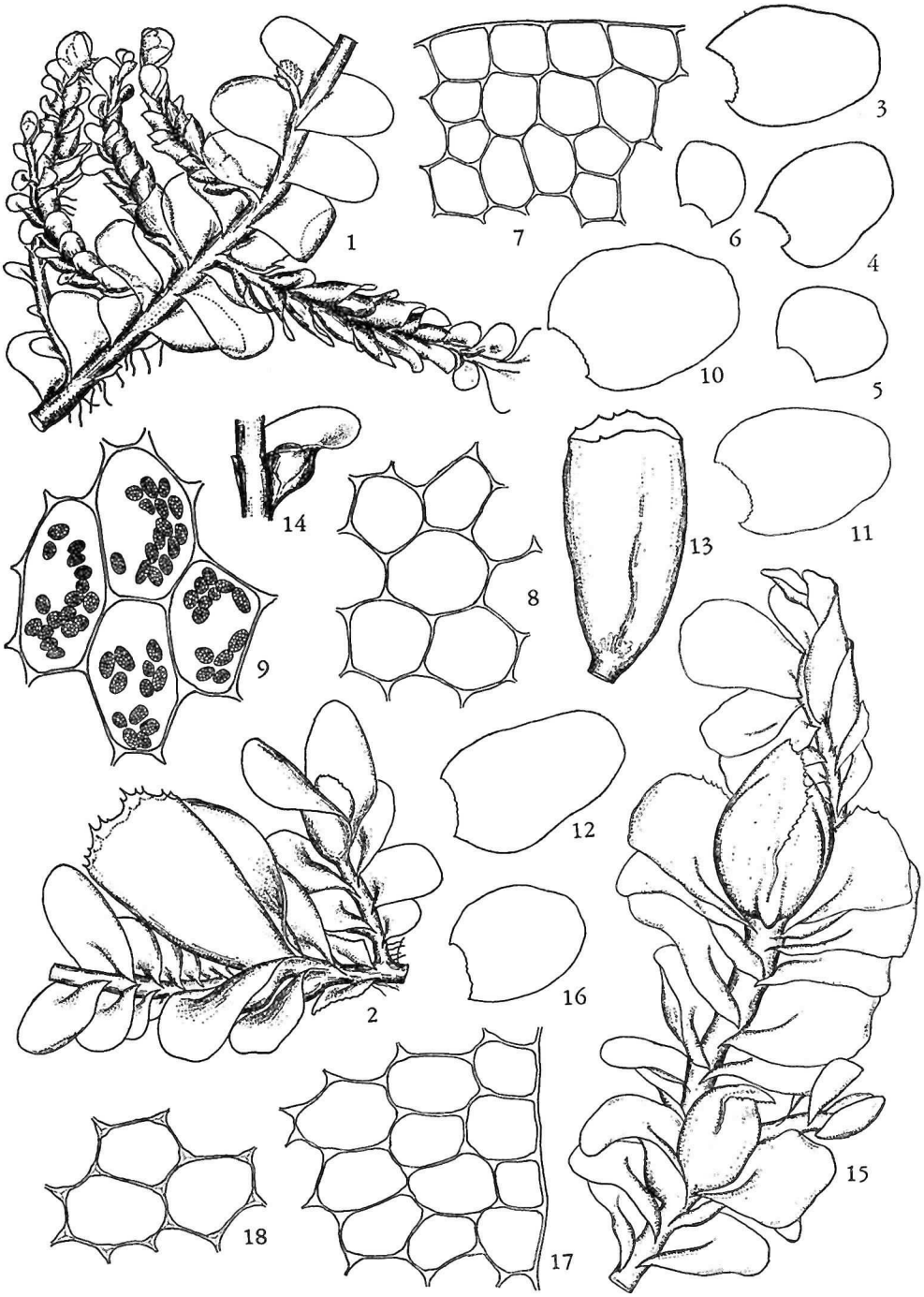

Fig. III.

curved semicircularly upward, and extending approximately 1/2 of the stem width, ventrally not decurrent, dorsally slightly decurrent, almost horizontally spreading, oblong-ovate to oval-quadrate, apex round, margin entire throughout, or rarely with 1–3 weak teeth near apex, 1.0–1.5 mm. long, 0.9–1.2 mm. wide, becoming gradually smaller towards base of stem. Cells of leaf apex and along margin 20×30 μ, subquadrate, of middle 23×30 μ, of base 28–33×40 μ, walls thin, trigones small, cuticule smooth. Oil-bodies usually 8–14 per cell, ellipsoid to spherical, grayish, with numerous globules, 10–11×3–4 μ. Underleaves rudimentally or not present, filiform or occasionally large and subquadrate. Male inflorescence intercalary on branches; bracts usually 4–6 pairs, margin entire throughout, dorsal margin strongly inflated embeding a single antheridium. Female inflorescence terminal on main stem with 1–2 innovations, bracts similar to leaves but more or less saccate at base and slightly larger; bracteole mostly absent, occasionally rudimentary. Perianth broadly ovate, laterally compressed in upper portion, 1.5–1.7 mm. long, 0.8–1.1 mm. wide, mouth truncate to semicircularly arched, usually with few teeth but occasionally entire throughout. Archegonia 13–15. Seta about 1.5 cm. long. Capsule oval, about 1.2 mm. long. Spores globose, brown, with minutely punctate coat, 9–12 μ. Elaters bispiral, 9–10 μ wide, about 90 μ long. Gemmae not present.

Ecology.—On bark, decaying logs, and damp rocks often covered with soil, in the deciduous forest to the coniferous forest zone at an elevation of 200–2000 m. The present subspecies grows mostly in pure mats, and occasionally with few mosses. Hepaticae occurring with this subspecies are mostly *Pycnolejeunea imbricata*, *Euosmolejeunea auriculata* and *Blepharostoma minus* in south-western Japan, and *Radula obtusiloba*, *Porella grandiloba*, *Lophocolea minor*, *L. heterophylla* and *Metzgeria conjugata* var. *jadouica* in middle to northern Japan. *Lejeunea flava* and *L. japonica* are occasionally seem among the mats of this subspecies throughout the present area. The present subspecies seems to have rather wide amplitude as to its substratum, however, the male inflorescence is usually seem in plants occurring in a calcareous region. On the otherhand, it is a noteworthy fact that on granitic or acidic substrata plants usually bear few or no male inflorescences. Consequently the fertile plants mostly come from calcareous regions. **Loc.**—Kyushu: Pref. Nagasaki, Mt. Unzen; Pref. Fukuoka, Mts. Syakagadake and Wakasugiyama. Honshu: Pref. Hiroshima, Sandankyo; Pref. Nagano, Mt. Shirouma and Todaimura; Pref. Saitama, Mts. Chichibu. Hokkaido: Hakodate (*U. Faurie 12602*-type of *Clasmatocolea truncata*), Mts. Daisetsu and Hidaka. The following specimens were collected by U. Faurie and determined by F. Stephani as *Plagiochila interruptum*: Aomori (*483,517*), Kattasan (*1136*), Chateau d'Akita (*1467*) Pratori in Yezo (*15242*), Kotsunagi (*15085*). The following specimens were determined as *Plagiochila integra* Steph. *n. sp.*: Pref. Nagano, Mt. Komagatake (*1737*), Mt. Norikura (1852). **Range.**—Endemic to Japan.

Fig. III. ***Pedinophyllum interruptum*** Lindb. **subsp.** ***trunatum*** (Steph.) Inoue (1–14) and its **var.** ***jungermannioides*** (Steph.) Inoue (15–18).

1. Part of plant with male inflorescence, ×12. 2. Do. with female inflorescence, ×12. 3–6. Leaves, ×12. 7. Cells from leaf margin, ×360. 8. Cells from leaf middle, ×360. 9. Cells from leaf base showing oil-bodies, ×480. 10–12. Female bracts, ×12. 13. Perianth, ×12. 14. Male bract, ×12. 15. Part of plant with perianth, dorsal view, ×12. 16. Leaf, ×12. 17. Cells from leaf middle, ×360. 18. Do. from leaf middle, ×360. Figs. 1–14 were based on *Inoue 7173* and figs. 15–18 on *Inoue 4725*.

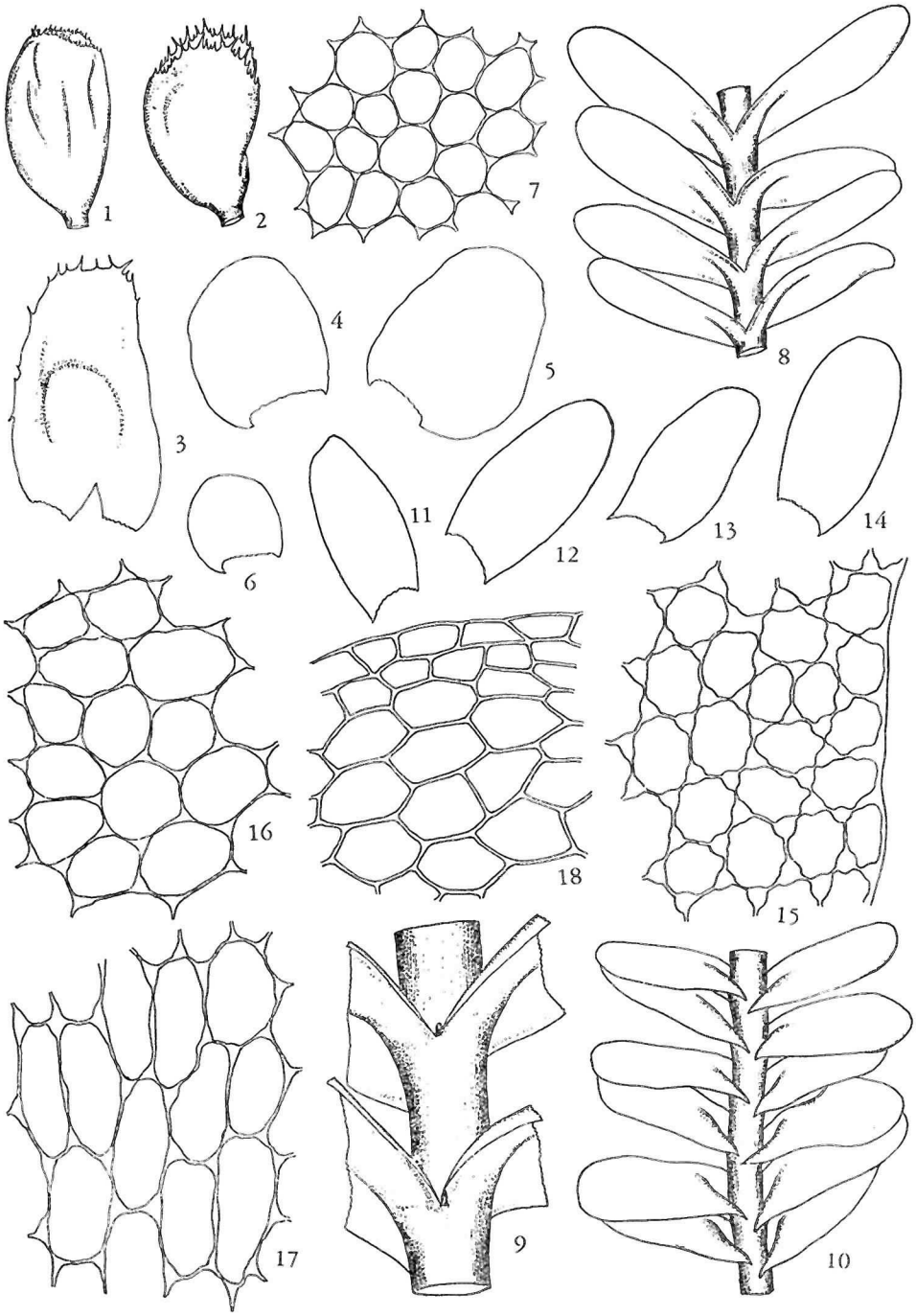

Fig. IV.

Hitherto the Japanese plant of *Pedinophyllum* was referred to the European *P. interruptum*. On the author's estimation, the Japanese plant differs clearly from the European one in its oil-bodies, female bracts, spores and elaters. K. Müller (1939, 1956) described the oil-bodies of *P. interruptum* as "4–8 je Zelle, wasserhell, traubenförmig, 5–7×9–10 μ", but in the Japanese plant there are 8–14 per cell measuring 10–11×3–4 μ as in the above diagnosis. The size of spore in *P. interruptum* is given as about 12–15 μ (Frye and Clark 1943) or 15 μ (K. Müller 1911, 1956), and that of the elater as 180–200 μ long and 12 μ wide. Though Japanese plants bearing sporophytes are few, the size of spore and elater is smaller than that of *P. interruptum*. Furthermore, according to descriptions by European bryologists, the female bracts of *P. interruptum* are not so inflated at base as those of Japanese plants. But this character of the female bracts is variable, mainly according to be fertile or not, or in young stage or not. The Japanese plants can hardly be distinguished from the European plant, especially so when sterile or dried. The calcareous substratum is apparently the same in Japan as it is in Europe. Accordingly, the author regards the Japanese plant as a geographical subspecies of European *P. interruptum*.

Clasmatocolea truncata Steph., the type of which came from Hokkaido (Hakodate), was reduced to a synonym of *P. interruptum* by S. Hattori (1950). R. Grolle (1956) and the authors arrived at the same conclusion. Consequently the above combination is need because of the separation of the Japanese plant by subspecies-rank from European *P. interruptum*.

—**var. *jungermannioides*** (Steph.) Inoue, comb. nov.
(Fig. III, 15–18 and Fig. IV, 1–7)

Plagiochila jungermannioides Steph. Bull. Herb. Boiss. **5**: 103 (1897).——*P. rikuzana* Steph. Spec. Hepat. **6**: 202 (1921)——*P. sendaica* Steph. l. c. **6**: 224 (1921).——*Pedinophyllum sendaicum* Hatt. Bull. Yamagata Agr. Coll. **1**: 41 (1949).——*P. rikuzanum* Hatt. in K. Ochi, Shizen-to-Jinmon **1**: 62 (1950).——*P. pyrenaicum* auct. quoad plant. Japon.——*P. interruptum* Lindb. var. *pyrenaicum* auct. quoad plant. Japon.

Plants 1–3 cm. long, 1.5–3.0 mm. wide. Stem 0.2–0.3 mm. thick; in cross-section slightly thickened outer 3–4 cell-layers seen. Leaves 1.5–2.0 mm. long, 1.2–2.0 mm. wide, margin entire or with 1–4 weak teeth. Female bracts more strongly inflated at base than those of subsp. *truncatum*, ventral margin with 4–9 teeth, dorsal margin entire or with 2–4 teeth. Mouth of perianth irregularly dentate or nearly entire, arching.

Ecology.—Similar to that of subsp. *truncatum* var. *truncatum* but occasionally in more xerophytic site, occurring rarely with *Plagiochila japonica* and *Jamesoniella autumnalis*. On Mt. Hakutai in Saitama Pref. this var. grows with *Calypogeia neesiana* and *Lepidozia*

Fig. IV. *Pedinophyllum interruptum* Lindb. **subsp. *truncatum*** (Steph.) Inoue **var. *jungermannioides*** (Steph.) Inoue (1–7) and ***Syzygiella nuda*** (Horik.) Hatt. (8–18).

1–2. Perianths, ×12. 3. Female bract, ×12. 4–6. Leaves, ×12. 7. Cells from leaf middle, ×190. 8. Part of plant, ventral view, ×18. 9. Do., ×42. 10. Do., dorsal v., ×18. 11–14. Leaves, ×18. 15. Cells from leaf margin, ×330. 16. Cells from leaf middle, ×330. 17. Cells from leaf base, ×330. 18. Part of cross-section of stem, ×330. Figs. 1–7 were based on *Inoue 4725* and figs. 8–18 on *Horikawa 10606b*-type.

vitrea on decying log. **Loc.**—Kyushu: Pref. Miyazaki, Mt. Sobozan. Shikoku: Pref. Kochi, Mt. Yokogura. Honshu: Pref. Saitama, Mt. Hakutai, Urayamamura, Ohochigawa, and Buko; Pref. Gunma, Mt. Tanigawa; Pref. Yamanashi, Mt. Daibosatsu. Hokkaido: Mt. Apoi. **Range.**—Restricted to Japan.

This variety occasionally is more than 3 cm. long and 3 mm. wide, forming compact mats without any associated bryophytes. The relationship between the present variety and subsp. *truncatum* var. *truncatum* is nearly analogous to that of var. *pyrenaicum* and its type. But according to the diagnosis of European bryologists, var. *pyrenacium* does not become as robust as var. *jungermannioides*.

Syzygiella Spruce

Jour. Bot. **14**: 33 (1876).

The present genus is distributed mainly in tropical and South America. In tropical Asia three species are known, *S. variegata*, *S. variabilis* and *S. plagiochiloides*.[5] Previously the genus was combined with *Plagiochila* and some authors confused it with *Plagiochila*, so that some species belonging to it were described under *Plagiochila*. This genus is distinct from *Plagiochila* in the following characteristics: leaves almost opposite, usually adherent at least ventrally; rhizoids crowded near ventral end of leaf; bracts often united with base of leaf; perianth rather large, cylindrical or oval, slightly narrower toward the more or less plicate mouth.

It may be that the similar structure of the sex organs constitutes a relation between *Syzygiella* and the Jungermanniaceae. For example, according to H. Carl (1931), in *S. manca* Steph. paraphyllia are found in the male bract with antheridia. The perianth form and the united bracts may be another relationship to the Jungermanniaceae. On the other hand, *Syzygiella* has an even closer relationship to *Noguchia* in the Plagiochilaceae, as will be discussed later.

In the present area only one species is found.

Syzygiella nuda (Horik.) Hatt. (Fig. IV, 8–18)

Jour. Jap. Bot. **25**: 142 (1950).——*Plagiochila nuda* Horik. Jour. Sci. Hiroshima Univ. b, 2, **2**: 159, *f. 19* (1934).

Plants about 2.5 cm. long, 2.5 mm. wide, olive-green to brown, growing among mosses. Stem 0.25–0.30 mm. thick, brown, simple, without rhizomatous stem and flagellum, ascending to erect; in cross-section, cortical cells not differentiated but smaller than interior cells, averaging $24\times12\,\mu$, walls brown, thin, interior cells $30\text{–}39\times18\text{–}27\,\mu$, walls yellow to pale brown, thin. Leaves distant, horizontally spreading, alternately to suboppositely inserted, ventral end slightly adherent to that of the opposite leaf, not decurrent, dorsally slightly decurrent, concave at base, 1.4–1.7 mm. long, 0.8–1.1 mm. wide, ligulate, entire throughout, apex rotundate. Cells of leaf apex and along margin $24\times26\,\mu$, trigones conspicuously large, bulging, occasionally confluent, at middle $30\text{–}31\,\mu$, at base $22\text{–}24\times40\text{–}45\,\mu$, trigones large,

[5] *Syzygiella plagiochiloides* Herz. (Ann. Bryol. **5**: 85. 1933) was described from Borneo. This specific epithet, however, is a later homonym of *S. plagiochiloides* Spruce (Trans & Proc. Bot. Soc. Edinburgh **15**: 500. 1885) from the Andes district of S. America, and so cannot be maintained.

acute, walls thin, cuticle smooth. Underleaves rudimentary, triangular, 2–3 cells wide at base. Rhizoids rare, only at lower portion of stem.

Loc.—Formosa: Between Shinsuiei and Schuchokyokai, Prov. Taito (Y. Horikawa 10606b-type) **Range.**—Endemic to Formosa.

Only the original specimen is known. As it is sterile, the relationships to other species are not clear. But, as already noted by S. Hattori (1950), in general appearance the present species is close to *S. variegata*, which is known from Ceylon, Java, Sumatra, Borneo, Halmahera and Philippines. The author considers both species to be conspecific. However, to settle this problem much more materials are needed. It differ from *S. variegata* only by its rudimentary underleaves, which Y. Horikawa did not mention in his original description, and its smooth cuticle.

Plagiochila Dum.

Rec. d'Obs. Jungerm. 14 (1835).——*Radula* sect. *Plagiochila* Dum. Syll. Jungerm. 42 (1831).

Plagiochila is the largest genus in the family and one of the most difficult one taxonomically. It contains more than 1300 species which are distributed mainly in tropical to subtropical regions. Most of them were proposed by F. Stephani in his "Species Hepaticarum", and have not been studied further. A monographic work on *Plagiochila* was first published by J. B. W. Lindenberg (1844) treating about 100 species, and he diveded *Plagiochila* into six sections. F. Stephani (1902) stresssed the angle of the leaf insertion and divided *Plagiochila* into two large groups of which there are many subdivisions. M. Dugas (1928) divided the genus into many groups without any regard to geographical distribution and stressing merely the leaf form and the angle of the leaf insertion. Besides those authors mentioned above, R. Spruce (1885) and V. Schiffner (1900) published unique system of *Plagiochila* in their floras.

As a conclusion, the treatments by those authors are superficial and cannot be said to be a natural and evolutional system. For example, those authors stressed merely one or two characteristics of sterile plants (the form of leaf, the leaf insertion, the branching mode of plant and so on). H. Carl (1931), after a full discussion of those author's systems, proposed a system of his own, in which he divided *Plagiochila* into many sections in three subgenera with special attention to geographical distributional patterns.

The present author thinks that it may be nearly impossible to devise a natural system of classification for this genus, as it is cosmopolitan in distribution and the scale of the diffentiation of species is markedly different among the various areas. Therefore a system proposed in one area cannot be successfully used for another area. For this reason, comparative studies are necessary and the method of correlation of the geological strata seems to bring satisfactory result for taxonomy of this genus.

From this point of view, H. Carl's system may be considered as a comparatively satisfactory one. For a more natural and evolutional system more data on the species in each area are needed, especially in tropical regions. In the present paper the author classified *Plagiochila* into two subgenera and eight sections, which conform, for the most part, to those of H. Carl with some changes.

Until now, the characteristics of leaves and cells were stressed as taxonomically

important. The oil-bodies of *Plagiochila* may not serve for the separation of the species or group, because they are uniformly non-homogeneous with numerous globules, usually 4–9 per cell in number, fusiform, grayish in color and moderate in size. But some species have nearly homogeneous oil-bodies (for an example, *Plagiochila titibuensis*), and rarely even in one species the globules occasionally are obscured becomeing nearly homogeneous oil-bodies (for an example, *Plagiochila satoi*). The characteristics of leaves (size, form, marginal teeth, thickness of cell-walls and so on) are evidently much modified by the factors of the environmental conditions. Most of the species which have been reduced to synonym are those established on the strength of those characteristics.

The species of *Plagiochila* in the area under consideration were described mainly by F. Stephani (1897, 1903, 1921), Y. Horikawa (1931–1935) and S. Hattori (1942–), and number over 60. Many of them, however, were reduced to the synonymy of other species and the reports of those from the present area have been rejected, but some of them have not been studied critically. Careful studies of Japanese species of *Plagiochila* have been published mainly by S. Hattori, who classified all recognized species of *Plagiochila* in Japan into eight sections (S. Hattori 1949); *Asplenioides*, *Zonnatae*, *Tridenticulatae*, *Villosae*, *Acanthophyllae*, *Trabeculatae*, *Frondescentes* and *Peculiares*. Among them, the section *Tridenticulatae*, including *P. tridenticulata*, must be rejected for the present area.

Key to subgenera and sections

1 { Plants usually with long flagella from ventral side of branching node; perianth campanulate with markedly bilabiate mouth; elaters unispiral .....Subgen. *Chiastocaulon*
Plants without or very rarely with flagella; the mouth of perianth usually not bilabiate; elaters bispiral .....Subgen. *Plagiochila*..(2)

2 { Leaves with appendage like water-sac on ventral base; under-leaves rather distinct..... .....Sect. *Cuculatae*
Leaves without such appendage; underleaves usually rudimentary or absent, rarely distinct.....(3)

3 { Plants dendritically branching; female inflorescence terminal on branches; perianth bowl shape.....Sect. *Frondescentes*
Plants simple or with a feather-like branching; female inflorescence terminal on main stem .....(4)

4 { Leaves with distinctly differentiated vitta at base .....(5)
Leaves without vitta .....(6)

5 { Cell walls of leaves much thickened in irregular shape; without rhizoids on main stem .....Sect. *Peculiares*
Cell walls of leaves thin or slightly thickened; usually with many rhizoids on ventral side of main stem .....Sect. *Zonnatae*

6 { Perianth cylindrical, usually with less than 20 archegonia.....Sect. *Asplenioides*
Perianth not cylindrical, usually with less than 20 archegonia .....(7)

7 { Male bracts dorsally strongly inflated and hardly crossed over stem; antheridium 1 per bract; perianth triangulary campanulate .....Sect. *Acanthophyllae*
Male bracts not so inflated dorsally and crossed over stem .....(8)

8 { Antheridium 1 per bract; leaves not fragile.....Sect. *Trabeculatae*
Antheridium 2 per bract; leaves much fragile and mostly breaking off from meddian portion.....Sect. *Yokogurenses*

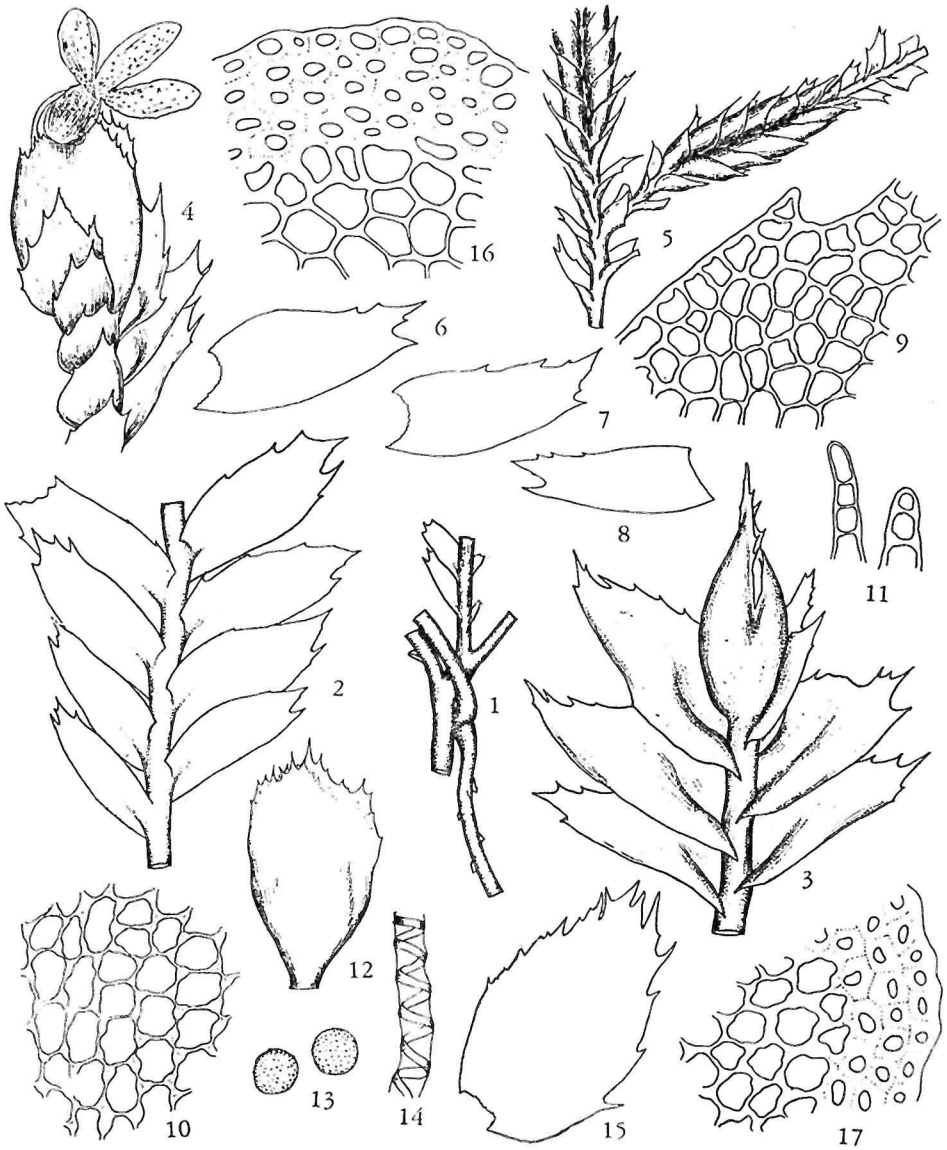

Fig. V. ***Plagiochila dendroides*** Lindenb.

1. Part of plant showing flagellum, ×12. 2. Do., ventral view, ×24. 3. Do., with perianth, dorsal v., ×24. 4. Do., lateral v., ×24. 5. Male inflorescence, dorsal v. ×12. 6-8. Leaves, ×24. 9. Cells from leaf margin, ×360. 10. Cells from leaf base, ×360. 11. Underleaves, ×360. 12. Perianth, ×24. 13. Spores, ×360. 14. Part of elater, ×900. 15. Female bract, ×34. 16. Part of cross-section of stem, ×360. 17. Part of cross-section of flagellum, ×360. All figs. except 5 were based on *D. Shimizu 55738*, and fig. 5 on *D. Shimizu 57104*.

Plagiochila* subgen. *Chiastocaulon (Carl) Inoue, stat. nov.

Chiastocaulon Carl, Flora **126**: 58 (1932).

H. Carl established *Chiastocaulon* stressing the following characteristics; branching mode of plant, long flagella, rhizoids which are rather fasciculate from ventral side of scale-like leaves of flagella, the presence of filiform underleaves or "Schleimpapille", and dorsally inflated bract involving single antheridium.

No taxonomical evaluation of *Chiastocaulon* has not been published except by Th. Herzog (1953), in which he treated the genus as a group of *Plagiochila*. The mode of branching of *Chiastocaulon* is very peculiar as H. Carl stressed in his description. This mode of branching is clearly caused by the long flagella. Similar cases are seen in some species of *Plagiochila* and *Noguchia*, but in those genera this is not common as in *Chiastocaulon*. Furthermore, in *Noguchia* and *Plagiochila* bearing such flagella the rhizoids on the flagella have the same characteristics as in *Chiastocaulon*. The presence or absence of flagella may be regarded as a valid taxonomical character. However, the author does not consider that it warrants the description of a new genus. The characteristic feature of the male inflorescence is found also in the species of *Pedinophyllum* and some species of *Plagiochila* (*Acanthophyllae* and *Frondescentes*).

Details of the sporophyte of *Chiastocaulon* have been unknown. V. Schiffner (1900) described *Plagiochila dendroides* as "Kapsel kugelig, braun; Seta das Perianth nur 1–2 mm. überragend." According to the author's investigations, the structure of the capsule wall and the seta almost completely agrees with that of *Plagiochila*. Only in the elaters is a distinct difference observed; that is, as shown in the key, the elater is always unispiral in *Plagiochila dendroides* but in other species of *Plagiochila* it is bispiral.

From those reasons the author reduced *Chiastocaulon* to a subgeneric rank of *Plagiochila*. The circumscription of the subgenus is the same as that of the single species known from this area. The present subgenus may have virtual relationship to the section *Frondescentes* in many ways, especially in the branching mode and the state of the female inflorescence.

Plagiochila dendroides Lindenb. (Fig. V)

In Gott. & Lindenb. Spec. Hepat. (Monogr. *Plagiochilae*) 146, *t. 30* (1840–1844).——*Jungermannia dendroides* Nees, Hepat. Javan. 77 (1830).——*Plagiochila zollingeri* Mont. Ann. Sci. Nat. 196 (1856).——*Chiastocaulon dendroides* Carl, Flora **126**: 59, *f. 1–7* (1932).

Plants in compact tufts, 2.0–5.0 cm. long, 1.5–2.0 mm. wide, yellowish green to pale brown. Stem about 0.7 mm. thick, spreading to erect or prostrate, yellowish brown to deep brown, densely dendritically branched, branches from lateral, occasionally becoming flagelliform, horizontally spreading, with flagella from ventral side of branching node, flagella nearly as thick as stem, long, about 2–3 cm. long, with minute scale-like leaves; in cross-section of stem cortical cells distinctly differentiated from interior cells, in 3–4 layers, averaging $4\times7\ \mu$, walls as thick as cell cavities or slightly larger, interior cells $17–20\times20–30\ \mu$, walls yellowish to white, moderately thickened; cross-section of flagella similar to that of stem. Leaves distant on stem, subimbricate on branches, succubous, obliquely spreading, inserted with the line of insertion curved upward and ending less than 1/2 of stem width,

ventral end hardly decurrent, narrowly ovate, 1.0–1.5 mm. long, 0.2–0.4 mm. wide, in female plants usually narrower than in male plants; dorsal margin moderately arching, entire or with 1–2 teeth near apex, long decurrent, ventral margin nearly straight or slightly arching but not as much as the dorsal one, with 1–4 teeth, apex subobtuse with 2 more or less distict lobes or teeth. Cells of leaf apex and along margin 10–17×20–34 μ, of middle 27–40×13–17 μ, of base 37–44×15 μ; trigones minute in apical and median portion, moderately large in base. Rhizoids absent on stem, present of flagella, few. Underleaves rudimentary or rarely large, filiform to triangular. Plants unisexual. Male inflorescence intercalary on branch, usually with 1 innovation from lateral side of base, bracts 5–11 pairs, similar to leaves but far smaller, densely imbricate, dorsal margin strongly inflated, marginal teeth 4–5. Antheridium 1 per bract; antheridial stalk biseriate. Female inflorescence terminal on branche, with 1 innovation, bracts larger than leaves, about 1.2 mm. long and 0.8 mm. wide, moderately saccate at base, amrginal teeth more numerous than in leaves. Perianth campanulate, about 1 mm. long, 0.6–0.8 mm. wide, mouth strongly arching, distinctly bilabiate (up to nearly 1/2 of total length of perianth), margin of lobes irregularly dentate. Archegonia 10–12. Seta about 5 mm. long, composed of numerous rows of cells; capsule oval, about 0.8 mm. long, blackish brown. Spores spherical, aproximately 21 μ in diameter, brown, with minutely punctate coat. Elaters 7–8 μ wide, unispiral.

Ecology.—On old trunks of trees, or rarely on rocks, in shady and humid sites at an elevation of 200-1000 (the ever green forest to the lower deciduous forest zone). On the bark of trees this species forms compact tufts without associated mosses, or loose tufts with *Plagiochila semidecurrens*, *Pl. crassitexta*, *Pl. belangeriana*, *Bazzania bidentula*, *Mastigophora diclados*, *Herberta longifissa*, *Saccogyna curiosissima*, *Frullania moniliata* subsp. *obscura*, *F. schensiana*, *Nipponolejeunea pilifera* and *Strepsilejeunea pusilla*. **Loc.**—Kyushu: Isl. Yakushima; Pref. Kagoshima, Mts. Hiyoshidake and Kirishima; Pref. Kumamoto, Mt. Ichifusa, Hitoyoshi, Itsuki. Shikoku: Pref. Kochi, Mt. Shiraga. Honshu: Pref. Tokyo, Mt. Kumotori. **Range.**—Java, Sumatra, Borneo, Philippines, Caroline, Micro- nesia, Japan.

Plagiochila subgen. ***Plagiochila***

Plagiochila Subg. *Euplagiochila* Carl, Ann. Bryol. Suppl. 2: 41 (1931).

Sect. ***Asplenioides*** Carl

Ann. Bryol. 2: 101 (1931).——*Plagiochila* Dum. sect. *Asplenioideae* Lindenb. in Gott. Lindenb. et Nees, Synop. Hepat. 48 (1844) pro parte.

In this section H. Carl (1931) enumerated three species, *Plagiochila asplenioides*, *Pl. delavayi* and *Pl. pulvinata*. Generally the members of this section vary considerably in size and branching of plants, in shape and size of leaves and in number of marginal teeth, so that there is occasionally some difficulty in recognizing species. But it is evident that this variability is caused by the environments, and even in one and the same specimen the plants vary markedly, especially in leaf dentation.

The present section may be characterized as follows:

Plants unisexual. Stem forked, or rarely simple, distinctly rhizomatous; in cross-section cortical cells in 2–3 rows with much thickened walls but thiner than cell cavities. Leaves alternately inserted, imbricate to subdistant, succubous; dorsal margin slightly to long decurrent on stem, ventral margin hardly to slightly

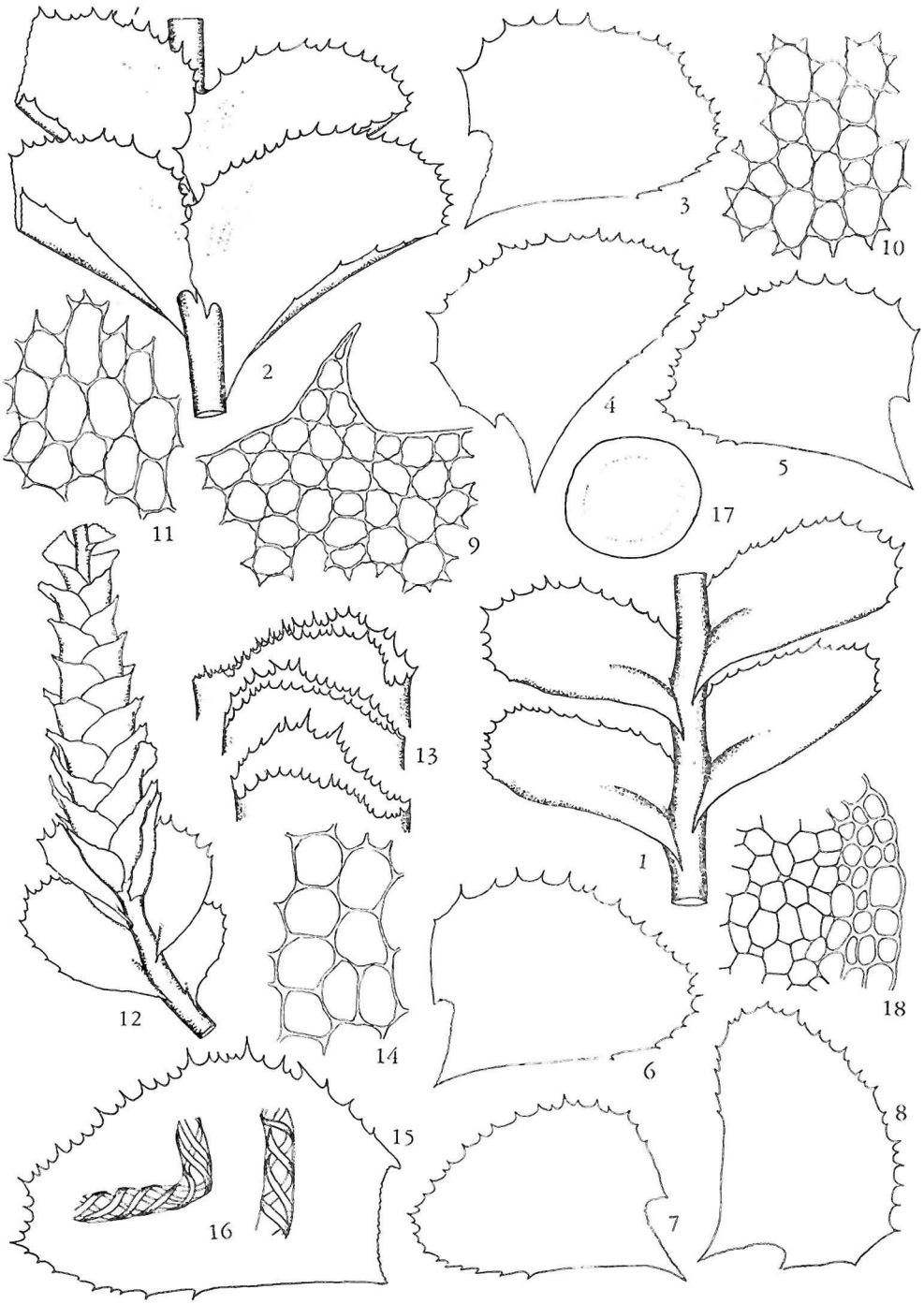

Fig. VI.

decurrent, orbicular to lanceolate, marginal teeth usually 10–25, occasionally entire throughout. Underleaves usually rudimentary or absent. Rhizoids not present on erect stem, but rather numerous on rhizomatous stem. Oil-bodies usually 4–9 per cell, spherical to fusiform, non-homogeneous with numerous granules. Male inflorescence terminal to intercalary, bracts similar to leaves but usually larger with ciliate margin. Perianth campanulate, mouth truncate to moderately arching, irregularly dentate. Archegonium 20–25 in number.

Key to species

1 { Plants small, less than 3 cm. long and 3 mm. wide; leaves nearly as long as wide ....(2)
Plants large, more than 3 cm. long and 3 mm. wide; leaves usually longer than wide..(3)

2 { Usually in the coniferous forest to the subalpine forest zone; leaves rather densely imbricate, 1–2 layers of cells along margin thicker than inner ones; mouth of perianth weakly dentate ..... *P. satoi*
Usually in the deciduous forest zone; leaves rather distant, marginal cells not so thickened; mouth of perianth weakly dentate ..... *P. orbicularis*
Usually in the deciduous forest to the coniferous forest zone; leaves subdistant; cell-walls thin throughout but with large trigones; mouth of perianth ciliate-dentate.. *P. hakkodensis*

3 { Plants about 10 cm. long and more than 1 cm. wide; leaves more than 5 mm. long and 4 mm. wide; marginal teeth of leaf more than 35 in number; leaf cells completely lack trigones ..... *P. magnifolia*
Plants up to 6 cm. long and 5 mm wide; leaves less than 4.5 mm. long and 3.5 mm. wide; marginal teeth usually less than 30 in number; leaf cells usually with small trigones throughout ..... *P. asplenioides* subsp. *ovalifolia*

Plagiochila asplenioides (1.) Dum.[6] **subsp. *ovalifolia*** (Mitt.) Inoue, stat. nov.
(Fig. VI and VIII, 7–11)

Plagiochila ovalifolia Mitt. Trans. Linn. Soc. London, s. 2, **3**: 193 (1891).——*P. nagasakiensis* Steph. Bull. Herb. Boiss. **5**: 104 (1897).——*P. odatensis* Steph. Spec. Hepat. **2**: 339 (1903).——*P. jishibana* Steph. Spec. Hepat. **6**: 169 (1921).——*P. toshoguna* Steph. l. c. 234 (1921). ——*Tylimanthus japonicus* Steph. l. c. 248 (1922), *syn. nov.*——*Plagiochila ovalifolia* Mitt. fo. *nagasakiensis* Hatt. Jour. Jap. Bot. **20**: 162, *f. 39* (1944), *syn. nov.*——*P. ovalifolia* Mitt. fo. *descendens* Hatt. Jour. Hattori Bot. Labor. **3**: 27, *f. 25* (1948), *syn. nov.*——*P. ovalifolia* Mitt. fo. *flagellata* Hatt. l. c. **3**: 27, *f.* 26 (1948), *syn. nov.*——*P. ovalifolia* Mitt. fo. *jishibana* Hatt. Jour. Jap. Bot. **25**: 48 (1950), *syn. nov.*——*P. ovalifolia* Mitt. fo. *toshoguna* Hatt. l. c. **25**: 48 (1950), *syn. nov.*——*P. ovalifolia* Mitt. fo. *odatensis* Hatt. Jour. Hattori Bot. Labor. **15**: 85 (1955), *syn. nov.*

Plants 3–5 cm. long, 2.0–4.8 mm. wide, green to brownish green, in compact mats or occasionally scattered among mosses. Stem about 0.3 mm. thick, brown

[6] Rec. d'Obs. 14 (1835)

Fig. VI. ***Plagiochila asplenioides*** (L.) Dum. **subsp. *ovalifolia*** (Mitt.) Inoue.

1. Part of plant, dorsal view, ×12. 2. Do., ventral v., ×12. 3–8. Leaves, ×12. 9. Cells from leaf margin, ×160. 10. Cells from leaf middle, ×160. 11. Cells from leaf base, ×160. 12. Male inflorescence, dorsal v., ×12. 13. Mouth of perianth, ×12. 14. Cells from perianth, ×360. 15. Female bract, ×12. 16. Parts of elater, ×360. 17. Cross-section of stem, ×24. 18. Part of (17), ×150. Fig. 12 was based on *Inoue 4510*, and the others *on Inoue 3562*.

to blackish brown, or yellowish brown, moderately forked; in cross-section cortical cells in 2–3 layers, averaging 20×24 μ, usually cells of the outermost layer slightly larger than other cortical cells, walls much thickened, deep brown, interior cells 24–31×31–41 μ, walls rather thin, pale brown to white. Leaves moderately imbricate, succubously inserted with the line of insertion curved and ending nearly 1/2 of stem width; moderately decurrent both dorsally and ventrally, dorsal margin usually more or less reflexed, nearly straight or slightly arching, with 3–6 teeth from middle to near apex or sometimes entirely lacking teeth, ventral margin more arching than dorsal one, variable in form, usually ovate to ovate-oblong or rotundate, 1.6–2.4 mm. wide, 2.0–2.8 mm. long, apex round to truncate, occasionally with suggestions of 2-lobes, marginal teeth usually 20–28 in number, 2–6 cells long and 1–3 cells wide at base. Cells of leaf apex and along margin, 27–37×31–44 μ, of middle 31–41×37–55 μ, of base 27–40×55–80 μ, trigones small or rarely absent, walls thin, cuticle smooth. Oil-bodies 4–11 per cell (mostly 5–7), 3–6×10–17 μ, spherical to ellipsoid, with numerous granules, grayish white. Underleaves usually rudimentary, filiform, but occasionally lacking on rhizomatous stem. Rhizoids usually on rhizomatous stem, colorless, long. Male plants usually in separate mats; male inflorescence terminal to intercalary, bracts in about 10 pairs, imbricate, strongly saccate, far smaller than leaves, with 3–4 small teeth near apex. Antheridia 2 per bract. Female inflorescence terminal, usually with 1 innovation: bracts similar to leaves but slightly larger, 3.6 mm. long and 2.2 mm wide, with about 30 marginal teeth, apex often more or less bilobed. Perianth oblong-campanulate, 3.8–4.8 mm. long, about 1.8 mm. wide at mouth, often slightly bent to one side, mouth irregularly ciliate-dentate, moderately arching, 2-lipped. Seta about 1.5 cm. long, long exserted, composed of many rows of cells. Capsule oblong, blackish brown. Spores spherical, 14–17 μ, with minutely punctate coat, brown; elaters 7–10 μ wide 170–220 μ long, bi- or rarely trispiral.

Ecology.—On wet or submerged rocks, on humus-covered on rocks, and occasionally on trunk base of trees, in the ever-green forest to the upper deciduous forest zone, at an elevation of 50–1500 m. This species generally grows in pure mats on wet rock or submerged one (sometimes with small amount of mosses). Occasionally, however, it is asociated with *Blepharostoma minus*, *Jubla hutchinsiae* ssp. *japonica*, *Heteroscyphus bescherellei*, *H. argutus*, *Metzgeria conjugata* var. *japonica*, *Radula japonica*, *Lejeunea japanica*, *L. rotundistipula*, *Dumortiera hirsuta* ssp. *tatunoi*, *Conocephalum conicum*, *Makinoa crispata* and other mosses. This species has rather wide ecological amplitude and grows on both calcareous and acidic rocks. This species is distributed all over the present area but the abundant materials came mainly from Kyushu, Shikoku and south-western Honshu. In northern Honshu and Hokkaido it is rather few in distribution. **Loc.**[7]—Formosa: Mt. Arisan (*U. Ara* without number). Kyushu: Isl. Yakushima (*S. Hattori 7923*-type of *P. ovalifolia* fo. *flagellaris*, *7212*-type of *P. ovalifolia* fo. *descendens*); Pref. Nagasaki, Mt. Unzen (*Faurie 15352-3*, determined by Stephani as *Pl. nagasakiensis*). Honshu: Pref. Akita, Jimba (*Faurie*

[7] Localities of this subspecies become over 200 and the specimens studied over 1000, so that, for the economy of space, details of localities are omitted. The localities cited are rather significant ones at where the important materials were collected. The number of the localities in several districts of Japan are as follows: Kyushu (66), Shikoku (51), southwest Honshu (42), middle Honshu (30), nothern Honshu (12), and Hokkaido (5).

1861-type of *Pl. odatensis*). Hokkaido: Shiribeshi (*Faurie 1826*-type of *Tylimanthus japonicus*). **Range.**—Japan, Korea, Ryukyu Isls., Formosa (new).

Mitten (1891) described *Plagiochila ovalifolia* comparing it with *P. asplenioides* and noting that "the perianth shows it to be different; instead of a truncate mouth, its (*P. ovalifolia*) mouth is oblique, and more deeply cleft on the ventral side." From that time onward many authors published reports on *P. ovalifolia*, and recently S. Hattori (1952) remarked on the relationship to *P. asplenioides*. He noted that this species is "possibly regarded as a geographical subspecies or variety of European *P. asplenioides*." *P. asplenioides* is a remarkably polymorphic species. *P. ovalifolia* is also very polymorphic one and many of its forms are described under different names by Stephani. The variations are chiefly in size and form of leaf and marginal teeth of leaf. But those variations are probably caused by environmental factors, such as light, humidity and density of mat, so that the author does not think it appropriate to separate them nomenclaturally.

After comparison with European material of *P. asplenioides*, the author found some reliable characteristics to separate *P. ovalifolia* from the former. These are the mouth of perianth as noted by Mitten (1891), and the number of cortical cell-layers in the stem, which is usually 2–3 in *P. ovalifolia* and 3–5 in *P. asplenioides*. The mouth of the perianth of *P. ovalifolia* is very variable, frequently bilobed, and is always oblique with strong dentation. Occasionally the lobes are slightly bilobed again at apex. In European material of *P. asplenioides*, at least according to my observations, the mouth of perianth is mostly truncate or very rarely arched inconsiderably and never bilobed. In the descriptions of *P. asplenioides* by European bryologists the characteristics of the mouth of the perianth are not given correctly.

It seems that European bryologists did not call attention to its close relation to *P. ovalifolia*, and also in Japan none did so before S. Hattori (1952).

It is evident that the variational pattern of both species is not the same; that is, leaf-margins of *P. ovalifolia* are always dentate, leaves occasionally are slightly bilobed at apex and the mouth of perianth has the variabilities described above. On the otherhand, in *P. asplenioides* the leaf-margins are occasionally enitre throughout (for example, var. *subintegra*), and there never is found any suggestion of bilobing as in the former species. Moreover, the mouth of the perianth is not as variable as in the former species. From the geographical point of view, those differences in variability should be regarded as of a subspecific rank.[8]

F. Stephani (1922) described *Tylimanthus japonicus* from Hokkaido from a collection by U. Faurie. As S. Hattori (1949) noted as "they belong to *Plagiochila*", the careful investigation of his original material proved it to be a form of this subspecies.

—forma *thylimanthoides* (Steph.) Inoue, comb. nov. (Fig. VII, 18–21)

Plagiochila thylimanthoides Steph. Spec. Hepat. **6**: 227 (1921).——*P. ovalifolifolia* Mitt. fo. *thylimanthoides* Hatt. Jour. Jap. Bot. **25**: 48, *f. 55* (1950).

[8] Recently Mr. M. Segawa (1957) published the study of chromosome in *Plagiochila ovalifolia* and *P. japonica*. According to him, there are some differences in the sex-chromosomes of *P. ovalifolia* and *P. asplenioides* in which Lorbeer studied (Jahrb. f. wiss. Bot. **80**: 565-818. 1934). The sex-chromosomes of *P. ovalifolia* is so-called 'structural sex-chromosomes', and the chromosome formular is 8+X(♀) and 8+Y(♂).

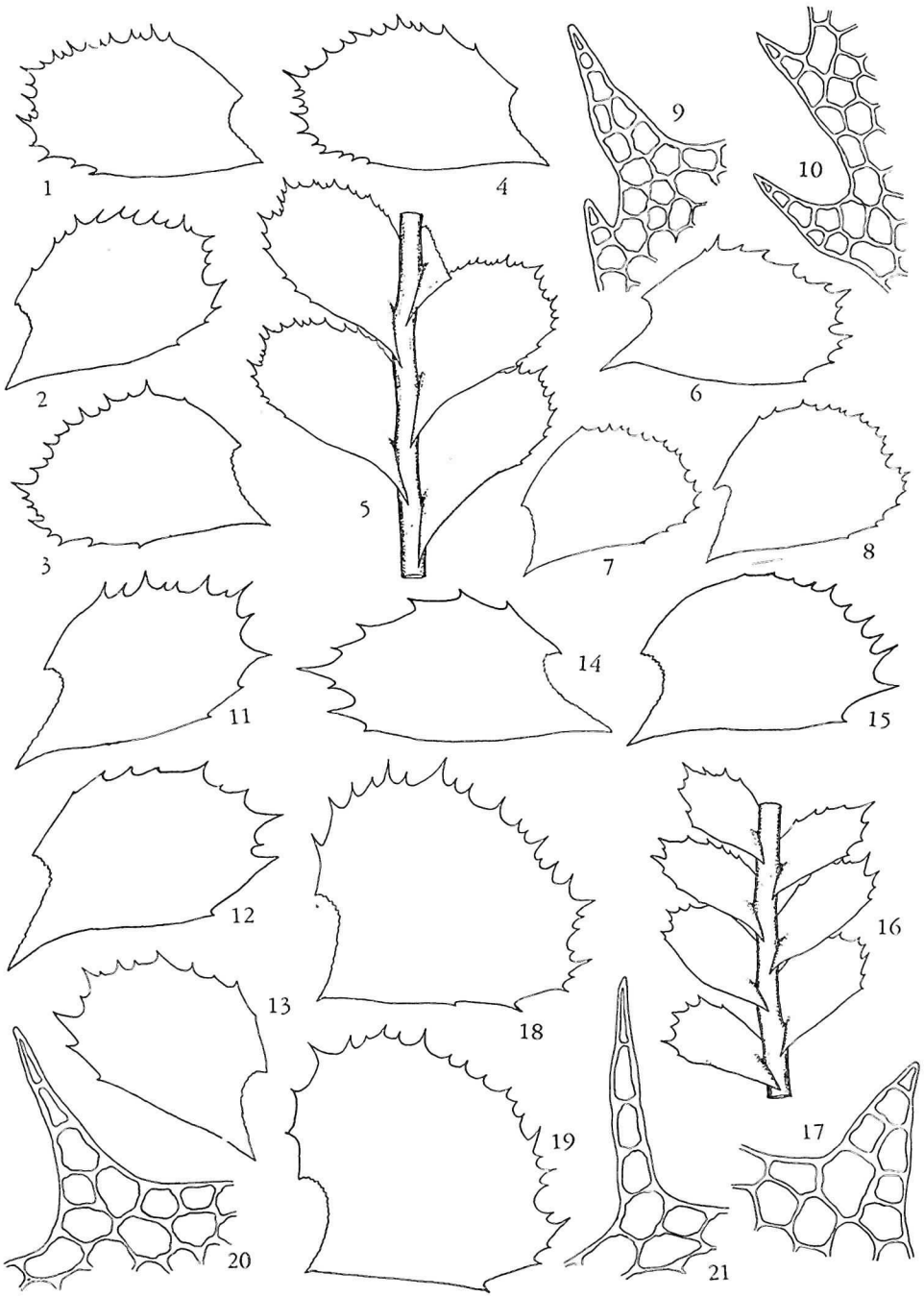

Fig. VII.

The present form is characterized as follows: leaves widely triangular-ovate, about 2.5 mm. long and wide, ventral margin more strongly arched, angle of dorsal and ventral margin near 90 degrees at base, suggestion of bilobing at apex distinct, marginal teeth mostly 20–35, triangular, strongist near apex.

Ecology.—In more humid habitats than the subspecies, usually without associated species. **Loc**.—Kyushu: Pref. Miyazaki, Kitago; Pref. Kumamoto, Mizukami. Shikoku: Pref. Kochi, Mts. Shiraga, Yokogura and Honokawa, Inabumura; Pref. Ehime, Mts. Omoga, Iwaya and Higashiakaishi. Honshu: Pref. Hyogo, Mt. Funakoshiyama; Pref. Mie, Akamekyo, Kamitsu; Pref. Chiba, Mt. Mitsuishi; Pref. Tokyo, Mt. Mitake; Pref. Saitama, Mts. Chichibu.

—**forma *magna*** Inoue, forma nova. (Fig. VIII, 1–6)

A typo differt: caulibus ad 2 cm. longis, foliis caulinis magnis, 3.5 mm. latis, 3.5–4.5 mm. longis, margine ad 45-dentatis, parietibus tenuibus, trigonis nullis.

Ecology.—On rocks at more shady and humid sites, usually with few mosses. **Loc**.——Kyushu: Pref. Kumamoto, Hitoyoshi (*K. Mayebara 67*). Shikoku: Pref. Kochi, Mt. Shiraga (*Inoue 1738*), Kaminiro (*Inoue 2372*). Honshu: Pref. Nara, Mt. Odaigahara (*Kodama 4688, 9736*); Pref. Hyogo, Mt. Mimuro (*Kodama 4604*); Pref. Nagano, Mt. Akaishi (*Takaki 6701*); Pref. Tokyo, Mt. Tenso (*Hattori 3151*-holotype, *Inoue 6820*-syntype); Pref. Gunma, Minakami (Inoue 5938).

—**var. *miyoshiana*** (Steph.) Inoue, comb. nov. (Fig. VII, 1–17)

Plagiochila miyoshiana Steph. Bull. Herb. Boiss. **5**: 104 (1897).——*P. spinulosa* Dum. sensu Steph. l. c. 81 (1897).——*P. fauriana* Steph. Spec. Hepat. **2**: 324 (1903).——*P. campanulata* Steph. l. c. 325 (1903).——*P. ovalifolia* Mitt. var. *miyoshiana* (Steph.) Hatt. Bull. Tokyo Sci. Mus. **11**: 60, *f. 36* (1944).——*P. ovalifolia* Mitt. var. *fauriana* (Steph.) Hatt. Jour. Jap. Bot. **25**: 49 (1950).——*P. ovalifolia* Mitt. var. *campanulata* (Steph.) Hatt. in K. Ochi, Shizen-to-Jinmon **1**: 65 (1950).

Plants small to medium in size, usually deep green, somewhat slender; leaves not so succubous as in the subspecies, 1.2 mm. long, 0.8–1.2 mm. wide, ovate-oblong to ovate, apex subacute to rotundate with slight suggestion of bilobing; marginal teeth 10–23, strong and acute, particularly so near apex. Cells of leaf apex and along margin 17–24×20–27 μ, of middle 27–31×27–34 μ, of base 17–27×44–65 μ, trigones small but distinct; underleaves none or rudimentary, occasionally conspicuous, bilobed up to 1/2 of length and with some marginal cilia.

Ecology.—Similar to that of the subspecies. **Loc**.—Kyushu: Pref. Kagoshima, Isl. Yakushima, Mt. Kirishima; Pref. Miyazaki, Kitagomura, Mt. Okuzure; Pref. Kumamoto, Ishochi, Mizukamimura, Shiramizumura, Suye; Pref. Ohita, Mt. Tsurumidake, Uchiyama; Pref. Fukuoka, Mt. Ehiko, Isl. Tsushima (*Faurie 962*-determined by Stephani as *P. chinensis*). Shikoku: Pref. Kochi, Mts. Kazigamori, Honokawa and Yokogura, Onomimura, Susaki, Zizoji;

Fig. VII. ***Plagiochila asplenioides*** (L.) Dum. **subsp. *ovalifolia*** (Mitt.) Inoue **var. *miyoshiana*** (Steph.) Inoue (1–17) and **forma *thylimanthoides*** (Steph.) Inoue (18–21).

1–4. Leaves, ×18. 5. Part of plant, ×12. 6–8. Leaves, ×12. 9–10. Cells from leaf margin, ×150. 11–15. Leaves, ×24. 16. Part of plant, dorsal view, ×12. 17. Cells from leaf margin, ×360. 18–19. Leaves, ×12. 20–21. Cells from leaf margin, ×150. Figs. 1–4 were based on *Sugino 4*; figs. 5–10 on *Kodama 6866*; 11–17 on *Ochi 645*; figs. 18–21 on *Ikegami 4050*.

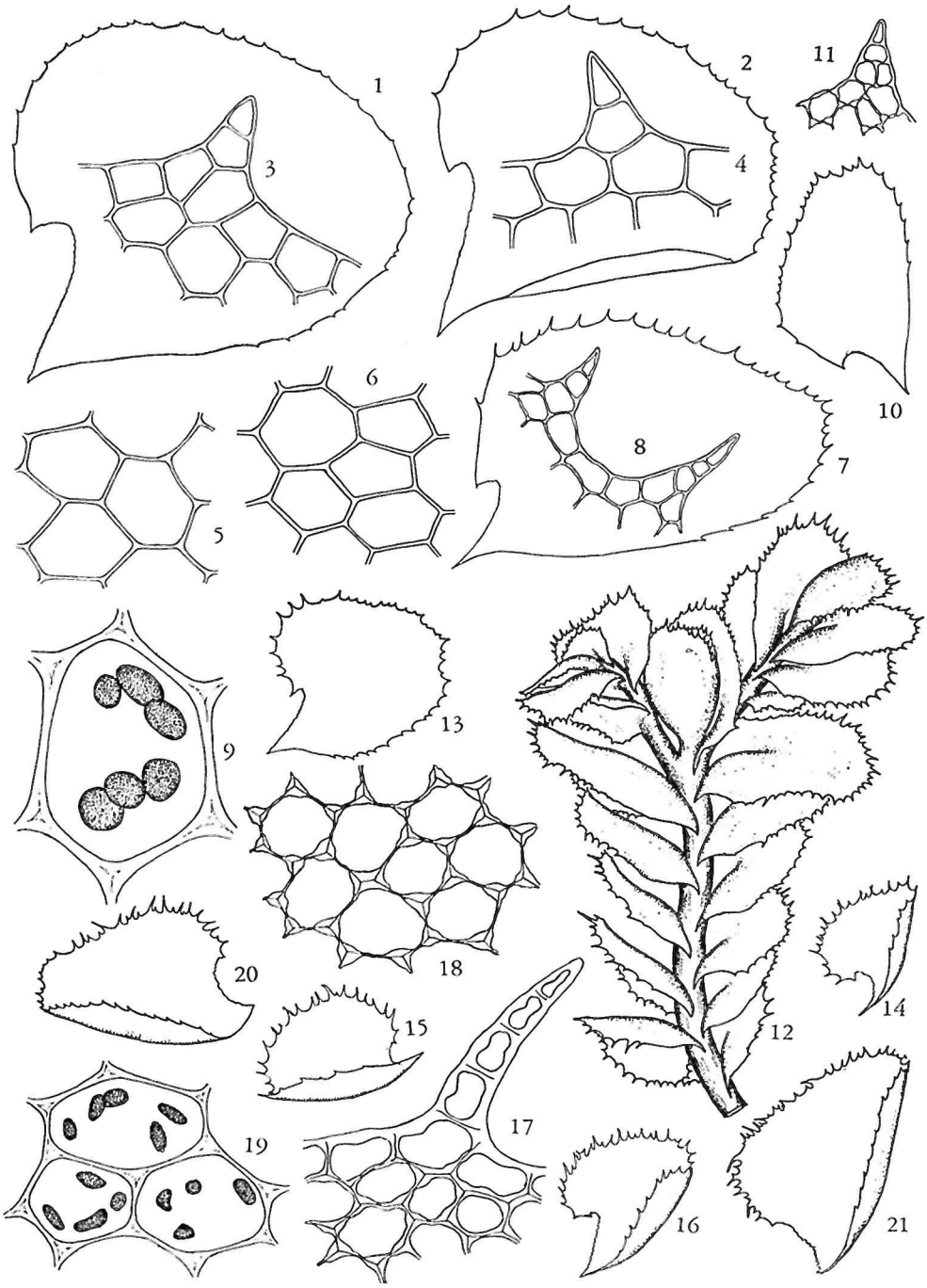

Fig. VIII.

Pref. Ehime, Tomisato, Ohugimura, Nakahagi-machi, Uwajima, Saijo, Mt. Higashiakaishi: Pref. Tokushima, Mt. Tsurugi. Honshu; Pref. Hyogo, Mt. Mayasan (*Faurie 932-3*-determined by Stephani as *P. chinensis*); Pref. Nara, Mt. Kasuga, Odaigahara; Pref. Mie, Akamekyo, Kodzumura, Mt. Asama; Pref. Wakayama, Kitayamamura, Mt. Koya; Pref. Okayama, Mt. Naginosen; Pref. Shiga, Mt. Hiei; Pref. Shizuoka, Mt. Amagi; Pref. Chiba, Mt. Mitsuiahi; Pref. Saitama, Mts. Chichibu; Pref. Nagano, Mt. Shirouma; Pref. Gunma, Minakami. Hokkaido: Hakodate (*Faurie 12604*-determined by Stephani as *P. spinulosa*). **Range.**—Restricted to Japan.

F. Stephani (1897) recorded *P. spinulosa* from Japan with some question. Later, some authors repeated Stephani's record, and recently S. Hattori (1949) marked *P. spinulosa* as doubtfully in Japan. U. Fauire's collection at Hakodate seems to be the basis for Stephani's record, but the material is clearly a form of this variety, and the record of *P. spinulosa* from Japan may be rejected.

Plagiochila satoi Hatt. (Fig. IX)

Bot. Mag. Tokyo **57**: 361, *f. 6* (1943).——*Plagiochila satoi* Hatt. var. *integerrima* Hatt. Jour. Hattori Bot. Labor. **12**: 84 (1954), nom. mud., *syn. nov.*——*Plagiochila wakawana* Steph. sensu Kamimura, Contr. Fl. Hepat. Shikoku. 61, *f. 56* (1952).

Plants 1.0–3.0 cm. long, about 2.5 mm. wide, light green to yellowish green, in compact mats or rarely scattered among mosses. Stem about 0.25 mm. thick, brown to yellowish brown, ascending to erect, simple or moderately forked; in cross-section cortical cells in 2–3 layers, 10–13×10 μ, walls much thickened, slightly smaller than cell cavities, deep brown, interior cells averaging 27 μ, walls thin, yellowish to white. Leaves strongly succubously inserted, imbricate to subdistant, horizontally spreading or obliquely, dorsal margin rather strongly reflexed, slightly to moderately long decurrent, ventral margin hardly decurrent, orbicular to widely ovate, 1.0–2.3 mm. long and wide, becoming gradually smaller toward lower portion of stem, dorsal margin straight or moderately arching, with 3–4 small teeth near apex, apex rotundate to truncate, with 4–6 small teeth, ventral margin strongly arching, with 10–14 teeth, angle of dorsal and ventral margin at base from 50–80 degrees; marginal teeth mostly 10–20 in number but occasionally completely entire throughout, teeth usually 2–4 cells long and 1–2 cells wide at base. Cells of leaf apex and along margin 20–27×20–26 μ, of middle 21–30×25–34 μ, of base usually forming vitta-like cell-mass composed of about 15 cells long and about 7 cells wide, measuring 27–34×50–80 μ; trigones small but very conspicuous, walls thin, but occasionally those of 2 cell-lines along leaf-margin slightly more thickened than

Fig. VIII. ***Plagichila asplenioides*** (L.) Dum. **subsp.** ***ovalifolia*** (Mitt.) Inoue **forma** ***magna*** Inoue (1–6), **forma** ***ovalifolia*** (7–11) and ***Plagiochila satoi*** Hatt. **forma** ***japonomontana*** (Hatt.) Inoue (12–21).

1–2. Leaves, ×12. 3–4. Cells from leaf margin, ×360. 5–6. Cells from leaf middle ×320. 7. Leaf, ×12. 8. Cells from leaf margin, ×190. 9. Do. showing oil-bodies, ×900. 10. Leaf, ×12. 11. Cells from leaf apex, ×190. 12. Part of plant, dorsal view, ×12. 13–16. Leaves, ×12. 17. Cells from leaf margin, ×360. 18. Cells from leaf middle, ×360. 19. Do. showing oil-bodies, ×900. 20–21. Female bracts, ×12. Figs. 1–6 were based on *Hattori 3515*-type; figs. 7–8 on *Inoue 1738*; figs. on *Inoue 7174*; figs. 12–21 on *Inoue 1560*.

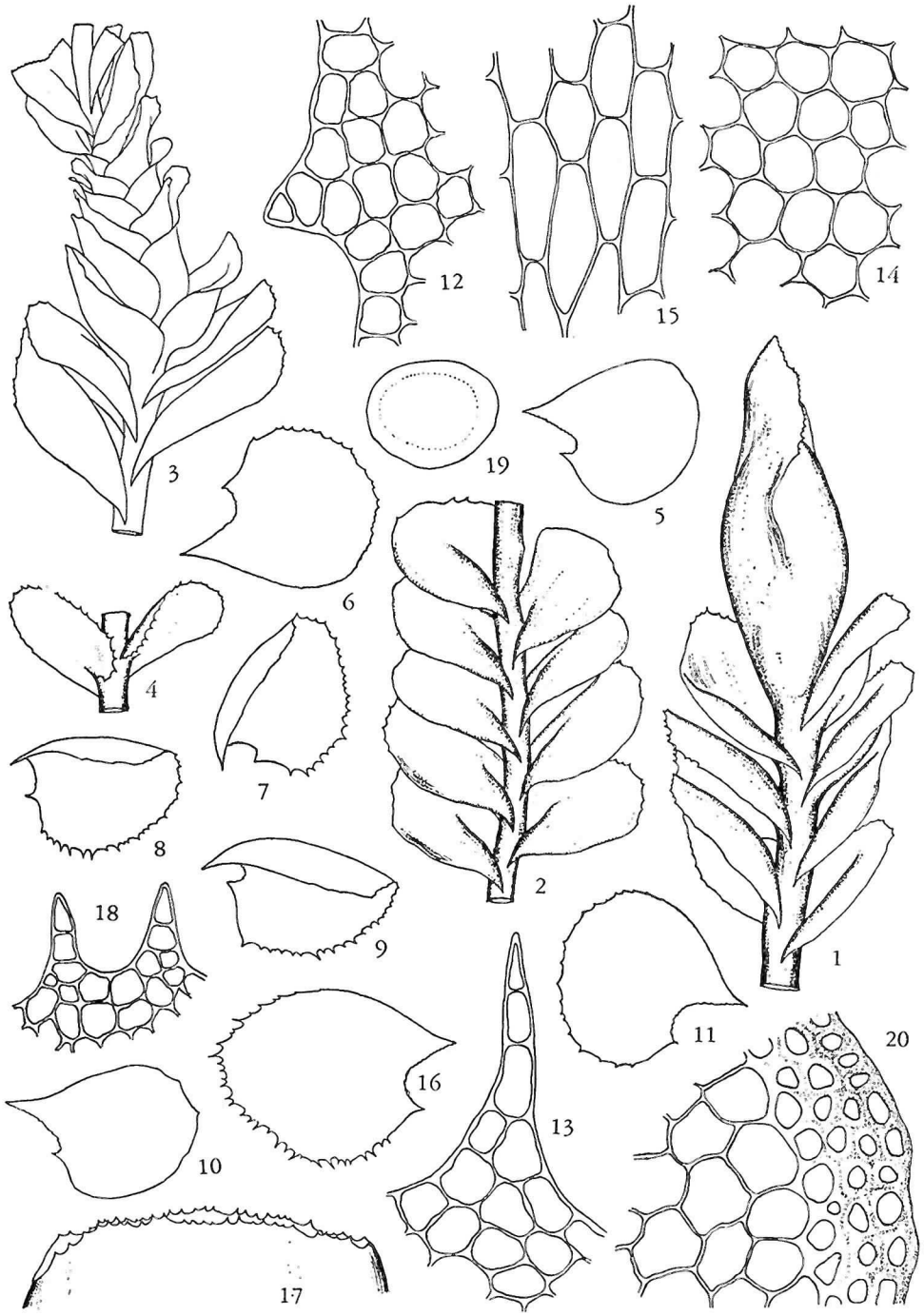

Fig. IX.

inner cells. Oil-bodies 5–10 per cell (mostly 6–8), sperical to ovoid, 5–7×4–5 μ, non-homogeneous or sometimes nearly homogeneous, grayish in color. Underleaves absent or rudimentary, filiform. Rhizoids absent on erect spreading stem but rather numerous on rhizomatous stem, colorless, long. Male plants usually in separated mats; inflorescence terminal or intercalary, bracts 4–9 pairs, closely imbricate, similar to leaves but far smaller, with 10–16 marginal teeth but sometimes entire throughout. Antheridia 2 per bract. Female inflorescence terminal, rarely with innovation, bracts similar to leaves in shape, but slightly larger with more marginal teeth. Perianth cylindrically campanulate, 2.0–2.8 mm. long, 1.3–1.6 mm. wide at mouth, mouth truncate, sometimes slightly arching, usually slightly narrower than immediately lower portion, irregularly dentate. Seta about 1.5 cm. long, composed of many rows of cells; capsule ovoid, about 1.5 cm. long, blackish brown. Spores spherical, about 17 μ, with minutely punctate coat, brown; elaters bispiral, about 10 μ wide and 180 μ long, deep brown.

Ecology.—On rocks covered with thin soil or humus, on humus, and on bark of tree, in the upper deciduous forest to the coniferous forest zone, and occasionally in the subalpine zone, at an elevation of 1000–2600 m. At northern part of the present area this species grows at lower altitude (the lowest is at Hokkaido, ca. 400 m.), and occasionally in calcareous regions at lower altitude. This species usually grows with the following species on rocks covered with thin soil or humus; *Nipponolejeunea pilifera*, *Euosmolejeunea auriculata*, *Trichocoleopsis sacculata*, *Trichocolea tomentella*, *Blepharostoma trichophyllum*, *B. minus* (on serpentine rock), *Bazzania ovifolia*, *Macrodiplophyllum plicatum*, *Scapania ampliata*, *S. ciliata* (very rarely), *Radula auriculata*. *R. obtusiloba*, and very rarely *Plagiochila asplenioides* subsp. *ovalifolia*; on bark of tree with *Bazzania ovifolia*, *Scapania ampliata*, *Radula fauriana* (very rarely) and *Mylia verrucosa*. **Loc**.—Shikoku: Pref. Kochi, Mt. Shiraga; Pref. Ehime, Mt. Higashiakaishi, Mt. Ishiduchi; Pref. Tokushima, Mt. Tsurugi, Higashiiyayamamura. Honshu: Pref. Tottori, Mt. Daisen; Pref. Okayama, Mt. Naki, Kamisoyama; Pref. Nara, Mts. Sanjogadake, Odaigahara and Inamuragadake; Pref. Gifu, Shirakawa; Pref. Nagano, Mt. Jonen (*Hattori 1342*-type), Tsubameiwa, Kitazawa-pass, Kirigamine, Kamikochi, Kawakamimura, Mt. Shirouma; Pref. Shiga, Mt. Bunagadake; Pref. Saitama, Mts. Chichibu; Pref. Iwate, Mt. Hayachine; Pref. Aomori, Mt. Hakkoda, Hokkaido: Mt. Apoi, Mt. Yubaridake, Isl. Rebun, Isl. Rishiri. **Range**.—Endemic to Japan.

The distinguishing characteristics of this species are its yellowish green to right green color, minute to medium size of plant, widely ovate to somewhat orbicular leaves which are densely imbricate, rather strongly reflexed dorsal margin of leaves, and occasionally thick-walled 1–2 cell-layers along leaf-margin. This species is also very variable, especially in its marginal teeth, which are occasionally lacking.

S. Hattori described *P. japonomontana* from a collection at Mt. Asahi, which is a form with more marginal teeth and more thickened marginal cell-layers. The

Fig. IX. ***Plagiochila satoi*** Hatt.

1. Part of plant with perianth, dorsal v., ×12. 2. Do., dorsal v., ×12. 3. Male inflorescence, dorsal v., ×12. 4. Part of plant, ventral v., ×12. 5–11. Leaves, ×12. 12–13. Cells from leaf margin, ×360. 14. Cells from leaf middle, ×360. 15. Cells from leaf base, ×360. 16. Female bract, ×12. 17. Mouth of perianth, ×27. 18. Part of (17), ×360. 19. Cross-section of stem, ×55. 20. Part of (19), ×360. All figs. were based on *Hattori 1342*-type.

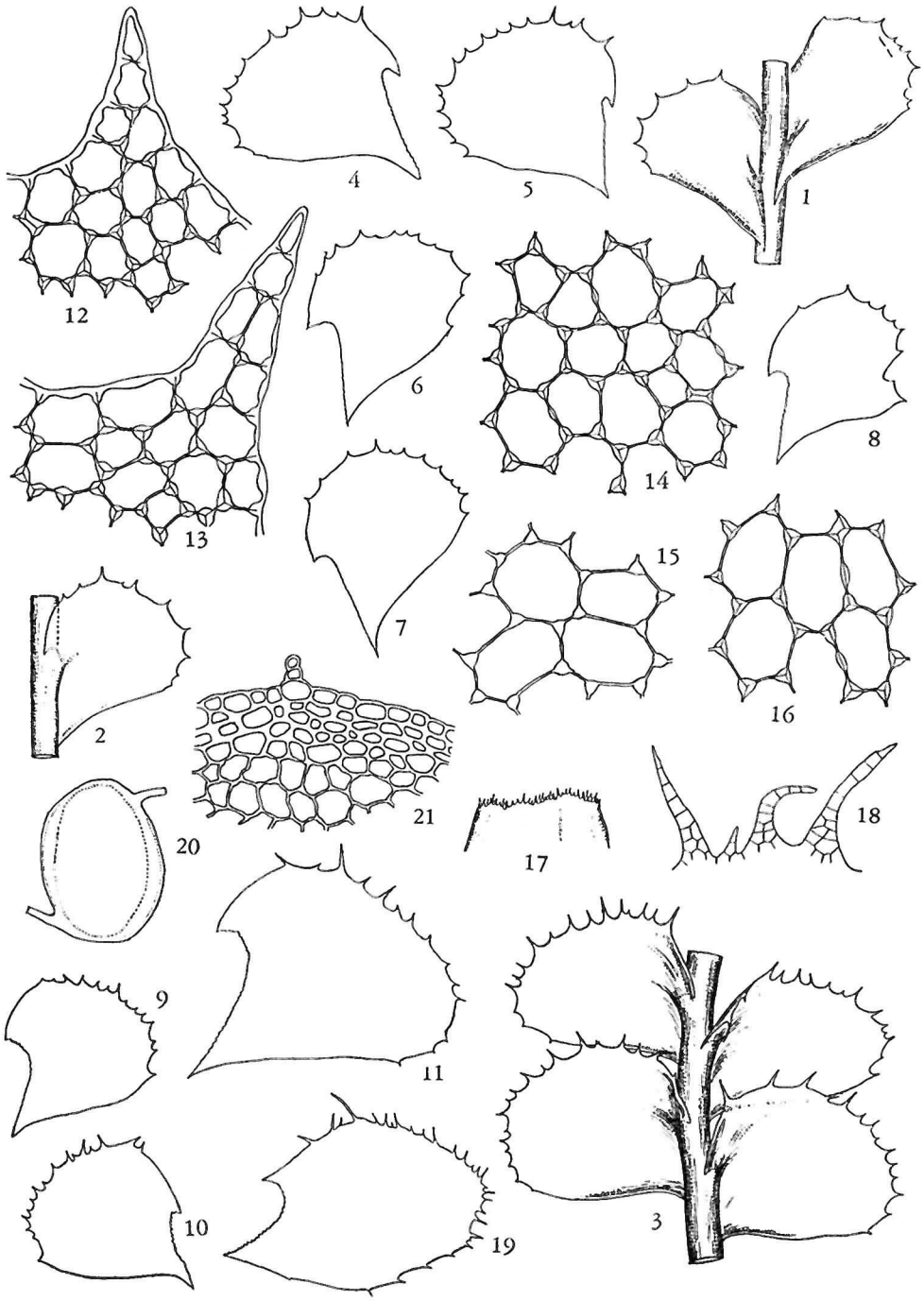

Fig. X.

perianth of *P. japonomontata* is not fully developed. Then the author reduced *P. japonomontana* to forma of *P. satoi*. On the otherhand var. *integerrima* is a form with nearly entire leaves. Generally at higher elevation (the upper coniferous to the subalpine zone) the plants usually have entire leaves.

—**forma *japonomontana*** (Hatt.) Inoue, stat. nov. (Fig. VIII, 12–21)

Plagiochila japonomontana Hatt. Bull. Yamagata Agr. Coll. **1**: 42 (1949).——*P. hakkodensis* Steph. var. *dentosa* Hatt. Jour. Jap. Bot. **25**: 139. *f. 56* (1950).——*P. dentosa* (Hatt.) Hatt. Jour. Hattori Bot. Labor. **12**: 84 (1955), *syn. nov.*

The present form is distinguished from the species as follows: more imbricate leaves which have more marginal teeth (1–3 cells wide and 2–7 cells long) and less reflexed dorsal margin, mostly always thickened cell walls along leaf margin, having no vitta-like cell-mass at leaf base, and female bracts having more marginal teeth. Between this form and the species there are many transitional forms, but this form seems to grow in shadier sites than the species.

Loc.—Kyushu: Pref. Miyazaki, Mt. Shiroiwa. Shikoku: Pref. Ehime, Mts. Ishizuchi, Omogo (*Hattori 6250*-type of *P. hakkodensis* var. *dentosa*), Higashiakaishi and Tebako. Honshu: Pref. Nagano, Nakabusa; Pref. Saitama, Mts. Chichibu; Pref. Iwate, Mt. Hayachine; Pref. Akita, Mt. Asahi (*Hattori 1448*-type).

Plagiochila hakkodensis Steph. (Fig. X)

In Besch. Rev. Bryol. **11**: 27 (1894), nom. nud.; Steph. Bull. Herb. Boiss. **5**: 103 (1897).——*Tylimanthus paucidens* Steph. Spec. Hepat. **6**: 250 (1922), *syn. nov.*——*Plagiochila ishizuchiensis* Horik. Jour. Sci. Hiroshima Univ. ser. b, 2, **1**: 59, *f. 3* (1931), *syn. nov.*——*P. kodukensis* Hatt. Jour. Jap. Bot. **20**: 160, *f. 38* (1944).——*P. hakkodensis* Steph. var. *kodukensis* Hatt. l. c. **25**: 47 (1950), *syn. nov.*

Plants 3–5 cm. long, 3.0–3.5 mm. wide, brown to yellowish green, in compact patches or rarely scattered among mosses. Stem about 0.28 mm. thick, yellowish green to right brown, ascending to erect or occasionally prostrate, mostly simple with some innovations, very rarely forked; in cross-section cortical cells in 2–3 layers, averaging $10\times16\,\mu$, walls much thickened but smaller than cell cavities, deep brown, occasionally outermost cell-layer with slightly larger cells than other cortical cells; interior cells (28)–20–17×20–27 μ walls thin, pale brown to yellowish white. Leaves distant to subimbricate, obliquely spreading, dorsal margin slightly reflexed, rather long decurrent, ventrally hardly decurrent, widely ovate to somewhat orbicular, 1.5–2.0 mm. long, 1.5–1.8 mm. wide, dorsal margin nearly straight to slightly arching, mostly without teeth, apex round to somewhat truncate, with 3–5 teeth, ventral margin somewhat strongly arching, with 6–11 teeth; marginal

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Fig. X. ***Plagiochila hakkodensis*** Steph.

1. Part of plant, dorsal view ×12. 2–3. Do., ventral v., ×12. 4–11. Leaves, ×12. 12–13. Cells from leaf apex, ×360. 14–15. Cells from leaf middle, ×360. 16. Cells from leaf base, 360. 17. Apex of perianth, ×12. 18. Part of perianth mouth, ×95. 19. Female bract, ×12. 20. Cross-section of stem, ×30. 21. Part of (20), ×160. Figs. 1, 2, 4–8, 12–13, and 15–16 were based on *Faurie 15116*; fig. 3 on *Sugino 12*; figs. 9–10 on *Inoue 4182*; figs. 11, 14, 20–21 on *Takaki 9894*; figs. 17–19 on *Ochi 1716*.

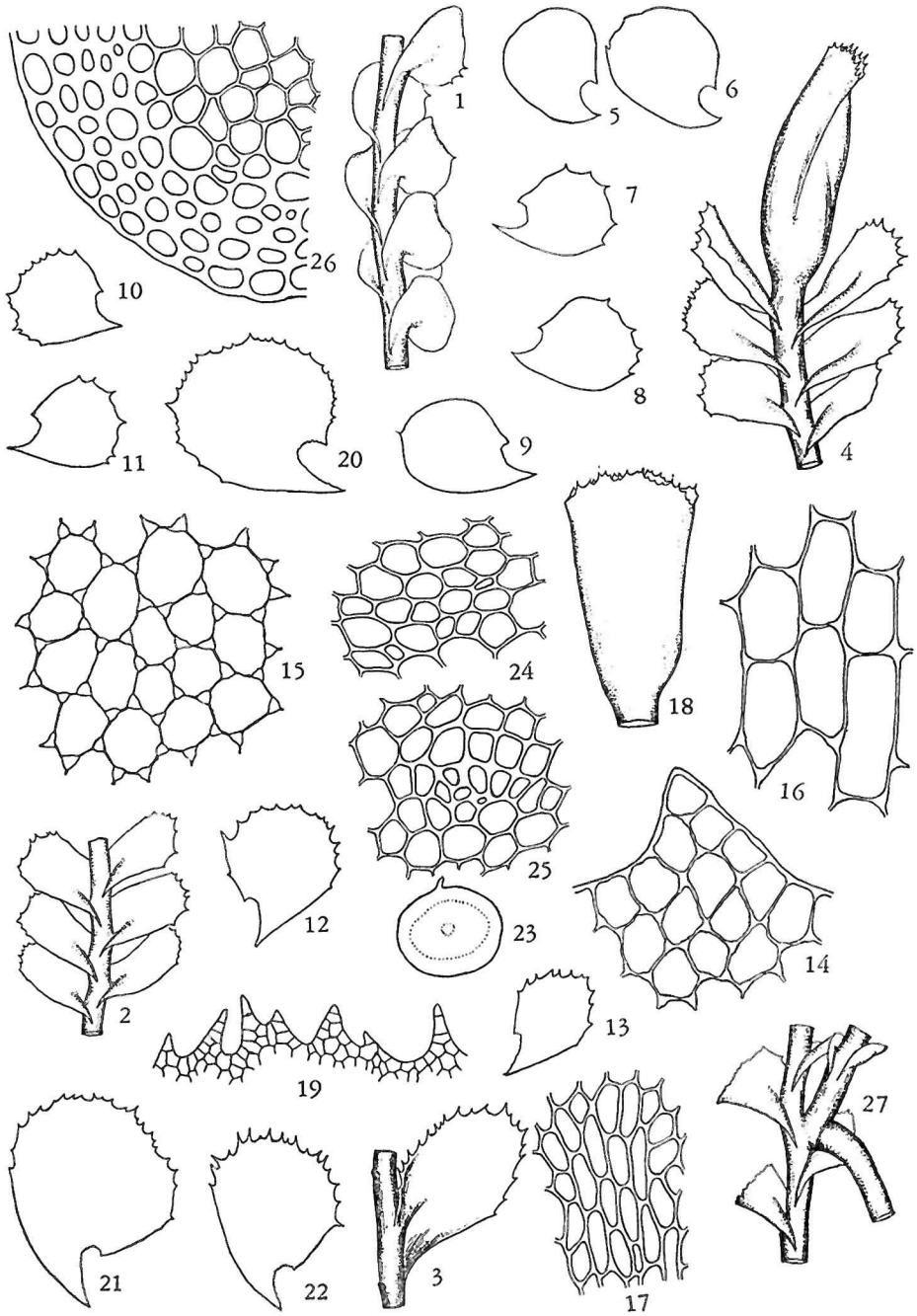

Fig. XI.

teeth mostly 10–16 in total number, occasionally less than 5, becoming stronger toward ventral base, 2–4 cells long and 2 cells wide at base, occasionally 1 celled throughout margin. Cells of leaf apex and along margin 20–27×24–31 μ, of middle 24–31×27–34 μ, occasionally 34–38×41 μ, of base 27–41×44–51 μ, trigones conspicuously large, bulging, walls thin, cuticle smooth. Oil-bodies 4–9 per cell (mostly 5–7), becoming larger toward base, ellipsoid with numerous granules, grayish white, 6–10×3–4 μ. Underleaves absent or rudimentary, filiform. Male plants in separate patches, rather smaller than female ones; inflorescence intercalary, several in same plant, closely imbricate, strongly saccate at base, with small 3–6 marginal teeth or sometimes entire throughout. Antheridia 2 per bract. Female inflorescence terminal with 1–3 innovations, bracts oblong-ovate, about 1.8 mm. long and 1.2 mm. wide, ventral margin with about 15 marginal teeth, teeth slightly longer than those of leaves, dorsal margin with 3–5 teeth near apex. Peianth cylindrically oblong, about 2.4 mm. long, 1.6 mm. wide at mouth, mouth slightly bent laterally, nearly truncate to slightly arching, irregularly ciliate-dentate. Archegonia about 23 in number. Sporophytes unknown.

Ecology.—On humus, rocks covered with thin soil or humus in shady sites in the deciduous forest to the coniferous forest zone, usually at an elevation of 700–2000 m. (occasionally at lower altitude, the lowest is ca. 350 m. at Shinmi, Okayama Pref.). This species generally grows in pure patches, and occasionally occurs with *Diplophyllum allicans*, *D. taxifolium*, *Bazzania fissifolia*, *Lophocolea minor*, *Jubula hutchinsiae* ssp. *jadonica*, *Euosmolejeunea auriculata* and some mosses. **Loc.**—Kyushu: Pref. Kumamoto, Gokoso; Pref. Ohoita, Mt. Yufudake. Shikoku: Pref. Kochi, Mt. Shiraga; Pref. Tokushima, Higashiiya-yamamura; Pref. Ehime, Tomisatomura, Mts. Sasagamine, Besshi and Nishiakaishi. Honshu: Pref. Tottori, Mt. Daisen; Pref. Okayama, Shinmi-city; Pref. Nara, Mt. Odaigahara; Pref. Toyama, Mt. Hakusan, Kurobe, Tateyama; Pref. Nagano, Mts. Shirouma, Senjo, Yatsugadake, and Kirigamiue, Kamikochi, Kitazawa-pass; Pref. Saitama, Mts. Chichibu; Pref. Gunma, Mt. Tanigawa, Oze; Pref. Akita, Mt. Asahi; Pref. Iwate, Mt. Hayachine; Pref. Aomori, Mt. Hakkoda, Towada. Hokkaido: Hirafu (*Faurie* without number-type of *Tylimanthus paucidens*), Yuhari, Mt. Ashibetsu, Horomi. **Range.**—Endemic to Japan.

The distinguishing characteristics of this species are its widely ovate to somewhat orbicular leaves with marginal teeth which become longer toward ventral base and sometimes incline to the ventral base of leaf, conspicuously large trigones and ciliate-dentate margin of perianth mouth. The present species is also very polymorphic in size, form and size of leaves and the number and length of marginal teeth.

S. Hattori's plants of *P. kodukensis* are a form which has longer marginal

Fig. XI. ***Plagiochila orbicularis*** (Hatt.) Hatt.

1. Part of plant, lateral view, ×12. 2. Do., dorsal v., ×12. 3. Do., ventral v., ×12. 4. Do., with perianth, ×12. 5–13. Leaves, ×12. 14. Cells from leaf apex, ×360. 15. Cells from leaf middle, ×360. 16. Cells from leaf base, ×360. 17. Do., ×120. 18. Perianth, ×12. 19. Mouth of perianth, ×90. 20–22. Female bracts, ×12. 23. Cross-section of stem, ×42. 24–25. Middle parts of (23) showing thickened central cells. ×270. 26. Part of (23), ×270. Figs. 1, 4–6, 8–9, 11, 13, 17–18, and 24–27 were based on *Hattori 7213*; figs. 2, 15–16, and 21–22 on *Kuwahara 1813*; and figs. 3, 7, 10, 12, 14, 19, 20, and 23 on *Hattori 398*. Figs. 5–6, 8, 18, and 24–27 were drown by S. Hattori.

teeth than species. As Stephani (1897) noted in his original description: "Cum *P. ovalifolia* Mitt. comparanda, a qua nostra differt statura multo minor, foliis brevibus, minus crebe dentatis, dentibus acuminatis, pungentibus, cellulis multo minoribus", a form of this species is similar to a form of *P. asplenioides* subsp. *ovalifolia*, but this species can be distinguished by the mouth of perianth and the characteristics of the marginal teeth of leaves, almost without difficulty when plants are well developed. Stephani's original specimen of this species (*Faurie no. 827*), judging from the figures in his Icon. Hepat. (*Plagiochila, Patulae* no. 3-b), may not have any well developed perianths. His figures agree with that of young stages of perianth.

Y. Horikawa (1931) described *P. ishizuchiensis* from Shikoku. After that time this species was reported by S. Hattori (1950) from Honshu and by M. Kamimura (1952) from Formosa. After a careful examination of the original material of *P. ishizuchiensis*, the author decided or reduce it to a synonym of *P. hakkodensis*. *P. ishizuchiensis* has leaves which are slightly more distant and have fewer marginal teeth than typical form of *P. hakkodensis*, but is not essentially different. M. Kamimura's record from Formosa is considered as an erroneous identification. *Tylimanthus paucidens* is identical with this species, and is a form described as *P. ishizuchiensis*.

Plagiochila orbicularis (Hatt.) Hatt. (Fig. XI)

Jour. Hattori Bot. Labor. **3**: 26 (1948).——*Plagiochila ovalifolia* Mitt. var. *orbicularis* Hatt. Bull. Tokyo Nat. Sci. Mus. **11**: 61, *f. 37* (1944).

Plants 2–3 cm. long, 1.5–2.0 mm. wide, in dense patches, green to olive green. Stem about 0.3 mm. thick, yellowish green, ascending to erect, moderately forked, very rarely with flagella in lower portion; in cross-section cortical cells usually in 3 layers or occasionally 4 layers, averaging 11 μ, cells of outermost layer slightly larger than other cortical cells, walls brown, much thickened, interior cells 20–23 × 17 μ, walls pale brown or white, rather thin, rarely in middle portion secondarily thickened cells differentiated. Leaves distant, succubous, obliquely spreading, slightly to hardly decurrent on ventral side of stem, dorsal margin moderately reflexed, long decurrent, cycloid to widely ovate, 1.2–1.4 mm long and wide, dorsal margin semicircularly arching, sometimes nearly straight, without or with 2–4 marginal teeth, apex round with 2–10 marginal teeth or rarely without them, ventral margin strongly arching with 3–10 marginal teeth or without them; marginal teeth usually 3–10 in number totally, 1–3 cells long and 1–2 cells wide, acute. Cells of leaf apex and along margin 17–24 × 24–27 μ; of middle 24–27 × 30–34 μ; of base much elongated measuring 51–60 × 24 μ; trigones large throughout, bulging, walls rather thin but sometimes slightly thickened, cuticle smooth. Oil-bodies 4–8 per cell, ellipsoid, 5–8 × 3–4 μ, grayish, with numerous granules. Underleaves not present. Rhizoids not present on ascending stem but present on rhizomatous stem though very few. Male plants usually in separate patches; bracts about 8 pairs, closely imbricate, similar to leaves but moderately smaller, with marginal teeth fewer than those of leaves. Female inflorescence terminal, usually without innovation, bracts larger than leaves, 1.5–1.8 mm. long and wide, margin more densely toothed. Perianth cylindrically oblong, 1.2 mm. wide at mouth, about 2.0 mm. long,

upper portion usually slightly bent toward the side, mouth truncate to slightly arched, irregularly dentate. Sporophytes unknown.

Ecology.—On wet rocks uncovered or covered with thin soil in shady and humid sites, under the deciduous forest or evergreen forest zone, at an elevation of 500–1500 m. This species is usually grows in pure patches, but sometimes occurs with *Jubula hutchinsiae* subsp. *japonica*, *Heteroscyphus bescherellei*, and rarely *Bazzania pompeana* at lower altitude; and with *Euosmolejeunea auriculata* and rarely *Marsupella* sp. at higher altitude. **Loc.**—Kyushu: Isl. Yakushima; Pref. Kagoshima, Mt. Kirishima (*S. Hattori* 398-type); Pref. Miyazaki, Mts. Osorezan, Osuzu, Shiroiwa and Sobo; Pref. Kumamoto, Mt. Ichifusa; Pref. Fukuoka, Mt. Homan. Shikoku: Pref. Kochi, Shiraga; Pref. Ehime, Mt. Omogo. Honshu: Pref. Nara, Mt. Odaigahara, Hikosan; Pref. Tokyo, Mt. Mitake. **Range.**—Endemic to Japan.

The distinct characteristics of this species are its small to medium size, ascending stem and rhizomatous stem which is rather reticulately tangled, nearly orbicular and comparatively small leaves, usually long decurrent dorsal margin of leaf, much elongated cells at the base of leaf, and conspicuously large trigones. The species is also so polymorphic that sometimes it is confusable with a form of *P. asplenioides* subsp. *ovalifolia*, or of *P. satoi*. The variations are mainly in the number of the marginal teeth, the length of the decurrence of dorsal leaf margin, and the form of leaf (especially in the basal portion).

Plagiochila magnifolia Horik.

Jour. Sci. Hiroshima Univ. s.b, 2, 2: 161, *pl. 12, f. 10–15* (1934).

Plants 8–11 cm. long, about 12 mm. wide, olive green, in dense patches. Stem about 0.7 mm. thick, blackish brown to brown, simply forked; in cross-section cortical cells in 4–5 layers, walls brown, slightly thickened, interior cell-walls pale brownish yellow, hardly thickened. Leaves subdistant, obliquely spreading, ovate-oblong, 4.0–5.3 mm. long and 3.0–3.5 mm. wide, dorsal margin moderately reflexed, long decurrent, nearly straight, ventral margin hardly decurrent, semicircularly arched, apex round, marginal teeth usually 45–56 in number, 2–6 cells long, 1–2 cells wide, acute. Cells of leaf apex and along margin 16–30×27–40 μ; of middle 37–50×37–40 μ; of base 67–83×40–44 μ; trigones absent throughout, walls thin, cuticle smooth. Underleaves not present. Male inflorescence terminal to intercalary, bracts about 10 pairs, closely imbricate, with some small marginal teeth. Female inflorescence terminal, bracts similar to leaves but slightly smaller, about 6 mm. long and 3 mm. wide. Perianth long exerted, oblong, about 12 mm. long and 2.5 mm. wide, mouth distinctly 2-lipped, obliquel, irregularly dentate. Sporophytes unknown.

Ecology.—On wet banks. **Loc.**—Formosa: Prov. Tainan, Mt. Taiheizan (*Y. Horikawa 9334*-type). **Range.**—Endemic to Formosa.

The present species is known only from Formosa, the type locality. The distinguishing characteristics of this species are its very large size of plant, thin-walled leaves with approximately 50 marginal teeth, and distinctly 2-lipped mouth of perianth. This species seems to be closely allied to *P. asplenioides* subsp. *ovalifolia*, but is easily distinguishable by the above mentioned characteristics. It is also very closely allied to *P. permagna* Schiff. known from Himalaya. But the latter species is very poorly known, so that a detailed comparison between them is impossible.

AN ADDITIONAL LIST OF MOSSES FROM NORTH KOREA

By Takemasa OSADA[1]

長田武正: 北朝鮮の蘚類追加目録

In 1954, A. Noguchi published "A list of mosses from Manchuria and North Korea" in the Journal of the Hattori Botanical Laboratory (No. 12), and reported 44 species gathered from the area. As he said in that report, our knowledge of the bryophyte flora of N. Korea is quite incomplete.

In this article, based on the materials[2] collected by the author who was aided by some of his friends in the summer of 1940, new species and localities are added to Noguchi's list and those of his predecessors. For convenience sake, the localities are expressed in abbreviated form as shown on the attached map, and further details are omitted. The species preceded by an asterisk are new additions to the Korean flora.

The author wishes to express his thanks to Mr. H. Ochi and Dr. N. Takaki for the identification of some species (the former—Bryaceae, the latter—Brachytheciaceae), and especially to Dr. A. Noguchi who made or verified the identification of many others.

Fissidentaceae

* *Fissidens adiantoides* Hedw. N (det. Nog.)

Ditrichaceae

Ceratodon purpureus (Hedw.) Brid. H

Dicranaceae

Dicranum fuscescens Turn. E
D. japonicum Mitt. L
D. nipponense Besch. M (det. Nog.)
D. scoparium Hedw. E, N
Orthodicranum flagellare (Hedw.) Loeske G

Leucobryaceae

Leucobryum neilgherrense C. M. L

Pottiaceae

* *Gymnostomum recurvirostrum* Hedw. R (det. Nog.)
* *Hyophila involuta* (Hook) Jaeg. L, Q (det. Nog.)
* *Tortella tortuosa* (Hedw.) Limpr. Q

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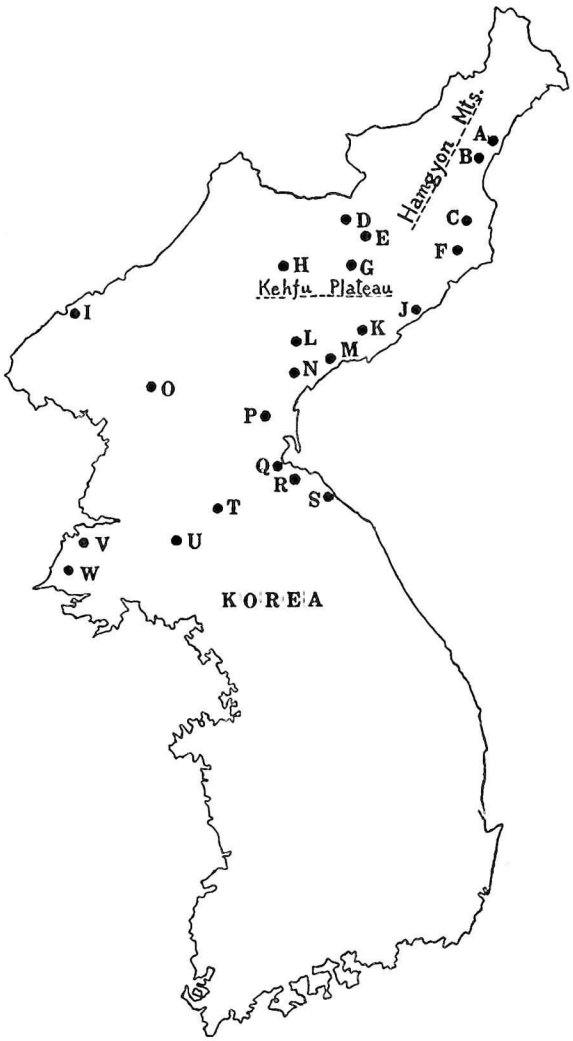
[1] Fukuoka Higher School, Fukuoka.
[2] 290 packets, including 112 species and 2 varieties.

Grimmiaceae

Grimmia apocarpa Hedw.　E, T, O
G. atroviridis Card. E, T, O (det. Nog.)
G. ovalis (Hedw.) Lindl.　O, E (det. Nog.)
G. pilifera P. Beauv.　N, R, L
Rhacomitrium canescens (Timm.) Brid.　N
R. fasciculare (Schrad.) Brid.　H (det. Nog.)
Ptychomitrium sinense (Mitt.) Jaeg.　O



Map 1. Korea. To economize space alphabet is used for the names of localities and collectors. The list below provides a key to these.

Table 1

	Habitat		Collector
A	Chonjun	咸北清津市郊外西水羅	斉藤龍本
B	Kyongson	咸北鏡城郡漁游　他	斉藤龍本　他
C	Myongtyon	咸北明川郡上雲北面	孫夢漢
D	Samsuh	咸南三水郡別東面	姜淵淑
E	Kapsan	咸南甲山郡雲興面 (1300 m) 他	武宮在結　他
F	Kitchu	咸北吉州郡東海面　他	李程洙・金淳奉
G	Punsan	咸南豊山郡安山面	永島誠傑・朱学宰
H	Pujongan plateau	咸南赴戦高原～遮日峯	長田武正
I	Chansong	平北昌城郡新倉面	姜俊熙
J	Tanchon	咸南端川郡何多面	姜学千
K	Pukchon	咸南北青郡厚昌面	朴基洛
L	Sinhung	咸南新興郡新中里　他	金載極　他
M	Hongwon	咸南洪原郡普賢面	金昇周
N	Hamhung	咸南咸興府	南宮昭・金鳳一
O	Yonbyong	平北寧辺鳳山面　他	朴命録・申獏圭
P	Yonghung	咸南永興郡徳坪面	?
Q	Wonsan	咸南元山府	車永俊
R	Anbyon	咸南安辺郡安辺面　他	松原武治・佐藤成典
S	Tongchon	江原道通川郡白雲峠	朴圭燦
T	Koksan	黄海道谷山郡雲平面	西村正雄
U	Pyokson	黄海道碧城郡	光金容九
V	Ulyul	黄海道殷栗郡九月山	福山　博
W	Changyon	黄海道長淵郡薪花面	許慶銘

Funariaceae

Funaria hygrometrica Hedw. H
? *Physcomitrium eurystomum* (Nees) Sendt. R (sterile specimen)

Bryaceae (det. H. Ochi)

* *Anomobryum gemmigerum* Broth. Q, R, S, W
Bryum argenteum Hedw. H
* *B. caespiticium* Hedw. U
* *B. pseudo-alpinum* Ren et Card. T
B. pseudo-triquetrum (Hedw.) Schw. S

Mniaceae

Mnium affine Bland. H
M. immarginatum (Lindb.) Broth. E
M. cuspidatum Hedw. G, H, J, L, Q, S
M. laevinerve Card. J
* *M. maximoviczii* Lindl. F
M. longirostrum Brid. G
* *M. stellare* Reich. F
* *M. undulatum* Hedw., Sp. Musc. (1801).—Syn. *Mnium koraiense* Sak., Bot. Mag. Tokyo **55**: 531 (1941), *syn. nov.* H

Aulacomniaceae

Aulacomnium palustre (Hedw.) Schw. G, H
A. turgidum (Wahlenb.) Schw. H

Bartramiaceae

Bartramia pomiformis Hedw. H, O
Philonotis coreensis Card. V (det. Nog.)
P. tenuissma Card. L (det. Nog.)
P. fontana Brid. B, C, H, L, S

Orthotrichaceae

Macromitrium gymnostomum Sull. et Lesq. W

Climaciaceae

Climacium americanum Brid. G
C. dendroides Web. et Mohr. G, J, N
Pleuroziopsis ruthenica (Weinm.) Kindb. H

Hedwigiaceae

Hedwigia ciliata (Hedw.) P. Beauv. E, S, T

Leucodontaceae

Leucodontella perdependens (Okam.) Nog. E, H, T

Neckeraceae

Neckera pennata Hedw. E, H

Lembophyllaceae

Thamnium alopecurum B. S. G. H

Fabroniaceae

* *Habrodon leucotrichus* (Mitt.) Perss. H (det. Nog.) Previously this species has been known from only two districts, namely Yakutat in Alaska and Japan proper.

Thuidiaceae

Abietinella abietina C. M. G, H, L
Anomodon minor (P.-Beauv.) Fürnr. K
A. ramulosus Mitt. H, T
A. thraustus C. M. C, H, N
Claopodium subpiliferum (Lindb. et Arn.) Broth. N
Haplocladium microphyllum (Sw.) Broth. W
* *H. subulaceum* (Mitt.) Broth. var. *microcarpum* (Card.) Ther. W
Haplohymenium triste (Ces.) Kindb. E (det. Nog.)
* *Helodium sachalinense* (Lindb.) Broth. in Engler & Prantl's Nat. Pflanzenfam. 1-3-2: 1018 (1908).—Syn. *Thuidium sachalinense* Lindb. Cont. ad Fl. cryptog. Asiae Bor.-orient. p. 244 (1872).—*Tetracladium osadae* Sak. Bot. Mag. Tokyo

55: 533 (1941), *syn. nov.* H The ciliato-serrate leaf margin and the costa with long spinose papillae on back are the remarkable characteristics of this species that has been thought to be endemic to Sakhalin.

* *Herpetineuron toccoae* (Sulliv. et Lesq.) Card. Beit. Bot. Centralbl. **19**: 128 (1905). —Syn. *Anomodon Toccoae* Sulliv. et Lesq. Musci bor. Amer. exsicc. ed. 1, no. 240; Sulliv. Moss. Unit. Stat. p. 58 (1856).—*Leskeella japonica* Sak. Bot. Mag. Tokyo **50**: 265 (1936), *syn. nov.* C The type specimen is a depauperate flagellose form of *H. toccoae* growing on exposed bark. Though its appearance resembles the genus *Leskeella*, the areolation is quite identical with that of *H. toccoae*.

Tetracladium molkenboerii S. Lac. H

Thuidium micropteris Besch. N (det. Nog.)

T. recognitum (Hedw.) Lindb. G, H, N This is the most common *Thuidium* in N. Korea, and its appearance seems to be more like that of the specimens collected in Europe than those in Japan.

Amblystegiaceae

* *Amblystegium serpens* (Hedw.) B. S. G. L. R, U

* *A. juratzkanum* Schimp. R, U This specimen may be only a habitat-form of the last species.

A. pseudo-radicale Card. P (det. Nog.)

* *Calliergon cordifolium* (Hedw.) Kindb. H (det. Nog.)

* *Campylium chrysophyllum* (Brid.) Bryhn. N, V

C. hispidulum (Brid.) Mitt. L (det. Nog.)

C. stellatum (Hedw.) Lange et C. Jens. L

* *Crateneuron filicinum* (Hedw.) Roth D, H, P

Drepanocladus uncinatus (Hedw.) Warnst. G, H

Hygrohypnum ochraceum (Turn.) Loeske H (det. Nog.)

Brachytheciaceae

Brachythecium buchanani (Hook.) Jaeg. K, L, R

B. populeum (Hook.) B. S. G. N

B. flagellare (Hedw.) Jenn. N

* *B. rivulare* B. S. G. F, G, H, O, Q (det. Tak.)

* *Bryhnia novae-angliae* (Sull. et Lesq.) Grout R (det. Tak.)

* *B. hultenii* Bartr. var. *cymbifolia* Nog. H (det. Tak.)

* *Eurhynchium eustegium* (Besch.) Dixon F

* *E. pulchellum* (Hedw.) Jenn. E

Myuroclada concinna (Wils.) Besch. F, G, H, I, M

Okamuraea brachydictyon (Card.) Nog. C

O. hakoniensis (Mitt.) Broth. C, K, L

—var. *ussuriensis* (Broth.) Nog. A, C

Entodontaceae

Entodon attenuatus Mitt. E

E. curvatirameus Mitt. H (det. Nog.)

E. robustus Broth. L, T (det. Nog.)
E. rostrifolius C. M. K, W (det. Nog.)
Erythrodontium leptothallum (C. M.) Nog. L, R

Sematophyllaceae

* *Brotherella henonii* (Dub.) Broth. N This polymorphic species has many names established for it. Though the Korean specimen is a little different from the Japanese one, I identified it as a form of the same species.
* *Brotherella yokohamae* Broth. H, L, O, R
Heterophyllium haldanianum (Grev.) Kindb. E

Plagiotheciaceae

* *Plagiothecium aomoriense* Besch. F
* *P. roseanum* var *julaceum* Card. H
P. silvaticum (Huds.) B. S. G. N
*?*P. depressum* Dixon K, L, R

Hypnaceae

Breidleria pratensis (Koch) Loeske Near B (det. Nog.)
Homomallium sp. L
Hypnum plumaeforme Wils. O, S
— var. *minor* Broth. R
Platygyrium repens (Brid.) B. S. G. H
Ptilium crista-castrensis (Hedw.) De Not. G. H
Rhytiadelphus calvescens (Wils.) Broth. E
R. triquetrus (Hedw.) Warnst. D, E, G, H
Rhytidium rugosum (Hedw.) Kindb. D, E, G, H
* *Taxiphyllum taxirameum* (Mitt.) Fl. N, Q

Hylocomiaceae

Hylocomium proliferum (Hedw.) Lindb. E, G, H
Pleurozium schreberii (Hedw.) Mitt. D, G, H

Polytrichaceae

Atrichum undulatum (Hedw.) P. Beauv. F
Pogonatum inflexum Lindb. M, N, S
* *P. spinulosum* Mitt. N
P. urnigerum (Hedw.) P. Beauv. H, M
* *Polytrichum formosum* Hedw. H, M
* *P. commune* Hedw. N
P. juniperinum Willd. G, H
P. strictum Banks F, H

A short sketch of the mossy vegetation

As is widely known, in Korea the forest vegetation on the low land is sparse. Almost all the primeval forests have been destroyed, and most hills are occupied by forests of *Pinus densiflora* or *Larix leptolepis*. It can easily be seen that in such

dry forests the moss vegetation is not rich. Such photophilous or subphotophilous species as *Pogonatum inflexum*, *Hypnum plumaeforme*, *Mnium cuspidatum*, *Polytrichum commune*, *Rhacomitrium canescens*, *Hedwigia ciliata*, *Brotherella yokohamae*, *Dicranum nipponense* and *Grimmia pilifera* are most representative of such areas.

In the valleys among low hills, we often find deciduous forest consisting of such trees as *Quercus mongolica*, *Populus simoni*, *Ulmus davidii*, *Alnus* spp., *Rhododendron schlippenbachii* and *Weigela* spp. Under the canopy of these forests, especially along the streams, the following species can be observed. *Anomodon* spp., *Atrichum undulatum*, *Brachythecium* spp., *Campylium chrysophyllum*, *Climacium dendroides*, *Dicranum scoparium*, *Erythrodontium leptothallum*, *Fissidens adiantoides*, *Leucobryum neilgherrense*, *Mnium leavinerve*, *Plagiothecium silvaticum* and *Philonotis fontana*.

Fig. 1. *Leucodontella perdependens*, ×4/5. Pendulous on trees at Kapsan, alt. s. m. ca. 1300 m.

A rich mossy vegetation can be seen only in the sparsely populated, mountainous regions above 1,000 or 1,500 m. s.m. In these areas, good primeval forests consisting of such conifers as *Abies nephrolepis* and *Picea ajanensis* are found, and the moist soil under them is densely covered with the following mosses: *Aulacomnium palustre*, *A. turgidum*, *Dicranum fuscescens*, *D. scoparium*, *Drepanocladus uncinatus*, *Helodium sachalinense*, *Heterophyllium haldanianum*, *Mnium undulatum*, *Ptilium crista-castrensis*, *Rhytidiadelphus triquetrus*, *Rhytidium rugosum*. *Tetracladium molkenboerii* and *Thuidium recognitum*. On the tree trunks and branches, the pendulous *Leucodontella perdependens* (Fig. 1) is abundant instead of species of Meteoriaceae as in tropical regions.

In S. Pyengan (平安南道), there is a large area where paleozoic limestone is exposed, and probably many species characteristic of limstone regions are to be found there. However the author's collections from this district were destroyed near the end of the last war.

As this small list shows, the flora is Holarctic. For instance in the genus *Thuidium*; *T. toyamae* is the commonest species in Japan, but *T. recognitum* is most common in our area. Whereas such Holarctic cosmopolitans as *Abietinella abietina*, *Amblystegium serpens*, *Neckera pennata* and *Aulacomnium* spp. are widely distributed, we seldom find species of Meteoriaceae, Lembophyllaceae, Hypopterygiaceae. Hookeriaceae and Rhizogoniaceae. Comparing this list with Noguchi's one, there are differences among genera and species, but the families in them are almost identical.

CHROMOSOME STUDIES OF MOSSES, III.

By Masanobu SANNOMIYA[1]

三宮正信: 蘚類の染色体研究, III.

In this paper (part III.), observations of meiotic chromosomes of thirteen moss species are reported. The material (Table I) used in this study was collected from several stations in Oita, Kumamoto and Miyazaki Prefectures (about 32°–34°N. Lat. and 131°–132° E. Long.), southern Japan. Chromosome counts were made on meiotic chromosomes at the first metaphase of meiosis. The preparations were made by the same method, as with the case of part I and II.

Table I. Chromosome numbers and localities of mosses studied.

Species examined	Numbers of bivalent	Localities	Figures
Pottiaceae			
Astomum crispum Hedw.	13_{II}	Wozi-machi, Oita	1
Grimmiaceae			
Rhacomitrium canescens (Hedw.) Brid.	12_{II}	Fukayabakei, Oita Prefecture	2
Funariaceae			
Funaria hygrometrica Hedw.	28_{II}	Mt. Heike-yama, Oita Prefecture	3
Bryaceae			
Pohlia japonica Ochi, MSC.	11_{II}	Mt. Aso, Kumamoto Prefecture	4
Bryum coronatum Schwgr.	20_{II}	Wozi-machi, Oita	5
Erpodiaceae			
Aulacopilum japonicum Broth.	13_{II}	〃 〃	6
Lembophyllaceae			
Dolichomitriopsis diversiformis (Mitt.) Nog.	10_{II}	Mt. Kurodake, Oita Prefecture	7-8
Thuidiaceae			
Haplocladium microphyllum (Sw.) Broth.	10_{II}	Wozi-machi, Oita	9
H. subulaceum var. *subulatum* (Card.) *Ther.*	10_{II}	Inohae, Miyazaki Prefecture	10
Brachytheciaceae			
Bryhnia noesica (Besch.) Broth.	11_{II}	Mt. Heike-yama, Oita Prefecture	11-12
B. novae-angliae (Sull. et Lesq.) Grout.	11_{II}	Mt. Kurodake, Oita Prefecture	13
Entodontaceae			
Entodon ramulosus Mitt.	11_{II}	〃 〃	14-16
Hypnaceae			
Hypnum plumaeforme Wils.	10_{II}	Asazi-machi, Oita Prefecture	17

Observations

Astomum crispum Hedw. (Fig. 1) The material was collected from a population growing in a sunny garden, at Oita University. The writer observed 13 bivalents at the first metaphase of meiosis. As for the chromosome numbers of this genus, Bryan (1956 a) reported n=13 *A. ludovicianum* and n=26 in *A. muhlen-*

[1] Biological Institute, Oita University, Oita, Japan.

bergianum, suggesting the existence of polyploidy among the members of this genus. Thus, Japanese *A. crispum* under study corresponds to the monoploid species of this polyploidy.

Rhacomitrium canescens (Hedw.) Brid. (Fig. 2) For this species, Vaarama (1953 b) has reported n=12 by observing meiotic chromosomes. Furthermore, Yano (1951, 1957 a) has given the chromosome formula, n=12=H+h+10, for this species and *R. canescens* var. *ericoides* from his observations of gametophytic chromosomes. The writer counted 12 bivalents clearly at metaphase I of meiosis, agreeing with the count by the prior authors.

Funaria hygrometrica Hedw. (Fig. 3) The writer counted 28 bivalents at metaphase I of meiosis. Concerning the chromosome number of this species or it's varieties, the following reports are avilable: n=14 for the species by Wettstein (1923, 1924 a, b, 1930) (cited by Lowry 1948), Vaarama (1953, 1955); n=28 for it's variety, *F. hygrometrica* var. *bivalens*, by Wettstein (1924 b) (cited by Lowry 1948), Vaarama (1955), Steere (1954); n=ca. 56 for another variety, *F. hygrometrica* var. *quadrivalens*, by Wettstein (1924 b) (cited by Lowry 1948). The material studied by the present writer, therefore, represents a diploid phase of this species.

Pohlia japonica Ochi *msc*. (Fig. 4) At MI of meiosis, 11 bivalents were observed with indisputable clearness, and no unequal association was seen among them. The same number has already been reported in many species of this genus by Yano (1953 a, 1956, 1957 a) from his observations of gametophytic chromosomes; i.e. *P. elongata*, *P. Fauriei*, *P. acuminata*, *P. revolvens*, *P. Wahlenbergii*, *P. cornea*, *P. columbica* and *P. revoluta*.

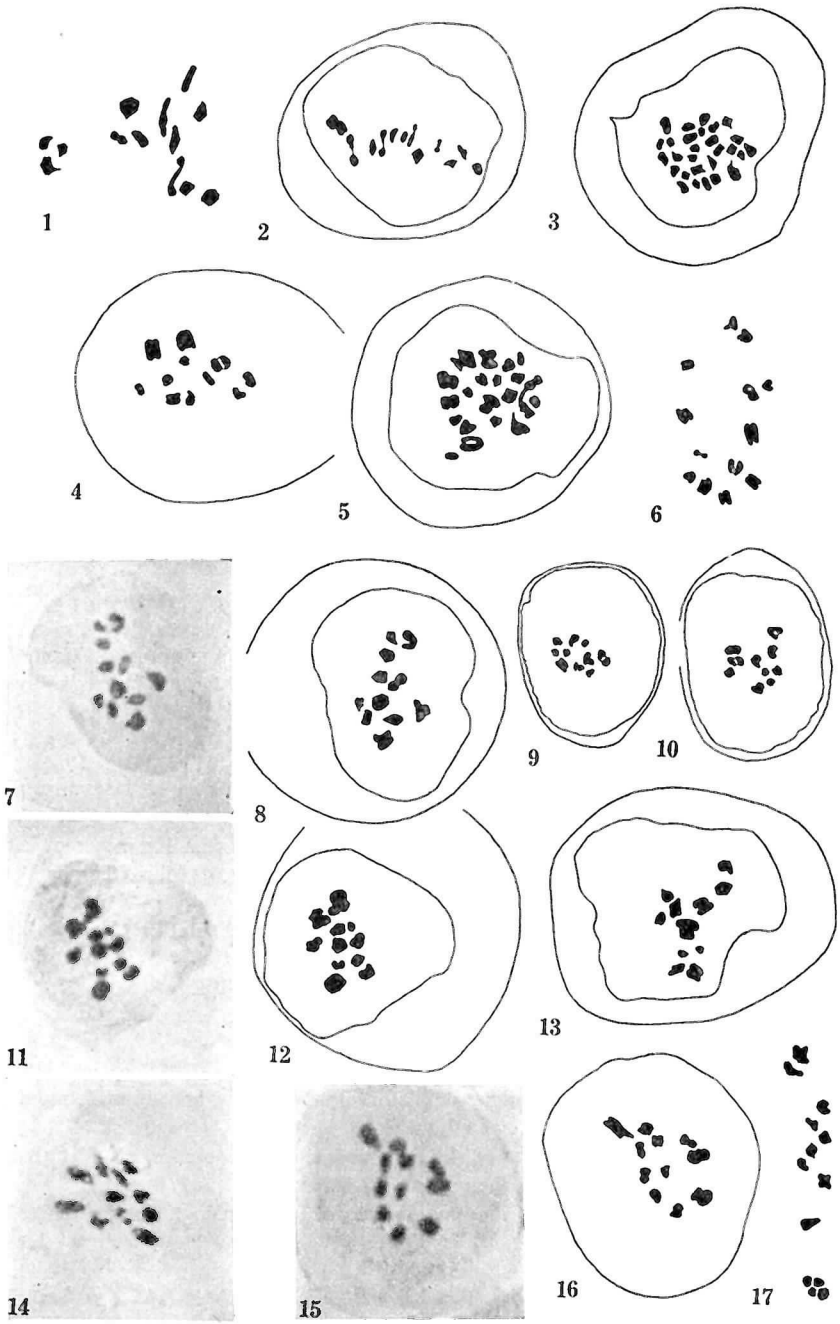
Bryum coronatum Schwgr. (Fig. 5) Twenty bivalents were counted at MI in SMC's. Many reports of chromosome number of Brya are available. As these numbers are mostly n=10 or its multiples, Yano (1957 a) has considered that to be the basic number of this genus. In an earlier paper, reported 10_{II} in B. nagasakense (Sannomiya 1957) and 20_{II} in *B. caespiticium* (Sannomiya 1955).

Aulacopillum japonicum Broth. (Fig. 6) Thirteen bivalents were observed consistently at the first metaphase of meiosis. This is the first and only member of the genus to be investigated cytologically.

Dolichomitriopsis diversiformis (Mitt.) Nog. (Figs. 7–8) Yano (1954 c) reported the karyotype of this species and *D. crenulata*, as follows: ♀, ♂, K(n)=10=V(H)+2 V+6(4 v+2 j)+m(h). The writer found 10 bivalents at the first metaphase of meiosis, conforming with Yano's count based on gametophytic chromosomes. Furthermore, the writer observed that one of these bivalents was usually precocious in it's anaphase movement.

Haplocladium microphyllum (Sw.) Broth. (Fig. 9) and *H. subulaceum* var. *subulatum* (Card.) Thér. (Fig. 10) Ten bivalents were found at the first metaphase of meiosis in both species. The same number was counted in *H. capillatum* by Kurita

Figs. 1–17. Meiotic chromosomes in spore mother cells. 1. *Astomum crispum* (13_{II}). 2, *Rhacomitrium canescens* (12_{II}). 3, *Funaria hygrometrica* (28_{II}). 4, *Pohlia japonica* (11_{II}). 5, *Bryum coronatum* (20_{II}). 6, *Aulacopilum japonicum* (13_{II}). 7–8, *Dolichomitriopsis diversiformis* (10_{II}). 9, *Haplocladium microphyllum* (10_{II}). 10, *H. subulaceum* var. *subulatum* (10_{II}). 11–12, *Bryhnia noesica* (11_{II}). 13, *B. novae-angliae* (11_{II}). 14–16, *Entodon ramulosus* (11_{II}). 17, *Hypnum plumaeforme* (10_{II}). Figs. 7, 11 and 15 are microphotographs of the nuclear plates showed in 8, 12 and 16, respectively.



Figs. 1-17.

(1950), *H. subulatum* and *H. subulaceum* by Yano (1957 b).

Bryhnia noesica (Besch.) Broth. (Figs. 11–12) and *B. novae-angliae* (Sull. et Lesq.) Grout. (Fig. 13) The writer counted 11 bivalents in both species. Yano (1957 b) has studied the gametophytic chromosomes of both species, and determined their karyotype as, ♀, ♂, $K(n)=11=V(H)+2V+6(4v+2j)+2m(h)$. The writer's counts in both species agree with Yano's results.

Entodon ramulosus Mitt. (Figs. 14–16) Concerning the chromosome number of the genus *Entodon*, n=11 has been reported in some species: i.e. *E. flaccidus*, *E. chloroticus*, *E. ramulosus*, *E. Challengeri* (Yano 1955 a); *E. Challengeri* (Sannomiya 1955). The present material, *E. ramulosus*, also show 11_{II} at the first metaphase of meiosis. Sometimes, the smallest one of these bivalents, separates precociously into two dyads at anaphase (Fig. 14).

Hypnum plumaeforme Wils. (Fig. 17) Ten bivalents were found consistently at the first metaphase of meiosis. This number coincides with the gametophytic chromosome number determined by Yano (1955 a) in this species.

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Summary

1. Thirteen moss species were investigated cytologically with special reference to their meiotic chromosome numbers. The results obtained are shown in Figures 1–17 and Table I.

2. The h-h association of *Entodon ramulosus* and *Dolichomitriopsis diversiformis* were usually precocious in its anaphase movement.

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GERMINATION OF SPORES IN TWO SPECIES OF *SPHAGNUM*

By Akira NOGUCHI[1]

野口　彰：ミズゴケ属2種の胞子発芽

The germination of the spores in several species of *Sphagnum* has already been discussed by some authors (P. W. Schimper, 1858, K. Goebel, 1889 and C. Müller, 1909). The general mode of germination of *Sphagnum* spores is known, but there is little detailed knowledge on the subject. There seems to have been no detailed description of the sporeling of *Sphagnum girgensohnii* and further development of the thallose protonema of *S. squarrosum*. The author maintained cultures of the spores of two species of the genus, *S. squarrosum* and *S. girgensohnii*. The cultures survived to produce leafy gametophores.

Material and method

The spores of *Sphagnum squarrosum* were collected from Mt. Yatsugatake, central Japan, on Aug. 19th, 1955 and those of *S. girgensohnii* from Mt. Ontake, central Japan, on Sept. 23rd, 1955. These spores were kept dry until the cultures were established. The cultures were maintained as follows: the spores were dispersed on the surface of small porous plates, measuring about 6×6×1 cm. The plates were made with felsitic soil whose pH values are almost neutral. The plates and Petri dish, measuring 11 cm. in diameter, in which the plates are placed were sterized by steam. As a culture medium, Benecke's solution was used, keeping the pH value at 4.5–5.0. The solution was poured into the dishes, keeping the upper surface of plates over the solution. All these cultures were kept at room temperature and illuminated by daylight coming through the window, avoiding direct rays of the sun. The cultures began Oct. 28th of the same year and continued until August of the next year.

Results

S. squarrosum.—About two months after sowing the endspore formed a protuberance which developed afterwards into a germ tube by breaking through the exospore. The germ tube was solitary and short. On germination the position of the germ tube was restricted to the pyramidal side of spore. The ruptured exospore remained at the base of the filamentous protonema for a long time, and frequently could be recognized when a large thallose protonema was formed. By successive division of the endospore cell a short filamentous protonema sometimes of two, but usually three, cells was formed. The cells of the filamentous protonema had few chloroplasts and considerably modified in shape. The thallose protonema was formed from the continued activity of the apical cell of the filamentous protonema. The division of the apical cell was intercalary in two planes, and thus

[1] Department of Botany, Faculty of Science, Kumamoto University, also Hattori Botanical Laboratory.

a multicellular but unistratose protonema was formed. At first the thallose protonema was two cells wide; its cells had many chloroplasts. In such a juvenile phase rhizoids were usually produced from the basal cells of a thallose protonema, occasionally from its adjacent cells. But in no case observed was the rhizoid produced from the endospore cell. In younger stages of the protonema the rhizoids usually were solitary and were formed from a few elongated colourless cells. Even in mature protonema rhizoids were rather few in number and arose from the peripheral basal cells of a protonema. None of the rhizoids observed formed thallose protonema at their apices. The cells of the apical region of a protonema divided more actively and therefore, were smaller in size than others, and the growth of the protonema was away from the rhizoids. Thus a large obovoid but unistratose

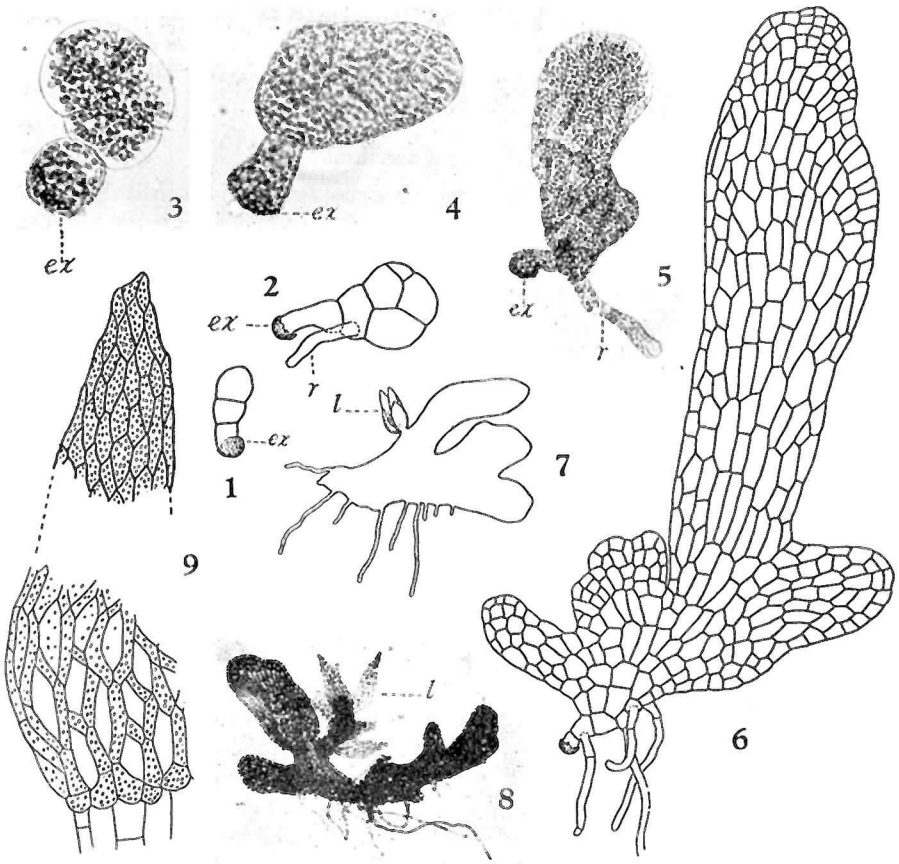

Fig. I. ***Sphagnum squarrosum*** Crome Samml

1. Formation of germ tube, ×166. 2-6. Formation of thallose protonemata (2, ×166; 3, 4, ×345; 5, ×116; 6, ×116). 7, 8. Formation of leafy plants (7, ×42; 8, ×50). 9. Juvenile leaf, ×166. *ex*—exospore, *l*—leafy plant, *r*—rhizoid. (Date of observation: 1—Feb. 10, 1956; 2-4—Mar. 5; 5, 6—Mar. 20; 7, 8—June 1).

protonema was formed. After considerable growth the development of the protonema was not restricted to the upper region, but occurred at several peripheral regions, resulting in a palmate or irregular outline. About 5–6 months after germination the protonemata seemed to gain their full growth. They produced a gametophore. The upper parts of the protonema stood up from the medium, showing positive phototropism.

On a mature protonema, measuring 0.5–1 mm. in length, the leafy plant arose from the activity of a marginal cell of the thallose protonema. The cell initial of the gametophore usually appeared on the side of the protonema opposite the rhizoidal margin. At first the cell initial arose like a protuberance and then divided to form a mass, from which a juvenile gametophore differentiated. Usually a leafy plant was solitary on a protonema. Soon after the differentiation of stem and leaves, the secondary rhizoids were formed from the base of the juvenile stem and the first or second leaves. At the same time the rhizoids on the basal part of the protonema increased in number. The juvenile leaves were ovate in outline and consisted entirely of uniformly hexagonal and chlorophyllose cells. However, in the upper 4–5th (and so on) leaves every other cell lost its green colour and increased its capacity as time went on. Thus, the large and colourless cells developed into hyaline cells and were surrounded by 5–6 elongate chlorophylliferous cells. In this species both left and right sided "Triaden", that is Müller's C-type, were found in a single leaf. The spiral thickenings were not yet apparent. In the upper part of juvenile leaves there was no differentiation between the hyaline and chlorophylliferous cells. After the formation of a leafy plant the protonema remained green.

S. girgensohnii.—The pattern of development of a juvenile protonema (consisting few cells) from a spore was similar to that of the preceding species. But in this species, it was characteristic that second and third thallose protonemata were successively derived from the first protonema. These thallose protonemata were connected with filaments. They were formed in the following manner. The filamentous protonema consisted of 1–3-cells; rarely it was longer and consisted of a considerable number of elongate chlorophyllose cells. After a small thallose protonema was formed, a cell of the filamentous protonema regained activity and produced another long filament. The filament consisted of several (usually 5–10 in number) elongate and chlorophyllose cells, but rarely, as seen in Fig. 2–7, it was only 2-cells long. The apical cell produced a thallose protonema as was the case with the first filamentous protonema. The secondary protonema grew rapidly and soon exceeded in size its predecessor. This development occurred at the beginning of April. Before long a cell of the secondary protonema produced a long filament in the same manner as the cell of the germ tube, the apical cell of which formed a third thallose protonema as well. In some cases the third protonema was not produced, although rarely a fourth one was found. The formation of rhizoids was restricted to the basal and marginal cell of the large protonema and was not found on the juvenile thallose protonema. As is the case with the preceding species the number of rhizoids was small. After 7–8-month in culture, the thallose protonemata seemed to attain their full growth, being 1–2 mm. in length. The mature protonema was ribbon-shaped but irregular in outline, and occasionally palmate. Again *l. c.* most parts of the protonema stood up from the substrata, showing positive phototropism.

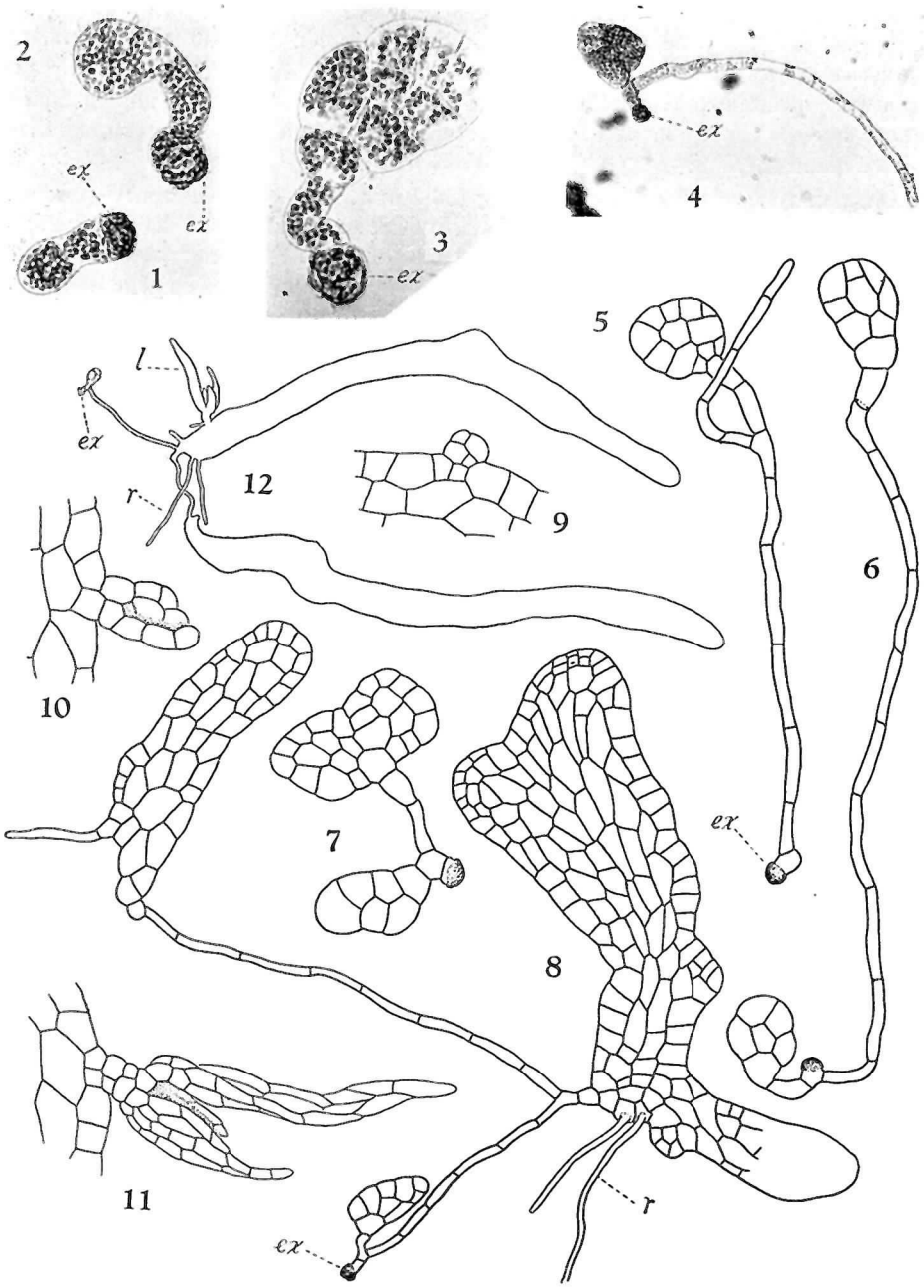

Fig. II. ***Sphagnum girgensohnii*** Russ.

1. Formation of germ tube, ×260. 2, 3. Formation of thallose protonemata (2, ×260; 3, ×330). 4, 5. Formation of the first filamentous protonemata (4, ×116; 5, ×166). 6, 7. Formation of the second thallose protonemata, ×166. 8. Formation of the second and third

At the beginning of July a basal marginal cell of the protonema underwent cell division in three planes, resulting in an initial cell of a gametophore. Its position was restricted to the base of the protonema and usually to the side opposite the rhizoidal area of the protonema. A protonema bore a single gametophore.

Discussion and summary

From the above observations, the general type of the germination of spores in *Sphagnum squarrosum* and *S. girgensohnii* is similar to that reported in other species of the genus (*e.g. S. cymbifolium=palustre*). That is, a thallose protonema derives from the terminal cell of a few celled filamentous one. In *S. squarrosum* a spore produces a single thallose protonema, while in *S. girgensohnii* a second or third protonemata are successively formed from the first one. Goebel (1889) figured such chained protonemata of a *Sphagnum*, but unfortunately he did not indicate any specific name. Contrary to an earlier opinion, the filaments, connecting the protonemata, differ from rhizoids. According to the species, the shape and size of thallose protonema are variable and even in a species the protonemata are polymorphous. But no filamentous protonema is found. The protonema, whose cells are chlorophylliferous, are positively phototrophic.

The formation of rhizoids is restricted to the basal and marginal cells of the protonemata. In certain species, the rhizoids are formed from the endospore, but not in *S squarrosum* and *S. girgensohnii*. Gametophores are derived from marginal and basal cells of the protonemata and on the side opposite the rhizoidal margin. Gametophores arising from a protonema are usually solitary.

The hyaline cells develop from ordinary leaf cells. The cells lose chlorophyll and increase their size gradually.

Hereby the author wishes to express his thanks to Dr. N. Takaki who placed material at his disposal and also to Mr. H. Furuta who cooperated with him in the cultures of protonemata.

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protonemata, ×116. 9, 10. Formation of the initial cells of leafy plants, ×166. 11. Showing leafy plant, ×166. 12. Entire protonema developed from spore, ×42. *ex*——exospore, *l*——leafy plant, *r*——rhizoid. (Date of observation: 1——Feb. 1, 1956; 2-5——Feb. 20; 6. 7——Apr. 5; 8——June 1; 9, 10——July 12; 11——Aug. 1; 12——Aug. 12).

A REVISION OF THE JAPANESE SPECIES OF THE FAMILY LEPIDOZIACEAE

By Sinske HATTORI and Masami MIZUTANI[1]

服部新佐・水谷正美: ムチゴケ科邦産種の再検討

The family of Lepidoziaceae may be a quite natural group of hepatics. It comprises 13 genera: *Lepidozia*, *Microlepidozia*, *Telaranea*, *Bazzania*, *Acromastigum*, *Archniopsis*, *Dendrolembidium*, *Lembidium*, *Mastigoplema*, *Micropterygium*, *Mytilopsis*, *Sprucella* and *Psiloclada*. All are regarded as tropical or southern in distribution. Under *Bazzania* and *Lepidozia* a number of species have been described from the tropics. Only the first 4 genera are also distributed in temperate~boreal regions. In Europe and North America (north of Mexico) 17 species are known.

In Japan, north of 30°N. Lat., there are *Lepidozia*, *Microlepidozia*[2] and *Bazzania*. Previously 47 species of *Bazzania* (=*Mastigobryum*) and 14 species of *Lepidozia* (including *Microlepidozia*) have been recorded as in Japan; most of them were described by Stephani (1897, 1908, 1924).

The earliest record was made by Sande Lacoste (1863/64) who described 2 new species, *Mastigobryum* (=*Bazzania*) *japonicum* and *M. pompeanum*, and recorded the occurrence of *M. tridens*[3] and *Lepidozia reptans*[4] in Japan. Then, Miyoshi (1887) recorded *M. trilobatum* occurring on Mt. Nachi in Kil Pen[5].

Mitten (1891) enumerated the above records and also reported *Lepidozia filamentosa* from Mt. Nantai near Nikko. Stephani (1893) described *Bazzania albicans* in Hedwigia, and the next year his *Mastigobryum semiconnatum* was published in Bescherelle's article as a *nomen nudum*.

In 1897 Stephani published his paper 'Hepaticae Japonicae' in which 6 new species, *Bazzania flavo-virens*, *Lepidozia makinoana*, *L. obliqua*, *L. obtusistipula*, *L. subtransversa* and *L. vitrea*, were described, two *Bazzanias*, *B. triangularis* and *B. sinensis*, were reported from Japan, and all the earlier records were repeated. In the same year Makino published an article 'List of Japanese Hepaticae determined by Mr. F. Stephani (Leipzig)' which, however, is entirely duplication of Stephani's records.

Inoue (1898) reported *Mastigobryum tenuistipulum* Stephani, nom. nud. *fide* Stephani's communication. Two years later he also listed, *fide* Stephani, *M. bidentulum* and *M. cordifolium*, and the next year, (1901), *M. ceylanicum* together with a *nomen nudum*, *Lepidozia exigua*. In 1905, two new species of Stephani, *Mastigo-*

[1] Hattori Botanical Laboratory.

[2] Recently K. Müller (1956) joined *Microlepidozia* and *Telaranea*. However, we follow Schuster and Blomquist (1955) in this paper.

[3] In this paper we regard all Japanese material recorded as *Mastigobryum* (or *Bazzania*) *tridens* to be identical with *B. albicans*.

[4] We suppose the material referred to *Lepidozia reptans* by Sande Lacoste should belong to *L. vitrea* described by Stephani (1897), although we can not locate Sande Lacoste's material.

[5] This record may be caused by an erroneous identification (likely of *B. pompeana*).

bryum cucullistipulum and *Lepidozia crassicaulis*, both lacking a diagnosis, were recorded by Nakanishiki. In 1906 four new species of Stephani were reported by Yoshinaga (formerly Inoue) also lacking diagnoses. They are: *Mastigobryum takeanum*, *M. fissifolium*, *M. subsimplex* and *M. yoshinaganum*.

Stephani (1908) in his 'Species Hepaticarum' vol. 3, gave the description of 7 species of *Mastigobryum* published between 1898 and 1906 as *nomina nuda*, excluding *Mastigobryum subsimplex* only, and described as new 7 species of the same genus: *M. hamatum*, *M. ovifolium*, *M. nagasakiense*, *M. oshimense*, *M. faurianum*, *M. vastifolium* and *M. shusensicum*. The next year in the same volume he also described as new 6 species of *Lepidozia*: *L. planifolia*, *L. tosana*, *L. lutchuensis*, *L. elegans*, *L. exigua* and *L. crassicaulis*; the latter two were already published as *nomina nuda* in 1901 (by Inoue) and 1905 (by Nakanishiki) respectively.

Mastigobryum tenuistipulum, *M. bidentulum*, *M. fissifolium*, *M. takeanum* and *M. yoshinaganum* were transferred to the earlier genus *Bazzania* in Yasuda's 'Shokubutsugaku Kakuron, Inkwabu', a text book of cryptogams issued, 1911. In the last and supplementary volume of Stephani's 'Species Hepaticarum' (1924) were described six more species of *Mastigobryum*: *M. aoyagianum*, *M. brevidens*, *M. koyasanum*, *M. jishibae* and *M. okamuranum*. In 1934, Horikawa described two *Bazzanias*, *B. yakushimensis* and *B. tridenticulata* from Isl. Yakushima. Ihsiba (1935) described a new variety '*minor*' of *Bazzania semiconnata*.

In 1942, Hattori illustrated *Lepidozia subtransversa* from an isotype. The next year he also illustrated and discussed *Bazzania oshimensis*, *B. ovifolia* and *B. vastifolia* (all published by Stephani under the genus *Mastigobryum*) again from isotypes. His contributions to the hepatic floa of southern Kyushu (1944) included a newly described *Bazzania kiushiana*, some new taxa below the specific rank, and illustrations of some *Bazzanias* including *B. nodulosa* which was an addition for this area. In the same year, Hattori also illustrated and discussed 7 species of *Bazzania*: *B. albicans*, *B. bidentula*, *B. fissifolia*, *B. flavo-virens*, *B. japonica*, *B. tenuistipula* and *B. yoshinagana*. Most of them were described from isotype specimens. In the same article he described *B. fissifolia* var. *subsimplex* which was named without a diagnosis by Stephani as *Mastigobryum simplex* (see, Yoshinaga, 1906).

In 1946 the description of two new *Bazzanias*, *B. patulistipula* and *B. platyphylla* together with a list of all species of *Bazzania* known in Japan at that time were published by Hattori. He doubted the occurrence of *B. cordifolia* and *B. sinensis* in Japan. In Hattori's contributions to the hepatic flora of Isl. Yakushima, II (1947), *B. kanemarui*, *B. trigona* and *Lepidozia subalpina*, together with two varieties of *Lepidozia* species, were described as new, *B. tenuistipula* and *B. takeana* were both reduced to synonymy under *B. albicans*, *Mastigobryum subhamatum* to syn. under *B. fissifolia*, both *M. hamatum* and *B. tridenticulata* to forms of *B. fissifolia* and of *B. japonica* respectively, both *Lepidozia fauriana* (*L. vitrea* var. *muscicola*, new syn.) and *L.* (*Microlepidozia*) *makinoana* (*L. setacea* auct. quoad plant. Japon., new syn.) were illustrated and discussed, and lastly *B. oshimensis* was recorded for the first time in our area.

Hattori (1951) in his paper 'Oil-bodies of Japanese Hepaticae' illustrated the oil-bodies of 12 species of *Bazzania*, 3 sp. of *Lepidozia* and a sp. of *Microlepidozia*. Among these *Bazzanias* 2 new taxa, *B. mayebarae* and *B. tokuiana*, both lacking

diagnoses, were included. In this paper he treated *B. okamurana* as a variety of *B. albicans*. The next year Hattori (1952) critically reviewed all species of the family in his 'Hepaticae of Shikoku and Kyushu, southern Japan' (2) which included the following new synonyms and reductions of taxonomic rank: (new synonymy) *Mastigobryum nagasakiense*→*B. albicans*!; *B. kiushiana*→*B. fauriana*!; *B. cordifolia* sensu Inoue, 1900, *B. triangularis* sensu Stephani, 1897, and *Mastigobryum jishibae*→*B. fissifolia* var. *subsimplex*!; *B. semiconnata*, *Mastigobryum cucullistipulum* and *M. shusensicum*→*B. japonica*!; *B. patulistipula*→*B. ovifolia*!; *Lepidozia obtusistipula*→*L. subtransversa*!; *L. subalpina*→*L. tosana*![6]; *L. exigua*→*Microlepidozia makinoana*!; (reductions of rank) *Bazzania platyphylla*→*B. yoshinagana* fo. *platyphylla*; *B. nodulosa*→*B. fauriana* var. *nodulosa*; *Mastigobryum vastifolium*→*B. ovifolia* var. *vastifolia*. Thus, he recognized in southern Japan (Shikoku and Kyushu) 14 species of *Bazzania*, 6 species of *Lepidozia* and a single species of *Microlepidozia*.

Later Kamimura (1952) described two species, *Bazzania hattoriana* and *B. minutissima*, and 3 subspecific taxa in his 'Contributions to hepatic flora of Shikoku' and enumerated, according to Hattori (1952), all Shikokian species whereupon. Hattori (1953) illustrated the oil-bodies of 3 species of *Bazzania* and 2 sp. of *Lepidozia*. In the same year he reduced *Lepidozia tosana* to a synonym of *Microlepidozia makinoana*, and mentioned that his former treatment was incorrect[6]. He (1955) also listed *Lepidozia obliqua* as a synonym of *L. reptans*.

Most of the species of this family were described by Stephani between 1897 and 1924. In 1942, Hattori began to review Stephani's species critically, and up to 1952 he had referred many of them to other taxa. Before 1947 Hattori also described a few new species, but later reduced some of them to synonymy himself. Thus, much of our confusion among Japanese Lepidoziaceae has been eliminated by him.

We wish to express our deep appreciations to Dr. C. E. B. Bonner, Conservateur botanique, Geneva, for his help in sending us on loan a number of specimens (including the type) in the Stephani Herb. We are much indebted to Dr. D. P. Rogers, New York Botanical Garden, and Dr. M. Tagawa, Kyoto University, for their help in the same way. Furthermore, our thanks are due to Mr. M. Kamimura, Mr. Y. Ikegami, Mr. H. Inoue, Mr. T. Kodama, and many other persons who sent their specimens of the family Lepidoziaceae to us for study. Finally, we are much obliged to Dr. L. Koch, University of Illinois, who read the manuscript and gave us editorial advice.

Key to genera

1) Plants small and delicate, less than 0.5 mm. wide; phyllid (*phyllidium*, "leaf")[7] and am-

[6] Later this reduction proved to be an error. Hattori corrected this error when he consulted the original material of *L. tosana* kept in Conserv. bot. Geneva, which was identified as *Microlepidozia makinoana* (see Hattori, 1953).

[7] Dr. Leo F. Koch's proposition. He wrote us, "I have been looking in various publications on bryophytes for terminology. The term *axis* is also used in an abstract sense as the longitudinal median line of a plant, whereas the term *phylloid* has the form of an adjective; so that perhaps they are not ideal. After due consideration, I think it would be preferable to follow the usage of Dixon in the Manual of Bryology and to use the noun form of *phyllid* (anglicised version of *phyllidium*) and *caulid* (anglicised version of *caulidium*) instead of "leaf" and "stem" respectively. There is no question of the appropriateness of the term *amphigastrium* for the "underleaf". An experimental usage of these terms would be most desirable and would seem to me not to involve any difficulty in application...."

phigastrium[7] transverse, divided nearly to base into 3 or 4 narrow segments; oil-bodies 1–5 per cell (or frequently wanting), rotundate and minute (less than 3 μ in diameter) but very difficult to observe; sporangial walls 2–3 cells thick; seta with 8 large epidermal cells and 4–16 small inner ones..... *Microlepidozia*.

1) Plants large and robust, over 1 mm. wide; phyllid incubous, about 1/2 or less divided; oil-bodies larger and easily observed, 5–10 per cell, ovate ($3-10\times4-20\,\mu$).
   2) Caulid (*caulidium*, "stem")[7] pinnately branched; postical flagella near base of caulid, few; branches often flagelliform (and with rhizoids) at tip; phyllids 4- or rarely 3-lobed for about half of their length; amphigastria resembling phyllids both in shape and size; sporangial walls 3–4 cells thick..... *Lepidozia*.
   2) Caulid furcately branched in appearance[8], producing many flagella from ventral side; phyllids normally tridentate (in subgen. *Bidentatae*, however, bidentate), ovate-lanceolate; amphigastria mostly far smaller, entire to dentate (seldom lobed); sporangial walls 4–5 cells thick..... *Bazzania*.

Lepidozia (Dum.) Dum. Rec. d'Obs. 19 (1835)

Syn. *Pleuroschisma* sect. *Lepidozia* Dum. Syll. Jungerm. 69 (1831). *Mastigophora* Nees, Naturg. Europ. Leberm. **1**: 95 (1833).—*Herpetium* sect. *Lepidozia* Nees, l.c. **3**: 31 (1838).

Key to species

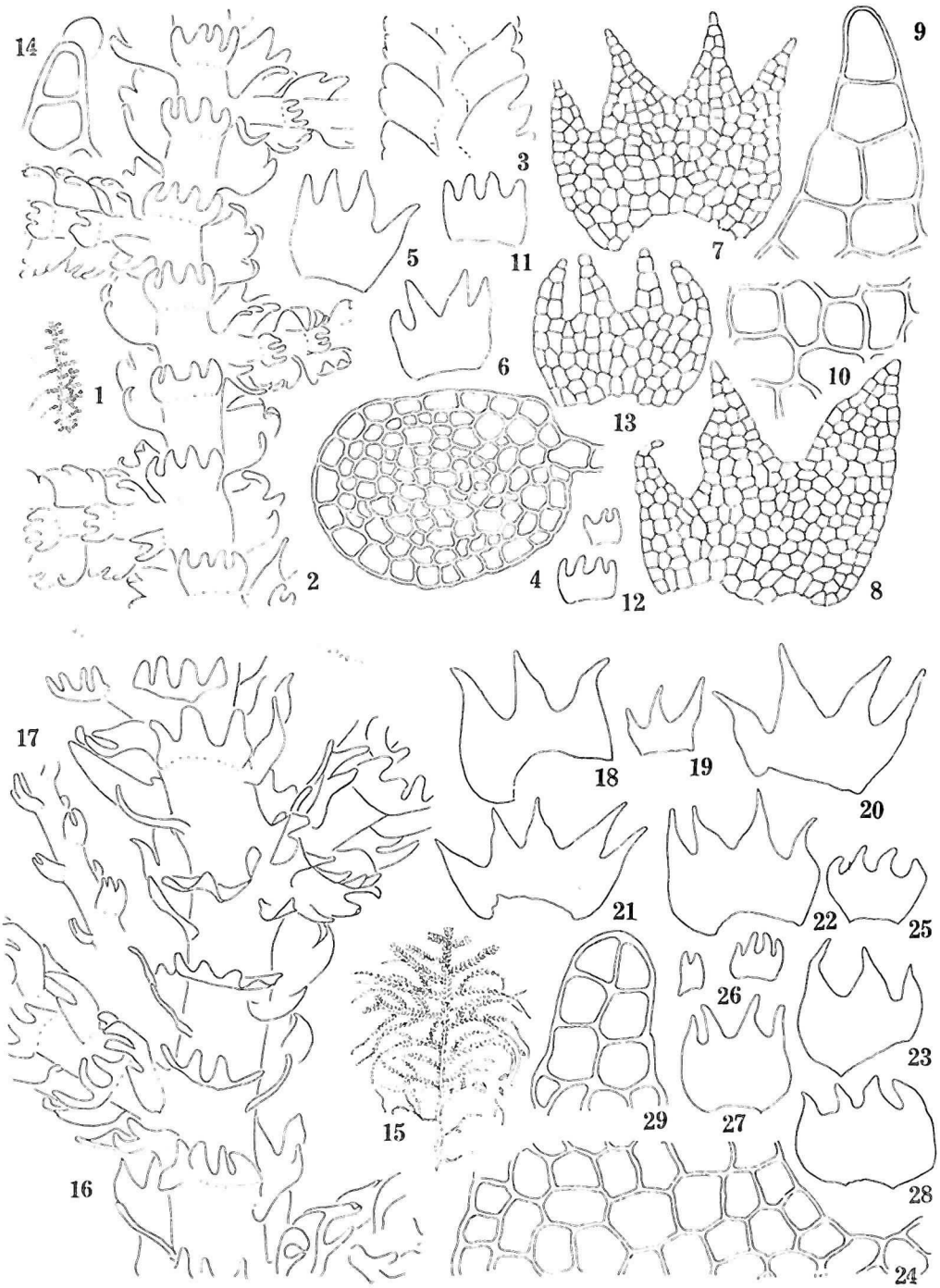
1) Median cells of phyllids 20–30 μ; phyllid-lobes 4 or more cells wide at base; distributed in central to northern Japan, or subalpine to alpine.
   2) Smaller; lateral branches occasionally tapering into flagelliform end; phyllids very obliquely or nearly lengthwise inserted; phyllid-lobes 4–8 cells wide at base .... *L. reptans*.
   2) Larger; lateral branches normally tapering into flagelliform ends; phyllids subtransversely inserted; phyllid-lobes 8–14 cells wide at base..... *L. filamentosa*.
1) Median cells of phyllids 30–50 μ; phyllid-lobes usually 2–3 cells wide at base; in central to southern Japan, not subalpine nor alpine.
   3) Caulid 0.2–0.6 mm. in diameter, its epidermal cells 20 or more; lateral branches frequently tapering into flagelliform ends; phyllid-lobes composed of 6–15 cells, 2–3 cells wide at base; caulidial phyllids suberect and incurved, subquadrate in outline.
      4) Smaller; caulid 1.5–4 cm. long, 0.2–0.3 mm. in diameter; lateral branches not always tapering into flagelliform ends; phyllids as wide as caulid, obliquely inserted; common in southern to central Japan..... *L. vitrea*.
      4) Larger; caulid 6–10 cm. long, 0.5–0.6 mm. in diameter, all lateral branches tapering into flagelliform ends; phyllids half the caulid width, nearly transversely inserted; uncommon, restricted to southernmost Japan..... *L. fauriana*.
   3) Small, caulid about 0.15 mm. in diameter, its epidermal cells about 12; flagelliform branches almost absent; caulidial phyllids obliquely to nearly horizontally spreading, rhombic in outline; phyllid-lobes composed of 3–5 cells only, 1–2 cells wide at base; rare; southern distribution..... *L. wallichiana*.

Lepidozia reptans (L.) Dum.[9] (Fig. I, 1–14)

Rec. d'Obs. 19 (1835). Syn. *L. obliqua* Steph. Bull. Herb. Boiss. **5**: 94 (1897).——*L. sub-*

[8] Branches normally are lateral, from the ventral portion of axils of phyllids as in *Lepidozia*, but their growth is as strong as that of the main caulid, so that they appear to be dichotomous.

[9] To economize space we do not cite the examined specimens except for rare species. In the description of each species we do not mention the sporophytes and inflorescences except in *Microlepidozia*, because they are seldom seen, and do not seem important as diagnostic characteristics at the specific level.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alpina Hatt. Jour. Hattori Bot. Lab. **2**: 21 (1947), *syn. nov.*

Plants medium in size, pale to more or less brownish green, in loose or less frequently compact patches, or scattered among mosses and hepatics. Main caulid (=stem) 1.5–3cm. long, 0.2–0.35mm. in diameter, prostrate or with slightly ascending apex, pinnate or occasionally pinnulate, branches patent, sometimes flagelliform at tip; postical flagella long, near base of axis; cross-section of caulid elliptical, epidermal cells larger than the inner; rhizoids rather numerous towards base and on flagella, scarce towards tip. Phyllids (=leaves) of caulid approximate to imbricate, very obliquely inserted, spreading but strongly convex in antical view, nearly quadrate in outline, antical base rounded (but not semicordate) and only crossing half the caulid, 3–4-lobed to 1/3–1/2, lobes triangular, acute to subobtuse, strongly incurved, 4–8 cells wide at base; discus 5–7 cells high, 10 cells wide; cells 22–30μ, quadrate-hexagonal, walls slightly or hardly thickened, trigones nearly wanting; cuticle smooth or nearly so; phyllids of branches resembling those of caulid, somewhat smaller. Amphigastria spreading, 4-lobed to 1/4–2/5, lobes short and incurved, obtuse or subacute, sinus acute to obtuse. Oil-bodies 10–25 per cell, ovate to fusiform, 2.5–4×4–7 (rarely to 9)μ, rarely orbicular, 2.5–3.5μ in diameter, homogeneous and glistening, longer oil-bodies occasionally with partition or constriction at both tips.

Type loc. European. Hab. on decayed woods, stumps and fallen logs, or rarely on bases of trees, normally in the subalpine coniferous forest zone, less frequently in the alpine *Pinus pumila* association, very rare below, thus, geographically, more frequent towards the north (*i.e.* seldom in Shikoku and Kyushu, whereas common in Hokkaido). Range: Europe, N. America, Siberia (Amur, Sakhalin), Himalayas, Formosa, Japan (Hokkaido, Honshu, Shikoku, Kyushu).

Most Japanese plants are smaller than European ones. *L. subalpina* may be considered to be a depauperate form occurring disjunctly on the summit of Yakushima Island near the southernmost end of our area.

Lepidozia filamentosa (Lehm. et Lindenb.) Gott., Lindenb. et Nees (Fig. I, 15–29)

Synop. Hepat. 206 (1845). Syn. *Jungermannia filamentosa* Lehm. et Lindenb. in Lehm. Stirp. Pugil. **6**: 29 (1834).——*Lepidozia attenuata* Tayl. London Jour. Bot. **5**: 369 (1846).——*L. subtransversa* Steph. Bull. Herb. Boiss. **5**: 95 (1897), *syn. nov.*——*L. obtusistipula* Steph. loc. cit., *syn. nov.*——*L. crassicaulis* Steph. Spec. Hepat. **3**: 632 (1909), *syn. nov.*——*L. coreana* Steph. Spec. Hepat. **6**: 332 (1922), *syn. nov.* (Exsiccata) Hatt. Hepat. Japon. ser. **4**: 170 (1951); **6**: 269 (1954); labeled, *L. substransversa*.

Fig. I.

1–14. ***Lepidozia reptans*** (L.) Dum. 1. Plant, ×1. 2. Part of caulid, ventral view, ×38. 3. Part of branch, dorsal v., ×38. 4. Cross-section of caulid, ×150, 5, 6. Caulidial phyllids, ×24. 7, 8. Do., ×80. 9. Phyllid-lobe, ×310. 10. Median cells of phyllid-discus, ×310. 11. Caulidial amphigastrium, ×24. 12. Branch-amphigastria, ×24. 13. Caulidial amphigastrium, ×80. 14. Amphigastrium-lobe, ×310.

15–29. ***Lepidozia filamentosa*** (Lehm. et Lndnb.) Lndnb. 15. Plant, ×1. 16. Part of caulid, ×24. 17. Part of flagellum, ×24. 18–23. Phyllids (18, 20–22 from caulid; others from branch), ×24. 24. Basal portion of phyllid-lobe, ×310. 25, 26. Branch-amphigastria, ×24. 27, 28. Caulid-amphigastria, ×24. 29. Amphigastrium-lobe, ×310.

Figs. 1–14 were drawn from specim. *D. Shimizu 54749*; figs. 15–29 from *D. S. 50376*; all drawn by M. Mizutani.

Plants large, pale, yellowish or whitish green, in loose mats often extensively covering substrata. Caulid 3–8cm. long, 0.4–0.6mm. in diameter, pale green, bipinnate or occasionally pinnate, branches slightly obliquely spreading, normally attenuate and ending in flagelliform extension; cross-section of caulid about 25 cells thick, epidermal cells larger than inner ones, walls slightly thickened, trigones almost wanting, inner cells with more thickened walls and trigones; postical flagella seldom seen or lacking, restricted to base, often branched; rhizoids rather scarce, mostly on base of caulid and on tips of flagelliform branches. Phyllids subtransversely inserted, not decurrent, distant to approximate, erect- or suberect-spreading, 0.65–0.8 mm. long, about 0.8 mm. wide at middle (1 mm. near apex, 0.5 mm. at base), asymmetrical, convex, quadrate to broadly cuneate in outline, 4-lobed to 1/2–2/3, lobes triangular, divergent, bent towards axis, acute and acuminate, 8–14 cells wide at base, antical lobes often larger, sinus rounded to subacute; discus obliquely truncate, margin arcuate (particularly so at antical base), sometimes with tooth at base, 0.2–0.3 mm. high at postical half and 0.3–0.4 mm. at antical half, about 0.5 mm. or 25–30 cells wide at base; cells of discus-middle 20–26×26–34 μ, cells of lobes 18×23–27 μ, walls slightly thick, trigones small to more or less large; cuticle nearly smooth. Amphigastria as wide as the caulid, distant, patent, transversely inserted, mostly twice as wide as long (0.35–0.6mm. long, 0.6–0.8mm. wide), rounded-quadrate with ampliate margins, often angular at base, 4-lobed to about 2/5 the length, lobes ligulate or lanceolate, subacute, more or less incurved, 6–7 cells wide at base. Branch-phyllids and -amphigastria contiguous or nearly so and little smaller than those on main caulid. Oil-bodies scarce, 10–15 per cell, ovate-fusiform, 2.5–3×4–4.5 (rarely to 6) μ, seldom orbicular, about 3 μ in diameter, homogeneous and glistening.

Type loc. West coast of North America (possibly Alaska). Hab. on rocks covered with humus, decayed wood, and on the forest-floor, often forming an extensive mat, or occasionally scattered among *Sphagna* in bogs; characteristically in the subalpine coniferous forest zone of Japan, where it is one of the common bryophytes among the forest-floor community, less frequently beneath *Pinus pumila* association on alpine zone of Japan. Range: N. America (Alaska and British Columbia), Japan (Honshu, Shikoku, Kyushu), Korea (Isl. Quelpart), ?S. America, ?Antarctic America, ?New Zealand.

This species was recorded in Japan by Mitten (1891, p. 199) and Ihsiba (1936, p. 190). Mitten's material was collected by Bisset on Mt. Nantai near Nikko. The report by Ihsiba is considered merely as a copied from Mitten. Stephani (1897, p. 80) doubted Mitten's record and, in his 'Species Hepaticarum' (1909), cited only Alaska as a locality for *L. filamentosa*. We have suspected that *L. subtransversa* is identical with this species, although we could have no specimens of Alaskan *L. filamentosa*. Frye & Clark (1946, p. 658) mentions, "A more complete description with figures is needed, particularly of the vegetative parts if the reproductive structures are not available". An important literature may be Howe's 'The Hepaticae and Anthocerotes of California' (1899). He (l.c. p. 138) mentions, "—a very distinct species, now certainly known from Alaska—will probably yet be found to extend farther down the coast, though we are inclined to doubt its occurrence within the limits of California."

Recently we could examine an Alaskan collection by the courtesy of Dr. R. D. Svihla. It proved to be identical with Japanese *L. subtransversa*. Thus, like *Scapania bolanderi* which frequently associates with it, *L. filamentosa* belongs to Northern

Pacific element. *Cololejeunea macounii*, *Macrodiplophyllum plicatum*, *M. microdontum*, and *Ptilidium californicum* also belong to it. All of them are distributed in the coniferous vegetational zone in the Japanese Archipelago and the west coast of North America.

The type locality of *L. coreana* which we reduced to a synonym of *L. filamentosa* is on Quelpart Island (Faurie 114, Oct. 1906), although Stephani (1922) cited only "Insula Corea (Faurie legit)" for the habitat of it.

European *L. pinnata* is different from *L. filamentosa* in the very oblique phyllid-insertion and the more imbricate phyllids. All the other Japanese members of *Lepidozia*, excluding *L. faurina*, are much smaller in size than the above-mentioned species and may be easily distinguished, even in the field.

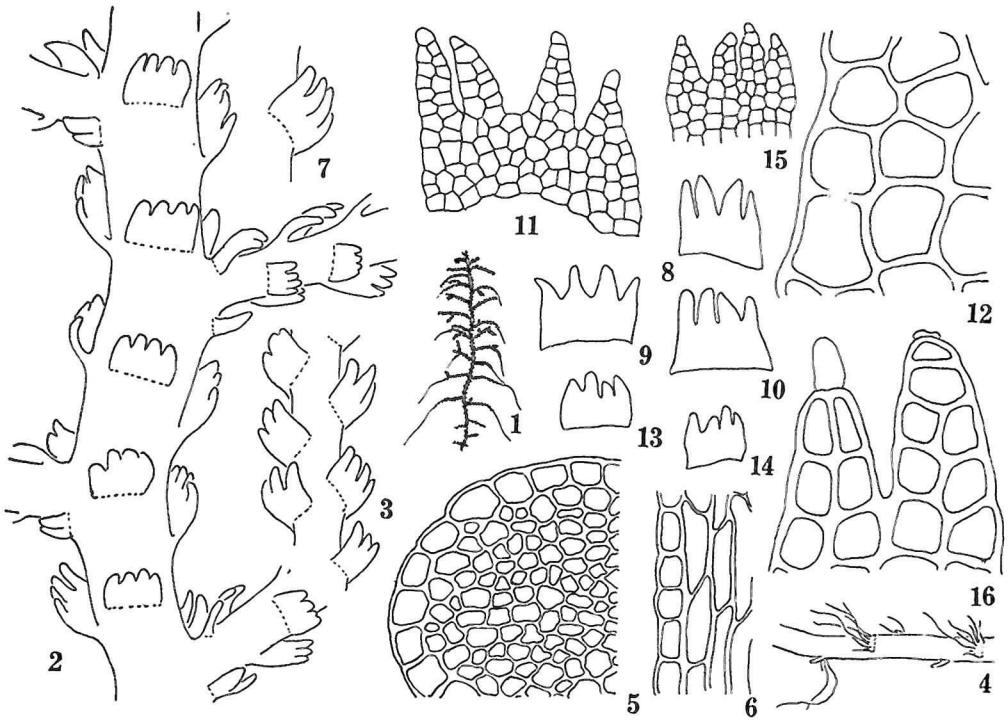
Lepidozia vitrea Steph. (Fig. II, 1–16)

Bull. Herb. Boiss. **5**: 96 (1897). Syn. *L. elegans* Steph. Spec. Hepat. **3**: 630 (1909), *syn. nov.* ——*L. lutschuensis* Steph. loc. cit. 631.——*L. formosae* Steph. var. *quadrifida* Hatt. Jour. Hattori Bot. Lab. **2**: 21, *f. 7, h–m* (1947), *syn. nov.*——*L. vitrea* var. *pusilla* Hatt. loc. cit. 25, *f. 10*. (Exsiccata) Hatt. Hepat. Japon. ser. **1**: 5 (1946); **7**: 321 (1956).

Plants in loose or compact patches, whitish to yellowish green, occasionally brownish green. Caulid 15–40 mm. long, 0.2–0.3 mm. in diameter, prostrate or with ascending apex, pinnate, branches often tapering into flagelliform tips; cross-section of caulid elliptical, epidermal cells larger than the inner; postical flagella few, long, usually near base of caulid; rhizoids almost restricted to postical flagella and flagelliform lateral branches. Phyllids of main caulid distant or less frequently approximate, very obliquely inserted, nearly quadrate, 0.3–0.5 mm. long and wide, 4-lobed to 1/2, lobes much incurved, narrowly triangular, acute or subacute, 2–3 cells wide at base, sinus narrow and acute; discus 4–6 cells high, 10–12 cells wide at base, cells in discus 30–50 μ, nearly quadrate, walls somewhat thickened. Phyllids of lateral branches approximate, almost rectangular, somewhat narrowed towards base, usually 3-lobed to 1/3, lobes less incurved, sublinear, mostly 2 cells wide at base. Amphigastria of main caulid quadrate, 4-lobed to 1/4–1/3, lobes incurved, short, obtuse or subacute, 1–2 cells wide at base; discus 3–5 cells high, 8 cells wide at base, cell walls thick; amphigastria of lateral branches smaller, usually 3-lobed. Oil-bodies 3–10 per cell, mostly oblong, 4–6 × 10–15 μ, ovate or rarely orbicular, 4–6 μ in diameter, composed of many globules, thus appearing somewhat like a 'grape-cluster', orbicular oil-bodies in amphigastria much the same as in phyllids, but those in epidermal cells of caulid usually longer.

Type loc. Mt. Unzen near Nagasaki, Japan. Hab. on bare or humus-covered rocks, rock-cliffs and -ledges, soil-banks and -cuttings, bases of trees, decayed wood, stumps in shaded places at low elevations, often forming wide patches, common in southern to middle Japan. Range: Japan (Honshu, Shikoku, Kyushu, Ryukyu), Formosa, Korea (Isl. Quelpart).

This species may be one of the most common in the family in southeastern Japan. It widely varies, and may be roughly divided into the following two major types. The first type (incl. the type specimen) forms loose patches, its lateral branches are long and mostly tapering into flagelliform tips, the lobes of caulidial phyllids 2 cells wide at base, and the amphigastria are narrower than the caulid. While, the second type forms rather compact patches, its branches usually short and seldom ending in flagelliform tips, the lobes of caulidial phyllids 2 or more fre-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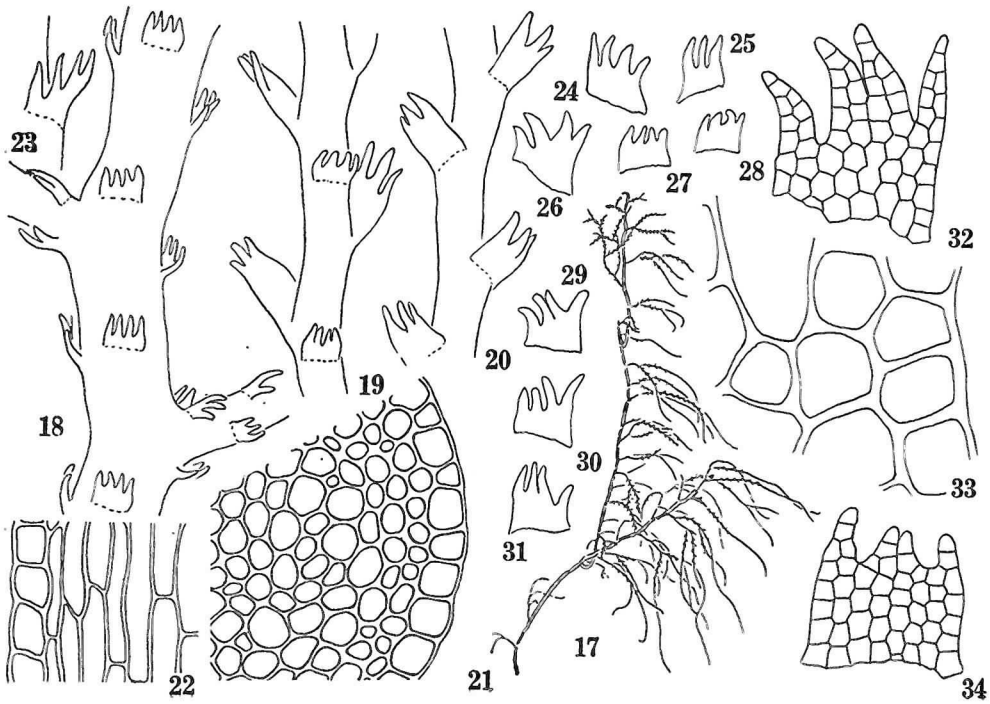
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quently 3 cells wide at base, and the amphigastria are as wide as the caulid or more or less wider. The first type usually occurs in southeastern Japan, south of 35°N. Lat. The second type extends far to the north, its northernmost known station is Mt. Hayachine, about 40°N. Lat.

The most closely related species may be *L. fauriana*. An extreme form of the first type resembles *L. fauriana* so that it is often difficult to separate them. The second type is somewhat similar to, and its extreme form often difficult to distinguish from, a not well-developed plant of *L. reptans*. In *L. reptans*, however, the phyllids are denser and very obliquely (almost lengthwise) inserted, the median cells of the phyllids 20–30 μ, and the phyllid-lobes 4–8 cells wide at base.

Lepidozia fauriana Steph. (Fig. II, 17–34)

Spec. Hepat. **3**: 631 (1908). Syn. *L. vitrea* Steph. var. *muscicola* Hatt. Bull. Tokyo Sci. Mus. **11**: 26 (1944).

Plants in loose greenish yellow mats. Caulid to 10 cm. long, 0.5–0.6 mm. in diameter, stout, olive, pinnate or pinnulate, branches 1–2 cm. or rarely 3 cm. long, tapering into flagelliform tips (no rhizoids occurring on tips), postically with many flagella as long as branches; cross-section of caulid elliptical, epidermal cells distinct, thin-walled, inside of epidermal layer intermediate layer of smaller and thick-walled cells differentiated in 2–3 rows, cells of innermost layer much the same as epidermal ones but somewhat smaller; rhizoids scarce. Phyllids of main caulid half as wide as caulid, remote, nearly appressed to caulid, subtransversely inserted, asymmetrical quadrate, 0.4–0.42 mm. long, 0.34 mm. wide, 4-lobed to 1/2, lobes sublinear, incurved, narrowly triangular, 2 cells wide at base, sinus acute and narrow; discus 4–5 cells high, 8–10 cells wide at base, postical margin longer than antical, cells in discus 30–35 × 30–45 μ, walls more or less thickened; phyllids of lateral branches somewhat flat and patent, usually 3-lobed to 1/3–1/2, 2 cells wide at base. Amphigastria of main caulid small, less than half its width, nearly flat, appressed to it, quadrate, 0.23 mm. long and 0.24 mm. wide, 4-lobed to 1/3–1/2, lobes shortly setulose, obtuse or acute, 1–2(–4) cells long, 1–2 cells wide at base, sinus acute, discus 4–5 cells high, 8 cells wide at base, cells much the same as in phyllid; amphigastria of lateral branches smaller, usually 3-lobed. Oil-bodies 4–8 per cell, nearly fusiform, 4 × 10–12 μ, or oblong, 4 × 8 μ, or rarely orbicular, 4 μ in diameter, formed of many globules (1 μ in diam.); oil-bodies in epidermal cells of caulid 8–12 per cell, mostly 6 × 6–15 μ.

Type loc. Isl. Yakushima, south of Kagoshima, Japan. Hab. on granitic rocks, cliffs and ledges covered with humus in shaded, very damp places at an elevation of about 1000 m.

Fig. II.

1–16. ***Lepidozia vitrea*** Steph. 1. Plant, × 1. 2. Part of caulid, ventral view, × 38. 3. Part of branch, dorsal v., × 38. 4. Part of flagellum, × 40. 5. Cross-section of caulid, × 150. 6. Longitudinal section of caulid, × 150. 7–10. Caulidial phyllids, × 38. 11. Do., × 80. 12. Basal portion of phyllid-lobe, × 310. 13, 14. Caulidial amphigastria, × 38. 15. Do., × 80. 16. Amphigastrium-lobes, × 310.

17–34. ***Lepidozia fauriana*** Steph. 17. Plant, × 1.2. 18. Part of caulid, ventral view, × 24. 19. Part of branch, ventral v., × 38. 20. Do., dorsal v., × 38. 21. Cross-section of caulid, × 150. 22. Longitudinal section of caulid, × 150. 23–31. Caulidial phyllids, × 24. 32. Do., × 80. 33. Basal portion of phyllid-lobe, × 310. 34. Amphigastrium, × 80.

Figs. 1–16 were drawn by M. Mizutani from specim. *M. M. 63815*; figs. 17–20, 22–34 from *S. Hattori 7481*; fig. 21 drawn by S. Hattori from *S. H. 6857*.

or below; common in forests on Yakushima Island, whereas rare in similar places in the southern part of the main island Kyushu. Kagoshima: Isl. Yakushima, Onoaida, *S. Hattori 6736, 6847, 7055*,—Kosugi valley, *S. H. 7207, 7251, 7269, 7279, 7280, 7341-2, 7481, T. Shin 3433, 3638-9, 3669, 3708, 3774, K. Mayebara 2936, 2971, S. Nishihara 533*,—Susukawa, *K. Mayebara 3033, 3043*. Miyazaki: Kitago near Nichinan, *S. H. 9582*-type of *L. vitrea* var. *muscicola, M. Mizutani 63818*. Range: Japan (s. Kyushu).

This grand *Lepidozia*, in spite of its apparent difference to the naked eye, is very closely related to *L. vitrea*. Both species have similar phyllids, amphigastria, cells, oil-bodies and so on. However, *L. fauriana* may be distinguished by its larger plant size, many flagella, long and stout caulid (0.5–0.6 mm. in diam.), texture in cross-section of caulid and transversely inserted and appressed caulidial phyllids, together with its much restricted range.

Lepidozia wallichiana Gott. (Fig. III, 1–15)

Gott., Lindenb. et Nees, Synop. Hepat. 204 (1845). Syn. *Mastigophora wallichiana* Trev. Mem. Istit. Lombardo, ser. 3, 4: 416 (1877), sine descr.——*Lepidozia planifolia* Steph. Spec. Hepat. 3: 629 (1909), *syn. nov.*

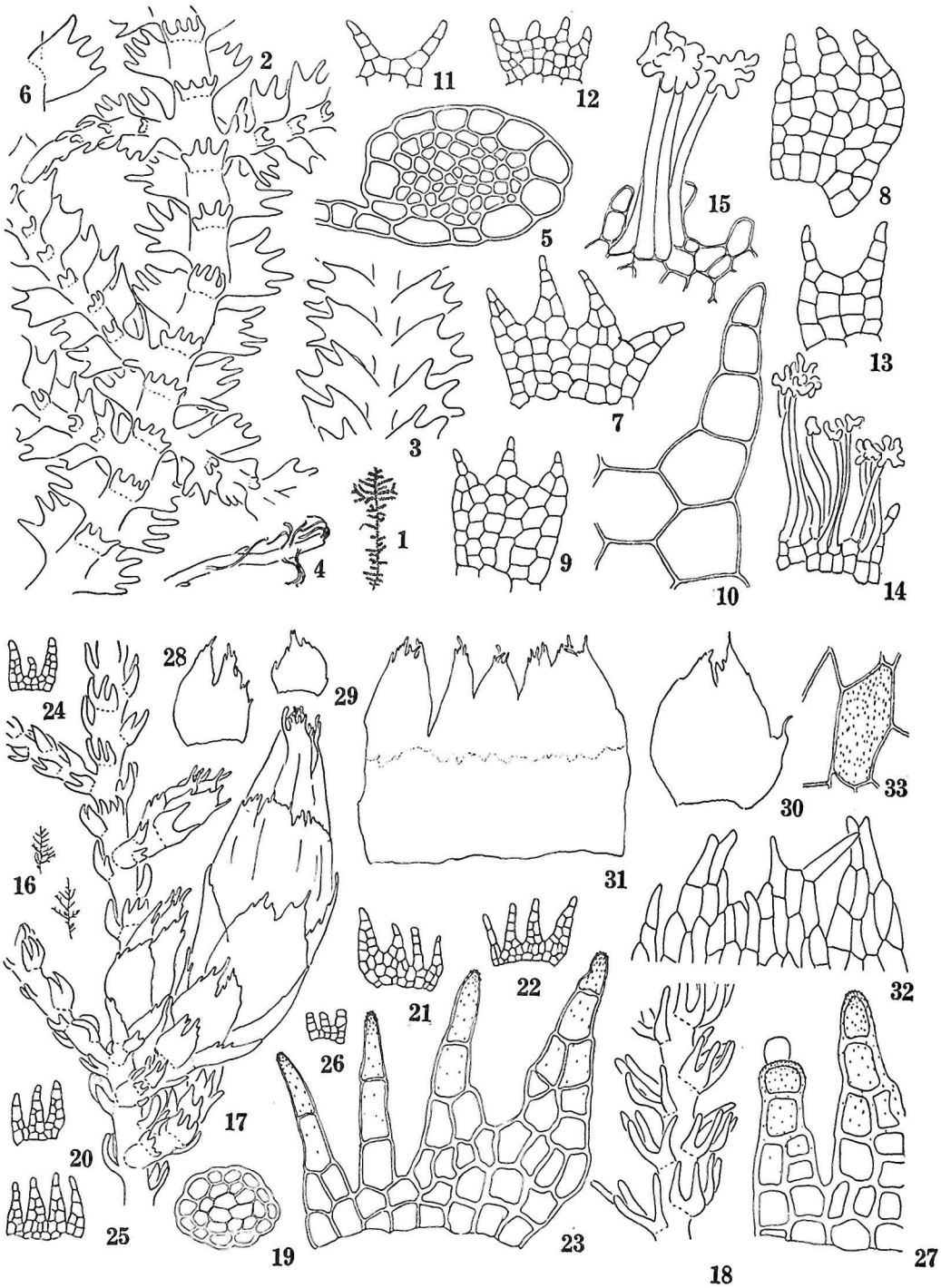
Plants in small pale green patches. Caulid about 2 cm. long or less, 0.15 mm. in diameter, prostrate, filiform and flexuose, irregularly pinnate, lateral branches short (2–3 mm. or rarely 4 mm. long), flagelliform branches almost absent; cross-section of caulid elliptical, epidermal cells about 12, thin-walled, much larger than the inner ones; rhizoids scarce and almost lacking towards tip, frequently on apical portion of amphigastria. Phyllids of main caulid distant to approximate, very obliquely inserted, horizontally spreading, nearly flat, subrhombic, 0.15–0.25 mm. long, 0.15–0.3 mm. wide, 4-lobed to 1/3–1/2, lobes linear, more or less divergent, acute, 4 cells long, 1–2 cells wide at base, sinus lunate, discus 4 cells high, 8 cells wide; cells in discus 30–40×40–60 μ, larger at base, cells in lobes 13–20×25–40 μ, walls thin (about 2 μ thick), cuticle nearly smooth. Phyllids on lateral branches closer together (contiguous to more or less imbricate) and narrower than those of main caulid, mostly 3-lobed to 1/4–1/3, lobes slightly incurved. Amphigastria of main caulid small, distant, suberect-patent, transversely inserted, low-rectangular, 0.08–0.12 mm. long, 0.1–0.15 mm. wide, 3–4-lobed to 1/3 or rarely to 1/2, lobes distant, somewhat incurved, setulose, unicellular or 2–3-celled, 1(–2) cell wide at base, sinus rounded and wide, discus 2–3 cells high, 6–8 cells wide; cells in discus 12–20× 12–40 μ, basal cells often very long, cuticle nearly smooth. Amphigastria of

Fig. III.

1–15. ***Lepidozia wallichiana*** Gott. 1. Plant, ×1. 2. Part of caulid, ventral view, ×38. 3. Part of branch, dorsal v., ×38. 4. Part of flagellum, ×38. 5. Cross-section of caulid, ×150. 6. Caulidial phyllids, ×38. 7–9. Do., ×80. 10. Phyllid-lobe, ×310. 11–14. Amphigastria, ×80. 15. Apical part of amphigastrium with rhizoids, ×150.

16–33. ***Microlepidozia makinoana*** (Steph.) Hatt. 16. Plants, ×1. 17. Part of caulid with perianths, ventral view, ×38. 18. Part of branch, dorsal v., ×80. 19. Cross-section of caulid, ×150. 20–22. Caulidial phyllids, ×80. 23. Do., ×310. 24, 25. Caulidial amphigastria, ×80. 26. Branch-amphigastrium, ×80. 27. Amphigastrium-lobes, ×310. 28–30. Involucral bracts, ×24. 31. Perianth, ×24. 32. Apex of perianth, ×150. 33. Cells from perianth, ×310.

Figs. 1–15 were drawn from specim. *S. Hattori 8041*; figs. 16–33 from *C. Iki 886*; all drawn by M. Mizutani.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lateral branches far smaller, 0.05–0.1 mm. long and wide, 2–3-lobed, lobes uni- or bicellular, discus 1–2 cells high, 2–3 cells wide, cells smaller than those of caulidial amphigastria, about 16 μ.

Type loc. Nepal (inter *Mastigobryum inaequilaterum*, coll. Dr. Wallich). Specim. exam. Hyogo: Mt. Mayasan near Kobe, Oct. 1901, *U. Faurie 938*-paratype in hb. G. (dupl. in hb. KYO). Tokushima: Mt. Tsurugisan in Prov. Awa, June 1900, *U. Faurie 654*-lectotype in hb. G. (dupl. in hb. KYO). Kagoshima: Isl. Yakushima, Susukawa valley, on decayed log, *S. Hattori 6771*,—Nagata, on granite, *D. Shimizu 57211*,—on decayed log, *D. S. 57288*, *57317*, *57257*,—Ambo, on decayed wood, *S. H. 8095*. Range: Nepal, India, Ceylon, Java, Banca, Borneo, Amboina, N. Guinea, Formosa (Isl. Botel Tobago),—widely distributed trop. & subtrop. Asia, Japan (Honshu, Shikoku, Kyushu).

We reduced Japanese *Lepidozia planifolia* to a synonym of *L. wallichiana* which is widely distributed in paleotropical regions. In 3 collections made in Malay Peninsula the phyllids of lateral branches are distinctly longer than those of the main caulid, compared with the type (Nepal) and others (collected at Malacca, Ceylon, etc.) and are thought to be well-developed plants. The Japanese material cited above agreed well with the type. This species is very rare and restricted to the southern parts of our area. Hattori (1947) recorded Yakushima Island as an additional station for this species (under *L. planifolia*), citing two collections made by himself, together with the two original collections of *L. planifolia* made on Mt. Mayasan near Kobe and on Mt. Tsurugi in Shikoku. It has not been rediscovered, however, on Mt. Mayasan (the northernmost known station) nor its neighbourhoods, since Faurie collected it there.

The most remarkable feature of this rare species may be seen in the cross-section of the caulid (Fig. III, 5). Besides, nearly flat phyllids whose lobes are composed of 4–5 cells only and are 1(–2) cell wide at base, and short lateral branches which are seldom tapering into flagelliform tips may serve to distinguish this species from all other Japanese *Lepidozias*.

Microlepidozia (Spruce) Joerg.

Bergens Museum Skrifter **16**: 303 (1934). Syn. *Lepidozia* subgen. *Microlepidozia* Spr. Trans. Bot. Soc. Edinb. **15**: 359 (1885). In our area we recognized only the following species.

Microlepidozia makinoana (Steph.) Hatt. (Fig. III, 16–33)

Jour. Hattori Bot. Lab. **7**: 42 (1952). Syn. *Lepidozia makinoana* Steph. Bull. Herb. Boiss. **5**: 94 (1897).——*L. sylvatica* Evans, Rhodora **6**: 186, *pl. 57* (1904), *syn. nov.*——*L. exigua* Steph. Spec. Hepat. **3**: 626 (1909).——*L. tosana* Steph. loc. cit. 629.——*Microlepidozia sylvatica* (Evans) Joerg. Bergens Mus. Skrifter **16**: 304 (1934), *syn. nov.*——*Telaranca sylvatica* (Evans) K. Müll. Leberm. Europ. (ed. 3) 1136, *f. 431* (1956), *syn. nov.*——'*Lepidozia setacea*' auct. (quoad plant. Japon.): Mitt. Trans. Linn. Soc. London, 2, **3**: 199 (1891) and others. (Exsiccata) Hatt. Hepat. Japon. ser. **3**: 107 (1949); **6**: 258 (1954); **7**: 326 (1956).

Dioicous. In small, green, dark or rarely brownish green patches, or scattered among other mosses and hepatics. Caulid 5–20 mm. long, filiform, ascending or prostrate, irregularly pinnate, branches spreading at about right angles, rarely attenuate into flagelliform tips; cross-section of caulid 5–6 cells thick, epidermal cells 10–12, thick-walled, inner cells smaller, thin-walled. Caulidial phyllids distant, not decurrent, transversely inserted, suberect and incurved, rarely widely spreading, deeply tri- or more frequently quadrifid, sinus descending 2/3 to 7/8, segments 3–5

cells long, 1–3 cells wide at base, tipped by a row of 2–3 linear cells (12×22–32 μ), unequal (antical larger), discus asymmetrical, 1–2 cells high at postical half and 2–3 cells high at antical half, 6–8 cells wide at base, with occasional tooth at antical base; cells in segments 10–12×12–20 μ, walls slightly thickened, trigones lacking, cuticle faintly verrucose or nearly smooth. Phyllids on branches approximate to loosely imbricate, mostly trifid. Caulidial amphigastria resemblingphyllids but smaller in size and more asymmetrical, tri- or quadrifid to 3/4–5/6 the length, segments mostly incurved, unequal, 4–5 cells long, 1–2 cells wide at base, discus 1 or more frequently 2 cells high, 6–8 cells wide at base. Ramous amphigastria smaller, bi- or rarely trifid, segments 3–4 cells long, unequal, discus mostly single cell high and about 6 cells wide. The female 'inflorescence' on very short postical branch; bracts and bracteoles much larger than phyllids, concave, ovate, 1–1.2 mm. long, 0.5–0.7 mm. wide, apex narrowed and shortly 2–3-lobed or irregularly toothed, lobes with few teeth, margins distantly serrulate. Perianth fusiform, 2–2.5 mm. long, gradually contracted to toothed mouth, teeth uni- or bicellular. Cells of perianths and bracts almost hyaline, rectangular, cuticle finely verrucose. Spores yellowish brown, about 15 μ in diameter, minutely granulate. Elaters bispiral. The male 'inflorescence' terminal on short branch, seldom on long branch or caulid; bracts multipairs. Oil-bodies scarce, difficult to observe, 1–5 per cell or lacking, orbicular, 0.5–3 μ in diameter, apparently homogeneous, oil-bodies in epidermal cells of caulid more or less larger (3.5 μ in diam.), those in interior cells far larger (4–4.5 μ) and orbicular-ovate, containing several granules in appearance.

Type loc. Shioeyama near Kochi, Shikoku, Japan. Hab. on rocky cliffs and ledges, banks and cuts and on decayed wood or rarely bases of trees, in shaded, moist sites or rarely in rather sunny places, usually in lowlands but sometimes in bogs on high mountains. Range: Japan (Hokkaido, Honshu, Shikoku, Kyushu, Ryukyu), Formosa(?), Europe, N. America.

This species is conspecific with *L. sylvatica*. K. Müller (1956, p. 1138 under *Telaranea sylvatica*) mentioned "Nach der Abbildung von Hattori in Contr. Flor. Hep. Yakusim. II (in Jour. Hattori Bot. Lab. **2**: 23. 1947) könnte *Lepidozia makinoana* Steph. aus Japan, vielleicht mit *T. sylvatica* oder *T. trichoclados* übereinstimmen, was noch nachgeprüft werden muss." We suppose the European *M. trichoclados* (K. Müll.) Joerg. is also conspecific and merely a habitat form of this species.

This species also resembles *M. setacea*. As mentioned by Hattori (1947, p. 23–24), all the records of *M. setacea* (as *Lepidozia setacea*) from Japanese territory are thought to have been misidentifications of this species. The important differences of the two species may be the involucral bracts and perianths; in *M. setacea* the teeth on the perianth-mouth are longer, the bracts are more deeply lobed and the teeth on lobes are similarly longer.

Bazzania Gray, Nat. Arr. Brit. Pl. **1**: 704 (1821).

Syn. *Herpetium* Nees, Naturg. Europ. Leberm. **1**: 96 (1833).——*Pleuroschisma* Dum. Rec. d'Obs. Jungerm. 19 (1835).——*Mastigobryum* Gott., Lindenb. et Nees, Syn. Hep. 214 (1845).

Key to subgenera and species

1) Phyllids normally bidentate; plants small, with poorly developed postical flagella; rhizoids on the basal portion of amphigastria; amphigastria appressed to caulid....Subgen. *Bidentatae*.
   2) Cells of amphigastria hyaline and thin-walled; cuticle of phyllidial cells papillose; at

lower elevations in southern Japan, on rocks, very rare..... *B. mayebarae.*

2) Cells of amphigastria not hyaline nor thin-walled; cuticle of phyllidial cells smooth; phyllids often caducous; in the subalpine to alpine areas in Japan, on decayed wood, common..... *B. bidentula.*

1) Phyllids normally tridentate (when not well-developed, often simply acute or bidentate).. ..... Subgen. *Bazzania.*

3) Phyllids nearly triangular and strongly deflexed, with narrowed and tri- or more frequently uni- or bidentate apex; plants slender.

4) Phyllids rather flaccid, with big and bulging trigones (about 1/3 or more the cell-diameter); occurring at an elevation of 1000–1700 m.s.m. in southern Japan, rare ..... *B. pearsonii.*

4) Phyllids rigid, with large but not bulging trigones (1/5 or less the cell-diameter with the borderline more or less indistinct); in the subalpine coniferous forests to alpine *Pinus pumila* scrubs, common.....*B. tricrenata.*

3) Phyllids ovate to ovate-lanceolate, nearly horizontal.

5) Cells of amphigastria neither hyaline nor thin-walled (that is, obscure and thick-walled as phyllid-cells).

6) Amphigastria large (thrice as wide as the caulid), cordate, entire, auriculate at base; restricted to Isl. Yakushima, the southernmost end of our area .... *B. yakushimensis.*

6) Amphigastria rather subquadrate, about twice as wide as the caulid or less, usually dentate or lobed at apex, never auriculate at base.

7) Phyllids non-caducous.

8) Plants smaller; caulid less than 0.3 mm. in diameter; phyllids ovate, less than 1.8 mm. long.

9) Amphigastria larger, recurved, dentate, more or less connate at base with phyllids; phyllids to 1.8 mm. long; common in lowlands..... ..... *B. japonica.*

9) Amphigastria smaller (less than twice as wide as caulid), flat and patent, apex nearly truncate, retuse or weakly lobate; phyllids 1.3 mm. long or less; in montane areas between 1200–1900 m.s.m. on Isl. Yakushima and s. Kyushu..... *B. kanemarui.*

8) Plants larger; caulid 0.3–0.45 mm. in diameter; phyllids sublinear, 1.8–2.5 mm. long; amphigastria not recurved along margin, apex irregularly 4–5-lobed, lobes acute (tooth-like) or nearly truncate; in montane areas less than 1000 m.s.m. in the southern flank of Kyushu (incl. Yakushima I.) and Shikoku..... *B. fauriana.*

8) Plants larger; caulid 0.45–0.6 mm. in diameter; phyllids ovate-oblong, 2–4 mm. long.

10) Phyllids densely imbricate; amphigastria subimbricate, more or less appressed to caulid, with margin recurved, apex serrate-dentate (not lobed), base more or less connate with phyllids; usually at an elevation between 1000 and 2000 m. in Honshu, Shikoku and Kyushu ..... *B. yoshinagana.*

10) Phyllids loosely imbricate; amphigastria mostly distant, frequently patent, margin never recurved, apex 4–5-lobed for 1/5–1/4 the length, lobes (and margins) sharply denticulate, base not connate with phyllids; distributed in Hokkaido and northern to central Honshu (mostly subalpine zone) and disjunctly occurring on summit area of high mountains (more than 1400 m.s.m.) in Shikoku.. ..... *B. trilobata.*

7) Phyllids, at least some of them, caducous, 1–1.5 mm. long, ovate; amphigastria flat and patent, apex repand or dentate; common in the subalpine to alpine area, descending, however, to *Fagus crenata* zone..... ..... *B. denudata* subsp. *ovifolia*.

5) Cells of amphigastria (excluding basal portion) hyaline and thin-walled.

11) Amphigastria lobed, lobes acute and sharply denticulate; plants larger; phyllids 2.5–3 mm. long; common at low elevations.....*B. pompeana*.

11) Amphigastria repand and/or with few weak teeth.

12) Amphigastria as long as wide or somewhat wider; phyllids less than 1.7 mm. long in general; common at low elevations.....*B. albicans*.

12) Amphigastria distinctly longer than wide; phyllids 1.8–2.2 mm. long; restricted to the southernmost part of our area..... *B. oshimensis*.

Bazzania mayebarae Hatt.[10] (Fig. IV, 1–16)

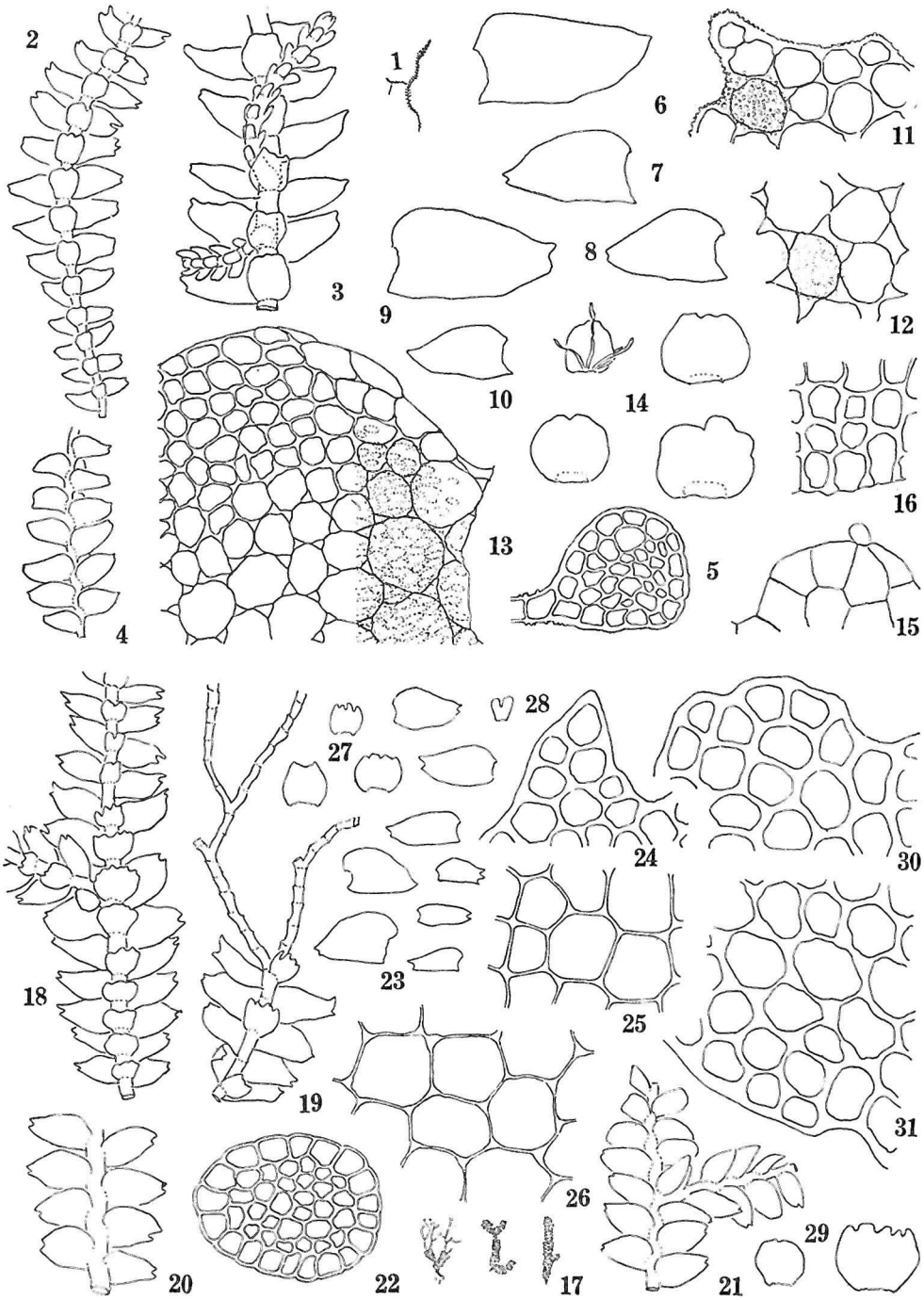
Jour. Hattori Bot. Lab. **10**: 73, *pl. 3, 13–17* (1951), sine descr.

Plants in small patches, olive-green; 0.5–1.2 mm. wide. Caulid to 2 cm. long, 0.1 mm. in diameter, olive-green, filiform, flexuose, simple or with few forks, flagella scarce, very short (1–2 mm. long), rhizoids few, brownish, usually on amphigastrium base; in cross-section of caulid epidermal cells about 15, inner cells smaller. Phyllids distant to contiguous, horizontally spreading, slightly deflexed when dry, not decurrent, oblong, nearly symmetrical, 0.3–0.6 mm. long, 0.18–0.3 mm. wide, antical base rounded and crossing only half the caulid, margins arcuate to substraight, apex narrowed and bidentate or simply acute, teeth irregular, short, acute or obtuse. Cells of phyllidial apex 8–16 μ, of base to 30×40 μ, trigones large, cells smaller and thick-walled toward antical base where occur several hyaline leptodermal cells lacking papillae (same as in amphigastria; see Fig. IV, 13); cuticle densely papillose, papillae low, rounded to oblong, about 6 μ in diameter, smaller towards margin. Amphigastria transversely inserted, flat and appressed to caulid, rotund to rotund-quadrate, 0.2–0.3 mm. long and wide, about twice as wide as caulid, apex rounded to truncate, entire or shortly lobate, margins entire to slightly sinuate; cells of amphigastria hyaline and thin-walled, subquadrate to rectangular, $12–20 \times 15–40$ μ, trigones entirely lacking. Oil-bodies 8–12 per cell, rotund to oblong, homogeneous and glistening, mostly $5 \times 5–11$ μ, occasionally with partitions, smaller towards marginal cells, nearly orbicular about 3 μ in diameter.

Type loc. Koonose near Hitoyoshi, Kumamoto Prefecture, Japan. Specim. exam. Mie: Binnoyama, ca. 100 m.s.m. on soil beneath forests, *K. Okada 41*. Kumamoto: Koonose near Hitoyoshi, ca. 70 m.s.m. on rocks, *K. Mayebara 1893*, *2827*-type in hb. NICH; Itsuki near Hitoyoshi, ca. 500 m.s.m. on limestone, *K. M. 1857*. Range: Japan (Honshu, Kyushu).

Hattori (1951) illustrated the oil-bodies of this remarkable species of the subgen. *Bidentatae*. But he gave no diagnosis of it. We found the above-cited four collections only, which came from three localities in southern Japan. It is very rare,

[10] Sterilis; parva, viridi-olivacea, 0.5–1.2 mm. lata. Caulis ad 2 cm. longus, filiformis, flexuosus, simplex vel paucipartitus, flagellis parvis, brevissimis, radicellis paucis. Folia remota vel contigua, horizontaliter patula, haud decurrentia, oblonga, subsymmetrica, 0.3–0.6 mm. longa, 0.18–0.35 mm. lata, apice bidentula vel acuta; cellulae apicales 8–16 μ, basales ad 30×40 μ, trigonis magnis, cuticula dense papillosa, papillis humilibus. Amphigastria caulina appressa, orbicularia vel orbiculari-quadrata, 0.2–0.3 mm. longa et lata, apice rotundata vel truncata, integerrima vel brevissime lobata; cellulae amphigastriorum hyalinae, leptodermes.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and seems to be relict. In appearance it is very similar to a depauperate or diminutive form of *B. albicans* of subgen. *Bazzania*. Both have hyaline amphigastria. *B. mayebarae* occurs on rocks or soil covering rocks (preferably on calcareous substrata), whereas the above form of *B. albicans* on bark of trees. From *B. bidentula*, the other Japanese member of subgen. *Bidentatae*, this species may easily be separable in its hyaline amphigastria and the papillose cuticle of phyllid-cells.

Bazzania bidentula (Steph.) Steph. (Fig. IV, 17–31)

In Yasuda, Shokubutsugaku Kakuron, Inkwabu, 711 (1911); Nichols. in Mazzetti, Symb. Sinic. **5**: 23 (1930). Syn. *Mastigobryum bidentulum* Steph. Soc. Sci. Nat. Cherbourg, **29**: 222 (1894).——*M. flagellare* Arnell, Rev. Bryol. **25**: 1 (1898).——*Pleuroschisma bidentulum* Steph.; Reimers, Hedwigia **71**: 26 (1931).

Plants in small patches, or often scattered among mosses (*Tetraphis*, etc.), pale to yellowish green, 1–1.4 mm. wide. Caulid to 2 cm. long, 0.15–0.18 mm. in diameter, olive-green, with few forked branches, postical flagella few, rhizoids scarce, mostly on basal portion of amphigastria, more or less brownish; cross-section of caulid elliptical, epidermal cells larger than the inner ones (like *Lepidozia*-type). Phyllids often falling off and leaving some caulids bare, widely spreading, not decurrent, ovate-oblong, 0.6–0.83 mm. long, 0.35–0.48 mm. wide, antical base slightly arched, apex narrowed and bidentate or simply acute, teeth short, acute, apiculate or obtuse. Apical cells of phyllids 12–20 μ, subquadrate, walls thick, median cells about 20×25 μ, nearly rectangular, walls thin or slightly thickened, trigones small, basal cells 22–30×30–40 μ (usually 25×30 μ), trigones more or less larger, cuticle smooth or nearly so. Amphigastria firm, 2–3 times as wide as, and appressed to, the caulid, transversely inserted, approximate, round-quadrate, slightly narrowed at base, 0.3–0.33 mm. long, 0.35–0.4 mm. wide, apex truncate, repand or shortly lobate, lobes irregular, obtuse; inner cells 16–28×16–32 μ, outer cells smaller, walls thick, trigones large compared to phyllid-cells. Oil-bodies 4–8 per cell, orbicular to oblong, 4.5×4.5–10 μ, homogeneous, occasionally with 1–2 partitions (in longer oil-bodies).

Type loc. Schen-si, China (Giraldi leg.). Hab. on decayed wood, rarely on trunk-bases, beneath subalpine coniferous forests, rather common. Range: Japan (Honshu, Shikoku, Kyushu), Korea, Manchuria (Altai), China (Yunnan, Schen-si), Formosa.

This species, as well as *B. mayebarae*, have essentially bidentate phyllids, rhizoids produced on the amphigastium base, and few weak flagella. These charac-

Fig. IV.

1–16. ***Bazzania mayebarae*** Hatt. 1. Plant, ×1. 2. Part of caulid, ventral view, ×13. 3. Do. showing flagella, ×24. 4. Do., dorsal v., ×13. 5. Cross-section of caulid, ×150. 6–10. Phyllids, ×40. 11. Apical tooth of phyllid, ×310. 12. Median cells of phyllid, ×310. 13. Cells from antical base of phyllid, ×310. 14. Amphigastria, ×40. 15. Apical portion of amphigastrium, ×310. 16. Basal cells of amphigastrium, ×310.

17–31. ***Bazzania bidentula*** (Steph.) Steph. 17. Plants, ×1. 18, 19. Parts of caulid, ventral view, ×13. 20, 21. Do., dorsal v., ×13. 22. Cross-section of caulid, ×150. 23. Phyllids, ×13. 24. Apical tooth of phyllid, ×310. 25. Median cells of phyllid, ×310. 26. Basal cells of phyllid, ×310. 27, 28. Amphigastria, ×13. 29. Do., ×24. 30. Apical portion of amphigastrium, ×310. 31. Basal portion of amphigastrium, ×310.

Figs. 1–16 were drawn from the type; figs. 21, 29 from *K. Mayabara 926*; the other from *N. Takai 12166*; all drawn by M. Mizutani.

teristics show that both belong to subgen. *Bidentatae*. *B. mayebarae*, however, may be clearly separable from this species by its hyaline and leptodermal cells of amphigastria, its papillose cuticle of phyllid-cells and non-caducous phyllids. In appearance small plants of *B. japonica* and *B. albicans* are often similar to the present species. However, in *B. japonica* the amphigastria are recurved and toothed at apex, the phyllid-cells are thick-walled and with large trigones, and the phyllids are mostly contact or connate with amphigastria at base. In *B. albicans* the cells of amphigastria are hyaline and leptodermal. Further, both *B. japonica* and *B. albicans* occur at far lower elevations compared to this species. *B. denudata* subsp. *ovifolia* and this species are the representative whose phyllids are often caducous, although such caducous phyllids are seldom obserbed in *B. albicans*, *B. tricrenata* and *B. japonica* when growing in dried or other unsuitable conditions.

Bazzania pearsonii Steph. (Fig. V, 1–21)

Hedwigia **32**: 212 (1893). Syn. *Mastigobryum pearsonii* Steph. Spec. Hepat. **3**: 476 (1908).——*Pleuroschisma pearsonii* K. Müll. in Rabenh. Krypt.-Fl. (ed. 2) **6** (2): 272 (1913).——*Bazzania trigona* Hatt. Jour. Hattori Bot. Lab. **2**: 17, *f. 6* (1947), *syn. nov.* (Exsiccata) Hatt. Hepat. Japon. ser. **6**: 257 (1954), labeled *B. trigona*.

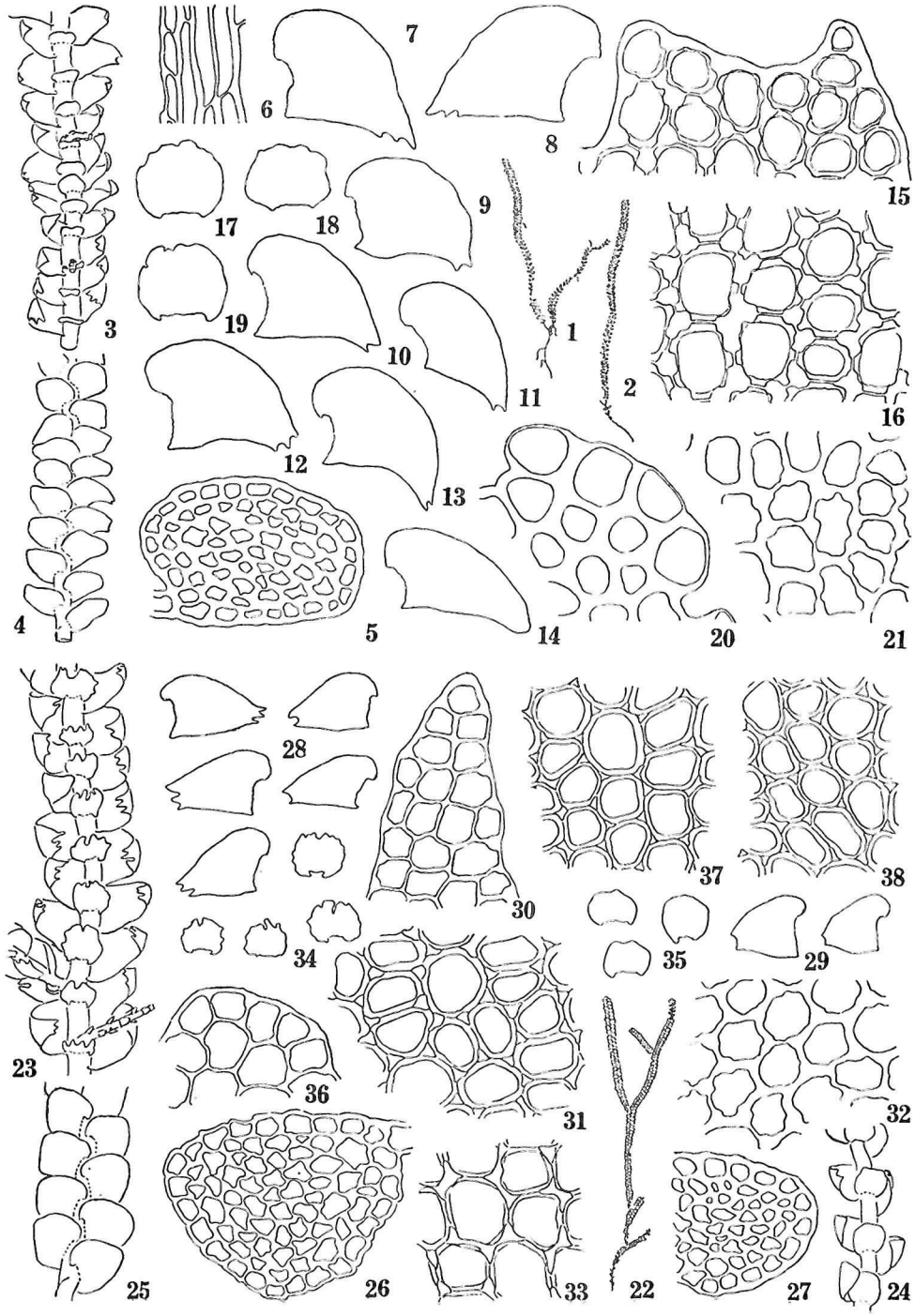
Plants in loose tufts, olive or pale brown, slender, rigid but flaccid when dry, 1–1.5 mm. wide. Caulid to 8 cm. long, 0.25–0.3 mm. in diameter, reddish brown, rigid, filiform, flexuous, simple or slightly forked, somewhat circinate at apex, flagella capillary, few, rhizoids scarce, almost lacking above. Phyllids flaccid in drying, approximate to imbricate, greatly deflexed, especially so when dry, obliquely inserted, slightly falcate, triangular-ovate, asymmetrical, 1–1.2 mm. long, 0.7–0.85 mm. wide, antical base greatly arched and usually considerably crossing caulid, antical margin widely arcuate, postical sinuate, apex greatly narrowed and with 3 (in well-developed phyllids) or 2 teeth or simply acute, teeth small, variously triangular and acute. Median cells of phyllids 23–26 μ, trigones very large, bulging, occasionally confluent, walls thin between non-confluent trigones, cell-cavity frequently stellate; cells of apex and margin 18–22 μ, basal cells much like those of middle, but larger (24–27 × 33–40 μ); cuticle smooth or finely verrucose. Amphigastria less than twice as wide as caulid, spreading, with margins slightly recurved,

Fig. V.

1–21. ***Bazzania pearsonii*** (Steph.) Pears. 1, 2. Plants, ×1. 3. Part of caulid, ventral view, ×13. 4. Do., dorsal v., ×13. 5. Cross-section of caulid, ×150. 6. Longitudinal section of caulid, ×150. 7–14. Phyllids, ×24. 15. Apical portion of phyllid, ×310. 16. Basal cells of phyllid, ×310. 17–19. Amphigastria, ×40. 20. Apical portion of amphigastrium, ×310. 21. Basal cells of amphigastrium, ×310.

22–38. ***Bazzania tricrenata*** (Wahl.) Pears. 22. Plant, ×1. 23, 24. Parts of caulid, ventral view, ×13. 25. Do., dorsal v., ×13. 26, 27. Cross-sections of caulid, ×150. 28, 29. Phyllids, ×13. 30. Apical tooth of phyllid, ×310. 31, 32. Median cells of phyllid, ×310. 33. Basal cells of phyllid, ×310. 34, 35. Amphigastria, ×13. 36. Apical lobe of amphigastrium, ×310. 37. Median cells of amphigastrium, ×310. 38. Basal cells of amphigastrium, ×310.

Figs. 1–12 were drawn from specim. *S. Hattori 7670*-paratype of *Bazzania trigona*; figs. 24, 27, 29, 32, 35 from *K. Tamura 12*-type of *Mastigobryum subsimplex*; the others from *D. Shimizu 55382*; all drawn by M. Mizutani.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oval, 0.4–0.45 mm. long and wide, apex rounded to emarginate, margin entire; cells same as in phyllid.

Type loc. Killarney, Ireland. Hab. on rocks (primarily acidic ones) covered with humus, or bases of trees, occurring disjunctly on the summit area of Yakushima Island and on highlands (1000–1700 m.s.m.) of southern Japan. Ehime: Mt. Sasa, ca. 900 m.s.m. *M. Tokui 1185*. Fukuoka: Mt. Kyogatake, ca. 1000 m.s.m. *Y. Kuwahara 6*; Mt. Gongen, ca. 1200 m.s.m. *Y. K. 4294*. Kumamoto: Mt. Ichifusa, ca. 1700 m.s.m. *K. Mayebara 1325*. Miyazaki: Mt. Osuzu, ca. 1000 m.s.m. *Y. K. 328*. Kagoshima: Isl. Yakushima, Mt. Miyanoura, ca. 1900 m.s.m. *S. Hattori 7717*-type of *B. trigona* in hb. NICH, *7733*, *7737*,—Mt. Kuromi, ca. 1800 m.s.m. *S. H. 7606*,—Hananoego, ca. 1600 m.s.m. *S. H. 7670*, *7676*, *T. Shin 3853*, *3855*,—between Hananoego and Kosugidani, 1000–1500 m.s.m. *S. H. 7477*. Range: British Isles, Alaska (Metlakatla), Japan (Shikoku, Kyushu).

A distinct species though similar to *B. tricrenata* in appearance: Both are slender, to 8 cm. long and only 1–2 mm. wide, with few, distant branches and strongly deflexed, ovate-triangular phyllids narrowed at apex. However, these two species have no direct relationship. Diagnostic characteristics are found in cell-texture and the apical lobation of phyllids and amphigastria: In *B. tricrenata* the cells of phyllids and amphigastria are more or less thick-walled and with trigones not rounded, and the phyllids and amphigastria are often lobed, particularly so when well-developed. As do *Pleurozia purpurea* and *Scapania ornithopodioides*, this species also has a distinct distributional area.

Bazzania tricrenata (Wahlenb.) Trev. (Fig. V, 22–38)

Mem. R. Istit. Lombardo 3, **4**: 415 (1877). Syn. *Jungermannia tricrenata* Wahlenb. Fl. Carpath. 364 (1814).——*Mastigobryum deflexum* Gott., Lindenb. et Nees, Syn. Hep. 231 (1845)= *J. deflexa* Mart. Fl. Crypt. Erlangensis, 135 (1817).——*B. triangularis* Lindb. Acta Soc. Sci. Fenn. **10**: 499 (1875)=*J. triangularis* Schleich. (1803), nom. nud.——*M. cordifolium* auct. (quoad plant. Japon.): Inoue, Bot. Mag. Tokyo **14**: 39 (1900); Steph. Spec. Hepat. **3**: 427 (1908), p.p. ——*M. triangulare* Steph. l.c. 475.——*M. fissifolia* Steph. l.c. 502, *syn. nov.*——*M. hamatum* Steph. l.c. 440, *syn. nov.*——*B. fissifolia* Steph. in Yasuda, Shokubutsugaku Kakuron, Inkwabu, 711 (1911); Hatt. Bot. Mag. Tokyo **58**: 64, *f. 23* (1944), *syn. nov.*——*M. jishibae* Steph. Spec. Hepat. **6**: 469 (1924), *syn. nov.*——*M. subhamatum* Beauv. in Steph. l.c. 465, *syn. nov.*——*B. jishibae* (Steph.) Hatt. Bot. Mag. Tokyo **59**: 29 (1946), *syn. nov.* (Exsiccatae) Hatt. Hepat. Japon. ser. **5**: 204, 205 (1951); **7**: 303 (1956)—labeled *B. fissifolia*; ser. **6**: 255 (1954)—labeled *B. fissifolia* var. *subsimplex*. For full synonymy of European and North American plants, see Frye & Clark, Hepat. N. Amer. pt. **4**: 669 (1946).

Plants slender, in olive-brown or brown patches or tufts; about 2 mm. wide. Caulid 3–8 cm. long, brown, filiform, flexuous, prostrate to suberect, usually with few branches which are distant from each other, spread at acute angle from caulid, slightly circinate at apex, flagella few, long, often branched, rhizoids scarce, almost absent above and mostly restricted to flagella; cross-section of caulid about 10 cells thick, epidermal and inner cells about the same in size and thick-walled. Phyllids distant to imbricate, strongly deflexed and more so when dried, obliquely inserted, hardly decurrent, more or less falcate, triangular-ovate, antical base strongly arching and covering half or more the caulid, 1–1.5 mm. long, 0.6–1 mm. wide, apex much narrowed and obliquely 2–3-dentate or -lobed, or frequently simply acute, teeth irregular, narrowly triangular, acute, sinus acute. Phyllid-cells rotund-hexagonal, smaller towards margin and apex, apical cells 18–22 μ, basal to 30×38 μ,

walls more or less thickened, trigones rather large but not bulging, cuticle smooth or more or less rough. Amphigastria large, twice as wide as the caulid, somewhat patent, rotundate-quadrate, slightly wider than long, 0.55–0.6 mm. long, 0.6–0.7 mm. wide, apex sinuate or 4-lobed for 1/5, rarely to 1/3, the length, lobes subtruncate to acute, margins nearly entire to sinuate-lobate; cells much the same as in phyllids. Oil-bodies homogeneous, 3–6 per cell, 4–6×4–11 μ in size, orbicular or more frequently oblong with protruding portion on both sides of middle spherule (named 'ocellus') which is seemingly identical with orbicular oil-body itself.

Type loc. European (Carpathians?). Hab. on rocks (primarily on acidic rocks such as granite), rocky banks, layer of humus covering rocks, or bases of trees and shrubs usually in the subalpine and alpine areas, forming a dense patch or tuft or frequently scattered in other bryophytes, common in boreal regions of Japan. Range: Japan (Hokkaido, Honshu, Shikoku, Kyushu), Formosa, China (Schensi, Yunnan), Himalayas, Europe, N. America.

This species varies greatly in the shape of phyllids and amphigastria, particularly in the degree of apical dentation or lobation, and many other vegetative features. This is one reason why this species has many synonyms. However, we can recognize this species by: (1) the slender plants usually brown in color, (2) the triangular or triangular-ovate phyllids, (3) the strongly deflexed, narrowed and obliquely acute or 2–3-dentate (or -lobed) apex of phyllids, and (4) the frequently lobed amphigastria. *B. pearsonii* is similar to this species in appearance, but it is easily separable by its almost always entire amphigastria and by its phyllid-cells, especially their big, rounded and frequently confluent trigones.

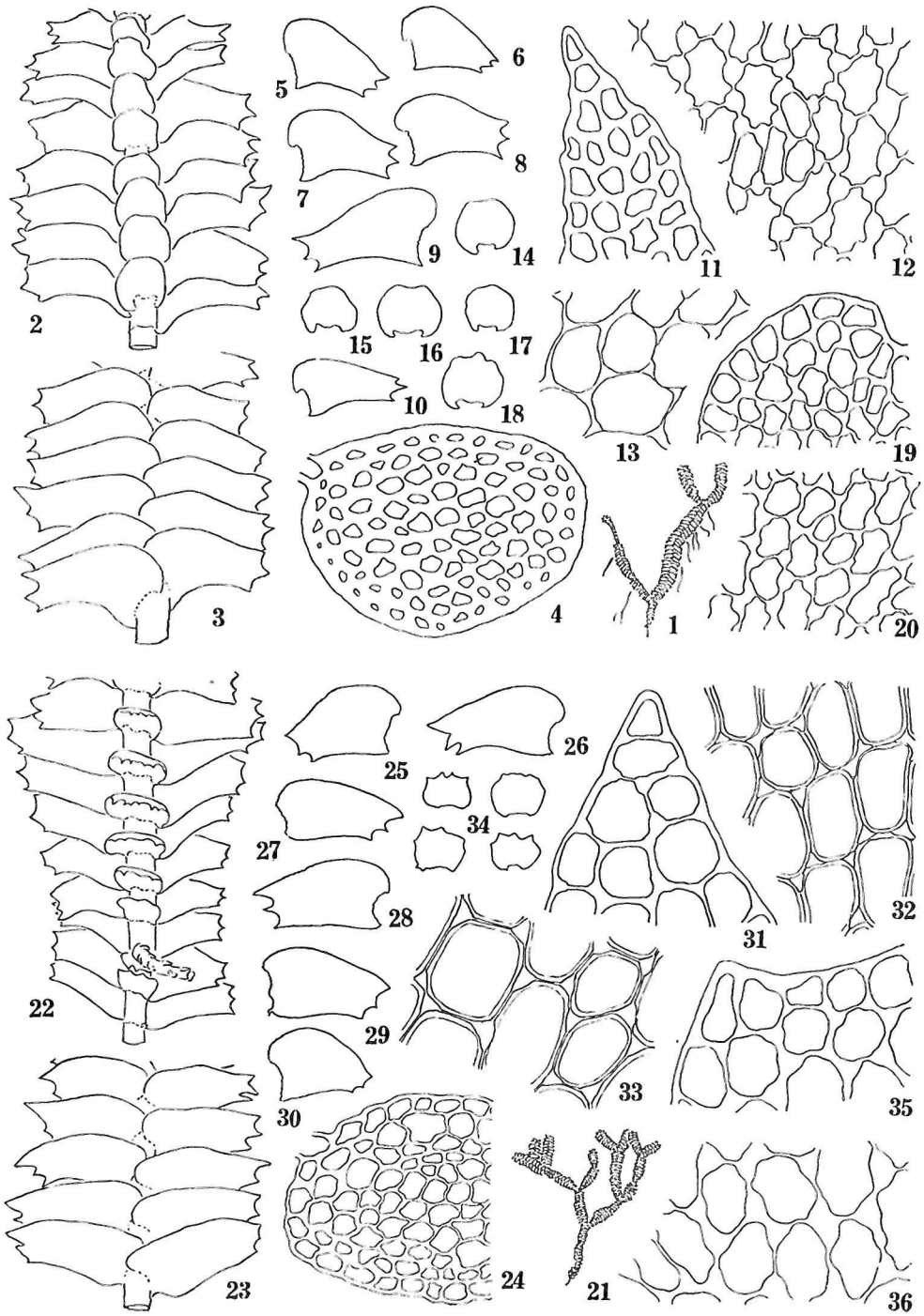
In the best-developed form ('*Mastigobryum fissifolium*') the phyllids and amphigastria are more deeply lobed than those of the European or North American form. The form which was named *B. fissifolia* var. *subsimplex* (=*M. subsimplex*) have the most slender and simple caulid, and the nearly entire amphigastria. We regard this form as a habitat-modification of the same species, as in the case of '*B. triangularis*' and *B. tricrenata* in Europe. *Mastigobryum hamatum* and other Japanese species cited above as synonyms are intermediate between the above-mentioned two extremes.

Chinese *Bazzania cordifolia* (Steph.)=*Mastigobryum cordifolium* was also recorded by Inoue (1900) and Stephani (1908) in Japan. However, their material may surely be identified as this species, although it is problematical and needs the critical study of Chinese material (including the type of *B. cordifolia*) to decide whether this species will be conspecific with *B. cordifolia* or not.

Bazzania yakushimensis Horikawa (Fig. VI, 1–20)

Jour. Sci. Hiroshima Univ. ser. b, 2, 2: 194, *pl. 16, 17–21* (1934). (Exsiccata) Hatt. Hepat. Japon. ser. 4: 151 (1951).

Plants in yellowish to brownish green patches which become nearly brown in drying; 1.5–2.5 mm. wide. Caulid about 3 cm. long, 0.25–0.33 mm. in diameter, relatively sout and rigid, brown, prostrate to ascending, regularly furcately branched, branches somewhat circinate at apex, postical flagella numerous, filiform, long, rhizoids scarce, almost lacking above; cross-section of caulid about 10 cells thick, cell walls strongly thickened throughout and especially so towards cortex, thus cell-cavity in cortex much smaller. Phyllids densely imbricate, nearly horizontally spreading, strongly deflexed when dry, oblique-inserted, oblong-ovate, 1–1.7 mm.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long, 0.7–1.3 mm. wide at base, antical base strongly arched, postical sinuous or substraight, apex 0.3–0.5 mm. wide, strongly tridentate, teeth triangular, acute, sinus obtuse to subacute. Apical cells of phyllids 12–20 μ, thick-walled, median cells about $25\times35\,\mu$, trigones large and nodulose (about 12 μ in diam.), cell-cavities often stellate, basal cells to $30\times40\,\mu$, walls thin, trigones mostly nodulose but frequently confluent, cuticle nearly smooth. Amphigastria large, twice as wide as the caulid, more or less erect-patent, mostly imbricate, insertion profoundly sinuate, nearly reniform, 0.4–0.6 mm. long and wide or a little wider, apex rounded, truncate or repand, or often slightly emarginate, margin entire, often slightly decurvate, base auriculately cordate; cells almost same as in phyllids but smaller, $12–15\times12–25\,\mu$, trigones remarkably large, cells larger towards base (to $25\times35\,\mu$). Oil-bodies several per cell, orbicular to oblong, $4–5\times4–7\,\mu$, homogeneous.

Type loc. Isl. Yakushima, southernmost Kyushu, Japan. Hab. on bases of trees (mainly *Cryptomeria japonica*), stumps and decaying wood, forming a dense mat or occurring with other bryophytes beneath forests at an elevation of 650–1200 m.s.m. Kagoshima: Isl. Yakushima, Kosugidani, *K. Mayebara 2939, 2940, 2943, 2951, T. Shin 3631, 3677b, D. Shimizu 55803, 55810, 55817, 57063, 57081, 57084, 57088, 57122, 57376, Y. Nishihara 585*,—between Kosugidani and Hananoego, *S. Hattori 7479*. Range: Japan (restricted in Isl. Yakushima, s. Kyushu), Formosa.

This species is the only Japanese representative of sect. *Appendiculatae* (*emend.*), a tropical element. The amphigastria are appendiculately cordate at base and the phyllids ampliate and more or less appendiculate at the antical base (weakly so at postical base also). In our area this species is restricted to Yakushima Island, in the southernmost Japan. In appearance it is similar to robust form of *B. japonica*, but may easily be distinguished by its large and bulging trigones of phyllid-cells and its imbricate, entire amphigastria together with the above-mentioned characteristics. Among *Bazzanias* described from the tropics we find some closely related species, such as Indian *Bazzania decurva* (Nees).

Bazzania japonica (Sande Lacoste) Lindb. (Fig. VI, 21–36)

Acta Soc. Sci. Fenn. **10**: 224 (1872). Syn. *Mastigobryum japonicum* Sde. Lac. in Miquel, Ann. Mus. Bot. Lugd.-Bat. **1**: 303 (1863/64).——*Bazzania semiconnata* Steph. Bull. Herb. Boiss. **5**: 86 (1897).——*B. flavo-virens* Steph. loc. cit., *syn. nov.*——*Mastigobryum semiconnatum* Steph.; Besch. Rev. Bryol. **21** (2): 26 (1894), num. nud.——*M. cucullistipulum* Steph. Spec. Hepat. **3**: 454 (1908).——*M. shusensicum* Steph. Spec. Hepat. **3**: 505 (1908).——*M. aoyagianum* Steph. Spec.

Fig. VI.

1–20. ***Bazzania yakushimensis*** Horik. 1. Plant, ×1. 2. Part of caulid, ventral view, ×13. 3. Do., dorsal v., ×13. 4. Cross-section of caulid, ×150. 5–10. Phyllids, ×13. 11. Apical tooth of phyllid, ×310. 12. Median cells of phyllid, ×310. 13. Basal cells of phyllid, ×310. 14–18. Amphigastria, ×13. 19. Apical portion of amphigastrium, ×310. 20. Median cells of amphigastrium, ×310.

21–36. ***Bazzania japonica*** (Sde. Lac.) Lindb. 21. Plant, ×1. 22. Part of caulid, ventral view, ×13. 23. Do., dorsal v., ×13. 24. Cross-section of caulid, ×150. 25–30. Phyllids, ×13. 31. Apical tooth of phyllid, ×310. 32. Median cells of phyllid, ×310. 33. Basal cells of phyllid, ×310. 34. Amphigastria, ×13. 35. Apical portion of amphigastrium, ×310. 36. Basal cells of amphigastrium, ×310.

Figs. 1–20 were drawn from specim. *K. Mayebara 2939*; figs. 21–36 from *T. Kodama 1871*; all drawn by M. Mizutani.

Hepat. **6**: 453 (1924), *syn. nov.*——*Bazzania tridenticulata* [non (Gott., Lindenb. et Nees) Trev.[11]] Horikawa, Jour. Sci. Hiroshima Univ. b, 2, **2**: 199, *pl. 17, 13-17* (1934).——*B. japonica* fo. *tridenticulata* (Horikawa) Hatt. Jour. Hattori Bot. Lab. **2**: 15 (1947).——*B. cucullistipula* (Steph.) Hatt. Bot. Mag. Tokyo **58**: 27 (1946).——*B. shusensica* (Steph.) Hatt. loc. cit. 30.——?*Mastigobryum semiconnatum* var. *minor* Ihsiba, Bot. Mag. Tokyo **49**: 602 (1935). (Exsiccata) Hatt. Hepat. Japon. ser. **1**: 3 (1946); **6**: 256 (1954).

Plants in olive-green patches of medium size; 2–3 mm. wide. Caulid to 6 cm. long, 0.2–0.3 mm. in diameter, reddish brown, rigid, prostrate to ascending, regularly and truncately branched, branches somewhat circinate at apex, postical flagella abundant, frequently branched, rhizoids seen on flagella; cross-section of caulid elliptical, cells of outer layer (about 3 cells thick) thick-walled, smaller than the inner ones whose walls are thin. Phyllids imbricate, usually subopposite, convex, nearly horizontally spreading, obliquely inserted, more or less falcate, hardly decurrent, 1–1.7 mm. (rarely 1.8 mm.) long, 0.6–0.9 mm. (rarely to 1.2 mm.) wide near base, antical base strongly arched, postical slightly sinuate or straight, apex narrowed and truncate-tridentate, teeth triangular, acute, sinus mostly lunate. Apical cells of phyllids 15–25 μ, thick-walled, median cells 20–25 × 25–35 μ, trigones large, acute or rarely subnodulose, basal cells 25–30 × 40–50 μ, trigones large, nearly nodulose, walls thick, cuticle smooth or nearly so. Amphigastria firm, twice as wide as the caulid or a little wider, more or less sinuately inserted, usually connate at base with one or both phyllids, quadrate-rotundate, slightly wider than long, 0.45–0.7 mm. long, 0.55–0.8 mm. wide, apex mostly strongly recurved, irregularly dentate or denticulate, teeth acute, sinus usually lunate, margins more or less recurved, mostly sinuate-angular and often denticulate; cells same as in phyllids, but mostly 15–20 μ (inner ones longer). Oil-bodies homogeneous, 4–10 per cell, orbicular, ovate or oblong, 5 × 5–10 μ, smaller towards marginal cells.

Type loc. Japan, lacking definite locality (leg. Textor; Pompe van Meerdervoort). Hab. on rocks covered with humus, bases, or less frequently, lower trunks of trees, or decaying wood; growth relatively dense and occasionally with other bryophytes. It is common in lowlands in Japan, but is not found at altit. higher than 1000 m.s.m. and is replaced there by *B. yoshinagana* which is closely related, but larger. Range: Japan (Honshu, Shikoku, Kyushu, Ryukyu), Sumatra (*B. japonica* var. *sumatrana* Herz. Ann. Nat.-hist. Mus. Wien **53**-1: 366. 1943).

This species is closely related to *B. yoshinagana*, in the sect. *Connatae*. However, *B. yoshinagana* is larger in size of plants, caulids and phyllids, and the apices of phyllids are not as narrow as in this species; the trigones of phyllid-cells are nodulose. Its occurrence is limited to altitudes between 1000–2000 m.s.m. in Japan (the northernmost limit of its known range is Mt. Hayachine in n. Honshu).

B. fauriana also is closely related to, and often difficult to separate from, this species. However, the typical form of *B. fauriana* is clearly distinct from it having long, sublinear phyllids (more than 2 cm. long, less than 1 mm. wide at base), large, distinctly nodulose trigones of phyllid- and amphigastrium-cells, hardly reflexed, often lobed (rarely to 1/3 the full length) amphigastria, and incrassate cells in the cross-section of caulid.

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[11] *Bazzania tridenticulata* (Gott., Lindenb. et Nees) Trev. Mem. Istit. Lombardo s. 3, 4: 415 (1877)=*Mastigobryum tridenticulatum* G. L. N. Syn. Hep. 230 (1845). Now in synonymy under *B. trilobata*.

Further, we can find many taxa in subtropical and tropical Asia, which are closely related to *B. japonica* and its allies in Japan. Herzog (*loc. cit.*) described a variety '*sumatrana*' of *B. japonica*.

This species together with *B. albicans* and *B. pompeana* may be the most common species in Japanese lowlands. As does *B. albicans*, this species varies widely, according to habitat and possibly also genetically.

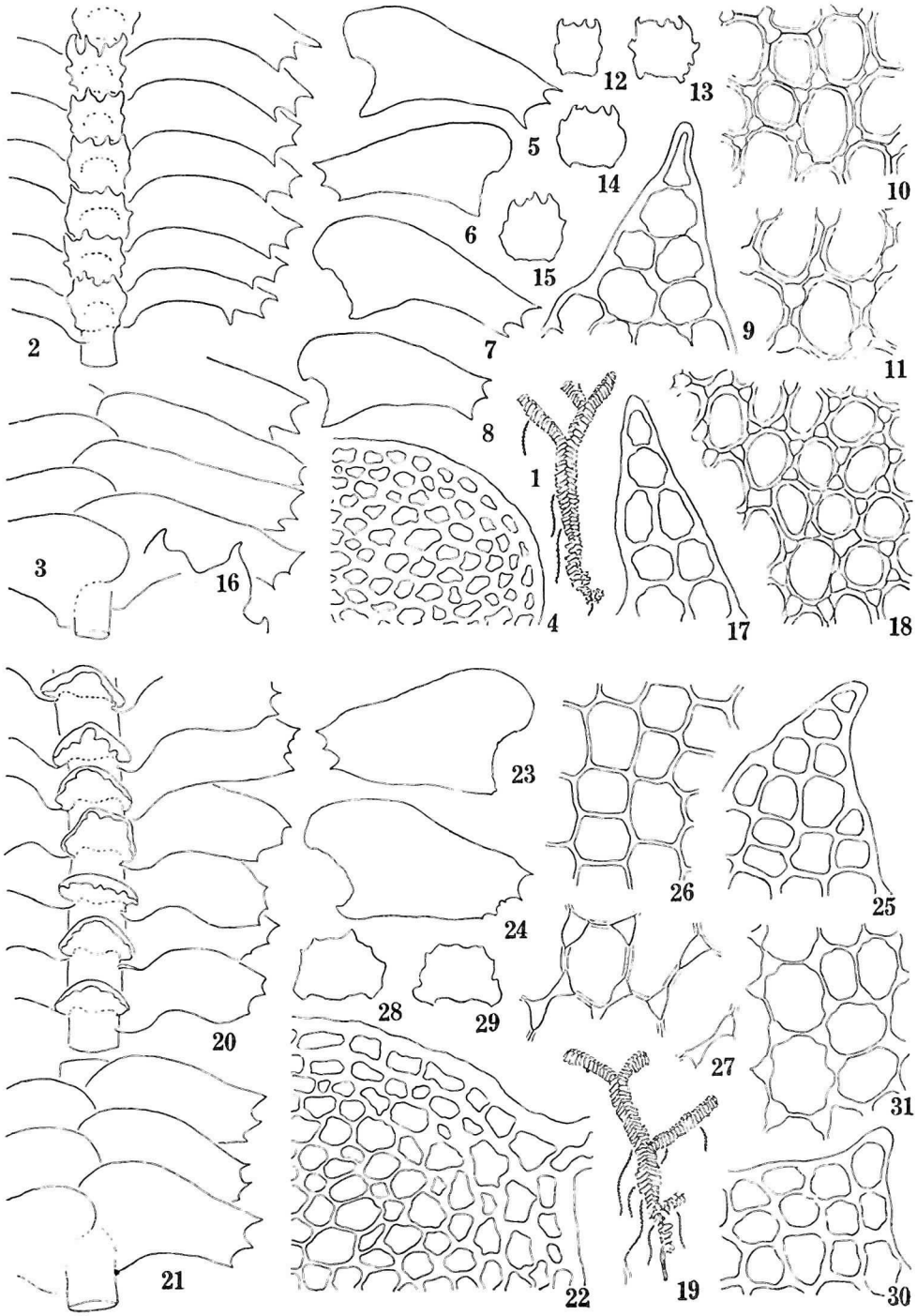
Bazzania fauriana (Steph.) Hatt. (Fig. VII, 1–18)

Bot. Mag. Tokyo **59**: 27 (1946). Syn. *Mastigobryum faurianum* Steph. Spec. Hepat. **3**: 467 (1908).——*B. nodulosa* Horikawa, Jour. Sci. Hiroshima Univ. ser. b, 2, **2**: 199, *pl. 18, 7–12* (1934).——*B. kiushiana* Hatt. Bull. Tokyo Sci. Mus. **11**: 19, *f. 11* (1944). (Exsiccata) Hatt. Hepat. Japon. ser. **6**: 254 (1954).

Plants in large, dark green or occasionally brownish patches; about 4 mm. wide. Caulid to 8 cm. long, 0.3–0.45 mm. in diameter, greenish, stout and rigid, procumbent to more or less ascending, regularly furcately branched, branches almost circinate at apex, postical flagella numerous, long and capillaceous, frequently branched, rhizoids mostly restricted to flagella; cross-section of caulid elliptical, inner cells somewhat larger than the outer ones, cell-walls much incrassate throughout. Phyllids densely imbricate, alternate to subopposite, horizontally spreading, but strongly deflexed when dry, from ovate base elongate-ligulate, slightly falcate, antical base strongly arched, 2–2.6 mm. long, 0.9–1.2 mm. wide at base, 0.6–0.8 mm. wide at middle, apex 0.4–0.5 mm. wide, tridentate, teeth large, more or less divaricate, triangular and acute, sinus acute or obtuse, nearly rectangular. Apical cells of phyllids 15–25 μ, basal ones 25–32 × 40–50 μ, walls thick, trigones very large, nodulose, cuticle nearly smooth. Amphigastria twice as wide as the caulid (or less), mostly in contact with one or less frequently both phyllids at base, somewhat patent, hardly recurved at apex, subquadrate, 0.6–0.8 mm. long and wide (or little narrower), apex irregularly 4-lobed or -toothed, lobes (or teeth) triangular or sublinear, acute but seldom obtuse, often with additional teeth, margins irregularly repand and often with 1–2 short but angular lobes; cells same as in phyllids, 15–20 μ, smaller along margin. Oil-bodies not yet observed.

Type loc. Mt. Ichifusa, Kumamoto Prefecture, Japan. Hab. on granitic rocks covered with humus, and bases of trees, usually forming a loose mat, beneath forests in rainy montane districts of southern Kyushu and Shikoku. Range: Honshu (Isl. Mikurajima, south of Izu Pen.), Shikoku, Kyushu, Ryukyu, Formosa.

This species is closely related to *B. japonica*. Distinctive features are mentioned under the latter species. The phyllids of *B. fauriana* are usually far longer than those of *B. japonica*, and in the former the plants are more or less flaccid and the phyllids are strongly deflexed when dry. The geographical distribution of *B. fauriana* is southern compared to that of *B. japonica*. The habitat of *B. fauriana* seems to be limited to rainy montane forests, whereas *B. japonica* is common in less shady and drier places in lowlands. *B. kiushiana* is a habitat form of *B. fauriana*, and is smaller in size, its phyllids being as long as those of large plants of *B. japonica* (1.6–1.7 mm. long). However, it has the diagnostic characteristics of *B. fauriana*: phyllids sublinear, the maximal width less than half the length, amphigastria about 4-lobed (see, Hattori, 1944, p. 17, *f. 9*) and the cells of phyllids and amphigastria with large and nodulose trigones.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Bazzania yoshinagana Steph. (Fig. VII, 19–31)

Yasuda, Shokubutsugaku Kakuron, Inkwabu, 711 (1911), nom. nud.; Hatt. Bot. Mag. Tokyo **58**: 71, *f. 29* (1944). Syn. *Mastigobryum yoshinaganum* Steph. Spec. Hepat. **3**: 490 (1908). ——*Bazzania platyphylla* Hatt. Bot. Mag. Tokyo **59**: 26, *f. 31* (1946). (Exsiccata) Hatt. Hepat. Japon. ser. **4**: 152 (1950).

Plants in yellowish or dark green, occasionally somewhat whitish, patches; 3–5 mm. wide. Caulid about 5 cm. long, 0.4–0.6 mm. in diameter, stout and rigid, greenish, prostrate to more or less ascending, furcately branched, branches circinate at apex, postical flagella long and strong, often branched, rhizoids mostly confined to flagella; in cross-section of caulid cells of outer layers (4–5 cells thick) thick-walled, particularly so in the outermost 2 layers. Phyllids firm, alternate to sub-opposite, densely imbricate, horizontally spreading, slightly deflexed when dry, obliquely inserted, more or less falcate *in situ*, 2–2.5 mm. long, 1.2–1.5 mm. wide at base, from strongly arched base the antical margin widely arcuate, postical nearly straight, apex truncate-tridentate, teeth acute and triangular, or often irregularly serrulate, sinus nearly lunate. Apical cells of phyllids 15–22 μ, thick-walled, basal cells 28–30 × 45–54 μ, walls thick, trigones large, mostly acute, cuticle nearly smooth. Amphigastria firm, twice as wide as the caulid, more or less sinuately inserted, connate at base with one or both phyllids, quadrate-rotundate, strongly recurved along margin, a little wider than long, 0.7–0.95 mm. long, 0.8–1.1 mm. wide, apex irregularly dentate, margins shortly lobate-angular; cells same as in phyllids, 15–20 μ, smaller in size, thicker in walls, towards margin. Oil-bodies 5–13 per cell, oblong, 5 × 10 μ or seldom 5 × 15 μ, or rarely orbicular, 5 μ in diam., homogeneous but long oil-bodies seldom with partitions.

Type loc. Mt. Kisokoma, Japan Alps, central Japan. Hab. on rocks covered with humus, and on forest-floor at an elevation of 1000–2400 m. in our area, between 30–40°N. Lat. Range: Japan (Honshu, Shikoku, Kyushu).

This species is closely related to *B. japonica*, and perhaps it may be possible to regard them as subspecies. This species, however, is much larger, occurs at distinctly higher altitudes, and is geographically limited to Japan between 30–40° N. Lat. It resembles northern *B. trilobata*, and the two are compared under the latter.

Bazzania trilobata (L.) Gray (Fig. VIII, 1–16)

Nat. Arr. Brit. Pl. **1**: 704 (1821). Syn. *Jungermannia trilobata* L. Sp. Pl. 1133 (1753).

Fig. VII.

1–18. ***Bazzania fauriana*** (Steph.) Hatt. 1. Plant, ×0.8. 2. Part of caulid, ventral view, ×13. 3. Do., dorsal v., ×13. 4. Cross-section of caulid, ×150. 5–8. Phyllids, ×13. 9. Apical tooth of phyllid, ×310. 10. Median cells of phyllid, ×310. 11. Basal cells of phyllid, ×310. 12–15. Amphigastria, ×13. 16. Apical portion of amphigastrium, ×40. 17. Apical tooth of amphigastrium, ×310. 18. Median cells of amphigastrium, ×310.

19–31. ***Bazzania yoshinagana*** (Steph.) Steph. 19. Plant, ×0.8. 20. Part of caulid, ventral view, ×13. 21. Do., dorsal v., ×13. 22. Cross-section of caulid, ×150. 23, 24. Phyllids, ×13. 25. Apical tooth of phyllid, ×310. 26. Median cells of phyllid, ×310. 27. Basal cells of phyllid, ×310. 28, 29. Amphigastria, ×13. 30. Apical portion of amphigastrium, ×310. 31. Basal cells of amphigastrium, ×310.

Figs. 1–18 were drawn from specim. *T. Shin 3622*; the others from *D. Shimizu 56447*; all drawn by M. Mizutani.

——*Mastigobryum trilobatum* G. L. et N. Syn. Hep. 230 (1845).——*M. pompeanum* var. *uedae* Ihsiba, Trans. Sapporo Nat. Hist. Soc. **13** (4): 397 (1934), *syn. nov.*——*Bazzania hattoriana* Kamimura, Contr. Hepat. Fl. Shikoku. 21, *pl. 1, a–h* (1952), *syn. nov.* Full synonymy of European and North American plants is given by Frye & Clark, Hepat. N. Amer. pt. 4: 667 (1946), and others.

Plants in large, whitish or pale to dull green mats; 3.5–6 mm. wide. Caulid 3–10 cm. long, 0.45–0.5 mm. in diameter, stout, green to brownish green, ascending or prostrate, furcately branched, branches more or less circinate at apex, with many postical flagella which are often branched, rhizoids colorless, scarce, almost lacking above; cross-section of caulid elliptical, cells of outer layers (several cells thick) thick-walled, cells of the outermost layer larger than those of the other outer layers, and as large as the inner cells whose walls, however, thinner. Phyllids contiguous to imbricate, slightly convex or plane, nearly horizontally spreading, more or less deflexed in drying, obliquely inserted, not decurrent, oblong-ovate, asymmetrical, 2–3 mm. long, about 1.5 mm. wide at base, antical margin strongly curved from more or less auriculate base, postical nearly straight, apex 0.5–0.7 mm. wide, truncate-tridentate, teeth triangular, acute, sinus mostly lunate, or more or less acute; cells of apical portion and marginal row 21–27 μ, of base 30×42 μ, trigones large, acute to nodulose, cuticle nearly smooth. Amphigastria mostly patent, about twice as wide as the caulid or more, rotund-quadrate, wider than long, to 1 mm. long, 1.4 mm. wide, apex irregularly 4–5-lobed for 1/5–1/4 the length, sinus acute, lobes acute, mostly sharply toothed, magins (particularly above) irregulary angular-lobate and/or toothed; cells 20–30 μ, those of 1 (rarely 2–3) marginal rows (particularly at apical portion) often hyaline and leptodermal. Oil-bodies 4–7, rarely to 10, per cell, orbicular, 5 μ in diameter, ovate, $4–5 \times 7–8$ μ, or rarely oblong, $4–5 \times 9–10$ μ, homogeneous and glistening.

Type loc. European. Hab. on rocks covered with humus, decayed wood, forest-floor, and swamps, often forming an extensive, thick mat. Common in Hokkaido, the northernmost large island of Japan, and less frequent southward; the southernmost known station is on Mt. Higashi-akaishi in Shikoku, at 1400–1500 m.s.m. It grows in wet places, at least in southern stations, compared to the other members whose distribution in Japan is similar to it. Range: Europe, N. America, E. Asia (Amur, Sakhalin), Japan (Hokkaido, Honshu, Shikoku).

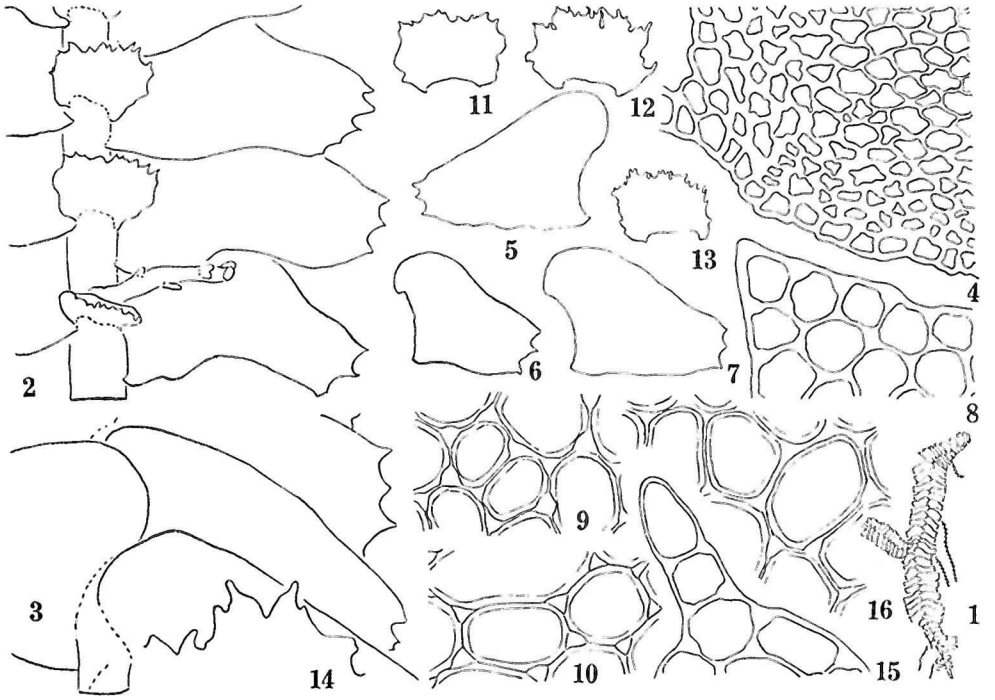
This northern species resembles *B. yoshinagana*, but may easily be separated as follows.

Fig. VIII.

1–16. ***Bazzania trilobata*** (L.) Gray. 1. Plant, ×0.8. 2. Part of caulid, ventral view, ×13. 3. Do., dorsal v., ×13. 4. Cross-section of caulid, ×150. 5–7. Phyllids, ×8. 8. Apical tooth of phyllid, ×310. 9. Median cells of phyllid, ×310. 10. Basal cells of phyllid, ×310. 11–13. Amphigastria, ×13. 14. Apical portion of amphigastrium, ×40. 15. Apical tooth of amphigastrium, ×310. 16. Median cells of amphigastrium, ×310.

17–33. ***Bazzania denudata*** **subsp.** ***ovifolia*** (Steph.) Hatt. 17. Plants, ×1. 18. Part of caulid, ventral view, ×13. 19. Do., dorsal v., ×13. 20. Cross-section of caulid, ×150. 21–25. Phyllids, ×13. 26. Apical tooth of phyllid, ×310. 27. Median cells of phyllid, ×310. 28. Basal cells of phyllid, ×310. 29, 30. Amphigastria, ×13. 31. Apical portion of amphigastrium, ×310. 32. Median cells of amphigastrium, ×310. 33. Basal cells of amphigastrium, ×310.

Figs. 1–16 were drawn from specim. *D. Shimizu 54729*; the others from *N. Takaki 9912*; all drawn by M. Mizutani.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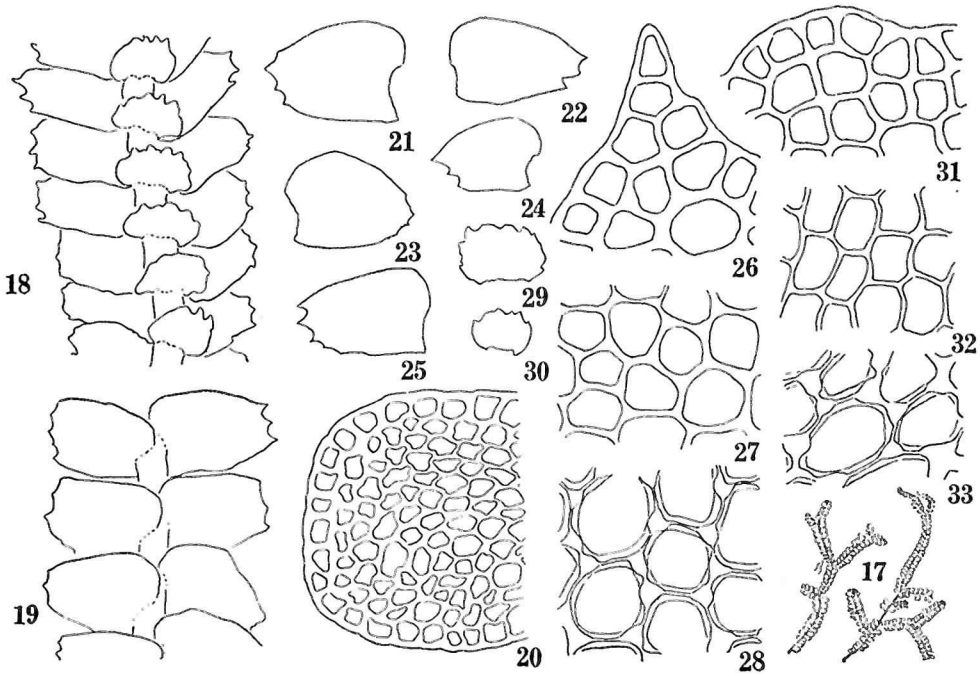
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1) *B. trilobata*: Phyllids loosely imbricate to contiguous; phyllid-cells 25–35 μ at middle; amphigastria not recurved along margin, usually lobed (lobes acute and sharply denticulate); cells of amphigastria 20–30 μ, marginal ones not so small, cells of 1 (rarely 2–3) marginal rows often hyaline and leptodermal.

2) *B. yoshinagana*: Phyllids densely imbricate, convex (postical margin recurved); phyllid-cells 20–30 μ at middle; amphigastria recurved along margin (especially so at apical portion); cells of amphigastria 15–20 μ, marginal ones smaller, not hyaline nor leptodermal.

Mastigobryum pompeanum var. *uedae* certainly is identical to *B. trilobata*, and does not belong to *B. pompeana*.

Bazzania denudata (Torr.) Trev.[12] **subsp. *ovifolia*** (Steph.) Hatt. (Fig. VIII, 17–33)

Jour. Hattori Bot. Lab. **18**: 82 (1957). Syn. *Mastigobryum ovifolium* Steph. Spec. Hepat. **3**: 464 (1908).——*M. vastifolium* Steph. loc. cit. 503.——*M. gibbifolium* Steph. Spec. Hepat. **6**: 464 (1924).——*Bazzania ovifolia* (Steph.) Hatt. Jour. Jap. Bot. **19**: 347, *f. 23* (1943).——*B. vastifolia* (Steph.) Hatt. loc. cit. 348, *f. 23*.——*B. patulistipula* Hatt. Bot. Mag. Tokyo **58**: 25, *f. 30* (1944)=*Mastigobryum takeanum* Steph. Spec. Hepat. **3**: 465 (1908), pro parte (excl. typ.).——*Bazzania ovifolia* var. *vastifolia* (Steph.) Hatt. Bull. Yamagata Agr. Coll. **1**: 41 (1949).

Plants in olive- to dull green, or somewhat brownish patches; 1.5–2.5 mm. wide. Caulid 1–3 cm. long, about 0.3 mm. in diameter, olive-green, prostrate or somewhat ascending, furcately branched, flagella rather few, rhizoids colorless, scarce, almost lacking above; in cross-section of caulid cells nearly the same throughout, but walls of inner cells thinner. Phyllids falling off sometimes, leaving some caulids almost bare, distant to imbricate, more or less convex, horizontally spreading, slightly deflexed in drying, more or less straightly inserted, ovate, rarely short-ligulate, subsymmetrical, 1–1.4 mm. long, 0.8–1.2 mm. wide, antical margin arched, postical straight or slightly arched, apex truncate-tridentate or -denticulate, teeth irregular, acute, rarely obtuse; apical cells 18–24 μ, basal cells 30×40–45 μ, walls thick, trigones large or small, acute, cuticle nearly smooth. Amphigastria mostly strongly patent, nearly flat, transversely inserted, quadrate-rotund, slightly wider than long, 0.5–0.65 mm. long, 0.7–0.85 mm. wide, apex irregularly 4–5-lobed, lobes short, obtuse or acute, rarely not lobed but irregularly denticulate or almost entire, margins sinuate to entire; cells same as in phyllid, 20–26 μ, smaller towards margin. Oil-bodies 6–13 per cell, orbicular (4–5 μ in diam.) or oblong (to 5×12 μ), homogeneous and glistening, long oil-bodies sometimes with partitions or constrictions near both edges.

Type loc. (subsp. *ovifolia*): Mt. Kaikoma, Prefecture Yamanashi, central Japan. Hab. on bases and lower portion of trees, on stumps and decaying wood, in *Quercus crispula* forests to alpine *Pinus pumila* shrubbery (mainly in subalpine coniferous forests), thus common in northern Japan, less frequent southward. *B. bidentula* occurs in nearly the same habitat as this species, but its substrata are almost exclusively wood and stumps usually much more rotten than the substrata of this species, and where *Tetraphis* often occurs with it. Range (subsp. *ovifolia*): Japan (Hokkaido, Honshu, Shikoku, Kyushu).

[12] Mem. Istit. Lomb. **13**: 414 (1887). Syn. *Mastigobryum denudatum* Torr.; G. L. et N. Syn. Hep. 216 (1845). Range: N. America and Greenland. Two North American species, *B. ambigua* (Lndnb.) Trev. and *B. nudicaulis* Evans, seem to be closely related to, and the former perhaps conspecific with, *B. denudata*.

This species varies widely in size of plant and in shape and size of phyllids and amphigastria. Stephani's '*Mastigobryum vastifolium*' is a robust form whose phyllids are as much as 1.2 mm. wide, whereas Hattori's '*Bazzania patulistipula*' is a form with narrow phyllids. Besides these extremes, we find depauperate plants on the bark of trees. These plants show remarkable caducity. Most of them are found near the lower altitudinal range of the species, and geographically frequent in its southern area. We consider these depauperate plants as a habitat modifications. The diagnostic characteristics of this species are its often caducous, ovate phyllids and nearly erect-patent amphigastria.

Hattori (1957) treated Japanese *B. ovifolia* as a subspecies of North American *B. denudata*. We sent some Japanese material to Dr. R. M. Schuster and asked for his opinion about the affinity of the two. He kindly studied our material and wrote us, "*B. ovifolia* is very closely allied to *B. denudata*, but differs as follows: the leaves are slightly falcate, when well-developed, with an arched anterior margin; the apical teeth are always well developed; the underleaves are often somewhat less transverse, in places as long as broad. The plants are identical in size, in the yellow-green color, and caducous leaves. Perhaps *B. ovifolia* is a subspecies of *B. denudata*?"

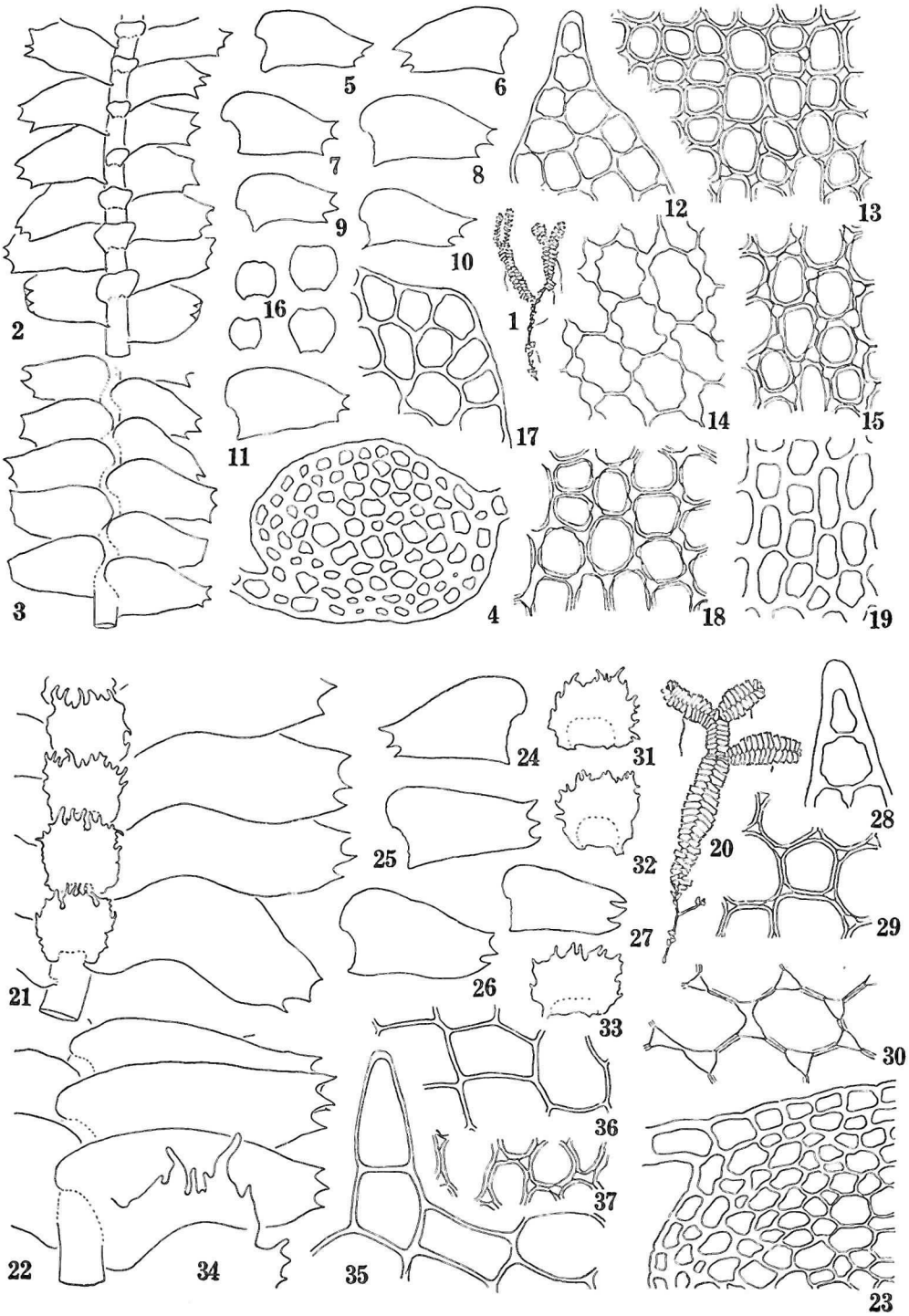
B. bidentula occurs in a similar habitat and is often confused with this species. However, it is usually smaller, with its amphigastria not erect-patent and phyllids not as wide nor ever tridentate at apex.

Bazzania kanemarui Hatt. (Fig. IX, 1–19)

Jour. Hattori Bot. Lab. **2**: 15, *f. 5* (1947).

Plants in small olive-green or brownish green patches; about 2 mm. wide. Caulid about 3 cm. long, 0.2 mm. in diameter, yellowish brown, somewhat rigid, prostrate to ascending, furcately branched, postical flagella few, more or less stout but rather short, rhizoids almost absent above, mostly on base of amphigastria and on flagella; cross-section of caulid elliptical, cells strongly thick-walled, inner cells somewhat larger and their walls somewhat thinner. Phyllids loosely imbricate, rarely approximate, almost horizontally to somewhat obliquely spreading, not decurrent, obliquely inserted, linear-oblong, 1.1–1.3 mm. long, 0.44–0.5 mm. wide at base, antical margin from base arcuate, postical straight to slightly sinuate, apex obliquely truncate and strongly tridentate, 0.3–0.37 mm. wide, teeth somewhat divaricate, large, triangular, acute, sinus acute or obtuse; apical cells of phyllid 13–18 μ, walls thick, trigones large and acute, median cells 20×20–$27\,\mu$, trigones large, acute or subnodulose, walls between trigones thin, basal cells 20–25×30–$40\,\mu$, trigones very large, nodulose, often confluent, cuticle nearly smooth. Amphigastria transversely inserted, oblique- to erect-patent, small, about 1.5 times as wide as the caulid, rotund-quadrate, slightly longer than wide, 0.32–0.37 mm. long, 0.3–0.33 mm. wide, apex truncate, entire, retuse or 3–4-lobed for 1/5 the length or less, lobes obtuse; cells same as in phyllid, but walls thicker. Oil-bodies 7–11 per cell, oblong to orbicular, 3.5×3.5–$6.5\,\mu$.

Type loc. Isl. Yakushima, southernmost Kyushu, Japan. Hab. on granitic rocks or a thin layer of humus deposited upon rocks, at elevations between 1200 and 1900 m.s.m. forming a small patch or scattered among other bryophytes. Kagoshima: Isl. Yakushima, Mt. Miyanoura, ca. 1900 m.s.m. *S. Hattori 7744*-type in hb. NICH, *7716*,—between Mt. Miyanoura and Hananoego, *S. H. 7799, 7805*,—Hananoego, ca. 1600 m.s.m. *S. H. 7667, T. Shin 3886*,—between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Hananoego and Kosugidani, 1200-1600 m.s.m. *S. H. 7565, T. Amakawa 19300.* Kumamoto: Mt. Ichifusa, ca. 1700 m.s.m. *K. Mayebara 903, 1642, 1646, 1653, 2585.* Range: Japan (s. Kyushu).

We do not find any closely allied species in our area. Small plants of *B. japonica* resemble this species in appearance. However, the small, flat and erect-patent amphigastria lacking teeth, the narrow phyllids with strong apical teeth, the more or less brownish and rigid plants, and the smaller phyllid-cells with large, nearly nodulose trigones are fine diagnostic characteristics of this species and are not seen in *B. japonica.*

Bazzania pompeana (Sande Lacoste) Mitt. (Fig. IX, 20-37)

Trans. Linn. Soc. London 2 (3): 200 (1891). Syn. *Mastigobryum pompeanum* Sde. Lacoste in Miquel, Ann. Mus. Bot. Lugd.-Bat. **1**: 304 (1863/64).——*B. tokuiana* Hatt. Jour. Hattori Bot. Lab. **5**: 73, *pl. 1, 11* (1951), sine descr. (Exsiccata) Hatt. Hepat. Japon. ser. **1**: 4 (1946).

Plants in large pale to dark green patches, occasionally somewhat brownish; up to 7 mm. wide. Caulid to 12 cm. long, 0.5 mm. in diameter, olive-green, ascending or prostrate, furcately branched, branches somewhat circinate at apex, postical flagella numerous, long, occasionally branched, rhizoids usually on flagella; cross-section of caulid elliptical, outer cells (in about 3 rows of cells) thick-walled, smaller than the inner, walls of inner cells thin. Phyllids imbricate, slightly convex, horizontally spreading, obliquely inserted, oblong, to 3.6 mm. long and 2.4 mm. wide at base, antical base strongly arched, margins straight or slightly sinuate, apex strongly tridentate, teeth large, triangular, acute; basal cells of phyllids to $36 \times 54\,\mu$, walls thick, trigones large, acute, cells smaller towards, and about $25\,\mu$ at, apex and margins, walls thick, cuticle nearly smooth. Amphigastria contiguous to imbricate, large, colorless excluding inner to basal portion, somewhat sinuately inserted, appressed to caulid or rarely somewhat patent, rotund-quadrate, about 1 mm. long and wide, apex (upper margin together) irregularly 4-6-lobed, lobes mostly with sharp teeth, seldom not lobed but irregularly sharply toothed; hyaline leptodermal cells (lacking chloroplasts and oil-bodies) occupying 2/3 to 5/6 of amphigastria, quadrate to rectangular, $25\text{-}30 \times 25\text{-}55\,\mu$, walls thin and weak, trigones entirely lacking, cuticle finely verrucose, inner (-basal) cells (occupying 1/6 to 1/3) same as in phyllids, but much smaller, $16\text{-}20\,\mu$, walls thick. Oil-bodies 4-10 per cell, seldom to 17, orbicular,

Fig. IX.

1-19. ***Bazzania kanemarui*** Hatt. 1. Plant, ×1. 2. Part of caulid, ventral view, ×13. 3. Do., dorsal v., ×13. 4. Cross-section of caulid, ×150. 5-11. Phyllids, ×13. 12. Apical tooth of phyllid, ×310. 13, 15. Median cells of phyllid, ×310. 14. Basal cells of phyllid, ×310. 16. Amphigastria, ×13. 17. Apical portion of amphigastrium, ×310. 18. Median cells of amphigastrium, ×310. 19. Basal cells of amphigastrium, ×310.

20-37. ***Bazzania pompeana*** (Sde. Lac.) Mitt. 20. Plant, ×0.8. 21. Part of caulid, ventral view, ×13. 22. Do., dorsal v., ×13. 23. Cross-section of caulid, ×150. 24-27. Phyllids, ×7. 28. Apex of phyllid-tooth, ×310. 29. Median cells of phyllid, ×310. 30. Basal cells of phyllid, ×310. 31-33. Amphigastria, ×13. 34. Apex of amphigastrium, ×40. 35. Apical tooth of amphigastrium (smaller one), ×310. 36. Median cells of amphigastrium, ×310. 37. Basal cells of amphigastrium, ×310.

Figs. 1-19 were drawn from specim. *S. Hattori 7805*-paratype; the others from *K. Okada 43*; all drawn by M. Mizutani.

ovate or oblong, homogeneous and glistening, 6–8×6–20 μ (usually about 7–12 μ), long oil-bodies occasionally partite or constricted, so that they appear to be fused with small ones at both edges; hyaline cells of amphigastria entirely lacking oil-bodies, but inner (-basal) cells containing several small oil-bodies together with many chloroplasts.

Type loc. Japan, lacking definite locality (leg. Siebold; Pompe van Meerdervoort). Hab. on rocks covered with humus, on banks and occasionally on stumps and decayed wood, in more or less shaded, moist places, usually forming loose mats, at low elevations; common in south-eastern Japan, less frequent northward and its northernmost known station is nr. Sendai, n. Honshu. Range: Japan (Honshu, Shikoku, Kyushu).

This rather magnificent species is known from Japan between 31–38° N. Lat. and nowhere else, and is regarded as a representative of Japanese Lepidoziaceae. Formosan *B. magna* Horikawa seems to be closely related to it. However, the hyaline cells of amphigastria are limited to several marginal rows. Boreal *B. trilobata* has amphigastria whose 1–2 rows of marginal cells are often hyaline and leptodermal. Ihsiba (1934) described a variety of *B. pompeana* from Sakhalin. But *B. pompeana* would never grow in such a northern locality. His material certainly belongs to *B. trilobata*.

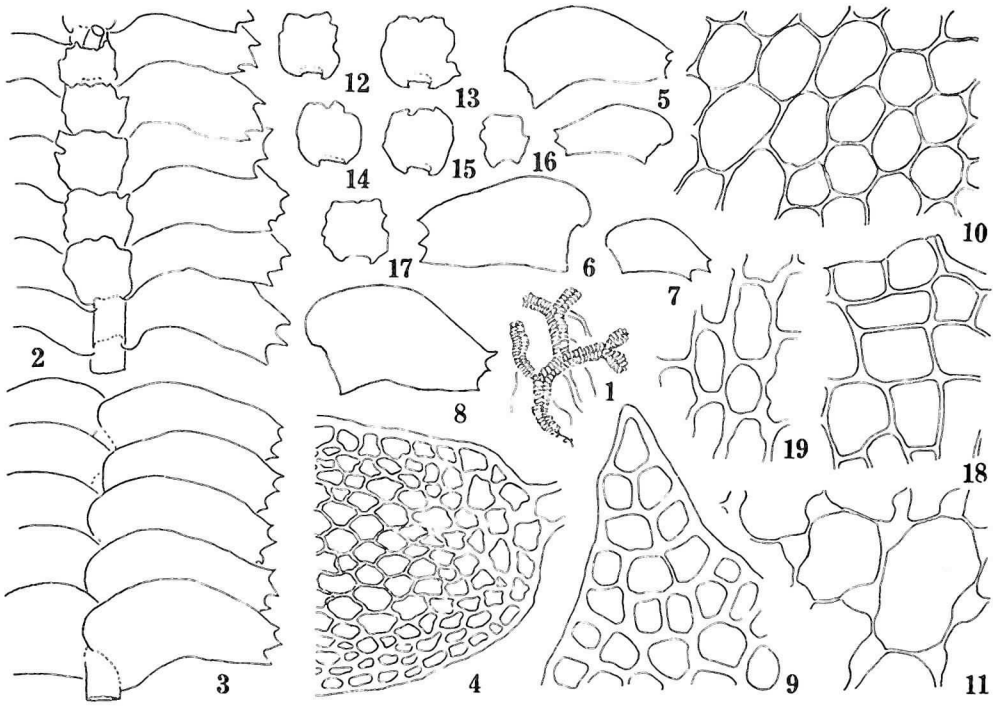
Bazzania albicans Steph. (Fig. X, 1–27)

Hedwigia **32**: 204 (1893). Syn. *Mastigobryum albicans* Steph. Spec. Hepat. **3**: 465 (1908).——*M. nagasakiense* Steph. loc. cit.——*M. takeanum* Steph. loc. cit., pro parte (incl. typ.).——*M. tenuistipulum* Steph. Spec. Hepat. **3**: 466 (1908).——*Bazzania tenuistipula* Steph. in Yasuda, Shokubutsugaku Kakuron, Inkwabu, 711 (1911).——*Mastigobryum brevidens* Steph. Spec. Hepat. **6**: 456 (1924), *syn. nov.*——*M. coreanum* Steph. Spec. Hepat. **6**: 470 (1924), *syn. nov.*——*M. koyasanum* Steph. Spec. Hepat. **6**: 471 (1924), *syn. nov.*——*M. okamuranum* Steph. Spec. Hepat. **6**: 475 (1924), *syn. nov.*——*Bazzania coreana* (Steph.) Hatt. Jour. Jap. Bot. **19**: 345, *f. 21* (1943).——*B. albicans* fo. *flavida* Hatt. Bull. Tokyo Sci. Mus. **11**: 12, *f. 3–5* (1944).——*B. tridens* var. *nipponica* Hatt. et fo. *subtridens* Hatt. Bull. Tokyo Sci. Mus. **11**: 21–23, *f. 12–13* (1944).——*B. brevidens* (Steph.) Hatt. Bot. Mag. Tokyo **59**: 26 (1946), *syn. nov.*——*B. koyasana* (Steph.) Hatt. Bot. Mag. Tokyo **59**: 29 (1946), *syn. nov.*——*B. nagasakiensis* (Steph.) Hatt. loc. cit., *syn. nov.*——*B. okamurana* (Steph.) Hatt. loc. cit., *syn. nov.*——*B. albicans* var. *intermedia* Hatt. Jour. Hattori Bot. Lab. **2**: 12, *f. 4* (1947).——*B. minutissima* Kamimura, Contr. Hepat. Fl. Shikoku. 23, *pl. 1, l–o* (1952), *syn. nov.*——*Mastigobryum tridens* [non (R. B. et N.) Lindenb.] auct. (quoad plant. Japon.): Sande Lacoste in Miquel, Ann. Mus. Bot. Lugd.-Bat. **1**: 303 (1863/64) & Prol. Fl. Jap. 391 (1867); Steph. Spec. Hepat. **3**: 442 (1908), p.p.; T. Ito, Fl. Mieken 800 (1932).——*Bazzania tridens* [non (R. B. et N.) Trev.] auct. (quoad plant. Japon.): Mitt. Trans,

Fig. X.

1–27. ***Bazzania albicans*** Steph. 1. Plant, ×1. 2. Part of caulid, ventral view, ×13. 3. Do., dorsal v., ×13. 4. Cross-section of caulid, ×150. 5–8. Phyllids, ×13. 9. Apical tooth of phyllid, ×310. 10. Median cells of phyllid, ×310. 11. Basal cells of phyllid, ×310. 12–17. Amphigastria, ×13. 18. Apical portion of amphigastrium, ×310. 19. Basal cells of amphigastrium, ×13. 20–27. Phyllids and amphigastria, ×13.
28. ***Bazzania oshimensis*** (Steph.) Horik. 28. Phyllids and amphigastria, ×13.

Figs. 1–19 were drawn from specim. *S. Hattori 18849*; fig. 20 from the type of *B. albicans*; fig. 21 from the type of *Mastigobryum coreanum*; fig. 22 from the type of *M. brevidens*; fig. 23 from the type of *M. okamuranum*; fig. 24 from the type of *M. nagasakiense*; fig. 25 from *Faurie 1336* (det. Stephani as *M. takeanum*); fig. 26 from the type of *M. tenuistipulum*; fig. 27 from Makino's collection (det. Stephani as *B. tridens* N.); fig. 28 from the type of *M. oshimense*; all drawn by M. Mizutani.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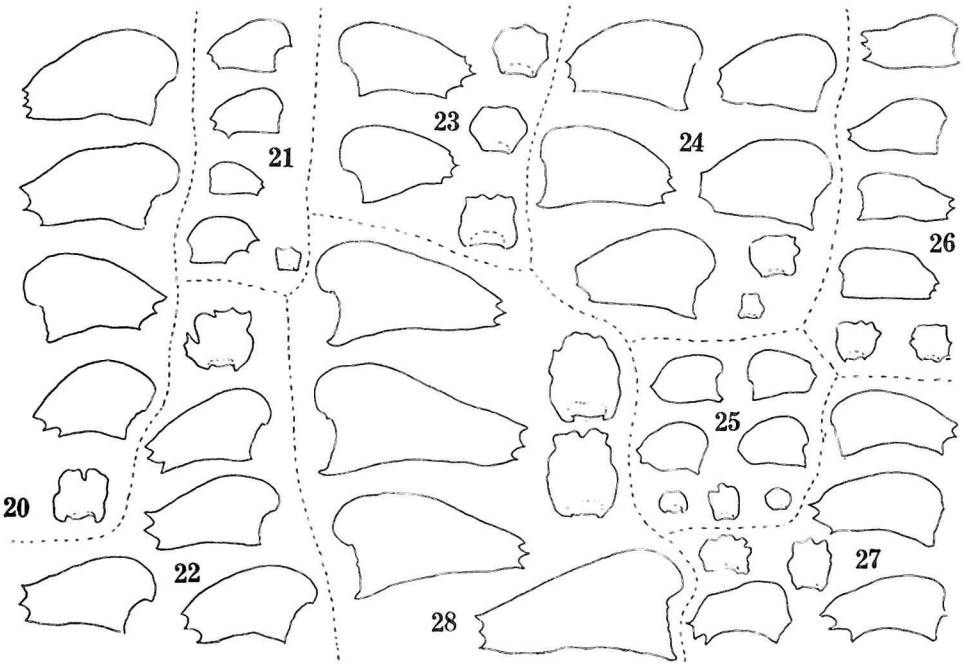
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Linn. Soc. London, ser. 2, **3**: 200 (1891); Steph. Bull. Herb. Boiss. **5**: 78 (1897); Makino, Bot. Mag. Tokyo **11**: 34 (1897); Steph. Spec. Hepat. **3**: 442 (1908), p.p.——*Mastigobryum ceylanicum* (non Mitt.) auct. (quoad plant. Japon.): Inoue, Bot. Mag. Tokyo **15**: 92 (1901).——*Bazzania ceylanica* [non (Mitt.) Nichols.] auct. (quoad plant. Japon.): Hatt. Bull. Tokyo Sci. Mus. **11**: 14, *f. 6-7* (1944); Jour. Hattori Bot. Lab. **7**: 40 (1951), cum not. (Exsiccata) Hatt. Hepat. Japon. ser. **1**: 2 (1946); **7**: 302 (1956); **8**: 352 (1956).

Plants in pale, yellowish or brownish green patches; 1.5–4 mm. wide. Caulid to 5 cm. long, 0.2–0.4 mm. in diameter, brownish, prostrate to ascending, furcately branched, branches somewhat circinate at apex, with several postical flagella which are rarely branched, rhizoids mostly limited to tips of flagella; cross-section of caulid elliptical, outer cells thick-walled and smaller than the inner ones. Phyllids alternate, imbricate, slightly convex, obliquely inserted, horizontally spreading, somewhat deflexed in drying, not decurrent, oblong-ovate, usually 1.3–1.7 mm. long (seldom up to 2 mm. or only 1 mm. long), 0.7–1 mm. wide (seldom to 1.3 mm. or only 0.5 mm. wide), antical base more or less strongly arched, antical margin arcuate, postical slightly sinuose or nearly straight, apex truncate and tridentate, usually 0.3–0.6 mm. wide, teeth triangular, acute, sinus acute or somewhat sinuate; basal cells of phyllids nearly oblong, up to $40\times60\,\mu$, thin-walled, trigones mostly large, acute, median cells rectangular, $20\text{–}30\times25\text{–}40\,\mu$, trigones smaller than the basal ones, apical and marginal cells subquadrate, $12\text{–}20\,\mu$, thick-walled, cuticle smooth or nearly so. Amphigastria hyaline and delicate in texture, appressed to caulid, slightly imbricate to contiguous, about twice as wide as the caulid, rotundate-quadrate, usually 0.5–0.8 mm. long and wide, apex rounded-truncate, nearly entire or repand, occasionally with few small teeth, margins entire or repand; cells (excluding basal portion) hyaline and leptodermal, quadrate to rectangular, $20\text{–}30\times20\text{–}50\,\mu$, trigones entirely lacking; basal cells smaller, in several rows along insertion, occupying 1/20–1/10 the amphigastria, $15\text{–}20\times15\text{–}30\,\mu$, thick-walled, obscure with chloroplasts and oil-bodies 2–12 (mostly 4–6) per cell, orbicular, about $5\,\mu$ in diameter, or ovate and about $7\times10\text{–}12\,\mu$, or oblong and up to $9\times18\,\mu$ in size, homogeneous and glistening, but faint, irregular net-like shadow often observed; oil-bodies few and smaller (merely $3\,\mu$ in diameter) and often nearly lacking in cells at apex and along margin; in hyaline cells of amphigastria oil-bodies entirely lacking.

Type loc. Saijoji, Japan (Dr. Karl Müller Halle no. 14-type in hb. G). Hab. on rock-walls, ledges and cliffs, soil-banks and cuts, bases and lower trunks of trees, stumps and decaying wood, forming small or often extensive patches in shady, moist to more or less sunny, dry places at low elevations in Japan; rare in northern Honshu and not occurring in Hokkaido. Range: Japan (Honshu, Shikoku, Kyushu, Ryukyu), Formosa, Korea, China.

The specific epithet '*albicans*' may refer to its occasionally whitish shoot-tips. In the type specimen we observed some such tips which were thought to be caused by injurious environmental factors such as drying and frost. Such whitish shoot-tips are very rare both in field and herbaria.

B. albicans may be the most frequent and most variable species of the family in our area, as shown by its extensive synonymy. The following 4 major groups will be recognized, although a number of intermediates occur between them:

1) The first group is small in size, clearly olive-green in color, somewhat glossy but brownish when dried. Its phyllids are small, nearly linear, that is, with apex slightly narrower than base. This form seems to be limited to the southern-

most end of our area, and on Yakushima Island it is especially common in lowland forests. Formerly this group was mostly identified as *B. ceylanica*.

2) The second form is large in size, forming rather loose green or yellowish green patches on decaying wood, humus-covered rocks or similar substrata in montane forests in south-western Japan. Its amphigastria tend to be more or less elongate. For this form several taxa were described (such as *B. albicans* var. *intermedia* Hatt.=fo. *flavida* Hatt.=*B. tridens* var. *nipponica* Hatt. and its forma *subtridens*). *B. oshimensis* may be the extreme form of this type, and may possibly be regarded as a localized vicariant of *B. albicans*.

3) The third form is most widely distributed in our area. The type specimen and most species cited in synonymy are included to this form. It occurs usually on bark of trees, tuff-cliffs, soil-banks and cuttings, when not so shady or damp. *Mastigobryum tenuistipulum*, *M. okamuranum*, *M. nagasakiense*, *M. takeanum*, *p. p.* and *M. coreanum* are small plants of this form. Caducous phyllids are occasionally observed in this form, possibly caused by drying and/or other unsuitable conditions.

4) The fourth form occurs in the montane districts of the northernmost part of the range of this species. Plants are as large as in the second form or even larger, and are green in color. Remarkable characteristics are the more or less toothed apex of amphigastria, and large phyllids with wide apex (about 2 mm. long, 1.2 mm. wide at base, 0.5–0.8 mm. wide at apex). The substrata include bases of trees, particularly of *Cryptomeria japonica*, decaying wood and humus-covered rocks beneath forests. Hattori once suggested a varietal name '*major*' for this form. It may be notable that *B. pompeana* does not occur in the area of this form and this form is the nearest to *B. pompeana* among the four.

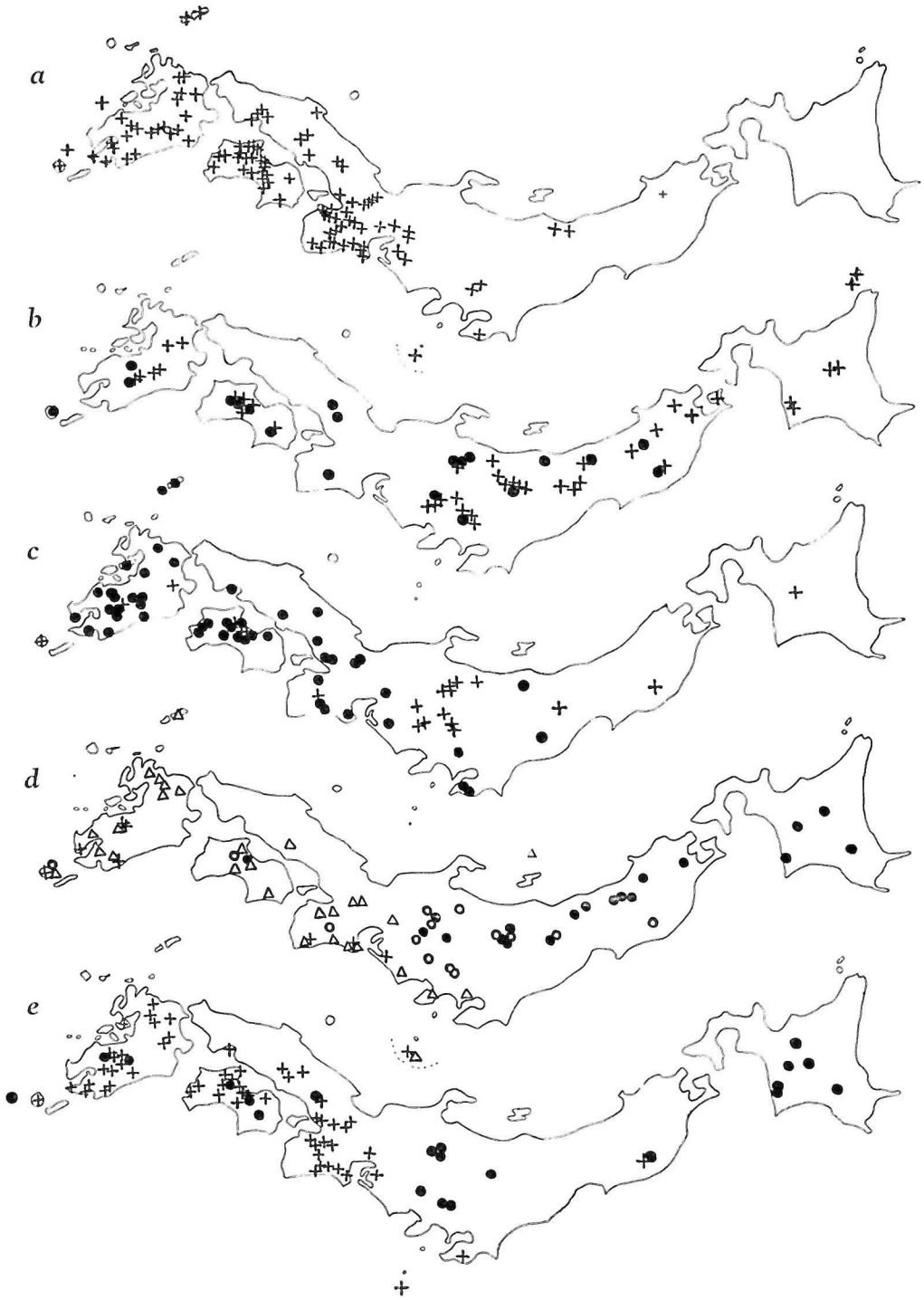
Also depauperate plants are often found on bark of trees. In such extremes, phyllids are often caducous, less than 0.5 mm. in length and mostly simply acute at apex, flagella are very poorly developed, and rhizoids are often seen on the base of the amphigastrium. *B. minutissima* is such an extreme form. These plants, however, are certainly habitat modifications, caused by severe conditions on trees, and may be included in the third form.

B. albicans seems to be of tropical origin. Paleotropic *B. intermedia* (G. et L.) Trev., *B. tridens* (R. B. et N.) Trev., and *B. formosae* (Steph.) Horik. are among its allied species. However, the most clearly related species may be *B. oshimensis* which occurs, although very rare, in the southern part of our area. We may, however, regard *B. oshimensis* as conspecific with *B. albicans*, uniting it through the second form of the latter. *B. oshimensis* is separable from the second form of *B. albicans* only by its elongate amphigastria.

Bazzania oshimensis (Steph.) Horikawa (Fig. X, 28)

Jour. Hiroshima Univ. ser. b, 2, **2**: 197 (1934). Syn. *Mastigobryum oshimense* Steph. Spec. Hepat. **3**: 466 (1908).

Plants in large, yellowish green or green, but brownish when dry, patches; 3–4 mm. wide. Caulid to 7 cm. long, 0.4–0.5 mm. in diameter, green, prostrate to ascending, furcately branched, branches somewhat circinate at apex, with several, occasionally branched postical flagella, rhizoids almost restricted to flagella-tips. Phyllids imbricate, convex, horizontally spreading, more or less strongly deflexed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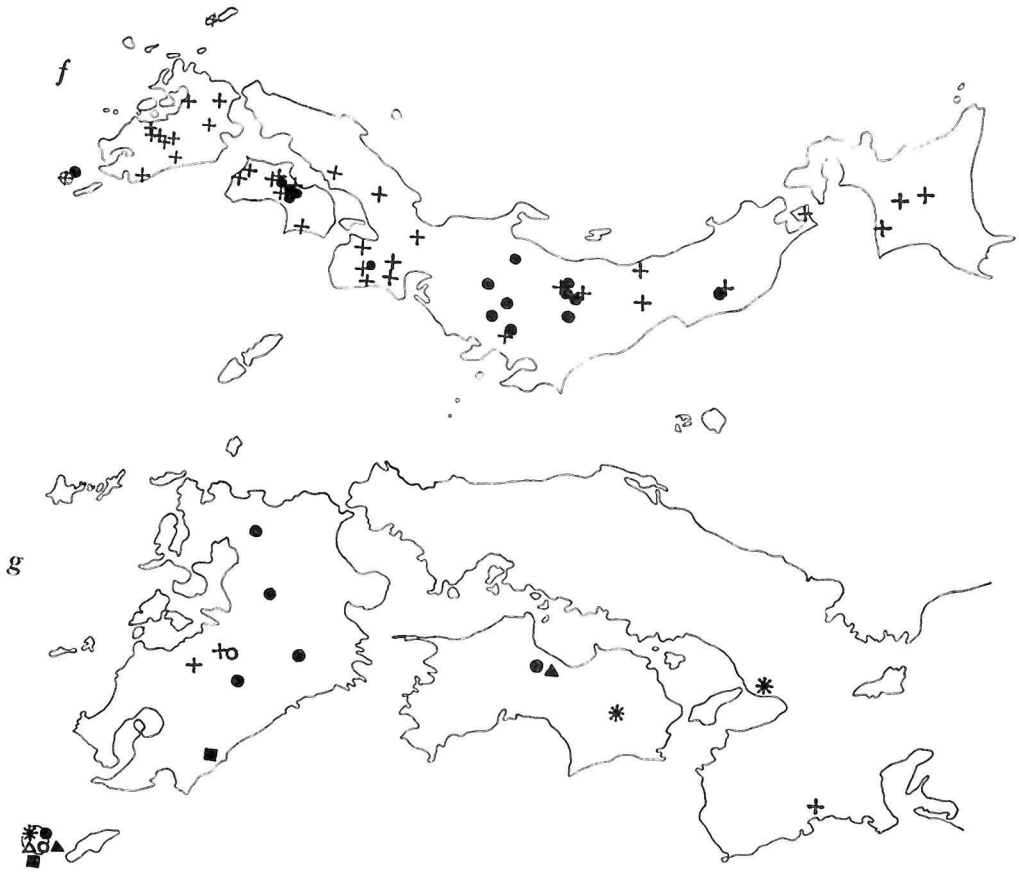

Maps a-g. Distribution of species in Japan.

a. + *Bazzania albicans.*
b. ● *B. bidentula,* + *B. denudata* subsp. *ovifolia.*
c. ● *B. pompeana,* + *B. tricrenata.*
d. ● *B. trilobata,* + *B. fauriana,* ○ *B. yoshinagana,* △ *B. japonica.*
e. ● *Lepidozia reptans,* + *L. vitrea.*
f. ● *L. filamentosa,* + *Microlepidozia makinoana.*
g. ● *Bazzania pearsonii,* + *B. mayebarae,* ○ *B. kanemarui,*
△ *B. yakushimensis,* ▲ *B. oshimensis,* ✻ *Lepidozia wallichiana,*
■ *L. fauriana.*

when dry, obliquely inserted, not decurrent, almost falcate *in situ*, ovate-oblong, 2–2.2 mm. long, 1.1–1.2 mm. wide at base, antical margin from strongly arched base widely arcuate, postical margin slightly sinuate, narrowed towards apex, apex 0.35–0.4 mm. wide, strongly tridentate, teeth large, triangular, acute, sinus acute or obtuse; apical cells of phyllids 15–20 μ, subquadrate, thick-walled, basal cells 28–35 $\times$50–60 μ, rectangular, walls thin, trigones large, acute or more or less nodulose, cuticle nearly smooth. Amphigastria hyaline and delicate in texture, more or less

densely imbricate, nearly transversely inserted, appressed to caulid, subrectangular, twice as wide as the caulid, about 1.5 times as long as wide, 1.2–1.3 mm. long, 0.8–0.85 mm. wide, apex subtruncate, irregularly repand or slightly 2–3-lobate, margins similarly repand; cells hyaline and leptodermal, mostly subquadrate, 15–25 μ, trigones entirely lacking, basal cells obscure with chloroplasts and oil-bodies, thick-walled, 15–20 × 30 μ, trigones large, the same as in phyllids. Oil-bodies unknown.

Type loc. Isl. Amami-oshima, Kagoshima Prefecture, southernmost Japan. Ehime: Mt. Higashi-akaishi, ca. 1400 m.s.m. on serpentine covered with humus and bases of *Chamaecyparis obtusa*, *H. Inoue 1461*. Kagoshima: Isl. Yakushima, Kosugi valley, 700–800 m.s.m. *S. Hattori 8288*,—ca. 1700 m.s.m. on granitic rocks covered with humus, *Y. Nishihara 638*; Isl. Amami-oshima, *U. Faurie 639*-schizotype in hb. KYO. Seemingly very rare and restricted to the southern part of our area. Range: Japan (Shikoku, Kyushu, Ryukyu).

The illustration of this species was given by Hattori (1943, p. 246, *f. 22*), based on the original material kept in the herbarium of Kyoto University. As already discussed by Hattori (1947, p. 17, *f. 4, a–d*; 1952, p. 41) this species is closely related to, and the local vicariant species of, *B. albicans*. The diagnostic characteristics of this species are its large size of plants, long phyllids (2–2.2 mm.) with narrowed and rather strongly tridentate apex (0.35 mm. wide) and particularly the elongate amphigastria (1.3 mm. long, 0.85 mm. wide) which are hyaline and delicate in texture.

Species whose records are uncertain

Microlepidozia setacea (Mitt.) Joerg. was recorded as in Japan under the genus *Lepidozia* by Mitten (1891, p. 199), Stephani (1897, p. 80), Inoue (1898, p. 74), Horikawa (1934, p. 202), Hattori (1944, p. 25) and others. However, as mentioned by Hattori (1947, p. 22–24), most of them are surely identical with *Microlepidozia makinoana*. We do not find true *M. setacea* occurring in Japan, although geographically it may be possible that *M. setacea* does grow in the northern or upland districts in Japan.

Bazzania ceylanica (Mitt.) Nichols. was also recorded in our area by Yoshinaga (1901, p. 92, under *Mastigobryum*) and Hattori (1944, p. 14). However, Hattori (1952, p. 40) doubted the identity of Japanese plants with those of Ceylon, the type locality. In this paper we treat these Japanese materials as a form of *B. albicans*. Recently we studied the type material of *B. ceylanica* which proved to be quite different taxon from the Japanese plant formerly identified with it. The true *B. ceylanica* has firm amphigastria as in *B. japonica* and its allies. The amphigastria are cuneiform-quadrate in shape and irregularly dentate at apex. We could not find no Japanese collections identical with *B. ceylanica*.

Bazzania cordifolia (Steph.) was once recorded by Inoue (1900, p. 39), referring to his collection (no. 22, Sept. 1898) made on Mt. Gozaisho in Prov. Tosa. The identification was made by Stephani to whom Inoue sent the duplicate. Stephani (1908, p. 427) cited Japan as the habitat of this species. We found a collection made by U. Faurie on Mt. Jizogadake near Kofu (no. 1312, July 1903) and so identified by Stephani. Hattori (1952, p. 40) treated the Japanese material recorded as *B. cordifolia* as identical with *B. fissifolia* var. *subsimplex* which is included in synonymy of *B. tricrenata* in this paper. We also examined the above-cited two collections, which proved to be identical with *B. tricrenata*. *B. cordifolia* is a little

known species only found in Yunnan. Its type specimen (leg. Delavay) has not yet been studied.

Bazzania sinensis (Gott.) Steph. was recorded as occurring in Japan by Stephani (1897, p. 78), Makino (1897, p. 34, after Stephani's determination) and Ihsiba (1936, p. 190). However, we regard these records as erroneous identifications by Stephani who did not cite Japan for its habitat in his 'Species Hepaticarum' vol. 3, p. 506 (1908). We examined Makino's collection (Nov. 1895, in hb. TSM, no. 21065) on which the former two records were based, and found it to be *B. albicans*, but not *B. sinensis*, as Hattori (1952, p. 41) suggested earlier.

Bazzania tridens (R. B. et N.) Trev. has been recorded several times in Japan. We consider, however, all the Japanese material referred to *B. tridens* to be conspecific with *B. albicans*. As for the affinity of the two species we wish to reserve our opinion until ample Indomalayan collections (incl. Himalayas) of *B. tridens* can be obtained.

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MUSCI JAPONICI EXSICCATI SER. 7-12
Alphabetical List of Species

By A. NOGUCHI[1] and S. HATTORI[2]

野口 彰・服部新佐: 日本蘚類標本第 7-12 集 ABC 順種名目録

Andreaea nivalis Hook. (Andreaeaceae) On andesite rocks submerged in stream, 2600–2700 m.[3], Mt. Ontake, Nagano, *N. T.*[4] *ser. 8, no. 351*; *ser. 12, no. 551.*

A. rupestris Hedw. var. *fauriei* (Besch.) Takaki On andesite rocks, 2890 m., Mt. Yatsu, Nagano, *N. T. ser. 9, no. 401*; on volcanic rocks, 1950 m., Mt. Daisetsu, Hokkaido, *Y. K. ser. 12, no. 552.*

Anisothecium rufescens (Dicks.) Lindb. (Dicranaceae) On wet rocks and cliff, 100 m., Hitoyoshi, Kumamoto, *K. M. ser. 8, no. 352*; *ser. 9, no. 402.*

Anomodon apiculatus Bryol. eur. (*ser. 7, no. 301*)→*A. rugelii* !

A. armatus Broth. (*ser. 7, no. 302*)→*A. longifolius* !

A. decurrens Card. (Thuidiaceae) On exposed limestones, 400 m., Mt. Kaharu, Fukuoka, *A. N. ser. 10, no. 451.*

A. giraldii C. Müll. On dry rocks, Kamuikotan, Hokkaido, *A. N. ser. 12, no. 553.*

A. longifolius (Schl.) Hartm. On trees, 300 m., Kamuikotan, Hokkaido, *A. N. ser. 7, no. 302.*

A. rugelii (C. M.) Keissl. On bark, 700 m., Sounkyo, Hokkaido, *A. N. ser. 7, no. 301*; on base of *Quercus*, 1300 m., Mt. Tateyama, Toyama, *Z. I. ser. 12, no. 554.*

Archidium japonicum Broth. (Archidiaceae) On moist soil, 10 m., Obi, Miyazaki, *M. M. ser. 12, no. 555.*

Astomum crispum (Hedw.) Hampe (Pottiaceae) On soil in pot, Fuchu, Tokyo, *U. M. ser. 10, no. 452.*

Atrichum undulatum (Hedw.) Beauv. (Polytrichaceae) On semishaded soil bank, 1600 m., Mt. Norikura, Gifu, *S. H. ser. 12, no. 556.*

A. undulatum var. *haussknechtii* (Jur. et Milde) Frye On andesite, 2050 m., Mt. Yatsu, Nagano, *Z. I. ser. 10, no. 453.*

Aulacomnium heterostichum (Hedw.) B. S. G. (Aulacomniaceae) On rotten logs in shade, 700 m., Mt. Meakan, Hokkaido, *A. N. ser. 11, no. 501.*

A. palustre Schwaegr. Wet sandy soil, Tsuiji, Niigata, *Y. I. ser. 9, no. 403.*

Barbella pendula (Sull.) Fleisch. (Meteoriaceae) Pendulating on twigs of shrubs, 20 cm., Obi, Miyazaki, *Z. I. & M. M. ser. 11, no. 502.*

Barbula gigantea Funck (Pottiaceae) On sandy limestone cliff, 1850 m., Chichibu, Saitama, *I. N. ser. 11, no. 503.*

B. reflexa (Brid.) Brid. On limestones, 700 m., Nippara, Tokyo, *U. M. ser. 9, no. 404*; on wet rocks, 1200 m., Misaka-pass, Yamanashi, *M. M. ser. 12, no. 557.*

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[1] Department of Biology, Faculty of Science, Kumamoto University; also Hattori Botanical Laboratory. [2] Hattori Botanical Laboratory. [3] *Altit. supra mare.*

[4] Initials of collector's name.—*Cf.* List of collector!

B. unguiculata Hedw. On calcareous rocks, 80 m., Koonose, Kumamoto, *K. M. ser. 9, no. 405*; on soil, Ofuki, Ehime, *K. O. ser. 10, no. 454.*

Brachymenium exile (Doz. et Molk.) Doz. et Molk. (Bryaceae) On sunny stone wall, 10 m., Oita, *A. N. ser. 9, no. 406.*

Brachythecium buchanani (Hook.) Jaeg. (Brachytheciaceae) Base of concrete wall and on loamy soil, Asakawa, Tokyo, *U. M. ser. 12, no. 558.* *Ser. 7, no. 303* should be *B. flagellare* !

B. eustegium Besch. On rotten logs beneath forest, 450 m., Nishitap, Hokkaido, *T. Yo. ser. 8, no. 353.*

B. flagellare (Hedw.) Jenn. On rocks, 600 m., Hitoyoshi, Kumamoto, *K. M. ser. 7, no. 303*,—labeled, *B. buchanani.*

B. helminthocladum Broth. et Par. On rocks, 100 m., Hitoyoshi, Kumamoto, *K. M. ser. 7, no. 304*; *ser. 9, no. 407.*

B. reflexum (Starke) B. S. G. On humus-covered rocks, 1000 m., Mt. Yubari, Hokkaido, *T. C. ser. 10, no. 455.*

B. rivulare B. S. G. On earth beneath *Larix* woods, 350 m., nr. Asahigawa, Hokkaido, *T. C. ser. 9, no. 408.*

B. uncinifolium Broth. et Par. Coniferous forest floor, 2600 m., Mt. Yatsu, Nagano, *D. S. ser. 12, no. 559.*

B. wichurae (Broth.) Par. On bank, 100 m., Isshoochi, Kumamoto, *K. M. ser. 12, no. 560.*

Breidleria arcuata (Lindb.) Loeske (Hypnaceae) Damp soil, 100 m., Nishinomura, Kumamoto, *K. M. ser. 7, no. 305.*

B. homaliacea (Besch.) Broth. On rocks, 600 m., nr. Hitoyoshi, Kumamoto, *K. M. ser. 12, no. 561.*

Brothera leana (Sull.) C. Müll. (Dicranaceae) On bark of *Cryptomeria*, Mt. Mitake w. of Tokyo, *U. M. ser. 9, no. 409*; on conifers, 100 m., Hitoyoshi, Kumamoto, *K. M. ser. 12, no. 564.*

Brotherella henonii (Dub.) Broth. (Sematophyllaceae) On *Cryptomeria* trunks, Mt. Myogi, Gumma, *U. M. ser. 7, no. 306*; on rocks, 160 m., Koonose, Kumamoto, *K. M. ser. 9, no. 410.*

Bruchia microspora Nog. (Dicranaceae) On muddy soil, 100 m., Kinoye, Kumamoto, *K. M. ser. 8, 354*; *ser. 12, no. 565.*

Bryhnia sublaevifolia Broth. et Par. (Brachytheciaceae) On damp soil, 1200 m., Ichibu, Kumamoto, *K. M. ser. 12, no. 562.*

B. trichomitria Dix. et Thér. On rocks, 600 m., nr. Hitoyoshi, Kumamoto, *K. M. ser. 12, no. 563.*

Bryoxiphium savatieri (Husn.) Mitt. (Bryoxiphiaceae) Overhanging granitic cliff, 2200 m., Mt. Kisokoma, Nagano, *D. S. ser. 11, no. 504.*

Bryum caespiticium Hedw. (Bryaceae) On boulders, 100 m., Hitoyoshi, Kumamoto, *K. M. ser. 11, no. 506.*

B. capillare Hedw. var. *nagasakense* (Broth.) Ochi (*ser. 11, no. 505*)→var. *rubrolimbatum* !

B. capillare Hedw. var. *rubrolimbatum* (Broth.) Bartr. On concrete, Tottori, *H. O. ser. 11, no. 505.*

B. coronatum Schwaegr. On soil, 150 m., Yoshio, Kumamoto, *K. M. ser. 11, no. 507.*

B. erythrocarpum Schwaegr. On moist rocks and on bank, 100 m., Ono nr. Hitoyoshi, Kumamoto, *K. M. ser. 10, no. 456*; *ser. 12, no. 566*.

B. higoense Ochi Abandoned charcoal-kiln, 200 m., nr. Hitoyoshi, Kumamoto, *K. M. ser. 12, no. 567*.

B. pallescens Schleich. On soil in rocky place, Ryogase, Niigata, *Y. I. ser. 11, no. 508*.

B. wichurae Broth. On moist rocks, 300 m., Hitoyoshi, Kumamoto, *K. M. ser. 10, no. 457*.

Buxbaumia aphylla Hedw. (Buxbaumiaceae) On semishaded bank, 1500–2000 m., Mt. Ontake, Nagano, *N. T. et al. ser. 11, no. 509*.

Calliergonella cuspidata (Brid.) Loeske (Amblystegiaceae) On semishaded, damp chert, 1250 m., Mt. Ontake, Nagano, *N. T. et al. ser. 10, no. 458*.

Calyptothecium japonicum Thér. (Neckeraceae) On semishaded rocks, 500 m., Isl. Tokunoshima, Kagoshima, *T. S. ser. 10, no. 459*.

Campylium chrysophyllum (Brid.) Bryhn (Amblystegiaceae) On bank, 200 m., Koonose, Kumamoto, *K. M. ser. 7, no. 307*; on limestones, 60 m., Agekawa, Niigata, *Y. I. ser. 10, no. 460*; on calcareous rocks, 100 m., Isshoochi, Kumamoto, *K. M. ser. 12, no. 568*.

C. stellatum (Schreb.) Lang. et C. Jens. On moist limestones in shade, 500 m., Rashomon, Okayama, *A. N. ser. 9, no. 411*.

Campylopodium euphorocladum (C. Müll.) Besch. (Dicranaceae) On tuff exposed and drying, 300 m., Sakurajima Volcano, Kagoshima, *T. S. ser. 7, no. 308*.

Claopodium microphyllum (C. Müll.) Broth. var. *septentrionale* Card. (*ser. 9, no. 412*)→*C. prionophyllum* var. *septentrionale* !

C. prionophyllum (C. Müll.) Broth. var. *septentrionale* Card. (Thuidiaceae) On calcareous rocks, 150 m., Koonose, Kumamoto, *K. M. ser. 9, no. 412*.

Clastobryum katoi Broth. (Sematophyllaceae) On tombstones beneath *Cryptomeria* forest, 800 m., Mt. Koya, Wakayama, *Z. I. & M. M. ser. 12, no. 569*.

Coscinodon cribrosus (Hedw.) Spruce (Grimmiaceae) On exposed, dry rocks, 1700 m., Mt. Sobo, Oita, *A. N. ser. 10, no. 461*.

Cratoneuron filicinum (Hedw.) Broth. (Amblystegiaceae) In patches on coniferous forest floor, 2330 m., Mt. Yatsu, Nagano, *D. S. ser. 7, no. 309*; on swampy grassland along river, 1100 m., Miwa, Nagano, *N. T. ser. 11, no. 510*.

Cryphaea obovatocarpa Okamura (Cryphaeaceae) On *Morus alba*, 400 m., Tomisu, Hyogo, *Y. T. ser. 9, no. 413*.

Ctenidium homalophyllum Broth. et Yas. (Hypnaceae) On rocks, 300 m., Isshoochi, Kumamoto, *K. M. ser. 11, no. 511*.

Cyathophorella hookeriana (Griffith) Fleisch. (Hypopterygiaceae) On semishaded rock-face, 300 m., Miwa, Aichi, *Z. I. ser. 10, no. 462*.

Cynodontium polycarpum Schpr. (Dicranaceae) On semishaded clay bank, 2850 m., Mt. Ontake, Nagano, *N. T. et al. ser. 8, no 355*. *Ser. 9, no. 414* should be *Oreoweisia laxifolia* !

Cyptodontopsis obtusifolia (Nog.) Nog. (Cryphaeaceae) On branches of *Rhododendron* side of Kagami riv., 120 m., Tosayama, Kochi, *T. Y. ser. 9, no. 415*; on twigs of *Rhododendron* along rapid stream, Furikusa, Aichi, *N. T. ser. 12, no. 570*.

Dendrocyathophorum paradoxum (Broth.) Dix. (Hypopterygiaceae) On shale beneath

Cryptomeria woods, 300 m., Izumi, Kagoshima, *M. M. ser. 11, no. 512.*

Dicranella tosaensis Broth. (Dicranaceae) On exposed clayey soil, 15 m., Nichinan, Miyazaki, *A. I. & C. M. ser. 8, no. 356*; on damp tuffaceous sand, 20 m., Nichinan, Miyazaki, *D. S. ser. 10, no. 463.*

Dicranodontium denudatum (Brid.) Hag. (Dicranaceae) On decaying wood, 600 m., Iino, Kumamoto, *K. M. ser. 8, no. 357.*

Dicranum hamulosum Mitt. (Dicranaceae) Beneath conifers, 2600 m., Mt. Yatsu, Nagano, *D. S. ser. 8, no. 358.*

D. majus Smith. Humus in shade, 1000 m., Mt. Daisetsu, Hokkaido, *A. N. ser. 7, no. 310.*

D. perindutum Card. (*ser. 8, no. 358*)→*D. hamulosum* Mitt.

D. rugosum Brid. Beneath conifers, 2600 m., Mt. Yatsu, Nagano, *D. S. ser. 8, no. 359*; on soil, 25 m., Kinoto, Niigata, *Y. I. ser. 12, no. 571.*

D. undulatum Ehrh. (*ser. 8, na. 359*)→*D. rugosum* !

Distichophyllum maibarae Besch. (Hookeriaceae) On wet rocks, 600 m., Hitoyoshi, Kumamoto, *K. M. ser. 8, no. 360*; on moist rocks beneath forest, 360 m., Mt. Miyagi, Aichi, *N. T. ser. 10, no. 464.*

Ditrichum pallidum (Hedw.) Hampe (Ditrichaceae) On soil, 700 m., Hitoyoshi, Kumamoto, *K. M. ser. 8, no. 361.*

Dolichomitra cymbifolia (Lindb.) Broth. var. *subintegerrima* Okamura (Lembophyllaceae) On decaying logs, 1700 m., Chichibu, Saitama, *D. S. ser. 7, no. 311*; on rotten logs, 750 m., nr. Hitoyoshi, Kumamoto, *K. M. ser. 11, no. 513.*

Dozya japonica Lac. (Leucodontaceae) On trees, Hongusan, Aichi, *N. T. ser. 8, no. 362.*

Drepanocladus exannulatus (Gumb.) Warnst. (Amblystegiaceae) submerged, 1400 m., Oze-bog, Fukushima, *U. M. ser. 8, no. 363.*

D. fluitans (Hedw.) Warnst. In bog nr. hot spring, 2400 m., Mt. Tateyama, Toyama, *Z. I. ser. 12, nos. 572/4.*

D. japonicus Dix. Seaside marsh, Isl. Tomogashima, Wakayama, *T. Ko. ser. 10, no. 465.*

D. uncinatus (Hedw.) Warnst. On tree-trunks and -bases in shade, 800 m., Mt. Daisetsu, Hokkaido, *A. N. ser. 9, no. 416.*

Duthiella flaccida (Card.) Broth. (Trachypodaceae) On moist rocks, 100 m., nr. Hitoyoshi, Kumamoto, *K. M. ser. 12, no. 575.*

D. pellucens Card. et Thér. On wetty shale cliff, 150 m., Sakatani, Miyazaki, *M. M. ser. 11, no. 514.*

Entodon challengeri Par. (Entodontaceae) On rocks, 150 m., Hitoyoshi, Kumamoto, *K. M. ser. 7, no. 312.*

E. chloroticus Besch. On rocky ledge, 600 m., Hitoyoshi, Kumamoto, *K. M. ser. 8, no. 364.*

E. curvatiramens Card. On wet rocks, 120 m., Nishinomura, Kumamoto, *K. M. ser. 12, no. 576.*

E. drummondii (B. et S.) Jaeg. On large *Shiia* trunk, 100 m., Dazaifu, Fukuoka, *T. O. ser. 12, no. 577.*

E. tereticaulis Nog. (*n. sp.*) On moist shale boulders, 300 m., Izumi, Kagoshima, *M. M. ser. 12, no. 578.*

E. tosae Besch. On shady rocks, 700 m., Obira, Oita, *A. N. ser. 10, no. 466.*

Epipterygium nagasakense Broth. (Bryaceae) On bank in woods, 100 m., Hitoyoshi, Kumamoto, *K. M. ser. 10, no. 467.*

Eriopus mollis Card. (Hookeriaceae) On wet shale, 4/500 m., Mt. Shibi, Kagoshima, *M. M. ser. 11, no. 515.*

Erythrodontium leptothallum (Müll.) Nog. fo. *tereticaule* (Müll.) Nog. (Entodontaceae) On stone wall, 100 m., Yao, Osaka, *T. Ko. ser. 11, no. 516.*

Eurhynchium hians (Hedw.) Lac. (Brachytheciaceae) On wetty rocks, 100 m., Hitoyoshi, Kumamoto, *K. M. ser. 12, no. 579.*

E. polystictum (Mitt.) Par. On rocks and on soil beneath woods, 100 m., Hitoyoshi, Kumamoto, *K. M. ser. 9, no. 417*; *ser. 12, no. 580.*

Fabronia matsumurae Besch. (Fabroniaceae) On *Salix babylonica*, Saijo, Ehime, *K. O. ser. 9, no. 418*; on *Celtis sinensis*, 30 m., Fukuoka, *T. O. ser. 11, no. 517.*

Fissidens gymnogynus Besch. (Fissidentaceae) On semishaded ledge of conglomerate, 350 m., Kitago, Miyazaki, *A. N. & S. H. ser. 9, no. 419*; on shale cliff, 400 m., Kitago, Miyazaki, *S. H. & T. K. ser. 11, no. 518.*

F. japonicus Doz. et Molk. On damp bank, 600 m., nr. Nichinan, Miyazaki, *M. M. ser. 12, no. 581.*

F. mayebarae Sak. On concrete wall, 120 m., Kawamura, Kumamoto, *K. M. ser. 12, no. 582.*

F. nagasakinus Besch. On wet rocks, 100 m., Hitoyoshi, Kumamoto, *K. M. ser. 8, no. 365.*

F. saxatilis Tuz. et Nog. On rocks, 150 m., Isshoochi, Kumamoto, *K. M. ser. 11, no. 519.*

Floribundaria floribunda (Doz. et Molk.) Fl. (Meteoriaceae) On bases of shrubs, 150 m., Isshoochi, Kumamoto, *K. M. ser. 11, no. 520.*

Fontinalis antipyretica Hedw. (Fontinalaceae) Rocks submerged in stream, 1500 m., Azumi, Nagano, *U. M. ser. 9, no. 420.*

F. hypnoides Hartm. On boulders in stream, 800 m., Mt. Okinoyama, Tottori, *H. O. ser. 11, no. 521.*

Forsstroemia dendroidea Toyama (*ser. 7, no. 313*)→*Leptodon dendroides* !

F. japonica (Besch.) Par. (*ser. 12, no. 583*)→*Leptodon japonicus* !

Funaria hygrometrica Hedw. (Funariaceae) On damp soil, 600 m., Hitoyoshi, Kumamoto, *K. M. ser. 8, no. 366*; abandoned charcoal-kiln, 150 m., Kitago, Miyazaki, *M. M. ser. 11, no. 522.*

Georgia geniculata (Gilg.) Lindb. (ser. 9, no. 421)→*Tetraphis geniculata* !

G. pellucida (L.) Rabenh. (*ser. 10, no. 468*)→*Tetraphis pellucida* !

Glyphomitrium humillimum (Mitt.) Card. (Erpodiaceae) On trees, 100 m., Nishinomura, Kumamoto, *K. M. ser. 9, no. 422.*

G. minutissimum (Okam.) Broth. On trees, 900 m., Itsuki, Kumamoto, *K. M. ser. 8, no. 367.*

Grimmia apocarpa Hedw. (Grimmiaceae) On chert, 100 m., Isshoochi, Kumamoto, *K. M. ser. 8, no. 368.*

G. apocarpa var. *microtheca* Card. On boulders, Mt. Kosho, Fukuoka, *Y. K. ser. 10, no. 469.*

G. decalvata Card. In crevices of andesite, 3000 m., Mt. Ontake, Nagano, *A. N. &*

S. H. ser. 9, no. 423; on exposed volcanic rocks, 2800 m., *M. Ms. ser. 12, no. 584.*

G. doniana Smith On rhyolite in snowy ravine, 2750 m., Mt. Tateyama, *Z. I. ser. 11, no. 523.*

G. pilifera Paris On rocks, 300 m., Isshoochi, Kumamoto, *K. M. ser. 9, no. 424*—occurring with *Rhacomitrium carinatum* Card.!

Gymnostomiella longinervis Broth. (Splachnaceae) On limestones and calcareous soil, 100 m., Onagara, Oita, *A. N. ser. 8, no. 369.*

Gymnostomum recurvirostrum Hedw. (Pottiaceae) On shaded limestones, 300 m., Onagara, Oita, *A. N. ser. 9, no. 425.*

Habrodon leucotrichus (Mitt.) Perss. (Fabroniaceae) On trunks of conifers, 2000 m., Mt. Kisokoma, Nagano, *Z. I. ser. 11, no. 524.*

Haplocladium microphyllum (Sw.) Broth. (Thuidiaceae) On concrete walls, 150 m., Kawamura, Kumamoto, *K. M. ser. 12, no. 585.*

H. subulaceum (Mitt.) Broth. var. *amblystegioides* (Broth. et Par.) Thér. On branches, 250 m., Kitago, Miyazaki, *Z. I. & M. M. ser. 11, no. 525.*

H. subulaceum var. *subulatum* (Card.) Thér. On thatched roof, 100 m., Nishimura, Kumamoto, *K. M. ser. 12, no. 586.*

Haplohymenium longinerve (Broth.) Broth. On shaded bark, 1300 m., Mt. Chausu, Aichi, *N. T. ser. 7, no. 314*; on *Ilex* bark, 920 m., Mt. Kaimon, Kagoshima, *Z. I. ser. 11, no. 526.*

Heterophyllium brachycarpum (Mitt.) Fl. (Sematophyllaceae) On decaying wood, 2200 m., Mt. Gaki, Nagano, *T. Ku. ser. 7, no. 315.*

Homalia trichomanoides (Schreb.) B. S. G. (Neckeraceae) On trees and tree bases in shade, 800 m., Mt. Daisetsu, Hokkaido, *A. N. ser. 9, no. 426.*

Homaliadelphus targionianus (Gough) Dix. et P. Varde var. *rotundatus* Nog. (Neckeraceae) On limestones, 300 m., Kawanobori, Oita, *A. N. ser. 8, no. 370.*

Hookeria nipponensis (Besch.) Broth. (Hookeriaceae) On moist shady rocks, 600 m., Hitoyoshi, Kumamoto, *K. M. ser. 8, no. 371.*

Hygrohypnum tsurugizanicum Card. (Amblystegiaceae) On chert in and by mountain stream, 1200 m., Ikura, Nagano, *D. S. ser. 8, no. 372.*

Hylocomium cavifolium Lac. (Hylocomiaceae) On rocks, 600 m., Hitoyoshi, Kumamoto, *K. M. ser. 9, no. 427.*

H. himalayanum Mitt. Forest floor, 1300 m., Mt. Chausu, Aichi, *N. T. ser. 7, no. 316.*

H. pyrenaicum (Spruce) Lindb. Coniferous forest floor, 1300 m., Mt. Daisetsu, Hokkaido, *A. N. ser. 7, no. 317.*

Hyophila propagulifera Broth. (Pottiaceae) On sunny concrete wall, 10 m., Oita, *A. N. ser. 9, no. 428*; on concrete wall, 100 m., Kawamura, Kumamoto, *K. M. ser. 12, no. 587.*

H. stenophylla Card. On rocks, 120 m., Kawamura, Kumamoto, *K. M. ser. 11, no. 527.*

Hypopterygium fauriei Besch. (Hypopterygiaceae) On shady damp rocks, Miwa, Aichi, *Z. I. ser. 9, no. 429.*

Hypnum oldhamii (Mitt.) Jaeg. (Hypnaceae) On shaded sandstone cliff, 400 m., Sakatani, Miyazaki, *S. H. ser. 12, no. 588.*

H. plumaeforme Wils. var. *minus* Broth. On trees, 100 m., Nishinomura, Kumamoto, *K. M. ser. 7, no. 318.*

H. tristo-viride (Broth.) Broth. On rotten logs, 600 m., Hitoyoshi, Kumamoto, *K. M. ser. 7, no. 319*; on decaying logs, 980 m., Towada, Aomori, *U. M. ser. 7, no. 320*; on decaying logs beneath forest, 1300 m., Mt. Chausu, Aichi, *N. T. ser. 7, no. 321.*

Isopterygium subalbidum (Sull. et Lesq.) Mitt. (Hypnaceae) On bases and trunks of oak, 200 m., Kitago, Miyazaki, *Z. I. ser. 12, no. 589.*

I. subarcuatum (Broth.) Nog. On bases of trees, 100 m., Ichibu, Kumamoto, *K. M. ser. 10, no. 470.*

I. textori Lac. On soil, 200 m., Ichibu, Kumamoto, *K. M. ser. 11, 528.*

Isothecium subdiversiforme Broth. (Lembophyllaceae) Bases of conifers, 700 m., Sakatani, Miyazaki, *S.H. ser. 11, no. 529.*

Leptobryum pyriforme (Hedw.) Wils. (Bryaceae) On shaded soil at the foot of tuff cliff, 160 m., Sakatani, Miyazaki, *S. H. ser. 10, no. 471.*

Leptodon[5] *dendroides* (Toyama) Nog. (Cryphaeaceae) On trunk of *Zelkowa serrata*, Yamakuni, Oita, *A. N. ser. 7, no. 313.*

L. japonicus (Besch.) Nog. On bark, 1100 m., Todai, Nagano, *N. T. ser. 12, no. 583.*

Leucodon nipponicus Nog. (Leucodontaceae) On trees, 300 m., Koonose, Kumamoto, *K. M. ser. 11, no. 530.*

Macromitrium gymnostomum Sull. et Lesq. (Orthotrichaceae) On rocks, 100 m., Hitoyoshi and Koonose, Kumamoto, *K. M. ser. 7, no. 322*; *ser. 9, no. 430.*

M. incurvum (Lindb.) Par. On exposed rocks, 60 m., Yoshio, Kumamoto, *K. M. ser. 9, no. 431.*

Macrosporiella dozyoides (Broth. et Par.) Nog. (Leucodontaceae) On trees, 500 m., Koonose, Kumamoto, *K. M. ser. 7, no. 323*; on bark, 900 m., Nakura, Aichi, *N. T. ser. 7, no. 324.*

M. sapporensis (Besch.) Nog. On *Tilia* trunks, Meguro, Hidaka, Hokkaido, *T. C. ser. 10, no. 472.*

M. scabriseta Dix. et Thér. On trees, 1700 m., Mt. Ichifusa, Kumamoto, *K. M. ser. 7, no. 325.*

Merceya gedeana (Lac.) Nog. (Pottiaceae) On stone pedestal of bronze statue in open place, Kamakura, Kanagawa, *Y. A. ser. 10, no. 474*; on stone stand of large bronze lantern and on gravels about it, Shiba-Zojoji, Tokyo, *U. M. ser. 11, no. 531.*

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[5] *Leptodon dendroides* (Toyama) Noguchi, comb. nov. (Basionym) *Forsstroemia dendroidea* Toyama, Acta Phytotax. et Geobot. 4: 217 (1935).

L. japonicus (Besch.) Noguchi, comb. nov. (Basionym) *Lasia japonica* Besch. Ann. Sci. Nat. 17: 357 (1893).

L. cryphaeoides (Card.) Noguchi, comb. nov. (Basionym) *Forsstroemia cryphaeoides* Card. Bull. Soc. Bot. Genève, s. 2, 1: 132 (1909).

L. recurvimarginatus (Nog.) Noguchi, comb. nov. (Basionym). *Forsstroemia recurvimarginata* Nog. Journ. Hattori Bot. Lab. 2: 36 (1947).

—form. *filiformis* (Nog.) Noguchi, comb. nov. *F. recurvimarginata* Nog. form. *filiformis* Nog. l. c. 37.

M. ligulata (Spruce) Schimp. On stone wall covered with copper-containing sand, 700 m., Sumino, Ehime, *A. N. & K. O. ser. 9, no. 432*; on vertical andesite cliff exposed to sulphurous gas and on sulphuric substrata at cliff base, 800 m. Aso, Kumamoto, *T. O. ser. 10, no. 473*.

Merceopsis sikkimensis (C. Müll.) Broth. et Dix. (*ser. 10, no. 474*) → *Mercea gedeana*!

Mielichhoferia japonica Besch. (Bryaceae) On and among volcanic rocks, 1900–2250 m., Mt. Daisetsu, Hokkaido, *H. O. ser. 10, no. 475*.

Mnium cuspidatum Hedw. (Mniaceae) On soil beneath conifers, 2600 m., Mt. Yatsu, Nagano, D. S. *ser. 8, no. 375*.

M. laevinerve Card. On bank, 100 m., Hitoyoshi, Kumamoto, *K. M. ser 7, no. 326*.

M. lycopodioides (Hook.) Schwaegr. On humus-covered andesite under conifers, 2100 m., Mt. Yatsu, Nagano, *Z. I. ser. 9, no. 433*.

M. speciosum Mitt. On humus, 2300 m., Mt. Yatsu, Nagano, *Z. I. ser. 10, no. 476*; on damp humus beneath conifers, 1600 m., Mt. Yatsu, Nagano, *N. T. ser. 11, no. 532*.

M. spinosum (Voit) Schwaegr. On humus beneath conifers, 2150 m., Mt. Yatsu, Nagano, *Z. I. ser. 9, no. 434*; on shady, moist humus, coniferous forest, 1800 m., Otaki, Saitama, *I. N. ser. 10, no. 477*.

M. striatulum Mitt. On decayed wood beneath forest, 1450 m., Miwa, Nagano, *N. T. ser. 7, no. 327*.

M. subglobosum B. S. G. On soil beneath conifers, 2600 m., Mt. Yatsu, Nagano, *D. S. ser. 8, no. 374*; on humus beneath conifers, 2300 m., Mt. Kisokoma, Nagano, *Z. I. ser. 11, no. 533*,

M. trichomanes Mitt. (*ser. 8, no. 375*) → *M. cuspidatum*!

M. undulatum Hedw. On humus beneath conifers, 2150 m., Mt. Yatsu, Nagano, *Z. I. ser. 9, no. 435*.

M. vesicatum Besch. On granitic gravels in mountain brook, Isl. Yakushima, Kagoshima, *D. S. ser. 8, no. 376*.

Molendoa sendtneriana (B. S. G.) Limpr. (Pottiaceae) On exposed limestones, 400 m., Mt. Kaharu, Fukuoka, *A. N. ser. 8, no. 373*.

Myurella gracilis (Weinm.) Lindb. (*ser. 9, no. 436*; *ser. 10, no.478*) → *M. sibirica*!

M. sibirica (C. Müll.) Reimers (Theliaceae) On limestones under conifers, 1800 m., Otaki, Saitama, *I. N. ser. 9, no. 436*; on shady, moist limestones, 500 m., nr. Niimi, Okayama, *A. N. ser. 10, no. 478*.

Myurium rufescens (Reinw. et Hornsch.) Fleisch. var. *yakushimense* (Sak.) Nog. (Pterobryaceae) On rocky ledges, 600 m., Mt. Osuzu, Miyazaki, *Y. K. ser. 7, no. 328*; on damp rocks, Osugi-valley, Mie, *Z. I. ser. 10, no. 479*.

Myuroclada concinna (Wils.) Besch. (Brachytheciaceae) Shaded ledges of chert, Kagemori, Saitama, *D. S. ser. 7, no. 329*.

Nanomitrium tenerum (Bruch) Lindb. (Ephemeraceae) On clay, river sides, Hayadori, Niigata, *Y. I. ser. 7, no. 330*.

Neckera borealis Nog. (Neckeraceae) On bark, 700 m., Sounkyo, Hokkaido, *A. N. ser. 7, no. 332*.

N. flexiramea Card. On trees, 600 m., Hitoyoshi, Kumamoto, *K. M. ser. 7, no. 331*; pendulous on branches, Osugi-valley, Mie, *Z. I. ser. 10, no. 480*.

N. humilis Mitt. On trees, 100 m., Ichibu, Kumamoto, *K. M. ser. 9, no. 437.*

N. konoi Broth. On limestone ledge, 1620 m., Mt. Shiroiwa, Miyazaki, *T. H. ser. 8, no. 377.*

N. laeviuscula Card. (*ser. 7, no. 332*) → *N. borealis*!

N. menziesii Drummond On shaded limestone ledge, 1100 m., Shiozawa, Nagano, *N. T. ser. 8, no. 378.*

N. muratae Nog. On semishaded, dry limestones, 400 m., Kusama, Okayama, *A. N. ser. 9, no. 438.*

N. pennata Hedw. On trees, 1450 m., Shiroiwa-valley, Nagano, *N. T. ser. 8, no. 379.*

N. pusilla Mitt. On shale rich in calcium beneath evergreens, 500 m., nr. Nichinan, Miyazaki, *M. M. ser. 12, no. 590.*

N. yezoana Besch. On trees, 900 m., Itsuki, Kumamoto, *K. M. ser. 8, no. 380.*

Okamuraea brachydictyon (Card.) Nog. (Leskeaceae) On trees, 100 m., Nishino-mura, Kumamoto, *K.M. ser. 8, no. 381.*

Oligotrichum parallelum (Mitt.) Kindb. (Polytrichaceae) On semishaded soil, 2600 m., Mt. Senjo, Nagano, *N. T. ser. 8, no. 382*; sandy substrata, wet ~ submerged, 2750 m., Mt. Kisokoma, Nagano, *D. S. ser. 8, no. 383*; on volcanic rocks often submerged in running water, 1850 m., Mt. Daisetsu, Hokkaido, *Y. K. ser. 12, no. 591.*

Oncophorus crispifolius (Mitt.) Lindb. (Dicranaceae) On boulders, 300 m., Sakatani, Miyazaki, *S. H. ser. 7, no. 333.*

O. wahlenbergii Brid. On granitic rocks, 2200 m., Mt. Kisokoma, Nagano, *Z. I. ser. 11, no. 534.*

Oreoweisia laxifolia (Hook.) Par. (Dicranaceae) On soil beneath conifers, 2000 m., Mt. Kisokoma, Nagano, *D. S. ser. 8, no. 384*; on soil among roots of spruce, 2050 m., Mt. Yatsu, Nagano, *Z. I. ser. 9, no. 414.*

Philonotis falcata (Hook.) Mitt. (Bartramiaceae) On concrete ditches, Saijo, Ehime, *K. O. ser. 7, no. 334*; on damp boulders along stream, Manai w. of Tokyo, *U. M. ser. 10, no. 481.*

Ph. fontana Brid. On damp soil along stream, 1800 m., Mt. Yatsu, Nagano, *Z. I. ser. 10, no, 482.*

Ph. setschuanica (C. Müll.) Par. Moist bank, 100 m., Hitoyoshi, Kumamoto, *K. M. ser. 7, no. 335.*

Ph. socia Mitt. Moist bank, 80–100 m., Hitoyoshi and Koonose, Kumamoto, *K. M. ser. 7, no. 336*; *ser. 11, no. 535.*

Ph. turneriana Mitt. Wet soil ledges, Ohwani, Aomori, *U. M. ser. 7, no. 337*; on shady, damp rocks, Mt. Mitsumine, Saitama, *D. S. ser. 8, no. 385.*

Physcomitrium japonicum (Hedw.) Mitt. (Funariaceae) On soil, Saijo, Ehime, *K. O. ser. 10, no. 483.*

Pilotrichopsis dentata (Mitt.) Besch. (Cryphaeaceae) Pendulous on branches, 700 m., nr. Nichinan, Miyazaki, *M. M. ser. 12, no. 592.*

Plagiopus oederi (Gunn.) Limpr. (Bartramiaceae) On shady, moist calcareous rocks, 1880 m., Otaki, Saitama, *I. N. ser. 10, no. 484.*

Plagiothecium aomoriense Besch. (Plagiotheciaceae) On trunks and bases of trees, 700 m., Sounkyo, Hokkaido, *A. N. ser. 7, no. 338.*

P. nemorale (Mitt.) Jaeg. On humus-covered rocks beneath forests, 1100 m., Mennoki-pass, Aichi, *N. T. ser. 12, 593.*

Platyhypnidium rusciforme (Neck.) Fleisch. (Amblystegiaceae) Submerged in stream, 200 m., Mt. Iwaki, Aomori, *U. M. ser. 7, no. 339.*

Pleuridium subulatum (Huds.) Rabenh. (Ditrichaceae) On low dike, rice field, 100 m., Hitoyoshi, Kumamoto, *K. M. ser. 10, no. 485.*

Pogonatum grandifolium (Lindb.) Jaeg. (Polytrichaceae) On humus, coniferous forest floor, 1300 m., Mt. Daisetsu, Hokkaido, *A. N. ser. 9, no. 439.*

P. inflexum Lindb. On soil, Saijo, Ehime, *K. O. ser. 9, no. 440.*

P. spurio-cirratum Broth. On bank, 150 m., nr. Hitoyoshi, Kumamoto, *K. M. ser. 10, no. 486.*

Pohlia acuminata Hoppe et Hornsch (Bryaceae) Thin soil on granitic rocks, 2900 m., Mt. Kisokoma, Nagano, *Z. I. ser. 10, no. 487.*

P. columbica (Kindb.) Andrews On semishaded, moist soil, Ubeno, Tottori, *H. O. ser. 10, 488.*

P. elongata Hedw. On soil in exposed place, Jumonji-pass, Saitama, *D. S. ser. 8, no. 386.*

P. revolvens (Card.) Nog. On conglomerate rocks in woods, 2500 m., Natsuzawa-pass, Nagano, *D. S. ser. 8, no. 387.*

P. scabridens Mitt. On tuffy bank, Yokogawa, Kagoshima, *Y. K. ser. 8, no. 388.*

Polytrichum attenuatum Menz. (*ser. 11, no. 536*)→*P. formosum*!

P. commune Hedw. (Polytrichaceae) Damp forest floor, 1300 m., Mt. Chausu, Aichi, *N. T. ser. 7, no. 340*; on soil, 100 m., Hitoyoshi, Kumamoto, *K. M. ser. 8, no. 389*; on damp soil in gorge, 1850 m., Mt. Daisetsu, Hokkaido, *Y. K. ser. 12, no. 594.*

P. formosum Hedw. On rocks, 100 m., Koonose, Kumamoto, *K. M. ser. 11, no. 536.*

P. juniperinum Hedw. On sandy soil, 2600 m., Mt. Gaki, Nagano, *T. Ku. ser. 7, no. 341.*

P. sphaerothecium (Besch.) Broth. On andesite cliff, 1700 m., Mt. Adatara, Fukushima, *Y. W. ser. 11, no. 537.*

Porotrichum gracilescens Nog. (Neckeraceae) On semishaded shale cliff in forest, 100 m., nr. Nichinan, Miyazaki, *M. M. ser. 12, no. 595.*

Pseudoleskeopsis orbiculata Mitt. (Leskeaceae) On wet rocks, 100 m., Nishimura, Kumamoto, *K. M. ser. 11, no. 538.*

Ptychomitrium dentatum (Mitt.) Jaeg. (Grimmiaceae) On rocks, 120 m., nr. Hitoyoshi, Kumamoto, *K. M. ser. 9, no. 441.*

P. fauriei Besch. On exposed, dry andesite rocks, 400 m., Yunohira, Oita, *A. N. ser. 9, no. 442.*

P. kiusiuense Sak. (*ser. 7, no. 342*)→*P. longisetum*!

P. linearifolium Reim. On shaded rocks beneath woods, 800 m., Mt. Sobo, Oita, *A. N. ser. 7, no. 343.*

P. longisetum Reim. et Sak. On limestones, 400 m., Koonose, Kumamoto, *K. M. ser. 7, no. 342.*

Rhabdoweissia fugax (Hedw.) B. S. G. var. *subdenticulata* Boulay (Dicranaceae) On rocks, 280 m., Antaroma, Hokkaido, *T. Sa. ser. 9, no. 443.*

Rhacomitrium anomodontoides Card. (Grimmiaceae) On rocks, 600 m., nr. Hitoyoshi, Kumamoto, *K. M. ser. 11, no. 539.*

R. fasciculare (Hedw.) Brid. On damp cliff, 1900 m., crater of Mt. Daisetsu, Hokkaido, *Y. K. ser. 12, no. 596.*

R. heterostichum (Hedw.) Brid. On moist rocks, 600 m., Hitoyoshi, Kumamoto, *K. M. ser. 8, no. 390.*

R. hypnoides (L.) Lindb. (*ser. 9, no. 444*)→*R. lanuginosum*!

R. lanuginosum (Hedw.) Brid. On exposed andesite rocks, 3000 m., Mt. Ontake, Nagano, *A. N. & S. H. ser. 9, no. 444.*

Rhacopilum aristatum Mitt. (Rhacopilaceae) On shady, damp shale cliff, 150 m., Kitago, Miyazaki, *Z. I. & M. M. ser. 11, no. 540.*

Rhaphidostichum macrostictum (Broth. et Par.) Broth. (Sematophyllaceae) On twigs, 700 m., Isl. Yakushima, Kagoshima, *T. S. ser. 10, no. 489.*

Rhizogonium badakense Fleisch. (Rhizogoniaceae) On decaying logs, 600 m., Hitoyoshi, Kumamoto, *K. M. ser. 7, no. 344.*

Rhodobryum roseum (Weis.) Limpr. (Bryaceae) On soil in open place, 1900 m., Mt. Yatsu, Nagano, *Z. I. ser. 9, no. 445.*

Schlotheimia japonica Besch. et Card. (Orthotrichaceae) On chert, 100 m., Ono, Kumamoto, *K. M. ser. 8, no. 391.*

Schwetschkea kiusiana Sak. (Fabroniaceae) On bark, 100 m., Ichibu, Kumamoto, *K. M. ser. 8, no. 392.*

S. robusta Toyama On trees, 100 m., Ichibu, Kumamoto, *K. M. ser. 10, no. 490.*

Sphagnum capillaceum (Weiss) Schrank (Sphagnaceae) In bog, 980 m., Mt. Hakkoda, Aomori, *U. M. ser. 10, no. 491.*

S. girgensohnii Russ. On damp soil, 2400 m., Mt. Gaki, Nagano, *T. Ku. ser. 7, no. 345.*

S. palustre L. On wet rocks, 900 m., Isl. Yakushima, Kagoshima, *K. M. ser. 8, no. 393.*

S. papillosum Lindb. Bog by Oze-numa, Gumma, *U. M. ser. 8, no. 394*; in bog, 1800 m., Mt. Azuma, Fukushima, *Y. W. ser. 9, no. 446.*

S. plumulosum Röll. On damp soil, Tonaru, Sumino, Ehime, *K. O. ser. 7, no. 346.*

S. recurvum Beauv. On damp soil in ditch, Fukushima, *Y. W. ser. 10, no. 492.*

S. robustum (Russ.) Röll. In bog, 2700 m., Mt. Ontake, Nagano, *A. N. & S. H. ser. 10, no. 493.*

S. squarrosum Crome Beneath woods side of bog, 1550 m., Oze, Fukushima, *U. M. ser. 8, no. 395.*

Syrrhopodon japonicus (Besch.) Broth. (Calymperaceae) On bases and trunks of trees, 150 m., Kitago, Miyazaki, *Z. I. ser. 11, no. 541.*

S. tosaensis Card. On bases and trunks of trees, 150 m., Kitago, Miyazaki, *Z. I. ser. 11, no. 542.*

S. tsushimae Card. On trunks of *Livistonia subglobosa*, 5 m., Isl. Aoshima, Miyazaki, *S. H. ser. 7, no. 347.*

Taxiphyllum taxirameum (Mitt.) Fleisch. (Hypnaceae) On concrete wall and on roam at the foot of it, Tama Imp. Tomb nr. Tokyo, *U. M. ser. 10, no. 494*; on soil in shade, 100 m., nr. Hitoyoshi, Kumamoto, *K. M. ser. 11, no. 543.*

Tetraphis geniculata Girgens (Tetraphidaceae) On decayed logs, 2150 m., Mt. Yatsu, Nagano, *Z. I. ser. 9, no. 421.*

T. pellucida Hedw. On rotten logs, 800 m., Mt. Ohira, Kumamoto, *K. M. ser. 10, no. 468.*

Thamnium alopecurum (Hedw.) B. S. G. (Neckeraceae) Shaded rocks beneath conifers, 1000 m., Mt. Daisetsu, Hokkaido, *A. N. ser. 7, no. 348*; on shady, moist limestones beneath *Quercus* forest, Shiroiwa-valley, Nagano, *N. T. ser. 11, no. 544.*

Th. sandei Besch. On chert, 100 m., Hitoyoshi, Kumamoto, *K. M. ser. 8, no. 396.*

Thuidium cymbifolium (Doz. et Molk.) Doz. et Molk. (Thuidiaceae) On damp, shaded sandstone boulders, 400 m., Sakatani, Miyazaki, *S. H. ser. 12, no. 597.*

Th. glaucinoides Broth. On humus-covered rocks, 200 m., Yunomaye, Kumamoto, *K. M. ser. 12, no. 598.*

Th. glaucinum (Mitt.) Jaeg. On shady, moist rocks, 300 m., Hitoyoshi, Kumamoto, *K. M. ser. 8, no. 397.*

Th. micropteris Besch. Forest floor, *Abies* plantation, 300 m., Antaroma, Hokkaido, *T. Sa. ser. 9, no. 447.*

Th. recognitum (Hedw.) Lindb. Wet soil, 1300 m., Mt. Chausu, Aichi, *N. T. ser. 7, no. 349*; on damp boulders, Meguro, Hidaka, Hokkaido, *T. C. ser. 10, no. 495.*

Th. toyamae Nog. On humus, 200 m., Yunomaye, Kumamoto, *K. M. ser. 12, no. 599.*

Th. uliginosum Card. Among rocks and on sand by stream, Towada, Aomori, *U. M. ser. 8, no. 398.*

Timmia megapolitana Hedw. (Timmiaceae) On limestones, 360 m., Nishitap, Hokkaido, *H. N. ser. 9, no. 448*; on shady calcareous soil at base of limestone cliff, 1800 m., Jumonji-pass, Saitama, *I. N. ser. 11, no. 545.*

Tortella tortuosa (Turn.) Limpr. (Pottiaceae) On limestones, 200 m., Mt. Kurohime, Niigata, *Y. I. ser. 9, no. 449*; on semishaded, dry limestones, 900 m., Mt. Buko, Saitama, *I. N. ser. 10, no. 496.*

Tortula muralis Hedw. var. *obcordata* Schimp. (Pottiaceae) Crevices of stone-fence in sunny place, 10 m., Oita, *A. N. ser. 9, no. 450.*

Trachypus bicolor Reinw. et Hornsch. (Trachypodaceae) On rocks, 600 m., Hitoyoshi, Kumamoto, *K. M. ser. 7, no. 350*; on moist granitic cliff, 950 m., Mt. Hoyoshi, Kagoshima, *M. M. ser. 11, no. 546.*

Trematodon atrovirens Broth. (Dicranaceae) On soil, Meike nr. Niigata, *Y. I. ser. 10, no. 497.*

T. drepanellus Besch. On damp, shady soil, Saijo, Ehime, *K. O. ser. 11, no. 547.*

T. flaccidisetus Card. On exposed tuffy bank, 10 m., Obi, Miyazaki, *S. H. ser. 8, no. 399*; on exposed, dry soil, 1900 m., Oyama, Toyama, *Z. I. ser. 10, no. 498.*

Trichodon tenuifolius (Schrad.) Lindb. (Ditrichaceae) On bank, 200 m., Hitoyoshi, Kumamoto, *K. M. ser. 10, no. 499.*

Trichostomum crispulum Broth. (Pottiaceae) On rocks, 100 m., Ono, Kumamoto, *K. M. ser. 11, no. 548.*

Ulota crispula Bruch (Orthotrichaceae) On branchlets of shrubs, 1090 m., Mt. Suzuka, Mie, *N. T. ser.12, no. 600.*

U. reptans Mitt. On *Abies* trunks, 2000 m., Mt. Kisokoma, Nagano, *Z. I. ser. 11, no. 549.*

Vesicularia apiculata Broth. (*ser. 11. no. 550*)→*V. ferriei!*

V. ferriei (Card. et Thér.) Broth.[6] (Hypnaceae) On moist rocks, 100 m., Hitoyoshi,

[6] Syn. nov. *V. apiculata* Broth. (cum v. *major* Broth.) and *V. japonica* Broth.

Kumamoto, *K. M. ser. 11, no. 550.*

Weissia controversa Hedw. (Pottiaceae) On bank, 100 m., Hitoyoshi, Kumamoto, *K. M. ser. 8, no. 400.*

W. longidens Card. Side of a charcoal-kiln, Uemura, Kumamoto, *K. M. ser. 10, no. 500.*

W. viridula (L.) Hedw. (*ser. 8, no. 400*)→*W. controversa*!

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List of collector

To economize space only initials were used for the names of collectors. The list below provides a key to these.

A.I.	A. Inazawa (Miss)	*T.K.*	T. Kurata
A.N.	A. Noguchi	*T.Ko.*	T. Kodama
C.M.	C. Matsuura (Miss)	*T.Ku.*	T. Kuno
D.S.	D. Simizu	*T.O.*	T. Osada
H.N.	H. Nakajima	*T.S.*	T. Shin
H.O.	H. Ochi	*T.Sa.*	T. Sasaki
I.N.	I. Nagano	*T.Y.*	T. Yamanaka
K.M.	K. Mayebara	*T.Yo.*	T. Yoshimoto
K.O.	K. Oti	*U.M.*	U. Mizushima (Mrs.)
M.M.	M. Mizutani	*Y.A.*	Y. Araki
M.Ms.	M. Mizushima	*Y.I.*	Y. Ikegami
N.T.	N. Takaki	*Y.K.*	Y. Kuwahara
S.H.	S. Hattori	*Y.T.*	Y. Tatebe
T.C.	T. Chiba	*Y.W.*	Y. Watanabe
T.H.	T. Hidaka	*Z.I.*	Z. Iwatsuki

Appendix. Corrigenda: Musci Japonici Exsiccati Ser. 1-6.

Bryhnia noesica (Besch.) Broth. (*ser. 6, nos. 255/6*)→*B. trichomitria* Dix. et Thér.!

Catharinaea chlorochaeta Card. (*ser. 3, no. 148*)→*Atrichum chlorochaetum* (Card.) Miz.!

Dicranum undulatum Ehrh. (*ser. 5, no. 211*)→*D. rugosum* Brid.!

D. japonicum Mitt. (*ser. 4, no. 159; ser. 6, nos. 262/3*)→*D. scoparium* Hedw.!

Distichophyllum gonoi Broth. (*ser. 5, no. 212*)→*D. collenchymatosum* Card.!

Eumyurium sinicum (Mitt.) Nog. (*ser. 1, no. 39*)→*Myuriopsis sinica* (Mitt.) Nog.!

Fissidens planicaulis Besch. (*ser. 3, no. 103*)→*F. grandifrons* Brid. var. *planicaulis* (Besch.) Nog.!

Forsstroemia cryphaeoides Card. (*ser. 2, no. 74*)→*Leptodon cryphaeoides* (Card.) Nog.!

F. dendroidea Toyama (*ser. 4, no. 174; ser. 7, no. 313*)→*Leptodon dendroides* (Toyama) Nog.!

F. japonica (Besch.) Par. (*ser. 4, no. 175; ser. 12, no. 583*)→*Leptodon japonicus* (Besch.) Nog.!

Georgia pellucida (L.) Rabenh. (*ser. 5, no. 219*)→*Tetraphis pellucida* Hedw.!

Gymnostomum rupestre Schl. (*ser. 3, no. 110*)→*Molendoa sendtneriana* (B. S. G.) Limpr.!

Haplohymenium microphyllum (Broth. et Par.) Broth. (*ser. 2, no. 87*)→*H. pseudotriste* C. Müll.!

Homalothecium tokiodense (Mitt.) Besch. (*ser. 2, no. 94; ser. 4, no. 185*)→*H. laevisetum* Lac.!

Hylocomium proliferum (L.) Lindb. (*ser. 2, no. 98*)→*H. splendens* (Hedw.) B. S. G.!

Neckeropsis lepineana (Mont.) Fleisch. (*ser. 1, no. 18*)→*N. calcicola* Nog.!

Okamuraea cristata Broth. (*ser. 1, no. 45*)→*O. hakoniensis* (Mitt.) Broth.!

Oncophorus crispifolius (Mitt.) Lindb. var. *brevipes* (Card.) Nog. (*ser. 3, no. 107*)→—(Card.) Thér.!

Oxyrrhynchium polystictum (Mitt.) Broth. (*ser. 4, no. 186*)→*Eurhynchium polystictum* (Mitt.) Par.!

Pleuropus fenestratus Griff. (*ser. 6, no. 288*)→*P. sciureus* (Mitt.) Toyama.!

Ptychomitrium sinense (Mitt.) Jaeg. (*ser. 4, no. 171*)→*P. sinense*! and *P. fauriei* Besch. (occurring with it).

Rhacomitrium carinatum Card. (*ser. 2, no. 62*)→*R. anomodontoides* Card.!

Schistostega osmundacea (Dicks.) Mohr. (*ser. 5, no. 246*)→*S. pennata* (Hedw.) Hook. et Tayl.!

Tetraplodon bryoides (Zoeg.) Lindb. (*ser. 6, no. 292*)→*T. mnioides* (Hedw.) B. S. G.!

Vesicularia apiculata Broth. (cum v. *major* Broth.) (*ser. 6, nos. 298/9*; *ser. 11, no. 550*)→*V. ferriei* (Card. et Thér.) Broth.!

V. japonica Broth. (*ser. 5, no. 250*)→*V. ferriei*!

Webera scabridens (Mitt.) Broth. (*ser. 2, no. 66*; *ser. 4, no. 167*)→*Pohlia scabridens* (Mitt.) Broth.!

昭和22年に第1集を出した日本蘚類標本集は27年に第6集まで刊行，同年の当所報告第8号 (67-76頁) に6集までの ABC 順種名リストを掲載した．その後次第に集を重ねて32年6月には第12集を完成することが出来たので，使用者の便にもと前目録にならい以上の如く ABC 順種名目録を作つた．

目録中，現行命名規約上又はその後の知見に依つて訂正を要する学名は気づいた限りすべて訂正した．又 Appendix として第1～6集中同様に訂正すべき種名リストを加えた．

この標本集の誕生から第6集までのことは前目録に附記したので，次にはその後の様子を簡単に書留め度い．第7～12集に入れた標本の採集者は30人に達するが，こうして第12集完成までこぎつけ得たことは全くこの方々の協力の賜である．次に前例にならつて7～12集300点の採集に関与した人々の内，5点以上の採集者名を列挙して見よう (以下敬称略).
前原勘次郎 96点，　野口彰 36点 (但しこの中8点は他との共同採品)，　岩月善之助 32点 (共同採品4点を含む)，　高木典雄 25点 (共同採品4点を含む)，清水大典 20点，　水島うらら 17点，　水谷正美 16点 (共同採品4点を含む)，　服部新佐 16点 (共同採品8点を含む)，桑原幸信 7点，　永野巌 6点．　尚5点以下の主な採集者には越智一男，越智春美，長田武正，新敏夫，建部恵潤，渡辺良象，久野哲夫，佐々木太一，児玉務の諸氏がある．

標本集も第12集迄来ると既に大低の種は収められ，多量一度に採り易い普通品は3回以上重復しがちとなり，1集中に多くの新品を入れることは次第に困難を加えて来る．はじめの頃は面白いように標本が集まりその処理に手を挙げる始末で1集200組も出来たものもあつた．今後は100組の線を割り50組しか出来ない標本集も出て来るが，之も止むを得ない．兎に角ずつと刊行を続けて行く考えである．

種名の同定乃至確認については現在次の専門家の援助を受けている．A. Le Roy Andrews (Sphagnaceae), 高木典雄 (Brachytheciaceae), 越智春美 (Bryaceae). 標本集の製作には種名に関しては野口が責任を持ち，その他の仕事は主に服部が野口と連絡をとり乍ら研究所職員と共に当つて来た．然し研究所にも岩月，水谷両氏の如き若手の専門家が入つたので，第13集以降は服部は共同編集者を退き，野口の下に直接研究所の職員がこの仕事に当ることとする．

終りに臨んで標本の採集，種名の同定乃至確認について援助，協力いただいた上掲各位に深謝すると同時に今後の御協力を切に期待する．又その製作に当られた倉田辰二，岩月善之助，水谷正美の諸氏その他研究所職員に感謝の意を表する．

TAKAKIA LEPIDOZIOIDES 予 報

服部新佐[1]・井上　浩[2]

S. Hattori and H. Inoue: Preliminary report on *Takakia lepidozioides*

昭和 27 年秋，高木典雄理博より服部へ 1 点の標本が届けられた．北アルプス餓鬼岳の尾根筋の岩隙に採ったが，苔類らしいから見てくれとのことである．早速調べて見た．植物体は一見小形の *Lepidozia* に似ているが，拡大して調べると全く異った形態を具え，既知の苔類の概念から逸脱する難物であった．而も残念ながら生殖器官も胞子体も無い sterile 標本である．これでは分類学上の位置に対する決め手は殆んど無い．野口彰教授にも見て貰ったが，高木氏と同様な意見――蘚類には入らぬ――であった．更に念のため岡田喜一，佐藤正己両理博の意見を乞うたが，予想通り藻類でも地衣類でも無いとの返書を得た．再採集も考えたが産地の詳細が不明なので，気に懸け乍ら一応仮にナンヂャモンヂャゴケと名付けて標本庫に納めてしまった．

昭和 31 年我々は北アルプス白馬岳の bryoflora 協同研究を計画し，同年の夏に井上は白馬に登った．この折の採集品の中から *Pleuroclada albescens* に混じて 1 点のナンヂャモンヂャが見出されたが，惜しい哉矢張り sterile であった．然しこの産地に記憶のあった井上は翌 32 年夏，ナンヂャモンヂャゴケ調査のため白馬再登山を試み，多量の標本を得た．この大部分は固定し，一部は乾燥標本とし，残りは培養を続け，研究は主に生品を用いた．

井上の現地調査でも生殖器官乃至胞子体を具えたものは発見できなかったが，採集した材料も全部 sterile であって而も如何なる生殖器官乃至胞子体の痕跡もまた徴候も確認できなかった．壁につき当った我々はそこで伊藤洋，津山尚の両教授，古沢潔夫理博，及び加崎英男助教授に願って各専門の立場より調べて貰った．結果は羊齒以上の高等植物では無いこと，羊齒の原葉体でもまた輪藻類でも無いことが確かめられた．更にマサチッセット大学の R. M. Schuster 博士の意見では "若しも胞子体が見付かり，その構造が一致すれば，苔類の Calobryales に入り，恐らく *Pachyglossa*[3] に近い科を設立すべき新植物であろう" との返事であった．いずれにせよ蘚苔類と考えられるが，それより先のことになると sterile 標本では全く決め手が見付からない．然し今までの調査から考えて生殖器官や胞子体が発見される可能性は乏しいようであり，近き将来確実な分類学上の位置付けを為し得る見通しを我々は持てない．以下に不満足ではあるが，取敢えず *Takakia lepidozioides* なる学名のもとに今迄の知見を整理，公表して皆様の批判と助言を得，更に後日を期し度いと思う次第である．

言うまでもなく属名は発見者高木理博にささげられたものである．同氏及び上述の御教示を戴いた各位に深く感謝する．なお，当研究所の水谷正美氏にはこの研究を通じて多大の援助を受けた．東京教育大学の橋本洋一氏からは細胞膜成分の貴重なデータを得た．葉緑粒の顕微鏡写真は同大学の村上悟氏の手に成る．併記して厚く謝意を表する．

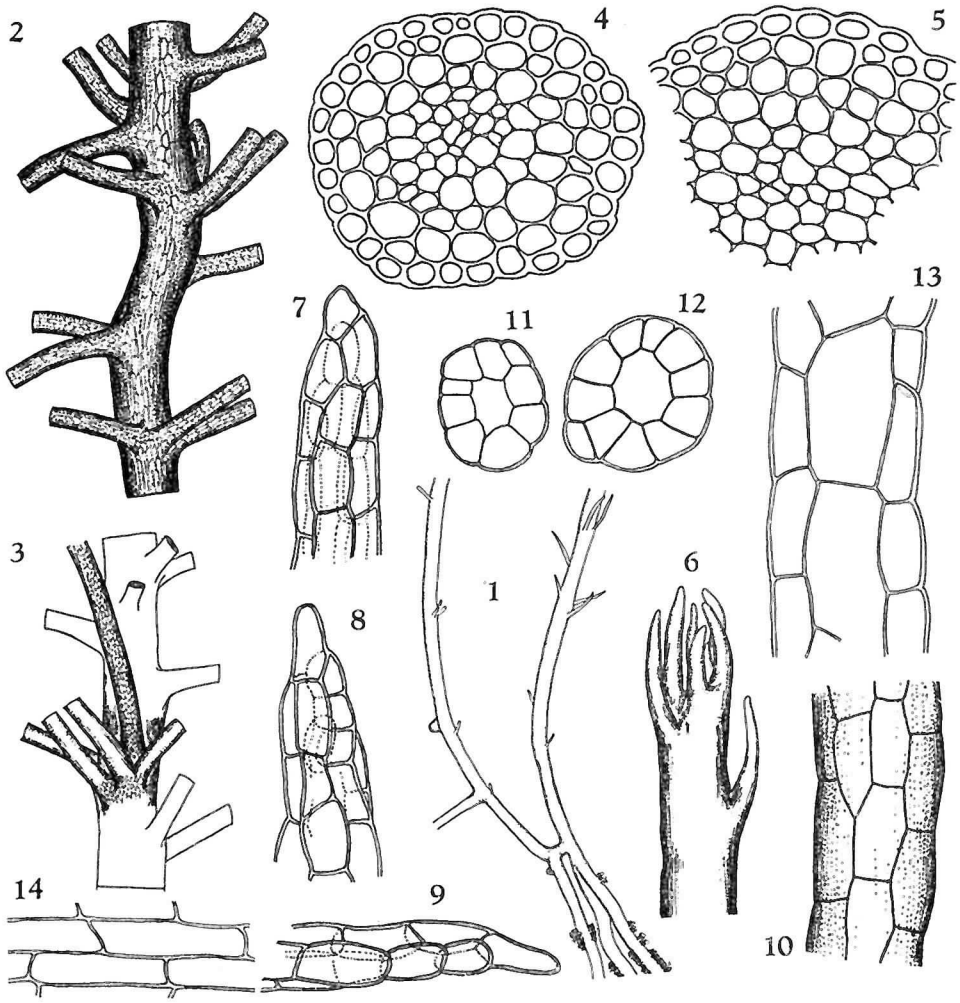
形　　態

茎．――*Calobryum* の茎に似て地下茎状の基部より立ち，高さ約 10 mm. 直径 0.15–0.2 mm.，上部は表皮細胞に葉緑粒を含んで緑色，下部へと淡色化，下方腹面より新しい茎を生じ (sympodial)，茎の基部腹面より白色の stolon 状の地下茎を下す (Fig. 1)．側枝は無い

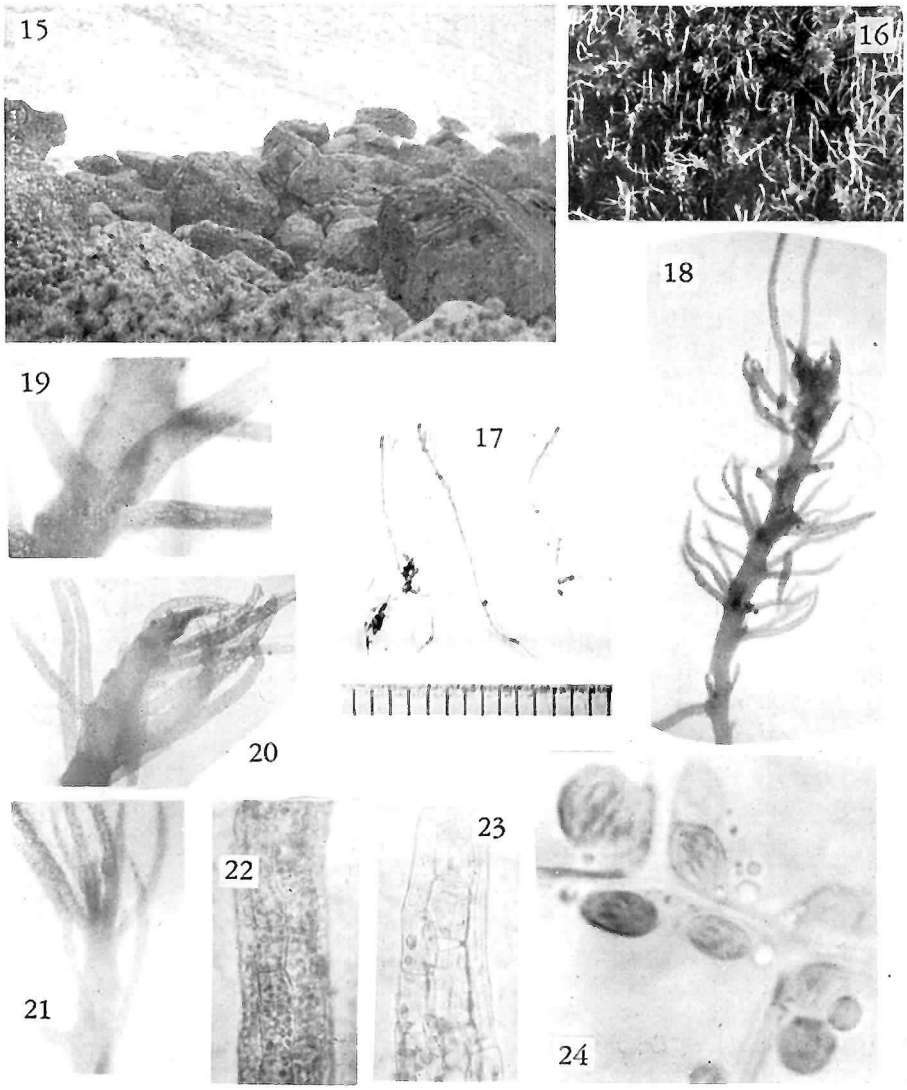
[1] 服部植物研究所．[2] 東京教育大学理学部植物学教室，服部植物研究所（兼）

[3] Martin, W. 1950, Trans. Roy. Soc. New Zealand, 78 (4). Herzog, Th. 1952, Rev. Bryol. et Lichenol. 21: 256–261.

が，培養中の植物は‘葉’(または‘葉’群) 腋またはそれに近い部分よりよくシュートを生ずる (Figs. 3, 18, 19). シュートの基部には多数の小形細胞塊が認められ，シュートはこの部分からはずれやすい (繁殖に有利?). **茎の断面**. 略円形で背腹の分化は無い. 内・外細胞の分布も余り明瞭ではないが，皮層 1 (～2) 列の細胞は 10–12×6–10 μ で比較的厚膜，その内方の細胞は 13–17×13–15 μ で薄膜，中心部の (数個～) 10 数個の細胞群は通例小形 (約 5 μ) となる (Figs. 4, 5). なお横断面に見る細胞は円形に近いが縦断面は長方形である



Figs. 1–14. ***Takakia lepidozioides***. 1. Part of plant, showing stolon-like stems underneath, ×12. 2. Middle part of stem showing phyllotaxy, ×48. 3. Do. showing axillary innovation, ×48. 4, 5. Cross-sections of stem, ×360. 6. Apex of innovation, ×120. 7–9. Apices of leaves, ×360. 10. Middle part of leaf, ×360. 11, 12. Cross-sections of leaf, ×360. 13. Longitudinal section of middle of leaf, ×360. 14. Epidermal cells of stem (surface view), ×360. The figures were drawn by H. Inoue from the type material.



Figs. 15–24. ***Takakia lepidozioides.*** 15. Habitat. 16. Plants, ×1. 17. Do. separated, ×3. 18. Stem, showing 2 axillar innovations occurred in cult., ×55. 19. Part of stem, showing base of innovation in fig. 18, ×100. 20, 21. Apices of stems, ×55. 22. Middle part of leaf, ×420. 23. Upper part of leaf, ×560. 24. Cells, showing chloroplats and disintegrating oil-bodies, ×1400. Fig. 24 was photographed by S. Murakami; others by H. Inoue.

(Fig. 14). 細胞膜は淡白～帯黄色．ミコリザは認められなかった．

仮根．—— 皆無[4]．

'葉'．—— 宛かも枝状 (Figs. 18–23) で見方によっては枝（生長が限定され特殊化した——）と見做すこともできようが，我々は種々の点より考察してこれを葉的器官 (phyllidium) と判断した．葉は多く斜めに出，長さ 1～1.5 mm.，直径 0.8 mm. 内外，表皮細胞に葉緑粒を含んで緑色を呈する．先細の枝状で多少湾曲したものが多く，頂端は1個の尖頭細胞に終る (Figs. 7–9)．葉は基部近くから脱落し易い．**葉の横断面**．円形で中心に 1 個の大形細胞（直径 20～30 μ）があり，これを (6)～10～12 個の表皮細胞がとりまく (Figs. 11, 12)[5]．細胞膜は薄い．茎と同じく相称的であるが，その構造は非常に異っている．**葉の縦断面**に見る細胞は茎と同じく長方形であるが，内部の細胞は特に長大で凡そ 60 × 30 μ に達する (Fig. 13)．**葉序**．不規則でこれが本種の最も特殊な点であろう (Figs. 2, 18)．一寸見た所では陰湿な環境に生えた幼弱なスギゴケの如くである (Fig. 17)．然しこの葉序もよく調べると非常に異り，次の如き多少の規則性が見出される．即ち葉は 2～4 個集まって並んで着く傾向が著しい．そしてこの葉群はほぼ互生している．葉は下部に疎に着き，頂部に密である．以上の如き傾向は明らかであるが，一言にして言えば不規則という外なく，これが本種の最大の特徴の一である．

細胞含有物．—— 多数の葉緑粒 (Fig. 24) と'油体'を含む．この油体は sudan III で殆んど染まらず，また培養を続けると次第に分解，消失することが多く新しいシュートには殆んど認められない点からして，真の油体ということができるか否か疑問が残っている．油体の数は一細胞に凡そ 10 個，ほぼ球状で内部の粒状構造は認められない (homogeneous)．大きさは一定しないが，凡そ葉緑粒と同大である．葉緑粒は円形で高等植物に似たグラナ構造の如きもの (0.2～0.3 μ) が認められ，内部に澱粉が形成される (JJK による呈色反応)．しばしばバナナ状，大形（長さは殆んど葉緑粒の直径に達する）の澱粉が認められる．細胞膜の主成分はセルローズである．

生 育 環 境

(昭和 32 年夏の長野県白馬番調査) 白馬大池に近い雪渓に接して安山岩の岩塊が広く露出，堆積している (Fig. 15)．高度は凡そ 2400 m. 安山岩は 1–2 cm の humus に覆われ，pH は 4.5～5.0 である．雪渓の溶ける水で湿り，温度は低い．附近の植生はハイマツの群落が主で，ハクサンシャクナゲ，チングルマ，シナノキンバイ，イワヒゲ，イワウメ，ハクサンコザクラ，アスヒカヅラなどが見られる．本種は安山岩基部の仄暗い場所にマットを形成する．このマットは殆んど純群落の場合と他の蘚苔類と混生する場合とがある (Fig. 16)．*Pleuroclada albescens* が一番よく混生するが，この外苔類では *Mylia taylori*, *Macrodiplophyllum plicatum*, *Tritomaria quinquedentata*, *Diplophyllum taxifolium* などもよく混生している．

考 察

上述の如き茎の形態及び分岐法，厚い葉，細胞の形態，葉緑粒に長大な澱粉粒が認められ

[4] 茎の下部乃至 stolon 状の地下茎の表面に点々と菌糸叢が認められる (Fig. 1)．この菌糸は茎内部には侵入しない．近縁と考えられる *Haplomitrium* にこのような菌類 (*Pythium haplomitrii*) が着生して居り，共生と考えられる (Lilienfeld, F. 1911 其他)．仮根を全く欠除する本属ではこの菌糸がその代りとなる．之は *Calobryum* にも記録があり，この点からも本種と Calobryales との類似性がうかがわれる．尚この菌類は小林義雄理博に研究していただく予定である．

[5] *Calobryum rotundifolium* の葉も基部 (～内部) は 2 (まれに 3) 細胞層の厚さとなることが少くない．この点からも *Pachyglossa* や本種との類縁関係が考えられる．

る点，側枝の見られないこと，仮根の欠如（そのかわり菌類が共生），その他 *Calobryum*, *Haplomitrium* に類似した点が少くない．然し乍ら特異な枝状葉と不規則な葉序は非常な相違点となる．この葉序はミズゴケ類の特殊な枝の着生型と軌を一にする点がある．また仮根を欠如する点もミズゴケと一致する．茎葉の分化する苔類で葉の厚さが多細胞のものは *Pachyglossa*（脚註 3）がある．本属はニュージーランド及びパタゴニアに知られる 2 種を含み Calobryaceae に近いと思われるが，花被未知のため正確な分類上の位置は今以て定まらない．この苔類の葉は被針形で頂端に欠刻があるが，厚さが殆んど頂部まで 2–3 細胞層である．然し葉は規則的 3 列で Calobryaceae の葉序と等しい．なお *Calobryum* でも葉基部が 2（まれに 3）細胞層となることが多い（脚註 5）．*Takakia* は上述の苔類に近いと考えられるが，sterile 材料に基いた結果だけでは決定的なことはいえない．然し若し生殖器官や胞子体の構造が上述の苔類と同型であるとしても，枝状の葉とその不規則な葉序などの特異性からして，本種は新しい一科，或いは更に一目を代表すべきものと考える．

Takakia lepidozioides Hattori et Inoue, gen. et spec. nov. (Fam. Takakiaceae —— Ord. Takakiales —— Bryophyta) Plantae steriles, virides, laxe foliosae, nusquam rhizophorae, e caudice rhizomato erectae (sympodialiter innovantes) lateque caespitosae vel rarius aliis muscis consociatae. Caulis viridulus, crassus, ca. 10 mm. altus, 0.15–0.2 mm. in diametro, simplex sed in cultura interdum ex subaxilla foliorum ramosus; in sectione transversa fere rotundatus, 10–12 cellulas crassus, cellulis corticalibus pachydermibus, ipsis centralibus parvis. 'Folia' optime ramiformia, cylindrica, 1–1.5 mm. longa, medio ca. 0.8. mm. in diametro, oblique patula, fere sinuata, apicem sensim attenuata, apice unam cellulas acutas superposito; in sectione transversa rotunda, 3 cellulas crassa, cellula interna magna; dispositio foliorum irregularis. Specim. exam. Middle Japan: andesite rocks covered with humus, alt. s.m. 2400 m., Mt. Shirouma, Aug. 1957, Coll. H. Inoue, Type in Herb. Hattori Bot. Laboratory, also Tokyo Univ. of Education; humus-containing soil on rocks, associating with *Pleuroclada albescens* etc. on the same mountain, Aug. 1956, Coll. H. Inoue (6186); near Peak of Goryu, alt. s.m. 26–2800 m., south of Mt. Shirouma, July 1951, Coll. N. Takaki (10302); in rock crevices near ridge-top of Gaki, alt. s.m. 2600 m., 15 km. northwest of Omachi, Aug. 1952, Coll. N. Takaki (12703). The genus was named in honour of Dr. N. Takaki who collected, and paid attention for the first time to, this peculiar bryophyte.

Summary

A new bryophyte, *Takakia lepidozioides*, was illustrated and discussed. Unfortunately it has been found always in sterile condition. However, its peculiar characteristics seen in the gametophyte are thought to be enough to propose for it a new genus and family, or even a new order (Takakiales). The related bryophytes seem to include *Pachyglossa*, *Haplomitrium* and *Calobryum*.

401. *Anthelia juratzkana* (Limpr.) Trev. (Hygrobiellaceae) ヒメカサナリゴケ 北海道大雪山，黒岳 (土上). 402. *Asterella sanoana* Shim. et Hatt. (Rebouliaceae) サノサイハイゴケ 長野県御嶽 (角岩隙の土上). 403. *Brachiolejeunea sandvicensis* (Gott.) Evs. (Lejeuneaceae) フルノコゴケ 宮崎県南那珂郡南郷町，虚空蔵島 (礫岩上). 404. *Cheilolejeunea imbricata* (Nees) Hatt. シゲリゴケ 宮崎県西臼杵郡戸川岳 (樹皮上). 405. *Ch. ontakensis* (Steph.) Hatt. オンタケカギゴケ 熊本県球磨郡. 渡 (樹皮上). 406. *Cephaloziella echinata* Hatt. (Cephaloziellaceae) ウニヤバネゴケ 熊本県人吉市 (岩上). 407. *Cololejeunea* (*Leptocolea*) *aoshimensis* (Horik.) Hatt. (Lejeuneaceae) アオシマヨージョーゴケ 宮崎県青島 (樹皮上). 408. *C.* (*L.*) *japonica* (Schiffn.) Hatt. ヤマトヨージョーゴケ 福岡県粕屋郡篠栗町五塔滝 (樹上). 409. *C.* (*L.*) *lanciloba* (Steph.) Evs. オーヨージョーゴケ 宮崎県南那珂郡北郷村 (葉上). 410. *C.* (*L.*) *longilobula* (Horik.) Hatt. ナガシタバヨージョーゴケ 熊本県球磨郡一武 (葉上). 411. *C. nipponica* (Horik.) Hatt. ヤマトケクサリゴケ 宮崎県南那珂郡北郷村(スジヒトツバ上). 412. *C.* (*Taeniolejeunea*) *ocelloides* (Horik.) Hatt. クチバシヨージョーゴケ 熊本県人吉市 (樹皮上). 413. *C.* (*T.*) *pseudofloccosa* (Horik.) Hatt. オビナシヨージョーゴケ 産地同上 (混生). 414. *C. spinosa* (Horik.) Pande et Misra ウニバヨージョーゴケ 宮崎県南那珂郡北郷村 (キジノオシダ上). 415. *C. yamanakana* Kamim. ヤマナカヨージョーゴケ 熊本県人吉市 (藓上). 416. *Conocephalum conicum* (L.) Dum. (Conocephalaceae) ジャゴケ 宮崎県南那珂郡北郷村 (頁岩上) 417. *Colura meijeri* Jovet-Ast (Lejeuneaceae) ボーズムシトリゴケ (新称) 熊本県人吉市 (樹幹上). 418. *Diplophyllum albicans* (L.) Dum. (Scapaniaceae) シロコオイゴケ 長野県木曽駒岳 (花崗岩上). 419. *Frullania hampeana* Nees (Frullaniaceae) ヒラキハヤスデゴケ 奈良県初瀬町天神山 (樹幹上). 420. *Fr. jackii* subsp. *japonica* (Sde. Lac.) Hatt. ヤスデゴケ 兵庫県宍粟郡船越山 (岩上). 421. *Fr. osumiensis* (Hatt.) Hatt. オースミヤスデゴケ 宮崎県南那珂郡北郷村 (樹枝上). 422. *Fr. pedicellata* Steph. クロアオヤスデゴケ 同県日南市おび (樹皮上). 423. *Fr. uvifera* Horik. フサヤスデゴケ 産地は 421 に同じ (同種と共生). 424. *Gymnocolea montana* (Horik.) Hatt. (Lophoziaceae) ヤマイチョーウロコゴケ 北海道大雪山. 黒岳 (湿土上). 425. *Gymnomitrium corallioides* Nees (Marsupellaceae) サキジロゴケ 長野県御岳 (安山岩上). 426. *Heteroscyphus bescherellei* (Steph.) Hatt. (Lophocoleaceae) オーウロコゴケ 宮崎県日南市小布瀬滝 (凝灰岩の湿崖上). 427. *Lejeunea aquatica* Horik. (Lejeuneaceae) サワクサリゴケ 産地同上 (相接して生ずる). 428. *L. pallide-virens* Hatt. モエギコミミゴケ 同県同市鵜戸神宮 (砂岩上). 429. *L. vaginata* Steph. カマハコミミゴケ 同県西臼杵郡戸川岳 (樹皮上). 430. *Lopholejeunea subfusca* (Nees) Steph. クロチャウロコゴケ 同県日南市男鈴山 (杉樹皮上). 431. *Lophozia* (*Hattoriella*) *diversiloba* Hatt. (Lophoziaceae) ハガワリイチョーウロコゴケ 埼玉県秩父白岩山 (石灰岩上). 432. *Marsupella commutata* (Limpr.) Bernet (Marsupellaceae) コアミメミゾゴケ 山梨県八ケ岳，権現岳 (安山岩上). 433. *M. revoluta* (Nees) Lindb. アカタカネゴケ 長野県木曽駒岳 (花崗岩上). 434. *M. tubulosa* Steph. タカネミゾゴケ 福岡県英彦山 (安山岩上). 435. *M. yakushimensis* (Horik.) Hatt. ヤクシマミゾゴケ 大分県祖母山 (安山岩上). 436. *Metzgeria fruticulosa* (Dicks.) Evs. (Metzgeriaceae) コモチフタマタゴケ 同県玖珠郡飯田村 (岩上). 437. *Nardia subclavata* (Steph.) Amak. (Jungermanniaceae) オリーブツボミゴケ 北海道大雪山，黒岳 (土上). 438. *Nipponolejeunea subalpina* (Horik.) Hatt. (Lejeuneaceae) ヒメケシゲリゴケ 埼玉県秩父郡大滝村トクサ山 (樹皮上). 439. *Notothylas japonica* Horik. (Anthocerotaceae) ツノゴケモドキ 宮崎県日南市おび (地上). 440. *Odontoschisma grosseverrucosum* Steph. var. *luteovirens* (Hatt.) Hatt. (Cephaloziaceae) モエギフジゴケ 鹿児島県屋久島永田川本谷 (花崗岩上). 441. *Pellia fabbroniana* Raddi (Pelliaceae) ホソバミズゼニゴケ 栃木県日光裏見滝 (湿岩上). 442. *Plagiochila ovalifolia* Mitt. (Plagiochilaceae) ハネゴケ 宮崎県南那珂郡北郷村 (岩上). 443. *Plagiochila trabeculata* Steph. キハネゴケ 鹿児島県屋久島，花ノ江川～小杉谷 (樹幹～根もと，倒木上). 444. *Plectocolea hattoriana* Amak., msc. (Jungermanniaceae) ハットリツボミゴケ 山梨郡八ケ岳，権現岳 (湿岩上). 445. *Porella densifolia* (Steph.) Hatt. (Porellaceae) コクラマゴケモドキ 新潟県中蒲原郡菅名山 (石灰岩上). 446. *Scapania bolanderi* Aust. var. *major* Amak. et Hatt. (Scapaniaceae) タマゴバヒシャクゴケ 鹿児島県屋久島，花ノ江川～小杉谷 (腐木上). 447. *Sc. irrigua* (N.) Dum. カラフトヒシャクゴケ 長野県上伊那郡仙丈岳 (湿硬砂岩上). 448. *Sc. spinosa* Steph. ウニバヒシャクゴケ 熊本県球磨郡神ノ瀬 (岩上). 449. *Sc. stephanii* K. Müll. チャボヒシャクゴケ 鹿児島県屋久島鈴川 (湿花崗岩上). 450. *Temnoma setiforme* (Ehrh.) Howe (Ptilidiaceae) フサアイバゴケ 長野県木曽駒岳 (岩上).

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Errata

No.	Page	Line	For	Read
12	77	7	527	257
〃	84	18	*pulcherrimum*	*pulcherrima*
17	75	20 from bottom	北海道大雪山国立公園，黒岳	長野県白馬岳
18	1	1	MALAYAN*	MALAYSIAN
〃	27	6	defferences	differences
〃	31	3	Evan's	Evans'
〃	68	12	***Pleuroziapur purea***	***Pleurozia purpurea***
〃	70	15 from bottom	edite	edit
〃	74	13	constrast	contrast
〃	83	23	soilcovered	soil-covered
〃	102	20 from bottom	*javanica*	*denudata*
〃	108	10 from bottom	mototype	monotype
〃	114	17	they are all lacked	they all lacked

* Dr. W. Meijer wrote to the editor: "It is a pity that in last copy of the manuscript the title was unintentionally changed in Malayan instead of Malaysian." The editor is very sorry for that mistake.

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* All communications should be addressed to:
Dr. Sinske HATTORI, 3888, Obi, Nichinan-shi, Miyazaki Prefecture (Japan).

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