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นางสาวเพียงพัทธ์ สุขรัักษ์

ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

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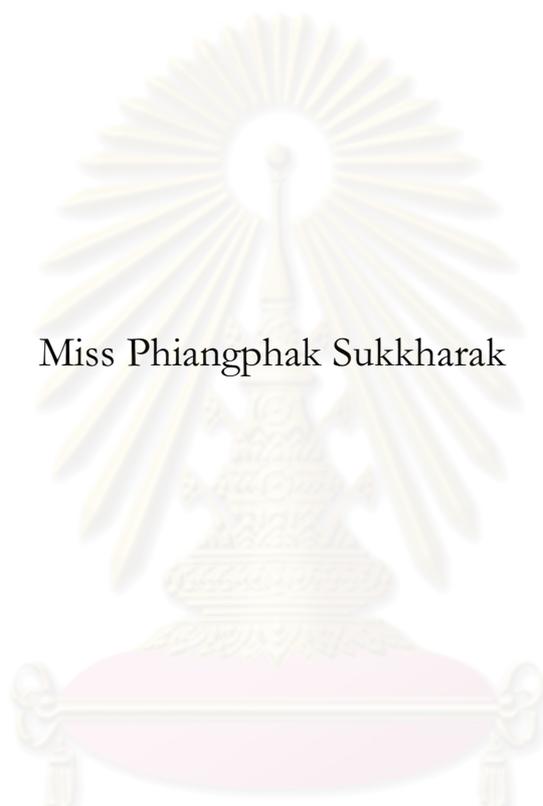
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ลิขสิทธิ์ของจุฬาลงกรณ์มหาวิทยาลัย

**LIVERWORT DIVERSITY AT KHAO NAN NATIONAL PARK,  
NAKHON SI THAMMARAT PROVINCE**

Miss Phiangphak Sukkharak



ศูนย์วิทยทรัพยากร  
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A Thesis Submitted in Partial Fulfillment of the Requirements  
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Department of Botany

Faculty of Science

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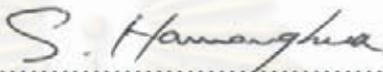
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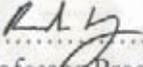
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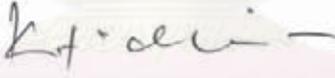
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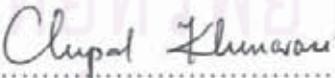
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เพียงพักตร์ สุขรักษ์ : ความหลากหลายของลิเวอร์เวิร์ตบริเวณอุทยานแห่งชาติเขานัน จังหวัดนครศรีธรรมราช (LIVERWORT DIVERSITY AT KHAO NAN NATIONAL PARK, NAKHON SI THAMMARAT PROVINCE) อ. ที่ปรึกษา: ผศ. ดร. ต่อศักดิ์ สีลานันท์, 213 หน้า.

การสำรวจความหลากหลายของลิเวอร์เวิร์ตบริเวณอุทยานแห่งชาติเขานัน จังหวัดนครศรีธรรมราช ตั้งแต่ความสูงประมาณ 320 เมตร ถึง 1,385 เมตรจากระดับน้ำทะเลปานกลาง ได้ดำเนินการระหว่างเดือนมกราคม พ.ศ. 2549 ถึงเดือนมิถุนายน พ.ศ. 2550 และสามารถรวบรวมตัวอย่างได้ทั้งสิ้น 547 หมายเลข จำแนกเป็นลิเวอร์เวิร์ต 103 ชนิด ใน 40 สกุล 17 วงศ์ โดยเป็นทิลลอยด์ลิเวอร์เวิร์ต 9 ชนิดและสปีฟี่ลิเวอร์เวิร์ต 94 ชนิด ในลิเวอร์เวิร์ตจำนวน 103 ชนิดที่พบนี้ ส่วนใหญ่เป็นพืชอิงอาศัย มีเพียงจำนวนน้อยที่เป็นพืชเจริญบนหินหรือบนดิน ลิเวอร์เวิร์ตวงศ์ที่พบจำนวนชนิดและสกุลมากที่สุด คือ วงศ์ Lejeuneaceae พบ 29 ชนิดใน 14 สกุล แต่เมื่อพิจารณาในระดับปริมาณแล้ว ลิเวอร์เวิร์ตสกุลที่พบปริมาณมากที่สุด คือ ลิเวอร์เวิร์ตสกุล *Bazzania* ซึ่งอยู่ในวงศ์ Lepidoziaceae นอกจากนี้ยังพบอีกว่า มีลิเวอร์เวิร์ต 30 ชนิดที่ไม่เคยมีรายงานพบในประเทศไทยมาก่อน ได้แก่ *Aneura indica* Steph., *Riccardia palmata* (Hedw.) Carruth., *Frullania campanulata* Sande Lac., *Frullania intermedia* (Reinw. et al.) Dumort. var. *submorokensis* S. Hatt., *Heteroscyphus acutangulus* (Schiffn.) Schiffn., *Heteroscyphus sarawaketanus* Piippo, *Lophocolea costata* (Nees) Gottsche, *Jungermannia polyrhizoides* Grolle, *Cololejeunea ocelloides* (Horik.) S. Hatt., *Cololejeunea yipii* R. L. Zhu., *Colura meijeri* Jovet-Ast, *Drepanolejeunea tematensis* (Gottsche) Schiffn., *Lejeunea boninensis* Horik., *Leptolejeunea apiculata* (Horik.) S. Hatt., *Lopholejeunea nipponica* Horik., *Schiffneriolejeunea tumida* (Nees) Gradst. var. *tumida*, *Bazzania fauriana* (Steph.) S. Hatt., *Bazzania yakushimensis* Horik., *Lepidozia cladorhiza* (Reinw., Blume & Nees) Nees, *Psiloclada clandestina* Mitt., *Metzgeria consanguinea* Schiffn., *Metzgeria lindbergii* Schiffn., *Plagiochila bicomuta* Steph., *Plagiochila longispica* Mitt., *Plagiochillon pachycephalum* (De Not.) Inoue, *Radula constricta* Steph., *Radula japonica* Gottsche ex Steph., *Radula kurzii* Steph., *Radula philippinensis* Yamada และ *Schistochila nuda* Horik.

## ศูนย์วิทยทรัพยากร จุฬาลงกรณ์มหาวิทยาลัย

ภาควิชา พฤกษศาสตร์  
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ลายมือชื่อนิสิต .....  
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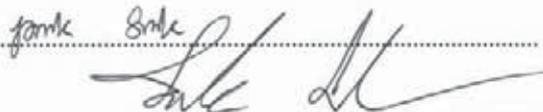
PHIANGPHAK SUKKHARAK : LIVERWORT DIVERSITY AT KHAO NAN NATIONAL PARK, NAKHON SI THAMMARAT PROVINCE.

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The investigation of liverwort diversity at Khao Nan National Park was undertaken from January 2006 to June 2007. Exploration and field collection of liverworts was carried out at elevations ranging from 320 m to 1,385 m amsl. In total, 547 specimens were enumerated, accounting for liverworts in 103 species, 40 genera, and 17 families. Habit-wise, 9 species were thalloid liverworts and 94 were leafy liverworts. Majority of liverworts were epiphytes, and a few were either lithophytes or terrestrials. Among 17 families of liverworts found, family Lejeuneaceae was the richest with respect to species diversity, represented by 29 species in 14 genera. Moreover, of all liverwort species found, members of the *Bazzania* taxa of family Lepidoziaceae had the highest relative abundance. As many as 30 liverworts may be new records to Thailand. These include *Aneura indica* Steph., *Riccardia palmata* (Hedw.) Carruth., *Frullania campanulata* Sande Lac., *Frullania intermedia* (Reinw. et al.) Dumort. var. *submorokensis* S. Hatt., *Heteroscyphus acutangulus* (Schiffn.) Schiffn., *Heteroscyphus sarawaketanus* Püppo, *Lophocolea costata* (Nees) Gottsche, *Jungermannia polyrhizoides* Grolle, *Cololejeunea ocelloides* (Horik.) S. Hatt., *Cololejeunea yipii* R. L. Zhu., *Colura meijeri* Jovet-Ast, *Drepanolejeunea ternatensis* (Gottsche) Schiffn., *Lejeunea boninensis* Horik., *Leptolejeunea apiculata* (Horik.) S. Hatt., *Lopholejeunea nipponica* Horik., *Schiffneriolejeunea tumida* (Nees) Gradst. var. *tumida*, *Bazzania sauriana* (Steph.) S. Hatt., *Bazzania yakushimensis* Horik., *Lepidozia cladorhiza* (Reinw., Blume & Nees) Nees, *Psiloclada clandestina* Mitt., *Metzgeria consanguinea* Schiffn., *Metzgeria lindbergii* Schiffn., *Plagiochila bicornuta* Steph., *Plagiochila longispica* Mitt., *Plagiochilon pachycephalum* (De Not.) Inoue, *Radula constricta* Steph., *Radula japonica* Gottsche ex Steph., *Radula kurzii* Steph., *Radula philippinensis* Yamada and *Schistochila nuda* Horik.

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จุฬาลงกรณ์มหาวิทยาลัย

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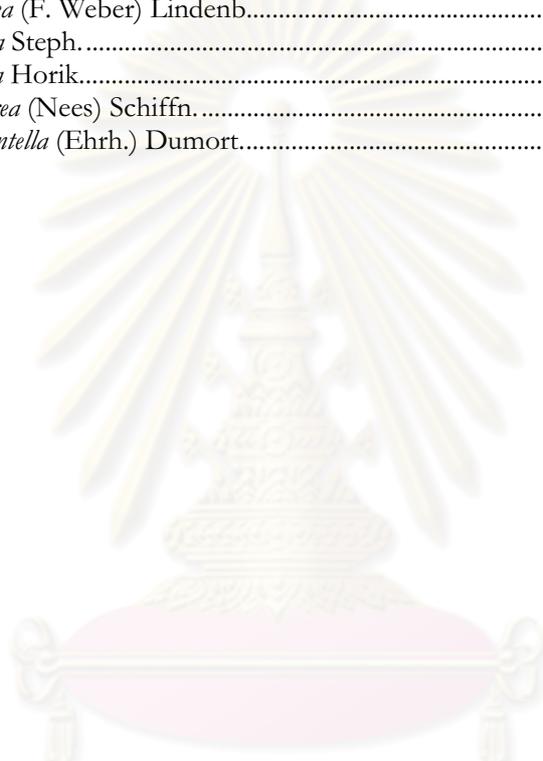
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ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

# CHAPTER 1

## INTRODUCTION

### 1. General introduction to liverworts

The liverworts or hepatics are small land plants belonging to class Marchantiopsida in Division Marchantiophyta (Crandall-Stotler and Stotler, 2000) and includes about 5,000 species (Gradstein et al., 2001); an estimate of 374 species belonging to 84 genera in 34 families occur in Thailand (Lai, Zhu & Chantanaorapint, inpress)

With regard to the liverworts habitat, there are epiphytes which grow on tree, branches or leaves; terrestrial which grow on soil, and lithophyte which grow on rock. Although there are xerotolerant taxa, the majority of the liverworts are found in humid and shaded places. The lower surface of liverworts is attached to the substrate by rhizoids. The rhizoids in liverworts, unlike those of the mosses, are unicellular, rarely septate-multicellular (e.g. *Schistochila*), and some taxa (Calobryales) lack them. They usually originate from the ventral side of the stem, rarely from the lobules (e.g. *Radula*) or from thalloid margins (e.g. *Metzgeria*). When in bundle, rhizoids usually originate from the base of the underleaves or near to it. When plants are prostrate, thalloid surface or stem that is in contact with substrate is referred to as ventral and the other as dorsal.

The oil bodies are unique organelles of most liverworts, and are not found in mosses nor hornworts. The number, chemical composition, shape, and sized of the oil bodies are variable. Upon drying of the plants, the oil bodies usually morphologically change or disintegrate. Specialized leaf cells occur in some liverworts have a very large oil body and lack chloroplasts, the so-called ocelli. In dry material ocelli may usually be recognized by their sized, which may be larger or smaller than ordinary leaf cells (Gradstein et al., 2001).

Liverworts, like mosses and hornworts, have a unique life cycle among land plants in that a gametophyte generation is dominant phase while sporophyte generation is ephemeral. Gametophytes are photosynthetic and variable in forms. On the other hand, sporophytes are not able to photosynthesize and much less variable. Accordingly, sporophytes must obtain nutrients from gametophytes. The mature sporophyte is composed of an expanded foot, anchoring the parasitic sporophyte into gametophyte; a stalk or seta which is colorless and very delicate; and a capsule. The mature capsule is spherical or cylindrical and dehisces by four valves. Within the mature capsule there are spores and elaters. The latter are narrowly single, elongated cells provided with one or more spirally thickened bands that may become compressed dehiscence of the capsule, causing movement and rotation of the elaters (hygroscopic movement). The function of the elaters is to facilitate the release of spores from a capsule. Each spore germinates into a tiny, thalloid protonema that may be globose, cylindrical, or discoidal in shape. Each protonema gives rise to one new gametophyte.

Based on morphology of gametophyte, there are two groups of liverworts, namely, thalloid liverworts and leafy liverworts.

#### **Thalloid liverworts**

Thalloid liverworts have a dorsiventrally flattened gametophyte or thallus, resembling a ribbon. A thallus is usually dichotomously branched, rarely pinnate (e.g. *Riccardia*).

There is variable in internal structure of thallus. In Metzgeriales, the thallus is internally simple and multistratose throughout, or composed of single layer of cells (the thallus wings) while the central portion is multistratose, resembling midrib. In Marchantiales, however, the thallus is internally differentiated, having a chlorophyllous tissue on the dorsal side, usually located in air chambers that open by specialized pores on the upper thallus surface. The rhizoids

are smooth, or in the Marchantiales composed of 2 types: smooth and tuberculate; the latter having peg-like projections on the inner walls. The ventral surface is sometimes covered by scales in 2 or more rows that may be colorless or deep purple to black coloration (e.g. *Marchantia*, *Ricciocarpos*).

The antheridia are produced on the thallus surface, naked or surrounded by an involucre, or inside thallus, in special antheridial chamber. In *Marchantia*, for example, the antheridial chambers are located on antheridiophores. The archegonia are on the thallus surface or embedded inside the thallus and are usually surrounded by an involucre. In Aneuraceae, however, there is no involucre; thus the young sporophyte is surrounded by a fleshy calyptra (modified fertilized archegonium). In Marchantiales, the archegonia are often located on archegoniophore. The sporophyte of thalloid liverworts is enveloped within the calyptra until maturity.

In addition, vegetative reproduction may be found by simple regeneration from thallus cells or by specialized diaspores, e.g., by gemmae produced at the apex of the thallus or in specialized flask-like (e.g. *Blasia*) or cup-like (e.g. *Lunularia*, *Marchantia*) structures, or by tubers produced on the underside of the thallus (e.g. *Cyathodium*, *Fossombronina*).

### Leafy liverworts

Gametophyte of leafy liverworts differentiates into stem-like (caulidium or caulid) and leaf-like (phyllidium or phyllid) structures. Leafy liverworts may be prostrate, ascending, erect or pendent. Erect growing gametophytes often originate from a creeping, may or may not bear leafless shoot or rhizome.

The leaf lamina is normally unistratose and without midrib. In some liverworts, the leaf lamina has rows of elongated cells in the middle, resembling a midrib, called vitta. The leaves are arranged in three rows: one ventral row (underleaves or amphigastria) and two lateral rows (lateral leaves or "leaves"). Underleaves are smaller than lateral leaves and sometimes they are lacking. Three basic patterns of lateral leaf orientation are found:

1. Transverse, where the leaf base attachment is perpendicular to the long axis of the stem.
2. Incubous, where the upper border of the lateral leaf, when viewed from the dorsal surface, overlaps the lower border of the leaf immediately above it on the stem.
3. Succubous, when viewed from the dorsal surface of the stem, the lower border of a leaf overlaps the upper border of the leaf immediately below it on the same side.

The internal structure of the stem is differentiated into a well-defined (outer) cortex and an (inner) medulla. The outer cortical layer is also called the epidermis. The cortex may consist of small, thick-walled cell layers (often with brownish-pigmented walls), or of much enlarged, thin-walled cells.

The branches have ordinary vegetative leaves, tiny, scale-like leaves or no leaves at all. Branches with scale-like leaves are called flagellae, and those without leaves are stolons. There are 2 kinds of branches: intercalary (or thecal) branches and terminal (or athecal) branches. Intercalary branches originate from inner cells of the stem, and tend to be at right angles to the stem and usually stand in the axils of the leaves (or underleaves) except in the *Lejeunea*-type branch (see below). There are four types of intercalary branches:

1. *Bazzaniana*-type: branches originate from the ventral side of stems, from underleaf axil.
2. *Plagiochila*-type: branches originate from the lateral side of stems, from lateral leaf axil.
3. *Lejeunea*-type: branches originate from the lateral side of stems, from behind the lateral leaf.
4. *Anomoclada*-type: branches originate from the dorsal side of stems.

Terminal branches originate from a leaf initial cell or from stem epidermis cells very near to the apex that no collar is formed. They develop at an angle of 45-60° to the stem. When originating from a leaf cell, the leaf associated with the branch is a half-leaf. There are three terminal branch types:

1. *Frullania*-type: branches originate from a ventral-leaf initial cell so that it replaces the ventral half of a leaf. Branches therefore are associated with a half-leaf on its dorsal side.
2. *Kurzia*-type: branches originate from a dorsal-leaf initial cell and therefore are associated with a half-leaf on its ventral.
3. *Radula*-type: branches originate from a stem epidermis cell and therefore are associated with an unmodified leaf.

Reproductive organs are produced from superficial cells of stems or branches. The antheridia are located on the axis of specialized leaves, the male bracts, on the main shoot or on specialized male branches. The archegonia are protected by bracts or bracteoles in one or more series. In many taxa the archegonia are surrounded by a thin tubular organ called perianth. The sporophyte of leafy liverworts is basically similar to that of the thalloid liverworts.

Leafy liverworts have a wide range of vegetative reproduction. Nearly every part of the gametophyte becomes an asexual reproductive diaspore. Vegetative reproduction can take place by simple regeneration from leaf or stem cells or by specialized diaspores such as gemmae produced on the surface or margins of leaves, caduceus branches (cladia), caducous or fragmenting leaves.

## 2. Taxonomy

The classification scheme presented below is according to Crandall-Stotler and Stotler (2000). It reflects state of current understanding of liverwort diversity and is based primarily on morphological evidence. This list includes ranks of family and above, up to the rank of Division.

### PHYLUM (DIVISION): MARCHANTIOPHYTA

CLASS: MARCHANTIOPSIDA

SUBCLASS: SPHAEROCARPIDAE

ORDER: SPHAEROCARPALES

SUBORDER: Sphaerocarpaceae

Sphaerocarpaceae

SUBORDER: Riellineae

Riellaceae

SUBCLASS: MARCHANTIIDAE

ORDER: MONOCLEALES

Monocleaceae

ORDER: MARCHANTIALES

SUBORDER: Marchantiineae

Aytoniaceae

Wiesnerellaceae

Conocephalaceae

Lunulariaceae

Marchantiaceae

Monosoleniaceae

Cleveaceae

Exormothecaceae

SUBORDER: Corsiniineae

Cyathodiaceae

Corsiniaceae

SUBORDER: Monocarpineae

Monocarpaceae  
 SUBORDER: Targioniineae  
 Targioniaceae  
 ORDER: Ricciales  
 Oxymitraceae  
 Ricciaceae  
 CLASS: JUNGERMANNIOPSIDA  
 SUBCLASS: METZGERIIDAE  
 ORDER: HAPLOMITRIALES  
 Haplomitriaceae  
 ORDER: BLASIALES  
 Blasiaceae  
 ORDER: TREUBIALES  
 SUBORDER: Treubiineae  
 Treubiaceae  
 SUBORDER: Phyllothalliineae  
 Phyllothalliaceae  
 ORDER: FOSSOMBRONIALES  
 SUBORDER: Fossombroniineae  
 Fossombroniaceae  
 Allisoniaceae  
 SUBORDER: Pelliineae  
 Pelliaceae  
 Sandeothallaceae  
 ORDER: METZGERIALES  
 SUBORDER: Pallaviciniineae  
 Pallaviciniaceae  
 Makinoaceae  
 Hymenophytaceae  
 SUBORDER: Metzgeriineae  
 Aneuraceae  
 Mizutaniaceae  
 Vandiemeniaceae  
 Metzgeriaceae  
 SUBCLASS: JUNGERMANNIIDAE  
 ORDER: LEPICOLEALES  
 SUBORDER: Ptilidiineae  
 Ptilidiaceae  
 Mastigophoraceae  
 Chaetophyllopsidaceae  
 SUBORDER: Lepicoleineae  
 Vetaformataceae  
 Lepicoleaceae  
 SUBORDER: Perssoniellineae  
 Schistochilaceae  
 Perssoniellaceae  
 SUBORDER: Lepidolaenineae  
 Trichocoleaceae  
 Lepidolaenaceae  
 Neotrichocoleaceae  
 Jubulopsidaceae  
 ORDER: JUNGERMANNIALES  
 SUBORDER: Herbertineae  
 Herbertaceae  
 Pseudolepicoleaceae  
 Trichotemnomataceae

Grolleaceae  
 SUBORDER: Balantiopsidineae  
   Balantiopsidaceae  
 SUBORDER: Lophocoleineae  
   Geocalycaceae  
   Gyrothyraceae  
   Plagiochilaceae  
   Acrobolbaceae  
   Arneliaceae  
 SUBORDER: Lepidoziineae  
   Phycolepidoziaceae  
   Calypogeiaceae  
   Lepidoziaceae  
 SUBORDER: Cephaloziineae  
   Cephaloziaceae  
   Cephaloziellaceae  
   Jackiellaceae  
   Adelanthaceae  
 SUBORDER: Antheliineae  
   Antheliaceae  
 SUBORDER: Brevianthineae  
   Brevianthaceae  
   Chonecoleaceae  
 SUBORDER: Jungermanniineae  
   Jungermanniaceae  
   Mesoptychiaceae  
   Gymnomitriaceae  
   Scapaniaceae  
 ORDER: PORELLALES  
 SUBORDER: Porellineae  
   Porellaceae  
 SUBORDER: Jubulineae  
   Goebeliellaceae  
   Jubulaceae  
   Bryopteridaceae  
   Lejeuneaceae  
   Radulaceae  
   Pleuroziaceae

### 3. Role of Liverworts to Ecology

The role of liverwort, especially at the species level, to ecology is little known. Liverworts, like mosses and hornworts, may have a major role in nutrient cycling, water retention and even in interference in precipitation input. There are the kinds of animals that depend on liverworts at some stage of their life cycle, whether for shelter, nesting, predator avoidance, or even food (Glime, 2007).

### 4. Khao Nan National Park

Khao Nan National Park is situated in the southern province of Thailand, covering an area of 408.09 square kilometers and occupying the areas of Amphoe Tha Sala, Amphoe Sichon and Amphoe Nopphitam of Nakhon Si Thammarat province. The National Park is also part of Nakhon Si Thammarat mountain range and is surrounded by three other National Parks and one Wildlife Sanctaury, namely Nam Tok See Keed National Park in the north, Tai Rom Yen National Park in the west and Katoon Wildlife Sanctuary and Khao Luang National Park in the south. The climate of this mountain range is under the influence of winds from the Gulf of

Thailand and the Andaman Sea during different seasons. The highest precipitation occurs between October and February.

There are 7 substations patrol the National Park. Among these, the 4<sup>th</sup> substation known as Thaton substation is responsible for the healthiness of Khao Nan National Park's highest peak known as Khao Yai. This peak is about 1,438 m above mean sea level (amsl) as indicated in the Royal Thai Survey Department (map series 1501 S, sheet NC 47-15, edition 1 RTSD printed in April, 1973); however many observation suggested that it is around 1,385 m amsl (GPS-elevation). There are other peaks in Khao Nan National Park in this elevation range such as San Yen plateau (1,310 m GPS-elevation) in the 1<sup>st</sup> substation (personal observation, April 20, 2007) or Khao Nom (1,350 m) in the 3<sup>rd</sup> substation (personal observation, August 10, 2007). Plant communities in these areas are different from that of Khao Yai; so does edaphic factor, e.g. sandy soil with less humus in Khao Nom and Sanyen plateau versus loamy soil with much humus a Khao Yai area (personal observation, August 12, 2007).

The 4<sup>th</sup> substation of Khao Nan National Park located in Amphoe Sichon. The surrounding area is large a para rubber plantation intermixed with oil palm plantation. Beyond, it is lower montane rain forest (ถ้ำชัย, 2550) with as many as 3 large stream passing through and up to altitude of 800 m amsl. The lower montane rain forest can be found at and above 800 m. At and along the high montane ridge, it consisted of a patch of lower montane oak forest intermixed with cloud-covering montane forest (Figure 1.1). The flora at this altitude consists of not only trees but also many orchids, ferns and bryophytes. This may be due to its geographic location and elevation, the vegetation close to and along ridge is covered by mist and cloud nearly all year round. Large mammals can also be found including a wild bear and a tapir. As many as 3 water seeps originate within this mountain ridge (Figure 1.1).

In 2006, the Biodiversity Research and Training program (BRT) initiated the area-based research project at Khao Nan National Park to enumerate biodiversity in this area, and to monitor any changes of biodiversity in long term research (BRT, 2007). As bryophytes are components of plant community, particularly at high elevation, yet no study of bryophyte have been taken place in this National Park. Therefore, it is need to conduct a research on this group of plants. Few trails were suggested by the working group of the BRT program, but one was chosen in this thesis, namely the 4<sup>th</sup> substation-Khao Yai. Therefore, this thesis aims to conduct biodiversity of bryophytes focusing on liverwort diversity in this area.

#### **Aim of the thesis**

This work aimed to investigate the diversity of liverworts at Khao Nan National Park, Nakhon Si Thammarat Province.



**Figure 1.1** The study sites: a. Para rubber plantation along perimeter of national park at 340 m; b. steep slope at 954 m; c.-e. plateau of the summit: c. in February at 1,205 m, d. in May at 1,375 m, e. in August at 1,100 m; f. seep near camping site at 1,250 m; g. the valley at 1,270 m

## CHAPTER 2 LITERATURE REVIEW

### Previous studies on liverworts of Thailand

Studies of liverworts in Thailand were started by foreign authors. The first record of members of liverwort was made by Stephani (1902) in Schmidt's "Flora of Koh Chang". He recorded 17 species, including 4 new species, based on the specimens collected during 1899 and 1900 from Koh Chang by Danish botanist Johannes Schmidt. All collected specimens were sent to the Botanical Museum in Copenhagen. Then, 9 years later Carl Curt Hosseus and Bad Reichenhall reported 5 species which 1 species was described as new from his own collections made on the top of the mountain of Doi Suthep, northern Thailand. (Hosseus & Reichenhall, 1911)

There was a lag on research in liverwort diversity until 1959, when R. M. Giesy and P. W. Richards recognized 3 species based on identifications by J. Proskauer (University of California, Berkeley, U.S.A.), P. Kachroo (Burdwan), and Mme S. Jovet-Ast (Paris). All collection of liverworts was made by P. W. Richards during a visit to Thailand in November-December, 1957, for the Ninth Pacific Science Congress at Bangkok. One species from Temple of Reclining Buddha Bangkok and the rest made from Chiang Dao in the mountainous part of Northern Thailand during the tour organized for the benefit of members of the Botany Division after the Congress. The first set of specimens is in the herbarium of P. W. Richards; other sets are in the herbarium of R. M. Giesy, the Royal Forest Department, Bangkok, and the British Museum (Natural History) (Giesy & Richards, 1959).

Since then, knowledge of liverwort diversity in Thailand had been advanced by Thai and foreign bryologists. In 1967, numerous studies of liverworts were made. Clyde F. Reed & Harold Robinson reported 8 species from various collections of bryophytes sent to the Clyde F. Reed by the curator of the Forest Herbarium, Royal Forest Department, Bangkok, Thailand. The specimens, many of which were already named, had been identified or verified by Harold Robinson. These specimens had been collected from Nakhon Si Thammarat, Nakhon Ratchasima and Trat by various workers involving in the Flora of Thailand project. The original specimens are in the Forest Herbarium in Bangkok (BKF). Duplicates are in the United States National Herbarium, Washington, D. C. and/or in the Reed Herbarium, Baltimore, Maryland (Reed & Robinson, 1967). In this year, Clyde F. Reed & Harold Robinson added 3 species of liverworts found in Thailand. The original specimens, they were collected from Chiang Mai and Kanchanaburi for the "Flora of Thailand" project, are in the herbarium of the Botanical Section of the Department of Agriculture in Bangkok, Thailand (BK). Duplicates are in the United States National Herbarium, Washington, D. C. and/or in the Reed Herbarium, Baltimore, Maryland (Reed & Robinson, 1967). Moreover, Kitagawa clarified 22 species of *Bazzania*, of which 4 were new species and 15 were new records for the flora of Thailand from two thousand packets of Hepaticae collected from northern mountainous and in the southern peninsular regions by M. Tagawa and N. Kitagawa and the central and southeast areas by K. Iwatsuki and N. Fukuoka during November 1965 to February 1966 in the Kyoto University Botanical Expedition to Thailand in cooperation with the Royal Forest Department of Thailand. The collections are deposited in the Herbarium of Kyoto University (KYO) and a set of duplicate in the Herbarium of the Royal Forest Department, Bangkok. Another complete set of bryophytes is kept in the Herbarium of the Hattori Botanical Laboratory (NICH) (Kitagawa, 1967).

In 1968, Kitagawa collected of more than 40 packets from dry mixed forests or in rather moist evergreen forests in the northern mountainous regions of the country, and reported 3 species of *Cephalozia* and 7 of *Cephalozijella* species. In addition, 3 species of *Leucolejeunea* were also reported (Kitagawa, 1968a, b).

In 1969, Naofumi Kitagawa described *Cololejeunea shimizui* N. Kitagawa which growing on a limestone cliff at seashore near Phang-nga, Thailand during the Kyoto University Botanical Expedition 1967. He also reported remarkable new species of Lejeuneaceae from Malay Peninsula including *Colura acroloba* (Mont.) S. J.-A. and *Diplasiolejeunea jovetastiae* Grolle from Trang (Kitagawa, 1969).

During 1973-1977, the studies of liverwort in Thailand had been focused on some genera including *Bazzanina*, *Plagiochila* and *Frullania*. In 1973, P. Tixier collected the specimens during a trip mainly in the North (Chiang Mai), the North East (Phu Mieng), the East (Khao Yai-Khao Khieo) and the South (Surat Thani) under the auspices of the South East Asia Treaty Organization. He reported 56 species of liverwort species (Tixier, 1973). In the next year, Hironori Inoue reported 46 species of *Plagiochila* including 3 new species collected by Dr. M. Tagawa and Dr. N. Kitagawa in the northern mountainous district and the southern peninsular districts of Thailand in 1965-1966. These specimens are all preserved in the herbarium of National Science Museum, Tokyo (TNS) and in the herbarium of Kyoto University, Kyoto (KYO) (Inoue, 1974). In 1977, Sinske Hattori, Obchant Thaithong and Naofumi Kitagawa studied the specimens collected in Thailand by various collectors from 1957-1977. Among them, there are 3 extensive collections, The Kyoto University Botanical Expedition to Thailand in cooperation with The Royal Forest Department of Thailand (November, 1965-February 1966, and August-October 1967), The Expedition of The Rijksherbarium, Leiden, and The Forest Herbarium, Bangkok (November 1965-February 1966), and The Aarhus University Expedition (July-August 1966). Their main collecting areas were in mountainous regions of Chiang Mai and Chaing Rai in the north, Loei in the northeast, and Nakhon Si Thammarat in the south, which are quite different in their topography. A total of 34 species were recognized, of which 20 species previously had not been known in the Thailand flora, and 2 other species, 1 varieties, and 1 forma were newly described. (Hattori, Thaithong & Kitagawa, 1977).

In 1978, Naofumi Kitagawa reported 64 species of liverworts based on 1,500 packets of specimens made by Dr. A. Touw in 1965-1966 as a member of the Expedition of the Rijksherbarium, Leiden (L) and the Forest Herbarium, Bangkok (BKF). In the next year, he reported 41 species and 2 varieties including 1 new variety. The specimens are deposited in the Rijksherbarium (L) and many duplicates are kept in the herbarium of Kyoto University (KYO) (Kitagawa, 1978, 1979).

In 1980, 1,300 liverwort species from 1,800 packets of bryophytes specimens were studied by several Japanese specialists: Plagiochilaceae by Dr. H. Inoue (National Science Museum); some of Lejeuneaceae by Dr. M. Mizutani (Hattori Botanical Laboratory); and all other Hepaticae by N. Kitagawa. All specimens were collected by Tatemi Shimizu, Naofumi Kitagawa, Hiroshige Koyama, Thawatchai Santisuk, Hideo Toyokumi & Tetsukazu Yahara on the Thai-Japanese Botanical Expedition in 1979 (Shimizu et al., 1980).

Sporadically, few Thai bryologists had published research articles on bryophyte diversity in various parts of Thailand. For instance, Dr. Obchant Thaithong (1984) carried out the biodiversity of epiphytic flora of the mangrove forest in the eastern coast, i.e. Chanthaburi, and in the western coast, i.e. Ranong, Phang-nga, Krabi and Satun from 1980 to 1982. She reported 21 species of liverworts.

Ranoo Sornsamran (1982) conducted a survey in Sakaerat Research Station, Nakhon Ratchasima province and found 26 liverwort species in order Jungermanniales.

Ranoo Sornsamran and Dr. Obchant Thaithong enumerated species of bryophytes of Thailand. They listed 279 species of liverworts from the 24 research articles on bryophytes of Thailand from 1900 to 1979 (Sornsamran & Thaithong, 1995). No revision or namechanged were made.

Sahut Chantanaorapint found that as many as 38 species of liverworts inhabiting in the summit of Khao Luang, Huai Yang Waterfall National Park, Prachuap Khiri Khan Province. In this work, he reported 8 species of liverworts as a new record to Thailand (Chantanaorapint, 2002).

Recently, in 2006, few bryophyte studies were undertaken in Chiang Mai. For instance, Soonthree Kornochalert found 18 species of liverworts from Khun Chang Khian Village, Doi Suthep-Pui National Park, Chiang Mai Province (Kornochalert, 2006). Furthermore, Sudchit Manachit reported 26 liverworts species from 327 bryophytes specimens in the area of Sirindhorn Observatory, Doi Suthep-Pui National Park, Chiang Mai Province (Manachit, 2006).

During the World Conference of Bryology 2007 held at Kaulalumper, Malaysia, Lai, Zhu and Chantanaorapint presented an updated and revised list of liverworts in Thailand. In their work, a total of 374 species were included. Many names have been changed or abandoned and reduced to synonym.



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## **CHAPTER 3**

### **MATERIALS AND METHODS**

#### **3.1 Materials**

##### **3.1.1 Specimen collecting equipments**

- plastic bags
- tags
- pocket knife
- pencil
- field note
- digital camera, model: Nikon D 70s with 60 mm Macro lens and SB-200/SU400 kit
- hand lens
- The Global Position System (GPS) receiver: Garmin 60CSx and 12XL

##### **3.1.2 Herbarium specimens preparing equipments**

- paper envelopes
- label paper

##### **3.1.2 Identification equipments**

- dissecting microscope with drawing tube
- light microscope with drawing tube
- microscopic slides and cover glasses
- dissecting needles
- razor blades
- Petri dishes
- Related taxonomic literatures of liverworts

#### **3.2 Methods**

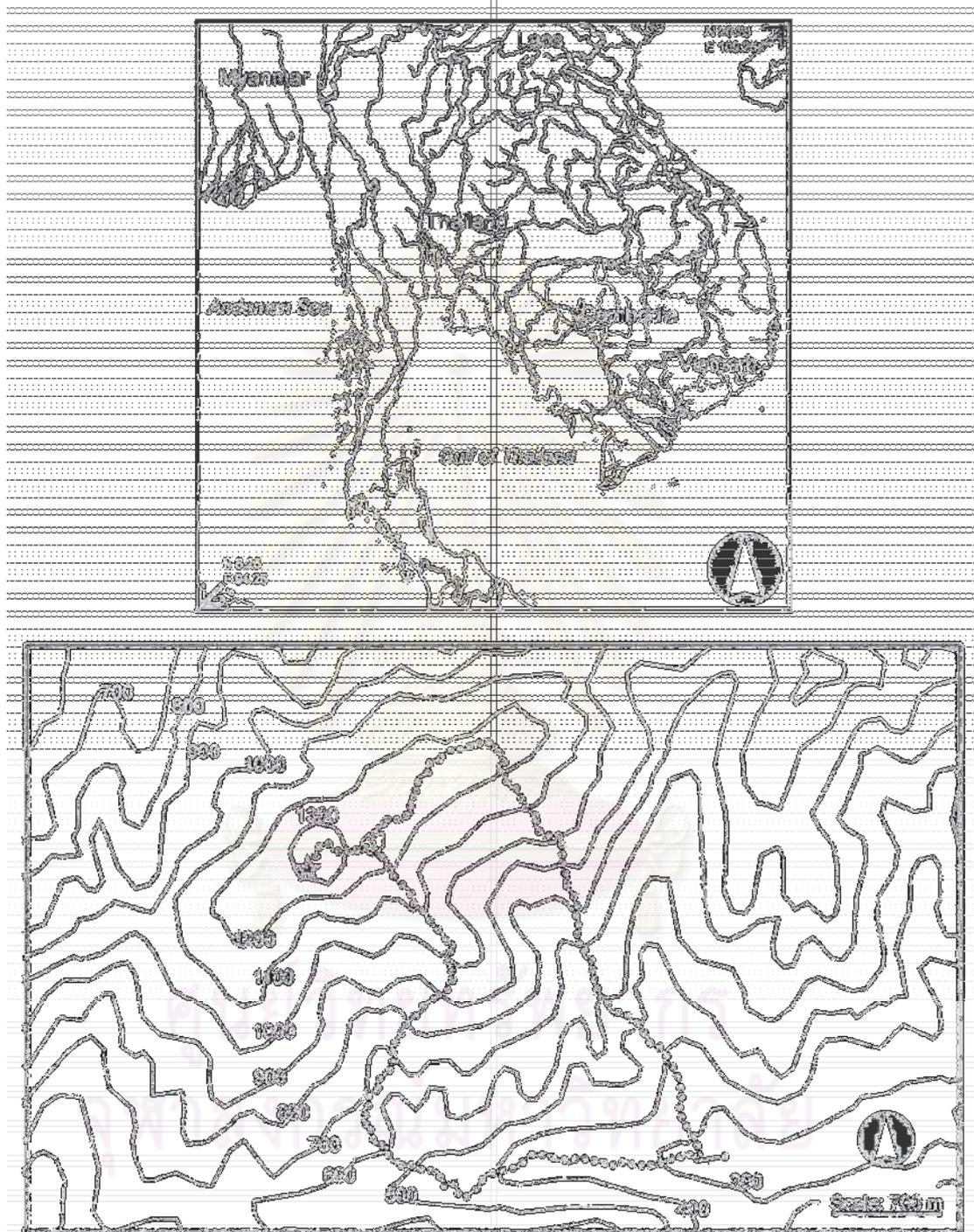
##### **3.2.1 Exploration and collection**

Exploration and field collections were carried out between January 2006 and June 2007; however, between October and December, 2006, no collections could be made due to the heavy rain and subsequently inaccessible trail. The areas for collection were restricted to liverworts found only at the Khao Yai at and above 320 m to 1,385 m. The trail for exploration was recommended by forest rangers at the 4<sup>th</sup> substation of Khao Nan National Park, and is shown in Figure 3.1. The total distance is ca. 16 Km (Figure 3.1). Collections were made according to the standard method (ทวีศักดิ์ บุญเกิดและคณะ, 2530). Localities were marked by a GPS receiver when applicable, and notes were made, with regards to ecological data, habitat, and some diagnostic characteristics. Liverworts presented in this study were collected mainly from the ground and trees trunks and leaves of a height no more than 2 m. No attempt was made to collect specimen on high canopy. However, it is unlikely that species composition at high canopy would differ substantially from lower habitat (Dobbs, 2006)

##### **3.2.2 Laboratory study**

Both morphological and anatomical features were later studied in the laboratory. Liverwort specimens were identified using both keys and descriptions from various taxonomic literatures previously reported, such as the Journal of the Hattori Botanical Laboratory and Acta Botanica Fennica. Full descriptions and line drawings of all species were given, key to families, genera and species for their identification were constructed, together with ecological data and their distributions. All voucher specimens were deposited at BCU and BKF (Holmgren, 1998).

Authors of scientific names and their abbreviation used in this thesis are in accordance with “Liverworts and hornworts of Thailand: an updated checklist and bryofloristic accounts” (Lai, Zhu & Chantanaorapint, inpress). The terminology used in this thesis was followed Malcolm & Malcolm (2000).



**Figure 3.1** Top - Locality of study site (marked as opened star). Bottom - Topological map illustrates the study trail (beaded line) and Khao Nan peak (solid star). Elevations are given in meters. Specimen collections were made at elevation of 320 meter and above.

## CHAPTER 4 RESULTS

A total of 547 specimens were collected, and accounting for 103 species in 40 genera, and 17 families (Table 4.1).

**Table 4.1** List of Liverworts at the summit of Khao Nan, Khao Nan National Park, Nakhon Si Thammarat Province.

Family	Genus	Species
Acrobolbaceae	<i>Marsupidium</i>	<i>Marsupidium knightii</i> Mitt.
Aneuraceae	<i>Aneura</i>	<i>Aneura indica</i> Steph.
	<i>Riccardia</i>	<i>Riccardia palmata</i> (Hedw.) Carruth.
		<i>Riccardia</i> sp. 1
Calypogeiaceae	<i>Calypogeia</i>	<i>Calypogeia</i> sp.
	Frullaniaceae	<i>Frullania</i>
<i>Frullania berthoumieuii</i> Steph.		
<i>Frullania campanulata</i> Sande Lac.		
<i>Frullania ericoides</i> (Nees) Mont.		
<i>Frullania gracilis</i> (Reinw. et al.) Dumort.		
<i>Frullania intermedia</i> (Reinw. et al.) Dumort. var. <i>submorokensis</i> Hatt.		
<i>Frullania nigricaulis</i> (Nees) Nees		
<i>Frullania nodulosa</i> (Reinw. et al.) Nees		
<i>Frullania serrata</i> Gottsche		
<i>Frullania</i> sp.		
Geocalyceae		<i>Conoscyphus</i>
	<i>Heteroscyphus</i>	<i>Heteroscyphus acutangulus</i> (Schiffn.) Schiffn.
		<i>Heteroscyphus argutus</i> (Reinw. et al.) Schiffn.
		<i>Heteroscyphus coalitus</i> (Hooks.) Schiffn.
	<i>Lophocolea</i>	<i>Lophocolea sarawaketanus</i> Piippo
		<i>Lophocolea costata</i> (Nees) Gottsche
	Jungermanniaceae	<i>Saccogynidium</i>
<i>Anastrophyllum</i>		<i>Anastrophyllum piligerum</i> (Nees) Steph.
<i>Jamesoniella</i>		<i>Jamesoniella contracta</i> (Reinw. et al.) N. Kitag.
		<i>Jamesoniella flexicaulis</i> (Nees) Schiffn.
<i>Jungermannia</i>		<i>Jungermannia comata</i> Nees
Lejeuneaceae	<i>Archilejeunea</i>	<i>Archilejeunea polyrbizoides</i> Grolle
		<i>Archilejeunea planiuscula</i> (Mitt.) Steph.
	<i>Ceratolejeunea</i>	<i>Archilejeunea polymorpha</i> (Sande Lac.) B. Thiers & Gradst.
		<i>Ceratolejeunea belangeriana</i> (Gottsche) Steph.
	<i>Chilolejeunea</i>	<i>Chilolejeunea</i> sp. 1
		<i>Chilolejeunea</i> sp. 2
	<i>Cololejeunea</i>	<i>Cololejeunea ocelloides</i> (Horik.) S. Hatt.
		<i>Cololejeunea spinosa</i> (Horik.) Pandé & Misra
		<i>Cololejeunea yipii</i> R. L. Zhu.
	<i>Colura</i>	<i>Colura conica</i> (Sande Lac.) K. I. Goebel
	<i>Drepanolejeunea</i>	<i>Colura meijeri</i> Jovet-Ast
<i>Drepanolejeunea angustifolia</i> (Mitt.) Grolle		
<i>Drepanolejeunea dactylophora</i> (Nees et al.) Schiffn.		
<i>Drepanolejeunea levicornua</i> Steph.		
	<i>Drepanolejeunea ternatensis</i> (Gottsche) Schiffn.	
	<i>Drepanolejeunea</i> sp. 1	

Family	Genus	Species
		<i>Drepanolejeunea</i> sp. 2
	<i>Lejeunea</i>	<i>Lejeunea boninensis</i> Horik. <i>Lejeunea</i> sp.
	<i>Leptolejeunea</i>	<i>Leptolejeunea apiculata</i> (Horik.) S. Hatt.
	<i>Lopholejeunea</i>	<i>Lopholejeunea nipponica</i> Horik. <i>Lopholejeunea subfusca</i> (Nees) Schiffn.
	<i>Metalejeunea</i>	<i>Metalejeunea cucullata</i> (Reinw. et al.) Grolle
	<i>Ptychanthus</i>	<i>Ptychanthus striatus</i> (Lehm. & Lindenb.) Nees
	<i>Schiffneriolejeunea</i>	<i>Schiffneriolejeunea cumingiana</i> (Mont.) Gradst. <i>Schiffneriolejeunea tumida</i> (Nees) Gradst. var. <i>tumida</i>
	<i>Spruceanthus</i>	<i>Spruceanthus semirepandus</i> (Nees) Verd.
	<i>Thysananthus</i>	<i>Thysananthus retusus</i> (Reinw. et al.) B. Thiers & Gradst. <i>Thysananthus spathulistipus</i> (Reinw. et al.) Lindenb. <i>Thysananthus</i> sp.
Lepidoziaceae	<i>Acromastigum</i>	<i>Acromastigum curtilobum</i> A. Evans.
	<i>Bazzania</i>	<i>Bazzania debilis</i> N. Kitag. <i>Bazzania fauriana</i> (Steph.) S. Hatt. <i>Bazzania loricata</i> (Nees) Trevis. <i>Bazzania spiralis</i> (Reinw., Blume et Nees) Meijer <i>Bazzania tridens</i> (Reinw. et al.) Trevis. <i>Bazzania uncigera</i> (Nees) Trevis. <i>Bazzania vittata</i> (Gottsche) Trevis. <i>Bazzania yakushimensis</i> Horikawa.
	<i>Lepidozia</i>	<i>Lepidozia cladorbiza</i> (Reinw., Blume & Nees) Nees <i>Lepidozia parvula</i> N. Kitag. <i>Lepidozia</i> sp.
	<i>Psiloclada</i>	<i>Psiloclada clandestina</i> Mitt.
Marchantiaceae	<i>Dumortiera</i>	<i>Dumortiera hirsuta</i> (Sw.) Nees
Mastigophoraceae	<i>Mastigophora</i>	<i>Mastigophora diclados</i> (Brid.) Nees
Metzgeriaceae	<i>Metzgeria</i>	<i>Metzgeria consanguinea</i> Schiffn. <i>Metzgeria furcata</i> (L.) Dumort. <i>Metzgeria lindbergii</i> Schiffn.
Pallavicaniaceae	<i>Symphogynopsis</i>	<i>Symphogynopsis filicum</i> (Nadeaud) Grolle
Plagiochilaceae	<i>Plagiochila</i>	<i>Plagiochila bicornuta</i> Steph. <i>Plagiochila javanica</i> (Sw.) Nees & Mont. <i>Plagiochila longispica</i> Mitt. <i>Plagiochila parvifolia</i> Lindenb. <i>Plagiochila sciophila</i> Nees ex Lindenb. <i>Plagiochila subtropica</i> Steph. <i>Plagiochila</i> sp.
	<i>Plagiochilion</i>	<i>Plagiochilion oppositum</i> (Reinw. et al.) S. Hatt. <i>Plagiochilion pachycephalum</i> (De Not.) Inoue
Pleuroziaceae	<i>Pleurozia</i>	<i>Pleurozia gigantea</i> (F. Weber) Lindenb.
Radulaceae	<i>Radula</i>	<i>Radula assamica</i> Steph. <i>Radula campanigera</i> Mont. <i>Radula constricta</i> Steph. <i>Radula formosa</i> (Meissn.) Nees <i>Radula japonica</i> Gottsche ex Steph. <i>Radula javanica</i> Gottsche <i>Radula kurzii</i> Steph. <i>Radula philippinensis</i> Yamada <i>Radula yangii</i> Yamada
Schistochilaceae	<i>Schistochila</i>	<i>Schistochila aligera</i> (Nees & Blume) Jack & Steph. <i>Schistochila blumei</i> (Nees) Trevis.

Family	Genus	Species
		<i>Schistochila nuda</i> Horik.
		<i>Schistochila sciurea</i> (Nees) Schiffn.
		<i>Schistochila</i> sp.
Trichocoleaceae	<i>Trichocolea</i>	<i>Trichocolea pluma</i> (Reinw. et al.) Mont.
		<i>Trichocolea tomentella</i> (Ehrh.) Dumort.

In the following, identification key to families, genera, and species of liverworts found is presented. Description of families, genera, and species were provided after respective key. Line drawing was given in all species and photographs of some liverworts were also shown. Taxa appear in alphabetical order with respect to families, genera, species, and lower ranges.



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## Class Hepaticopsida

### Key to the families

1. Plants thalloid form.
  2. Rhizoids with smooth walled.
    3. Hair absent.
      4. Midrib without central strands ..... **Aneuraceae**
      4. Midrib with central strands ..... **Pallaviciniaceae**
    3. Hair present on thallus surface, margin, and underside of midrib ..... **Metzgeriaceae**
  2. Rhizoids composed of 2 types: smooth and tuberculate ..... **Marchantiaceae**
1. Plants leafy form.
  5. Incubous.
    6. Underleaves present.
      7. Lateral leaves undivided.
        8. Sparing branch, flagella absent.
          9. Lateral leaves deeply 2 lobes, appendage at basal part .... **Mastigophoraceae**
          9. Lateral leaves undivided, appendage absent ..... **Calypogeiaceae**
        8. Pinnate or forked, flagella frequently present ..... **Lepidoziaceae**
      7. Lateral leaves divided into two-three part.
        10. Lateral leaves divided into small dorsal lobe and larger ventral ..... **Schistochilaceae**
        10. Lateral leaves divided into large lobe and small lobule.
          11. Lateral leaves divided into large lobe and lobule attached to dorsal lobe along keel, stylus reduced ..... **Lejeuneaceae**
          11. Lateral leaves divided into lobe, saccate lobule, stylus present ..... **Frullaniaceae**
    6. Underleaves absent.
      12. Lateral leaves divided into large lobe and saccate lobule sometime explanate ..... **Pleuroziaceae**
      12. Lateral leaves divided into large dorsal lobe and small lobule ..... **Radulaceae**
  5. Succubous.
    13. Underleaves lacking.
      14. Apex of lateral leaves undivided or bilobed ..... **Jungermanniaceae**
      14. Apex of lateral leaves toothed to ciliate ..... **Plagiochilaceae**
    13. Underleaves present.
      15. Underleaves never connate to lateral leaves.
        16. Lateral leaves densely hairy.
          17. Cells with a papillose cuticle ..... **Acrobolbaceae**
          17. Cells without a papillose cuticle ..... **Trichocoleaceae**
        16. Lateral leaves not hairy.
          18. Apex of lateral leaves entire ..... **Jungermanniaceae**
          18. Apex of lateral leaves toothed to ciliate ..... **Plagiochilaceae**
      15. Underleaves often connate to lateral leaves ..... **Geocalyceae**

## Acrobolbaceae

**Plants** leafy, usually glistening whitish-green to pale bluish-green, creeping or upright, sometimes with a stoloniferous base. **Stems** with or without thick-walled cortex. **Branches** intercalary (lateral or ventral); stolons present or absent. **Lateral leaves** succubous, undivided or 2-lobed (rarely 3-4 lobed). **Cells** usually with a papillose cuticle; oil bodies brown, finely granular. **Underleaves** usually divided into cilia resemble segment. **Rhizoids** scattered. **Sporophytes** in a fleshy, pendent marsupium; perianth lacking. **Capsules** with acute tip, wall very thick, 5-10 layered. **Vegetative reproduction** rare, by caducous leaves or gemmae.

### *Marsupidium*

*Marsupidium* Mitt., Handbook of the New Zealand Flora 751. 1867.; Grolle, R. J. Hattori Bot. Lab. 66: 337-342. 1989; Gradstein, S. R., Churchill, S. P. & Allen, N. S., Guide to the bryophytes of tropical America: 78-79. 2001.

**Plants** glossy whitish-green to bluish-green when flesh, sometimes brownish when dry, usually rather fleshy, growing upright for a stoloniferous base, forming dense mats. **Stems** flaccid with thin-walled cortex. **Lateral leaves** ovate to oblong, with typically oblique and truncate to emarginate apex, leaf tips rounded to acute to ciliate, margin entire or finely toothed toward the apex. **Cells** thin-walled, without trigones, smooth to verruculose cuticle. **Sporophytes** on very short branches, bearing only a few bracts and lacking vegetative leaves, usually hidden among the stolons, at the base of the stems, and are rather inconspicuous. **Antheridia** rather numerous, 4-10 per bract.

#### *Marsupidium knightii* Mitt.

Handbook of the New Zealand Flora 753. 1867.; Furuki, T. & Mizutani M., Proceedings of the Bryological Society of Japan 6: 75-83. 1993.; Piippo, S. J. Hattori Bot. Lab. 68: 1-192. 1990.

**Plants** yellowish green, stem and rarely branches nearly equal in diameter 2.5-3 mm wide, spongy, julaceous. **Stems** branching sympodial forming flocculent, in cross section of stem with 8-9 cells in diameter. **Rhizoids** at the base of underleaves. **Lateral leaves** imbricate, 1.5-1.8 mm long and 1.8-2 mm wide, divided into 5-6 segments which are triangular in outline, each segment with simple branch which is one cell wide, cells hyaline with cuticular striolate-papillose. **Underleaves** 0.5-0.8 mm long and 0.8-1 mm wide, divided into 4 segments, each segment divided into simple branch cilia resemble to those of the lateral leaves. **Sporophytes** not found. (Figure 4.1 and 4.104)

**Thailand** — PENINSULAR: Nakhon Si Thammarat.

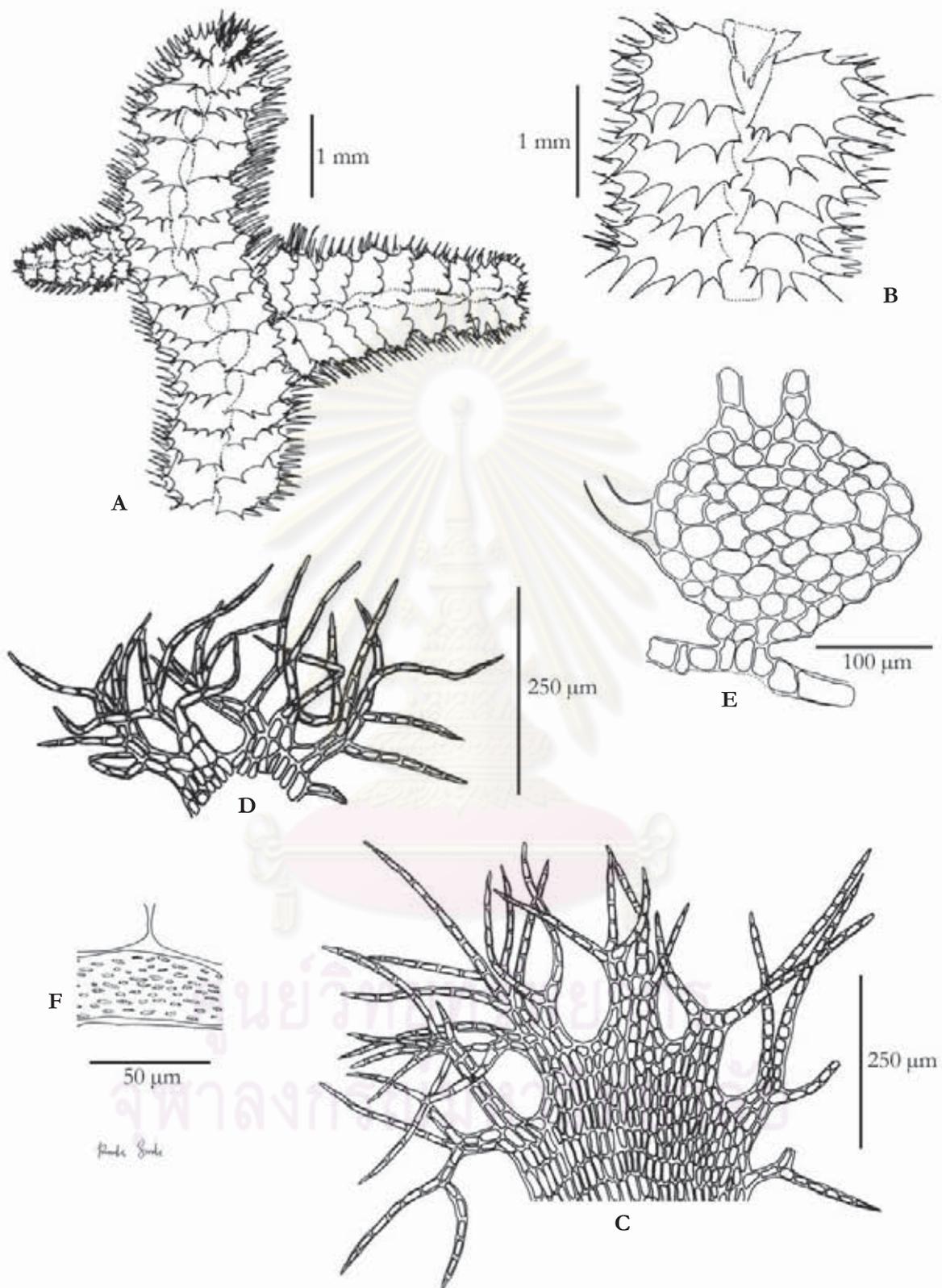
**Distribution** — China, Japan, New Zealand.

**Ecology** — on living bark of tree.

**Specimens examined** — P. Sukkharak 471 (BCU); M. Tagawa & N. Kitagawa T4972 (BKF).

**GPS location** — 8.87681365° N 99.69001651° E

**Altitude** — 1,303 m



**Figure 4.1** *Marsupidium knightii* Mitt.

A. habit; B. portion of plant; C. lobe of lateral leaf; D. lobe of underleaf; E. cross section of stem; F. part of lobe with verruculose cuticle. P. Sukkharak 471.

## Aneuraceae

**Plants** thalloid, pure green to blackish, small to large, fleshy or membranous, prostrate or erect, irregular branched or pinnate to bi-pinnate, without a midrib or with an ill-defined midrib in the branch, the inner cells are considerably larger and less chloroplasts than the outermost layer of cells on both surface, thallus apex with or without slime papillae. **Rhizoids** smooth, on lower surface. **Dioicous**. **Androecia** 2 rows of androecia sunk in short lateral branches which have a raised cup-like margin. **Gynoeceia** on lateral-ventral, produced under margin of the thallus. **Capsules** oval or cylindrical, surrounded by tall and thick calyptras, 4-valved, composed of two layers of cells, of which the inner possesses more or less distinct semi-annular bands. **Elaters** either free or fixed: the free one tapering towards both ends with one broad spiral band; those with tufts of fixed and erect elaters at the apex of the valves having indistinct spiral band.

### Key to genera

1. Thallus, irregular branched, prostrate, 5-6 mm wide, apex without mucilage papillae on ventral surface ..... *Aneura*
1. Thallus, pinnate to bi-pinnate, prostrate or erect, 0.4-2 mm wide, apex with mucilage papillae on ventral surface ..... *Riccardia*

### 1. *Aneura*

*Aneura* Dumort., Commentationes Botanicae 115. 1822. — *Riccardia* S. F. Gray, Nat. Arr. Brit. Pl. 1: 683. 1821. — *Aneura* Dum., Comm. Bot.: 115. 1822.; Kashyap, S. R., Liverworts of the Western Himalayas and the Panjab plain. Part 1: 111; Gradstein, S. R., Churchill, S. P. & Allen, N. S., Guide to the bryophytes of tropical America: 202. 2001.

**Plants** pale green, prostrate, irregular branched, medium to large, fleshy, thallus apex without slime papillae. **Gynoeceia** calyptras cylindrical or clavate, fleshy. **Capsules** longly pedicellate or oblong-cylindric. **Elaters** attenuate, mono-spiral, fixed persistent as erect tufts on the apex of valve.

#### *Aneura indica* Steph.

Kashyap, J. Bomb. Nat. Hist. Soc. Vol. XXV: 280. 1917.; Kashyap, R., Liverworts of the Western Himalayas and the Panjab plain. Part I: 111-113, Plate XXIII. 1929.

**Plants** light green, up to 20 mm long and 5-6 mm wide; in cross section, epidermal cells with small chloroplasts, inner cells hyaline and larger 9-10 cells wide at midrib, margin entire and undulate, oil body scattered. **Androecia** not found. **Gynoeceia** enclosed by calyptra 5-6 mm wide. **Capsules** cylindrical. **Elaters** with 1-spiral thickening walled, 150-220 µm long. (**Figure 4.2 and 4.105**)

**Thailand** — New record to Thailand.

**Distribution** — India.

**Ecology** — on rocks along stream.

**Specimens examined** — P. Sukkharak 217, 379, 381, 495 (BCU).

**GPS location** — 8.88071895° N 99.69965637° E

**Altitude** — 1,205-1,340 m

### 2. *Riccardia*

*Riccardia* Gray, A Natural Arrangement of British Plants 1: 679. 1821.; Hewson 1970a, b (Key A4); Scott, G. A. M., Southern Australian Liverworts: 36. 1985.

**Plants** green, prostrate or erect, palmate, pinnate to bi-pinnate branched, small to medium, the inner cells are considerably larger and less densely provided with chloroplasts than the outermost layer of cells on both surface, thallus apex with transparent slime papillae on ventral surface. **Gemmae** usually 2 celled and are formed endogenously in the cells of the uppermost layer of the thallus, becoming free by the rupture of the cell wall.

#### Key to species

1. Plants with palmate branch.
  2. Cross section of main axis; inner cells hyaline and larger 1 cell thick in middle..... **R. sp. 2**
  2. Cross section of main axis; inner cells hyaline and larger 6-7 cells thick in middle .....  
..... **R. palmata**
1. Plants with irregular branch ..... **R. sp. 1**

#### 1. *Riccardia palmata* (Hedw.) Carruth.

In Seemann, J. Bot. 3: 302. 1865.; Mizutani, M. & Hattori, S., J. Hattori Bot. Lab. 18: 44-46, fig V. 1957.; Lindb., Musc. Scand. 5. 1879.; Lindb. & Arnell, Kongl. Sv. Vet.-Akad. Handl. 23 (5): 25. 1889.; Horikawa, J. Sci. Hiroshima Univ. ser. B, 2, 2: 125. 1934.; Evans, Ann. Bryol. 10: 25-27, f. 3. 1937.; Hatt., J. Hattori Bot. Lab. 6: 10, f. 44. 1951 & 8: 42. 1952.; K. Müll., Leberm. Europ. (ed. 3) 1: 504, f. 140. 1954. — *Jungermannia palmata* Hedw., Theor. gen. (ed. 1) 87. 1784. — *Aneura palmata* Dum., Comm. Bot. 115. 1822.; Mitt., Trans. Linn. Soc. London ser. 2, 3: 205. 1891.; Makino, Bot. Mag. Tokyo 11: 34. 1897.; Steph., Bull. Herb. Boiss. 5: 77. 1897.; Spec. Hepat. 1: 263. 1899.; Inoue, Bot. Mag. Tokyo 14: 39. 1900 & 15: 179. 1901.; K. Müll., Leberm. Europ. (ed. 2) 1: 343, f. 205. 1908.; Macvicar, Student's Handb. Brit. Hepat. (ed. 2) 57, f. 1926.; Nicholson in Mazzetti, Symb. Sinic. 5: 7. 1930.

**Plants** light green to brownish-green 300-400 µm wide, slightly erect, branch palmate, near the apex with transparent mucilage-papillae on ventral surface; in cross section of main axis, epidermal cells with chloroplast and small, inner cells hyaline and larger 6-7 cells thick in middle, oil bodies scattered. **Dioicous**. **Androecia** on short lateral branches in pinnate sequence containing 2 rows of 7-8 embedded antheridia. **Gynoecia** including calyptrae 1 mm wide. **Capsules** cylindrical. **Elaters** with 1-spiral thickening walled, 185-260 µm long. (**Figure 4.3**)

**Thailand** — New record to Thailand.

**Distribution** — China, Europe, Greenland, Japan, North and South America, Siberia.

**Ecology** — on rocks along stream.

**Specimens examined** — P. Sukkharak 376, 438, 509 (BCU).

**GPS location** — 8.87631476° N 99.69027936° E

**Altitude** — 1,275-1,340 m

#### 2. *Riccardia* sp. 1

**Plants** brownish-green 1.5-2 mm wide, near the apex with transparent mucilage-papillae on ventral surface; in cross section of main axis, inner cells larger than outer 4 cells thick in middle tapering to 1 cell thick in the marginal cell row which appear as a transparent border. **Dioicous**. **Androecia** on short lateral branches in pinnate sequence containing 2 rows of 4-10 embedded antheridia. **Gynoecia** including calyptrae 1 mm wide. (**Figure 4.4**)

**Thailand** —

**Distribution** —

**Ecology** — on living bark of tree.

**Specimens examined** — P. Sukkharak 514, 534 (BCU).

**GPS location** — 8.88128757° N 99.69551504° E, 8.87689412° N 99.69203353° E

**Altitude** — 1,340 m

### 3. *Riccardia* sp. 2

**Plants** green 0.5-0.8 mm wide, near the apex with transparent mucilage-papillae on ventral surface; in cross section of main axis, inner cells with 3 cells thick in middle tapering to 1 cell thick in the marginal cell row which appears as a transparent border. **Dioicous**. **Androecia** not found. **Gynoecia** including rough 0.5 mm wide. **Elaters** with 1-spiral thickening walled. (Figure 4.5)

**Thailand —**

**Distribution —**

**Ecology —** on rotten log.

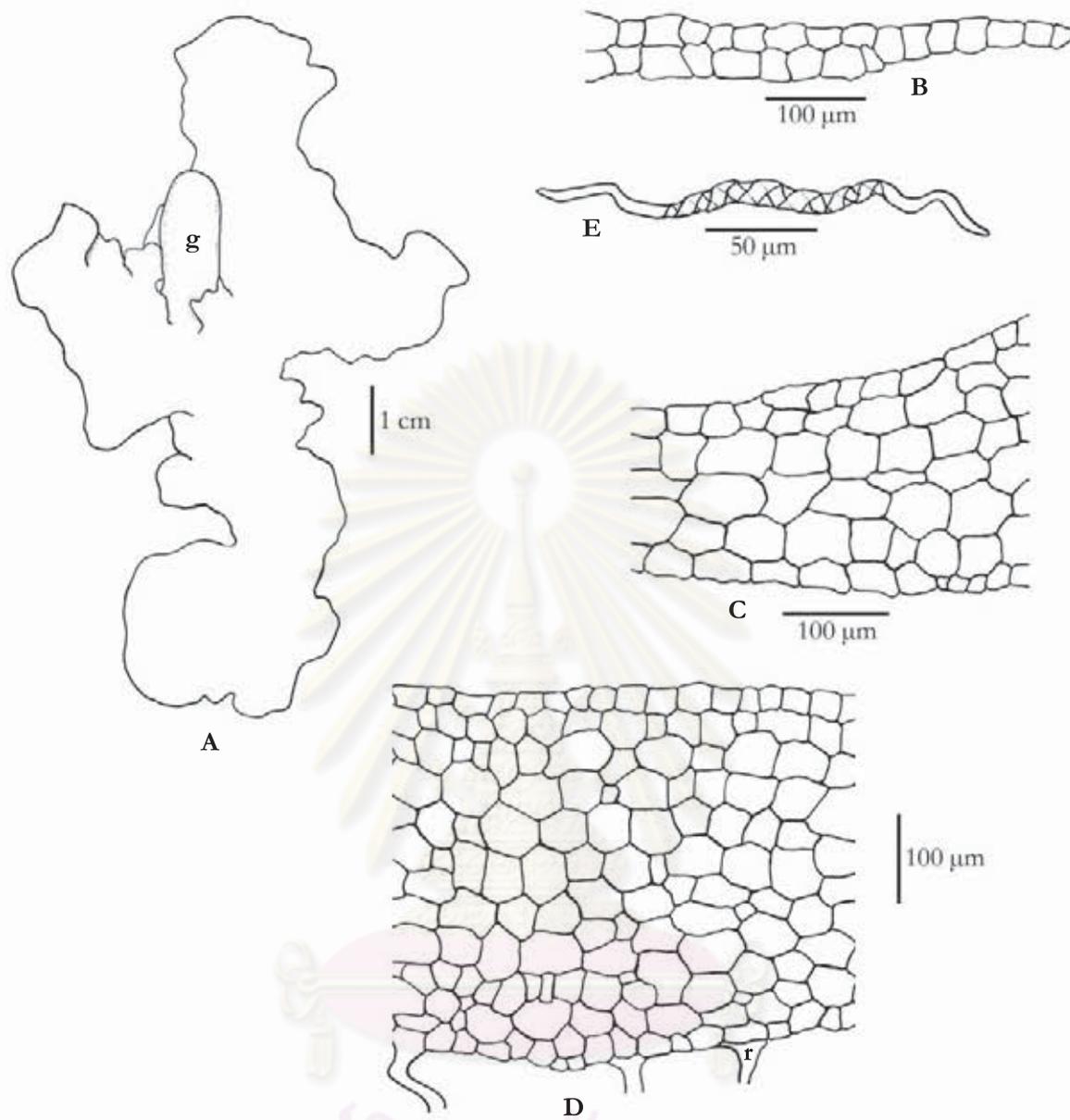
**Specimens examined —** P. Sukkharak 527 (BCU).

**GPS location —** 8.88013959° N 99.69494641° E

**Altitude —** 1,272 m

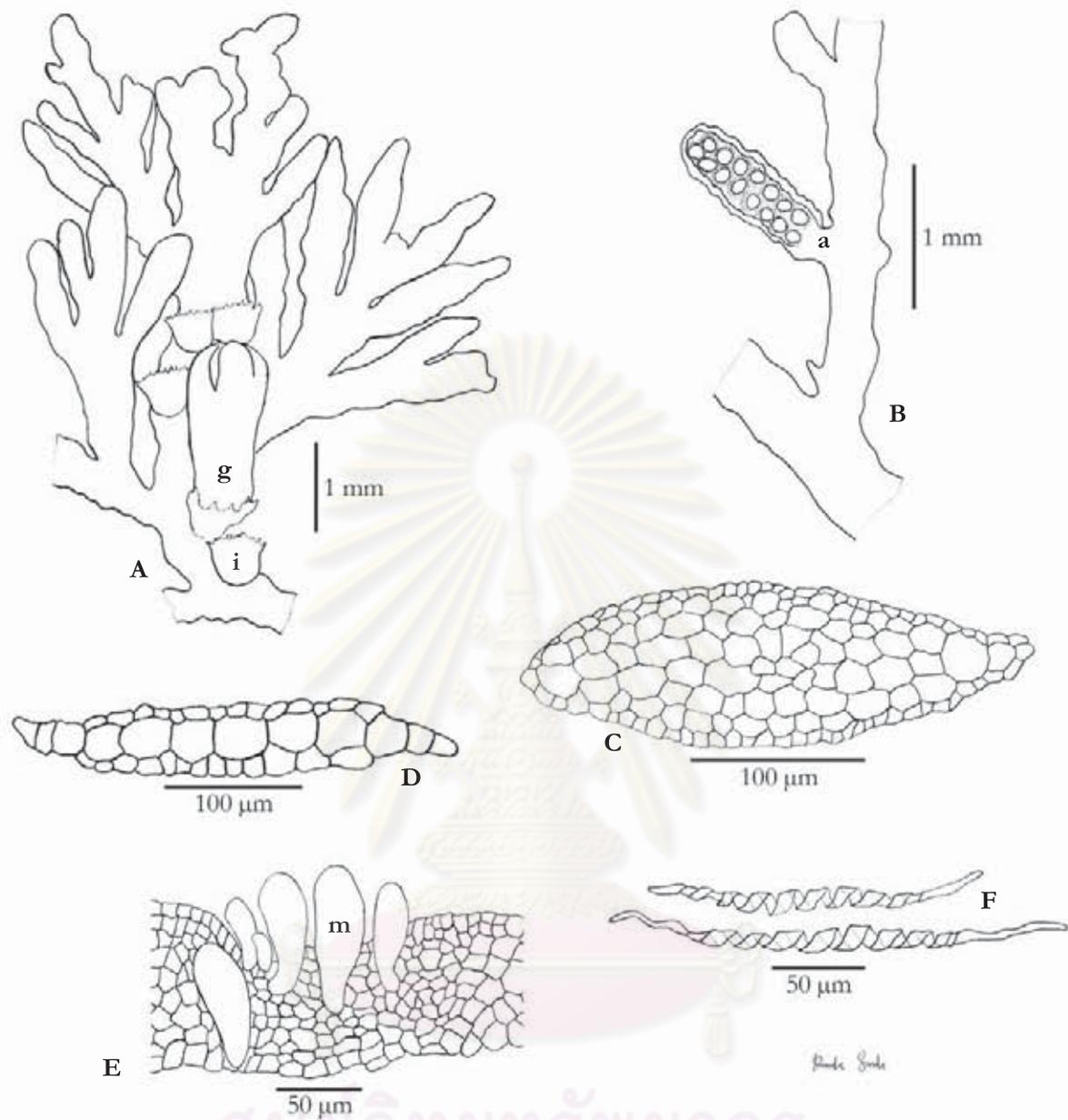


ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย



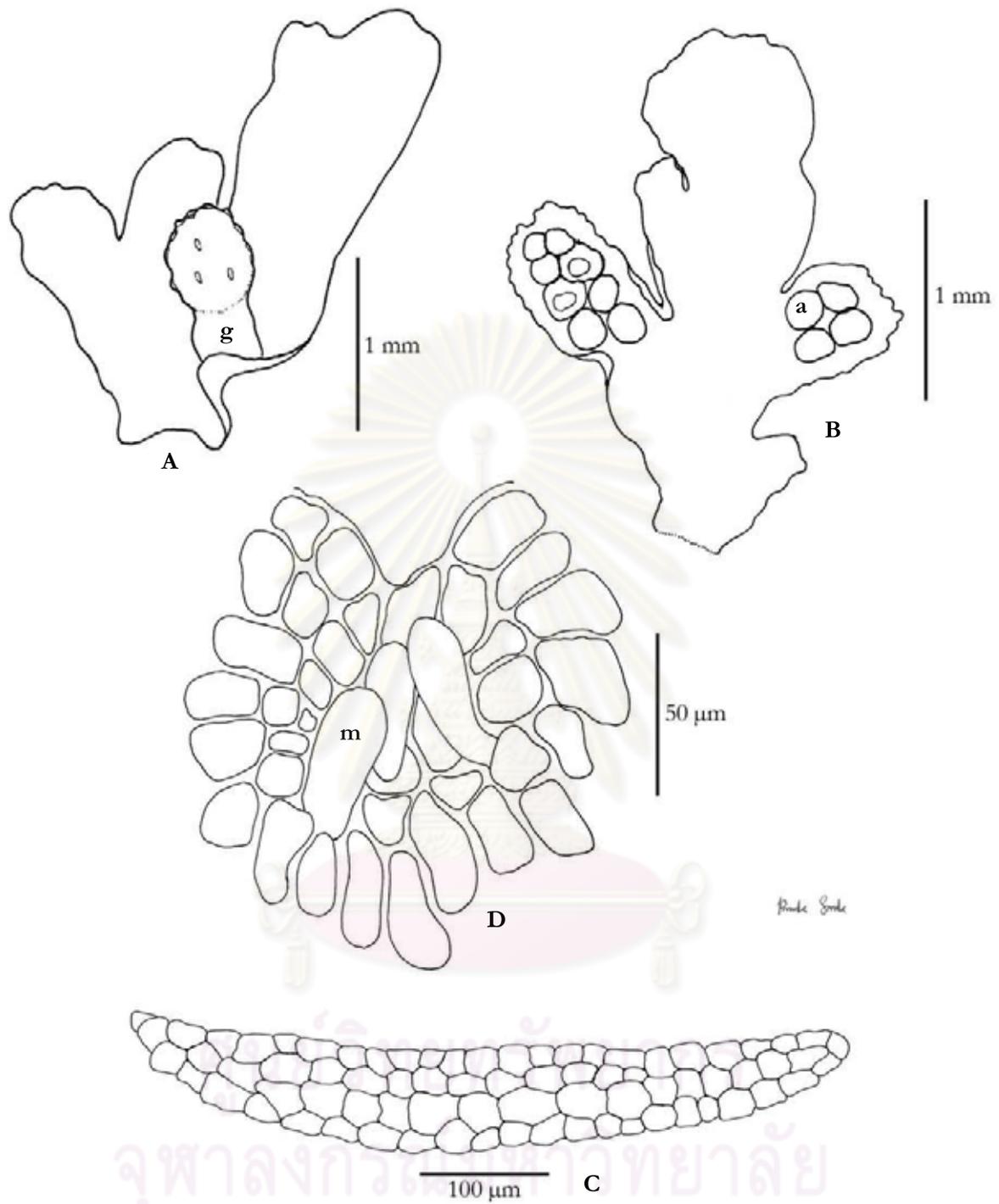
**Figure 4.2** *Aneura indica* Steph.

A. habit with gynoecium (g); B.-D. cross section of thallus, B. margin, C. middle, D. midrib with rhizoids (r); E. elater. Based on P. Sukkharak 379.



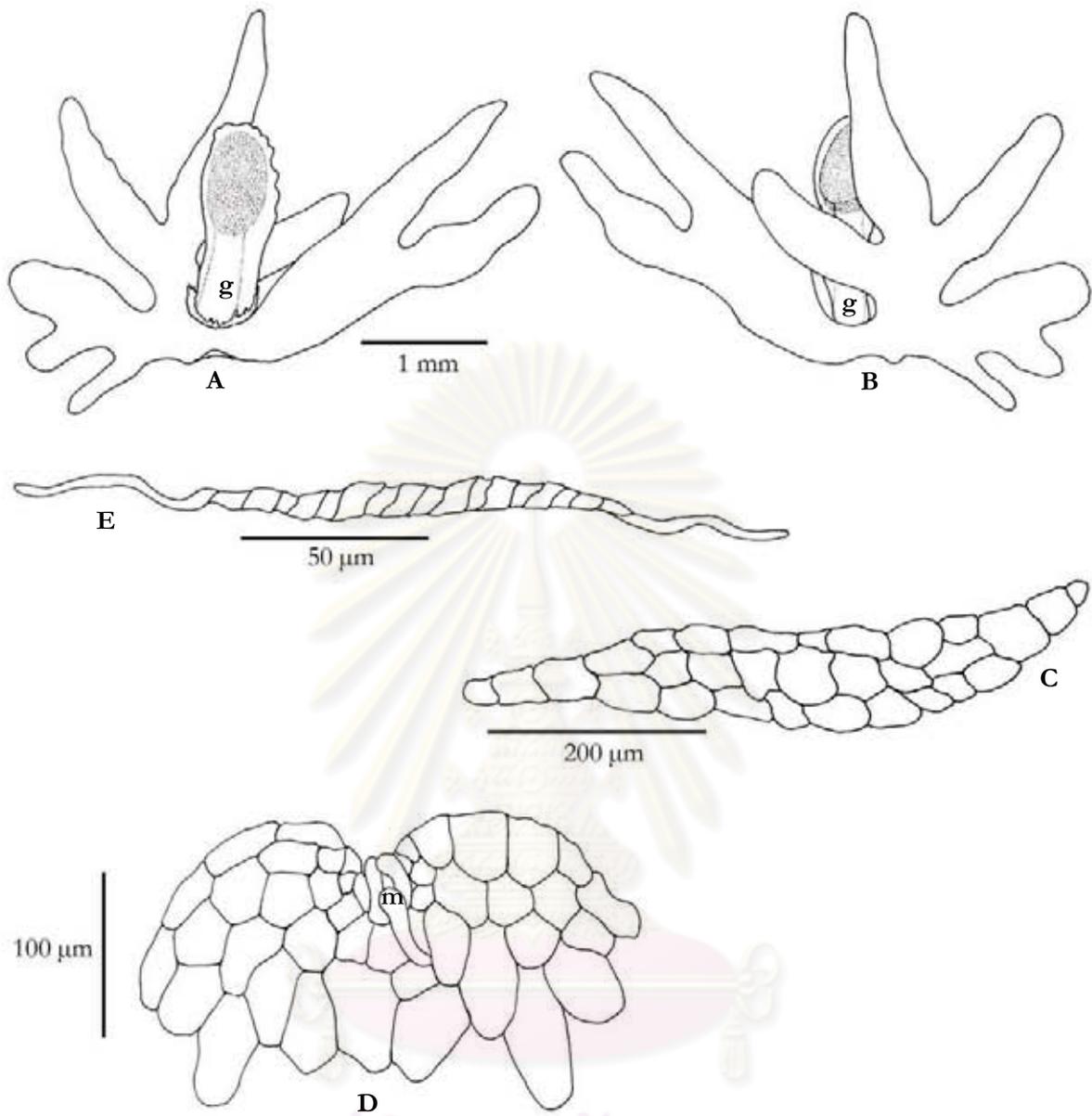
**Figure 4.3** *Riccardia palmata* (Hedw.) Carruth.

A. habit on ventral side with gynoecium (g) and involucre (i); B. habit on ventral side with androecium (a); C.-D. cross section of thallus, C. main axis, D. palmate frond; E. apex with mucilage papillae (m) on ventral surface; F. elaters. P. Sukkharak 376.



**Figure 4.4** *Riccardia* sp. 1

A. habit on ventral side with gynoecium (g); B. habit on ventral side with androecium (a); C. cross section of main axis; D. apex with mucilage papillae (m) on ventral surface. P. Sukkharak 514, 534.



**Figure 4.5** *Riccardia* sp. 2

A-B. habit with gynoecium (g): A. dorsal view; B. ventral view; C. cross section of main axis; D. apex with mucilage papillae (m) on ventral surface. E. elater. P. Sukkharak 527.

## Calypogeiaceae

**Plants** leafy, translucent whitish-green to deep-green to brownish, creeping. **Branches** exclusively ventral-intercalary, usually sparse. **Rhizoids** in tufts from underleaf bases. **Lateral leaves** incubous, undivided or very short-bifid, margins entire or finely crenulate, sometimes bordered. **Cells** thin-walled, cuticle smooth or finely papillose; oil bodies finely or coarsely granular, colorless, sometimes bluish or sepia. **Underleaves** small, undivided or bifid. **Androecia and Gynoecia** born on very short ventral branches. **Sporophytes** a fleshy, subterranean marsupium. **Capsules** cylindrical, wall 2-layered, valves spirally twisted. **Vegetative reproduction** by gemmae produced on flagelliform shoots or by caducous leaves.

### *Calypogeia*

*Calypogeia* Raddi, Jungermannioграфия Etrusca 31. 1818.; Fulford, M. H., Manual of the leafy Hepaticae of Latin America, Part III. Memoirs of the New York Botanical Garden 11 (3): 279-310. 1968.; Gradstein, S. R., Churchill, S. P. & Allen, N. S. Guide to the bryophytes of tropical America: 84-85. 2001.

**Plants** pale green. **Lateral leaves** apex short bifid, rarely entire, leaf margins sometimes bordered by elongated cells. **Cells** thin-walled, trigones small to medium-sized, cuticle smooth, striate or papillose; oil bodies pale-colored, bluish, or sepia, coarsely granular (resembling a small grape-cluster). **Underleaves** variable in size and shape, bilobed to at least 1/4 of their length, border lacking.

#### *Calypogeia* sp.

**Plants** yellowish pale green in herbaria, 1-1.2 mm wide. **Stems** creeping, exclusively ventral calary, sparsely, in cross section of stem 6 cells across, 12-13 cortical cells in circle with 11-13 medullary cells, all cells thin-walled. **Rhizoids** in bundle on underleaf base (fasciculate, at base of underleaves). **Lateral leaves** slightly remote, opposite, broadly ovate to slightly ligulate, 540-650 µm long and 430-450 µm wide, apex obtuse with papillose, margin with papillose, marginal cells 17-22 µm long and 10-18 µm wide, median cells 26-39 µm long and 18-26 µm wide, basal cells 34-65 µm long and 18-39 µm wide, trigones absent, all cells with papillose. **Underleaves** distant, apex shallowly, less than 1/4 of their length, in two lobes, 190-200 µm long and 180-210 µm wide, all cells with papillose. **Sporophytes** not found. (Figure 4.6)

**Thailand** —

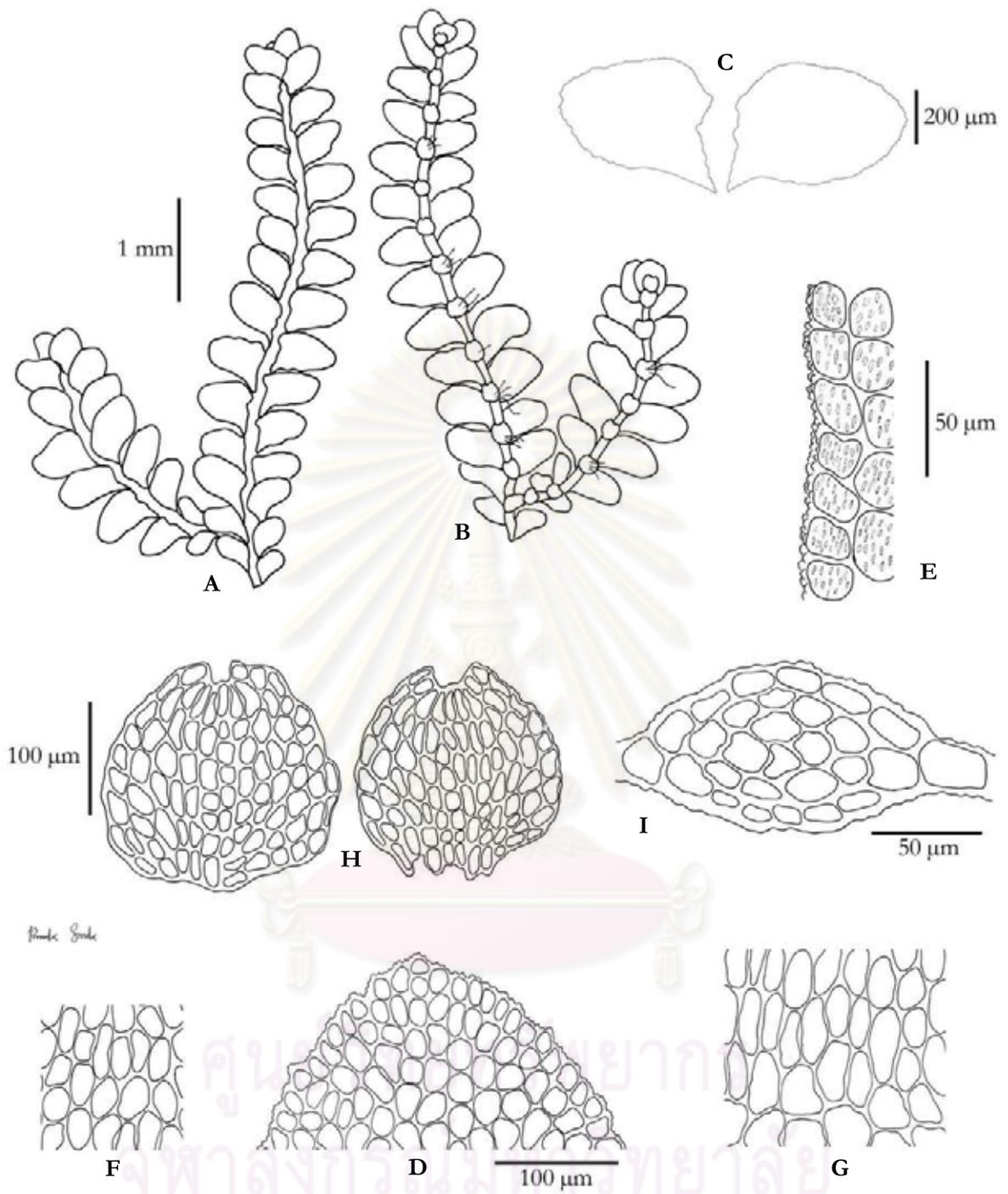
**Distribution** —

**Ecology** — on soil near base of tree.

**Specimen examined** — P. Sukkharak 455 (BCU).

**GPS location** — 8.87715161° N 99.68955517° E

**Altitude** — 1,328 m



**Figure 4.6** *Calypogeia* sp.

A.-B. portion of plant: A. dorsal view, B. ventral view; C. lateral leaves; D. cells at leaf apex; E. cells at leaf margin; F. cells at leaf median; G. cells at leaf base; H. underleaves; I. cross section of stem. P. Sukkharak 455.

## Frullaniaceae

**Plants** leafy, small or large, green to brown, reddish, or purple-blackish, creeping to ascending or pendent, may or may not pinnate. **Stems** rigid, without hyalodermis. **Intercalary Branches** always lateral, usually *Frullania*-type, sometimes *Lejeunea*-type. **Lateral leaves** incubous, divided into three portions: a large dorsal lobe, a small ventral lobe (= lobule) hidden under the dorsal lobe, and a tiny triangular or filiform stylus between the lobule and stem; lobe margins usually entire, rarely toothed. **Lobules** almost free from the dorsal lobe, inflated and transformed into a water-sac, rarely flat, cells with trigones, cuticle smooth; oil bodies finely granular. **Underleaves** small or large, usually bifid. **Rhizoids** in tufts from underleaf bases. **Androecia and Gynoecia** on leading shoots or on short branches. **Sporophytes** surrounded by a perianth; mouth of the perianth usually contracted into a short beak, foot of the sporophyte not penetrating into the stem. **Seta** very short, thick. **Capsules** globose, wall 2-layered, 4 valves at maturity. **Elaters** attached to the capsule valves, arranged vertically inside the capsule. **Spores** large, multicellular, germination endosporic. **Vegetative reproduction** rare, by caducous or fragmenting leaves.

### *Frullania*

***Frullania Raddi***, Jungermanniaografia Etrusca 9. 1818.; Gradstein, S. R. The Bryologist 92: 329-348. 1989.; Gradstein, S. R., Churchill, S. P. & Allen, N. S., Guide to the bryophytes of tropical America: 105. 2001; Schuster, R. M., The Hepaticae and Anthocerotae of North America, Vol. V: 1-286. 1992.

**Plants** usually reddish, reddish-brown, or purplish, sometimes dull green, creeping, ascending or pendent, regularly or irregularly 1-3-pinnately branched. **Intercalary Branches** *Frullania*-type, on broken stems sometimes *Lejeunea*-type. **Lateral leaves** with a very short, subtransverse insertion; leaf lobe usually ovate-orbicular, the apex rounded to acute to acuminate, the margins entire, rarely toothed; leaf lobule usually very close to the stem, globose to linear, sometimes may or may not flat; styluses (between lobule and stem) usually linear and minute, sometimes large, cells usually with trigones and intermediate thickenings, the trigones often confluent with the walls irregularly sinuose; ocelli sometimes present in leaf lobes. **Underleaves** rather large, usually 2-lobed, rarely undivided. **Dioicous** or **Autoicous**, rarely **Parioicous**. **Androecia** usually on a very short, globose male branch. **Gynoecia** on short or elongated shoots, without innovations. **Perianths** flattened or inflated, with 0-12 keels, the mouth contracted into a beak. **Seta** massive, of numerous rows of cells.

### Key to species

1. Leaf lobules galeate, wide or wider than long.
  2. Underleaves imbricate.
    3. Leaf lobules skull-shaped not extending below ventral margin of lobe, perianths densely covered with spinose protrusions throughout the surface..... *F. ericoides*
    3. Leaf lobules cuculate, incurved, extending below ventral margin of lobe, perianths covered with few paraphyllium-like protrusions scattered over the surface  
.....*F. berthoumieurii*
  2. Underleaves remote .....*F. nigricaulis*
1. Leaf lobules cylindrical or clavate, longer than wide.
  4. Leaf lobules pendent, the mouth oriented upward the stem.
    5. Leaf lobules margin conic-mammillose .....*F. intermedia* var. *submorokensis*
    5. Leaf lobules margin smooth .....*F. nodulosa*
  4. Leaf lobules not pendent, the mouth oriented down the stem.
    6. Leaf lobes apex cuspidate-apiculate.
      7. Underleaves imbricate, bract and bracteoles densely toothed along margin *F. serrata*
      7. Underleaves remote, bract and bracteoles margin smooth.....*F. apiculata*

6. Leaf lobes apex round.  
 8. Underleaves margin smooth ..... *F. sp. 1*  
 8. Underleaves margin with blunt tooth or angle on margin.  
 9. Perianth 3-keeled (2 lateral, 1 ventral).....*F. gracilis*  
 9. Perianth 5-keeled (2 lateral, 2 ventral, 1 dorsal).....*F. campanulata*

### 1. *Frullania apiculata* (Reinw. et al.) Dumort.

Recueil d'Observations sur les Jungermanniacées 13. 1835.; Hattori, S., J. Hattori Bot. Lab. 38. VI: 224-226, fig. 107-108. 1974.; Hattori, S., Thaithong, O., Kitagawa, N., J. Hattori Bot. Lab. 43: 441. 1977.; Hattori, S. J. Hattori Bot. Lab. 36:109-113, fig. 1-3. 1972. — *Jungermannia apiculata* Reinw., Blume & Nees, Nova Acta Acad. Leop.-Carol 12: 222 [Hepat. Jav.]. 1825. — *F. apiculata* subsp. *kaindimontana* Hatt., J. Hattori Bot. Lab. 36: 417-420, f. 4-5. 1972. — *F. anamensis* Steph., Spec. Hepat. 4: 551. 1911.; Bonner Index Hepat. pt. 5: 230. 1965. — *F. densifolia* Steph., Hedwigia 33: 161. 1894.; Spec. Hepat. 4: 544. 1911.; Bonner, Index Hepat. pt. 5: 285. 1965. — *F. englereri* Steph. ex Bonner, Index Hepat. pt. 5: 296. 1965.

**Plants** yellowish-brown, stems up to 7 cm long, with leaves 0.8-1.5 mm wide, bipinnately branched. **Leaf lobes** somewhat concave ventrally with incurved apex, when flattened ovate; stem lobes 656-680 µm long and 480-520 µm wide; branch lobes 240-256 µm long and 148-184 µm wide, cell with thickened wall, apex mucronate-minutely cuspidate, margin entire, ocelli at basal part. **Leaf lobules** saccate, cylindrical 204-236 µm long and 92-100 µm wide, apex obtuse and wide, mouth-margin slightly crenate. **Styluses** filiform. **Underleaves** remote, inflate, ovate 272-300 µm long and 216-252 µm wide, bilobed, sinus acute, lobes triangular-acute. **Gynoecea** terminal on stem and branch. **Bracts** 3 pairs, ovate, bifid 2/3, apex acuminate, margin slightly entire. **Bracteoles** ovate, sinus acute, bifid more than 1/2, entire margin. **Perianths** oblong, inflated, with 3 principal plicae (2 lateral and 1 ventral), apex sub-truncate, long-beaked. **Elaters** with 1-spiral, 256-360 µm long. (**Figure 4.7 and 4.106**)

**Thailand** — NORTH: Chiang Mai, Nakhon Sawan; NORTH-EASTERN: Loei; EASTERN: Nakhon Ratchasima; SOUTH-EASTERN: Trat; PENINSULAR: Nakhon Si Thammarat, Trang.

**Distribution** — widely distributed in tropical Asia, also the Pacific Islands (including Hawaii) and Madagascar.

**Ecology** — on living bark of tree, twig of shrub, rotten log, leaves, fronds of fern.

**Specimens examined** — P. Sukkharak 77, 146, 187, 253, 270, 280, 284, 285, 369, 372, 383, 391, 403, 460, 477 (BCU).

**GPS location** — 8.87761451° N 99.7029344° E, 8.87695849° N 99.68960345° E, 8.87664735° N 99.69184577° E, 8.88229072° N 99.69644308° E, 8.8778007° N 99.70351875° E

**Altitude** — 631-1,385 m

### 2. *Frullania bertboumieuvi* Steph.

Steph., Hedwigia 33: 140. 1894.; Hattori, S., J. Hattori Bot. Lab. 38: 188-190, fig. 87-88. 1974.; Spec. Hepat. 4: 459. 1910.; Verdoorn, Ann. Bryol. Suppl. 1: 37. 1930.; Hattori, S., Thaitong, O., Kitagawa, N., J. Hattori Bot. Lab. 43: 448. 1977. — *F. fauriana* auct. non Steph. 1897; Steph., Spec. Hepat. 4: 402. 1910.

**Plants** olive-green, stems with leaves 1.2-1.3 mm wide, bipinnately branched. **Leaf lobes** imbricate, concave when dry, when flat nearly squarrose, slightly convex, apex round sometime slightly acute, margin entire, stem lobes 0.7-0.8 µm long and 0.7-0.9 µm wide; branch lobes 0.3-0.4 µm long and 0.4-0.5 µm wide, marginal cell 13-18 µm long and 15-21 µm wide, sinuate with nodulose-flexuose and confluent trigones, median cells 26-34 µm long and 18-21 µm wide, sinuate with nodulose-flexuose and confluent trigones, basal cells 28-40 µm long and 21-28 µm wide, sinuate with nodulose-flexuose and confluent trigones. **Leaf lobules** saccate or explanate, when saccate comparatively large, inflate, cuculate with truncate mouth and truncate beak, incurved, and extending below ventral margin of lobe, 236-242 µm long and 210-215 µm

wide, when flat ovate-lanceolate, margin slightly recurved, apex apiculate. **Styluses** 4-5 cells long. **Underleaves** imbricate, slightly flat, orbicular, margin convex, 1-1.1  $\mu\text{m}$  long and 0.8-0.9  $\mu\text{m}$  wide, bilobed, sinus acute sometimes narrowly, lobes triangular-acute. **Gynoecea** terminal on stem and branch. **Bracts** lobe oblong, apex obtuse, margin entire, the lobule 2/3 of lobe, margin with spinose teeth and connate with bracteole. **Bracteoles** oblong, with 2-3 toothed along margin, bifid 1/2, sinus acute. **Perianths** semi-exserted, long obovate, inflated, with 3 principal plicae (2 lateral and 1 ventral), covered with few paraphyllium-like protrusions scattered over the surface, apex sub-truncate, long-beaked, 2.4-2.5  $\mu\text{m}$  long, 1.1-1.2  $\mu\text{m}$  wide. (**Figure 4.8**)

**Thailand** — NORTH: Chiang Mai, Nakhon Sawan; EASTERN: Nakhon Ratchasima; PENINSULAR: Trang.

**Distribution** — Borneo, Burma, Nepal, Philippines.

**Ecology** — on living bark of tree.

**Specimens examined** — P. Sukkharak 542 (BCU).

**GPS location** — 8.8582158 ° N 99.7137752° E

**Altitude** — 329 m

### 3. *Frullania campanulata* Sande Lac.

Nederl. Kruidk. Arch. 3: 422. 1854.; Hattroi S., J. Hattori Bot. Lab. 38: 199-201, fig. 94 1974.; Heat. Javan.: 82, t. 16. 1856.; Schiffn., Conspect. Hepat. Archip. Indici: 322. 1898.; Steph., Spec. Hepat. 4: 442. 1910.; Verdoorn, Ann. Jard. Bot. Buitenz. 40: 143. 1929; Ann. Bryol. 2: 123 & 160. 1929.; suppl. 1: 40-41, f. 46-50. 1930.

**Plants** reddish-brown, stems 1-1.3 cm long, with leaves 1 mm wide. **Leaf lobes** widely spreading, rounded 480-560  $\mu\text{m}$  long and 456-416  $\mu\text{m}$  wide, apex rounded, margin entire, ocelli at basal part. **Leaf lobules** bell-shaped 288-304  $\mu\text{m}$  long and 160-184  $\mu\text{m}$  wide. **Styluses** filiform. **Underleaves** remote, inflate, orbicular, 280-344  $\mu\text{m}$  long and 180-400  $\mu\text{m}$  wide, bilobed, sinus acute. **Gynoecea** terminal on stem. **Bracts** lobe ovate, apex obtuse, margin slightly entire. **Bracteoles** oblong, bifid 1/2, sinus acute, margin slightly entire. **Perianths** obovate, inflated, with 3-4 principal plicae (2 lateral and 1-2 ventral) and 1-2 small, addition plicae (1-2 dorsal), apex sub-truncate, short-beaked. **Capsules** spherical. **Elaters** with 1-spiral, 200-480  $\mu\text{m}$  long. **Spores** yellow-brown. (**Figure 4.9**)

**Thailand** — New record to Thailand.

**Distribution** — Java and Sumatra.

**Ecology** — on living bark of para rubber tree.

**Specimens examined** — P. Sukkharak 104 (BCU).

**GPS location** — 8.8582158 ° N 99.7137752° E

**Altitude** — 329 m

### 4. *Frullania ericoides* (Nees) Mont.

Ann. Sci. Nat. Bot. Sér. 2, 12: 51. 1839.; Hattori, S. Thaithong, O. & Kitagawa, N., J. Hattori Bot. Lab. 43: 448-449. 1977.; Hattori S., J. Hattori Bot. Lab. 24: 17-19, fig IV. 1961. as *F. squarrosa* (Reinw., Bl. et Nees) Dum in Rec. d'Obs. 13. 1835. — *Jungermannia squarrosa* Reinw, Bl. et Nees, Nova Acta Acad. Caes. Leop.-Carol. 12: 219. 1824. — *Jungermannia ericoides* Nees ex Mart., Flora Brasiliensis 1: 346. 1833. — *F. aeolotis* var. *squarrosa* Mont. et Nees in Ramon de la Sagra's Hist. Nat. Cuba Crypt., French ed., 461. 1898. — *F. laciniosa* auct. non Gottsche: Lehm., Strip. Pugillus, 8: 18. 1844. — *F. squarrosa* var. *ericoides* Schiffn. Oesterr. Bot. Zeitsch. 49: 9 & 391. 1899. — *F. silvestris* Steph., Rev. Bryol. 35: 29. 1908. — *F. symmetrica* Steph., ibid. 35: 29. 1908. — *F. luxonensis* Steph., Spec. Hepat. 4: 477. 1910. — *F. lonispica* Steph., ibid. 4: 454. 1910. — *F. vesiculosa* Steph., ibid. 4: 457. 1910. — *F. birmensis* Steph., ibid. 4: 497. 1910. — *F. contracta* Steph., ibid. 4: 459. 1910. — *F. rotundiloba* Steph., ibid. 4: 679. 1911. — *F. subnigra* Steph., ibid. 6: 544. 1924. — *F. mikawana* Steph. in sched.

**Plants** dark reddish-brown, stems with leaves 0.6-1 mm wide, bipinnately branched. **Leaf-lobes** imbricate, apex round, concave when dry, when flat nearly squarrose, margin entire,

stem lobes 76-85  $\mu\text{m}$  long and 66-69  $\mu\text{m}$  wide; branch lobes 40-46  $\mu\text{m}$  long and 26-34  $\mu\text{m}$  wide, marginal cell 9-14  $\mu\text{m}$  long and 9-15  $\mu\text{m}$  wide, sinuate with nodulose-flexuose and confluent trigones, median cells 19-27  $\mu\text{m}$  long and 14-21  $\mu\text{m}$  wide, sinuate with nodulose-flexuose and confluent trigones, ocelli on base of lobe, thin wall. **Leaf lobules** comparatively large, inflate but dosiventally compressed, skull-shape, 28-39  $\mu\text{m}$  long and 19-22  $\mu\text{m}$  wide, apex obtuse, mouth widely truncate, margin smooth. **Styluses** filiform. **Underleaves** imbricate, inflate, orbicular, margin often with tooth or blunt tooth but entire below, margin 310-421  $\mu\text{m}$  long, 305-489  $\mu\text{m}$  wide, bilobed, sinus acute sometimes narrowly, lobes triangular-acute. **Gynoecea** terminal on stem and branch. **Bracts** 3 pairs, oblong, irregular tooled along margin. **Bracteoles** obovate, densely toothed along margin, bifid more than 1/2, sinus acute. **Perianths** obovate, inflated, with 3 principal plicae (2 lateral and 1 ventral), densely covered with spinose protrusions throughout the surface, apex sub-truncate, long-beaked, 192-196  $\mu\text{m}$  long and 115-119  $\mu\text{m}$  wide. (**Figure 4.10**)

**Thailand** — NORTH: Chiang Rai, Chiang Mai, Mae Hong Son, Tak, Phitsanulok; NORTH-EASTERN: Loei; SOUTH-WESTERN: Kanchanaburi, Prachuap Khiri Khan; PENINSULAR: Nakhon Si Thammarat, Phang-nga.

**Distribution** — widely distributed in warm-temperate to tropical regions of the world.

**Ecology** — on living bark of para rubber tree.

**Specimens examined** — P. Sukkharak 543 (BCU).

**GPS location** — 8.8582158 ° N 99.7137752° E

**Altitude** — 329 m

##### 5. *Frullania gracilis* (Reinw. et al.) Dumort.

Rec. d' Obs. Jungerm.: 13. 1835. Hattori S., J. Hattori Bot. Lab. 38: 174. 1974.; Hattori, S. Thaithong, O. & Kitagawa, N., J. Hattori Bot. Lab. 43: 445. 1977. — *Jungermannia gracilis* Reinw. Blume & Nees, Nova Acta Acad. Leop.-Carol 12: 221 [Hepat. Jav.]. 1825.

**Plants** reddish-brown, stems with leaves 0.5-0.7 mm wide, bipinnately branched, branch obliquely spreading. **Leaf lobes** slightly imbricate, widely ovate; stem lobes 390-410  $\mu\text{m}$  long and 260-280  $\mu\text{m}$  wide; branch lobes 130-230  $\mu\text{m}$  long and 140-210  $\mu\text{m}$  wide, apex round-obtuse, slightly incurved, margin entire, marginal cell 7-10  $\mu\text{m}$  long and 9-11  $\mu\text{m}$  wide, median cells 10-17  $\mu\text{m}$  long and 9-11  $\mu\text{m}$  wide, cell with thickened wall, medium trigones, 8-9 ocelli at basal part. **Leaf lobules** remote from stem, clavate-cylindrical 184-210  $\mu\text{m}$  long and 92-105  $\mu\text{m}$  wide, apex widely obtuse, mouth-margin slightly crenate. **Styluses** filiform. **Underleaves** remote, inflate, orbicular 147-247  $\mu\text{m}$  long and 105-147  $\mu\text{m}$  wide, bilobed, sinus acute, lobes triangular-acute, margin often with blunt tooth or angle on margin. **Gynoecea** terminal on stem and branch. **Bracts** 3 pairs, obovate, irregular tooled along margin. **Bracteoles** obovate, irregular toothed along margin, sinus acute, bifid more than 1/2. **Perianths** obovate, inflated, with 3 principal plicae (2 lateral and 1 ventral), smooth, apex sub-truncate, long-beaked, 148-151  $\mu\text{m}$  long, 53-56  $\mu\text{m}$  wide. (**Figure 4.11**)

**Thailand** — NORTHERN: Chiang Mai, Chiang Rai, Lampang, Mae Hong Son, Phitsanulok; NORTH EASTERN: Loei; SOUTH-EASTERN: Chantaburi, Trad; PENINSULAR: Phang-gna, Phuket, Nakhon Si Thammarat, Surathani.

**Distribution** — Andaman Islands, Borneo, Ceylon, Java, Malay Peninsular, Palau Islands (Micronesia), Philippines, Sumatra.

**Ecology** — on living bark of tree.

**Specimens examined** — P. Sukkharak 330, 518, Kai Sri Wirunjarnya 16, W. Pongmala 27 (BCU); Kai Larsen, T. Smitinan & E. Warncke No. 691, 1800 (BKF).

**GPS location** — 8.88229072° N 99.69644308° E

**Altitude** — 340-1,385 m

##### 6. *Frullania intermedia* (Reinw. et al.) Dumort. var. *submorokensis* S. Hatt.

Hattori S., J. Hattori Bo. Lab. 40: 483-484, fig. 187. 1976.

**Plants** yellow in herb, stems with leaves 0.9-1.3 mm wide, bipinnately branched. **Leaf lobes** imbricate, orbicular; stem lobes 66-78  $\mu\text{m}$  long and 51-53  $\mu\text{m}$  wide; branch lobes 42-47  $\mu\text{m}$  long and 23-28  $\mu\text{m}$  wide, apex round-obtuse, margin entire, marginal cell 11-19  $\mu\text{m}$  long and 15-17  $\mu\text{m}$  wide, trigones large, median cells 22-25  $\mu\text{m}$  long and 25-27  $\mu\text{m}$  wide, trigones large, basal cells 19-35  $\mu\text{m}$  long and 22-25  $\mu\text{m}$  wide, trigones large. **Leaf lobules** pendulous, clavate-oblongate 152-155  $\mu\text{m}$  long and 105-107  $\mu\text{m}$  wide, apex widely obtuse, margin mammillose. **Styluses** filiform. **Underleaves** imbricate, nearly flate, wide orbicular 44-46  $\mu\text{m}$  long and 59-67  $\mu\text{m}$  wide, bilobed, sinus acute, lobes triangular-acute, margin entire. **Sporophytes** not found. (Figure 4.12)

**Thailand** — New record to Thailand.

**Distribution** — Kinabalu (Endemic).

**Ecology** — on rock along water fall.

**Specimens examined** — P. Sukkharak 331(BCU).

**GPS location** — Exact locality not applicable. Between TT06 and TT07.

**Altitude** — ca. 553 m

### 7. *Frullania nigricaulis* (Nees) Nees

In Gott. et al., Synop. Hepat.: 457. 1845.; Hattori, S., J. Hattori Bot. Lab. 38: 194-196. fig. 91. 1974; Hattori, S., Thaithong, O. & Kitagawa, N., J. Hattori Bot. Lab. 43: 451. 1977.; Sande Lac., Synop. Hepat. Javan.: 91. 1856.; Schiffn., Consp. Hepat. Arch. Indici: 333. 1898.; Steph., Spec. Hepat. 4: 610. 1911.; Verd., Ann. Bryol. 2: 149 & 159. 1929.; suppl. 1: 153-155. f. 243, 263-266. 1930. with var. *elongata* Verd. (Fig. 91).

**Plants** pale green, flaccid, stems with leaves 1.2-2 mm wide, bipinnately branched, branch nearly horizontal spreading. **Leaf lobes** loosely imbricate, widely orbicular; stem lobes 125-153  $\mu\text{m}$  long and 134-140  $\mu\text{m}$  wide; branch lobes 50-70  $\mu\text{m}$  long and 40-50  $\mu\text{m}$  wide, apex round usually involute, margin entire, marginal cell 13-18  $\mu\text{m}$  long and 15-18  $\mu\text{m}$  wide, trigones large, median cells 22-27  $\mu\text{m}$  long and 21-25  $\mu\text{m}$  wide, trigones large, basal cells 38-48  $\mu\text{m}$  long and 17-28  $\mu\text{m}$  wide, trigones large. **Leaf lobules** remote from stem, clavate-oblongate, 342-347  $\mu\text{m}$  long and 157-168  $\mu\text{m}$  wide, apex obtuse, mouth-margin smooth, obliquely truncate. **Styluses** filiform. **Underleaves** remote, flate, wide orbicular-cordate, 1.1-1.2  $\mu\text{m}$  long and 1-1.2  $\mu\text{m}$  wide, bilobed nearly continuous to each other, sinus narrowly u-shaped-obtuse 1/5 of lobe, lobes triangular-acute, margin entire. **Sporophytes** not found. (Figure 4.13)

**Thailand** — PENINSULAR: Nakhon Si Thammarat.

**Distribution** — Halmahera, Java, Malay Peninsular, Sumatra.

**Ecology** — on branch and twig, on rotten log.

**Specimens examined** — P. Sukkharak 492, 494 (BCU).

**GPS location** — 8.87994647° N 99.70141053° E, 8.88010204° N 99.70120668° E

**Altitude** — 1,160-1,165 m

### 8. *Frullania nodulosa* (Reinw. et al.) Nees

In Gott. et al., Syn. Hep.: 433, fig. 1-2, 28-29, 41. 1845.; Hattori, S., J. Hattori Bot. Lab. 47: 209-213. fig. 28. 1980.; Hattori, S. Thaithong. O. & Kitagawa., N., J. Hattori Bot. Lab. 43: 446. 1977. — *Jungermannia nodulosa* Reinw et al., Nova Acta 12: 217. 1824. — *F. nodulosa* fo. *irreflexa* Verd., Ann. de Crypt. Exot. 1: 220. 1928. — *F. nodulosa* var. *plana* Schiffn., Forschungreise "Grazelle" 4(4): 37. 1890. — *F. nodulosa* fo. *dapitana* (Steph.) Verd., Ann. de Crypt. Exot. 1: 220. 1928. — *F. nodulosa* var. *secundiflora* (Mont.) Verd., Ann., Bryol. suppl. 1: 183, f. 304. 1930.

**Plants** yellow in herb, stems with leaves 2.1-2.2 mm wide, bipinnately branched. **Leaf lobes** slightly imbricate, widely ovate; stem lobes 810-870  $\mu\text{m}$  long and 530-550  $\mu\text{m}$  wide; branch lobes 680-700  $\mu\text{m}$  long and 350-380  $\mu\text{m}$  wide, apex round-obtuse, margin entire, marginal cell 15-23  $\mu\text{m}$  long and 15-21  $\mu\text{m}$  wide, trigones large, median cells 18-27  $\mu\text{m}$  long, 22-25  $\mu\text{m}$  wide, trigones large, basal cells 31-42  $\mu\text{m}$  long and 18-25  $\mu\text{m}$  wide, trigones large. **Leaf lobules** pendulous, clavate-oblongate 118-121  $\mu\text{m}$  long and 65-68  $\mu\text{m}$  wide, apex widely obtuse,

margin smooth. **Styluses** filiform. **Underleaves** imbricate, inflate, orbicular 65-69  $\mu\text{m}$  long and 74-76  $\mu\text{m}$  wide, bilobed, sinus narrowly acute, lobes triangular-acute, margin strongly revolute throughout. **Gynoecea** terminal on stem or branch. **Bracts** 3 pairs, ovate, irregular blunt tooted along margin. **Bracteoles** obovate, irregular toothed along margin, sinus acute, bifid less than 1/2. **Perianths** obovate, inflated, with 3 principal plicae (2 lateral and 1 ventral), smooth, apex sub-truncate, long-beaked, 251-255  $\mu\text{m}$  long, 97-102  $\mu\text{m}$  wide, not exerted from the bracts or only slightly. (**Figure 4.14**)

**Thailand** — SOUTH-EASTERN: Chanthaburi, Trat; SOUTH-WESTERN: Prachuap Khirikhan; PENINSULAR: Nakhon Si Thammarat; Ranong.

**Distribution** — widely distributed in tropic regions of the world and also in Australia.

**Ecology** — on living bark of tree.

**Specimens examined** — P. Sukkharak 195, 411, 413 (BCU)

**GPS location** — 8.88215661° N 99.69638944° E

**Altitude** — 1247-1,385 m

### 9. *Frullania serrata* Gottsche

In Gott. et al., Synop. Hepat.: 453. 1845.; J. Hattori Bot. Lab. 37: 71-75, fig. 33-35.1973.; Hattori, S., Thaithong, O. & Kitagawa N., J. Hattori Bot. Lab. 43: 443. 1977.; Sande Lac., Synop. Hepat. Javan.: 91. 1856.; in Miquel, Ann. Mus. Lugd. Batavi 1: 313. 1863/64.; Gott., Abh. Naturw. Ver. Bremen 7: 363. 1882.; Schiffn., Nova Acta Leop.-Carol. 60(2): 226. 1893.; in Engl. & Prantl, Nat. Pfl.-fam. 1, 3: 134, f. 70a. 1895.; Steph. in Engler, Bot. Jahrb. 8(2): 90. 1886.; Schiffn., Consp. Hepat. Archip. Indici: 333. 1898.; Hedwigia 39: 208. 1900.; Steph., Spec. Hepat. 4: 478. 1911.; Verd., Ann. Bryol. 2: 141. 1929.; suppl. 1: 85-87, f. 125-128, 149-152. 1930; 5: 139. 1932.; suppl. 4. 205. 1934.; Bull. Jard. Bot. Buitenzorg sér. 3, 12(1): 58. 1932.; Nederl. Kruidk. Arch. Jaarg. 1930, Afl. 2: 168-169, f. 1. 1930.; Jaarg. 1932, Afl. 2: 496. 1932.; Chopra, Indian Acad. Sci. 7(5): 249. 1938.; Jour. Ind. Bot. Soc. 22: 249. 1943.; Herzog, Ann. Nat.-hist. Mus. Wien 53(1): 368 1943.; Clark & Svihla, the Bryologist 51:26. 1948.; Herzog, Trans. Brit. Bryol. Soc. 1(4): 317. 1950.; Vanden Berghen, Sv. Bot. Tidskr 47(2): 266. 1953.; Arnell, Arkiv Bot. 3 (16): 531. 1956; Bot. Not. 110(1): 22. 1957.; Res. Norw. Sci. Exp. Tristan da Cumha 42: 10. 1958; Abeywickrama, Ceylon Jour. Sci. (Biol. Sci.) 2(1): 58. 1959.; Vanden Berghen, Rev. Bryol. Lichénol. 29:54. 1960.; Bull. Soc. Roy. Bot. Belgique 93: 73. 1961.; Arnell, Sv. Bot. Tidskr. 56(1): 57. 1962.; Hepat. of S. Africa: 154, f. 113. 1963.; Sv. Bot. Tidskr. 59(1): 74. 1965. — *Jungermannia ndulosa* Reinw., Nees & Blume, Nova Acta Acad. Leop.-Carol 12: 217 [Hepat. Jav.]. 1825.

**Plants** dark reddish-brown, stems with leaves 1.4-1.6 mm wide, bipinnately branched. **Leaf lobes** imbricate, apex cuspidate-apiculate, strongly incurved, widely ovate when flatten, base of leaf-lobe is strongly appendiculate, margin entire; stem lobes 82-68  $\mu\text{m}$  long and 53-57  $\mu\text{m}$  wide; branch lobes 74-64  $\mu\text{m}$  long and 35-42  $\mu\text{m}$  wide, marginal cell 6.5-9.2  $\mu\text{m}$  long and 6-8.5  $\mu\text{m}$  wide, cell with thickened wall, median cells 13-15  $\mu\text{m}$  long and 5-9  $\mu\text{m}$  wide, cell with thickened wall, basal cells 36-60  $\mu\text{m}$  long and 10-36  $\mu\text{m}$  wide, trigones large. **Leaf lobules** remote from stem, cylindrical, 194-197  $\mu\text{m}$  long and 89-92  $\mu\text{m}$  wide, apex obtuse, mouth truncate, margin smooth. **Styluses** filiform. **Underleaves** imbricate, inflate, orbicular, margin convex, 47-48  $\mu\text{m}$  long and 43-45  $\mu\text{m}$  wide, bilobed, sinus narrowly acute-u-shaped, lobes triangular-acute, margin strongly revolute throughout. **Gynoecea** terminal on stem and branch. **Bracts** 3 pairs, ovate, irregular tooted along margin. **Bracteoles** obovate, densely toothed along margin, sinus acute, bifid less than 1/2. **Perianths** obovate, inflated, with 3 principal plicae (2 lateral and 1 ventral), smooth, apex sub-truncate, long-beaked, 192-196  $\mu\text{m}$  long, 86-88  $\mu\text{m}$  wide. (**Figure 4.15**)

**Thailand** — NORTHERN: Phitsanulok; NORTH-EASTERN: Loei; EASTERN: Nakhon Ratchasima; PENINSULAR: Nakhon Si Thammarat.

**Distribution** — one of the most representative species in the Palaeotropics: Borneo, Celebes, Ceylon, Fiji, India, Java, New Caledonia, New Guinea, Marquesas, Tahiti, Viet Nam, Sumatra, Viet Nam and other islands in tropical Asia and Oceania, also in Africa and Madagascar.

**Ecology** — on living bark of tree.

**Specimens examined** — P. Sukkharak 517, O. Thaithong 160 (BCU).

**GPS location** — 8.88215661° N 99.69638944° E  
**Altitude** — 1,385 m

10. *Frullania* sp.

**Plants** green to brownish-green, creeping on bark, stem up to 2 cm long, with leaves 0.5-1 cm wide. **Leaf lobes** orbicular, 400-520  $\mu\text{m}$  long and 360-480  $\mu\text{m}$  wide, apex rounded, margin entire, ocelli at basal part. **Leaf lobules** oblong, 148-164  $\mu\text{m}$  long and 84-100  $\mu\text{m}$  wide. **Styluses** filiform. **Underleaves** remote, inflate, orbicular 172-240  $\mu\text{m}$  long and 164-220  $\mu\text{m}$  wide, bilobed, sinus acute. **Sporophytes** not found. (**Figure 4.16**)

**Thailand** —

**Distribution.** —

**Ecology** — on living bark of rattan.

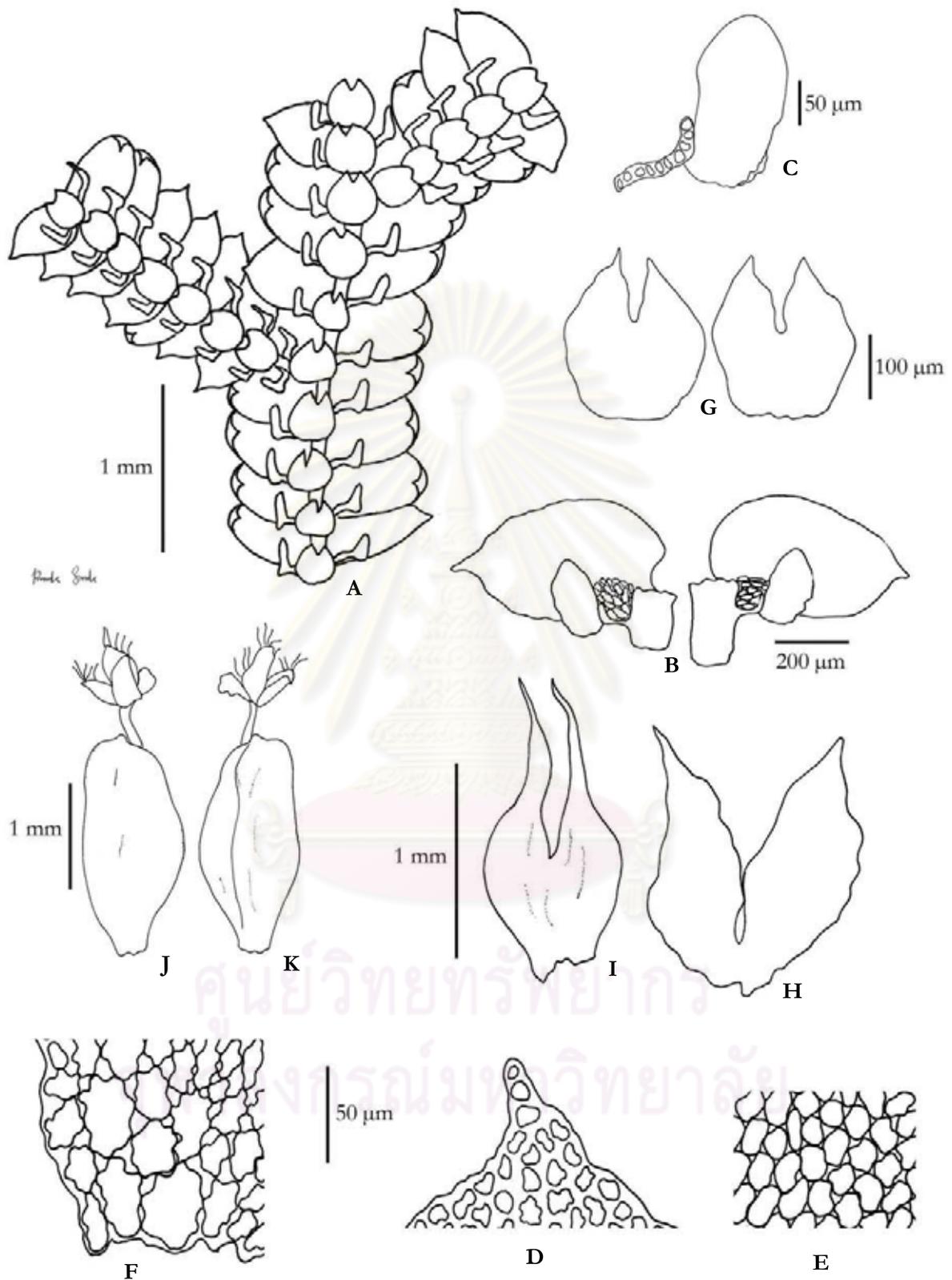
**Specimens examined** — P. Sukkharak 277 (BCU).

**GPS location** — Exact locality not applicable. Between TT16

**Altitude** — ca. 1,089 m

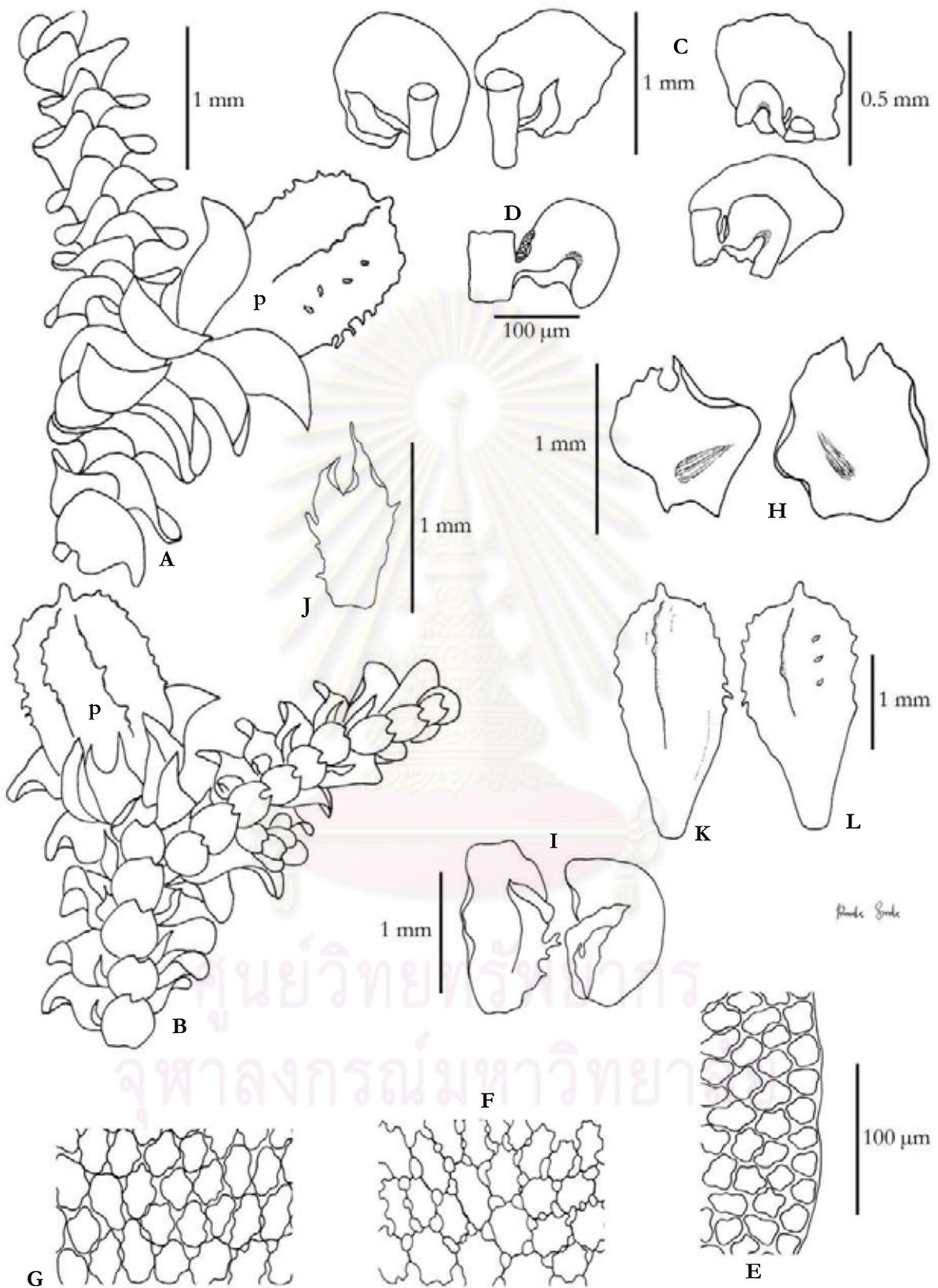


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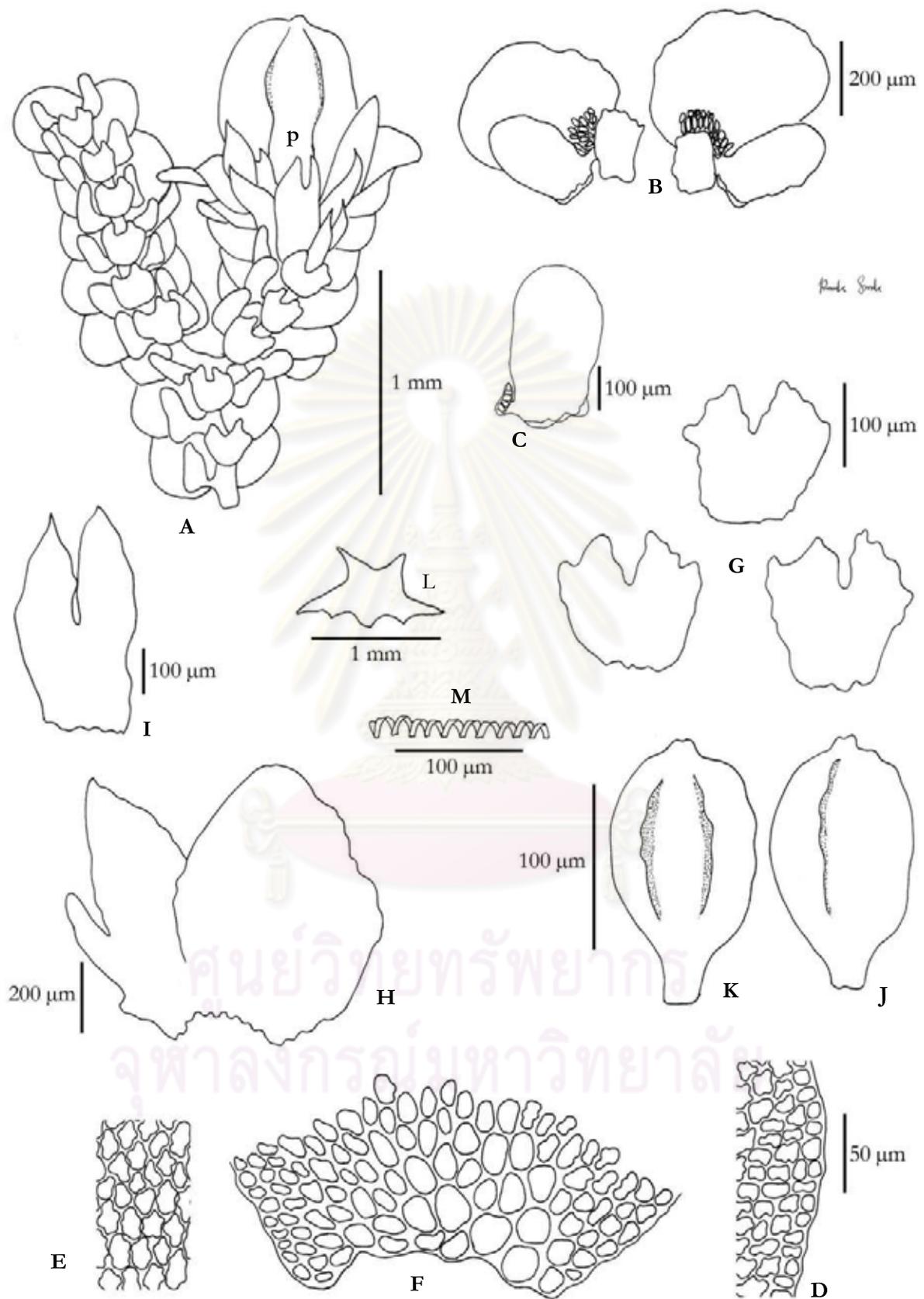
**Figure 4.7** *Frullania apiculata* (Reinw. et al.) Dumort.

A. ventral portion of plant; B. lateral leaves; C. leaf lobule with stylus; D. cells at leaf apex; E. cells at leaf median; F. cells at leaf base; G. underleaves; H. bract; I. bracteole; J.-K. perianth: J. dorsal view, K. ventral view. P. Sukkharak 403.



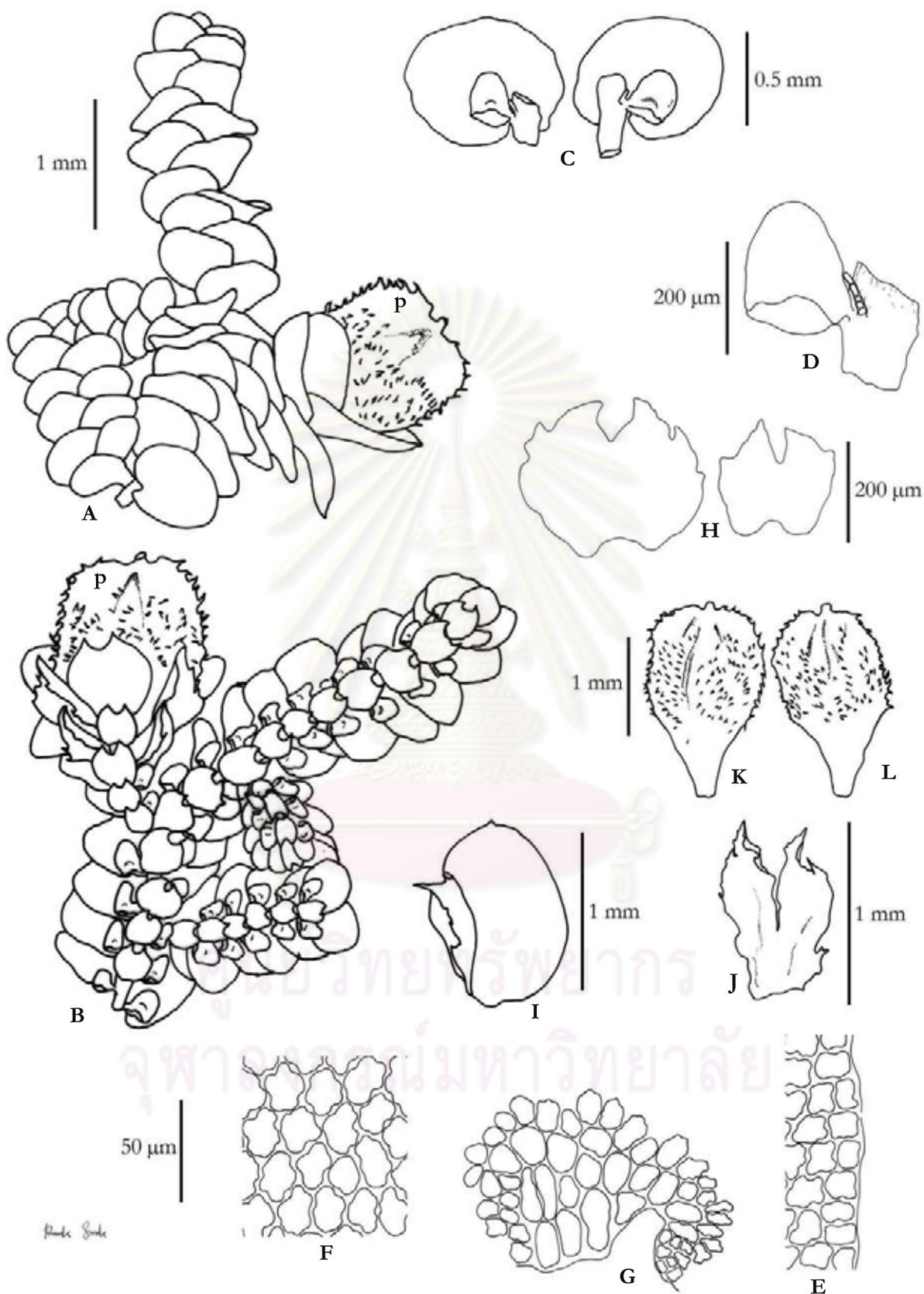
**Figure 4.8** *Frullania berthoumieuii* Steph.

A.-B. portion of plant with perianth (p): A. dorsal view, B. ventral view; c. lateral leaves; D. leaf lobule with stylus; E. cells at leaf margin; F. cells at leaf median; G. cells at leaf base; h. underleaves; I. bract; J. bracteole; K.-L. perianth: K. dorsal view, L. ventral view. P. Sukkharak 542.



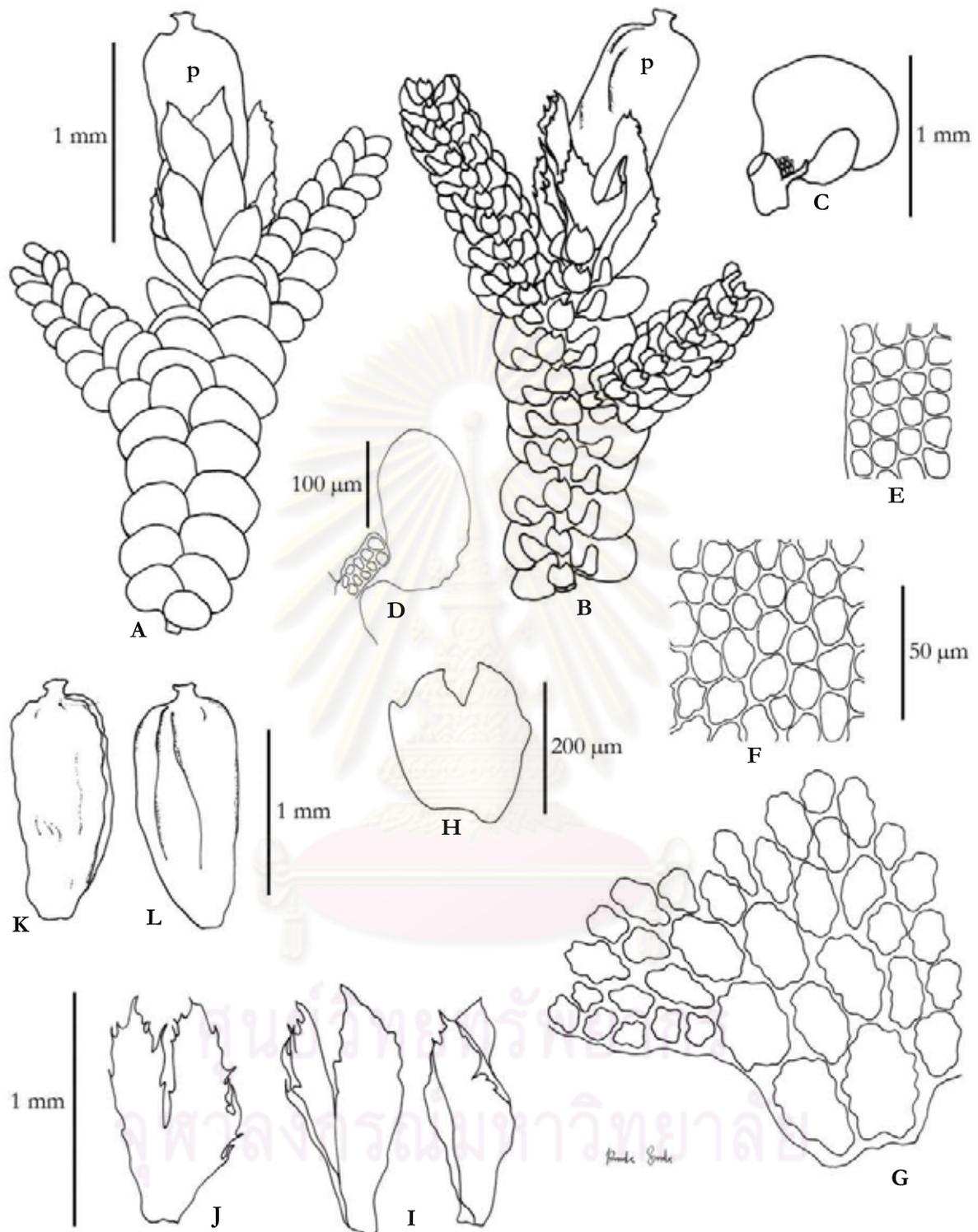
**Figure 4.9** *Frullania campanulata* Sande Lac.

A. ventral portion of plant with perianth (p); B. lateral leaves; C. leaf lobule with stylus; D. cells at leaf margin; E. cells at leaf median; F. cells at leaf base; G. underleaves; H. bract; I. bracteole; J-K. perianth: J. dorsal view, K. ventral view; L. cross section of perianth; M. elater. P. Sukkharak 104.



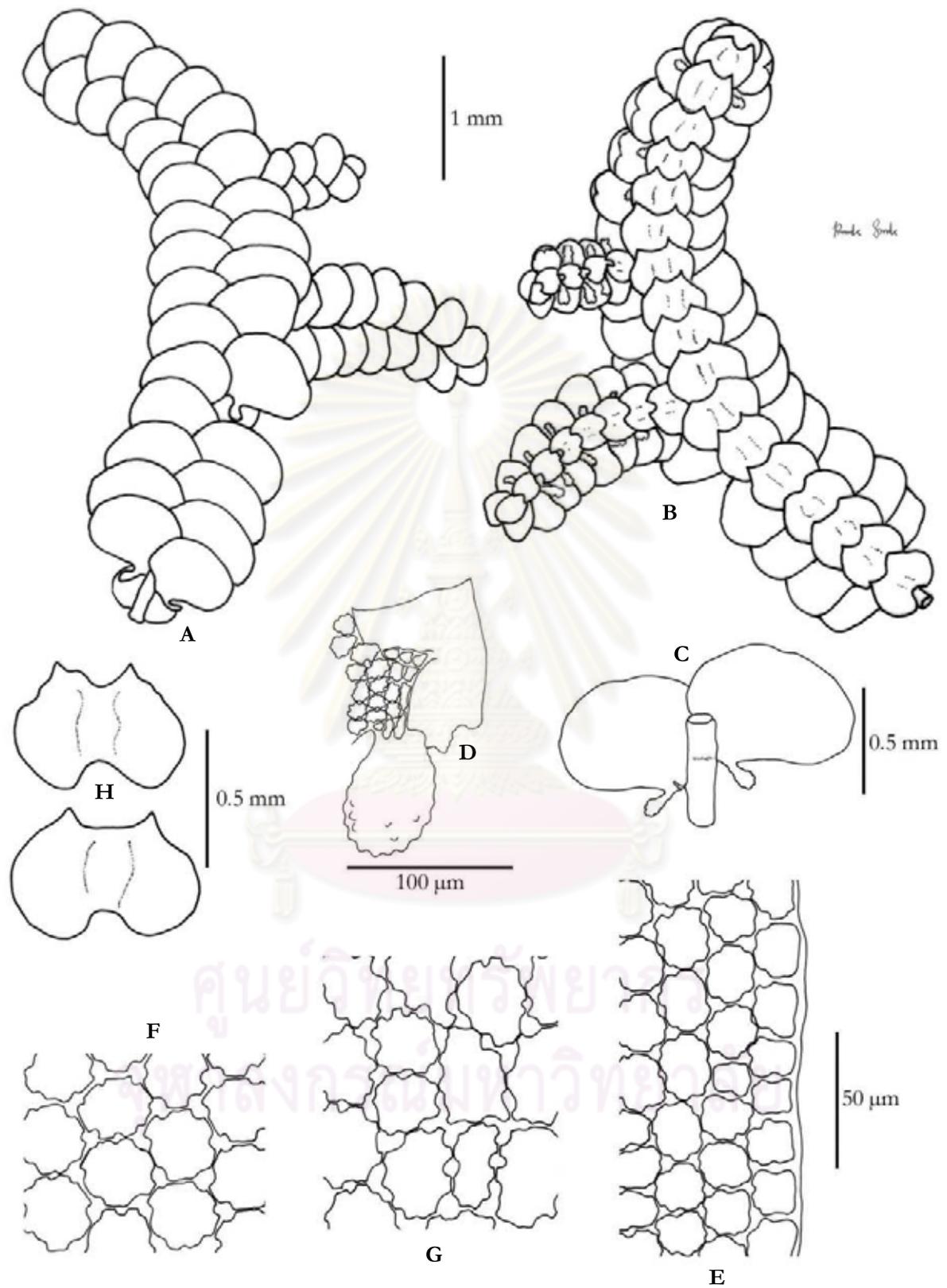
**Figure 4.10** *Frullania ericoides* (Nees) Mont.

A.-B. portion of plant with perianth (p): A. dorsal view, B. ventral view; C. lateral leaves; D. leaf lobule with stylus; E. cells at leaf margin; F. cells at leaf median; G. cells at leaf base; H. underleaves; I. bract; J. bracteole; K.-L. perianth: K. dorsal view, L. ventral view. P. Sukkharak 543.



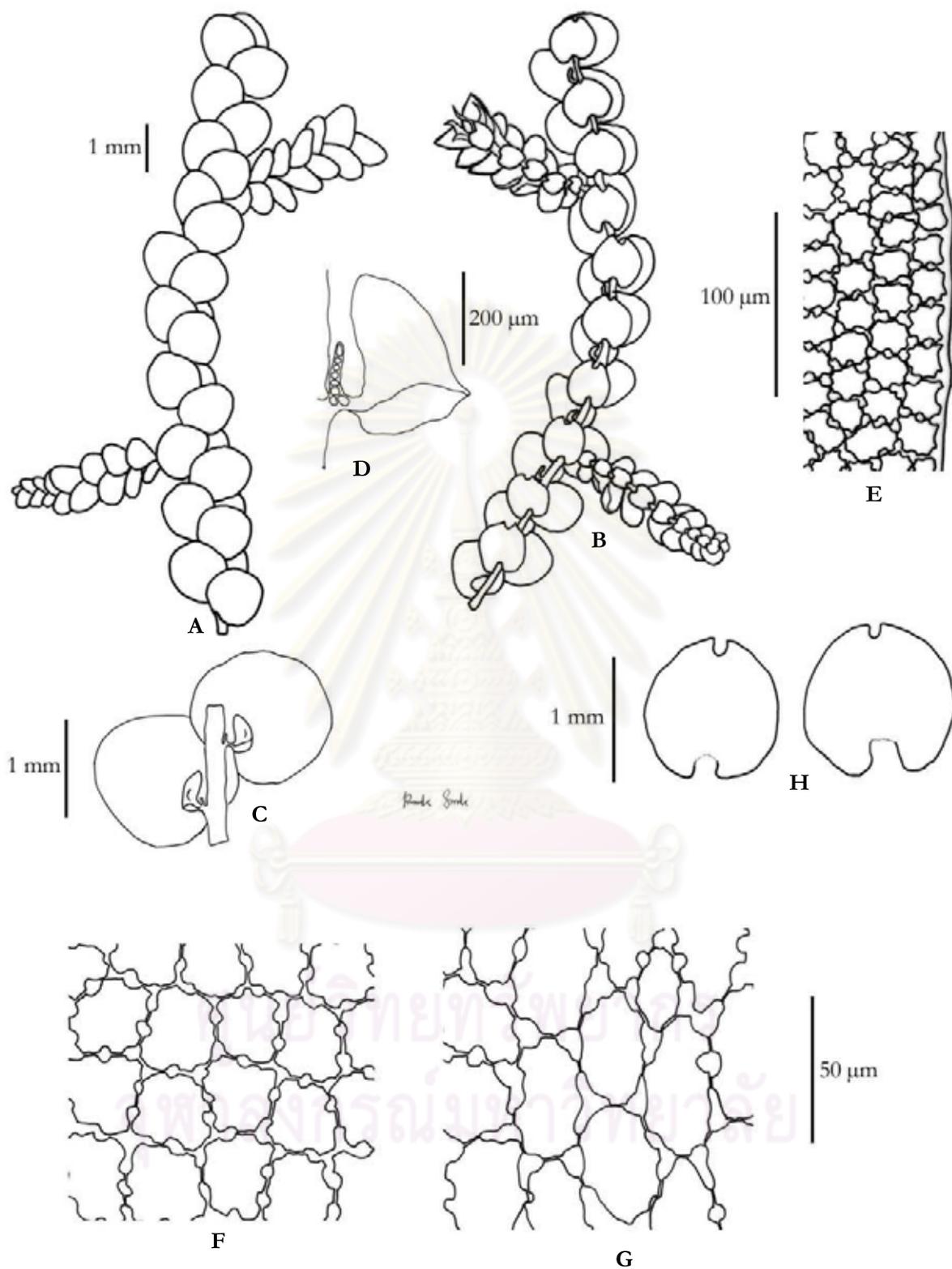
**Figure 4.11** *Frullania gracilis* (Reinw. et al.) Dumort.

A.-B. portion of plant with perianth (p): A. dorsal view, b. ventral view; C. lateral leaf; D. leaf lobule with stylus; E. cells at leaf margin; F. cells at leaf median; G. cells at leaf base; H. underleaf; I. bracts; J. bracteole; K.-L. perianth: K. dorsal view, L. ventral view. P. Sukkharak 518.



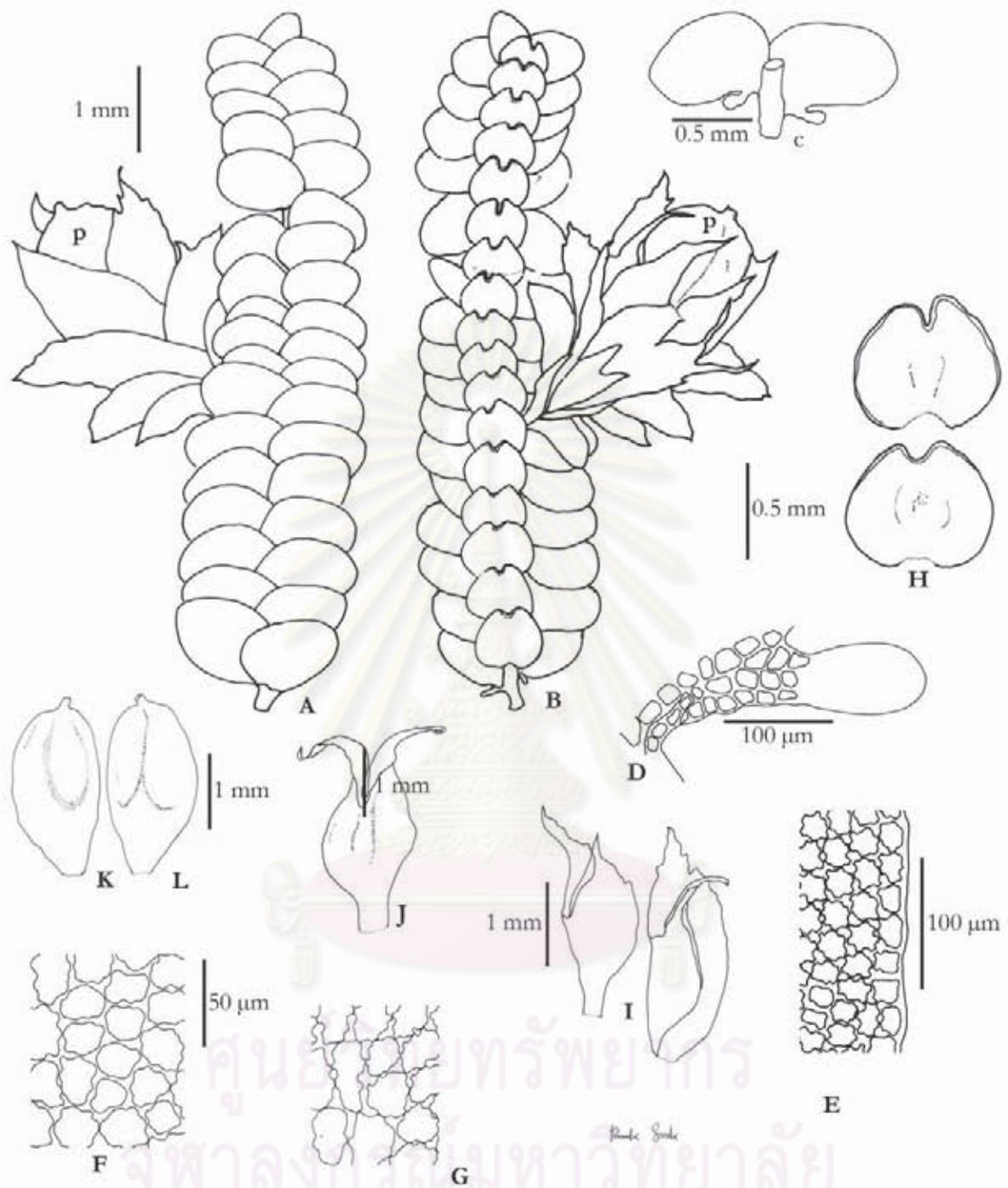
**Figure 4.12** *Frullania intermedia* (Reinw. et al.) Dumort. var. *submorokensis* S. Hatt.

A.-B. portion of plant: A. dorsal view, B. ventral view; C. lateral leaves; D. leaf lobule; E. cells at leaf margin; F. cells at leaf median; G. cells at leaf base; H. underleaves. P. Sukkharak 331.



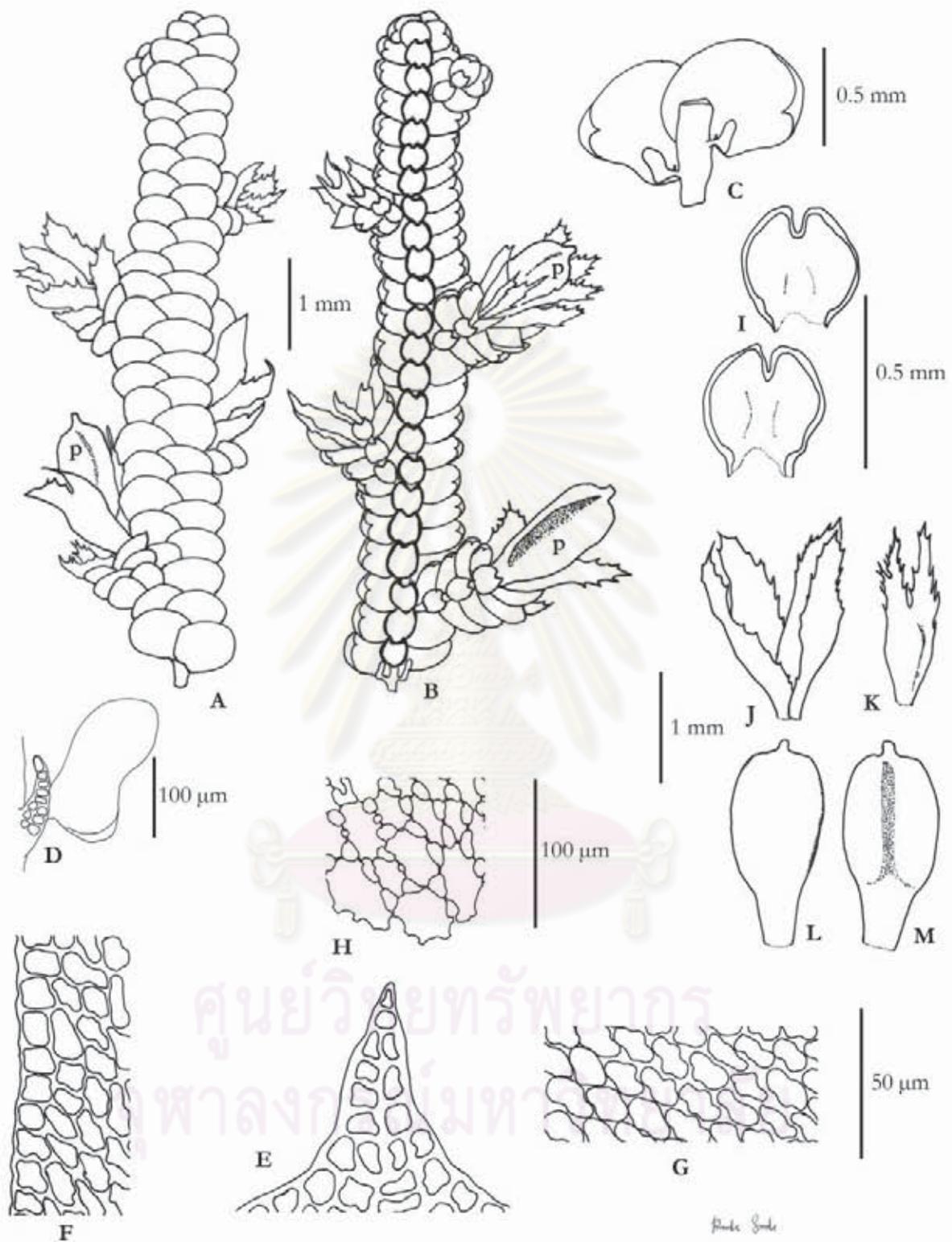
**Figure 4.13** *Frullania nigricaulis* (Nees) Nees

A.-B. portion of plant: A. dorsal view, B. ventral view; C. lateral leaves; D. leaf lobule with stylus; E. cells at leaf margin; F. cells at leaf median; G. cells at leaf base; H. underleaves. P. Sukkharak 494.



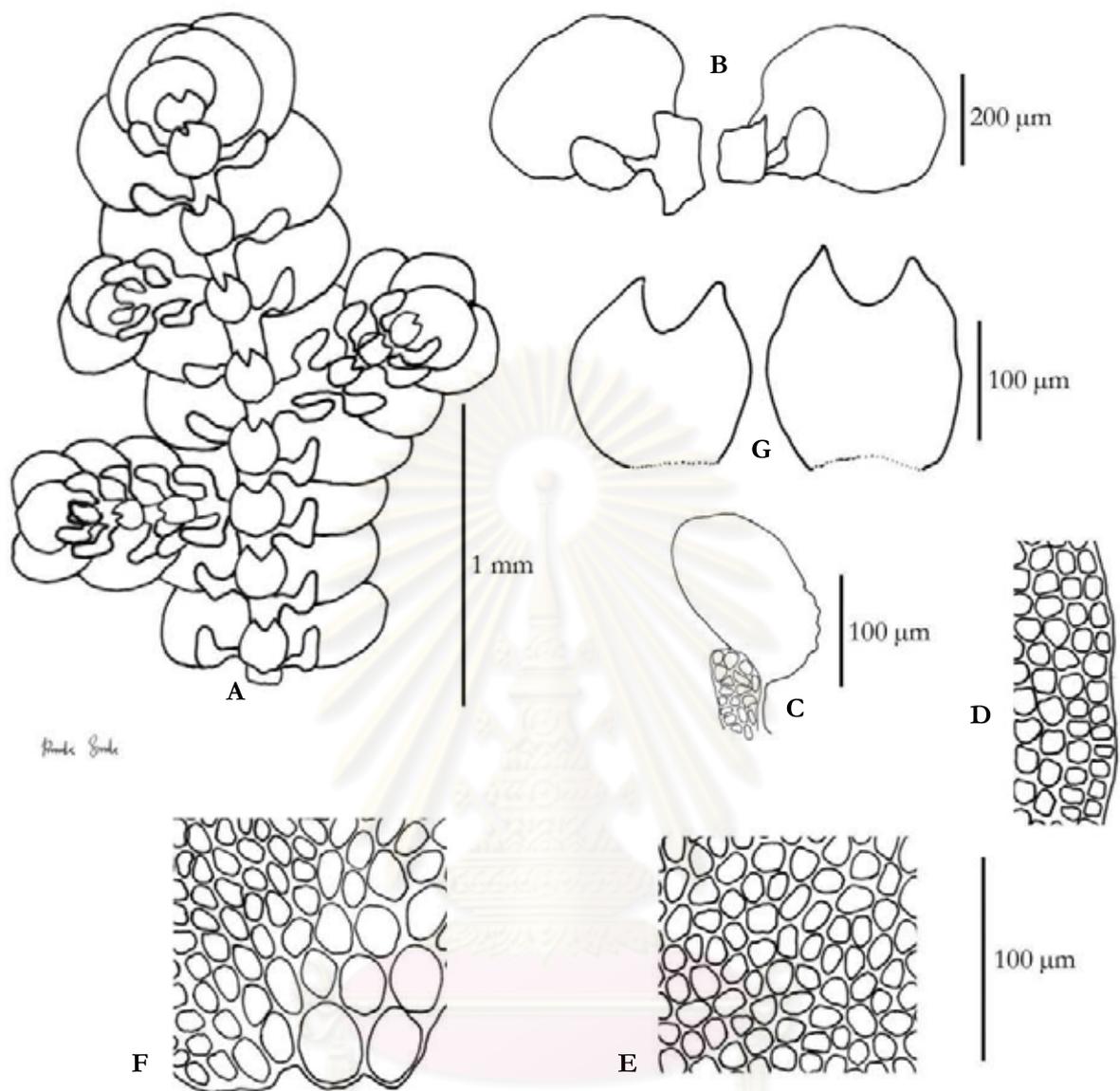
**Figure 4.14** *Frullania nodulosa* (Reinw. et al.) Nees

A.-B. portion of plant with perianth (p): A. dorsal view, B. ventral view; C. lateral leaves; D. leaf lobule with stylus; E. cells at leaf margin; F. cells at leaf median; G. cells at leaf base; H. underleaves; I. bracts; J. bracteole; K.-L. perianth: K. dorsal view, L. ventral view. P. Sukkharak 413.



**Figure 4.15** *Frullania serrata* Gottsche

A.-B. portion of plant with perianth (p): A. dorsal view, B. ventral view; C. lateral leaves; D. leaf lobule with stylus; E. cells at leaf apex; F. cells at leaf margin; G. cells at leaf median; H. cells at leaf base; I. underleaves; J. bracts; K. bracteole; L.-M. perianth: L. dorsal view, M. ventral view. P. Sukkharak 517.



**Figure 4.16** *Frullania* sp.

A. ventral portion of plant; B. lateral leaves; C. leaf lobule with stylus; D. cells at leaf margin; E. cells at leaf median; F. cells at leaf base; G. underleaves. P. Sukkharak 277.

## Geocalyceae

**Plants** leafy, green to brown, creeping or ascending. **Lateral leaves** succubous, usually almost horizontal in position, often 2-lobed or 2-tooth at apex or becoming entire, lateral leaves in and near gynoecia are lobed and/or toothed. **Underleaves** 2-lobed with often additional teeth, or the apex merely 2-toothed, often connate to the lateral leaves. **Gynoecia** are variable developed: perichaetial leaves are large to almost totally reduced, the perianth is well-developed, or there is a pendent perigynium present. The position of gynoecia vary from terminal to lateral or to postical-intercalary.

### Key to genera

1. Underleaf not connate with lateral leaves.
  2. Lateral leaves not muricate.
    3. Cuticle smooth, cells without trigones ..... *Lophocolea*
    3. Cuticle mamilllose, cells with large trigones ..... *Conoscyphus*
  2. Lateral leaves muricate, underleaves deeply 2-lobed ..... *Saccogynidium*
1. Underleaf connate with lateral leaves ..... *Heteroscyphus*

### 1. *Conoscyphus*

*Conoscyphus* Mitt., Flora Vitiensis 404. 1873.; Piippo S. Acta Bot. Fennica. 131: 134. 1985.

**Plants** brown or brownish or somewhat reddish. **Lateral leaves** are clasping on dorsal side of stem. **Underleaves** are large, and only one of the basal margins fuses with the lateral leaf. The cuticle always highly papillose. **Gynoecia** are terminal on shoots. **A monotypic genus**

#### 1. *Conoscyphus trapezioides* (Sande Lac.) Schiffn.

Consp. Hep. Arch. Ind 125. 1898.; Piippo S. Acta Bot. Fennica. 131: 133-134, fig. 2. 1985. — *Chiloscyphus trapezioides* Sande Lac., Nederl. Kruidk. Arch. 3: 417. 1854. — *Thysananthus erosus* Steph., Spec. Hep. 6: 568. 1924.

**Plants** yellowish pale-green, 2.7-2.9 mm wide. **Stems** creeping. **Lateral leaves** imbricate, opposite, clasp on dorsal side of stem when dry, widely ovate, 1.2-1.3 mm long and 0.7-0.8 mm wide, apex slightly acute and mamilllose, dorsal margin mamilllose, ventral margin arched and with 2-5 teeth near basal part, margin and median cells 23-28 µm long and 23-28 µm wide, trigones large, basal cells 21-34 µm long and 15-23 µm wide, trigones large. **Underleaves** imbricate, round, apex 2 lobes, margin with 6-9 short teeth, 0.8-0.9 mm long and 0.6-0.7 mm wide. **Sporophytes** not found. (Figure 4.17)

**Thailand** — PENINSULAR: Nakhon Si Thammarat.

**Distribution** — on the Huon Peninsular, in Western Melanesia: West Irian, Papua New Guinea, Solomon Islands.

**Ecology** — on living bark of tree.

**Specimens examined** — P. Sukkharak 544a (BCU).

**GPS location** — Exact locality not applicable. Between TT22 and TT23.

**Altitude** — Exact altitude not applicable. ca. 1,381-1333 m

### 2. *Heteroscyphus*

*Heteroscyphus* Schiffn., Oesterreichische Botanische Zeitschrift 60: 171. 1910.; Piippo, S., Acta Bot. Fennica. 131: 135. 1985.; Fulford, M. H. 1976. *Heteroscyphus*. Memoirs of the New York Botanical Garden 11 (4): 485-505; Gradstein, S. R., Churchill, S. P. & Allen, N. S., Guide to the bryophytes of tropical America: 96. 2001.

**Plants** medium-sized to large, green to brown, creeping, irregularly branched. **Lateral leaves** may or may not flat, alternate or opposite, ovate to subrectangular, apex entire, margin entire, short-bifid or with a few teeth, dorsal margin usually entire, ventral margin entire or toothed and often somewhat undulate, cells thin-walled or with distinct trigones, cuticle smooth or weakly papillose. **Underleaves** usually also connate with lateral leaves, 2-lobed, often toothed. **Monoicous** the androecia and gynoecia usually side by side. **Androecia and Gynoecia** on very short ventral branches hidden behind the stem leaves. **Perianths** inflated, without keels, often immersed within the bracts, perianth mouth 3-lobed and ciliate.

#### Key to species

1. Lateral leaves apex not round.
  2. Lateral leaves apex bifid.
    3. Lateral leaves apex blunt or slightly bifid.....*H. acutangulus*
    3. Lateral leaves apex truncate with 2 teeth.....*H. coalitus*
  2. Lateral leaves apex with several teeth.....*H. argutus*
1. Lateral leaves apex round to shallowly 2-lobed with round lobe apices.....*H. sarawaketanus*

#### 1. *Heteroscyphus acutangulus* (Schiffn.) Schiffn.

Österr. Bot. Zeitschr. 60: 172. 1910.; Piippo, S., Acta Bot. Fennica. 131: 135-137, fig. 3. 1985. — *Chiloscyphus acutangulus* Schiffn., Denkschr. Kais. Akad. Wiss. Wien Math.-Nat. Clas. 70: 209. 1900.

**Plants** yellowish green with pale green at shoot apices, 2-4 mm wide. **Stems** creeping, unbranch. **Rhizoids** in bundle on underleaf base (fasciculate, at base of underleaves). **Lateral leaves** imbricate, concave, opposite, ovate, 1.5-2 mm long and 1.3-1.5 mm wide, apex blind bifid, margin entire, median cells 31-39 µm long and 39-52 µm wide, trigones large. **Underleaves** imbricate, connate with the lateral leaves, 1-1.1 mm long and 0.8-0.9 mm wide, apex deeply 2 lobes with 2-3 teeth on margin. **Perianths** on ventral branch hidden under the leaves, inflate, without keel, mouth with spinose-tooth, 3-4 mm long and 1.5-2 mm wide. (**Figure 4.18**)

**Thailand** — New record to Thailand.

**Distribution** — Java, on the Huon Peninsular, in Western Melanesia.

**Ecology** — on living bark of tree.

**Specimens examined** — P. Sukkharak 533 (BCU).

**GPS location** — 8.87699604° N 99.69201744° E

**Altitude** — 1,338 m

#### 2. *Heteroscyphus argutus* (Reinw. et al.) Schiffn.

Österr. Bot. Zeitschr. 60: 172. 1910.; Piippo, S., Acta Bot. Fennica. 131: 137-138, fig. 4. 1985. — *Jungermannia arguta* Reinw. et al., Hep. Javan. 206, n. 14. 1824. — *Chiloscyphus argutus* (Reinw. et al.) Nees in Gott. et al., Syn. Hep. 183. 1845. — *Chiloscyphus cubans* Tayl., London J. Bot. 5: 282. 1846. — *Heteroscyphus cubans* (Tayl.) Schiffn., Österr. Bot. Zeitschr. 60. 172. 1910. — *Chiloscyphus endlicherianus* (Nees) Nees var. *novoguineensis* Schiffn., Forschungsreise S. M. S. "Gazelle" IV: 14. 1890.

**Plants** yellowish pale-green, 2-3 mm wide. **Stems** creeping, usually branch. **Rhizoids** in bundle on underleaf base (fasciculate, at base of underleaves). **Lateral leaves** imbricate, convex, subopposite to opposite, rectangular, 1-1.2 mm long and 0.6-0.7 mm wide, apex truncate with 4 teeth, margin entire, median cells 15-18 µm long and 13-15 µm wide, basal cells 26-31 µm long and 23-26 µm wide, trigones absent. **Underleaves** distant, one connate with the lateral leaves, another connate or not, apex deeply 2 short lobes and 2 long lobes. **Perianths** on ventral branch hidden under the leaves, campanulate, 3-plicates, mouth 3 lobes with spinose-tooth. (**Figure 4.19**)

**Thailand** — NORTHERN: Chiang Mai, Phitsanulok; NORTH-EASTERN; Loei, PENINSULAR: Ranong.

**Distribution** — on the Huon Peninsular, in Western Malanesia: West Irian, Papua New Guinea, Solomon Island.

**Ecology** — on rotten log, bark of tree, rock.

**Specimens examined** — P. Sukkharak 5, 30, 64, 65, 150, 151, 428 (BCU).

**GPS location** — 8.87901697° N 99.70197342° E, 8.87435675° N 99.69430268° E

**Altitude** — 790-1,170 m

### 3. *Heteroscyphus coalitus* (Hook.) Schiffn.

Österr. Bot. Zeitschr. 60: 172. 1910.; Piippo, S., Acta Bot. Fennica. 131: 141-143, fig. 4. 1985. — *Jungermannia coalita* Hook., Musci Exot. 2: 23, t. 123. 1819. — *Chiloscyphus coalitus* (Hook.) Nees in Gott. et al., Syn. Hep. 180. 1845. — *Lophocolea reflexistipula* Steph., Hedwigia 28: 265. 1889. — *Chiloscyphus communis* Steph., Spec. Hep. 3: 211. 1906. — *Heteroscyphus communis* (Steph.) Schiffn., Österr. Bot. Zeitschr. 60: 171. 1910. — *Lophocolea tamina* Steph., Spec. Hep. 6: 295. 1922.

**Plants** yellowish pale-green, 3-4.5 mm wide. **Stems** creeping, rarely branch. **Rhizoids** in bundle on underleaf base (fasciculate, at base of underleaves). **Lateral leaves** loosely imbricate, flat, subopposite to opposite, rectangular, 2-2.5 mm long and 1-1.2 mm wide, apex truncate with 2 teeth, margin entire, median cells 31-36 µm long and 23-28 µm wide, basal cells 39-47 µm long and 26-31 µm wide, trigones absent. **Underleaves** distant, connate with the lateral leaves, apex with 4-5 teeth. **Sporophytes** not found. (Figure 4.20 and 4.107)

**Thailand** — NORTHERN: Pitsanulok; NORTH-EASTERN: Loei; SOUTH-WESTERN: Chanthaburi, Trat.

**Distribution** — on the Huon Peninsular, in Western Melanesia: West Irian, Papua New Guinea, America, Taiwan, Indonesia, Bourne, Philippine, Australia.

**Ecology** — on living bark of tree, on branch, on rotten log, soil near base of tree trunk, rock.

**Specimens examined** — P. Sukkharak 50, 52, 67, 68, 69, 71, 73, 75, 78, 101, 152, 153, 154, 156, 157, 160, 192, 216, 218, 221, 229 (BCU).

**GPS location** — 8.88136365° N 99.70037524° E, 8.88183572° N 99.70015354° E

**Altitude** — 598-1,283 m

### 4. *Heteroscyphus sarawaketanus* Piippo

In Piippo S. Acta Bot. Fennica. 131: 143-144, fig. 8. 1985.

**Plants** yellowish green, 4-5 mm wide. **Stems** creeping, unbranch. **Rhizoids** in bundle on underleaf base. **Lateral leaves** imbricate, concave (clasping at dorsal side of stem), opposite, orbicular to ligulate, 1.5-2 mm long and 1.3-1.5 mm wide, apex round to shallowly 2-lobed with round lobe apices, margin entire, median cells 26-39 µm long and 21-34 µm wide, trigones large. **Underleaves** imbricate, connate with the lateral leaves, 1-1.1 mm long and 0.8-0.9 mm wide, apex deeply 2 lobes. **Sporophytes** not found. (Figure 4.21)

**Thailand** — New record to Thailand.

**Distribution** — on the Huon Peninsular, in Western Melanesia, endemic to Papua New Guinea.

**Ecology** — on living bark and branch of tree.

**Specimens examined** — P. Sukkharak 200, 451 (BCU).

**GPS location** — 8.87710333° N 99.68977511° E

**Altitude** — 1,275-1,327 m

## 3. *Lophocolea*

*Lophocolea* (Dumort.) Dumort., Recueil d'Observations sur les Jungermanniacées 17. 1835.; Fulford, M. H. 1976.; Memoirs of the New York Botanical Garden 11 (4): 420-485.; Gradstein, S. R., Churchill, S. P. & Allen, N. S. Guide to the bryophytes of tropical America: 98. 2001.

**Plants** small to large, (pale) green, rarely brown, creeping, irregularly branches. **Lateral leaves** alternate to opposite, ovate-orbicular to rectangular, apex truncate, 2-lobed or with a few teeth or cilia, margin entire or toothed to ciliate, leaf surface smooth or with teeth-like processes, cells usually thin-walled, trigones lacking or small, rarely large, cuticle smooth or papillose; oils bodies usually finely granular. **Underleaves** free or connected to the lateral leaves, 2-lobed, often toothed. **Dioicous** or **Monoicous**. **Androecia and Gynoecia** on elongated shoot. **Perianths** 3-keeled, long-exserted beyond the bracts. **Gemmae** sometimes produced.

#### Key to species

1. Lateral leaves without papillae on dorsal surface ..... *L. costata*  
 1. Lateral leaves with papillae on dorsal surface ..... *L. muricata*

#### 1. *Lophocolea costata* (Nees) Gottsche

Bot. Zeit. 16, Beitr. 38. 1858.; Piippo S. Acta Bot. Fennica. 131: 156-159, fig. 15. 1985. — *Jungermannia costata* Nees, Hep. Javan. 69, n. 94. 1830. — *Lophocolea giulianettii* Steph., Spec. Hep. 3: 133. 1906.

**Plants** yellowish pale-green to black, 2.3-2.5 mm wide. **Stems** creeping, unbranch, in cross section of stem 10-11 cells in diameter. **Rhizoids** not seen. **Lateral leaves** imbricate, convex with decurved spex, subopposite, long ovate, 1.8-2 mm long and 0.8-1 mm wide, apex bifid to trifid, margin slightly crenulate, median cells nearly quadrate 31-42  $\mu\text{m}$  long and 26-31  $\mu\text{m}$  wide, trigones absent. **Underleaves** distant, densely toothed along margin, 65-70  $\mu\text{m}$  long and 55-80  $\mu\text{m}$  wide. **Bracts** long ovate nearly lanceolate, margin dentate. **Bracteoles** oblong, margin dentate. **Perianth** 3 keels with board wing, 4-5 mm long and 1.5-2.5 mm wide. (**Figure 4.22**)

**Thailand** — New record to Thailand.

**Distribution** — on the Huon Peninsular, in Western Melanesia, Taiwan, Malaysia, Indonesia, Borneo, Philippines.

**Ecology** — on living bark of tree and tree fern.

**Specimens examined** — P. Sukkharak 190, 207, 466 (BCU).

**GPS location** — 8.87695849° N 99.68960345° E

**Altitude** — 1,282-1,356 m

#### 2. *Lophocolea muricata* (Lehm.) Nees

In Gott. et al., Syn. Hep. 169. 1845. Piippo S. Acta Bot. Fennica. 131: 161-162, fig. 18. 1985.; Scott, G. A. M., Southern Australian liverworts: 144, fig. 91 1985. — *Jungermannia muricata* Lehm., Linnaea 4: 363. 1829.

**Plants** yellowish pale-green to pale at tip, 0.5-0.8 mm wide. **Stems** creeping, unbranch, in cross-section of stem 8-9 cells in diameter. **Rhizoids** in bundle, numerous. **Lateral leaves** imbricate, convex with decurved spex, subopposite, ovate with papillae on dorsal surface, 0.7-0.8 mm long and 0.3-0.4 mm wide, apex bifid, margin dentate, median cells quadrate 13-15  $\mu\text{m}$  long and 7-10  $\mu\text{m}$  wide, basal cells rectangular 26-32  $\mu\text{m}$  long and 13-14  $\mu\text{m}$  wide, trigones absent. **Underleaves** distant, apex deeply 2 long lobes. **Bracts** similar to leaves but larger. **Bracteoles** ovate, bifid 1/3, sinus acute, margin dentate. **Perianths** tubular, 3 keels with papillae 1.2-1.3 mm long, 0.5-0.7 mm wide. (**Figure 4.23**)

**Thailand** — PENINSULAR: Nakhon Si Thammarat.

**Distribution** — widely distributed in the tropics and extending southward to South Africa, New Zealand (endemic) and Chile; in the adjacent regions known from Java, Borneo; Papua New Guinea (endemic), on the Huon Peninsular, In Western Melanesia.

**Ecology** — on tree fern, rock.

**Specimens examined** — P. Sukkharak 45, 49, 344 (BCU).

**GPS location** — Exact locality not applicable. Near TT14.

**Altitude** — ca. 970-979 m

#### 4. *Saccogynidium*

*Saccogynidium* Grolle, Journal of the Hattori Botanical Laboratory 23: 43. 1961.; Piippo S. Acta Bot. Fennica. 131: 131. 1985.; Grolle, R. 1960. Über *Saccogyna* Dum. und *Saccogynidium*, eine neue Lebernoosgattung. J. Hattori Bot. Lab. 23: 41-67. 1961.; Gradstein, S. R., Churchill, S. P. & Allen, N. S., Guide to the bryophytes of tropical America: 99-100. 2001.

**Plants** green to brown, creeping, irregularly branched. **Stems** with densely papillose cuticle. **Lateral leaves** may or may not convex, opposite, the bases free, ligulate-oblong, dorsally connate, deeply 2-lobed, apex rounded-truncate, margins entire, cells thin-walled, with rather small trigones, cuticle papillose. **Underleaves** free from the leaves, deeply 2-lobed, margin entire, **Gametoecia** on very short ventral branches. **Perianth** lacking, sporophyte developing in a marsupium.

##### *Saccogynidium muricellum* (De Not.) Grolle

J. Hatt. Bot. Lab. 36: 80. 1972.; Piippo, S., Acta Bot. Fennica. 131: 131-132, fig. 1. 1985. — *Chiloscyphus muricellus* De Not., Mem. Real. Accad. Sci. Torino, Ser. 2, 28: 24. 1874.; Nuovo Giornale Botanico Italiano 8: 234. 1876. — *Saccogyna muricella* (De Not.) Schiffn. in Besch., J. Bot. [Paris] 12: 143. 1898. — *Saccogynidium rigidulum* sensu Grolle, J. Hatt. Bot. Lab. 23: 52. 1961, *non* (Nees) Grolle.

**Plants** yellowish pale-green, 2.8-3 mm wide. **Stems** creeping, usually unbranch, in cross section of stem 9-10 cells across, 25-26 cortical cells in circle with 37-40 medullary cells, all cells thin-walled, cortical cell wall slightly thicker than medullary cell wall. **Rhizoids** in bundle on underleaf base. **Lateral leaves** imbricate, opposite, ligulate to rectangular, 1-1.2 mm long and 0.8-1 mm wide, apex slightly acute to unequally 2 teeth, margin entire, median cells and lower margin 21-31  $\mu\text{m}$  long and 21-34  $\mu\text{m}$  wide, upper margin 42-68  $\mu\text{m}$  long and 15-26  $\mu\text{m}$  wide, basal cells 57-68  $\mu\text{m}$  long and 21-31  $\mu\text{m}$  wide, trigones absent, all cells with papillose. **Underleaves** distant, apex deeply 2 long lobes, 0.4-0.5 mm long and 0.3-0.4 mm wide. **Sporophytes** not found. (Figure 4.24 and 4.108)

**Thailand** — NORTH-EASTERN: Loei; PENINSULAR: Nakhon Si Thammarat.

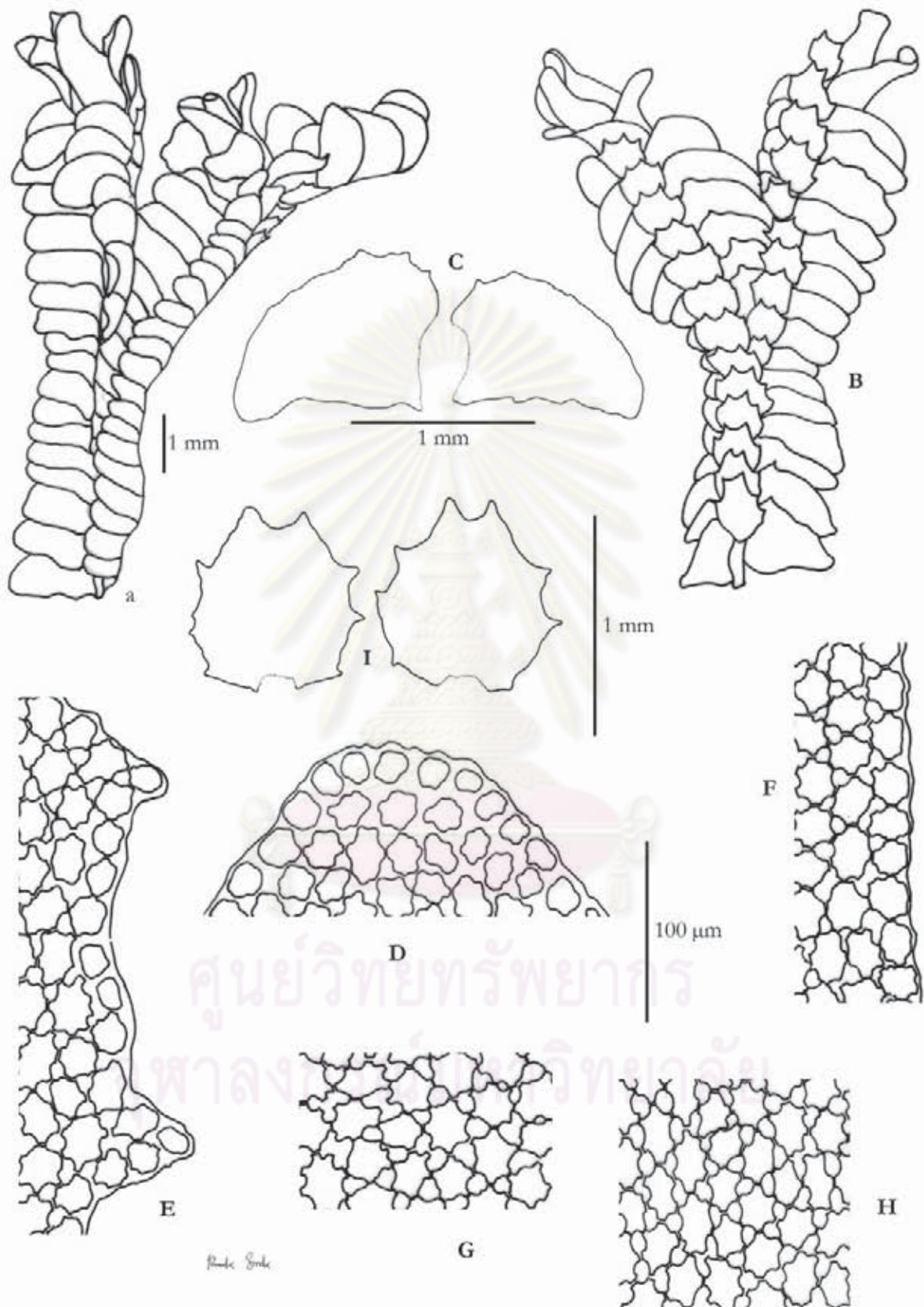
**Distribution** — widely distributed in south-eastern Asia and Pacific islands; on the Huon Peninsula, in Western Melanesia: West Irian, Papua New Guinea, Solomon Islands, Taiwan, Indonesia, Malaysia, Philippines, Borneo.

**Ecology** — on soil near base of tree trunk.

**Specimens examined** — P. Sukkharak 447 (BCU).

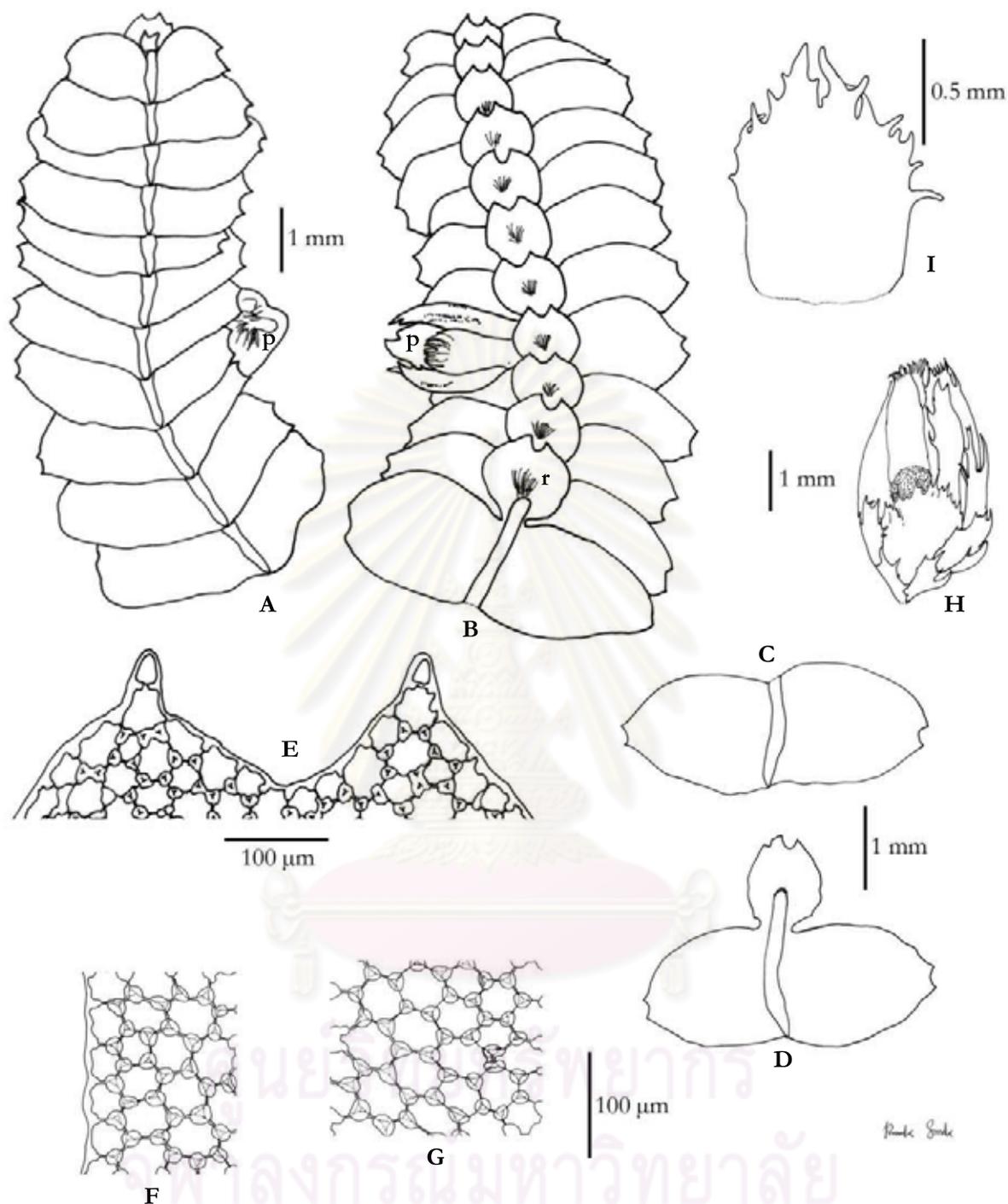
**GPS location** — 8.8770926° N 99.68966782° E

**Altitude** — 1,330 m



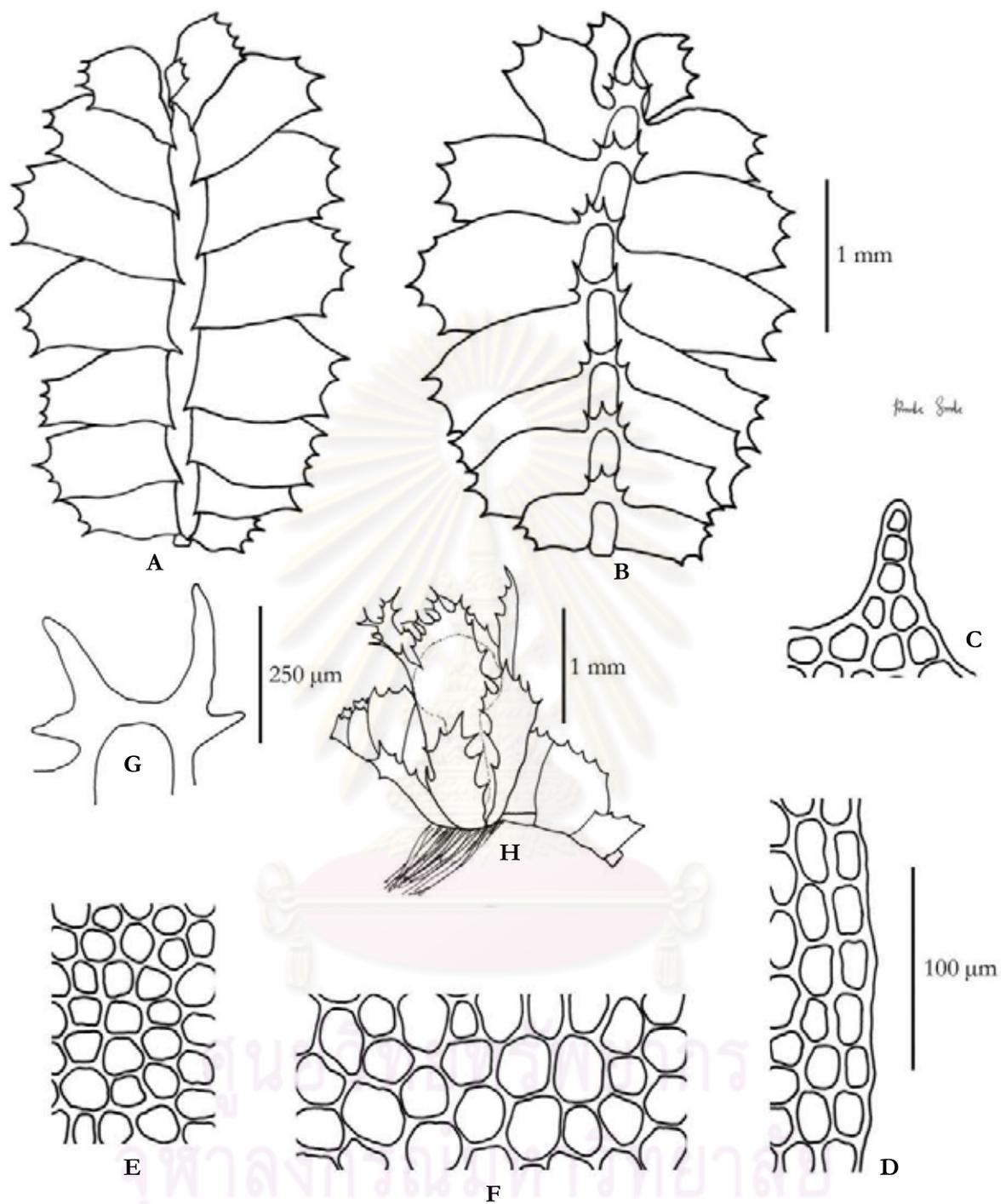
**Figure 4.17** *Conoscyphus trapezioides* (Sande Lac.) Schiffn.

A.-B. portion of plant: A. dorsal view, B. ventral view; C. lateral leaves; D. cells at leaf apex; E. cells at leaf upper margin; F. cells at leaf lower margin; G. cells at leaf median; H. cells at leaf base; I. underleaves. P. Sukkharak 544a.



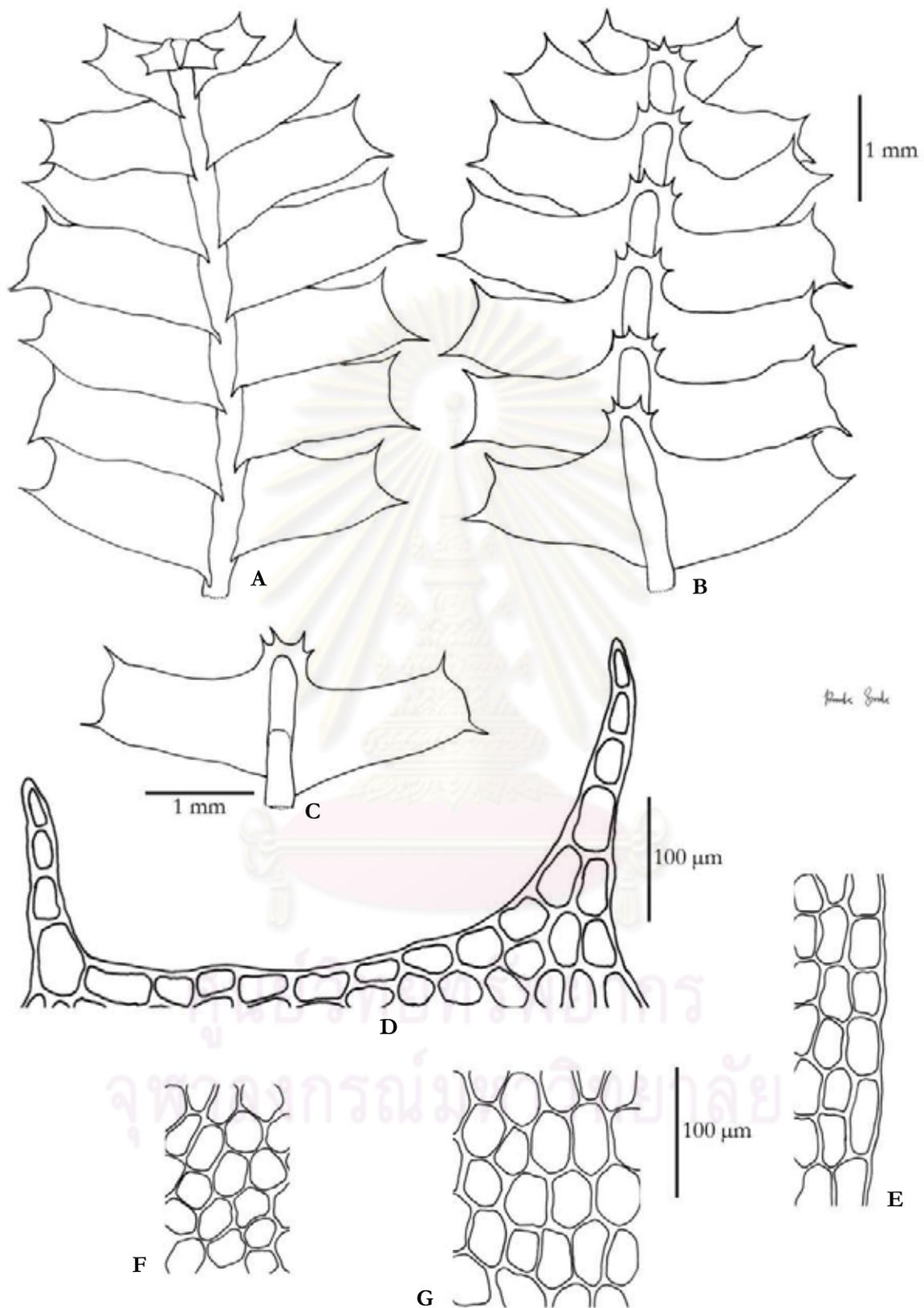
**Figure 4.18** *Heteroscyphus acutangulus* (Schiffn.) Schiffn.

A.-B. portion of plant with perianth (p): A. dorsal view, B. ventral view with rhizoids (r); C. lateral leaves; D. lateral leaves and underleaf; E. cells at leaf apex; F. cells at leaf margin; G. cells at leaf median; H. perianth; I. bracteole. P. Sukkharak 533.



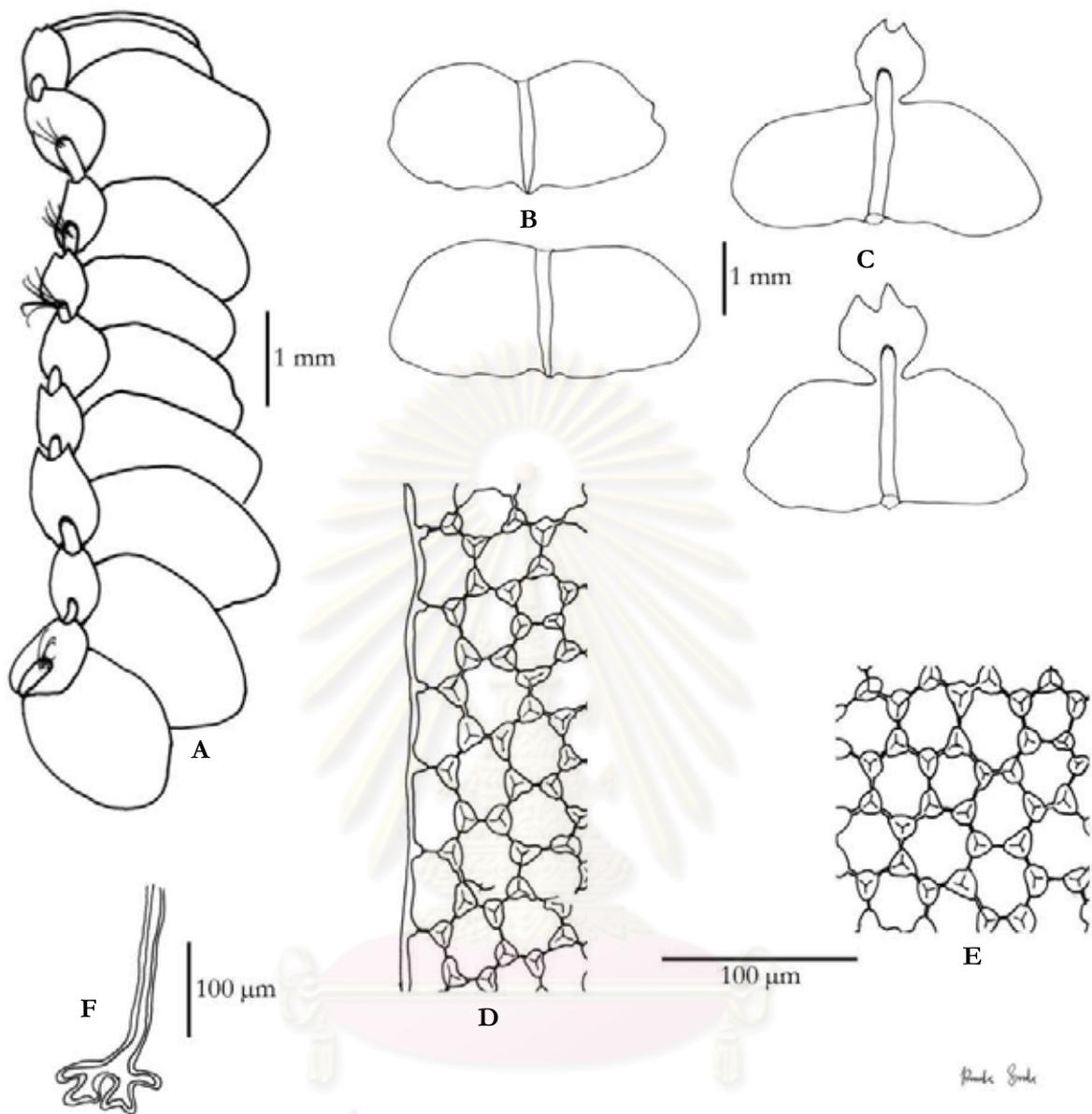
**Figure 4.19** *Heteroscyphus argutus* (Reinw. et al.) Schiffn.

A.-B. portion of plant: A. dorsal view, B. ventral view; C. cells at leaf apex; D. cells at leaf margin; E. cells at leaf median; F. cells at leaf base; G. underleaf; H. perianth. P. Sukkharak 150.



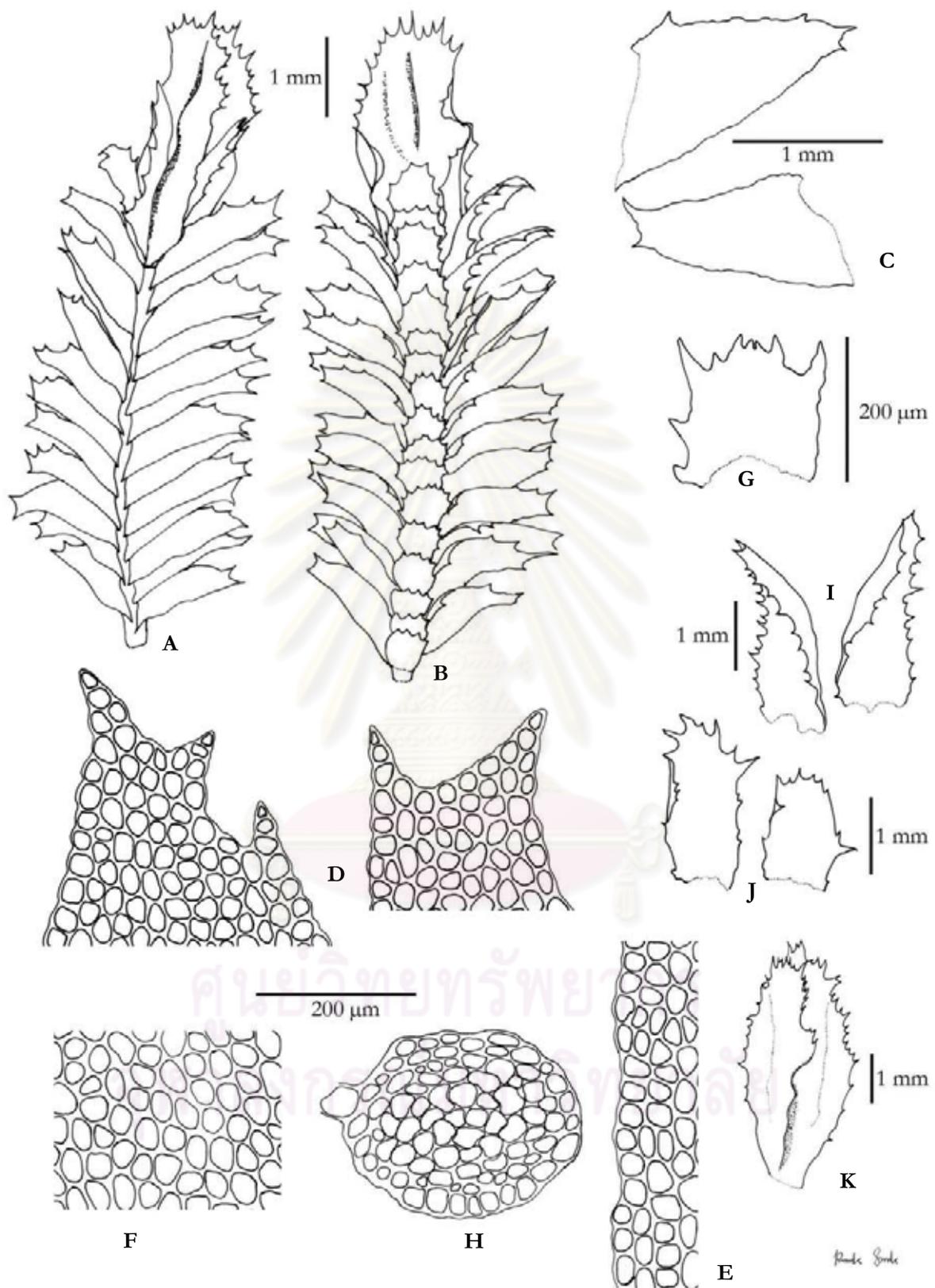
**Figure 4.20** *Heteroscyphus coalitus* (Hooks.) Schiffn.

A.-B. portion of plant: A. dorsal, B. ventral; C. lateral leaves and underleaf; D. cells at leaf apex E. cells at leaf margin; F. cells at leaf median; G. cells at leaf base. P. Sukkharak 75.



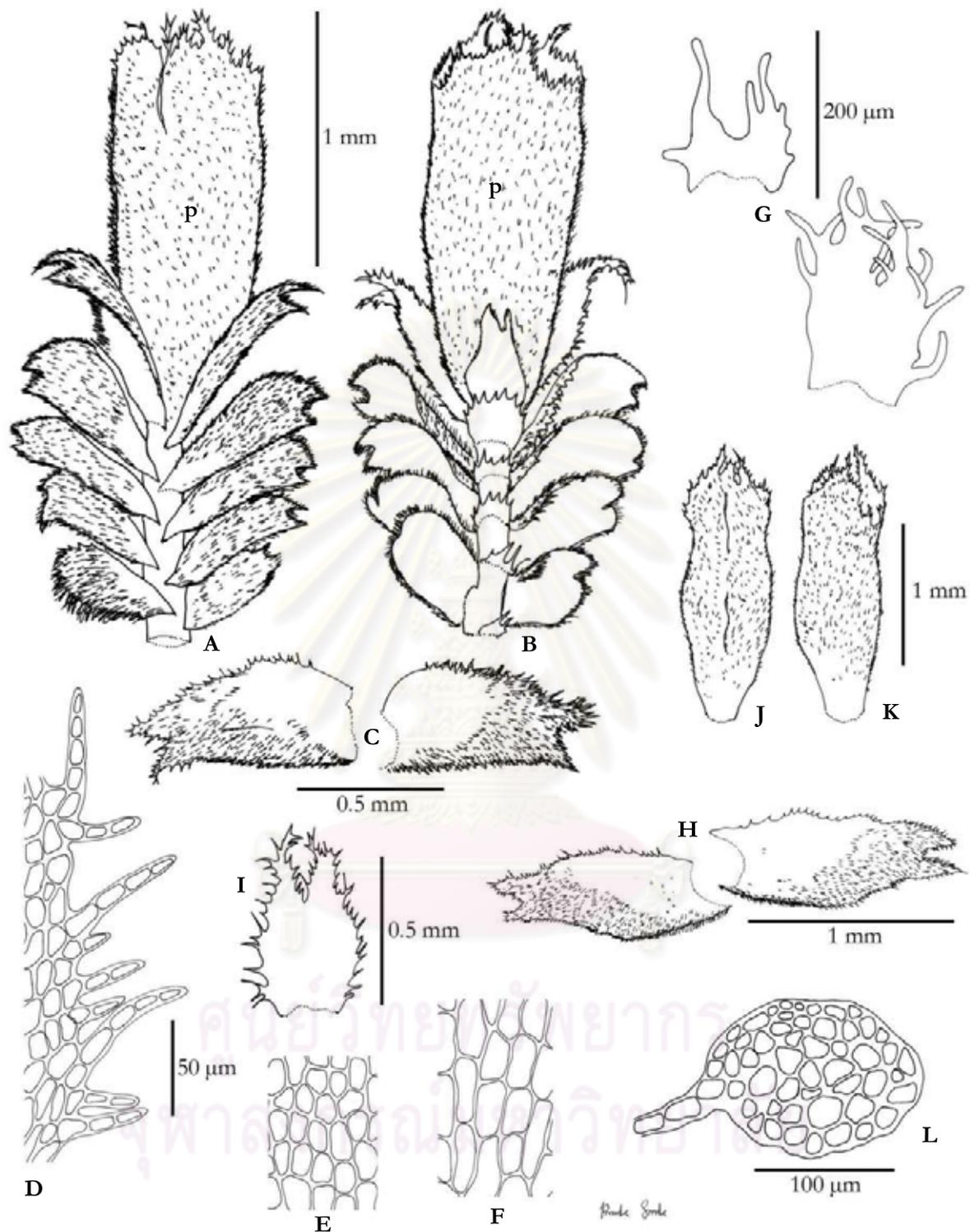
**Figure 4.21** *Heteroscyphus sarawaketanus* Piippo

A. ventral portion of plant; B. lateral leaves; C. lateral leaves and underleaf; D. cells at leaf margin; E. cells at leaf median; F. part of rhizoid. P. Sukkharak 200, 451.



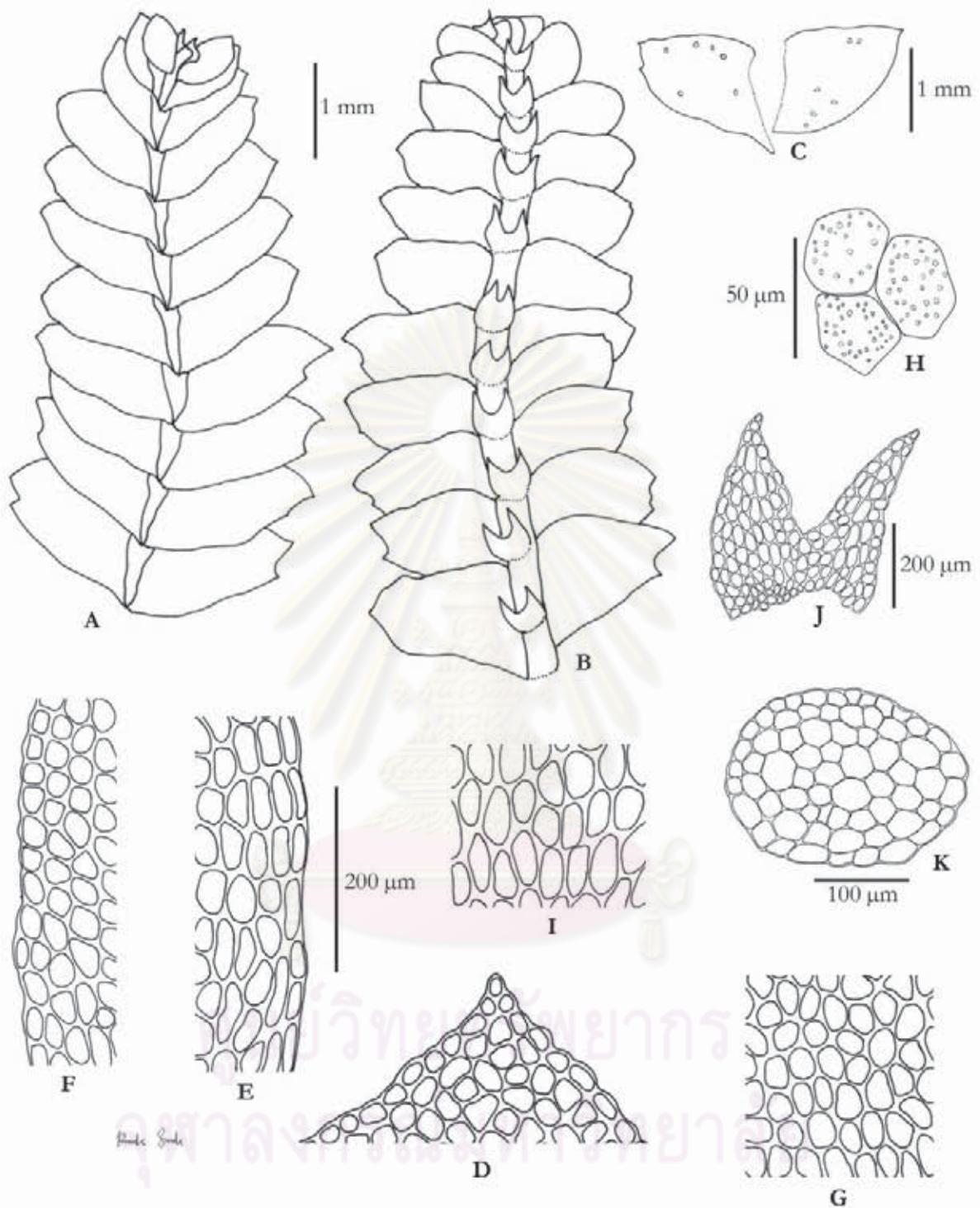
**Figure 4.22** *Lophocolea costata* (Nees) Gottsche

A.-B. portion of plant with perianth (p): A. dorsal view, B. ventral view; C. lateral leaves; D. cells at leaf apex; E. cells at leaf margin; F. cells at leaf median; G. underleaf; H. cross section of stem; I. bracts; J. bracteoles; K. perianth. P. Sukkharak 207.



**Figure 4. 23** *Lophocolea muricata* (Lehm.) Nees

A.-B. portion of plant with perianth (p): A. dorsal view, B. ventral view; C. lateral leaves; D. cells at leaf margin; E. cells at leaf median; F. cells at leaf base; G. underleaves; H. bracts; I. bracteole; J.-K. perianth: J. dorsal view, K. ventral view; L. cross section of stem. P. Sukkharak 45.



**Figure 4.24** *Saccogynidium muricellum* (De Not.) Grolle

A.-B. portion of plant: A. dorsal view, B. ventral view; C. lateral leaves; D. cells at leaf apex; E. cells at leaf upper margin; F. cells at leaf lower margin; G. cells at leaf median; H. cells at leaf median with papillae; I. cells at leaf base; J. underleaf; K. cross section of stem. P. Sukkharak 447.

## Jungermanniaceae

**Plants** leafy, green to brown to red or purple, creeping or erect, rarely pendent, simple or irregular branched. **Rhizoids** scattered, sometimes reddish. **Lateral leaves** succubous, alternate, rarely opposite, undivided or bilobed, leaf margins entire, rarely toothed, insertion line usually reaching dorsal stem-midline, cells usually with trigones; oil bodies granular or homogenous. **Underleaves** lacking or very small. **Gametoecia** on leading shoots. **Perianths** inflated, plicate or smooth. **Capsules wall** 2-5-layered. **Vegetative reproduction** lacking or by gemmae, the gemmae usually angular-stellate.

### Key to genera

1. Lateral leaves undivided.
  2. Rhizoids absent, cuticle slightly papillose ..... *Jamesoniella*
  2. Rhizoid usually present, cuticle smooth ..... *Jungermannia*
1. Lateral leaves bilobes..... *Anastrophyllum*

### 1. *Anastrophyllum*

*Anastrophyllum* (Spruce) Steph., Hedwigia 32: 139. 1893.; Váňa, J. Proceedings of the Third Meeting of the Bryologists from Central and East Europe, Praha (ed. J. Váňa), p. 99-106. 1984.; Gradstein, S. R., Churchill, S. P. & Allen, N. S., Guide to the bryophytes of tropical America: 110-111. 2001.

**Plants** small to medium-sized, dark reddish-brown or purple, sometimes brownish green, creeping or ascending, little branched. **Stems** fragile to rigid. **Lateral leaves** ± symmetrically 2-lobed, the dorsal segment transversely inserted and the ventral segment oblique, strongly concave to canaliculate with the tips often somewhat incurved, apices acute to acuminate, rarely obtuse, margin entire, cells usually with large trigones, cuticle smooth or papillose. **Underleaves** lacking. **Rhizoids** scarce. **Dioicous**. **Perianths** plicate, usually with a white mouth. **Gemmae** present or absent, when present yellow-brown to wine-red to purplish, angular, produced on the apices of upper leaves, sometimes on upright flagelliform shoots.

*Anastrophyllum piligerum* (Nees) Steph.

J. Bot London 14: 235. 1876.; Kitagawa, N., J. Hattori Bot. Lab. 33: 212-213, fig. 4. 1970.; Hedwigia 32: 140. 1893. — *Jungermannia piligera* Nees, Nova Acta Acad. Leop.-Carol 12(1): 414. 1825.

**Plants** brownish-green, 1.5-2 cm long and 2-3 mm wide. **Stems** suberect to erect, branching from ventral side of stem; in cross section, cortical cells with thick walled smaller than medulla cells. **Rhizoids** scattered, colorless. **Lateral leaves** obliquely inserted, concave dorsally second, 0.8-2 mm long and 0.8-2 mm bilobes for 1/2 the length; lobe ovate, sinus acute, margin entire, leaf cells longitudinally seriate, apical cells 6-7 µm long and 5-6 µm wide, median cells 9-10 µm long and 4-5 µm wide, basal cells 21-22 µm long and 5-6 µm wide, trigones large and nodulose, cuticle verrucose. **Underleaves** lacking. **Dioecious**. **Gynoecia** terminal of stem with 1 subflora innovation. **Perianths** cylindrical 4-5 mm long and 0.8-1 mm wide deeply pluriplicate near ciliate-spinose mouth. **Bracts** similar to leaves but larger. **Bracteoles** lacking. (Figure 4.25 and 4.109)

**Thailand** — SOUTH-WESTERN: Prachuap Khiri Khan; PENINSULAR: Nakhon Si Thammarat.

**Distribution** — widely distributed in tropical and subtropical regions of Asia, Oceania, Central and South America.

**Ecology** — on rotten log.

**Specimens examined** — P. Sukkharak 458, 459 (BCU); M. Tagawa & N. Kitagawa 4920 (BKF).

**GPS location** — 8.87695849° N 99.68960345° E

**Altitude** — 1,326 m

## 2. *Jamesoniella*

*Jamesoniella* (Spruce) Carrington, The London Catalogue of British Mosses, ed. 2 25. 1881.; Grolle, R., Feddes Repertorium 82: 1-99. 1971.; Gradstein, S. R., Churchill, S. P. & Allen, N. S., Guide to the bryophytes of tropical America: 113. 2001.

**Plants** medium-sized to large, yellowish-green to orange-brown to reddish brown or olive-brown, creeping to erect with decurved shoot apex, little branched, stolons lacing. **Stems** rigid. **Lateral leaves** transverse to succubous, laterally appressed to the stem or spreading, weakly concave, undivided, ovate-orbicular, leaf apex broadly rounded, margin entire and usually somewhat incurved, bases decurrent, cells elongate at base, trigones usually large, cuticle papillose. **Underleaves** very small, subulate. **Perianths** plicate or smooth, when plicate the folds straight, not twisted. **Gemmae** lacking.

### Key to species

1. Lateral leaves apex cuspidate, median cells without trigones ..... *J. contracta*  
 1. Lateral leaves apex round, cells with trigones ..... *J. flexicaulis*

#### 1. *Jamesoniella contracta* (Reinw. et al.) N. Kitag.

Bulletin of Nara University of Education. Series B, Natural Sciences 30: 45. 1981.; ec. Hepat. 2: 124: 1901. as *Cuspidatula contracta* (Reinw., Bl. et Nees) Steph. Kitagawa, N., J. Hattori Bot. Lab. 33: 220. 1970. — *Jungermannia contracta* Reinw., Bl. et Nees, Nova Acta Acad. Leop.-Carol. 12(1): 223. 1825.

**Plants** brownish green, 2.5-4 mm wide. **Stems** creeping, unbranch. **Rhizoids** not found. **Lateral leaves** imbricate, concave (clasping at dorsal side of stem), opposite, orbicular to ligulate, 1.8-2 mm long and 0.8-1 mm wide, apex cuspidate, margin entire, margin cells 18-21 µm long and 10-15 µm wide, median cells 18-28 µm long and 21-26 µm wide, trigones small, basal cells 44-55 µm long and 15-23 µm wide, trigones large, confluent, cuticle slightly papillose. **Underleaves** not found. **Perianths** 2-2.5 mm long, 1-1.3 mm wide. (**Figure 4.26**)

**Thailand** — PENINSULAR: Nakhon Si Thammarat.

**Distribution** — Sumatra, Java, Amboina, Borneo, New Guinea, Samoa, Tahiti.

**Ecology** — on living branch and bark of tree, on rock.

**Specimens examined** — P. Sukkharak 201, 502, 505 (BCU); M. Tagawa & N. Kitagawa T5191, T5230, T5244 (BKF).

**GPS location** — 8.88334751° N 99.69933987° E, 8.88082623° N 99.69511271° E

**Altitude** — 1,275-1,371 m

#### 2. *Jamesoniella flexicaulis* (Nees) Schiffn.

Denkschriften der Kaiserlichen Akademie der Wissenschaften. Mathematisch-naturwissenschaftliche Klasse 67: 196. 1898.; — *Jungermannia flexicaulis* Nees, *Linnaea* 6: 604. 1831. dgson, E. A., Valley K., Wairoa & Bay, H., Transactions of the Royal Society of New Zealand. 76. Part 1. 80-81. 1946. as *Jamesoniella kirkii* St. — *Jungermannia flexicaulis* Nees, in Handb. N. Z. Fl., ii, 502, 1867. — *Jamesoniella scolopendrina* Berggr., in Hep. Nov. Zel., i, 16. — *J. kirkii* Spec. Hep., ii, 94.

**Plants** brownish yellow, 3.5-4 mm wide. **Stems** flexuous, creeping, unbranch, with flagella. **Rhizoids** not found. **Lateral leaves** imbricate, obliquely spreading, ligulate, concave

(clasping at dorsal side of stem), leaf apices round, incurved at the dorsal base, 2-2.2 mm long and 0.4-0.5 mm wide, margin entire, marginal cells 21-23  $\mu\text{m}$  long and 15-18  $\mu\text{m}$  wide, median cells 31-34  $\mu\text{m}$  long and 23-26  $\mu\text{m}$  wide, basal cells 55-56  $\mu\text{m}$  long and 26-31  $\mu\text{m}$  wide, trigones large, confluent, cuticle slightly papillose. **Underleaves** scarcely, with 2 large segment. **Sporophytes** not found. (Figure 4.27)

**Thailand** — NORTH-EASTERN: Loei; PENINSULAR: Nakhon Si Thammarat.

**Distribution** — widely distributed in tropical Asia, extending to New Caledonia, Tahiti, Caroline Islands, New Zealand.

**Ecology** — on soil base of tree trunk.

**Specimens examined** — P. Sukkharak 197 (BCU).

**GPS location** — Exact locality not applicable. Near KNY02.

**Altitude** — ca. 1,275 m

### 3. *Jungermannia*

*Jungermannia* L., Species Plantarum 1131. 1753.; Váña, J. 1974. Folia Geobotanica et Phytotaxonomica 9: 179-208. 1974.; Gradstein, S. R., Churchill, S. P. & Allen, N. S., Guide to the bryophytes of tropical America: 113-114. 2001.

**Plants** small to medium-sized, pale green to reddish or brown, creeping or ascending little branched. **Stems** fragile. **Rhizoids** numerous, often reddish or brown. **Lateral leaves** usually somewhat spreading, concave and clasping the stem in the lower half, undivided, ovate-orbicular, rarely lingulate, leaf apex broadly rounded, margin entire, not incurved, bases not or short-decurrent, cells with usually rather small trigones, cuticle smooth or papillose. **Underleaves** lacking. **Perianths** plicate, long-exserted or short and hidden between the bracts, perianth base sometimes united with the bracts and forming a short perigynium, perianth mouth sometimes narrowed into a short beak.

#### Key to species

1. Basal cells with trigones, apical cells smaller than other cells.....*J. comata*
1. All cells without trigones .....*J. polyrhizoides*

#### 1. *Jungermannia comata* Nees

Hepat. Jav. 78. 1830.; Amakawa, T., J. Hattori Bot. Lab. 22: 38-40, fig. 26, 1960. — *Plagiobhila comata* (Nees) Dum. Rec. d'Obs. 15. 1835. — *Jungermannia comata* Nees, Enumeratio Plantarum Cryptogamicarum Javae 78. 1830. — *J. junghubniana* Nees in G. L. N. Synop. Hepat. 87. 1844. — *J. rubida* Mitt. Proc. Linn. Soc. Bot. 5: 90. 1860. — *Plectocolea junghubniana* (Nees) Mitt. in Seeman, Fl. Viti. 405. 1871. — *Nardia granulata* Steph. Bull. Herb. Boiss. 5: 100. 1897. — *Nardia comata* (Nees) Schiffn. Denkschr. Mathem.-Naturw. Cl. Kais. Akad. Wiss. Wien 57: 36. 1898. — *Jungermannia vaginans* Steph. Spec. Hepat. 6: 95. 1917. — *Plectocolea comata* (Nees) Hatt. Bull. Tokyo Sci. Mus. 11: 38. 1944. — *Solenostoma comatum* (Nees) C. Gao, Flora Hepaticarum Chinae Boreali-Orientalis 73. 1981.

**Plants** dark green, 2.7-3 mm wide. **Stems** creeping, unbranch. **Rhizoids** numerous, long, reddish. **Lateral leaves** loosely imbricate, obliquely spreading, ligulate, incurved at the dorsal base, 1.1-1.2 mm long and 1.1-1.2 mm wide at base, 0.4-0.5 mm wide at apex, margin entire, marginal cells 21-26  $\mu\text{m}$  long and 18-21  $\mu\text{m}$  wide, apical cells 10-13  $\mu\text{m}$  long and 10-13  $\mu\text{m}$  wide, median cells 26-31  $\mu\text{m}$  long and 21-26  $\mu\text{m}$  wide, trigones absent and basal cells 31-44  $\mu\text{m}$  long and 26-34  $\mu\text{m}$  wide, trigones large. **Sporophytes** not found. (Figure 4.28)

**Thailand** — NORTHERN: Chiang Mai.

**Distribution** — Japan, China, India, Sumatra, Java, Philippines, New Guinea.

**Ecology** — on rock.

**Specimens examined** — P. Sukkharak 483 (BCU).

**GPS location** — Exact locality not applicable. Near TT07.

**Altitude** — ca. 650 m

## 2. *Jungermannia polyrbizoides* Grolle

In Amakawa, T., J. Hattori Bot. Lab. 29: 262-263, fig. 7. 1966.

**Plants** brownish yellow, 1-2.3 mm wide. **Stems** creeping, unbranch. **Rhizoids** numerous, long, reddish. **Lateral leaves** loosely imbricate, obliquely spreading, ligulate, incurved at the dorsal base, 1-1.1 mm long and 0.8-0.9 mm wide, margin entire, marginal cells 18-23  $\mu\text{m}$  long and 13-15  $\mu\text{m}$  wide, median cells 26-31  $\mu\text{m}$  long and 21-26  $\mu\text{m}$  wide and basal cells 42-55  $\mu\text{m}$  long and 21-26  $\mu\text{m}$  wide, trigones absent. **Bracts** one pair, similar to stem-leaves, recurved. **Bracteoles** lacking. **Perianths** short exert, inflate, narrowed towards the apex, 1.5-1.7 mm long and 0.5-0.7 mm wide. (**Figure 4.29 and 4.110**)

**Thailand** — New record to Thailand.

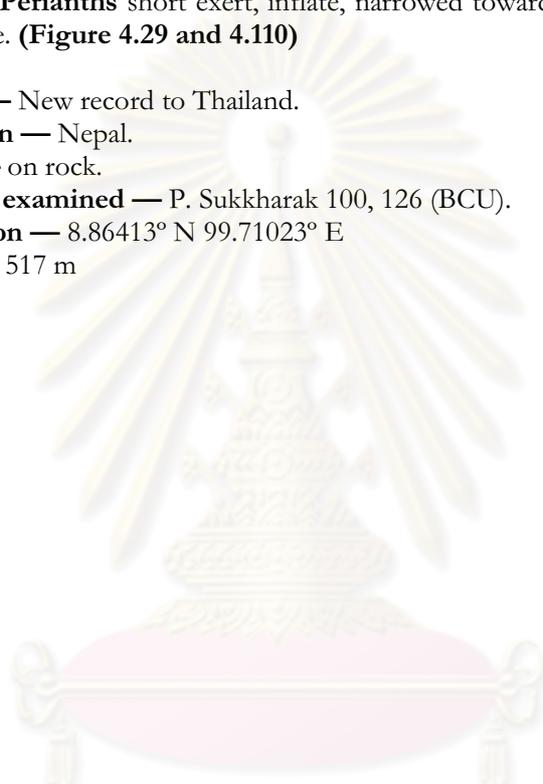
**Distribution** — Nepal.

**Ecology** — on rock.

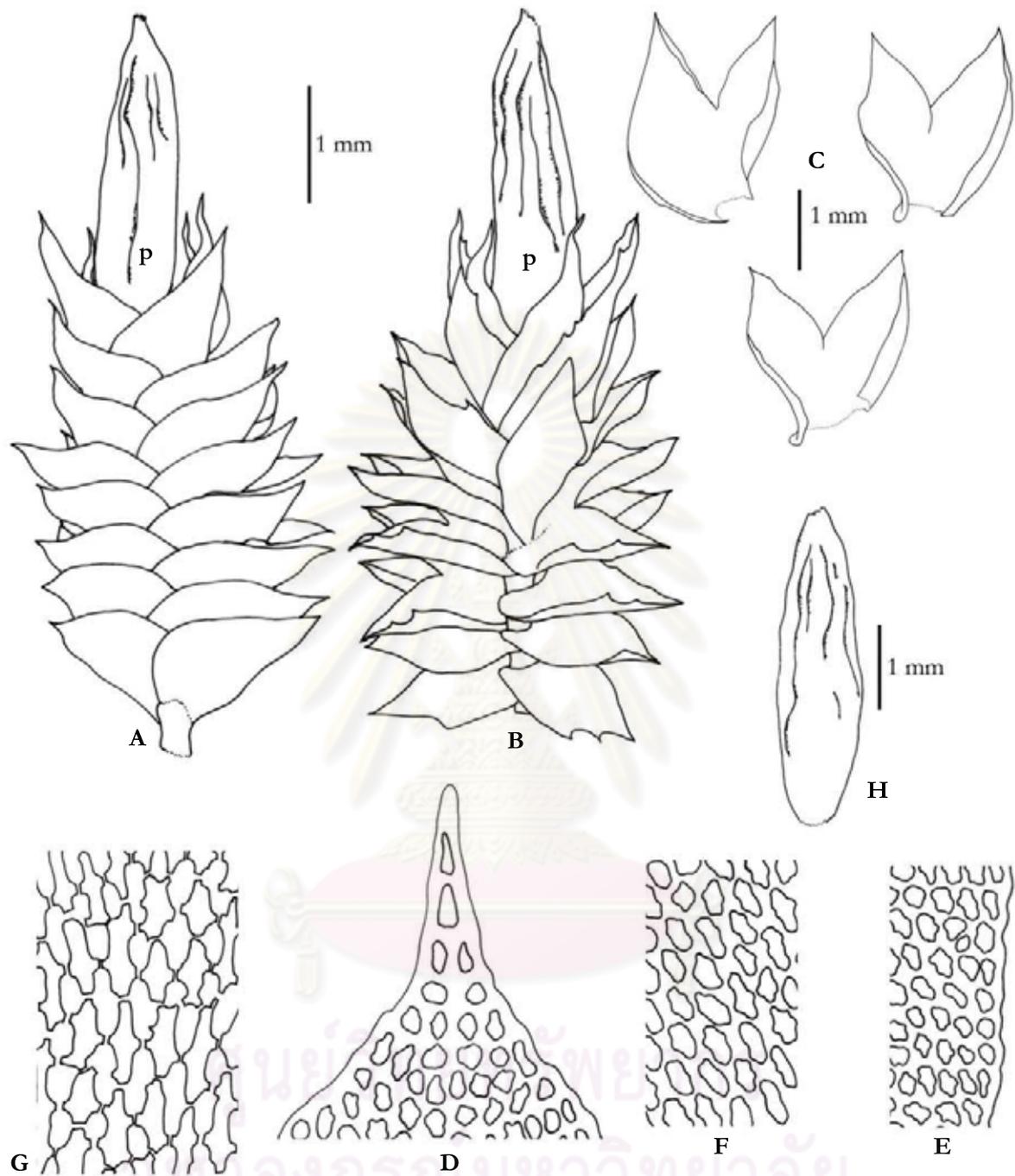
**Specimens examined** — P. Sukkharak 100, 126 (BCU).

**GPS location** — 8.86413° N 99.71023° E

**Altitude** — 517 m

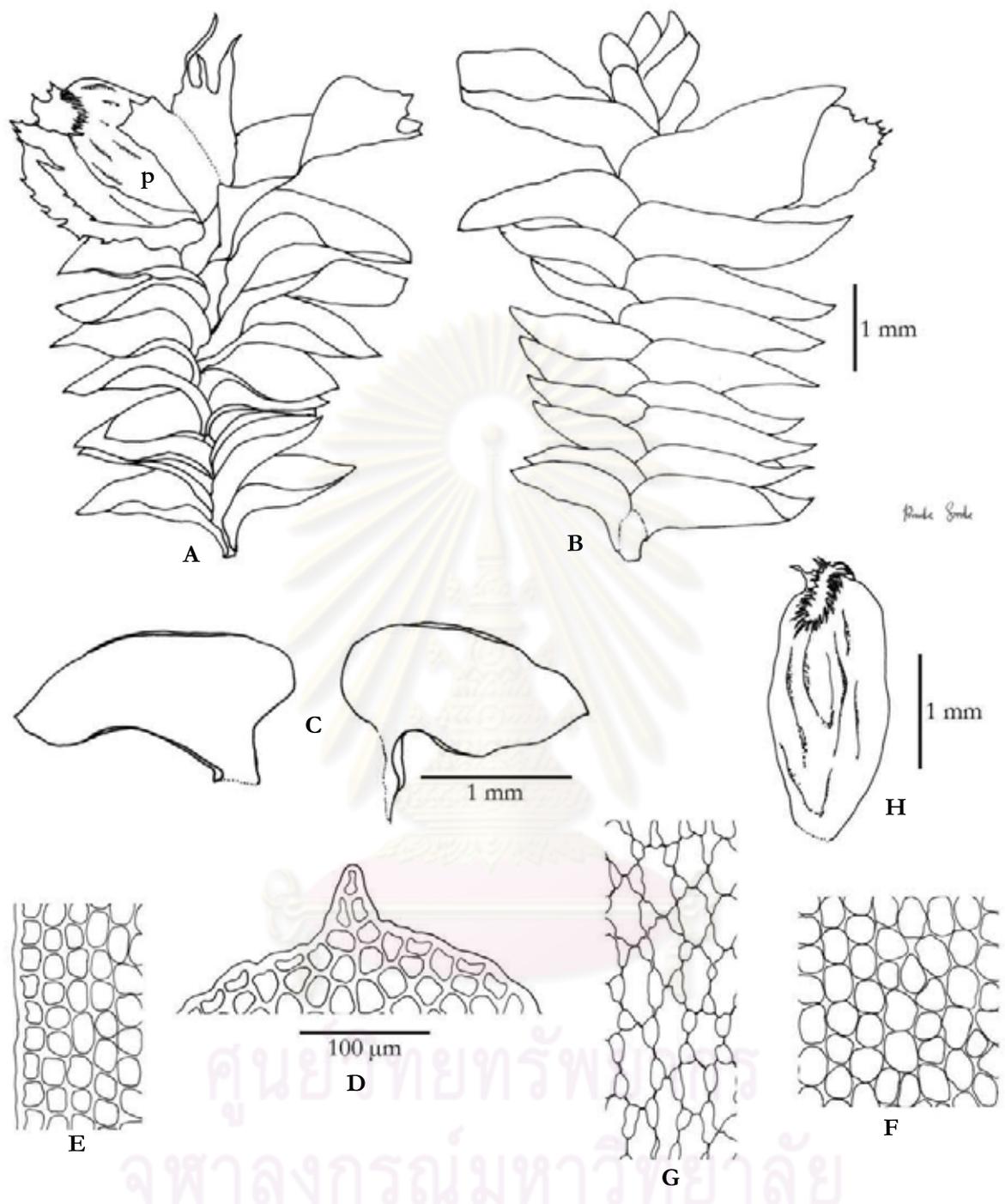


ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย



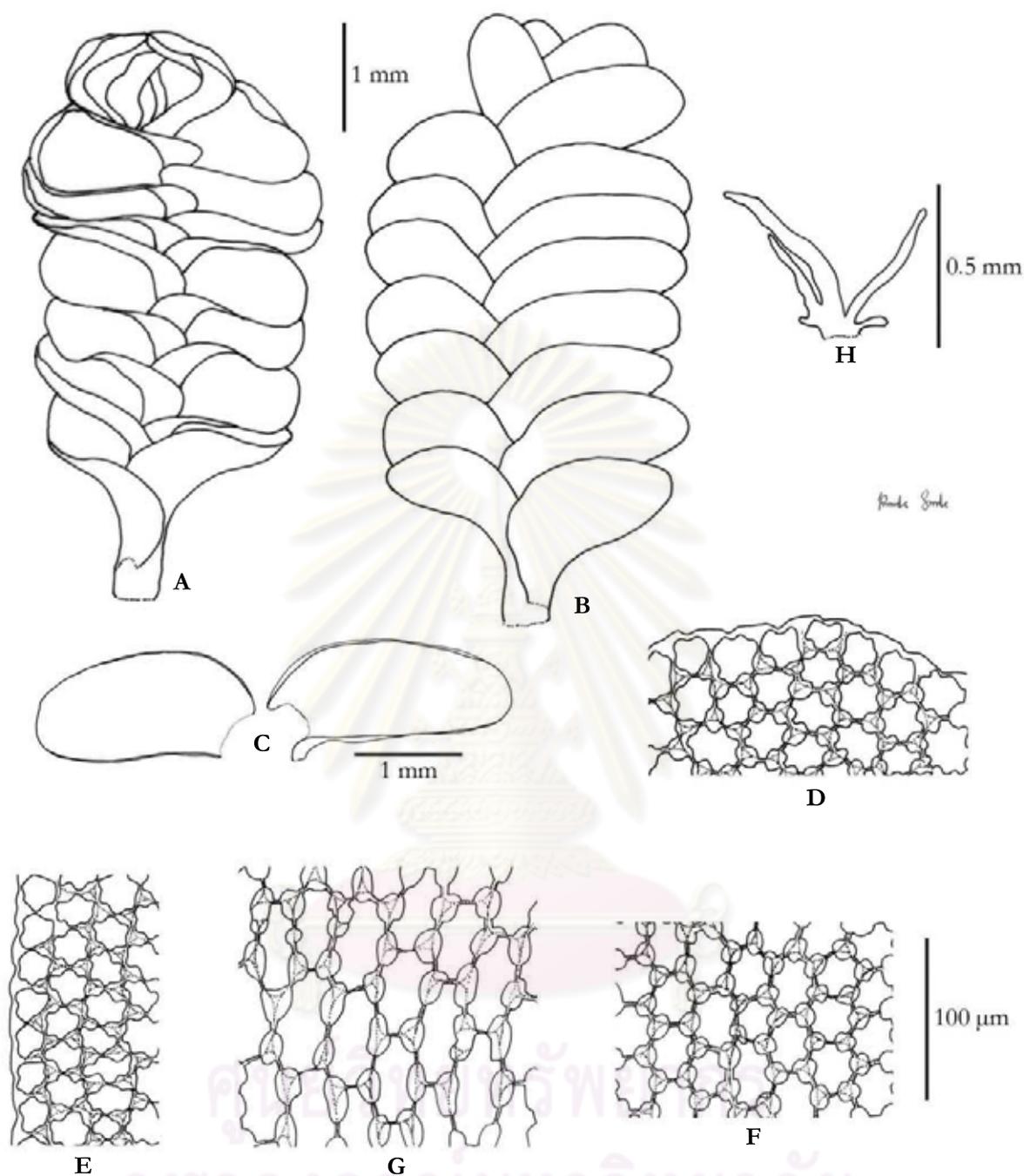
**Figure 4.25** *Anastrophyllum piligerum* (Nees) Steph.

A.-B. portion of plant with perianth (p): A. dorsal view, B. ventral view; C. lateral leaves; D. cells at leaf apex; E. cells at leaf margin; F. cells at leaf median; G. cells at leaf base; H. perianth. P. Sukkharak 458.



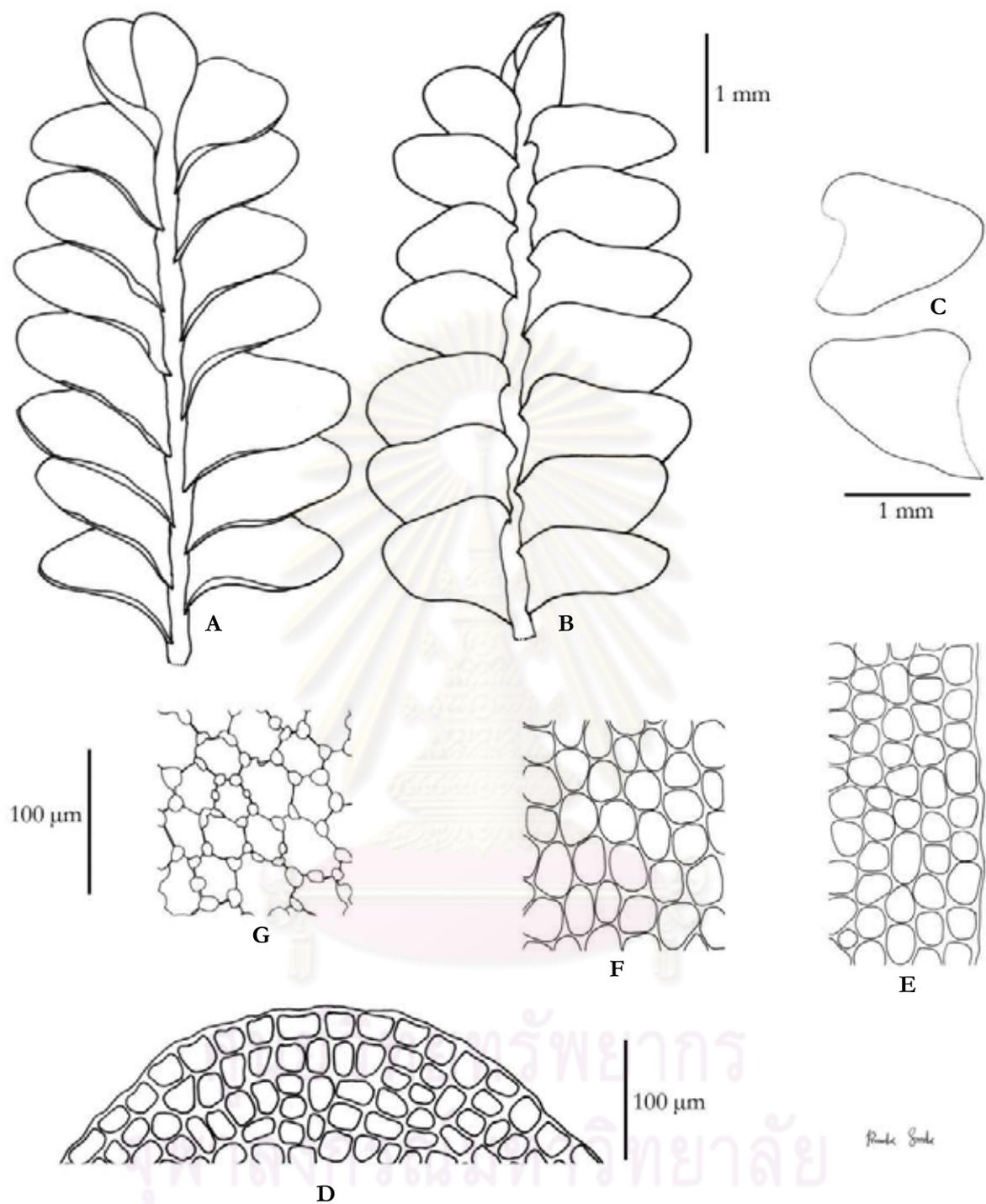
**Figure 4. 26** *Jamesoniella contracta* (Reinw. et al.) N. Kitag.

A.-B. portion of plant: A. dorsal view with perianth (p), B. ventral view; C. lateral leaves; D. cells at leaf apex; E. cells at leaf margin; F. cells at leaf median; G. cells at leaf base; H. perianth. P. Sukkharak 505.



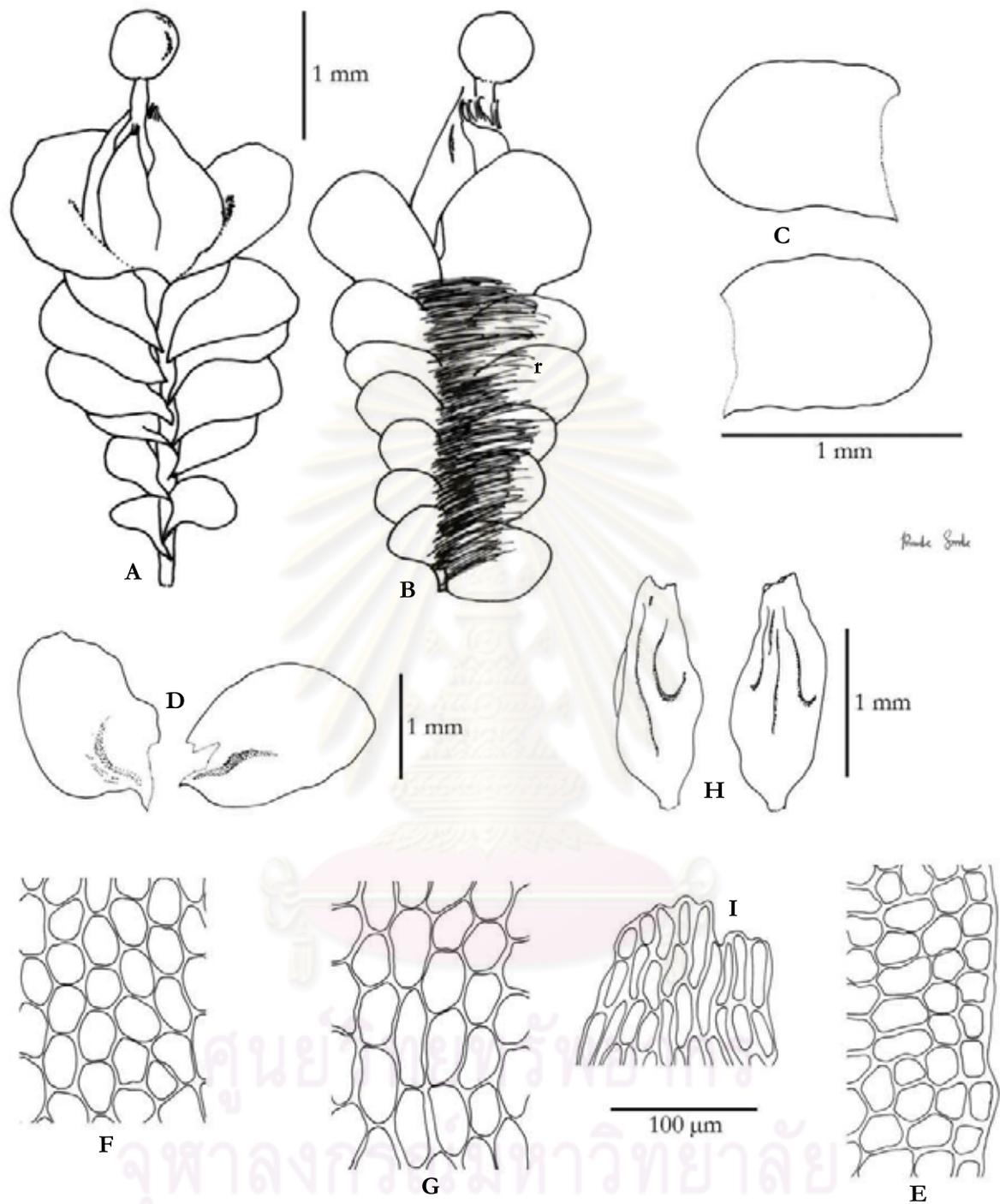
**Figure 4. 27** *Jamesoniella flexicaulis* (Nees) Schiffn.

A.-B. portion of plant: A. dorsal view, B. ventral view; C. lateral leaves; D. cells at leaf apex; E. cells at leaf margin; F. cells at leaf median; G. cells at leaf base; H. underleaf. P. Sukkharak 197.



**Figure 4.28** *Jungermannia comata* Nees

A.-B. portion of plant: A. dorsal view, B. ventral view; C. lateral leaves; D. cells at leaf apex; E. cells at leaf margin; F. cells at leaf median; G. cells at leaf base. P. Sukkharak 483.



**Figure 4.29** *Jungermannia polyrhizoides* Grolle

A.-B. portion of plant with sporophyte: A. dorsal view, B. ventral view with rhizoids (r); C. lateral leaves; D. bracts; E. cells at leaf margin; F. cells at leaf median; G. cell at leaf base; H. perianth; I. part of perianth mouth. P. Sukkharak 100, 126.

## Lejeuneaceae

**Plants** leafy, green, yellowish, brown, black or whitish, never reddish; creeping to ascending or penent, pinnate, forked or irregularly branched. **Stems** with or without hyalodermis. **Branches** usually *Lejeunea*-type, sometimes *Frullania*-type, rarely *Aphanolejeunea*-type. **Rhizoids** in tufts from underleaf bases. **Lateral leaves** incubous, divided into a large dorsal lobe and a small ventral lobule, the lobule broadly attached to the dorsal lobe along a keel; stylus reduced, cells with homogeneous or segment oil bodies; ocelli sometimes present. **Underleaves** undivided or bifid, rarely lacking. **Androecia** usually with 1-2 antheridia per bract, antheridium globose, on a long 1-seriate stalk. **Gynoeceia** with only 1 archegonium. **Sporophytes** surrounded by a perianth; mouth of the perianth usually contracted into a short beak. **Capsules** globose, wall 2-layered. **Elaters** attached to the capsule valves, arranged vertically inside capsule, spiral well-developed or reduced. **Spores** large, germination endosporic. **Vegetative reproduction** by gemmae, caducous leaves, caducous branches or fragmentation.

### Key to genera

1. Underleaves present.
  2. Underleaves undivided.
    3. Keels of perianth spinose.
      4. Perianth 3-keeled..... *Thysananthus*
      4. Perianth 4-keeled..... *Lopholejeunea*
    3. Keels of perianth smooth.
      5. Leaves flat.
        6. Keels of Perianth less than 8.
          7. Perianth 5 keeled..... *Archilejeunea*
          7. Perianth 5-8 keeled ..... *Spruceanthus*
        6. Perianth with numerous keels..... *Ptychanthus*
      5. Leaves when dry strongly wrapped around the stem ..... *Schiffneriolejeunea*
  2. Underleaves bilobes.
    8. Leaf lobules broadly attached to the dorsal leaf lobes.
      9. Stem with a ring of 7 cortical cells and 3 medullary cells.
        10. Underleaves with very slender, diverging lobes.
          11. Apex of lateral leaves obtuse to acute ..... *Leptolejeunea*
          11. Apex of lateral leaves acuminate or falcate..... *Drepanolejeunea*
        10. Underleaves ovate-orbicular with triangular lobes..... *Metalejeunea*
      9. Stem with a ring of more than 7 cortical cells and 3 medullary cells.
        12. Sinus of underleaf U-shaped.
          13. Perianth horn-like projection..... *Cerotolejeunea*
          13. Perianth with 5 smooth keels..... *Lejeunea*
        12. Sinus of underleaf V-shaped ..... *Chilolejeunea*
    8. Leaf lobules connate with leaf lobe leading into a sac..... *Colura*
1. Underleaves absent..... *Cololejeunea*

### 1. *Archilejeunea*

*Archilejeunea* (Spruce) Schiffn., In Engler & Prantl, Nat. Pfl.-fam. 1, 3: 130. 1893.; Misutani, M., J. Hattori Bot. Lab. 24: 171. 1961. — *Lejeunea* subgen. *Archi-Lejeunea* Spruce, Trans. Proc. Bot. Soc. Edinburgh, 15: 88. 1884.

**Plants** dark green to brownish or blackish. **Stems** irregularly pinnate, branching by intercalary; cells of cross section of the stem thick-walled, the cortical cells slightly larger than the medullary cells, in about 15 longitudinal rows. **Leaf lobes** ovate, the margin entire, the apex rounded; oil-bodies small, numerous, homogeneous. **Leaf lobules** more or less inflated, usually

with 1 tooth, the hyaline papilla on the inner surface of lobule at base of the tooth. **Underleaves** orbicular, the margin entire. **Bracts and Bracteoles** entire at margin, the lobule of bract large, ligulate. **Perianths** more or less flat, 4-6-keeled (0-1 dorsal, 2 lateral, 2-3 ventral), keels smooth or slightly crenate.

#### Key to species

1. Underleaves apex entire.....*A. planiuscula*  
 1. Underleaves apex dentate.....*A. polymorpha*

#### 1. *Archilejeunea planiuscula* (Mitt.) Steph.

Sp. Hepat. 4: 731. 1911.; Thiers, B. M. & Gradstein, S. R., Memoirs of the New York Botanical Garden. 52: 8-10, fig. 1. 1989. — *Lejeunea planiuscula* Mitt., J. Proc. Linn. Soc., Bot. 5: 111. 1861. — *Ptychocoleus planiuscula* (Mitt.) Verd., Ann. Bryol. Suppl. 4: 126. 1934. — *Lejeunea samoana* Mitt. in Seemann, Fl. Vit. 415. 1873. — *Archilejeunea samoana* (Mitt.) Steph., Sp. Hepat. 4: 731. 1911. — *Archilejeunea mariana* auct., non (Gott.) Schiffn.

**Plants** brownish yellow, 1.6-2 mm wide. **Stems** irregular; in cross section of stem: 9-10 cells cross, thick walled, the cortical cells slightly larger than the medullary cells. **Rhizoids** scattered on underleaves. **Leaf lobes** loosely imbricate, ovate, slightly convex, margin entire, apex obtuse to acute, 0.9-1 mm long and 0.6-0.7 mm wide, marginal cells 6-7 µm long and 5-6 µm wide, median cells 13-17 µm long and 13-18 µm wide, trigones large, basal cells 39-47 µm long and 18-21 µm wide, trigones large. **Leaf lobules** 1/2 as long as the lobe, ovate, flat, apex truncate with 1 tooth. **Underleaves** imbricate, orbicular, 0.34-0.36 mm long and 0.3-0.4 mm wide, apex and margin entire. **Bracts** the lobe of bract ovate, margin entire, apex acute, the lobule of bract 1/2 of the length of the lobe, ovate, margin entire, apex acute. **Bracteoles** obovate, margin entire and recurved, apex emarginated to slightly truncate. **Perianths** obovate, 0.8-1 mm long and 0.6-0.7 mm wide, margin entire, sharply 5 keels. **Elaters** brown, 16-18 µm wide, attached on upper surface of the capsule valves. (Figure 4.30)

**Thailand** — SOUTH-EASTERN: Trat.

**Distribution** — Indopacific region.

**Ecology** — on living bark of tree, rocks.

**Specimens examined** — P. Sukkharak14, 18, 25, 34, 113, 125 (BCU).

**GPS location** — Exact locality not applicable. Between TT05 and TT11.

**Altitude** — ca. 555-833 m

#### 2. *Archilejeunea polymorpha* (Sande Lac.) B. Thiers & Gradst.

In Thiers, B. M. & Gradstein, S. R., Memoirs of the New York Botanical Garden. 52: 10-14, fig. 2-3. 1989. — *Phragmicoma polymorpha* Sande Lac., Ned. Kruidk. Arch. 3(4): 420. "1855" (cover). [According to Wachter (1937) the actual date of publication is Dec 1854.] — *Phragmicoma polymorpha* Sande Lac. & *undulifolia* Sande Lac., Syn. hepat. jav. 58. 1856 [1857]. — *Brachiolejeunea polymorpha* (Sande Lac.) Steph., Hedwigia 28: 168. 1889. — *Phragmolejeunea polymorpha* (Sande Lac.) Schiffn., Forschungsreise Gazelle 4: 25. 1890. — *Thysanolejeunea polymorpha* (Sande Lac.) Schiffn., Nova Acta Acad. Caes. Leop.-Carol. German. Nat. Cur. 60: 228. 1893. — *Thysananthus polymorphus* (Sande Lac.) Schiffn., Consp. hep. arch. ind. 305. 1898. — *Archilejeunea wattsiana* Steph. in Steph. & Watts, J. Proc. Roy. Soc. New South Wales 48: 97. 1914.

**Plants** yellowish green to dull green, 1.5-1.7 mm wide. **Stems** irregular; in cross section of stem: 16-18 cortical cells surrounding medulla 7-9 cells wide, thick wall. **Rhizoids** not seen. **Leaf lobes** imbricate, obliquely spreading, wide ovate, margin entire to denticulate, apex round to apiculate, 0.8-0.9 mm long and 0.5-0.6 mm wide, marginal cells 5-7 µm long and 6-9 µm wide, trigones indistinct, median cells 14-22 µm long and 8-14 µm wide, trigones large, basal cells 25-40 µm long and 11-15 µm wide. **Leaf lobules** 1/5 as long as the lobe, ovate to slightly rectangular, incurved, apex with one celled tooth. **Underleaves** imbricate, orbicular, apex truncate with dentate, margin slightly entire, 0.3-0.4 mm long and 0.2-0.4 mm wide. **Bracts** the lobe of bract

ovate, margin entire, apex dentate, the lobule of bract 2/5 of the length of the lobe, ovate, apex and margin entire. **Bracteoles** oblong, margin slightly entire, apex dentate. **Perianths** obovate, 1.4-1.6 mm long and 0.7-0.8 mm wide, 5-keeled, with one small dorsal keel, two lateral keels and two ventral keel, margin smooth. (**Figure 4.31**)

**Thailand** — NORTHERN: Chiang Mai.

**Distribution** — has a rather typical Indopacific distribution, Japan.

**Ecology** — on living branch and bark of tree.

**Specimen examined** — P. Sukkharak 17, 21, 22, 23, 27, 35, 79, 111, 129, 131, 293, 338, 421, 422, 430, 481, 484a, 485, O. Thiathong 883, 950, S. Hattori & T. Kurata, IX. 1948 (BCU).

**GPS location** — 8.86956632° N 99.69712973° E, 8.87458742° N, 99.69421685° E, 8.86853099° N 99.70594347° E, 8.87091279° N 99.70502615° E, 8.87371838° N 99.70452189° E

**Altitude** — 555-1,239 m

## 2. *Ceratolejeunea*

*Ceratolejeunea* (**Spruce**) **Schiffn.**, In Engler & Prantl, Nat. Pfl.-fam. 1, 3: 130. 1893.; Fulford, M. H., Brittonia 5 (4): 368-403. 1945.; Gradstein, S. R., Churchill, S. P. & Allen, N. S., Guide to the bryophytes of tropical America: 145. 200; Grolle, R. In: W. Frey (ed.), Moosflora und –vegetation in Regenwäldern NO-Perus. Beihefte zur Nova Hedwigia 88: 91-92. 1987.; Onraedt, M., Cryptogamie, Bryologie et Lichénologie 10 : 119-129. 1989.; Schuster, R. M., The Hepaticae and Anthocerotae of North America, Vol. IV: 909-929. 1980.

**Plants** small to medium-sized, glossy greenish-brown to dark brown, creeping to ascending or pendent. **Stems** with hyalodermis. **Leaf lobes** wide-spreading, apex rounded to acute, margins entire or toothed, cells with elongated, triradiate trigones or uniformly thick-walled, the walls pale brown with darker brown middle lamellae, cuticle smooth, rarely bulging and tuberculate; oil bodies small, finely granular; ocelli present or absent, when present 1-10 at the base or in the lower half of the leaf, sometimes in a short row, rarely present in the underleaves. **Leaf lobules** 1/6-1/3(-1/2) leaf length, sometimes reduced, inflated, ovate to globose, at the base of branches sometimes much enlarged (“utricle”), apical tooth 1-celled, the cell short and obtuse or long and sharp, hyaline papilla proximal. **Underleaves** bifid with U-shaped sinus or undivided, small or large, insertion line shallowly curved to deeply arched. **Gynoecea** on long or short branches. **Perianths** normally with 4 keels which are extended above into narrow, horn-like or bulbous projections.

### *Ceratolejeunea belangeriana* (**Gottsche**) **Steph.**

Species Hepaticarum 5: 396. 1913. — *Lejeunea belangeriana* Gottsche, Synopsis Hepaticarum 398. 1845.; Mizutani, M., J. Hattori Bot. Lab. 49: 305-307, fig. 1. 1981.; Spec. Hepat. 5: 428; 1913. as *Ceratolejeunea oceanica* (Mitt.) Steph. — *Lejeunea oceanica* Mitt. in Seemann, Fl. Vitiensis: 414: 1871. — *Ceratolejeunea renistipula* Steph., Hedwigia 34: 236. 1895. — *Ceratolejeunea emarginata* Steph., Bot. Tidskrift 24: 278. 1902. — *Ceratolejeunea exocellata* Herz., J. Hattori Bot. Lab. 14: 47, f. 11. 1955. — *Ceratolejeunea ryukyensis* Amak., J. Jap. Bot. 45: 180, f. 28. 1970.

**Plants** 5-20 mm long and 0.7-1.2 mm wide; yellowish-brown. **Stems** creeping; 7 thin-walled cortical cells, medullary cells thick-walled and smaller. **Rhizoids** in bundle at underleaf base. **Leaf lobes** imbricate, orbicular 560-640 µm long and 400-440 µm wide, spines acute or obtuse, incurved, margin entire, trigones and intermediate thickening large; ocelli 1-3 in basal portion of leaf-lobe; Leaf-lobule small, inflated, ovate 1/4 as long as the lobe. **Leaf lobules** small, inflated, ovate 1/4 as long as the lobe. **Underleaves** approximate 5-6 times as wide as the stem, wide orbicular, 360-424 µm long and 264-280 µm wide, bilobed to about 1/3 the length. **Gynoecea** on stem. **Bracts** ovate 0.7-0.8 mm long and 0.5-0.7 mm wide, margin dentate, apex acute. **Bracteoles** ovate, apex dentate, margin entire. **Perianths** inflated, obovate 1-1.2 mm long and 0.4-0.6 mm wide, upper surface mammillose, horn 4, 0.3-0.4 mm long. **Sporophytes** not found. (**Figure 4.32**)

**Thailand** — SOUTH-EASTERN: Trat.

**Distribution** — Malay Peninsular, Java, Borneo, Philippines, Botel Tobago, Ryukyu, Papua New Guinea, Samoa, Tahiti.

**Ecology.** — on rocks.

**Specimens examined.** — P. Sukkharak 6, 10, 11, 114, 116 (BCU).

**GPS location** — 8.86413° N 99.71023° E

**Altitude** — 505-ca. 602 m

### 3. *Cheilolejeunea*

*Cheilolejeunea* (Spruce) Schiffn., In Engler & Prantl, Nat. Pfl.-fam. 1, 3: 124. 1893.; Misutani, M., J. Hattori Bot. Lab. 24: 189. 1961. — *Lejeunea* subgen. *Strepsi-Lejeunea* Spruce, Trans. Proc. Bot. Soc. Edinburgh, 15: 179. 1884. — *L.* subgen. *Euosmo-Lejeunea* Spruce, ibid. 15: 241. 1884. — *L.* subgen. *Cheilo-Lejeunea* Spruce, ibid. 15: 251. 1884. — *Euosmolejeunea* (Spruce) Schiffn, in Engler & Prantl, Nat. Pfl.-fam. 1, 3: 124. 1895. — *Strepsilejeunea* (Spruce) Schiffn. ibid. 1, 3: 127. 1895.

**Plants** green to pale green. **Stems** irregularly pinnate by the intercalary branching; cross section of the stem with a circle of about 7 cortical cells (1 dorsal, 4 lateral, 2 ventral) and 7-17 medullary cells, cell walls thick, trigones present, the cortical cells larger than the medullary cells. **Leaf lobes** ovate, the margin entire, the apex rounded to acute, cells without the dorsal protruding, ocelli absent; oil bodies large, 1-2 per cell, mostly composed of large globules, and of the grape cluster type. **Leaf lobules** more or less inflated, the first tooth very weak or almost absent, the second tooth rather large, falcated. **Underleaves** bilobed, the margin entire. **Bracts and Bracteoles** similar to leaves and underleaves. **Perianths** (4)-5 keeled (0-1 dorsal, 2 lateral), keels smooth.

#### Key to species

1. Lateral leaf flat, cells with trigones..... **C. sp. 1**  
 1. Lateral leaf concaved, cells without trigones..... **C. sp. 2**

#### 1. *Cheilolejeunea* sp. 1

**Plants** pale yellow in herbaria, 1.9-2.1 mm wide. **Stems** irregular; in cross-section of stem: 10-11 cortical cells surrounding smaller medulla 15-17 cells, thick wall. **Rhizoids** not seen. **Leaf lobes** imbricate, spreading, wide ovate, margin entire, apex round, 1.1-1.2 mm long and 0.7-0.8 mm wide, 2 rows of nearly rectangular marginal cells 10-11 µm long and 7-9 µm wide, trigones indistinct, median cells 17-21 µm long and 15-19 µm wide, trigones small, basal cells 30-43 µm long and 14-22 µm wide, trigones large. **Leaf lobules** 1/2 as long as the lobe, rectangular, incurved, apex with 2-3 celled tooth. **Underleaves** remote, orbicular, apex bilobed 1/2 of the length, margin entire, 0.2-0.5 mm long and 0.2-0.3 mm wide. **Sporophytes** not found. (**Figure 4.33**)

**Thailand** —

**Distribution** —

**Ecology** — on leaf surface.

**Specimens examined** — P. Sukkharak 529 (BCU).

**GPS location** — 8.87827814° N 99.69324589° E

**Altitude** — 1,285 m

#### 2. *Cheilolejeunea* sp. 2

**Plants** pale yellow in herbaria, mm wide. **Stems** irregular; in cross section of stem 8-9 cortical cells surrounding smaller medulla 15-17 cells, thick wall. **Rhizoids** not seen. **Leaf lobes** imbricate, obliquely spreading, wide obovate, margin entire, apex round incurved, 0.6-0.7 mm long and 0.5-0.6 mm wide, 2 rows of marginal cells 13-19  $\mu\text{m}$  long and 13-18  $\mu\text{m}$  wide, trigones indistinct, median and basal cells 18-21  $\mu\text{m}$  long and 13-15  $\mu\text{m}$  wide, trigones indistinct, 5-6 ocelli scatter on basal part. **Leaf lobules** 1/5 as long as the lobe, rectangular, incurved, apex with 2-3 celled tooth. **Underleaves** remote, orbicular, apex bilobed 1/3-1/4 of the length, margin entire, 0.3-0.4 mm long and 0.3-0.4 mm wide. **Sporophytes** not found. (**Figure 4.34**)

**Thailand —**

**Distribution —**

**Ecology —** on living bark of tree.

**Specimens examined —** P. Sukkharak 487 (BCU).

**GPS location —** 8.8778007° N 99.70351875° E

**Altitude —** 1,074 m

#### 4. *Cololejeunea*

*Cololejeunea* (Spruce) Schiffn., In Engler & Prantl, Nat. Pfl.-fam. 1, 3: 121. 1893.; Misutani, M., J. Hattori Bot. Lab. 24: 237. 1961. — *Lejeunea* subgen. *Colo-Lejeunea* Spruce, Trans. Proc. Bot. Soc. Edinburgh. 15: 291. 1884.

**Plants** irregularly pinnate by intercalary branching except the subfloral innovation which is terminal, of the *Radula* type; cross section of the stem: 5 cortical and one medullary cell, cells almost equal in size; rhizoid initial group one per lateral leaf, rhizoids usually in tufts. **Leaf lobes** varying in shape, often with seriate ocelli and/or hyaline marginal cells; oil-bodies usually hyaline, few, minute; in ocelli the oil-bodies large, grayish, compound, usually filling cell-rumen. **Leaf lobules** with a very narrow insertion to the stem, varying in shape, typically 2-toothed at apex. **Underleaves** always absent. **Gemmae** usually numerous on the ventral surface of the leaf-lobe, discoid, 20-40-celled. **Bracts** similar to leaves. **Bracteoles** always absent. **Perianths** 5-keeled (1 dorsal, 2 lateral, 2 ventral), the dorsal keel frequently indistinct or absent.

#### Key to species

1. Dorsal surface of lateral leaf smooth.
  2. Apex of leaf lobe bordered by 2-3 rows of hyaline cells, gemmae absent..... *C. yipii*
  2. Apex of leaf lobe not bordered by hyaline cells, gemmae present..... *C. ocelloides*
1. Dorsal surface of lateral leaf spinose..... *C. spinosa*

#### 1. *Cololejeunea ocelloides* (Horik.) S. Hatt.

J. Hattori Bot. Lab. 19: 138. 1958.; Zhu, R. L. & So, M. L. Nova Hedwigia. 121: 364-367, fig. 136. 2001. — *Leptocolea ocelloides* Horik., J. Sci. Hiroshima Univ., Ser. B, Div. 2, Bot. 2: 280. 1934. — *Taeniolejeunea ocelloides* (Horik.) S. Hatt., J. Jap. Bot. 17: 462. 1942. — *Cololejeunea leonidens* Benedix, Feddes Repert. Spec. Nov. Regni Veg. Beih. 134: 39. 1953.

**Plants** pale yellow in herbarium, 1.4-1.5 mm wide. **Stems** flatly strongly appressed to substratum, pinnate; in cross section of stem: 5 cortical cells in circle with one medullary cell. **Rhizoids** numerous, in tuft, hyaline. **Leaf lobes** imbricate, obliquely spreading, ovate, margin entire, apex round, 0.8-0.9 mm long and 0.4-0.5 mm wide, marginal cells subquadrate, 4-12  $\mu\text{m}$  long and 2-4  $\mu\text{m}$  wide, median cells 8-13  $\mu\text{m}$  long and 5-9  $\mu\text{m}$  wide, trigones small, vitta at basal portion composed of 2-3 rows each of 6-8 oblong ocelli, 28-78  $\mu\text{m}$  long and 7-34  $\mu\text{m}$  wide. **Leaf lobules** 1/2 of the length of lobe, obovate-oblong, inflate, apex with two tooth, first tooth 2-3 cells long, 1 cell wide, spreading towards stem apex, second tooth 3-4 cells long, 2-3 cells wide. **Underleaves** absent. **Gemmae** discoid, scattered on leaf lobe. **Sporophytes** not found. (**Figure 4.35**)

**Thailand** — New record to Thailand.

**Distribution** — Cambodia, China, Indonesia, Japan, Malaysia, Philippines, Vietnam.

**Ecology** — on leaf surface.

**Specimen examined** — P. Sukkharak 539 (BCU)

**GPS location** — 8.88229072° N 99.69644308° E

**Altitude** — 1,385 m

## 2. *Cololejeunea spinosa* (Horik.) Pandé & Misra

J. Indian Bot. Soc. 22: 166. 1943.; Zhu, R. L. & So, M. L. Nova Hedwigia. 121: 316-318, fig. 119. 2001. — *Physocolea spinosa* Horik., J. Sci. Hiroshima Univ., Ser. B, Div. 2, Bot. 1: 70. 1931. — *Cololejeunea baskarliana* (Lehm. & Lindenb.) Schiffn. var. *spinosa* (Horik.) T. Kodama, J. Hattori Bot. Lab. 17: 66. 1956. — *Cololejeunea indica* Pandé & Misra, J. Indian Bot. Soc. 22: 166. 1943.

**Plants** yellow, 0.4-0.6 mm wide. **Stems** appressed to substratum, in cross section of stem: 5 cortical cells in circle with one medullary cell. **Rhizoids** fasciculate. **Leaf lobes** slightly imbricate, spreading obliquely 40°-60°, ovate, dorsal spinose, margin densely spinose, apex obtuse, 0.2-0.3 mm long and 0.1-0.2 mm wide, marginal cells 10-13 µm long and 0.6-0.7 µm wide, median cells 13-18 µm long and 10-13 µm wide, basal cells 23-34 µm long and 5-9 µm wide. **Leaf lobules** 1/3-1/2 of the length of lobe, ovate, inflated, apex with tooth, first tooth with 1-2 celled long, smooth ventral surface. **Underleaves** absent. **Sporophytes** not found. (Figure 4.36)

**Thailand** — NORTH: Chiang Mai; EASTERN: Nakhon Ratchasima.

**Distribution** — China, India, Japan, Korea, Nepal, Philippines.

**Ecology** — on leaf surface.

**Specimen examined** — P. Sukkharak 538b (BCU).

**GPS location** — 8.88229072° N 99.69644308° E

**Altitude** — 1,385 m

## 3. *Cololejeunea yipii* R. L. Zhu.

In Zhu, R. L. & So, M. L. Nova Hedwigia. 121: 346-349, fig. 130. 2001.

**Plants** pale whitish, 1.5-1.7 mm wide. **Stems** flatly strongly appressed to substratum, pinnate; in cross section of stem: 5 cortical cells in circle with one medullary cell. **Rhizoids** numerous, in tuft, hyaline. **Leaf lobes** imbricate, widely spreading, orbicular to obovate, margin entire, apex round bordered by 2-3 rows of hyaline cells, 0.74-0.75 mm long and 0.4-0.5 mm wide, marginal cells 7-10 µm long and 3-5 µm wide, median cells 9-13 µm long and 7-9 µm wide, trigones small, basal cells 26-78 µm long and 17-19 µm wide, vitta from base to middle of leaf-lobe. **Leaf lobules** 2/5 of the length of lobe, obovate-oblong, apex with tooth, 2 celled. **Underleaves** absent. **Bracts** the lobe of bract orbicular-obovate, margin entire, apex round the margin bordered by 2-3 rows of hyaline cells, the lobule of bract 2/5 of the length of the lobe, obovate. **Bracteoles** absent. **Perianths** obovate, flat dorsal, 0.80-0.84 mm long and 0.6-0.7 mm wide, 3 keeled. (Figure 4.37)

**Thailand** — New record to Thailand.

**Distribution** — China.

**Ecology** — on leaves.

**Specimen examined** — P. Sukkharak 279, 294, 522 (BCU).

**GPS location** — 8.88229072° N 9.69644308° E

**Altitude** — 1,385 m

## 5. *Colura*

*Colura* Dumort., Rec. d'obs. 12. 1835.; Misutani, M., J. Hattori Bot. Lab. 24: 235. 1961. — *Lejeunea* subgen. *Colura-Lejeunea* Spruce, Trans. Proc. Bot. Soc. Edinburgh. 15: 303. 1884. — *Colurolejeunea* Schiffn. in Engler & Prantl, Nat. Pfl.-fam. 1, 3: 121. 1895.

**Plants** pale green. **Stems** irregularly pinnate, by intercalary branching; cross section of the stem: 7 cortical cells and 3 medullary cells, cell walls all thickened, the cortical cells as large as or slightly larger than the inner cells. **Leaf lobes** approximate, variously saccate at the upper part, the sac with a pore and valve, cells often with dorsal protrusions; ocellus absent; oil-bodies small. **Underleaves** one per lateral leaf, deeply bilobed, the margin entire. **Bracts** shortly bilobed, the margin more or less sinuate. **Bracteoles** small, similar to underleaves. **Perianths** cylindrical, clearly 5-keeled above (1 dorsal, 2 lateral, 2 ventral), keels usually horn-shaped at apex.

### Key to species

1. Apex of leaf lobules acute ..... *C. conica*  
 1. Apex of leaf lobules broadly rounded ..... *C. meijeri*

#### 1. *Colura conica* (Sande Lac.) K. I. Goebel

Ann. Jard. Bot. Buitenzorg 39: 3. 1928.; Zhu, R. L. & So, M. L. Nova Hedwigia. 121: 245-247, fig. 95. 2001. — *Lejeunea conica* Sande Lac., Ann. Mus. Bot. Lugduno-Batavum 1: 311. 1864. — *Colurolejeunea conica* (Sande Lac.) Schiffn., Consp. Hepat. Arch. Ind.: 258. 1898. — *Colura acutifolia* Ast, Rev. Bryol. Lichénol. 25: 281. 1953.

**Plants** pale green to yellow, 3-3.5 mm wide. **Stems** appressed to substratum; in cross section of stem: 7 cortical cells in circle with 3 medullary cells. **Rhizoids** numerous. **Leaf lobes** imbricate, orbicular, margin entire, 1.5-1.8 mm long and 0.8-1 mm wide, marginal cells 26-31 µm long and 15-21 µm wide, median cells 47-52 µm long and 21-28 µm wide, trigones large, basal cells 63-71 µm long and 26-34 µm wide. **Leaf lobules** linear, leading into a sac, margin involute, connate with leaf-lobe, narrowly cylindrical, lateral margin strongly incurved, sac inflated, 1.3-1.4 mm long and 0.86-0.89 mm wide, apex acute. **Underleaves** distant, deeply bilobed, sinus wide, lobe lanceolate 8-11 cells long and 5-6 cells wide. **Sporophytes** not found. (Figure 4.38 and 4.111)

**Thailand** — PENINSULAR: Surat Thani.

**Distribution** — Australia, Borneo, Cambodia, China, Chittagong, Fiji, Indonesia, Laos, Malaysia, New Caledonia, Papua New Guinea, Philippines, Vietnam.

**Ecology** — on leaves.

**Specimens examined** — P. Sukkharak 482, 521 (BCU).

**GPS location** — 8.88229072° N 99.69644308° E

**Altitude** — 650-1,385 m

#### 2. *Colura meijeri* Jovet-Ast

Rev. Bryol. 22: 290, f. 56. 1953.; Mizutani, M., J. Hattori Bot Lab. 24. 236-238, fig. XXVI. (Exsicc.) Hatt. Hepat. Jap. 9: 417. 1958.

**Plants** pale yellowish green, 1.8-2 mm wide. **Stems** appressed to substratum; in cross section of stem: 7 cortical cells in circle with 3 medullary cells. **Rhizoids** numerous. **Leaf lobes** incubous, slightly imbricate, nearly triangular, margin entire, 1.2-1.3 mm long and 0.5-0.6 mm wide, marginal cells 21-34 µm long and 21-28 µm wide, sinuate with nodulose-flexuose and confluent trigones, median cells 23-36 µm long and 21-32 µm wide, sinuate with nodulose-flexuose and confluent trigones basal cells 32-53 µm long and 23-28 µm wide, sinuate with nodulose-flexuose and confluent trigones. **Leaf lobules** linear, leading into a sac, margin involute, connate with leaf-lobe, sac inflated, apex round. **Underleaves** distant, deeply bilobed, sinus acute, lobe lanceolate 8-9 cells long. **Sporophytes** not found. (Figure 4.39)

**Thailand** — New record to Thailand.

**Distribution** — Japan, Java.

**Ecology** — on leaves.

**Specimens examined** — P. Sukkharak 544b (BCU).

**GPS location** — Exact locality not applicable. Between TT22 and TT23.

**Altitude** — Exact altitude not applicable. ca. 1,333-1,381 m

## 6. *Drepanolejeunea*

*Drepanolejeunea* (Spruce) Schiffn., In Engler & Prantl, Nat. Pfl.-fam. 1, 3: 126. 1893.; Misutani, M., J. Hattori Bot. Lab. 24: 218. 1961. — *Lejeunea* subgen. *Drepano-Lejeunea* Spruce, Trans. Proc. Bot. Soc. Edinburgh, 15: 186. 1884.

**Plants** usually yellowish green. **Stems** irregularly branched, branching intercalary; cross section of the stem: 7 cortical cells (1 dorsal, 4 lateral, 2 ventral) and 3 small medullary cells, cell walls thick, trigones indistinct. **Leaf lobes** more or less falcate, triangular or ovate oblong to lanceolate, the margin denticulate to spinose, cells mostly with the dorsal protrusion; oil-bodies numerous, small, elliptical, composed of globules. **Leaf lobules** inflated, the first tooth acute, consisting of a single elongate cell, more or less curved toward keel, the second tooth reduced, the hyaline papilla on the proximal base of the first tooth. **Underleaves** usually small, deeply bilobed, lobes divaricate, lanceolate, acuminate. **Bracts and Bracteoles** dentate. **Perianths** clearly 5-keeled (1 dorsal, 2 lateral, 2 ventral), keels often winged, wings usually toothed, ending above as horizontally spreading horns.

### Key to species

1. Lobes of underleaf one cell wide.
  2. Base of underleaf two cells high.
    3. Leaf lobe smooth.
      4. Apex of leaf lobe acuminate.
        5. Leaf lobe remote, long ovate leaf lobes ..... *D. angustifolia*
        5. Leaf lobe imbricate, ovate leaf lobes ..... *D. sp. 2*
      4. Apex of leaf lobe falcate..... *D. sp. 1*
    3. Leaf lobe densely long toothed..... *D. dactylophora*
  2. Base of underleaf more than two cells high..... *D. ternatensis*
1. Lobes of underleaf two cells wide..... *D. levicornua*

### 1. *Drepanolejeunea angustifolia* (Mitt.) Grolle

J. Jap. Bot. 40: 206. 1965.; Zhu, R. L. & So, M. L. Nova Hedwigia. 121: 186-189, fig. 70. 2001. — *Lejeunea angustifolia* Mitt., J. Proc. Linn. Soc., Bot. 5: 116. 1861 “1860”. — *Jungermannia tenuis* Reinw. et al., Nova Acta Phys.-Med. Acad. Caes. Leop.-Carol. Nat. Cur. 12: 226. 1825 “1824”, nom. illeg. (Art. 53.1) (non *J. tenuis* Ehrh. 1789). — *Jungermannia cucullata* var. *tenuis* Nees, Enum. Pl. Crypt. Jav.: 57. 1830. — *Lejeunea tenuis* (Nees) Gottsche et al., Syn. Hepat.: 390. 1845; nom. illeg. (Art. 53. 6, cf. Grolle 1965) (non *L. tenuis* (Ehrh.) Gottsche et al., Syn. Hepat.: 407. 1845). — *Drepanolejeunea tenuis* (Nees) Schiffn., Consp. Hepat. Arch. Ind.: 280. 1898. — *Drepanolejeunea szechuanica* P. C. Chen, Feddes Repert. 58: 42. 1955.

**Plants** yellowish green, 0.5-0.6 mm wide. **Stems** creeping as isolated plants, in cross section of stem: 7 cortical cells in circle with 3 medullary cells, all cells thick-walled. **Rhizoids** fasciculate at base of underleaves. **Leaf lobes** remote, spreading obliquely 40°-45°, lanceolate, margin entire, apex acuminate, 0.2-0.3 mm long and 0.1-0.2 mm wide, cells 21-23 µm long and 13-15 µm wide, small trigones, 1-2 forming continuous longitudinal series basal ocelli. **Leaf lobules** 1/3 of the length of lobe, ovate-triangular, apex with hyaline papilla of first tooth, keel arched, inflated and entire to slightly crenulate. **Underleaves** remote, margin entire, bilobed,

lobes one cell wide except at base with two cells, 2-3 cells long, sinus U shape, 78-83  $\mu\text{m}$  long and 50-55  $\mu\text{m}$  wide. **Sporophytes** not found. (Figure 4.40)

**Thailand** — EASTERN: Nakhon Ratchasima.

**Distribution** — Cambodia, Java, Malaysia, Philippines, Sumatra, Vietnam.

**Ecology** — grow on *Frullania apiculata* (Reinw. et al.) Nees.

**Specimens examined** — P. Sukkharak 436 (BCU).

**GPS location** — 8.87622893° N 99.69291866° E

**Altitude** — 1,304 m

## 2. *Drepanolejeunea dactylophora* (Nees et al.) Schiffn.

Species Hepaticarum 5: 342.; In Engler & Prantl, Nat. Pflanzenfam. 1 (3): 126. 1893.; Zhu, R. L. & So, M. L. Nova Hedwigia. 121. 176-178, fig. 66. 2001. — *Lejeunea dactylophora* Nees et al., Nov. Actorum Acad. Caes. Leop-Carol. Nat. Cur. 19, suppl. 1: 473. 1843. — *Drepanolejeunea grossidentata* Horik., J. Sci. Hiroshima Univ., Ser. 2, Div. 2, Bot. 2: 263. 1934.

**Plants** pale yellow, 0.3-0.5 mm wide. **Stems** creeping as isolated plants, in cross section of stem: 7 cortical cells in circle with 3 medullary cells, all cells thick-walled. **Rhizoids** fasciculate at base of underleaves. **Leaf lobes** remote, obliquely spreading, ovate, asymmetric, margin recurved densely toothed, apex acute, recurved, 165-189  $\mu\text{m}$  long and 63-81  $\mu\text{m}$  wide, cells 13-18  $\mu\text{m}$  long and 7-10  $\mu\text{m}$  wide, small trigones, 4-5 forming non-continuous longitudinal series ocelli in lobe. **Leaf lobules** 2/3 of the length of lobe, ovate-oblong, apex elongate with 4 rectangular cells, keel arched, strongly inflated and crenulate. **Underleaves** remote, margin entire, bilobed, lobes one cell wide except at base with two cells, 3-4 cells long, sinus widely U shape, 140-144  $\mu\text{m}$  long and 100-110  $\mu\text{m}$  wide. **Bracts** margin densely toothed **Perianths** obovate 5 keels with densely toothed at margin. (Figure 4.41)

**Thailand** — SOUTH-WESTERN: Prachuap Khiri Khan.

**Distribution** — Australia, China, Indonesia, Japan, Malaysia, Philippines, Vietnam.

**Ecology** — on leaves.

**Specimens examined** — P. Sukkharak 538 (BCU).

**GPS location** — 8.88229072° N 99.69644308° E

**Altitude** — 1,385 m

## 3. *Drepanolejeunea levicornua* Steph.

Sp. Hepat. 5: 347. 1913.; Zhu, R. L. & So, M. L., Nova Hedwigia. 121: 193-195, fig. 73. 2001.

**Plants** yellowish green, 1.8-2 mm wide. **Stems** creeping, irregularly branch, in cross section of stem: 7 cells of cortical cells and 3 medullary cells. **Rhizoids** numerous, fasciculate forming adhesive disc adhered to the leaf surface at base of underleaves. **Leaf lobes** imbricate, obliquely ovate, margin dentate, 0.8-0.9 mm long and 0.4-0.5 mm wide, marginal cells 11-13  $\mu\text{m}$  long and 7-13  $\mu\text{m}$  wide, median cells 18-23  $\mu\text{m}$  long and 17-19  $\mu\text{m}$  wide, trigones small, basal cells 40-52  $\mu\text{m}$  long and 13-18  $\mu\text{m}$  wide, trigones small, ocelli 1-3 suprabasal type which separate from each other by ordinary cell if 2-3. **Leaf lobules** 1/3 of the length of lobe, oblong, apex with one tooth, inflated. **Underleaves** distant, obtuse, 0.3-0.4 mm long and 0.6-0.8 mm wide, margin entire, lobe lanceolate, horizontal spreading 5-6 cells long with 2 cells wide, apex with 1-2 uniseriate cells. **Sporophytes** not found. (Figure 4.42)

**Thailand** — PENINSULAR: Ranong.

**Distribution** — China, Indonesia, Malaysia, Papua New Guinea.

**Ecology** — on fronds of fern and leaf surface.

**Specimens examined** — P. Sukkharak 245, 530 (BCU).

**GPS location** — 8.87842739° N 99.69416173° E, 8.87803137° N 99.69275236° E

**Altitude** — 1,220-1,285 m

## 4. *Drepanolejeunea ternatensis* (Gottsche) Schiffn.

Hedwigia 29: 73. 1890.; In Engler & Prantl, Nat. Pflanzenfam. 1 (3): 126. 1893.; Zhu, R. L. & So, M. L., Nova Hedwigia. 121: 191-194, fig. 72. 2001. — *Lejeunea ternatensis* Gottsche in Gottsche et al., Syn. Hepat.: 346. 1845. — *Drepanolejeunea unidentata* Horik., Bot. Mag. (Tokyo) 49: 589. 1935. — *Drepanolejeunea ternatensis* (Gottsche) Steph. var. *lancispina* Herzog, Ann. Bryol. 12: 119.

**Plants** yellowish green, 0.4-0.6 mm wide. **Stems** creeping as isolated plants, in cross section of stem: 7 cortical cells in circle with 3 medullary cells, all cells thick-walled. **Rhizoids** fasciculate at base of underleaves. **Leaf lobes** continuous to nearly imbricate, obliquely spreading, ovate, margin crenulate to dentate, apex acuminate, incurved, 0.28-0.3 mm long and 0.2-0.25 mm wide, cells 18-22  $\mu\text{m}$  long and 14-18  $\mu\text{m}$  wide, small trigones, lacking basal ocelli, papillae at dorsal. **Leaf lobules** 1/2 of the length of lobe, ovate-triangular, apex with one tooth, keel arched, strongly inflated and crenulate. **Underleaves** distant, margin entire, bilobed, lobes one cell wide except at base with two cells, 3-4 cells long, sinus U and slightly V shape, basal 1 row of cells, 80-90  $\mu\text{m}$  long and 98-116  $\mu\text{m}$  wide. **Sporophytes** not found. (Figure 4.43)

**Thailand** — New record to Thailand.

**Distribution** — Australia, China, Fiji, Indonesia, Japan, Malaysia, Micronesia, Papua New Guinea, Philippines, Samoa, Seychelles, Sri Lanka.

**Ecology** — on *Bazzania tridens* (Reinw. et al.) Trevis.

**Specimens examined** — P. Sukkharak 464 (BCU).

**GPS location** — 8.87582123° N 99.68859494° E

**Altitude** — 1,363 m

##### 5. *Drepanolejeunea* sp. 1

**Plants** yellowish green, 0.4-0.5 mm wide. **Stems** creeping as isolated plants, in cross section of stem: 7 cortical cells in circle with 3 medullary cells, all cells thick-walled. **Rhizoids** fasciculate at base of underleaves. **Leaf lobes** remote, obliquely spreading, falcate, margin entire to slightly crenulate, apex acute, incurved, 0.3-0.4 mm long and 0.2-0.25 mm wide, marginal cells 10-21  $\mu\text{m}$  long and 10-15  $\mu\text{m}$  wide, trigones indistinct, median cells 10-15  $\mu\text{m}$  long and 15-23  $\mu\text{m}$  wide, trigones indistinct, basal cells 26-50  $\mu\text{m}$  long and 10-21  $\mu\text{m}$  wide, trigones indistinct. **Leaf lobules** 1/2 of the length of lobe, ovate-triangular, apex with one tooth, keel arched, strongly inflated and crenulate. **Underleaves** distant, margin entire, bilobed, lobes one cell wide except at base with two cells, 2-3 cells long, sinus U and slightly V shape, basal one rows of cells. **Bracts** margin densely toothed, connate with bracteo. **Bracteoles** bilobed, margin irregular dentate. **Perianths** obovate, 5-keels, margin smooth, 0.7-0.8 mm long and 0.3-0.4 mm wide. (Figure 4.44)

**Thailand.** —

**Distribution.** —

**Ecology** — on leaf surface.

**Specimens examined** — P. Sukkharak 536 (BCU)

**GPS location** — Exact locality not applicable. Near TT07.

**Altitude** — ca. 650 m

##### 6. *Drepanolejeunea* sp. 2

**Plants** brownish yellow, 0.3-0.4 mm wide. **Stems** creeping as isolated plants, in cross section of stem: 7 cortical cells in circle with 3 medullary cells, all cells thick-walled. **Rhizoids** fasciculate at base of underleaves. **Leaf lobes** remote, obliquely spreading, ovate, margin entire, apex acute, 136-144  $\mu\text{m}$  long and 63-65  $\mu\text{m}$  wide, cells 7-11  $\mu\text{m}$  long and 4-5  $\mu\text{m}$  wide, trigones small, ocelli scatter on lobe. **Leaf lobules** 1/3 of the length of lobe, ovate-triangular, apex with one tooth, keel arched, strongly inflated and crenulate. **Underleaves** distant, margin entire, bilobed, lobes one cell wide except at base with two cells, one cell long, sinus wide U shape, basal 2 rows of cells. **Bracts** margin densely toothed, connate with bracteo. **Bracteoles** bilobed,

margin irregular dentate. **Perianths** obovate, 5 horn-shaped keels, margin smooth, 36-38  $\mu\text{m}$  long and 18-20  $\mu\text{m}$  wide. (**Figure 4.45**)

**Thailand** —

**Distribution** —

**Ecology** — on living bark of tree.

**Specimens examined** — P. Sukkharak 545 (BCU).

**GPS location** — Exact locality not applicable. Near TT24.

**Altitude** — Exact altitude not applicable. ca. 1283 m

## 7. *Lejeunea*

*Lejeunea* Lib., Ann. Gen. Sci. Phys. 6: 372. 1820.; Misutani, M., J. Hattori Bot. Lab. 24: 199. 1961. — *Lejeunea* subgen. *Eu-Lejeunea* Spruce, Trans. Proc. Bot. Edinburgh, 15: 260. 1884. — *L.* subgen. *Micro-Lejeunea* Spruce, ibid, 15: 286. 1884. — *Microlejeunea* (Spruce) Jack & Steph. Bot. Centralbl. 60: 106. 1894. — *Eulejeunea* (Spruce) Schiffn. in Engler & Prantl, Nat. Pfl.-fam. 1, 3: 122. 1895. — *E.* subgen. *Microlejeunea* (Spruce) Schiffn. ibid. 1, 3: 124. 1895.

**Plants** green or yellowish green. **Stems** irregularly pinnate by intercalary branching; cross section of the stem: 7 cortical cells (1 dorsal, 4 lateral, 2 ventral) and 5-25 medullary cells, the cortical cells much larger than the medullary cells. **Leaf lobes** entire at margin, the apex usually rounded, rarely apiculate to acute; cells without dorsal protrusion; ocelli absent; oil-bodies numerous, small, hyaline or often with indistinct granules. **Leaf lobules** usually inflated, the first tooth usually unicellular, forming an obtuse angle, the second tooth almost reduced. **Underleaves** bilobed, sinus U-shaped, margin entire. **Bracts** entire at margin. **Bracteoles** bilobed, the margin entire. **Perianths** inflated, 5-keeled (1 dorsal, 2 lateral, 2 ventral), keels smooth.

### Key to species

1. Underleaves obovate, sinus widely obtuse ..... *L. boninensis*  
 1. Underleaves orbicular, sinus acute ..... *L. sp.*

#### 1. *Lejeunea boninensis* Horik.

J. Sci. Hiroshima Univ. ser. b, div. 2, 1: 24, f. 7: 1931.; Misutani, M., J. Hattori Bot. Lab. 24: 208-210, fig. XX. 1961. — *L. kiiensis* Horik. Bot. Mag. Tokyo, 48: 602, f. 2. 1934. (Exsicc.) Hatt. Hepat. Jap. 8: 369. 1956.

**Plants** yellowish green, 0.4-0.5 mm wide. **Stems** appressed to substratum, pinnate, in cross section of stem: 5-6 cells across, 7 cortical cells in circle with 8-9 medullary cells, cortical cells larger than medullary cells, all cells thin-walled. **Rhizoids** few, at the base of underleaves. **Leaf lobes** imbricate, widely spreading, orbicular, margin entire, apex truncate, 0.22-0.24 mm long and 0.19-0.20 mm wide, marginal cells 7-10  $\mu\text{m}$  long and 5-6  $\mu\text{m}$  wide, median cells 13-15  $\mu\text{m}$  long and 9-11  $\mu\text{m}$  wide, trigones small, basal cells 23-26  $\mu\text{m}$  long and 17-19  $\mu\text{m}$  wide, trigones small. **Leaf lobules** 1/4 of the length of lobe, ovate, apex with obtuse tooth, inflated. **Underleaves** distant, obovate, 105-126 mm long and 85-95 mm wide, margin entire, bilobed for 1/2 of the length, lobe acute, sinus obtuse. **Bracts** the lobe of bract obovate, margin entire, apex round to obtuse; the lobule of bract 1/2-3/4 of the length of the lobe, ovate, apex acute. **Bracteoles** obovate, apex bilobed, lobes acute, sinus narrow acute. **Perianths** obovate, inflated, 0.36 mm long and 0.30 mm wide, 4-keeled. (**Figure 4.46**)

**Thailand** — New record to Thailand.

**Distribution** — Japan.

**Ecology** — on living bark of tree and tree fern.

**Specimen examined** — P. Sukkharak 16, 19, 33, 39 (BCU).

**GPS location** — Exact locality not applicable. Near TT11.

**Altitude** — ca. 646-870 m

## 2. *Lejeunea* sp.

**Plants** pale green, 1.2-1.5 mm wide. **Stems** appressed to substratum, pinnate; in cross section of stem: 5-6 cells across, the cortical cells larger than the medullary cells. **Rhizoids** numerous, in tuft, hyaline. **Leaf lobes** loosely imbricate to distant, widely spreading, orbicular, margin entire, apex round, 0.6-0.7 mm long and 0.44-0.46 mm wide, marginal cells 10-11  $\mu$ m long and 9-10  $\mu$ m wide, median cells 17-18  $\mu$ m long and 11-13  $\mu$ m wide, trigones small, basal cells 32-36  $\mu$ m long and 17-19  $\mu$ m wide, trigones medium. **Leaf lobules** 1/5 of the length of lobe, ovate, apex with one tooth. **Underleaves** distant, orbicular, margin entire, bilobed, lobes acute, sinus obtuse 0.34-0.40 mm long and 0.33-0.38 mm wide. **Bracts** the lobe of bract ovate, margin entire; the lobule of bract 2/3 of the length of the lobe, ovate to oblong. **Bracteoles** obovate, apex bilobed, lobe acute, sinus acute. **Perianths** obovate, inflated, 0.6 mm long and 0.4 mm wide, 5-keeled. (**Figure 4.47**)

**Thailand** —

**Distribution** —

**Ecology** — on tree fern.

**Specimen examined** — P. Sukkharak 231 (BCU).

**GPS location** — Exact locality not applicable. Near TT20.

**Altitude** — Exact altitude not applicable. ca. 1,275 m

## 8. *Leptolejeunea*

*Leptolejeunea* (Spruce) Schiffn., In Engler & Prantl, Nat. Pflanzenfam. 1 (3): 126. 1893.; Misutani, M., J. Hattori Bot. Lab. 24: 229-230. 1961. — *Lejeunea* subgen. *Lepto-Lejeunea* Spruce, Trans. Proc. Bot. Soc Edinburgh, 15: 193. 1884.

**Plants** pallid green. **Stems** closely appressed to substrata, irregularly pinnate by the intercalary branching; cross section of the stem: 7 cortical cells and 3 small medullary cells, cells rather thick-walled; rhizoids from the central group of cells of underleaves. **Leaf lobes** more or less shrinking when dry, distant or approximate, the lobe elliptical to ovate, the apex obtuse to acute, the margin entire to dentate; cells large, walls thin but with small nodulose intermediate thickenings and trigones which are hyaline, in dried specimens cells more or less shrunken and cell walls flexuose even in long soakage, but intermediate thickenings and trigones still distinctive as in fresh state; ocelli one at base, often several additional one scattered in leaf-lamina; oil bodies 5-10 per cell, minute, homogeneous, those in ocellus single but nearly filling cell-lumen. **Leaf lobules** large, inflated, the first tooth small, usually consisting of one projecting cell, the second tooth reduced, the hyaline papilla on the proximal base of the first tooth. **Underleaves** small, deeply bilobed, lobes divaricate, acute, lanceolate, the basal portion bordered by 6 elongate cells. **Bracts and Bracteoles** more or less acute at apex, the margin sparingly dentate. **Perianths** 5-keeled (1 dorsal, 2 lateral, 2 ventral), keels wide, smooth, with apices extending upwards and outwards as acute to truncate horns.

### *Leptolejeunea apiculata* (Horik.) S. Hatt.

J. Hattori Bot. Lab. 5: 46. 1951.; Zhu, R. L. & So, M. L., Nova Hedwigia. 121: 201-204, fig. 76. 2001. — *Drepanolejeunea apiculata* Horik., J. Sci. Hiroshima Univ., Ser. B, Div. 2, Bot. 2: 266. 1934.

**Plants** blackish green, 1-1.1 mm wide. **Stems** appressed to substratum, pinnate, in cross section of stem: 7 cortical cells in circle with 3 medullary cells, cortical cells larger than medullary cells, all cells thin-walled. **Rhizoids** few, at the base of underleaves. **Leaf lobes** imbricate, obliquely spreading, obliquely elliptical, margin entire, apex acute, 0.6-0.7 mm long and 0.2-0.3 mm wide, marginal cells 10-22  $\mu$ m long and 10-13  $\mu$ m wide, intermediate thickening trigones,

median cells 21-28  $\mu\text{m}$  long and 17-26  $\mu\text{m}$  wide, intermediate thickening trigones, ocelli 3-7 per leaf lobe, irregularly scattered, basal cells 21-39  $\mu\text{m}$  long and 13-15  $\mu\text{m}$  wide, trigones intermediate. **Leaf lobules** 1/2 of the length of lobe, ovate, bordered by 4-5 elongate cells, apex consisting of one oblong cell, hyaline papilla at the proximal side of first tooth, inflated. **Underleaves** distant, deeply bilobed, lobe lanceolate, 2-3 cells long, 2 cells wide at base, sinus widely obtuse-U-shape, margin entire. **Bracts** the lobe of bract obovate, margin entire, apex apiculate; the lobule of bract 3/4 of the length of the lobe, ligulate, apex acute. **Bracteoles** obvate, apex bilobed, lobes acute, sinus narrow acute, connate at base with both bracts. **Perianths** obovate, inflated, 0.67-0.69 mm long and 0.26-0.27 mm wide, 5-keeled, keel smooth, horn shape. (Figure 4.48)

**Thailand** — New record to Thailand.

**Distribution** — China, Japan.

**Ecology** — on leaf surface.

**Specimens examined** — P. Sukkharak 526 (BCU)

**GPS location** — 8.88284862° N 99.69769835° E

**Altitude** — 1,344 m

## 9. *Lopholejeunea*

*Lopholejeunea* (Spruce) Schiffn., In Engler & Prantl, Nat. Pflanzenfam. 1 (3): 129. 1893.; Misutani, M., J. Hattori Bot. Lab. 24: 175. 1961. — *Lejeunea* subgen. *Lepho-Lejeunea* Spruce, Trans. Proc. Bot. Soc Edinburgh, 15: 119. 1884.

**Plants** glossy green to brown or black. **Stems** usually irregularly pinnate, by the intercalary branching; cells in cross section of the stem: thick-walled, trigones absent, the cortical cells slightly larger than the medullary cells, in 10-12 longitudinal rows. **Leaf lobes** entire at margin, the apex rounded or rarely apiculate; oil-bodies small homogeneous, numerous. **Leaf lobules** more or less inflated, angles obtuse or with 1-2 small teeth. **Underleaves** large, reniform or orbicular, the margin entire. **Bracts** dentate toward the acute apex. **Bracteoles** dentate to entire at margin, often emarginate to slightly bilobed. **Perianths** obovate, flattened, 4-5-keeled, keels irregularly spinose.

### Key to species

1. Margin of female bracteoles entire.....*L. subfusca*  
1. Margin of female bracteoles dentate.....*L. nipponica*

#### 1. *Lopholejeunea nipponica* Horik.

J. Sci. Hiroshima Univ. ser. b, div. 2, 1: 200, pl. 25, 9-12. 1933.; Misutani, M., J. Hattori Bot. Lab. 24: 178-180, fig. XIII. 1961. — *L. brunnea* var. *nipponica* (Horik.) Hatt. Bull. Tokyo Sci. Mus. 11: 119. 1944.

**Plants** blackish brown, 1-1.2 mm wide. **Stems** appressed to substratum, pinnate branch; in cross section of stem: 5-6 cells across, the cortical cells larger than the medullary cells. **Rhizoids** rarely. **Leaf lobes** imbricate, convex with incurved apex, ovate to falcate, margin entire, 0.52-0.56 mm long and 0.3-0.4 mm wide, marginal cells 9-11  $\mu\text{m}$  long and 7-9  $\mu\text{m}$  wide, median cells 13-15  $\mu\text{m}$  long and 13-14  $\mu\text{m}$  wide, trigones median, basal cells 21-23  $\mu\text{m}$  long and 13-15  $\mu\text{m}$  wide, trigones median. **Leaf lobules** 1/3 of the length of lobe, ovate-oblong, apex with one tooth, inflated. **Underleaves** imbricate, orbicular, margin entire, apex truncate, 0.2-0.3 mm long and 0.3-0.4 mm wide. **Bracts** the lobe of bract ovate, margin dentate, apex obtuse; the lobule of bract 4/5 of the length of the lobe, ovate, margin dentate, apex acute. **Bracteoles** orbicular, margin dentate, apex slightly truncate. **Perianths** obovate, 1-1.5 mm long and 0.8-1 mm wide, 4 keeled, keels winged with spinose. (Figure 4.49)

**Thailand** — New record to Thailand.

**Distribution** — Japan.

**Ecology** — on living bark of tree.

**Specimens examined** — P. Sukkharak 145, O. Thaithong 989, 12682 (BCU).

**GPS location** — 8.87761451° N 99.7029344° E

**Altitude** — 1,097 m

## 2. *Lopholejeunea subfusca* (Nees) Schiffn.

Hedwigia, 29: 16. 1890.; Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzengeographie 23: 593. 1897.; Misutani, M., J. Hattori Bot. Lab. 24. 180-181, fig. XII. 1961; Zhu, R. L. & So, M. L., Nova Hedwigia. 121: 94-96, fig. 39. 2001. — *Jungermannia subfusca* Nees, Hepat. Javan. 36. 1830. — *Lejeunea subfusca* (Nees) Nees & Mont., Ann. Sci. Nat., Bot., Sér. 2, 5: 61. 1836. — *Phragmicoma subfusca* (Nees) Nees, Naturg. Eur. Leberm. 3: 248. 1838. — *P. sagraeana* Mont. in Ramon de la Sagra, Hist. Fis. Poly. Nat. Cuba, 9: 464. 1843. — *Lejeunea sagraeana* (Mont.) Gott., Lindenb. & Nees, Synop. Hepat. 314. 1845. — *L. subfusca* (Nees) Gott., Lindenb. & Nees, ibid. 315. 1845. — *Phragmicoma cyclostipa* Tayl. London Jour. Bot. 5: 387. 1846. — *Lejeunea cyclostipa* (Tayl.) Gott., Lindenb. & Nees, Synop. Hepat. 749. 1848. — *Symbiezidium subfuscum* (Nees) Trev. Mem. Ist. Lomb. ser. 3, 4: 403. 1877. — *S. sagraeanum* (Mont.) Trev. loc. cit. — *S. cyclostipum* (Tayl.) Trev. loc. cit. — *Lejeunea* subgen. *Lopho-Lejeunea sagraeana* (Mont.) Spruce, Trans. Proc. Bot. Soc. Edinburgh, 15: 120. 1884. — *Lopholejeunea sagraeana* (Mont.) Schiffn. in Engler & Prantl. Nat. Pfl.-fam. 1, 3: 129. 1895. — *L. sundaica* Steph. Hedwigia, 35: 112. 1896. — *L. sagraeana* var. *subfusca* (Nees) Schiffn. Conspectus, 294. 1898. — *Mastigolejeunea andreana* Steph. Spec. Hepat. 4: 778. 1912. — *Lopholejeunea asiatica* Steph. ibid. 5: 82. 1912. — *L. pyriflora* Steph. ibid. 5: 88. 1912. — *L. levieri* Schiffn. Ann. Bryol. 6: 134. 1933. — *L. formosana* Horik. Jour. Sci. Hiroshima Univ. ser. b, div. 2, 2: 256, f. 51. 1934. (Exsicc.) Hatt. Hepat. Jap. 3: 139. 1950, as *L. formosana*; 9: 430. 1958.

**Plants** blackish brown, 0.8-1 mm wide. **Stems** appressed to substratum, pinnate branch; in cross section of stem: 5-6 cells across, the cortical cells larger than the medullary cells. **Rhizoids** rarely. **Leaf lobes** imbricate, widely spreading, orbicular to falcate, margin entire 0.24-0.26 mm long and 0.18-0.21 mm wide, marginal cells 10-13 µm long and 7-9 µm wide, median cells 15-19 µm long and 14-17 µm wide, trigones small, basal cells 23-25 µm long and 17-19 µm wide, trigones small. **Leaf lobules** 1/3 of the length of lobe, ovate, apex with one tooth, inflated. **Underleaves** slightly imbricate, orbicular, margin entire, apex truncate, 0.24-0.29 mm long and 0.4-0.5 mm wide. **Bracts** the lobe of bract orbicular, margin dentate, apex truncate; the lobule of bract 1/5 of the length of the lobe, oblong. **Bracteoles** orbicular, margin entire, apex truncate. **Perianths** obovate, 0.6-0.8 mm long and 0.5-0.6 mm wide, 4 keeled, keels winged with spinose. **Elaters** 12 µm wide with one spiral. (**Figure 4.50**)

**Thailand** — SOUTH-EASTERN: Chantaburi, CENTRAL: Prachin Buri  
PENINSULAR: Phang-nga, Ranong, Satun.

**Distribution** — Tropical Asia and Australia: Japan, Ryukyu, Formosa, India, Ceylon, Malaysia, Sumatra, Java, Borneo, Philippines, New Guinea, New Caledonia, Tahiti, North & South America, British Honduras, Africa.

**Ecology** — on living bark of tree and para rubber tree.

**Specimens examined** — P. Sukkharak 57, 59, 105, 107, 127, 128, 148, 537, O. Thaithong 995b, 1120, 1128, 1185, 1186, 1206, W. Porn-sook-sawang 36, R. Moennonsri 544, 613, 663, 664, 665a, 683a, 1035a, 1044a, 1045, 1063, 1064, 1070a, 1071, 1074a, 1075a, 1077a, 1080a, 1088, 1091a, 1155, 1189, 1191, 1235, 1261, 1295, 1298b, 1299a, 1301, 1306, 1318 (BCU); Kai Larsen, T. Smitinand & E. Warncke 127, 1712, 1728 (BKF).

**GPS location** — 8.87091279° N 99.70502615° E

**Altitude** — 340-1,034 m

## 10. *Metalejeunea*

*Metalejeunea* Grolle, Bischler, H., C. E. B. Bonner & H. A. Miller. Nova Hedwigia 5: 359-411 as *Microlejeunea monoica*. 1963.; Bryophytorum Bibliotheca 48: 17. 1995.; Gradstein, S. R.,

Churchill, S. P. & Allen, N. S., Guide to the bryophytes of tropical America: 161. 2001; Grolle, R., Bryophytorum Bibliotheca 48: 1-178. 1995.

**Plants** leafy, very small, whitish-green to dull yellowish, creeping. **Stems** zig-zag, rather rigid, of thick-walled cells, in cross section of 7 outer rows of cells and 3 smaller inner cells. **Leaf lobes** distant, hardly spreading suberect, elongated, with very large lobules (more than 1/2 the size of the lobe), apex rounded, margins entire, cells small, strongly and evenly thick-walled, ocelli lacking. **Leaf lobules** 0.5-0.8 leaf length, sometimes reduced, strongly swollen, keel crenate, apical tooth rather long and curved. **Underleaves** bifid, small. **Perianths** inflated-pyriform, with 5 smooth keels. **A monotypic genus**

***Metalejeunea cucullata* (Reinw. et al.) Grolle**

Bryophyt. Biblioth. 48: 100. 1995.; Zhu, R. L. & So, M. L. Nova Hedwigia. 121. 166-168, fig. 65. 2001. — *Jungermannia cucullata* Reinw. et al., Nova Acta Phys.-Med. Acad. Caes. Leop.-Carol. Nat. Cur. 12: 227. 1825 “1824”. — *Lejeunea cucullata* (Reinw. et al.) Nees, Naturgesch. Eur. Leberm. 3: 293. 1838. — *Microlejeunea cucullata* (Reinw. et al.) Jack & Steph., Bot. Centralbl. 60: 106. 1894. — *Eulejeunea cucullata* (Reinw. et al.) Schffin., Consp. Hepat. Arch. Ind.: 254. 1898. — *Micro-Lejeunea cucullata* (Reinw. et al.) Steph., Sp. Hepat. 5: 829. 1915. — *Microlejeunea sumdaica* Steph., Sp. Hepat. 5: 826. 1915.

**Plants** yellowish green to pale green, 0.2-0.4 mm wide. **Stems** creeping as isolated plants forming diffuse patches, in cross section of stem: 7 cortical cells in circle with 3 medullary cells, all cells thick-walled. **Rhizoids** fasciculate at base of underleaves. **Leaf lobes** distant to nearly imbricate, obliquely spreading, oblong, margin entire, apex round, 0.18-0.19 mm long and 0.11-0.12 mm wide, cells 9-11  $\mu$ m long and 7-9  $\mu$ m wide, small trigones. **Leaf lobules** 2/3 of the length of lobe, ovate-triangular, apex with two teeth, hyaline papilla at proximal side of first tooth, keel arched, strongly inflated and crenulate. **Underleaves** distant, orbicular, margin entire, bilobed, lobes acute, sinus obtuse, 60-80  $\mu$ m long and 60-64  $\mu$ m wide. **Bracts** the lobe of bract obovate, margin slightly sinuate to entire; the lobule of bract 3/4 of the length of the lobe, ovate, apex acute. **Bracteoles** obovate, slightly sinuate, apex bilobed, lobes acute, sinus very narrow. **Perianths** obovate, inflated, 0.6 mm long and 0.4 mm wide, 5 keeled. **(Figure 4.51)**

**Thailand** — PENINSULAR: Ranong.

**Distribution** — China.

**Ecology** — on living bark of tree.

**Specimens examined** — P. Sukkharak 143, 237 (BCU).

**GPS location** — 8.8775141° N 99.70278294° E, 8.87887615° N 99.69447228° E

**Altitude** — 1,074-1,210 m

## 11. *Ptychanthus*

***Ptychanthus* Nees**, Naturg. Eur. Leberm. 3: 212. 1838.; Misutani, M., J. Hattori Bot. Lab. 24: 147. 1961. — *Lejeunea* subgen. *Ptycho-Lejeunea* Spruce, Trans. Proc. Bot. Soc. Edinburgh, 15: 97. 1884. — *Ptycholejeunea* Steph. Hedwigis, 28: 258. 1889.

**Plants** dull green, dark green to brown when dry. **Stems** regularly pinnate or bipinnate, branching terminal, of the *Frullania* type; the cortical cells of the stem in about 50 longitudinal rows, the outer most cells of medulla smaller and with thicker walls than the interior cells which are thin-walled and about as large as the cortical cells. **Leaf lobes** dentate at margin, acute or acuminate at apex, cells thick-walled; oil-bodies about 10 per cell, large and of the “grape cluster” type. **Leaf lobules** saccate, usually with a single tooth. **Underleaves** sinuately inserted, dentate or occasionally emarginately bilobed at apex. **Bracts** resembling leaves but with the lobule plane,

smaller. **Bracteoles** resembling the underleaves. **Perianths** obovate, inflated, 10-keeled (3 dorsal, 4 lateral, 3 ventral), keels sharp, smooth.

***Ptychanthus striatus* (Lehm. & Lindenb.) Nees**

Naturgesch. Eur. Leberm. 3: 212. 1838.; Zhu, R. L. & So, M. L., Nova Hedwigia. 121: 88-91, fig. 38. 2001. — *Jungermannia striata* Lehm. & Lindenb. in Lehmann, Nov. Stirp. Pug. 4: 16. 1832. — *Frullania striata* (Lehm. & Lindenb.) Mont., Ann. Sci. Nat., Bot. 2: 17. 1842. — *Bryopteris striata* (Lehm. & Lindenb.) Mitt. in Seemann, Fl. Vit.: 411. 1873. — *Lejeunea striata* (Lehm. & Lindenb.) Steph., Hedwigia 29: 140. 1890. — *Ptycholejeunea striata* (Lehm. & Lindenb.) Steph. in Engler, Pflanzenw. Ost-Afrikas C: 65. 1895. — *Ptychanthus caudatus* Herzog in Handel-Mazzetti, Symb. Sin. 5: 43. 1930. — *Ptychanthus integerrimus* Horik., J. Sci. Hiroshima Univ., Ser. B, Div. 2, Bot. 2: 245. 1934.

**Plants** pale green, 1.7-1.9 mm wide, pendent on twig **Stems** irregular; in cross section of stem: 2-3 rows of small and thick walled cortical cells surrounding medullary cells. **Rhizoids** not seen. **Leaf lobes** slightly imbricate, widely ovate, margin entire, dorsal margin auricle at base, apex apiculate, 1.4-1.6 mm long and 0.8-0.9 mm wide, marginal cells 7-10 µm long and 7-13 µm wide, median cells 23-36 µm long and 10-19 µm wide, trigones large, basal cells 26-47 µm long and 15-28 µm wide, trigones large. **Leaf lobules** 1/6 of the length of leaf lobe, ovate to orbicular, strongly inflate, apex with 2-3 teeth, sharply triangular. **Underleaves** imbricate, orbicular, base auricle, apex emarginated, irregular tooth, margin entire, recurved, 0.6-0.7 mm long and 0.5-0.6 mm wide. **Bracts** the lobe of bract lanceolate, margin entire, apex acute to apiculate, the lobule of bract 1/3 of the length of the lobe, ovate, margin entire. **Bracteoles** oblong, margin entire, apex emarginated 1/8 of its length. **Perianths** obovate to elliptical, 1.3-1.4 mm long and 0.5-0.6 mm wide, margin entire, 10 keels to 2/3 of its length. (**Figure 4.52**)

**Thailand** — NORTH: Chiang Mai; NORTH-EASTERN: Loei; SOUTH-WESTERN: Prachuap Khiri Khan.

**Distribution** — China, widely distributed in the tropical and subtropical region of Asia, Oceania and Africa.

**Ecology** — on living bark of tree.

**Specimen examined** — P. Sukkharak 546 (BCU).

**GPS location** — Exact locality not applicable. Near TT03.

**Altitude** — ca. 449 m

## 12. *Schiffneriolejeunea*

***Schiffneriolejeunea* Verd.**, Annales Bryologici 6: 89. 1933.; Gradstein, S. R., Flora Neotropica Monograph. 62: 1-216. 1994.; Gradstein, S. R., Churchill, S. P. & Allen, N. S., Guide to the bryophytes of tropical America: 132. 2001.

**Plants** green to rather glossy brown, creeping or ascending. **Stems** with enlarged dorsal epidermal (ventral epidermis not enlarged), epidermis brown, medulla cells thick-walled. **Leaf lobes** wide-spreading, when dry convolute and wrapped around the stem, apex rounded, margin entire, cells slightly longer than wide, trigones cordate; oil-bodies coarsely granular. **Leaf lobules** 1/3-1/2 leaf length, sometimes reduced, with 1-2 teeth, free margin not inflexed. **Underleaves** undivided, with entire margins and straight or weakly curved insertion line. **Bract** apices acute-acuminate. **Perianths** with 4(-6) keels, the keels inflated-swollen or sharp. **Vegetative reproduction** by regeneration from leaf cells.

### Key to species

1. Apex of female bracteoles round..... *S. cumingiana*
1. Apex of female bracteoles bifid..... *S. tumida* var. *tumida*

### 1. *Schiffneriolejeunea cumingiana* (Mont.) Gradst.

J. Hattori Bot. Lab. 38: 335. 1974.; Gradstein, S. R., He, X.-L., Piippo, S. & Mizutani, M. Acta Bot Fennica. 174. 58-59, fig. 36. 2002. — *Phragmicoma cumingiana* Mont., London J. Bot. 4: 7. 1845. — *Ptychocoleus cumingianus* (Mont.) Trevis., Mem. Reale Ist. Lomb. Sci. Mat. Nat., Ser. 3, 4: 405. 1877.

**Plants** pale green, 1.5-1.7 mm wide. **Stems** irregular; in cross section of stem: thick walled, the cortical cells slightly larger than the medullary cells. **Rhizoids** bundle on the basal of underleaves. **Leaf lobes** densely imbricate, convolute and clasp the stem when dry, spreading and nearly squarose to orbicular when moist, margin entire, apex round and slightly recurved, 1-1.1 mm long and 0.8-0.9 mm wide, marginal cells 9-13  $\mu\text{m}$  long and 7-10  $\mu\text{m}$  wide, median cells 19-22  $\mu\text{m}$  long and 11-13  $\mu\text{m}$  wide, trigones medium, basal cells 23-35  $\mu\text{m}$  long and 18-25  $\mu\text{m}$  wide, trigones large. **Leaf lobules** revolute in basal half, apex with 1-2 teeth, margin involute forming a closed sac. **Underleaves** imbricate, broadly orbicular, 0.5-0.6 mm long and 0.6-0.7 mm wide, recurved, margin entire. **Bracts** the lobe of bract suborbicular, margin entire and incurved, the lobule of bract 2/3 of the length of the lobe, ovate, margin entire. **Bracteoles** oblong, margin entire, apex round. **Perianths** obovate, 1-1.1 mm long and 0.7-0.8 mm wide, margin entire, inflated on upper half 5 keels, beak short. (**Figure 4.53**)

**Thailand** — PENINSULAR: Surat Thani.

**Distribution** — Papua New Guinea, Singapore.

**Ecology** — on bark of para rubber tree.

**Specimen examined** — P. Sukkharak 547 (BCU).

**GPS location** — 8.8582158° N 99.7137752° E

**Altitude** — 329 m

### 2. *Schiffneriolejeunea tumida* (Nees) Gradst. var. *tumida*

J. Hattori Bot. Lab. 38: 335. 1974.; Gradstein, S. R., He, X.-L., Piippo, S. & Mizutani, M., Acta Bot Fennica. 174. 61-64, fig. 39. 2002. — *Phragmicoma tumida* (Nees) Nees & Mont. In Gottsche et al., Syn. Hep. 300. 1845. — *Ptychocoleus tumidus* (Nees) Trevis., Mem. Reale Ist. Lomb. Sci. Mat. Nat., Ser. 3, 4: 405. 1877. — *Acrolejeunea tumida* (Nees) Schiffn., Hedwigia 33: 185. 1894.

**Plants** brownish yellow, 2-2.5 mm wide. **Stems** irregular; in cross section of stem: thick walled, the cortical cells as large as the medullary cells. **Rhizoids** few. **Leaf lobes** densely imbricate, convolute when dry, suborbicular, margin entire, apex round, 1-1.1 mm long and 0.8-0.9 mm wide, marginal cells 9-11  $\mu\text{m}$  long and 13-14  $\mu\text{m}$  wide, median cells 21-23  $\mu\text{m}$  long and 13-14  $\mu\text{m}$  wide, medium trigones, basal cells 32-36  $\mu\text{m}$  long and 26-32  $\mu\text{m}$  wide, large trigones. **Leaf lobules** 1/3 as long as the lobe, ovate, apex truncate with 1-2 teeth, margin involute forming a closed sac. **Underleaves** imbricate, orbicular, 0.8-1 mm long and 1-1.1 mm wide, recurved, margin entire. **Bracts** the lobe of bract suborbicular, margin entire and incurved, the lobule of bract 1/2-1/3 of the length of the lobe, ovate, margin entire and incurved. **Bracteoles** obovate-oblancoolate, margin entire, apex bifid 1/5 of the length. **Perianths** obovate, 1.2-1.3 mm long and 0.6-0.7 mm wide, margin entire, sharply 5-keels. (**Figure 4.54**)

**Thailand** — New record to Thailand.

**Distribution** — West Irian, Papua New Guinea, Solomon Islands.

**Ecology** — on living bark of para rubber tree.

**Specimen examined** — P. Sukkharak 103 (BCU).

**GPS location** — 8.8582158° N 99.7137752° E

**Altitude** — 329 m

## 13. *Spruceanthus*

*Spruceanthus* Verd., Ann. Bryol, suppl. 4: 151. 1934.; Mizutani, M., J. Hattori Bot. Lab. 24: 160-161. 1961.

**Plants** green to brown. **Stems** irregularly branched by the intercalary branching; in cross section of the stem, cells thick-walled, trigones large, the cortical cells in 30-35 longitudinal rows, slightly smaller than the medullary cells. **Leaf lobes** dentate to almost entire at margin, acute or rarely obtuse at apex; cells thick-walled, intermediate thickenings and trigones large, nodulose; oil-bodies numerous, 25-40 per cell, minute, homogenous, hyaline. **Leaf lobules** with 1-3 teeth. **Underleaves** orbicular, the margin entire or dentate. **Bracts** spinose-dentate at margin, acute at apex. **Bracteoles** entire or dentate at margin. **Perianths** 5-10-keeled (1-2 dorsal, 2 alteral, 2-5 ventral), keels smooth.

***Spruceanthus semirepandus* (Nees) Verd.**

Ann. Bryol. suppl. 4: 153. 1934.; Mitzutani, M., J. Hattori Bot. Lab. 24. 161-164, fig. IX. 1961. — *Jungermannia semirepanda* Nees, Hepat. Javan. 39. 1830. — *Ptychanthus semirepandus* (Nees) Nees, Naturg. Eur. Leberm. 3: 212. 1838. — *Phragmicoma semirepanda* (Nees) Gott. in Gott., Lndnb. & Nees, Synop. Hepat. 302. 1845. — *Lejeunea semirepanda* (Nees) Mitt. J. Proc. Linn. Soc. Bot. 5: 111. 1861. — *L.* subgen. *Ptyco-Lejeunea semirepanda* (Nees) Spruce, Trans. Proc. Bot. Soc. Edinburgh, 15: 99. 1884. — *Thysananthus rotundistipulus* Steph. Spec. Hepat. 6: 565. 1924. — *T. fragillimus* Herz. in Mazzetti, Symb. Sinic. 5: 45, f. 16. 1930. — *Ptychanthus madothecoides* Horikl. J. Sci. Hiroshima Univ. ser. b, div. 2, 2: 248, f. 48. 1934. — *Spruceanthus semirepandus* fo. *integerrimus* Hatt. Bull. Tokyo Sci. Mus. 11: 132, f. 83. 1944. (Exsicc.) Hattori, Hepat. Jap. 2: 86. 1947.

**Plants** brownish-green to blackish brown, 3-5 mm wide. **Stems** irregular; in cross section of stem: thick wall, the cortical cells as large as the medullary cells. **Rhizoids** few. **Leaf lobes** imbricate, obliquely spreading, ovate, margin entire, apex cuspidate, 2.3-2.5 mm long and 1.3-1.4 mm wide, median cells 26-27  $\mu\text{m}$  long and 21-23  $\mu\text{m}$  wide, trigones large, basal cells 46-69  $\mu\text{m}$  long and 17-19  $\mu\text{m}$  wide, trigones large. **Leaf lobules** 1/5 as long as the lobe, ovate, flat, apex truncate with 2 small teeth. **Underleaves** imbricate, orbicular, apex truncate, 0.82-0.80 mm long and 0.85-0.88 mm wide. **Bracts** the lobe of bract ovate, margin entire, apex dentate, the lobule of bract 2/3 of the length of the lobe, ovate, apex truncate, margin entire. **Bracteoles** orbicular, margin entire, apex truncate. **Perianths** oblanceolate, 2.8-3 mm long and 1.3-1.5 mm wide, 6 keeled. (Figure 4.55)

**Thailand** — PENINSULAR: Nakhon Si Thammarat.

**Distribution** — Borneo, China, Formosa, India, Japan, Java, Philippines.

**Ecology** — on living bark and twig of tree, rotten log, rock.

**Specimen examined** — P. Sukkharak 87, 123, 179, 193, 232, 244, 271, 288, 370, 371, 392, 416, 437, 453, 519, 520, 531, 535 (BCU).

**GPS location** — 8.85642° N 99.71506° E, 8.87903574° N 99.69451696° E, 8.87842739° N 99.69416173° E, 8.8762933° N 99.69270945° E, 8.87710333° N 99.68977511° E, 8.88229072° N 99.69644308° E, 8.8769263° N 99.692173° E, 8.87729645° N 99.69225347° E

**Altitude** — ca. 559-1,385 m

## 14. *Thysananthus*

***Thysananthus* Lindenb.**, In Lehm. Pugillus, 8: 24. 1844.; Mitzutani, M., J. Hattori Bot. Lab. 24: 152-153. 1961. — *Lejeunea* subgen. *Thysano-Lejeunea* Spruce, Trans. Proc. Bot. Soc. Edinburgh, 15: 105. 1884. — *Lejeunea* subgen. *Dendro-Lejeunea* Spruce, ibid. 15: 110. 1884. — *Thysanolejeunea* Sim, Trans. Roy. Soc. S. Afr. 15: 50. 1926.

**Plants** dull olive green to dark green to black or dark brown with age. **Stems** irregularly pinnate, mostly by intercalary branch except the subfloral innovation; the cortical cells of the stem in about 30 longitudinal rows, as large as the medullary cells, both medullary and cortical cells much thick-walled, thigones large. **Leaf lobes** densely imbricate, the lobe dentate at margin, acute at apex; cell walls thick and with large intermediate thickening and trigones; oil-bodies large, of the grape cluster type, usually 2-3 per cell. **Leaf lobules** saccate, the free margin mostly involute, with 1-2 teeth at apex. **Underleaves** densely imbricate, the margin dentate, the apex

often emarginate. **Bracts and Bracteoles** similar to leaves and underleaves, but slightly longer and more acute at apex. **Perianths** sharply 3-keeled, often with 1-7 (0-3 dorsal, 2 lateral, 1-3 ventral) small additional keels, keels typically ciliate-dentate.

#### Key to species

1. Leaf lobes without vitta.
  2. Lateral leaves and underleaves margin entire..... *T. sp.*
  2. Lateral leaves and underleaves margin dentate..... *T. spathulistipus*
1. Vitta present from middle to base of leaf lobes ..... *T. retusus*

#### 1. *Thysananthus retusus* (Reinw. et al.) B. Thiers & Gradst.

Mem. N. Y. Bot. Garden 52: 67. 1989.; Gradstein, S. R., He, X.-L., Piippo, S & Mitzutani, M., Acta Bot Fennica. 174: 78-80, Fig. 50. 2002. — *Jungermannia retusa* Reinw. et al., Acta Phys.-Med. Acad. Caes. Leop.-Carol. Nat. Cur. 12: 214. 1824. — *Ptychanthus retusus* (Reinw. et al.) Nees var. *alpha* (Nees) Nees in Gottsche et al., Syn. Hep. 292. 1845. — *Thysananthus planus* Sande Lac., Ned. Kruidk. Arch. 3, 4: 419. 1854.

**Plants** brownish green, 1-2 mm wide. **Stems** irregular; in cross section of stem: 10-11 cells cross, thick wall. **Rhizoids** few. **Leaf lobes** imbricate, obliquely spreading, ovate, margin entire, apex acute-cuspidate, 1.1-1.2 mm long and 0.49-0.56 mm wide, non-vitta cells quadrate, median cells 5-7  $\mu$ m long and 5-7  $\mu$ m wide, vitta from base to middle of leaf-lobe, vitta from base to middle of leaf-lobe, median vitta cells 32-36  $\mu$ m long and 7-8  $\mu$ m wide, basal vitta cells 35-52  $\mu$ m long and 11-13  $\mu$ m wide. **Leaf lobules** 1/4 as long as the lobe, ovate, flat, apex truncate with 1 linear tooth, 5-6 cells long. **Underleaves** imbricate, orbicular, apex retuse to slightly truncate 0.44-0.48 mm long and 0.31-0.40 mm wide. **Bracts** the lobe of bract ovate, margin entire, apex acute, the lobule of bract 1/4 of the length of the lobe, ovate, margin entire, apex dentate, vitta from base to middle of bract. **Bracteoles** obovate, margin entire, apex with 2 acute lobes. **Perianths** obovate, 1.1-1.2 mm long and 0.6-0.8 mm wide, sharply 3 keeled. (**Figure 4.56**)

**Thailand** — SOUTH-WESTERN: Prachuap Khiri Khan.

**Distribution** — West Irian, Papua New Guinea, Solomon Islands, Indonesia, Australia, Oceania.

**Ecology** — on living bark of tree.

**Specimen examined** — P. Sukkharak 44, 291b, 423 (BCU).

**GPS location** — 8.87009203° N 99.69762325° E

**Altitude** — 956-1,080 m

#### 2. *Thysananthus spathulistipus* (Reinw. et al.) Lindenb.

Syn. Hep. 287. 1845.; Gradstein, S. R., He, X.-L., Piippo, S & Mitzutani, M., Acta Bot Fennica. 174. 80-82, fig. 51. 2002. — *Jungermannia spathulistipa* Reinw. et al., Acta Phys.-Med. Acad. Caes. Leop.-Carol. Nat. Cur. 12: 212. 1824. — *Thysananthus aculeatus* Herzog, Ann. Bryol. 4: 89. 1931.

**Plants** blackish-brown, 1.5-2 mm wide. **Stems** irregular; in cross section of stem: 11 cells cross, thick wall. **Rhizoids** few. **Leaf lobes** imbricate, obliquely to widely spreading, ovate, margin entire, apex dentate, 1.3-1.4 mm long and 0.7-0.8 mm wide, median cells 14-17  $\mu$ m long and 6-9  $\mu$ m wide, trigones large, basal cells 32-55  $\mu$ m long and 17-23  $\mu$ m wide. **Leaf lobule** 1/2 as long as the lobe, ovate, incurved, apex narrow. **Underleaves** imbricate, obovate, apex truncate with dentate, margin entire, 0.5-0.6 mm long and 0.60-0.64 mm wide. **Bracts** the lobe of bract ovate, margin entire, apex dentate, the lobule of bract 1/3 of the length of the lobe, ovate, apex and margin dentate. **Bracteoles** oblong, margin recurved, apex dentate. **Perianths** obovate, 1.8-2 mm long and 0.5-0.8 mm wide, 3 keeled, margin dentate. (**Figure 4.57 and 4.112**)

**Thailand** — NORTH-EASTERN: Loei; SOUTH-EASTERN: Trat; PENINSULAR: Phang-nga, Ranong.

**Distribution** — Madagascar to Oceania, West Irian, Papua New Guinea, Solomon Islands, Australia, Indonesia, Philippines.

**Ecology**. — on living bark and twig of tree, rotten log.

**Specimen examined**. — P. Sukkharak 56, 58, 86, 133, 144, 170, 175, 212, 234, 282, 349, 354, 357, 386, 405, 462, 467, O. Thaithong 972, 981, T. Boonkerd 14 (BCU).

**GPS location** — 8.87761451° N 99.7029344° E, 8.88259495° N 99.70011875° E, 8.88279939° N 99.70001649° E, 8.87903574° N 99.69451696° E, 8.87594461° N 99.68868077° E, 8.87663126° N 99.69043493° E

**Altitude** — 970-1,364 m

### 3. *Thysananthus* sp.

**Plants** blackish brown, 2-2.5 mm wide. **Stems** irregular; in cross section of stem: 11-12 cells cross, thick walled, the cortical cells as large as the medullary cells. **Rhizoids** few. **Leaf lobes** densely imbricate, orbicular, slightly convex, margin entire and undulate, apex obtuse, 1.1-1.2 mm long and 0.9-1 mm wide, marginal cells 10-12  $\mu$ m long and 10-13  $\mu$ m wide, median cells 21-22  $\mu$ m long and 11-13  $\mu$ m wide, trigones large, basal cells 46-59  $\mu$ m long and 17-21  $\mu$ m wide, trigones large. **Leaf lobules** 2/3 as long as the lobe, ovate, flat, apex truncate with 2 small teeth, margin incurved. **Underleaves** imbricate, orbicular, 0.5-0.6 mm long and 0.62-0.67 mm wide, apex slightly dentate to entire, margin entire. **Bracts** the lobe of bract ovate, margin and apex dentate, the lobule of bract 1/2 of the length of the lobe, ovate, margin and apex dentate. **Bracteoles** oblong, margin dentate, apex with 2 acute lobes. **Perianths** oblong, 1.2-1.3 mm long and 0.7-0.8 mm wide, margin ciliate, sharply 3 keels with smaller supplementary keels. (**Figure 4.58**)

**Thailand** —

**Distribution** —

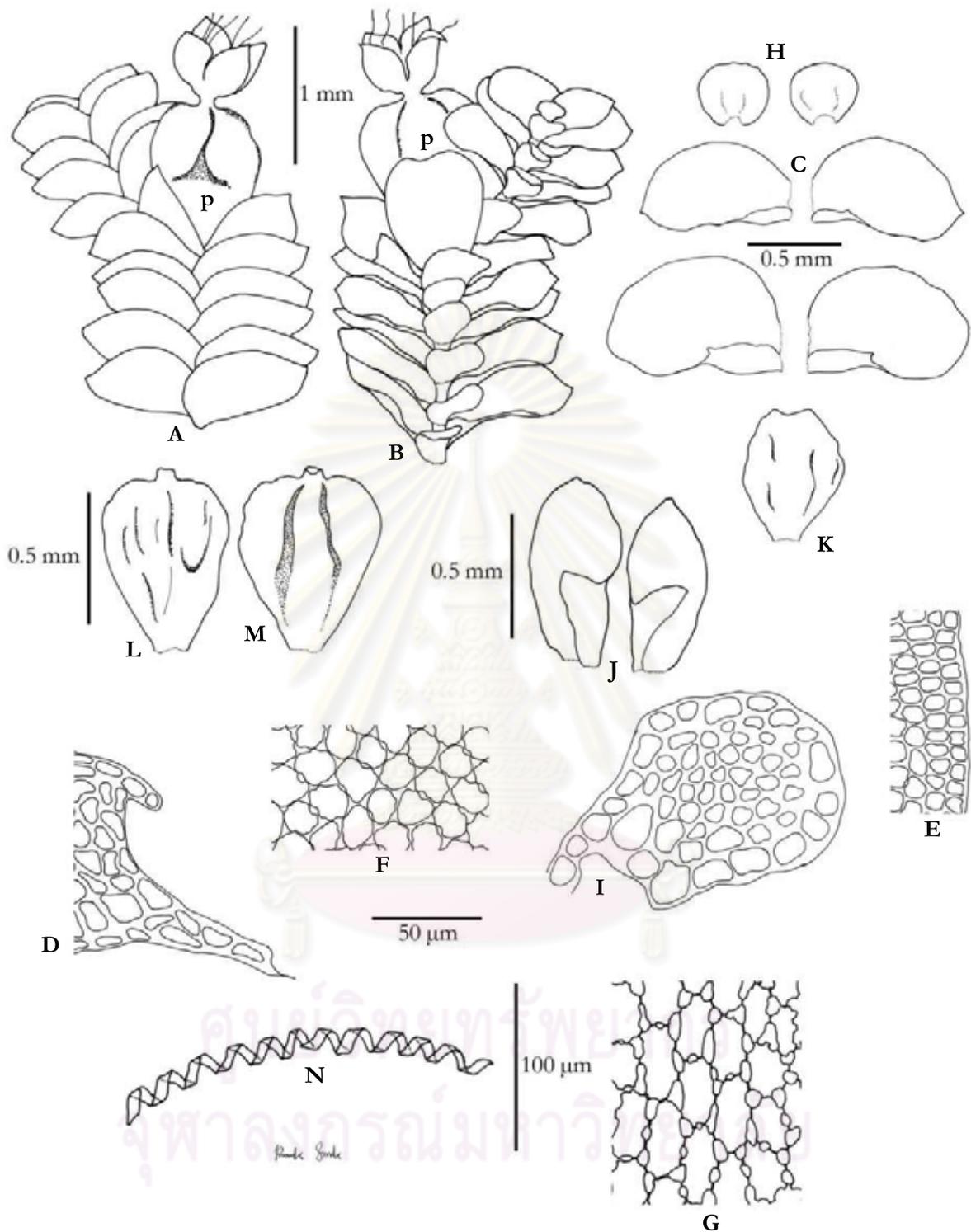
**Ecology** — on living branch and bark of tree.

**Specimen examined** — P. Sukkharak 208, 334, 348 (BCU).

**GPS location** — Exact locality not applicable. Between TT06-TT24.

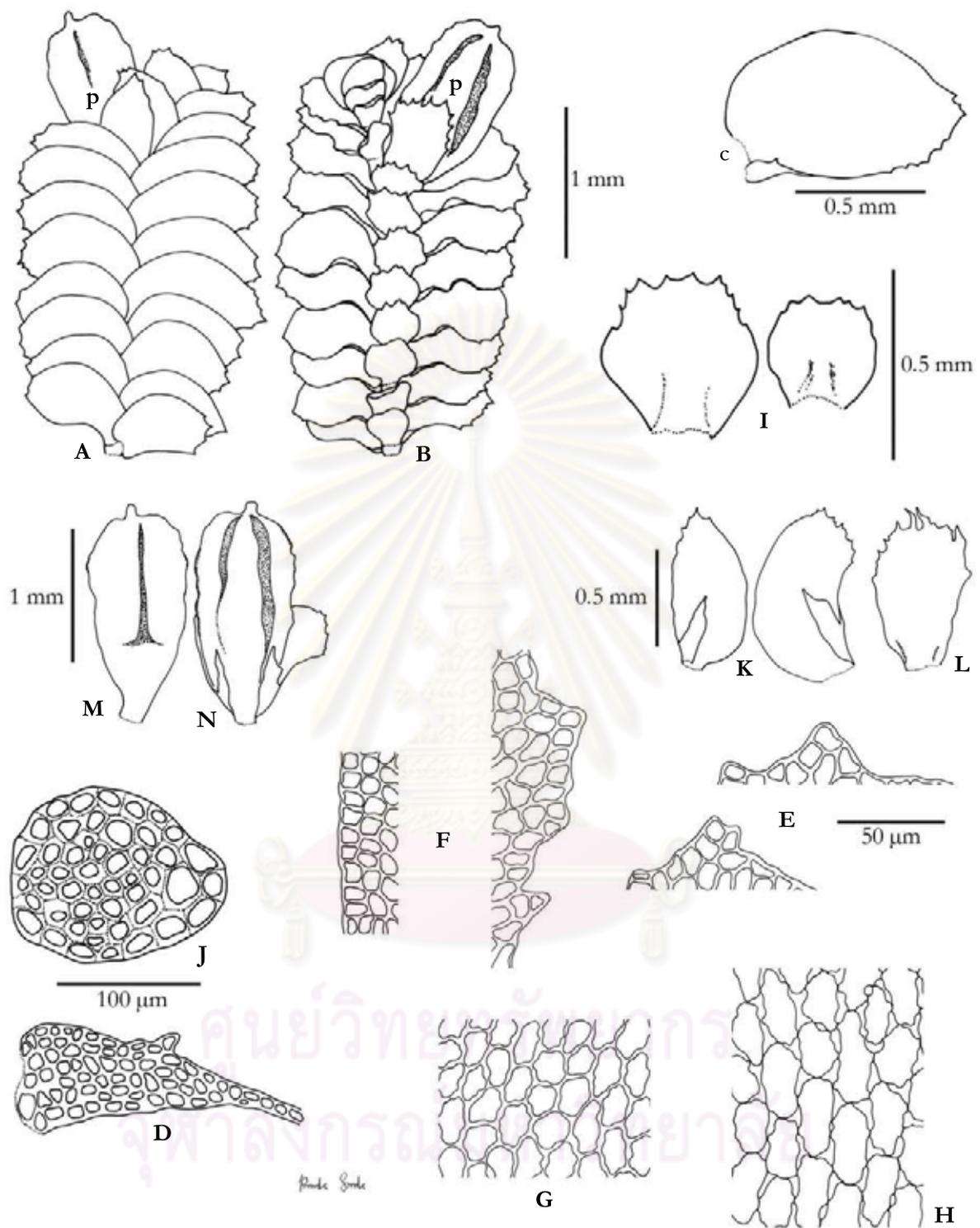
**Altitude** — Exact locality not applicable. ca. 599-1,282 m

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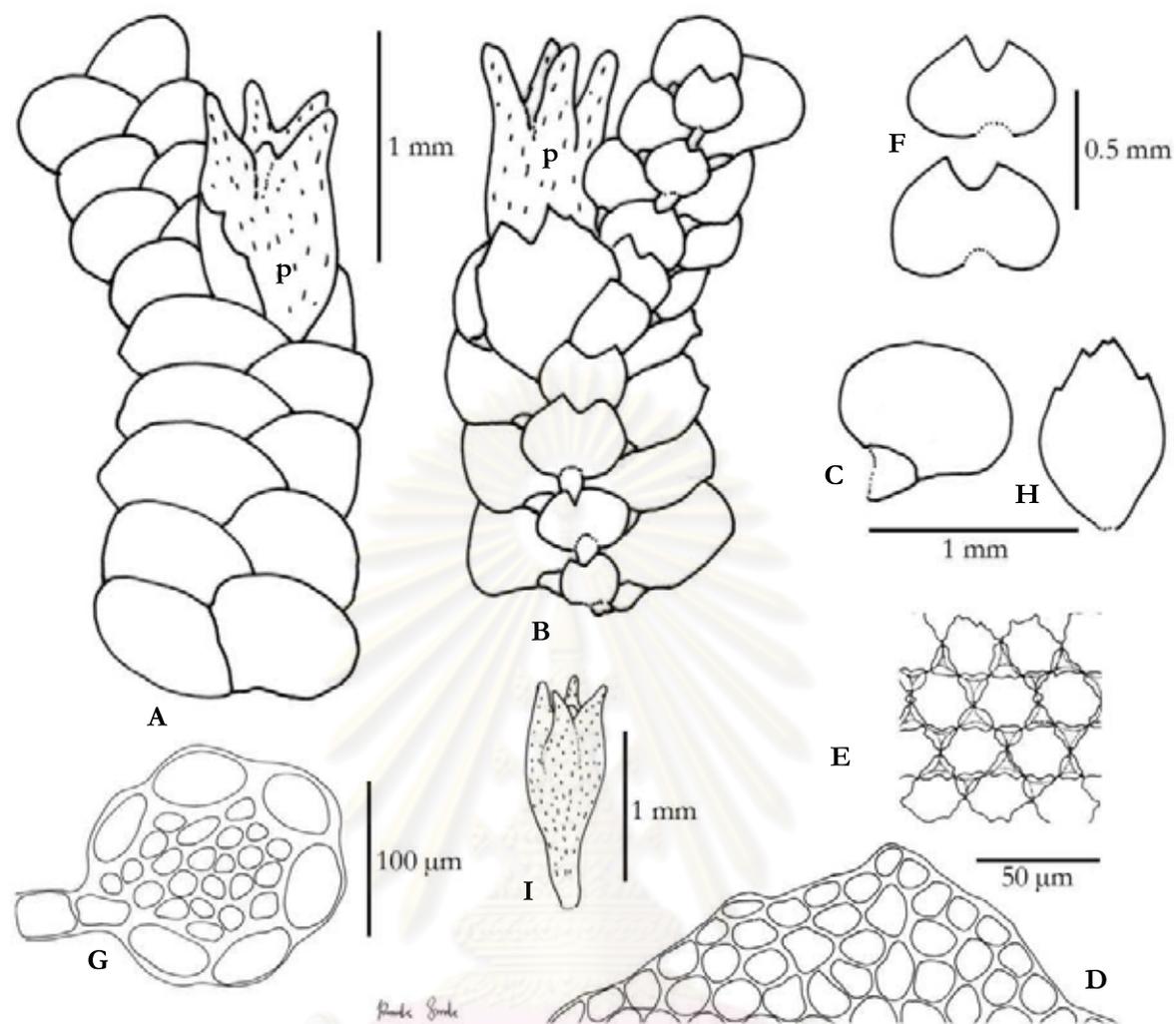
**Figure 4.30** *Archibolejeunea planinscula* (Mitt.) Steph.

A.-B. portion of plant with perianth (p): A. dorsal view, B. ventral view; C. lateral leaves; D. apical portion of leaf lobule; E. cells at leaf margin; F. cells at leaf median; G. cells at leaf base; H. underleaves; I. cross section of stem; J. bracts; K. bracteole; L.-M. perianth: L. dorsal view, M. ventral view; N. part of elater. P. Sukkharak 14



**Figure 4.31** *Archilejeunea polymorpha* (Sande Lac.) B. Thiers & Gradst.

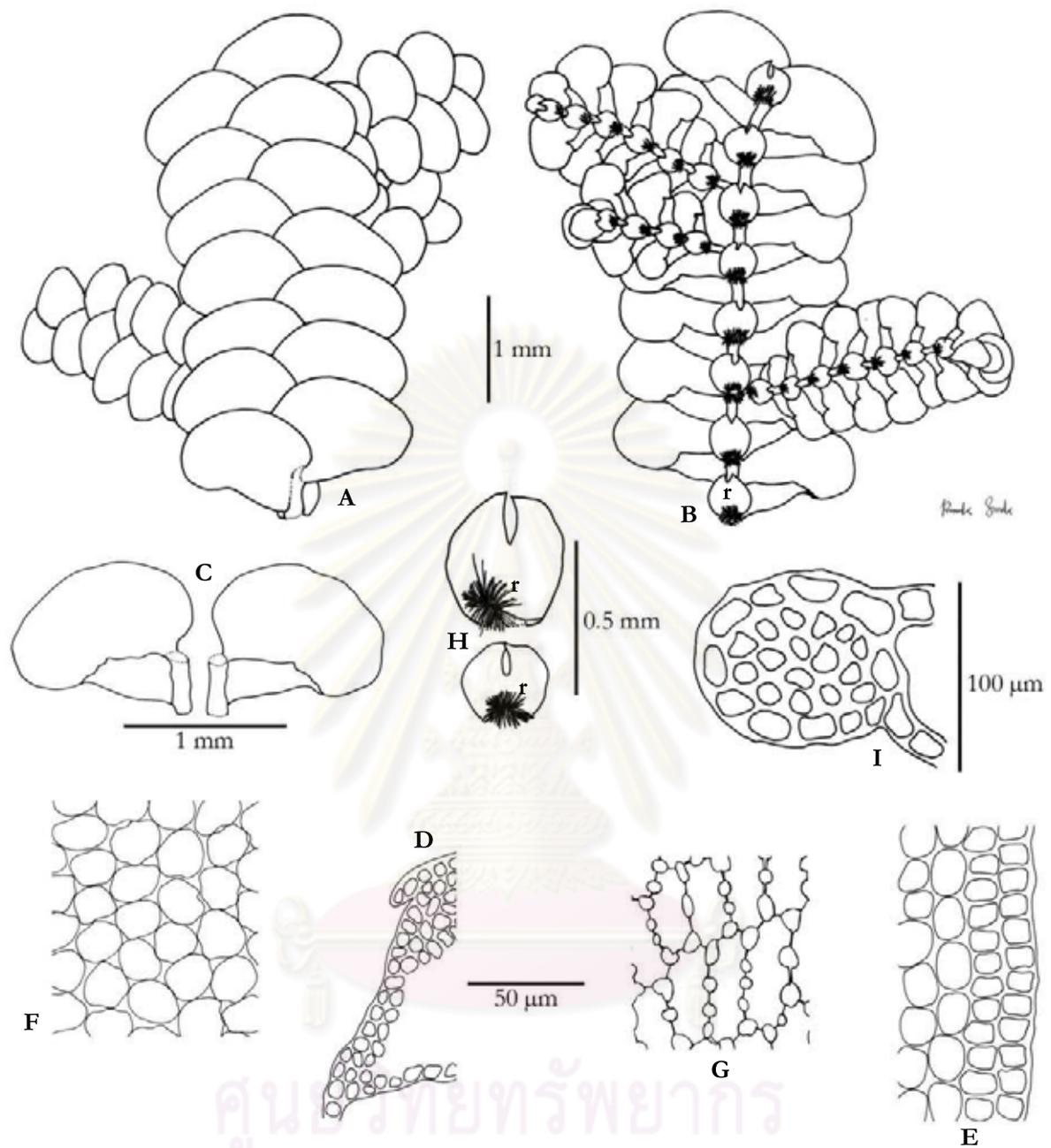
A.-B. portion of plant with perianth (p): A. dorsal view, B. ventral view; C. lateral leaves; D. apical portion of leaf lobule; E. cells at leaf apex; F. cells at leaf margin; G. cells at leaf median; H. cells at leaf base; I. underleaves; J. cross section of stem; K. bracts; L. bracteole; M.-N. perianth: M. dorsal view, N. ventral view with bracts. P. Sukkharak 293.



**Figure 4. 32** *Ceratolejeunea belangeriana* (Gottsche) Steph.

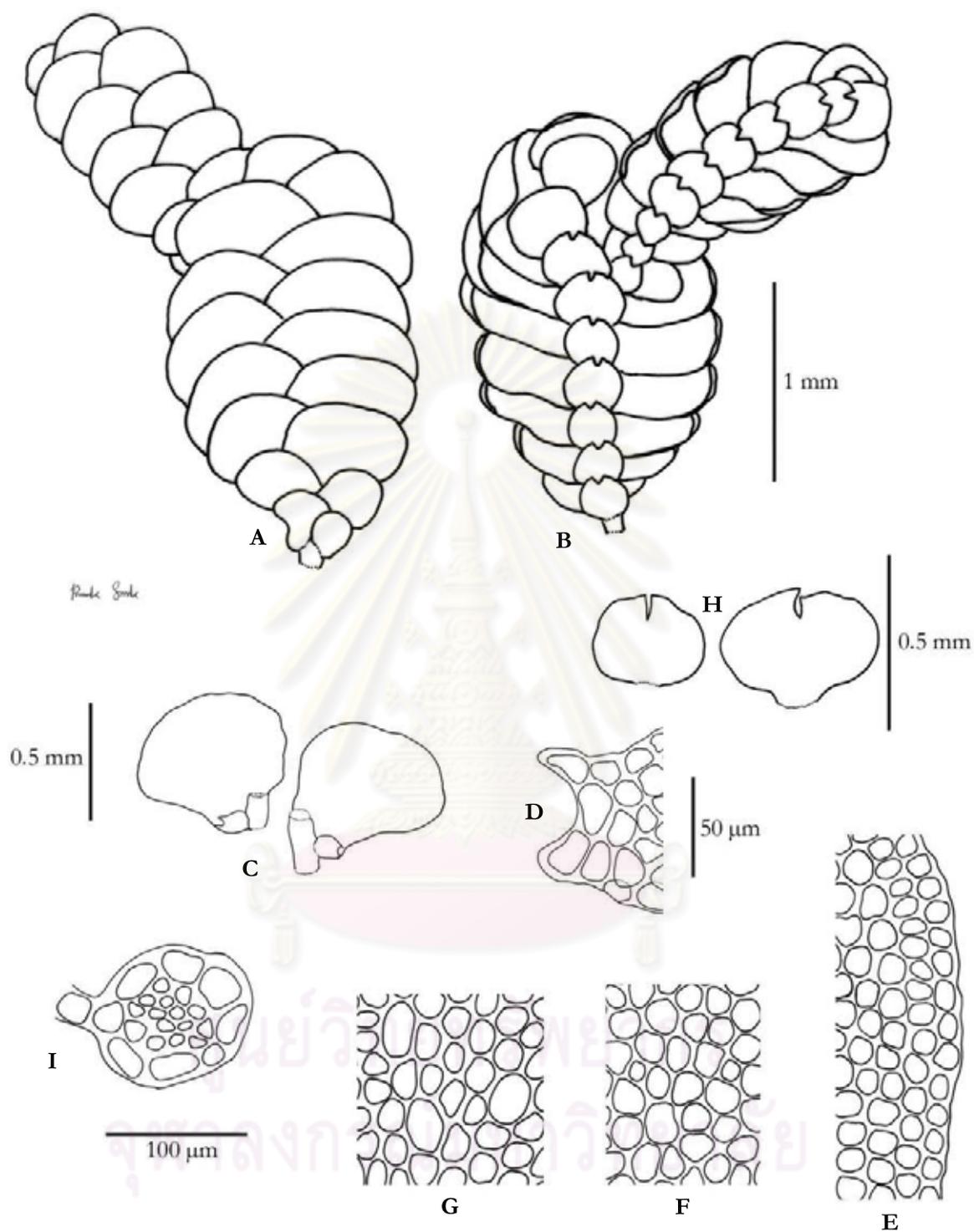
A.-B. portion of plant with perianth (p): A. dorsal view, B. ventral view; C. lateral leaf; D. cells at leaf apex; E. cells at leaf median; F. underleaves; G. cross section of stem; H. bracteole; I. perianth.  
P. Sukkharak 6.

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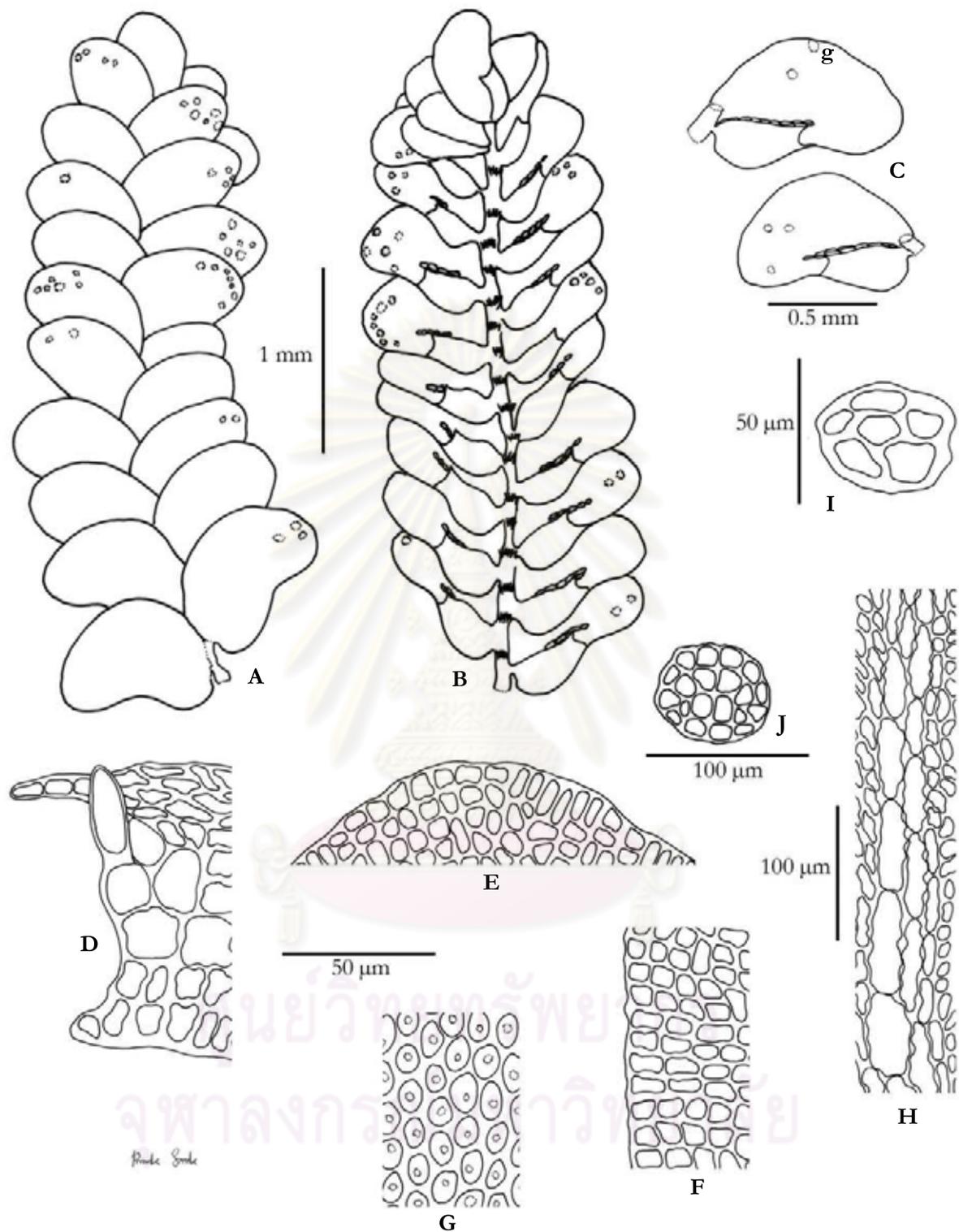
**Figure 4. 33** *Cheilolejeunea* sp. 1

A.-B. portion of plant: A. dorsal view, B. ventral view with rhizoids (r); C. lateral leaves; D. apical portion of leaf lobule; E. cells at leaf margin; F. cells at leaf median; G. cells at leaf base; H. underleaves with rhizoids (r); I. cross section of stem. P. Sukkhararak 529.



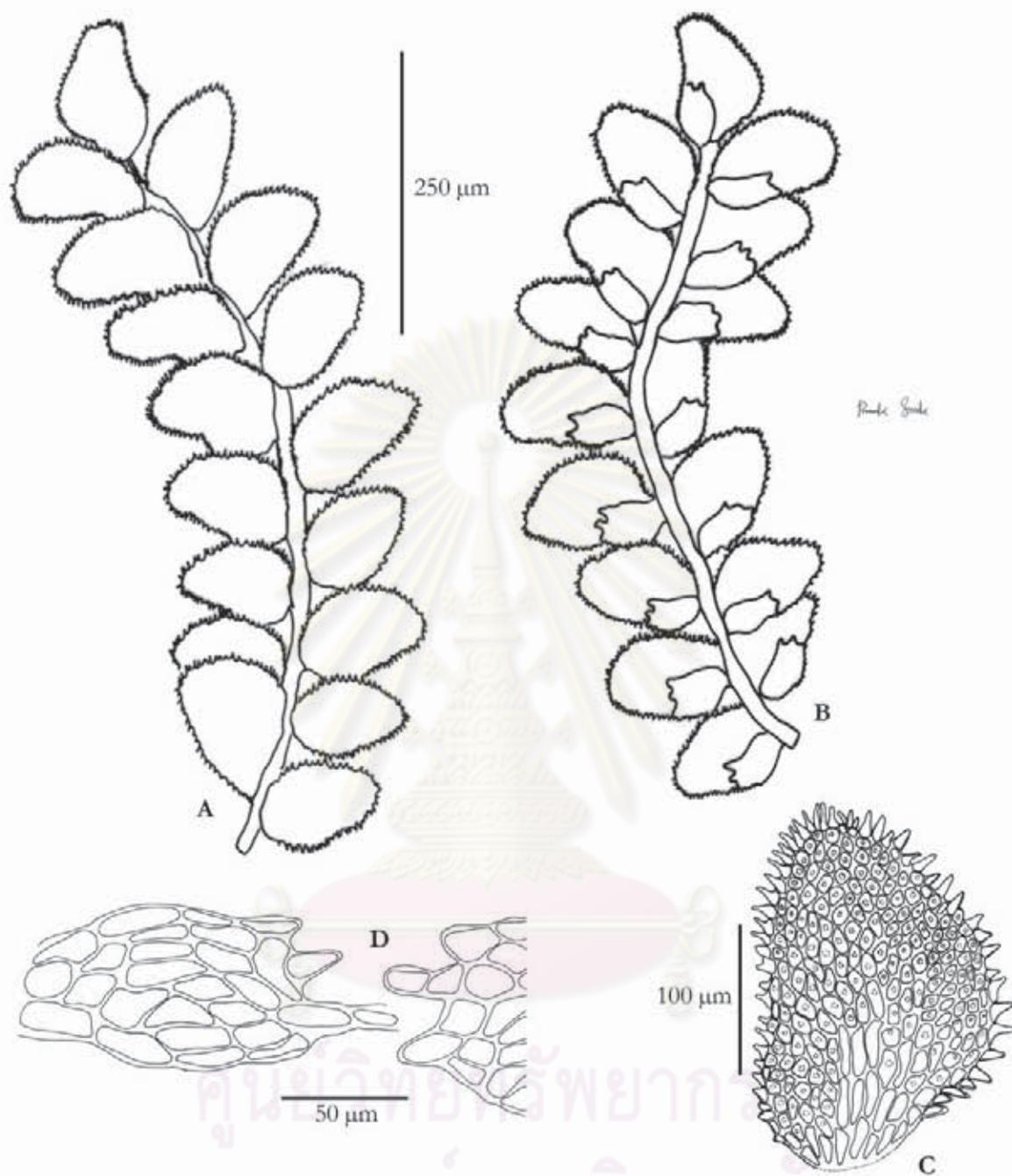
**Figure 4. 34** *Cheilolejeunea* sp. 2

A.-B. portion of plant: A. dorsal view, B. ventral view; C. lateral leaves; D. apical portion of leaf lobule; E. cells at leaf margin; F. cells at leaf median; G. cells at leaf base with ocelli; H. underleaves; I. cross section of stem. P. Sukkharak 487.

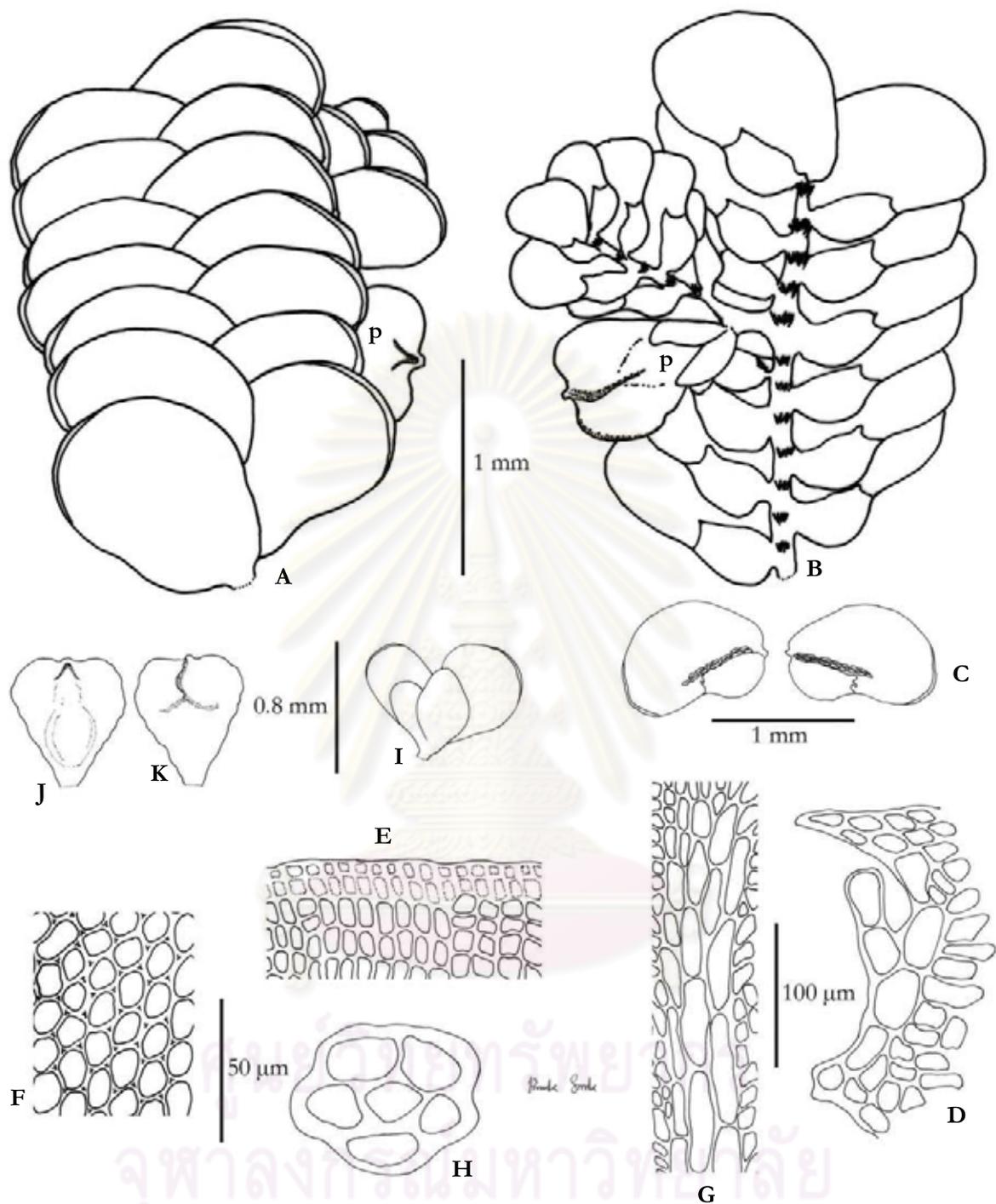


**Figure 4. 35** *Cololejeunea ocelloides* (Horik.) S. Hatt.

A.-B. portion of plant: A. dorsal view, B. ventral view; C. lateral leaves with gemmae (g); D. apical portion of leaf lobule; E. cells at leaf apex; F. cells at leaf margin; G. cells at leaf median; H. cells at leaf base; I. cross section of stem; J. gemma. P. Sukkharak 539.

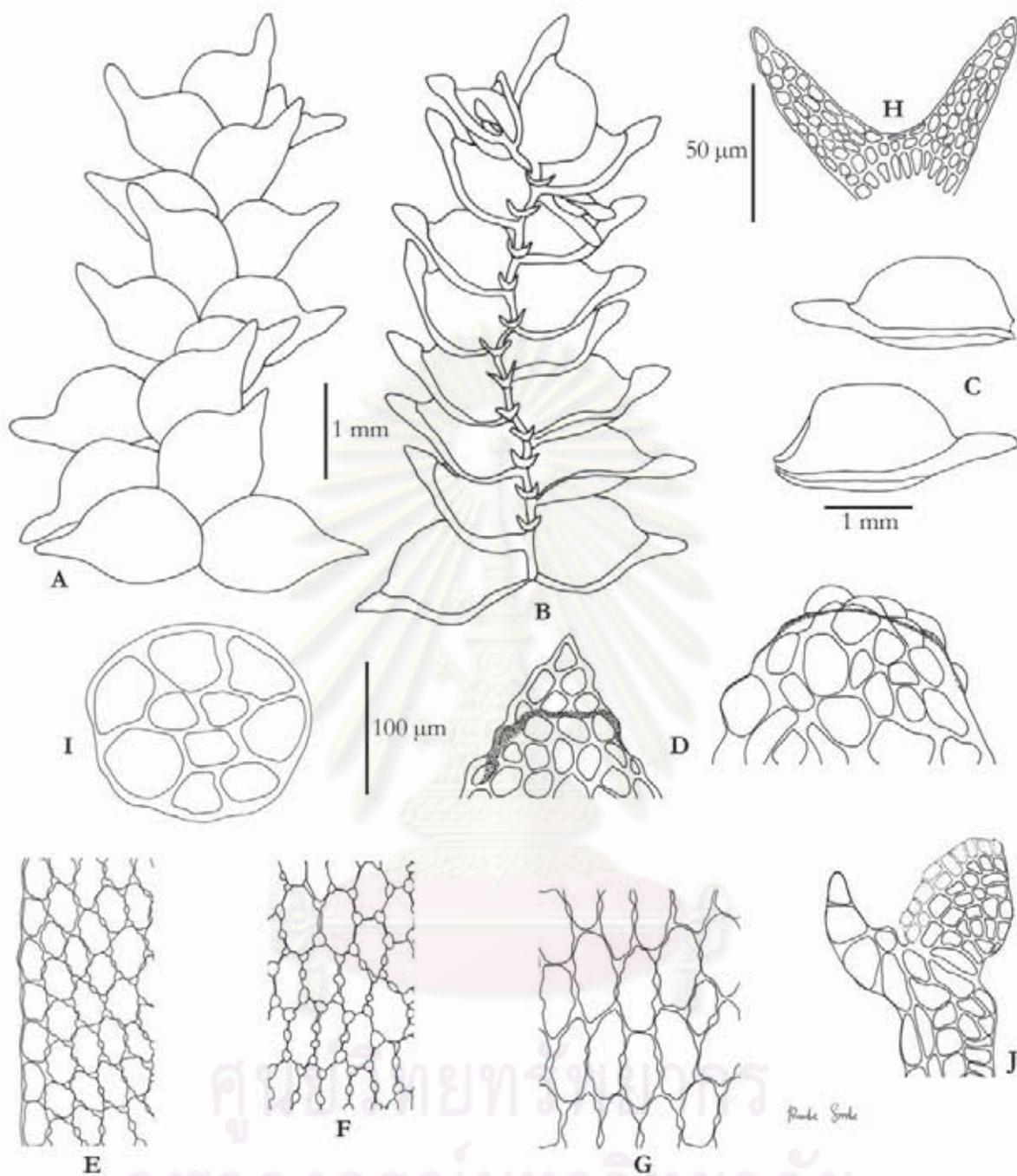


**Figure 4. 36** *Cololejeunea spinosa* (Horik.) Pandé & Misra  
 A.-B. portion of plant: A. dorsal view, B. ventral view; C. lateral leaves; D. apical portion of leaf lobule.  
 P. Sukkharak 538b.



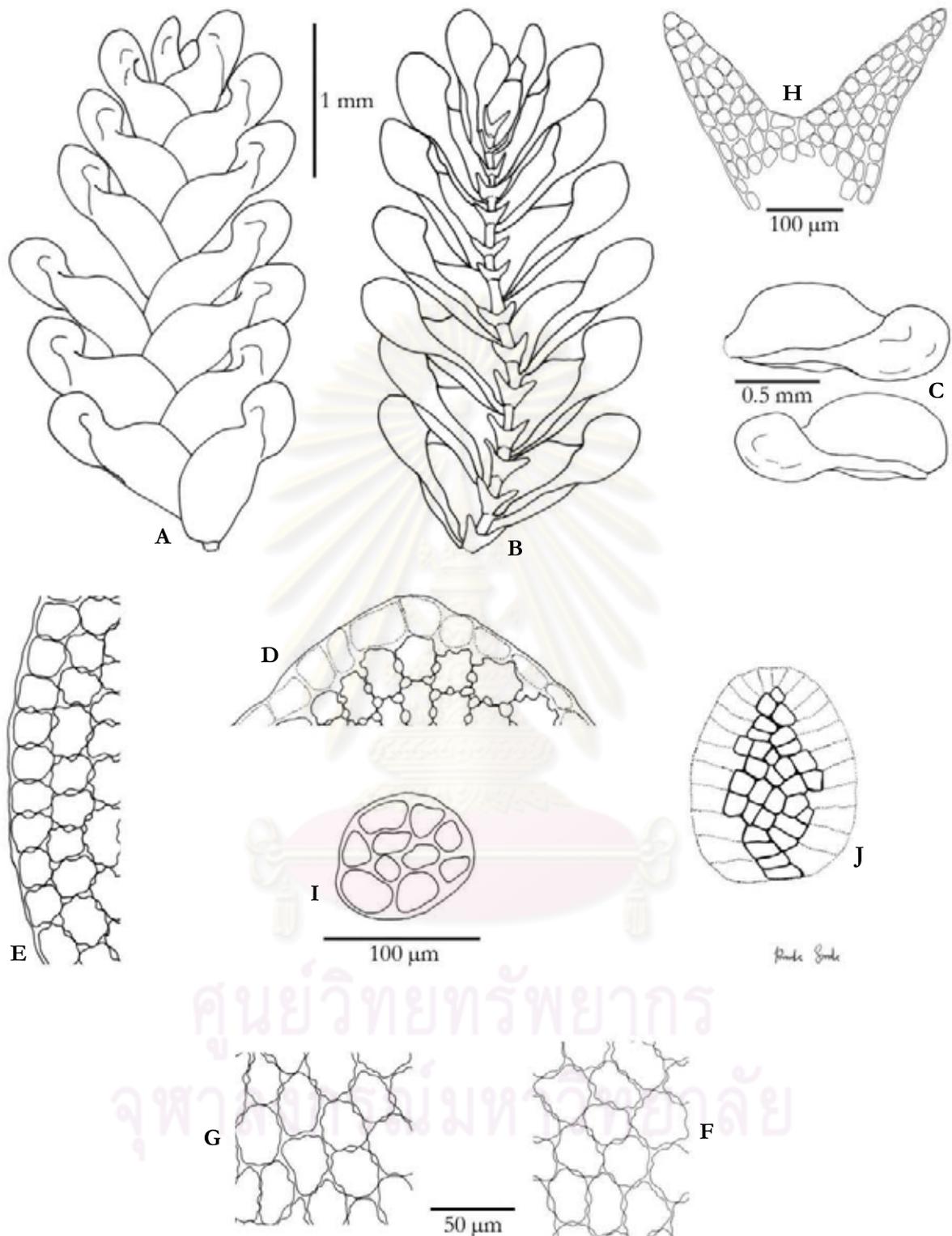
**Figure 4. 37** *Cololejeunea yipii* R. L. Zhu.

A.-B. portion of plant with perianth (p): A. dorsal view, B. ventral view; C. lateral leaves; D. apical portion of leaf lobule; E. cells at leaf apex; F. cells at leaf median; G. cells at leaf base; H. cross section of stem; I. bracts; J.-K. perianth: J. dorsal view, K. ventral view. P. Sukkharak 279.



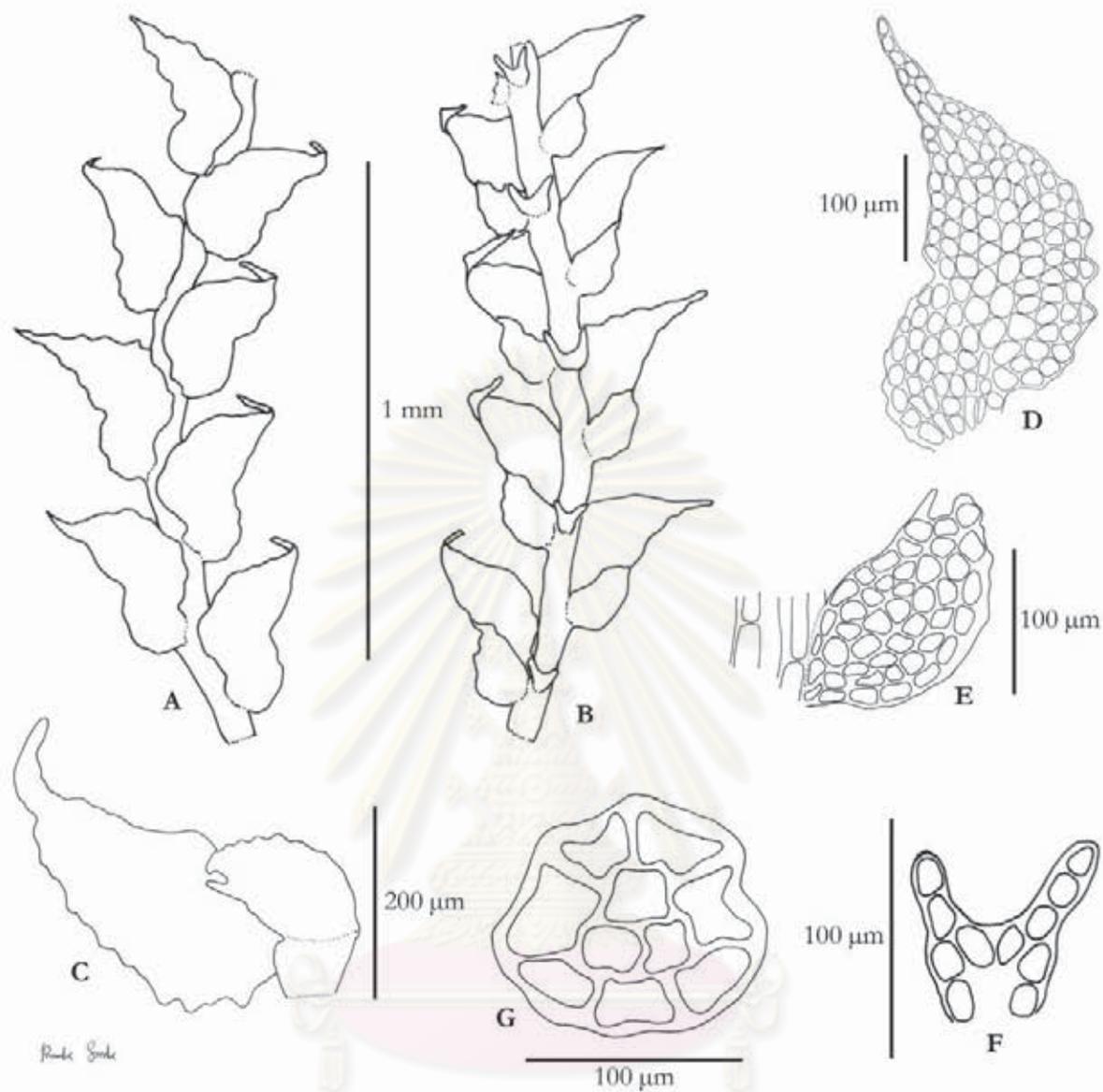
**Figure 4.38** *Colura conica* (Sande Lac.) K. I. Goebel

A.-B. portion of plant: A. dorsal view, B. ventral view; C. lateral leaves; D. cells at leaf apex; E. cells at leaf margin; F. cells at leaf median; G. cells at leaf base; H. underleaf; I. cross section of stem; J. valve. P. Sukkharak 521.

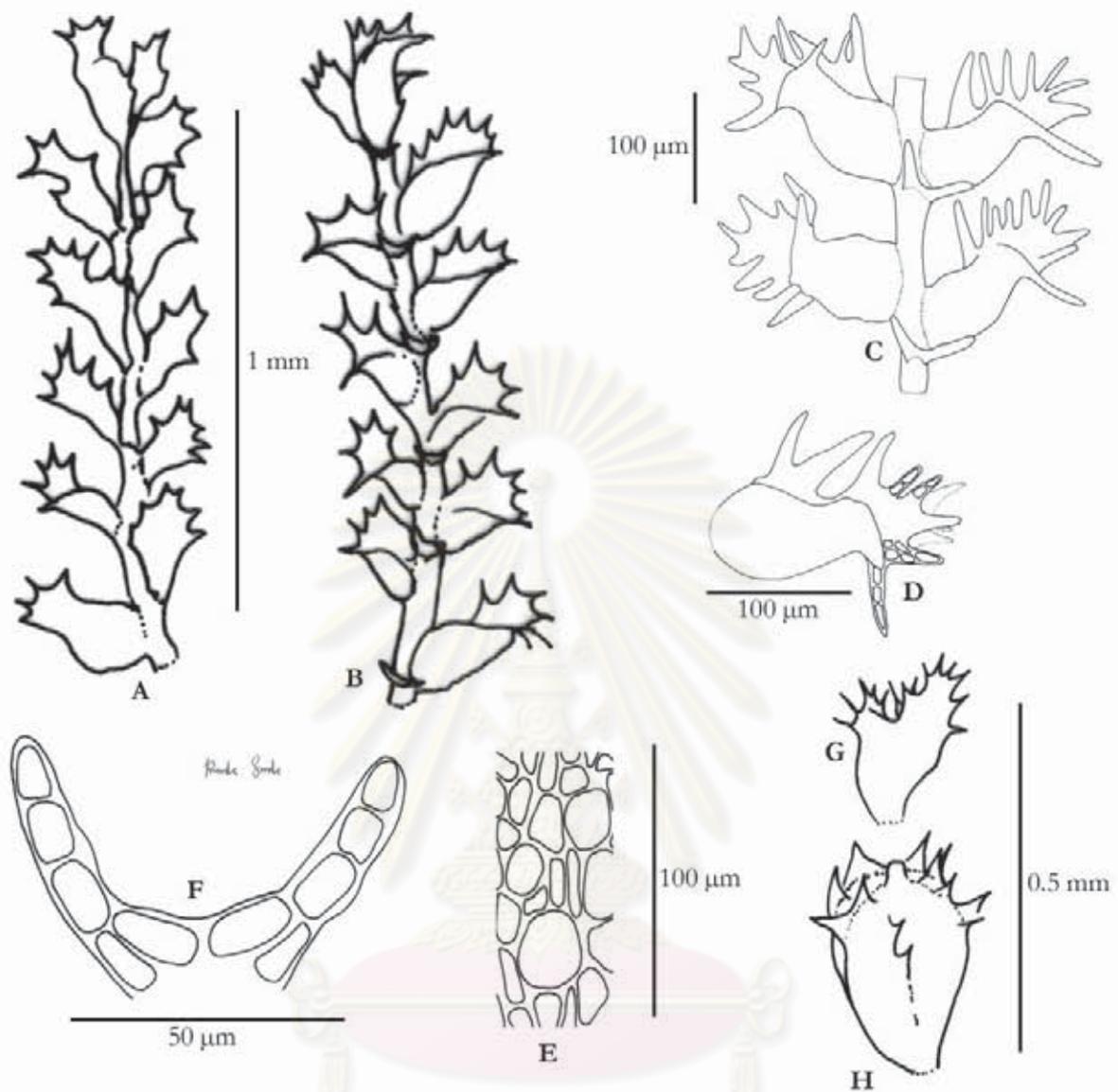


**Figure 4.39** *Colura meijeri* Jovet-Ast

A.-B. portion of plant: A. dorsal view, B. ventral view; C. lateral leaves; D. cells at leaf apex; E. cells at leaf margin; F. cells at leaf median; G. cells at leaf base; H. underleaf; I. cross section of stem; J. valve. P. Sukkharak 544b.



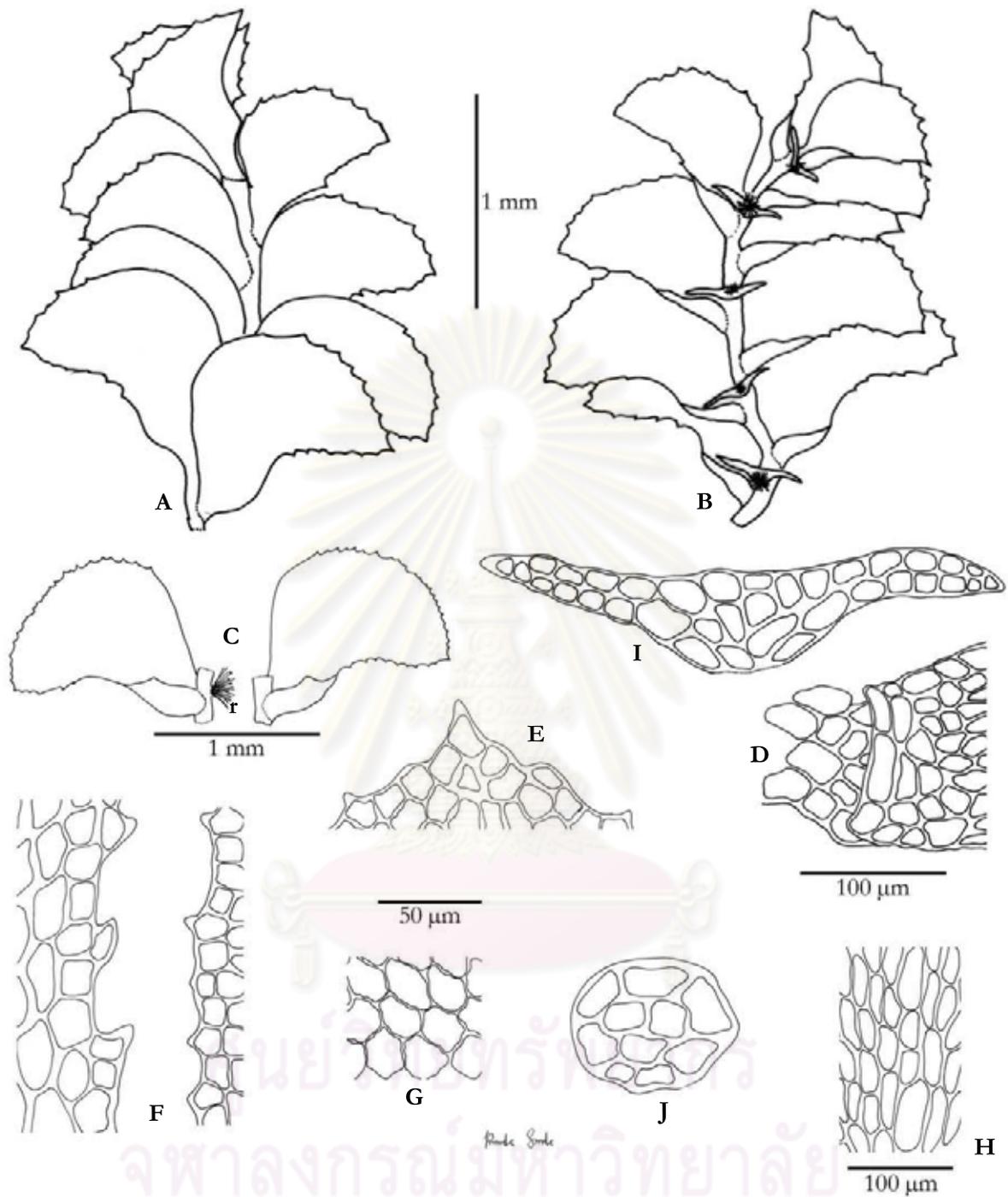
**Figure 4. 40** *Drepanolejeunea angustifolia* (Mitt.) Grolle  
 A.-B. portion of plant: A. dorsal view, B. ventral view; C. lateral leaf; D. cells of leaf lobe; E. leaf lobule;  
 F. underleaf; G. cross section of stem. P. Sukkharak 436.



**Figure 4.41** *Drepanolejeunea dactylophora* (Nees et al.) Schiffn.

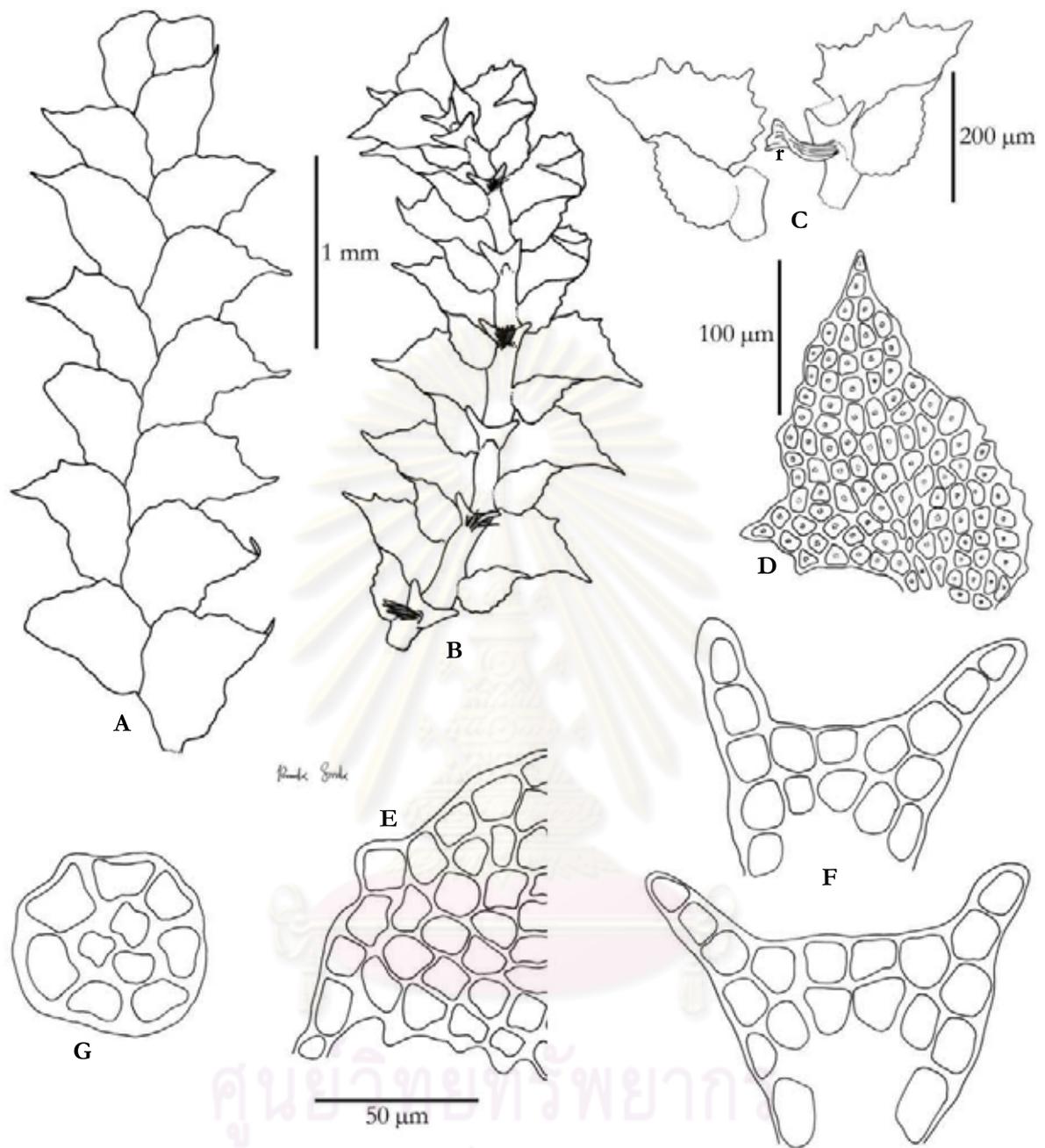
A.-B. portion of plant: A. dorsal view, B. ventral view; C. portion of shoot, ventral view; D. lateral leaf; E. median cells of leaf lobe showing ocelli; F. underleaf; G. bract; H. perianth. P. Sukkharak 538.

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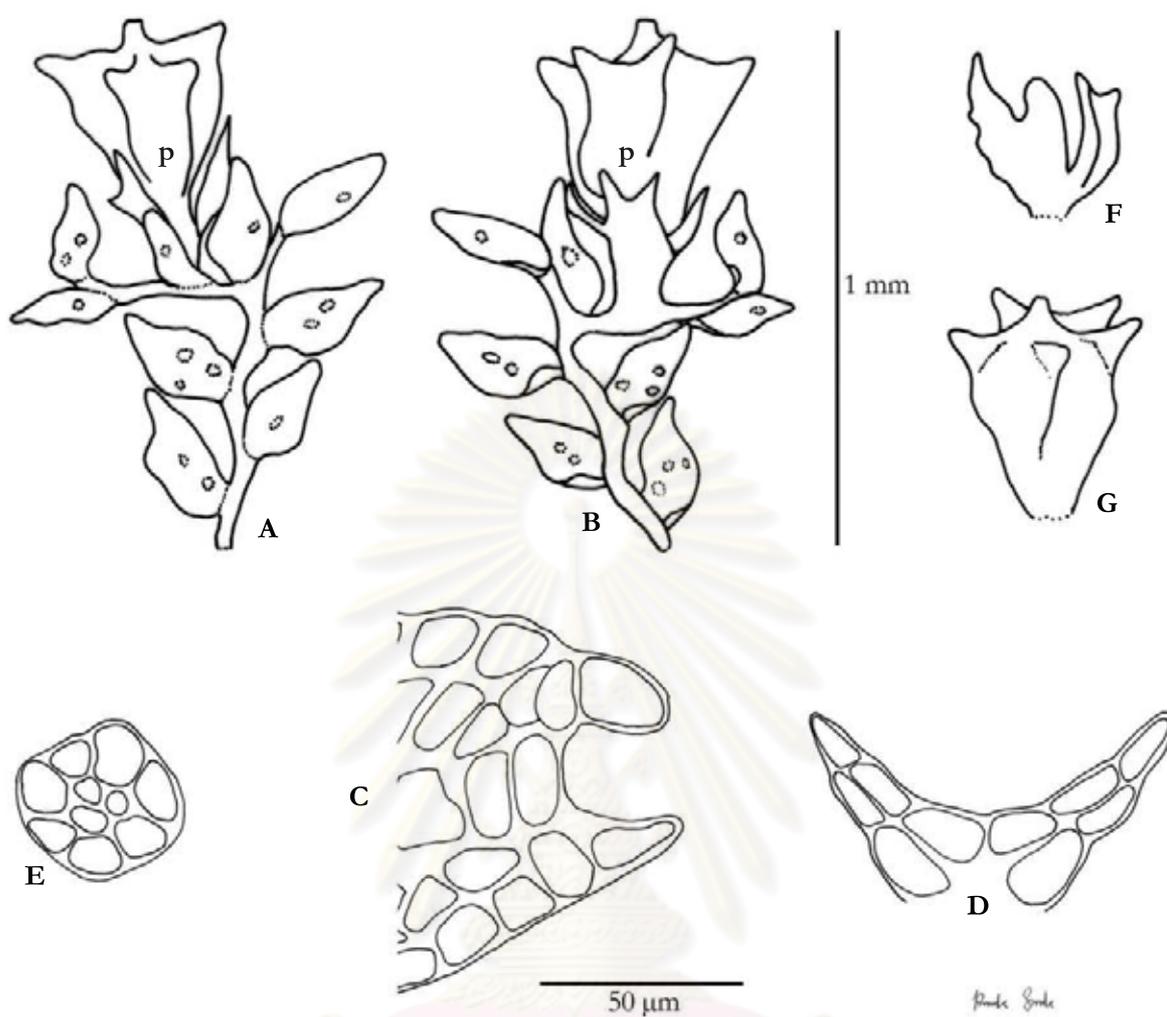
**Figure 4.42** *Drepanolejeunea levicornua* Steph.

A.-B. portion of plant: A. dorsal view, B. ventral view; C. lateral leaves with rhizoid (r); D. apical portion of leaf lobule; E. cells at leaf apex; F. cells at leaf margin; G. cells at leaf median; H. cells at leaf base; I. underleaf; J. cross section of stem. P. Sukkharak 245.



**Figure 4.43** *Drepanolejeunea ternatensis* (Gottsche) Schiffn.

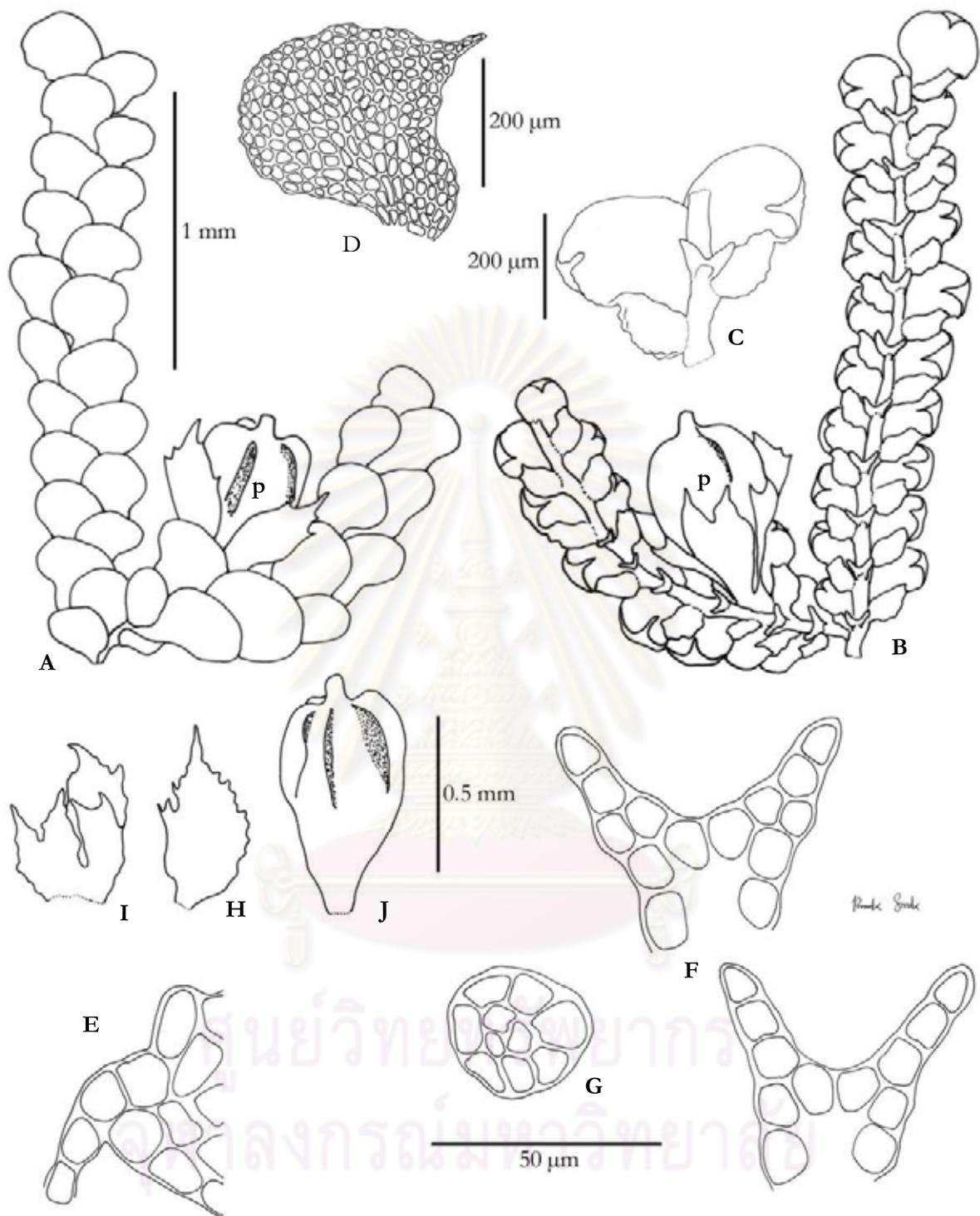
A.-B. portion of plant: A. dorsal view, B. ventral view; C. lateral leaves with shizoids (r); D. cells of lateral leaf; E. apical portion of leaf lobule; F. underleaves; G. cross section of stem. P. Sukkharak 464.



**Figure 4.44** *Drepanolejeunea* sp. 1

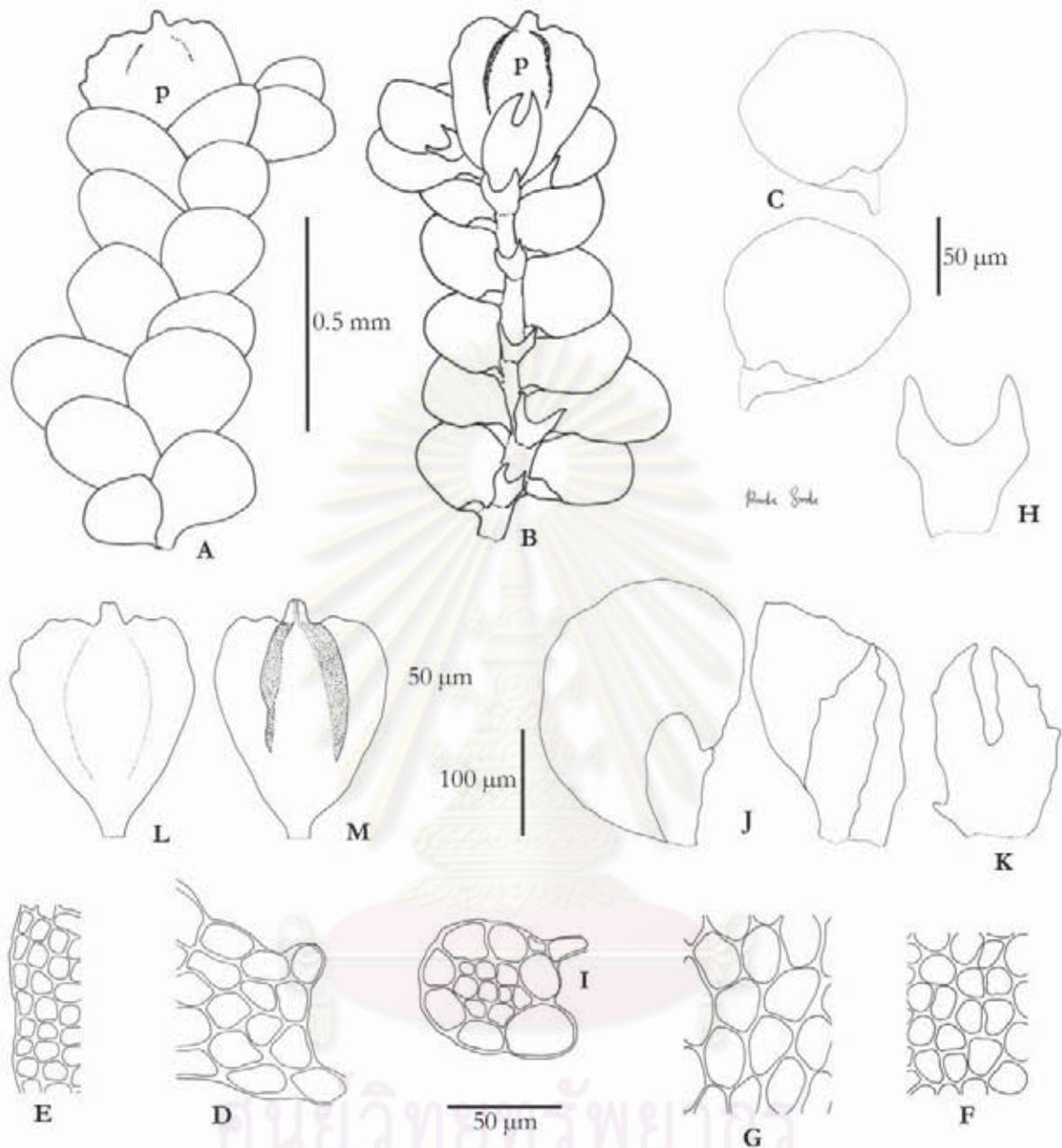
A.-B. portion of plant with perianth (p); A. dorsal view, B. ventral view; C. apical portion of leaf lobule; D. underleaves; E. cross section of stem; F. bract and bracteole; G. perianth. P. Sukkharak 536.

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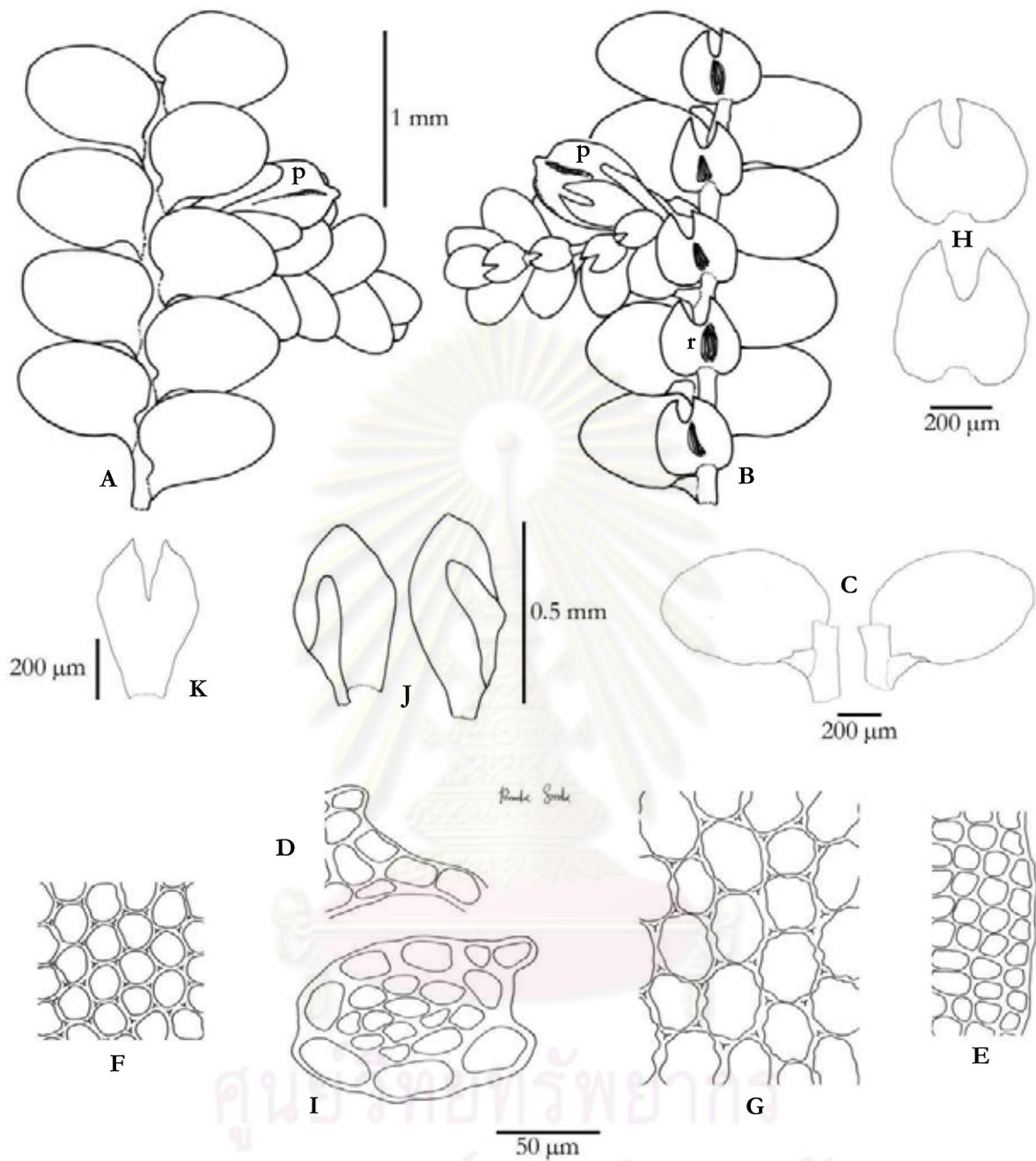
**Figure 4.45** *Drepanolejeunea* sp.2

A.-B. portion of plant with perianth (p): A. dorsal view, B. ventral view; C. lateral leaf; D. cells at leaf lobe; E. apical portion of leaf lobule; F. underleaves; G. cross section of stem; H. bract; I. bract and bracteole; J. perianth. P. Sukkharak 545.



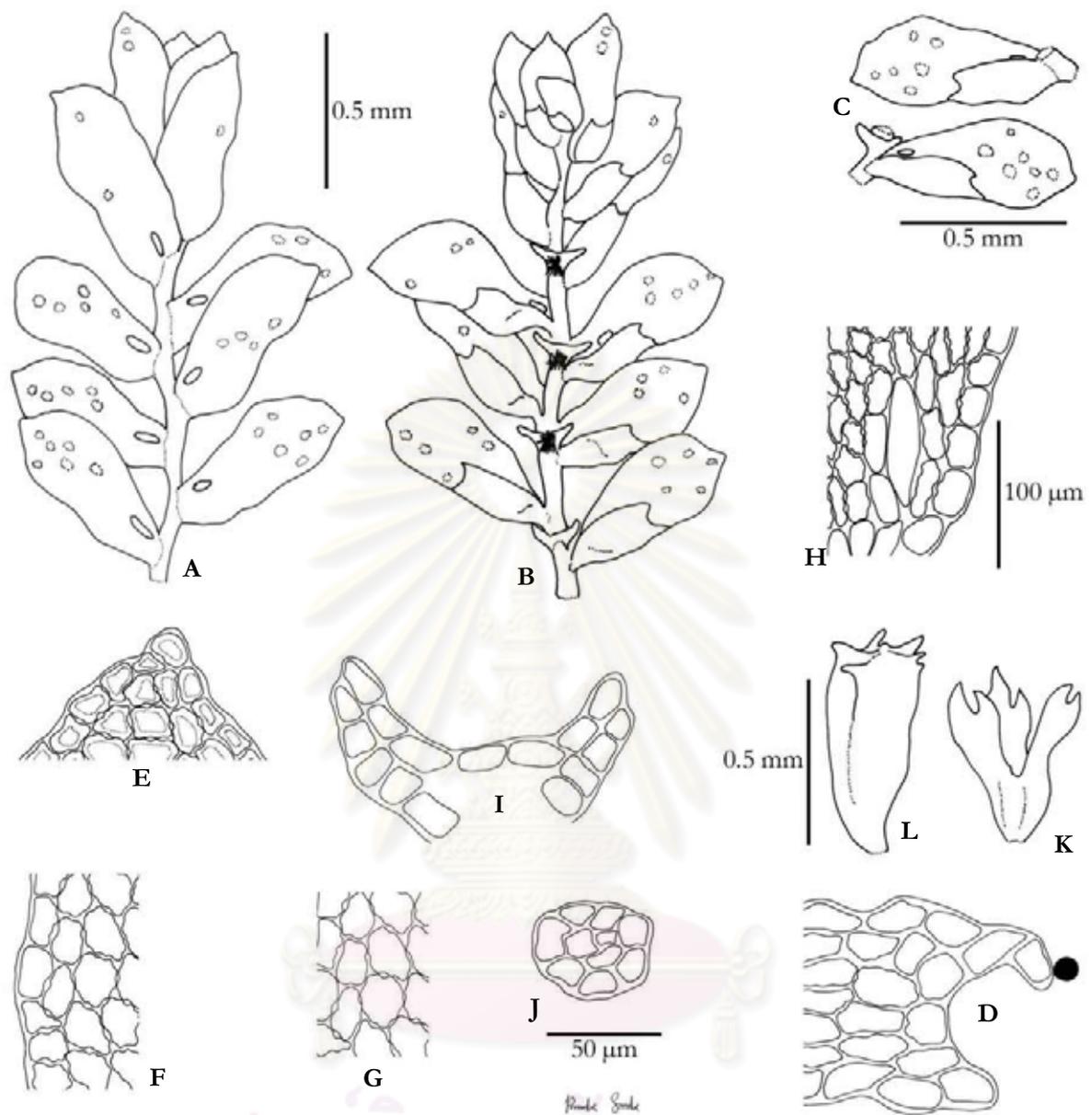
**Figure 4.46** *Lejeunea boninensis* Horik.

A.-B. portion of plant with perianth (p): A. dorsal view, B. ventral view; C. lateral leaves; D. apical portion of leaf lobule; E. cells at leaf margin; F. cells at leaf median; G. cells at leaf base; H. underleaf; I. cross section of stem; J. bracts; K. bracteoles; L.-M. perianth: L. dorsal view, M. ventral view. P. Sukkharak 16.



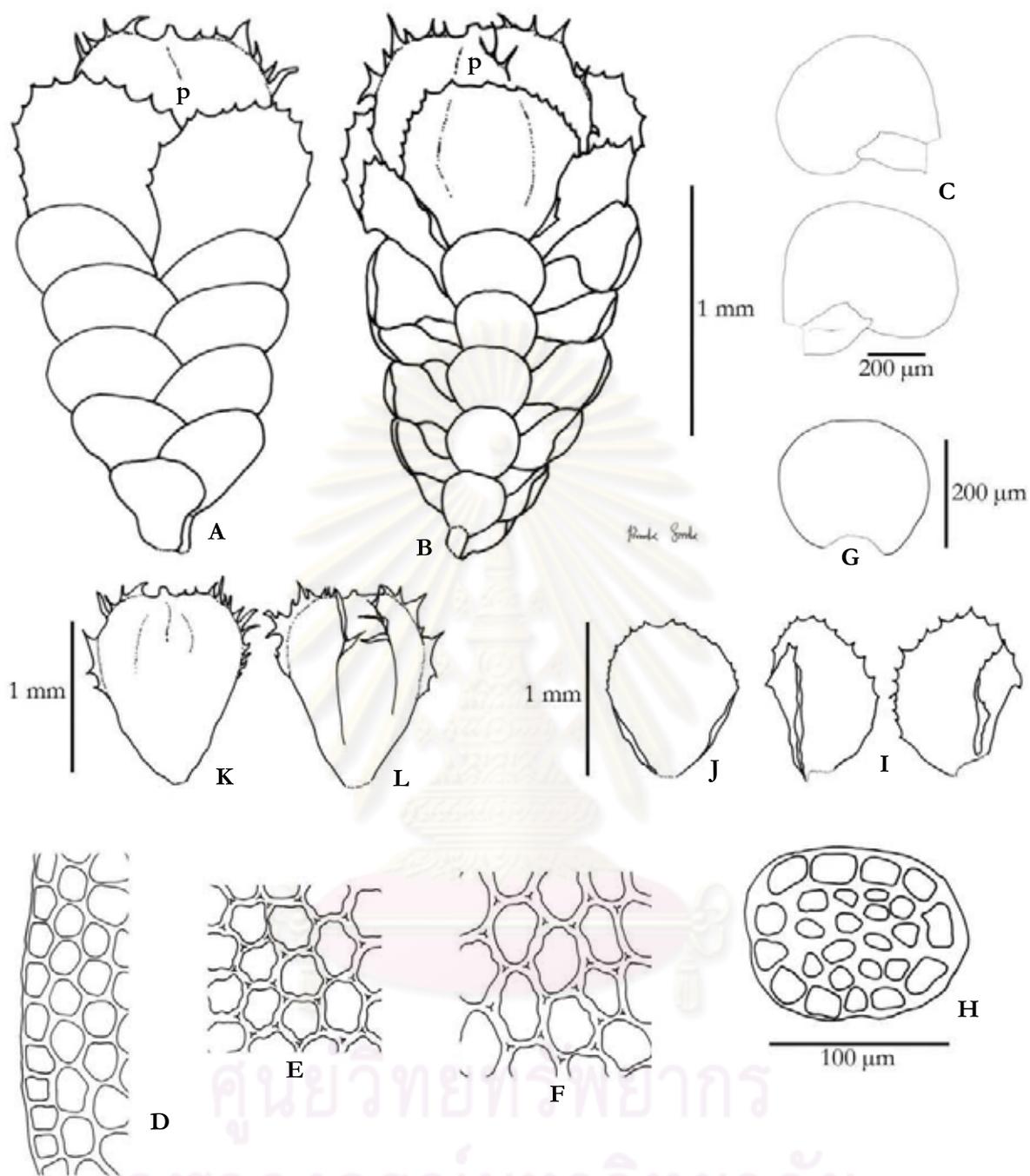
**Figure 4.47** *Lejeunea* sp.

A.-B. portion of plant with perianth (p): A. dorsal view, B. ventral view with rhizoids (r); C. lateral leaves; D. apical portion of leaf lobule; E. cells at leaf margin; F. cells at leaf median; G. cells at leaf base; H. underleaves; I. cross section of stem; J. bracts; K. bracteole. P. Sukkharak 231.



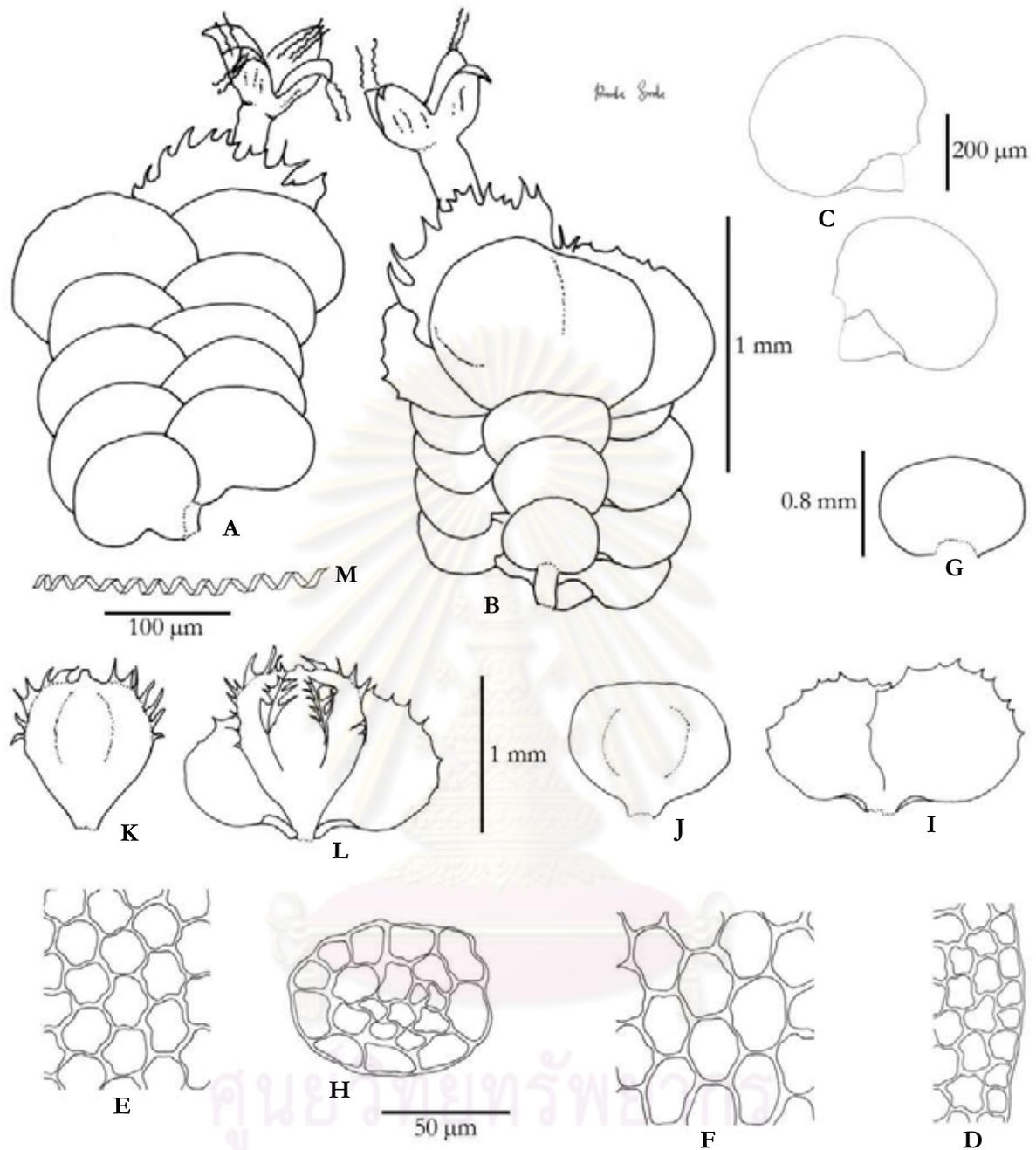
**Figure 4.48** *Leptolejeunea apiculata* (Horik.) S. Hatt.

A.-B. portion of plant with perianth: A. dorsal view, B. ventral view; C. lateral leaves; D. apical portion of leaf lobule; E. cells at leaf apex; F. cells at leaf margin; G. cells at leaf median; H. cells at leaf base; I. underleaf; J. cross section of stem; K. bracts and bracteole; L. perianth. P. Sukkharak 526.



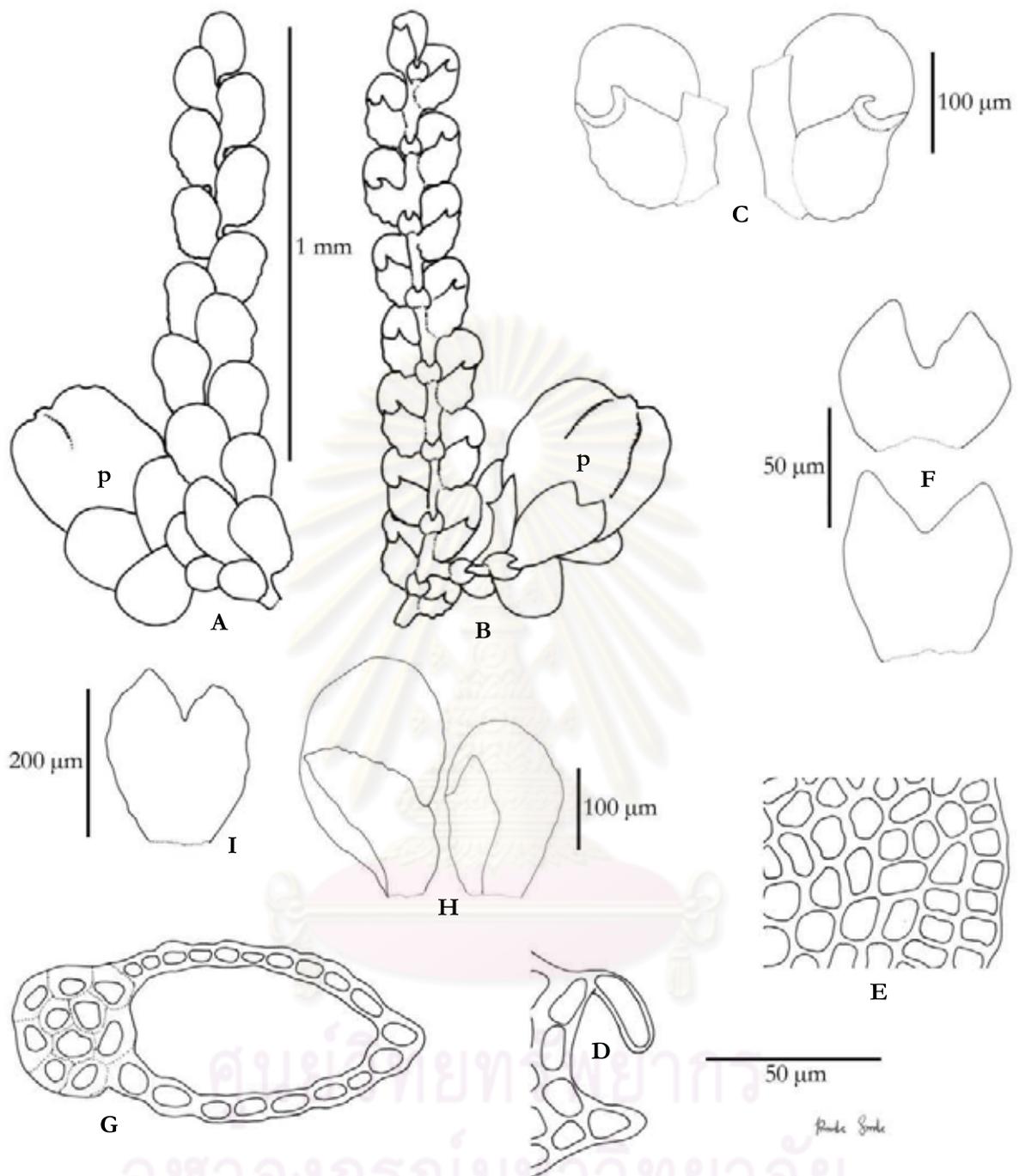
**Figure 4.49** *Lobolejeunea nipponica* Horik.

A.-B. portion of plant with perianth (p): A. dorsal view, B. ventral view; C. lateral leaves; D. cells at leaf margin; E. cells at leaf median; F. cells at leaf base; G. underleaf; H. cross section of stem; I. bracts; J. bracteole; K.-L. perianth: K. dorsal view, L. ventral view. P. Sukkharak 145.



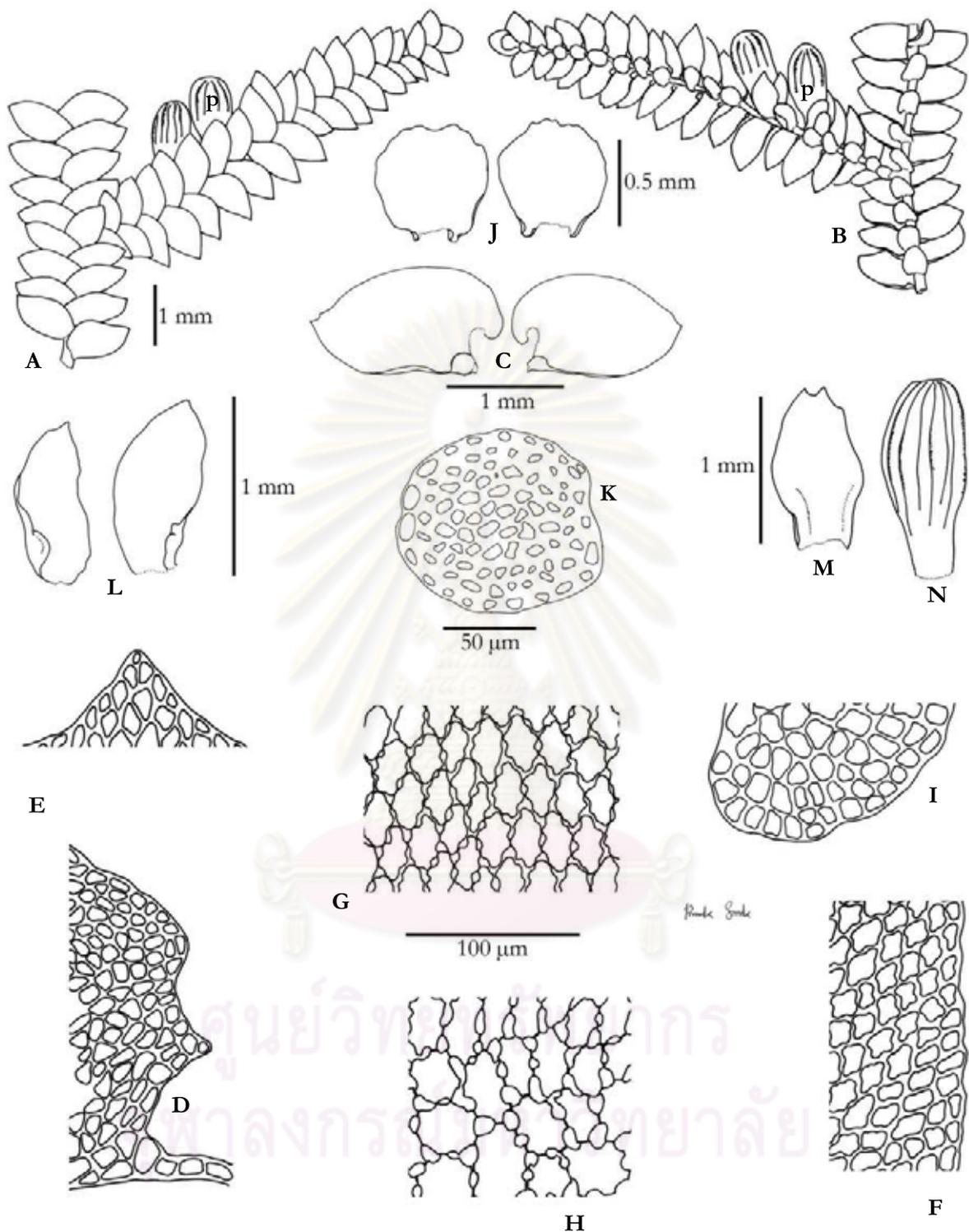
**Figure 4.50** *Lopholejeunea subfusca* (Nees) Schiffn.

A.-B. portion of plant with sporophyte: A. dorsal view, B. ventral view; C. lateral leaves; D. cells at leaf margin; E. cells at leaf median; F. cells at leaf base; G. underleaf; H. cross section of stem; I. bracts; J. bracteole; K. perianth, dorsal view; L. perianth with bracts, ventral view; M. part of elater. P. Sukkharak 128.



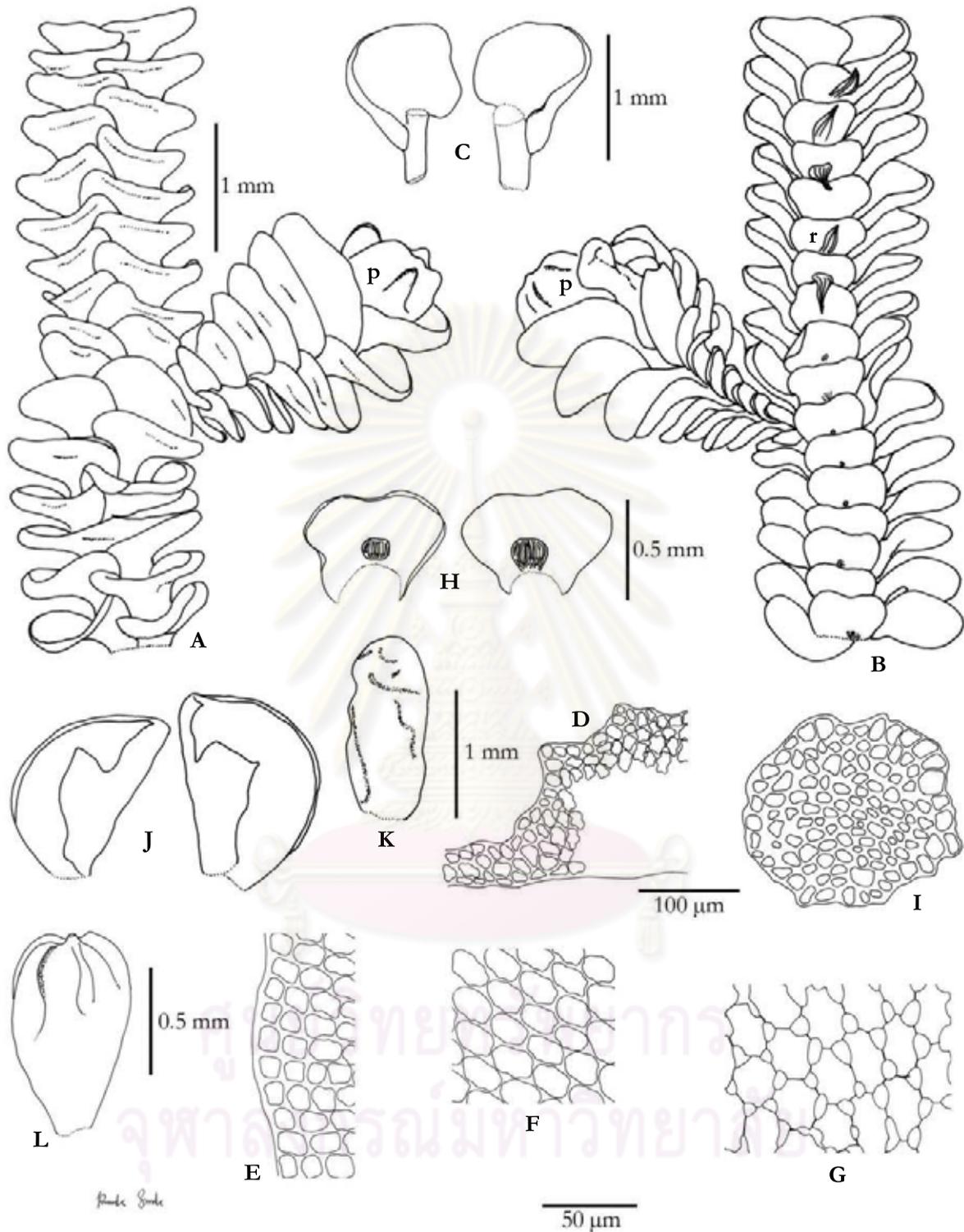
**Figure 4.51** *Metalejeunea cucullata* (Reinw. et al.) Grolle

A.-B. portion of plant with perianth (p): A. dorsal view, B. ventral view; C. lateral leaves; d. apical portion of leaf lobule; E. cells at leaf margin and median; F. underleaf; G. cross section of stem; H. bracts; I. bracteole. P. Sukkharak 143.



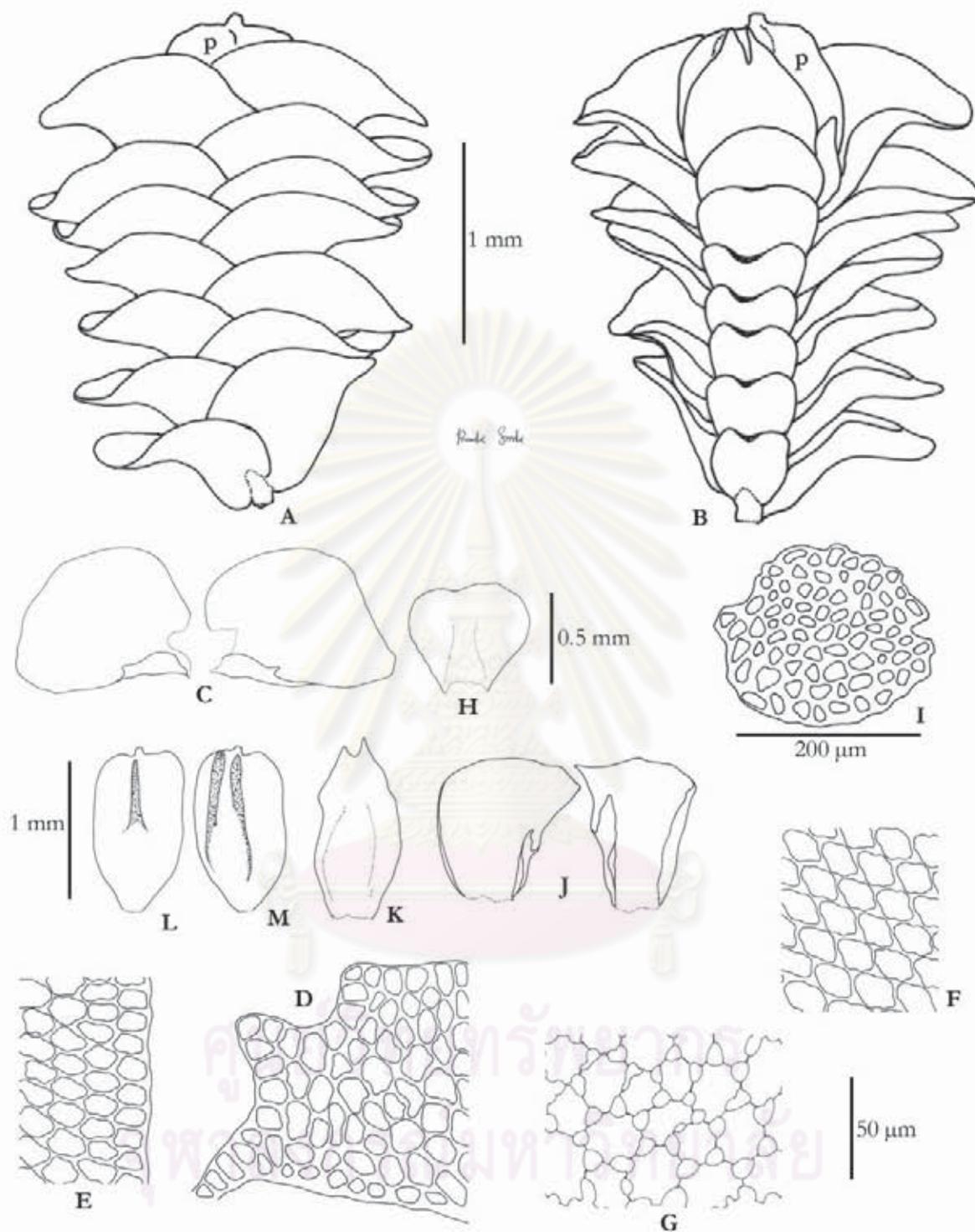
**Figure 4.52** *Ptychanthus striatus* (Lehm. & Lidenb.) Nees

A.-B. portion of plant with perianth (p); A. dorsal view, B. ventral view; C. lateral leaves; D. apical portion of leaf lobule; E. cells at leaf apex; F. cells at leaf margin; G. cells at leaf median; H. cells at leaf base; I. auricle at leaf basal; J. underleaves; K. cross section of stem; L. bracts; M. bracteole; N. perianth. P. Sukkharak 546.



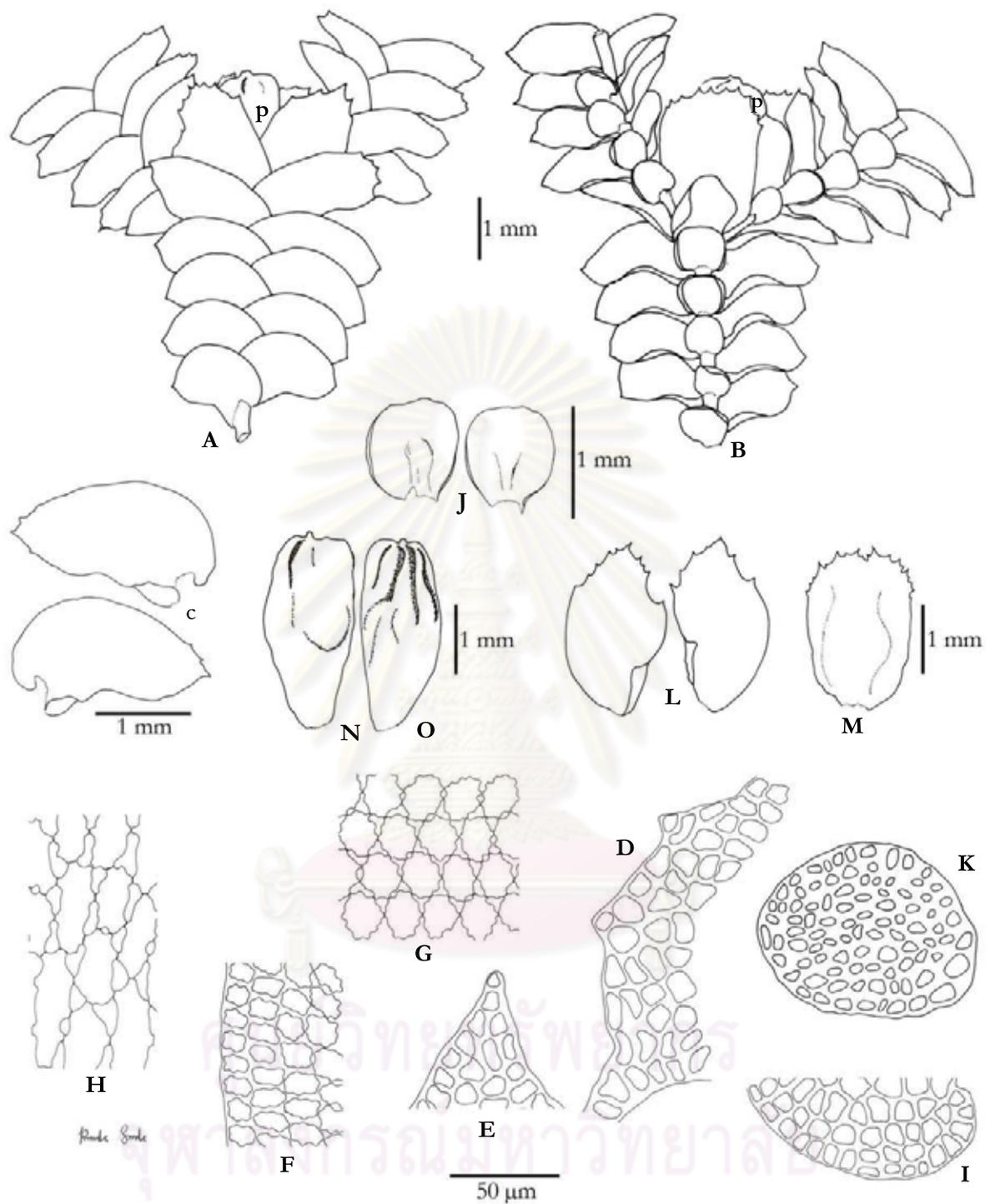
**Figure 4.53** *Schiffneriolejeunea cumingiana* (Mont.) Gradst.

A.-B. portion of plant with perianth (p): A. dorsal view, B. ventral view with rhizoids (r); C. lateral leaves; D. apical portion of leaf lobule; E. cells at leaf margin; F. cells at leaf median; G. cells at leaf base; H. underleaf; I. cross section of stem; J. bracts; K. bracteole; L. perianth. P. Sukkharak 547.



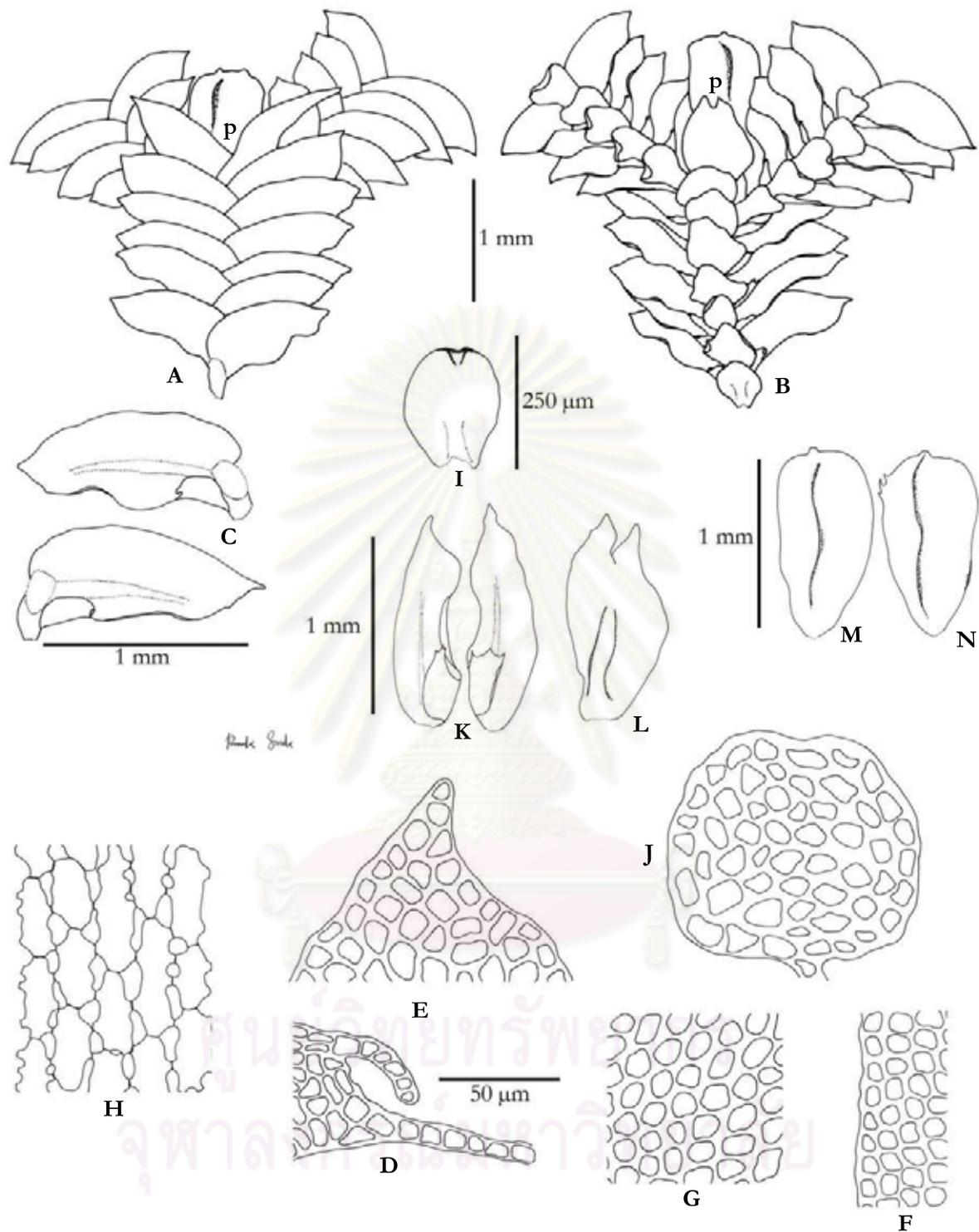
**Figure 4.54** *Schiffneriolejeunea tumida* (Nees) Gradst. var. *tumida*

A.-B. portion of plant with perianth (p): A. dorsal view, B. ventral view; C. lateral leaves; D. apical portion of leaf lobule; E. cells at leaf margin; F. cells at leaf median; G. cells at leaf base; H. underleaf; I. cross section of stem; J. bracts; K. bracteole; L.-M. perianth: L. dorsal view, M. ventral view. P. Sukkharak 103.



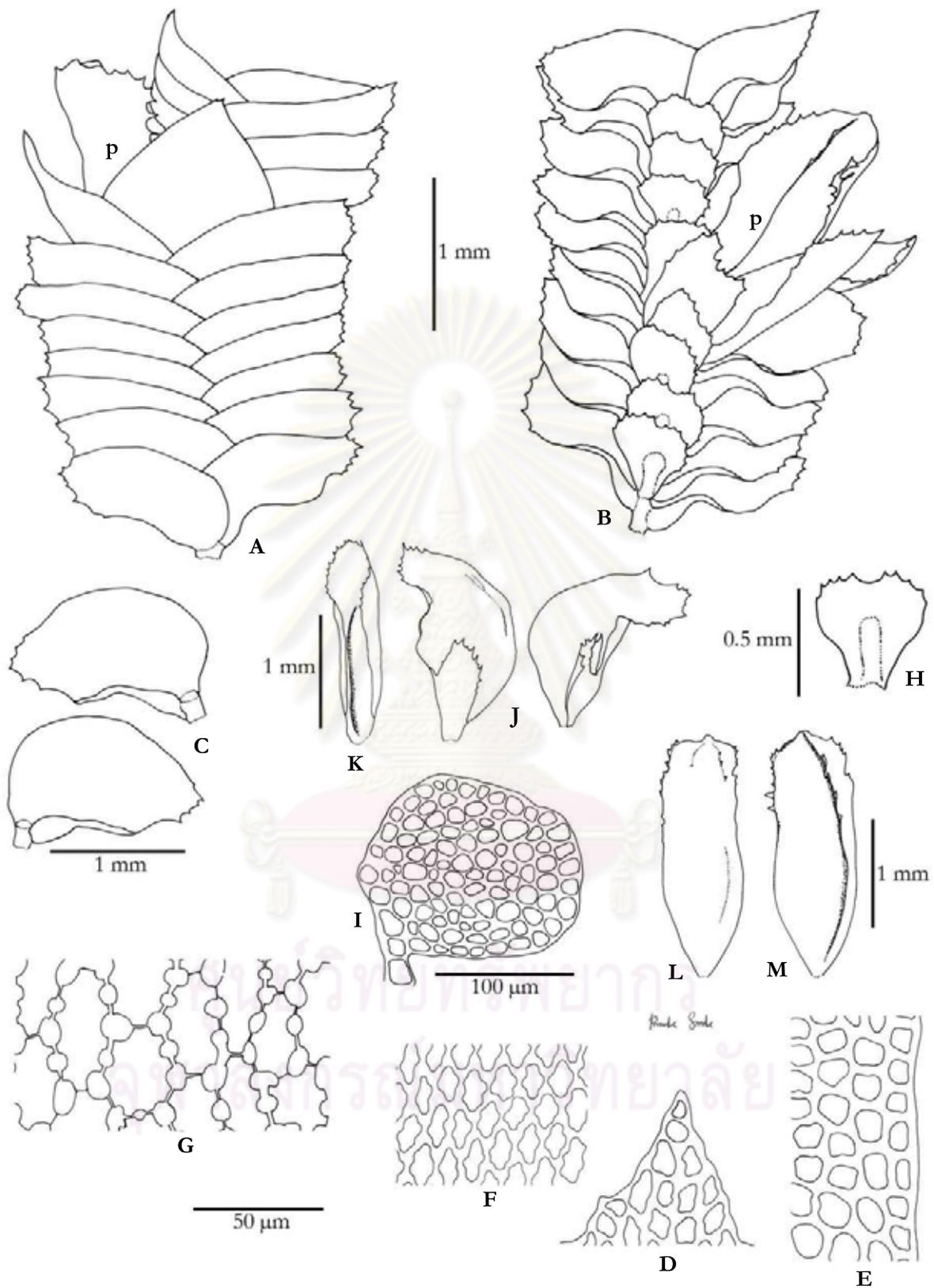
**Figure 4.55** *Spruceanthus semirepandus* (Nees) Verd.

A.-B. portion of plant with perianth (p): A. dorsal view, B. ventral view; C. lateral leaves; D. apical portion of leaf lobule; E. cells at leaf apex; F. cells at leaf margin; G. cells at leaf median; H. cells at leaf base; I. auricle; J. underleaves; K. cross section of stem; L. bracts; M. bracteole; N.-O. perianth: N. dorsal view, O. ventral view. P. Sukkharak 87.



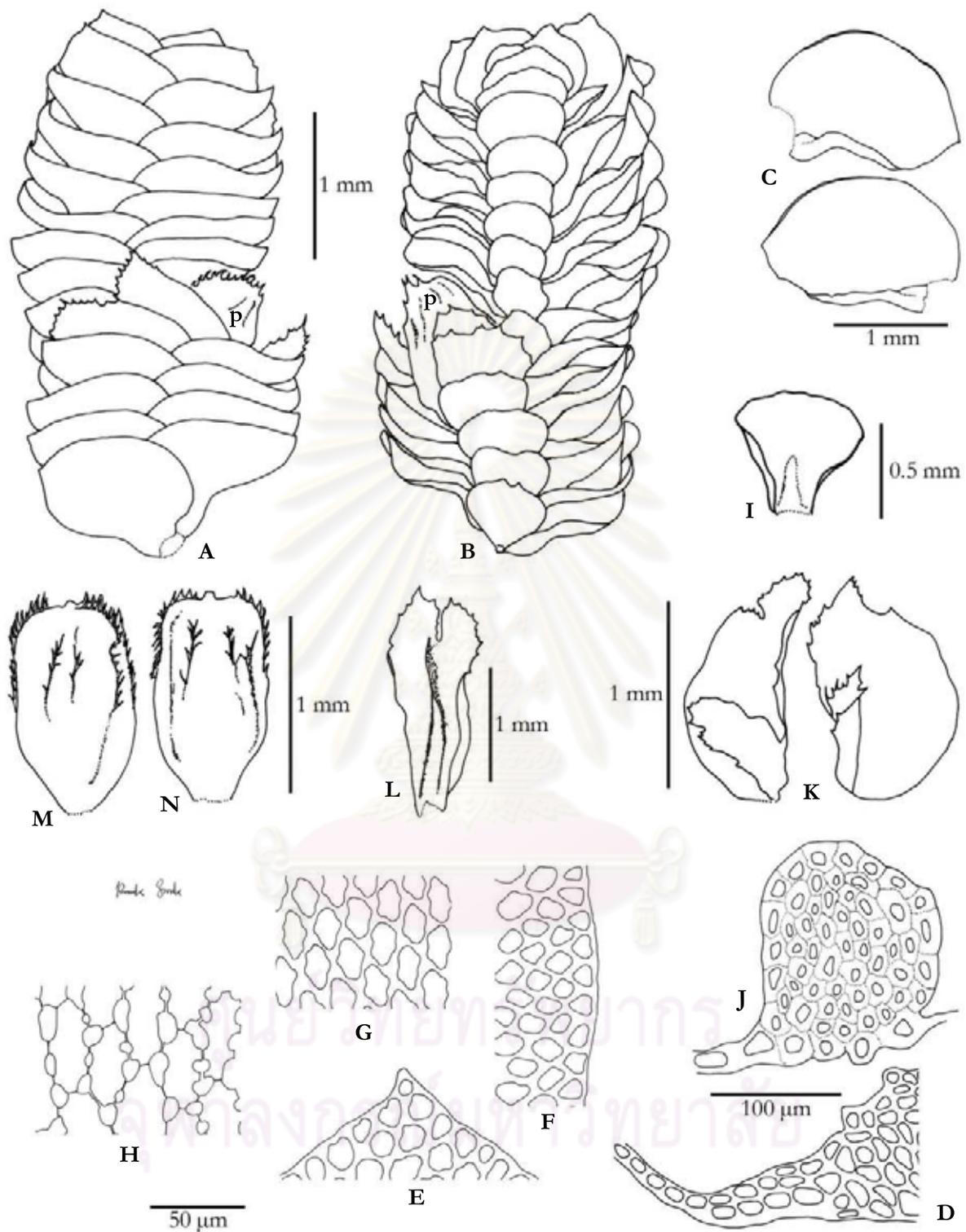
**Figure 4.56** *Thysananthus retusus* (Reinw. et al.) B. Thiers & Gradst.

A.-B. portion of plant with perianth (p): A. dorsal view, B. ventral view; C. lateral leaves; D. apical portion of leaf lobule; E. cells at leaf apex; F. cells at leaf margin; G. cells at leaf median; H. cells at basal vitta; I. underleaf; J. cross section of stem; K. bracts; L. bracteole; M.-N. perianth: M. dorsal view, N. ventral view. P. Sukkharak 291b.



**Figure 4.57** *Thysananthus spatbulistipus* (Reinw. et al.) Lindenb.

A.-B. portion of plant with perianth (p): A. dorsal view, B. ventral view; C. lateral leaves; D. cells at leaf apex; E. cells at leaf margin; F. cells at leaf median; G. cells at leaf base; H. underleaves; I. cross section of stem; J. bracts; K. bracteole; L.-M. perianth: L. dorsal view, M. ventral view. P. Sukkharak 56.



**Figure 4.58** *Thysananthus* sp.

A.-B. portion of plant with perianth (p): A. dorsal view, B. ventral view; C. lateral leaves; D. apical portion of leaf lobule; E. cells at leaf apex; F. cells at leaf margin; G. cells at leaf median; H. cells at leaf base; I. underleaf; J. cross section of stem; K. bracts; L. bracteole; M.-N. perianth: M. dorsal view, N. ventral view. P. Sukkharak 334.

## Lepidoziaceae

**Plants** leafy, pale green to brown or reddish-brown, creeping to ascending, usually pinnate or forked, sometimes arising from a stoloniferous base. **Branches** *Frullania*-type and ventral-intercalary, rarely lateral-intercalary; flagella frequently present. **Rhizoids** in tufts from underleaf bases. **Lateral leaves** transverse, incubous or succubous, usually divided into several segments or teeth, rarely undivided, insertion extending to the dorsal midline of the stem or not, leaf margins usually entire; cells variable, with or without oil-bodies. **Underleaves** well-developed, rarely reduced. **Androecia and Gynoecia** on short ventral branches, the androecia occasionally on long shoots. **Sporophytes** surrounded by a 3-keeled perianth. **Vegetative reproduction** by caducous leaves.

### Key to genera

1. Apex of lateral leaves end in finger-like single-celled spines at right angles to the base ..... *Psiloclada*
1. Apex of lateral leaves otherwise.
  2. Lateral leaves more than bifid.
    3. Lateral leaves divided into 3-numerous segments, branch (bi) pinnate ..... *Lepidozia*
    3. Lateral leaves with 2-3 teeth at apex or undivided, branch forked ..... *Bazzania*
  2. Lateral leaves bifid ..... *Acromastigum*

### 1. *Acromastigum*

*Acromastigum* A. Evans, Bulletin of the Torrey Botanical Club 27: 103. 1900.; Hodgson, E. A., Valley, K., Wairoa, Bay, H. Trans. & Proc. Roy. Soc. New Zealand. 82 (1). 17. 1954. — *Mastigobryum* B (in great part), G. L. et N., Syn. Hep., 218. 1845. — (section) 111. *Inaequilatena* Steph. Hedwigis, 25, 245. 1886. — *Bazzania* Section 111 *Inaequilatereae* Schiff. — *Acromastigum* A. Evans, Bull., Tom. Club, 27, 103. 1900. — *Mastigobryum* (subgenus) *Inaequilatena* Steph., Bull., Herb., Boissier: 11, 8, 408. 1908.

**Plants** light green or strongly pigmented with brown, loosely matted, or in denser cushions, or creeping amongst other hepatics. **Stems** prostrate, branched as in *Bazzania* but ventral flagellae not axillary. **Lateral leaves** incubous, bidentate with 2 exception, which are entire and squarrose, tending to be unequally bilobed, insertion oblique. **Underleaves** small, often with bulging sides, entire or 3-lobed, cells larger in the ventral part, arranged in rows, sometimes forming a vitta. **Male bracts** delication, form of hollow sacs monandrous.

*Acromastigum curtilobum* A. Evans.

Ann. Bryol. Suppl. 3: 97: 1934. Kitagawa, N., Acta Phytotax. Grobot. XXIX, Nos. 1-5: 50-51, fig. 2. 1978.

**Plants** pale green, 0.4-0.5 mm wide. **Stems** creeping, widely diverging Y-branch, Flagella from the ventral surface, in cross section of stem 7 of thickened wall and large cortical cells and 3-4 small medullary cells. **Rhizoids** absent. **Lateral leaves** slightly overlapping, ovate to oblong, 2.1-2.2 mm long and 0.8-0.9 mm wide, apex unequally bilobed to about 1/2 of leaf length, margin entire, cells of leaf squarish, median cells 7-10  $\mu$ m long and 7-10  $\mu$ m wide, trigones small, basal cells 7-10  $\mu$ m long and 15-18  $\mu$ m wide. **Underleaves** distant, rather square, at base 3-4 cells row, apex divide into 3 irregular lobes, each lobe about 1/2 of underleaf length with 1-2 cells wide, 0.7-0.8 mm long and 0.6-0.7 mm wide, margin entire. **Sporophytes** not found. (Figure 4.59)

**Thailand** — NORTH-EASTERN: Loei; SOUTH-EASTERN: Prachin Buri.

**Distribution** — Philippines, Borneo.

**Ecology** — on living bark of tree.

**Specimens examined** — P. Sukkharak 275, 512 (BCU); M. Tagawa & N. Kitagawa No. T1673 (BKF).

**GPS location** — 8.88082623° N 99.69511271° E

**Altitude** — 1,271-1,312 m

## 2. *Bazzania*

*Bazzania* Gray, A Natural Arrangement of British Plants 1: 704. 1821.; Fulford, M. H., Memoirs of the New York Botanical Garden 11 (1): 106-172. 1963.; Gradstein, S. R., Churchill, S. P. & Allen, N. S., Guide to the bryophytes of tropical America: 181-183. 2001.

**Plants** typically bright green to olive-green, sometimes brown or reddish-brown, creeping, forked, with long ventral flagella. **Branches** *Frullania*-type and ventral-intercalary. **Lateral leaves** incubous, wide-spreading, ovate-rectangular, apex truncate and divided into 2-3 large teeth, rarely rounded and without teeth, margins entire, rarely finely toothed, cells with small or large trigones, cuticle smooth or papillose, a vitta sometimes present; oil-bodies large, homogeneous or few segmented. **Underleaves** large, undivided or shallowly lobed, margins entire or toothed, underleaf bases sometimes united with the leaves on one or both sides. **Vegetation reproduction** by caducous leaves.

### Key to species

1. Apex of lateral leaves unlobed or with indistinct lobes, or serrulate.
  2. Underleaves not reflexed.
    3. Apex of lateral leaves dentate .....*B. yakushimensis*
    3. Apex of lateral leaves finely serrulate.....*B. loricata*
  2. Underleaves strongly reflexed at the apex.....*B. spiralis*
1. Apex of lateral leaves with distinct lobes.
  4. Underleaves entire.
    5. Lateral leaves trifid.
      6. Lateral leaves with asperous cuticle .....*B. vittata*
      6. Lateral leaves smooth cuticle .....*B. tridens*
    5. Lateral leaves bifid .....*B. debilis*
  4. Underleaves dentate.
    7. Underleaf longer than wide and bearing four principle apical lobes .....*B. uncigera*
    7. Underleaf subquadrate .....*B. fauriana*

### 1. *Bazzania debilis* N. Kitag.

In Kitagawa, N., J. Hattori Bot. Lab. 30: 256-257, fig. 3. 1967.

**Plants** slender, olive-pale green, 0.7-1 mm wide. **Stems** creeping, furcately branch, with 2-10 mm long ventral flagella. **Lateral leaves** distant, spreading at an angle of 80-90 degrees with the stem, oblong-sublinear 320-560 µm long and 200-320 µm wide, the apex unequally 2-lobed, the middle and base elongated; trigones lacking. **Underleaves** distant, appressed to the stem, rounded-rectangular, 120-176 µm long and 80-160 µm wide, cells of the underleaf hyaline. **Sporophytes** not found. (Figure 4.60)

**Thailand** — NORTH-EASTERN: Loei. Endemic to northeastern Thailand

**Distribution** — Japan.

**Ecology** — on living bark of tree.

**Specimens examined** — P. Sukkharak 163, 243, 259 (BCU); M. Tagawa & N. Kitagawa 727 (BKF).

**GPS location** — 8.88173757° N 99.70036786° E

**Altitude** — 1,220-1,275 m

## 2. *Bazzania fauriana* (Steph.) S. Hatt.

Bot. Mag. Tokyo 59; 27. 1946.; Hattori, S. & Mitzutani, M., J. Hattori Bot. Lab. 19: 101-102, fig. VII. 1958. — *Mastigobryum faurianum* Steph. Spec. Hepat. 3: 467. 1908. — *B. nodulosa* Horikawa, J. Sci. Hiroshima Univ. ser. v, 2, 2: 199, pl. 18, 7-12. 1934. — *B. kiushiana* S. Hatt. Bull. Tokyo Sci. Mus. 11: 19, f. 11. 1944.

**Plants** pale green, 3.8-5 mm wide. **Stems** rigid, creeping, furcately branch, with 3-20 mm long ventral flagella. **Lateral leaves** densely imbricate, lingulate, apex divided into 3 teeth, margin entire 1.8-2 mm long and 0.8-1 mm wide; trigones nodulose. **Underleaves** appressed to stem, subquadrate, 1-1.2 mm long and 1-1.1 mm wide, margin irregularly repand, acute tooth. **Sporophytes** not found. (Figure 4.62)

**Thailand** — New record to Thailand.

**Distribution** — Japan.

**Ecology** — on living bark and twig of tree and rotten log.

**Specimens examined** — P. Sukkharak 76, 80, 89, 167, 178, 191, 230, 246, 254, 262, 263, 268, 289 (BCU).

**GPS location** — 8.8818773° N 99.70022461° E, 8.87548442° N 99.69336889° E

**Altitude** — 631-1,345 m

## 3. *Bazzania loricata* (Nees) Trevis.

Mem. Istit. Lombardo, ser. 3, 4: 414. 1877.; Kitagawa, N., J. Hattori Bot. Lab. 30: 254. 1967. — *Jungermannia loricata* Reinw., Bl. et Nees, Nova Acta Leop.-Carol. 12: 233. 1824. — *Mastigobryum loricatum* (Reinw., Bl. et Nees) Nees in Gott., Lindenb. & Nees, Syn. Hepat: 217. 1845.

**Plants** pale green, 2.8-4 mm wide. **Stems** creeping, furcately branch, with 3-16 mm long ventral flagella. **Lateral leaves** wide-spreading, ovate, apex and margin serrulate except near the base, 1-2 mm long and 0.8-1 mm wide near the base, 0.46- 0.71 mm wide near the apex. **Underleaves** semicircular unlobed, 0.5-0.7 mm long and 0.5-0.8 mm wide, appressed to stem, hyaline margins of one to two rows of cells wide. **Sporophytes** not found. (Figure 4.62)

**Thailand** — PENINSULAR: Nakhon Si Thammarat, Surat Thani.

**Distribution** — Philippines, Malacca, Java, Sumatra.

**Ecology** — on living bark and twig of tree, tree fern.

**Specimens examined** — P. Sukkharak 81, 83, 85, 88, 93, 95, 172, 174, 183, 184, 194, 198, 199, 205, 248, 258, 260, 266, 432, 433 (BCU); M. Tagawa & N. Kitagawa 4970 (BKF).

**GPS location** — 8.88259495° N 99.70011875° E, 8.88279939° N 99.70001649° E, 8.87584269° N 99.69320834° E

**Altitude** — 1,230-1,356 m

## 4. *Bazzania spiralis* (Reinw., Blume et Nees) Meijer

Blumea 10: 381. 1960.; Kitagawa, N., J. Hattori Bot. Lab. 30: 254-256, fig. 2. 1967. — *Jungermannia spiralis* Reinw., Blume. et Nees, Nova Acta Leop.-Carol. 12: 231. 1824. — *Mastigobryum spirale* (Reinw., Blume. et Nees) Steph., Spec. Hepat. 3: 481. 1908.

**Plants** yellow-green, 2-4 mm wide. **Stems** creeping, furcately branch, with 1-2 cm long ventral flagella. **Lateral leaves** triangular-oblong, apex denticulate to serrulate, the margin somewhat serrulate except near the base, 1.8-2.2 mm long and 0.8-1.2 mm wide near the base, 0.56-0.65 mm near apex, trigones nodulose. **Underleaves** distinct, semicircular, 720-880 µm long and 320-480 µm wide, strongly reflexed at the apex, margin subentire, hyaline margins of one to two cells wide. **Sporophytes** not found. (Figure 4.63)

**Thailand** — PENINSULAR: Nakhon Si Thammarat.

**Distribution** — Malaya, Banka, Sumatra, Java, Borneo.

**Ecology** — on living bark of tree.

**Specimens examined** — P. Sukkharak 242, 252 (BCU); M. Tagawa & N. Kitagawa 4911 (BKF).

**GPS location** — Exact locality not applicable. Near TT19.

**Altitude** — ca. 1,220-1,240 m

### 5. *Bazzania tridens* (Reinw. et al.) Trevis.

Mem. R. Istit. Lombardo ser. 3, 4: 415. 1877.; Mitzutani, M., J. Hattori Bot. Lab. 30: 72-74, fig. I. 1967; Kitagawa, N., J. Hattori Bot. Lab. 30: 259-260. 1967. — *Jungermannia tridens* Reinw., Blume et Nees, Nova Acta Acad. Caes. Leop.-Carol. 12: 228. 1824. — *Mastigobryum tridens* (Reinw., Blume et Nees) Dum., Rec. d'Obs: 20. 1835. — *M. tridens* (Reinw., Blume et Nees) Nees in Gott., Lindenb. et Nees, Synop. Hepat.: 227. 1845. — *M. oblongum* Mitt., Jour. Proc. Linn. Soc. London 5: 106. 1861. — *Bazzania albicans* Steph., Hedwigia 32: 204. 1893. — *B. oblonga* (Mitt.) Schiffn., Nova Acta Leop.-Carol. 60: 259. 1893. — *Mastigobryum olivaceum* Steph., Spec. Hepat. 3: 441. 1908. — *M. pinniforme* Steph., Spec. Hepat. 3: 462. 1908. — *M. lobulistipum* Steph., l.c., — *M. takeanum* Steph., Spec. Hepat. 3: 465. 1908. — *M. nagasakiense* Steph., l.c. — *M. albicans* (Steph.) Steph., l.c. — *M. tenuistipulum* Steph., Spec. Hepat. 3: 466. 1908. — *M. cardotii* Steph., Spec. Hepat. 3: 515. 1908. — *M. lobulistipum* Steph., l.c. 462. 1908. — *Bazzania tenuistipula* (Steph.) Steph. in Yasuda, Shokubutugaku Kakuron, Inkwabu: 711. 1911. — *M. coreanum* Steph., Spec. Hepat. 6: 470. 1924. — *M. koyasanum* Steph., Spec. Hepat. 6: 471. 1924. — *M. okamuranum* Steph., Spec. Hepat. 6: 475. 1924. — *M. orientale* Steph., Spec. Hepat. 6: 476. 1924. — *M. tjiberrum* Steph., Spec. Hepat. 6: 483. 1924. — *M. typicum* Steph., Spec. Hepat. 6: 484. 1924. — *Bazzania coreana* (Steph.) Hatt., Jour. Jap. Bot. 19: 345, f. 21. 1943. — *B. koyasana* (Steph.) Hatt., Bot. Mag. Tokyo 59: 29. 1946. — *B. nagasakiensis* (Steph.) Hatt., l.c. — *B. okamurana* (Steph.) Hatt., l.c. — *B. minutissima* Kamimura, Contr. Hapat. Fl. Shikoku: 23, pl. 1, l-o. 1952. — *B. lobulistipa* (Steph.) Hatt. In Hara, Fl. E. Himalaya: 505. 1966. — *B. pinniformis* (Steph.) Hatt. in Hara, Fl. E. Himalaya: 506. 1966.

**Plants** olive green, 2-3 mm wide. **Stems** creeping, furcately branch, with 0.5-1.7 mm long ventral flagella. **Lateral leaves** wide-spreading, rectangular, apex divided into 2-3 teeth, margin entire; vitta present 3-5 cells wide running nearly from base to apex of the leaf 1.3-2 mm long and 480-520 µm wide; trigones lacking. **Underleaves** appressed to stem, shallowly lobed, 00-480 µm long, 336-400 µm wide 400-480 µm long and 336-400 µm wide, margin entire, cells of the underleaf hyaline. **Sporophytes** not found. (**Figure 4.64 and 4.113**)

**Thailand** — NORTH: Chiang Mai, Chiang Rai; NORTH-EASTERN: Loei, Nakhon Ratchasima; CENTRAL: Prachin Buri, SOUTH-EASTERN: Chantaburi, Prachuap Khiri Khan, Trad; PENINSULAR: Phuket.

**Distribution** — South India, West Bengal, Assam, Nepal, Sikkim, Bhutan, Burma, Thailand, Ceylon, Sumatra, Java, Celebes, Borneo, Ceram, China, Formosa, Japan, Korea.

**Ecology** — on living bark and twig of tree, tree fern, rock, soil.

**Specimens examined** — P. Sukkharak 3, 4, 53, 90, 112, 117, 118, 122, 137, 138, 139, 141, 142, 159, 164, 165, 168, 182, 202, 203, 219, 226, 227, 228, 235, 238, 239, 240, 241, 255, 256, 267, 269, 352, 435, A. Kunoithai et al. 58, M. Tagawa & N. Kitagawa 7022, O. Thaithong 907, 928, 976, R. Mernnonsee 690, 1213, 1246, S. Juraitasani et al 19, W. Pornpipat 23 (BCU); Kai Larsen, T. Smitinand & E. Warncke 77a, M. Tagawa & N. Kitagawa 683, 848, 860, 1456, 2726, 3091, 3361, 3601, 3618, 3735, 3884, 4338, 7024, 7223 (BKF).

**GPS location** — 8.87772565° N 99.70343346° E, 8.87793956° N 99.70316423° E, 8.88173757° N 99.70036786° E, 8.88259495° N 99.70011875° E, 8.87887615° N 99.69447228° E, 8.87584269° N 99.69320834° E

**Altitude** — ca. 409-1,345 m

### 6. *Bazzania uncigera* (Nees) Trevis.

Mem. Istit. Lombardo, ser. 3, 4; 415. 1877.; Kitagawa, N., J. Hattori Bot. Lab. 30: 264. 1967. — *Jungermannia uncigera* Reinw., Blume et Nees, Nova Acta Leop.-Carol. 12: 230. 1824. — *Mastigobryum uncigerum* (Reinw., Blume et Nees) Lindenb. in Gott., Lidenb. & Nees, Syn. Hepat. 233. 1845.

**Plants** yellowish-brown, 4-5 mm wide. **Stems** creeping, furcately branch, with 0.7-1.4 mm long ventral flagella. **Lateral leaves** ovate, apex with 3 deeply teeth, 2.8-3 mm long and 0.5-0.8 mm wide near the apex, and 1.2-1.5 mm wide near the base, margin entire, trigones large, median cells 31-39  $\mu\text{m}$  long and 15-21  $\mu\text{m}$  wide, trigones large, basal cells 47-60  $\mu\text{m}$  long and 26-34  $\mu\text{m}$  wide. **Underleaves** oblong, 1-1.3 mm long and 1-1.5 mm wide, irregular dentate with acute teeth margins, appressed to stem, hyaline. **Bracts** 3-6, margin with teeth, 0.8-1 mm long and 0.5-0.8 mm wide. **Perianths** cylindrical with 3 keels, 1.5-1.8 mm long and 0.8-1 mm wide. **(Figure 4.65)**

**Thailand** — NORTH: Chiang Mai; SOUTH-EASTERN: Chantaburi, Prachuap Khiri Khan; PENINSULAR: Nakhon Si Thammarat, Surat Thani.

**Distribution** — widely distributed in southeastern Asia, extending to New Guinea and Fiji.

**Ecology** — on living bark of tree, rotten log.

**Specimens examined** — P. Sukkharak 162, 166, 173, 176, 177, 186, 189, 213 (BCU); M. Tagawa & N. Kitagawa 1677, 2741, 4953, 4982, 5090, 5093, 7218, 7233, 7234, 7262 (BKF).

**GPS location** — 8.88173757° N 99.70036786° E, 8.8818773° N 99.70022461° N, 8.88279939° N 99.70001649° E

**Altitude** — 1,275-1,356 m

### 7. *Bazzania vittata* (Gottsche) Trevis.

Mem. Istit. Lombardo, ser. 3, 4: 414. 1877; Kitagawa, N. J. Hattori Bot. Lab. 30: 262-263. 1967. — *Mastigobryum vittatum* Gott. in Gott., Lindenb. & Nees, syn. Hepat. 216. 1845.

**Plants** yellow, 1-1.3 mm wide. **Stems** creeping, furcately branch, with 1.5-2.5 mm long ventral flagella. **Lateral leaves** ovate, apex with 3 teeth, margin entire, 576-608  $\mu\text{m}$  long and 328-360  $\mu\text{m}$  wide, trigones absent, a vitta present 3-4 cells wide at basal part, asperulous cuticle. **Underleaves** oblong, 256-288  $\mu\text{m}$  long and 184-216  $\mu\text{m}$  wide, margin entire, appressed to stem, hyaline. **Sporophytes** not found. **(Figure 4.66)**

**Thailand** — NORTH-EASTERN: Loei; CENTRAL: Phitsanulok.

**Distribution.** — Java and other regions of tropical Asia, extending to New Guinea and to Tahiti.

**Ecology** — on living bark and twig of tree, rotten log, rock, soil.

**Specimens examined** — P. Sukkharak 47, 51, 54, 55, 84, 135, 136, 161, 180, 225, 264, 448 (BCU); Kai Larsen, T. Smitinand & E. Warncke 1061, M. Tagawa & N. Kitagawa 669, 674, 725, 840, 845, 1406 (BKF).

**GPS location** — 8.88173757° N 99.70036786° E, 8.8770926° N 99.68966782° E

**Altitude** — 976-1,345 m

### 8. *Bazzania yakushimensis* Horik.

J. Sci. Hiroshima Univ. ser. b, 2, 2: 194, pl. 16, 17-21. 1934; Hattori, S. & Mizutani, M., J. Hattori Bot. Lab. 19: 97-99, fig. VI. 1967. (Exsiccata) Hatt. Hepat. Japon. ser. 4: 151. 1951.

**Plants** yellowish-brown, 3-5 mm wide. **Stems** creeping, furcately branch, circinate at the apex, with 5-20 mm long ventral flagella. **Lateral leaves** ovate, apex and margin dentate except near the base, 2-2.3 mm long and 560-800  $\mu\text{m}$  wide near the base, 560-700  $\mu\text{m}$  wide near the apex, trigones nodulose. **Underleaves** rotund-reniform, 620-650  $\mu\text{m}$  long and 680-720  $\mu\text{m}$  wide, smooth margins, appressed to stem, hyaline margins of one to two cells wide. **Sporophytes** not found. **(Figure 4.67)**

**Thailand** — New record to Thailand.

**Distribution** — Japan.

**Ecology** — on living bark of tree and rotten log.

**Specimens examined** — P. Sukkharak 91, 169, 204, 251 (BCU).

**GPS location** — 8.88259495° N 99.70011875° E

Altitude — 1,240-1,312 m

### 3. *Lepidozia*

*Lepidozia* (Dumort.) Dumort., Recueil d'Observations sur les Jungermanniacées 19. 1835.; Fulford, M. H. Memoirs of the New York Botanical Garden 11(2): 180-213. 1966; Gradstein, S. R., Churchill, S. P. & Allen, N. S., Guide to the bryophytes of tropical America: 183-184. 2001.

**Plants** small to rather large but always narrow, typically pale green to whitish, sometimes greenish-brown, rarely dark, creeping, sometimes long pendent, 1-3-pinnate. **Branches** mostly *Frullania*-type, often ending in slender flagella; ventral-intercalary branches also present, these sometimes stoloniform. **Lateral leaves** small, incubous sometimes transverse, usually concave, divided into 4(-6) equal or very unequal segments, the segments triangular and usually incurved, margins entire or with a few teeth or cilia; cells wall uniformly thicken, trigones  $\pm$  lacking, cuticle usually smooth; oil-bodies finely granular. **Underleaves** about half the size of the leaves, divided into 4 equal segments. **Androecia and Gynoecia** as in the family.

#### Key to species

1. Lateral leaves deeply divided into hair-like lobes, the lobes only 2 cell wide.
  2. Lateral leaves orbicular, margin with 6-8 cells ciliate teeth..... *L. cladorhiza*
  2. Lateral leaves divided into 4-6 lobes ..... *L. parvula*
1. Lateral leaves divided into short 3 segments..... *L. sp.*

#### 1. *Lepidozia cladorhiza* (Reinw., Blume & Nees) Nees

Syn Hep 210. 1845. [http://mobot.mobot.org/cgi-bin/search\\_vast](http://mobot.mobot.org/cgi-bin/search_vast). — *Jungermannia cladorhiza* Reinw., Blume & Nees, Nova Acta Leop.-Carol 12: 203 [Hepat. Jav.]. 1825.

**Plants** pale green, 4-5 mm wide. **Stems** creeping, pinnate branching. **Rhizoids** not found. **Lateral leaves** imbricate, concave (clasping at dorsal side of stem), orbicular to ligulate, 0.8-0.9 mm long and 0.7-0.8 mm wide, margin with 6-8 cells long teeth, median cells 13-21  $\mu$ m long and 10-13  $\mu$ m wide, trigones small, basal cells 26-39  $\mu$ m long and 21-26  $\mu$ m wide, trigones small. **Underleaves** imbricate, connate with the lateral leaves, 0.8-0.85 mm long and 0.60-0.65 mm wide, apex deeply 2 lobes. **Sporophytes** not found. (**Figure 4.68 and 4.114**)

**Thailand** — New record to Thailand.

**Distribution** — Java.

**Ecology** — on living bark of tree, rotten log.

**Specimens examined** — P. Sukkharak 283, 525 (BCU).

**GPS location** — 8.87610694° N 99.68858475° E, 8.88278425° N 99.69716728° E

**Altitude** — 1,270-1,362 m

**Note:** Key was not accessed by the author. This species as determined by Dr. Tatsuwo Furuki.

#### 2. *Lepidozia parvula* N. Kitag.

In Kitagawa, N., Acta Phytotax. Grobot. XXIX, Nos. 1-5: 60-61, fig. 6. 1978.

**Plants** yellowish green, 0.5-1 mm wide. **Stems** flattened, irregularly pinnate branching forming flocculent, in cross section of stem 12 of large cortical cells and 14-15 small medullary cells. **Rhizoids** absent. **Lateral Leaves** slightly alternate to nearly transverse. **stem-leaves** remote, 0.5-0.6 mm long and 0.2-0.3 mm wide, divided into 4-6 lobes which 2 cells wide at base, 1-2 cells rows of base. **Branch-leaves** imbricate, 0.4-0.5 mm long and 0.2-0.3 mm wide, divided into 4-6 lobes which 2 cells wide at base, 1-2 cells rows of base. **Underleaves** distant. **Stem-underleaves** 0.2-0.3 mm long and 0.2-0.3 mm wide, divided into 4 lobes which 2 cells wide at base, 1 cell rows and 8 cells wide of base. **Branch-underleaves** 0.4-0.5 mm long and 0.2-0.3

mm wide, divided into 3 lobes which 2 cells wide at base, 1 cell rows and 6 cells wide of base. **Sporophytes** not found. **(Figure 4.69)**

**Thailand** — PENINSULAR: Nakhon Si Thammarat.

**Distribution** — Thailand.

**Ecology** — on tree fern, rotten log.

**Specimens examined** — P. Sukkharak 188, 222, 431 (BCU).

**GPS location** — 8.87584269° N 99.69320834° E

**Altitude** — 1,270-1,356 m

### 3. *Lepidozia* sp.

**Plants** pale yellow, 0.3-0.5 mm wide. **Stems** flattened, without a hyaloderm, irregularly pinnate branching, sometimes with flagellate tip. **Rhizoids** absent. **Lateral Leaves** minute, incubous, slightly alternate to nearly transverse, slightly remote, 184-240 µm long and 112-120 µm wide, usually divided into 3 lobes which 2 cells wide at base, 4-5 cells rows of base, apical 2 cells. **Underleaves** distant, 96-120 µm long and 104-120 µm wide, divided into 3 lobes which 2 cells wide at base, apical 2 cells, 1-2 cell rows of base. **Sporophytes** not found. **(Figure 4.70)**

**Thailand** —

**Distribution** —

**Ecology** — on twig of shrub.

**Specimens examined** — P. Sukkharak 345 (BCU).

**GPS** — Exact locality not applicable. Along Naka cliff.

**Altitude** — Exact altitude not applicable. ca. 1,055 m

### 4. *Psiloclada*

*Psiloclada* Mitt., Flora Novae-Zelandiae 2: 143. 1854.; Fulford, M. & Taylor, J., J. Hattori Bot. Lab. 21: 79-84. 1959.; Scott, G. A. M. Southern Australian Liverworts: 97. 1985.; Schuster, R. M. J. Journ. Hattori Bot. Lab. 48: 337-421. 1980.

**Lateral leaves** succubous, lobes end in finger-like single-celled spines at right angles to the base. In other respects it is like *Lepidozia*.

#### *Psiloclada clandestina* Mitt.

Flora Antarctica 2: 143. 1854.; Fulford, M. & Taylor, J., J. Hattori Bot. Lab. 21. 79-84, Plate I. 1959; Scott, G. A. M. Southern Australian Liverworts: 97-99, fig. 54. 1985.

**Plants** pale yellow, 0.2-0.3 mm wide. **Stems** flattened, slender with a hyaloderm, irregularly pinnate branching. **Rhizoids** absent. **Lateral Leaves** minute, slightly remote, 72-96 µm long and 92-104 µm wide, usually divided into 5 lobes rarely 3-4 lobes which 2 cells wide at base, 1-2 cells rows of base, apical spines long, erect terminal single-celled, paralleled to the stem. **Underleaves** distant, 88-120 µm long and 40-128 µm wide, usually divided into 3-4 lobes rarely 2 lobes which 2 cells wide at base, 1 cell rows of base. **Sporophytes** not found. **(Figure 4.71)**

**Thailand** — New record to Thailand.

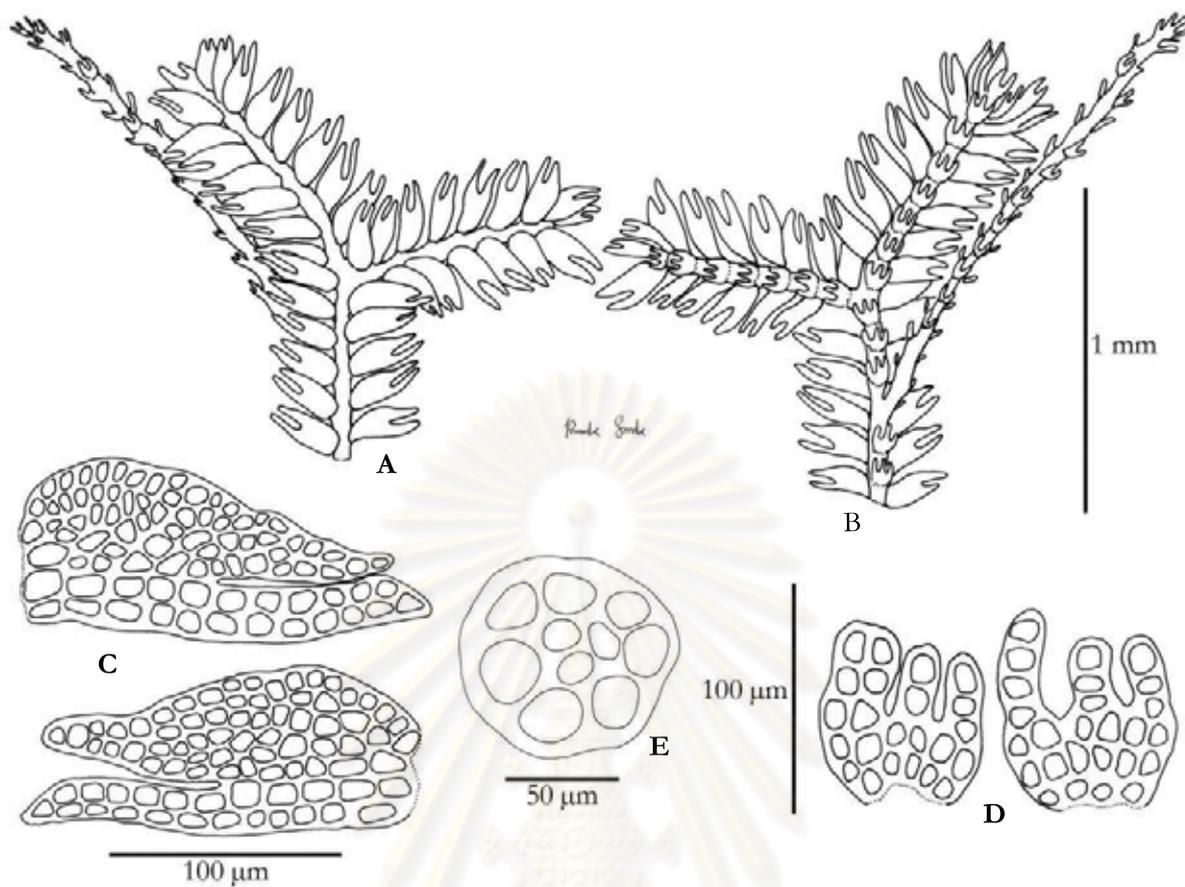
**Distribution** — Australia.

**Ecology** — on rotten log.

**Specimens examined** — P. Sukkharak 92 (BCU).

**GPS location** — Exact locality not applicable. Near TT20.

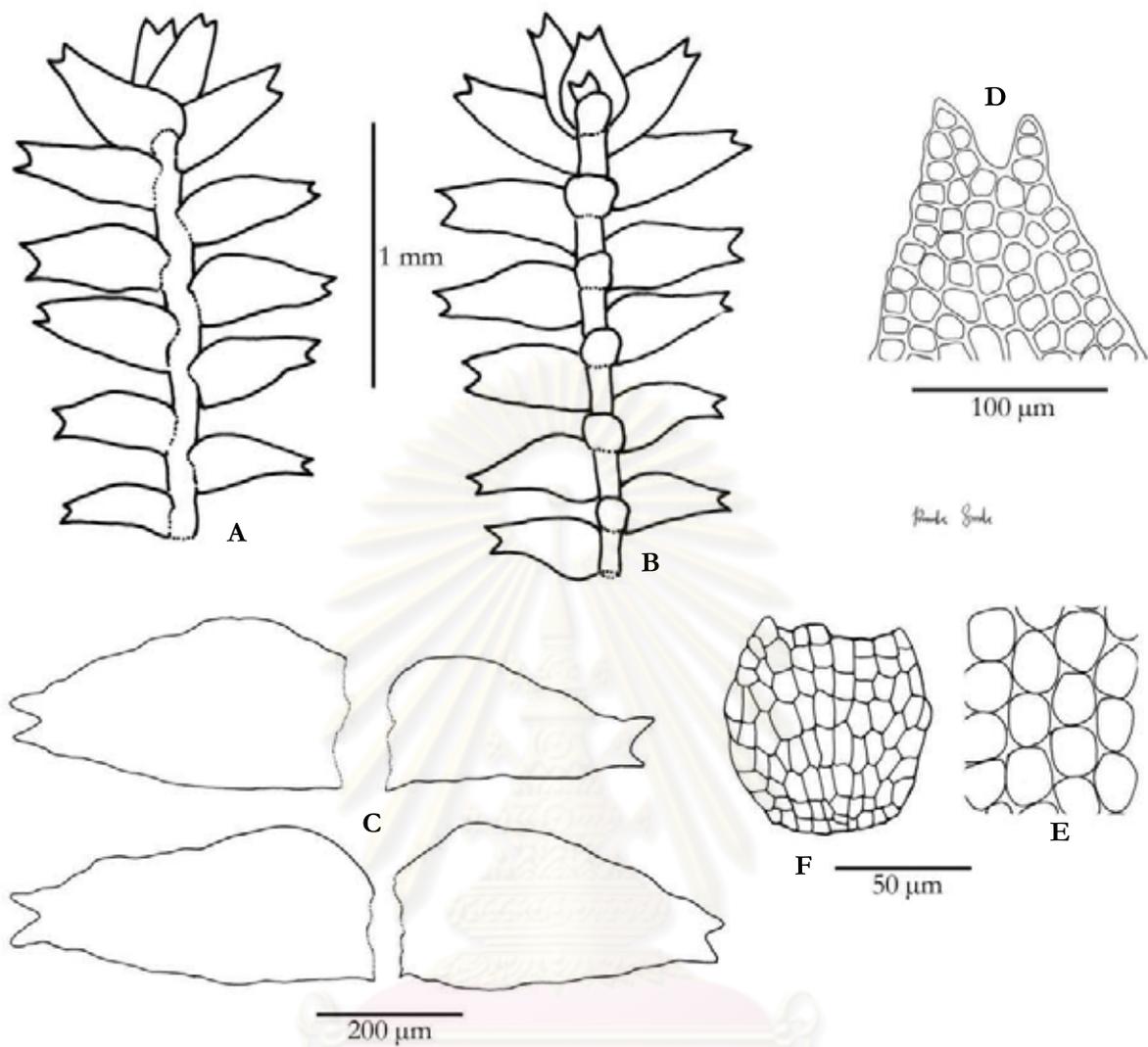
**Altitude** — ca. 1,270 m



**Figure 4.59** *Acromastigum curtilobum* A. Evans.

A.-B. portion of plant: A. dorsal view, B. ventral view; C. lateral leaves; D. underleaves; E. cross section of stem. P. Sukkharak 275.

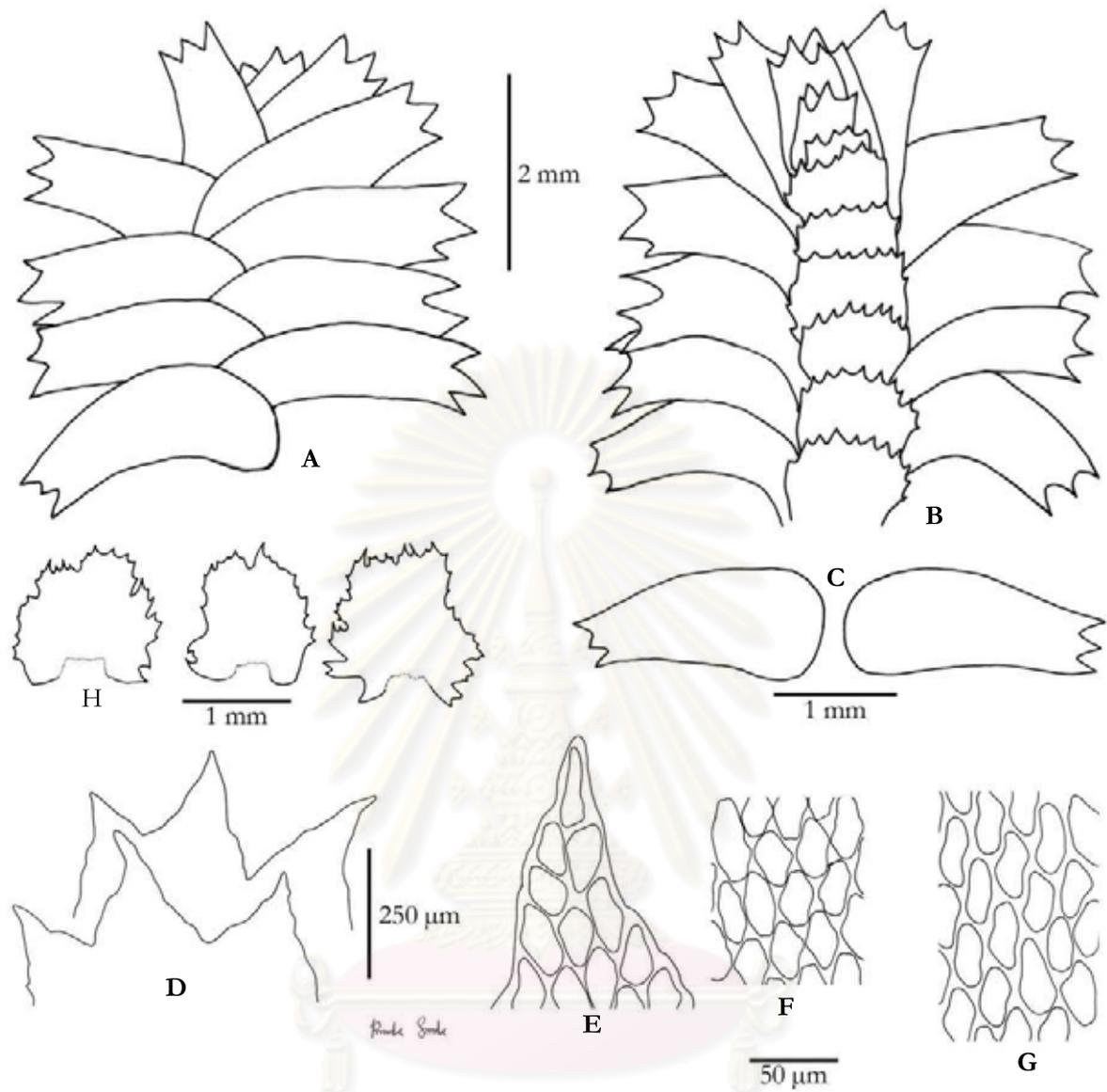
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**Figure 4.60** *Bazzania debilis* N. Kitag.

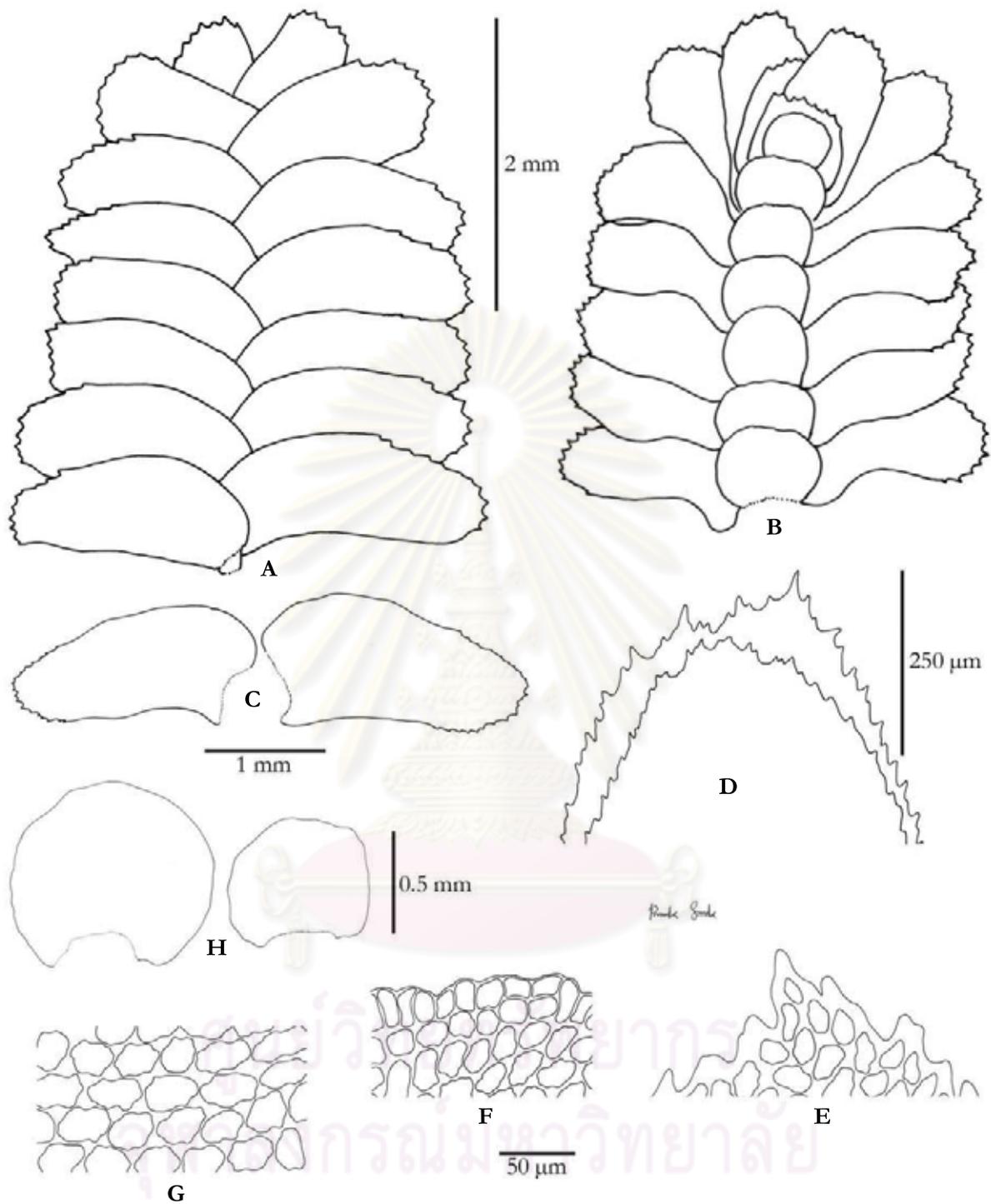
A.-B. portion of plant: A. dorsal view, B. ventral view; C. lateral leaves; D. cells at leaf apex; E. cells at leaf base; F. underleaves. P. Sukkharak 163.

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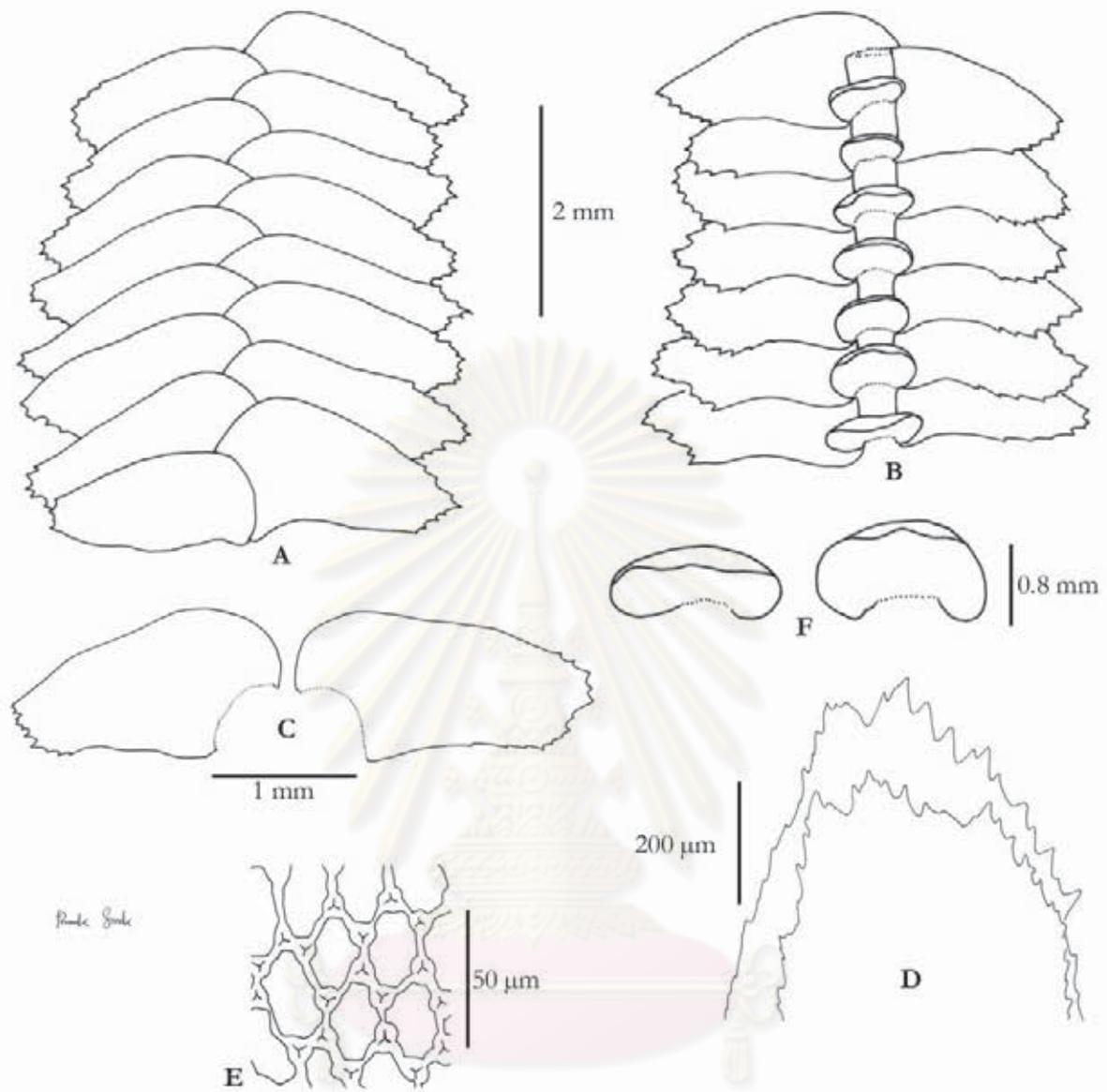
**Figure 4.61** *Bazzania fauriana* (Steph.) S. Hatt.  
 A.-B. portion of plant: A. dorsal view, B. ventral view; C. lateral leaves; D. leaf apices; E. cells at leaf apex; F. cells at median; G. cells at leaf base; H. underleaves. P. Sukkharak 76.

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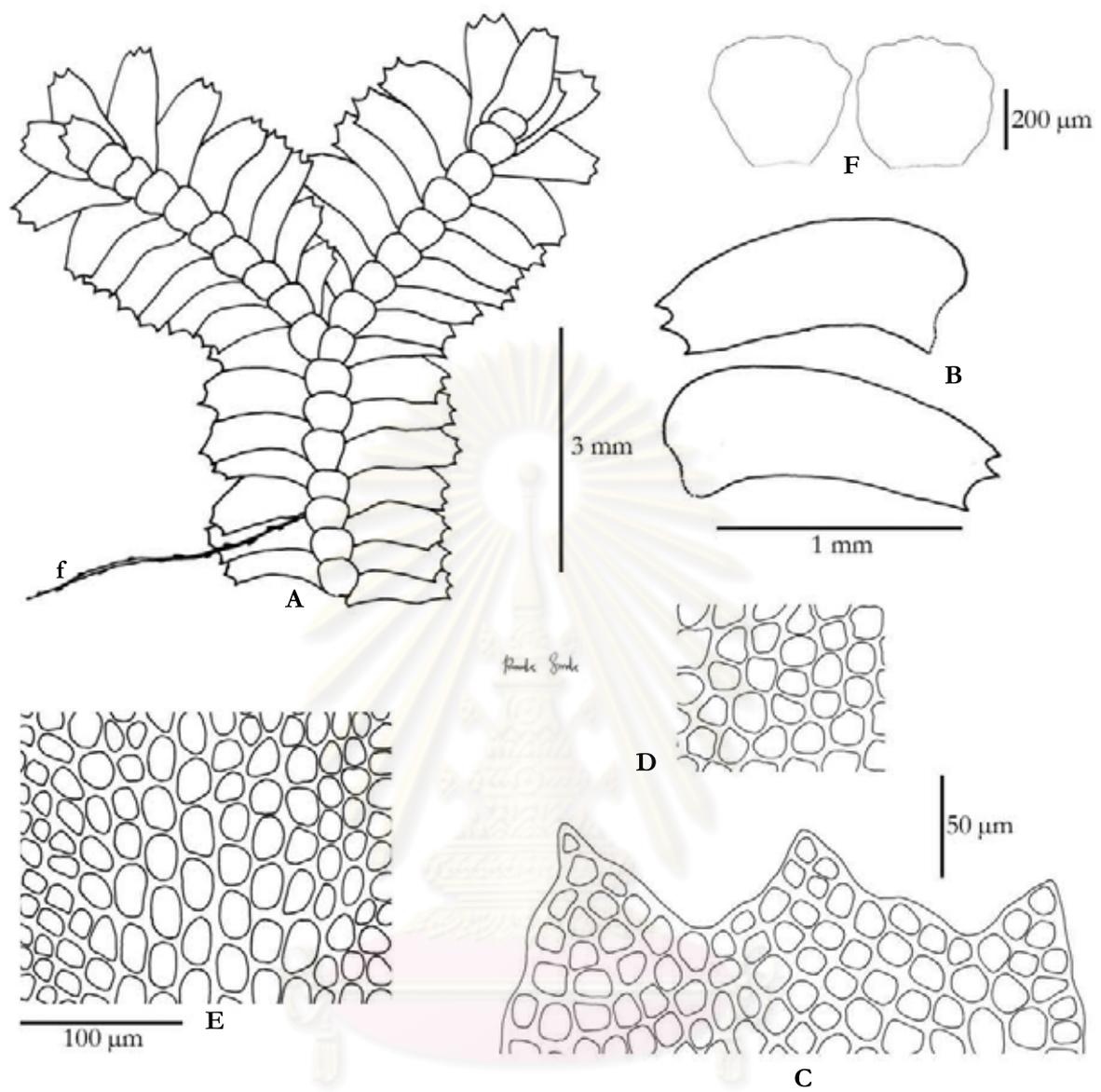
**Figure 4.62** *Bazzania loricata* (Nees) Trevis.

A.-B. portion of plant: A. dorsal view, B. ventral view; C. lateral leaves; D. leaf apices; E. cells at leaf apex; F. cells at margin; G. cells at leaf median; H. underleaves. P. Sukkharak 81.



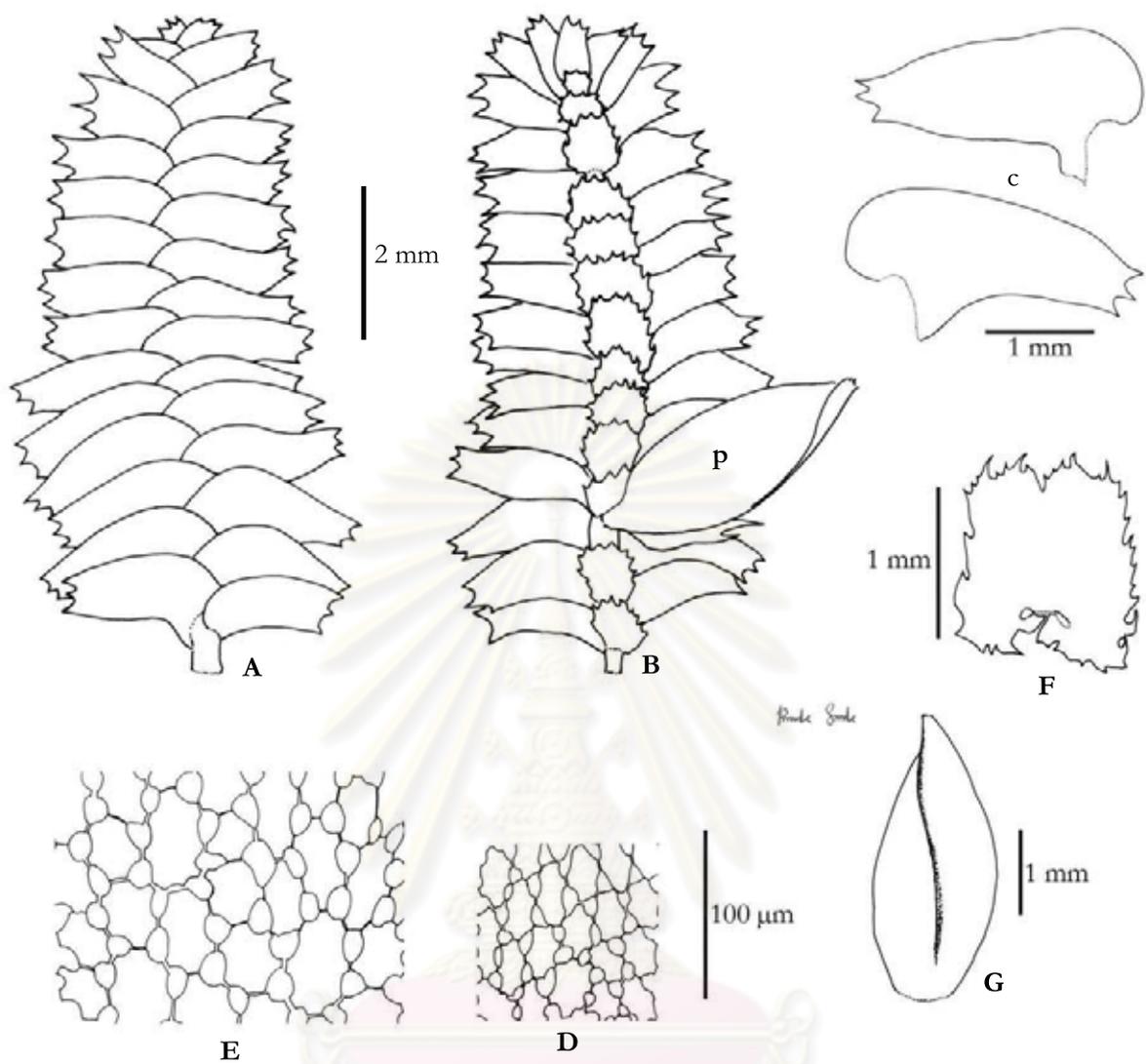
**Figure 4.63** *Bazzania spiralis* (Reinw., Blume et Nees) Meijer

A.-B. portion of plant: A. dorsal view, B. ventral view; C. lateral leaves; D. leaf apices; E. cells at median; F. underleaves. P. Sukkharak 252.



**Figure 4.64** *Bazzania tridens* (Reinw. et al.) Trevis.

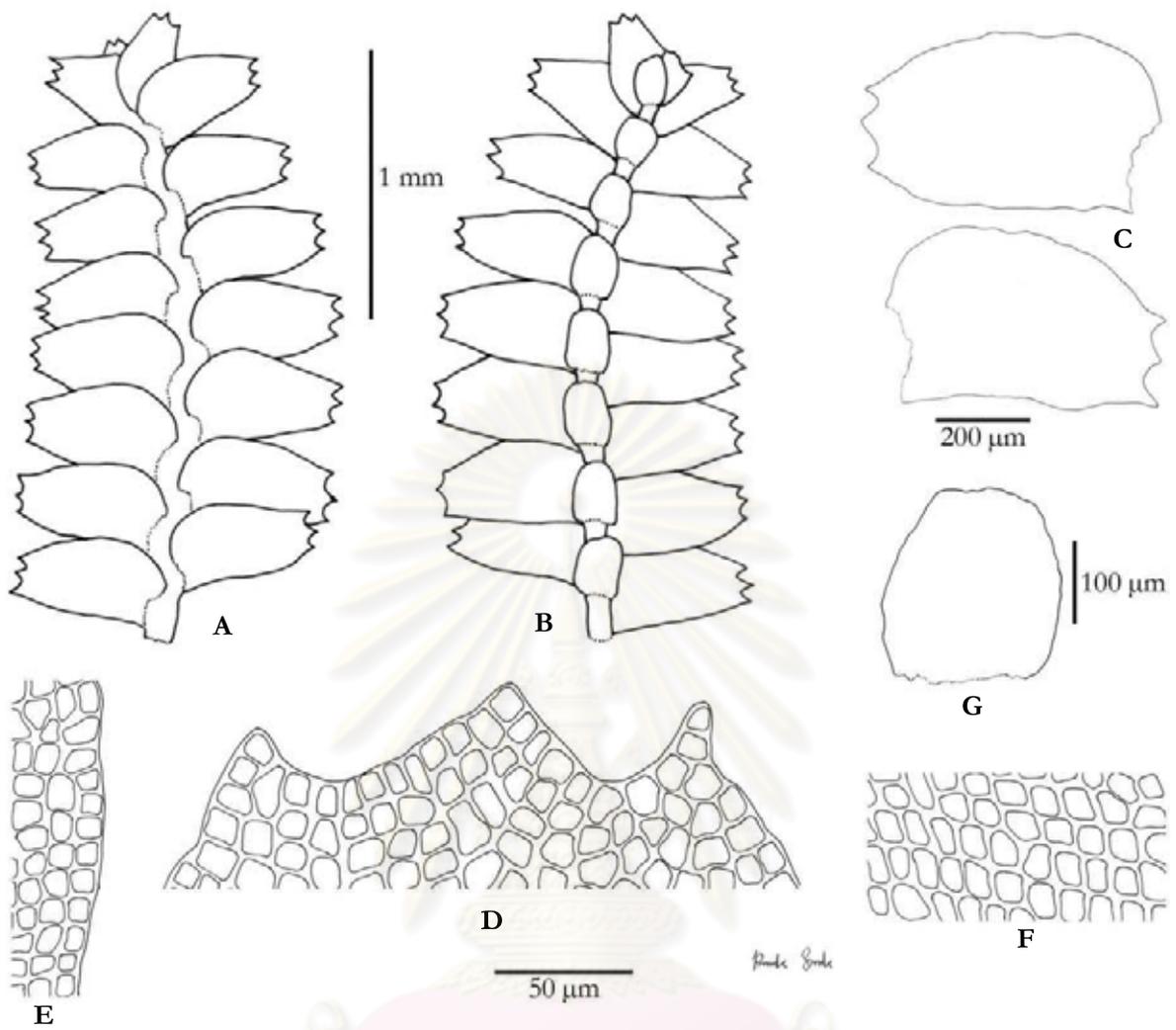
A. ventral portion of plant with flagella (f); B. lateral leaves; C. cells at leaf apex; D. cells at leaf median; E. cells at base showing vitta; F. underleaves. P. Sukkharak 3.



**Figure 4.65** *Bazzania uncigera* (Nees) Trevis.

A.-B. portion of plant: A. dorsal view, B. ventral view with perianth (p); C. lateral leaves; D. cells at leaf median; E. cells at leaf base; D. underleaves; G. perianth. P. Sukkharak 173.

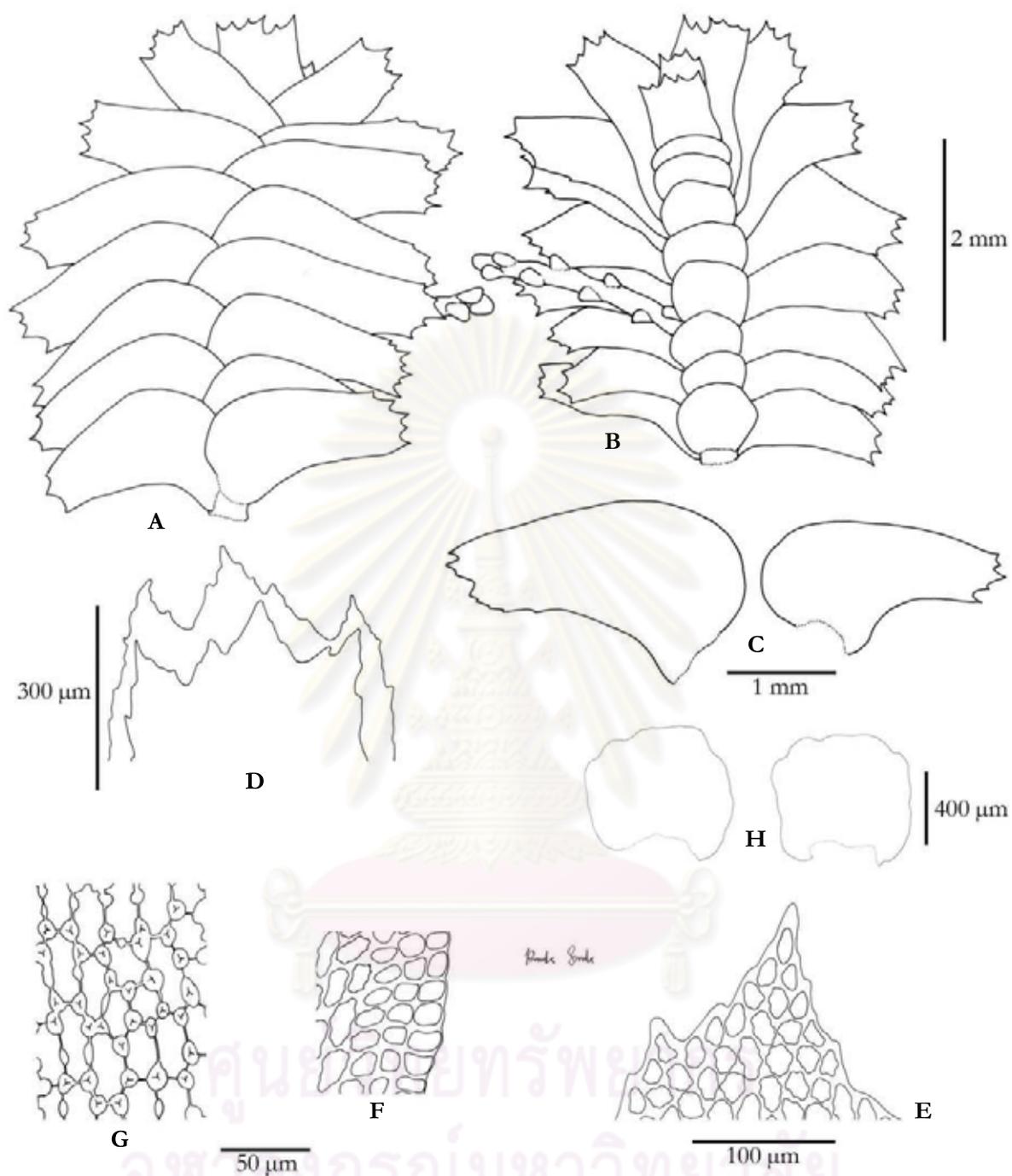
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**Figure 4.66** *Bazzania vittata* (Gottsche) Trevis.

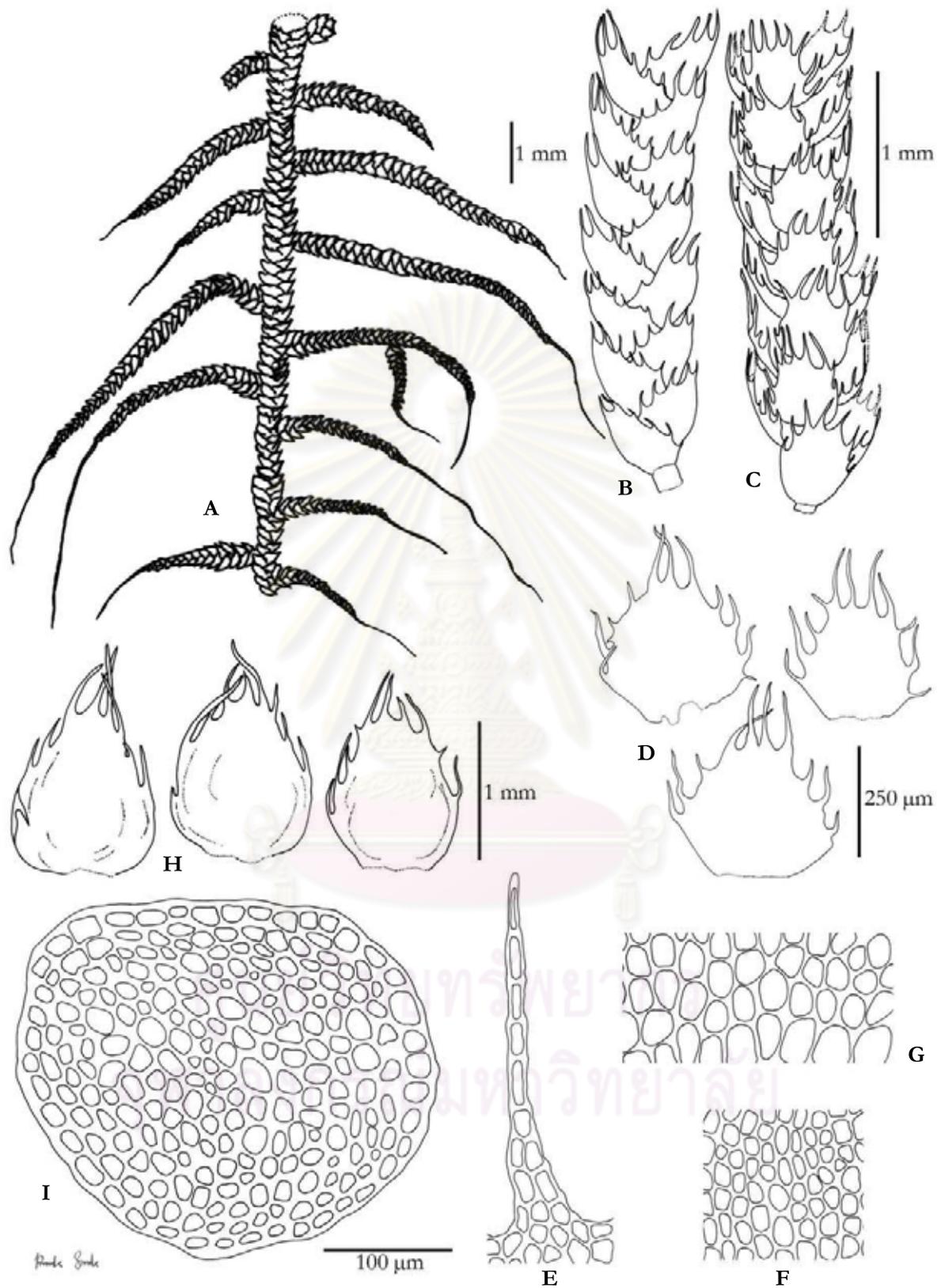
A.-B. portion of plant: A. dorsal view, b. ventral view; C. lateral leaves; D. cells at leaf apex; E. cells at leaf margin; F. cells at leaf median; G. underleaf. P. Sukkharak 47.

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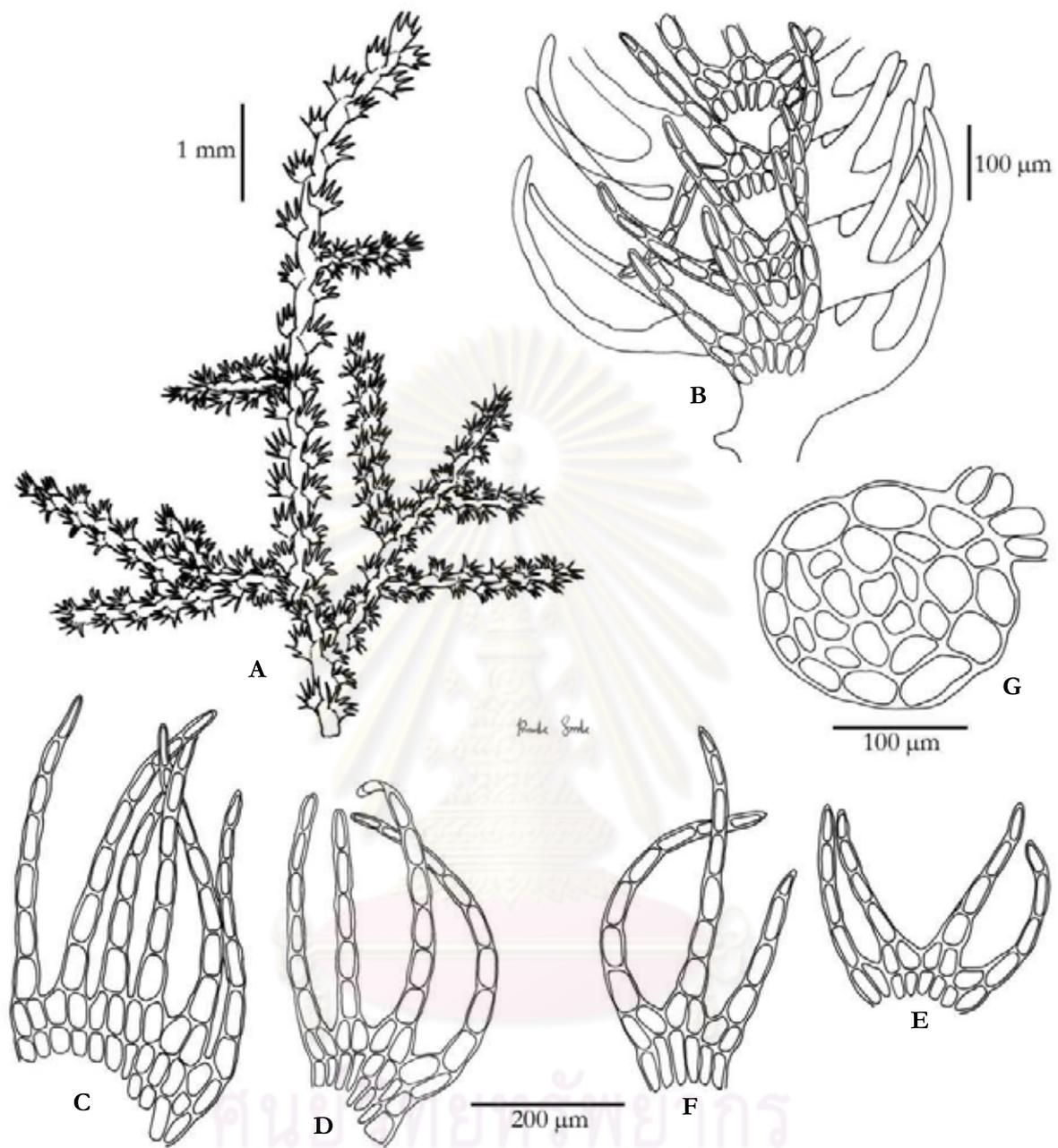
**Figure 4.67** *Bazzania yakushimensis* Horik.

A.-B. portion of plant: A. dorsal view, B. ventral view; C. lateral leaves; D. leaf apices; E. cells at leaf apex; F. cells at leaf margin; G. cells at leaf median; H. underleaves. P. Sukkharak 91.



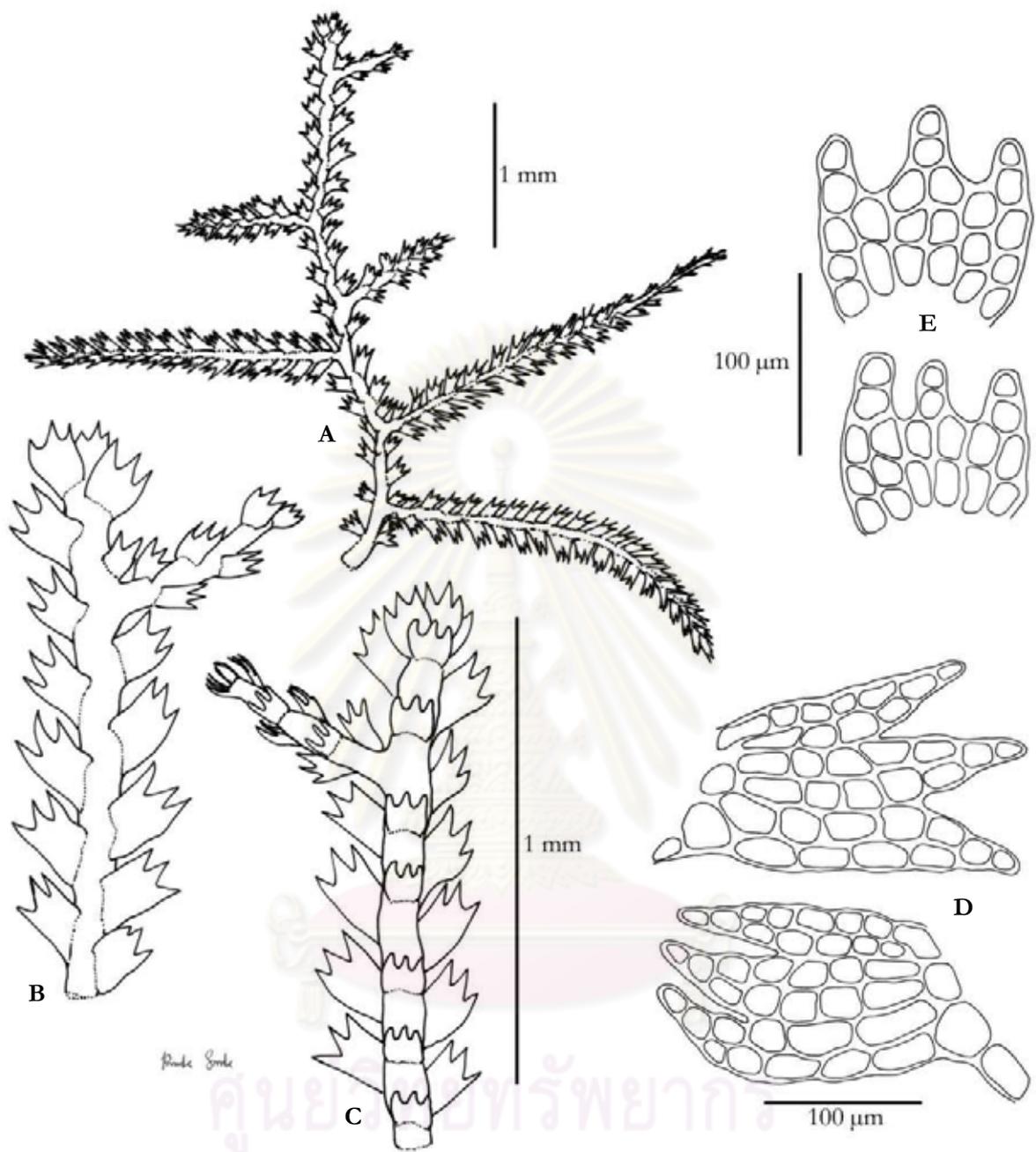
**Figure 4.68** *Lepidozia cladorbiza* (Reinw., Blume & Nees) Nees

A. whole; B.-C. portion of plant: B. dorsal view, C. ventral view; D. lateral leaves; E. cells at leaf margin; F. cells at leaf median; G. cells at leaf base; H. underleaves; I. cross section of stem. P. Sukkharak 283.



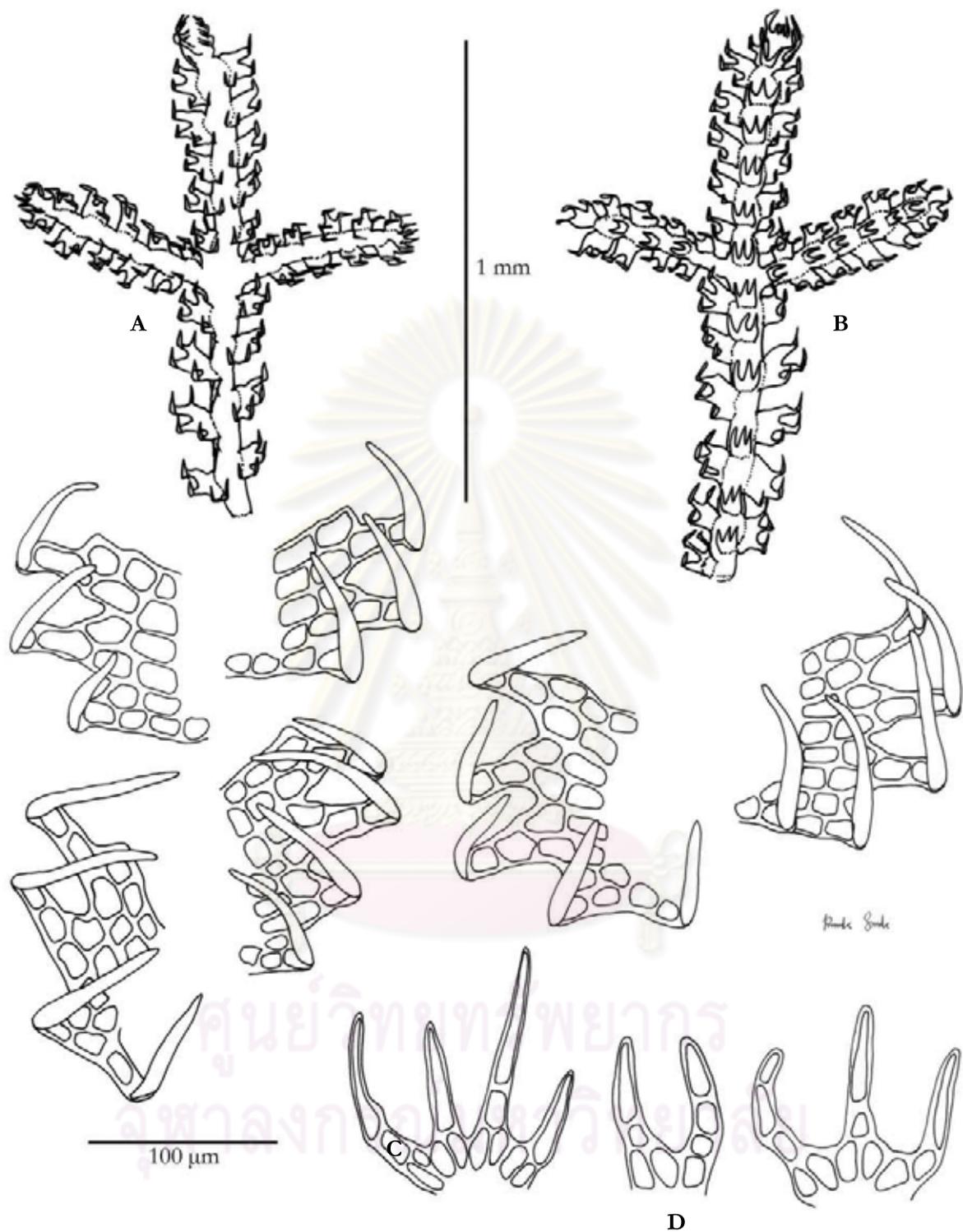
**Figure 4.69** *Lepidozia parvula* N. Kitag.

A. whole plant; B. portion of plant, dorsal view; C. lobe of stem-lateral leaf; D. lobe of branch-lateral leaf; E. lobe of stem-underleaf; F. lobe of branch-underleaf; G. cross section of stem. P. Sukkharak 188.



**Figure 4.70** *Lepidozia* sp.

A. whole plant; B.-C. portion of plant: B. dorsal view, C. ventral view; D. lateral leaves; E. underleaves.  
P. Sukkharak 345.



**Figure 4.71** *Psiloclada clandestina* Mitt.

A.-B. portion of plant: A. dorsal view, B. ventral view; C. lateral leaves; D. underleaves. P. Sukkharak 92.

## Marchantiaceae

**Plants** thalloid, usually large, dorsal surface with or without pores, pores compound when present, barrel-shaped (cross-section), surrounded by 1 to several rings of differentiated cells. **Air chambers** in 1 layer or reduced, with or without green filaments. **Ventral scales** in 2-10 rows. **Rhizoid** composed of 2 types: smooth and tuberculate; the latter having peg-like projections on the inner walls. **Antheridia and archegonia** developed on stalked receptacles (antheridiophore, archegoniophore) arising from the thallus tip, the stalk with 2(-4) furrows. **Archegonia** in rows on the ventral side of the receptacle, each row surrounded by an involucre. Each fertilized archegonium and young sporophyte sometimes surrounded by a pseudoperianth. **Sporophytes** with a short seta. **Capsules** opening by irregular valves. **Spores** small or large, unicellular. **Vegetative reproduction** sometimes by gemmae produced in cup-shaped receptacles on the thallus surface, or lacking.

### *Dumortiera*

*Dumortiera* Nees, Nova Acta Physico-medica Academiae Caesareae Leopoldino-Carolinae Naturae Curiosorum Exhibentia Ephemerides sive Observationes Historias et Experimenta 12: 410. 1824.; Evans, A. W., Bulletin of the Torrey Botanical Club 46: 167-182. 1981; Schuster, R. M., The Hepaticae and Anthocerotae of North America, Vol. VI: 1992.; Gradstein, S. R., Churchill, S. P. & Allen, N. S., Guide to the bryophytes of tropical America: 226-227. 2001.

**Plants** uniformly deep green, large, 5-20 cm long, 1-3 cm wide, forked; dorsal surface of thallus not reticulate, without pores, sometimes with papilliform cells in groups on the surface; thallus margins often with hairs, underside green, with small, colorless scales in 2 rows, often radiating to the thallus margins. **Air chambers** lacking or vestigial. **Monoicous**. **Androecia** almost sessile, on a very short stalk, circular and may or may not unlobed, margins with stiff, bristle-like hairs. **Gynoecea** on an elongate stalk, 8-10-lobed after fertilization, margins with stiff, bristle-like hairs. **Archegonia** in groups on the ventral side of the segments, each group surrounded by a tubular involucre. **Spores** small, 20-35 µm in diameter. **Sporophytes** otherwise as in the family. **Vegetative reproduction** lacking.

#### *Dumortiera hirsuta* (Sw.) Nees

Flora Brasiliensis seu Enumeratio Plantarum 1: 307. 1833.; Evans, A. W., A taxonomic study of *Dumortiera*. Bulletin of the Torrey Botanical Club 46: 177-178. 1981. — *Marchantia hirsuta* Sw., Nova Genera et Species Plantarum seu Prodrum 145. 1788. — *Dumortiera hirsuta* Nees, Nova Acta Acad. Lepo.-Carol. 12: 410. 1824. — *Marchantia irrigua* Wils; Hooker. Brit. Fl. 2: 106. 1833. — *Hygropyla irrigua* Tayl.; Mackay, Fl. Hibern. 2: 54. 1836. — *Dumortiera irrigua* Nees, Naturg. Europ. Leberm. 4: 159. 1838. — *Dumortiera hirsuta angustior* G. L. & N. Syn. Hep. 544. 1846. — *Dumortiera hirsuta intermedia* G. L. & N. l. c. — *Askepos brevipes* Griffith, Not. Pl. Asiat. 2: 340. 1849. — *Dumortiera hirsuta irrigua* Spruce, Trans. Bot. Soc. Edinb. 15: 566. 1885.

**Plants** prostrate, undulate, dark green, 1-3.4 cm long and 0.6-0.9 mm wide; in cross section, thallus without internal differentiation into pore and air chamber, small epidermal cell with chloroplast, inner cells larger, thin-walled and hyaline, upper surface of thallus without papillose. **Rhizoids** 2 kinds; smooth walled and pegged. **Gynoecea** with long archegoniophores, archegonial heads rounded, margin slightly divide 4-5 lobes, bristle-like hairs on the upper surface, 1-4 mature sporophyte per each head. **Seta** 0.5-2.5 cm long. **Capsules** obovate. **Elaters** with spiral thickening walled. **Gemma** not found. (Figure 4.72 and 4.115)

**Thailand** — NORTH: Chiang Mai, Phitsanulok; SOUTH-WESTERN: Prachuap Khiri Khan.

**Distribution** — America; Mexico, Guatemala, Nicaragua and Panama; Bermuda; Cuba, Hispaniola, Jamaica, Porto Rico, Montserrat, Guadeloupe, Martinique and Grenada; Colombia, Peru and Bolivia; Venezuela, Brazil and Paraguay; Ireland, England and France; Madeira and the

Canary Island, Fernando Po and Kamerun, China, India, France Indo-China, Japan, the Philippine Islands, Java and the Hawaiian Islands, Nepal, Assam.

**Ecology** — on rocks along stream.

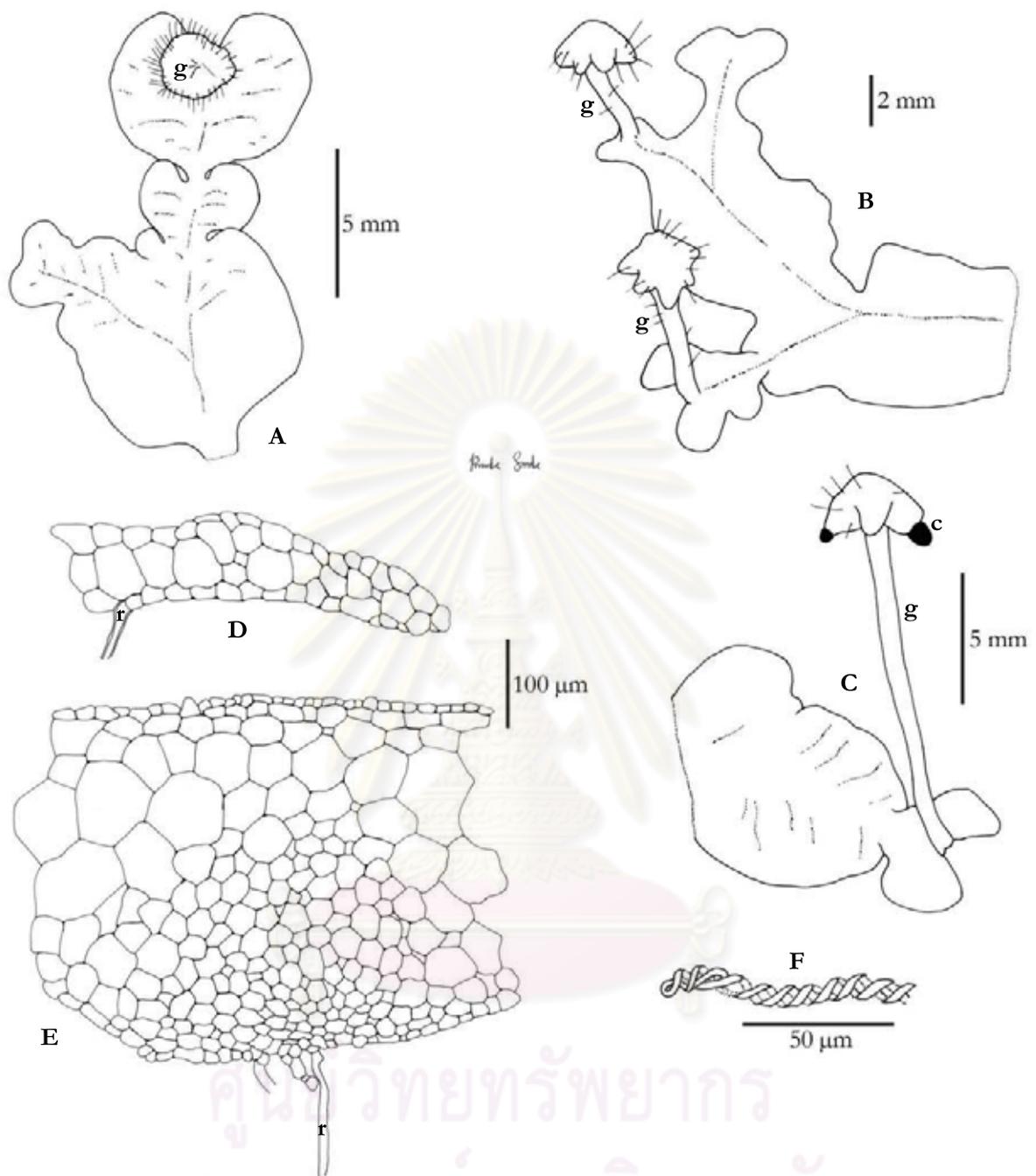
**Specimens examined** — P. Sukkharak 296 (BCU).

**GPS location** — Exact locality not applicable. Between KNY19 and KNY20.

**Altitude** — ca. 425 m



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**Figure 4.72** *Dumortiera birsuta* (Sw.) Nees

A. habit with gynoecium (g); B. habit with gynoecia; C. habit with gynoecia (g) and capsule (c); D.-E. cross section of thallus with rhizoids (r): D. margin, E. midrib; F. elater. P. Sukkharak 296.

## Mastigophoraceae

**Plants** leafy, brownish yellow. **Stems** creeping, irregular pinnate branching. **Lateral leaves** incubous, imbricate, concave, deeply 2 lobes, sinus obtuse, 1/2 of the length, margin entire, apex acuminate, basal part with appendage, trigones large. **Underleaves** almost as large as lateral leaves, imbricate, apex deeply 2 lobes.

### *Mastigophora*

*Mastigophora* Nees, Naturgeschichte der Europäischen Lebermoose 3: 89. 1838.

For description of the genus, see above.

#### *Mastigophora diclados* (Brid.) Nees

Naturgeschichte der Europäischen Lebermoose 3: 18. 1838. — *Jungermannia dicladus* Brid. ex F. Weber, Historiae Muscorum Hepaticorum Prodrum 56. 1815.

**Plants** brownish yellow, main stem 1-1.5 mm wide. **Stems** creeping, irregular pinnate branching. **Rhizoids** not found. **Lateral leaves** imbricate, concave, deeply 2 lobes, sinus obtuse, 1/2 of the length, margin entire, apex acuminate, basal part with appendage 0.1-0.2 mm long; stem leaves 0.7-0.8 mm long and 0.6-0.7 mm wide, median cells 36-50  $\mu\text{m}$  long and 21-31  $\mu\text{m}$  wide, trigones large. **Underleaves** imbricate, 0.7-0.8 mm long and 0.5-0.6 mm wide, apex deeply 2 lobes. **Sporophyte not found.** (Figure 4.73 and 4.116)

**Thailand** — North: Phitsanulok.

**Distribution** — China, Indonesia, Japan, Mauritius, Papua New Guinea, Philippines, Reunion, Seychelles, Taiwan.

**Ecology** — on bark of tree, rotten log, rock.

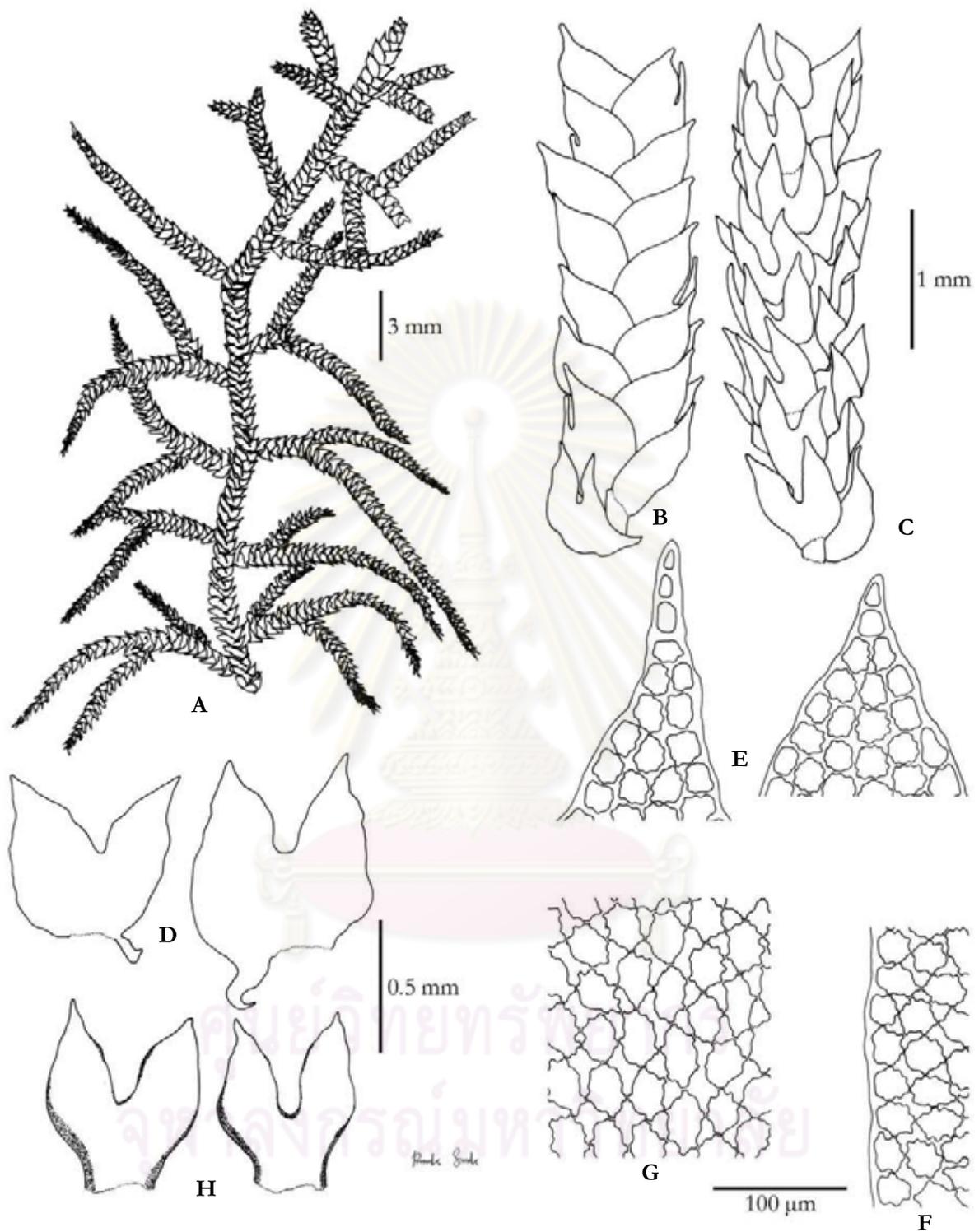
**Specimens examined** — P. Sukkharak 97, 287, 382, 441, 475, 504 (BCU); Bertel Hansen, Gunner Seidenfaden and Tem Smitinand 11561, 11673a, 11673b (BKF).

**GPS location** — 8.87631476° N 99.69027936° E, 8.87658298° N 99.69112158° E, 8.88219953° N 99.69647527° E

**Altitude** — 1,245-1,371 m

**Note:** Key was not access by the author. These specimens were determined by Dr. Tatsuwo Furuki.

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**Figure 4.73** *Mastigophora diclados* (Brid.) Nees.

A. whole; B.-C. portion of plant: B. dorsal view, C. ventral view; D. lateral leaves; E. cells at leaf apex; F. cells at leaf margin; G. cells at leaf median; H. underleaves. P. Sukkharak 441.

## Metzgeriaceae

**Plants** thalloid, narrow, to 2(-3) mm wide, with a narrow midrib and a unistratose lamina, prostrate or erect or pendent, forked, rarely pinnate, sometimes with ventral branches. **Hairs** usually present on thallus margins, on the underside of the midrib, and sometimes on the thallus surface. **Midribs** with large epidermal cells, without central strand. **Oil bodies** absent or very small, homogeneous. **Ventral scales** lacking. **Monoicous or Dioicous**. **Androecia and Gynoecia** on highly abbreviated branchlets scattered along the ventral side of the midrib, the antheridia inside a globose sac, the archegonia hidden under a thallus flap. **Sporophyte** surrounded by a fleshy calyptra; pseudoperianth lacking. **Capsules** spherical to ovoid, opening by 4 valves, wall 1-2 layered. **Spores** small, unicellular. **Elaters** with 0-1 spirals, attached to valve apices. **Vegetative reproduction** by gemmae or caduceus branches.

### *Metzgeria*

*Metzgeria* Raddi, Jungermanniografia Etrusca 34. 1818.; Costa, D. 1999. Tese de Doutorado, Universidade de São Paulo, Instituto de Biociências, São Paulo, 261 p.; Kuwahara, Y. Bryophytorum Bibliotheca 28: 1-254. 1986.; Gradstein, S. R., Churchill, S. P. & Allen, N. S., Guide to the bryophytes of tropical America: 207-209. 2001.

**Plants** thin, with a narrow midrib, pale green to yellowish, sometimes blue when dry, 0.5-15 cm long and 0.3-2(-3) mm wide, prostrate to erect or pendent, forked, rarely irregularly pinnate, with numerous hairs along the margins, on the underside of the midrib, and, sometimes, on the ventral surface of the thallus: hairs unicellular, arising singly or in pairs, sometimes in groups of 3-5, thallus surfaces plane to deeply concave with inflex margins. **Midribs** 2-8(-12) cells wide, epidermal cells smooth or papillose, larger than the inner cells; central strand absent. **Thallus wings** unbordered. **Elaters** with one spiral. Otherwise see family description.

#### Key to species

1. Marginal hairs single.
  2. Attenuated branches present, with marginal gemmae.....*M. consanguinea*
  2. Attenuated absent, gemmae absent.....*M. furcata*
1. Marginal hairs pair .....*M. linbergii*

#### 1. *Metzgeria consanguinea* Schiffn.

Nova Acta Acad. Caes. Leop.-Carol. German. Nat. Cur. 60: 271. 1893.; Zhu, R. L. & So, M. L., Nova Hedwigia 121: 33-35, fig 12. 2001.

**Plants** appressed to the substrate, light green, dichotomously branched. **Rhizoids** smooth with digitate at apex on ventral side of midrib along midrib. **Thalluses** attenuated-gemma-bearing branches present, 0.5-1 mm. wide, in cross section of the midrib, 2 dorsal and 2-3 ventral epidermal cells appearing large and distinct from the medullary cells which are thick-walled and composed of 19-20 cells in 4-5 tiers, unistratose wing 9-10 cells wide. **Hairs** sparse along margin and scattered on the ventral side of midrib. **Slime papillae** on apical ventral surface. **Gemmae** discoid, 10-14 cells in diameter, at margin of attenuated branches. **Sporophytes** not found. (Figure 4.74)

**Thailand** — New record to Thailand.

**Distribution** — China.

**Ecology** — on rock near the waterfall.

**Specimens examined** — P. Sukkharak 524 (BCU).

**GPS location** — 8.88269305° N 99.6968776° E

**Altitude** — 1,362 m

## 2. *Metzgeria furcata* (L.) Dumort.

Naturalienausch 12: 654. 1829.; Recueil Observ. Jungerm.: 26. 1835. Zhu, R. L. & So, M. L. Nova Hedwigia 121: 35. 2001. — *Jungermannia furcata* L., Sp. Pl.: 1136. 1753.

**Plants** green, dichotomously branched, thallus 1-1.5 mm. wide; in cross section of the midrib, 2 dorsal and 3-4 ventral epidermal cells appearing large and distinct from the medullary cells which are thick-walled and composed of 17-18 cells in 3-4 tiers, unistratose wing 9-10 cells wide. **Rhizoids** smooth along midrib. **Hairs** straight and single sparse along margin and scattered on the ventral side of midrib. **Slime papillae** on apical ventral surface. **Monoicous**. **Androecia** globular on ventral side. **Gynoecia** within hairy involucre on ventral side. **Sporophyte** in involucre on ventral side. (**Figure 4.75 and 4.117**)

**Thailand** — EASTERN: Nakhon Ratchasima.

**Distribution** — Pantropical: China, Australia, United Kingdom.

**Ecology** — on living branch and bark of tree and shrub, leaf surface, rock near the waterfall.

**Specimens examined** — P. Sukkharak 8, 12, 115, 278, 292, 399, 410, 418 (BCU).

**GPS location** — 8.87710333° N 99.68977511° E

**Altitude** — 553-1,385 m

## 3. *Metzgeria lindbergii* Schiffn.

Denkschriften der Kaiserlichen Akademie der Wissenschaften. Mathematisch-naturwissenschaftliche Klasse 67: 182. 1898.; Zhu, R. L. & So, M. L., Nova Hedwigia 121: 36. 2001.

**Plants** pale green, dichotomously branched, thallus 0.5-0.7 mm. wide; in cross section of the midrib, 2 dorsal and 2-3 ventral epidermal cells appearing large and distinct from the medullary cells which are thick-walled and composed of 9-10 cells in 3 tiers, unistratose wing 9-13 cells wide. **Rhizoids** smooth along midrib. **Hair** pair, sparse along margin and scattered on the ventral side of midrib. **Slime papillae** on apical ventral surface. **Sporophytes** not found. (**Figure 4.76**)

**Thailand** — New record to Thailand.

**Distribution** — widely distributed in South East Asia and tropical Oceania.

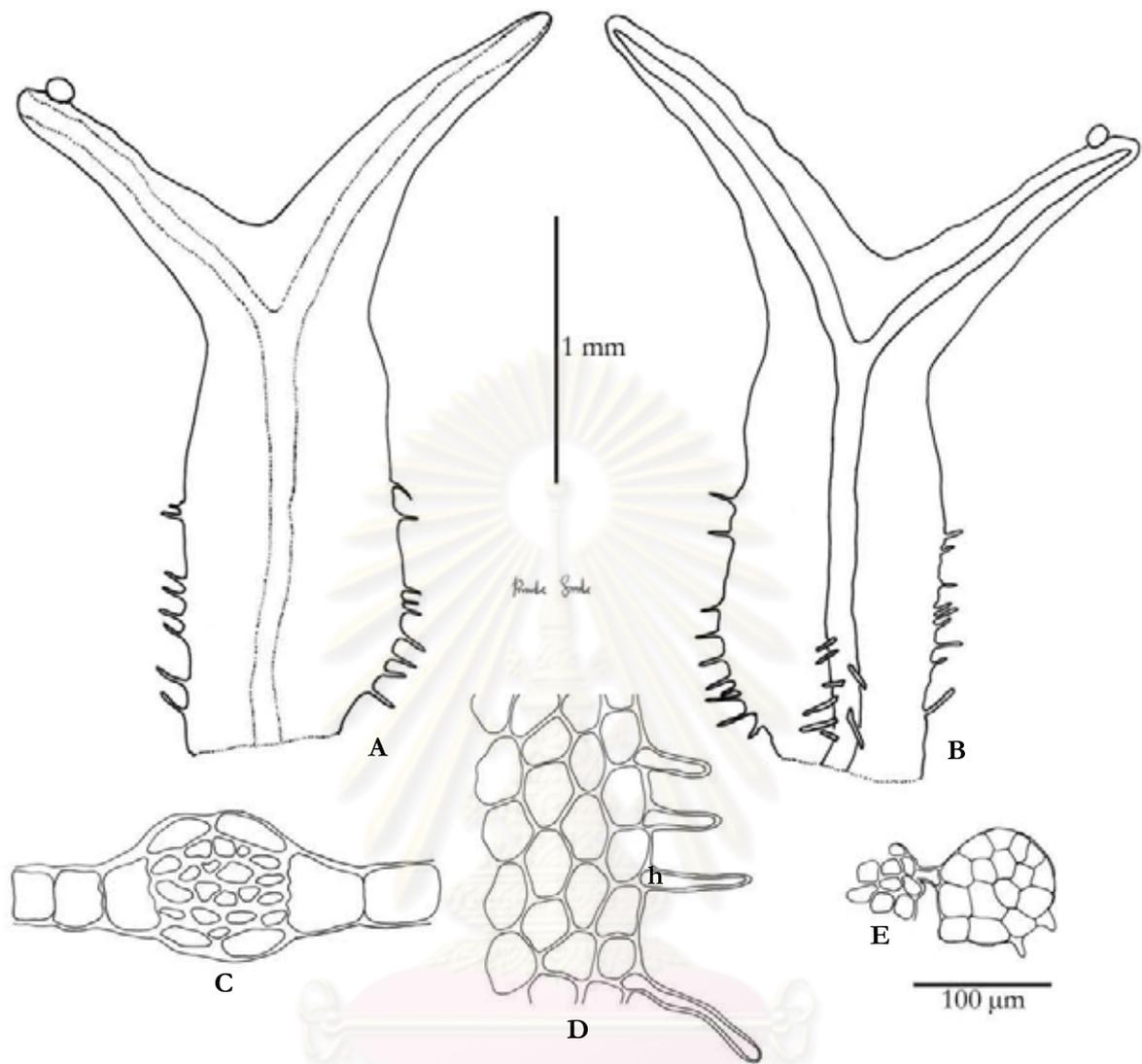
**Ecology** — on leaves and living branch of tree.

**Specimens examined** — P. Sukkharak 206, 273, 454 (BCU).

**GPS location** — 8.87710333° N 99.68977511° E

**Altitude** — ca. 980-1,327 m

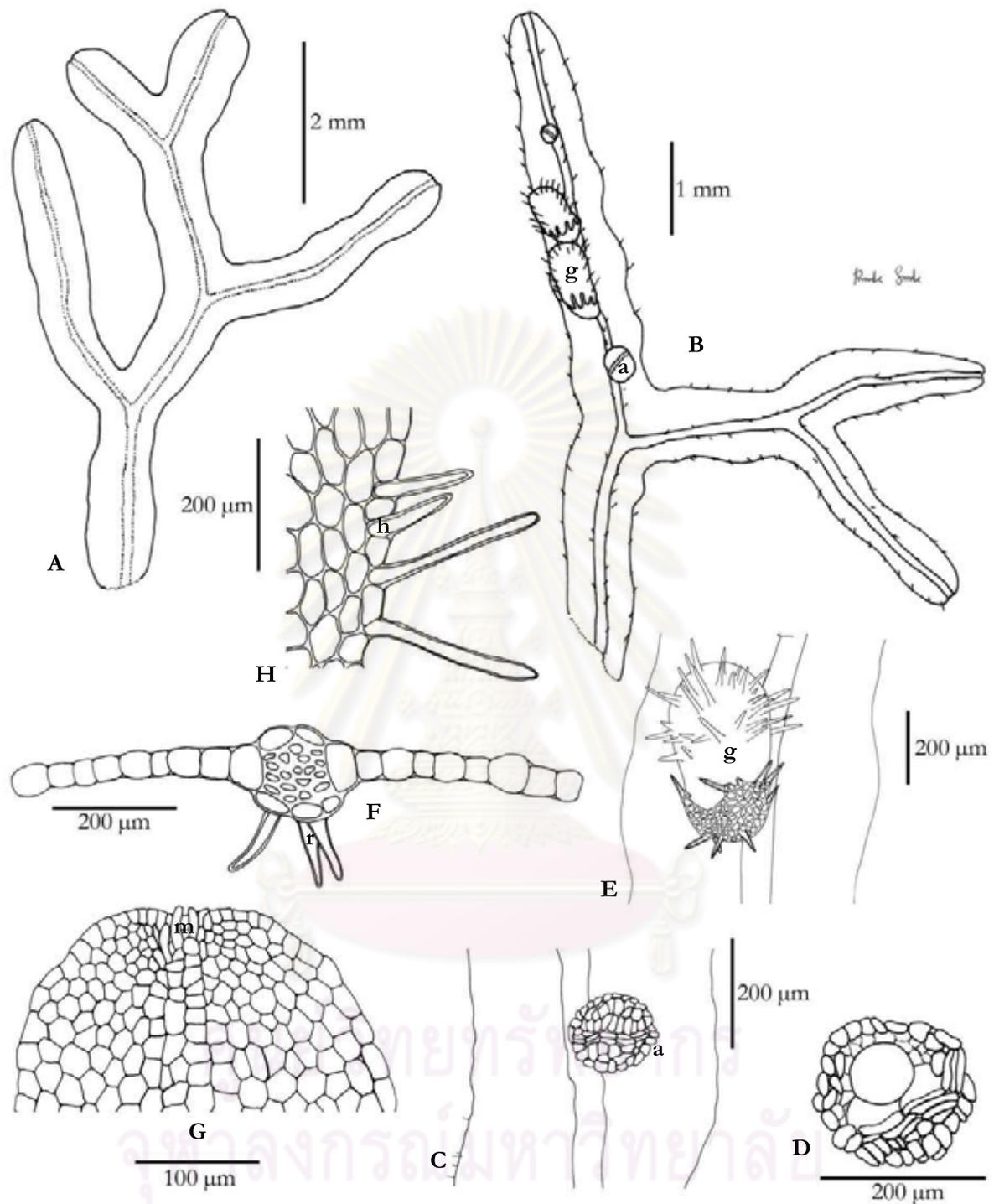
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จุฬาลงกรณ์มหาวิทยาลัย



**Figure 4.74** *Metzgeria consanguinea* Schiffn.

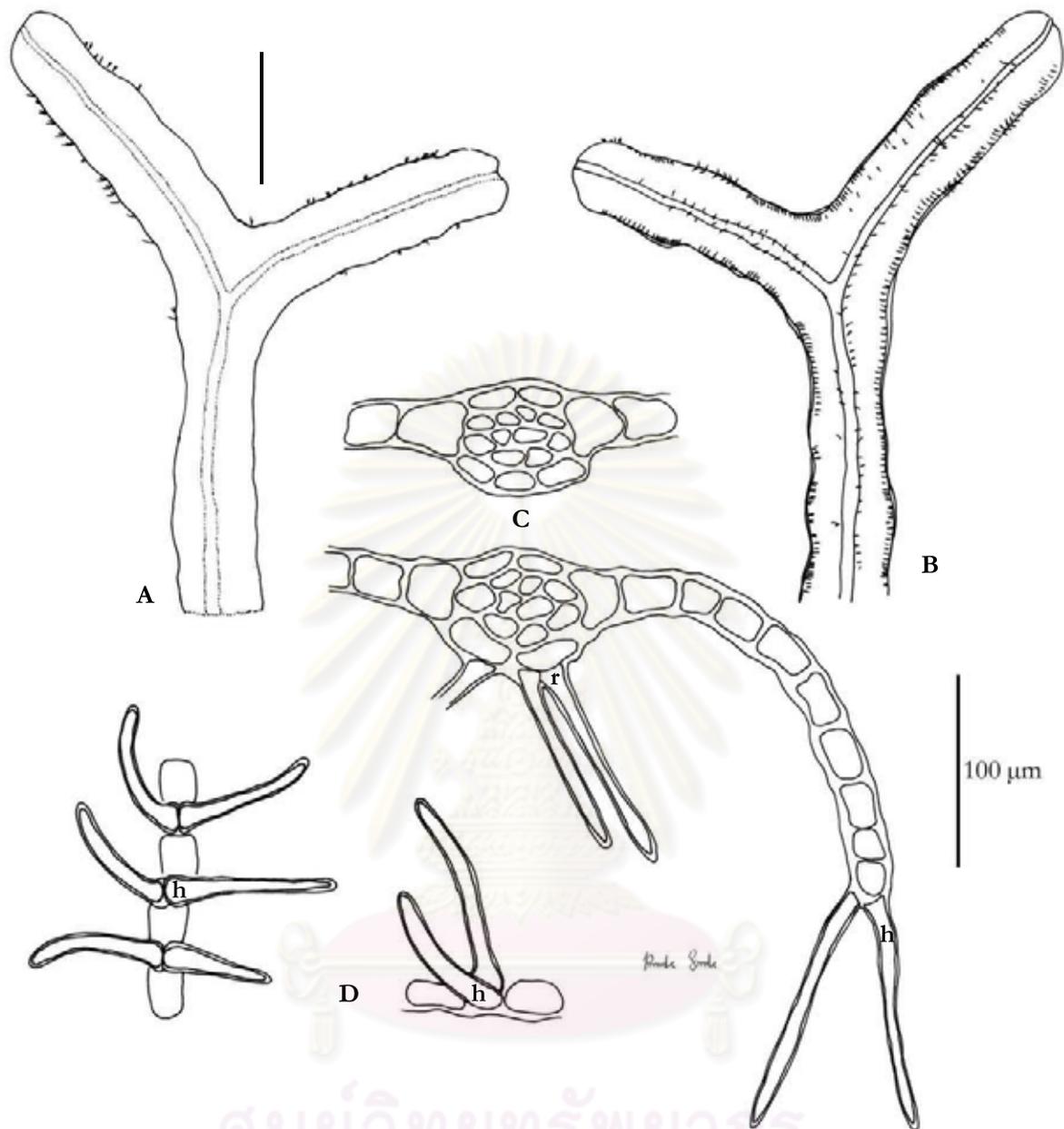
A. habit, dorsal view; B. habit, ventral view; C. cross section of thallus; D. thallus margin with hairs (h); E. gemma. P. Sukkharak 524.

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**Figure 4.75** *Metzgeria furcata* (L.) Dumort.

A. habit, dorsal view; B. habit with androecia (a) and gynoecia (g), ventral view; C. portion of thallus with androecia (a), ventral side; D. androecium; E. portion of thallus with gynoecium (g), ventral side; F. cross section of thallus with rhizoids (r); G. apex of thallus showing mucilage papillae (m), ventral view; H. thallus margin with hairs (h). P. Sukkharak 8.



**Figure 4.76** *Metzgeria lindbergii* Schiffn.

A.-B. portion of thallus: A. dorsal view, B. ventral side; C. cross section of thallus with hairs (h) and rhizoids (r); D. thallus margin with hairs (h). P. Sukkharak 273.

## Pallaviciniaceae

**Plants** thalloid, with a distinct, swollen midrib and a unistratose lamina, prostrate or erect, simple or forked, sometimes with ventral branches, midribs with 1(-3) central strands. **Oil bodies** finely granular. **Rhizoids** colourless, rising from the ventral side of midrib. **Ventral scales** lacking. **Dioicous**. **Androecia and Gynoecia** on the dorsal surface of the midrib, with scales; **Antheridia** in a row on the midrib, hidden under lacinate scales. **Archegonia** in small groups on the midrib, surrounded by a scale-like or closed-tubular involucre. **Sporophytes** surrounded by a deeply lacinate pseudoperianth or a fleshy calyptra. **Capsules** ellipsoidal to narrow-cylindrical, opening into (1-)2(-4) valves. **Spores** small, unicellular. **Elaters** with 2-3 spirals, free, not attached to capsule valves.

### *Symphyogynopsis*

*Symphyogynopsis* Grolle, in Grolle & Piippo, S., Acta Bot. Fenn. 133: 72. 1986.

**Plants** intercalary branching a little frequent, always prostrate, thallus ribbon-like, shallowly canaliculated, apex with deep indentation between two rounded wing lobes, margin with bicellular slime-hairs, midribs 10-20 cells high, thin-walled, wing unistratose. **Female involucre** lacinate-ciliate.

#### *Symphyogynopsis filicum* (Nadeaud) Grolle

In Grolle, R. & Piippo, S., Acta Bot. Fenn. 133: 73, figs. 4-5. 1986. — *Symphyogyna filicum* Nadeaud, Enum. Pl. Ind. Île Tahiti 9. 1873. — *Symphyogyna vitiensis* Jack & Steph., Bot. Centralbl. 60: 108. 1894— *Symphyogyna exincrassata* Steph., Spec. Hep. 1: 342. 1900. — *Pallavicinia levieri* var. *imperfecta* Sciffn., Denkschr. Math.-Nat. Cl. Kais. Akad. Wiss. Wien 67: 185. 1895.

**Plants** green, prostrate, thallus 1-1.5 mm. wide with bicellular slime-hairs scattered along margin, unistratose wing 9-11 cells wide, a central strand of narrow, thin-walled cells, 8-10 cells high. **Rhizoids** smooth. **Dioicous**. **Androecia** not found. **Gynoecia** on dorsal surface of the midrib within involucre a cup-like structure with pale, deeply incised-lacinate-ciliate scale. (Figure 4.77)

**Thailand.** — SOUTH- WESTERN: Prachuap Khiri Khan.

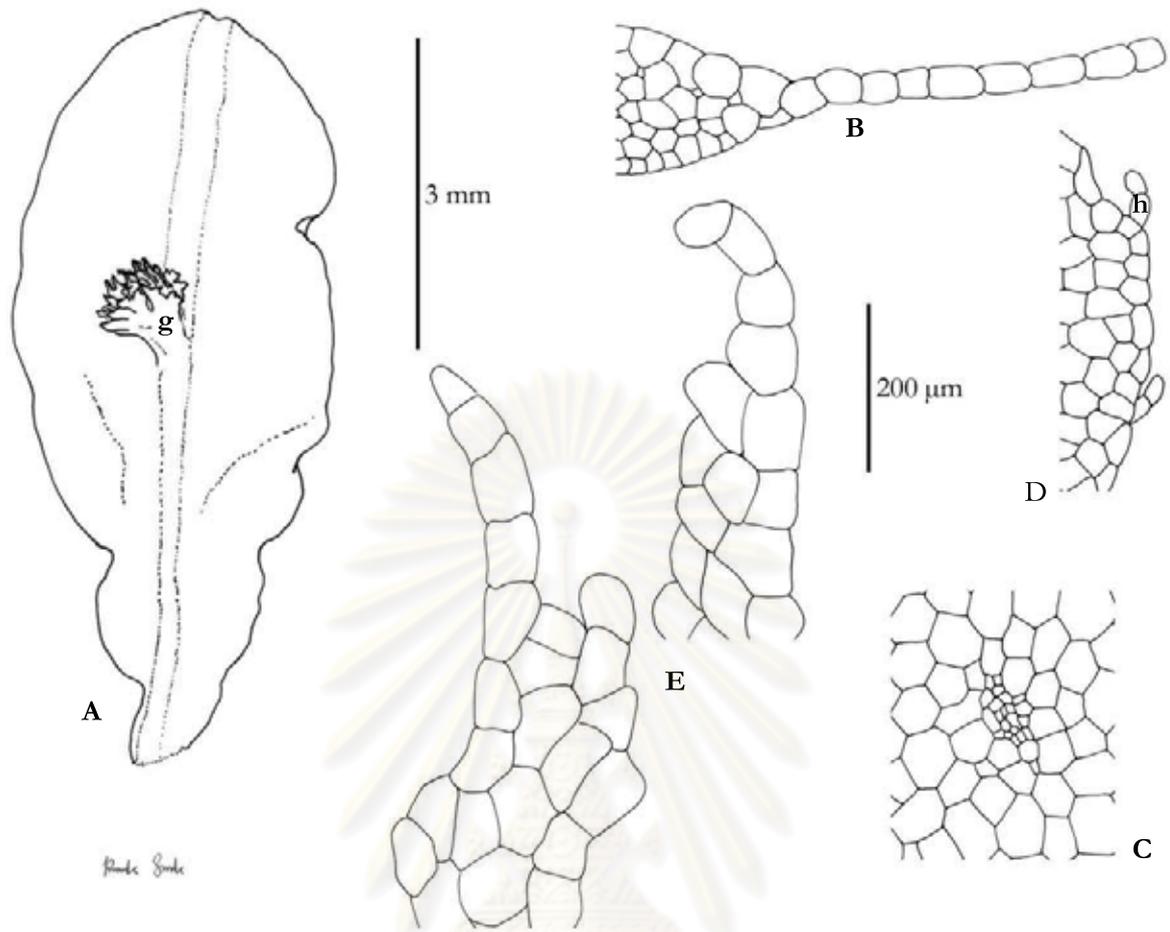
**Distribution.** — Cameroun, Fiji, Java, Madagascar, Malaysia, Papua New Guinea and Tahiti.

**Ecology.** — on living bark of tree, rock, soil.

**Specimens examined.** — P. Sukkharak 24, 26, 82, 130, 155, 158, 223, 290, 412 (BCU).

**GPS.** — 8.87512592° N 99.69447572° E

**Altitude.** — 731-1,385 m



**Figure 4.77** *Symphyogynopsis filicum* (Nadeaud) Grolle

A. habit with gynoecium (g), dorsal view; B. cross section of thallus; C. cross section through thallus middle; D. thallus margin with bicellular slime hairs (h); E. scales. P. Sukkharak 24, 25, 82.

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## Plagiochilaceae

**Plants** leafy, may or may not firm, green to brown, creeping to ascending or pendent, often with a rhizome-like creeping base. **Stems** usually with a brown cortex of thick-walled cells in several layers. **Intercalary Branches** *Frullania*-type. **Rhizoids** few, scattered, occasionally in tufts. **Lateral leaves** succubous, alternate, rarely opposite (*Plagiochilion*), bases decurrent and dorsal margin usually recurved, insertion line reaching dorsal stem midline, apex and margins (especially the ventral margin) toothed to ciliate, rarely entire; cells variable; oil-bodies usually granular. **Underleaves** normally lacking, when present very small. **Androecia and gynoecia** on elongated shoots. **Sporophytes** surrounded by a perianth, perianth laterally compressed, with a wide mouth, often with innovations. **Vegetative reproduction** by cladia, caduceus leaves or leaf fragmentation, rarely by gemmae.

### Key to genera

1. Lateral leaves opposite, leaf base united both dorsal and ventrally.....*Plagiochilion*
1. Lateral leaves alternate, leaf base not united both dorsal and ventrally.....*Plagiochila*

### 1. *Plagiochila*

***Plagiochila* (Dumort.) Dumort.**, Recueil d'Observations sur les Jungermanniacées 14. 1835.; Carl, H., Annales Bryologici Supplementary Volume 2: 1-170 1931.; Gradstein, S. R., Churchill, S. P. & Allen, N. S., Guide to the bryophytes of tropical America: 191-192. 2001.; Heinrichs, J., Gradstein, S. R. & Grolle, R., J. Hattori Bot. Lab. 25: 1-32. 1998.; Heinrichs, J., Anton, H., Gradstein, S. R. & Mues, R., Plant Systematics and Evolution 220: 115-138. 1999.; Heinrichs, J. & Gradstein, S. R., Nova Hedwigia 70: 161-184. 2000.; Inoue, H. The Bryologist 92. 1989.; Müller, J., Heinrichs, J. & Gradstein, S. R., The Bryologist 102. 2000.; Schuster, R. M. The Hepaticae and Anthocerotae of North America, Vol. IV: 325-539 1980.; Spruce, R. Transactions and Proceedings of the Botanical Society of Edinburgh 15: 449-499. 1885.; Wolf, J. H. D., Phytocoenologia 22: 1-103. 1994.

**Plants** green to brown, creeping, ascending or pendent, on tree trunks, often dendroid with erect leafy shoots arising from a creeping rhizome-like stem, irregularly branched to regularly pinnate. **Rhizoids** scattered, often lacking. **Lateral leaves** orbicular to ovate to oblong to almost linear, often asymmetrical, with reflexed dorsal margin and decurrent bases, apex undivided or 2-3-lobed, margins usually toothed to ciliate, especially along the apical and ventral margins, teeth at the apex often larger, margin rarely entire; cells with conspicuous trigones or thin-walled, cuticle smooth or tough; oil bodies usually finely granular. **Underleaves** usually lacking, small when present. **Gametoecia** as in the family. **Vegetative reproduction** common, by tiny leafy shoots developing from the leaf surfaces and by caducous or fragmenting leaves.

### Key to species

1. Underleaves absent.
  2. Lateral leaves imbricate.
    3. Lateral leaves with short teeth.
      4. Ventral margin of lateral leaf not form sac.
        5. Dorsal margin revolute .....*P. javanica*
        5. Dorsal margin not revolute..... *P. sciophila*
      4. Ventral margin of lateral leaf form oblong sac.....*P. longispica*
    3. Lateral leaves with 7-9 cells long ciliary teeth along margin.....*P. subtropica*
  2. Lateral leaves remote..... *P. bicornuta*
1. Underleaves present.
  6. Margin of lateral leaves with long ciliary teeth ..... *P. sp. 1*
  6. Margin of lateral leaves serrate..... *P. parvifolia*

### 1. *Plagiochila bicornuta* Steph.

Bot. Jarhb. 23: 305. 1896.; Inoue, H., J. Hattori Bot. Lab. 49: 353-354, fig. 9. 1-8. 1981.

**Plants** small, yellowish-green, 2-2.5 cm long and 1.5-2 mm wide. **Stems** ascending erectly from rhizomatous caulids; in cross section of stem, cortical cells thick-walled with 2-3 layers, medullar cells thin-walled and much larger than cortical cells. **Rhizoids** not seen. **Lateral leaves** remote, obliquely spreading, oblong, apex with 6-7 teeth; teeth restricted to the apical leaf-margin, 0.8-1 mm long and 0.1-0.3 mm wide, cells thin-walled, trigones small. **Underleaves** absent. **Androecia** terminal on shoot, bract 10-14 pairs closely imbricate, basal inflated, apex with teeth. **Gynoecea** terminal and intermediate on shoot. **Perianths** campanuated 2-2.3 mm long and 1.5-2 mm wide, mouth arched, margin irregularly dentate. (Figure 4.78)

**Thailand** — New record to Thailand

**Distribution** — Samoa.

**Ecology** — on living bark of tree.

**Specimens examined** — P. Sukkharak 407, 446 (BCU).

**GPS location** — 8.87681901° N 99.68998432° E

**Altitude** — 1,310-1,385 m

### 2. *Plagiochila javanica* (Sw.) Nees & Mont.

Rec. d'Obs. Tournay 15. 1835.; Inoue, H. Journ. Hattori Bot. Lab. 32: 50-56, fig. I- II. 1969. — *Jungermannia javanica* Sw., Methodus Muscorum Illustrata 35, tab. II. fig. 2. 1781. — *Plagiochila terebrans* auct. non Nees et Mont.: Sande Lac., Syn. Hepat. Javae 11. 1856. — *Plagiochila tennis* auct. non Lindenbergl: Sande Lac., Ann. Mus. Bot. Lugd.-Bat. 1: 291. 1864. — *Plagiochila revolutifolia* Schiffn., Denksr. Math.-Nat. Cl. Ksl. Akad. Wiss. Wien, 70: 172. 1900.

**Plants** yellowish-brown, 3-5 cm wide. **Stems** *Frullania*-type branch; in cross section of stem, cortical cells thick-walled with 3-4 layers, medullar cells thin-walled and much larger than cortical cells. **Rhizoids** not seen. **Lateral leaves** contiguous, obliquely spreading, oblong, apex with teeth, margin entire, revolute along dorsal margin which is long-decurrent on dorsal stem-midline, 2-2.5 mm long and 0.8-1.2 mm wide, cells thin-walled, trigones small. **Underleaves** absent. **Sporophytes** not found. (Figure 4.79)

**Thailand** — SOUTH-WESTERN: Prachup Khiri Khan.

**Distribution** — Java.

**Ecology** — on living bark and twig of tree, rotten log.

**Specimens examined** — P. Sukkharak 353, 359, 360, 385, 388, 425 (BCU).

**GPS location** — 8.87009203° N 99.69762325° E

**Altitude** — 1,080-1,260 m

### 3. *Plagiochila longispica* Mitt.

Seemann. Fl. Vitiensis: 407. 1873.; Inoue, H., J. Hattori Bot. Lab. 49: 345-347, fig. 5 1981. — *Plagiochila sacculata* Jack et Steph., Bot. Centralb. 60: 99. 1894. — *Plagiochila rechingeri* Steph., Denkschr. Math.-Nat. Cl. K. Akad. Wiss. Wien. 81: 290. 1908.

**Plants** large, pale green, 4-7 cm long and 0.8-1 cm wide. **Stems** ascending erectly from differentiated rhizomatous caulids, rarely branch; in cross section of stem, cortical cells thick-walled with 3-4 layers, medullar cells thin-walled and much larger than cortical cells. **Rhizoids** not seen. **Lateral leaves** loosely imbricate, spreading, oblong, apex truncate-rounded with teeth, many spinose teeth on whole margin, ventral margin forming oblong sac at the base with small teeth, 5-6 mm long and 2-2.5 mm wide at apex and 3-4 mm wide at base, cells thin-walled, trigones small. **Underleaves** absent. **Perianths** cylindrical, mouth truncate with dentate, 5-5.5 mm long and 2-3 mm wide; capsule 3-3.5 mm long and 1.8-2 mm wide, elaters 0.9-1 mm wide with 2 spiral bands. (Figure 4.80 and 4.118)

**Thailand** — New record to Thailand.

**Distribution** — Samoa.

**Ecology** — on living bark of tree.

**Specimens examined** — P. Sukkharak 364, 465 (BCU).

**GPS location** — 8.87695849° N 99.68960345° E

**Altitude** — 1,252-1,326 m

#### 4. *Plagiobhila parvifolia* Lindenb.

Schuster, R. M., J. Hattori Bot. Lab. 18: 14-26, fig. I-IV. 1957. as *Plagiobhila yokogurensis* Steph.; Bull. Herb Boiss. 5: 104. 1897.; Inoue, Bot. Mag. Tokyo 12: 74. 1898.; Steph., Spec. Hep. 2: 375. 1903.; Horikawa, J. Sci. Hiroshima Univ. Ser. B, Div. 2, 1: 63, pl. VII; 12-17. 1931.; Hattori, Bull. Tokyo Sci. Mus. No. 11: 65. 1944. — *Plagiobhila okamurana* Steph., Sp. Hep. 6: 190. 1921., (fide Hattori, 1952: 23). — *Plagiobhila yokogurensis* var. *kinsiana* Hattori, Bull. Tokyo Sci. Mus. No. 11: 65, fig. 41. 1944., fide Hattori, 1952: 23.

**Plants** yellow, 3-3.5 cm wide. **Stems** ascending erectly from rhizomatous caulid, *Frullania*-type branch; in cross section of stem, cortical cells thick-walled with 3-4 layers, medullar cells thin-walled and much larger than cortical cells. **Rhizoids** not seen. **Lateral leaves** contiguous, obliquely spreading, ovate to triangular, apex truncate with teeth, margin serrate, revolute along dorsal margin, 2-2.3 mm long and 1.5-2 mm wide, median cells 21-26 µm long and 21-26 µm wide, trigones large, basal cells 47-52 µm long and 21-26 µm wide. **Underleaves** bilobed with teeth along margin. **Sporophytes** not found. (**Figure 4.81**)

**Thailand** — NORTH: Chiang Mai, Chiang Rai; SOUTH-WESTERN: Prachuap Khiri Khan.

**Distribution** — China, Sumatra, Taiwan, Japan, India, Madagascar, East Africa, Bourbon, Hawaii.

**Ecology** — on living twig of shrub, on rock.

**Specimens examined** — P. Sukkharak 108, 119, 120, 333, K. Mayebara, XI. 1947. (BCU).

**GPS location** — Exact locality not applicable. Between TT01-TT05.

**Altitude** — ca. 320-598 m

#### 5. *Plagiobhila sciophila* Nees ex Lindenb.

Inoue, H., J. Hattori Bot. Lab. 25: 97-98, fig. V. 1962. as *P. acanthophylla* Gott.; Bot. Zeit., Beil. Z. 16: 38. 1858.; Sande Lac., Ann. Musei Bot. Lugduno-Batavi 1: 292. 1864.; Schiffn., Fl. Butenzorg 4: 159. 1900.; Steph., Spec. Hepa. 2: 370. 1906.; Dugas, Ann. Sci. Nat. ser. 10, 11: 164, f. 154, C. 1929.; Carl, Ann. Bryol. suppl. 2: 105. 1931. — *P. sciophila* auct. non. Nees: Sande Lac., Synop. Hepat. Javan. 11. 1856. — *P. tonkinensis* Steph., Spec. Hepat. 6: 232. 1924. — *P. acanthophylla* var. *plurilaciniata* Herz., Ann. Bryol. 5: 73. 1932.

**Plants** yellowish to light green, 1-2 cm long and 4-5 mm wide. **Stems** ascending erectly from rhizomatous caulids; in cross section of stem, cortical cells thick-walled with 3-4 layers, medullar cells thin-walled and much larger than cortical cells. **Rhizoids** not seen. **Lateral leaves** imbricate, obliquely to nearly horizontally spreading, oblong, the antical margin with small spinose teeth, the postical entire, 2.5-3 mm long and 1-1.2 mm wide, cells thin-walled, trigones small. **Underleaves** absent. **Sporophytes** not found. (**Figure 4.82**)

**Thailand** — CENTRAL: Phitsanulok; SOUTH-WESTERN: Prachuap Khiri Khan; PENINSULAR: Nakhon Si Thammarat.

**Distribution** — Java, Sumatra, Andaman Islands, Celebes, Philippines, Tonkin.

**Ecology** — on tree fern.

**Specimens examined** — P. Sukkharak 29, 37, 38 (BCU); Kai Larsen, T. Smitinand & E. Warncke No. 1063 (BKF).

**GPS location** — Exact locality not applicable. Near TT12.

**Altitude** — ca. 787-870 m

### 6. *Plagiobhila subtropica* Steph.

Bulletin de la Société Botanique de Belgique 38 (Mem.): 46. 1900.; Inoue, H., J. Hattori Bot. Lab. 38: 560-561, fig. 2. 1974. as *Plagiobhila kitagawae* Inoue.

**Plants** light yellow, 1-2.1 cm long and 4-6 mm wide. **Stems** ascending erectly from rhizomatous caulids; in cross section of stem, cortical cells thick-walled with 3-4 layers, medullar cells thin-walled and much larger than cortical cells. **Rhizoids** not seen. **Lateral leaves** imbricate, obliquely spreading, triangular-ovate, with 7-9 cells long ciliary teeth along margin, 2-2.2 mm long 1-1.2 mm wide at the base and 0.8-1 mm wide at the apex, trigones nodulose. **Underleaves** bilobed, 240-360 µm long and 224-240 µm wide. **Sporophytes** not found. (Figure 4.83 and 4.119)

**Thailand** — NORTH: Chiang Mai.

**Distribution** — China.

**Ecology** — on living bark of tree.

**Specimens examined** — P. Sukkharak 473 (BCU).

**GPS location** — 8.8769263° N 99.6907407° E

**Altitude** — 1,313 m

### 7. *Plagiobhila* sp.

**Plants** brownish-yellow, 1-4 cm long and 3.5-5 mm wide. **Stems** ascending erectly from rhizomatous caulids; in cross section of stem, cortical cells thick-walled with 3-4 layers, medullar cells thin-walled and much larger than cortical cells. **Rhizoids** not seen. **Lateral leaves** imbricate, obliquely spreading, ovate, with 5-6 cells long ciliary teeth along margin, 2-3 mm long and 1.5-2 mm wide at the base and 0.5-0.8 mm wide at the apex, trigones nodulose. **Underleaves** bilobed, 240-256 µm long and 320-336 µm wide. **Androecia** intermediated rarely on terminal on shoot, bract 13-15 pairs closely imbricate, basal inflated, margin entire. **Sporophyte not found.** (Figure 4.84)

**Thailand** —

**Distribution** —

**Ecology** — on living twig of shrub.

**Specimens examined** — P. Sukkharak 452 (BCU).

**GPS location** — 8.87710333° N 99.68977511° E

**Altitude** — 1,327 m

## 2. *Plagiobhilion*

*Plagiobhilion* S. Hatt., Biosphaera 1: 7. 1947.; Inoue, H., J. Hattori Bot. Lab. 27: 51-72. 1964; Gradstein, S. R., Churchill, S. P. & Allen, N. S., Guide to the bryophytes of tropical America: 192. 2001.

**Plants** rather small, green to yellowish-brown, ascending from a creeping rhizome-like base. **Branches** intercalary (both lateral and ventral), the ventral-intercalary branches stoloniform. **Rhizoids** in tufts from near ventral bases of leaves. **Lateral leaves** transverse, opposite, wide spreading and asymmetrically ovate-oblong, with reflexed dorsal margins and decurrent bases, apical and ventral margins toothed, the apical teeth sometimes larger; cells with cordate trigones (two sides convex, on side concave) and intermediate thickenings, cuticle smooth. **Underleaves** lacking.

### Key to species

1. Lateral leaves subreniform ..... *P. oppositum*

1. Lateral leaves obovate-oblong.....*P. pachycephalum*

**1. *Plagiobhilion oppositum* (Reinw. et al.) S. Hatt.**

Biosphaera 1: 7. 1947.; Inoue, H., J. Hattori Bot. Lab. 27: 61-64, fig. VI. 1964. as *Plagiobhilion oppositum* (Reinw., Blume et Nees) S. Hatt., Biosphaera 1: 7. 1947. — *Jungermannia opposita* Reinw., Blume et Nees, Hepat. Jav. 236. 1824. — *Plagiobhila opposita* (Reinw., Blume et Nees) Dum., Rec. d'Obs. 15. 1835. — *Noguchia opposita* (Reinw., Blume et Nees) Inoue, J. Hattori Bot. Lab. 20: 102. 1958. — *Plagiobhila zygothylla* Tayl., J. Bot. London, 5: 271. 1846. — *Plagiobhila geminifolia* Mitt. in Seeman, Flora Vitiensis 408. 1871. — *Plagiobhila gunniana* Steph., Spec. Hepat. 6: 164. 1924. — *Plagiobhila nigra* Steph., l. c. 2: 403. 1906. — *Plagiobhila samoana* Steph., Denkschr. Math. Nat. Kl. Wien 85: 197. 1910.

**Plants** light green to yellowish green, up to 4 cm long and 1.8-2 mm wide. **Stems** ascending erectly from differentiated rhizomatous caulids; in cross section of stem, cortical cells thick-walled with 3-4 layers, medullar cells thin-walled and much larger than cortical cells. **Rhizoids** scattered along rhizomatous caulids. **Lateral leaves** distant, subreniform, wider than long, margin dentate, 1.3-1.5 mm long and 1.5-1.8 mm wide, median cells 23-26  $\mu\text{m}$  long and 13-17  $\mu\text{m}$  wide, trigones minute; base cells 39-65  $\mu\text{m}$  long and 13-21  $\mu\text{m}$  wide, trigones large. **Underleaves** absent. **Perianths** cylindrical-oblong with dentate mouth, 2-3 mm long and 1.5-2 mm wide, at apex and lateral branch. **Bracts** 1 pair, reniform, margin with sharp teeth, 2-2.5 mm long and 2-2.5 mm wide. (**Figure 4.85 and 4.120**)

**Thailand** — SOUTH-WESTERN: Prachuap Khiri Khan.

**Distribution** — Samoa, Papua New Guinea, New Hebrides, Celebes, Java, Borneo, Sumatra, Philippines, Formosa, Vietnam, Burma, Ceylon.

**Ecology** — on living twig of shrub, rotten log.

**Specimens examined** — P. Sukkharak 400, 402 (BCU).

**GPS location** — Exact locality not applicable. Near TT20.

**Altitude** — ca. 1,290 m

**2. *Plagiobhilion pachycephalum* (De Not.) Inoue**

Inoue, H., J. Hattori Bot. Lab. 27: 55-57, fig. III. 1964. — *Plagiobhila pachycephala* De Not., Estr. Real. Acad. Sci. Torino, ser. 2, 28: 14. 1874. — *Chiastocaulon pachycephalum* (De Not.) Herz. Trans. Brit. Bryol. Soc. 1 (4): 286. 1950.

**Plants** yellow-brown, up to 1.5 cm long and 1-2 mm wide. **Stems** ascending erectly from differentiated rhizomatous caulids; in cross section of stem, cortical cells thick-walled with 2-3 layers, medullar cells thin-walled and much larger than cortical cells. **Rhizoids** scattered along rhizomatous caulids. **Lateral leaves** distant, obovate-oblong, apex with 3 large teeth, margin entire, 0.8-1 mm long and 0.3-0.5 mm wide, median cells 26-31  $\mu\text{m}$  long and 21-26  $\mu\text{m}$  wide, trigones large; base cells 39-47  $\mu\text{m}$  long and 26-28  $\mu\text{m}$  wide, trigones large. **Underleaves** absent. **Perianths** cylindrical with dentate mouth, 2-2.5 mm long and 1-1.2 mm wide, at apex and lateral branch. **Bracts** 1 pair, widely ovate, margin with sharp teeth, 1.8-2 mm long and 1-1.2 mm wide. (**Figure 4.86**)

**Thailand** — New record to Thailand.

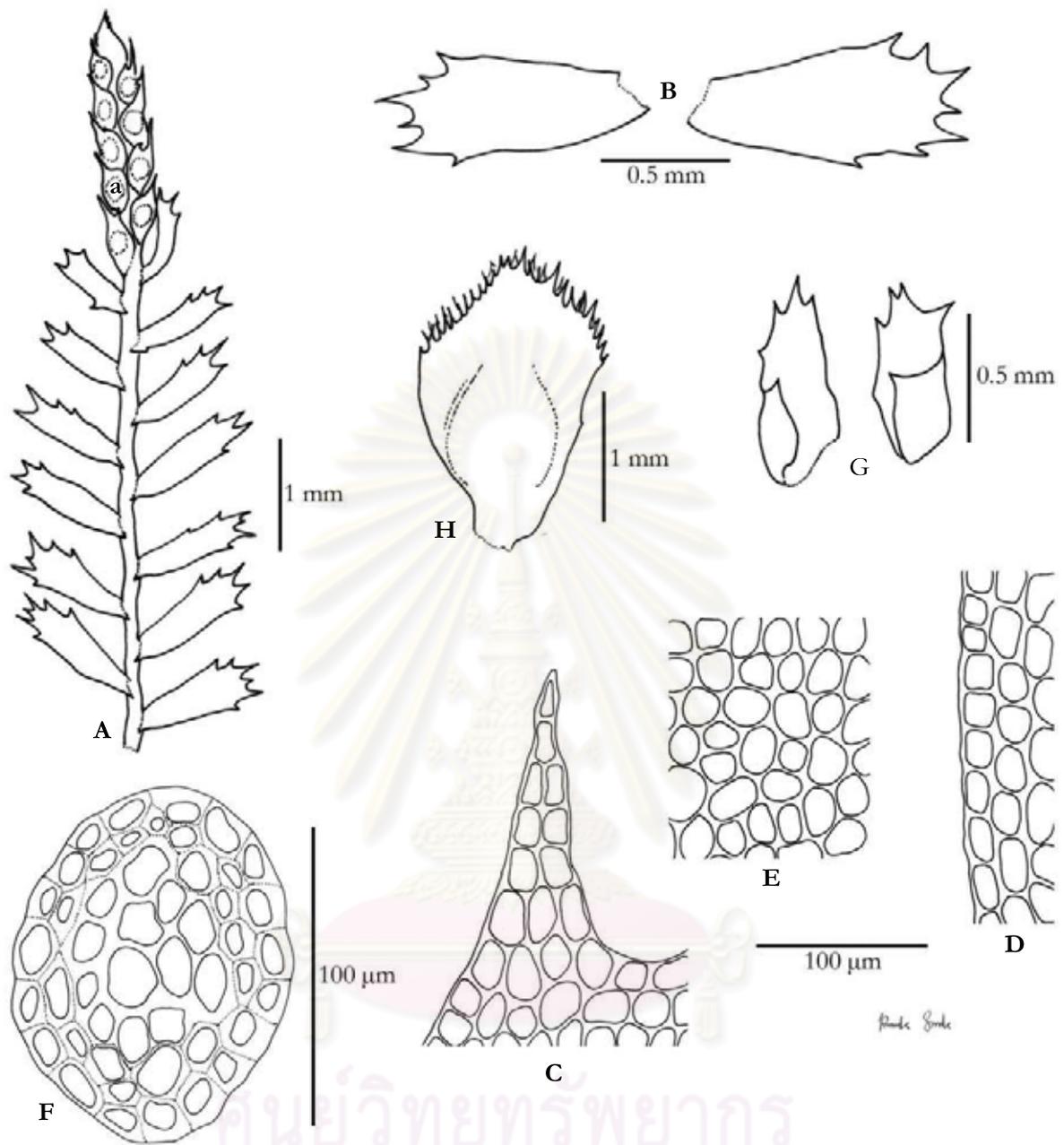
**Distribution** — Borneo.

**Ecology** — on living twig of shrub.

**Specimens examined** — P. Sukkharak 281 (BCU).

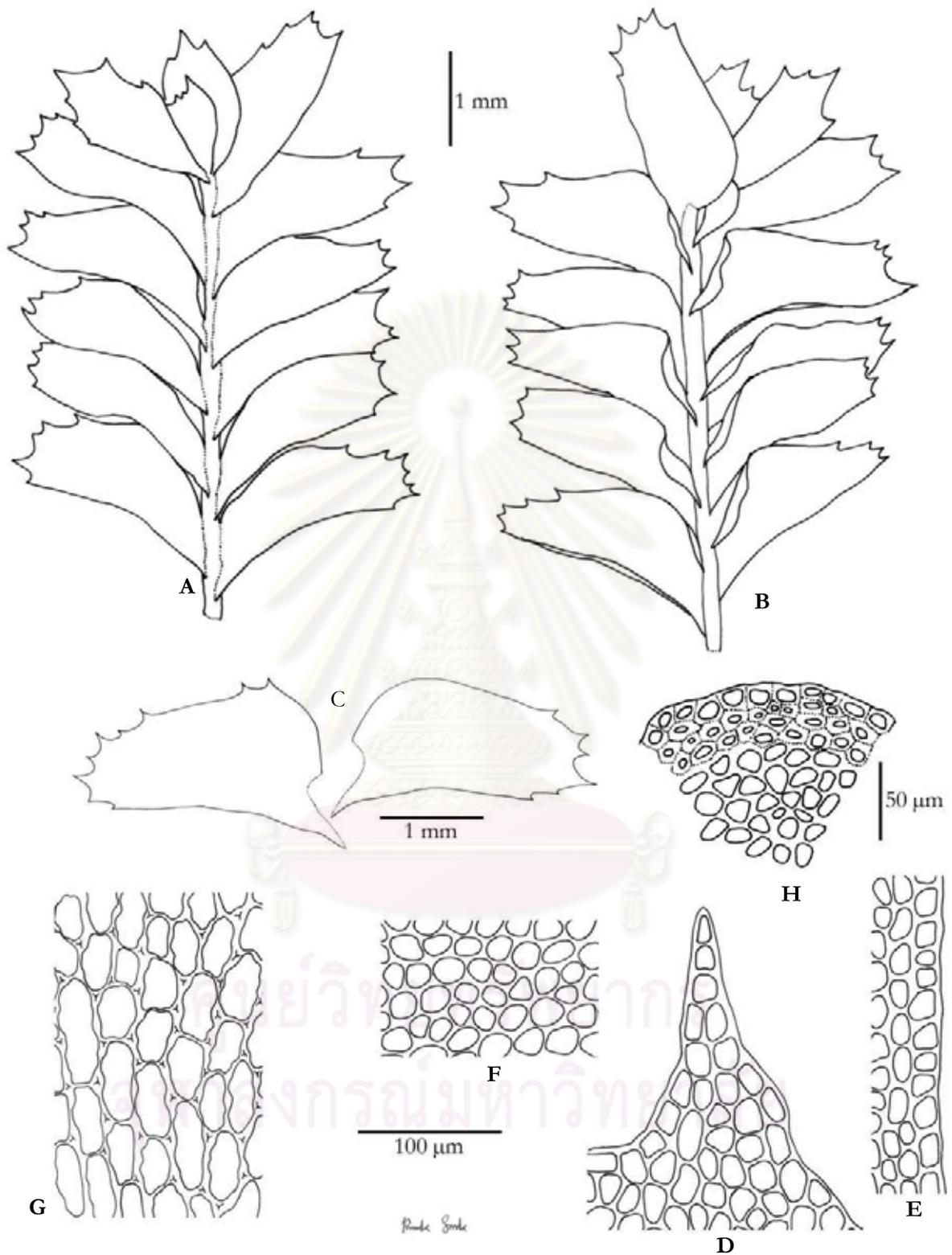
**GPS location** — Exact locality not applicable. Near TT20.

**Altitude** — ca. 1,275 m



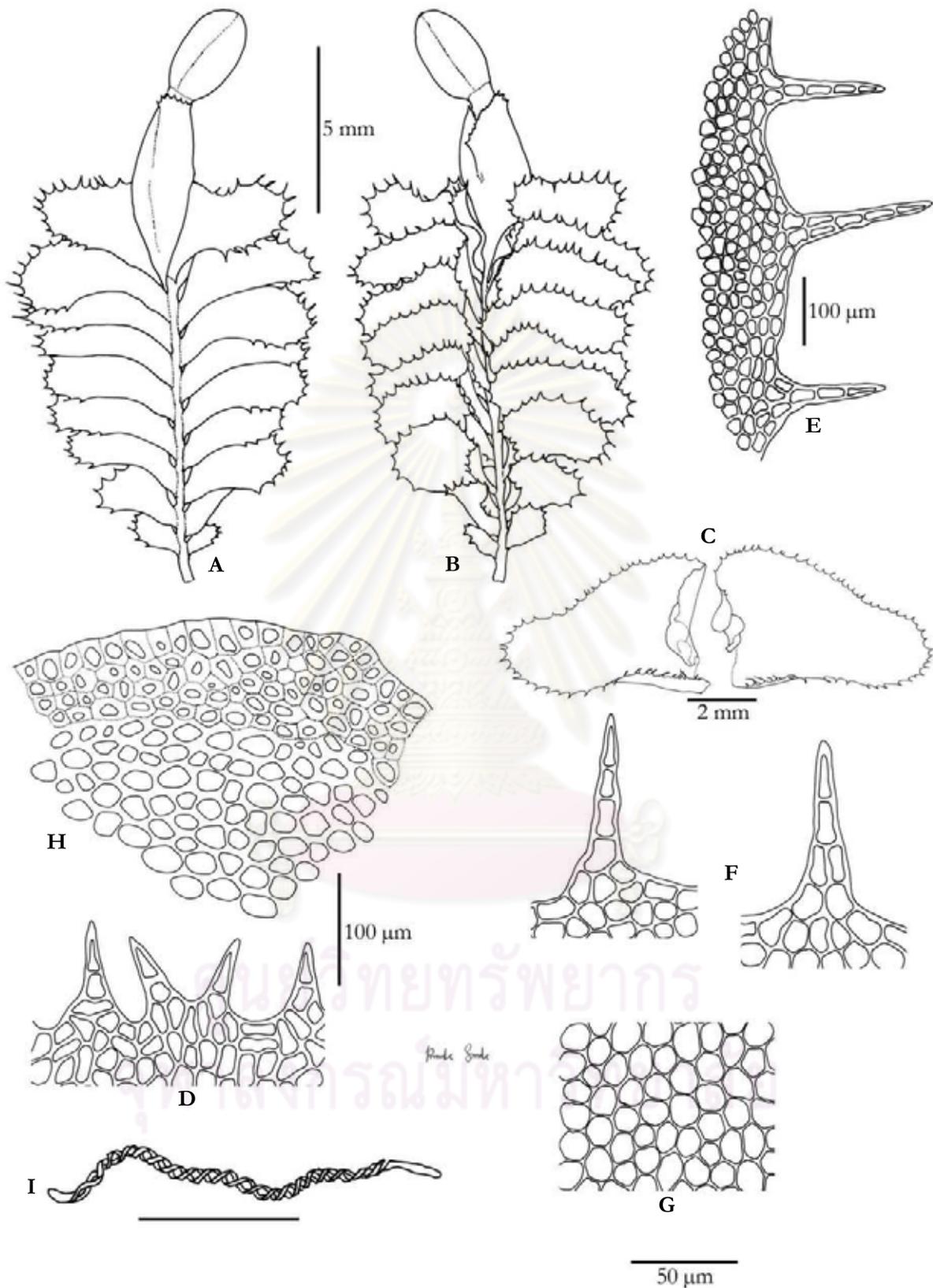
**Figure 4.78** *Plagiochila bicornuta* Steph.

A. portion of plant with androecia (a), dorsal view; B. lateral leaves; C. cells at leaf apex; D. cells at leaf margin; E. cells at leaf median; F. cross section of stem; G. bracts; H. perianth. P. Sukkharak 407.



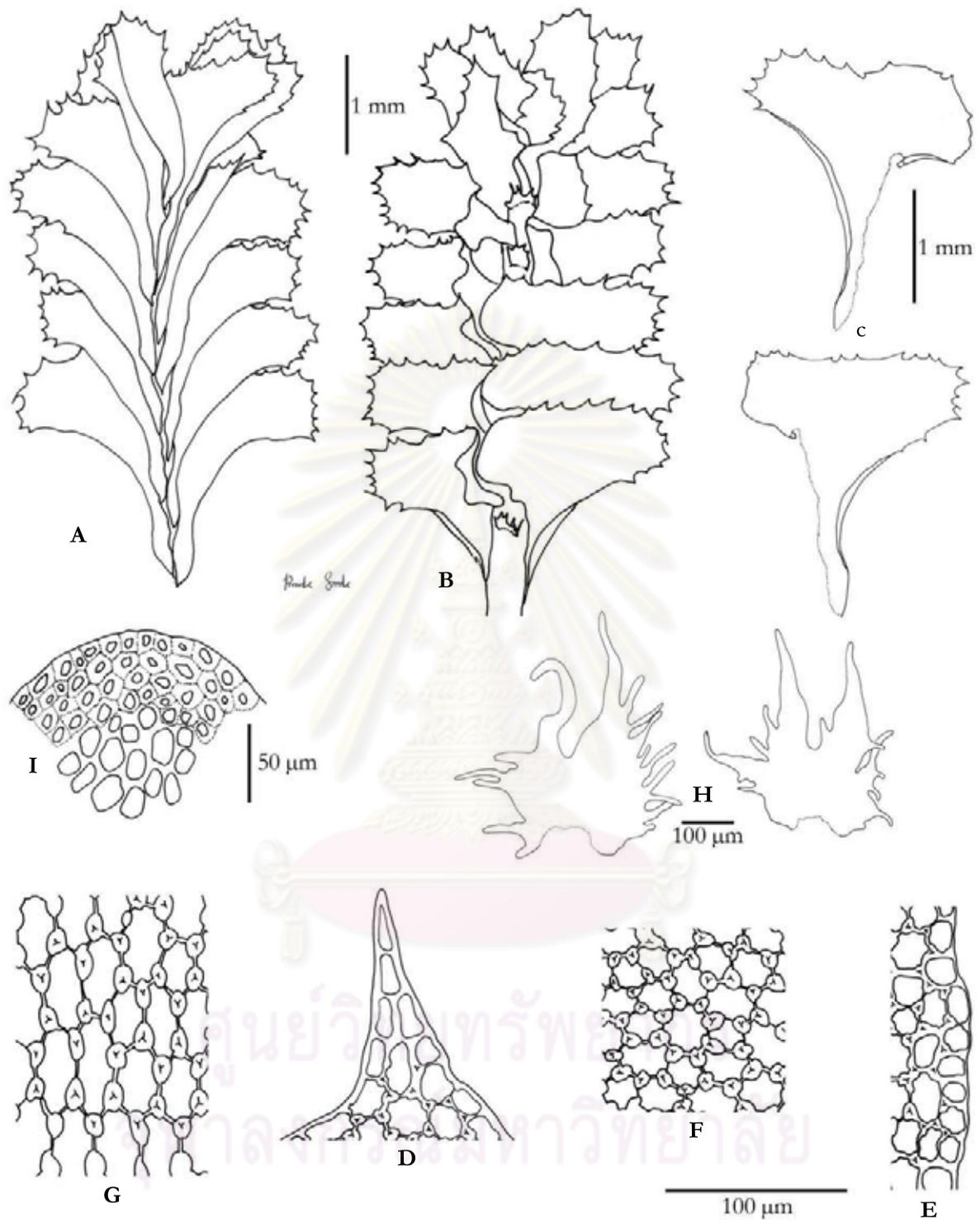
**Figure 4.79** *Plagiochila javanica* (Sw.) Nees & Mont.

A.-B. portion of plant: A. dorsal view, B. ventral view; C. lateral leaves; D. teeth on dorsal leaf apex; E. cells at leaf margin; F. cells at leaf median; G. cells at leaf base; H. part of cross section of stem. P. Sukkharak 353.



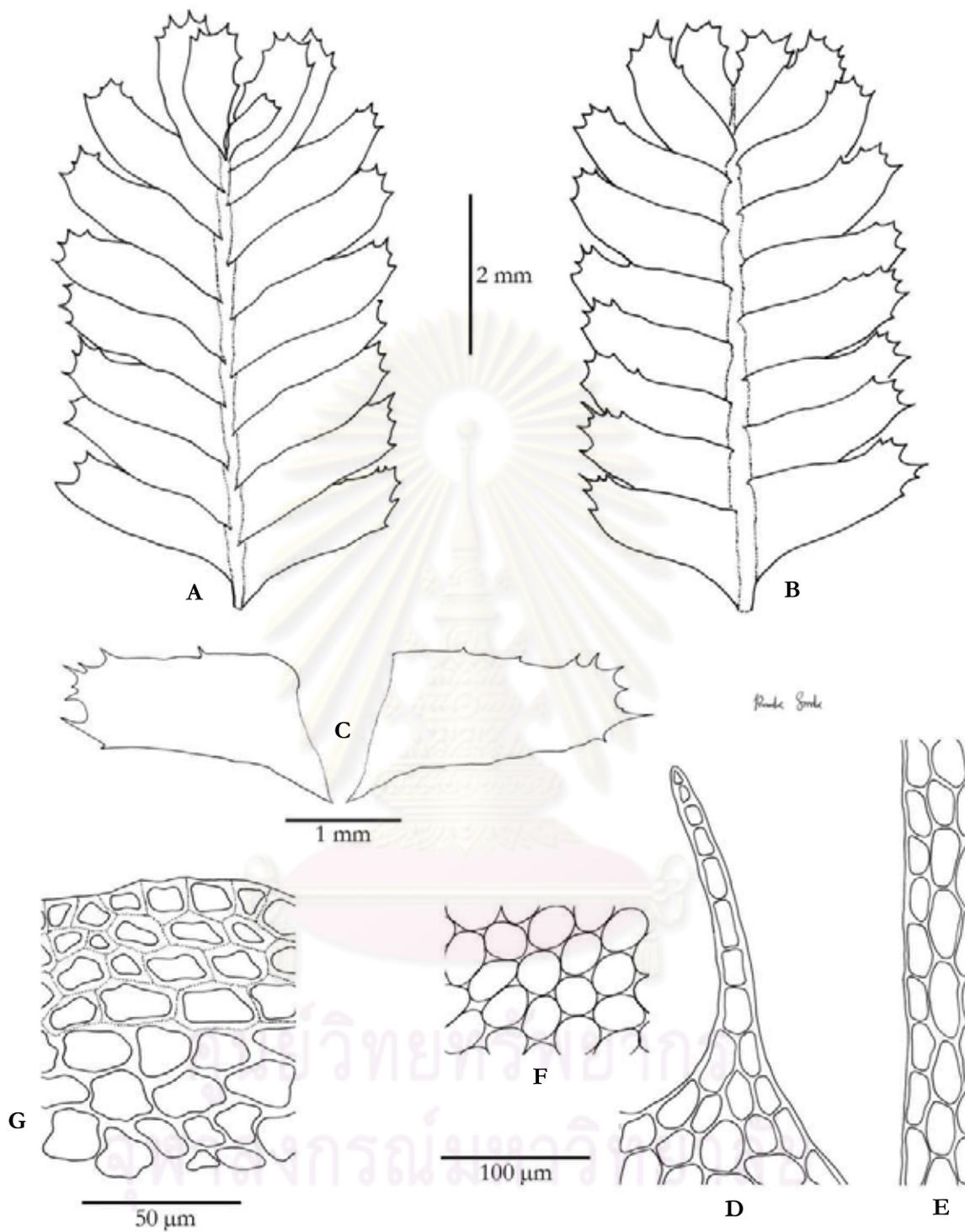
**Figure 4.80** *Plagiochila longispica* Mitt.

A.-B. portion of plant with sporophyte: A. dorsal view, B. ventral view; C. lateral leaves; D. cells at leaf apex; E. cells at leaf margin; F. teeth of leaf margin; G. cells at leaf median; H. part of cross section of stem; I. elater. P. Sukkharak 465.



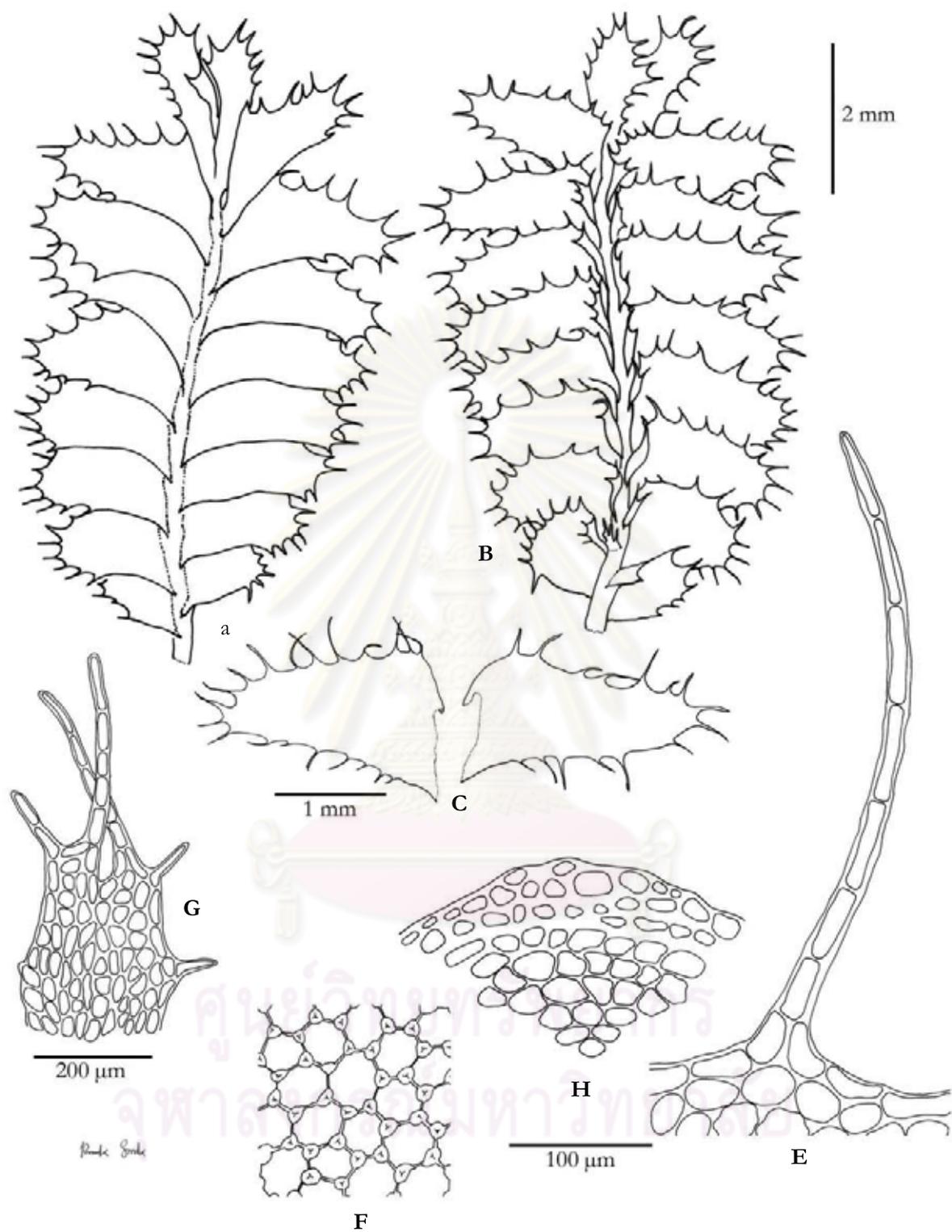
**Figure 4.81** *Plagiochila parvifolia* Lindenb.

A.-B. portion of plant: A. dorsal view, B. ventral view; C. lateral leaves; D. teeth on dorsal leaf apex; E. cells at leaf margin; F. cells at leaf median; G. cells at leaf base; H. underleaves; I. part of cross section of stem. P. Sukkharak 108.



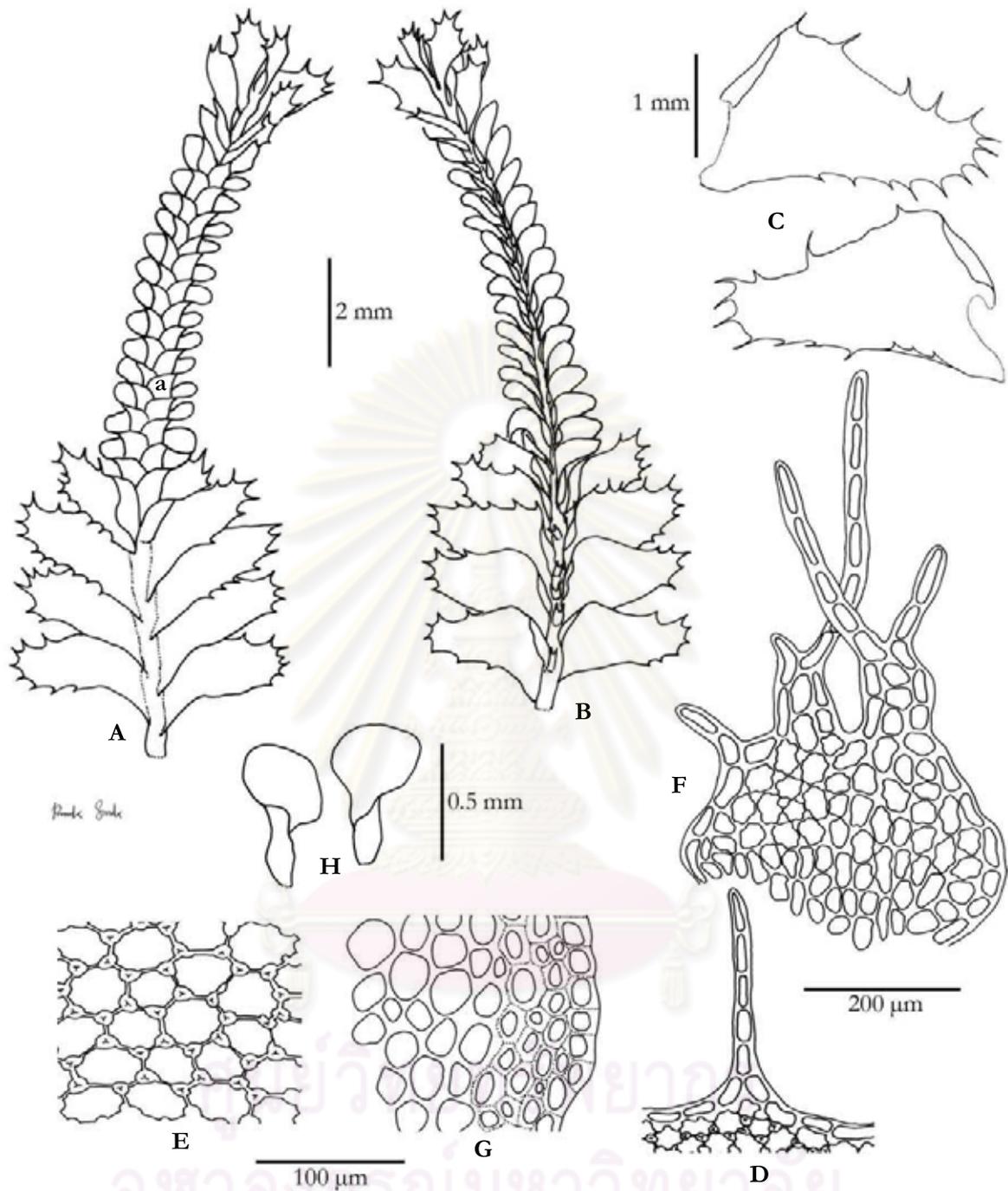
**Figure 4.82** *Plagiochila sciophila* Nees ex Lindenb.

A.-B. portion of plant: A. dorsal view, B. ventral view; C. lateral leaves; D. teeth of leaf apex; E. cells at leaf margin; F. cells at leaf median; G. part of cross section of stem. P. Sukkharak 37.



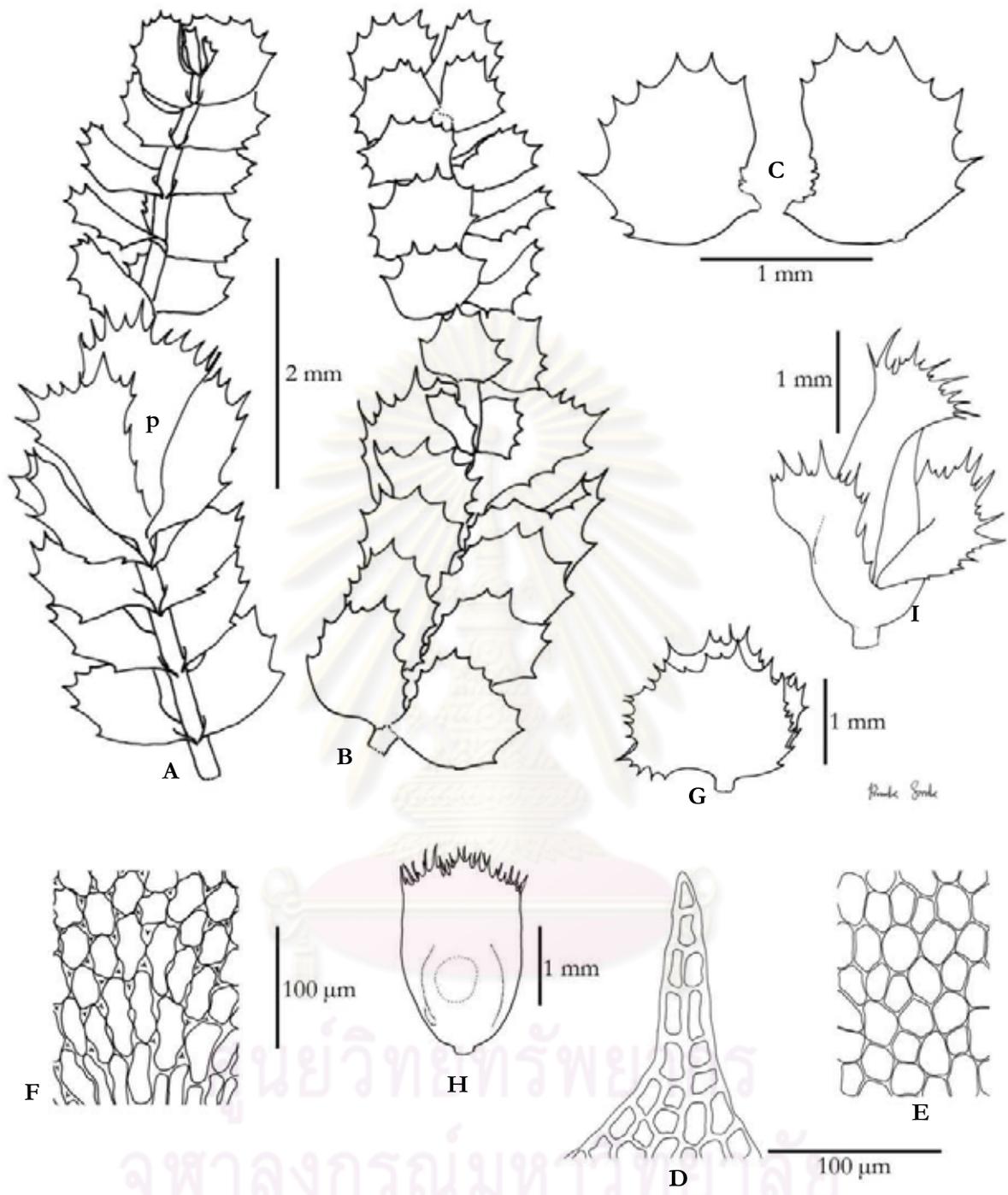
**Figure 4.83** *Plagiobhila subtropica* Steph.

A.-B. portion of plant; A. dorsal view, B. ventral view; C. lateral leaves; E. teeth on dorsal leaf apex; F. cells at leaf median; G. underleaf; H. part of cross section of stem. P. Sukkharak 473.



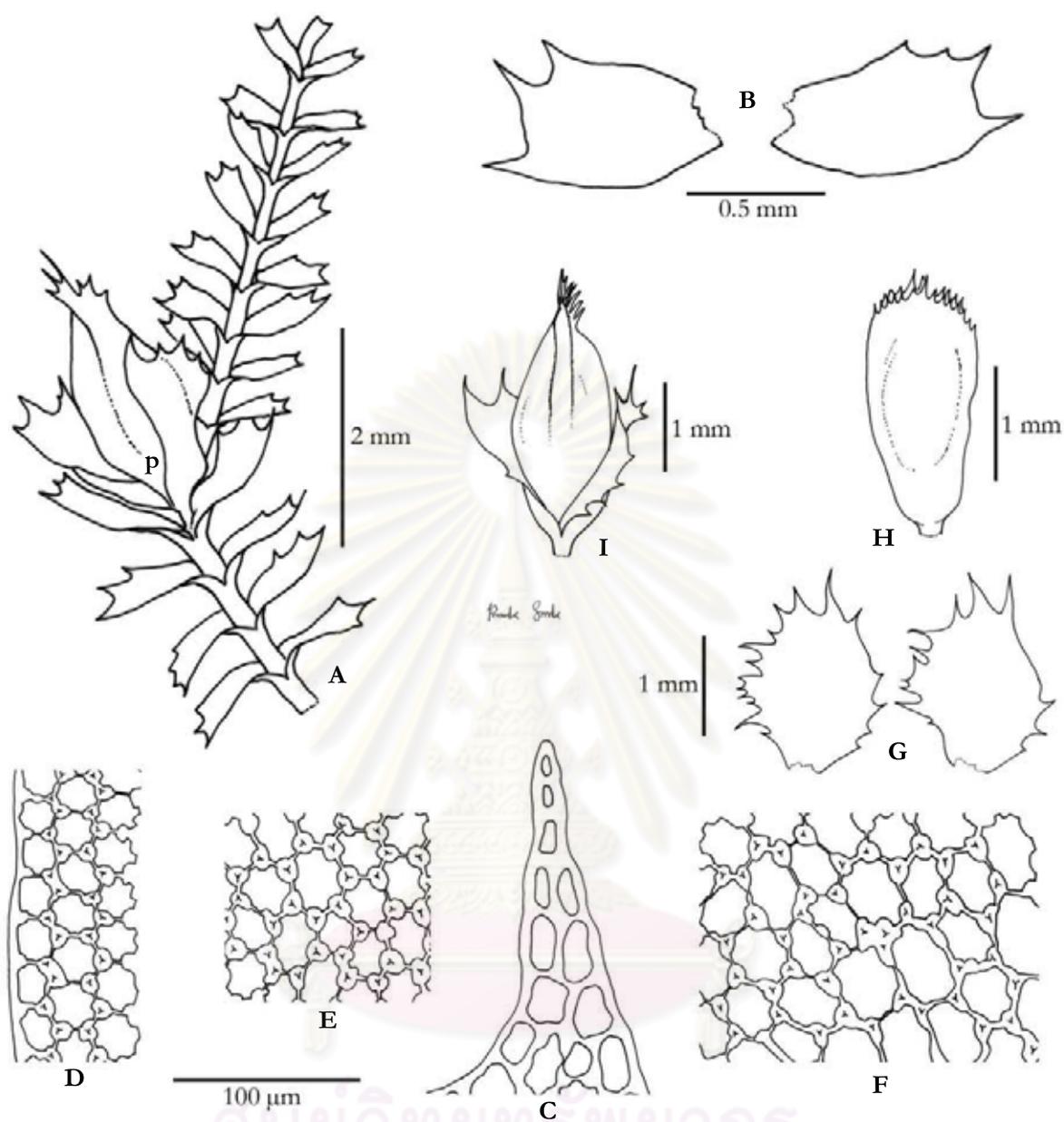
**Figure 4.84** *Plagiochila* sp. 1

A.-B. portion of plant with androecia (a): A. dorsal view, B. ventral view; C. lateral leaves; D. teeth of leaf median; E. cells at leaf median; F. underleaf; G. part of cross section of stem; H. androecial bracts. P. Sukkharak 452.



**Figure 4.85** *Plagiobolion oppositum* (Reinw. et al.) S.Hatt.

A.-B. portion of plant with perianth (p): A. dorsal view, B. ventral view; C. lateral leaves; D. teeth of leaf margin; E. cells at leaf median; F. cells at leaf base; G. bracts; H. perianth; I. perianth with bracts. P. Sukkharak 400.



**Figure 4.86** *Plagiochilium pachycephalum* (De Not.) Inoue  
 A. dorsal portion of plant with perianth (p); B. lateral leaves; C. cells at leaf apex; D. cells at leaf margin;  
 E. cells at leaf median; F. cells at leaf base; G. bracts; H. perianth; I. perianth with bracts. P. Sukkharak 281.

## Pleuroziaceae

**Plants** leafy, robust, olive-green to deep wine-red to purplish, 2-10 cm long, 4-7 mm wide, creeping to ascending, loosely branched or in dense tufts. **Stems** rigid, usually brown, with a thick-walled cortex. **Branches** lateral-intercalary. **Lateral Leaves** incubous, deeply concave, and strongly enveloping the stem, undivided or divided into 2 segments, the dorsal segment usually smaller and saccate (sometimes explanate), opening of the sac controlled by a valve, leaf tips acute or short-bifid, margins entire or toothed, sometimes with a white border, cells quadrate to rectangular, large, 40-100  $\mu\text{m}$  long, trigones large, cuticle smooth; oil bodies finely granular. **Underleaves** lacking. **Rhizoids** scarce, usually restricted to the stem bases, scattered. **Gametoecia** borne on short branches. **Perianths** large, cylindrical, of 2 types: fertile and plicate or sterile and completely smooth. **Seta** of numerous cells (cross section). **Capsule** ovoid, wall thick (6-8-layered). **Vegetative reproduction** no observed. **A monotypic family**

### *Pleurozia*

*Pleurozia* Dumort., Recueil d'observ. Jungerm. 15. 1835.; Thiers, B. M., the Bryologist 96: 517-554. 1993; Gradstein, S. R., Churchill, S. P. & Allen, N. S., Guide to the bryophytes of tropical America: 193-195. 2001. — *Physotium* Nees, Naturgesch. Eur. Leberm. 3: 75. 1838.

For description of the genus, see above.

#### *Pleurozia gigantea* (F. Weber) Lindenb.

In Lindb. & Lackström, Hapat. Scand. Exs. Fasc. 1, no. 5. 1874.; Thiers, B. M., the Bryologist 96: 517-554, fig. 101-128. 1993. — *Physotium giganteum* (Web.) Lindb., Oefvers. Förh. Finska Vetensk.-Soc. 12: 81. 1869. — *Jungermannia gigantea* Web., Hist. Musc. Hapat. Prodr. 57. 1815. — *Pleurozia sphagnoides* A. Rich. ex Trev., Mem. Reale Ist. Lomb. (ser. 3) Cl. Sci. 4: 412. 1877. — *Pleurozia sphagnoides* Dum., Recueil Observ. Jungerm. 15. 1835. — *Physotium sphagnoides* A. Rich. ex Nees, Naturgesch. Eur. Leberm. 3: 85. 1838. — *Pleurozia borneensis* (De Not.) Trev., Mem. Reale Ist. Lomb. (ser. 3) Cl. Sci. 4: 412. 1877. — *Physotium sphagnoides* var. [beta] *borneense* De Not., Mem. Reale Accad. Sci. Torino (ser. 2) 28: 304. 1876. — *Pleurozia gigantea* (Web.) Lindb. var. *major* (Jack) Evans, Trans. Connecticut Acad. Arts 8: 255. 1892. — *Physotium giganteum* var. *major* Jack, Hedwigia 25: 65. 1886. — *Physotium philippinense* Jack, Hedwigia 25: 65. 1886. — *Physotium elatum* Carring. ex Rabenh., Hapat. Europ. Exsic. 633. 1887. — *Eopleurozia simplicissima* (Herz.) Schust., the Bryologist 64: 200. 1961. — *Pleurozia simplicissima* Herz., Trans. British Bryol. Soc. 1: 316. 1950.

**Plants** pale green sometimes dark red, 7-8 mm wide. **Stems** creeping to slightly ascending. **Rhizoids** not seen. **Leaf lobes** densely imbricate, ovate, convex, dorsal margin teeth with irregular ligulate appendage, ventral margin incurved, apex acute with many teeth, 3.9-4.1 mm long and 2.5-2.8 mm wide, median cells 18-34  $\mu\text{m}$  long and 13-18  $\mu\text{m}$  wide, trigones large, basal cells 52-65  $\mu\text{m}$  long and 13-18  $\mu\text{m}$  wide, trigones large. **Leaf lobules** saccate, 1.5-1.8 mm long and 0.5-0.8 mm wide, ovate, apex obtuse, base with bilobed ligulate appendage. **Underleaves** absent. **Bracts** trilobed with acuminate apices. **Fertile Perianths** narrowly ovate to cylindrical, 6-7 mm long and 1.5-1.8 mm wide, plicate in upper part, apex (mouth) ciliated. **Sterile Perianths** widely cylindrical to flask-shaped, 2.5-3 mm long and 1-1.2 mm wide, apex (mouth) with hole. (**Figure 4.87 and 4.121**)

**Thailand** — NORTH: Chiang Mai; EASTERN: Naknon Ratchasima, Loei; SOUTH-EASTERN: Prachin Buri; PENINSULAR: Nakhon Si Thammarat.

**Distribution** — Africa (Macaronesia, Mauritius, Réunion, Tanzania), Asia (Burma, China, India, Japan, Sri Lanka, Indonesia, Malaysia, Papua New Guinea, Philippines), and Australasia (New Caledonia, Fiji, New Hebrides), and other tropical Pacific islands.

**Ecology** — on living branch and bark of tree, rotten log.

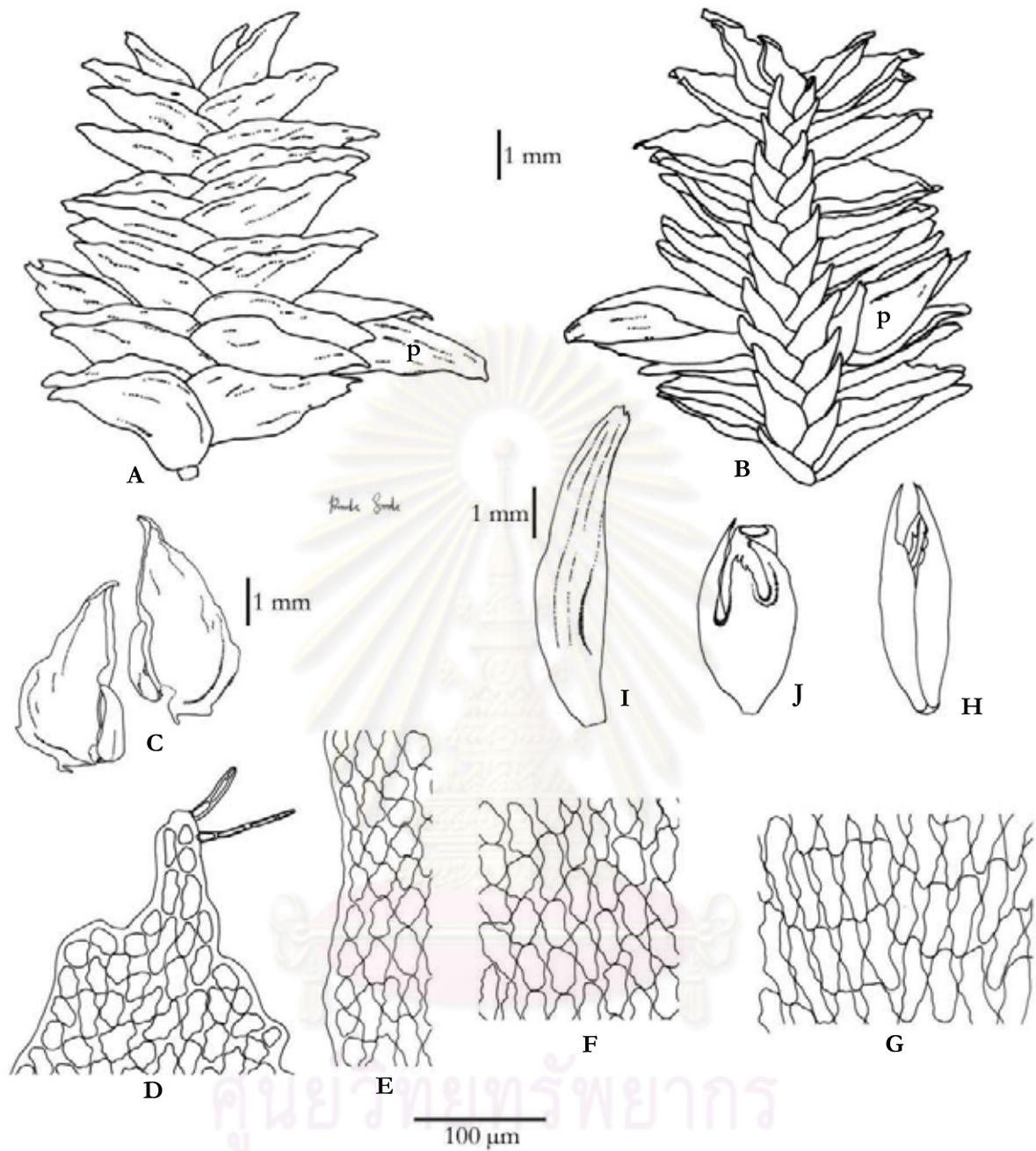
**Specimen examined** — P. Sukkharak 215, 461, 503, 513, O. Na-Thalang 62 (BCU).

**GPS location** — 8.87663662° N 99.68915284° E, 8.88219953° N 99. 69647527° E,  
8.88088524° N 99.69516635° E

**Altitude** — 1,282-1,374 m



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย



**Figure 4.87** *Pleurozia gigantea* (F. Weber) Lindenb.

A.-B. port of plants with perianth (p): A. dorsal view, B. ventral view; C. lateral leaves; D. cells at leaf apex; E. cells at leaf margin; f. cells at leaf median; G. cells at leaf base; H. bracts; I. perianth; J. sterile perianth. P. Sukkharak 461.

## Radulaceae

**Plants** leafy, small to medium-sized, dull pale green to bright green, rarely brownish, creeping, sometimes pendent, (bi)pinnate. **Branches** *Radula*-type. **Stems** rigid, without hyalodermis. **Lateral leaves** incubous, divided into a large dorsal lobe and a small ventral lobe, apex of lobe rounded (occasionally acute), margin entire. **Leaf lobules** broadly attached to the dorsal lobe by a keel and to the stem, quadrate to oblong, flat or somewhat inflated; cells thin-walled or with small trigones, cuticle smooth; oil bodies very large, brown, 1-2 per cell, rarely more. **Underleaves** lacking. **Rhizoids** in tufts at the lobules. **Sporophytes** surrounded by a flattened, 2-keeled perianth. **Vegetative reproduction** by large, multicellular gemmae or caduceus leaf segments. **A monotypic family**

### *Radula*

*Radula* Dumort., Commentationes Botanicae 112. 1822.; Reiner-Drehwald, M. E. El género *Radula* Dum. en el Noreste de Argentina. Tropical Bryology 9: 5-22. 1994.; Gradstein, S. R., Churchill, S. P. & Allen, N. S., Guide to the bryophytes of tropical America: 198. 2001.; Schuser, R. M., J. Hattori Bot. Lab. 70: 51-62. 1991.; Yamada, K., Beihefte zur Nova Hedwigia 88: 77-81. 1987.; Yamada, K., J. Hattori Bot. Lab. 65: 379-390. 1988.; Yamada, the Bryologist 92. 1989.; Yamada, K. & S. R. Gradstein. Tropical Bryology 4: 63-68. 1991.

For description of the genus, see above.

#### Key to species

1. Cross-section of stem more than 4 cells thick.
  2. Cortical cell strongly thick wall than medullary cells.
    3. Cross section of stem 12-13 cells thick, ventral margin incurved.....*R. kurzii*
    3. Cross section of stem 17-18 cells thick, obliquely spreading.....*R. campanigera*
  2. Both cortical and medullary cells thin-walled.
    4. Reduced leaves present.
      5. Leaf lobule covering the stem, adaxial margin arched.....*R. formosa*
      5. Leaf lobule not covering the stem, adaxial margin straight.....*R. yangii*
    4. Reduced leaves absent.
      6. Cross section of stem 6-7 cells thick.
        7. Gemmae present.....*R. constricta*
        7. Gemmae absent.....*R. japonica*
      6. Cross section of stem more than 6-7 cells thick.
        8. Cross section of stem 8-9 cells thick, leaf lobule rhomboidal .....*R. philippinensis*
        8. Cross section of stem 11-12 cells thick, leaf lobule quadrate .....*R. javanica*
  1. Cross-section of stem 4 cells thick.....*R. assamica*

#### 1. *Radula assamica* Steph.

Hedwigia 23: 151. 1884.; Yamada, K., J. Hattori Bot. Lab. 45. 288-289, fig. 48. 1979. — *Radula platyglossa* Chen, Acta Phytotax. Sin. 9(3): 221. 1964.

**Plants** pale greenish-yellow, 0.8-1.8 mm wide. **Stems** pinnate branched, branches obliquely spreading; in cross section of stem 4 cells thick, cortical cells equal to medullary cells in size, both of them thin-walled. **Leaf lobes** imbricate, obliquely spreading, falcate-ovate, numerous discoid gemmae occurring on the ventral margin of leaf-lobe, obtuse apex, entire margin, 104-106 mm long and 77-79 mm wide, marginal cells 7-13 µm long and 6-9 µm wide, thin walled, trigones absent, median cells 13-20 µm long and 13-19 µm wide, thin walled, trigones absent, basal cells 19-30 µm long and 14-22 µm wide, thin walled, trigones absent. **Leaf lobules** subtriangular, 0.3-0.37 mm long and 0.18-0.28 mm wide. **Gynoecia** lateral to stems, bract-lobes

orbicular-oblong, bract-lobules oblong. **Perianths** flat-cylindrical 174-176 mm long and 58-60 mm wide at middle, mouth undulate. (**Figure 4.88**)

**Thailand** — PENINSULAR: Trang.

**Distribution** — Ceylon, India, Burma, Vietnam.

**Ecology** — on living branch and bark of tree, leaves, rock.

**Specimens examined** — P. Sukkharak 36, 41, 42, 43, 46, 48, 395, 510, 540 (BCU).

**GPS location** — 8.87803137° N 99.69275236° E

**Altitude** — ca. 867-1,290 m

## 2. *Radula campanigera* Mont.

London J. Bot. 3: 634. 1844.; Yamada, K., J. Hattori Bot. Lab. 45: 308-309, fig. 60. 1979.

**Plants** yellowish-green, 2.1-2.8 mm wide. **Stems** pinnate branched, branches obliquely spreading; in cross section of stem 17-18 cells thick, cortical cells yellowish-brown, strongly thick wall so that cavities much smaller than medullary cells. **Rhizoids** not seen. **Leaf lobes** imbricate to slightly remote slightly concave, obliquely spreading, ovate, round apex, entire margin, 1.65-1.71 mm long and 1.05-1.19 mm wide, marginal cells 10-11  $\mu$ m long and 11-14  $\mu$ m wide, trigones large, median cells 17-21  $\mu$ m long and 17-19  $\mu$ m wide, trigones large, basal cells 25-42  $\mu$ m long and 15-21  $\mu$ m wide, trigones large. **Leaf lobules** obovate, 0.32-0.42 mm long and 0.44-0.57 mm wide. **Sporophytes** not found. (**Figure 4.89**)

**Thailand** — NORTH-EASTERN: Loei; PENINSULAR: Nakhon Si Thammat.

**Distribution** — Nicobar Islands, Malay Peninsular, Sumatra, Japan, Java, Borneo, Celebes, Micronesia (Kusaie), Sumatra, Tahiti.

**Ecology** — on living branch and bark of tree, tree fern, rotten log.

**Specimens examined** — P. Sukkharak 265, 272, 356, 434, 470 (BCU).

**GPS location** — 8.87584269° N 99.69320834° E, 8.8767761° N 99.69019353° E

**Altitude** — 687-1,305 m

## 3. *Radula constricta* Steph.

Spec. Hepat. 6: 506. 1924.; Yamada, K., J. Hattori Bot. Lab. 45: 229-231, fig. 11. 1979. — *Radula lindbergiana* Gott. var. *onoii* Hatt., J. Hattori Bot. Lab. 5: 80. 1951.

**Plants** pale yellowish-green, 1-1.5 mm wide. **Stems** pinnate branched, branches obliquely spreading; in cross section of stem 6-7 cells thick, both cortical medullary cells thin-walled. **Leaf lobes** imbricate to slightly remote, obliquely spreading, ovate, numerous discoid gemmae occurring on the dorsal margin of leaf-lobe, round apex, entire margin, 61-63 mm long and 69-71 mm wide, thin walled, trigones absent, marginal cells 3-7  $\mu$ m long and 3-6  $\mu$ m wide, median cells 11-14  $\mu$ m long and 10-15  $\mu$ m wide, thin walled, trigones absent, basal cells 14-27  $\mu$ m long and 9-13  $\mu$ m wide, thin walled, trigones absent. **Leaf lobules** subtriangular, 34-52 mm long and 30-39 mm wide. **Sporophyte not found.** (**Figure 4.90 and 4.122**)

**Thailand** — New record to Thailand.

**Distribution** — India, Japan, Korea, Nepal, Taiwan

**Ecology** — on living bark of tree.

**Specimens examined** — P. Sukkharak 426 (BCU).

**GPS location** — 8.87140095° N 99.69688296° E

**Altitude** — 1,094 m

## 4. *Radula formosa* (Meissn.) Nees

In Gott. et al., Synop. Hepat.: 258. 1845; Yamada, K., J. Hattori Bot. Lab. 45: 273-274, fig. 39. 1979. — *Jungermannia formosa* Meissn. Sprengel in Linnaeus, Syst. Veg. 4(2): 325. 1827. — *Radula pycnolejennae* Schiffn., Nova Acta Acad. Caes. Leop.-Carol 60(2): 247. 1893. — *Radula novae-guineae* Steph., Spec. Hepat. 4: 233. 1910.

**Plants** pale yellow, 1.1-1.6 mm wide. **Stems** pinnate branched, branches obliquely spreading, 3-7 pairs of reduced leaves, 0.35-0.55 mm. long; in cross section of stem 5-6 cells thick, both cortical medullary cells thin-walled. **Rhizoids** not seen. **Leaf lobes** imbricate, obliquely spreading, ovate-oblong, round apex, slightly concave, entire margin, 0.73-0.76 mm long and 0.97-1.16 mm wide, marginal cells 9-11  $\mu\text{m}$  long and 7-10  $\mu\text{m}$  wide, trigones large, median cells 18-26  $\mu\text{m}$  long and 13-23  $\mu\text{m}$  wide, trigones large, basal cells 26-50  $\mu\text{m}$  long and 14-18  $\mu\text{m}$  wide, trigones large. **Leaf lobules** covering the stem, quadrate to subrectangular, adaxial margin arched, rarely straight, 0.25-0.35 mm long and 0.3-0.4 mm wide. **Sporophyte not found.** (Figure 4.91)

**Thailand** — PENINSULAR: Nakhon Si Thammarat.

**Distribution** — Ceylon, Malay Peninsular, Sumatra, Java, Borneo, Celebes, Ceram, Papua New Guinea, Philippines, Japan (Ryukyu Islands), New Caledonia, Fiji, Tahiti, Micronesia (Kusaie Islands).

**Ecology** — on living twig of shrub.

**Specimens examined** — P. Sukkharak 286 (BCU).

**GPS location** — Exact locality not applicable. Near TT27.

**Altitude** — ca. 1,320 m

##### 5. *Radula japonica* Gottsche ex Steph.

Hedwigia 23: 152. 1884.; Yamada, K., J. Hattori Bot. Lab. 45: 234-235, fig. 14. 1979. — *Radula sendaica* Steph., Spec. Hepat. 6: 514. 1924.

**Plants** yellow, 0.9-1 mm wide. **Stems** pinnate branched; in cross section of stem 6-7 cells thick, both cortical medullary cells thin-walled. **Rhizoids** not seen. **Leaf lobes** imbricate, obliquely spreading, ovate, entire margin, 0.4-0.5 mm long and 0.44-0.48 mm wide, marginal cells 1 layer 7-10  $\mu\text{m}$  long and 13-15  $\mu\text{m}$  wide, median cells 15-18  $\mu\text{m}$  long and 13-17  $\mu\text{m}$  wide, trigones absent. **Leaf lobules** subquadrate 0.2-0.3 mm long and 0.22-0.25 mm wide. **Sporophytes** not found. (Figure 4.92)

**Thailand** — New record to Thailand.

**Distribution** — Japan, Korea.

**Ecology** — on living bark of tree and rotten log.

**Specimens examined** — P. Sukkharak 61, 489, A. Noguchi, VIII. 1948 (BCU).

**GPS location** — 8.87838006° N 99.70228493° E

**Altitude** — 1,035-1,100 m

##### 6. *Radula javanica* Gottsche

In Gott. et al., Synop. Hepat.: 257. 1845.; Yamada, K., J. Hattori Bot. Lab. 45: 235-238, fig. 15. 1979. — *Radula sandei* Steph., Hedwigia 23: 130. 1884. — *Radula nietneri* Steph., Spec. Hepat. 6: 512. 1924. — *Radula wallichiana* Lehm., Pugillus 10: 9. 1857. — *Radula ceramensis* Steph., Hedwigia 23: 132. 1884. — *Radula ovalifolia* Steph., Hedwigia 23: 135. 1884. — *Radula colliculosa* Mitt., Jour. Proc. Linn. Soc. 5: 107. 1861. — *Radula variabilis* Hatt., Bull. Tokyo Sci. Mus. 11: 86. 1944.

**Plants** greenish-yellow, 2-2.2 mm wide. **Stems** pinnate branched; in cross section of stem 11-12 cells thick, both cortical medullary cells thin-walled. **Rhizoids** not seen. **Leaf lobes** imbricate, widely spreading, ovate-oblong, entire margin, 0.9-1 mm long and 0.6-0.7 mm wide, marginal cells 1 layer, one slime papillae present near the basal of margin, 13  $\mu\text{m}$  long and 11-13  $\mu\text{m}$  wide, median cells 15-17  $\mu\text{m}$  long and 18-19  $\mu\text{m}$  wide, trigones absent. **Leaf lobules** subquadrate 0.3-0.4 mm long and 0.3 mm wide. **Gemmae** discoid to quadrate, occur on the margin of the leaf-lobe, 40-41  $\mu\text{m}$  in diameter. **Sporophytes** not found. (Figure 4.93)

**Thailand** — NORTH: Tak; NORTH-EASTERN: Loei; SOUTH-EASTERN: Chantaburi, Prachin Buri; PENINSULAR: Nakhon Si Thammarat, Phuket.

**Distribution** — widely distributed in the tropical and subtropical regions of southeastern Asia and the Pacific Islands, extending northward through the Ryukyu Archipelago to the southeastern flank of Japan.

**Ecology** — on living bark of tree.

**Specimens examined** — P. Sukkharak 2, 32, 60, 110, Thaithong No 93 (BCU).

**GPS location** — Exact locality not applicable. Between TT01 and TT16.

**Altitude** — ca. 320-1,036 m

### 7. *Radula kurzii* Steph.

Hedwigia 23: 153. 1884.; Yamada, K., J. Hattori Bot. Lab. 45: 239-240, fig. 17. a-o. 1979. — *Radula speciosa* Gott. ex Steph., Hedwigia 23: 155. 1884. — *Radula andreana* Steph., Spec. Hepat. 4: 182. 1910.

**Plants** brownish- yellowish, 2.5-3.5 mm wide. **Stems** pinnate branched; in cross section of stem 12-13 cells thick, cortical cells thick-walled with 3 layers, medullar cells thin-walled and larger than cortical cells. **Rhizoids** not seen. **Leaf lobes** moderately to loosely imbricate, obliquely spreading, widely ovate, entire margin, incurved along ventral margin 1.4-1.7 mm long and 0.9-1.2 mm wide, marginal cells 1 layer, 10-14  $\mu\text{m}$  long and 14-15  $\mu\text{m}$  wide, median cells 19-22  $\mu\text{m}$  long and 18-21  $\mu\text{m}$  wide, trigones absent. **Leaf lobules** subrectangular to subquadrate 0.4-0.5 mm long and 0.3 mm wide. **Sporophytes** not found. (Figure 4.94)

**Thailand** — New record to Thailand.

**Distribution** — Ceylon, India, Andamann Islands.

**Ecology** — on living twig of shrub.

**Specimens examined** — P. Sukkharak 257 (BCU).

**GPS location** — Exact locality not applicable. Near TT19.

**Altitude** — ca. 1,240 m

### 8. *Radula philippinensis* Yamada

In Yamada, K., J. Hattori Bot. Lab. 45: 299-300, fig. 55. 1979.

**Plants** yellowish green, 2-2.3 mm wide. **Stems** pinnate branched; in cross section of stem 8-9 cells thick, both cortical and medullary cells thin-walled. **Rhizoids** not seen. **Leaf lobes** slightly remote, obliquely spreading, orbicular, entire margin 0.9-1 mm long and 0.7-0.8 mm wide, marginal cells 10-11  $\mu\text{m}$  long and 7-9  $\mu\text{m}$  wide, median cells 13-15  $\mu\text{m}$  long and 11-13  $\mu\text{m}$  wide, trigones absent. **Leaf lobules** rhomboidal 0.3-0.4 mm long and 0.3 mm wide. **Sporophytes** not found. (Figure 4.95)

**Thailand** — New record to Thailand.

**Distribution** — Malay Peninsular, Philippines.

**Ecology** — on living bark of tree.

**Specimens examined** — P. Sukkharak 469 (BCU).

**GPS** — 8.8767761° N 99.69019353° E

**Altitude** — 1,305 m

### 9. *Radula yangii* Yamada

In Yamada, K., J. Hattori Bot. Lab. 45: 279-280, fig. 43. 1979. — *Radula pinnulata* Yang, Taiwania 7: 35-39. 1960., non Mitt. In Seemann, Flora Vitiensis: 410. 1871.

**Plants** greenish-yellow, 1.8-2 mm wide. **Stems** pinnate branched, amentulose branches obliquely spreading, 3-7 pairs of reduced leaves, 0.4-0.8 mm. long; in cross section of stem 6-7 cells thick, both cortical medullary cells thin-walled. **Rhizoids** not seen. **Leaf lobes** imbricate, obliquely spreading, ovate-oblong, entire margin, 1-1.1 mm long and 0.7-0.8 mm wide, marginal cells 1 layer 11-13  $\mu\text{m}$  long and 5-6  $\mu\text{m}$  wide, median cells 13  $\mu\text{m}$  long and 17-18  $\mu\text{m}$  wide, basal cells 23-26  $\mu\text{m}$  long and 9-10  $\mu\text{m}$  wide, trigones absent. **Leaf lobules** not covering the stem, rectangular, adaxial margin straight, 0.5-0.6 mm long and 0.24-0.28 mm wide **Gynoecea** lateral to

stems, with two subfloral innovations; bract-lobe orbicular-oblong, bract-lobule oblong. **Perianths** flat-cylindrical 2.3-2.6 mm long and 0.8 mm wide at middle, mouth undulate. **Spores** red-brown 43-44  $\mu\text{m}$  in diameter. **Elaters** red-brown, bispiral, 6-7  $\mu\text{m}$  wide. (**Figure 4.96**)

**Thailand** — PENINSULAR: Nakhon Si Thammarat.

**Distribution** — Ceylon, Malay Peninsular, Sumatra, Borneo, Taiwan.

**Ecology** — on living bark of tree, leaf surface.

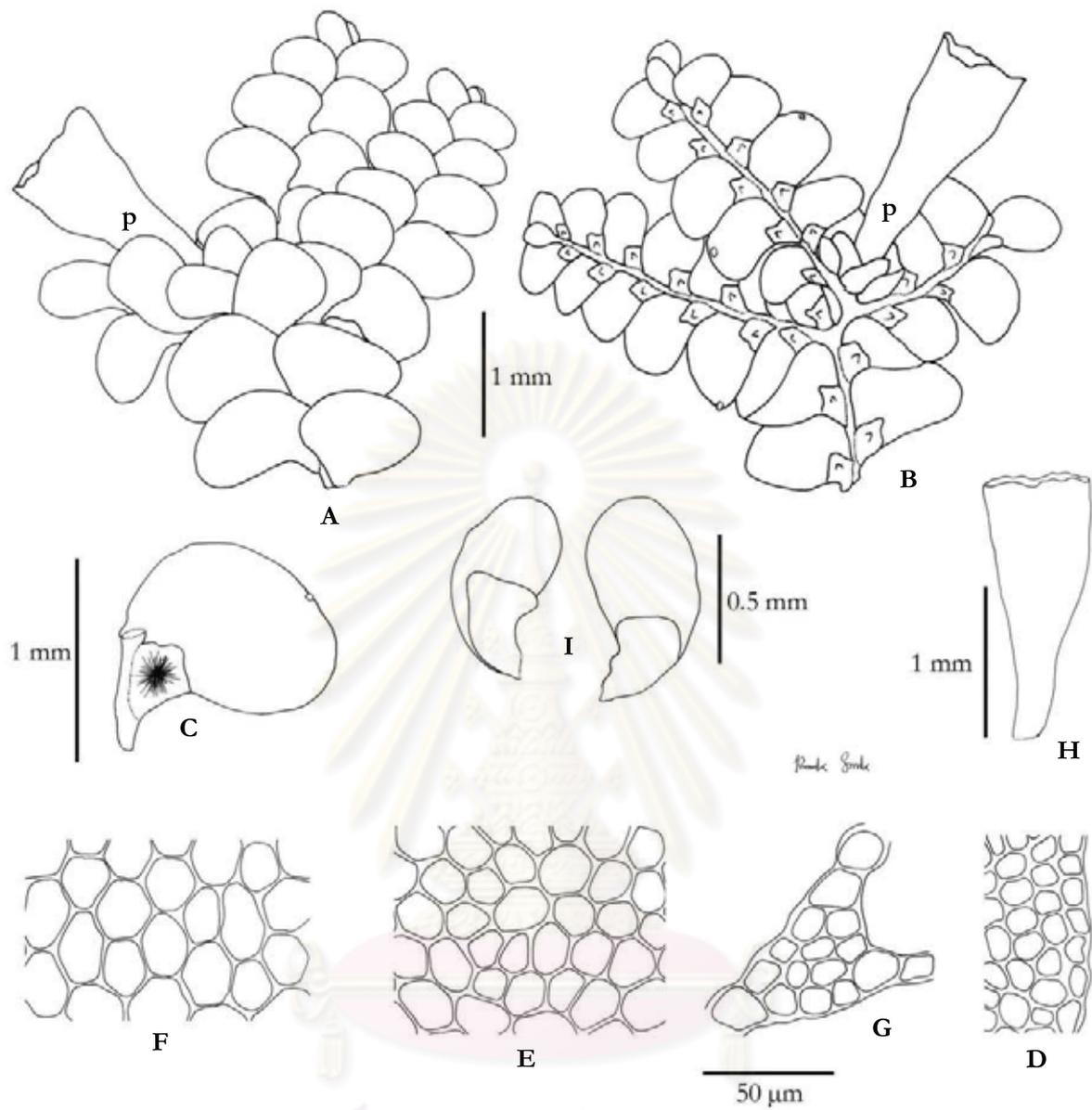
**Specimens examined** — P. Sukkharak 236, 450, 468, 474, 501, 515, 523 (BCU).

**GPS location** — 8.87887615° N 99.69447228° E, 8.87710333° N 99.68977511° E, 8.87667418° N 99.69022036° E, 8.8769263° N 99.6907407° E, 8.88314903° N 99.69976366° E, 8.88204932° N 99.69624996° E, 8.88229072° E 99.69644308° E

**Altitude** — 1,210-1,385 m

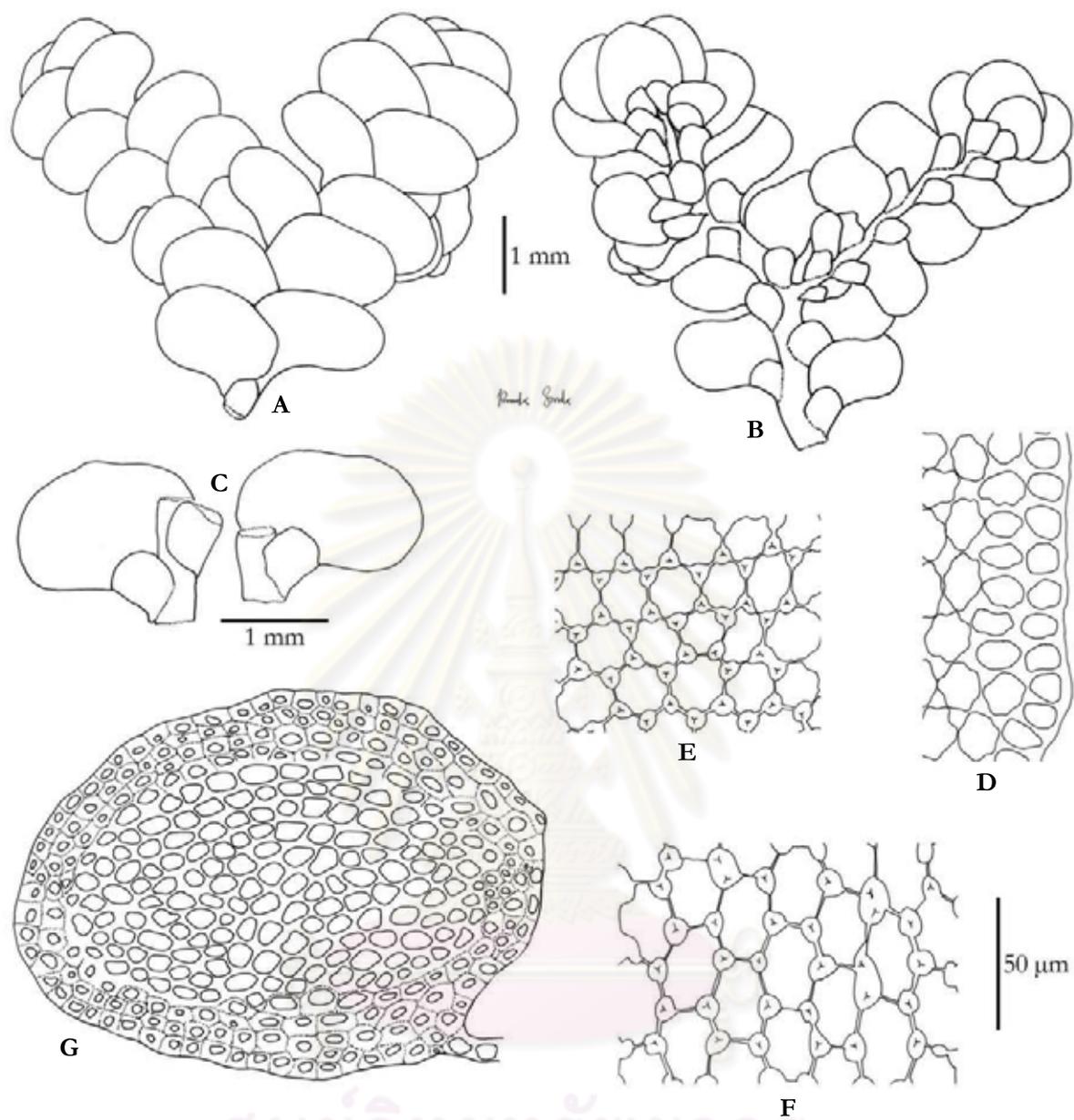


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จุฬาลงกรณ์มหาวิทยาลัย



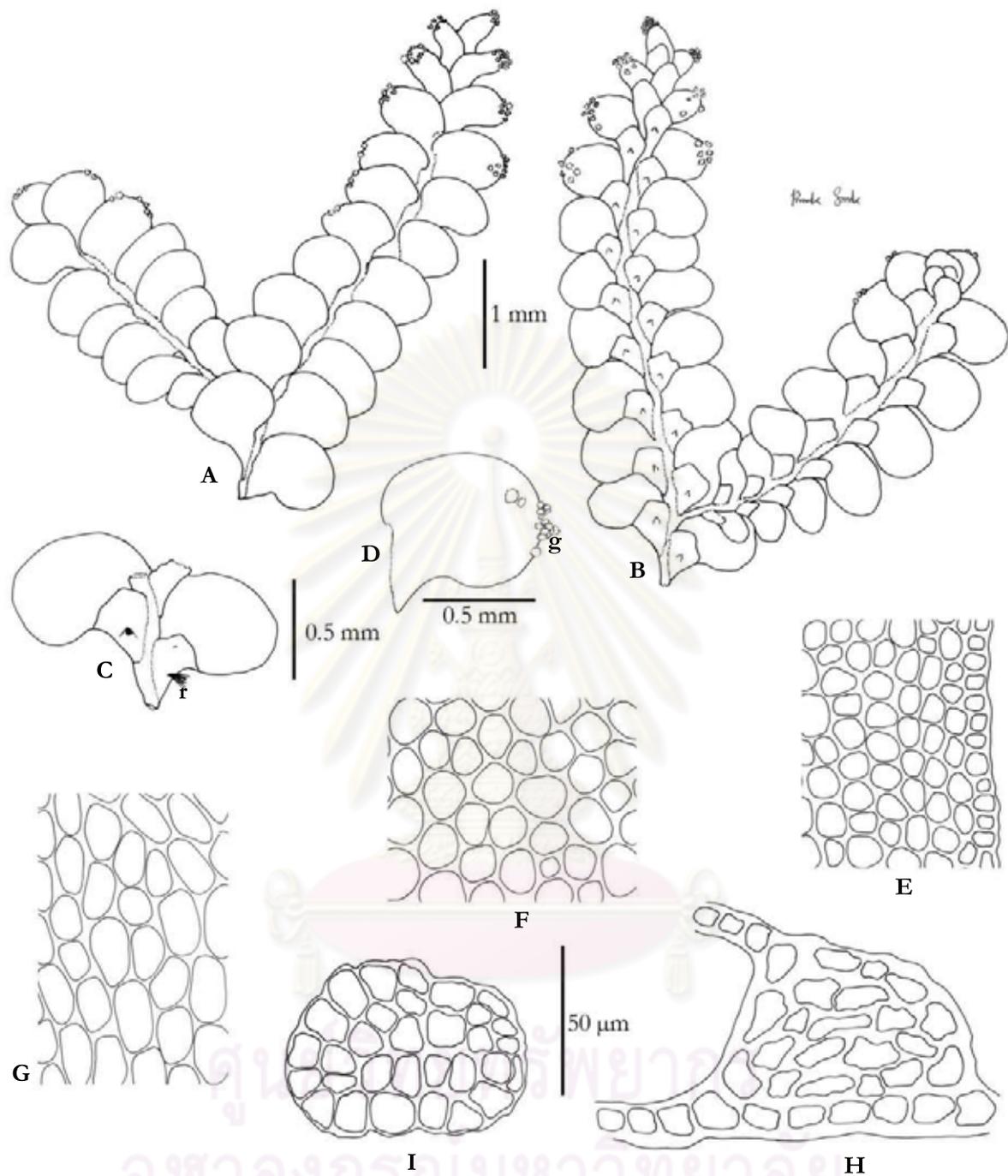
**Figure 4.88** *Radula assamica* Steph.

A.-B. portion of plant with perianth (p): A. dorsal view, B. ventral view; C. lateral leaf; D. cells at leaf margin; E. cells of leaf median; F. cells of leaf base; G. cross section of stem; H. perianth; I. bracts. P. Sukkharak 510.



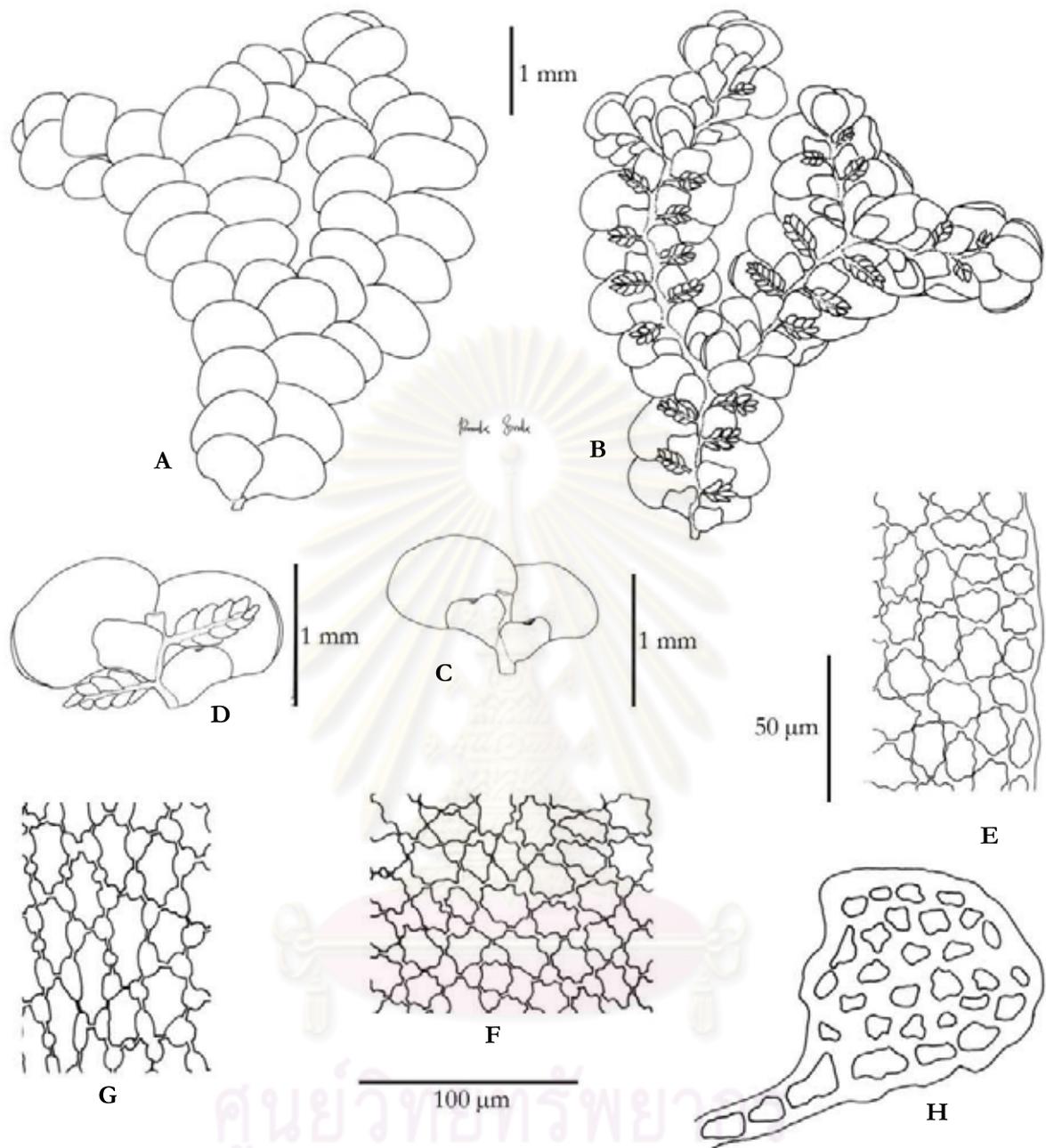
**Figure 4.89** *Radula campanigera* Mont.

A.-B. portion of plant: A. dorsal view, B. ventral view; C. lateral leaves; D. cells at leaf margin; E. cells of leaf median; F. cells of leaf base; G. cross section of stem. P. Sukkharak 470.



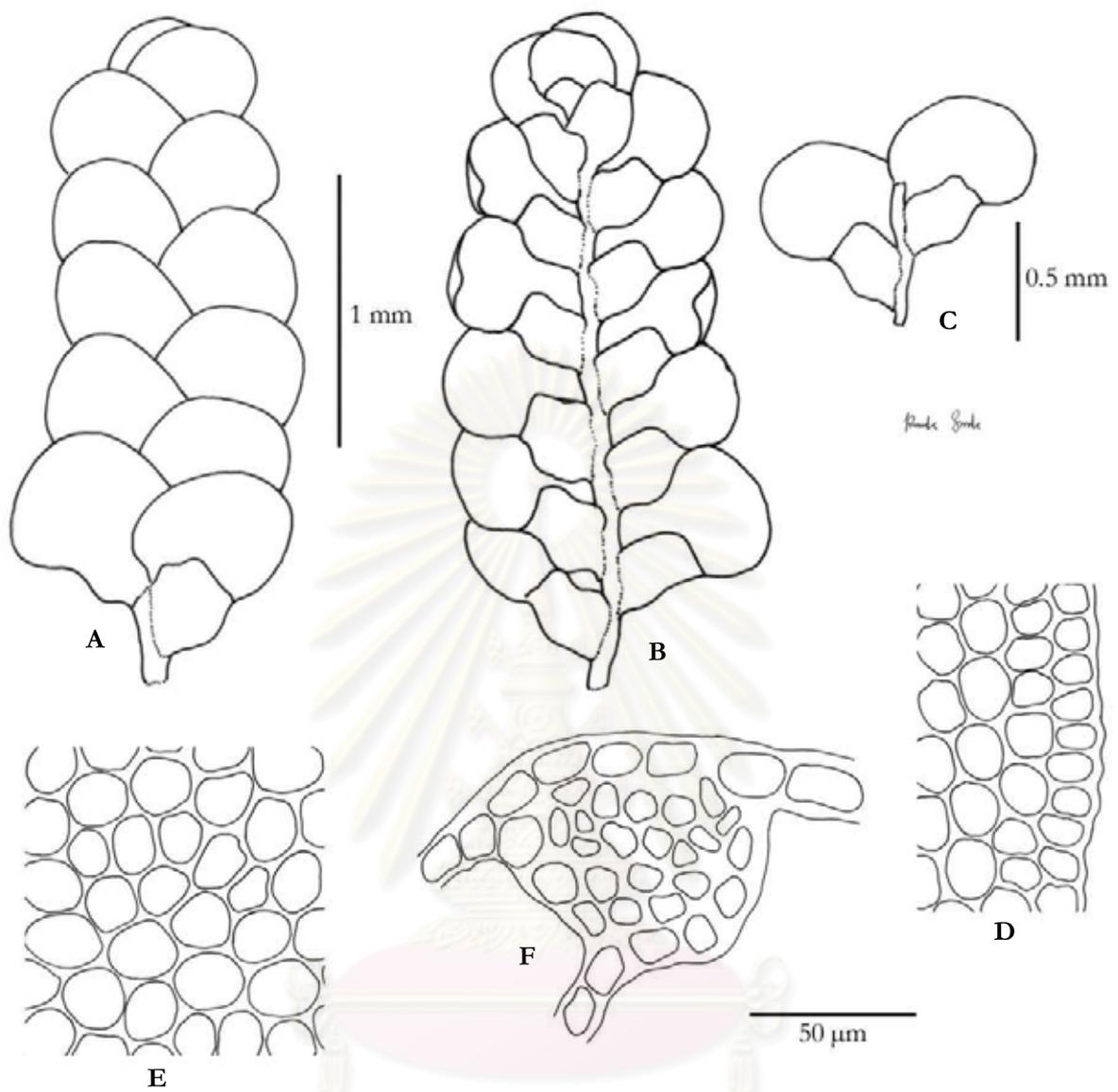
**Figure 4.90** *Radula constricta* Steph.

A.-B. portion of plant: A. dorsal view, B. ventral view; C. lateral leaves with rhizoids (r); D. lateral leaves with gemmae (g) on dorsal part; E. cells at leaf margin; F. cells of leaf median; G. cells of leaf base; H. cross section of stem; I. gemma. P. Sukkharak 426.



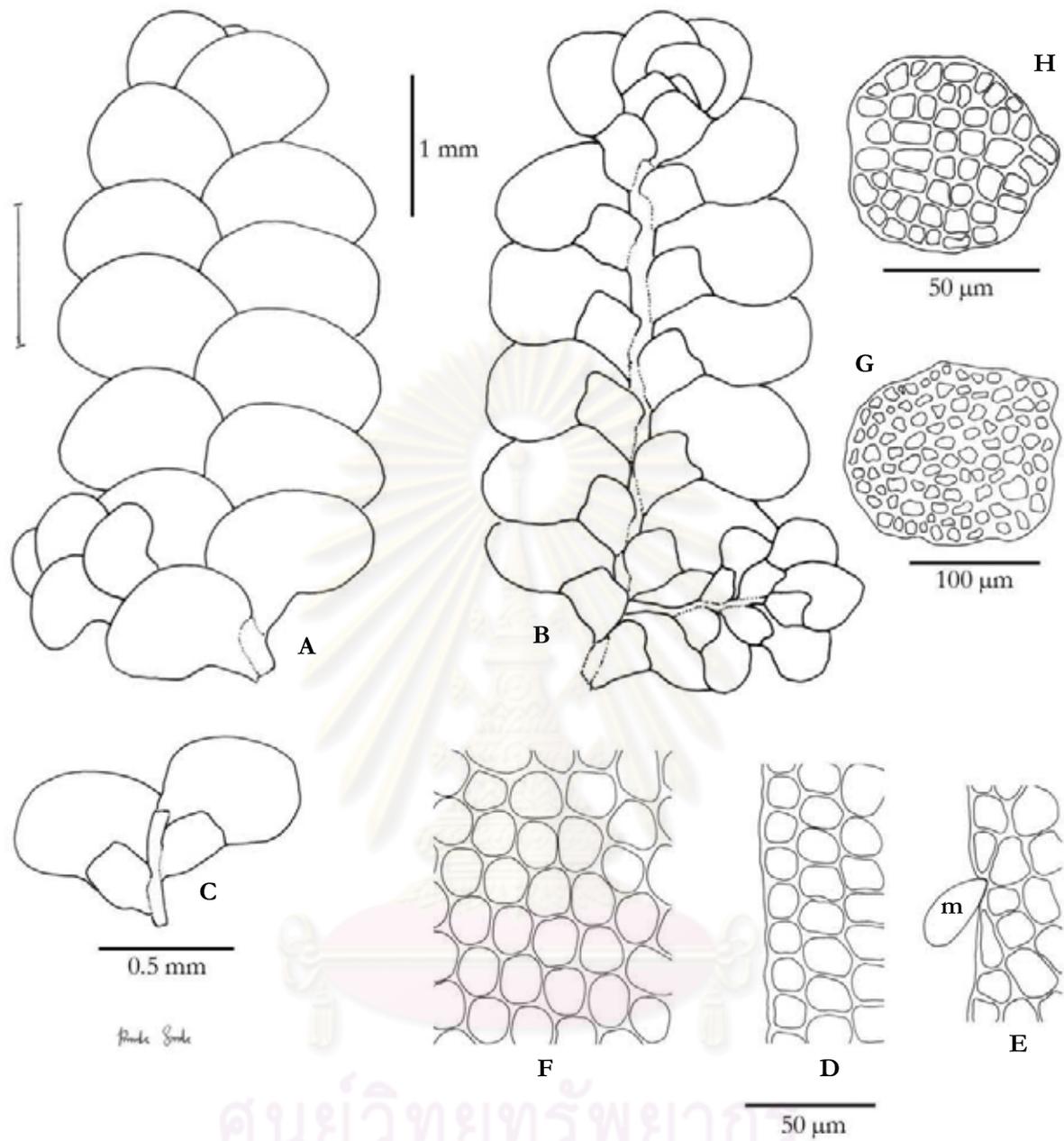
**Figure 4.91** *Radula formosa* (Meissn.) Nees

A.-B. portion of plant: A. dorsal view, B. ventral view; C. lateral leaves; D. lateral leaves with reduced leaves; E. cells at leaf margin; F. cells of leaf median; G. cells of leaf base; H. cross section of stem. P. Sukkharak 286.



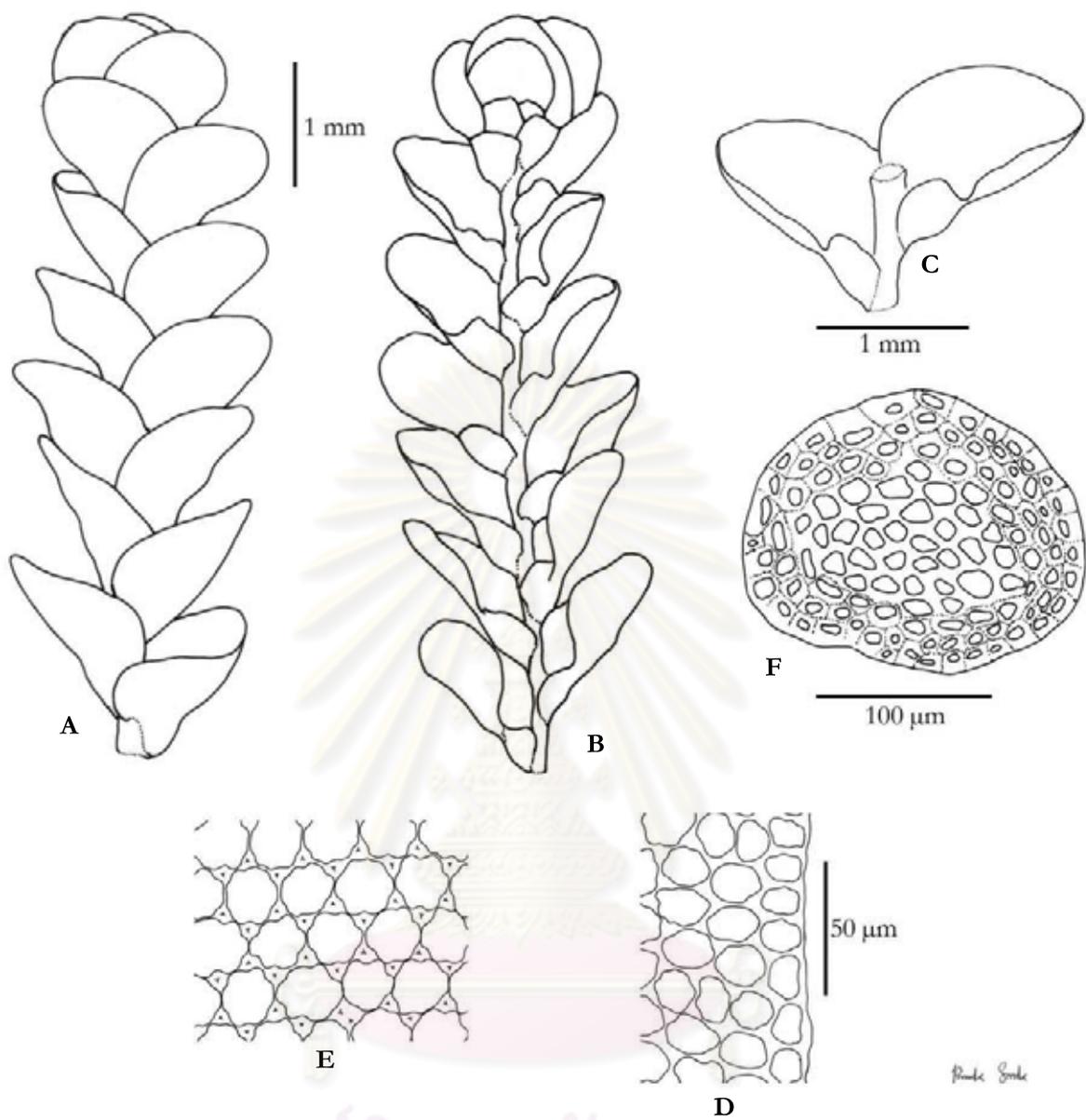
**Figure 4.92** *Radula japonica* Gottsche ex Steph.

A.-B. portion of plant: A. dorsal view, B. ventral view; C. lateral leaves; D. cells at leaf margin; E. cells of leaf median; F. cross section of stem. P. Sukkharak 61.



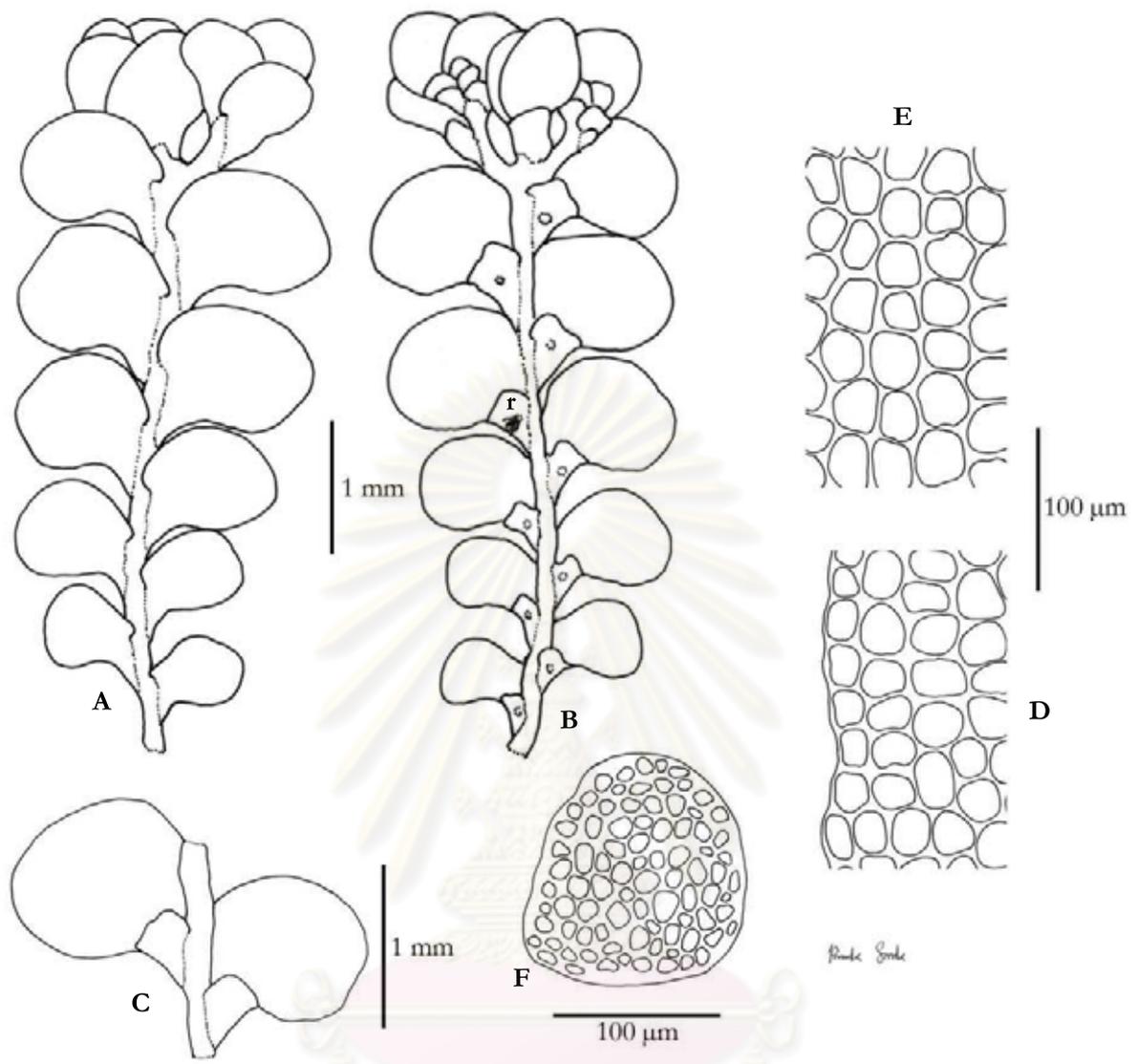
**Figure 4.93** *Radula javanica* Gottsche

A.-B. portion of plant: A. dorsal view, B. ventral view; C. lateral leaves; D. cells of leaf margin; E. cells at leaf margin with mucilage papillae (m); F. cells at leaf median; G. cross section of stem; H. gemmae. P. Sukkharak 60.



**Figure 4.94** *Radula kurzii* Steph.

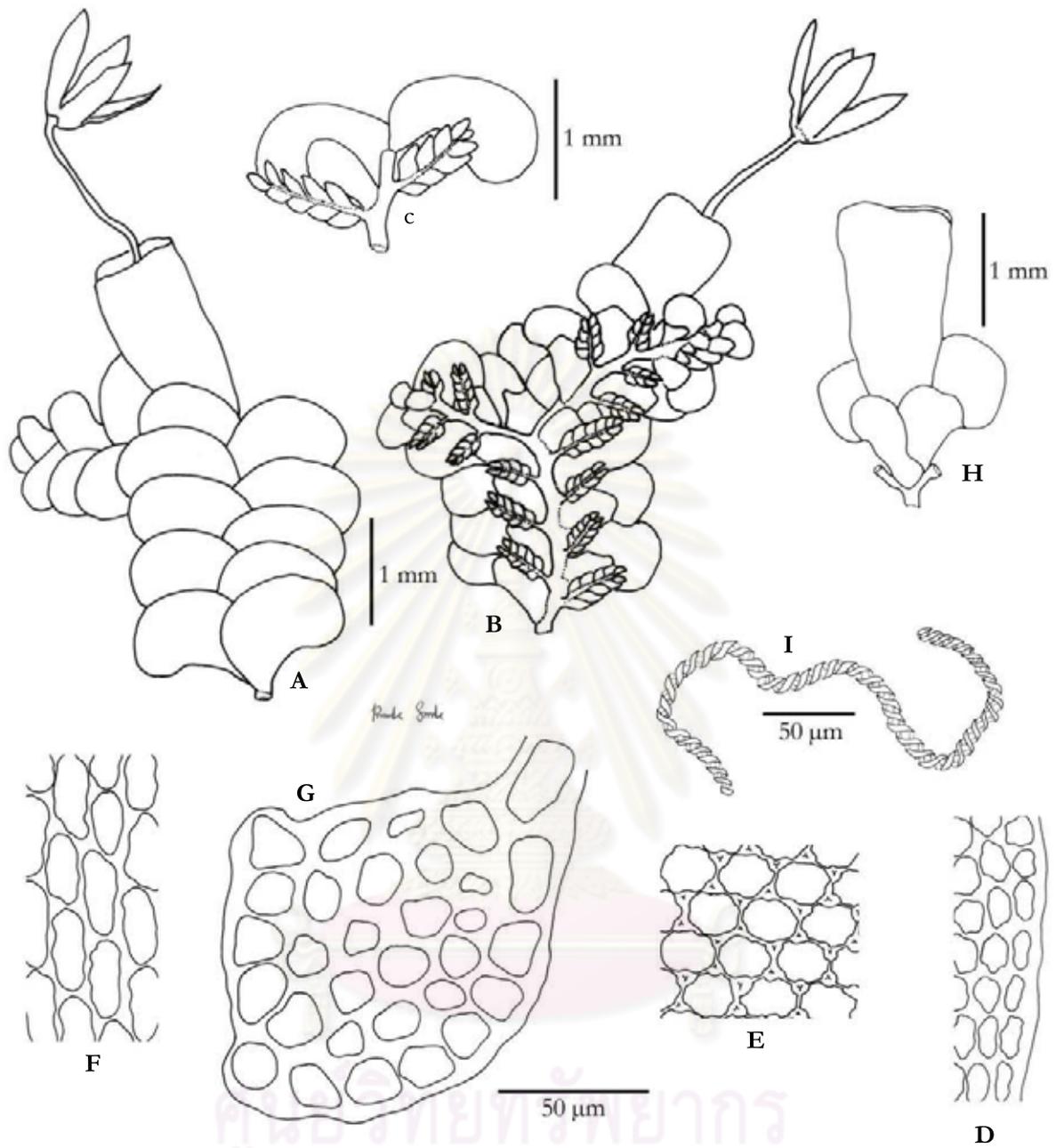
A.-B. portion of plant: A. dorsal view, B. ventral view; C. lateral leaves; D. cells at leaf margin; E. cells of leaf median; F. cross section of stem. P. Sukkharak 257.



**Figure 4.95** *Radula philippinensis* Yamada

A.-B. portion of plant: A. dorsal view, B. ventral view with rhizoids (r); C. lateral leaves; D. cells at leaf margin; E. cells of leaf median; F. cross section of stem. P. Sukkharak 469.

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**Figure 4.96** *Radula yangii* Yamada

A.-B. portion of plant with sporophyte: A. dorsal view, B. ventral view; C. lateral leaves with reduced leaves; D. cells at leaf margin; E. cells of leaf median; F. cells of leaf base; G. cross section of stem; H. perianth with bracts; I. elater. P. Sukkharak 450.

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## Schistochilaceae

**Plants** leafy, medium-sized to large, flattened, green to yellowish brown, sparingly branched. **Lateral leaves** incubous, oblong-ovate, divided into a smaller dorsal lobe and a larger ventral lobe, base of dorsal lobe sometimes ampliate, dorsal lobe about 1/2-2/3(-4/5) size of ventral lobe, adjoined with latter at varying distances from the margin, marginal teeth varied, some long ciliate, others dentate or blunt; laminal cells usually with large nodulose trigones, walls thin, cuticle smooth. **Underleaves** present or absent, if present, usually bilobed, marginal teeth often conforming with that of the leaves. **Paraphyllia** sometimes numerous, usually in axils of leaves. **Dioicous**. **Gynoecia** at apex or on short lateral branches, coelocaul forming a tubular structure with its mouth cut into 6-8 equal dentate segments; bracts and bracteoles as small appendages from the coelocaul; sporophytes developing within the coelocaul.

### *Schistochila*

*Schistochila* Dumort., Recueil d'observ. Jungerman., 15. 1835.; So, M. L., New Zealand Journal of Botany. 2003. Vol. 41: 256.

For description of the genus, see that of the family.

#### Key to species

1. Apex of ventral lobes dentate or with ciliate teeth.
  2. Margin of ventral lobes not entire.
    3. Margin of lateral leaf serrate or dentate.
      4. Ventral lobes lanceolate-oblong.....*S. blumei*
      4. Ventral lobes ovate.....*S. sp.*
    3. Margin of ventral lobes with addition long ciliate teeth.....*S. sciurea*
  2. Margin of ventral lobes entire throughout.....*S. aligera*
1. Apex of ventral lobes entire.....*S. nuda*

#### 1. *Schistochila aligera* (Nees & Blume) Jack & Steph.

Hedwigia 31: 12. "*Schistocheila*" 1892; So, M. L., J. Hattori Bot. Lab. 93: 81-87, fig. 1. 2003. — *Jungermannia aligera* Nees & Blume, Nova Acta Acad. Leop.-Carol. 11: 135. 1832. — *Schistochila philippinensis* (Mont.) Steph. in Engler (ed.), Bot. Jahrb. Syst. 23: 308. "*Schistocheila*" 1896. — *Gottschea philippinensis* Mont., Ann. Sci. Nat. Bot. Ser. 2, 19: 224. 1843; *vide* Stephani 1909. — *Schistochila philippinensis* Jack & Steph., Bot. Jahrb. Syst. 60: 98. "*Schistocheila*" [=Hep. Ins. Vitens. Samoa., Graeffe 1864 Lect.: 2, 3]. 1894. Art. 32.1 (c). — *Schistochila notarisii* Schiffn., Consp. Hep. Archip. Ind.: 217. 1898. — *Schistochila gaudichaudii* (Gottsche) Schiffn., Consp. Hep. Archip. Ind.: 216. 1899. — *Gottschea gaudichaudii* Gottsche, Ann. Sci. Nat. Bot. Ser. 4. 8: 319. 1857. — *Schistochila aligeriformis* (De Not.) Schiffn., Consp. Hep. Arch. Ind.: 213 "*aligeriformis*" 1898. — *Gottschea aligeriformis* De Not., Mem. Reale Accad. Sci. Torino, ser. 2, 28: 276. 1874. — *Schistochila sumatrana* Steph., Sp. Hepat. 4: 74. 1909. — *Schistochila commutata* Steph., Sp. Hepat. 4: 74. 1909. — *Schistochila cuspidata* Steph., Sp. Hepat. 4: 79. 1909; *vide* Busch 1939. — *Schistochila curtisii* Steph., Sp. Hepat. 4: 79. 1909. *vide* Kitagawa 1973. — *Schistochila fleischeri* Steph., Sp. Hepat. 4: 81. 1909; syn. nov. — *Schistochila maxima* Steph., Sp. Hepat. 6: 493. 1924; *vide* Kitagawa 1973. — *Schistochila recurvata* Buch, Ann. Bryol. 12: 10. 1939. (Art 36.1). — *Schistochila caudata* Buch, Ann. Bryol. 12: 12. 1939. (Art. 36.1).

**Plants** large, light green to brownish green, 2.5-6 cm long and 1-1.7 cm wide. **Stems** complanate, ascending erectly from the main axis, paraphyllia on lateral sides of stem; in cross section of stem with thin-walled cell. **Rhizoids** occasionally in dense mat along ventral surface of stem, red- purplish red. **Lateral leaves** imbricate, widely spreading, dorsal lobes 4-5 mm long and 1.8-2 mm wide, asymmetrically ovate, apex acute-acuminate, margin entire; ventral lobes 9-11 mm long and 2-2.5 mm wide at base, 1.3-1.8 mm wide at apex, elongate, narrowly ovate, apex

with teeth, margin entire, leaf cells 36-44  $\mu\text{m}$  long and 26-32  $\mu\text{m}$  wide, trigones triangular. **Underleaves** lacking in sterile plant, occur only in fertile plant, bilobes, spreading, ovate, margin dentate. **Capsules** cylindrical-elliptic 6-7 mm long and 1.5-2 mm wide. **Spores** red-brown 10-12  $\mu\text{m}$ . **Elaters** red-brown, bispiral, 14-22  $\mu\text{m}$  wide. (**Figure 4.97**)

**Thailand** — NORTH: Chiang Mai, PENINSULAR: Nakhon Si Thammarat.

**Distribution** — Asia and Melanesia.

**Ecology** — on living bark of tree, tree fern, rotten log.

**Specimens examined** — P. Sukkharak 390, 456, 472, 499, 532 (BCU).

**GPS location** — 8.87715161° N 99.68955517° E, 8.8770014° N 99.69020426° E, 8.88230145° N 99.70021963° E, 8.87699604° N 99.69201744° E

**Altitude** — 1,280-1,338 m

## 2. *Schistochila blumei* (Nees) Trevis.

Mem. Reale Ist. Lombardo Sci., Ser. 3, Cl. Sci. Mat. 4: 392. 1877. [Schema Classific. Epat.: 10]; So, M. L., J. Hattori Bot. Lab. 93: 89-90, fig. 6. 2003. — *Jungermannia blumei* Nees in Blume, Nova Acta Acad. Leop-Carol 11 (1): 136. 1832. — *Schistochila wallisii* Jack & Gottsche in Jack & Stephani, Hedwigia 31: 26. “*Schistocheila*” 1892; fide Stephani 1909. — *Schistochila formosana* Horik., Ann. Bryol. 6: 59. 1933; fide Inoue 1985.

**Plants** large, light green to green, up to 4 cm long and 1-1.5 cm wide. **Stems** complanate, ascending erectly from the main axis, paraphyllia scattered on lateral sides of stem; in cross section of stem with thin-walled cell. **Rhizoids** scattered, reddish brown. **Lateral leaves** imbricate, widely spreading, dorsal lobes 3-4 mm long and 1-1.5 mm wide, lanceolate-oblong, about 1/2 area of ventral leaf lobe, margin of dorsal and ventral lobes serrate; ventral lobes 6-7 mm long and 2-2.5 mm wide oblong, median cell of leaf lobes 44-47  $\mu\text{m}$  long and 26-31  $\mu\text{m}$  wide, small and thin wall trigones. **Underleaves** bilobes, with dentate margin. **Sporophytes** not found. (**Figure 4.98**)

**Thailand** — NORTH-EASTERN: Loei, PENINSULAR: Nakhon Si Thammarat.

**Distribution** — Asia and Melanesia.

**Ecology** — on tree fern, rock.

**Specimens examined** — P. Sukkharak 377, 380, 506 (BCU).

**GPS location** — Exact locality not applicable. Near TT20-TT22.

**Altitude** — ca. 1,269-1,340 m

## 3. *Schistochila nuda* Horik.

J. Sci. Hiroshima Univ., Ser. B, Div. 2, Bot. 2: 215. 1934.; So, M. L., J. Hattori Bot. Lab. 93: 94, fig. 7. 2003.

**Plants** medium, light green, 4-5.2 mm wide. **Stems** complanate, prostrate, paraphyllia scarcely on lateral sides of stem. **Rhizoids** red, in dense mat along ventral surface of stem except apex. **Lateral leaves** imbricate, widely spreading, dorsal lobes 1.5-2 mm long and 0.5-1 mm wide, about 1/2 area of ventral leaf lobe, ovate, apex truncate, margin entire; ventral lobes 2.8-3 mm long and 1-1.5 mm wide, rectangular to slightly ovate, apex obtuse, margin entire; leaf cells 13-21  $\mu\text{m}$  long and 15-21  $\mu\text{m}$  wide, trigones triangular. **Underleaves** lacking. **Sporophytes** not found. (**Figure 4.99 and 4.123**)

**Thailand** — New record to Thailand, Taiwan.

**Ecology** — on rotten log.

**Specimens examined** — P. Sukkharak 488 (BCU).

**GPS location** — 8.8778007° N 99.70351875° E

**Altitude** — 1,075 m

#### 4. *Schistochila sciurea* (Nees) Schiffn.

Nova. Acta. Acad. Caes. Leop.-Carol. German. Nat. Cur. 60: 251. [Exot. Hep.: 35]. “*Schistocheila*” 1893.; So, M. L., J. Hattori Bot. Lab. 93: 98-99, fig. 7. 2003. — *Jungermannia sciurea* Nees, Hep. Javan.: 34. 1830. — *Schistochila javanica* (Nees) Steph., Sp. Hepat. 4: 72. 1909. — *Gottschea javanica* Nees in *Gottsche*, Lindenberg & Nees, Syn. Hepat. Fasc. 1: 19. 1844; *fide* Buch 1939. — *Schistochila thwaitesii* (Mitt.) Steph., Sp. Hepat. 4: 72. 1909. — *Gottschea thwaitesii* Mitt., J. Proc. Linn. Soc., Bot. 5: 101. ‘1861’ 1860. — *Schistochila difficilis* Steph., Sp. Hepat. 4: 72. 1909. — *Schistochila inversa* Herzog, Hedwigia 66: 342. 1926.

**Plants** pale yellow-brownish yellow, 15-17 mm long and 2-3 mm wide. **Stems** complanate, prostrate; in cross section of stem with thin-walled cell. **Rhizoids** scattered, pale red-red. **Lateral leaves** imbricate, widely spreading, dorsal lobes 1.8-2 mm long and 0.8-1 mm wide, ovate, margin dentate, 0.5-0.6 area of ventral lobe, free for only 0.3-0.4 its length; ventral lobes 2-2.3 mm long and 1.3-1.5 mm wide ovate, apex with teeth, margin entire; leaf cells 18-19  $\mu\text{m}$  long and 18-19  $\mu\text{m}$  wide, trigones triangular. **Underleaves** bilobes with cilia along margin. **Sporophytes** not found. (Figure 4.100 and 4.124)

**Thailand** — PENINSULAR: Nakhon Si Thammarat.

**Distribution** — South East Asia and Melanesia.

**Ecology** — on living bark of tree.

**Specimens examined** — P. Sukkharak 457 (BCU).

**GPS location** — 8.87710333° N 99.68977511° E

**Altitude** — 1,327 m

#### 5. *Schistochila* sp.

**Plants** large, light green, 0.9-1 cm wide. **Stems** complanate, procumbent in lower half and then erect or flexuose from the substrate, paraphyllia on lateral sides of stem; in cross section of stem with thin-walled cell. **Rhizoids** occasionally in dense mat along ventral surface of stem, red- purplish red. **Lateral leaves** imbricate, widely spreading, dorsal lobe 2.8-3 mm long and 1.6-1.8 mm wide, asymmetrically ovate, apex acute, margin dentate; ventral lobe 5.5-6 mm long and 2-2.5 mm wide at base, 0.9-1 mm wide at apex, elongate, narrowly ovate, apex with teeth, margin dentate, leaf cells 36-44  $\mu\text{m}$  long and 26-32  $\mu\text{m}$  wide, trigones triangular. **Underleaves** bilobes, spreading, ovate, margin dentate. **Sporophytes** not found. (Figure 4.101)

**Thailand** —

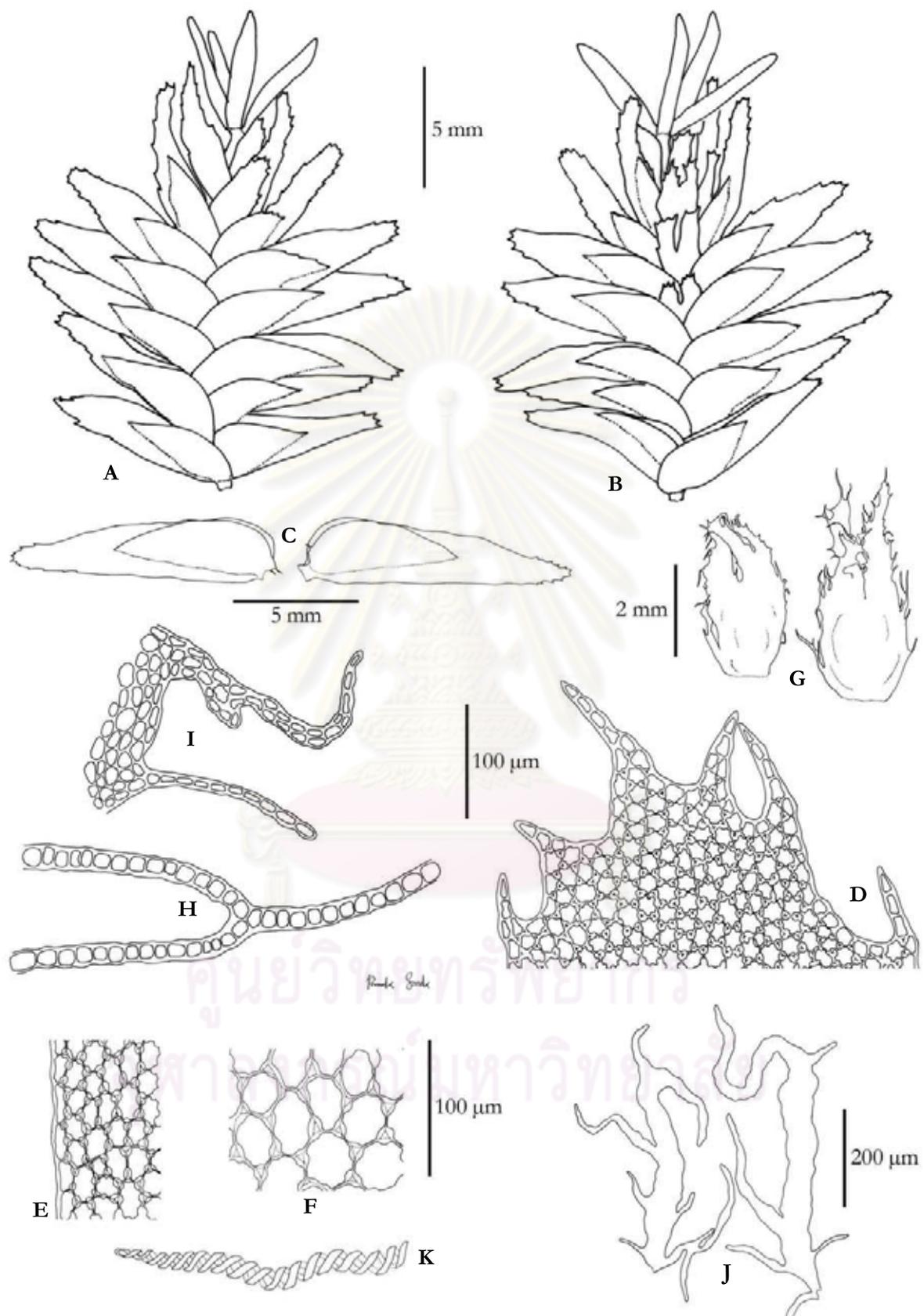
**Distribution** —

**Ecology** — on living bark of tree.

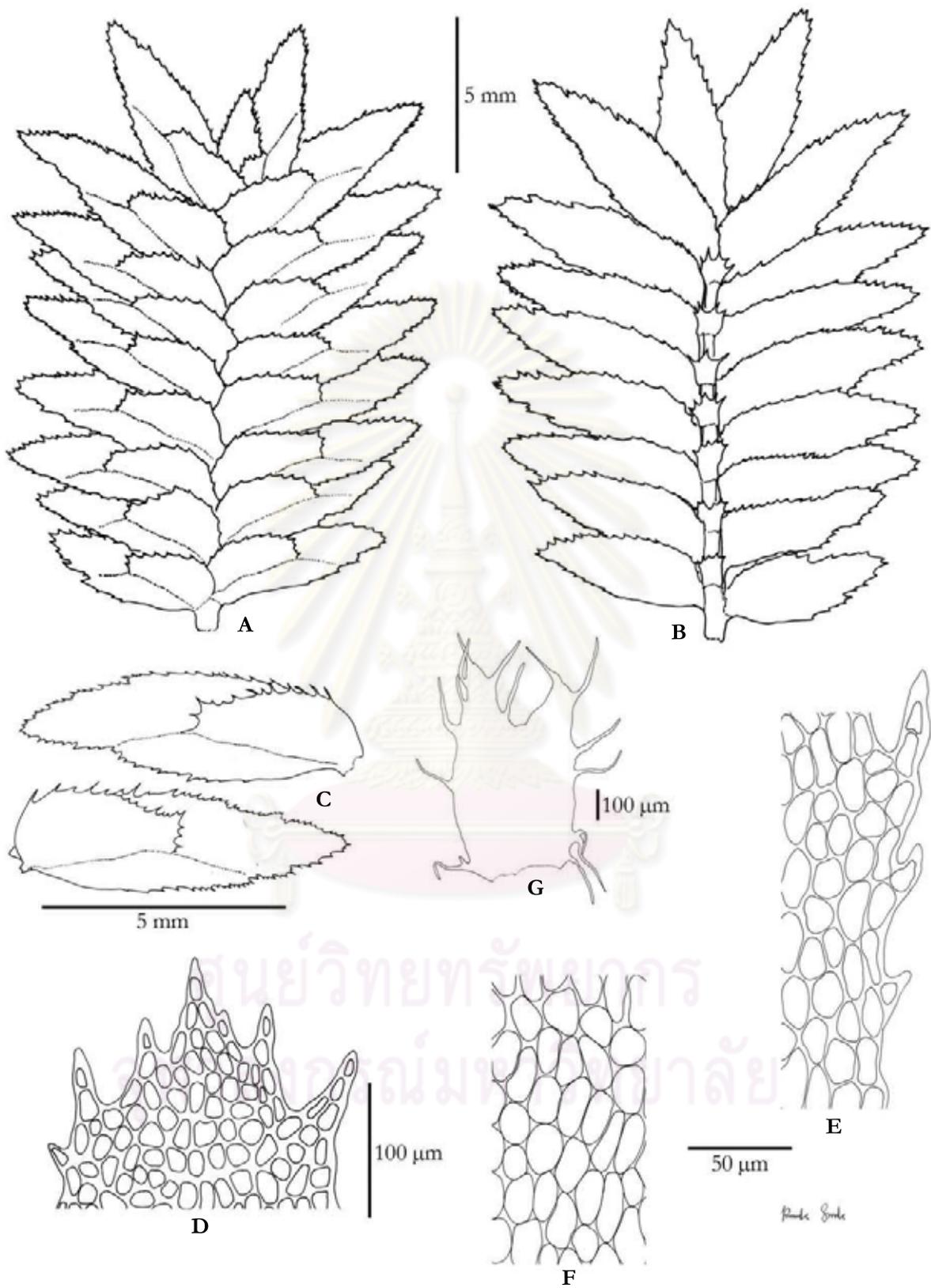
**Specimens examined** — P. Sukkharak 541 (BCU).

**GPS** — 8.8758129° N 99.6885736° E

**Altitude** — 1359 m

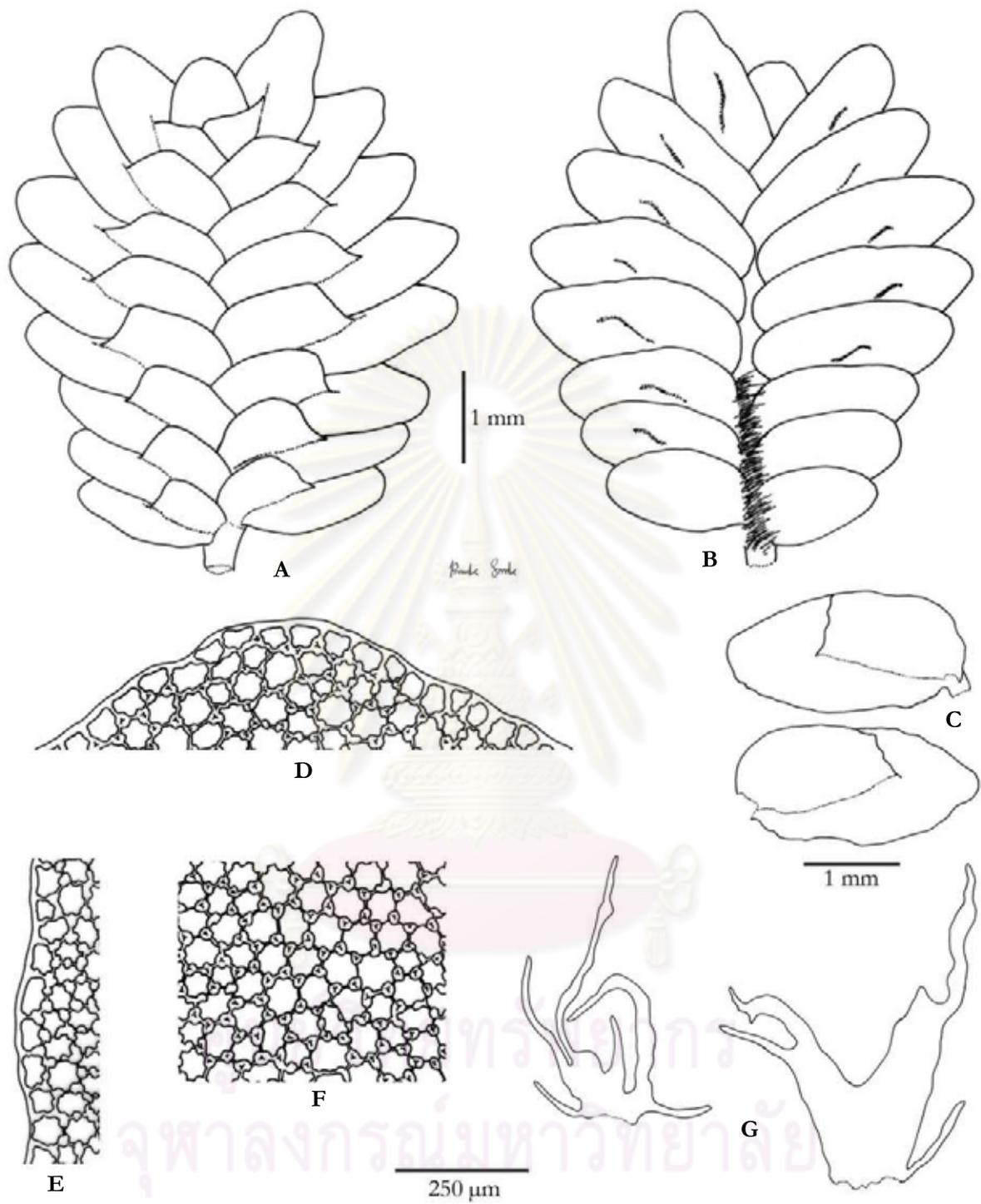


**Figure 4.97** *Schistochila aligera* (Nees & Blume) Jack & Steph.  
 A.-B. portion of plant with sporophyte: A. dorsal view, B. ventral view; C. lateral leaves; D. cells at leaf apex; E. cells at leaf margin; F. cells at leaf median; G. underleaves; H. cross section of stem; I. keelar sector of leaf; J. paraphyllia; K. part of elater. P. Sukkharak 472.



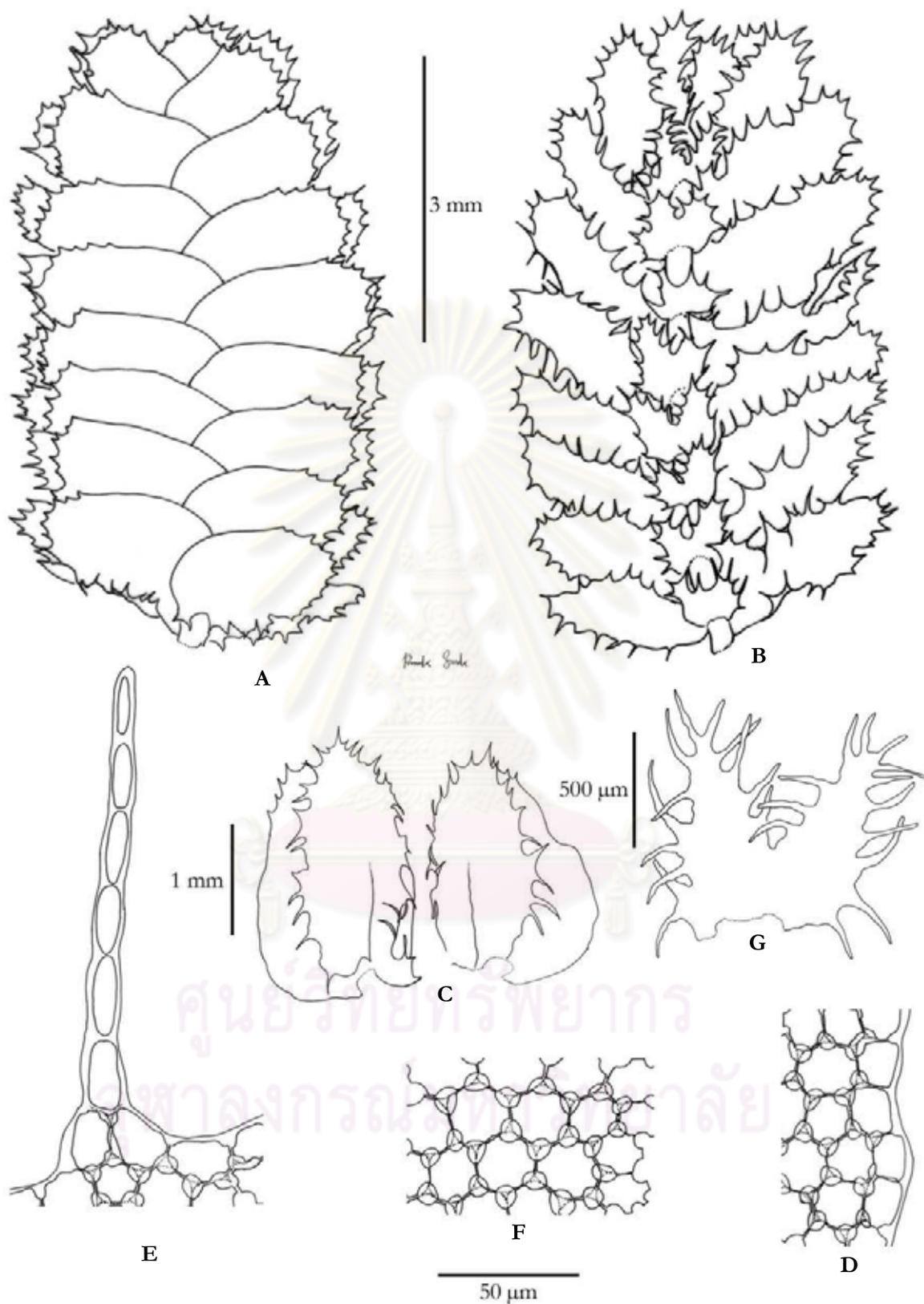
**Figure 4.98** *Schistochila blumei* (Nees) Trevis.

A.-B. portion of plant: A. dorsal view, B. ventral view; C. lateral leaves; D. leaf apex; E. cells at leaf margin; F. cells at leaf median; G. underleaves. P. Sukkharak 377.



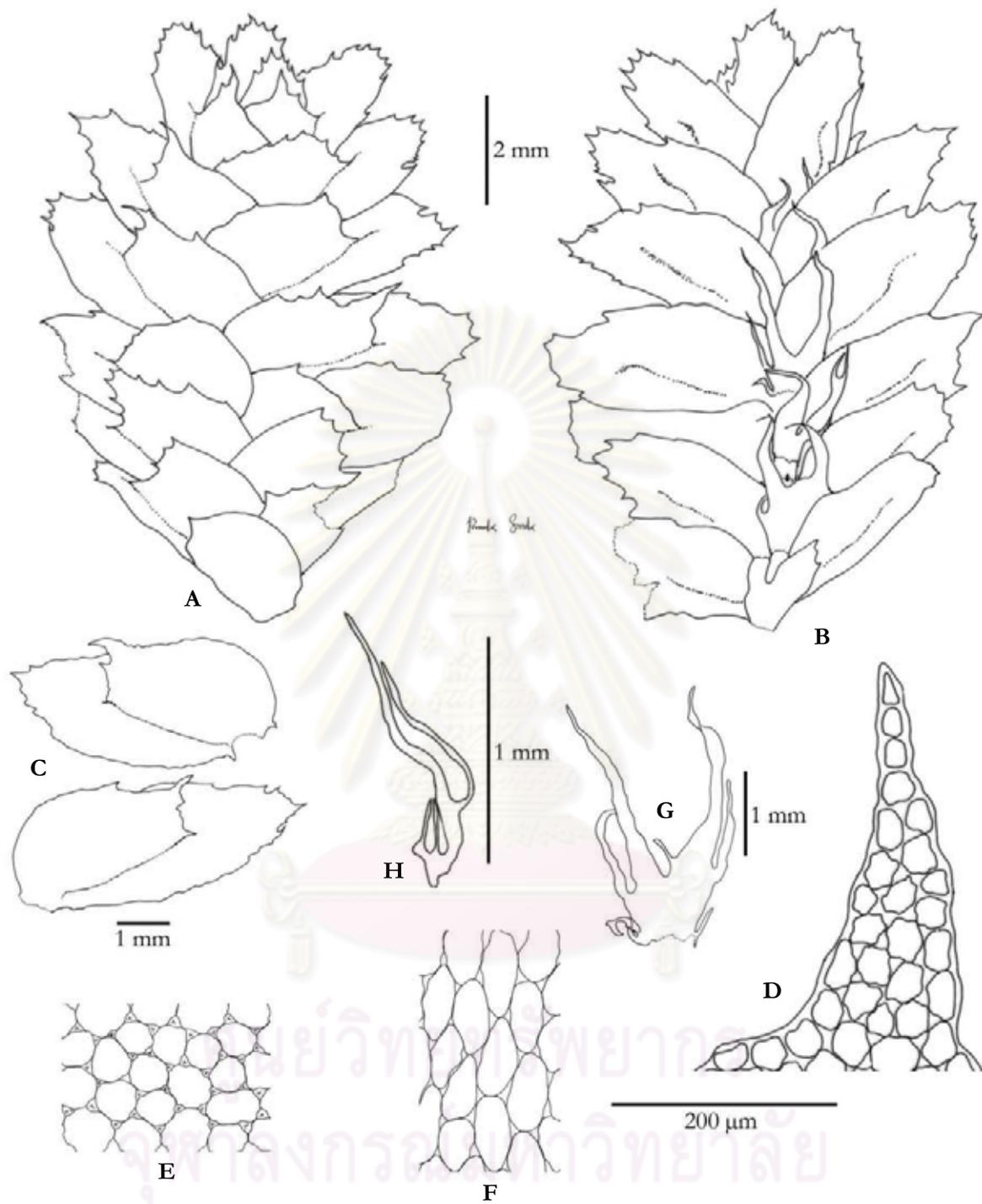
**Figure 4.99** *Schistochila nuda* Horik.

A.-B. portion of plant: A. dorsal view, B. ventral; C. lateral leaves; D. cells at leaf apex; E. cells at leaf margin; F. cells at leaf median; G. paraphyllia. P. Sukkharak 488.



**Figure 4. 100** *Schistochila sciurea* (Nees) Schiffn.

A.-B. portion of plant: A. dorsal view, B. ventral view; C. lateral leaves; D. cells at leaf margin; E. cells at leaf margin; F. cells at leaf median; G. underleaves. P. Sukkharak 457.



**Figure 4. 101** *Schistochila* sp.

A.-B. portion of plant: A. dorsal view, B. ventral view; C. lateral leaves; D. cells at leaf apex; E. cells at leaf median; F. cells at leaf base; G. underleaves; H. paraphyllia. P. Sukkharak 541.

## Trichocoleaceae

**Plants** leafy, small to large, whitish-green to pale brown, creeping, 1-3-pinnately branched, stolon lacing. **Branches** purely *Frullania*-type. Stems with a weakly differentiated cortex of thick-walled cells, sometimes with paraphyllia. **Rhizoids** lacking or very scarce, in tufts from the bases of the underleaves. **Lateral leaves** succubous, densely hairy, deeply divided into 4-9 strongly ciliate segments; cells narrowly elongate, with uniformly thickened walls, cuticle striate-papillose; oil bodies small, homogeneous. **Underleaves** similar to the leaves but slightly smaller. **Androecia and Gynoecia** on long shoots or on short branches. **Sporophytes** surrounded by a fleshy perigynium (coelocaulis) with or without a short perianth at the tip.

### *Trichocolea*

*Trichocolea* Dumort., Commentationes Botanicae 113. 1822.; Fulford, M. H., Memoirs of the New York Botanical Garden 11 (1): 40-53 1963.; Gradstein, S. R., Churchill, S. P. & Allen, N. S., Guide to the bryophytes of tropical America: 200. 2001.

For description of the genus, see above.

#### Key to species

1. Plants with paraphyllia, in cross section of stem 8-9 cells across ..... *T. tomentella*
1. Plant without paraphyllia, in cross section of stem 14-15 cells across..... *T. pluma*

#### 1. *Trichocolea pluma* (Reinw. et al.) Mont.

Recueil d'Observations sur les Jungermanniacées 20. 1835.; Crypt. Cellul. Voy. Aut. Ann. 1836 et 1837 la Bonite: 238. 1844-6.; Inoue, H. Bull. Natn Sci. Mus., Ser. B. (Bot.), 4 (3), Sept. 22. 102, fig. 3. 1978. — *Jungermannia pluma* Reinw. et al., Nov. Acad. Caes. Leop. Nat. Cur. 12: 209. 1825.

**Plants** pale green to whitish green, 1-1.2 mm wide of stem and 0.6-0.8 mm wide of branch, without paraphyllia. **Stems** flattened, branching into bi to tri-pinnate forming flocculent, in cross-section of stem 14-15 cells across; cortical cells with 3-4 rows with thickened wall and smaller than medullary cells. **Rhizoids** absent. **Lateral Leaves** remote on stem, imbricate on branch, alternate, 0.6-0.7 mm long and 0.6-0.8 mm wide, divided into 3 lobes, each lobe divided into 4-5 simple or branch cilia which are one cell wide, cells hyaline with cuticular striolate-papillose. **Underleaves** 0.4-0.5 mm long and 0.5-0.6 mm wide divided into 2 lobes, each lobe divided into 4-5 simple or branch cilia resemble to those of the lateral leaves. **Sporophytes** not found. (Figure 4.102)

**Thailand** — NORTH: Chiang Rai; SOUTH-EASTERN: Prachin buri; PENINSULAR: Nakhon Si Thammarat.

**Distribution** — Pantropical: Samoa, Fiji, Australia, Papua New Guinea, Caroline Islands, Indomalaya, Philippines, Samoa and Taiwan.

**Ecology** — on living bark of tree, rotten log, soil.

**Specimens examined** — P. Sukkharak 94, 185, 196, 384, 409 (BCU).

**GPS** — Exact locality not applicable. Near TT25-TT26.

**Altitude** — 1,247-1,385 m

#### 2. *Trichocolea tomentella* (Ehrh.) Dumort.

Sylloge Jungerm. Europ. Indig.: 67. 1831. (as "*Tricolea*"; corr. Nees, Naturg. Europ. Lebem. 3: 105. 1838); Inoue, H. Bull. Natn Sci. Mus., Ser. B. (Bot.), 4 (3), Sept. 22: 102-103, fig. 3. 1978. — *Jungermannia tomentella* Ehrh., Hannov. Mag. 21: 277. 1783; Beiträge zur Naturkunde 2: 150. 1785.

**Plants** yellowish green to green, stem and branches nearly equal in diameter 0.7-0.8 mm wide, with paraphyllia. **Stems** flattened, branching into bi-pinnate forming flocculent, in cross-section of stem 8-9 cells across; cortical cells with 2 rows with thickened wall and smaller than medullary cells. **Rhizoids** absent. **Lateral Leaves** imbricate on both stem and branch, alternate, 0.3-0.5 mm long and 0.6-0.7 mm wide, divided into 3 lobes, each lobe divided into 4-5 simple or branch cilia which are one cell wide, cells hyaline with cuticular striolate-papillose. **Underleaves** 0.3-0.4 mm long and 0.4-0.5 mm wide divided into 2 lobes, each lobe divided into 4-5 simple or branch cilia resemble to those of the lateral leaves. **Sporophytes** not found. (Figure 4.103 and 4.125)

**Thailand** — PENINSULAR: Nakhon Si Thammarat.

**Distribution** — Northern Hemisphere, Europe, North America, Himalaya-China regions, Taiwan, Japan.

**Ecology** — on living bark of tree.

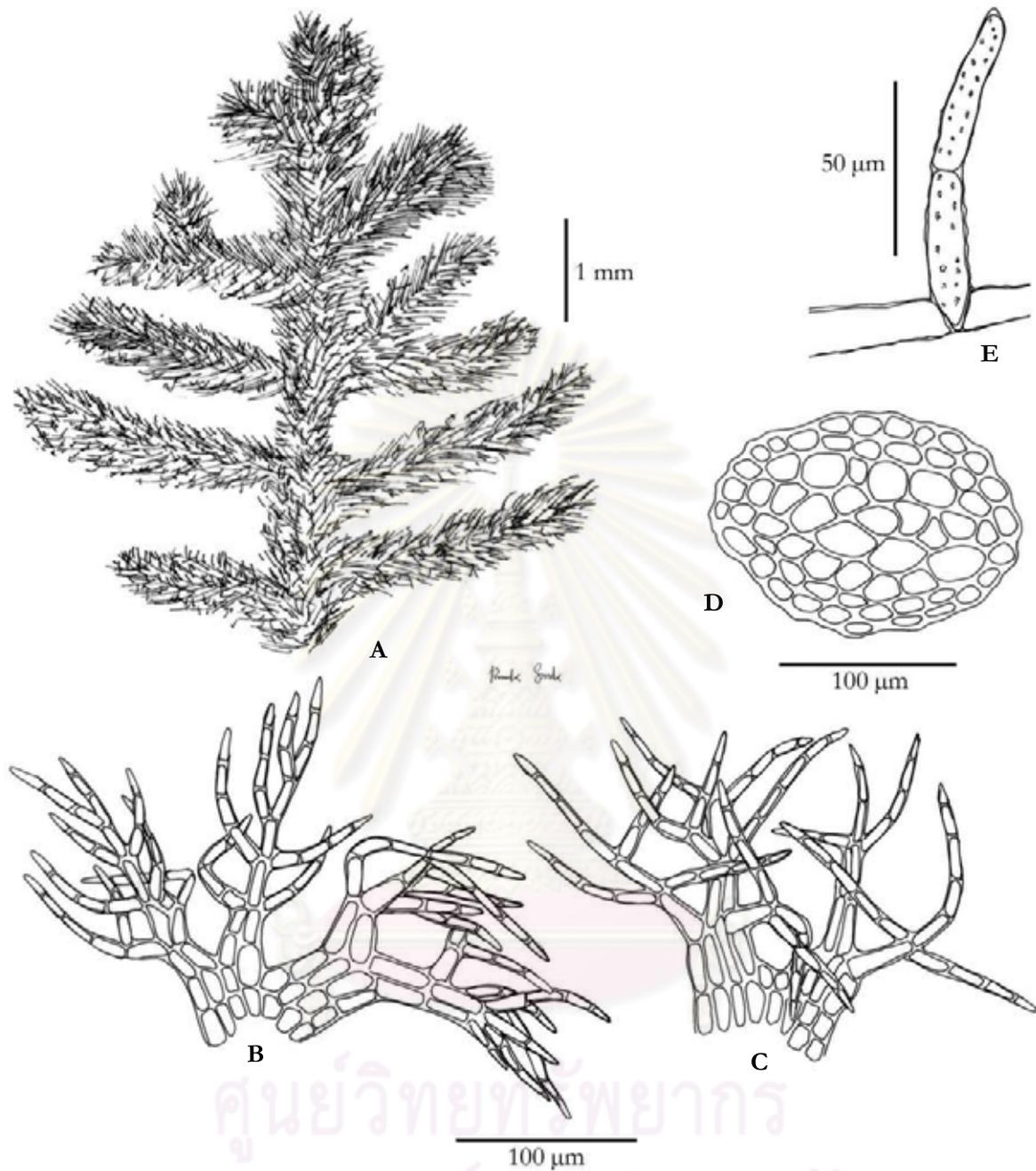
**Specimens examined** — P. Sukkharak 408 (BCU).

**GPS** — 8.88229072° N 99.69644308° E

**Altitude** — 1,385 m

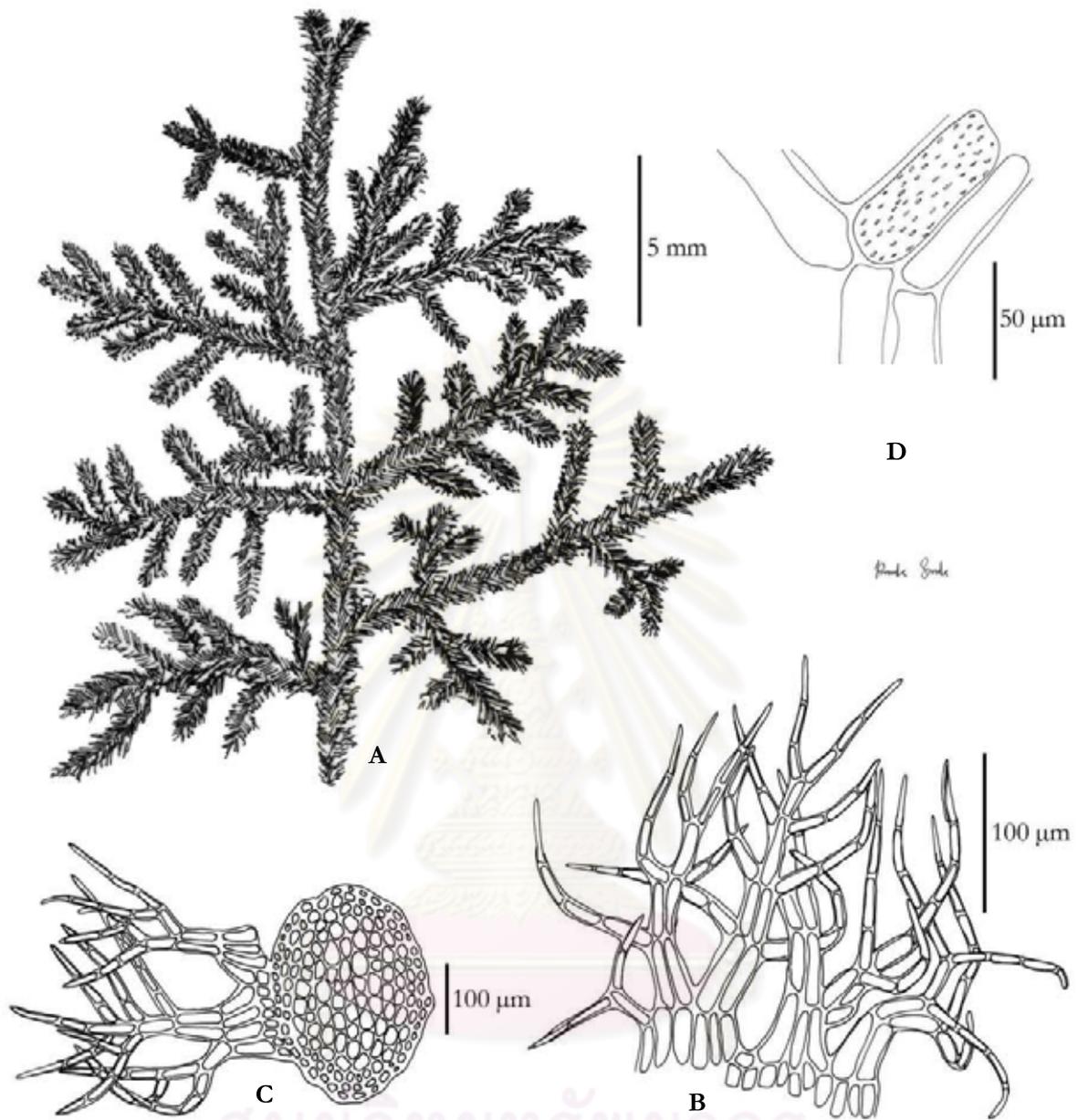


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**Figure 4.102** *Trichocolea pluma* (Reinw. et al.) Mont.

A. portion of plant; B. lobe of lateral leaf; C. lobe of underleaf; D. cross section of stem; E. part of lobe with verruculose cuticle. P. Sukkharak 94.



**Figure 4.103** *Trichocolea tomentella* (Ehrh.) Dumort.

A. portion of plant; B. lobe of lateral leaf; C. cross section of stem with lobe of underleaf; D. part of lobe with verruculose cuticle. P. Sukkharak 408.



Figure 4.104 *Marsupidium knightii* Mitt.



Figure 4.105 *Aneura indica* Steph.



Figure 4.106 *Frullania apiculata* (Reinw. et al.) Dumort.



Figure 4.107 *Heteroscyphus coalitus* (Hooks.) Schiffn.



Figure 4.108 *Saccogynidium muricellum* (De Not.) Grolle



Figure 4.109 *Anastrophyllum piligerum* (Nees) Steph.



Figure 4.110 *Jungermannia polyrhizoides* Grolle



Figure 4.111 *Colura conica* (Sande Lac.) K. I. Goebel



Figure 4.112 *Thysananthus spatulistipus* (Reinw. et al.) Lindenb.



Figure 4.113 *Bazzania tridens* (Reinw. et al.) Trevis.



Figure 4.114 *Lepidozia cladorhiza* (Reinw., Blume & Nees) Nees



Figure 4.115 *Dumortiera hirsuta* (Sw.) Nees



Figure 4.116 *Mastigophora diclados* (Brid.) Nees



Figure 4.117 *Metzgeria furcata* (L.) Dumort.



Figure 4.118 *Plagiochila longispica* Mitt.



Figure 4.119 *Plagiochila subtropica* Steph.



Figure 4.120 *Plagiobhion oppositum* (Reinw. et al.) S. Hatt.



Figure 4.121 *Pleurozia gigantea* (F. Weber) Lindenb.

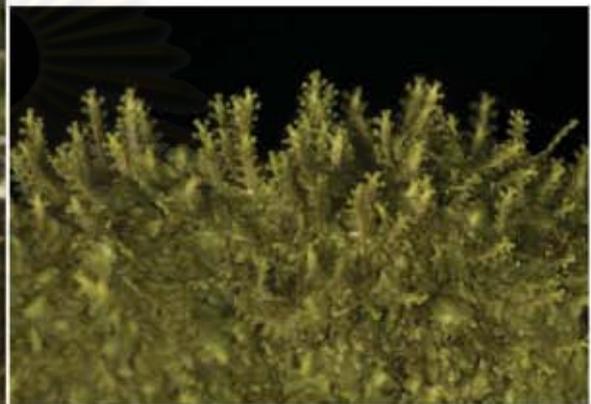


Figure 4.122 *Radula constricta* Steph.



Figure 4.123 *Schistochila nuda* Horik.



Figure 4.124 *Schistochila sciurea* (Nees) Schiffn.



Figure 4.125 *Trichocolea tomentella* (Ehrh.) Dumort.

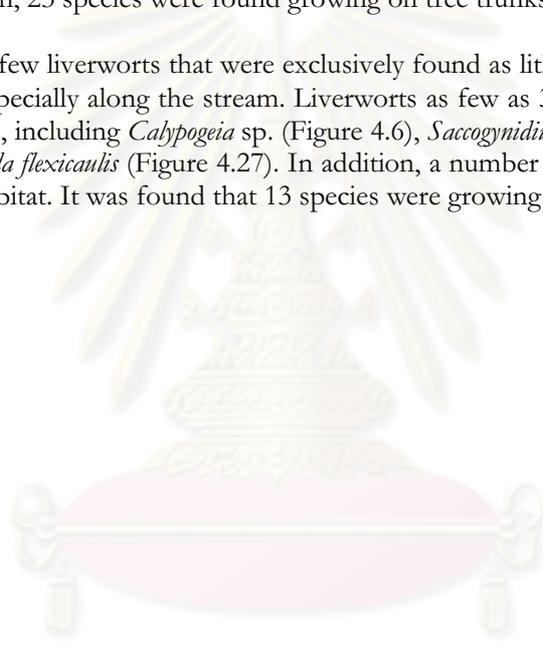
## CHAPTER 5 DISCUSSION AND CONCLUSION

### 5.1 Habitat of Liverworts

Habitat-wise, of 103 species in 40 genera and 17 families inhabiting this area, 80 species were epiphyte, 7 species were lithophyte, 3 species were terrestrial and 13 species were found as epiphytes and on forest floor.

Majority of epiphytic liverworts (35 species, Table 5.1) were corticolous or hylaculous, i.e. living on tree trunks. Seven species were remicolous epiphytes growing on branches and twigs. Ten species were epiphyllous or folicolous epiphytes growing on leaf surface. Moreover, there were 2 tiny liverworts namely *Drepanolejeunea angustifolia* (Figure 4.40) and *Drepanolejeunea ternatensis* (Figure 4.43), that grow on other liverwort species. Only 3 species were lignicolous liverworts that grow on rotten log or lignum, which is wood that's lost its bark in the first stages of rotting. In addition, 23 species were found growing on tree trunks, branches and rotten logs.

There were few liverworts that were exclusively found as lithophytes. Seven species were occurred on rock especially along the stream. Liverworts as few as 3 species were found only on soil near base of tree, including *Calyptogeia* sp. (Figure 4.6), *Saccogynidium muricellum* (Figure 4.24 and 4.108) and *Jamesoniella flexicaulis* (Figure 4.27). In addition, a number of liverworts were inhabiting different types of habitat. It was found that 13 species were growing as epiphytes and terrestrials.



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Table 5.1 Liverwort Habit.

Taxon	Epiphytes					Lithophytes	Terrestrials
	on living bark of tree	on branches or twig of shrub	on rotten log	on leaf surface	on other species		
<b>Acrobolbaceae</b>							
<i>Marsupidium knightii</i> Mitt.	✓						
<b>Aneuraceae</b>							
<i>Aneura indica</i> Steph.						✓	
<i>Riccardia palmata</i> (Hedw.) Carruth						✓	
<i>Riccardia</i> sp. 1						✓	
<i>Riccardia</i> sp. 2	✓						
<b>Calyptogiaceae</b>							
<i>Calyptogea</i> sp.							✓
<b>Frullaniaceae</b>							
<i>Frullania apiculata</i> (Reinw. et al.) Nees	✓	✓		✓			
<i>Frullania berthoumieu</i> Steph.	✓						
<i>Frullania campanulata</i> Sande Lac.	✓						
<i>Frullania ericoides</i> (Nees) Mont.	✓						
<i>Frullania gracilis</i> (Reinw. et al.) Dumort.	✓						
<i>Frullania intermedia</i> (Reinw. et al) var. <i>submorokensis</i> Hatt.						✓	
<i>Frullania nigricaulis</i> (Nees) Nees	✓	✓	✓				
<i>Frullania nodulosa</i> (Reinw. et al.) Nees	✓						
<i>Frullania serrata</i> Gottsche	✓						
<i>Frullania</i> sp.							
<b>Geocalycaceae</b>							
<i>Conoscyphus trapezoides</i> (Sande Lac.) Schiffn.	✓						
<i>Heteroscyphus acutangulus</i> (Schiffn.) Schiffn.	✓						
<i>Heteroscyphus argutus</i> (Reinw. et al.) Schiffn.	✓		✓			✓	
<i>Heteroscyphus coalitus</i> (Hooks.) Schiffn.	✓	✓	✓			✓	✓
<i>Heteroscyphus sarawaketanus</i> Piippo	✓	✓					

Table 5.1(continued).

Taxon	Epiphytes					Lithophytes	Terrestrials
	on living bark of tree	on branches or twig of shrub	on rotten log	on leaf surface	on other species		
<i>Lophocolea costata</i> (Nees) Gottsche	✓						
<i>Lophocolea muricata</i> (Lehm.) Nees	✓					✓	
<i>Saccogynidium muricellum</i> (De Not.) Grolle							✓
<b>Jungermanniaceae</b>							
<i>Anastrophyllum piligerum</i> (Nees) Steph			✓				
<i>Jamesoniella contracta</i> (Reinw. et al.) N. Kitag.	✓	✓					✓
<i>Jamesoniella flexicaulis</i> (Nees) Schiffn.							✓
<i>Jungermannia comata</i> Nees						✓	
<i>Jungermannia polyrhizoides</i> Grolle						✓	
<b>Lejeuneaceae</b>							
<i>Archilejeunea planiuscula</i> (Mitt.) Stephan.	✓					✓	
<i>Archilejeunea polymorpha</i> (Sande Lac.) B. Thiers & Gradst.	✓	✓	✓				
<i>Ceratolejeunea belangeriana</i> (Gottsche) Steph.						✓	
<i>Chilolejeunea</i> sp. 1					✓		
<i>Chilolejeunea</i> sp. 2	✓						
<i>Cololejeunea ocelloides</i> (Horik.) S. Hatt.					✓		
<i>Cololejeunea spinosa</i> (Horik.) Pandé & Misra					✓		
<i>Cololejeunea yipii</i> R. L. Zhu.					✓		
<i>Colura conica</i> (Sande Lac.) K. I. Goebel					✓		
<i>Colura meijeri</i> Jovet-Ast					✓		
<i>Drepanolejeunea angustifolia</i> (Mitt.) Grolle					✓		
<i>Drepanolejeunea dactylophora</i> (Nees et al.) Schiffn.					✓		
<i>Drepanolejeunea levicornua</i> Steph.					✓		
<i>Drepanolejeunea ternatensis</i> (Gottsche) Schiffn.					✓		
<i>Drepanolejeunea</i> sp. 1					✓		
<i>Drepanolejeunea</i> sp. 2	✓						
<i>Lejeunea boninensis</i> Horik.	✓						

Table 5.1(continued).

Taxon	Epiphytes					Lithophytes	Terrestrials
	on living bark of tree	on branches or twig of shrub	on rotten log	on leaf surface	on other species		
<i>Lejeunea</i> sp.	✓						
<i>Leptolejeunea apiculata</i> (Horik.) S. Hatt.				✓			
<i>Lopholejeunea nipponica</i> Horik.	✓						
<i>Lopholejeunea subfusca</i> (Nees) Steph.	✓						
<i>Metalejeunea cucullata</i> (Reinw. et al.) Grolle	✓						
<i>Ptychanthus striatus</i> (Lehm. & Lidenb.) Nees	✓						
<i>Schiffneriolejeunea cumingiana</i> (Mont.) Gradst.	✓						
<i>Schiffneriolejeunea tumida</i> (Nees) Gradst. var. <i>tumida</i>	✓						
<i>Spruceanthus semirepandus</i> (Nees) Verd.	✓	✓	✓		✓		
<i>Thysananthus retusus</i> (Reinw. et al.) B. Thiers & Gradst.	✓						
<i>Thysananthus spathulistipus</i> (Reinw. et al.) Lindenb.	✓	✓	✓				
<i>Thysananthus</i> sp.	✓	✓					
<b>Lepidoziaceae</b>							
<i>Acromastigum divaricatum</i> A. Evans.	✓						
<i>Bazzania debilis</i> N. Kitag.	✓						
<i>Bazzania fauriana</i> (Steph.) Hatt.	✓	✓	✓				
<i>Bazzania loricata</i> (Nees) Trevis.	✓	✓	✓				
<i>Bazzania spiralis</i> (Reinw., Blume & Nees) Meijer	✓						
<i>Bazzania tridens</i> (Reinw. et al.) Trevis.	✓	✓	✓				✓
<i>Bazzania uncigera</i> (Nees) Trevis.	✓		✓			✓	✓
<i>Bazzania vittata</i> (Gottsche) Trevis.	✓	✓	✓				
<i>Bazzania yakushimensis</i> Horik.	✓		✓				
<i>Lepidozia cladorhiza</i> (Reinw., Blume and Nees) Nees	✓		✓				
<i>Lepidozia parvula</i> N. Kitag.	✓		✓				
<i>Lepidozia</i> sp.		✓					
<i>Psiloclada clandestina</i> Mitt.			✓				
<b>Marchantiaceae</b>							
<i>Dumortiera hirsuta</i> (Sw.) Nees						✓	

Table 5.1(continued).

Taxon	Epiphytes					Lithophytes	Terrestrials
	on living bark of tree	on branches or twig of shrub	on rotten log	on leaf surface	on other species		
<b>Mastigophoraceae</b>							
<i>Mastigophora diclados</i> (Brid.) Nees		✓	✓			✓	
<b>Metzgeriaceae</b>							
<i>Metzgeria consanguinea</i> Schiffn.		✓					
<i>Metzgeria furcata</i> (L.) Dumort.	✓	✓	✓	✓		✓	
<i>Metzgeria lindbergii</i> Schiffn.		✓		✓			
<b>Pallaviciniaceae</b>							
<i>Symphyogynopsis filicum</i> (Nadeaud) Grolle	✓					✓	✓
<b>Plagiochilaceae</b>							
<i>Plagiochila bicornuta</i> Steph.							
<i>Plagiochila javanica</i> (Sw.) Nees & Mont.		✓	✓				
<i>Plagiochila longispica</i> Mitt.							
<i>Plagiochila parvifolia</i> Lindenb.						✓	
<i>Plagiochila sciophila</i> Nees ex Lindenb.	✓						
<i>Plagiochila subtropica</i> Steph.	✓						
<i>Plagiochila</i> sp.							
<i>Plagiochilion oppositum</i> (Reinw. et al.) S.Hatt.		✓	✓				
<i>Plagiochilion pachycephalum</i> (De Not.) Inoue.		✓					
<b>Pleuroziaceae</b>							
<i>Pleurozia gigantea</i> (F.Weber) Lindbenb.	✓	✓	✓				
<b>Radulaceae</b>							
<i>Radula assamica</i> Steph.	✓	✓	✓	✓		✓	
<i>Radula campanigera</i> Mont.	✓	✓	✓				
<i>Radula constricta</i> Steph.	✓						
<i>Radula formosa</i> (Meissn.) Nees		✓					
<i>Radula japonica</i> Gottsche ex Steph.	✓		✓				
<i>Radula javanica</i> Gottsche	✓						

Table 5.1(continued).

Taxon	Epiphytes					Lithophytes	Terrestrials
	on living bark of tree	on branches or twig of shrub	on rotten log	on leaf surface	on other species		
<i>Radula kurzii</i> Steph.		✓					
<i>Radula philippinensis</i> Yamada	✓						
<i>Radula yangii</i> Yamada	✓			✓			
<b>Schistochilaceae</b>							
<i>Schistochila aligera</i> (Nees & Blume) Jack & Steph.	✓		✓			✓	
<i>Schistochila blumei</i> (Nees) Trevis.	✓						
<i>Schistochila nuda</i> Horik.		✓					
<i>Schistochila sciurea</i> (Nees) Schiffn.	✓						
<i>Schistochila</i> sp.	✓						
<b>Trichocoleaceae</b>							
<i>Trichocolea pluma</i> Dumort.	✓		✓			✓	
<i>Trichocolea tomentella</i> (Ehrh.) Dumort.	✓						

## 5.2 Diversity of liverworts and species richness

Among 17 families, it was found that 11 families have more than one species inhabiting this study area. These include Aneuraceae, Frullaniaceae, Geocalyceae, Jungermanniaceae, Lejeuneaceae, Lepidoziaceae, Metzgeriaceae, Plagiochilaceae, Radulaceae, Schistochilaceae and Trichocoleaceae. Of these, the family Lejeuneaceae was the richest in term of species composition representing by 29 species in 14 genera including *Archilejeunea* (2), *Ceratolejeunea* (1), *Chilolejeunea* (2), *Cololejeunea* (3), *Colura* (2), *Drepanolejeunea* (6), *Lejeunea* (2), *Leptolejeunea* (1), *Lopholejeunea* (2), *Metalejeunea* (1), *Ptychanthus* (1), *Schiffneriolejeunea* (2), *Spruceanthus* (1) and *Thysananthus* (3). The remaining families are each represented by only one species, including Acrobolbaceae, Calypogeiaceae, Marchantiaceae, Mastigophoraceae, Pallaviciniaceae and Pleuroziaceae (Table. 4.1).

Among 40 genera of liverworts found, *Frullania* with 10 species was the most speciose genus; however, only *Frullania apiculata* occurs conspicuously on tree trunks. *Radula* was the second richest genus with nine species found. Nevertheless, plants of *Radula* were not abundant. In contrast, 8 species of *Bazzania* were found and common throughout the area. This finding is in line with previous suggestion that this genus is one of the most conspicuous genera of the montane cloud forest (Gradstein et al., 2001). In particular, *Bazzania tridens*, the most abundant species among the *Bazzania* taxa, was found in large mats on the bases of tree trunks, rotten wood, rock and soil at elevations ranging from 553 m to the summit.

There are also other species that related to could forest. For instance, in the Huon Peninsula, Papua New Guinea most often *Heteroscyphus coalitus* occurs in primary and secondary-growth montane rain forests, more rarely in open, montane forests with scattered tall trees. Its altitudinal distribution ranges from 200 to 3,100 m. Mostly the species grows on fallen rotten logs, but also on boulders or rock outgroups, soil, tree trunks, climbers, stumps, and limbs of fallen trees (Piippo, 1985). Here, at Khao Nan summit in this study, a similar ecology applied to *H. coalitus* which can be found on tree trunk, branch and twig of shrub, rotten log, rock and soil from 979-1,275 m. Moreover, according to Schiffner (1900b), this species is one of the most common hepatics in Melanesia occurring in rain and cloud forest (“Regen und Wolkenzone”), but only rarely at the highest altitudes (Piippo, 1985). Another species of the cloud forest, *Symphyogynopsis filicum*, was found on living bark of tree, rock and soil. This finding is also the same as what Piippo (1985) reported that this species occurs not only on tree trunks (especially of tree fern), decaying wood, roots, at the base of tree fern but also on soil (limestone and sandstone), in very sheltered wet place in rain forest and wet mossy forest.

## 5.3 Altitudinal Zoning

When considering distribution of liverwort along altitudinal gradient in this study site, it was found that species distribution was not homogeneous. As mentioned in Chapter 1, the perimeter of Khao Nan National Park at the 4<sup>th</sup> substation has been transformed to para rubber plantation, and it was found that 5 liverworts were restricted to this disturbed area, including *Frullania berthoumieni*, *F. campanulata*, *F. ericoides*, *Schiffneriolejeunea cumingiana* and *S. tumida* var. *tumida*. Two other taxa, namely *Plagiochila parvifolia* and *Radula javanica* were also found but these two taxa were also occurred in the lower montane rain forest up to 1,074 m. It is likely that the former 5 taxa are “invading” from other area while the latter 2 taxa are from nearby undisturbed forest. Whether the former 5 taxa could be used as indicator of disturbed area need more studies, but here it suggests so.

At altitude from 334 to 1,074 m the forest is not disturbed by human activity, and it is slightly shady with sparsely open canopy. Fourteen taxa are found including *Dumortiera hirsuta*, *Frullania intermedia* var. *Submorokensis*, *Lophocolea muricata*, *Jungermannia comata*, *J. polyrhizoides*, *Archilejeunea planiuscula*, *Ceratolejeunea belangeriana*, *Cheilolejeunea* sp. 2, *Drepanolejeunea* sp. 1, *Lejeunea boninensis*, *Lopholejeunea subfusca*, *Ptychanthus striatus*, *Lepidozia* sp. and *Plagiochila sciophila*. Most taxa occupied habitat such as bark with few grown on soil especially in open canopy. Interestingly,

none of these 15 taxa (and 14 more, below) were not found in the para rubber plantation. Thus it is suggestion that light condition, humidity, substrates and degree of disturbance may play roles in restricting these 29 taxa not to spread to nearby para rubber plantation, and *Plagiochila parvifolia* and *Radula javanica* may be tolerant to these factors than other liverworts.

In wider range of altitude, it was found that as many as 20 taxa were occurred in lower montane rain forest from 334-1,385 m. These including *Frullania apiculata*, *F. gracilis*, *Heteroscyphus argutus*, *H. coalitus*, *Archilejeunea polymorpha*, *Colura conica*, *Metalejeunea cucullata*, *Spruceanthus semirepandus*, *Thysananthus retusus*, *T. spathulistipus*, *T. sp.*, *Bazzania fauriana*, *B. tridens*, *B. vittata*, *Metzgeria furcata*, *Plagiochila javanica*, *Radula assamica*, *R. campanigera*, *R. japonica* and *Symphyogynopsis filicum*.

The 62 remaining taxa were restricted to forest at altitude from 1,074-1,385 m which is shady and open canopy. A number of taxa were reported to be number of these type of montane rain forest, i.e. cloud forest.

#### 5.4 Comparison of Liverworts diversity to previous studies in Thailand

When compared to nearby areas, i.e. the summit of Khao Luang, Huai Yang Waterfall National Park, Prachuap Khiri Khan Province, 38 species in 20 genera and 11 families were recorded (Chantanaorapint, 2002). Although lower evergreen forest is found in both areas, there was comparatively fewer liverwort diversity at Khao Luang. The summit of Khao Luang is 1,250 m and situated in the South-Western region which corresponds to the Tenasserim or Lower Burmese Flora whereas this area is 1,385 m and situated in Peninsular region that is under not only the Malayan element but also Burmese element (Smitinand, 1958). Moreover, the high species of liverworts were found in the summit of Khao Nan, probably due to closed structure of canopy cover which liverworts would prefer shadier environment rather than direct sunlight, richness of tree species (host diversity), microhabitats inside the forest and high humidity. This area is covered with mist and cloud nearly all year round. The availability of plentiful water due to impact of these fog and mist favour the accumulation of dead organic matter on the ground making them the perfect home for bryophytes especially liverworts (Gradstein, 2000). Although both areas are different in altitude and floristic region, it was found that as many as 17 taxa were common to both areas, namely *Frullania apiculata* (Reinw et al.) Dumort. [= *F. apiculata* (Reinw et al.) Nees], *F. berthoumieuü* Steph., *F. ericoides* (Nees) Mont., *Bazzania tridens* (Reinw. et al.) Trevis. [= *B. tridens* (Reinw., Blume et Nees) Trevis.], *B. uncigera* (Nees) Trevis. [= *B. uncigera* (Reinw., Blume & et Nees) Trev.], *Heteroscyphus argutus* (Reinw. et al.) Schiffn., *H. coalitus* (Hooks.) Schiffn., *Anastrophyllum piligerum* (Nees) Steph., *Lopholejeunea subfusca* (Nees) Schiffn. [= *Lopholejeunea subfusca* (Nees) Steph.], *Ptychanthus striatus* (Lehm. & Lindenb.) Nees, *Dumortiera hirsuta* (Sw.) Nees [= *Dumortiera nepalensis* (Taylor) Nees], *Symphyogynopsis filicum* (Nadeaud) Grolle, *P. javanica* (Sw.) Nees & Mont. [= *P. javanica* (Swartz) Dum], *P. parvifolia* Lindenb. [= *P. yokogurensis* Steph.], *P. sciophila* Nees ex Lindenb. [= *P. acanthophylla* subsp. *japonica* var. *japonica*], *Plagiochilon oppositum* (Reinw. et al.) S. Hatt. [= *Plagiochilon oppositum* (Reinw., Blume et Nees) S. Hatt.], *Pleurozia gigantea* (F. Weber) Lindenb.

Chronologically, a number of studies on Thai liverworts including Reed and Robinson (1967), Inoue (1974), Hattori, Thaithong and Kitagawa (1977) and Kitagawa (1978, 1979) had reported that a number of liverworts occurred in vicinity of Khao Nan National Park, namely Khao Luang. From these reports, 26 taxa was given, and these were also occurred in this study site (Table 5.2). In most taxa altitudinal distribution of liverwort from both area were in accordance, except few taxa, namely *Frullania nodulosa* and *Plagiochila sciophila* (see Table 5.2). According to Hattori (1980), although *Frullania nodulosa* is commonly found at low elevations ranging from below 200 m to 700 m, it can occurs above 700 m with very few populations. Moreover, one report had showed that *Plagiochila sciophila* was found from 600-1,300 m at Doi Pachompok in Chiang Rai Province (Inoue, 1974). Thus, discrepancy on altitudinal distribution of these taxa in Khao Nan National Park and Khao Luang is not substantial.

**Table 5.2** Liverworts shared by this study and reported by Reed and Robinson (1967), Inoue (1974), Hattori, Thaithong and Kitagawa (1977) and Kitagawa (1978, 1979) from Khao Luang.

Species	this study	Khao Luang
<i>Frullania apiculata</i>	631-1,385 m	1,000-1,740 m
<i>Frullania ericoides</i>	329 m	250-370 m
<i>Frullania gracilis</i>	340-1,385 m	400-1,450 m
<i>Frullania nigricaulis</i>	1,160-1,165 m	1,300 m
<i>Frullania nodulosa</i>	1,247-1,385 m	200 m
<i>Frullania serrata</i>	1,385 m	1,700-1,780 m
<i>Lophocolea muricata</i>	970-979 m	900-1,100 m
<i>Saccogynidium muricellum</i>	1,330 m	1,000 m
<i>Anastrophyllum piligerum</i>	1,326 m	1,700-1,740 m
<i>Jamesoniella flexicaulis</i>	1,275 m	1,250-1,450 m
<i>Bazzania loricata</i>	1,230-1,356 m	1,250-1,740 m
<i>Bazzania spiralis</i>	1,220-1,240 m	1,740 m
<i>Bazzania tridens</i>	409-1,345 m	800-1,000 m
<i>Bazzania uncigera</i>	1,275-1,356 m	1,250-1,740 m
<i>Lepidozia parvula</i>	1,270-1,356 m	1,740-1,780 m
<i>Mastigophora diclados</i>	1,245-1,371 m	1,700-1,740 m
<i>Plagiochila sciophila</i>	787-870 m	1,300 m
<i>Pleurozia gigantea</i>	1,282-1,374 m	1,250-1,740 m
<i>Radula campanigera</i>	1,100-1,305 m	1,250-1,740 m
<i>Radula formosa</i>	1,320 m	1,000-1,740 m
<i>Radula javanica</i>	320-1,036 m	250-1,700 m
<i>Schistochila aligera</i>	1,280-1,338 m	1,650-1,740 m
<i>Schistochila blumei</i>	1,269-1,340 m	1,650 m
<i>Schistochila sciurea</i>	1,327 m	1,740 m
<i>Trichocolea pluma</i>	1,247-1,385 m	1,000-1,530 m

### 5.5 Phytogeography and Distribution

In this study site, there are five cosmopolitan species that can be found in tropical region to warm-temperate region of the world. For instance, *Riccardia palmata* (Mizutani & Hattori, 1957), *Frullania ericoides* (Hattori, Thaithong & Kitagawa, 1977), *Lophocolea muricata* (Piippo, 1985), *Lopholejeunea subfusca* (Mizutani, 1961), *Dumortiera hirsuta* (Evans, 1981). Some species are belonging to tropical and subtropical region all over of the world including *Anastrophyllum piligerum* (Kitagawa, 1970), *Pleurozia gigantea* (Thiers, 1993), *Radula javanica* (Yamada, 1979). The rest are widely distributed especially in Tropical region of the world (as indicate in chapter 4 and reference therein).

Some species found at this area include several species that are once known to be endemic species of other country for example, *Frullania intermedia* var. *submorokensis* was endemic species to Kinabalu (Hattori, 1976). Some species like *Bazzania debilis* was found on moist rock by a stream at Phu Kradung and considered to be the endemic species to northeastern Thailand (Kitagawa, 1967).

Very recently, Lai, Zhu & Chantanaorapint (2007) compiled the checklist of Thai liverworts and included 374 species. However, it was found that as many as 30 species are new records to Thailand as presented in Table 5.3.

**Table 5.3 New records of liverworts to Thailand and its previously known geographic distribution.**

Species	Distribution
1. <i>Aneura indica</i>	India
2. <i>Riccardia palmata</i>	China, Europe, Greenland, Japan, North and South America, Siberia
3. <i>Frullania campanulata</i>	Java and Sumatra
4. <i>Frullania intermedia</i> var. <i>submorokensis</i>	Kinabalu
5. <i>Heteroscyphus acutangulus</i>	Huon Peninsular, in Western Melanesia
6. <i>Heteroscyphus sarawaketanus</i>	Huon Peninsular, in Western Melanesia, endemic to Papua New Guinea
7. <i>Lophocolea costata</i>	Huon Peninsular, in Western Melanesia, Taiwan, Malaysia, Indonesia, Borneo, Philippines
8. <i>Jungermannia polyrhizoides</i>	Nepal
9. <i>Cololejeunea ocelloides</i>	Cambodia, China, Indonesia, Japan, Malaysia, Philippines, Vietnam
10. <i>Cololejeunea yipii</i>	China
11. <i>Colura mejieri</i>	Japan, Java
12. <i>Drepanolejeunea ternatensis</i>	Australia, China, Fiji, Indonesia, Japan, Malaysia, Micronesia, Papua New Guinea, Philippines, Samoa, Seychelles, Sri Lanka
13. <i>Lejeunea boninensis</i>	Japan
14. <i>Leptolejeunea apiculata</i>	China, Japan
15. <i>Lopholejeunea nipponica</i>	Japan
16. <i>Schiffneriolejeunea tumida</i> var. <i>tumida</i>	West Iran, Papua New Guinea, Solomon Islands
17. <i>Bazzania fauriana</i>	Japan
18. <i>Bazzania yakushimensis</i>	Japan
19. <i>Lepidozia cladorhiza</i>	Java
20. <i>Psiloclada clandestina</i>	Australia
21. <i>Metzgeria consanguinea</i>	China
22. <i>Metzgeria lindbergii</i>	widely distributed in South East Asia and tropical Oceania
23. <i>Plagiochila bicornuta</i>	Samoa
24. <i>Plagiochila longispica</i>	Samoa
25. <i>Plagiochilium pachycephalum</i>	Borneo
26. <i>Radula constricta</i>	India, Japan, Korea, Nepal, Taiwan
27. <i>Radula japonica</i>	Japan, Korea
28. <i>Radula kurzii</i>	Ceylon, India, Andamann Islands
29. <i>Radula philippinensis</i>	Malay Peninsular, Philippines
30. <i>Schistochila nuda</i>	Japan, Philippines, Taiwan

## 5.6 Zoophagous plants

*Colura* and *Pleurozia* are known as a zoophagous liverworts by mean of trapping. These two genera have a tiny valvate sac (see Fig 4.38, 4.39 and 4.87) and elaborated device for trapping minute organisms as found in *Utricularia*. (Shimizu et al., 1980; Barthlott et al., 2000; Hess et al., 2005). In this study site, *Colura conica*, *Colura mejieri* and *Pleurozia gigantea* were found at elevation of 1,314-1,385 m

## 5.7 Dubious Species

From the specimens collected, there were 2 species of liverwort that are dubious species: *Trichocolea pluma* (Figure 4.102) and *Trichocolea tomentella* (Figure 4.103). Lai, Zhu and Chantanaorapint (2007) regarded *Trichocolea pluma* as a synonym of *Trichocolea tomentella*, and

considered difference between these two taxa as morphological variation. Based on morphological characters investigation showing in Figure 4.102 and 4.103, it is clearly demonstrated that morphological difference warrants their own entities. Thus, in this study, taxonomic treatment of these two taxa was followed that of Inoue (1978).

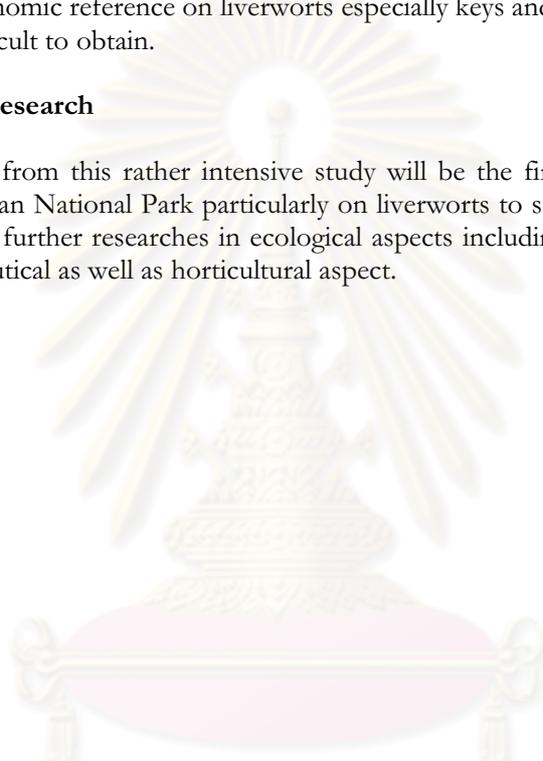
### 5.8 Obstacles

Few obstacles were encountered during thesis ongoing. Some were the act of mother nature that can not be controlled while others were simply technical issues. These are:

1. There are still several areas that are difficult to access for example high steep slopes and up on forest canopy.
2. During rainy season between October and December, 2006, no collections could be made due to heavy rain and subsequently inaccessible trail.
3. The taxonomic reference on liverworts especially keys and species descriptions are insufficient and difficult to obtain.

### 5.9 Benefit of this research

The results from this rather intensive study will be the first to account for bryophyte diversity of Khao Nan National Park particularly on liverworts to serve as the basic information and be beneficial to further researches in ecological aspects including forest composition, forest indicator, pharmaceutical as well as horticultural aspect.



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## REFERENCES

### Thai

ทวีศักดิ์ บุญเกิด, มณฑกานติ วัชรภักย์, สุทธพรพรรณ ตีร์รัตน์, เขาวลัษณ์ มณีรัตน์, ออบฉันท์ ไทยทอง และนาฏฉลวย หลายชูไทย. 2530. การเก็บและรักษาตัวอย่างพันธุ์ไม้. กรุงเทพมหานคร: อรุณอมรินทร์การพิมพ์.

ธวัชชัย สันติสุข. 2550. ป่าของประเทศไทย. กรุงเทพมหานคร: กรมอุทยานแห่งชาติ สัตว์ป่า และพันธุ์พืช.

### English

Amakawa, T. 1960. Family Jungermanniaceae of Japan. II. J. Hattori Bot. Lab 22: 1-90.

Amakawa, T. 1966. New or little known Asiatic species of the family Jungermanniaceae of Japan. II. J. Hattori Bot. Lab 229: 1-90.

Barthlott, W., Fischer, E., Frahm, J.-P., and Seine, R. 2000. First Experimental Evidence for Zoophagy in the Hepatic *Colura*. Plant Biol 2: 93-97.

BRT. 2007. Khao Nan: Cloud Forest Research Project [online]. Available from: <http://brt.biotech.or.th/post.php?pstID=10&backTskID=15> [2007, January, 12]

Chantanaorapint, S. 2002. Bryophytes diversity at the summit of Khao Luang, Huai Yang Waterfall National Park, Prachuap Khiri Khan Province. Master's Thesis. Department of Botany, Faculty of Science, Chulalongkorn University, Bangkok, Thailand.

Crandall-Stotler, B. and Stotler, R. E. 2000. Morphology and classification of Marchantiophyta. In A. Jonathan Shaw and Bernard Goffinet. (eds.), Bryophyte Biology, pp. 21-70. Cambridge: Cambridge University Press.

Crosby, M. R. 1992. Bryophytes. In R. K. Brummitt and C. E. Powell. (eds.), Authors of plant names. Whitstable, Kent: Whitstable Litho Ltd.

Dobbs, A. M. 2006. Factor influencing Epiphyte Habitat Preference in Moorea, French Polynesia. Water Resources Center Archives. University of California, Berkeley, U.S.A.

Fulford, M. and Taylor, J. 1959. *Psiloclada* and the species of *Microlepidozia* with succubous leaves. J. Hattori Bot. Lab 21: 79-84.

Glime, Janice M. 2007. Bryophytes Ecology [Online]. Available from: <http://www.bryoecol.mtu.edu/chapters/1-Intro.pdf>[2008, January 16].

Gradstein, S. R., Griffin, S., Morales, M. I., and Nadkarni, N. M. 2000. Diversity and habitat differentiation of mosses and liverworts in the cloud forest of Monteverde, Costa Rica. Caldasia 23(1): 203-212.

Gradstein, S. R., Steven, P., Churchill, S. P., and Salazar-Allen, N. 2001. Guide to the Bryophytes of Tropical America. The New York Botanical Garden Press, New York, U.S.A.

Gradstein, S. R., He, X.-L., Piippo S. & Mizutani, M. 2002. Bryophyte flora of the Huon Peninsula, Papua New Guinea. LXVIII. Lejeuneaceae subfamily Ptychanthoideae (Hepaticae). Acta Bot Fennica 174.

Giesy, R. M. and Richards, R. W. 1959. A collections of bryophytes from Thailand (Siam). Tran. Brit. Bryol. Soc 3: 575-581.

Hattori, S. 1972. A revision of the subgenus Homotropantha of the genus *Frullania*, Hepaticae. J. Hattori Bot. Lab 47: 165-236.

Hattori, S. 1972. Notes on Asiatic species of the genus *Frullania*, Hepaticae. I. J. Hattori Bot. Lab 36: 109-140.

Hattori, S. 1973. Notes on Asiatic species of the genus *Frullania*, Hepaticae. II. J. Hattori Bot. Lab 37: 55-84.

Hattori, S. 1974. *Frullania* taxa in the Philippine collection made by Dr. and Mrs. A. J. Sharp and Dr. Z. Iwatsuki. J. Hattori Bot. Lab 38: 169-183.

Hattori, S. 1974. Notes on Asiatic species of the genus *Frullania*, Hepaticae. V. J. Hattori Bot. Lab 36: 185-221.

Hattori, S. 1976. Notes on Asiatic species of the genus *Frullania*, Hepaticae. X. J. Hattori Bot. Lab 40: 461-507.

- Hattori, S. and Mitzutani, M. 1958. A revision of the Japanese species of the family Lepidoziaceae. J. Hattori Bot. Lab 19: 76-118.
- Hattori, S., Thaithong, O. and Kitagawa, N. 1977. The genus *Frullania* in Thailand. I. J. Hattori Bot. Lab 43: 439-457.
- Hess, S., Frahm, J.-P. and Theisen, I. 2005. Evidence of Zoophagy in a second liverwort species, *Pleurozia purpurea*. The Bryologist 108: 35-41.
- Hodgson, E. A., Valley K., Wairoa and Bay, H. 1946. New Zealand Hepaticae (Liverworts) V. The family Jungermanniaceae. Transactions of the Royal Society of New Zealand 76(1): 68-86.
- Hodgson, E. A., Valley, K., Wairoa, and Bay, H. 1954. Transactions of the Royal Society of New Zealand 82: 7-24.
- Holmgren, P.K. and Holmgren, N. H. 1998. Index Herbariorum [Online]. Available from: <http://sciweb.nybg.org/science2/IndexHerbariorum.asp> [2007, May 23].
- Hosseus, C. C. and B. Reichenhall. 1911. Die Botanischen Ergebnisse meiner Expedition nach Siam, hepaticae. Beih. Bot. Centr 28: 358-370.
- Inoue, H. 1962. Contributions to the knowledge of the Plagiochilaceae of Southeastern Asia. J. Hattori Bot. Lab 25: 91-101.
- Inoue, H. 1964. The genus *Plagiochilon*. J. Hattori Bot. Lab 27: 51-72.
- Inoue, H. 1969. Contributions to the knowledge of the Plagiochilaceae of Southeastern Asia. XII. Typification of *Plagiochila javanica* (Swartz) Dum. J. Hattori Bot. Lab 32: 50-56.
- Inoue, H. 1974. Contributions to the knowledge of the Plagiochilaceae of Southeastern Asia XV. Enumeration of *Plagiochila* species from Thailand. J. Hattori Bot. Lab 38: 555-563.
- Inoue, H. 1978. Studies on Taiwan Hepaticae, III. Subord. Herbertinae and Subord. Ptilidiinae. Bull. Natn Sci. Mus 22: 93-103.
- Inoue, H. 1981. Notes on the Plagiochilaceae, XI. A review of the species of *Plagiochila* (Dum.) Dum. form Samoa. J. Hattori Bot. Lab 49: 335-357.
- Kamimura, M. 1961. A monograph of Japanese Frullaniaceae. J. Hattori Bot. Lab 24: 1-109.
- Kitagawa, N. 1967. Studies on the Hepaticae of Thailand I: The genus *Bazzania*, with general introduction J. Hattori Bot. Lab 30: 249-270.
- Kitagawa, N. 1968a. Studies on the Hepaticae of Thailand II: *Cephalozia* and *Cephalozjiella*. J. Hattori Bot. Lab 32: 290-306.
- Kitagawa, N. 1968b. Studies on the Hepaticae of Thailand III: The genus *Leucolejeunea*. Tonan Aija Kenkyu (The Southeast Asian Studies) 6(3): 608-613.
- Kitagawa, N. 1969. A new species of *Cololejeunea* (*Chondriolejeunea*) from Malay Peninsula. Acta Phytotax. Geobot. XXIII (5~6): 184-188.
- Kitagawa, N. 1970. Lophoziaceae of North Borneo. J. Hattori Bot. Lab 33: 203-221.
- Kitagawa, N. 1978. The Hepaticae of Thailand collected by Dr. A. Touw (I). Acta Phytotax. Grobot 29: 47-64.
- Kitagawa, N. 1979. The Hepaticae of Thailand collected by Dr. A. Touw (II). Acta Phytotax. Grobot 30: 31-40.
- Kornochalart, S. 2006. Diversity of Bryophytes at Khun Chang Khian Village, Doi Suthep-Pui National Park, Chiang Mai Province. Master's Thesis. Department of Biology, Faculty of Science, Chiang Mai University, Chiang Mai, Thailand.
- Lai, M.-J., Zhu, R.-L. and Chantanaorapint, S. 2007. Liverworts and hornworts of Thailand: an updated checklist and bryofloristic accounts. (in press)
- Malcolm, B. & Malcolm, N. 2000. Mosses and other bryophytes an illustrated glossary. Micro-Optics Press, a division of Micro-Optics Ltd., Nelson, New Zealand.
- Manachit, S. 2006. Diversity of Bryophytes in the area of Sirindhorn Observatory, Doi Suthep-Pui National Park, Chiang Mai Province. Master's Thesis. Department of Biology, Faculty of Science, Chiang Mai University, Chiang Mai, Thailand.
- Misutani, M. 1961. A revision of Japanese Lejeuneaceae. J. Hattori Bot. Lab 24: 296.
- Mitzutani, M. 1967. Studies of the Himalayan species of *Bazzania*. J. Hattori Bot. Lab 30: 71-90.
- Mizutani, M. 1981. Notes on the Lejeuneaceae. 5. some Asiatic species of the genus *Ceratolejeunea*. J. Hattori Bot. Lab 49: 305-318.

- Piippo, S. 1985. Bryophyte flora of the Huon Peninsula, Papua New Guinea XII. Acta Bot. Fennica 131: 129-167.
- Posu, S. 2000. Khao Nan National Park. Tanboukaew Publishing, Bangkok, Thailand.
- Reed, C. F. and Robinson, H. 1967. Contribution to the Bryophytes of Thailand I. Phytologia 15(1): 61-170
- Reed, C. F. and Robinson, H. 1967. Contribution to the Bryophytes of Thailand II. Phytologia 15: 447-452.
- Schuster, R. M. 1957. Notes on Nearctic Hepaticae, IX. A study of *Plagiobila Yokogurensis* Steph. J. Hattori Bot. Lab 18: 14-26.
- Shimizu, T., Kitagawa, N., Koyama, H., Santisuk, T., Toyokuni, H., Yahara, T. 1980. A report on the Thai-Japanese botanical expedition 1979. Thai For. Bull 13: 47-60.
- So, M. L. 2003. *Schistochila* (Hepaticae) in Oceania. New Zealand Journal of Botany 41: 255-275.
- So, M. L. 2003. The genus *Schistochila* in Asia. J. Hattori Bot. Lab 93: 79-100.
- Solomon, J. 2007. W<sup>3</sup> TROPICOS: The Missouri Botanical Garden's VAST (VAScular Tropicos) nomenclatural database and associated authority files [online]. Available from: <http://mobot.mobot.org/W3T/Search/most.html> [2007, November, 22]
- Sornsamran, R. 1982. Taxonomic study of Bryophytes order Jungermanniales in Sakaerat Area. Master's Thesis. Department of Botany, Faculty of Science, Chulalongkorn University, Bangkok, Thailand.
- Sornsamran, R. and Thaithong, O. 1995. Bryophytes in Thailand. Bangkok: Office of Environmental Policy and Planning.
- Smitinand, T. 1958. The genus *Dipterocarpus* Gaertn. f. in Thailand. Thai Forest Bulletin 4: 1-26.
- Scott, G. A. M. 1985. Southern Australian liverworts. Canberra: Australian Government Publishing Service.
- Stephani, F. 1902. Hepaticae. In J. Schmidt. (ed.), Flora of Koh Chang, Botanisk Tidsskrift 24: 277-280.
- Tixier, P. 1973. Bryophytae Indosinicae – Liverworts collected in Thailand. Nat. Hist. Bull. Siam Soc 24: 449-456.
- Thaithong, O. 1984. Bryophytes of the mangrove forest. J. Hattori Bot. Lab 56: 85-87.
- Thiers, B. M. and Gradstein, S. R. 1989. Lejeuneaceae (Hepaticae) of Australia. I. Subfamily Ptychanthoideae. Memoirs of the New York Botanical Garden 52: 1-82.
- Thiers, B. M. 1993. A monograph of *Pleurozia* (Hepaticae; Pleuroziaceae). The Bryologist 96: 517-554
- Yamada, K. 1979. A revision of Asian taxa of Radula, Hepaticae. J. Hattori Bot. Lab 45: 201-322.
- Zhu, R. L. and So, M. L. 2001. Epiphyllous liverwort of China. Nova Hedwigia 121.



**APPENDICES**

ศูนย์วิทยทรัพยากร  
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## Appendix A

### Latitude and longitude of some landmarks in study trail as refer in GPS location in species description

**Table A1.** GPS sites along Thathon substation – Khao Nan Yai for locality referrals when exact GPS localities were not applicable. The altitudinal interval is at 50 meters.

Name	Latitude	Longitude	Altitude (meter)	comment
TT01	8.8580579	99.7119198	333	GPS pt.# TT01 at altitude 333 m
TT02	8.8597077	99.7115349	384	GPS pt.# TT02 at altitude 384 m
TT03	8.8610235	99.7109843	433	GPS pt.# TT03 at altitude 433 m
TT04	8.8650314	99.7093898	483	GPS pt.# TT04 at altitude 483 m
TT05	8.8662052	99.7083766	534	GPS pt.# TT05 at altitude 534 m
TT06	8.8668119	99.7075466	583	GPS pt.# TT06 at altitude 583 m
TT07	8.8670904	99.7068126	633	GPS pt.# TT07 at altitude 633 m
TT08	8.8687374	99.7057799	684	GPS pt.# TT08 at altitude 684 m
TT09	8.8705139	99.7052637	734	GPS pt.# TT09 at altitude 734 m
TT10	8.8714681	99.7048257	783	GPS pt.# TT10 at altitude 783 m
TT11	8.8725080	99.7048189	833	GPS pt.# TT11 at altitude 833 m
TT12	8.8734300	99.7046734	882	GPS pt.# TT12 at altitude 882 m
TT13	8.8744401	99.7041857	932	GPS pt.# TT13 at altitude 932 m
TT14	8.8761190	99.7038850	982	GPS pt.# TT14 at altitude 982 m
TT15	8.8772843	99.7037322	1033	GPS pt.# TT15 at altitude 1,033 m
TT16	8.8776916	99.7034177	1084	GPS pt.# TT16 at altitude 1,084 m
TT17	8.8789696	99.7020372	1133	GPS pt.# TT17 at altitude 1,133 m
TT18	8.8803883	99.7008084	1182	GPS pt.# TT18 at altitude 1,182 m
TT19	8.8811509	99.7005195	1232	GPS pt.# TT19 at altitude 1,232 m
TT20	8.8821321	99.7002827	1284	GPS pt.# TT20 at altitude 1,284 m
TT21	8.8831711	99.6996015	1333	GPS pt.# TT21 at altitude 1,333 m
TT22	8.8821387	99.6963976	1381	GPS pt.# TT22 at altitude 1,381 m
TT23	8.8811483	99.6952927	1333	GPS pt.# TT23 at altitude 1,333 m
TT24	8.8801727	99.6950389	1283	GPS pt.# TT24 at altitude 1,283 m
TT25	8.8788865	99.6946701	1235	GPS pt.# TT25 at altitude 1,235 m
TT26	8.8785707	99.6933816	1283	GPS pt.# TT26 at altitude 1,283 m
TT27	8.8769601	99.6922440	1323	GPS pt.# TT27 at altitude 1,323 m

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**Table A2.** GPS sites along Khao Nan Yai –Thathon substation for locality referrals when exact GPS localities were not applicable. The altitudinal interval is at 50 meters.

Name	Lat	Long	Altitude	comment
KNY01	8.8758129	99.6885736	1359	GPS pt.# KNY01 at altitude 1,359 m
KNY02	8.8766810	99.6901385	1309	GPS pt.# KNY02 at altitude 1,309 m
KNY03	8.8755072	99.6934041	1259	GPS pt.# KNY03 at altitude 1,259 m
KNY04	8.8749057	99.6939141	1209	GPS pt.# KNY04 at altitude 1,209 m
KNY05	8.8732290	99.6952161	1159	GPS pt.# KNY05 at altitude 1,159 m
KNY06	8.8714160	99.6967949	1109	GPS pt.# KNY06 at altitude 1,109 m
KNY07	8.8703650	99.6969134	1058	GPS pt.# KNY07 at altitude 1,058 m
KNY08	8.8685253	99.6969732	1009	GPS pt.# KNY08 at altitude 1,009 m
KNY09	8.8676615	99.6958365	959	GPS pt.# KNY09 at altitude 959 m
KNY10	8.8668658	99.6951446	910	GPS pt.# KNY10 at altitude 910 m
KNY11	8.8660690	99.6942246	859	GPS pt.# KNY11 at altitude 859 m
KNY12	8.8640110	99.6935815	809	GPS pt.# KNY12 at altitude 809 m
KNY13	8.8631884	99.6929884	760	GPS pt.# KNY13 at altitude 760 m
KNY14	8.8625570	99.6926960	710	GPS pt.# KNY14 at altitude 710 m
KNY15	8.8596846	99.6923710	659	GPS pt.# KNY15 at altitude 659 m
KNY16	8.8586734	99.6932720	609	GPS pt.# KNY16 at altitude 609 m
KNY17	8.8579213	99.6938970	559	GPS pt.# KNY17 at altitude 559 m
KNY18	8.8569970	99.6965494	509	GPS pt.# KNY18 at altitude 509 m
KNY19	8.8563543	99.6986458	459	GPS pt.# KNY19 at altitude 459 m
KNY20	8.8581423	99.7033973	409	GPS pt.# KNY20 at altitude 409 m
KNY21	8.8577685	99.7083284	358	GPS pt.# KNY21 at altitude 358 m
KNY22	8.8582158	99.7137752	329	GPS pt.# KNY22 at altitude 329 m
KNY23	8.85899305	99.72375333	300	GPS pt.# KNY23 at altitude 300 m – Starting

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## Appendix B

### Glossary

- asperulous** — somewhat roughened.
- attenuae** — (1) narrowing gradually, (2) tapering gradually to a point.
- autoicous** — monoicous, producing both male and female sex organs (antheridia and archegonia) on the same plant but in separate inflorescences. When the male and female inflorescences are on separate branches, the arrangement is said to be cladautoicous, whereas if the male is bud-like in an axil of the same stem or branch as the female inflorescence, that's called gonioautoicous, and when the male plant is a short branch attached to the female with rhizoids, that's termed rhizautoicous. Dwarf male plants growing epiphytically on the female are dioicous rather than autoicous, but they're nonetheless sometimes termed pseudautoicous or pseudomonoicous.
- caducous** — falling off readily or early.
- canaliculate** — grooved or channeled lengthwise like a canal, gutter, or channel.
- canaliculate** — grooved or channeled lengthwise like a canal, gutter, or channel.
- cladium** (plural **cladia**) — a modified branch that acts like a vegetative propagule.
- clavate** (or **claviform**) — club-shaped, elongate and thickened toward the tip.
- coelocaul** — in liverworts, a hollow fleshy structure that's derived from both stem and archegonium tissue and protects the embryonic sporophyte. It's a type of perigynium, and has the same function as a perianth and bracts. (synonyms stem-calyptra and shoot calyptra)
- concave** — curving inwards.
- cortical** — referring to belonging to the cortex
- crenulate** — having minute rounded teeth or scallops along the edge, usually the bulging walls of individual cells.
- cuticle** (adjective **cutinized**) — a non-cellular, waxy or fatty coating on the outermost wall of cells in direct contact with the environment, often roughened or ornamented. In general, cuticle is only weakly developed in bryophytes. That trait, along with a large surface-to-volume ratio, boosts the uptake of water and dissolved mineral nutrients.
- decurrent** — (1) said of leaf margins which extend below the leaf's insertion as ridges or wings on the stem, (2) said of anything which extended below its point of origin on a structure.
- decurved** — curved downward.
- dioicous** — producing male and female sex organs (antheridia and archegonia) on separate plants.
- divaricate** — attaching at almost a 90° angle.
- explanate** — flattened.
- filiform** — filamentous, thread-like, long and slender.
- flaccid** — soft, flabby, or limp.
- galeate** — helmet-shaped.
- hyaloderm** (or **hyalodermis**) — in the stem of leafy liverworts and species of *Sphagnum*, a cortex composed of large, empty, colorless cells.
- incurved** — curved upwards and inwards.
- involute** — rolled inwards or upwards at the edges.
- julaceous** — said of a leafy shoot that looks like a worm or catkin because its leaves are crowded and appressed against the stem.
- mammillose** (or **mamillose**) — bulging with a blunt central projection.
- marsupium** (plural **marsupia**) — a swollen and elongate pouch of stem tissue that encloses and protects the sporophyte in some jungermannialean liverworts. A highly elongated marsupium is sometimes called a marupidium.
- mat** — a growth form in which stems are flattened on the substratum and densely interwoven.
- medulla** — the central region of a stem, surrounded by the cortex.
- muricate** — roughened with many sharp points or spines.
- nodulose** — minutely knobbed.

- ocellus** (plural **ocelli**) — in leafy liverworts, a leaf cell that's unusually large, often contains one or more larger-than-usual oil-bodies, and lacks chloroplasts.
- papilla** (plural **papillae**) — (1) a minute, solid protuberance on a cell surface, variously wart-like, spinous, forked, branched, or shaped like the letter C, (2) a mucilage-secreting cell in some liverworts.
- papillose** (or **papillate** or **papulose**) — roughened or ornamented with one or more papillae.
- paraphyllum** (plural **paraphyllia**) — tiny filaments, scales, or leaf-like structures scattered on the stems.
- paroicous** — having antheridia near to the archegonia but not mixed in with them, often sited in leaf axils just below the perichaetium.
- pedicellate** — stalked.
- pendulous** — drooping from lack of support.
- pluri-** — a prefix meaning several or many, as in plurisetose, producing several setae.
- revolute** — rolled backwards or downwards and under at the edges.
- saccate** — forming a sac.
- sinus** — the gap between two adjacent lobes of a leaf or other structure, typically either U-shaped (horseshoe-shaped), or V-shaped.
- stoloniferous** — producing stolons.
- striate** — marked with longitudinal lines or ridges.
- trigone** — a triangle-shaped wall thickening in the corner of a cell where it abuts against two other cells. The presence, shape, and sized of trigones are characteristic of some liverwort genera, and so are useful tool for identification and classification.
- tuft** — (1) a clump of more or less erect shoots, (2) a clump or bundle of similar structures such as leaves or hairs.
- verruculose** — warty or roughened.
- vestigial** — said of a structure or a function that's reduced to only a remnant, trace, or hint.
- vitta** (plural **vittae**) (adjective **vittate**) — (1) a stripe, (2) near the center of the leaf of some leafy liverworts, one or more rows of enlarged cells running along roughly the middle of the leaf.
- xerophyte** — a plant adapted to dry habitats.

## BIOGRAPHY

Miss Phiangphak Sukkharak was born in Nan Province, Thailand, on 7<sup>th</sup> March 1982. She earned her Bachelor Degree of Science (Biology) from the Department of Biology, Faculty of Science, Chiang Mai University, Chiang Mai Province, in 2005. Then, she continued her study for Master of Science in Botany Major at Department of Botany, Faculty of Science, Chulalongkorn University, Bangkok during 2006-2008.



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