

# ***Plagiochila* (marchantiophyta) of mount sibayak north sumatra**

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**Abstract** Information on the liverworts (*Marchantiophyta*) flora of Sumatra is still less reported, including the knowledge on the genus of *Plagiochila* (*Plagiochilaceae*). Research is conducted to explore the diversity of *Plagiochila* in Mount Sibayak North Sumatra. Exploration was carried out in along the track of study site. Eighteen species of *Plagiochila* were found, of which two species were recognized as new records to Sumatra (*Plagiochila gracilis* and *Plagiochila laxissima*). Species description and the key to species of *Plagiochila* in Mount Sibayak North Sumatra are provided.

**Keywords:** Liverworts, *Marchantiophyta*, Mount Sibayak, North Sumatra, *Plagiochila*

## **1. Introduction**

*Plagiochila* is the largest genus in *Marchantiophyta*, consisting of more than 1600 species ever assigned to the genus [1]. Asia and the Neotropics are centers of diversity for *Plagiochila*, estimated 480 species recognized from Asia [2]. The specific characters of this genus are: 1) plant medium to large sized, 2) dorsal leaf base decurrent, 3) leaf apex and margins toothed, 4) perianths compressed laterally or inflated at least on the basal half, 5) androecia with long spikes in cluster or solitary, terminal or intercalary [1,3].

The floristic work on *Plagiochila* in Indonesia is still very scarce. A monograph of *Plagiochila* from Southeast Asia was published by Inoue (1984), who listed 48 species from Southeast Asia, includes 31 species from Sumatra. After Inoue, no further study on *Plagiochila* in Sumatra. More comprehensive study on *Plagiochila* in Sumatra will find a greater number of species. Mount Sibayak is one of the suitable area for the liverworts including *Plagiochila*. However, knowledge on *Plagiochila* from this location is poorly understood. Exploration of the diversity of *Plagiochila* in Mount Sibayak North Sumatra is badly needed for comparing with the one by Inoue [1]. This paper is one of the series dealing with the *Marchantiophyta* in Mount Sibayak North Sumatra.



## 2. Methods

The study area is located in Mount Sibayak, North Sumatra, Indonesia, approximately 60 km from Medan city. The locality has an altitude of about 700–2050 m, annual rainfall of 2400–2800 mm/year, and relative humidity of at least 80–90 %. Exploration was carried out along the tracks of Mount Sibayak from lowland to the peak. The specimens collected were classified and identified based on morphological characters, using Inoue [1], Gradstein [3] and other publications of *Plagiochila*. The voucher collected specimens are deposited at the Herbarium Medanense (MEDA), Biology Department, University of Sumatra Utara. An identification key to the species of *Plagiochila* known from Mount Sibayak North Sumatra is provided.

## 3. Results and Discussion

There are eighteen species of *Plagiochila* found in Mount Sibayak North Sumatra; sixteen species are previously known in Sumatra, two of the species are new records, *Plagiochila gracilis* and *P. laxissima*.

### 3.1. Key to species of *Plagiochila* in Mount Sibayak North Sumatra:

- 1 Lateral leaves with a distinct tubular sac at the ventral base..... 2
- 1 Lateral leaves without a distinct tubular sac at the ventral base..... 5
- 2 Free margin of sac entire.....3
- 2 Free margin of sac toothed..... 4
- 3 Teeth on leaf-margin small, triangular, lacking on dorsal margin, free margin of sac strongly incurved..... 5. *P. clavato-saccata*
- 3 Teeth on leaf-margin strongly ciliate, present on dorsal margin, free margin of sac slightly incurved.....4. *P. blepharophora*
- 4 Underleaves lacking..... 14. *P. sandei*
- 4 Underleaves present, ciliate .....3. *P. bantamensis*
- 5 Plants dendroid, flagelliform branches present.....6. *P. dendroides*
- 5 Plant not dendroid, flagelliform branches absent.....6
- 6 Stem with paraphyllia .....7
- 6 Stem without paraphyllia.....8
- 7 Paraphyllia dense on the ventral and dorsal side of the stem, leaves loosely imbricate, leaf-lobes broadly ovate.....1. *P. abietina*
- 7 Paraphyllia dense only on the ventral side of the stem, leaves closely imbricate, leaf-lobes ovate-oblong .....12. *P. obtusa*
- 8 Branches frequent.....9
- 8 Branches infrequent.....10
- 9 Flabellately branched, ventral leaf base dilated, underleaves absent.....2. *P. arbuscula*
- 9 Pseudodichotomously branched, ventral leaf base not dilated, underleaves vestigial.....8. *P. javanica*
- 10 Leaves linearly oblong, usually 2 – 3 times as long as wide, teeth almost restricted to around apex.....11
- 10 Leaves ovate or oblong-ovate, less than two times as long as wide, teeth on whole of leaf-margin (sometimes absent on dorsal margin).....12
- 11 The cuticle of leaf-cells is verrucose ..... 16. *P. singularis*
- 11 The cuticle of leaf-cells is smooth ..... 11. *P. laxissima*
- 12 Branches dominantly dichotomous.....13
- 12 Branches dominantly lateral intercalary or rarely branched.....15
- 13 Leaves always with two distinct, larger teeth at the apex..... 9. *P. junghuhniana*
- 13 Leaves without two larger teeth at the apex.....14

- 14 Teeth of leaves margin 7–12 in total, the apex of leaves often asymmetric bilobed.....13. *P. salacensis*
- 14 Teeth of leaves margin 18–35 in total, the apex of leaves symmetric, entire.....18. *P. teysmannii*
- 15 Teeth on leaf-margin are long ciliate ..... 15. *P. sciophila*
- 15 Teeth on leaf-margin are spinose or short triangular..... 16
- 16 Leaves widest at or around the middle part, cells margin of leaves never elongated ..... *P. gracilis*
- 16 Leaves widest at the 1/3 basal part, cells margin of leaves elongated.....17
- 17 Ventral leaves with a distinct keel on the shoot, leaf base dilated..... 17. *P. sumatrana*
- 17 Ventral leaves without a distinct keel on the shoot, leaf base not dilated .....10. *P. korthalsiana*

### 3.2. Species description

#### 1. *Plagiochila abietina* (Nees) Lindenb.

Plant 25–50 mm long, about 1 mm wide, brownish in the the dry specimen, with a habit of *Mastigophora* species. Paraphyllia dense both on the dorsal and ventral side of stem and branch, 1–2 cells wide at the base and 2–10 cells long; branches very frequent, pinnate, terminal and *Frullania*-type, rarely lateral intercalary on lower; leaves loosely imbricate, lobes broadly ovate, 0.4–0.5 mm long and wide; dorsal margin strongly recurved, long decurrent along dorsal stem midline, ventral margin hardly or only shortly decurrent at the base; apex rounded; teeth present on the whole margin, stronger towards the ventral base, 5–10 x 2–4 cells. Leaf cells at the middle portion 20–32.5 µm x 15–20 µm, at leaf-base 20–35 µm x 12.5–15 µm, at the marginal 20–30 µm x 12.5–15 µm; trigones medium size, cuticle smooth. Underleaves are indistinguishable from paraphyllia.

Dioicous. Gynoecia on the terminal of branches, with one innovation, bracts similar to branch leaves in shape, 0.45 mm long, 0.35 mm wide, margin densely ciliate; perianth campanulate, 0.55 mm long, 0.7 mm wide, mouth slightly arched, the margin of mouth ciliate. Androecia not seen.

Ecology: found on the tree trunks and tree root in lowland forest.

Distribution: Australia, Borneo, Celebes, Fiji, Java, New Caledonia, Papua New Guinea, Sumatra, Solomon Islands, [1,4,5].

Specimens examined: Mount Sibayak, Etti Siregar 154, 304a, 1568

Note: *Plagiochila abietina* is easily recognized from 1) the very frequently and pinnately branched, 2) the densely spine-like paraphyllia on the stem, 3) the habit of *Mastigophora* species.

#### 2. *Plagiochila arbuscula* (Brid. ex Lehm. & Lindenb.) Lindenb.

Plant robust, 30–70 mm long, about 5–6 mm wide, yellowish brown in the the dry specimen, with rhizomatous caulids; branches frequent, almost of the terminal and *Frullania*-type, sometimes with lateral intercalary on the lower portion of the shoot, forming a weakly flabellate habit. Leaves approximately imbricate, lobes ovate-oblong, 2.5–3 mm long, 1.75–2.0 mm wide; dorsal margin slightly recurved and moderately decurrent along dorsal stem midline; ventral margin shortly decurrent, base dilated; apex rounded; teeth present on whole margin, or sometimes absent on basal half of dorsal margin, 15–18 in total number, triangular, 3–7–(8–10) x 2–4–(6–7) cells. Leaf cells at the middle portion 20–45 µm x 12.5–17.5 µm, at leaf-base 25–50 µm x 12.5–17.5 µm, at the marginal 17.5–25 µm x 10–15 µm; trigones medium sized, triangular or nodulose, cuticle smooth; underleaves absent.

Dioicous. Androecia intercalary or terminal on branches, bracts small, 6–10 pairs, closely imbricate. Gynoecia not seen.

Ecology: found on the tree trunks in lowland to lower montane forest.

Distribution: Australia, Borneo, China, Java, Japan, Malaya, New Caledonia, Papua New Guinea, Philippines, Samoa, Solomon Islands, Sumatra (Mt. Singgalang, Mt. Sibayak), Taiwan, Thailand [1, 6, 7].

Specimens examined: Mount Sibayak, Etti Siregar 279, 560, 747a, 866.

Note: diagnostic characters of *P. arbuscula* are 1) plant robust with frequently branches, forming a weakly flabellate habit, 2) the broadly ovate-oblong leaves with a distinctly dilated ventral base, 3) the teeth present on the whole leaf margin. *Plagiochila arbuscula* is readily distinguished from other species of *Plagiochila* by the frequently terminal branches forming a weakly flabellate habit.

### 3. *Plagiochila bantamensis* (Reinw., Blume, and Nees) Mont.

Plant 20–40 mm long, 4–5 mm wide, greenish to pale brown in the dry specimen, with a rhizomatous caulids; branches very rare, if present almost of the lateral intercalary branches. Leaves closely imbricate; lobes oblong, 2.0–3.0 mm long, 1.25–1.5 mm wide; dorsal margin strongly incurved, moderately decurrent along dorsal stem midline; ventral margin not decurrent, the base with tubular sac; sac globose or broadly ovate, with ciliate margin, free margin not involute; apex of lobes rounded; teeth present on whole margin, 3–10 cells long, 2 cells wide at the base. Leaf cells at middle portion 17.5–32.5  $\mu\text{m}$  x 17.5–25  $\mu\text{m}$ , at leaf-base 25–37.5  $\mu\text{m}$  x 17.5–25  $\mu\text{m}$ , at the marginal 30–45  $\mu\text{m}$  x 10–15  $\mu\text{m}$ ; trigones medium sized, triangular, cuticle smooth; underleaves large, margin strongly ciliate. Generative organ not seen.

Ecology: found on the tree trunks in lowland to lower montane forest.

Distribution: Borneo, Cambodia, Celebes, China, Indian mainland, Japan, Java, Malaya, Nicobar Islands, Melanesia, Philippines, Sumatra (Enggano, Padang, Jambi, Mt. Sibolga), Sri Lanka, Taiwan, Thailand [6,7,8,9].

Specimens examined: Mount Sibayak, Etti Siregar 147, 310, 333a, 351, 527, 1495, 1636.

Note: diagnostic characters of *P. bantamensis* are 1) the oblong leaves with ciliate margin, 2) the globose or broadly ovate sac at the ventral base of the leaf with ciliate free margin, 3) the rather large underleaves with ciliate margin.

*Plagiochila bantamensis* seems to be rather common in Mount Sibayak. This species can be readily distinguished from the rest of the species by the presence of ventral globular sac on mature leaves. *Plagiochila bantamensis* is variable in size of plants, leaves, underleaves, and sac on ventral leaf base. The sac on ventral leaf-bases sometimes are small or not well developed or only strongly incurved.

### 4. *Plagiochila blepharophora* (Nees) Lindenh.

Plant 25–40 mm long, 4–5 mm wide, pale greenish in the dry specimen, with a few rhizomatous caulids. Plants usually simple, or sometimes with lateral intercalary branches, shoot apex sometimes ceasing to grow further and produce 1–2 vegetative innovation, forming a dichotomous habit. Leaves moderately or loosely imbricate, lobes ovate-oblong, 2.5–3.25 mm long, 1.1–1.6 mm wide; dorsal margin revolute and decurrent along dorsal stem midline; ventral margin nearly straight, the base forming an oblong or ovate-oblong sac, free margin entire; apex rounded; margin spinose or ciliate on whole ventral and dorsal side of lobes, or sometimes absent from dorsal and basal half of ventral margin. Leaf cells at the middle portion 30–45  $\mu\text{m}$  x 22.5–30  $\mu\text{m}$ , at the leaf-base 30–50  $\mu\text{m}$  x 25–35  $\mu\text{m}$ , at the marginal 30–0  $\mu\text{m}$  x 12.5–15  $\mu\text{m}$ ; trigones small to medium size, acute, cuticle smooth; underleaves small, vestigial, base 6–10 cells wide, 2–4 lobed, lobes composed of uniseriate 1–3 cells.

Dioicous. Gynoecia on the terminal of stem, with one innovation, bracts similar to leaves in shape and size, wider at the base, two pairs, 3.5 mm long, 2.1 mm wide, with weakly incurved ventral base, margin ciliate, more dense and stronger than leaf-margin; perianth cylindrical, 1.87 mm long, 1.37 mm wide, mouth truncate, margin of mouth ciliate. Androecia on terminal or intercalary of the main stem, in long or short spicate, bracts (9) – 12 – 27 pairs, moderately to closely imbricate, distal half obliquely or nearly vertically spreading.

Ecology: found on the tree trunks in lowland to lower montane forest.

Distribution: Japan, Thailand, Philippines, Sumatra (Mt. Singgalang), Java, Borneo, Papua New Guinea [1, 5].

Specimens examined: Mount Sibayak, Etti Siregar 85, 272, 274, 307, 388, 491, 548, 718, 719, 724, 753, 1438, 1713, 1724, 1734.

Note: the diagnostic characters of *P. blepharophora* are 1) the ovate-oblong leaves, 2) the oblong or ovate-oblong sac at the ventral leaf-base, with entire free margin, 3) the vestigial underleaves.

*Plagiochila blepharophora* seems to be common in Mount Sibayak. This species is variable in the shape of tubular sac from ovate to ovate-oblong; wide variation in the size of toothed margin, spinose to ciliate. The sac at the ventral leaf-base sometimes is weakly developed or only incurved. The number of teeth on the leaf margin is also variable; toothed on the whole leaf margin or sometimes entire from the dorsal margin.

### 5. *Plagiochila clavato-saccata* Steph.

Plant robust, 30–60 mm long, 6–8 mm wide, yellowish in the dry specimen, arising from creeping rhizomatous caulids. Plants usually simple, branches very rare. Leaves densely imbricate, horizontally spreading, lobes oblong, 5–6 mm long, 2.2–2.5 mm wide; dorsal margin moderately revolute and recurved and long decurrent along the dorsal stem midline, ventral margin forming a distinct keel on the shoot, long decurrent along the ventral stem midline; the ventral base dilated, with tubular sac at the base; sac oblong, free margin strongly incurved and entire; apex obtuse or rounded nearly; margin of leaves toothed, but entire on dorsal margin. Leaf cells at middle portion 35–45  $\mu\text{m}$  x 37–50  $\mu\text{m}$ , at the marginal 10–12.5  $\mu\text{m}$  x 65–75  $\mu\text{m}$ ; trigones small to medium sized, acute, cuticle smooth; underleaves present, bilobed to the middle, margin ciliate. Generative structures not seen.

Ecology: found on the tree trunk in lowland forest.

Distribution: Malaya, Sumatra [1, 10].

Specimen examined: Mount Sibayak, Etti Siregar 337.

Note: the diagnostic characters of *P. clavato-saccata* are 1) the large and robust plant, 2) the oblong leaves, 3) the small, triangular teeth on the leaf-margin (dorsal margin entire), 3) the oblong sac at the base of the ventral leaf-margin, with entire and strongly incurved free margin, 4) the small underleaves with ciliate margin.

*Plagiochila clavato-saccata* is closely to *P. sandei* but the later without underleaves, teeth on the whole of leaf-margin and the free margin of sac on the ventral leaf-base with irregular teeth. *Plagiochila clavato-saccata* was uncommon in Mount Sibayak, only one specimen was found.

### 6. *Plagiochila dendroides* (Nees) Lindenb.

Plant yellowish to pale brown in the dry specimen, 15–45 mm long, 1.7–2.2 mm wide, stem often with scale-like small leaves; branches very frequent of terminal and *Frullania*-type, forming a dendroid habit, apex of *Frullania*-type branches frequently elongated and becoming minute-leaved, flagelliform. Leaves remote, lobes ovate-oblong, 0.7–0.9 mm long, 0.4–0.5 mm wide; dorsal margin moderately revolute and shortly decurrent along dorsal stem midline; ventral margin shortly decurrent; apex of lobes with shallowly and asymmetrically bilobed, or with 2–(3) teeth; dorsal and ventral margin entire. Leaf cells at the middle portion 20–32  $\mu\text{m}$  x 10–13  $\mu\text{m}$ , at leaf-base 25–40  $\mu\text{m}$  x 10–15  $\mu\text{m}$ , at the marginal 17.5–25  $\mu\text{m}$  x 10–12.5  $\mu\text{m}$ ; trigones indistinct, cuticle smooth. Underleaves vestigial, filiform.

Androecia terminal or intercalary of branches. Gynoecia terminal on branched or intercalary with 1 or 2 innovation; bracts ovate-oblong, 1.2–1.5 mm long, 0.5–0.7 mm wide; perianth 1.5 mm long, 0.5–0.8 mm wide, the margin of mouth rounded, with coarsely spinose.

Ecology: found on the tree trunks from lowland to lower montane forest.

Distribution: Borneo, Fiji, Java, Malaysia, Japan, New Caledonia, Papua New Guinea, Philippines, Sumatra (Mt. Singgalang, Mt. Talang), Taiwan, West Irian [1].



Specimens examined: Etti Siregar 151c, 215, 287, 296, 500, 1484, 1645, 1651, 1714, 1732.

Note: the diagnostic characters of *P. dendroides* are 1) the very frequent of branches, forming a dendroid habit, the flagelliform branches often present on the ventral of stem, 2) the small and remote leaves on the main stem, 3) the shallowly and asymmetrically bilobed leaves, or with 2–(3) teeth at the apex.

*Plagiochila dendroides* is very common in Mount Sibayak. This species is readily distinguished from other species of *Plagiochila* by the shallowly and asymmetrically bilobed leaves or with 2–(3) teeth at the apex.

#### **7. *Plagiochila gracilis* Lindenb. et Gott.**

Plant small 10–20 mm long, 2.5–3.5 mm wide, yellowish brown in the dry specimen; branches very rare, if present exclusively lateral intercalary. Leaves distant to contiguous, lobes oblong–ovate or obovate, widest at or around the middle part, 1.25–1.5 mm long, 0.6–0.8 mm wide; the dorsal margin slightly revolute, long decurrent along the dorsal margin; ventral margin not decurrent; the apex rounded, with 2–4 teeth (two theeth are often prominent when plants are young), the two prominent teeth show a tendency toward bilobed); margin entire on the dorsal side, ventral margin with 4–6 teeth on distal half; teeth on leaf margin 6–10 in total number, triangular, 2–6 x 2–4 cells. Leaf cells at the middle portion 25–32.5  $\mu\text{m}$  x 12.5–22.5  $\mu\text{m}$ , basal cells 25–40  $\mu\text{m}$  x 12.5–20  $\mu\text{m}$ , marginal cells 22.5–30  $\mu\text{m}$  x 12.5–17.5  $\mu\text{m}$ ; trigones medium sized, acute, cuticle smooth; underleaves very vestigial, filiform, 1–2 cells wide at the base, 2–3 cells long. Generative organ not seen.

Ecology: found on the tree trunks from lowland to lower montane forest.

Distribution: Buthan, China, India, Japan, Java, Nepal, Philippines, Sri Lanka, Sumatra (new record based on this study), Taiwan, Thailand, [6,8,10,12].

Specimens examined: Etti Siregar 782, 1739, 1949, 2006a.

Note: the diagnostic characters of *P. gracilis* are 1) the oblong–ovate or obovate leaves, widest at or around the middle part, 2) the teeth on the dorsal leaf margin absent, ventral margin with 4–6 teeth on distal half, 3) the rounded apex of leaf with 2–4 teeth (two are often prominent).

*Plagiochila gracilis* seems to be rare in Mount Sibayak, although we found this species in four collections, they were in a limited population. The species also seems to be quite rare in tropical Asia [1].

#### **8. *Plagiochila javanica* (Swartz) Dum.**

Plant green yellowish in the dry specimen, 30–80 mm long, 3–6 mm wide, with rhizomatous caulids; branches very frequent, predominantly of terminal and *Frullania*-type, often forming a pseudo dichotomous habit. Leaves contiguous, lobes ovate-oblong, 1.25–1.8 mm long, 1.0–1.2 mm wide; the dorsal margin revolute and long decurrent along dorsal stem midline; ventral margin straight, shortly decurrent at the base, slightly incurved along 1/3 basal; apex obtuse; teeth present on whole of leaf margin, except 1/3 basal of dorsal margin, marginal teeth small, triangular, 15–20 in number, 2–3 cells wide at the base, 2–5 cells long. Leaf cells at middle portion 17.5–32.5  $\mu\text{m}$  x 12.5–20  $\mu\text{m}$ , at leaf-base 20–37.5  $\mu\text{m}$  x 20–25  $\mu\text{m}$ , at the marginal 12.5–25  $\mu\text{m}$  x 10–12.5  $\mu\text{m}$ ; trigones medium to large, nodulose, cuticle smooth; underleaves are small or vestigial. Generative organ not seen.

Ecology: found on the tree trunks from lowland to lower montane forest.

Distribution: Java, Philippines Sumatra (Mount Merapi and Mount Singgalang) [1].

Specimens examined: Etti Siregar 747b, 849

Note: the diagnostic characters of *P. javanica* are 1) the predominantly of a terminal and *Frullania*-type branches, often forming a pseudo dichotomous habit, 2) the ovate-oblong or oblong leaves, 3) the small, triangular teeth on whole of leaf margin with rather short terminal cells.

#### **9. *Plagiochila junghuhniana* S. Lac.**

Plant 25–50 mm long, about 2.5–3 mm wide, green to yellowish in the dry specimen; branches few to frequent, almost terminally and *Frullania*-type branched, often forming dichotomous habit. Leaves

imbricate, lobes ovate-oblong to oblong, 1.3–1.6 mm long, 0.6–1 mm wide; dorsal margin long decurrent along stem midline; ventral margin shortly decurrent; apex rounded to truncate; two apical teeth are larger than others. The leaf cells at middle portion 17–28  $\mu\text{m}$  x 14–21  $\mu\text{m}$ , at leaf-base 24–44  $\mu\text{m}$  x 12–19  $\mu\text{m}$ , at the marginal 24–37  $\mu\text{m}$  x 7–9.5  $\mu\text{m}$ ; trigones small, acute, cuticle smooth; underleaves are vestigial.

Dioicous. Androecia terminal or intercalary on branches, bracts 5–13 pairs. Gynoecia terminal or intercalary on branches with 1–2 innovation; bracts larger than lateral lobes and with strongly toothed, 27–30 teeth per bract, dorsal margin strongly revolute; perianth obovate, 1.5–2.4 mm long, 1.2–1.5 mm wide, mouth ciliate-dentate, 4–20 cells long.

Ecology: found on the tree trunks and rotten logs from lowland to lower montane forest.

Distribution: Java, Malaysia, Myanmar, Papua New Guinea, Philippines, Sumatra (Dolok Barus, Mount Singgalang), Thailand [1,6,8].

Specimens examined: Mount Sibayak, Etti Siregar 46b, 158, 159, 261, 275, 290, 302, 343, 385, 395, 438, 457, 508, 534, 632, 712, 740, 765, 779, 780b, 794, 815, 858, 884, 1418, 1429, 1560, 1696, 1723, 1738, 1744, 1771, 1785, 1829, 1881, 1934, 1958, 2028.

Note: the diagnostic characters of *P. junghuhniana* are 1) the frequently dichotomous, terminal and *Frullania*-type branches, 2) the ovate-oblong or oblong rectangular leaves, 3) the two prominently teeth on the leaf apex.

*Plagiochila junghuhniana* is variable in the size and shape of leaves from small to medium sized, from ovate-oblong to oblong rectangular or linear oblong. The ventral base of leaves variable from not dilated to dilated. *Plagiochila junghuhniana* seems to be the most common in Mount Sibayak.

#### **10. *Plagiochila korthalsiana* Molkenb.**

Plant 20–45 mm long, 2.3–3.0 mm wide, green yellowish in the dry specimen, with a few rhizomatous caulids; branches rare, the apex of main shoots with vegetative innovation. Leaf lobes ovate-oblong, widest at 1/3 of basal portion, 1.5–1.7 mm long, 0.7–0.8 mm wide; dorsal margin slightly recurved and decurrent along dorsal stem midline; ventral base shortly decurrent, not dilated; apex widely obtuse to rounded; margin with 9–12 teeth (dorsal entire or with 1–2 small teeth near apex, ventral margin toothed from base to apex or entire at the basal portion); teeth small, 1–2 cells wide at the base, and 1–3 cells long. The leaf cells at middle portion 21–38  $\mu\text{m}$  x 20–24  $\mu\text{m}$ , those of leaf-base 38–54  $\mu\text{m}$  x 18–23  $\mu\text{m}$ , at the marginal 18–29  $\mu\text{m}$  x 13–18  $\mu\text{m}$ ; trigones small to medium sized, acute, cuticle smooth; without underleaves. Generative organ not seen.

Ecology: found on the tree trunk in lower montane forest.

Distribution: Java, Malaysia, Papua New Guinea, Philippines, Sumatra [1,2].

Specimen examined: Mount Sibayak, Etti Siregar 1768.

Note: the diagnostic characters of *P. korthalsiana* are 1) rarely with branches, the apex of main shoots sometimes with vegetative innovation, 2) leaves ovate-oblong, widest at 1/3 basal portion, 3) the small teeth were on the apical of a dorsal and ventral margin of leaves.

#### **11. *Plagiochila laxissima* Schiffn.**

Plant 15–20 mm long, about 3–3.5 mm wide, yellowish brown in the dry specimen, without rhizomatous caulids; branches very rare, if present almost of the lateral intercalary branched. Leaves distant, lobes linear-oblong, 1.5–1.8 mm long, 0.5–0.8 mm wide; dorsal margin weakly recurved and moderately decurrent along dorsal stem midline; ventral margin shortly decurrent; apex obtuse; teeth restricted to the apex of leaves, dorsal and ventral margin entire; toothed on distal portion, 6–9 in total number, triangular, 1–3 cells wide at the base and 1–4 cells long. Leaf cells at the middle portion 27–37  $\mu\text{m}$  x 15–20  $\mu\text{m}$ , at leaf-base 35–50  $\mu\text{m}$  x 10–20  $\mu\text{m}$ , at the marginal 25–35  $\mu\text{m}$  x 7–12  $\mu\text{m}$ ; trigones small, acute, cuticle smooth. Underleaves vestigial, 1–4 cells long. Generative organ not seen.

Ecology: found on the tree trunk in lowland forest.

Distribution: Java, Malaysia, Philippines, Sumatra (new records) [1,10].

Specimen examined: Mount Sibayak, Etti Siregar 128.

Note: the diagnostic characters of *P. laxissima* are 1) the rarely branched plant 2) the distant and the linear-oblong leaves, 3) the teeth on leaves margin restricted to the apex, 4) underleaves are vestigial

*Plagiochila laxissima* is closely related to *P. singularis*, but the latter with verrucose cuticle cells. *Plagiochila laxissima* is uncommon in Mount Sibayak, only one sample was found.

### **12. *Plagiochila obtusa* Lindenb.**

Plant yellowish to brownish in the dry specimen, 39–64 mm long 4–5 mm wide, with rhizomatous caulids; branches infrequent, somewhat dichotomous and often unbranched; paraphyllia are present along the ventral of stem, margin with long ciliate. Leaves imbricate, stem surface invisible; lobes ovate-oblong, 2.5–2.7 x 2.0–2.25 mm; dorsal margin slightly revolute and moderately decurrent along dorsal stem midline; ventral margin shortly decurrent, forming a distinct ventral keel on the shoot, ventral base dilated; margin of leaves wavy; apex widely obtuse or rounded; teeth present on whole leaves margin or sometimes absent from the basal half of dorsal margin, 25 – 28 in number; around the ventral base margin usually ciliate, 2–3 cells wide at the base and 7–15–(19) cells long; teeth on the other portion of leaf margin rather small, triangular, 2–3 cells wide at the base, 1–4 cells long. Leaf cells at the middle portion 24–38  $\mu\text{m}$  x 14–23  $\mu\text{m}$ , at leaf-base 28–43  $\mu\text{m}$  x 14–22  $\mu\text{m}$ , at the marginal 17–29  $\mu\text{m}$  x 9–14  $\mu\text{m}$ ; trigones medium to large, triangular, acute or nodulose, often confluent, cuticle smooth. Underleaves absent. Reproduction organ not seen.

Ecology: found on the tree trunk in lower montane forest.

Distribution: Java, Sumatra (Padang: Mount Singgalang and Mount Talang), Taiwan [1,7].

Specimen examined: Mount Sibayak, Etti Siregar 781.

Note: the diagnostic characters of *P. obtusa* are 1) plant rarely branched, 2) the numerous paraphyllia on the stem, 3) the ovate-oblong leaves, teeth on the whole margin. *Plagiochila obtusa* is uncommon in Mount Sibayak, only one specimen was found.

### **13. *Plagiochila salacensis* Gott.**

Plant 25 mm long, 2.5 mm wide, yellowish brown in the dry specimen. Branches moderate in number, terminal and *Frullania*-type, usually forming a dichotomous system and sometimes producing lateral intercalary. Leaves approximately imbricate, lobes ovate or oblong-ovate, 1.25–1.5 mm long, 0.75–1 mm wide; ventral base dilated, basal ventral margin closely appressed to the base of opposite leaves, forming a distinct keel on ventral side of shoot; the apex sub truncate or rounded, often with two larger (often showing a tendency toward asymmetric bilobed) teeth; teeth are absent on the dorsal margin of leaves, or with 1–2 small teeth near the apex, 2–4 cells wide at the base and 2–7 cells long. Leaf cells at the middle portion 19–31  $\mu\text{m}$  x 12–2.5  $\mu\text{m}$ , those of leaf-base 24.5–37  $\mu\text{m}$  x 12–19  $\mu\text{m}$ , at the marginal 22–34.5  $\mu\text{m}$  x 10.5–13 (15)  $\mu\text{m}$ ; trigones small, acute or sub nodulose, cuticle smooth; underleaves vestigial, often found on young branches.

Dioicous. Gynoecia terminal, without or with one innovation; bracts ovate, 1.5 mm long and 0.8 mm wide, margin ciliate; perianth about 2.25 mm long and 1.5 mm wide, mouth truncate, margin ciliate about 2–3 (4) cells wide and 5–13(14) cells long, mostly uniseriate on 2/3 distal. Male plants not found.

Ecology: found on a rotten log in lowland forest.

Distribution: China, India, Indonesia (Java, Bali, Sulawesi, Sumatra: Mount Singgalang Padang), Philippines, Thailand [6].

Specimen examined: Mount Sibayak, Etti Siregar 559.

Note: the diagnostic characters of *P. salacensis* are 1) forming a dichotomous branching system, 2) the leaves are imbricate, 3) the leaves are ovate with dilated ventral base, 3) the basal ventral margin closely appressed to the base of opposite leaves, 4) the dorsal margin entire and rather small number of teeth on the ventral and apical margin.



*Plagiochila salacensis* is variable in the size of lobes and the number of teeth on lobe margin. *Plagiochila salacensis* seems to be uncommon in Mount Sibayak, only one specimen was found.

#### **14. *Plagiochila sandei* Dozy.**

Plant robust, pendulous, 5–10 cm long, 8–12 mm wide, greenish in the dry specimen, with strong rhizomatous caulids. Plants usually simple (rarely with branches). Leaves closely imbricate, lobes oblong–ovate, 4–6 mm long, 2.5–4 mm wide; dorsal margin strongly recurved and long decurrent along dorsal stem midline; ventral margin with a tubular sac at the base; sac oblong in outline, free margin strongly inrolled, ciliate (variable in size and number); apex rounded; teeth present on whole of leaf margin, 1–2 (3–4) cells wide at the base, 4–6 cells long on ventral margin and 7–11 cells long on basal of dorsal margin. Leaf cells at the middle portion 35–45  $\mu\text{m}$  x 20–25  $\mu\text{m}$ , at leaf-base 37.5–67.5  $\mu\text{m}$  x 20–25  $\mu\text{m}$ , at the marginal 25–37.5  $\mu\text{m}$  x 10–12.5  $\mu\text{m}$ ; trigones very small, acute, cuticle smooth. Underleaves absent.

Dioicous. Gynoecia on the terminal of stem or branches, with one innovation; bracts similar to leaves in shape and size, two pairs, with smaller tubular sac on ventral base; teeth on margin of bracts more dense and stronger than the leaf-margin; perianth long cylindrical, 6 mm long, 3.13 mm wide, mouth truncate, margin of mouth spinose. Androecia terminal on shoots, in long spicate, 7–10 mm long, 2–7 in number and gregarious at shoot apex; bracts 4–24 pairs, closely imbricate.

Ecology: found on the tree trunks and rotten log from lowland to lower montane forest.

Distribution: Borneo, Java, Philippines, Sulawesi, Sumatra [1,13].

Specimens examined: Mount Sibayak, Etti Siregar 325, 335, 336, 338, 734, 756, 1776, 2009.

Note: the diagnostic characters of *P. sandei* are 1) robust and pendulous plant, 2) the imbricate leaves with a ventral keel, 3) the tubular sac on the base of ventral leaves, with strongly inrolled free margin, 3) the long spicate and gregarious androecia at the shoot apex.

*Plagiochila sandei* is variable in the size of a tubular sac of ventral lobes base and the number of their cilia. This species is rather common in Mount Sibayak.

#### **15. *Plagiochila sciophila* Nees ex Lindenb.**

Plant 20–35 mm long, 2.5–3.5 mm wide, green to yellowish-brown in the dry specimen; rarely branches. Leaves distant or loosely to moderately imbricate, lobes short to long rectangular or oblong, 1.4–1.7 mm long, 0.6–0.8 mm wide; dorsal margin weakly recurved, short decurrent; ventral margin weakly recurved, hardly or only shortly decurrent; apex rounded, leaf apex seems bilobed; teeth are present on the whole of leaf margin, long ciliate, 8–18 in total number, 1–3 cells wide and 3–10 cells long, two teeth at the leaf apex are often larger than the other. Leaf cells at middle portion 25–37.5  $\mu\text{m}$  x 17.5–25  $\mu\text{m}$ , at leaf-base 27.5–37.5  $\mu\text{m}$  x 17.5–25  $\mu\text{m}$ , at the marginal 25–37.5  $\mu\text{m}$  x 12.5–27.5  $\mu\text{m}$ ; trigones small, cell walls thin, cuticle smooth. Underleaves are usually vestigial, 2–3 lobes, 4–8 cells long of uniseriate cells. Generative organ not seen.

Ecology: found on the tree trunks and rotten logs from lowland to lower montane forest.

Distribution: Bhutan, China, India, Indonesia (Sumatra, Java, Borneo, Bali, Sulawesi), Japan, Korea, Nepal, Papua New Guinea, Philippines, Thailand, Vietnam [1,6,13,14].

Specimens examined: Mount Sibayak, Etti Siregar 86, 323, 334, 387, 564, 641, 852.

Note: the diagnostic characters of *P. sciophila* are 1) rarely branched, 2) the rectangular or oblong leaves, 3) teeth of leaf-margin long ciliate, present on the whole leaf margin. *Plagiochila sciophila* seems to be common in Mount Sibayak.

#### **16. *Plagiochila singularis* Schiff.**

Plant 25–35 mm long, 3 mm wide, pale yellowish in the dry specimen, branches very rare (most plants simple). Leaves distant, caducous, dropping off from sub basal portion, so most of the stem denuded, lobes oblong, 1.4–1.5 mm x 0.6–0.67 mm; dorsal margin plane, moderately decurrent at the base; ventral margin hardly decurrent at the base; apex obtuse, often with two large teeth; teeth on margin almost restricted to around the leaf-apex. Leaf cells at the middle portion 25–37.5  $\mu\text{m}$  x 17.5–25  $\mu\text{m}$ ,

at leaf-base 25–37.5  $\mu\text{m}$  x 17.5–25  $\mu\text{m}$ , at the marginal 25–37.5  $\mu\text{m}$  x 12.5–20  $\mu\text{m}$ ; cell walls thin, trigones small, cuticle verrucose; underleaves are vestigial, 2–3 cells. Generative organ not seen.

Ecology: found on the tree trunk in lowland forest.

Distribution: Indonesia (Java, Sumatra: Mount Singgalang), Malaysia, Thailand [1,8].

Specimen examined: Mount Sibayak, Etti Siregar 250.

Note: the diagnostic characters of *P. singularis* are 1) very rarely branches, 2) leaves distant, oblong, 3) teeth almost restricted to around the leaf-apex, 4) cuticle cells verrucose.

*Plagiochila singularis* is closely related to *P. laxissima*, as mentioned before.

### 17. *Plagiochila sumatrana* Schiff.

Plant 30–60 mm long, 4.5–5.5 mm wide, with rhizomatous caulids; branches rather frequent, dominantly lateral intercalary. Leaves moderately imbricate, lobes broadly ovate, 1.75–2.25 mm long, 1.6–1.8 mm wide; dorsal margin strongly recurved with shortly decurrent along dorsal stem midline, ventral margin shortly decurrent at the base, dilated toward the base, closely appressed to that of opposite leaves, so the ventral surface of stem completely hidden, forming a ventral keel on shoot; apex rounded; dorsal margin entire, ventral margin toothed; teeth small, triangular, 15–23 in number, (1)–2–3 cells wide at the base, 2–4 cells long. Leaf cells at the middle portion 24.5–37.5  $\mu\text{m}$  x 17.5–21.5  $\mu\text{m}$ , at leaf-base 38–54.5  $\mu\text{m}$  x 18.5–19.5  $\mu\text{m}$ , at the marginal 24.5–37.0  $\mu\text{m}$  x 9.5–12.0  $\mu\text{m}$ ; trigones medium sized, triangular or nodulose, cuticle smooth; underleaves absent.

Diocious. Androecia terminal on shoots apex, in 3 gregarious long spicate; bracts 10–12 pairs, closely imbricate.

Ecology: found on the tree trunk in lowland forest.

Distribution: Borneo, Java, Papua New Guinea, Philippines, Sumatra (Mount Singgalang) [1,6].

Specimen examined: Etti Siregar 882a.

Note: the diagnostic characters of *P. sumatrana* are 1) the rather frequently branches, dominantly lateral intercalary, 2) ventral margin of leaves dilated toward the base, closely appressed to the opposite leaves, 3) forming a ventral keel on shoot, 4) the small teeth on the whole ventral margin and absent on the dorsal margin.

*Plagiochila sumatrana* seems to be uncommon at Mount Sibayak, only one specimen was found. The species has a wide variable in total number of marginal teeth of the leaf (15–23 marginal teeth per leaf).

### 18. *Plagiochila teysmannii* S. Lac.

Plant large, 30–120 cm long, 4–6.5 mm wide, yellowish to pale brown in the dry specimen, with a rhizomatous caulids; branches moderately in number, *Frullania*-type, dominantly terminal or sometimes with lateral intercalary branched, forming a distinctly dichotomous habit. Leaves loosely to closely imbricate, stem visible or invisible, lobes broadly ovate, 2.3–3.5 x 2.2–3.3 mm; dorsal margin strongly recurved and long decurrent along dorsal stem midline; ventral margin short decurrent, usually closely appressed to that of the opposite leaf and forming a ventral keel on shoot, ventral base dilated; apex broadly rounded; teeth present on the whole of leaf margin or entire on basal half of dorsal margin, coarse, 18–35 in number, 2–4 cells wide at the base, 3–6–(10) cells long. Leaf cells at the middle portion 27.5–47.5  $\mu\text{m}$  x 20–25  $\mu\text{m}$ , at leaf base 42–55  $\mu\text{m}$  x 17.5–25  $\mu\text{m}$ , at the marginal 15–37.5  $\mu\text{m}$  x 12.5–20  $\mu\text{m}$ ; trigones large, nodulose, somewhat confluent, cuticle smooth; underleaves absent. Generative organ not seen.

Ecology: found on the tree trunks in lowland forest

Distribution: Borneo, Cambodia, Java, Sulawesi, Sumatra (Mount Singgalang, Padang), Philippines, Thailand [1; 13; 8].

Specimens examined: Mount Sibayak, Etti Siregar 241, 1986, 2008b; Etti Siregar and Nunik S Ariyanti 1444.

Note: the diagnostic characters of *P. teysmannii* are 1) the dominantly terminal and *Frullania*-type branches, forming a dichotomously habit, 2) the ventral keel on the shoot, 3) the broadly ovate leaves, 4) trigones large, nodulose, and somewhat confluent

#### 4. Conclusions

In this study, 18 species of *Plagiochila* from Mount Sibayak were recognized. The species recorded in this study is 60 percent of the total number of *Plagiochila* in Sumatra reported by Inoue [1]. Two of the species were recognized as new records for Sumatra.

*Plagiochila junghuhniana* and *P. dendroides* were the most common species recorded at Mount Sibayak. The uncommon species of *Plagiochila* in Mount Sibayak, found only in a limited population are *P. gracilis*, *P. korthalsiana*, *P. laxissima*, *P. obtusa*, *P. salacensis*, *P. sumatrana* and *P. singularis*.

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