

**STUDIES ON LIVERWORTS AND HORNWORTS
OF KOHIMA AND MOKOKCHUNG DISTRICTS,
NAGALAND**

**THESIS
SUBMITTED TO
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**In partial fulfilment of the requirements of the degree
of
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**BY
KAZHUHRII ESHUO
PH. D. REGISTRATION NO: 375/2009**



**DEPARTMENT OF BOTANY
NAGALAND UNIVERSITY
LUMAMI-798 627 (NAGALAND)
2013**

NAGALAND



UNIVERSITY

Headquaters : Lumami -798601, Nagaland

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I, **KAZHUHRII ESHUO**, hereby declared that the subject matter of this thesis is the record of work done by me and the contents of this thesis did not form basis of the award of any previous degree to me or to the best of my knowledge to any body else, and that the thesis has not been submitted by me for any research degree in any other University/ Institute.

This is being submitted to Nagaland University for the degree of Doctor of Philosophy in Botany.

(KAZHUHRII ESHUO)

(Head of the Department)

(S.K. CHATURVEDI)

Supervisor

NAGALAND



UNIVERSITY

Headquaters : Lumami, Post. Box. No. 53, Mokokchung-798601, Nagaland

Prof. S.K.Chaturvedi
M. Sc., D. Phil. FBS, FBRS.
Department of botany
Co-ordinator
UGC-Special Assistance programme
Acting Director
Centre for Biodiversity Study
Director
IQAC, N.U. Lumami

Phone @ 0369/ 2229141
(O) 0369/ 2268211
Fax- 0369/ 2268247
email – sunchat1@rediffmail.com
chatur_mkh@yahoo.com

CERTIFICATE

This is to certify that the thesis entitled “**Studies on Liverworts and Hornworts of Kohima and Mokokchung districts, Nagaland**” submitted to Nagaland University in partial fulfilment of the requirements for the degree of Doctor of Philosophy in Botany is an original research work carried by Mr. KAZHUHRII ESHUO, Registration No. 375/2009 under my supervision and guidance.

Further, certified that no part of thesis has been submitted anywhere for any other research degree. The assistance and help received during the course of study have duly been acknowledged.

Place:

(S.K. CHATURVEDI)

Date:

Supervisor

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CONTENTS

CHAPTER	TITLE	PAGE NO.
I	INTRODUCTION	1-12
	GENERAL FEATURES OF LIVERWORTS AND HORNWORTS	2-3
	LIFE CYCLE	3
	REPRODUCTION	3-4
	ECOLOGY AND HABITAT	4-5
	ECONOMIC IMPORTANCE	5-7
	REVIEW OF LITERATURE	7-12
II	MATERIALS AND METHODS	13-23
III	OBSERVATIONS	24-350
IV	SUMMARY AND CONCLUSION	351-364
	REFERENCES	365-385
	MAPS	18-20
	TABLES	356-364
	PHOTO PLATES	21-23
		386-402

CHAPTER-I

INTRODUCTION

GENERAL FEATURES OF LIVERWORTS AND HORNWORTS

The term “Bryophyta” means a moss plant, derived from the Greek words ‘*Bryon*’ meaning moss and “*Phyton*” meaning plant. It was Robert Brown who first introduced this term in 1864 to include the algae, the fungi, the lichens and the mosses. However, in recent years the term “Bryophyta” has been used to denote plants which include the class viz., *Hepaticae*, *Anthocerotae* and *Musci*. The term Hepaticopsida is derived from a Latin word Hepatica means “*Liver*” and therefore, the plants belonging to class Hepaticopsida are commonly called as “Liverworts”. Liverworts are either thallose without any differentiation into root, stem or leaf (except order Jungermanniales, i.e., leafy liverworts). The members of Class Anthocerotopsida are commonly called as “Hornworts” due of the presence of “*Horn*” like sporophyte on their thalli. Hornworts are thallus, without air chambers and scales, but possessing slit-like pores on the under surface.

Bryophytes are the second largest land plants after angiosperms and among the bryophytes, Liverworts and Hornworts comprise of 6000 species and 383 genera in the world. Leafy liverworts differ from mosses in possessing characters like:

- a. In leafy liverworts leaves are arranged in two or three rows while in Mosses, leaves are arranged spirally.
- b. Leafy liverworts rhizoids are hyaline and non-septate, while mosses have coloured rhizoids which are branched and septate.
- c. In leafy liverworts mid-rib or costa are absent while it is present in mosses.
- d. Elaters are present in the capsule of leafy liverworts while absent in mosses.
- e. Peristome, columella are absent in leafy liverworts but present in mosses.
- f. Protonema not well developed or ephemeral in leafy liverworts but protonema well developed in mosses.

Liverworts, Hornworts and Mosses are the simplest and smallest terrestrial plants. They have no highly differentiated tissues for the conduction of water, minerals and food transport. Despite of their simple and small structure, they add beauty and diversity in landscape. Plant lovers, botanists and taxonomists are fascinated by the variety of habitats (they forms/exhibits) and their tolerance to extreme ecological conditions in nature. They occur on all habitats even on rocks, crevices (saxicolous) forming a thin green carpet where higher vascular plants cannot inhabit or grow.

LIFE CYCLE:

The plant body in bryophytes is a gametophyte (haploid) which is dominant in their life cycle and which limits their ability to store recessive alleles. The life cycle involves a protonema that develops from the germinating spore and gives rise to thalloid like structure in most of the liverworts and Sphagnopsida but it becomes a branched thread like structure in most of the mosses. The protonema buds develop into leafy gametophores. Gametophores produce archegonia and/ or antheridia and the zygote divides to form an embryo that develops within the archegonium. The sporophytes remain attached to the gametophyte and produce spores by meiosis.

Mosses exhibit 57% dioicy, Liverworts exhibit 68% dioicy, while flowering plants exhibit only 6% Dioicous (Glime, 2007).

REPRODUCTION:

The process of reproduction in liverworts (Hepaticae) and hornworts (Anthocerotae) is rather interesting. These groups of plants fall between simple thallophyta and the vascular plants. As the liverworts and hornworts are intermediate between the two groups, they show asexual and sexual reproduction. In most of the cases, the Hepatics taxa propagate by asexual mode of reproduction and they show a very high rate of regeneration through death and decay of the vegetative thalli.

Asexual Mode of Reproduction: The following modes of asexual reproduction have been observed during the field exploration.

I. Regeneration from old thalli- This mode of asexual/vegetative reproduction is mostly found in thalloid liverworts, viz., *Asterella*, *Riccia*, *Marchantia*, etc. during the dry and extreme seasons and when there is no moisture available, the older thalli start progressive death leaving a vigorous thallus at the apical region. When this vigorous apical thallus gets moisture and favourable climate they propagate and regenerate at a rapid rate and covers the landscape within a short period of time.

II. Gemmae: This type of asexual/vegetative reproduction is also mostly found in thalloid liverworts like *Marchantia*, *Conocephalum* and leafy liverworts like *Lophozia* sp., *Calypogeia* sp. etc. It is interesting to note that species like *Conocephalum japonicum* (Thunb.) Grolle, the gemmae regenerate into young thalli when they are still attached with the parent thalli and while other gemmae are still developing.

III. Ocelli- This type of asexual/vegetative reproduction is mostly found in the leafy liverworts of the families Plagiochilaceae, Radulaceae, Lejeuneaceae, etc. Ocelli are special cells which have the capability to regenerate into new plants. This is a common phenomenon where the plants fail to produce (sporophytic plants) spores.

ECOLOGY AND HABITAT

Liverworts (Hepaticae) and Hornworts (Anthocerotae) are the two very diverse groups of plants which are found to occur on all habitats viz., Soil (terricolous), rocks (saxicolous), bark (corticolous), epiphyllous (foliicolous) and in water (aquatic). No other group of plants on earth has such diverse and varied habitats as the bryophytes. Although the bryophytic plants prefer mostly the moist, shady and damp moist areas, yet, they can withstand extreme drought and adverse climate too. Bryophytes are also called as the “*Amphibian plants*” on account of their complete dependence on external

water to complete their life cycle. They are found to occur abundantly in the moist humid areas where light is available. They include most simple, inconspicuous group of plants which form the green mat of the landscape particularly in the tropical, sub-tropical rainforests of the globe. Bryophytes are richly and luxuriantly distributed in the tropics, sub-tropics and temperate cold regions of the earth hemisphere. The diversity of bryophytic taxa also decreases with rise in altitude and also from tropical to alpine region.

ECONOMIC IMPORTANCE

Bryophytes are the pioneer plants or the primary colonizer of land form. This group of taxa plays an important role ecosystem. Since, bryophytes are the pioneer plants; they bind the soil, check soil erosion by wind and water, and also add fertility to the soil by their decayed bodies. Recent studies show that this group of taxa has enormous economic values. Some of these species have anti-bacterial, anti-microbial, anti-oxidant properties, e.g., *Plagiochasma appendiculatum* L. Many species of bryophytes are used in horticulture (*Sphagnum*, *Hypnum*, *Leucobryum*, etc), fine art decoration (*Hypnum*, *Thuidium*, *Ptilium*, etc.), surgical and wound healing (*Sphagnum* sp.) and aquarium (*Riccia fluitans* L., *Ricciocarpos natans* Corda). People used *Marchantia polymorpha* L. for the treatment of liver ailment and jaundice due to livershape structure of the thalli and believed that this can cure their liver ailment. The use of peat moss (*Sphagnum* sp.) as antiseptic bandage during the First World War and during Russo-Japanese War (1904-05) is popularly known across the globe. The British Army used about 1,000,000 pounds of *Sphagnum* sp for dressing per month (Nichols 1918, 1920), and saving about \$200,000 per month (Bland 1971). The superiority of *Sphagnum* bandage is attributed in part to its ability to absorb 3-4 times as much liquid as cotton bandage at a rate three times as fast (Porter 1917).

Bryophytes are sensitive to UV-light, chemical, acids, pollution, and change of climate. This is because of the presence single cell on the leaf lamina except in few mosses where they possess multi-layer cells. When exposed to chemical acids, pollutants and UV-light directly the cells get damaged and killed. Change in climatic condition adversely affects the ecology of bryophytes. It is not surprising that these plants can control pollution or to check global warming. Bryophytes are the primary form of carbon storage in many ecosystems. There is more carbon stored in *Sphagnum* and *Sphagnum* litter (150×10^{12} g) than any other genus of plants, vascular or non-vascular (Clymo-Hayward 1982). Climate effects are expected to be most pronounced in boreal arctic ecosystems, with a predicted surface temperature increase of 2-4° C in the summer and as much as 6-15° C in the winter and spring (Meehl *et al.* 1993). Certain bryophytes possess a light tolerance to SO₂ pollution and may actually benefit from components of urban pollution e.g. *Funaria hygrometrica* Hedw., *Ceratodon purpureus* (Hedw.) Brid., *Leptobryum* sp., *Bryum argenteum* Hedw.

Cleaning up heavy metals from waterways is one of the most important environmental problems facing throughout the world. To remove these heavy metals, viz., zinc, cadmium, etc., selectively from mine wastewater, *Sphagnum* has been used and thereby reducing the concentrations to below the national drinking water standards. *Sphagnum* has the ability to clean up oil spills as they are the best oil adsorbent and can rescue birds and other aquatic animals covered in oil.

Forensic scientist is now using bryophytes to put suspects at scene of a crime, using the techniques of DNA fingerprinting to match fragments to a particular location. Many species of bryophytic taxa fragment easily and stick to clothing, making DNA analysis possible after the event of fragmentation. Bryophytes are good organisms for testing the toxicity of various substances, a moss species, viz.,

Physcomitrella patens (Hedw.) Bruch & Schimp. commonly known as “**Lab Rat**”. *Sphaerocarpos*, a liverwort is used to test the effect of mutagenic X-rays in genetic research arena. *Riccia* species were used by the tribal in the Himalayas to treat ringworm. *Riccia fluitans* L. has the ability to inhibit the growth of bacteria and yeast. A mixture of *Conocephalum conicum* L. and *Marchantia polymorpha* L. a thalloid liverworts, with vegetable oils is used for the treatment of boils, burns, cuts, eczema and wounds (Wu 1977; Ding 1982; Ando 1983). *Marchantia paleacea* Bertol, *M. polymorpha* L., *Riccardia multifida* (L.) Gray and *Radula perrottetii* Gotsche ex Stephani exhibit antileukemic activity. *Herbertus* and *Scapania* species are used as a filter for smoking by the Kumaun Indians (Pant and Tewari 1989).

REVIEW OF LITERATURE

The studies on Bryophytes date back to 1741 by Dillenius in his “*Historia muscorum*” where he described many species of algae, fungi, mosses, liverworts, hornworts, lichens and lycopods. Linnaeus (1753) in his “*Species Platarum*” recognized the single genus *Jungermannia* and described 25 species under the genus *Jungermannia*. The work on liverworts in India date back to the publication made by Lehman and Lindenberg (1832) on some liverworts of India and Nepal. Later on, Mitten (1861) worked on the bryoflora of Indian subcontinent and published “*Hepaticae Indiae Orientalis*” and perhaps this is the first extensive work on liverworts of Indian subcontinent. He has listed 39 genera and 205 species of liverworts, based on the specimens collected by J.D. Hooker from Himalaya, Thomson from Khasi Hills, Gardner and Thwaites from Ceylon and Western Himalaya.

The bryological study in India is very recent. Until, Kashyap (1914-1932), no detailed work was published on Indian bryophytic flora, except for a few collection

here and there by some foreign workers. Professor S.R. Kashyap was the first Indian to investigate Indian bryoflora and therefore, he is known as the father of Indian Bryology. He has contributed valuable, authentic works on Indian Hepaticae and his two volume of books entitled “Liverworts of the Western Himalayas and the Punjab Plains Vol. I & II.” (Kashyap, 1929, 1932) were the original pioneer works. However, many bryologists from other countries have also described the liverworts (Hepaticae) and hornworts (Anthocerotae) of the tropics and sub-tropics of the globe. The “Hepaticae and Anthocerotae of North America” by Schuster (1966, 1969, 1974, 1980), “Species Hepaticarum” by Stephani (1900, 1906, 1909-1912, 1912-1917, 1917-1924), “Hepaticae of South Africa” by Arnell (1963) are remarkable publications on Hepaticae and Anthocerotae.

The earlier bryologists from India have mostly investigated bryoflora of the Western Himalayas, South and the Western Ghats. The work done on Hepaticology in the Eastern Himalayas is recent and fragmentary. Udar and Kumar (1981,1982); Srivastava and Srivastava (2002); Sharma and Srivastava (1993); Rawat and Srivastava (2007); Singh and Nath (2004, 2007), Singh *et al.* (2002), Singh and Singh (2009), Singh and Singh (2008, 2009, 2010); Dey *et al.* (2007, 2008, 2009, 2011), Dey and Singh (2010); Chaturvedi and Chaturvedi (2007); Chaturvedi *et al.* (2011), Chaturvedi and Eshuo (2012); Eshuo and Chaturvedi (2011a, 2011b, 2011c), Eshuo *et al.* (2012) have contributed to the bryoflora of Eastern Himalayas in genera and North East India in particular.

Genus *Herbertus* Gray in India has been worked out by Montagne (1842); Stephani (1909, 1922); Herzog (1939); Miller (1965, 1968); So (2003); Singh and Nath (2007) and revision of Asiatic *Herbertus* was done by Juslén (2004, 2006a, 2006b). Udar and Singh (1977) described *Trichocolea indica* and *T. tenera* from

Eastern Himalayas. The member of the family Lepidoziaceae in India was worked out by Sharma and Srivastava (1993), Chopra (1938, 1943) and Hattori (1966, 1969, 1971). The family Cephaloziaceae and cephaloziellaceae was worked out by Udar and Kumar (1976); Udar and Nath (1973); Singh *et al.* (2003); Singh and Nath (2007). The Geocalycaceae in India was exclusively worked out by Kashyap (1932); Srivastava and Srivastava (2002); Singh and Singh (2003); Singh and Singh (2009) and Eshuo and Chaturvedi (2011). The genus *Jungermannia* L. in India has been worked out by many bryologists like Amakawa (1963, 1966, 1967, 1968, 1969, 1970, 1972); Udar and Kumar (1981); Srivastava *et al.* (2003); Vana (1972, 1974); Singh and Nath (2007) and Singh and Singh (2009). Hattori (1966, 1969, 1971) made comprehensive studies on the genus *Jamesoniella* Spruce. Udar and Kumar (1981, 1982) described *Jackiella javanica* Schiffn., *J. javanica* var. *cavifolia* Schiffn. and *J. javanica* var. *cordifolia* Schiffn. from Eastern Himalayas and South India. The genus *Calypogeia* and *Metacalypogeia* are contributed and extensively worked out in India by Bischler (1970); Sharma and Srivastava (1993), Singh and Nath (2007); Singh and Singh (2009).

The genus *Plagiochila* Dumort. belonging to family Plagiochilaceae and one of the most diverse form of the taxa were mostly studied in India by Inoue (1960, 1962, 1963, 1964, 1965); Herzog (1930, 1951); Mitten (1861); Heinrich *et al.* (1998); Srivastava *et al.* (1994); Srivastava and Dixit (1994, 1996); Grolle and So (1999a, 1999b, 2000). Rawat and Srivastava (2007) exclusively investigated on the genus *Plagiochila* Dumort. of the Eastern Himalayas and they have reported the occurrence of this taxon from all North Eastern states except for Nagaland.

Pioneer worker on the genus *Scapania* in India are Gotsche *et al.* (1844-1847); Stephani (1900-1924); Hattori (1966, 1971, 1975); Singh and Singh (2008); and

Eshuo *et al.* (2012). Amakawa (1964) made a short revisionary study on the Japanese and Himalayan *Scapania* Dumort. and described two new species, viz., *S. harae* Amak. and *S. pseudoferruginea* Amak. from Darjeeling. Srivastava and Srivastava (1994), Potemkin (2001), Potemkin *et al.* (2004) and Singh and Nath (2007) also contributed on the genus *Scapania* in India.

The genus *Porella* L. in India in particular and in Asia in general was mostly worked out by Hattori (1967, 1969, 1970, 1971, 1975 & 1976); So (2002). Pocs (1968) described *P. plumosa* var. *hattoriana* Pocs from Khasi Hills, Meghalaya. Udar and Shaheen (1983) work on the genus *Porella* and described *P. plumosa* Inoue and *P. hattorii* Udar *et* Shaheen from Western Himalaya. Singh *et al.* (2001) for the first time reported the occurrence of *P. hattorii* Udar *et* Shaheen from Eastern Himalayas. Singh and Singh (2006) investigated on the genus *Porella* and reported the occurrence of 11 species from Great Himalayan National Park, Kullu (Himachal Pradesh). Singh and Nath (2007) reported the occurrence of 6 species of the genus *Porella* from Meghalaya state. Eshuo and Chaturvedi (2011) reported *P. obtusata* var. *macroloba* (Steph.) S. Hatt. & Zhang as new record for Nagaland and addition to the bryoflora of the Eastern Himalayas.

Verdoorn (1930, 1934) made comprehensive studies on genus *Frullania* Raddi and published report on Indo-Malayan Frullaniaceae and Jubulaceae. Hattori (1972, 1973, 1974, 1975, 1976, 1980) had made series of publication on the Studies on Asiatic species of genus *Frullania*. Nath (1977) also contributed on the genus *Frullania* in his Ph. D. thesis “Studies on Indian Frullaniaceae.” Udar and Nath (1979, 1984) worked on the oil bodies of *Frullania* Raddi. Nath and Asthana (1998) reported the occurrence of 12 species of the genus *Frullania* from South India. Nath and Singh (2006) described a new species of genus *Frullania*, viz., *F. udarii* Nath *et* Singh from

Meghalaya. Udar and Nath (1978) have made an important contribution to the family Jubulaceae in India. These author have described a new species of genus *Jubula*, viz., *J. hattorii* Udar *et* Nath from Darjeeling. Singh and Nath (2007) also reported *J. hattorii* Udar *et* Nath from Meghalaya. Dey *et al.* (2011) reported *J. pennsylvanica* (Steph.) A. Evans as new record to Asia from Sikkim Himalaya, India.

Lejeuneaceae represent the largest family of liverworts comprises of 23 genera (Crandall-Stotler *et al.* 2009) and it is one of the diverse and complex groups of Hepaticae. In India, many workers like Mitten (1861); Stephani (1914); Mizutani (1961); Mizutani (1964, 1967, 1972); Theirs (1992); Hattori (1966); Asthana *et al.* (1995); Udar and Srivastava (1982, 1983); Udar *et al.* (1985, 1986); Srivastava and Srivastava (1989); Agarwal and Srivastava (1985); Asthana and Srivastava (2003) and Poc (1995, 2006); Singh and Nath (2007); Zhu and So (1998, 1999, 2001); Zhu and Lu (1995) have contributed on family Lejeuneaceae. Udar and Awasthi (1979, 1982) described *Leptolejeunea sikkimensis* Udar *et* Awasthi and *L. foliicola* Steph. from Sikkim Himalaya and Khasi Hills, Meghalaya. Dey and Singh (2010) described two new species of *Leptolejeunea*, viz., *L. mirikana* and *L. udarii* M. Dey *et* D.K. Singh from Eastern Himalayas, India. Dey *et al.* (2008) reported new species of *Cololejeunea tixieriana* from Darjeeling and Sikkim Himalaya, India. Dey *et al.* (2007) reported *Lejeunea eifrigii* Muzit. as new to India from Sikkim, India.

On the family Fossombroniaceae, many workers like Kashyap (1915, 1929); Pande *et al.* (1954); Udar and Srivastava (1969); Srivastava and Udar (1975) have contributed. In the North Eastern States of India, Nath and Singh (2007) reported the occurrence of genus *Fossombronia* from the state of Meghalaya and Chaturvedi *et al.* (2011) reported *F. wondraczekii* (Corda) Dumort. as new to Eastern Himalaya from Nagaland. Metzgeriaceae has been work out by many workers like Kuwahara (1960,

1965, 1975); Srivasatva (1960, 1961, 1969, 1972, 1976); Srivastava and Udar (1975, 1976, 1977); Udar and Srivastava (1973); Pande and Srivastava (1953, 1958); Schiffner *et al.* (1959).

The members of the order Marchantiales have been work in India by many workers like Kashyap (1916, 1917, 1929); Bishler (1989); Schiffner (1942); Srivastava and Dixit (1996); Srivastava and Sharma (1987); Singh and Nath (2007); Singh and Singh (2009); Singh and Singh (2002, 2012), etc. the Ricciaceae in India has been investigated by many bryologists like Ahmad (1942); Kachroo and Bapna (1963); Pande (1924, 1933); Pande and Udar (1957, 1958, 1959); Srivastava (1964), Udar (1956, 1957, 1959); Bag *et al.* (2007) and Singh *et al.* (2010). The work on Indian Anthocerotae were done by Bharadwaj (1950, 1952, 1960, 1965, 1971, 1978); Asthana and Srivastava (1986, 1991), Srivastava and Asthana (1987, 1989); Kachroo (1954); Singh (1987), Udar and Singh (1979, 1980, 1981, 1986) and Udar and Asthana (1985). However, there are scanty reports on the studies of liverworts and hornworts of Nagaland. Therefore, to access the diversity of liverworts and hornworts in the state of Nagaland, the present investigation on the studies of liverworts and hornworts of Kohima and Mokokchung districts of Nagaland has been undertaken.

CHAPTER-II
MATERIALS AND METHODS

The present investigation was carried out at the various natural localities of Kohima and Mokokchung districts of Nagaland state. The collections were done in different natural localities of the districts viz., Kohima and Mokokchung of Nagaland state at different seasons of the years from 2008-2012. In Kohima districts the collection sites/areas are: Khuzama, Viswema, Jakhama, Kigwema, Japfu Peak, Kohima Town, Jotsoma, Khonoma, Botsa, Nerhema, Kedima, Chakhabama, Ruzoma and in Mokokchung district the collection sites/areas are: Longkhum, Mokokchung Town, Chuchuyimpang, Tuli, Mirangkong, Yisimyong, Minkong, Mopungchuket, Changki, Khensa, Ungma. In Kohima districts the altitude varies from 1060-2750 m above sea level (a.s.l) and in Mokokchung district it ranges from 190-1650 m above sea level (a.s.l).

Geographically, the state of Nagaland lies between 25° 60' N and 27° 40' N latitude and 93° 20' E and 95° 15' E longitude. It is located in the north-eastern part of India and having an area of *ca* 16,578 squares kilometres. It is bounded in the east by Myanmar (Burma), on the west by Assam, on the north by Arunachal Pradesh and part of Assam and on the south by Manipur. It is divided into eleven (11) administrative units viz., Dimapur, Kiphire, Kohima, Longleng, Mokokchung, Mon, Phek, Peren, Tuensang, Wokha and Zunheboto and inhabited by 15 major tribes along with sub-tribes. The state is mostly mountainous and rocky. The topography is severe with many ranges and Mount Saramati with an altitude of 3,826 m above sea level is the highest peak in the state and at this place Naga Hills merges with the Patkai range of Myanmar. The climate is warm in summer and cool in winter. The humidity of this region is very high. The average annual rainfall from May to September is 170-250 cm and the average mean temperature ranges from 20°-30° C in summer. The state

has mostly sub-tropical evergreen forest, sub-tropical deciduous, temperate pine forest, and sub-mountain forest type of forest.

Kohima district (25°53' N-26°01' N latitude and 93°91' E-94°32' E longitude) is located in the southern part of the state of Nagaland. It covers an area of about 1,041 squares kilometers with a mean altitude of about 1444 m above sea level. Kohima district is inhabited by the two major tribes of Nagas viz., *Angami* and *Rengma*. Kohima district has a pleasant climate which is generally cold in winter and pleasantly warm in summer. The mean temperature in summer season ranges from 18°-25° C and it receive rainfall almost throughout the year and the average annual rainfall from May to September is 200 – 250 cm. The Mokokchung district (26°22' N-26°83' N latitude and 94°29' E-94°76' E longitude) is located in the north-western part of the state of Nagaland. It covers an area of about 1,615 squares kilometres with a mean altitude of about 1325 m above sea level. Mokokchung district is inhabited by the *Ao* Naga tribe. The climate is pleasant which is generally cold in winter and warm in summer. The average summer temperature ranges from 20°-30° C and the temperature never come down below 5° C in winter. The climatic conditions are most favourable for the prevalence of Bryophytes especially liverworts in this region.

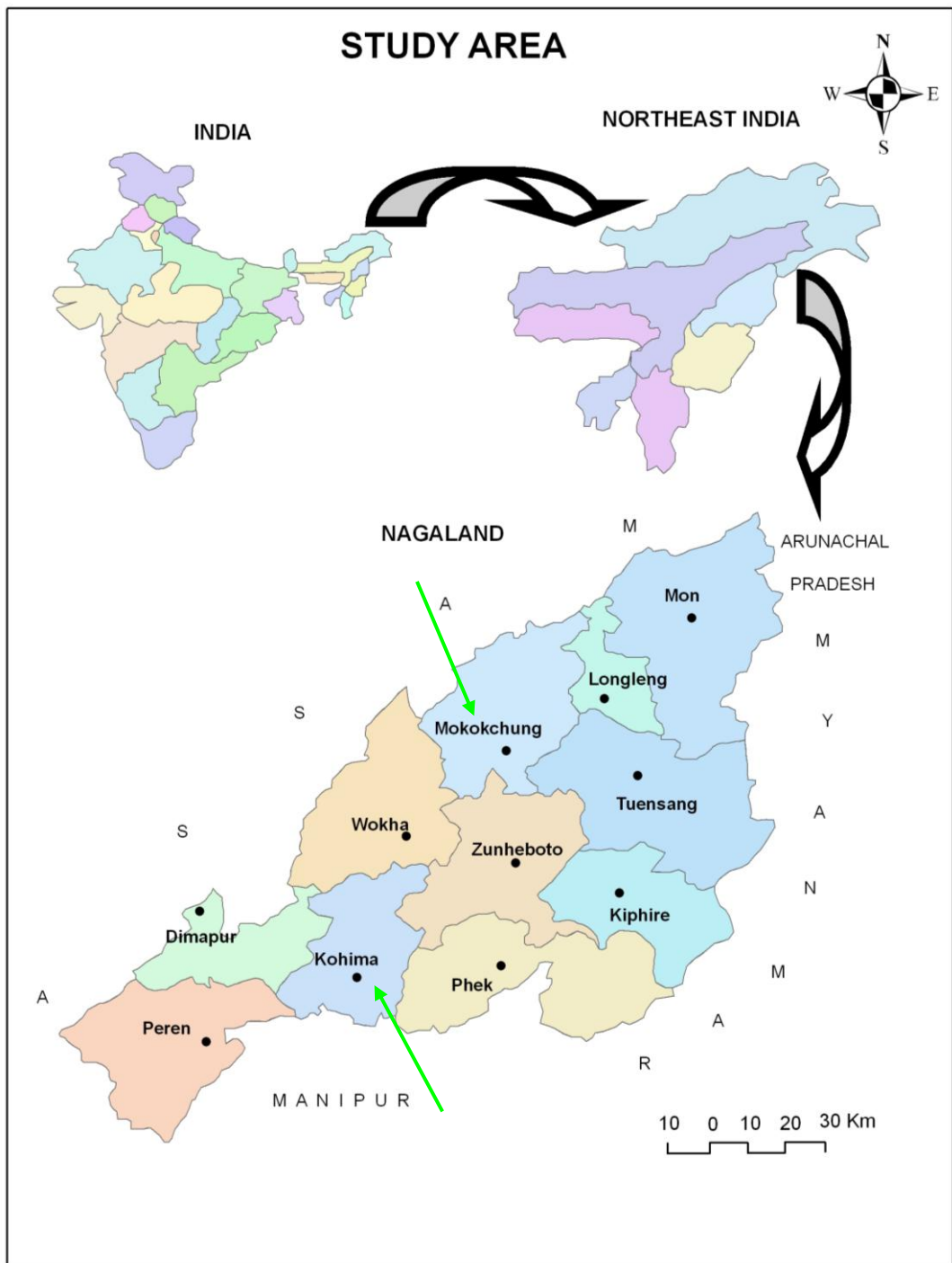
The fresh specimen were collected from their natural habitats and put in polythene bags (in field) and transferred them to blotting papers to absorbed moisture and dry them accordingly. The air dry specimens were preserved in bamboo sheet brown paper packets of size 4 x 6 inches. It is found that when specimens were preserved in fresh conditions in polythene bags, it can retain its full characters specially the oil bodies for week or even a month. In such case, oil bodies have been studied in the laboratory and their photomicrographs were taken under digital light Leica microscope (DM1000).

The morphological characters of the collected plants specimen were studied under Leica digital Stereo-zoom (S6D). The dry specimens were soaked in water for 10-15 minutes or in some cases 30-60 minutes before studied. The thalloid forms need more time to stress into full structure and so they were soaked in water for 2-3 hours before observations or even more. The anatomical studies of leaves, underleaves and stems/thallus, oil bodies were studies under Leica digital Microscope. The hand sections of stem/thallus, perianth, air-pore, spores and elaters were mounted in 30% aqueous solution of glycerin and observed under the Leica digital Microscope. The photomicrographs and photomacrographs were taken under Leica digital Microscope and Leica stereo-zoom respectively. The herbarium specimens have been deposited in the “Clarke Herbabrium”, Department of Botany, Nagaland University.

The morphological and anatomical features of all investigated taxa have been described. The characteristic features used for the identification of the taxa in the present investigation are i. Morphology features like plant size, colour, leaves shape and size, number of teeth per leaf, lobule shape and size, and underleaves shape and size, etc; ii. Anatomy features like stem size, cells size, trigones present or absent, cells differentiation, etc; iii. Reproductive structures like male and female inflorescence, bract and bracteole shape and size, perianth shape, keel, spores size, elaters size, etc and iv. Oil bodies features like number of oil bodies present per cell, size, shape, segmentation, etc. An artificial bracketed keys of all the investigated taxa, viz., families, genera and species have been provided along with hand drawing illustrated diagrams and coloured photo plates. Coloured photographs of various collection sites of Kohima and Mokokchung districts of Nagaland, and Maps of the study areas been provided.

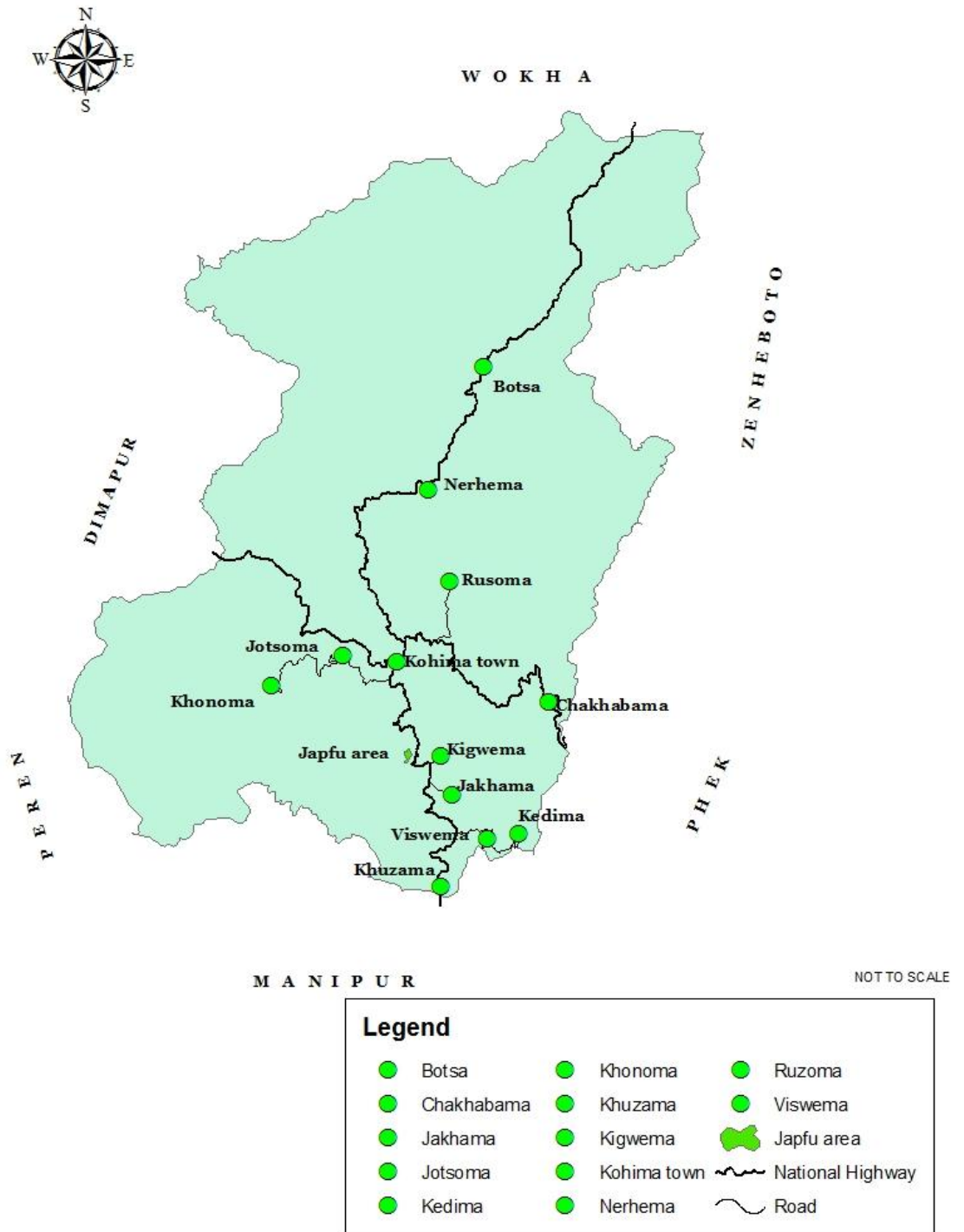
During the present investigation, the system of classification given by Schuster (1984) and Crandal-Stotler *et al.* (2009) for the liverworts and by Duff *et al.* (2007) for hornworts have been followed. These system of classifications for liverworts and hornworts have been used due to wide recognition by the world bryologists and its easy practical application.

The present investigation reveals the occurrence of 123 species belonging to 31 families, 50 genera. The highest genera in the order Jungermanniales was represent by the family Lejeuneaceae (11 genera), in Marchantiales by family Aytiniaceae (3 genera), in Metzgeriales, each family was represented by a single genus. The highest species in order Jungermanniales was found in genus *Plagiochila* (10 species), in Mrachnatilaes by *Riccia* and *Mrachantia* (4 species each) and in Metzgeriales by *Riccardia* and *Metzgeria* (4 species each). In the order Anthocerotales reveals the occurrence of 2 families and 2 genera and 4 species. For easy reference they are shown in histogram.



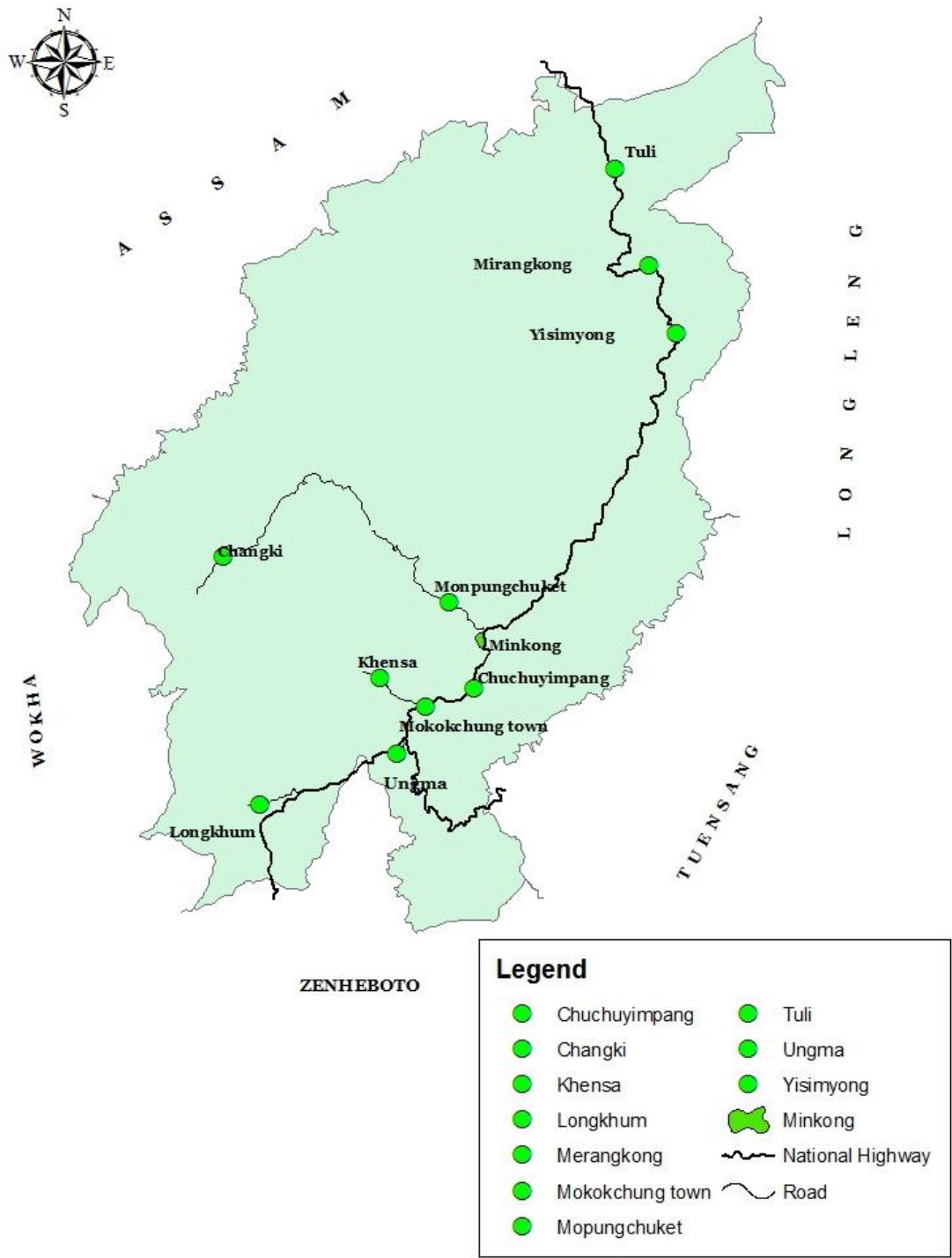
Map 1. Showing the Study area; green arrow point to the present study area

KOHIMA DISTRICT



Map 2. District map of Kohima showing the collection localities

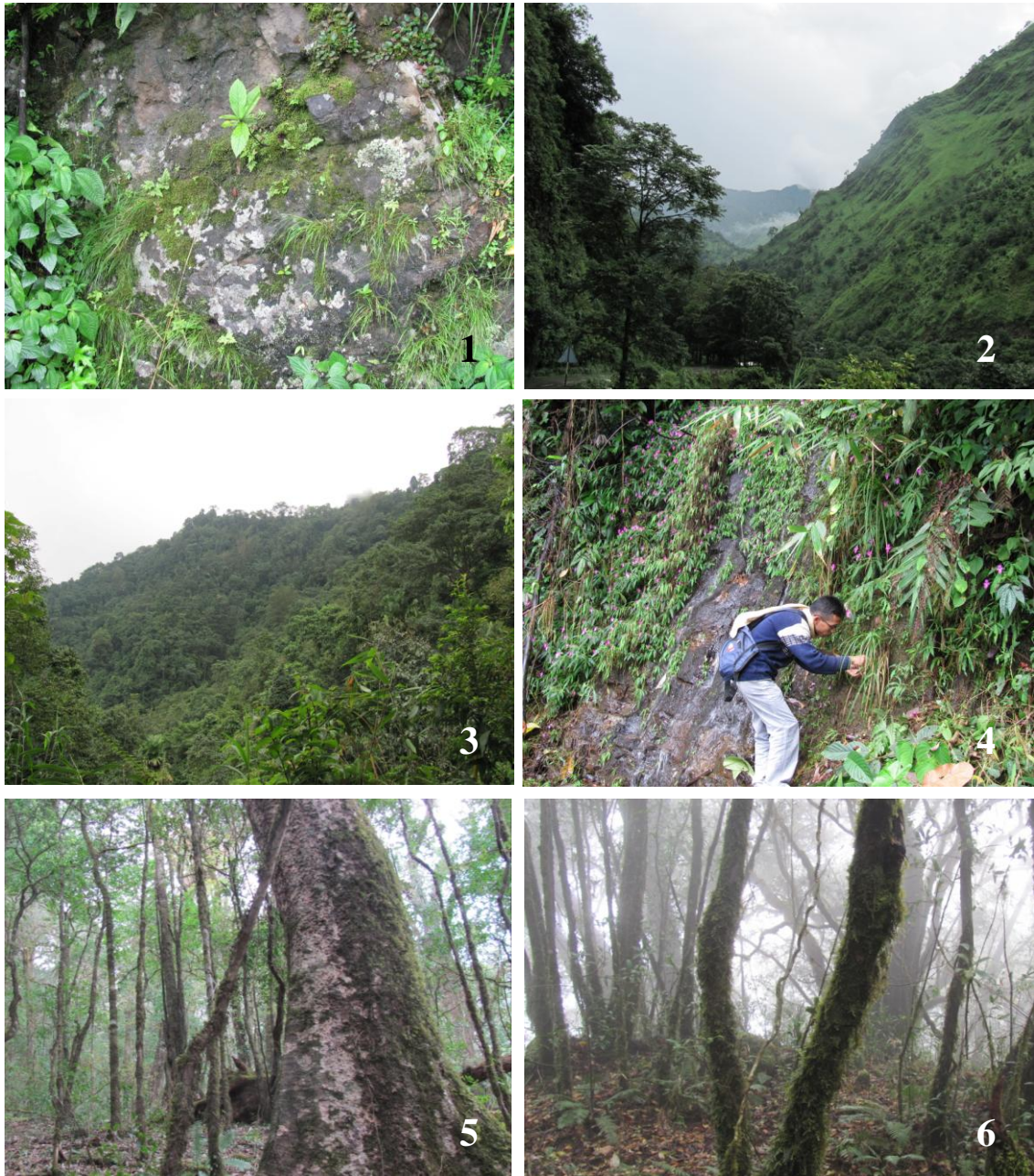
MOKOKCHUNG DISTRICT



NOT TO SCALE

Map 3. District map of Mokokchung showing the collection localities

Photo Plate I.



Figures 1-6. Showing collection sites.

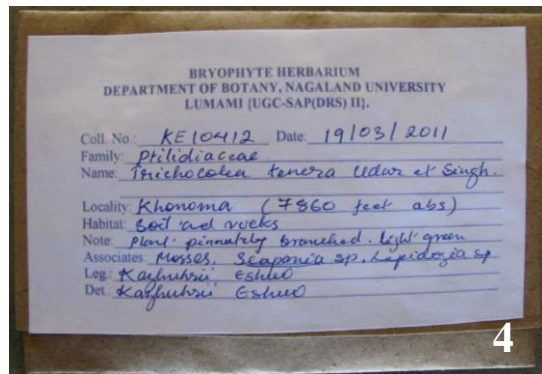
1. Viswema; 2. Viswema & Jakhama border; 3-4. Changki; 5-6. Japfu Peak.

Photo Plate II.



Figures 7-9. Showing Collection sites at Khonma

Photo Plate III.



Figures 1-4. Showing methods of preservation of specimens.

Figs. 1. Preservation of specimen in 70% alcohol solution with 20% glycerine; 2. Preservation of packets in brown paper; 3. Temporary preservation in zip polythene bags; 4. Sample of complete packet.

CHAPTER-III

OBSERVATIONS

The present investigation reveals the occurrence of 123 species belonging to 31 families, 50 genera. The investigated taxa have been classified into four orders, viz., Marchantiales, Metzgeriales, Jungermanniales and Anthocerotales. The order Marchantiales is represented by 8 families, 11 genera and 20 species; order Metzgeriales is represented by 5 families, 5 genera and 13 species; order Jungermanniales is represented by 16 families, 32 genera and 86 species and in order Anthocerotales is represented by 2 families, 2 genera and 4 species in the study areas.

ORDER: JUNGERMANNIALES H. Klinggr.

Jungermanniales H. Klinggr., *Höh. Crypt. Preuss.*: 16. 1858.

Plants differentiated into stems and leaves, prostrate to erect or creeping, branches few to numerous, intercalary, terminal, pinnate to bipinnately branched; leaves succubous, incubous, alternate, opposite, lobed or unlobed, transversely to obliquely inserted, simple to complicate imbricate, margin entire to dentate; leaf lobules present or absent; underleaves present or absent, when present similar to lateral leaves or smaller, lobed or unlobed, free or connate with the postical base of a leaf. Rhizoids in fascicled from the underleaf base or scattered along the ventral side of the stem. Gemmae present or absent. Gametangia terminal on main stem or lateral or postical branches; androecia branched generally well defined, bracts in 1 or many more pairs; androecia 1-3 per bracts. Gynoecial branches often form 1 or 2 or more sub-floral innovations; bracts usually larger than the leaves; perianth usually present; young sporophytes usually enclosed within a perianth. Sporophytes well developed and deffirentiated into foot, seta and capsule. Capsule walled 2-8 layered; outer layer generally with nodular thickenings and inner layer usually with semi annular thickenings. Spores smooth, granulate or minutely papillose-vermiculose and elaters free or fixed, with spiral thickenings.

Key to families of the order Jungermanniales

- 1. Underleaves absent..... 2
- 1a. Underleaves present..... 6
- 2. Leaves entire, complicate bilobed..... 3
- 2a. Leaves bifid to toothed..... 6
- 3. Leaves complicate bilobed with the dorsal segment smaller, 2-4 lobed, dentate to ciliate..... Scapaniaceae
- 3a. Leaves succubous, entire or lobed..... 4
- 4. Leaves entire, pinnately branched, rhizoids confined at the base of the lobule, oil bodies 1 large per cell..... Radulaceae
- 4a. Leaves entire or shallowly lobed, rhizoids in fascicles along the ventral stem, oil bodies 1 to many per leaf cell..... 5
- 5. Leaves entire or shallowly 2-3 lobed, perianth terete, smooth, plicate near the mouth..... Jungermanniaceae
- 5a. Leaves entire, perianth often reduced, pluriplicate above, mouth gradually contracted..... Solenostomaceae
- 6. Leaves bifid to deeply lobed, gemmae present..... Cephaloziaceae
- 6a. Leaves toothed, dentition 7-35 per leaf, tooth cells 1-12 cells long, perianth mouth wide.....Plagiochilaceae
- 7. Leaves lobule absent..... 8
- 7a. Leaves lobule present..... 13
- 8. Leaves 2-6 deeply lobed..... 9
- 8a. Leaves undivided or 2-lobed..... 11
- 9. Leaves deeply divided in 2-6 lobes, lobes further divided and ciliate, underleaf similar or slightly smaller than the lateral leaves..... Trichocoleaceae

- 9a. Leaves deeply 2-4 lobed, lobes no further divided and ciliate, underleaves dissimilar with lateral leaves..... 10
10. Leaves deeply 2-lobed, vitta cells present, cells trigonous..... Herbertaceae
- 10a. Leaves deeply 3-4 lobed, vitta absent, trigones indistinct..... Lepidoziaceae
11. Leaves incubous, entire or bidentate, perianth absent..... Calypogeiaceae
- 11a. Leaves succubous, bidentate to pluridentate, perianth present..... 12
12. Leaves entire or 2-lobed, underleaf bifid or undivided, free or connate with the leaves, capsule ovoid to cylindrical..... Geocalyceae
- 12a. Leaves 2-lobed or entire, dentate, underleaf bifid and frequently connate with the leaves, capsule ovoid to ellipsoidal..... Lophocoleaceae
13. Plant robust, leave entire to dentate, lobule explanate, ligulate to lanceolate, entire to toothed, underleaf undivided..... Porellaceae
- 13a. Plant medium, lobule galeate, saccate, underleaf bifid.....14
14. Leaves entire, branching of *Lejeunea* type, lobule form water sac, saccate, sometime with a small stylus, underleaf bifid or absent, discoids gemma form in some taxa..... Lejeuneaceae
- 14a. Leaves complicate 2-3 lobed, branching of *Frullania* type, lobule dimorphic, underleaf bifid..... 15
15. Leaves complicate imbricate, 3 lobed, lobule galeate, saccate, seta upto 12 cells in diameter..... Frullaniaceae
- 15a. Leaves 2 lobed, lobules dimorphic, both saccate and explanate form, seta 4 cells in diameter..... Jubulaceae

FAMILY: PORELLACEAE Cavers

PORELLACEAE Cavers, in *New Phytol.* 9: 292. 1910.

Plants robust, prostrate to loosely flocculent-pendulous, olive green to brownish green, 1-2 (-3) pinnately branched, branches of *Frullania*-type¹. Leaves imbricate, incubous, obliquely inserted, deeply complicate bilobed, often virtually to the base, keel normally very short or vestigial on mature leaves. Dorsal lobe subrotund to ovate or lanceolate, entire to cuspidate or dentate or ciliate at margins; lobule parallel and contiguous to the stem, explanate, sometimes elaborate at basal portions and form water-sacs, usually free from lobe, attachment largely to stem by an incubous or transverse or arcuate-decurrent line of insertion. Underleaves large, entire or emerginate at apex, sometimes toothed. Rhizoids fasciculated at underleaf base. Dioicous. Androecia spicate; bracts in 8-12 pairs, usually connate with bracteoles, 1 androus. Gynoecia on short lateral branch; bracts and bracteoles in 1 to several pairs. Perianth obtusely trigonous, with third ventral keel often dorso-ventrally compressed, either wide at mouth or gradually narrowed from an inflated basal portion to a slender, dorso-ventrally compressed apex, never rostellate, often with weak supplementary keels; mouth narrow to wide, usually bilabiate. Capsule globose; wall many layered; cells with thickened radial walls. Spores pluricellular at release, verrucose to echinulate. Elaters slender, vermiculate, with 1-3 spiral thickenings.

Type: *Porella* L.

¹ *Frullania*-Type: A type of branching where lateral branch lack a collar-like structure at base and replacing the leaf lobule of the leaf subtending it.

Genus: *Porella* L.

Porella L. Sp. Pl. 2: 1106. 1753.

Plants pale yellow-olive green or yellowish or reddish brown, prostrate to pendent, regularly or irregularly pinnately branched; branching of *Frullania*-type, occasionally lateral, axillary-intercalary. Stem in cross section differentiated into 2-6 cortex region and medulla region. Leaves incubous, approximate to closely imbricate, deeply complicate bilobed, obliquely to widely spreading, ovate-oblong to ovate lanceolate, suborbicular to reniform, often appendiculate; lobule obliquely spreading, patent or parallel to stem, linear, oblong or broadly ovate, entire or toothed at margins, decurrent, incised to ciliate or appendiculate at base. Underleaves distant to contiguous, large, entire or toothed, orbicular-oblong, rounded or emerginate at apex, short –long decurrent, undulate, incised, appendiculate at base. Dioicous. Androecia on short lateral branches; bracts and bracteoles in 3-15 pairs, connate with each other; bracts bifid to 1/3 or 2/3, entire or rarely with short teeth at margins. Gynoecia on short lateral branches; bracts and bracteoles in 1 to several pairs, bracts unequally divided to 2/3, toothed or long ciliate at margin. Perianth ovoid, cylindrical, fusiform or more or less campanulate somewhat dorsally compressed with 3 to many keels or folds; mouth broad, deeply lacerate, laciniate or contracted into a short beak with 1-3 cells long cilia. Capsule globose, reddish brown; wall 2-6 layered; cells of outer layer with knot-like thickenings on radial walls; those on inner layer with transverse thickenings on tangential walls. Spores globose, yellowish brown, echinate-spinose. Elaters with 2-3 spiral thickenings.

Type: Porella pinnata L.

Key to the species of the genus *Porella*

1. Leaf lobe margin entire, lobule large, broadly ovate.....*P. obtusata* var. *macroloba*
 - 1a. Leaf lobe margin dentate, lobule small to large, dentate or entire.....2
2. Plants large 5-7 mm wide, lobules with long ciliate teeth.....*P. perottiana*
 - 2a. Plants 2-4 mm wide, leaves dentate, lobule dentate or entire.....3.
3. Leaf lobule with 1-2 teeth, underleaf with 5-9 teeth.....*P. campylophylla*
 - 3a. Leaf lobule and underleaves entire.....4
4. Lobe apex acute-acuminate, lobule 0.7-1.4 mm long.....*P. caespitans*
 - 4a. Lobe apex acute or obtuse, lobule 0.3-0.4 mm long..... *P. plumosa*

Porella obtusata (J. Taylor) Trevis. var. *macroloba* (Steph.) S. Hatt. & Zhang, in J.

Jap. Bot. 60 (11): 325. 1985. (Plate 1. Figs. 1-15)

Plant medium to large, light green to light yellowish green, brownish green, branched, intercalary, terminal, irregularly branched, and pinnately branched; 50-85 mm long, 2-3.5 mm wide including leaves. Stem oval to elliptical shape, 16-18 cells across in diameter, 2-3 thick cortical cells, 6.6-22.2 μm long and 6.0-16.5 μm wide, medullary cells thin walled, 13.2-31.9 μm long, 8.8-22.2 μm wide. Leaves closely imbricate, incurve at apex, entire, oblong-ovate, 1.5-1.8 mm long, 1.2-1.7 mm wide, rounded, broadest at base, recurved, short decurrent; apical cells 14.3-22.6 μm long, 8.4-15.4 μm wide, trigonous, trigones nodulose, bulging, middle cells 15.5-27.9 μm long, 13.3-21.4 μm wide, trigones nodulose, epidermal cells 11.5-18.6 μm long, 8.9-15.6 μm wide, basal cells large, 31.0-52.2 μm long, 15.4-26.5 μm wide, trigones bulging, nodules like. Lobule upto half of the leaf length, ovate, oblong, apex rounded, entire, 1.-1.2 mm long, 0.6-0.8 mm wide, base sometime tooth present, tooth blunt. Underleaves sub-orbicular to semicircular, 0.8-1.0 mm long, 0.7-0.8 mm wide, base long decurrent, on the decurrent base 1 or 2 teeth arises from the base, 1-4 cells

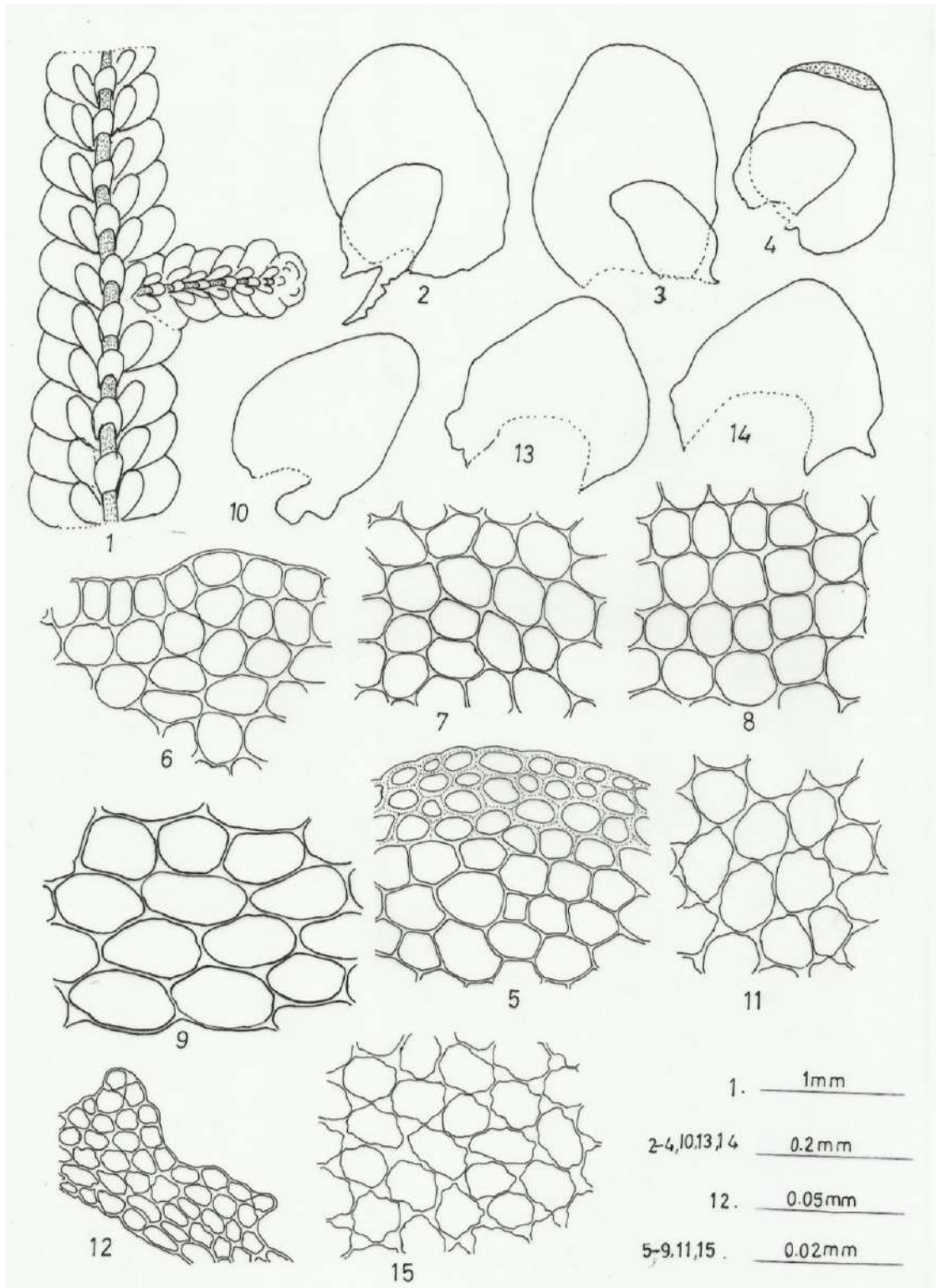


Plate 1. *Porella obtusata* (J. Taylor) Trevis. var. *macroloba* (Steph.) S. Hatt. & Zhang; Figs. 1-15.

Figs. 1. Plant habit in ventral view; 2-4. Leaves; 5. Cross section of stem; 6. Leaf apical cells; 7-8. Leaf median cells; 9. Leaf basal cells; 10. Lobule; 11. Lobule median cells; 12. Lobule appendages cells; 13-14. Underleaves; 15. Underleaf median cells.

long, apex incurve, and margin entire, incurved at margin; cells trigonous, trigones nodulose, bulging at basal cells. Androecia and gynoecia not seen.

Habitat: Plants grow on moist rocks (saxicolous) cover with thin layer of soil (terricolous) and on bark of trees (corticolous) in association with *Plagiochila* sp., *Ptychanthus* sp., *Trocholejeunea* sp., *Thuidium* sp. and other mosses at an altitude of ca 1500 – 1700 m asl (above sea level).

Range: Europe, Africa, Vietnam, China, Taiwan, Japan and India.

Distribution in India: Western Himalaya: Jammu & Kashmir, Himachal Pradesh, Uttaranchal (Mussoorie). Eastern Himalaya: **Nagaland**²**.

Specimen examined: Nagaland: Mokochung District: Longkhum: KE 10144: 12-09-2009; Kazuhrii Eshuo; Kohima District: Jakhama, Viswema: KE 10280, KE 10366: 08.08.2010; Kazuhrii Eshuo; Khonoma: KE 10401: 19.03.2010: Kazuhrii Eshuo.

Porella perotteniana (Mont.) R. Trevis., Mem. Reale Ist. Lomb. Ser. **3, 4:** 2408.
1877. **(Plate 2. Figs. 1-14)**

Plant large, light yellowish green to brownish green, green, upto 85 cmm long, 5-7 mm wide including leaves; pinnately branched, branching intercalary, of Frullania-type, or terminal or irregularly branched. Rhizoids scarce, at the basal portion of the stem. Stem oval, brownish red, 0.4 x 0.64 mm in diameter, 25-32 cells across; differentiate into thick cortical walled of 3-5 (-6) cells, 9.5-26 µm long and 4.5-11.5 µm wide; medullary cells thin walled, 16.3-35.7 µm long and 7-26.5 µm wide. Leaves closely imbricate, oblong-ovate, 3.5-5 mm long, 2.2-3.2 mm wide, broadest at base, apex acuminate, acute, denticulate, dentition spinose, long, sharp, 5-7 teeth per leaf, 5-20 cells long, 2-5 cells broad at base, 2-10 uniseriate cells at apex; cells trigonous, nodulose, bulging; apical cells rectangular, subquadrate, 13.2-30.6 µm

² Nagaland**= New distributional records for Eastern Himalayan bryoflora.

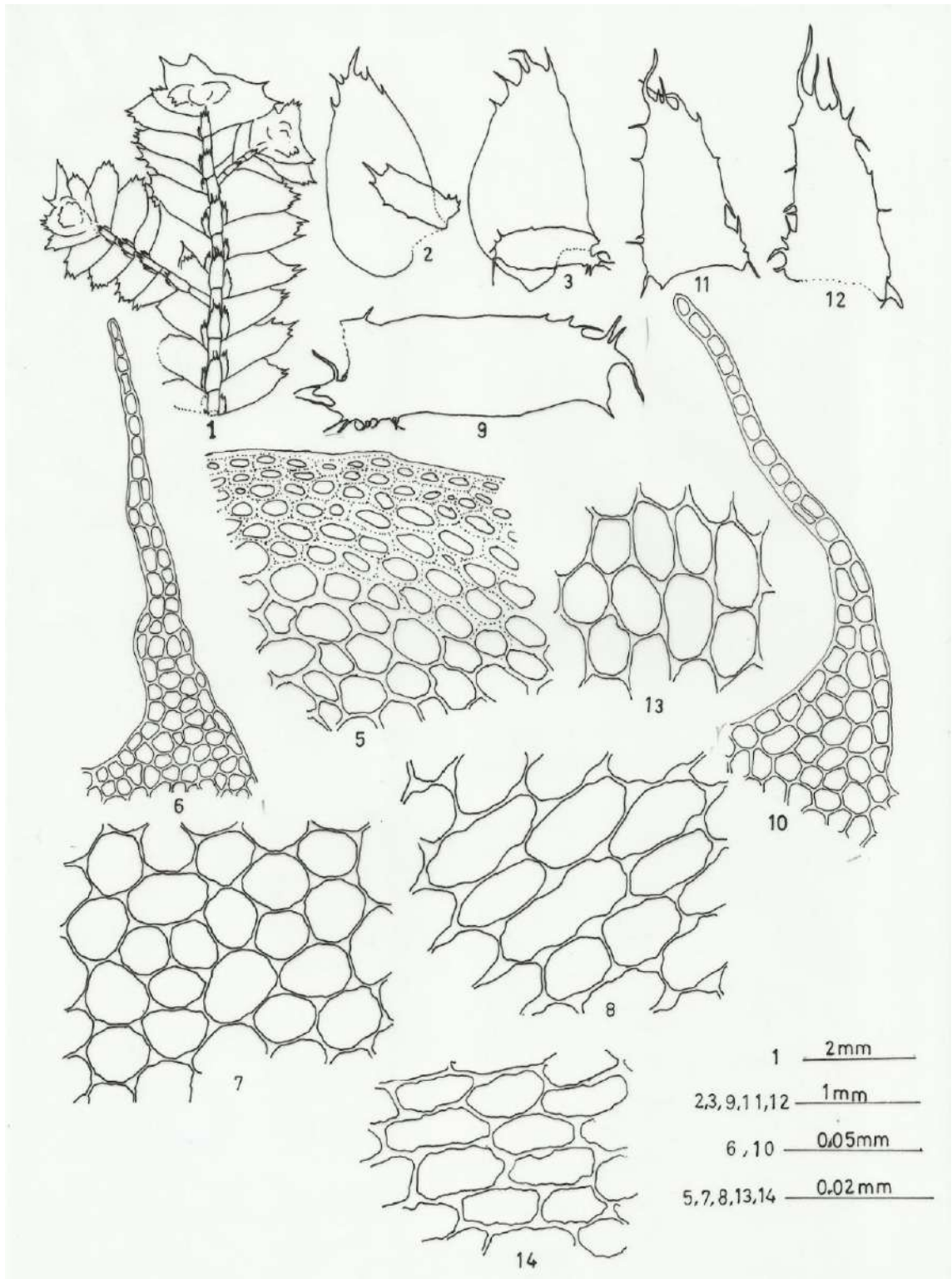


Plate 2. *Porella perotteniana* (Mont.) R. Trevis., Figs. 1-14.

Figs. 1. A portion of plant in ventral view; 2-3. Leaves; 5. Cross section of stem; 6. Leaf apical tooth cells; 7. Leaf median cells; 8. Leaf basal cells; 9. Lobule; 10. Lobule tooth cells; 11-12. Underleaves; 13. Underleaf median cells; 14. Underleaf basal cells.

long, 10-27.5 μm wide; median cells subquadrate, pentagonal, 25.4-37.2 μm long, 22-31 μm wide; basal cells rectangular, subquadrate, trigones nodules, bulging, 32.8-75.3 μm long and 23.5-3-40.2 μm wide. Leaf lobule rectangulate, ligulate, apex dentate, margin entire, 2.4-2.7 mm long, 0.7-0.9 mm wide; apex teeth 5-7 per lobule, teeth spinose, long, upto 27 cells long, 2-6 cells broad at base, cells like the leaf; basal portion denticulate, basal teeth 6-11 per lobule, 3-18 cells long, 3-16 uniseriate cells at apex. Underleaves imbricate to contiguous, shortly decurrent at base, rectangulate, broadest at base, 2-2.5 long, 0.7-1.2 mm wide, denticulate, 13-16 per underleaf. Androecia and gynoecia not seen.

Habitat: Plants grows on tree trunk (corticolous) in association with *Plagiochila* sp. *Lejeunea* sp. and Mosses at 1400 – 1700 m asl.

Range: India and widely distributed in the tropics.

Distribution in India: *Eastern Himalaya: Nagaland**.* *Western Ghats:* Tamil Nadu.

Specimen examined: Nagaland: Kohima District: Kigwema (Japfu Range): KE 10367: 17.03.2011: Kazuhrii Eshuo.

Porella campylophylla (Lehm. & Lindenb.) Trevis., in Mem. Reale Ist. Lombardo Sci., ser. 3, Cl. Sci. Mat. 4: 408. 1877. (Plate 3. Figs. 1-16).

Plant green to light green, branched, pinnately branched, large, primary branched 40-80 mm long, 3-4.5 mm wide, including leaves, secondary branched 10-25 mm long, 3-4 mm wide including leaves, tertiary branched 5-10 mm long, 3-4 mm wide. Rhizoids scarce, confined at the base of the stem. Stem oval, 22-26 cells across in diameter, 2-3 thick walled cortical cells, non-trigonous, 5.5-16.5 μm long, 4-8.9 μm wide, medullary cells thin walled, non-trigonous, 13.2-29.7 μm long and 8.8-22.2 μm wide. Leaves imbricate, opposite, ovate, acuminate, rectangulate to triangulate, 2-

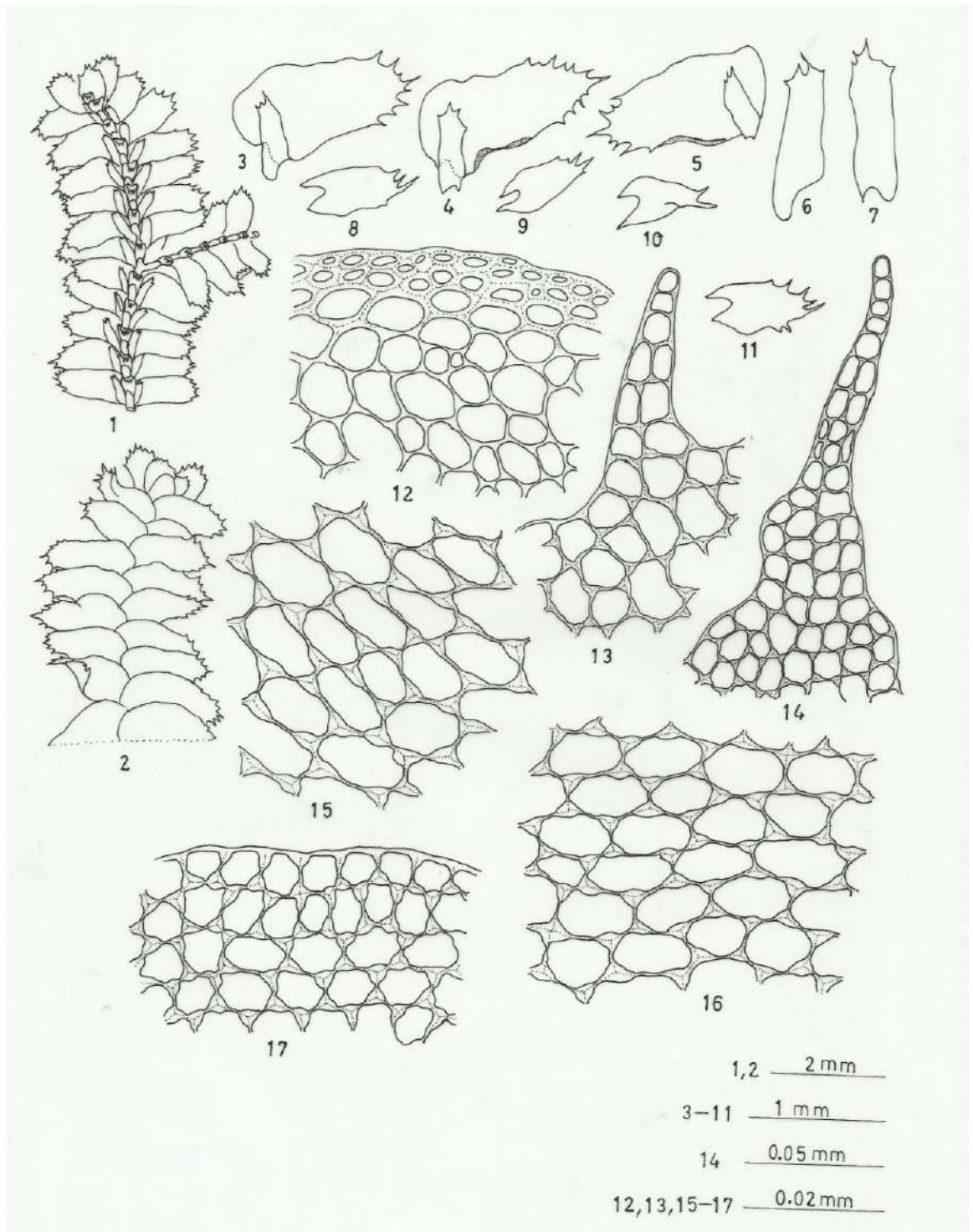


Plate 3. *Porella campylophylla* (Lehm. & Lindenb.) Trevis. Figures 1-16

Figs. 1. A portion plant in ventral view; 2. A portion plant in dorsal view; 3-5. Leaves; 6-7. Leaf lobule; 8-11. Underleaves; 12. A portion of stem in cross section; 13-14. Leafapical cells; 15. Leaf basal cells; 16. Leaf median cells; 17. Leaf marginal cells.

2.4 mm long, 1-1.3 mm wide; denticulate, dentition mostly at apex, 9-15 teeth per leaf, 1-8 cells long, 1-4 cells broad at base; apical cells trigonous, trigones nodulose, 20.5-34.6 μm long, 10.8-22.4 μm wide, middle cells trigonous, trigones nodules like, bulging, 24-41.2 μm long, 14.3-25.3 μm wide, basal cells oval to circular, trigonous, trigones nodulose, bulging, 28.7-59.9 μm long and 23.2-33.3 μm wide. Under leaves contiguous, decurrent at both ends, ovate-oblong ovate, triangulate, 0.9-1.4 mm long, 0.7-1.0 mm wide, denticulate, 5-9 teeth per under leaves, 4-9 cells long, 1-3 cells broad at base, 2-6 uniserriate cells at apex, cells trigonous, middle cells, slightly trigonous, 21.6-32.0 μm long, 10.6-18.2 μm wide, basal cells large, trigonous, trigones nodulose, bulging, 21.2-43.8 μm long and 8.7-14.0 μm wide. Lobule ligulate, long, 1-1.4 mm long, 0.4-0.57 m wide, 1-2 tooth present. Androecia and gynoecia not seen.

Habitat: Plants grows epiphytically on tree bark (corticolous) in association with *Ptychanthus striatus*, *Plagiochila* sp. and Mosses and Lichens at 1700-2600 m asl.

Range: India, China, Bhutan, Nepal, Myanmar, Vietnam.

Distribution in India: *Eastern Himalaya:* West Bengal, Sikkim, Arunachal Pradesh, Meghalaya, Nagaland^{*3}; *Western Himalaya:* Himachal Pradesh, Uttarakhand.

Specimen examined: Nagaland: Kohima District: Khuzama: KE 10084: KE 10086: 16.11.2009: Kazuhrii Eshuo.

Porella caespitans (Steph.) S. Hatt. J. Hattori Bot. Lab. 33: 50. 1970.

(Plate 4. Figs. 1-14)

Plants light yellowish green to light brown, 40-60 mm long, 3-5 mm wide including leaves, irregularly branched or pinnately branched; rhizoids scanty. Stem in cross

³ Nagaland*= New distributional records for Nagaland state bryoflora.

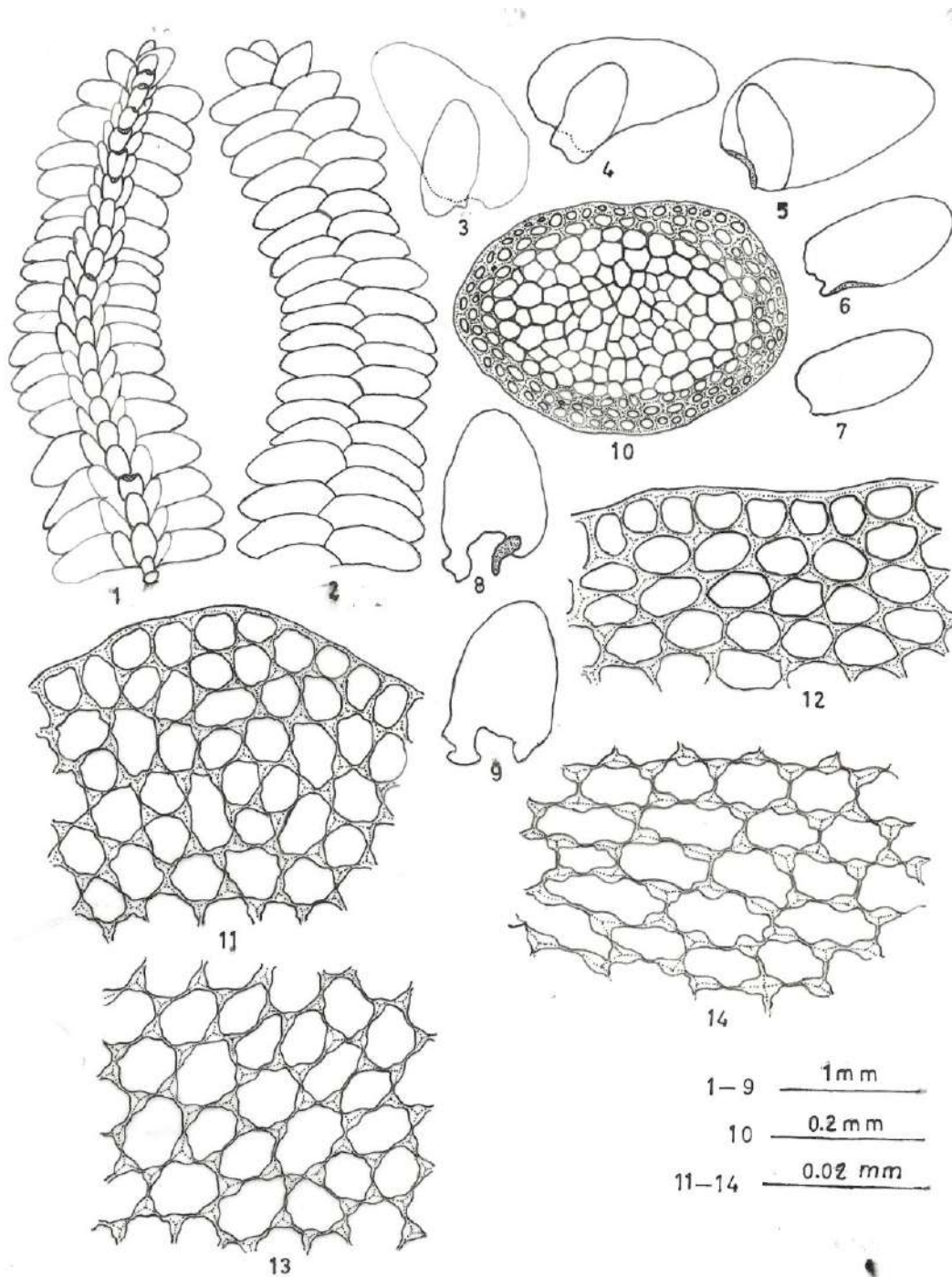


Plate 4. *Porella caespitans* (Steph.) S. Hatt., Figures 1-14.

Figs. 1. A portion of plant in ventral view; 2. A portion of plant in dorsal view; 3-5. Leaves; 6-7. Leaf lobules; 8-9. Underleaves; 10. Cross section of stem; 11. Leaf apical cells; 12. Leaf marginal cells; 13. Leaf median cells; 14. Leaf basal cells.

section ovoid-ellipsoid, 0.35-0.40 x 0.2-0.28 mm in diameter, 15-21 cells across, cortical cells in 3-4 layers, thick-walled, 9-30 x 6-14 μm , medullary thin-walled, 20-36 x 11-26 μm , pentagonal-hexagonal. Leaves closely imbricate, incubous, widely spreading, ovate-oblong, 1.7-2.4 mm long, 0.9-1.5 mm wide, margin entire, arched, rounded at dorsal base, apex rounded or with acuminate tooth, often with 1-2 teeth at apex, teeth 3-5 cells long, 2 cells broad at base; apical cells 12-24 x 9-16 μm , quadrate to subquadrate, median cells 24-33 x 17-25 μm , quadrate, polygonal, basal cells 26-45 x 17-26 μm , cells elongate, polygonal, thin-walled throughout, trigones large, triangular, tri-radiate; leaf lobule ligulate 0.7-1.4 mm long, 0.4-0.7 mm wide, obliquely spreading, apex obtuse, margin entire, base decurrent. Underleaves contiguous, ligulate, 0.9-1.2 mm long, 0.6-0.8 mm wide, margin entire, usually recurved, apex acut or obtuse, or truncate, auriculate on both side at the base, cells trigonous, large, triangular or tri-radiate. Androecia and gynoecia not seen.

Habitat: Plants grows on bark of tree (corticolous) along *Plagiochila* sp., *Lejeunea* sp., and Mosses at 1500-2000 m asl.

Range: India, Nepal Bhutan, China, Thailand.

Distribution in India: *Western Himalaya:* Himachal Pradesh; *Eastern Himalaya:* Nagaland**.

Specimen examined: Nagaland: Kohima District: Khonoma: KE 10455: 19.03.2011: Kazhuhrii Eshuo.

Porella plumosa subsp. *plumosa* (Mitt.) Inoue, Bull. Natl. Sci. Mus. Tokyo 9: 385.

1966. (Plate 5. Figs. 1-19).

Plants medium, light yellowish green to green, stem 40-60 mm long, 2-3 mm wide including leaves, irregularly branched; stem in cross section ovoid to circular, 170-220 μm , cortical cells 2-3 layers thick-walled, 8-19 x 5-14 μm , medullary cells

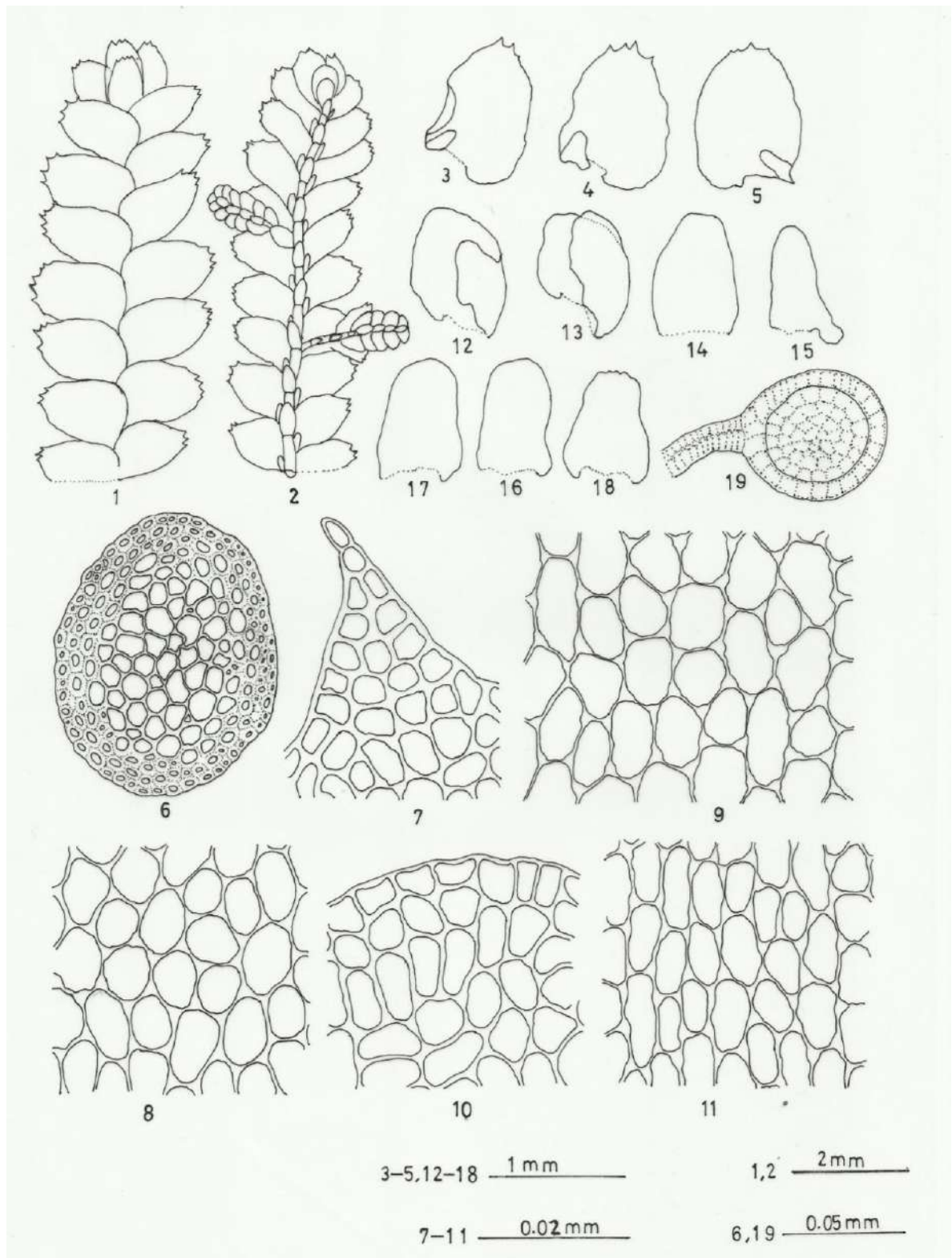


Plate 5. *Porella plumosa* subsp. *plumosa* (Mitt.) Inoue, Figures 1-19.

Figs. 1. A portion of plant in dorsal view; 2. A portion of plant in ventral view; 3-5. Leaves; 6. Cross section of stem; 7. Leaf apical cells; 8. Leaf median cells; 9. Leaf basal cells; 10. Underleaf apical cells; 11. Underleaf median cells; 12-13. Male bracts; 14-15. Leaf lobules; 16-18. Underleaves; 19. Antheridium.

thin-walled, 16-25 x 10-17 μm ; rhizoids scanty. Leaves imbricate, oblong, ovate, 1.4-1.7 mm long, 1-1.3 mm wide, denticulate, sometime entire, margin entire, crenulate, dentition 1-5 per leaf, teeth 2-6 cells long, 2-4 cells broad at base; leaf apex obtuse or acute; apical cells 15-19 x 10-16 μm , sub-quadrate to quadrate, median cells 15-30 x 13-20 μm , sub-quadrate to polygonal, basal cells 24-45 x 14-26 μm , cells elongate, polygonal, cells thin-walled throughout, trigones medium to large, tri-radiate to nodulose. Leaf lobule lanceolate. 0.3-0.4 mm long, 0.15-0.23 mm wide, apex rounded obtuse, entire, lobule nearly parallel to the stem. Underleaves distant small, ovate-oblong, 0.7-0.8 mm long, 0.4-0.5 mm wide, broadest at base, apex entire, rounded to obtuse, or sometime truncate, margin entire, cells trigonous and like the leaf cells. Male inflorescence on short lateral branches, terminal, closely imbricate, bracts 4-5 pairs, bracteole lanceolate, entire and present throughout the androecium; 1 androecium in each male bract. Gynoecia not seen.

Habitat: Plants grows epiphytically on tree bark (corticolous) in association with *Plagiochila* sp., *Ptychanthus* sp., *Lejeunea* sp. and Mosses at 1700- 2500 m asl.

Range: India, Pakistan, Nepal, China, Myanmar, Philippines, Thailand, Vietnam.

Distribution in India: *Western Himalaya:* Himachal Pradesh, Uttarakhand; *Eastern Himalaya:* Meghalaya, **Nagaland***; *Western Ghats:* Tamil Nadu.

Specimen examined: Nagaland: Kohima District: Khonoma: KE 10470: 19.03.2011: Kazhuhrii Eshuo.

FAMILY: RADULACEAE (Dumort.) Müll. Frib.

RADULACEAE (Dumort.) Müll. Frib. Lebermoose 1: 404. 1909.

Plants irregularly pinnate to bipinnately branched, with branches of *Radula*-type⁴; leaves 2-lobed, with the ventral lobule slightly inflated near the keel; rhizoids in fascicles from the leaf lobules; androecia amentiferous on lateral branches, rarely intercalary on the leading axis; gynoecia terminating at leading axis, rarely on a lateral branch, with 2-4 archegonia; bracts in a single series; bracteoles absent; sporophytes enclosed by a shoot calyptras or stem perigynium and perianth. Perianth 2-keeled, dorsiventrally compressed, mouth truncate; capsule cylindrical, walls 2-stratose, both epidermal and inner cells bearing wall thickenings; multicellular discoid gemmae present in some species.

Type: *Radula* Dumort. *nom. cons.*

Genus: *Radula* Dumort.

Radula Dumort., Comment. Bot.: 112. 1822.

Plants olive-yellowish green or reddish green, pinnate to bipinnately branched, branches usually obliquely spreading, sometimes dichotomously by floral innovations. Stem in cross section 5-15 celled across, usually differentiated into cortex and medulla. Leaves alternate, remote-densely imbricate, widely or obliquely spreading, conduplicately bilobed; leaf lobes ovate, obovate, rounded or apiculate-subacute at apex, entire or rarely dentate at margins; leaf lobules obliquely or widely spreading, or rarely erect, 1/2-2/3 of the lobe length, ovate, quadrate, orbicular, obovate, rectangular or lingulate, apex obtuse, subacute, blunt tip or abruptly turn out from the stem, abaxial margin straight or arched, often more or less involute at middle, often decurrent to the lobe. Underleaves absent. Dioicous or rarely

⁴ *Radula*-type: A type of branching where lateral branch arising at the base of the leaf keel, lack collar-like structure and never replacing the leaf lobule of the leaf subtending it.

monoicous. Androecia on terminal or intercalary branches; bracts in 2-20 pairs, densely imbricate; bract lobe ovate, obtuse-rounded or rarely apiculate-acute at apex, entire or rarely dentate at margins; bracts lobules ovate, usually inflated, keel strongly arched. Gynoecia terminal on main stem and branches, with 1-2 subfloral innovations or not; bract 1, rarely in 2-4 pairs, bracts lobe ovate or oblong-ovate, widely obtuse-rounded or rarely apiculate at apex, entire or dentate at margin; bracts lobules sinuate or arched. Perianth flat-cylindrical or rarely trumpet-shaped; mouth usually 2 lipped, truncate, more or less densely toothed. Seta short, massive, with numerous cells. Capsule ovoid to cylindrical, 4-valved; walls 2-layered; cells of outer layer large with nodular thickenings on radial walls; the inner layer with semi-annular or feeble nodulose thickenings. Spores minutely granulate-papillate or subechinate. Elaters long, slender, usually with bi-spiral thickenings.

Type: Radula complanata (L.) Dumort.

Key to the species of the genus *Radula*

1. Leaves strongly caducous, stem 8-9 cells cross, lobule 1/3 of the length of the lobe, trigones minute to tri-radiate.....*R. madagascariensis*
- 1a. Leaves not caducous, lobule 1/2 of the length of lobe, trigones nodulose.....2
2. Stem 6 cells across, lobule 1/2 as long as the lobe,.....*R. obscura*
- 2a. Stem 9-11 cells across, lobule 1/3 as long as the lobe,.....*R. javanica*

Radula madagascariensis Gottsche. Abhandl. Naturwis. Verein (Bremen) 7: 349.

1882. (Plate 6. Figs. 1 – 11)

Plants medium, light brown in dry herbarium, 25-40 mm long, 1-1.7 mm wide including leaves, irregularly branched, branching of *Radula*-type, intercalary-terminal; rhizoids scanty or few, rhizoid initial area convex, brown. Stem oval, brown, 151-153 x 117-125 μm in diameter, 6-8 cells across, cortical cells 28-29 in radial rows, 9-22 x 7-15 μm , thick-walled, medullary cells larger than the cortical cells, 9-25 x 7-18 μm , thick-walled, trigonous. Leaves strongly caducous, often only the scar remain on the stem, slightly imbricate, ovate, 0.8-1.2 mm long, 0.8-1 mm wide, apex broadly rounded, entire, dorsal margin convex, covering 1/3 of the stem width; apical cells quadrate to rectangular, 15-29 x 9-14 μm , median cells 16-21 x 12-18 μm , sub-quadrate, polygonal, basal cells 17-32 x 16-20 μm , sub-quadrate, polygonal, thin-walled throughout, trigones, small, tri-radiate; gemmae absent, ocelli and vitta absent. Leaf lobule sub-rectangular, 1/3 length of the lobe, apex truncate, saccate, adaxial margin straight, 0.28-0.34 mm long, 0.2-0.3 mm wide. Androecia and gynoecia not seen.

Habitat: Plants grows on moist rocks (saxicolous) or epiphytic (corticolous) in association with *Plagiochila* sp., *Trocholejeunea* sp., *Heteroscyphus* sp., *Ptychanthus* sp. and Mosses at 1500 – 1700 m asl..

Range: India, Nepal, Java, Sumatra, Indonesia, Sri Lanka, Madagascar, Mauritius Island.

Distribution in India: *Eastern Himalaya:* West Bengal-Darjeeling, Meghalaya-Mawphlong, Sikkim, **Nagaland***.

Specimen examined: Nagaland: Kohima District: Jakhama: KE 10227: 08.08.2010: Kazhuhrii Eshuo.

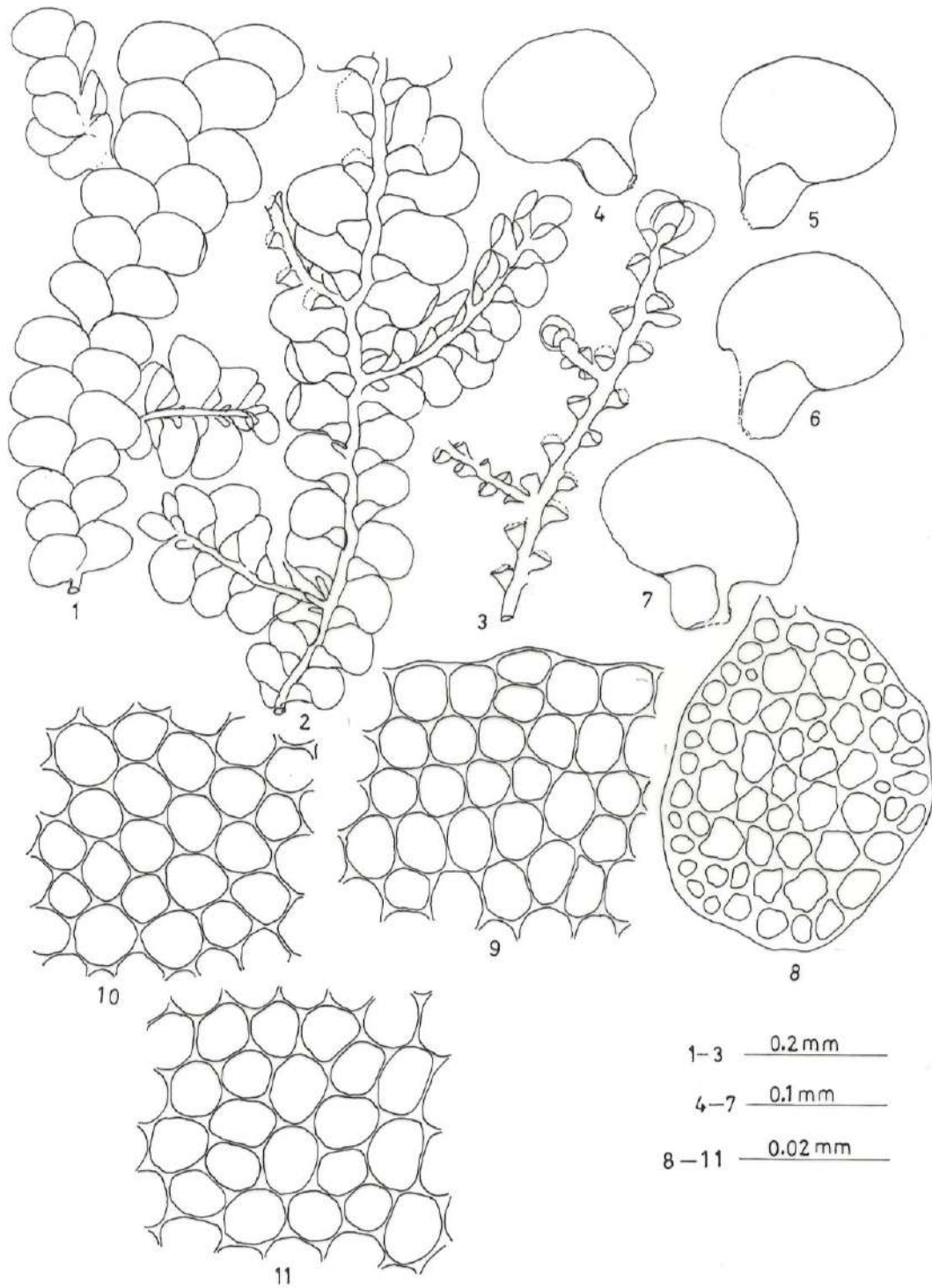


Plate 6. *Radula madagascariensis* Gottsche, Figures 1-11.

Figs. 1-3. Plant showing habit, 1- plant in dorsal view, 2- plant in ventral view, 3- plant showing denuded leaves; 4-7. Leaves; 8. Cross section of the stem; 9. Leaf apical cells; 10. Leaf median cells; 11. Leaf basal cells.

Radula obscura Mitt. Journ. Proc. Linn. Soc. London 5: 107. 1861.

(Plate 7. Figs. 1-12)

Plants small to medium, whitish green to light green, light brown in dry herbarium, 8-12 (-15) mm long, 1-.15 mm wide including leaves, branched, branching irregular, intercalary, terminal, branching of *Radula*-type. Rhizoids hyaline, and at the base of the lobule base. Stem circular, 62 x 65 µm in diameter, 4 cells across, cortical cells 11-13 in radial rows, thick walled, 6.3-12.7 x 7.6-11.7 µm in diameter, medullary cells thick walled, trigonous, 9.2-13 x 5.8-11.2 µm in diameter. Leaves distant to slightly imbricate, retuse, entire, oblong ovate, 0.7-1.0 mm long, 0.6-0.78 mm wide, apex broadly rounded; cells trigonous, triangular to nodulose trigones; apical cells 12-23 µm long, 8-14 µm wide, sub-quadrate, to sub-rectangular; median cells sub-quadrate to polygonal, 11-18 µm long, 8-13 µm wide; basal cells sub-quadrate to rectangular, 14-23 µm long, 10-20 µm wide; epidermal cells quadrate to rectangular, 8-18 µm long, 7-13 µm wide. Leaf lobule sub-quadrate, persistent, saccate, almost 1/3 of the leaf length, 0.3-0.34 mm long, 0.14-0.2 mm wide, apex truncate, obtuse, adaxial margin sinuate to straight. Oil bodies large, one per cell, finely to coarsely segmented, 11-17 x 6-11.5 µm in diameter. Androecia and gynoecia not seen.

Habitat: Plants grows on bark (corticolous), on leaves (foliicolous) in association with *Plagiochila* sp., *Trocholejeunea* sp. and Mosses at 1900-2600 m asl.

Range: India, Taiwan, Indonesia, Philippines, Thailand, Nepal, Sri Lanka.

Distribution in India: *Western Himalaya:* Himachal Pradesh, Uttarakhand; *Eastern Himalaya:* West Bengal, Meghalaya, **Nagaland***; *South India:* Tamil Nadu.

Specimen examined: Nagaland: Kohima District: Khuzama: KE 10245, 10253: 05.0.8.2010: Kazhuhrii Eshuo.

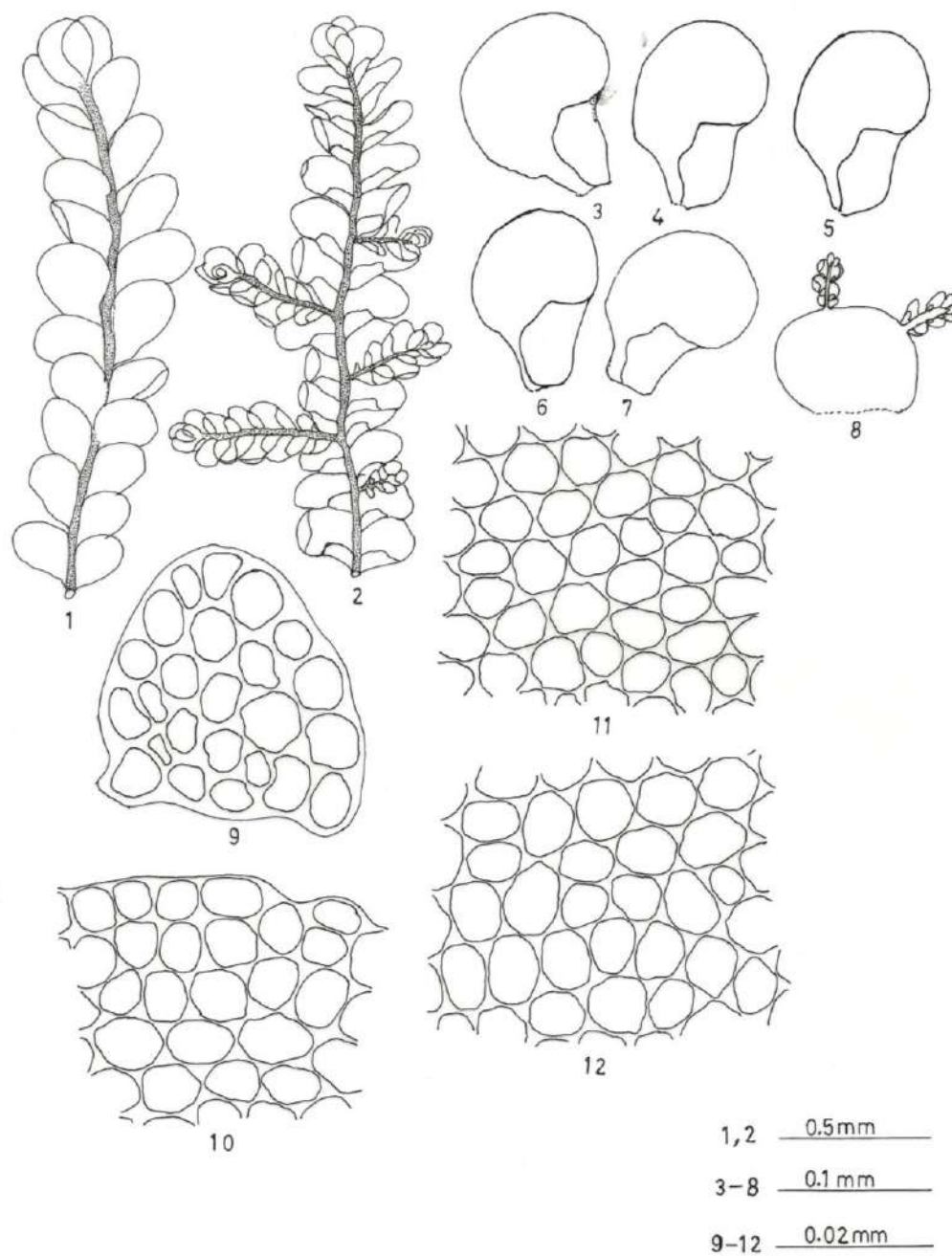


Plate 7. *Radula obscura* Mitt. Figures 1-12

Figs. 1-2. Plants showing habit, 1- plant in dorsal view and 2- plant in ventral view; 3-7. Leaves; 8. Leaf showing young plants from the leaf ocelli; 9. Cross section of the stem; 10. Leaf apical cells; 11. Leaf median cells; 12. Leaf basal cells.

Radula javanica Gottsche in Gottsche, Lindenb. et Nees, Syn. Hep.: 257. 1845.

(Plate 8. Figs. 1 – 14)

Plants light green to yellowish green, upto 25 mm long, 1.8-2 mm wide including leaves, irregularly branched, pinnately branched, branching of Radula-type; rhizoids numerous, fasciculate, arises in the middle, rhizoid-initial area slightly inflated. Stem in cross section ovoid, 150-181 x 120-130 μm in diameter, 9-11 cells across, cortical cells thick-walled, 9-18 x 8-14 μm , medullary cells thick-walled, 11-23 x 10-17 μm , trigonous, trigones large. Leaves loosely imbricate to contiguous, widely spreading, lobe ovate, 1-1.2 mm long, 0.9-1.1 mm wide, apex rounded, margin entire; lobe apical cells 9-16 x 7-12 μm , median cells 16-21 x 11-17 μm , cells isodiametric, basal cells 20-30 x 16-21 μm , cells thin-walled throughout, trigones small, intermediate thickenings absent. Cuticle nearly smooth. Ocelli and vitta absent. Oil body 1 per cell, or rarely 2 at basal cells, large, oblong, spherical, 11-22 x 8-13 μm in diameter, finely to coarsely segmented. Lobule quadrate, nearly flattened, 0.4-.05 mm long, 0.35-.48 mm wide, apex truncate, adaxial margin straight, entire, smooth, 1/3 as long as the lobe, base covering 1/2-2/3 of the stem width. Gemmae absent or sometime present. Androecia and gynoecia not seen.

Habitat: Plants grows on the tree trunks (corticolous) in association with *Heteroscyphus* sp., *Lejeunea* sp., *Metzgeria* sp. and Mosses at 1200-1650 m asl.

Range: China, Japan, India and widely distributed in tropics and subtropics of South Eastern Asia and pacific islands.

Distribution in India: *South India:* Tamil Nadu-Nilgiri Hills; *Eastern Himalaya:* Meghalaya; **Nagaland***.

Specimen examined: Nagaland: Mokokchung district: Longkhum: KE 10519: 14.04.2012: Kazhuhrii Eshuo.

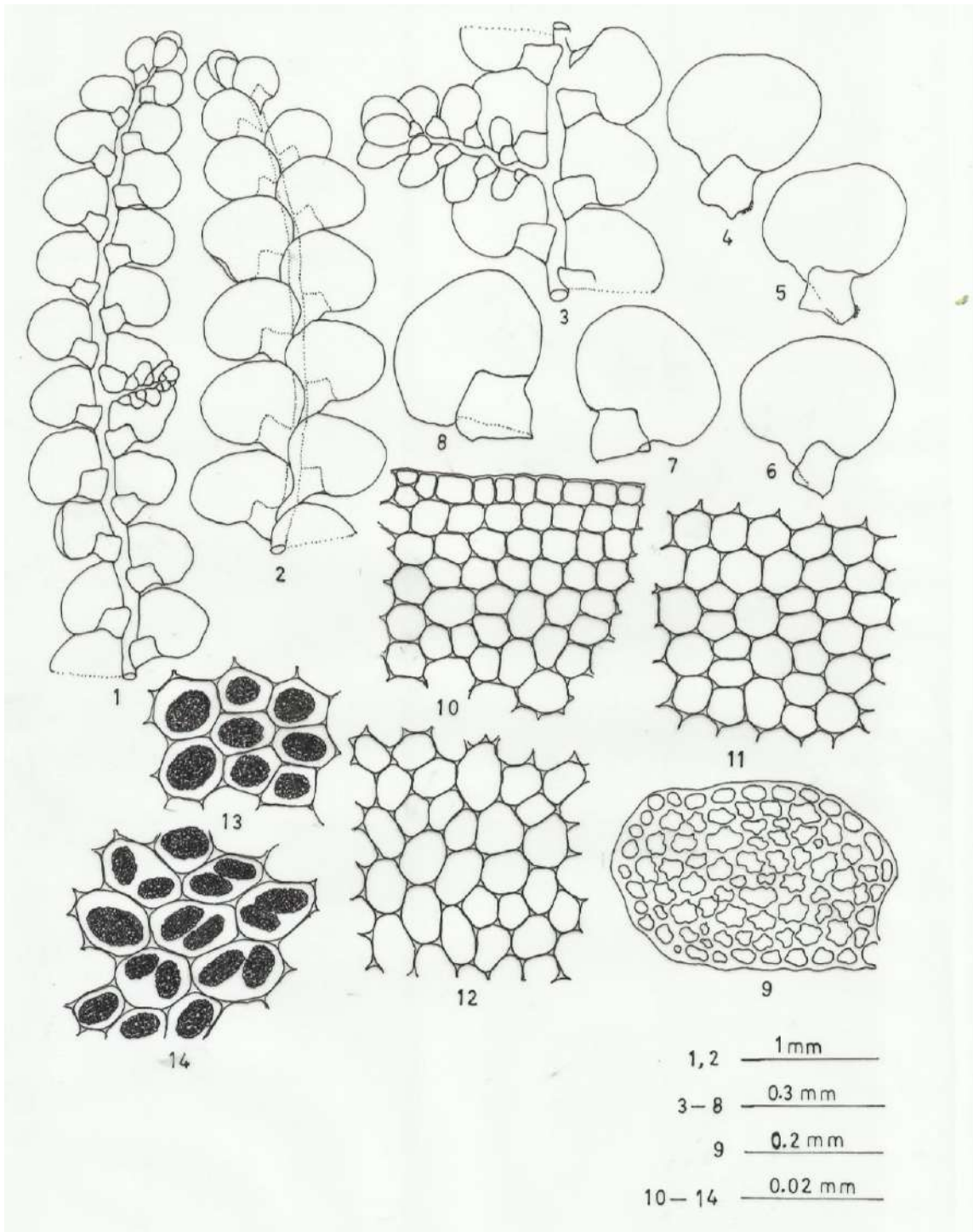


Plate 8. *Radula javanica* Gottsche. Figures 1-14

Figs. 1-3. Plants showing habit, 1- plant in ventral view, 2- plant in dorsal view, 3- enlarge ventral view; 4-8. Leaves; 9. Cross section of the stem; 10. Leaf apical cells; 11. Leaf median cells; 12. Leaf basal cells; 13-14. Oil bodies.

FAMILY: FRULLANIACEAE J.W. Lorch

FRULLANIACEAE J.W. Lorch, in G. Lindau, Krypt.-Fl. Anf. 6: 174. 1914.

Plants medium to large, dark reddish green to dull green, blackish green, pinnately branched, branching of *Frullania*-type. Stem undifferentiated, thick walled, or rarely thin walled. Leaves incubous, complicate bilobed, 3 lobed, with the dorsal lobe usually entire, the median lobule forming a *Frullania*-type water sac, and the ventral-most segment forming a uniseriate or laminar stylus or absent; cell thick walled, well mark with trigones, oil bodies spherical-elliptical or oval, 2-12 or per cell. Underleaves always present, bilobed or bifid, rarely unlobed, entire. Monoicous or dioicous. Androecia terminal, usually on short lateral branches, closely spicate; gynoecia terminal on main stem or on lateral branches, bracts in 2-5 pairs, usually dentate or lacinate, the inner most generally adnate to each other and to the bracteole. Perianth usually flattened, dorso-ventrally compressed, with 3-5 keel, mouth small with a beak. Seta short, 4-9 celled thick; capsule spherical, globose; wall 2 layered; outer layer with coarse nodular thickenings at angles; inner layer variously ornamented, often with sheet-like thickenings. Spores oblong to orbicular, spherical smooth or tuberculate or papillate. Elaters trumpet shaped, with usually unispiral thickenings.

Type: *Frullania* Raddi

Genus: *Frullania* Raddi

Frullania Raddi, Atti Soc. Ital. Medona 18: 20. 18118.

Plants medium to large, blackish green to brownish green, light green to dull green, pinnately branched, branches axillary, of *Frullania* type; stem undifferentiated, cortical cells thick walled, medullary cells thick or thin walled. Leaves imbricate,

incubous, almost transversely inserted, dorsal lobe ovate to sub-orbicular, entire; cells thick walled with tri-radiate to bulging trigones and intermediate thickenings; lobule galeate, cucullate, explanate; stylus present or absent; underleaves always present, large, bilobed or rarely entire, margin entire or undulate. Dioicous or monoicous. Androecia usually terminal on short lateral branches, globose, bracts closely imbricate, 2-5 pairs or more. Gynoecia terminal on main stem or on lateral branches without subfloral innovations; bracts in 2-5 pairs, dentate or lacinate, bracteole free or united with 1 or both bracts. Perianth usually flattened, dorso-ventrally compressed, with 3-5 keel, mouth small and forming a beak or rostrum. Seta short, 8-9 celled thick; capsule globose; wall 2 layered; cells of outer layer with coarse nodular thickenings; inner layer diversely ornamented, often with sheet-like thickenings. Spores with orbicular, oblong, brownish, papillate or with minute tubercles. Elaters trumpet shaped, truncate at free end, with uni or bi-spiral thickenings.

Type: *Frullania dilatata* (L.) Dumort.

Key to the species of the genus *Frullania*

- 1. Underleaves entire..... 2
- 1a. Underleaves bilobed..... 4
- 2. Stem 13-14 cells across, underleaf 0.6-0.8 mm long..... *F. physantha*
- 2a. Stem 6-10 cells across, underleaf 0.4-0.6 mm long..... 3
- 3. Stem 6-8 cells across, lobule helmet shaped, cucullate, parallel to the stem, apex acute, with a prominent beak..... *F. retusa*
- 3a. Stem 9-10 cells across, lobule cap shaped, beak long..... *F. rotundistipula*
- 4. Leaves lobes squarrose..... 5
- 4a. Leaves lobes not squarrosa..... 6

5. Leaves fragile, denuded, lobule helmet shaped, explanate, mouth truncate, oil bodies 2-5 per cell, finely segmented..... *F. ericoides*
- 5a. Leaves not fragile, incurved when dry, lobule saccate, vertex rounded, apex obliquely truncate..... *F. squarrosa*
6. Stem 8-9 cells across, thick walled, trigones tri-radiate, lobule dimorphic, galeate and explanate..... *F. muscicola*
- 6a. Stem 9-14 cells across, trigones nodulose, lobule not dimorphic..... 7
7. Female bracts irregularly dentate, spores brownish green..... *F. araca*
- 7a. Female bracts not irregularly dentate, entire..... 8
8. Lobule helmet shaped, underleaf distant and decurrent..... *F. nepalensis*
- 8a. Lobule galeate, underleaf imbricate and non-decurrent..... *F. galeata*

***Frullania phisantha* Mitt. J. Proc. Linn. Soc. Bot. 5: 121. 1861. (Plate 9. Fig. 1-15)**

Plant medium, brownish green to brown, 30-40 mm long, 2-3 mm wide including leaves, pinnately branched, intercalary, terminal, *Frullania* type of branching, rhizoids confined to the basal part mostly, in tuft at base of the ventral leaves. Stem brown, circular, 13-14 cells across, cortical cells thick walled, 8.8 μm -15.6 μm long, 11.2 μm -19.8 μm wide, medullary cells slightly thinner than the cortical cells, 17.6 μm -26.4 μm long, 6.6 μm -19.8 μm wide, cells trigonous. Leaves complicate bilobed, imbricate, closely packed, oblong to ovate, entire, apex incurved, 1.2-1.3 mm long, 0.9-1.1 mm wide, broadest at base, cells trigonous, trigones nodules like, basal cells 24.2 μm -44.0 μm long, 12.1 μm -28.6 μm wide, central cells 22.0 μm -30.8 μm long, 12.1 μm -22.0 μm wide, epidermal cells 15.4 μm -18.7 μm long, 9.9 μm -13.2 μm wide. Under leaves contiguous to slightly imbricate, bilobed, 0.6-0.8 mm long, 0.9-1.0 mm wide, wider than long, cordate at base, basal cells 22.0-37.2 μm

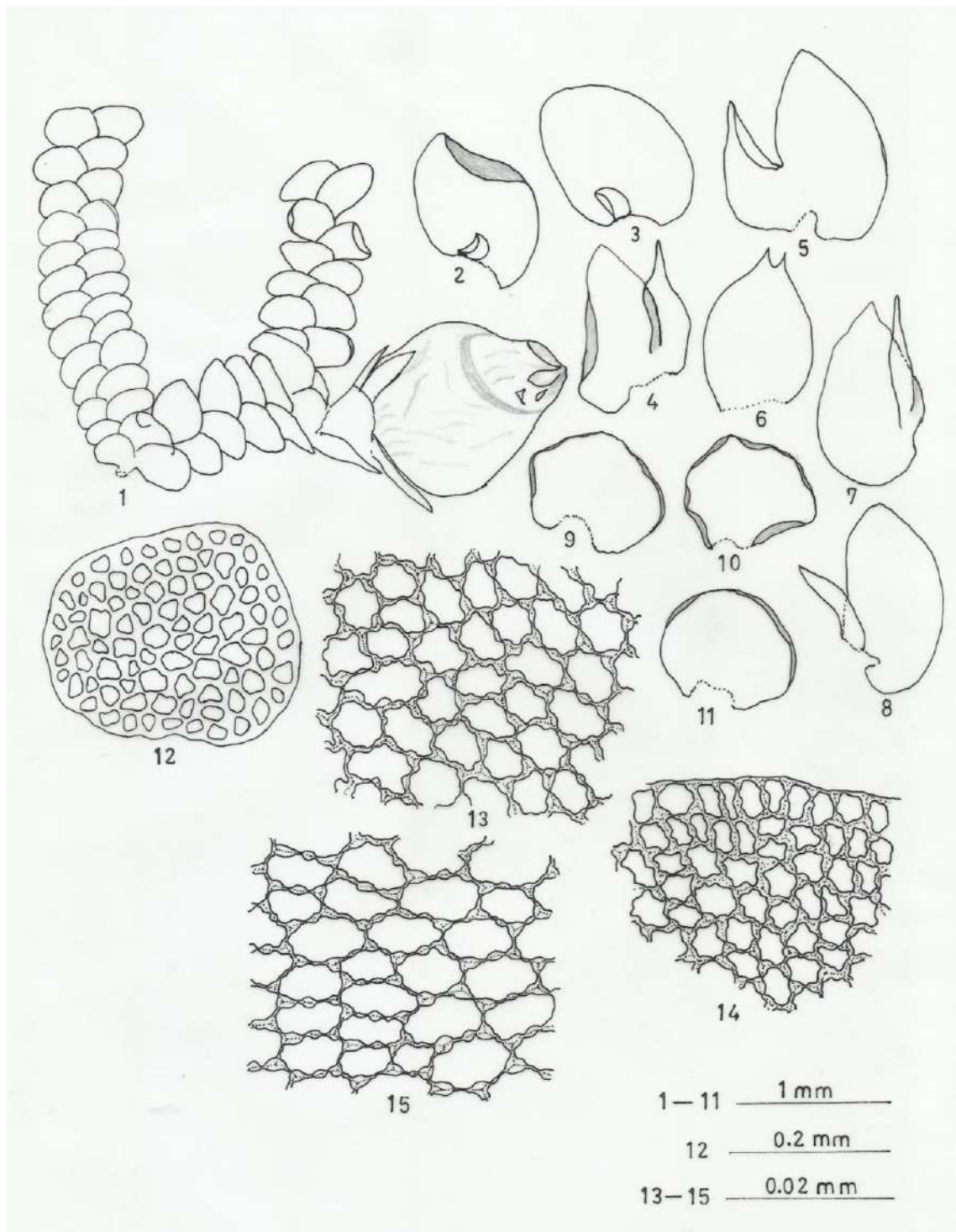


Plate 9. *Frullania physantha* Mitt.; Figures 1-15.

Figs. 1. A portion of plant in dorsal view; 2-3. Leaves; 4-8. Female bracts; 9-11. Underleaves; 12. Cross section of stem; 13. Leaf median cells; 14. Leaf apical cells; 15. Leaf basal cells.

long, 9.9 μm -22.0 μm wide, central cells 13.2 μm -24.2 μm long, epidermal cells 13.2-25.3 μm long, 13.2 μm -18.7 μm wide. Lobule beak long, helmet like. Female sporophyte borne on the main branched at apex or on the lateral branched at apex, the perianth is fully enclosed by bracts, only the perianth tip is visible, bracts 3, the uppermost bract covers the whole of the sporophyte, toothed, perianth 4-6 keeled. Sporophyte foot and seta present, spores circular to oval, green and brownish red patches with circular dots seen in the spores, spherical, 46-48.8 μm in diameter, elaters long, mono-spiral, 6.6-8.4 μm in diameter.

Habitat: Plants grows on bark of trees (corticolous) in association with *Frullania* sp., *Lejeunea* sp. and Mosses at 1500-1700 m asl.

Range: India

Distribution in India: *Eastern Himalaya:* Sikkim and **Nagaland***.

Specimen examined: Nagaland: Kohima District: Khuzama: KE 10100: 16.11.2009: Kazhuhrii Eshuo.

Frullania retusa Mitt., J. Proc. Linn., Bot. 5: 119. 1861. (Plate 10. Figs 1-18)

Plant brownish green to reddish brown in dry herbarium, stem upto 40-60 mm long, 2 mm wide including leaves, irregularly branched, primary branched 15-25 mm long, secondary 5-10 mm long, branching of *Frullania* type; rhizoids in bunch at the base and middle region of the underleaf. Stem brownish red, oval, 121-127 x 156-163 μm in diameter, 6-8 cells across, cells undifferentiated, thick-walled, 13-23 x 9-16 μm , trigonous. Leaves imbricate, widely spreading, often breaking off the margin, ovate-oblong, 0.8-1.0 mm long, 0.6-0.8 mm wide, incurved apices, apex rounded to obtuse, margin entire; apical cells 14-21 x 11-16 μm , quadrate to sub-quadrate, median cells 18-26 x 15-21 19-36 x 115-31 μm , sub-quadrate, polygonal, basal cells 19-36 x 115-31 μm , ovate, sub-quadrate or polygonal; cells trigonous, trigones medium

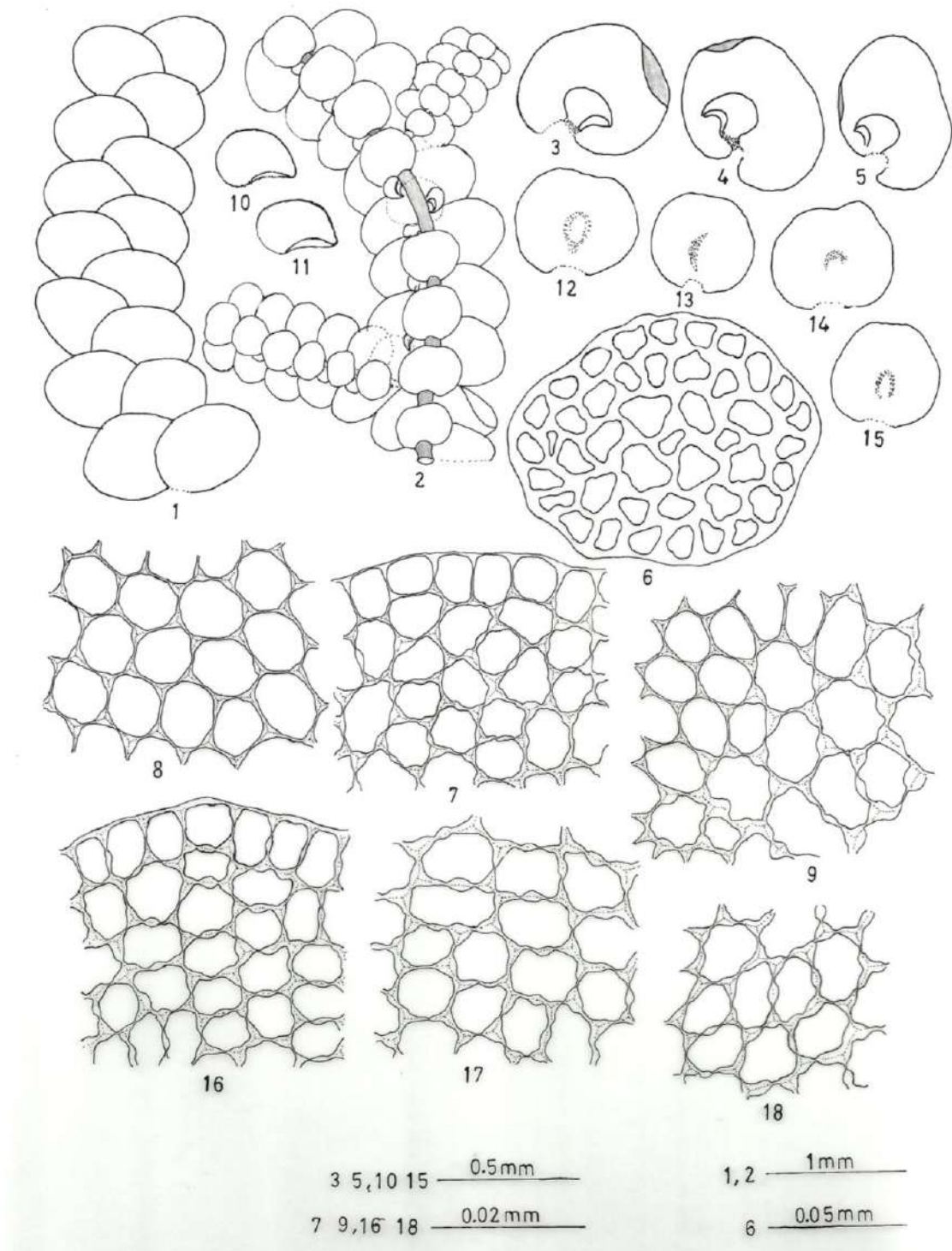


Plate 10. *Frullania retusa* Mitt., Figures 1-18.

Figs. 1. A portion of plants in dorsal view; 2. A portion of plant in ventral view; 3-5. Leaves; 6. Cross section of stem; 7. Leaf apical cells; 8. Leaf median cells; 9. Leaf basal cells; 10-11. Lobules; 12-15. Underleaves; 16. Underleaf apical cells; 17. Underleaf median cells; 18. Underleaf basal cells.

to large, nodulose and with intermediate thickenings. Lobule helmet-shaped, erect, with a prominent beak, apex acute, mouth wide. Underleaves distant, large, appressed to the stem, orbicular, reniform, 0.4-0.5 mm long, 0.55-0.6 mm wide, as broad as long, rotundate or retuse at apex, transversely inserted, margin entire and rhizoids arises from the bases of the underleaf. Androecia and gynoecia not seen.

Habitat: Plants grows epiphytically on tree bark (corticolous) in association with *Plagiochila* sp., *Bazzania* sp., *Lejeunea* sp. and Mosses at 2000-2713 m asl.

Range: India, Nepal and China.

Distribution in India: *Western Himalaya:* Himachal Pradesh, Uttarakhand; *Eastern Himalaya:* West Bengal, Sikkim, Meghalaya, **Nagaland***.

Specimen examined: Nagaland: Kohima District: Japfu Peak: KE 10377: 17.03.2011: Kazhuhrii Eshuo.

Frullania rotundistipula Steph., Hedwigia 33: 147. 1894. **(Plate 11. Figs. 1-15)**

Plant medium, brownish green to blackish green, 35-40 mm long, 2 mm wide including leaves, branched, branching irregular, *Frullania*-type. Rhizoids in tuft on the base of underleaves sometimes in the middle of the under leaves, hyaline, transparent. Stem circular, 180-209 x 150-170 μm in diameter, 9-10 cells across, cortical cells thick walled, trigonous, 8.6-15.4 μm long, 10.5-16.3 μm wide, medullary cells thick walled, 15.6-21.9 μm long, 9.6-17.4 μm wide. Leaves closely imbricate, obvate-oblong, entire, 1.0-1.2 mm long, 1.0-1.3 mm wide, broader than long, cells trigonous, trigones tri-tetra radiate, basal cells 15.4-26.5 μm long, 14.3-19.4 μm wide, central cells 21.4-28.9 μm long, 14-16.3 μm wide, epidermal cells 10-16.3 μm long, 10.6-20.2 μm wide. Underleaves orbicular, distant, oblong, entire, retuse, 0.50-0.55 mm long, 0.7-0.8 mm wide, wider than long, sinus very short, wide,

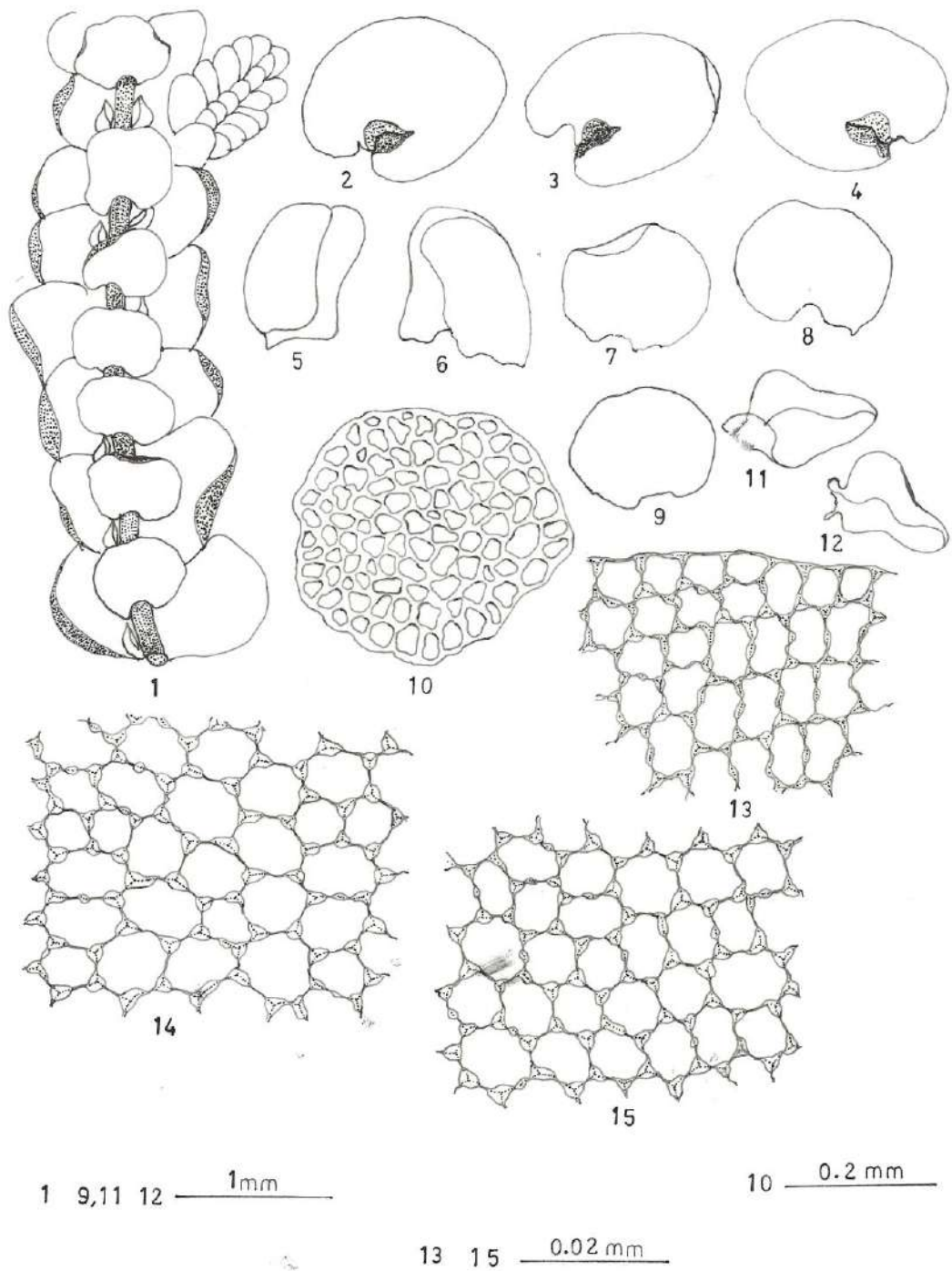


Plate 11. *Frullania rotundistipula* Steph., Figures 1-15.

Figs. 1. A portion of plant in ventral view; 2-4. Leaves; 5-6. Male bracts; 7-9. Underleaves; 10. Cross section of stem; 11-12. Lobules; 13. Leaf apical cells; 14. Leaf median cells; 15. Leaf basal cells.

cells thick walled, trigonous, cells 12.2-18.4 μm long, 4.6-11.4 μm wide. Lobule cap-shape, beak long, length ratio 1:1 with beak, 0.4-.6 mm long, 0.15-0.4 mm wide, cells trigonous, like the cells of the underleaves. Male inflorescent born on short lateral branched, 5-9 pairs of bracts, entire, bilobed, sinus wide, short, oblong-obtuse, antherozoids 1-3 per bract. Gynoecia not seen.

Habitat: Plants grows epiphytically on tree bark (corticolous) in association with *Plagiochila* sp., *Frullania* sp., and Mosses at 1200- 1500 m asl.

Range: India and china.

Distribution in India: *Eastern Himalaya:* Meghalaya, **Nagaland***.

Specimen examined: Nagaland: Kohima District: Chakhabama: KE 10283: Kazhuhrii Eshuo.

Frullania ericoides (Nees) Mont., in Ann. Sci. Nat. Bot. 12: 51. 1839.

(Plate 12. Figs. 1-13)

Plants brownish green to reddish green, pale dark green, 20-45 mm long, 1-1.5 mm wide including leaves, irregularly branched, pinnately branched, branching of *Frullania*-type; rhizoids in tuft at the bases of the underleaf and on the middle of the underleaf. Stem circular, 0.17-0.20 x 0.15-0.16 mm in diameter, 9-10 cells across, cells undifferentiated into cortex and medulla region, thick-walled, 13-25 x 8-20 μm , trigonous. Leaves imbricate to contiguous, obliquely spreading, lobes squarrose, ovate-oblong, 0.75-1.2 mm long, 0.6-0.8 mm wide, apex rounded, incurved, interior margin bent upward and thereby become depressed at upper surface, base auriculate; marginal cells 12-22 x 10-16 μm , quadrate, to sub-quadrate, median cells 20-27 x 18-23 μm , quadrate, sub-quadrate, basal cells 22-35 x 18-27 μm , quadrate, cells thin-walled, trigones large, nodulose, intermediate thickenings present. Oil bodies 2-5 per cell, circular, oval or spherical, 4-9 μm in diameter, finely segmented. Lobule saccate,

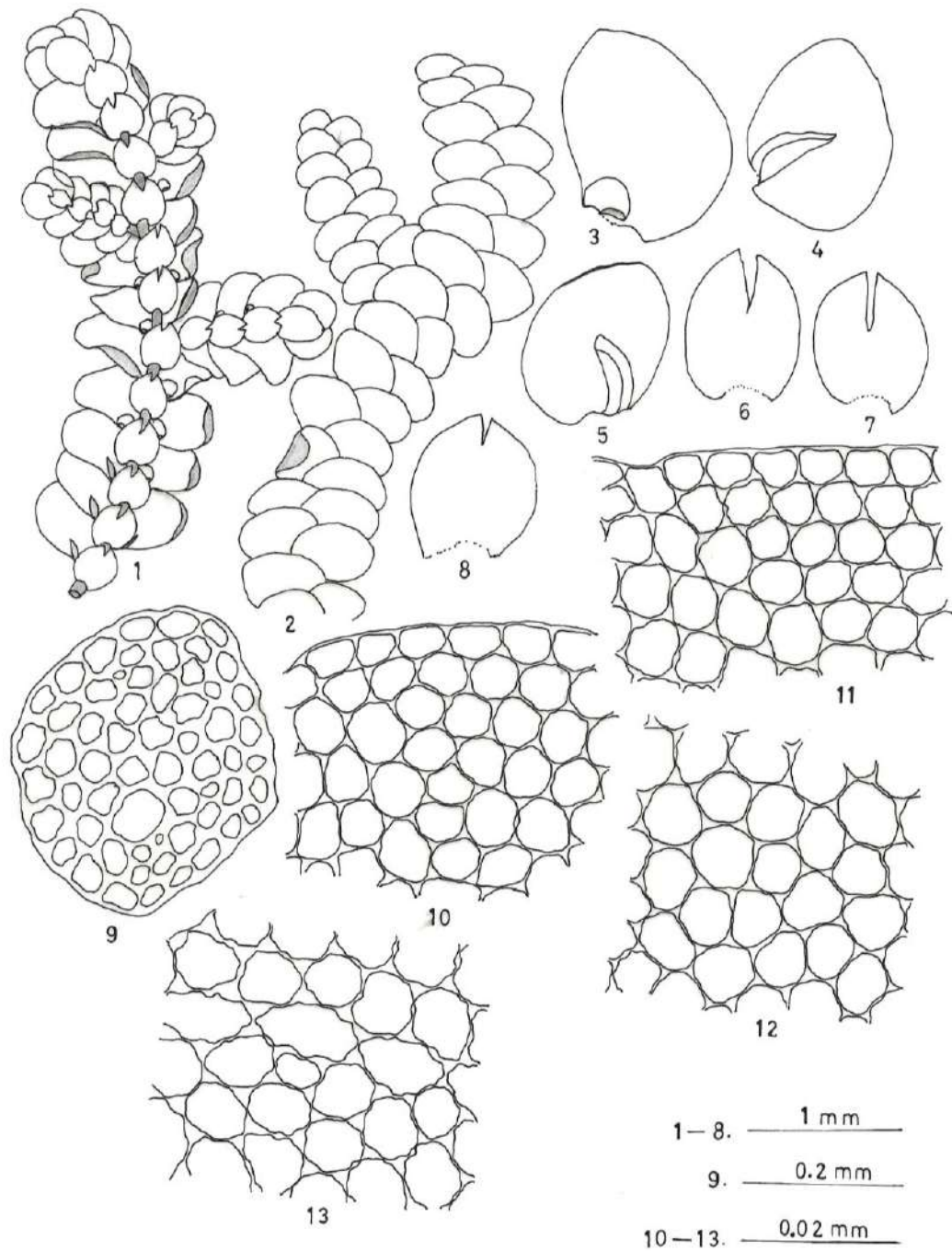


Plate 12. *Frullania ericoides* (Nees) Mont., Figures 1-13.

Figs. 1. A portion of plant in ventral view; 2. A portion of plant in dorsal view; 3-5. Leaves; 6-8. Underleaves. 9. Cross section of stem; 10. Leaf apical cells; 11. Leaf marginal cells; 12. Leaf median cells; 13. Leaf basal cells.

helmet shaped, explanate, mouth truncate. Underleaves contiguous to slightly distant, ovoid, 0.35-0.45 mm long, 0.4-0.48 mm wide, slightly broader than long, bilobed to 1/3-1/4 of the length, sinus wide, lobe acute, margin entire and incurved. Androecia and gynoecia not seen.

Habitat: Plants grows epiphytically or on moist rocks in association with *Plagiochila* sp., *Ptychanthus* sp., *Frullania* sp., *Lejeunea* sp., *Bazzania* sp. and Mosses at 900-1200 m asl.

Range: India, Nepal, Bhutan, China, Japan, Korea, Philippines, Melanesia, Europe, Africa, Australia, North, Central and South America, Indonesia.

Distribution in India: *Western Himalaya:* Himachal Pradesh, Uttarakhand; *Eastern Himalaya:* West Bengal, Meghalaya, Nagaland; *central India:* Madhya Pradesh; *Western Ghats:* Karnataka, Tamil Nadu; Andaman and Nicobar Island.

Specimen examined: Nagaland: Mokokchung District: Longkhum: KE 10147: 12.09.2009: Mopungchuket: KE 10237: 23.09.2009: Kazhuhrii Eshuo; Kohima District: Khonoma: KE 10442: 19.03.2011: Kazhuhrii Eshuo.

Frullania squarrosa Dumort. Rec. D' Obs. 13: 1835. (Plate 13. Figs. 1-15)

Plant small to medium, light yellowish green to brownish green, stem 30-60 mm long, 1-1.5 mm wide including leaves, branched, irregularly branched, *Frullania* type; rhizoids in tuft or bunch at the bases of underleaf. Stem brown, circular, 0.18 x 0.21 mm in diameter, 9-10 cells across, cortical cells thick wall, 12.1-24.4 μm long, 8-18.7 μm ; medullary cells thinner than the cortical cells, trigonous, 16.5-30.8 μm long, 10-20.0 μm wide. Leaves closely imbricate, orbicular, squarrose, ovate, 1-1.4 mm long, 0.9-1.2 mm wide; apex rounded, incurved, margin entire, basal slightly cordate; apical cells rectangular-sub-quadrate, squarrose, 14.9-19.7 μm long, 8.6-17.0 μm wide, trigonous, trigones nodulose, bulging, intermediate thickening of walls present; median cells quadrate, rectangular, squarrose, 22.9-35.0 μm long, 15.2-23.5 μm wide, trigonous, trigones nodulose, bulging, intermediate thickening of walls present; basal cells sub-quadrate, squarrose, 27.5-37.5 μm long, 17.6-22.3 μm wide, trigonous,

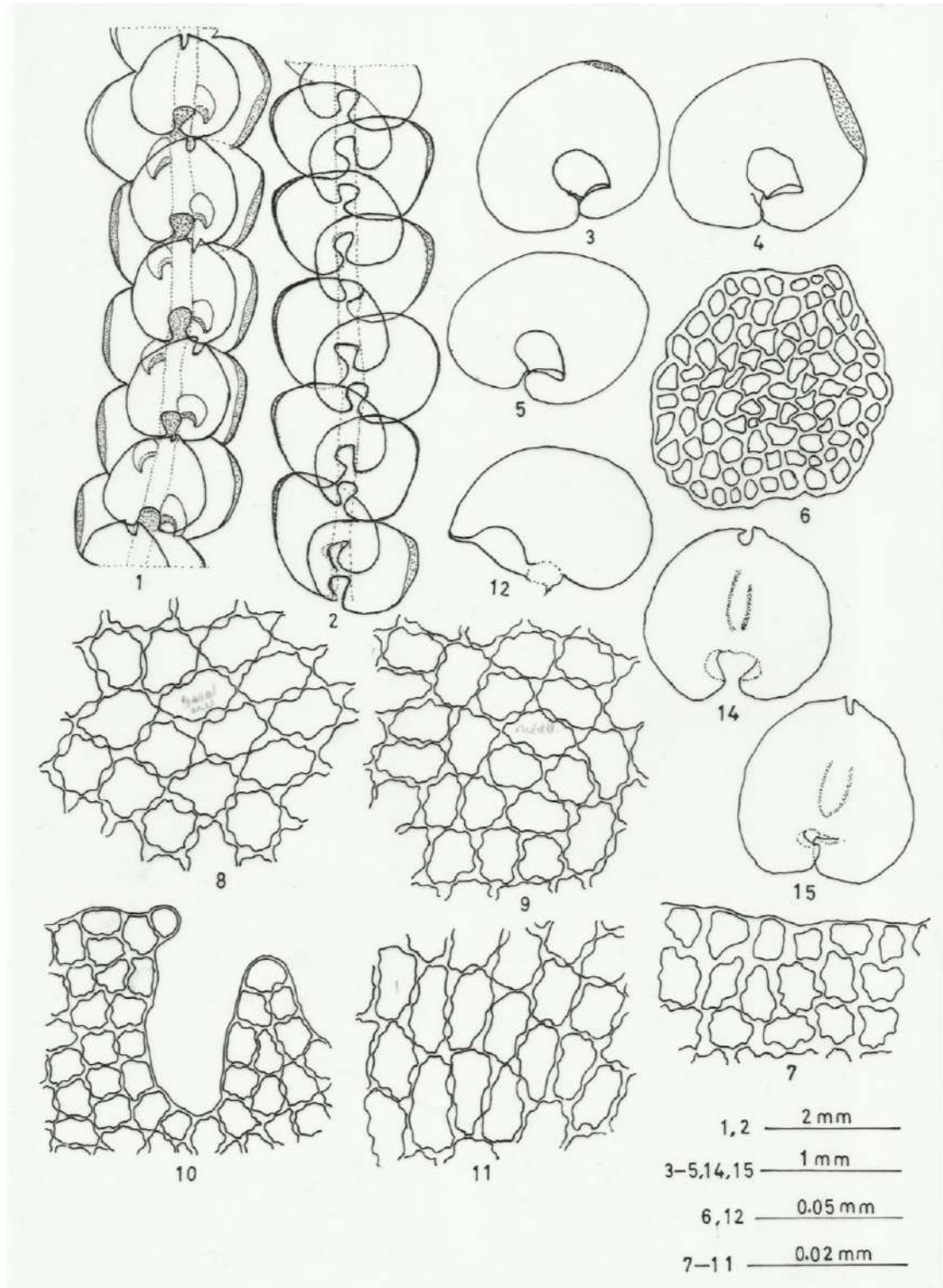


Plate 13. *Frullania squarrosa* Dumort., Figures 1-15.

Figs. 1. A portion of plant in ventral view; 2. A portion of plant in dorsal view; 3-5 & 12. Leaves; 6. Cross section of stem; 7. Leaf apical cells; 8. Leaf median cells; 9. Leaf basal cells; 10. Underleaf apical cells; 11. Underleaf median cells; 14-15. Underleaves.

trigones nodulose, bulging, intermediate thickening of walls present. Leaves lobules basal cells; 10. Underleaf apical cells; 11. Underleaf median cells; 14-15. Underleaves. saccate, helmet like, vertex rounded, apex obliquely truncate, forming obtuse rostrum, beak short and 0.25 x 0.40 mm in diameter. Underleaves distant, orbicular, ovate, 0.6-1.1 mm long, 0.9-1.2 mm wide, sinus short, narrow, obtuse, sinus 1/5-1/6 of the length of underleaf, margin entire, cells trigonous and like the cells of the leaves.

Habitat: Plants grows epiphytically (corticolous) or on moist rocks (saxicolous) in association with *Heteroscyphus* sp., *Trocholejeunea* sp., *Plagiochila* sp. and Mosses at 1050-1200 m asl.

Range: India, Japan, Formosa, Korea, Australia, North and South America.

Distribution in India: *Eastern Himalaya: Nagaland**.*

Specimen examined: Nagaland: Kohima district: Jakhama: KE 10271: 08.08.2010: Kazhuhrii Eshuo.

Frullania muscicola Steph., Hedwigia 33: 146. 1894. (Plate 14. Figs. 1-18)

Plants medium, dull green to brownish green, 12-30 mm long, 1.5-2 mm wide including leaves, pinnately branched, branching of *Frullania*-type, or sometimes irregularly branched. Rhizoids hyaline, colourless, and confined at the bases of the underleaf. Stem in cross section orbicular, circular, 135-145 x 169-175 μm in diameter, cells undifferentiated, thick walled, 8-9 cells across, trigonous, 12-29.5 x 6.5-18.7 μm . Leaves imbricate to closely imbricate, entire, oblong-ovate, orbicular, 0.8-1 (-1.5) mm long, 0.7-1 mm wide; margin entire, apex rounded, incurved; cells trigonous, leaf epidermal cells 9.9-14.9 μm long, 10.4-14.3 μm wide, quadrate, rectangular, trigones tri-radiate; median cells 17-25 μm long, 12.3-21.5 μm wide, subquadrate, polygonal, trigones tri-radiate, sometimes with intermediate thickenings; basal cells 20-35.5 μm long, 12.4-28.5 μm wide, quadrate, ovoid to suborbicular, trigones large, tri-radiate to nodulose. Leaf lobule dimorphic, galeate, explanate-

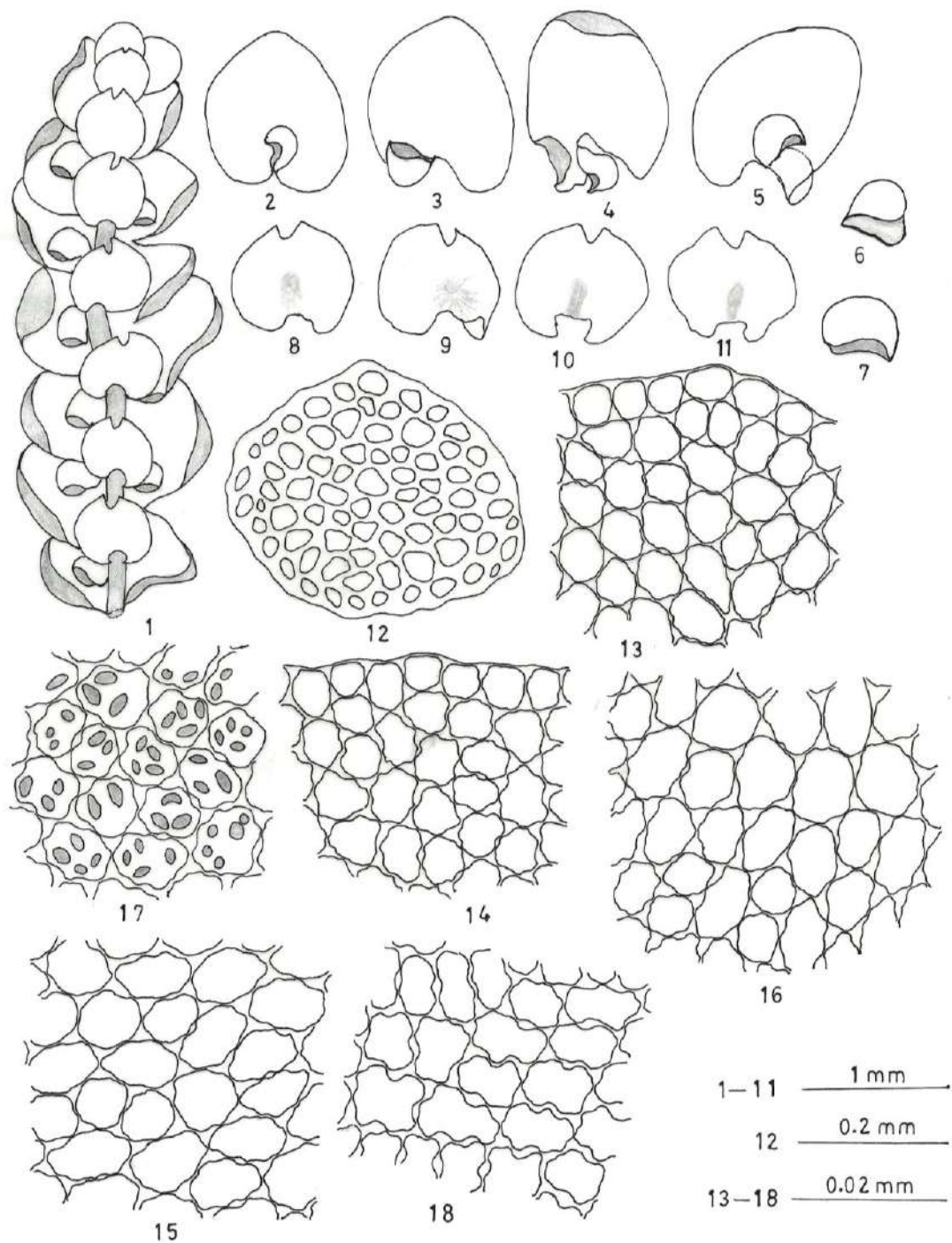


Plate 14. *Frullania muscicola* Steph., Figures 1-18.

Figs. 1. A portion of plant in ventral view; 2-5. Leaves; 6-7. Lobules; 8-11. Underleaves; 12. Cross section of stem; 13. Leaf apical cells; 14. Leaf marginal cells; 15. Leaf median cells; 16. Leaf basal cells; 17. Leaf oil bodies; 18. Underleaf median cells.

ligulate, saccate, 0.2-0.4 mm long, 0.25-0.35 mm wide, stylus 4-5 cells long. Underleaves distant, reniform, entire to angulate, 0.35-0.65 mm long, 0.3-0.52 mm wide, bifid, 1/3 to 1/2 of the length lobe, sinus narrow, acute, divergent. Perianth terminal on the main stem or on lateral branched, apical beak small, bracts 2-3 pairs, oblong-ovate, entire, lobule explanate; bracteole oblong, sinus deep. Sporee and elaters not seen.

Habitat: Plants grows epiphytically on trees barks (corticolous) in association with *Plagiochila* sp., *Lejeunea* sp., *Frullania* sp. and Mosses at 1500-2000 m asl.

Range: India, Nepal, China, Japan, Korea.

Distribution in India: *Western Himalaya:* Himachal Pradesh, Uttarakhand; *Eastern Himalaya:* Sikkim, Assam, Meghalaya, Nagaland; *Western Ghats:* Tamil Nadu.

Specimen examined: Nagaland: Kohima District: Jakhama: KE 10272: 08.08.2010; Viswema: KE 10304: 08.08.2010: Kazuhrii Eshuo; Mokokchung District: Mopungchuket: KE 10237: 23.09.2009: Kazuhrii Eshuo

Frullania arecae (Spreng.) Gottsche, Mexik. Leverm. 236. 1863.

(Plate 15. Figs. 1-22)

Plant medium, brownish green, brown, pale green, 30-40 mm long, 2-3 mm wide including leaves; branched, branching irregular, *Frullania*-type of branching. Rhizoids in bunch or tuft at the base of underleaves. Stem circular, oval, 0.2 x 0.26 mm in diameter, cells thick walled, trigonous, cells 15.4-26.4 x 11-19.8 μm . Leaves complicate imbricate, closely packed, ovate, orbicular, 1-1.2 mm long, 0.8-1.2 mm wide, broadest at base, entire, apex incurved, cordate at base; cells trigonous, trigones nodulose, bulging, large; marginal cells 16.5-22.0 μm long, 11-17.6 μm wide, middle cells 19.8-28.6 μm long, 13.2-22.0 μm wide, basal cells 22-37.5 μm long, 18.7-24.2 μm wide. Oil bodies circular, elongate or elliptical, small, 4-0.9 μm long, 4-5.3 μm

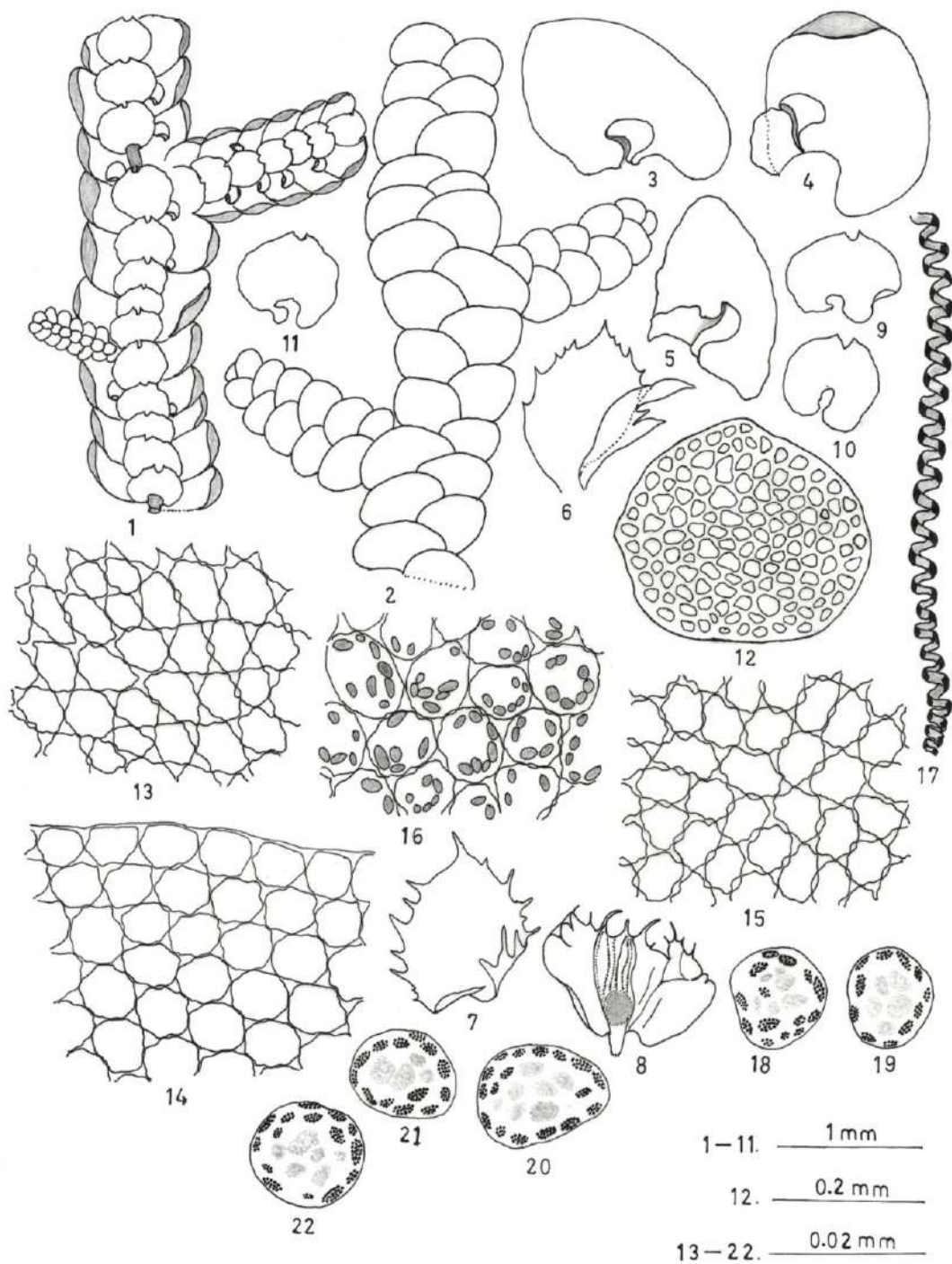


Plate 15. *Frullania arecae* (Spreng.) Gottsche, figure 1-22.

Figs. 1. A portion of plant in ventral view; 2. A portion of plant in dorsal view; 3-5. Leaves; 6-8. Female bracts; 9-11. Underleaves; 12. Cross section of stem; 13. Leaf basal cells; 14. Leaf apical cells; 15. Leaf median cells; 16. Leaf oil bodies; 17. Elater; 18-22. Spores.

wide, finely segmented. Leaves lobule small, helmet shape, attached to base of the leaves base and the stem. Underleaves imbricate to contiguous, bilobed, margin entire, recurved, 0.6-0.8 mm long, 0.9-1.0 mm wide, broadest at middle, sinus short, narrow to wide; cells trigonous, trigones nodulose and like the leaves cells. Female inflorescence borne on the main terminal branched or on short lateral branched terminal, 3 pairs of bracts, bracts densely or sharply toothed, teeth spinose, uppermost bract enclosed the whole of perianth and only the perianth tip is visible, perianth keel 4-6; spores circular to oval, spherical, spores brownish green, green patches present, surface smooth, 33-49.5 x 27.5-37.4 μm in diameter. Elater mono-spiral, long, coil like a spring, 5.5 μm in diameter, upto 286 μm long.

Habitat: Plants grows epiphytically on tree bark (corticolus) in association with *Plagiochila* sp., *Frullania* sp., and Mosses at 1200-1700 m asl.

Range: India and China.

Distribution in India: *Eastern Himalaya:* Meghalaya, Sikkim, Nagaland.

Specimen examined: Nagaland: Kohima District: Khuzama; KE 10167: 16.11.2009: Kazhuhrii Eshuo; Mokokchung District: Longkhum: KE 10141: 12.09.2009: Kazhuhrii Eshuo.

Frullania nepalensis (Spreng.) Lehm, & Lindenb., in Leh. Pugillus 4: 19. 1832.

(Plate 16. Figs. 1 – 18)

Plant small to medium, light green to yellowish green, brownish green, 80-90 mm long, 1.5-2 mm wide including leaves, branched, pinnately branched, secondary branched 30-40 mm long and tertiary branched 3-8 mm long. Rhizoids scarce, hyaline, transparent, confined near the base of the under leaf. Stem circular to oval, 9-10 cells across, 1 thick cortical cells, medullary cells thin, cells trigonous, cortical cells 12.8 μm -16.7 μm long, 5.4 μm -12.6 μm wide, medullary cells 15.2 μm -32.3 μm long, 9.6 μm -17.5 μm wide. Leaves imbricate, closely packed, entire, oblong, apex obtuse, 1-1.2 mm long, 0.8-1.1 mm wide, cells trigonous, trigones like nodular, star like, basal cells 17.3 μm -42.2 μm long, central cells 14.1 μm -21.6 μm long, 6.5

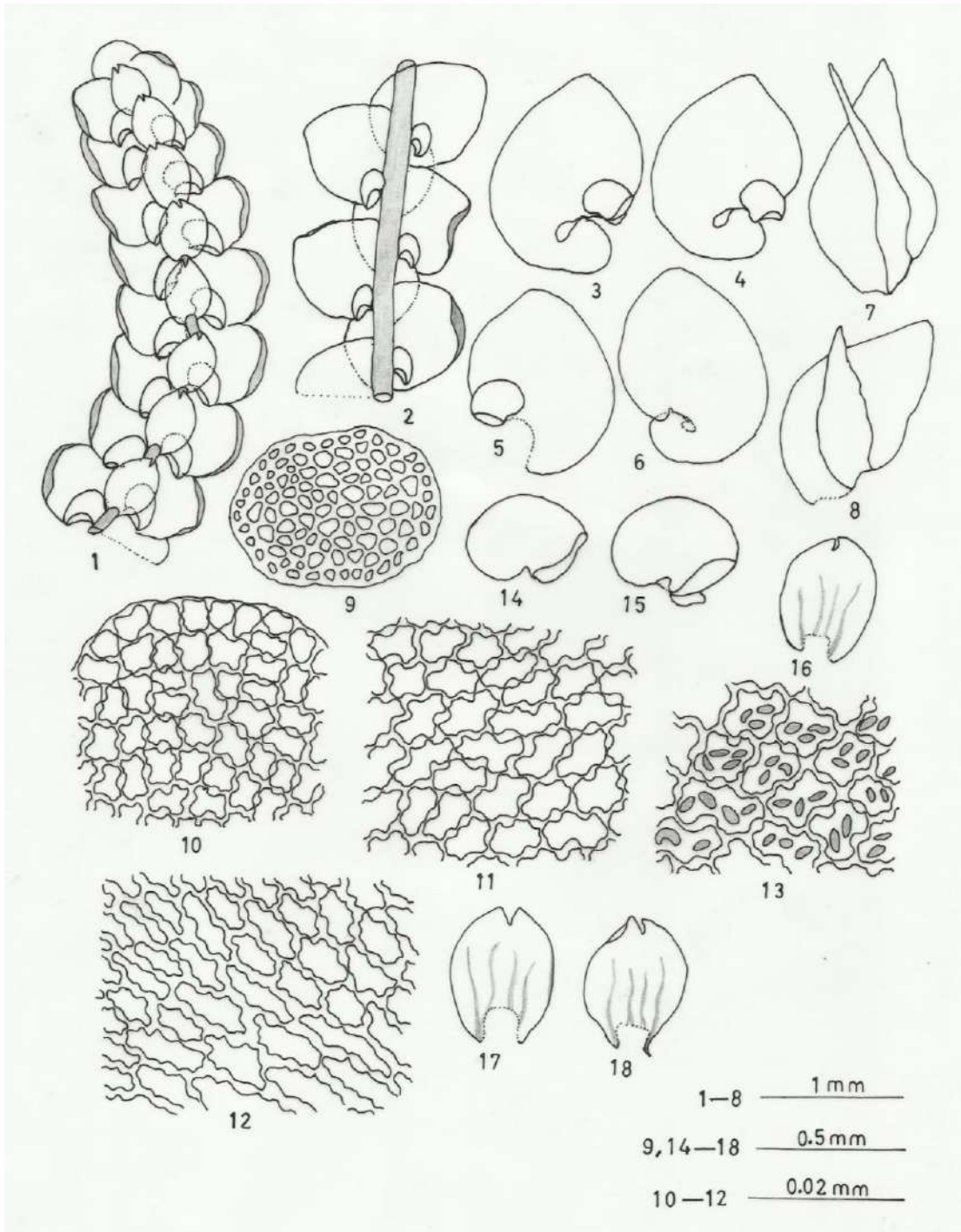


Plate 16. *Frullania nepalensis* (Spreng.) Lehm. & Lindenb., figures 1-18.

Figs. 1. A portion of plant in ventral view; 2. Ventral view showing lobule attachment; 3-6. Leaves; 7-8. Femal bracts; 9. Cross section of stem; 10. Leaf apical cells; 11. Leaf median cells; 12. Leaf basal cells; 13. Leaf oil bodies; 14-15. Lobules; 16-18. Underleaves.

µm-12.6 µm wide, epidermal cells 10.6 µm-16.7 µm long, 5.3 µm-11.3 µm wide, oil bodies circular, oval, elongated, 3-5 per cell, 3-5.5 µm long, 1.4-2.7 µm wide. Lobules small, helmet shape, beak short, 0.04-0.06 mm long, 0.032-0.04 mm wide. Under leaves distant, bilobed, 0.5-0.7 mm long, 0.32-0.55 mm wide, cells trigonous, trigones like leaves cells. Sporophytes not seen.

Habitat: Plants grows epiphytically on trees bark (corticolous) in association with *Plagiochila* sp., *Frullania* sp., *Lejeunea* sp., *Ptychanthus* sp. and Mosses at 1500-2700 m asl.

Range: India, Nepal, China, Philippines, Korea, Japan, Thailand.

Distribution in India: *Eastern Himalaya:* Assam, Meghalaya, Sikkim, West Bengal, Nagaland*.

Specimen examined: Nagaland: Kohima District: Khuzama: Khuzama: KE10166: 16.16.2009: Kazhuhrii Eshuo; Japfu Peak: KE 10385: 17.03.2010: Kazhuhrii Eshuo.

Frullania galeata (Reiwn., Nees & Blume) Dumort., Recueil Observ. Jungerm. 13:

13. 1835.

(Plate 17. Figs. 1-19).

Plants medium, brownish green to reddish green, pale green or green, dark brown in dry herbarium, 15-35 mm long, 2 mm wide including leaves, branched, irregular, of *Frullania*-type. Rhizoids in tuft at the bases of underleaf, hyaline, transparent. Stem circular, 0.15-0.16 x 0.13-0.14 µm in diameter, 9-10 cells across, thick-walled, cortical cells 8.5-17 x 5.6-14 µm, medullary cells 12-17 x 6-16 µm, cells trigonous. Leaves closely imbricate, complicate imbricate, oblong-ovate, 0.8-1.1 mm long, 0.7-0.9 mm wide, margin entire, apex rounded, incurved, recurved; apical cells 12-21 x 9-16 µm, sub-quadrate, trigonous, trigones nodulose; median cells 19-26 x 11-21 µm, sub-quadrate, trigones nodulose, bulging, intermediate thickenings present; basal cells

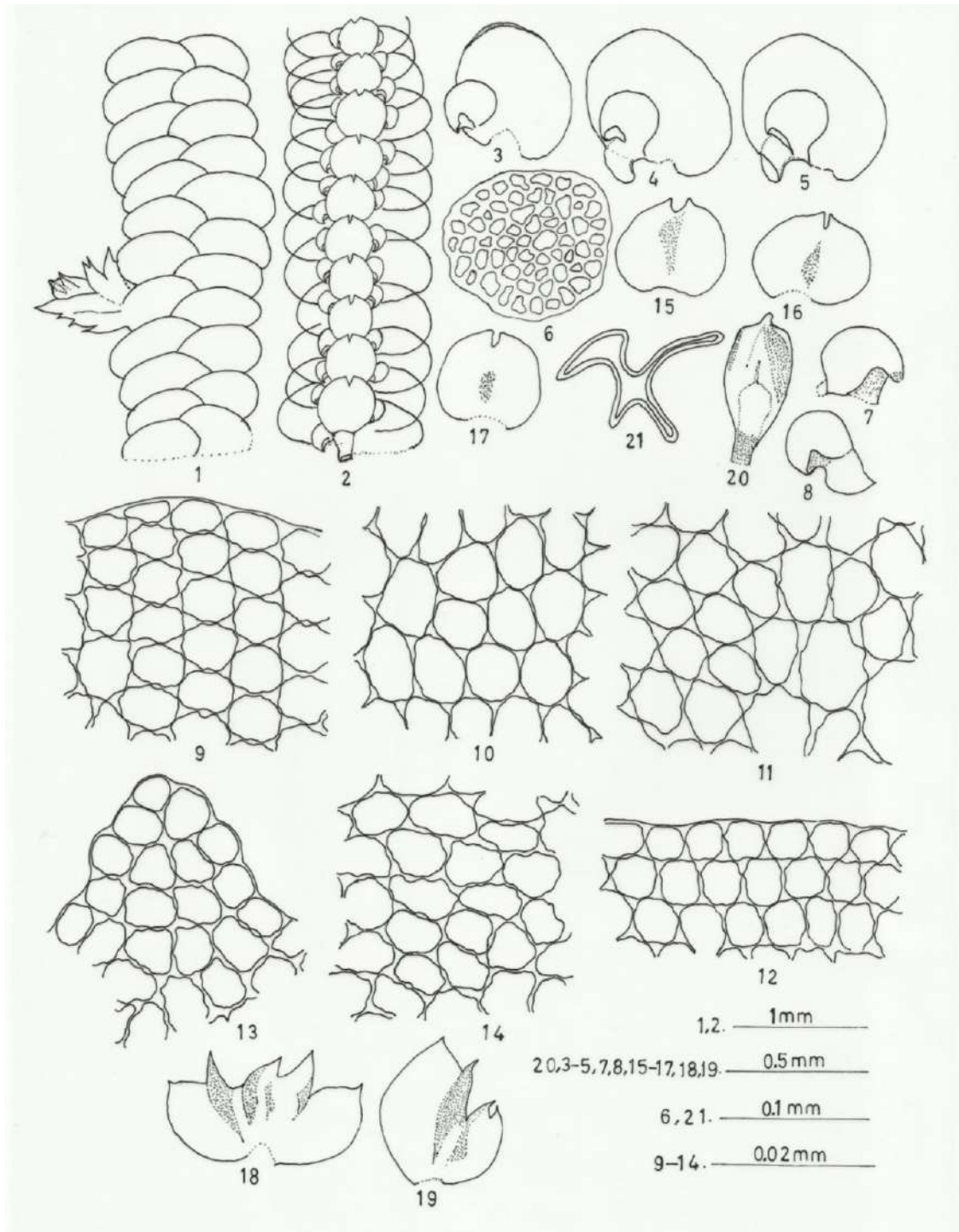


Plate 17. *Frullania galeata* (Reiwn., Nees & Blume) Dumort., figures 1-19.

Figs. 1. A portion of plant in dorsal view; 2. A portion of plant in ventral view; 3-5. Leaves. 6. Cross section of stem; 7-8. Lobules; 9. Leaf apical cells; 10. Leaf median cells; 11. Leaf basal cells; 12. Leaf marginal cells; 13. Underleaf apical cells; 14. Underleaf median cells; 15-17. Underleaves; 18-19. Female bracts.

22-39 x 15-29 μm , sub-quadrate, trigones nodulose, bulging, intermediate thickenings present; leaf lobule helmet, gealate, 0.3-0.4 mm long, 0.3-0.43 mm wide, slightly wider than long. Underleaves imbricate to contiguous, orbicular, 0.5-0.7 mm long, 0.6-0.8 mm wide, as broad as long, bilobed 1/5-1/6 of the length, sinus narrow to wide, lobes triangulate, apiculate. Male inflorescence not seen. Female inflorescence on short lateral branches; bracts ovate-oblong, 0.9-1.4 mm long, 0.9-1.2 mm wide; margin entire, apex acute to acuminate; innermost bract-lobe largest, connate with the lobule and completely surround the perianth; perianth exerted, 1.3 mm long, 0.7 mm wide, beak short; 5 keeled, 2 sharp ventral keel, 1 wide dorsal keel and 2 small keel, keel smooth or papillose. Spores and elaters not seen.

Habitat: Plants grows epiphytically on trees bark (corticolous) in pure patches or in association with *Trocholejeunea* sp., *Lejeunea* sp. and Mosses at 900-1400 m asl.

Range: India,

Distribution in India: *Eastern Himalayas:* **Nagaland****.

Specimen examined: Nagaland: Mokokchung District: Mopungchuket: KE 10241: 23.09.2009: Kazhuhrii Eshuo.

FAMILY: JUBULACEAE H.K. Klinggr.

JUBULACEAE H. K. Klinggr., Höh. Crypt. Preuss.: 40. 1858.

Plants small to medium, pale green to green, leaves 2-lobed, with the dorsal lobe margin spinose, rarely entire, ventral lobule forming water sacs of *Frullania*-type (*Jubula*) or *Lejeunea*-type (*Nipponolejeunea*), with a stalk slime papilla at the postical insertion of the lobe in *Jubula*; underleaves bifid; vegetative branches mostly of the *Frullania*-type; androecia spicate, collared, *Bryopteris*-type branches, or intercalary on a leading axis; gynoecia on leading axes, with 1 or 2 archigonia; bracts and bracteoles in 1-3 series, with 1 or 2 subfloral innovations; seta 4 cells in diameter, cruciate, non-articulate; gemmae absent.

Genus: *Jubula* Dumort.

Jubula Dumort. Comment. Bot.: 112. 1822.

Plants small to medium, dark green to brownish green, dull green; stem prostrate, pinnately to bipinnately branched, branching terminal and of *Frullania*-type, with an antical elobulate leaf at the inserted of each, seated partly on the stem and partly on the branch. Stem in cross section cortical cells 30-32 longitudinal rows, thick walled and non-pigmented, slightly smaller than the medullary cells. Leaves incubous, entire to spinose, apex acute to acuminate; leaf cells usually isodiametric, usually thin, trigones wanting or minute with minute intermediate nodulose thickenings in basal cells; ocelli absent. Leaf lobule saccate, water sac like, or explanate, distant from the stem, small, rarely evolute, acuminate, stylus usually unicellular, papillose. Underleaves sharply bilobed, apex of each lobe acute to acuminate, margin entire or dentate or spinulose with the insertion on the stem strongly arching. Dioicous or monoicous. Male inflorescence on lateral branches of *Radula*-type, spicate; bracts 2-5 pairs or more; bracteoles bilobed. Female inflorescence with 2 (-1), opposite subfloral innovations, terminal on the main stem or

lateral branches; bracts in one pair, archegonia 1-2, rarely 3-4, bract usually entire or spinose; bracteoles free from the lobes, deeply bilobed, entire or spinose. Perianth sharply 3 angled, smooth with short beak; seta slender, 4 cells thick, in cross section cruciate and articulate when dry. Capsule cylindrical or ovoid, outer layer of capsule with nodular brownish trigones on radial walls, intermediate thickenings absent; inner layers thickenings usually sheet like or with fenestrate patterns, rarely with intermediate nodular thickenings. Spores spherical, smooth or slightly papillate. Elaters uni-spiral, brown.

Jubula hutchinsiae subsp. *javanica* (Steph.) Verd., Ann. Crypt. Exot. 1: 216. 1928.

(Plate 18. Figs. 1 – 21).

Plants pale green to green, pale brown in dry herbarium, upto 65 mm long, 1-1.5 mm wide including leaves, irregularly branched, branching of *Frullania*-type; rhizoids in tuft at the bases of the underleaf. Stem circular, brown, 156-165 x 210-216 μm in diameter, cortical cells thick walled, arranged in 29 cells in radial rows, 13-29 μm long, 11-20 μm wide; medullary cells thin walled, 16-38 μm long and 14-25 μm wide. Leaves closely imbricate, oblong-ovate, 9.5-1.2 mm long, 7.5-0.9 mm wide; margin entire, apex acuminate, 1-3 teeth present at apex; apical cells 3-5 cells long, 1-2 cells broad, tooth cell 2-3 long, 1-2 cells broad; apical cells 18-25 μm long, 12-15 μm wide, rectangular, trigones triangular, thin walled; median cells 24-42 μm long, 16-28 μm wide, sub-quadrate, pentagonal, trigones triangulate or triradiate, thin walled; basal cells 28-44 μm long, 16-30 μm wide, sub-quadrate, pentagonal, trigones triangular, larger than the median and apical cells, thin walled. Oil bodies 5-9 (-11) per cell, circular to ellipsoidal, 4-10 x 3-5 μm in diameter. Cuticle slightly papillose. Leaf lobule dimorphic, galeate or explanate, when galeate ovoid, 188-232 μm long, 134-217 μm wide, apex rounded, mouth truncate; when explanate ligulate, 110-125

µm long, 66-95 µm wide, apex apiculate. Underleaves distant, or slightly contiguous, 3-4 times as wide as the stem, orbicular-ovate, 500-572 µm long, 505-581 µm wide, slightly wider than long, bilobed to 1/2 of the underleaf length, lobes apices with long acuminate, margin entire, sinus narrow to wide, apex apiculate. Monoicous. Male inflorescence on short lateral branched, closely imbricate, bracts in 3-5 pairs, oblong-ovate, 0.3-0.44 mm long, 0.19-0.25 mm wide, apex acute to acuminate. Female inflorescence terminal on main stem or long lateral branches with 1-2 subfloral innovation, bracts obovate, ovate-oblong, 1-1.5 mm long, 0.7-0.8 mm wide, apex acute, margin entire, bracteole obovate, 0.9 x 1.5 mm, bilobed to 2/3 of their length, lobes apices acuminate, margin entire. Perianth obovate, 0.8 x 1.3 mm in diameter, keels 3 (2 lateral, 1 ventral). Mature spores not seen.

Habitat: Plants grows on moist rock or decayed bark of trees along with *Metacalypogeia* sp., *Lepidozia* sp., *Frullania* sp. and Mosses at an altitude of 2000-2700 m asl.

Range: India, China

Distribution in India: *Eastern Himalayas:* Assam; West Bengal; Sikkim; Nagaland*.

Specimen examined: Nagaland: Kohima district: Khonoma: KE 10426: 19.03.2011: Kazhuhrii Eshuo.

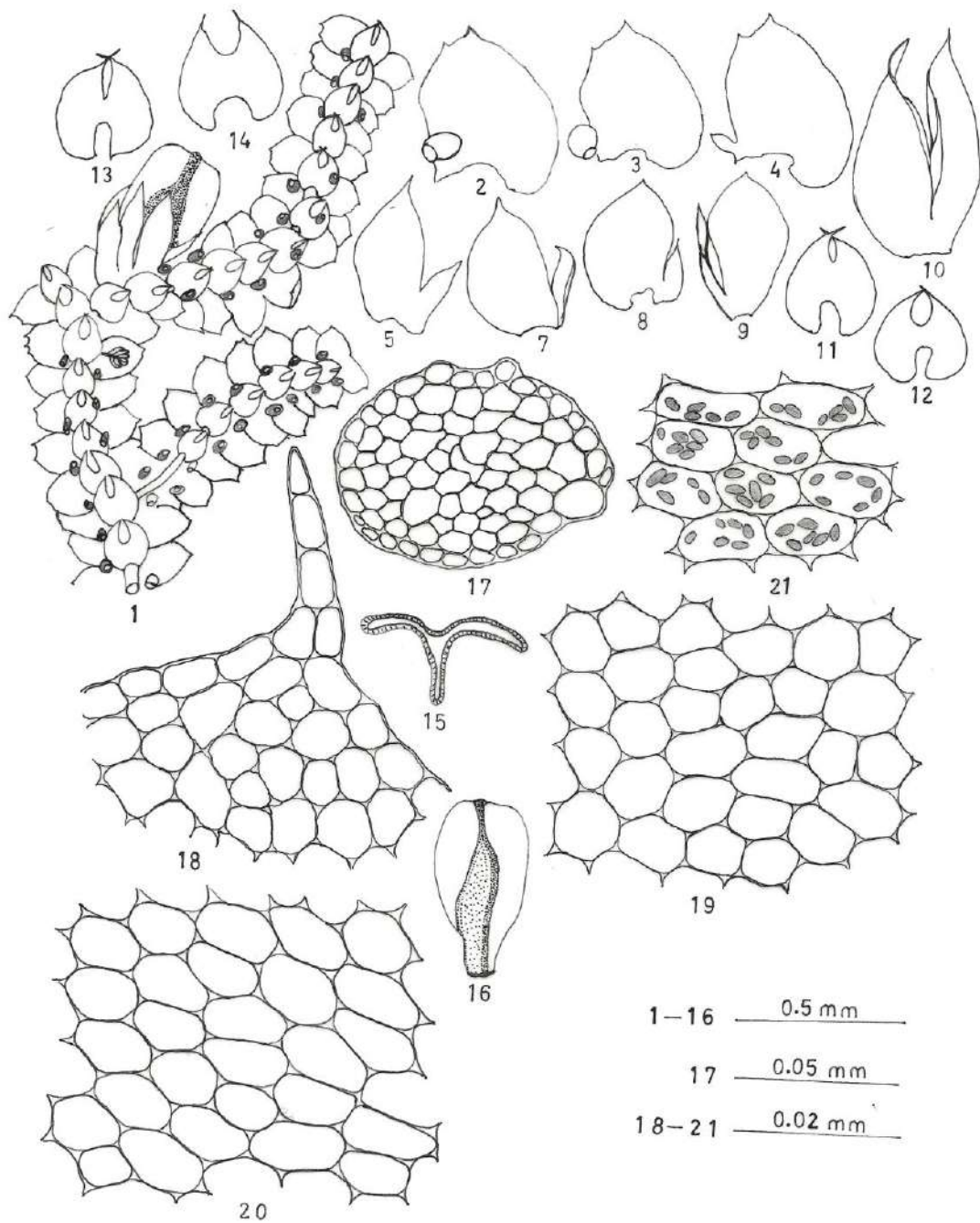


Plate 18. *Jubula hutchinsiae* subsp. *javanica* (Steph.) Verd., Figures 1-21.

Figs. 1. A portion of plant in ventral view; 2-4. Leaves; 5-8. Male bracts; 9-10. Female bracts; 11-14. Underleaves; 15. Cross section of perianth; 16. Perianth; 17. Cross section of stem; 18. Leaf apical cells; 19. Leaf median cells; 20. Leaf basal cells; 21. Oil bodies

FAMILY: LEJEUNEACEAE Casares-Gil

LEJEUNEACEAE Casares-Gil, Fl. Ibér. Briof. 1: 703.1919.

Plant green to light yellowish green, blackish green to brownish green; branches lateral-terminal, usually of *Lejeunea*-type⁵, rarely of *Frullania*-type. Leaves incubous, mostly imbricate, complicate bilobed; leaves lobe more or less convex, ovate, entire, dentate-ciliate or serrulate at margins, broadly inserted to the stem; cells collenchymatous; leaf lobule smaller than lobe, folding under it, usually ciliate, oblong-lanceolate with revolute margins, 1-3 (7) toothed at apex, first tooth usually with a hyaline papilla; keel nearly as long as leaf lobule, obtuse, never winged. Underleaves entire, bifid or bilobed or absent. Rhizoids at the base of the underleaves, usually fasciculate. Gemmae discoid, at margins or ventral surface of the leaf. Dioicous or monoicous. Androecia usually terminal on short, intercalary branches, spicate or capitate. Gynoecia terminal on main or lateral-intercalary branches, with or without sub-floral innovations; female bracts usually in one pair; bracteole often one per bract, rounded or bilobed. Perianth polymorphic. Typically obovoid, 3-5 plicate, narrow at apex to a usually well-marked, slender beak. Seta typically 2 layered with 4 inner and 12 or 16 outer rows of cells. Capsule walled 2 layered; cells of outer layer with distinct nodular thickenings at corners; inner layer with irregular thickenings or hyaline. Spores granulate, with scattered coarse tubercles oriented in rings. Elaters few, trumpet-shaped, with 1-2 spiral thickenings.

Type: Lejeunea Gilib., *nom. cons.*

⁵ *Lejeunea*-type: A type of branching where lateral branch arising at the base of the leaf keel, bearing collar-like structure, and never replacing the leaf lobule of the leaf subtending it.

Key to genera of the family Lejeuneaceae

1. Underleaves absent.....*Cololejeunea*
- 1a. Underleaves present 2
2. Underleaves lobed or bifid..... 3
- 2a. Underleaves entire..... 6
3. Perianth on the main stem, intermediate thickenings absent.....*Drepanolejeunea*
- 3a. Perianth on short lateral stem, intermediate thickenings present..... 4
4. Underleaves basal cells bordered by six large cells, gynoecia innovation absent..... *Leptolejeunea*
- 4a. Underleaf large, bifid, gynoecia innovation present..... 5
5. Leaf lobule with a distinct second toothed, first tooth usually obsolete, bracteole bilobed..... *Cheilolejeunea*
- 5a. Leaf lobule second tooth usually obsolete or poorly developed, hyaline papilla on the proximal side of the first tooth..... *Lejeunea*
6. Underleaves entire, lobule with 1-7 tooth..... 7
- 6a. Underleaves irregularly dentate, lobule apex truncate, with 1-3 tooth..... 10
7. Leaf lobule 4-7 toothed, 1-2 (-3) uniseriate cells long, spores granulate to spinate, elaters monospiral with thickenings band..... *Frullanoides*
- 7a. leaf lobule $\frac{1}{2}$ to $\frac{3}{4}$ of the lobe length, underleaf incurved..... 8
8. Leaf cells with brown pigmentation, obovate perianth, 4-5 keeled, keel dentate-laciniate..... *Lopholejeunea*
- 8a. Perianth keel smooth, 8-10 lobes..... 9
9. Leaf sequence of the gynoecial innovation pycnolejeunoid type, cordate trigones..... *Tricholejeunea*
- 9a. Leaf lobe oblong-ovate, perianth 10 keeled, smooth..... *Tuzibeanthus*

10. Oil bodies small, homogenous, perianth keel 5-10..... *Spruceanthus*

10a. Oil bodies grape cluster, large, perianth keel 10..... *Ptychanthus*

Genus: *Cololejeunea* (Spruce) Schiffn.

Cololejeunea (Spruce) Schiffn., *In Engler & Prantl, Nat. Pflanzenfam. 1(3): 117.*

1893.

Plants pale to dull green, dark green, more or less glossy when fresh, appressed to the substratum, irregularly pinnately branched, *Lejeunea*-type, branching intercalary except the subfloral innovation which is terminal. Stem in cross section shows 5 (-8) longitudinal rows of cortical cells and one medullary cell. Rhizoid initial single per leaf and usually in tuft. Leaves lobes variable often with hyaline marginal cells or serrate ocelli; oil bodies small, homogenous or compound; leaf lobule attached to the stem by 1 stem cell, variable in shape, typically with 2 apical marginal toothed, hyaline papillae on the proximal base of the first tooth or rarely on the tip of the first tooth; ocelli and vita cells present or absent on the leaf lobes. Underleaves absent. Gemmae discoid, numerous on the ventral surface of the leaf lobe. Male inflorescence terminal on more or less elongate branch, capitate or spicate; male bracteole absent. Female inflorescence terminal on more or less elongated branch with one subfloral innovation; female bracts similar to leaf lobe; bracteole absent. Perianth 2-5 keeled, dorsal keel usually obsolete. Seta articulate with 12 outer cells rows surrounding 4 inner cell rows. Capsule walled 2 layered, outer layer thin walled and those of inner walled with irregular thickenings bands. Elaters colourless, spiral indistinct and few per capsule.

Type: Cololejeunea calcarea (Gilib.) Schiffn.

Key to species of the genus *Cololejeunea*

1. Leaf-lobe ovate, apex acute, margin spinose..... *C. spinosa*
1a. Leaf-lobe oblong, ovate, apex rounded, margin smooth and hyaline..... 2
2. Leaf-lobule ciliate, 6-10 cells long and 2-3 cells wide..... *C. ceratilobula*
2a. Lobule broadly triangulate, tooth absent..... *C. latilobula*

Cololejeunea spinosa (Horik.) Pandé & Misra, J. Indian Bot. Soc. 22: 166. 1943.

(Plate 19. Figs. 1 – 15)

Plants green, appressed to substratum, pale dull brown in dry herbarium, branched, branching irregular; stem upto 5-10 mm long, 0.8-1.1 mm wide including leaves. Stem 40-66 μm in diameter, in cross section consist of 5 cortical cells, 15-30 x 9-21 μm and 1 medullary cell, 10-19 μm , ventral merophytes 2 cells wide. Rhizoids fasciculate, clourless rhizoid disc absent. Leaves imbricate, leaf-lobe ovate to oblong-ovate, 0.4-0.6 mm long, 0.3-0.4 mm wide,; apex obtuse to acute, margin densely spinose; cells thin walled, trigones indistinct or small, intermediate thickenings absent; apical marginal cells 14-21 x 8-11 μm ; median cells hexagonal, rectangular, 16-27 x 8-16 μm ; basal cells larger than the median cells, pentagonal to hexagonal, 19-36 x 14-20 μm , dorsal protrusion spinose, 1 per cell, 8-18 μm in height. Leaf-lobule ovate, 1/3 as lond as the lobe length, strongly inflated, smooth on ventral surface, first tooth 1-2 cells long, 1 cells wide; second tooth unicellular, hyaline papilla at proximal base, spherical, keel usually arched. Stylus not seen. Ocelli absent. Androecia and gynoecia not seen.

Habitat: Foliicolous

Range: India, China, Japan, Korea, Nepal and Philippines.

Distribution in India: *Eastern Himalaya:* West Bengal, Arunachal Pradesh, Nagaland*.

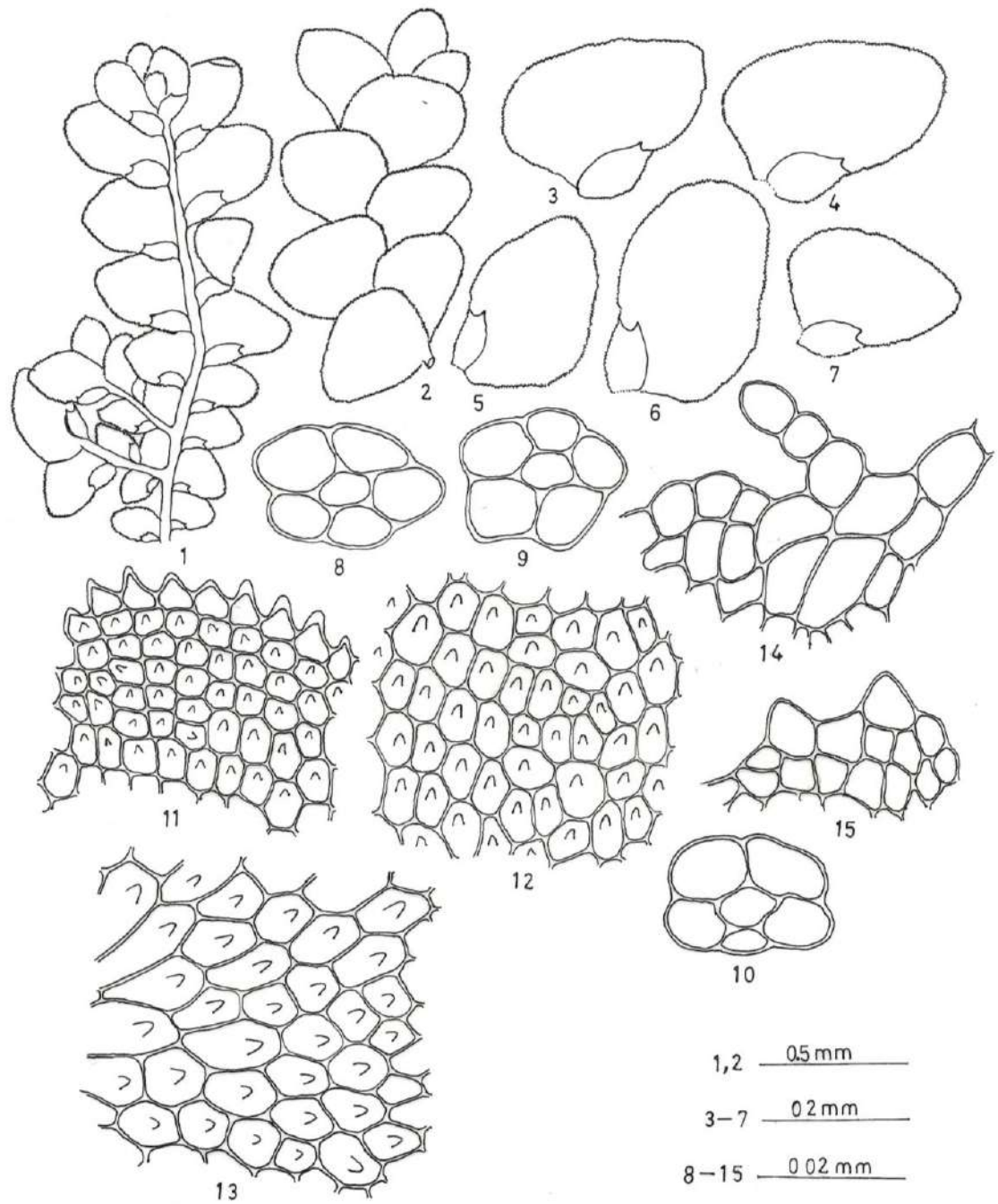


Plate 19. *Cololejeunea spinosa* (Horik.) Pandé & Misra, Figures 1-15.

Figs. 1. A portion of plant in ventral view; 2. A portion of plant in dorsal view; 3-7. Leaves; 8-10. Cross section of stems; 11. Leaf apical cells; 12. Leaf median cells; 13. Leaf basal cells; 14-15. Lobule cells.

Specimen examined: Nagaland: Kohima District: Jotsoma: KE 10082b: 18.03.2009:
Kazhuhrii Eshuo.

Cololejeunea ceratilobula (P.C. Chen) R. M. Schust., Beih. Nova Hedwigia 9:

179.1963.

(Plate 20. Figs. 1 – 13)

Plants green to light green, dull pale brown in dry herbarium, appressed to the substratum, branched or unbranched, branching irregular; stem upto 8 mm long, 1-1.5 mm wide including leavaes. Stem 60-105 μm in diameter, cross section of the stem shows with 5 cortical cells, \pm rectangular, 25-43 x 15-30 μm and 1 medullary cell, \pm isodiametric, 23-35 x 20-22 μm , ventral merophytes 2 cells wide. Rhizoids numerous, fasciculate hyaline and rhizoidal disc absent. Leaves imbricate, leaf-lobe ovate to sub-orbicular, 0.9-1.2 mm long, 0.7-1.0 mm wide, with entire margin and rounded apex, slightly arched at base. Lobes cells thin walled, trigones and intermediate thickenings absent or indistinct, marginal cells hyaline with sigmoid shaped, 20-30 x 6-10 μm ; median cells larger, hexagonal, rectangular, 27-43 x 15-23 μm ; basal cells larger than the median cells, rectangular, hexagonal, 33-62 x 22-30 μm . Cuticle smooth; ocelli and vitta absent. Lobule small, narrowly lanceolate, 6-10 cells long, 2-3 cells wide at base, hyaline papilla present at the lobule apex. Stylus not seen. The mature fertile plants not seen.

Habitat: Foliicolous

Range: India, China, Cambodia, Indonesia, Japan, Malaysia, Sri Lanka and Vietnam.

Distribution in India: *Eastern Himalaya:* Arunachal Pradesh, **Nagaland***.

Specimen examined: Nagaland: Kohima District: Jotsoma: KE 10081: 18.03.2009:
Kazhuhrii Eshuo.

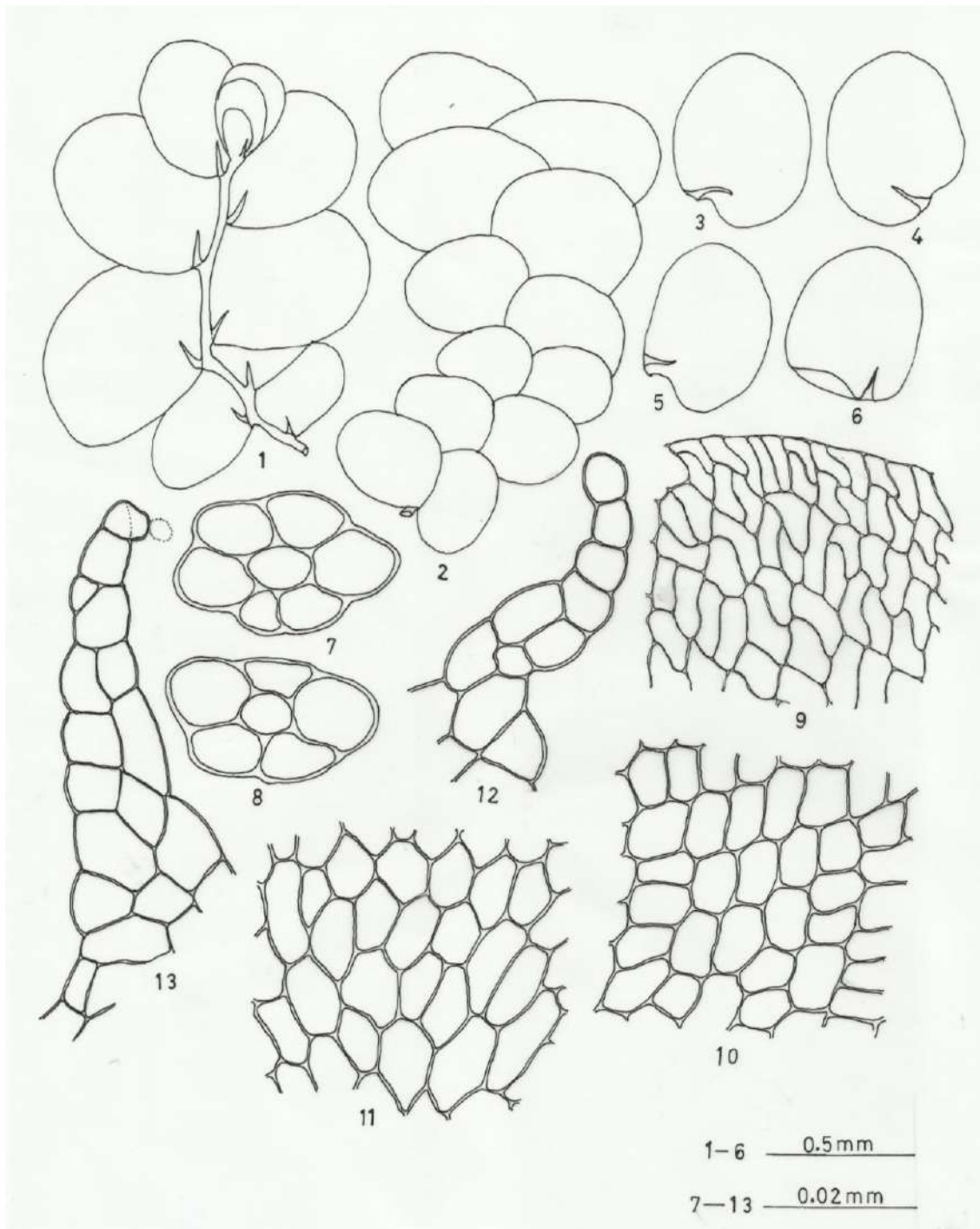


Plate 20. *Cololejeunea ceratilobula* (P.C. Chen) R. M. Schust., Figures 1-13.

Figs. 1. A portion of plant in ventral view; 2. A portion of plant in dorsal view; 3-6. Leaves; 7-8. Cross section of stems; 9. Leaf apical cells; 10. Leaf median cells; 11. Leaf basal cells; 12-13. Lobules cells.

Cololejeunea latilobula (Herzog) Tixier, Bryophyt. Biblioth. 27: 156. 1985.

(Plate 21. Figs. 1 - 13)

Plant small, dull green to brown-blackish green, brownish black in dry herbarium, 7-12 mm long, 1.2-1.6 mm wide, dorso-ventrally flat, branched, branching irregular, Frullania type; rhizoids in tuft at the bases of underleaf, hyaline and rhizoidal disc absent. Stem small, whitish, 78.8 x 45.5 μm in diameter, 2 ventral merophyte cells wide, cortical in 7 radial rows of cells, 11.4-30.2 μm long, 8.4-26.4 μm wide, thin walls; medullary 1 cell wide, large, thin wall, 33.2 x 17.4 μm in diameter. Leaves closely imbricate, entire, oblong-ovate, 0.6-1.0 mm long, 0.5-0.7 mm wide; apex rounded, hyaline cells of 3-5 (-6) cells long present except at the base of the leaf; hyaline cells rectangular-rhomboidal, 17.6-44.0 μm long, 8.8-22.0 μm wide; apical cells hexagonal-rectangular, polygonal, trigones minute, tri-radiate or indistinct, 12.5-25.0 μm long, 6.6-13.5 μm wide; median cells quadrate-hexagonal, polygonal, trigones tri-radiate, minute, 18.3-28.3 μm long, 12.8-19.5 μm wide; basal cells quadrate-hexagonal, polygonal, 25.1-47.8 quadrate-hexagonal, polygonal long, 17.9-28.6 μm , trigone tri-radiate, intermediate thickening of cells absent. Cuticle smooth. Leaves lobule large, triangular-oblong, mango shape like, entire, 292-303.4 μm long, 143-176.0 μm wide, a hyaline cell present at apex, apex obtuse or truncate. Vittae and ocelli absent. Underleaves absent. Androecia not seen. Gynoecia on short lateral branched, perianth obovate, never emerginate, from dorsal view cannot see the perianth, 4-keeled, surface smooth, beak 1 cell long. Spores not seen.

Habitat: Epiphyllous or foliicolous.

Range: India, China, Myanmar, Nigeria, Tanzania and Vietnam.

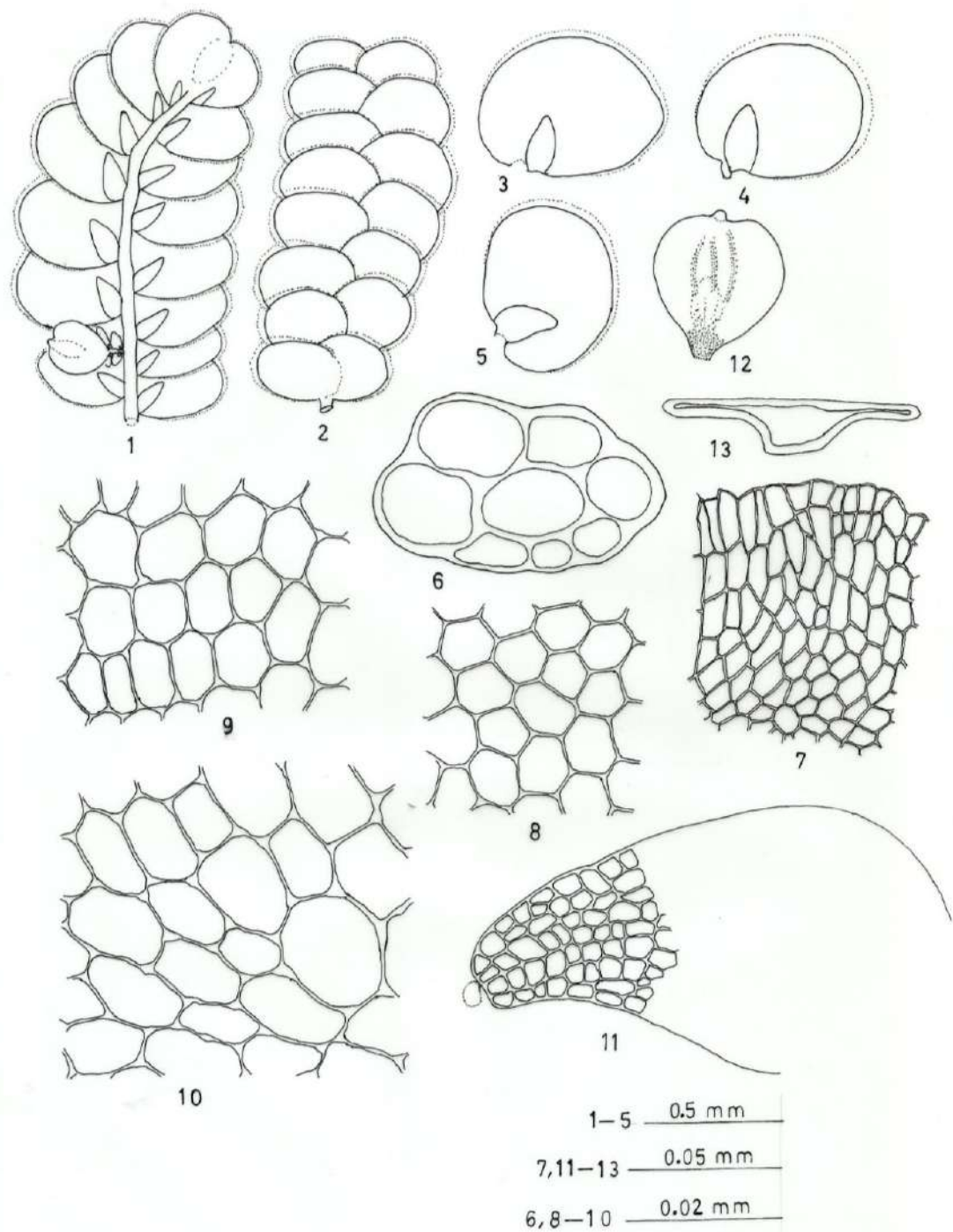


Plate 21. *Cololejeunea latilobula* (Herzog) Tixier, Figures 1-13.

Figs. 1. A portion of plant in ventral view; 2. A portion of plant in dorsal view; 3-5. Leaves; 6. Cross section of stem; 7. Leaf apical cells; 8-9. Leaves median cells; 10. Leaf basal cells; 11. Lobule; 12. Perianth; 13. Cross section of perianth.

Distribution in India: *Western Himalaya:* Uttaranchal; *Eastern Himalaya:* Manipur, Meghalaya, **Nagaland***; *Central India:* Madhya Pradesh; *South India:* Karnataka, Kerala, Tamil Nadu.

Specimen examined: Nagaland: Kohima District: Khuzama: KE 10162: 14.05.2009: Kazhuhrii Eshuo.

Genus: *Drepanolejeunea* (Spruce) Schiffn.

Drepanolejeunea (Spruce) Schiffn., in Engler & Prantl, Nat. Pflanzenfam. 1(3): 126. 1895.

Plants yellowish green or brownish green, small, or minute, stem irregularly branched; branching intercalary of *Lejeunea*-type; stem in cross section consist of cortical cells in 7 longitudinal rows and 3 longitudinal rows of medullary cells, cells thick walled, trigones indistinct. Leaves usually falcate, erect, spreading, triangular, or ovate oblong to lanceolate, margin denticulate, spinose or entire, cells mostly with dorsal protrusion; oil bodies elliptical, composed of globules, small and numerous. Leaves lobule ovate-rectangular, inflated, first tooth acute; consisting of a single elongate cell, more or less curved towards keel, second tooth reduced, hyaline papilla on the proximal base of the first tooth. Underleaves bilobed for about $\frac{1}{2}$ of their length, lobes divaricates, lanceolate, acuminate, and usually small. Male inflorescence on a short lateral branch, capitate; male bracteoles small, limited to the base or absent. Female inflorescence mostly on a more or less elongate branch usually with one subfloral innovation; female bracts and bracteoles dentate. Perianth 5 keeled (2 ventral, 2 lateral, 1 dorsal), often winged, wing toothed, ending above as horizontally spreading horns. Seta (12+4), articulate, outer cells in 12 longitudinal rows and inner cells in 4 longitudinal rows. Capsule wall 2 layered, pale brown or hyaline; outer layer thick wall with intermediate thickenings and indistinct trigones; inner layer cells

irregularly thickened. Elaters colourless, with a very slender spiral and few in a capsule.

Type: Drepanolejeunea hamatillofolia (Hook.) Schiffn.

Drepanolejeunea augustifolia (Mitt.) Grolle, J. Jap. Bot. 40: 206. 1965.

(Plate 22.. Figs. 1 - 11)

Plants minute, yellowish green, 5-12 mm long, 0.3-0.5 mm wide including leaves, branched, branching sometime irregular. Stem 45-56 μm in diameter, circular, transverse section of stem shows 7 cortical cells and 3 medullary cells. Rhizoids few, fasciculate near the bases of the underleaves, hyaline, rhizoidal disc absent. Leaves distant, sometime contiguous, spreading, lobe narrowly ovate to lanceolate, falcate, 0.23-0.34 mm long, 0.12-0.15 mm wide, apex acuminate, plane to incurved, margin entire to crenulate; apical cells 10-18 x 6-11 μm , median cells hexagonal, 16-27 x 11-14 μm , basal cells similar to that of median cells, trigones small, intermediate thickenings present. Cuticle smooth; oil bodies not seen. Lobule ovate, 1/3-1/2 as long as the lobe, incurved. Underleaves distant, small, obcuneate, deeply bilobed, lobes 3-4 (-5) cells long, 2 cells wide, sinus lunate. Androecia on very short branches, bracts in 2-3 pairs, bracteoles absent. Gynoecia not seen.

Habitat: Plants grows epiphytically (corticolous) along with *Lejeunea* sp., *Frullania* sp. *Trocholejeunea* sp. and Mosses at 1500-2700 m asl.

Range: Bhutan, China, India, New Caledonia, Indonesia, Japan, Papua New Guinea, Philippines, Sri Lanka, Thailand and Vietnam.

Distribution in India: *Eastern Himalaya:* Sikkim, **Nagaland***.

Specimen examined: Nagaland: Kohima District: Khuzama: 1.12.2008: KE 10074: kazhuhrii Eshuo.

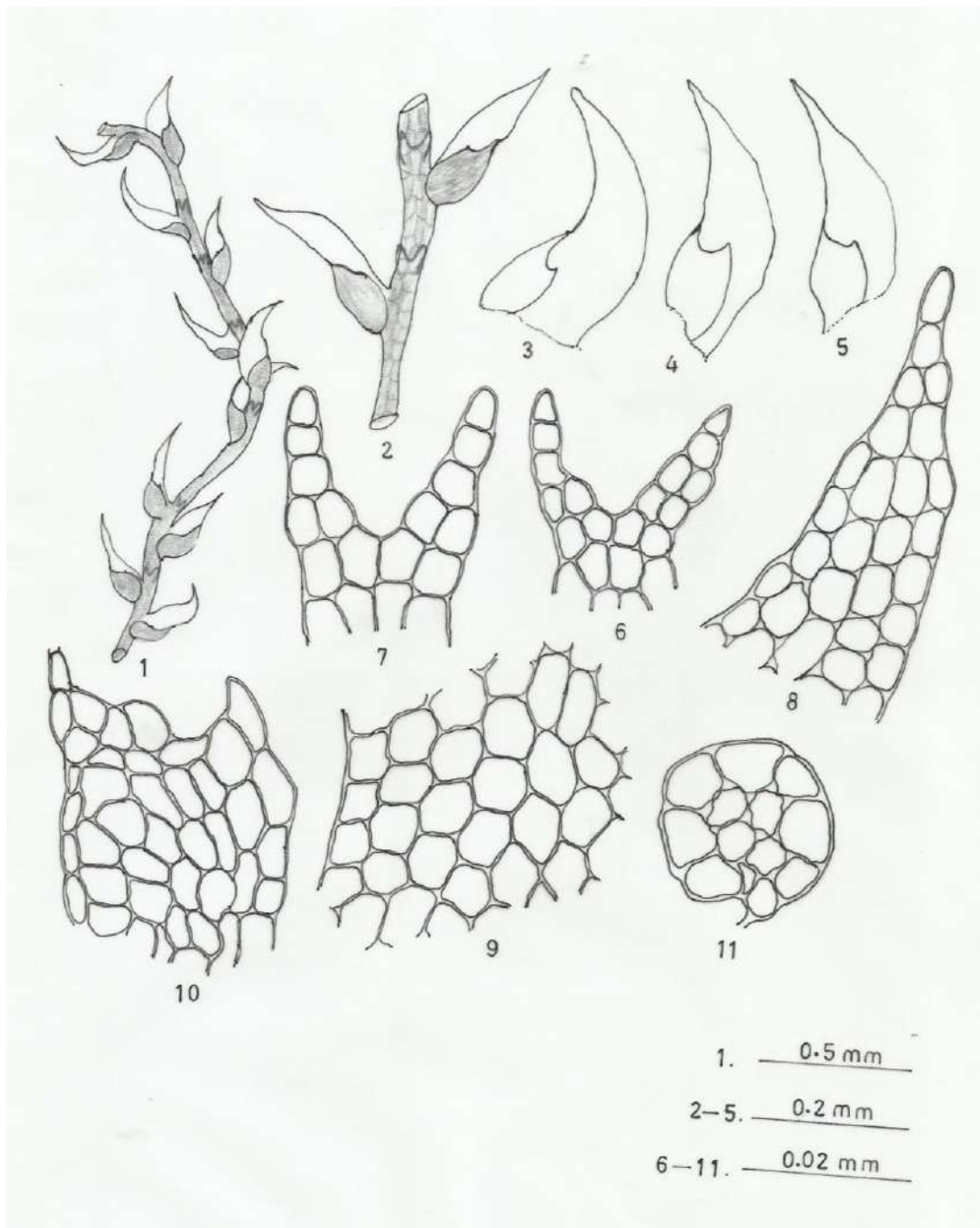


Plate 22. *Drepanolejeunea augustifolia* (Mitt.) Grolle, Figures 1-11.

Figs. 1-2. A portion of plants in ventral view; 3-5. Leaves; 6-7. Underleaves; 8. Leaf apical cells; 9. Leaf median cells; 10. Lobules cells; 11. Cross section of stem.

Genus: *Leptolejeunea* (Spruce) Schiffn.

Leptolejeunea (Spruce) Schiffn., In Engler & Prantl, Nat. Pfl.-fam. 1,3: 126. 1895.

Plants minute to medium size, pallid green, light green, prostrate, closely appressed to the substratum, irregularly pinnate by the intercalary branching. Stem in cross section shows 7 cortical cells in longitudinal rows and the medullary in 3 longitudinal rows, cells thick walled. Rhizoids in tuft at the bases of the underleaf. Leaves more or less shrinking when dry, distinct to approximate imbricate, lobes ovate to elliptical with obtuse to acute apex; margin entire to dentate; cells large, thin walled with small nodulose trigones, intermediate thickenings sometimes; ocelli one at base, often several additional ones in the leaf lamina; oil bodies homogenous, small, 5-10 per cell. Leaf lobule large, inflated, first tooth small, usually consisting of one projecting cell, second tooth reduced, hyaline papillae on the proximal base of the first tooth. Underleaves bilobed, lobes divaricate, acute, small, basal portion bordered by 6 elongate cells. Male inflorescence capitate; male bracteole small, restricted towards base of the inflorescence. Female inflorescence terminal on a short lateral branch without subfloral innovation; female bracts and bracteoles more or less acute at apex, margin poorly dentate. Perianth 5 keeled (2 ventral, 2 lateral, 1 dorsal), keels smooth, wide with apices extending upwards and downwards as acute to truncate horns. Seta (12+4), articulate, outer cells in 12 longitudinal rows and the inner in 4 longitudinal rows. Capsule wall 2layered, hyaline, both inner as well as outer layers irregularly thick walled, walls pale brown. Elaters colourless, and few per capsule.

Leptolejeunea elliptica (Lehm. et Lindenb.) Schiffn., in Engler & Prantl, Nat. Pfl. 1:

126 (1895).

(Plate 23. Figs. 1 - 12)

Plant small, light green to yellowish green, 4-10 mm long, 0.8-0.9 mm wide including leaves; branched, branching irregular, terminal, intercalary to pinnately branched. Rhizoids in bunch near the bases of underleaf. Stem circular, 0.06 x 0.07 mm in diameter, 4 cells across, cortical cells in 7 radial rows, 17.5-25.3 μm long, 6.8-22.0 μm wide, medullary cells in 3 radial cells, 17.5-22.0 μm long, 11.1-17.5 μm wide. Leaves distant, alternate, acute, oblong, 0.6-0.75 mm long, 0.3-0.45 mm wide; cells non-trigonus, trigones wanting, pentagonal to hexagonal; apical cells 16.5-23.4 μm long, 8.8 – 18.7 μm wide, middle cells 14.3-33.0 μm long, 11-19.8 μm wide, epidermal cells 10.17.6 μm long, 7.7-13.2 μm wide, basal cells 17.6-36.3 μm long, 9.9-22.3 μm wide; ocelli cells scatter, 4-6 per leaf lobe, separated by many ordinary cells. Leaves lobule small, oblong to ovate, 1/3 as long as the leaf lobe, 0.2-0.25 mm long, 0.11-0.14 mm wide, first tooth not prominent, slightly inflated, apex rounded to truncate, second tooth obsolete. Underleaves distant, free, 2-3 times as wide as the stem, 0.06-0.09 mm long, 0.09-0.12 mm wide, bilobed, sinus wide, 2-3 cells wide, 3-4 cells long, 1 cell wide, or rarely 2 cells at base, 2-3 uniseriate cells. Gynoecia born on the lateral leaf apex, 3 bract arranged in valvate at the base of the sporophyte; perianth 4 lobes. Spores not seen.

Habitat: Plants epiphyllous (foliicolous) in pure patches at 1700- 2300 m asl.

Range: India, China

Distribution in India: *Eastern Himalaya:* Sikkim, Meghalaya, **Nagaland***.

Specimen examined: Nagaland: Kohima District: Khuzama: KE 10208: 14.05.2009:

Kazhuhrii Eshuo

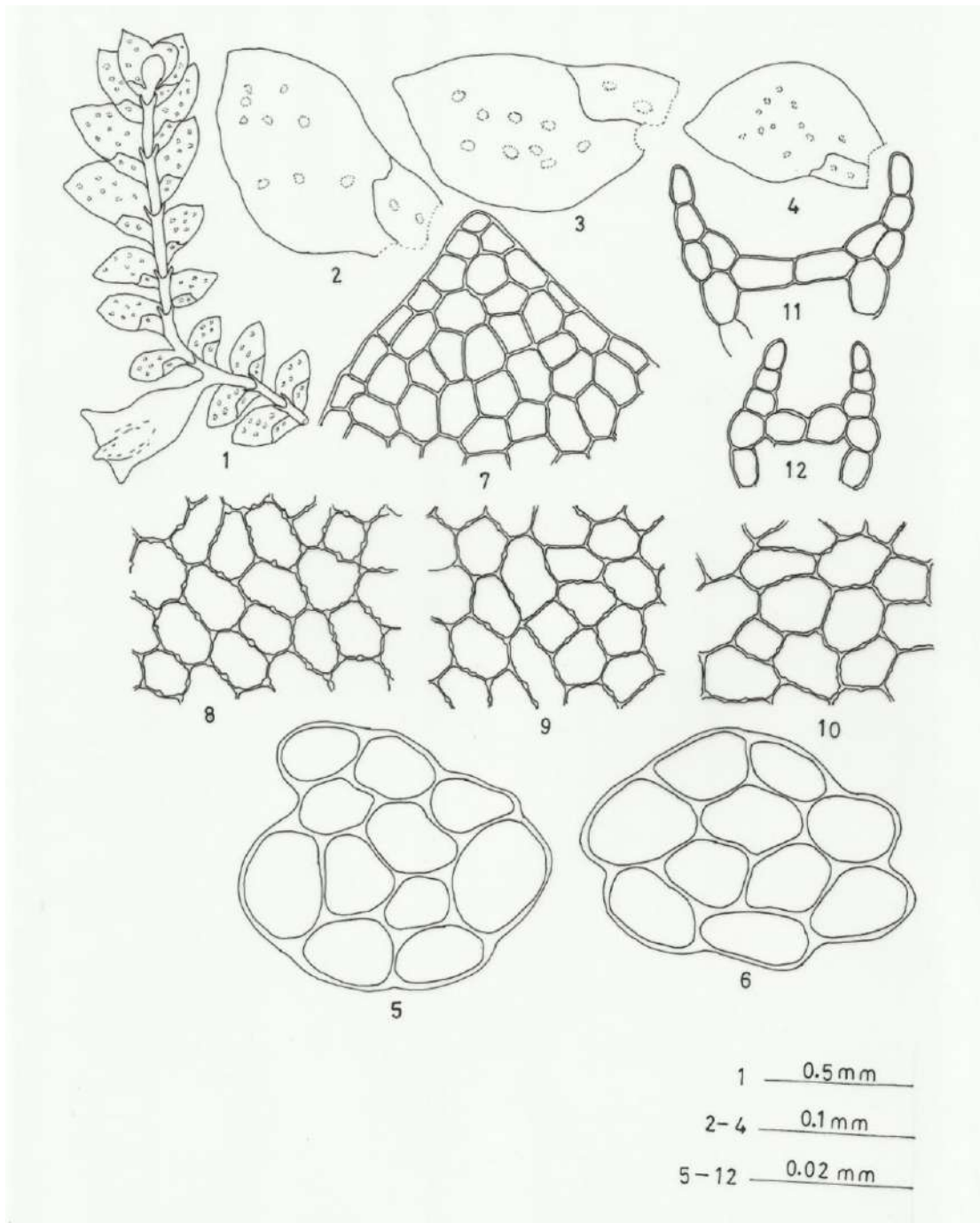


Plate 23. *Leptolejeunea elliptica* (Lehm. et Lindenb.) Schiffn., Figures 1-12.

Figs. 1. A portion of plant in ventral view; 2-4. Leaves; 5-6. Cross section of stem; 7. Leaf apical cells; 8-9. Leaf median cells; 10. Leaf basal cells; 11-12. Underleaves.

Genus: *Cheilolejeunea* (Spruce) Schiffn.

Cheilolejeunea (Spruce) Schiffn., in Engler & Prantl, Nat. Pflanzenfam. 1(3): 118-129.
1893.

Plants yellowish green to brownish green, small to medium, irregularly, pinnately branched, branching intercalary, of *Lejeunea*-type. Stem usually with 7 cortical cells and 7-17 medullary cells; cortical cells larger than the medullary cells; ventral merophytes cells 2 cells wide. Leaf lobe ovate, margin entire, apex rounded to acute; cells without the dorsal protruding; ocelli absent; oil bodies usually composed of large globose, grapes cluster type, large, 1-3 per cell. Leaf lobule small to large, attached to stem by 2 stem cells, with a distinct second tooth and obsolete first tooth, hyaline papilla at the distal side of second tooth of leaf lobule. Underleaves bilobed, distant or close, margin entire, orbicular, reniform. Male inflorescence on short lateral branch, capitate; bracteole usually restricted to the base of the inflorescence. Female inflorescence usually on elongated branch with 1-2 subfloral innovations; female bracts and bracteole similar to leaves and underleaves. Perianth 3-5 keeled, without horns and denticulations on surface and keels. Seta articulate with 12 outer cells rows surrounding the inner 4 cell rows. Capsule 2 layered and 4 valved, outer layer thin walled with faint sinuate thickenings, inner layer with irregular, nodular thickenings. Spores irregularly elongate with papillae or minute spines on the surface, sometimes spines forming indistinct rosettes. Elaters brown to pale brown, thick walled, slender or often indistinct, spiral.

Type; Cheilolejeunea decida (Spruce) A. Evans (= *Lejeunea decidas* Spruce)

Key to species of the genus *Cheilolejeunea*

1. Leaves apex acute to acuminate, stem cortical cells in 7 radial rows, leaf lobule first tooth one cell or obsolete, second tooth one cell long.....*C. subopaca*

1a. Leaves apex rounded, stem cortical cells in 9 radial rows, leaf lobule $\frac{1}{2}$ of the leaf length, first tooth one cell long, second tooth 3 cells long..... *C. imbricata*

Cheilolejeunea subopaca (Mitt.) Mizut., J. Hattori Bot. Lab. **26**: 183. 1963.

(Plate 24. Figs. 1 - 12)

Plant light green to green, whitish to brownish in dry herbarium, small, upto 20 mm long, 0.5-.7 mm wide including leaves, irregularly branched, branching of Lejeunea type; rhizoids in bunch at the base of the underleaf, rhizoidal disc absent. Stem oval, 81.9-109 μm in diameter, 7 rows of cortical cells, large, thin wall, 25.3-34.0 μm long, 9.1-21.4 μm wide; medullary cells 4-5 across, thin wall, smaller than the cortical cells, 13-16 cells in radial rows, 10.2-21.5 μm long, 6.6-11.4 μm wide. Leaves contiguous to slightly imbricate, imbricate, alternate, oblong, apex acute to acuminate, 0.3-0.44 mm long, 0.25-0.34 mm wide, margin entire, cells slightly trigones or trigones minute, tri-radiate trigones, cells pentagonal to hexagonal, thin wall; apical cells 11-15.5 μm long, 7.6-11.7 μm wide; median cells 12.1-20.9 μm long, 7-16.5 μm wide; basal cells 13.2-21.9 μm long, 9.9-20.0 μm wide. Leaf lobules $\frac{3}{4}$ - $\frac{1}{2}$ th of the leaves length, 0.16-0.23 mm long, 0.08-0.12 mm wide, first tooth one cell, obsolete, second tooth one cell long. Underleaves distant, free, small, bifid, oblong, 0.17-0.22 mm long, 0.19-0.20 mm wide; sinus narrow to wide, deep, bilobed, $\frac{1}{2}$ bifid, margin entire, cells like the cells of the leaves. Androecia and gynoecia not seen.

Habitat: plants grows epiphytically on bark of trees (corticolous) in association with *Drepenolejeunea* sp., *Bazzania* sp., *Plagiochila* sp. and Mosses at 2000-2700 m asl..

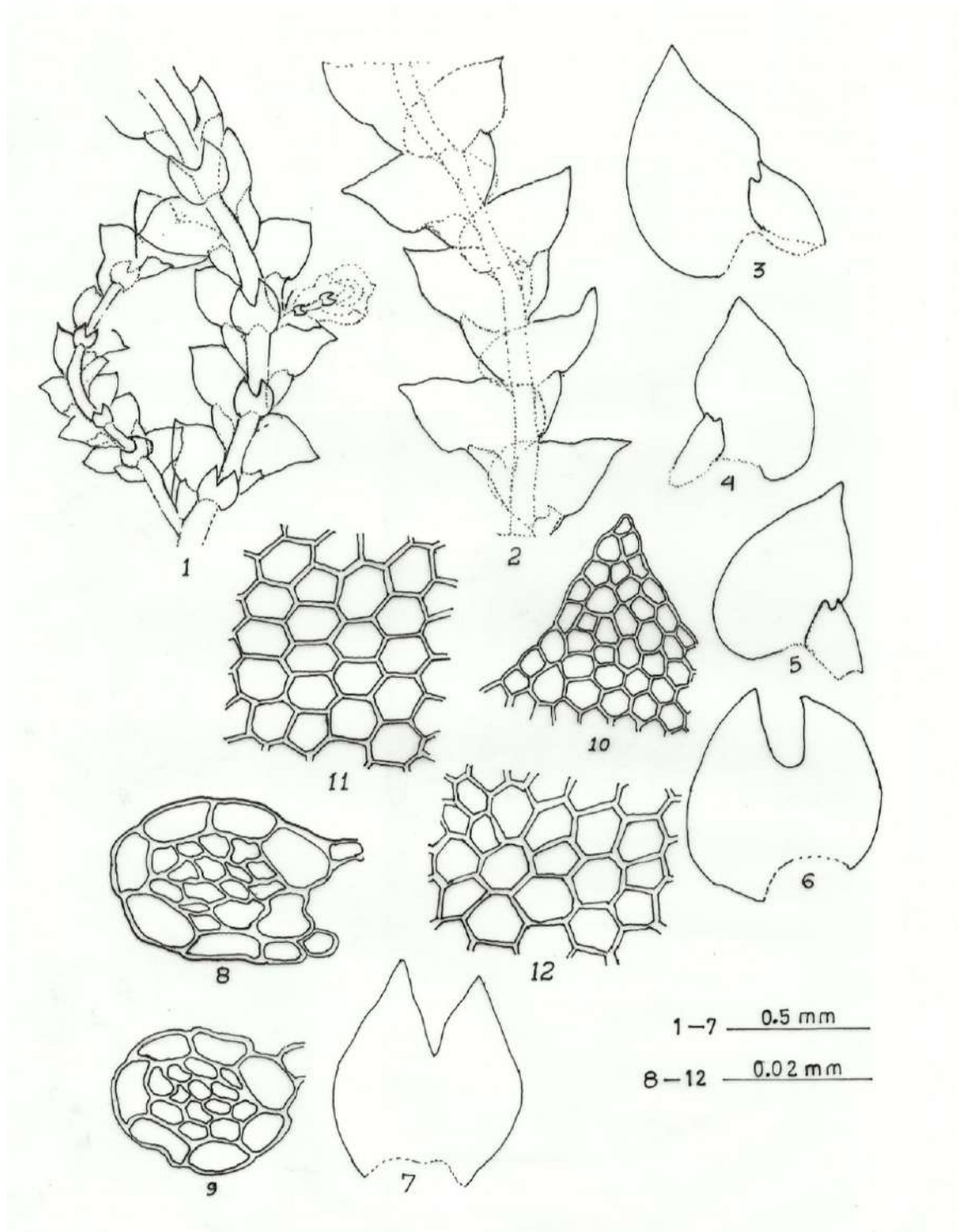


Plate 24. *Cheilolejeunea subopaca* (Mitt.) Mizut., Figures 1-12.

Figs. 1. A portion of plant in ventral view; 2. A portion of plant in dorsal view; 3-5. Leaves; 6-7. Underleaves; 8-9. Cross section of stems; 10. Leaf apical cells; 11. Leaf median cells; 12. Leaf basal cells.

Range: India, Bhutan, China, Nepal and Sri Lanka

Distribution in India: *Eastern Himalaya:* Assam, West Bengal, Sikkim, Meghalaya, Nagaland*.

Specimen examined: Nagaland: Kohima District: Khuzama: KE 10074: 16.11.2009: Kazhuhrii Eshuo; Japfu Peak: KE 10385: 17.03.2011: Kazhuhrii Eshuo.

Cheilolejeunea imbricata (Nees) S. Hatt., Misc. Bryol. Lichenol. **1**: 1. 1957.

(Plate 25. Figs. 1 - 13)

Plant small, brownish green, brown in dry herbarium, plant upto 35 mm long, 0.9-1.2 mm wide including leaves, branched, branching intercalary, terminal, of *Lejeunea* type; rhizoids in bunch at the bases of underleaf, rhizoidal disc absent. Stem circular, 99-107 x 126-132 μm in diameter, 6-7 cells across; cortical cells large, thin wall, 9 cells in radial rows, 18.4-33.1 μm long, 12-22.2 μm wide; medullary cells smaller than the cortical cells, slightly trigonous, 9-17.9 μm long, 5.4-11.5 μm wide. Leaves closely imbricate, orbicular, oblong-ovate, 0.77-0.85 mm long, 0.5-0.6 mm wide; margin entire, apex rounded, obtuse; apical cells 11.8-19.5 μm long, 5.7-14.4 μm wide, rectangular, sub-quadrate, trigones minute, tri-radiate; median cells 15.2-27.0 μm long, 11.7-18.2 μm wide, cells pentagonal-hexagonal, sub-quadrate, trigones minute, tri-radiate; basal cells 18.2-32.1 μm long, 11.8-20.4 μm wide, cells quadrate, penta-hexagonal, trigone tri-radiate, thin wall, slightly bulging trigones, intermediate thickening of walls absent. Leaves lobules rectangular, large, $\frac{1}{2}$ of the leaf length, apex truncate, first tooth one cells, second tooth 3 cells long. Underleaves distant, free, orbicular, oblong-ovate, 0.28-0.38 mm long, 0.3-0.35 mm wide, bifid, sinus deep, narrow to wide, $\frac{1}{2}$ deep of the underleaf length, underleaves cells trigonous, tri-radiate trigones, something slightly bulging. Androecia and gynoecia not seen.

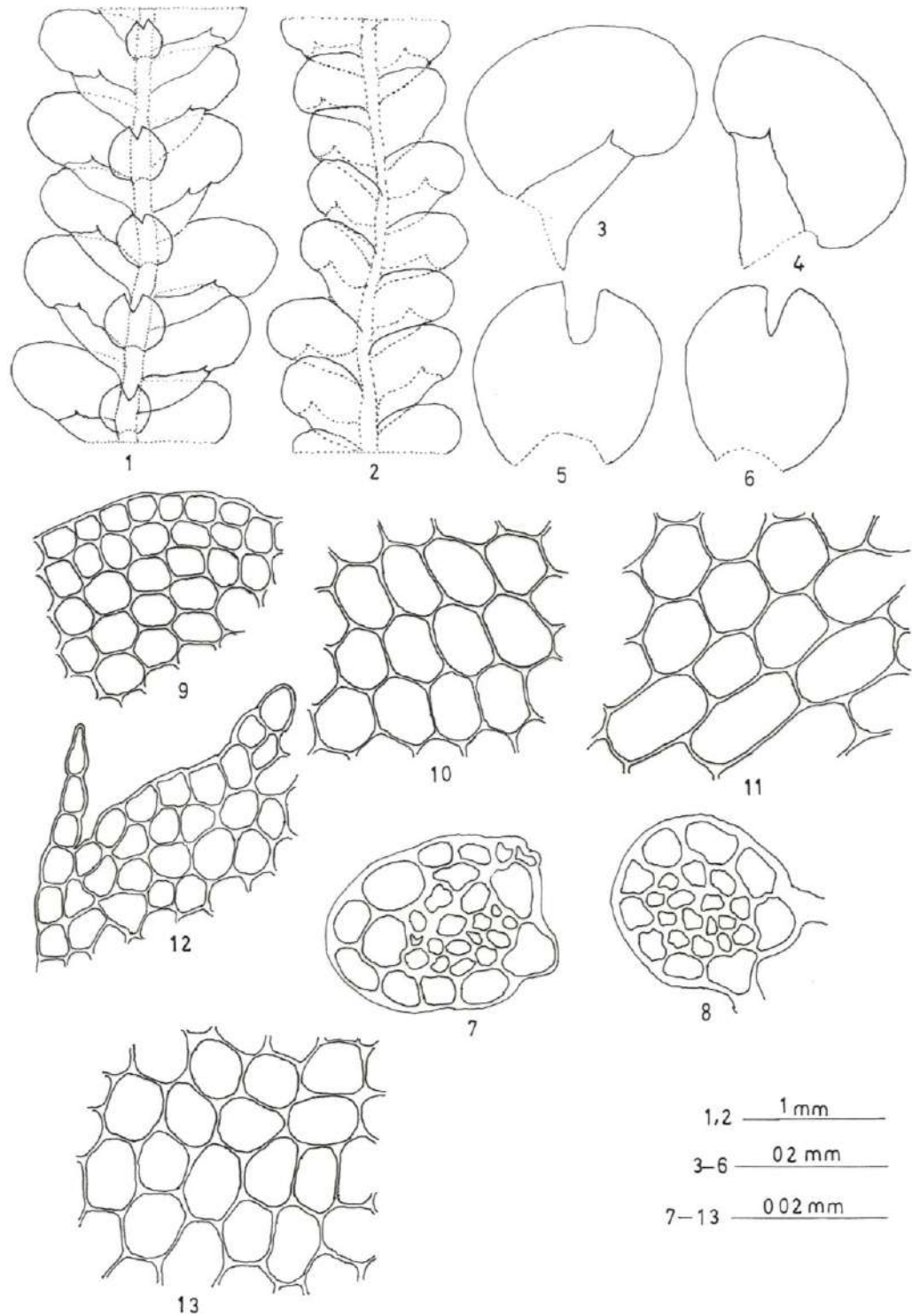


Plate 25. *Cheilolejeunea imbricata* (Nees) S. Hatt., Figures 1-13.

Figs. 1. A portion of plant in ventral view; 2. A portion of plant in dorsal view; 3-4. Leaves; 5-6. Underleaves; 7-8. Cross section of stems; 9. Leaf apical cells; 10. Leaf median cells; 11. Leaf basal cells; 12. Lobule cells; 13. Underleaf median cells.

Habitat: Plants grows on bark of trees (corticolous) and on rocks (saxicolous) in association with *Trocholejeunea* sp., *Lejeunea* sp., *Heteroscyphus* sp. and Mosses at 1500-1700 m asl.

Range: India, China, Taiwan, Japan, Philippines, Borneo, New Guinea, Korea.

Distribution in India: *Eastern Himalaya:* Meghalaya, Sikkim, **Nagaland***; *South India:* Kerala, Karnataka and Tamil Nadu.

Specimen examined: Nagaland: Kohima District: Jakhama: KE 10271 (B), KE 10284: 08.08.2010: Kazhuhrii Eshuo.

Genus: *Lejeunea* Gilib.

Lejeunea Gilib., Ann. Gen. Sci. Phy. 6: 372. 1820

Plants small or medium sized, green or yellowish green, light brownish green, irregularly pinnate by intercalary branching, branching of *Lejeunea* type. Stem in cross section consisting of 7 cortical cells and 3-25 medullary cells; cortical cells much larger than the medullary cells; medullary cells non-trigonus, thin walled. Ventral merophytes of stem 2 cells wide. Rhizoids few, fasciculate at base of underleaves, rhizoid disc absent. Leaves imbricate to distant, ovate, apex rounded to obtuse, rarely subacute, margin entire; ocelli absent; oil bodies hyaline, small, numerous, homogenous type. Leaf lobule attached to stem by 3 stem cells, truncate at apex, second tooth obsolete and unicellular, lobule inflated, hyaline papillae on the proximal of the first tooth. Underleaves distant to contiguous, bilobed with entire margin. Male inflorescence on a long or short lateral branches, capitates; male bracts in 2-4 (-8) pairs; male bracteoles usually limited to the base of the inflorescence. Female inflorescence on an elongate branch with one subfloral innovation; female bracts entire; bracteole bilobed, entire at margin. Perianth 5 keeled (2 ventral, 2 lateral, 1 dorsal), keels smooth. Seta (12+4), articulate, outer cells in 12 rows and

inner cells in 4 rows. Capsule wall 2 layered; outer layer with pale brown, sinuate thickenings; inner layer with irregular thickenings on the wall. Elaters wall sinuately thickened, spiral band slender, colourless to pale brown and few per capsule.

Type: Lejeunea serpilifolia Lib. (non *Jungermannia serpilifolia* Scop.)

Key to species of the genus *Lejeunea*

1. Plants small, 0.4-0.55 mm wide, perianth mammillose..... *L. tuberculosa*
- 1a. Plants larger, 0.5-1.3 mm wide, perianth not mammillose..... 2
2. Underleaves large, contiguous to imbricate, longer than wide..... *L. flava*
- 2a. Underleaves small to medium, distant to contiguous, wider than long..... 3
3. Plants 1-1.5 mm wide, stem 6-7 cells across, trigones small..... *L. obscura*
- 3a. Plants 1-1.3 mm wide, stem 7-8 cells across, trigones large..... *L. cavifolia*

Lejeunea tuberculosa Steph., Sp. Hepat. 5: 790. 1915. (Plate 26. Figs. 1 - 12)

Plants small, light green to light yellowish green, upto 12 mm long, 0.4-0.55 mm wide including leaves, branched, branching of *Lejeunea*-type, intercalary or irregularly branched. Stem 48-65 μm in diameter, cortical cells 7 in radial rows, larger than the medullary cells; medullary cells 9 in radial rows, thin walled. Ventral merophytes of the stem 2 cells wide. Rhizoids numerous, fasciculate at the base of underleaf, rhizoid disc absent. Leaves slightly imbricate to contiguous, spreading widely, lobes ovate, orbicular, oblong-ovate, 0.24-0.32 mm long, 0.2-0.25 mm wide; apex rounded and plane, margin entire. Lobe cells thin walled, trigones large, intermediate thickenings usually frequent, apical cells sub-quadrate, 13-17 μm long, 8-12 μm wide, median cells hexagonal, 14-27 μm long, 12-17 μm wide, basal cells similar to the median cells. Oil bodies 2-5 per cell, mostly fusiform, spherical, or circular, finely segmented, 4-12.7 x 1.8-4 μm in diameter. Ocelli and vita absent. Lobule small, ovate, 1/3 of the length of leaf lobe, inflated, first tooth small,

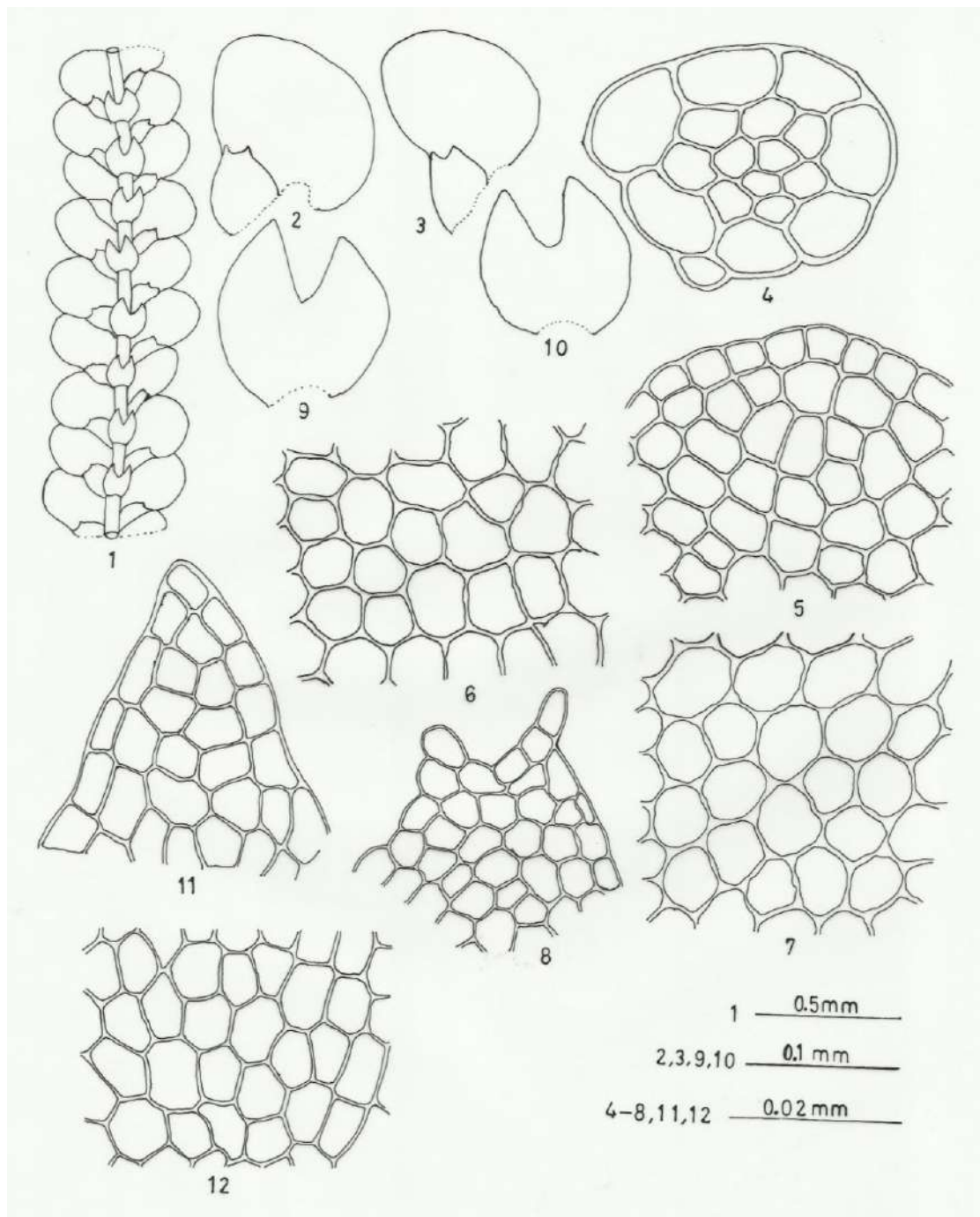


Plate 26. *Lejeunea tuberculosa* Steph., Plate 26. Figures. 1 - 12

Figs. 1. A portion of plant in ventral view; 2-3. Leaves; 4. Cross section of stem; 5. Leaf apical cells; 6. Leaf median cells; 7. Leaf basal cells; 8. Leaf lobule cells; 9-10. Underleaves; 11. Underleaf lobe apical cells; 12. Underleaf basal cells.

unicellular, second tooth obsolete, hyaline papilla at the proximal side of the first tooth. Underleaves distant, free, small, sub-orbicular, 0.13-0.16 mm long, 0.14-0.16 mm wide, 2-3 times as wide as the stem, slightly wider than long, bilobed 1/2, sinus obtuse to acute, margin entire.

Habitat: Plants grow on bark and on moist rocks in association with *Heteroscyphus* sp., *Plagiochila* sp., *Trocholejeunea* sp., *Frullania* sp. and Mosses at

Range: India, China, Africa, Bhutan, Indonesia, Nepal and Philippines.

Distribution in India: *Eastern Himalaya:* West Bengal, Sikkim, **Nagaland***.

Specimen examined: Nagaland: Kohima District: Kohima (II World War cemetery): 05.08.2010: KE 10254: Kazhuhrii Eshuo; Longkhum: 14.04.2012: KE 10523: Kazhuhrii Eshuo.

Lejeunea flava (Sw.) Nees, Naturgesch. Eur. Leberm. 3: 277. 1838.

(Plate 27. Figs 1-13)

Plant small, light green to yellowish green, in dry herbarium whitish brown to reddish, 8-15 mm long, 0.9-1.2 mm wide including leaves, branched, branching intercalary, terminal, of *Lejeunea* type. Rhizoids hyaline, transparent, in bunch at the base of the underleaf; rhizoidal disc absent. Stem circular, 0.06 x 0.07 mm in diameter, 5-6 cells across, cortical cells in 7 radial rows, 10.1-25.6 µm long, 5.7-12.8 µm wide; medullary cells thin walled, 10.1-15.4 µm long, 6.2-11.3 µm wide, cells slightly trigonous. Leaves imbricate, entire, oblong, ovate, 0.55-0.7 mm long, 0.4-0.55 mm wide; apex obtuse, rounded; apical cells 10.4-22.5 µm long, 7.2-11.2 µm wide, cells quadrate, rectangular, trigones minute; median cells 15.3-29.7 µm long, 10.5-17.9 µm wide, cells quadrate to sub-quadrate, rectangular, trigones bulging, intermediate thickening of walls present; epidermal cells 6.4-16.4 µm long, 6-11.9 µm

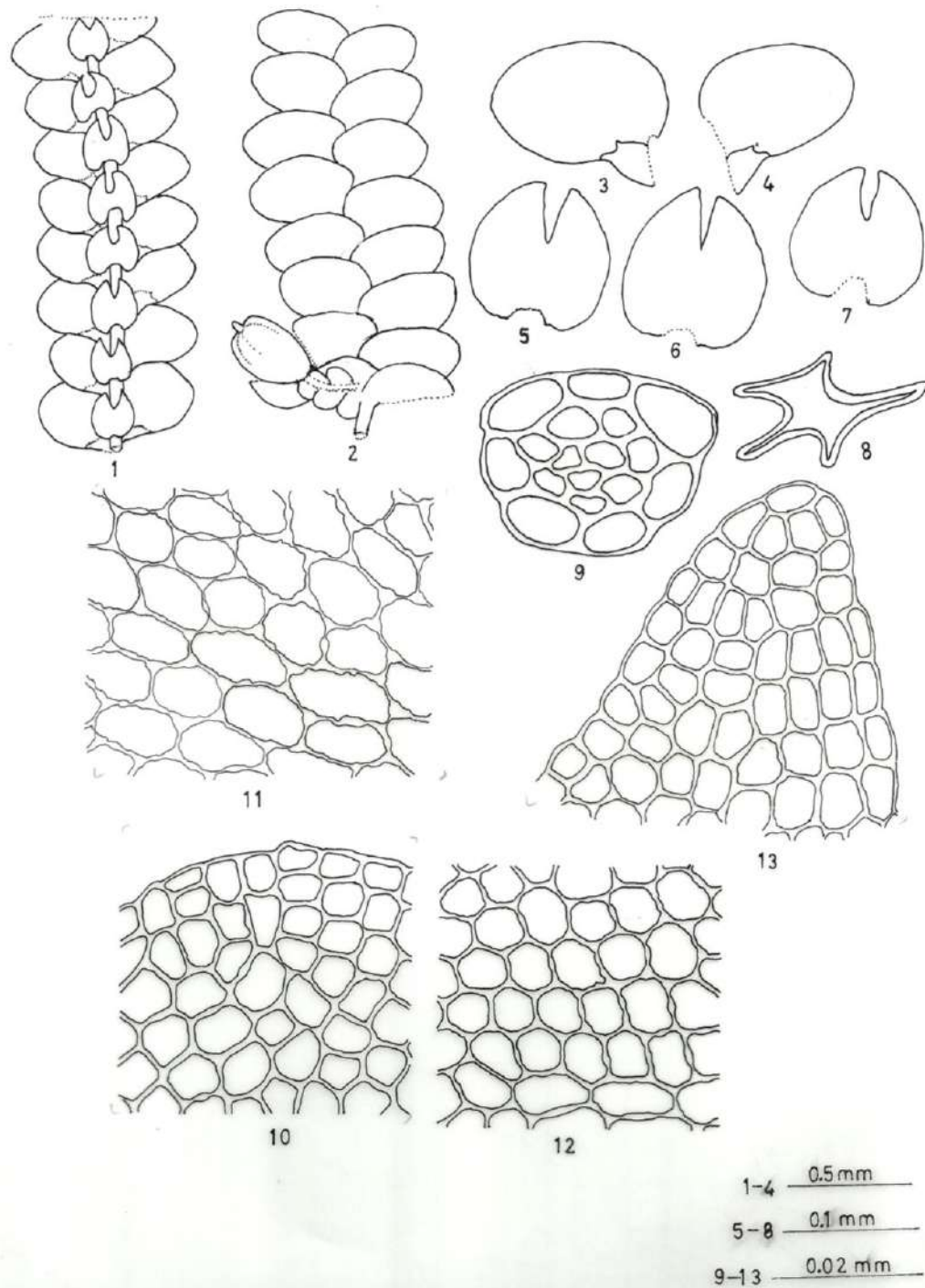


Plate 27. *Lejeunea flava* (Sw.) Nees, Figures 1-13.

Figs. 1. A portion of plant in ventral view; 2. A portion of plant in dorsal view; 3-4. Leaves; 5-7. Underleaves; 8. Cross section of perianth; 9. Cross section of stem; 10. Leaf apical cells; 11. Leaf basal cells; 12. Leaf median cells; 13. Underleaf apical cells.

wide, cells rectangular, quadrate; basal cells 18.8-38.1 μm long, 15.8-20.3 μm wide, cells quadrate, rectangular, trigones nodulose, bulging, thickening of walls present; lobule small, oblong, apex obliquely truncate, first tooth absent, second tooth one cell, 1/3-1/4 of the length of the lobe, cells like the leaves cells. Underleaves distant, small, oblong, ovate, 0.3-0.4 mm long, 0.25-0.3 mm wide, bifid, sinus deep, 1/2 of the lobe, sinus wide, rarely narrow, lobes triangulate, cells like the leaves cells. Female inflorescence borne on the main plant or on the lateral branched at the apex, perianth 5 lobes, entire and bract like the leaves. Male plant borne on short lateral branched, closely packed, 5-6 pairs of bract. Spores not seen.

Habitat: Plants grow on bark of trees (corticolous) and on moist rocks in association with *Lejeunea* sp., *Ptychanthus* sp., *Plagiochila* sp. and Mosses at 950-1700 m asl.

Range: India, Nepal, Bhutan, China, Indonesia, Polynesia, Papua New Guinea, Europe, North & South America.

Distribution in India: *Western Himalaya:* Himachal Pradesh; *Eastern Himalaya:* West Bengal, Sikkim, Assam, Meghalaya, **Nagaland***; *Western Ghats:* Karnataka, Tamil Nadu; Andaman & Nicobar Islands.

Specimen examined: Nagaland: Mokokchung District: Dikhu: KE 10240; Longkhum: 14.04.2012: KE 105521: Kazuhrii Eshuo; Kohima District: Khuzama: KE 10232: 05.07.20010: Kazuhrii Eshuo.

Lejeunea obscura Mitt., J. Proc. Linn. Soc. Bot. 5: 112. 1861. (**Plate 28. Figs 1-13**)

Plants green to dark green, upto 15 mm long, 1-1.5 mm wide including leaves, branched, branching irregular, of *Lejeunea* type. Stem 88-104 x 122-140 μm in diameter, cortical cells 7 in radial rows, large, 33-60 x 17-25 μm in diameter; medullary cells 15-22 x 8-14 μm in diameter, 16-18 cells in radial rows. Ventral merophytes of the stem 2 cells wide. Rhizoids numerous, fasciculate at the base of the

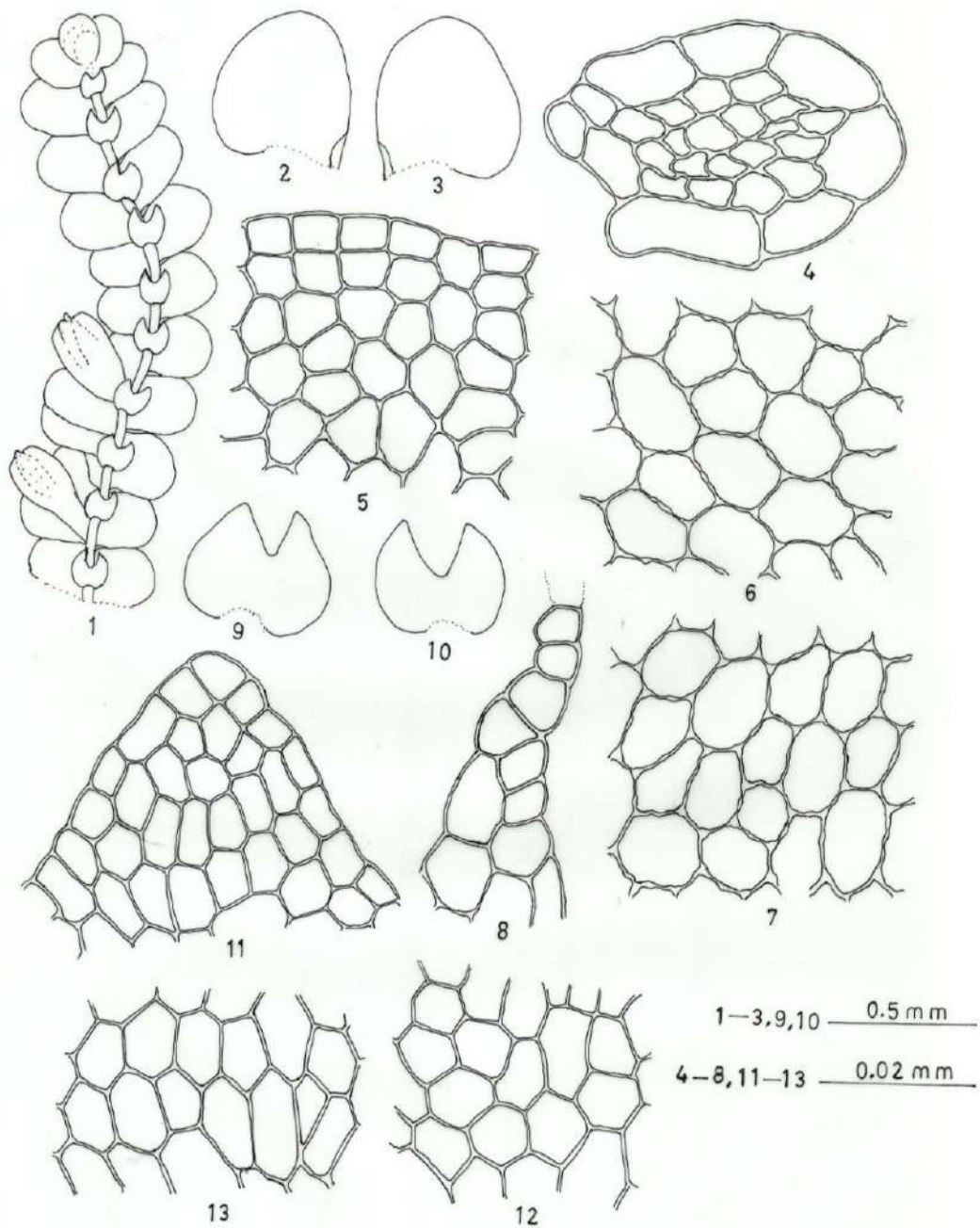


Plate 28. *Lejeunea obscura* Mitt., Figures 1-13.

Figs. 1. A portion of plant in ventral view; 2-3. Leaves. 4. Cross section of stem; 5. Leaf apical cells; 6. Leaf median cells; 7. Leaf basal cells; lobule cells; 9-10. Underleaves; 11. Underleaf apical cells; 12. Underleaf median cells; 13. Underleaf basal cells.

underleaf. Leaves imbricate, contiguous, widely spreading, oblong-ovate, ovate, 0.7-0.9 mm long, 0.65-0.7 mm wide, apex rounded, margin entire. Lobe thin-walled, trigones and intermediate thickenings small, marginal cells quadrate to oblong, 15-20 μm long, 10-14 μm wide; apical cells 15-26 μm long, 8-16 μm wide, median cells hexagonal, 28-40 μm long, 17-26 μm wide, basal cells similar to that of the median cells, trigones and intermediate thickenings small. Leaf lobule highly reduced less than 1/5 of the lobe length, apex obliquely truncate, first tooth small, unicellular, second tooth obsolete. Oil bodies not seen. Ocelli and vita cells not seen. Underleaves distant, orbicular to sub-orbicular, 0.35-0.4 mm long, 0.45-0.5 mm wide, wider than long, bilobed 1/2, sinus wide to narrow, lobes triangular, apex obtuse. Androecia and gynoecia not seen.

Habitat: Plants grow on bark of trees (corticolous) in association with *Frullania* sp., *Lejeunea* sp. and Mosses at 1200-1600 m asl.

Range: India, China, Indonesia, Nepal and Sri Lanka.

Distribution in India: *Eastern Himalaya:* Sikkim, **Nagaland***.

Specimen examined: Nagaland: Kohima District: Kohima (II World War cemetery): 05.08.2010: KE 10253: Kazuhrii Eshuo.

Lejeunea cavifolia (Ehrh.) Lindb., Acta Soc. Sci. Fenn. 10: 43. 1871.

(Plate 29. Figs. 1-16)

Plants light yellowish green, pale brown in dry herbarium, stem upto 10-20 mm long, 1-1.3 mm wide including leaves, branched, irregularly branched, branching of *Lejeunea*-type; rhizoids in tuft at the bases of the underleaf. Stem 90-96 x 130-135 μm in diameter, 7 cells across in cross section, cortical cells large, 23-55 x 15-23 μm , in 7 radial rows of cells; medullary cells small, 11-21 x 9-14 μm , in 23-25 radial rows of cells, thin walled. Leaves imbricate, oblong-ovate, ovate, broadest at middle, 0.8-

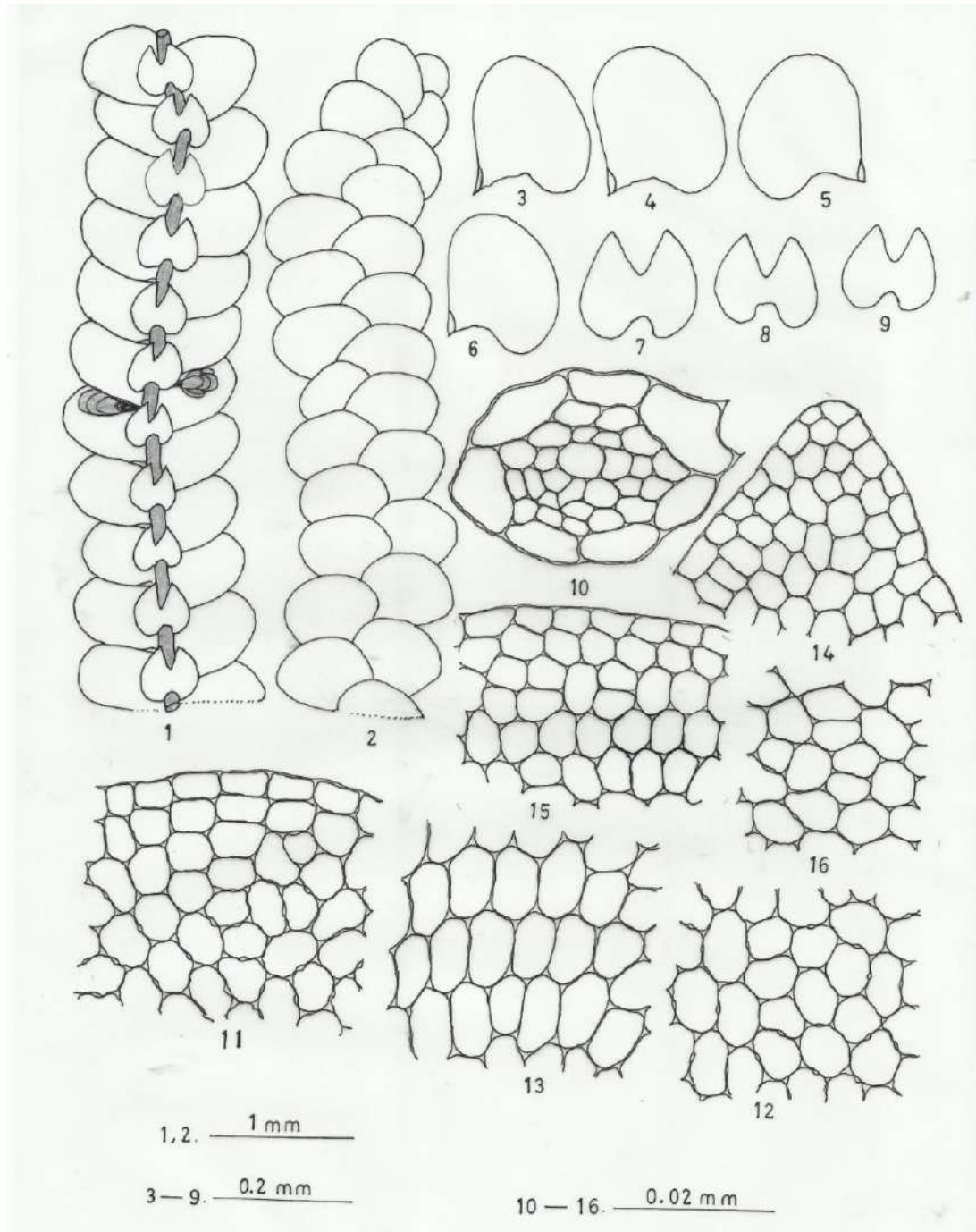


Plate 29. *Lejeunea cavifolia* (Ehrh.) Lindb., Figures 1-16.

Figs. 1. A portion of plant in ventral view; 2. A portion of plant in dorsal view; 3-6. Leaves; 7-9. Underleaves; 10. Cross section of stem; 11. Leaf apical cells; 12. Leaf median cells; 13. Leaf basal cells; 14. Underleaf lobe apical cells; 15. Leaf marginal cells; 16. Underleaf basal cells.

1.0 mm long, 0.8-.85 mm wide, obliquely to transversely inserted; margin entire, apex obtuse, rounded, postical margin straight; leaf apical cells 13-27 x 9-18 μm , median cells 27-40 x 16-29 μm , basal cells 30-62 x 26-38 μm , thin-walled, trigones small, triangular or tri-radiate, intermediate thickenings present or indistinct. Cuticle smooth. Leaf lobule highly reduced, 1/5 of the lobe length, first tooth one cell, second tooth obsolete or absent, apex oblique. Underleaves distant, orbicular, 0.3-0.4 mm long, 0.4-0.46 mm wide; broader than long, 3-4 times wider than the stem, bilobed 1/2, sinus wide, obtuse, lobes triangular, apex acute or obtuse. Androecia and gynoecia not seen.

Habitat: Plants grows on moist rocks (saxicolous) in association with *Lejuenea* sp. *Heteroscyphus* sp., and Mosses.

Range: India, Nepal, Europe, Russia, Sideria, Caucasus, North America.

Distribution in India: *Eastern Himalaya:* West Bengal, Meghalaya, **Nagaland***; *Sotuh India:* Kotagiri, Kodaikanal and Western Himalaya.

Specimen examined: Nagaland: Mokokchung District: Mokokchung: KE 10306: 04.12.2010: Kazhuhrii Eshuo; Kohima District: Jotsoma: KE 10120: 10.0.2010: Kazhuhrii Eshuo.

Genus: *Frullanoides* Raddi

Frullanoides Raddi, Proc. Bot. Soc. Edinburgh 15: 129. 1884.

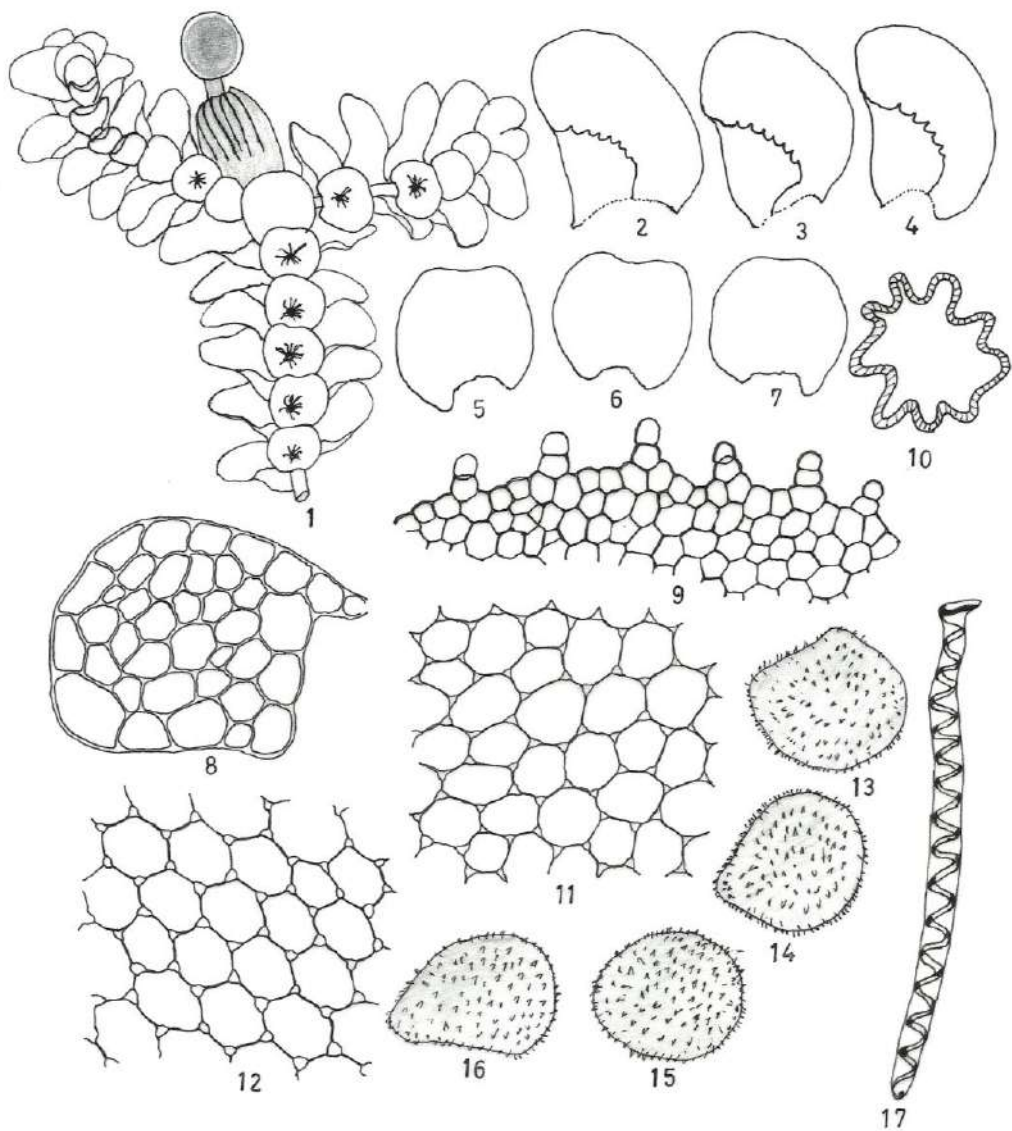
Plants medium sized, pale to olive green or yellowish brown, stem irregularly branched, branching of *Frullania* type; stem in cross section consist of cortical cell in 15-20 longitudinal rows, thin walled, small trigones and slightly larger than the medullary cells. Leaf lobes densely imbricate, subtransversely inserted, more or less squarrose when moist, lobes ovate, margin entire, with rounded apex; oil bodies hyaline, homogenous, small, numerous; lobules large, free margin with 4-10 teeth,

hyaline papilla on the surface of the lobule at the base of the first tooth. Underleaves with entire margin, orbicular. Male inflorescence terminal on the main branch or on lateral branch. Female inflorescence on the main branch with 1-2 subfloral innovations of the *Radula*-type; female bracts entire at margin; bracteoles entire or often bilobed. Perianth inflated, 3-10 keeled (1-3 ventral, 2-4 lateral and 0-3 dorsal), keel rounded and smooth. Seta (16+4) seriate type. Capsule wall 2 layered; outer layer with nodular inetermediate thickenings and trigones; inner layer with an irregular net like thickening bands. Elaters brown, numerous, uni-spiral. Spores greenish, yellowish, oval, cylindrical, finely papillose.

Frullanoides tristis (Steph.) Van Slageren, meded. Bot. Mus. Herb. Vande Rijks

Univ. Utrecht 544: 110. 1985. **(Plate 30. Figs. 1-17)**

Plants medium, light green to brownish green, 15-34 mm long, 1.5-2 mm wide including leaves, branched, branching irregular, branching of *Radula* type or of *Frullania* type. Rhizoids in tuft at the bases of the underleaf. Stem circular, 0.13 x 0.16 mm in diameter, 6-7 cells across, cortical cells larger than the medullary cells, 14 rows of cells, 18.2-33.4 μm long, 12-22.6 μm wide, cells thin walls or slightly thick walls; medullary cells 14-28.4 μm long, 10-22.1 μm wide. Leaves closely imbricate, oblong-ovate, broadest at base, entire, 0.8-1 mm long, 0.6-0.8 mm wide, apex rounded, obtuse; epidermal cells 11-15 μm long, 11-12 μm wide, cells trigonous, thin walls; median cells 18-29 μm long, 17-22 μm wide, cells trigonous, quadrate, thin walls; basal cells 20-31 μm long, 12-24 μm wide, quadrate, cells trigonous, sometime intermediate thickening present. Lobules short, denticulate, 0.3-0.4 mm long, 0.4-0.5 mm wide, 6-7 teeth per lobule, 1-2 uniseriate cells long. Underleaves distant to contiguous, oblong, orbicular, 0.4-0.6 mm long, 0.4-0.6 mm wide; apex obtuse, truncate, broad, entire, cells like the leaves cells. Spore light green, 38-42 x 51-61 μm



1-7 — 1 mm
 8-10 — 0.2 mm
 11-17 — 0.02 mm

Plate 30. *Frullanoides tristis* (Steph.) Van Slageren, figures 1-17.

Figs. 1. A portion of plant in ventral view; 2-4. Leaves; 5-7. Underleaves; 8. Cross section of stem; 9. Lobule cells; 10. Cross section of perianth; 11. Leaf median cells; 12. Leaf basal cells; 13-16. Spores; 17. Elater.

in diameter, exine spinous, oval, elongate, elaters mono-spiral, 13-16 µm in diameter, upto 302 µm long.

Habitat: Plants grow on bark in pure patches or in association with *Frullania* sp., *Lejeunea* sp. and Mosses.

Range: India

Distribution in India: *Eastern Himalaya:* Meghalaya, **Nagaland***.

Specimen examined: Nagaland: Kohima district: Khuzama: KE 10230: Kazhuhrii Eshuo.

Genus: *Lopholejeunea* (Spruce) Schiffn.

Lopholejeunea (Spruce) Schiffn., in Engler & Prantl, Nat. Pfl. 1,3: 129. 1884.

Plants medium sized, dark green to blackish brown or reddish brown, stem usually irregularly branched, branching intercalary, or sometimes pinnately branched. Stem in cross section cortical cells 10-12 longitudinal rows, thick walled, trigones absent, larger than the medullary cells, medullary cells thin walled. Leaves lobes entire at margin, apex rounded or rarely acuminate; oil bodies homogenous, small; leaf lobule inflated, angles obtuse or with 1-2 small teeth. Underleaves orbicular, large, entire, reniform. Male inflorescence on a short lateral branches, capitate; bracteoles similar to underleaves. Female inflorescence on the lateral intercalary branches, without or rarely with one innovation; female bracts dentate towards acute apex; bracteoles dentate to entire at margin, often emerginate to slightly bilobed. Seta (16+4), articulate; outer cells in 16 longitudinal rows, inner in 4 longitudinal rows. Capsule wall 2 layered; outer layer with irregular nodulose or sinuate thickenings; inner layer irregularly thickened. Elaters brown, uni-spiral and numerous.

Type: *Phragmicoma sagreana* Mont. [*Lopholejeunea sagreana* (Bond.-Mont.) Schiffn.]

Lopholejeunea abortiva (Mitt.) Steph., Spec. Hepat. 5: 70. 1912.

(Plate 31. Figs. 1-12)

Plant small, 20-56 mm long, 0.9-1.2 mm wide including leaves, branched, branching irregular, intercalary, *Lejeunea* type, widely spreading, blackish green to brownish green. Rhizoids in bunch at the bases of the underleaf. Stem oval, brown, 98.1-109.8 x 135.7-137.4 μm in diameter, 7 cells across, 11 cells of cortical in radial rows, slightly larger than the medullary cells, 17.4-32.8 μm long, 9.8-18.2 μm wide; medullary cells 13.2-22.1 μm long, 10.4-14.7 μm wide, thin walled. Leaves distant to contiguous, rarely imbricate, alternate to sub-opposite, orbicular, oblong-ovate, 0.54-0.6 mm long, 0.5-0.53 mm wide, apex rounded, margin entire, basal lobule margin slightly incurved; cells thin walled, trigones minute, tri-radiate; apical cells 11.8-14.5 μm long, 7.3-10.7 μm wide, cells non-trigonous or trigones wanting, cells rectangular, hexagonal; middle cells 13.3-19.4 μm long, 10-13.5 μm wide, trigones minute, cells hexagonal; basal cells 19.2-32.9 μm long, 15.5-24.6 μm wide, cells larger, trigones tri-radiate, quadrate, hexagonal to polygonal. Lobule 1/3 of the leave lobe length, small, oblong-ovate, 0.2-0.22 mm long, 0.13-0.14 mm wide, first tooth 1 cell, second tooth obsolete, apex obliquely truncate, cells like the leaves cells. Underleaves distant, free, small, orbicular, 0.16-0.2 mm long, 0.25-0.29 mm wide; apex rounded to rotundate, basal cordate, margin entire and sinuately inserted.

Habitat: Plants grow on rocks in association with *Lejeunea* sp., *Plagiochila* sp., *Trocholejeunea* sp. and Mosses.

Range: India, Bangladesh, Bhutan, China, Japan, Indonesia, Malaysia, Myanmar, Nepal, Papua New Guinea, Philippines, Thailand, Vietnam, Yemen.

Distribution in India: *Eastern Himalaya:* Meghalaya, Sikkim, Nagaland*.

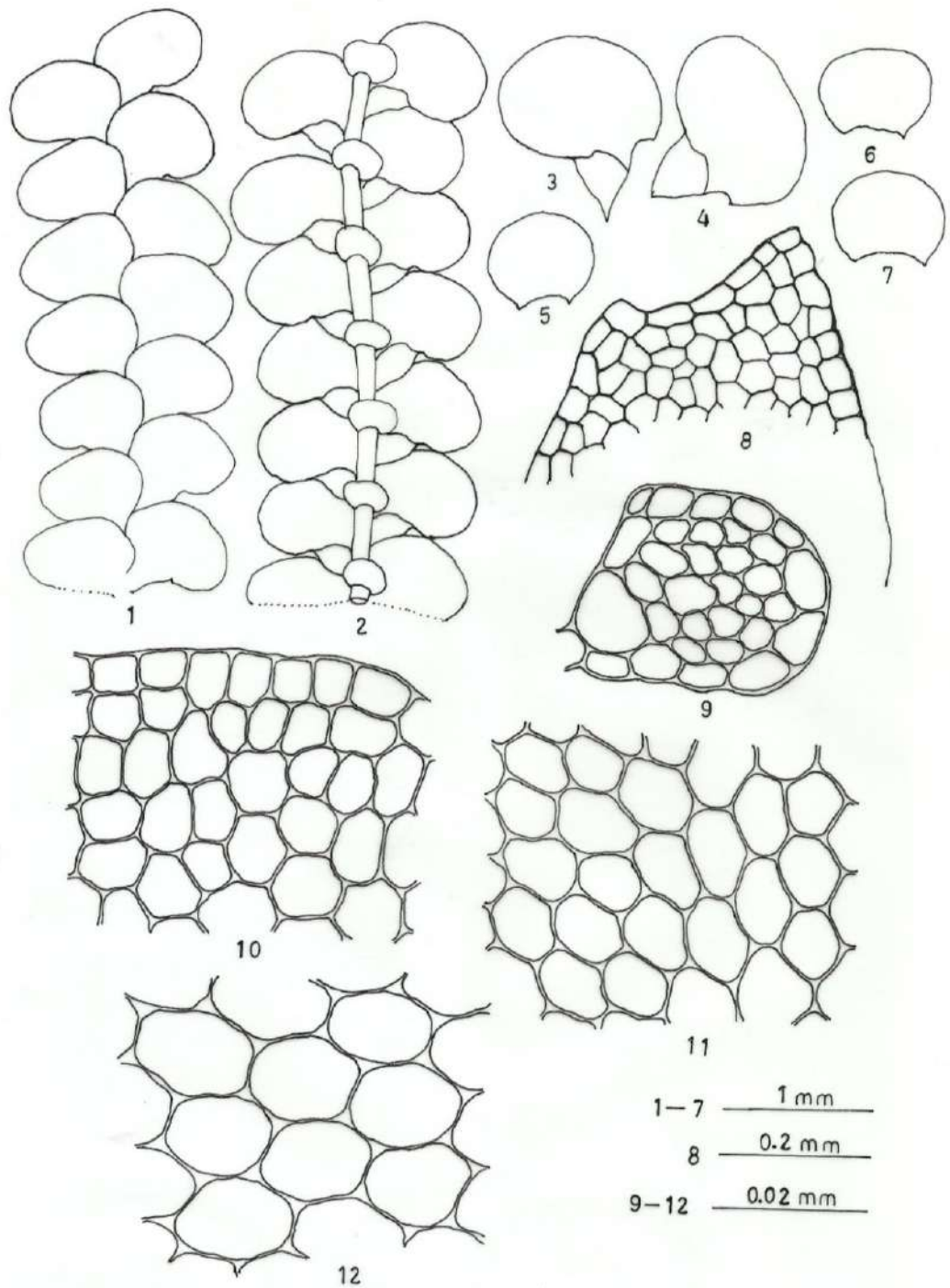


Plate 31. *Lopholejeunea abortiva* (Mitt.) Steph., Figures 1-12.

Figs. 1. A portion of plant in dorsal view; 2. A portion of plant in ventral view; 3-4. Leaves; 5-7. Underleaves; 8. Lobule cells; 9. Cross section of stem; 10. Leaf apical cells; 11. Leaf median cells; 12. Leaf basal cells.

Specimen examined: Nagaland: Kohima District: Jakhama: KE 10288: 08.08.2010:
Kazuhrii Eshuo.

Genus: *Trocholejeunea* Schiffn.

Trocholejeunea Schiffn., Ann. Bryol. 5: 160. 1932.

Plants pale to olive green, brownish to blackish green, irregularly branched, branching of *Frullania* or *Radulla*-type; stem in cross section differentiate into cortex and medulla region, cells thin or thick walled. Leaves closely imbricate, subtransversely inserted, ovate, margin entire with rounded apex, incurved; oil bodies hyaline, homogenous, small and numerous. Leaf lobule large, free margin with 2-3 marginal teeth, hyaline papillae on the inner surface of the lobule at the base of the tooth. Underleaves distant to contiguous, with entire margin, orbicular, apex slightly recurved. Male inflorescence terminal on the main or on short lateral branch. Female inflorescence on the main branch with 1-2 subfloral innovations of the *Radula* and *Frullania* type; female bracts entire at margin (if lobule present) never with winged keel; bracteole entire or often bilobed. Perianth inflated, 8-10 plicate to near base. Seta with epidermal cells in 16-32 rows. Inner cells in 8-16 rows. Capsule wall 2 layered; outer layer with large nodular intermediate thickenings and trigones; inner layer with an irregular net like thickenings bands. Elaters brown, numerous, uni- bi-spiral.

Type: *Brachiolejeunea* (*Trocholejeunea*) *sandvicensis* (Schiffn.) Schust.

Key to species of the genus *Trcholejeunea*

1. Plants small, 1-1.5 mm wide, stem 6-7 cells across, leaf lobule first tooth 1 cell, second tooth obsolete, underleaf wider than long..... *T. sandvicensis*
- 1a. Plants medium, 2-3 mm wide, stem 8-9 cells across, leaf lobule firts tooth 1 cell, second tooth 1 cell, underleaf longer than wide..... *T. infuscata*

Trocholejeunea sandvicensis (Gottsche) Mizut., in Misc. Bryol. Lichenol. 2: 169.

1962. (Plate 32. Figs. 1-15)

Plant medium, brownish green to brown, light green, dull brown in dry herbarium, 18-25 mm long, 1-1.5 mm wide including leaves; branched, branching intercalary, dorsal ventrally flattened. Rhizoids in bunch at the bases of underleaf. Stem circular, 0.14 x 0.18 mm in diameter, 6-7 cell across, thin walled, cells slightly trigonous; cortical in 14-16 cells in radial rows, cortical larger than the medullary cells, 19-42.0 μm long, 15.5-17.5 μm wide, medullary cells usually smaller, 13.2-276.4 μm long, 10-16.5 μm wide. Leaves closely imbricate, entire, oblong, racket shape like, 0.9-1.1 mm long, 0.7-0.8 mm wide; margin entire, incurve, apex rounded, incurved; cells trigonous, trigones tri-radiate to nodulose, bulging; apical cells 15.5-27.5 μm long, 12-17.8 μm wide, middle cells 19-30.8 μm long, 14-26.5 μm wide, basal cells 30-43.4 μm long and 24-29.7 μm wide. Lobule small, oblong-ovate, 0.5-0.6 mm long, 0.3-0.4 mm wide; apex rounded to truncate, margin entire, first tooth 1 cell, second tooth obsolete to papillae, 1 cell, indistinct; cells similar to leaves cells. Underleaves small, contiguous to slightly imbricate, rarely distant, orbicular, 0.3-0.5 mm long, 0.5-0.6 mm wide, 2-3 times as wide as stem, wider than long; apex rounded to truncate, incurved, margin entire, cells trigonous, trigones nodulose, like the cells of the leaves cells. Sporophytes no seen.

Habitat: Plants grows on barks (corticolous) and on rocks (saxicolous) in association with *Plagiochila* sp., *Heteroscyphus* sp., *Lejeunea* sp., *Jungermannia* sp. and Mosses at 1700-2700 m asl.

Range: India, Pakistan, Nepal, Bhutan, China, Sri Lanka, Myanmar, Japan, Korea, Malaysia, Vietnam, Polynesia, Melanesia.

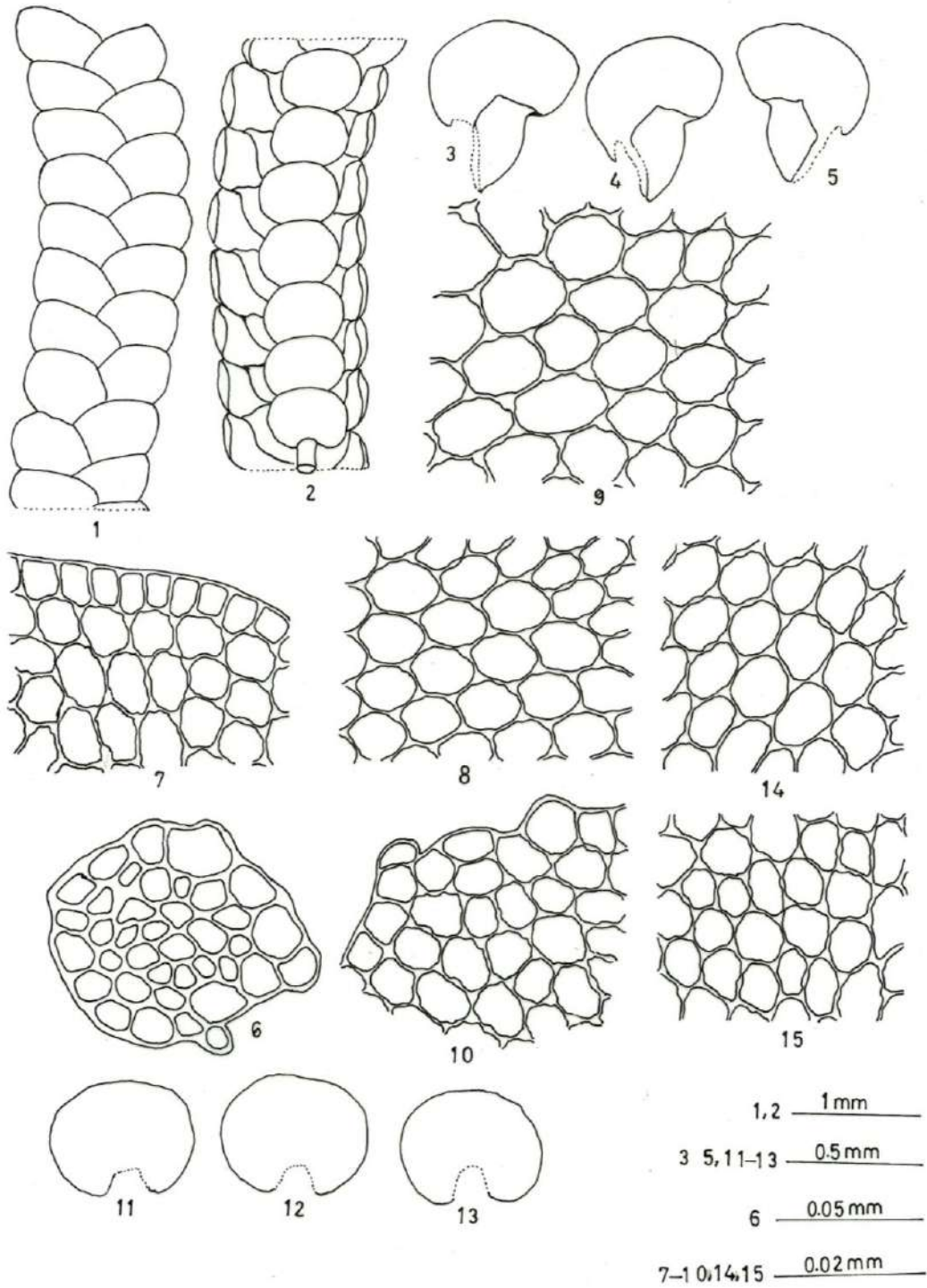


Plate 32. *Trocholejeunea sandvicensis* (Gottsche) Mizut., Figures 1-15.

Figs. 1. A portion of plant in dorsal view; 2. A portion of plant in ventral view; 3-5. Leaves; 6. Cross section of stem; 7. Leaf apical cells; 8. Leaf median cells; 9. Leaf basal cells; 10. Lobule cells; 11-13. Underleaves; 14. Underleaf median cells; 15. Underleaf basal cells.

Distribution in India: *Western Himalaya:* Himachal Pradesh, Uttarakhand; Eastern Himalaya: Sikkim, Meghalaya, **Nagaland***; *Western Ghats:* Tamil Nadu.

Specimen examined: Nagaland: Kohima District: Khuzama: 1.12.2008: KE 10070; 16.11.2009: KE 10179: Kazhuhrii Eshuo.

Trocholejeunea infuscata (Mitt.) Verd., in Ann. Bryol. 4: 190. 1934.

(Plate 33. 13)

Plant medium, light green to yellowish green, brownish green to blackish green, branched, branching intercalary, terminal, *Frullania* type, 40-60 mm long, 2-3 mm wide including leaves, blackish brown in dry herbarium. Rhizoids in bunch at the bases of underleaf, hyaline and thin-walled. Stem oval to circular, 0.16-0.17 x 0.17-0.18 mm in diameter, 8-9 cells across, cell not differentiated, thin walled, cortical cells 16-18 in radial rows, 22.3-32.5 μm long, 17.5-26.2 μm wide, medullary cells 21.4-29.1 μm long, 17.0-26.2 μm wide. Leaves closely imbricate, alternate, entire, amplicate, apex rounded, incurved, lobes widely spreading, obliquely ovate, oblong, triangular, 1-1.2 mm long, 0.6-.075 mm wide; cells thin walled, trigonous, trigones tri-radiate to slightly nodulose; leaf apical cells rectangulate, quadrate, 20.4-31.6 μm long, 12.9-20.6 μm wide; epidermal cells barrel to rectangular, 9.9-18.8 μm long, 9.9-15.9 μm wide; middle cells polygonal, quadrate to sub-quadrate, 24.1-32.1 μm long, 12.9-20.9 μm wide; basal cells sub-quadrate to quadrate, polygonal, 22.6-37.5 μm long, 16.4-22.9 μm wide; leaves lobules triangular-ovate, 1/3 of the length of leaf lobe, apex truncate, 1-2 tooth at apex, 1 or 2 cells long, cells trigonous and like the leaves cells. Underleaves contiguous to slightly imbricate, free, orbicular, amplicate, incurved, apex rounded, entire, 0.53-0.7 mm long, 0.55-0.62 mm wide, cells trigonous, similar to that of the leaves cells. Female inflorescence borne on the lateral side, perianth lobes irregularly lobes, apex broad, flat.

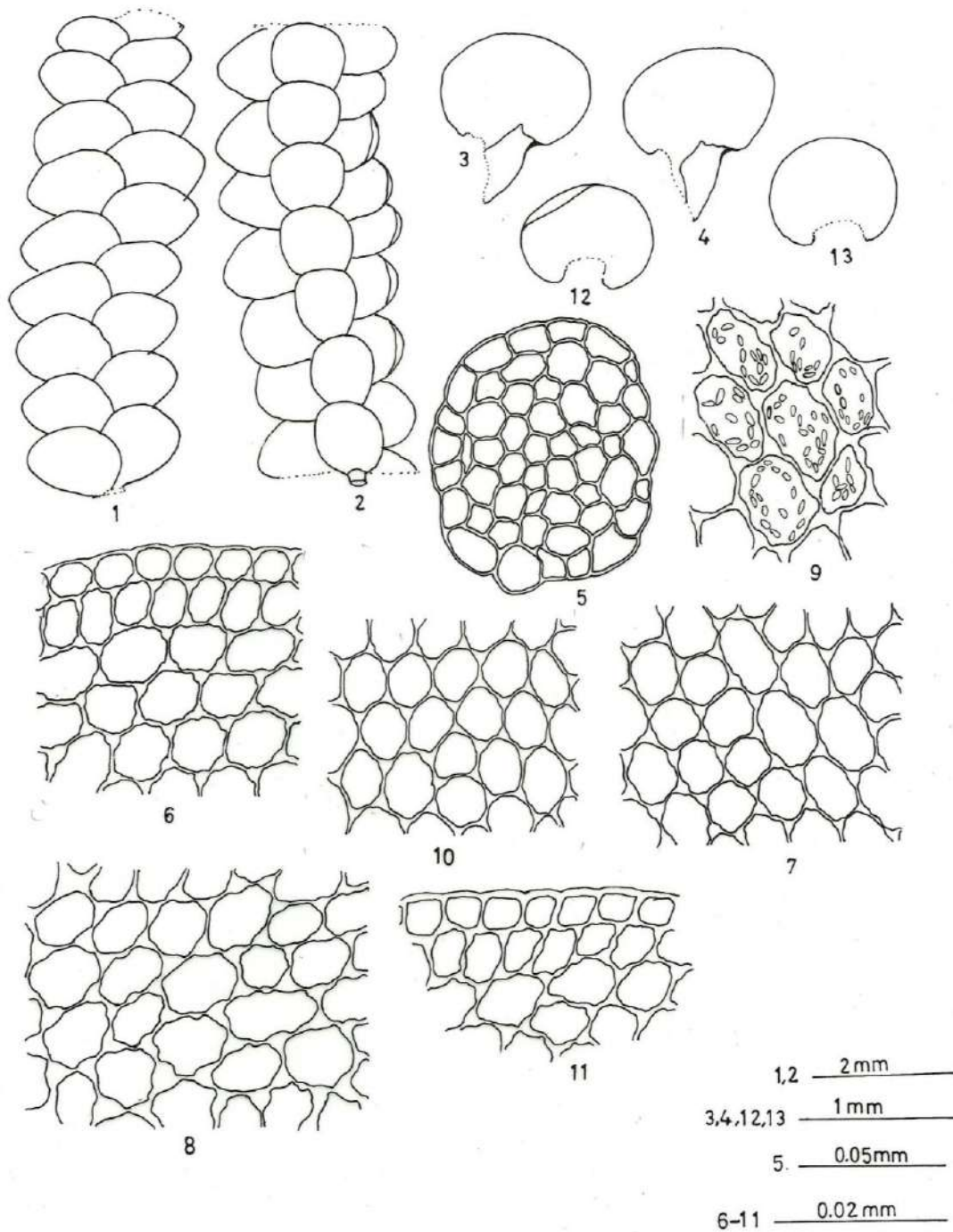


Plate 33. *Trocholejeunea infuscata* (Mitt.) Verd., Figures 1-13.

Figs. 1. A portion of plant in dorsal view; 2. A portion of plant in ventral view; 3-4. Leaves; 5. Cross section of stem; 6. Leaf apical cells; 7. Leaf median cells; 8. Leaf basal cells; 9. Oil bodies; 10. Underleaf median cells; 11. Underleaf apical cells; 12-13. Underleaves.

Habitat: Plants grows on barks (corticolous) and on moist rock (saxicolous) in association with *Heteroscyphus* sp., *Lejeunea* sp., *Trocholejeunea* sp., *Plagiochila* sp. and Mosses at 1500-2600 m asl.

Range: India, Bhutan, China, Sri Lanka, Myanmar.

Distribution in India: *Western Himalaya:* Himachal Pradesh; *Eastern Himalaya:* West Bengal, Sikkim, Meghalaya, **Nagaland***.

Specimen examined: Nagaland: Kohima District: Khuzama: 16.11.2009: KE 10164; Viswema: 08.08.2010: KE 10300: Kazhuhrii Eshuo.

Genus: *Tuzibeanthus* S. Hatt., in Biosphaera 1: 7. 1947.

As it is a monotypic genus, hence the description of the species will suffice the characters of the genus as well.

Type: *Tuzibeanthus chinensis* (Steph.) Mizut.

Tuzibeanthus chinensis (Steph.) Mizut., J. Hattori Bot. Lab. 24: 151. 1961.

(Plate 34. Figs. 1-20)

Plants dull green to brownish green in dry herbarium, upto 55 mm long, 2-3.5 mm wide including, rhizoids in bunch at the bases of underleaf. Stem 0.25 x 0.33 mm in diameter, 14-16 cells across, 2-3 thick cortical cells, cortical cells 11-24 μm long, 8-18 μm wide, medullary cells 15-32 μm long, 10-22 μm wide. Leaves imbricate (closely), ovate, oblong, 1.5-2 mm long, 1.2-1.4 mm wide, apex rounded, entire, trigonous, intermediate thickening of walls present; apical cells 8-22 μm long, 6-17 μm wide; median cells 18-34 μm long, 13-25 μm wide; basal cells 30-45 μm long, 26-33 μm wide. Lobule small, 1/10- 1/12th of the leaf length, tooth 2-3 cells long, 1-3 cells wide. Underleaves entire, free, recurved, basal cordate, orbicular, ovate, 0.56-0.7 mm long, 0.56-0.68 (7) mm wide. Female plant on short lateral branch, perianth 10 lobes, spores not seen.

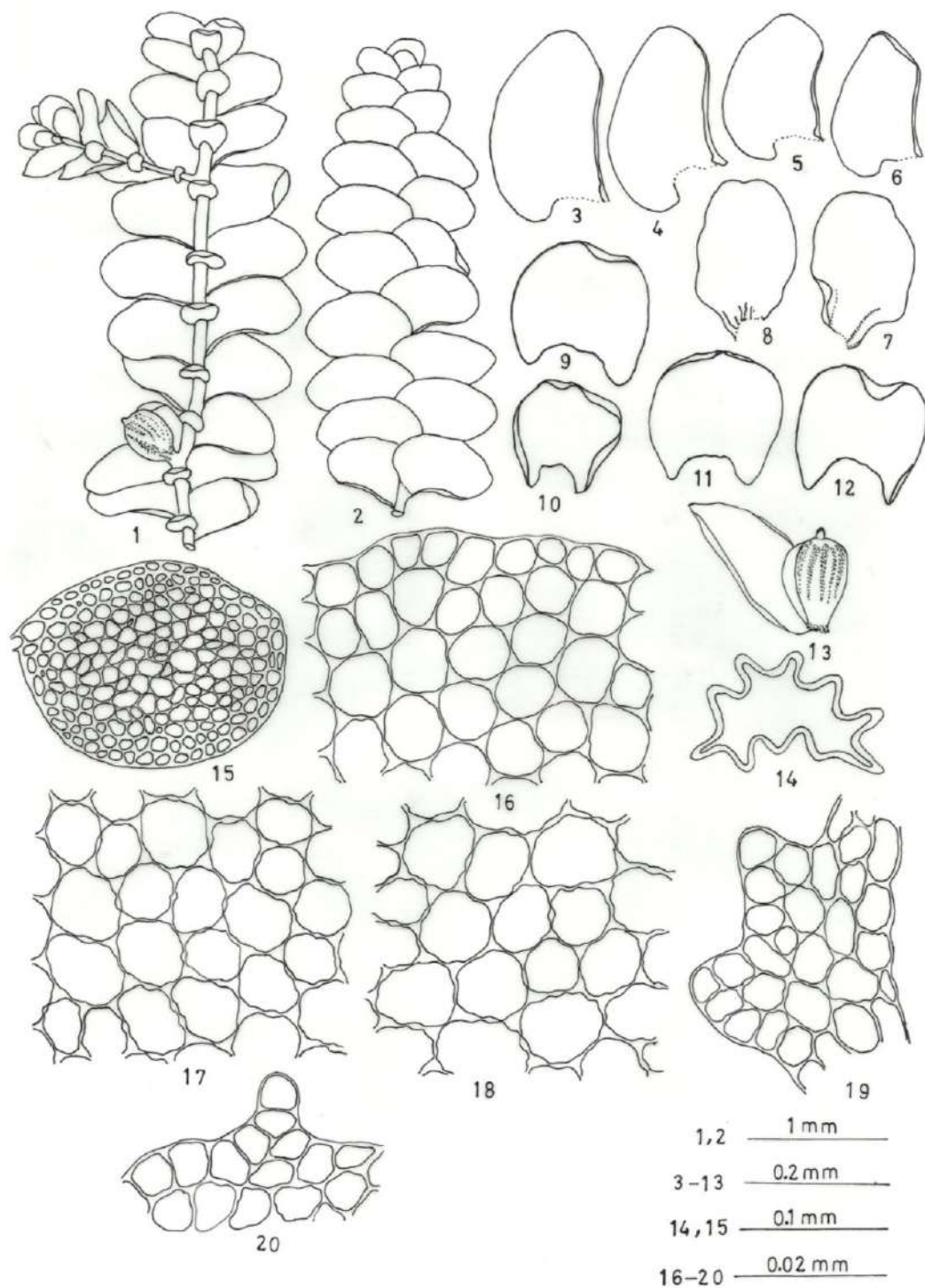


Plate 34. *Tuzibeanthus chinensis* (Steph.) Mizut., Figures 1-20.

Figs. 1. A portion of plant in ventral view; 2. A portion of plant in dorsal view; 3-6. Leaves; 7-8. Female bracts; 9-12. Underleaves; 13. Perianth; 14. Cross section of perianth; 15. Cross section of stem; 16. Leaf apical cells; 17. Leaf median cells; 18. Leaf basal cells; 19-20. Lobules cells.

Habitat: Plants epiphytic in association with *Plagiochila* sp., *Bazzania* sp., *Ptychanthus striatus* and Mosses.

Range: India, China

Distribution in India: *Western Himalaya:* Himachal Pradesh; *Eastern Himalaya:* Nagaland**.

Specimen examined: Nagaland: Kohima District: Khonoma: 19.03.2010: KE 10403: Kazuhrii Eshuo.

Genus: *Spruceanthus* Verd., Ann. Bryol. Suppl. 4: 153. 1934.

Plants brown to greenish brown, medium to large. Stem dark brown-brown, irregularly branched by the intercalary branching; in cross section of the stem cortical cells in 30-35 longitudinal rows, smaller than the medullary cells, cells thick walled, with large trigones. Leaf lobes dentate to almost entire at margin with acute or rarely obtuse apex; cells thick walled, trigones large, nodulose with intermediate thickenings; oil bodies minute, 20-40 per cell, homogenous, hyaline; leaf lobule with 1-3 teeth. Underleaves orbicular with entire or dentate margin. Male inflorescence terminal on short lateral branch; male bracts and bracteole similar to leaves and underleaves. Female inflorescence terminal on main branch, usually with 1-2 innovations; bracts spinose-dentate at margin, acute at apex; bracteole entire or dentate at margin. Perianth 5-10 keeled, keel smooth. Seta (14+4), occasionally articulate, outer cells in 16 longitudinal rows, the inner cells in 4 rows. Capsule wall 2 layered; outer layer with large trigones and occasionally with nodular intermediate thickenings; inner layer an irregular net like thickenings bands. Elaters brown, uni-spiral and numerous.

Type: Jungermannia semirepanda Nees

Spruceanthus semirepandus (Nees) Verd., Ann. Bryol. Suppl. 4: 153. 1934.

(Plate 35. Figs. 1-12)

Plant large, pale yellowish brown in dry herbarium, 30-45 mm long, 3-5 mm wide including leaves, branched, branching intercalary, terminal, branched arises from the ventral surface of the stem. Rhizoids scarce. Stem oval, 0.22 x 0.28 mm in diameter, 12-14 cells across, cortical cells thick walled, 10-22 μm long, 6-10 μm wide, smaller than the medullary cells; medullary cells thinner than the cortical cells, larger, 16.5-27.5 μm long, 10-18.8 μm wide. Leaves closely imbricate, widely spreading, ovate, oblong, 2.5-3 mm long, 1-1.5 mm wide, apex acute, acuminate, lower half of leaf margin entire and upper half dentate, dentition 6-9 per leaf, 2-7 cells long, 2-4 cells broad at base; apical cells 10-17 μm long, 7-15.4 μm wide, cells thick walled, trigonous, walls with intermediate thickening; marginal cells 6.6-20.2 μm long, 7.6-17.6 μm wide, thick walled, trigonous, walls with intermediate thickening; central cells 17.6-35.2 μm long, 14.3-23.2 μm wide, trigonous, trigones nodulose, bulging, walls with intermediate thickening; basal cells 22.1-46.2 μm long, 15.4-29.7 μm wide, trigonous, trigones nodulose, bulging, walls with intermediate thickening; cuticle smooth; leaf lobule 0.5-0.66 mm long, 0.3-0.34 mm wide, $\frac{1}{4}$ of the length of the lobe, inflated, apex obliquely truncate, with 2 teeth, teeth 1-2 (-3) cells long. Underleaves slightly imbricate to contiguous, free, orbicular, oblong, 1-1.1 mm long, 0.9-1.0 mm wide, 3-4 times wider than the stem, apex truncate to rounded, dentate, cells like the leaves cells. Androecia and gynoecia not seen.

Habitat: Plants grow on bark of trees (Corticolous) in association with *Plagiochila* sp., *Ptychanthus* sp., *Lejeunea* sp., *Bazzania* sp. and Mosses at 2000- 27000 m asl.

Range: India, Java, Taiwan, Japan, China, Philippines, Borneo.

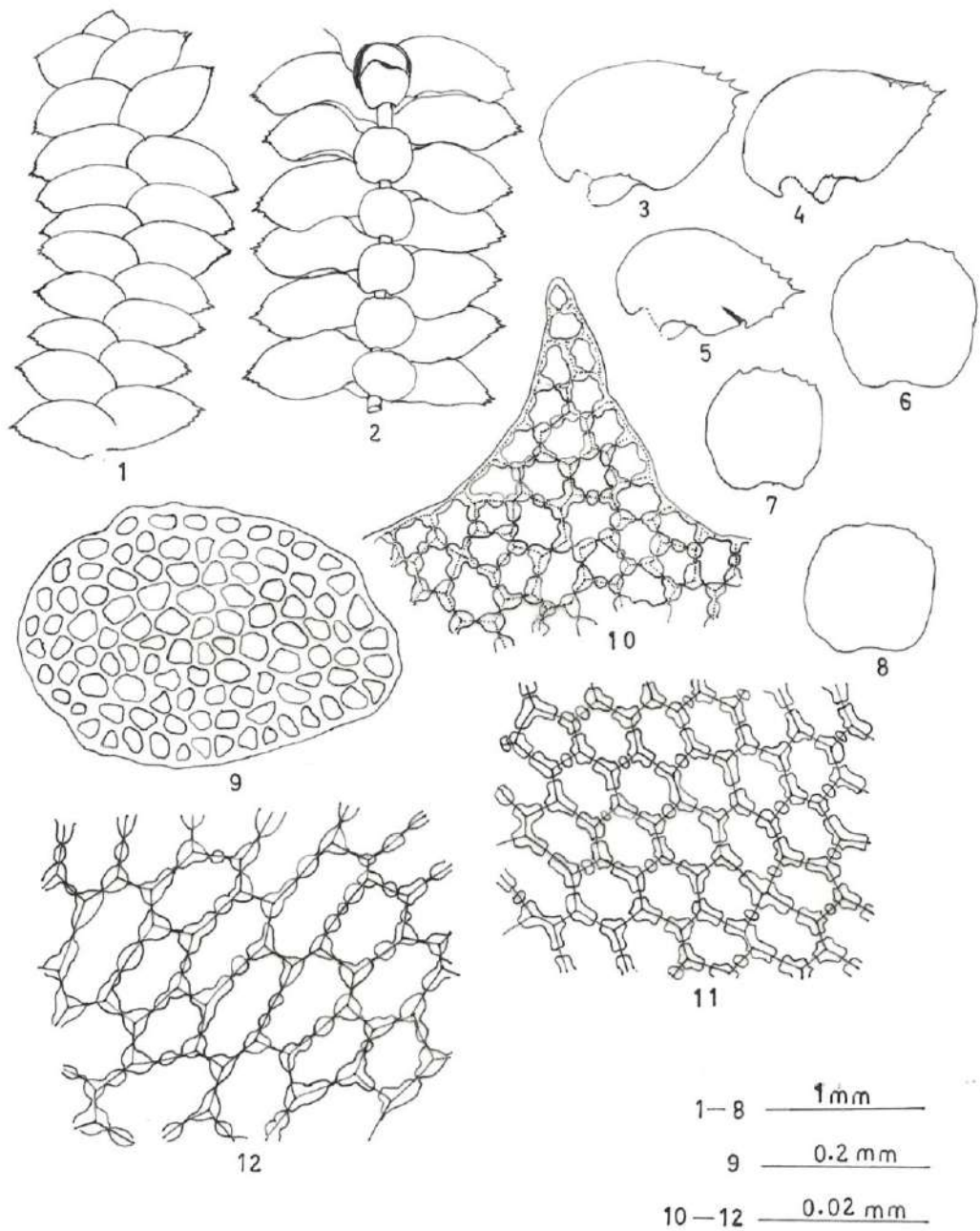


Plate 35. *Spruceanthus semirepandus* (Nees) Verd., Figures 1-12.

Figs. 1. A portion of plant in dorsal view; 2. A portion of plant in ventral view; 3-5. Leaves; 6-8. Underleaves; 9. Cross section of stem; 10. Leaf apical cells; 11. Leaf median cells; 12. Leaf basal cells.

Distribution in India: *Eastern Himalayas:* West Bengal, Sikkim, Meghalaya, Assam, Nagaland*; *South India:* Tamil Nadu.

Specimen examined: Nagaland: Kohima District: Khuzama: KE 10074: 01:12.2008: Kazhuhrii Eshuo.

Genus: *Ptychanthus* Nees

Ptychanthus Nees, *Naturg. Eur. Lebern.* 3: 212. 1838.

Plants light green to green or yellowish green to brownish green. Stem regularly pinnate or bipinnately branched, branching of *Frullania*-type. Stem in cross section shows differentiation into thick cortex and thin walled medulla region, medullary cells larger than the cortical cells. Leaves lobes dentate at margin with acute or acuminate apex; cells thick walled. Oil bodies large, grapes cluster type, and about 10 per cell. Leaf lobule saccate with a single toothed. Underleaves distant, dentate or emerginate, bilobed at apex, sinuately inserted. Male inflorescence spicate, terminal on lateral branches. Female inflorescence terminal on primary and secondary lateral branches, with a single innovation, innovations mostly successively floriferous; female bracts similar to leaves; bracteole similar to underleaves. Perianth inflated, 10 keeled (3 ventral, 4 lateral, 3 dorsal), keels sharp, smooth. Seta (16+4), not articulate, 4 cells in diameter, outer cells in 16 longitudinal rows and inner one in 4 rows. Capsule walled 2 layered; outer layer with brown nodulose trigones on the radial wall; the inner layer with an irregular net like thickenings bands. Elaters unispiral, brown and numerous.

Type: *Jungermannia striata* Lehm. & Lindenb.

Ptychanthus striatus (Lehm. et Lindenb.) Nees, Naturg. Eur. Lebern. 3: 212 (1838).

(Plate 36. Figs. 19)

Plant robust, brownish green to yellowish green, dark green, branched, pinnately branched, branching of *Frullania* type, 30-95 mm long, 2-3 mm wide including leaves. Rhizoids few and confined at the basal part of the stem. Stem dark brown, circular, 0.25 x 0.34 mm in diameter, 17-21 cells across, 2-3 thick cortical cells, cortical cells 8.8-22.0 μm long, 6.6-15.4 μm wide; medullary cells 12.2-27.5 μm long, 8.8-18.7 μm wide, larger than the cortical cells, thin walled. Leaves imbricate, widely spreading, lobes oblong-ovate, 1.6-1.8 mm long, 1.2-1.4 mm wide, apex acute to short acuminate, denticulate, teeth present mostly at the leaves apex region, dentition 4-8 (10-18) per leaf, 1-7 cells long, 2-5 cells broad at base; apical cells non-trigonus, thin walled, 8.8-22 μm long, 5-12.2 μm wide; maginal cells thin walled, non-trigonus, 6-12.2 μm long, 4-8.8 μm wide; middle cells trigonus, nodulose, walls with large intermediate thickening, 22-37.4 μm long, 11-17.6 μm wide; basal cells 22.5-40.7 μm long, 16.5-27.5 μm wide, cells trigonus, trigones nodulose, walls with large intermediate thickening; cuticle smooth; leaves lobule 275-330 μm long, 165-220 μm wide, about 1/4-1/5 of the length of leaf lobe, rectangular, oblong, apex obliquely truncate, first tooth 2-3 (-4) cells long, second tooth absent. Underleaves distant to slightly contiguous, oblong, orbicular, basal cordate, 1-1.2 mm long, 0.9-1.0 mm wide, apex irregularly dentate, dentition 10-15 teeth per underleaf, teeth short, 1-3 cells long, 1-2 (-3) cells broad at base, cells trigonus, trigones nodulose and like the leaves cells. Female inflorescence on primary or secondary branches, with a single innovation, female bract similar to that of a leaves or slightly smaller, oblong-ovate, denticulate, apex acute to short acuminate. Perianth ovate, oblong, inflated, 9-10 keeled, keel smooth and rounded.

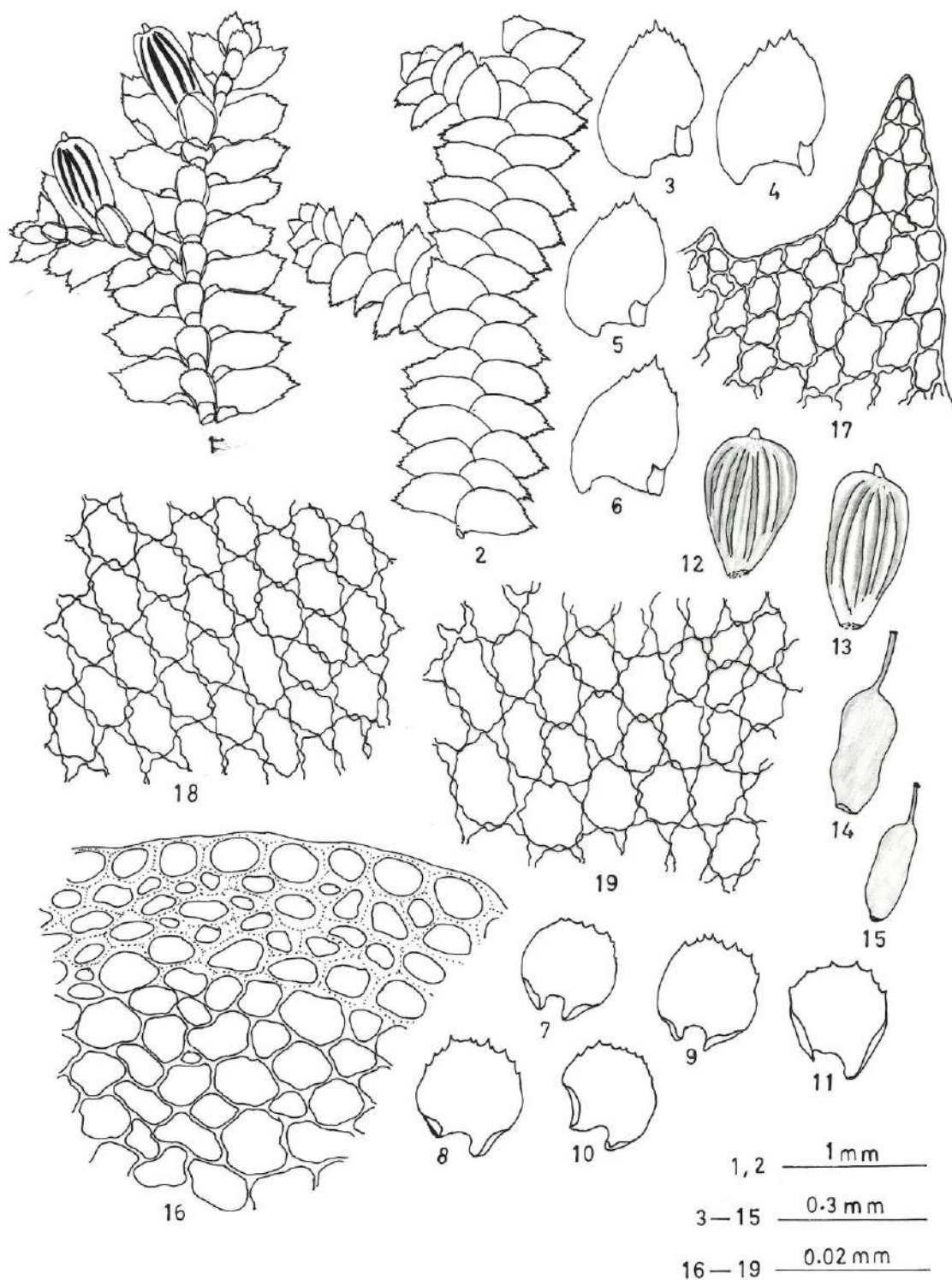


Plate 36. *Ptychanthus striatus* (Lehm. et Lindenb.) Nees, figures 1-19.

Figs. 1. A portion of plant in ventral view; 2. A portion of plant in dorsal view; 3-6. Leaves; 7-11. Underleaves; 12-13. Perianth; 14-15. Sporogonia; 16. A portion of stem in cross section; 17. Leaf apical cells; 18. Leaf median cells; 19. Leaf basal cells.

Habitat: Plants grows on barks of trees (corticolous) in association with *Plagiochila* sp., *Bazzania* sp., *Lejeunea* sp., *Frullania* sp., Mosses and Lichens at 1500-2700 m asl.

Range: India, Nepal, Bhutan, China, Myanmar, Japan, Philippines, Indonesia, Malaysia, Sri Lanka, Polynesia, Australia, Africa, New Zealand, Java.

Distribution in India: *Western Himalaya:* Himachal Pradesh, Uttarakhand; *Eastern Himalaya:* west Bengal, Sikkim, Meghalaya, **Nagaland***.

Specimen examined: Nagaland: Kohima District: Khuzama: KE 10161, KE 10177, KE 10177: 16.11.2009: Kazuhrii Eshuo; Mokokchung District: Longkhum: KE 10140, KE 10143: 12.09.2009: Kazuhri Eshuo.

FAMILY: TRICHOCOLEACEAE Nakai

Trichocoleaceae Nakai, Chosakuronbun Mokuroku [Ord. Fam. Trib. Nov.]: 201.
1943.

Plants light yellowish green to green, irregularly branched to pinnately branched, branches of *Frullania*-type, rarely of the ventral *Acromastigum*-type; leaves succubous, asymmetrically 4-lobed, with the lobes often further divided and ciliate, cells cylindrical, thin walled; underleaves smaller than the lateral leaves, 4-lobed, with the margins ciliate; sporophytes enclosed by a fleshy shoot calyptras, coelocaulis, or stem perigynium; perianths usually absent (present in *Castanoclobus*); capsule spheroidal or ellipsoidal, with the wall 6 to 8 stratose.

Genus: *Trichocolea* Dumort.

Trichocolea Dumort., Comment. Bot. 113. 1822.

Plants whitish green to light yellowish green, forming loosely prostrate-procumbent rarely erect, pinnately branched, branching of *Frullania*-type, with 1-3 gynoecial branches. Stem subcylindrical-spherical; cells hardly differentiated, cortical cells usually smaller than the medullary cells. Rhizoids scarce or confined at the bases of the ventral leaves. Leaves distant to imbricate, succubously inserted, more or less asymmetrically; 4-7 lobes lobed with the ventral portion of leaf larger; lobes descending 0.5-0.9 the leaf length, lamina often largely resolved into narrowly triangular lobes ending with long cilia, and sparingly to copiously armed with opposite to simple to branched cilia. Cells rectangular and elongate, rarely subquadrate to oblong-hexagonal, thin walled, without trigones; cuticle striolate-papillose; oil bodies small, glistening and distinct. Underleaves slightly smaller than the lateral leaves, transversely inserted, asymmetrically bifid with the primary lobes again bilobed, typically 4 segmented and with margin similarly armed with cilia as leaf lobes. Dioicous. Androecia branches like vegetative branches; bracts 12-15 or more pairs, concave similar to leaves; antheridia globose 1-2 per bract; bracteole similar to underleaves. Gynoecia terminal on main axis, bracts and bracteoles in 3 imbricate series, innermost largest; bracts similar to leaves. Archegonia 8-20 or more per gynoecium, immersed in a dense mass of paraphyllia. Perianth feebly or not developed. Sporophyte massive. Seta of innumerable rows of cells. Capsule 4 valved, oblong-ovoid, capsule wall 6-8 stratose; outer layer ephemeral; inner layer with semiannular brownish thickenings bands. Spores smooth or minutely papillose. Elaters with 2-3 spiral thickenings, end narrow.

Type: *Trichocolea tomentella* (Ehrh.) Dumort. Corr. Nees

Trichocolea tenera Udar et Singh, Geophytology, 7(1): 65-72. 1977.

(Plate 37. Figs. 1-6)

Plant medium, plant yellowish green to green, pinnately branched, 40-90 mm long, 10-13 mm wide including branched, prostrate; rhizoids present near the bases of underleaf, hyaline, transparent and in tuft. Stem circular, transparent, whitish, 0.6 x 0.7 mm in diameter, 13-14 cells across; cells undifferentiated, cortical cells polygonal, 12.2-33.7 μm long, 8.5-21.4 μm wide, medullary cells larger than the cortical cells, non-trigonous, 22.3-48.5 μm long, 16.5-37.4 μm wide. Leaves succubous, asymmetrically lobed, 4-6 lobes, filiforms, ciliate, filiforms leaves again branched, leaves cells, 1-2 cells long; cells non-trigonous, polygonal, barrel shape to cylindrical like, end in papillae, 42.2-60.5 μm long, 10-12.5 μm wide. Leaves oil bodies 2-4 per cell, circular, spindle like, 4.3-9.5 μm long, 3-4.3 μm wide. Underleaves succubous, asymmetrically lobed, 4-6 lobes, slightly smaller than the lateral leaves or alike; filiforms, ciliate, cells non-trigonous, 1.1-1.4 mm long, 0.5-0.6 mm wide. Androecia and gynoecia not seen.

Habitat: The plants grows in moist rocks (saxicolous) covered with thin layer of soils along other liverworts like *Metacalypogeia alternifolia*, *Lepidozia* sp., *Scapania* sp., and mosses like *Thuidium* sp. at 1800- 2700 m asl.

Range: India.

Distribution in India: *Eastern Himalaya:* Sikkim, Meghalaya, **Nagaland***.

Specimen examined: Nagaland: Kohima District: Khuzama: Khonoma: KE 10171: 19.03.2010: Kazuhrii Eshuo; Khonoma: KE 10412: 19.03.2011: Kazuhrii Eshuo.

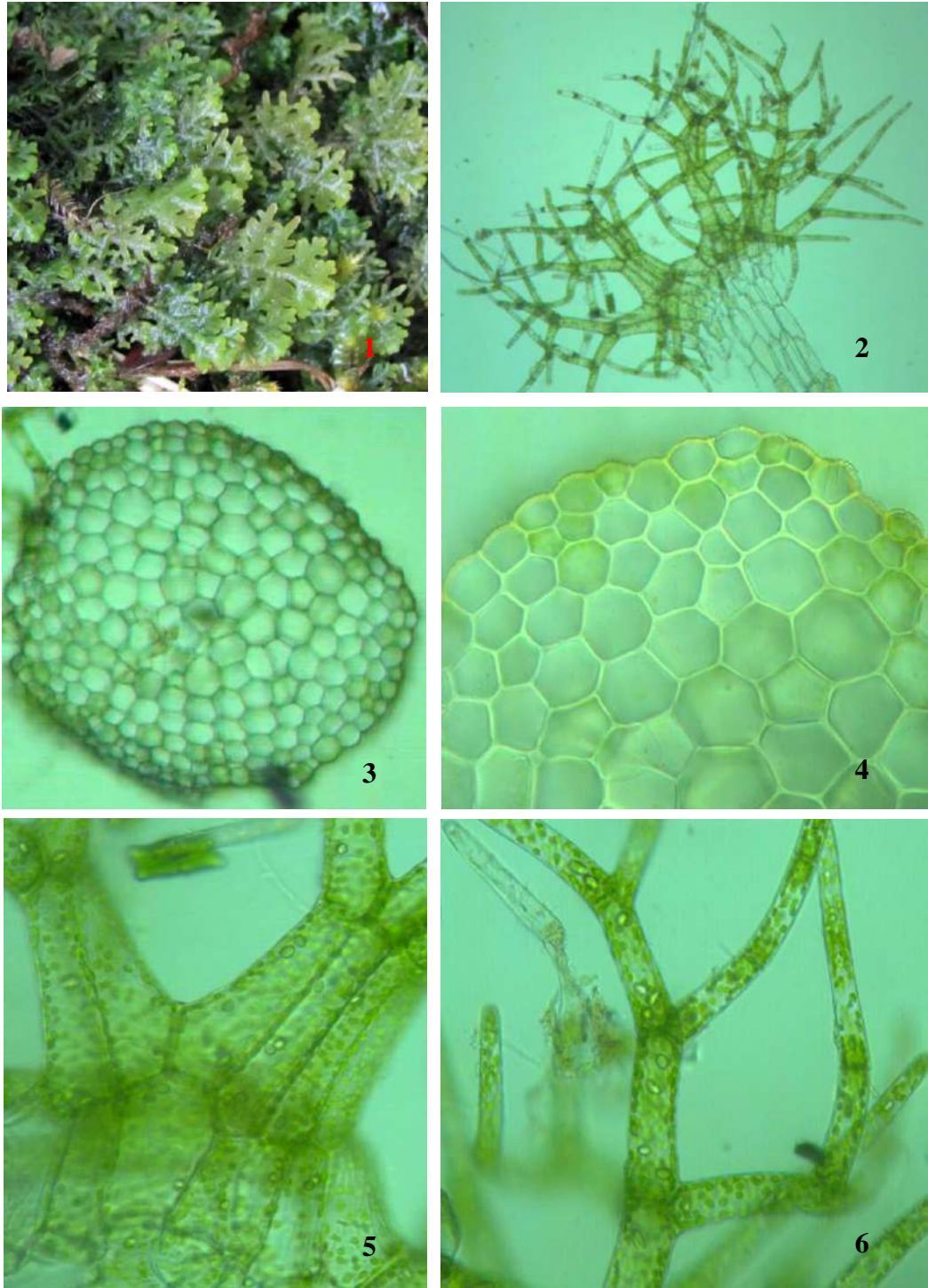


Plate 37. *Trichocolea tenera* Udar et Singh, Figures 1-6.

Figs. 1. Plant habit; 2. Leaves; 3-4. Cross section of stem, 4- enlarge portion of stem;
 5. Leaf basal cells; 6. Leaf apical cells.

Scale: Figs. 1= 5 mm; 2-3=0.2 mm; 4-6 = 0.02 mm.

FAMILY: HERBERTACEAE Müll.

Herbertaceae Müll. Frib. ex. Fulford & Hatcher, Bryologist 61: 284. 1958.

Plants with primary rhizotomous axes, leafy shoots with leaves transverse to weakly incubous; 2-3 or 4 lobed, with the lobe entire, isophyllous; branches endogenous, of *Bazzania* type and *Plagiochila* type; androecia with bracteolar antheridia; gynoecia on leading axes; sporophytes enclosed by a calyptras and perianth; perianth with 3-keeled, with the third keel dorsal, with the mouth deeply 6-lobed, capsule spheroidal, with the wall 7-10 stratose.

Genus: *Herbertus* Gray

Herbertus Gray, Nat. Arr. Brit. Pl. 1: 705. 1821.

Plants ascending to erect or pendulous, brownish green to reddish brown, green, simple or branched, pinnately branched, postical, flagelliform, stem robust, cortical cells 2-4 thick-walled, medullary cells thin-walled; rhizoids restricted to the base of the underleaf and on rhizotomous branched. Leaves remotely-distant, imbricate to contiguous, incubously inserted, bifid, 1/2-3/4 of the lobe length, strongly falcate, apex acute to long acuminate, lobes narrowly triangulate, leaf margin entire or hyaline papillae present at the bases of the leaf; cells trigonous, trigones nodulose, bulging, large; vitta cells present, distinct, extend upto 1/2-3/4 of the lobe length or in some upto the leaf tip. Underleaves similar to the lateral leaf or slightly smaller. Dioicous. Androecia usually od 4-8 pairs of bracts, spicate, with 2-3 antheridia per bract; female bracts and bracteole identical, deeply bilobed; perianth lobed, seta numerous cells; capsule wall 4-7 stratose, 4 valved; outer layered covered with wax like substances and all cells with distinct thickenings.

Type: *Herbertus adunca* (Dicks) Gray

Key to species of the genus *Herbertus* Gray

1. Plants large, vita cells medium, leaf apex not piliferous.....*H. dicranus*
- 1a. Plants small to medium, vita cells strong, leaf apex piliferous..... 2
2. Leaf lobe long and narrow, 4-6 uniseriate cells at apex.....*H. aduncus*
- 2a. Vita cells strong, bifurcating at mid basal, 5-9 (-12) uniseriate cells at leaf apex.....*H. arminatus*

Herbertus dicranus (Taylor ex Gottsche) R. Trevis., J. Hattori Bot. Lab. 28: 299-412.

1965.

(Plate 38. Figs. 1-12)

Plant medium, upto 60 mm long, 2-3.5 mm wide including leaves, branched, branching irregular, intercalary, terminal, dark brown in dry herbarium, stem arises from the rhizotomous stalk, rhizoids scarce, confined at the base on the stem. Stem circular to oval, 0.3 x 0.4 mm in diameter, 15-19 cells across; 3-4 thick cortical cells, medullary cells larger than the cortical cells. Leaves bifid, contiguous to distant, alternate, 2/3-3/4 bifid, second, apex acute-acuminate, cells trigonous, trigones nodulose, bulging, intermediate thickening of walls present. Underleaves similar to that of the lateral leaves. Androecia and gynoecia not seen.

Habitat: Plants grows epiphytically on trees bark (corticolous) in association with *Plagiochila* sp., *Bazzania* sp., *Lejeunea* sp. and Mosses at 2000-2750 m asl.

Range: India, Nepal, China, Japan, Bhutan, Sri Lanka, Thailand, Vietnam, Indonesia, Malaysia, Philippines, Canada, USA, Congo, Kenya, Rwanda, Tanzania, Uganda, Hawaii, New Caledonia (Juslén, 2006).

Distribution in India: *Eastern Himalaya:* Sikkim, Meghalaya, West Bengal, **Nagaland***; *South India:* Nilgiri Hills.

Specimen examined: Nagaland: Kohima District: Khuzama: KE 10087: 04.11.2008: Kazhuhrii Eshuo

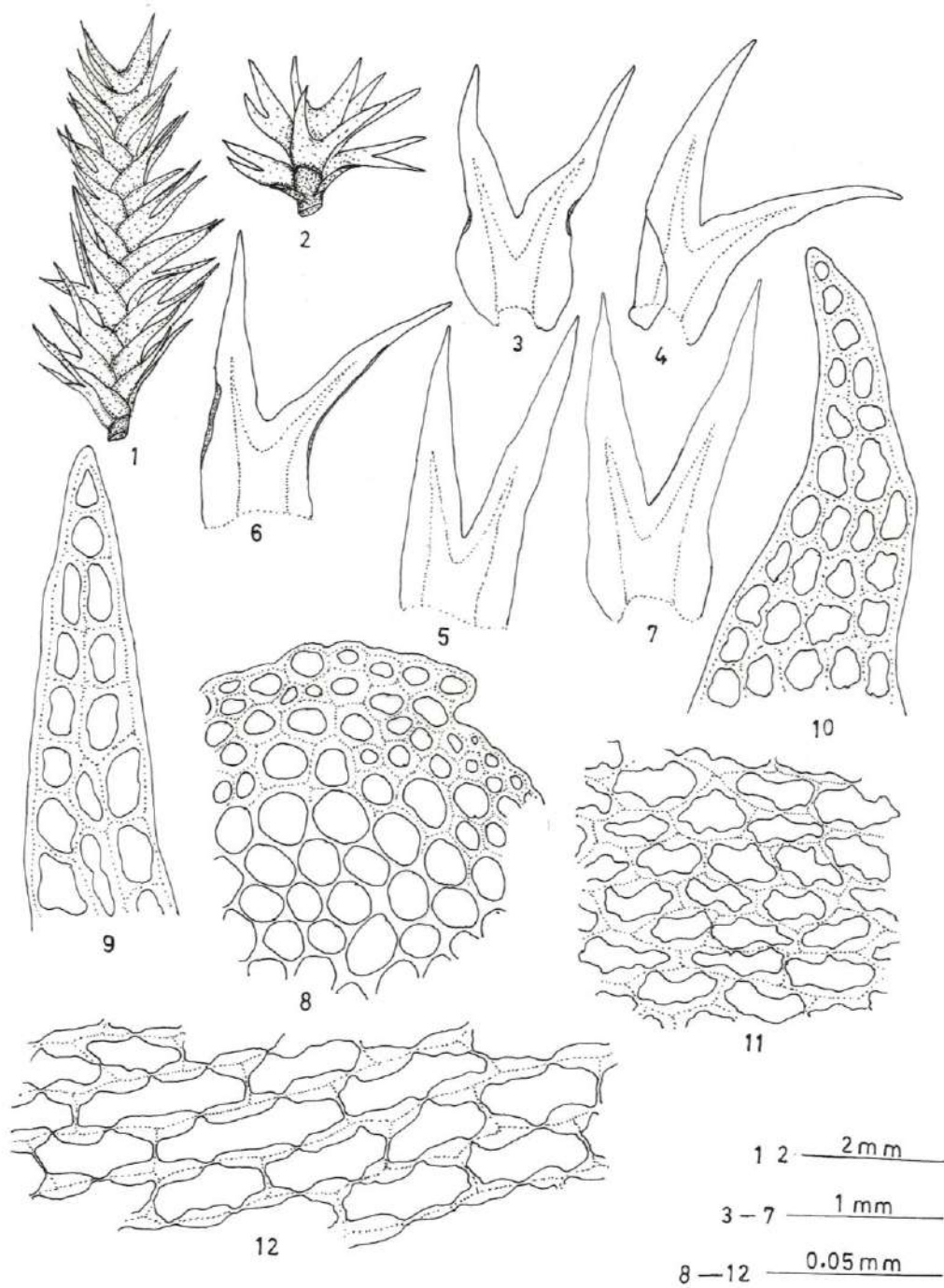


Plate 38. *Herbertus dicranus* (Taylor ex Gottsche) R. Trevis., figures 1-12.

Figs. 1. A portion of plant dorsal view; 2. A portion of plant in ventral view; 3-5. Leaves; 6-7. Underleaves; 8. A portion of stem in cross section; 9-10. Leaves apical cells; 11. Leaf lobe median cells; 12. Leaf basal vitta cells.

Herbertus aduncus (Dicks) Gray, Nat. Arrang. British Plants 1: 705. 1821.

(Plate 39. Figs. 1-14)

Plant small to medium, erect or sub erect, prostrate, 35-45 mm long, 2-3 mm wide including leaves, branched, branching intercalary, terminal, yellowish green to green. Rhizoids scarce, confined at the base of the stem. Stem circular to oval, dark brown to reddish brown, 0.17-0.19 x 0.2-0.24 mm in diameter, 2-3 thick cortical cells, 7.8-16.3 μm long, 4.3-10.2 μm wide; medullary cells thick walled, larger than the cortical cells, 13.6-21.2 μm long and 10-18.6 μm wide. Leaves contiguous, bifid, 1/3 bifid, acuminate, entire, alternate, 1.7-1.8 mm long, 0.5-0.6 mm wide; cells trigonous, trigones nodulose, thickening of walled, vascular cells extend upto almost apex region, 3-6 uniseriate cells at leaves apex; apical cells 19.8-37.5 μm long, 10-20.0 μm wide, rectangular, sub-quadrate, trigonous, trigones nodulose; median cells 16.5-29.7 μm long, 10-16.5 μm wide, cells rectangular, quadrate, trigones nodulose; basal vascular cells 24.2-46.2 μm long, 10-16.5 μm wide, rectangular, trigones nodulose, bulging, thickening of walls present; oil bodies 2-9 per cell, circular, spherical, elliptical. Underleaves contiguous to distant, bifid and like the lateral leaves.

Habitat: Plants grows epiphytically on trees bark (corticolous) in association with *Plagiochila* sp., *Bazzania* sp., *Lejeunea* sp. and Mosses at 2000-2750 m asl.

Range: India, Japan, China, South Korea, Bhutan, Nepal, Canada, USA.

Distribution in India: *Eastern Himalaya:* Sikkim, **Nagaland***.

Specimen examined: Nagaland: Kohima District: Khuzama: 16.11.2009: KE 10171: Kazhuhrii Eshuo.

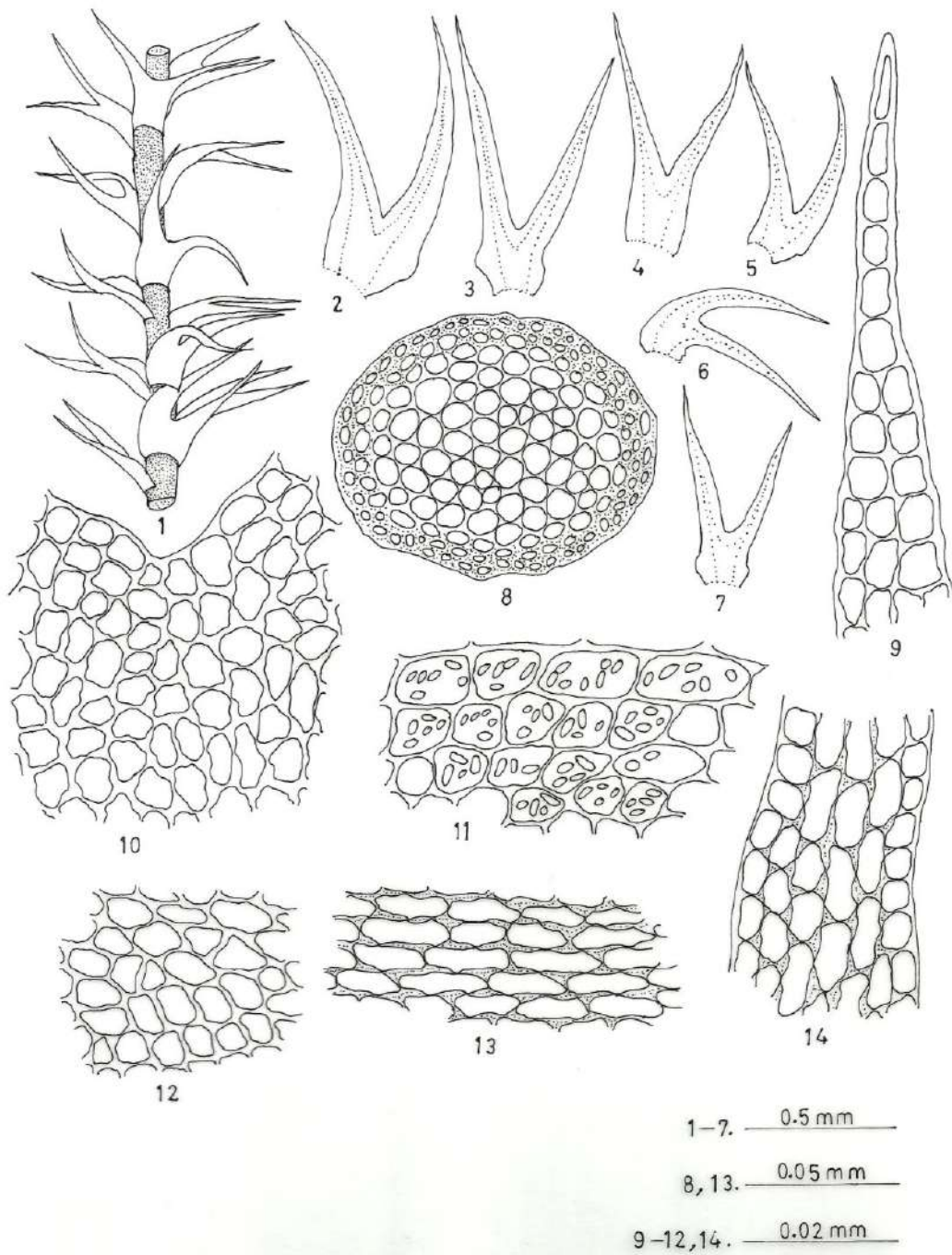


Plate 39. *Herbertus aduncus* (Dicks) Gray, Figures 1-14.

Figs. 1. A portion of plant in ventral view; 2-4. Leaves; 5-7. Underleaves; 8. Cross section of stem; 10. Leaf cells in sinus; 11. Oil bodies; 12. Leaf basal lamina cells; 13. Leaf vitta cells; 14. Leaf lobe middle cells.

Herbertus arminatus (Steph.) H.A. Mill., J. Hattori Bot. Lab. 28: 324. 1965.

(Plate 40. Figs. 1-17)

Plants light yellowish brown to light brown green, brownish red in dry herbarium, branched, branching intercalary, 25-35 mm long, 0.9-1.5 mm wide. Stem circular, 92-100 x 109-115 μm in diameter, cortical cells thick-walled, medullary cells thin walled, trigonous. Leaves imbricate, contiguous, falcate and almost symmetric, leaves length 1-1.4 mm long, 0.35-0.45 mm wide; basal part of the leaves expanded, 20-28 cells wide at leaf bases; bifid $2/3$ - $3/4$ of the leaf length; lobes linear-lanceolate, (-6) 8-13 cells wide at lobes base, 6-12 cells wide at point half way toward apex; lobes apices acuminate, with 5-9 (-12) uniseriate cells and below 3-6 rows of two cells wide; basal margin usually with sessile or upto 4 cells long stalk slime papillae; vitta cells strong, extending almost upto the apex; vitta cells at mid basal cells 34-66 μm long, 12-19 μm ; cells at bifurcating region 13-29 μm long, 11-20 μm wide; basal cells lamina cells 15-26 μm long, 12-15 μm wide; cells trigonous, bulging; Underleaf similar to lateral leaves or slightly smaller and symmetric. Androecia and gynoecia not seen.

Habitat: The plants on moist rocks along with other Liverworts like *Lepidozia* sp., *Metacalypogeia* sp., *Plagiochila* sp., *Bazzania* sp., *Scapania* sp. and Mosses at an altitude of 2600-2800 m asl.

Range: Thailand, Vietnam, Indonesia, Papua New Guinea, Philippines and India.

Distribution in India: *Eastern Himalaya:* Sikkim, **Nagaland***.

Specimen examined: Nagaland: Kohima District: Khonoma: KE 10421: 19.03.2011: Kazuhrii Eshuo.

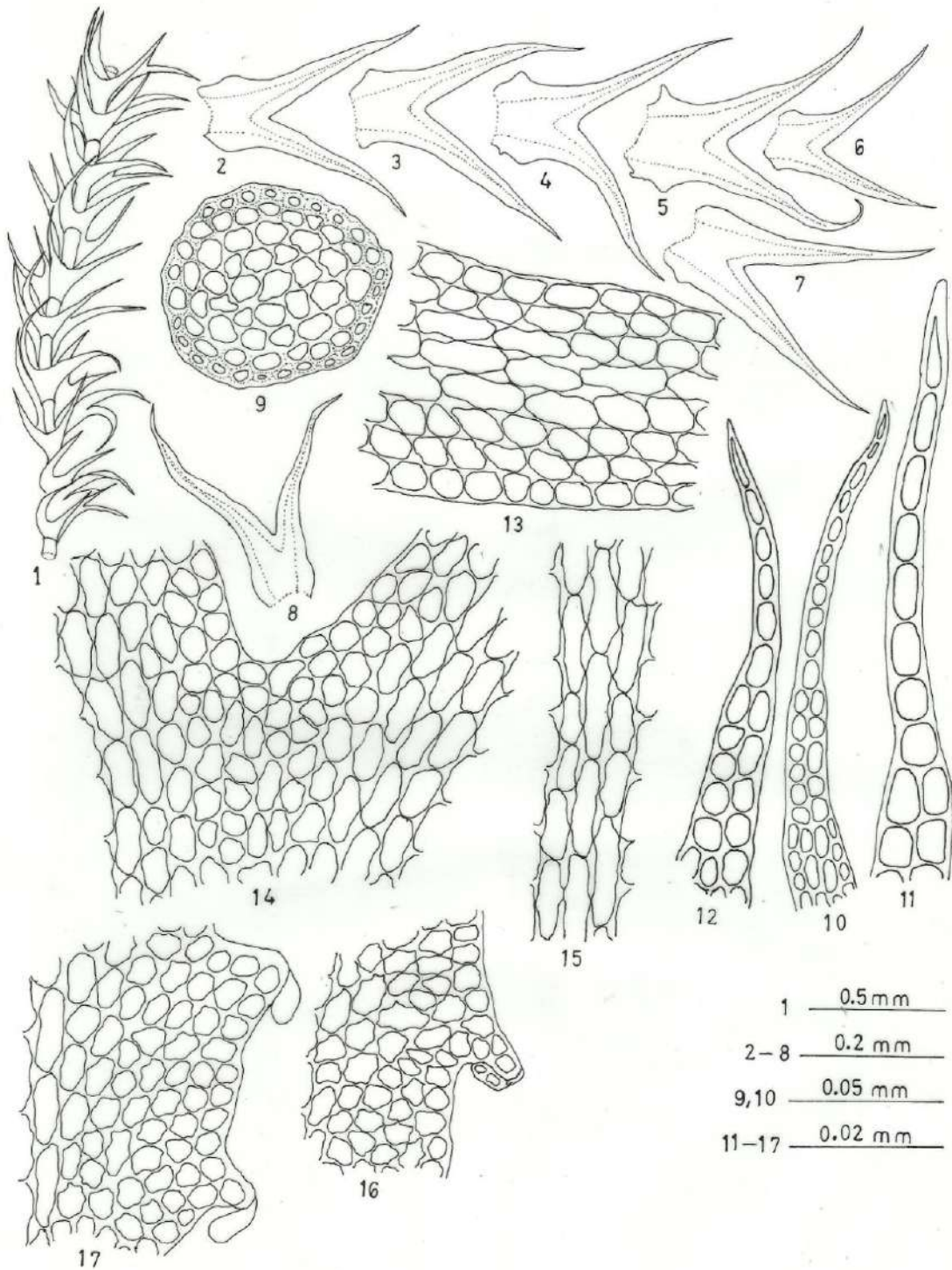


Plate 40. *Herbertus arminatus* (Steph.) H.A. Mill., Figures 1-17.

Figs. 1. A portion of plant in ventral view; 2-5. Leaves; 6-8. Underleaves; 9. Cross section of stem; 10-12. Leaves apical cells; 13. Leaf lobe middle cells; 14. Leaf cells in sinus; 15. Leaf vitta cells; 16-17. Leaves basal lamina cells with hyaline papillae.

FAMILY: LEPIDOZIACEAE H. Limpr.

LEPIDOZIACEAE H. Limpr., in Cohn. Kryptogamen-Flora Von Schlesien, p. 310.
1857.

Plants prostrate-erect or procumbent, brownish green to yellowish green, whitish, small to robust, pinnately or pseudo-dichotomously branched, branching lateral, terminal of *Frullania*-type, postical intercalary replacing the dorsal half. Stem with single cortical cells, small, rectangulate; medullary cells usually thin walled, elongate, or sometime with thick walled. Rhizoids at the base of the underleaf. Leaves and underleaves rather similar in size and form; lateral leaves imbricate to subimbricate or alternate at distant, slightly to strongly succubous, usually 3-5 (6-12) lobed or dentate, rarely bidentate or entire; lobes entire. Underleaves usually large, lobed or dentate like leaves, rarely vestigial or absent. Dioicous or monoicous. Androecia on short, abbreviated, postical terminal branches; bracts somewhat similar to leaves or smaller; antheridia 1-2 per bract, stalk seriate. Gynoecia uniformly on abbreviated postical branches with isophyllous bracts, without normal vegetative leaves, 2 or more pairs, inner larger than leaves; bracteole similar to bracts. Perianth cylindrical, large, fusiform. Sporophyte elongate, seta with 8-16 longitudinal rows of epidermal cells; capsule ovoid to ovoid-cylindrical, 4 valves; wall 2-4 layered; outer layers with nodulose thickenings along the adjacent faces of the secondary longitudinal walls; inner layer with semi-annular thickenings, transverse on all longitudinal walls. Spores papillate or verrucose or vermiculate to delicately areolate. Elaters free, normally bispirate tapering slightly at the blunt ends.

Type: *Lepidozia* (Dumort.) Dumort.

Key to genera of the family Lepidoziaceae

1. Plants small to robust, flagilliform branches postical, leaves usually 2-3 lobed, underleaves entire or dentate..... *Bazzania*
- 1a. Plants small, flagilliform, fragile, leaves usually 3-4 lobed, obliquely inserted, underleaves usually 4-lobed..... *Lepidozia*

Genus: *Bazzania* A. Gray

Bazzania A. Gray, Nat. Arr. Brit. Pl. 1: 704-775. 1821.

Plants small to robust, light yellowish green to brownish green, green, rigid to flaccid when dry, branched, branching lateral, usually pseudodichotomous-type, postical branches usually flagilliform with reduced leaves and underleaves, slender to robust, long or short, few or numerous. Stem rigid, prostrate to sub-erect, stem in cross section (-8) 10-15 (-17) across, cells usually undifferentiated, cells thin or thick walled. Leaves incubous and obliquely inserted, contiguous to imbricate, widely spreading to incurved, ovate-triangulate to rectangulate, narrowly ligulate, apex bidentate to tridentate, margin entire, apiculate to truncate, lobes triangulate, cells trigonous, trigones small to large, nodulose, bulging. Oil bodies colourless, usually 2-9 per cell, homogenous to finely segmented. Underleaves distant to slightly imbricate, transversely inserted, orbicular, rectangular, usually longer than wide or vice versa, hyaline papillae usually present, apex rounded or truncate, cells like the cells of the lateral leaves. Dioecous. Male inflorescence bud-like to spicate, bracts 3-5 pairs, strongly concave, ovate, apex truncate. Female inflorescence bud-like to spicate, bracts and bracteole similar, imbricate to erect-appressed, ovate triangular-ovate; perianth elongate, sub-fusiform, triplate, lobes dentate to ciliate, perigynium absent. Sporophytes with distinct foot, seta and capsule; seta usually reduced, having 16 large epidermal cell rows surrounding numerous rows of smaller inner walls; capsule ovoid,

oblong-ovoid, dehiscing into 4 valves; capsule wall 3-5 stratose, outer layer with coarse nodular thickenings on the tangential walls; inner layer usually smaller and with semi-annular thickenings bands at the tangential and radial walls. Spores 11-19 μm in diameter, yellowish to dark brown, globose to sub-globose, vermivulate to papillose. Elaters bi-spirate, elongate, 124-620 μm long and 6-19 μm wide with a blunt tapering ends.

Type: *Bazzania triloba* (L.) gray

Key to species of the genus *Bazzania*

1. Underleaves cells thick walled and similar to leaves cells.....2
 - 1a. Underleaves cells thin-walled and hyaline5.
2. Plant large, 3-4.5 mm wide and robust; leaves large; underleaf arm with auriculate and irregular lobed appendages at their base..... *B. appendiculata*
- 2a. Plant medium, 2-3 mm wide; stem cells upto 13 cells wide; Underleaves and leaves not arm with appendages.....3
3. Leaves usually 2 lobed at apex; cells thin walled; underleaf 4-7 teeth..... *B. sikkimensis*
- 3a. Leaves usually 3 lobed at leaf apex; cells thick walled; underleaf entire to tooth.....4
4. Plant 2-2.5 mm wide; stem cells 9-10 cells across; leaves cells trigonous; trigones bulging; underleaf oblong, wider than long..... *B. ovistipula*
- 4a. Plant 2-3.5 mm wide; stem 8-9 cells across; leaves cells trigonous, trigones nodulose, bulging, confluent; underleaf cells like the leaf cells..... *B. praerupta*
5. Stem cells 6-7 cells across; leave acute, rarely bifid; underleaf rectangulate, apex entire to bifid, sinus broad and blunt *B. tricrenata*
- 5a. Stem 8-16 cells across, underleaf appendiculate or hyaline papillae..... 6

6. Stem 10-11 cells across, underleaf hyaline and thin walled..... *B. tridens*

6a. Stem 16-18 cells across; underleaf distant, reniform, sinuately inserted, margin with some exudates depositions, slime papillae *B. himalayana*

Bazzania appendiculata (Mitt.) Hatt. Mirzut., J. Hattori Bot. Lab. 30: 83. 1961.

(Plate 41. Figs. 1-14)

Plant medium to large, widely spreading, branched, branching irregular, intercalary, terminal; 30-50 mm long, 3-4.5 mm wide including leaves; brown to pale red in dry herbarium. Flagelliform branches postical intercalary, thread like, small and numerous. Rhizoids scarce and confined at the basal part of the stem. Stem oval, 0.16-0.19 x 0.23-0.26 mm in diameter, 11-13 cells across, cells slightly trigonous, thick walled, differentiated into 2-3 thicker outer layer, 13.5-36.3 μm long, 8-7-15.3 μm wide; inner cells slightly thinner, 15.8-36.3 μm long, 12.5-19.7 μm wide. Leaves closely imbricate, rectangulate to triangulate, oblong, 1.8-2.2 mm long, 0.8-1.0 mm wide at base, 0.4-0.5 mm wide at apex; apex dentate, 3 toothed, tooth triangular, 4-6 cells long, 3-5 cells broad at base, 2 (-3) uniserriate cells at apex; apical cells trigonous, trigones nodulose, bulging, 16.1-26.6 μm long, 9.6-18.8 μm wide; middle cells trigonous, trigones nodulose, bulging, 17.6-38.9 μm long, 10.8-18.9 μm wide; basal cells trigonous, trigones nodulose, bulging, 25.2-44.8 μm long, 21.3-33.0 μm wide. Underleaves distant to slightly contiguous, small, oblong, ovate, apex rounded to truncate, appendiculate, appendages finger like projecting out at bases of the underleaf.

Habitat: The plants grows on bark of trees (corticolous) in association with *Thuidium* sp. *Plagiochila* sp. *Ptychanthus striatus* and Mosses at 1500-2000 m asl.

Range: Asia- Bhutan, China, India, Myanmar (Burma), Nepal, Thailand.

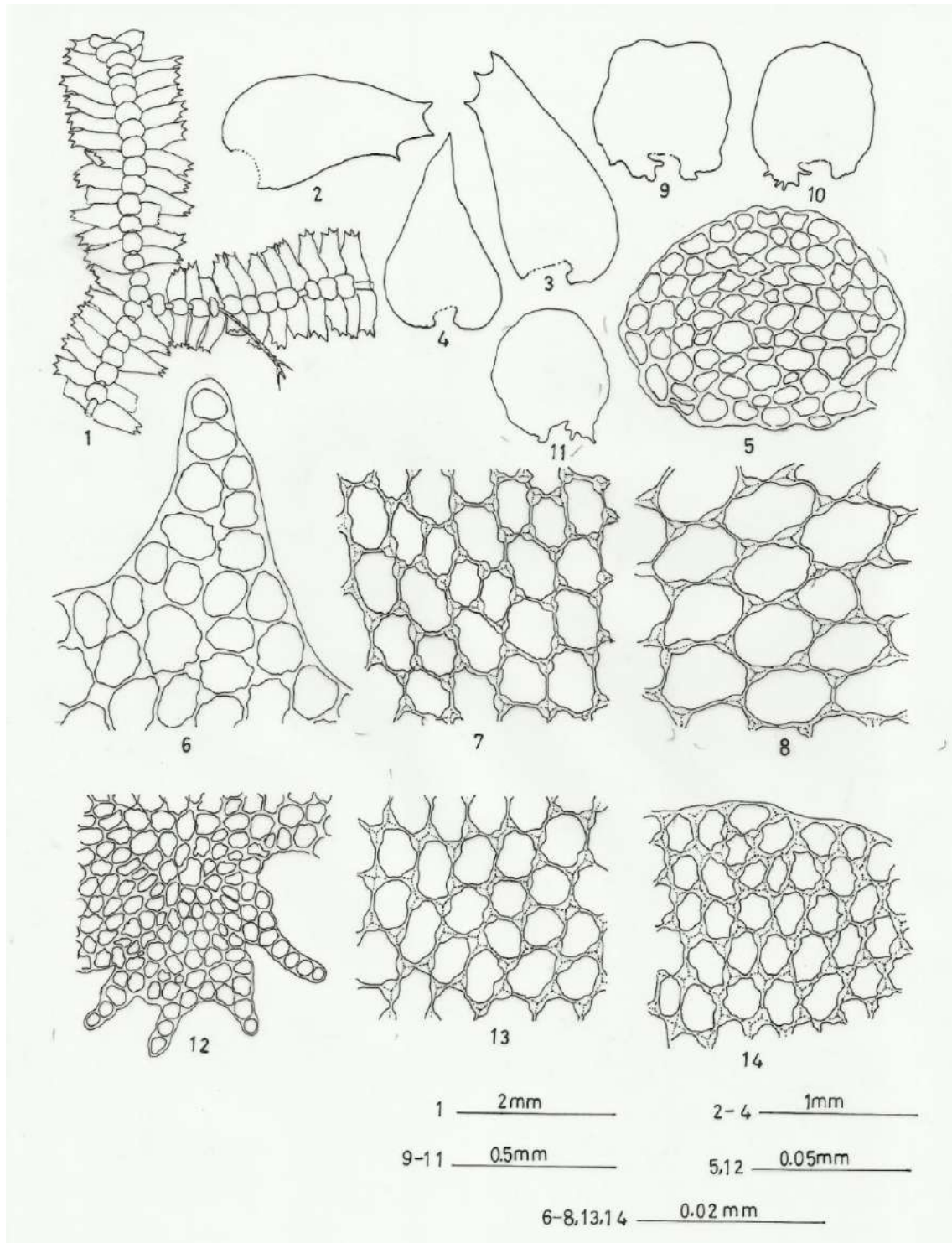


Plate 41. *Bazzania appendiculata* (Mitt.) Hatt. Mirzut., Figures 1-14.

Figs. 1. A portion of plant in ventral view; 2-4. Leaves; 5. Cross section of stem; 6. Leaf apical cells; 7. Leaf median cells; 8. Leaf basal cells; 9-11. Underleaves; 12. Basal appendages of underleaf; 13. Underleaf median cells; 14. Underleaf apical cells.

Distribution in India: *Eastern Himalaya:* Assam, Meghalaya, Sikkim, West Bengal, Nagaland*.

Specimen examined: Nagaland: Kohima District: Botsa: KE 10321: 06.07.2009: Kazhuhrii Eshuo.

Bazzania sikkimensis (Steph.) Herzog., Ann. Bryol. 12: 78. 1939.

(Plate 42. Figs. 1-14)

Plant small, yellowish green to light green, 20-22 mm long, 1-1.5 mm wide including leaves, branched, branching intercalary, terminal. Flagillae long, many. Plant widely spreading, dorso-ventrally flat. Rhizoids in tuft at the base of underleaves, hyaline, present mostly at base of the stem. Stem 12 cells across. Leaves closely imbricate, triangulate, ovate, bidentate, bifid, leaves 1-1.2 mm long, 0.5-0.6 mm wide at base, 0.3-0.4 mm wide at apex broadest at base, leaf teeth 4-9 cells long, 2-4 cells wide at base, 2-3 uniseriate cells at apex. Apical cells 13.8-20.5 μm long, 10.7-16.8 μm wide, cells rectangular to pentagonal, squarose, trigonous, minute; middle cells 13.8-20.5 μm long, 10.7-16.8 μm wide, cells thin walled, trigones minute, triangular; basal cells 24.4-32.7 μm long, 14.9-23.8 μm wide, cells thin walled, trigones minute, triangular like the middle cells. Underleaves distant-contiguous, orbicular-oblong, denticulate, underleaf 0.3-0.45 mm long, 0.4-.05 mm wide, 4-7 teeth per underleaf, 1-4 cells long, 1-3 cells broad at base.

Habitat: The plants grows on the bark of trees pure mat or in association with *Plagiochila* sp., Mosses and Lichens at 2000-2700 mm asl.

Range: Asia- Bhutan, China, **India**, Nepal, Philippines, Thailand.

Distribution in India: *Eastern Himalaya:* Meghalaya, Sikkim, West Bengal, Nagaland*.

Specimen examined: Nagaland: Kohima District: Khuzama: KE 10205: 16.11.2009: Kazhuhrii Eshuo.

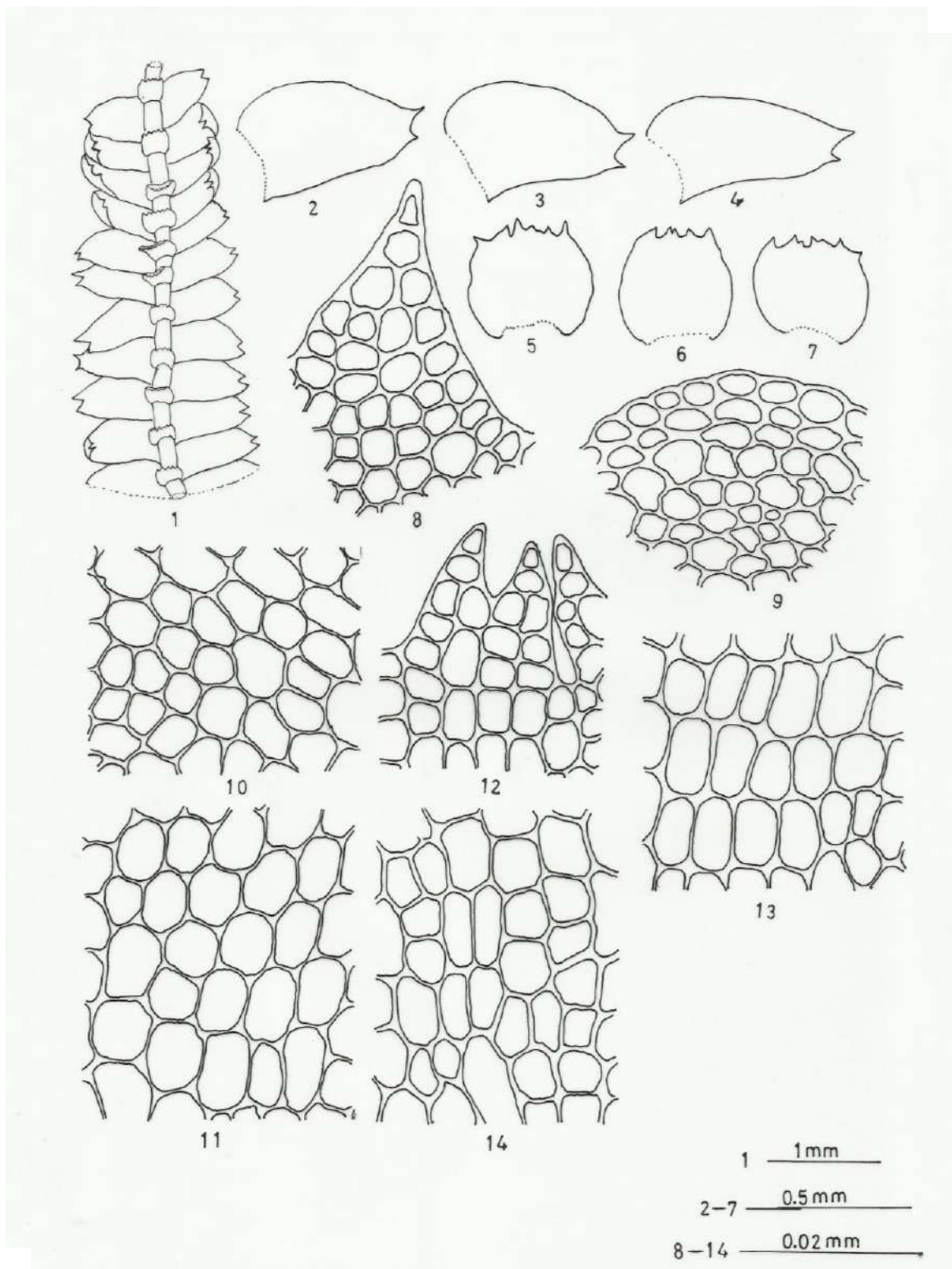


Plate 42. *Bazzania sikkimensis* (Steph.) Herzog., Figures 1-14.

Figs. 1. A portion of plant in ventral view; 2-4. Leaves; 5-7. Underleaves; 8. Leaf apical cells; 9. A portion of stem in cross section; 10. Leaf median cells; 11. Leaf basal cells; 12. Underleaf apical cells; 12. Underleaf median cells; 14. Underleaf basal cells.

Bazzania ovistipula (St.) Abeyw., Ceylon J. Sci. 2: 45 (1959).

(Plate 43. Figs. 1-16)

Plant medium, brownish green to yellowish green, blackish brown in dry herbarium, 20-32 mm long, 2-2.5 mm wide including leaves, branched, branching intercalary, terminal, widely spreading, flagillae many, long. Rhizoids confined at the base of the stem. Stem circular to oval, 0.2 x 0.3 mm in diameter, 9-10 cells across, cells non-trigonous, cortical cells 12.7-22.2 μm , 6.5-17.7 μm wide, medullary cells 15.5-26.3 μm long and 11.3-23.7 μm wide. Leaves closely imbricate, triangulate, apex acute, tri-dentate, 1-1.4 mm long, 0.9-1.0 mm wide at base, 0.4-0.5 mm wide at apex, cells trigonous, rectangulate, apical cells 13.2-19.8 μm long, 6.6-16.5 μm wide, middle cells 14.3-25.3 μm long, 6.4-16.5 μm wide, trigonous, cells rectangular, squarose; basal cells 15.5-34.7 μm long, 9.8-18.7 μm wide, trigonous, cells slightly thick walled, trigones nodules like. Under leaves distant, orbicular, apex rounded, oblong, 0.55-0.7 mm long, 0.5-0.6 mm wide, entire to minute toothed, tooth cells 1-2, cells like the leaves. Sporophyte no seen.

Habitat: The plants grow on the bark of trees (corticolous) in association with *Plagiochila* sp., *Herbertus* sp. and Mosses at 2000-2750 m asl.

Range: Asia- Ceylon, China, **India**, Nepal, Philippines, Thailand, Vietnam.

Distribution in India: *Eastern Himalaya:* Meghalaya-Cherrapunji, West Bengal-Darjeeling, **Nagaland***; *South India:* Karnataka-Kudremukh.

Specimen Examined: Nagaland: Kohima District: Khuzama: KE 10165: 16.11.2009: Kazhuhrii Eshuo.

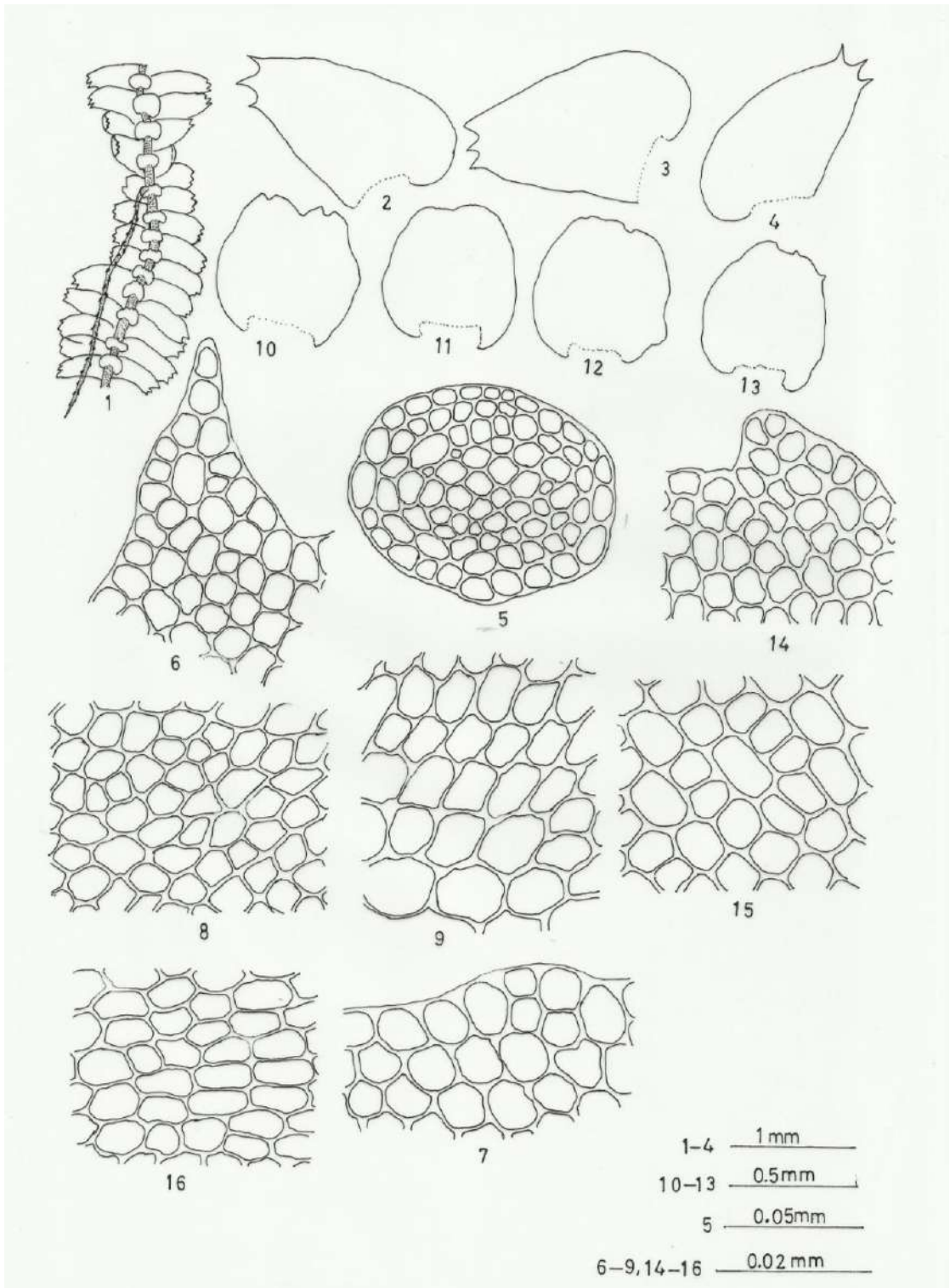


Plate 43. *Bazzania ovistipula* (St.) Abeyw., Figures 1-16.

Figs. 1. A portion of plant in ventral view; 2-4. Leaves; 5. Cross section of stem; 6. Leaf apical cells; 1. Leaf marginal cells; 8. Leaf median cells; 9. Leaf basal cells; 10-13. Underleaves; 14. Underleaf apical cells; 15. Underleaf median cells; 16. Underleaf basal cells.

Bazzania praerupta (Reinw., Blume *et* Nees) Strev., Mem. Reale Ist. Lomb., Ser. 3,4:

414. 1877.

(Plate 44. Figs. 1-15)

Plant, medium, light green to yellowish green, light brown to brown in dry herbarium, 25-38 mm long, 2-3 mm wide including leaves, dorso-ventrally flat, branched, branching intercalary, terminal, or irregularly branched, flagella many, long. Rhizoids scarce and confined at the base of the stem. Stem circular, 0.18 x 0.21 mm in diameter, 8-9 cells across, cells thick walled, undifferentiated, trigonous, trigones nodulose. Closely imbricate, widely spreading, oblong-ovate, 1.5-1.7 mm long, 0.9-1.2 mm wide at the base, 0.3-0.5 mm wide at apex, apex tooth 3, rarely 2, teeth medium, 3-7 cells long, 2-5 cells broad at base, 2-3 uniseriate cells at apex; leaves cells thick walled throughout, trigonous, trigones bulging, dumbbell shape, confluent, apical cells 14.6-23.0 μm long, 12.5-15.4 μm wide, middle cells 16.6-25.0 μm long, 12.1-15.2 μm wide, basal cells 26.5-36.5 μm long, 13.5-20.5 μm wide; oil bodies 3-6 per cell, long, elliptical, circular. Under leaves contiguous to distant, orbicular, connate to leave base on one side, 0.5-0.65 mm long, 0.7-0.82 mm wide, wider than long, entire to retuse, cells thick walled like the leaves cells. Sporophyte no seen.

Habitat: The plants grows on the bark of trees (corticolous) in association with *Ptychanthus striatus*, *Porella* sp., *Plagiochila* sp. and Mosses at 1400-1600 m asl.

Range: Sri Lanka, China, **India**, Indonesia, Japan, Java, Kalimantan, Myanmar, Nepal, Philippines, Sulawesi, Sumatera, Taiwan, Vietnam, Hawaii.

Distribution in India: *Eastern Himalaya:* Meghalaya, Sikkim, West Bengal, **Nagaland***; *Western Himalaya:* Uttar Pradesh-Dhakuri, Loharket, Valley of Flower.

Specimen examined: Nagaland: Mokokchung District: Longkhum: KE 10138:

12.09.2009: Kazhuhrii Eshuo.

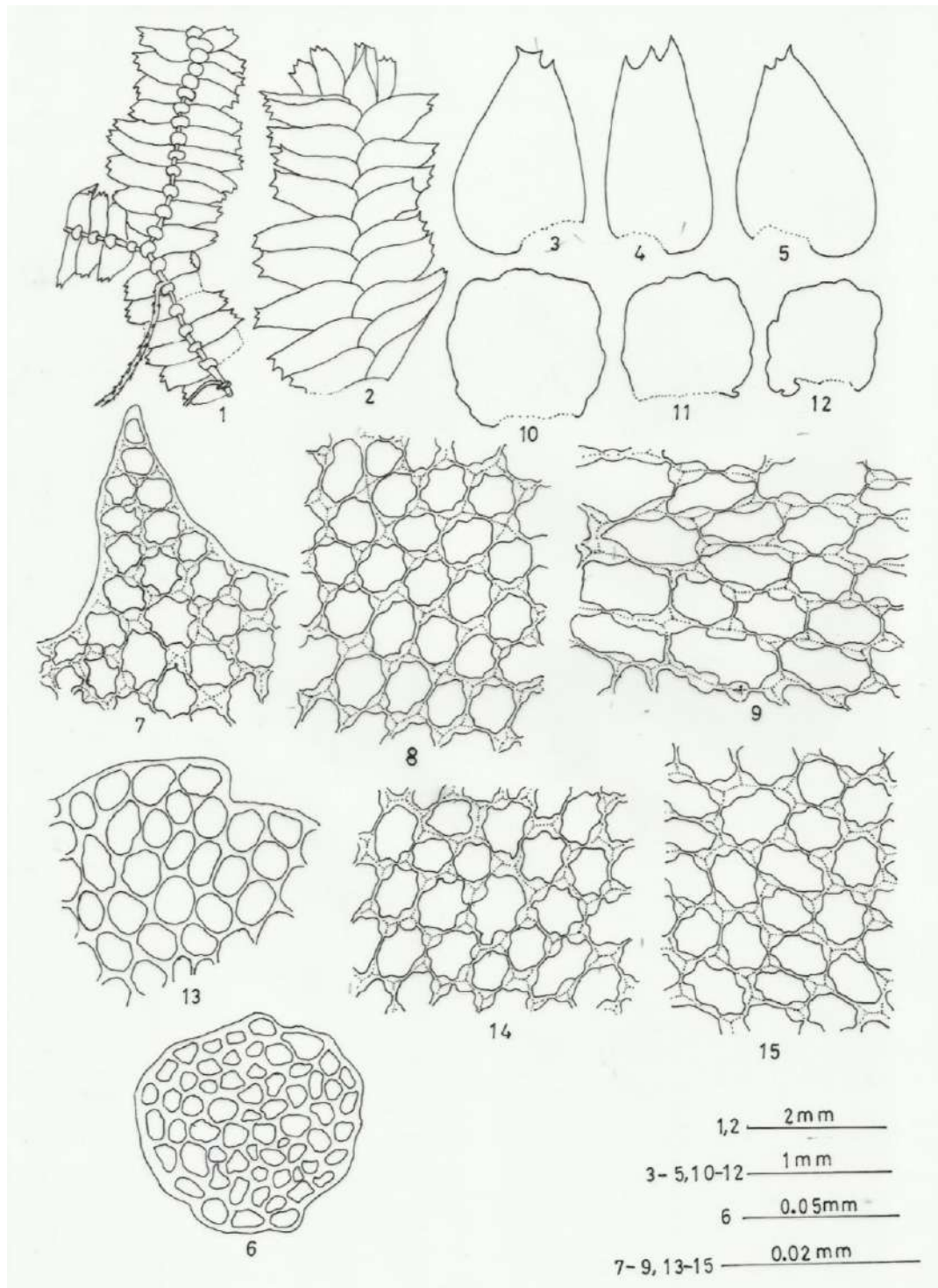


Plate 44. *Bazzania praerupta* (Reinw., Blume *et* Nees) Strev., Figures 1-15.

Figs. 1. A portion of plant in ventral view; 2. A portion of plant in dorsal view; 3-5. Leaves; 6. Cross section of stem; 7. Leaf apical cells; 8. Leaf median cells; 9. Leaf basal cells; 10-12. Underleaves; 13. Underleaf apical cells; 14. Underleaf median cells; 15. Underleaf basal cells.

Bazzania tricrenata (Wahlenb.) Trivis., Mem. Reale Ist. Lomb., Ser. 3,4: 415. 1877.

(Plate 45. Figs. 1-15)

Plant small, brownish red to pale greenish brown in dry herbarium, 10-20 mm long, 0.8-1.00 mm wide including leaves, branched, branching intercalary, rarely terminal. Leaves distant, alternate, acuminate, acute, apex rarely bifid, 0.5-0.72 mm long, 0.3-0.36 mm wide, cells squarose to pentagonal, circular, oval, trigonous, trigones nodules like, triangulate; apical cells 14.3-25.2 μ m long, 12.1-24.2 μ m wide, middle cells 20.1-30.1 μ m long, 12.3-19.4 μ m wide, epidermal cells 14.4-26.5 μ m long, 11.1-17.0 μ m wide, basal cells 15.8-28.9 μ m long, 9.2-24.2 μ m wide. Under leaves distant, rectangulate, apex entire to bifid, sinus blunt, broad, 0.28-0.34 mm long, 0.18-0.26 mm wide. Under leaves cells similar to that of the leaves cells.

Habitat: The plants grows on the bark of trees (corticolous) in association with *Frullania* sp., *Plagiochila* sp. and Mosses at 7000-8200 feet, Khuzama.

Range: Widely distributed in the temperate and boreal regions of Asia, Europe, Asia Minor, North America.

Distribution in India: *Eastern Himalaya:* Sikkim, West Bengal-Darjeeling, Nagaland*; *Western Himalaya:* Himachal Pradesh; *South India:* Tamil Nadu-Nilgherries.

Specimen examined: Nagaland: Kohima District: Khuzama: KE 10243: 16.11.2009: Kazhuhrii Eshuo.

Bazzania tridens (Reinw., Blume et Nees) Trevis., Mem. R. Instit. Lombardo Ser. 3,4:

415. 1877.

(Plate 46. Figs. 1-14)

Plants medium, light green to light yellowish green, 15-25 mm long, 1.5-2 mm wide, branched, branching postical intercalary-postical terminal, pseudodichotomous-type,

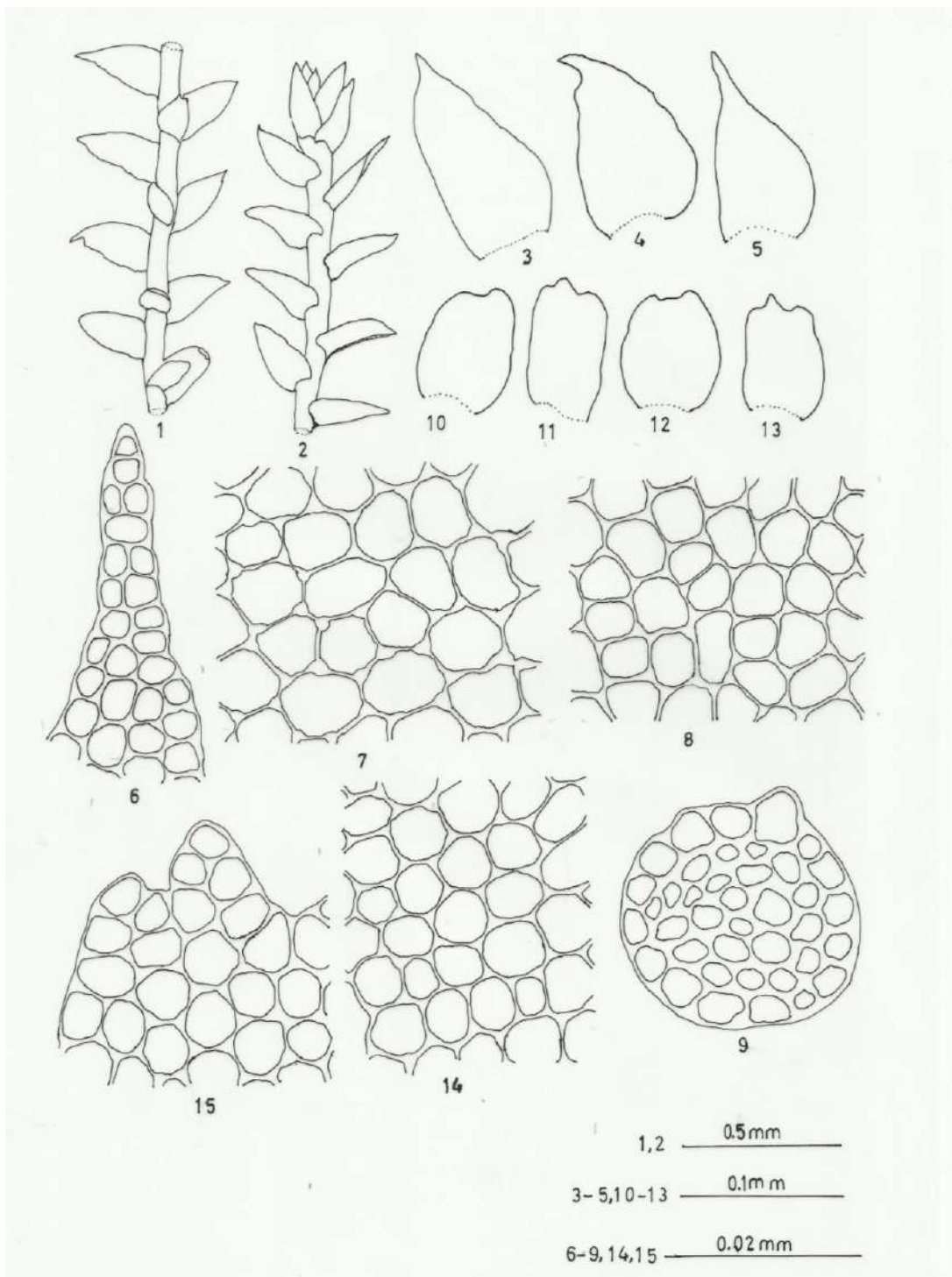


Plate 45. *Bazzania tricrenata* (Wahlenb.) Trivis., Figures 1-15.

Figs. 1. A portion of plant in ventral view; 2. A portion of plant in dorsal view; 3-5. Leaves; 6. Leaf apical cells; 7. Leaf basal cells; 8. Leaf median cells; 9. Cross section of stem; 10-13. Underleaves; 14. Underleaf median cells; 15. Underleaf apical cells.

flagilliform branches, long and numerous; rhizoids scarce and confined at the basal part of the stem near the bases of underleaf. Stem circular, 170-200 μm in diameter, 10-12 cells cross, 1-2 thick cortical cells, medullary cells thin walled. Leaves contiguous to slightly imbricate, slightly sub-opposite, incubous, widely spreading, obliquely inserted, ovate-oblong, 1-1.2 mm long, 0.6-0.7 mm wide, 0.25-0.35 mm wide at apex, widest just above the basal or towards the middle, apex narrow, truncate, 3 (-2) lobed, lobes triangular, parallel to divergent, cells trigonous, trigones minute to prominent towards basal parts of the leaf cells; apical leaf cells 14-21 x 11-15 μm , median cells 18-30 x 14-25 μm , basal cells 25-46 x 18-33 μm ; cuticle smooth. Oil bodies 2-5 per cell, oval, ellipsoidal, 6-16 x 2.6-10 μm in diameter. Underleaves distant to slightly contiguous, appressed, transversely inserted, quadrate to subquadrate, 0.3-0.35 mm long, 0.35-0.4 mm wide, hyaline, apex truncate, angular, sometime recurved, slime papillae present, cells thin-walled and transparent. Mature sporophyte not seen.

Habitat: Plants grows on moist rocks (saxicolous), soil (terricolous) and on bark of trees (corticolous) in association with *Jungermannia* sp., *Heteroscyphus* sp., *Dumortiera* sp., *Notoscyphus* sp. and Mosses.

Range: India, Nepal, Bhutan, China, Japan, Korea, Sri Lanka, Myanmar, Philippines, java, Thailand, Vietnam, Borneo, Celebes, Taiwan.

Distribution in India: *Eastern Himalaya:* Assam, Meghalaya, Sikkim, West Bengal, **Nagaland***; *South India:* Tamil Nadu.

Specimen examined: Nagaland: Mokochung District: Changki: 02.11.2010: KE 10357: Kazhuhrii Eshuo; Kohima District: Khonoma: KE 10429: 19.03.2010: Kazhuhrii Eshuo.

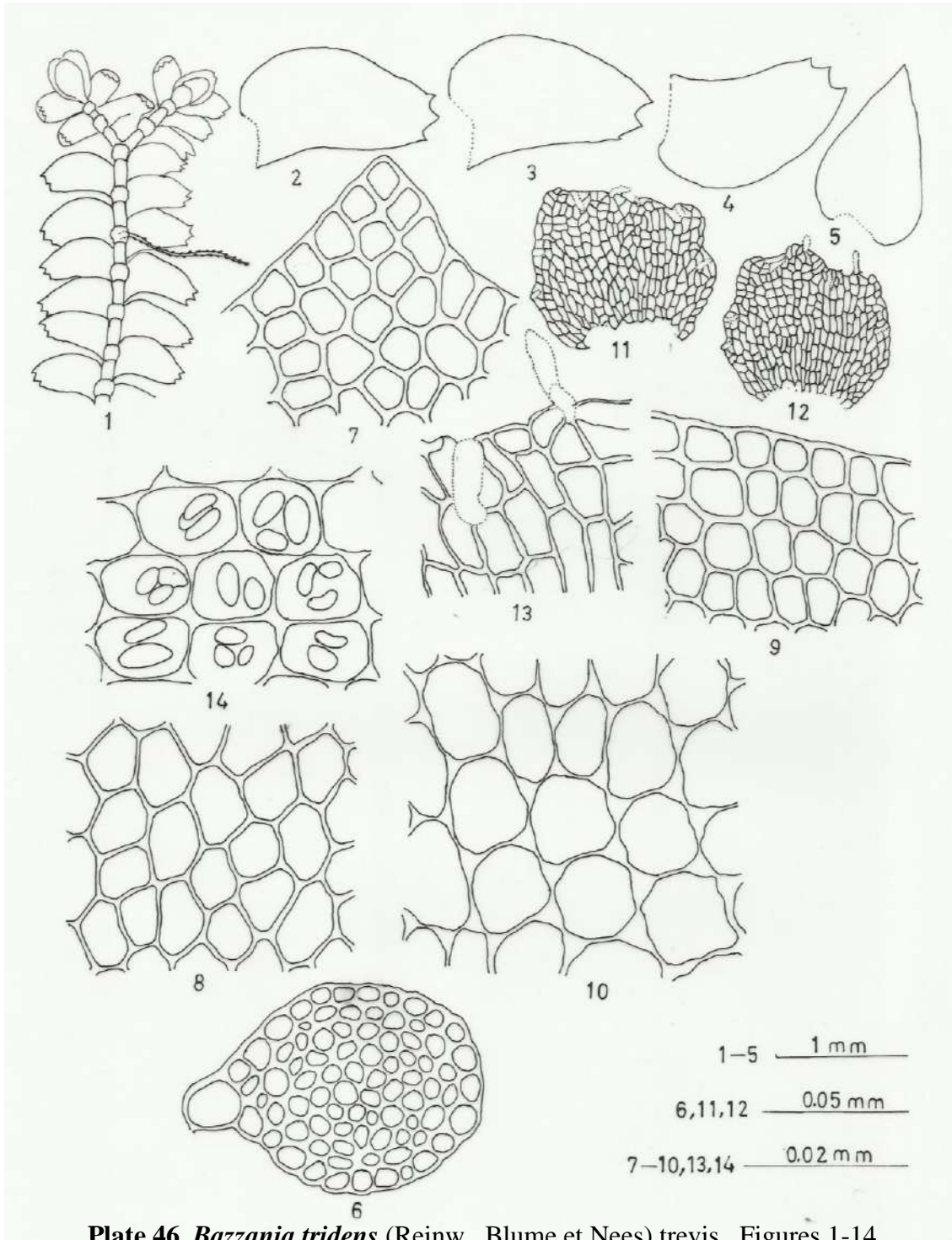


Plate 46. *Bazzania tridens* (Reinw., Blume et Nees) trevis., Figures 1-14.

Figs. 1. A portion of plant in ventral view; 2-4. Leaves; 5. Leaf near the branch emergence; 6. Cross section of stem; 7. Leaf apical cells; 8. Leaf median cells; 9. Leaf marginal cells; 10. Leaf basal cells; 11-12. Underleaves; 13. Underleaf apical cells with hyaline papillae; 14. Oil bodies.

Bazzania himalayana (Mitt.) Schiffn., Oesterr. Bot. Zeitchr. 49: 132 (1899).

(Plate 47. Figs. 1-14)

Plant medium to large, yellowish to brownish green, blackish brown in dry herbarium, dorso-ventrally flatten, widely spreading, 30-55 mm long, 3.5-4.5 (-5) mm wide including leaves, branched, branching intercalary, terminal, flagella many, long. Rhizoids scarce and confined at the base of the stem. Stem oval, 0.38 x 0.27 mm in diameter, 16-18 cells across, 3 thick cortical cells walled, 14.6-19.7 μm long, 5.9-11.0 μm wide, medullary cells thin walled, 19.8-33.3 μm long, 10-23.2 μm wide. Leaves closely imbricate, long, ovate, 1.8-2.8 mm long, 0.7-1.2 mm wide at base, 0.5-0.7 mm wide at apex, apex dentate, 3 toothed, teeth triangular, 4-8 cells long, 3-5 cells broad at base, 1-2 (-3) uniseriate cells at apex; apical cells trigonous, trigones nodulose, bulging, 22.0-29.9 μm long, 13.2-23.1 μm wide, middle cells 17.6-28.6 μm long, 13.2-27.5 μm wide, trigonous, trigones large, bulging, nodulose, basal cells large, 28.6-50.6 μm long, 19.8-30.8 μm wide, trigonous, trigones large, nodulose, bulging, trigones 9.9-20.2 μm long and 7.7-12.1 μm wide in the basal leaves cells. Oil bodies 5-7 per cell, circular to elliptical, 5.5-13.2 μm long, 3.4-7.8 μm wide. Under leaves distant, orbicular, always wider than long, 0.5-.06 mm long, 0.7-0.8 mm wide, margin crenulate with some exudates and slime papillae, cells thin walled, overlapping. Sporophyte not found.

Habitat: The plants grow on the bark of trees (corticolous) in association with *Plagiochila* sp. and *Moses* at 2000-2700 m asl.

Range: Asia- Bhutan, China, India, Japan, Philippines, Thailand.

Distribution in India: *Eastern Himalaya:* Meghalaya, Sikkim, West Bengal, Nagaland*.

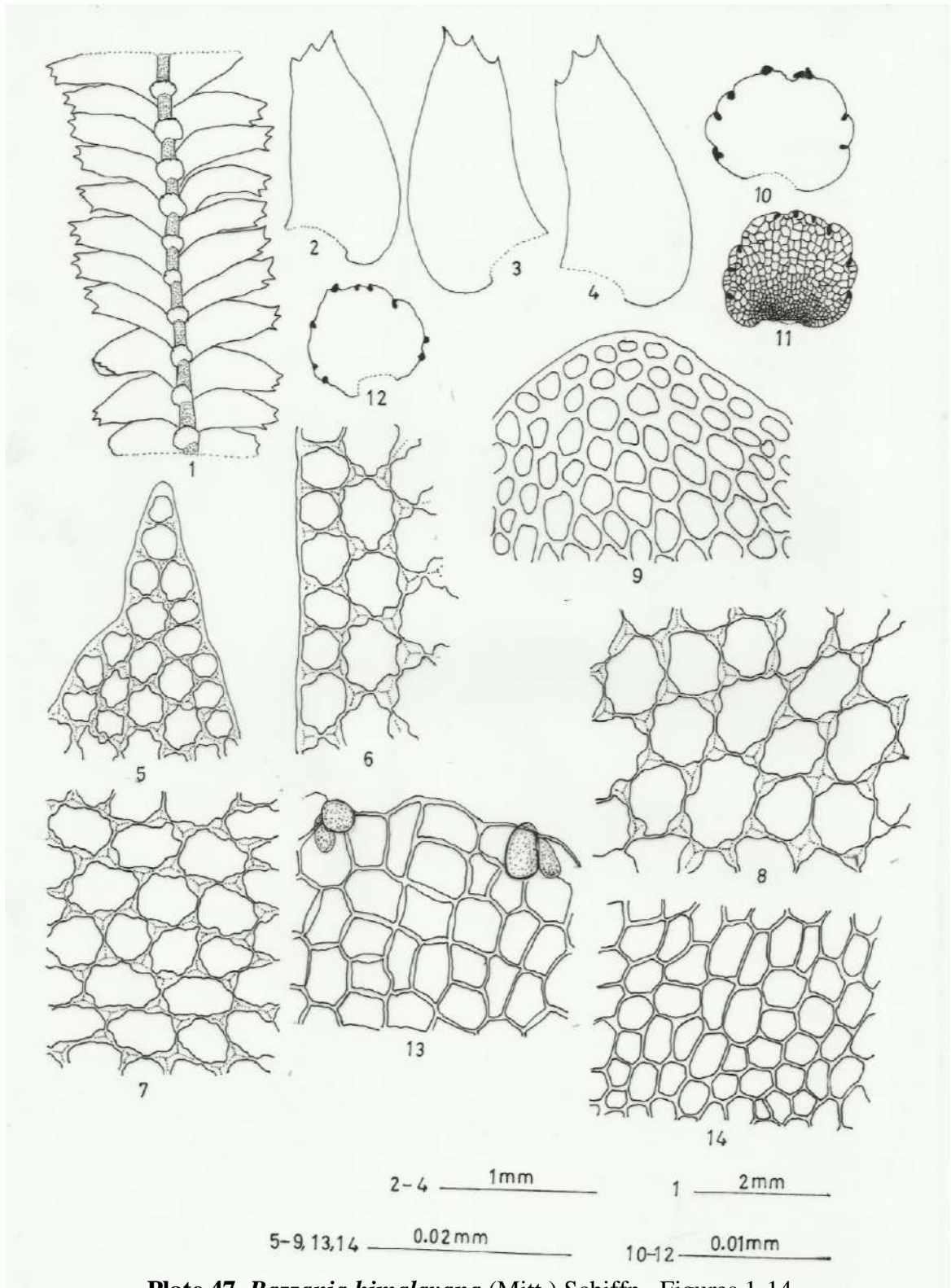


Plate 47. *Bazzania himalayana* (Mitt.) Schiffn., Figures 1-14.

Figs. 1. A portion of plant in ventral view; 2-4. Leaves; 5. Leaf apical cells; 6. Leaf marginal cells; 7. Leaf median cells; 8. Leaf basal cells; 9. A portion of stem in cross section; 10-12. Underleaves; 13. Underleaf apical cells with hyaline papillae; 14. Underleaf basal cells.

Specimen examined: Nagaland: Kohima District: Khuzama: KE 10168: 16.11.2009:
Kazhuhrii Eshuo.

Genus: *Lepidozia* (Dumort.) em. Dumort.

Lepidozia (Dumort.) em. Dumort., Syll. Jungerm. Eur., P. 69. 1831.

Plants small to medium, yellowish or whitish-olive green, freely pinnately or bipinnately branched, prostrate-procumbent or erect. Stem spherical, generally with 18-24 longitudinal rows of thick walled cortical cells; medullary cells in numerous longitudinal rows, thin or very rarely slightly thick walled. Branching generally two types i.e lateral monopodial of *Frullania*-type, replacing the half of a leaf from both series of the lateral merophytes and postical intercalary from underleaf axils *Microleppidozia*-type; lateral and postical branches running out as whip-like. Rhizoids frequent from base of underleaf. Leaves and underleaves similar or underleaves slightly smaller. Leaves more or less asymmetric, incubously inserted, 4-5 lobed for 1/3-2/3 their length; margin entire to spinose-dentate; lobes triangular, 3-5 cells wide or more at base. Underleaf small, transversely lobed. Cells thick walled, medium, with minute or without trigones; oil bodies 5-16 per cell, homogenous. Asexual reproduction absent. Monoicous or dioicous. Androecia on short postical or terminal on short lateral branches; bracts lobed like normal leaves, smaller, containing globose antheridia; antheridial stalk 1-2 seriate. Gynoecia on postical branches, bracts several pairs, sub-entire or more shallowly lobed than vegetative leaves; bracteoles similar to leaf. Perianth pedicellate, elongate. Seta of 12 or more longitudinal rows of outer layer and larger than the numerous interior longitudinal rows. Capsule oval with 3-5 stratose walled; outer layer with nodular thickenings; inner with semiannular bands. Spores brown and granulate-papillate.

Type: *Lepidozia reptans* (L.) Dumort.

Lepidozia wallichiana Gottsche, Sp. Hepat. 6: 335. 1922. (Plate 48. Figs. 1-16)

Plants small, light yellowish green to light brownish green, 25-50 mm long, 0.3-0.5 mm wide, irregularly branched, branching nearly 90° to the main stem, becoming flagelliform at the apex; rhizoids scarce. Stem 81-141 µm in diameter, 8 cells across in cross section, thin-walled, cortex cells 15-23 x 10-18 µm, medulla cells 13-19 x 7-14 µm. Leaves remote, distant, obliquely inserted, straight or slightly incurved, 124-280 µm long, 113-218 µm wide, 3 (-4) lobed, 1/2 lobe of the leaf length, sinus wide; lobes triangulate, apex acute, 2-3 uniserriate cells at apex, 2 (-3) bi-serriate cells just below the uniserriate cells, 7-12 cells long, 8-13 cells wide at base; apical cells 16-20 x 9-12 µm, medium cells 18-21 x 13-16 µm, basal cells 20-32 x 11-22 µm, cells thin walled, trigones small or absent. Cuticle smooth or..... Underleaves small, distant, remote, transversely inserted, incurved, 110-135 µm long, 123-150 µm wide, slightly wider than long, 4 lobed, lobes triangulate, apex acute or obtuse, sinus wide, 5-7 cells long, 8 cells wide. Androecia and gynoecia not seen.

Habitat: Plants grows on moist rocks covered with thin layered of soils in association with *Lepidozia* sp., *Scapania* sp., *Calypogeia* sp. and Mosses at 2400-2700 m asl.

Range: India, Japan, Nepal, Philippines, Taiwan, Borneo, Sri Lanka, Java, Amboina, Bangka.

Distribution in India: *Eastern Himalaya: Nagaland**.

Specimen examined: Nagaland: Kohinma District: Khonoma: 19.03.2011: KE 10423: Kazhuhrii Eshuo.

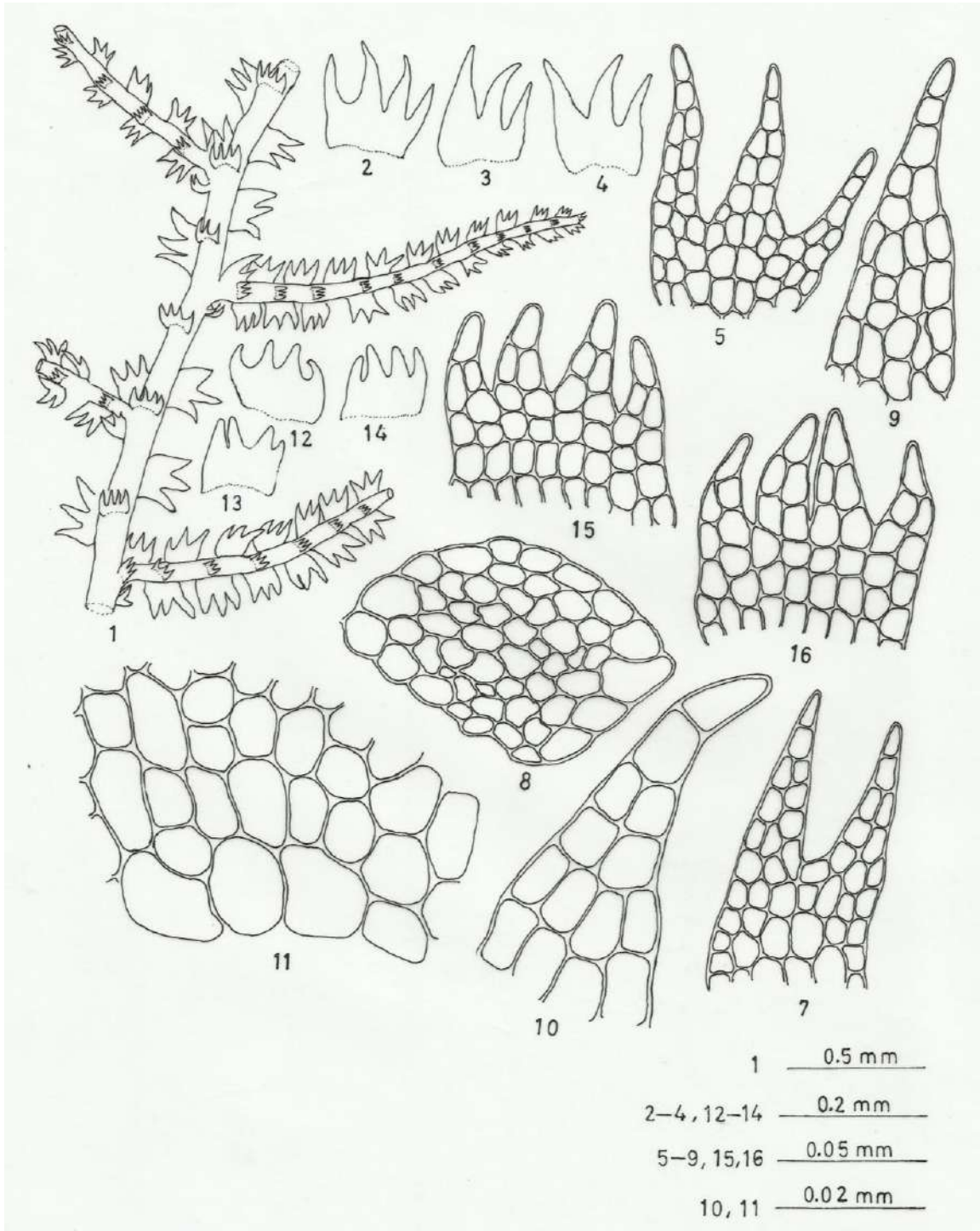


Plate 48. *Lepidozia wallichiana* Gottsche, Figures 1-16.

Figs. 1. Apportion of plant in ventral view; 2-4. Leaves; 5. Leaf cells; 7. Leaf near the branch emergence; 8. Cross section of stem; 9-10. Leaves apical cells; 11. Leaf basal cells; 12-16. Underleaves.

Lepidozia brevifolia Mitt., Journ. Proc. Linn. Soc. 5: 104. 1861. (Plate 49. Figs. 1-22)

Plants small, brownish green to light yellowish green, 20-30 mm long, 0.5-0.9 mm wide, pinnately branched, irregular, branching lateral, flagelliform at the apex. Rhizoids scarce. Stem 211-268 μm in diameter, 12-15 cells across in cross section, cortical cells slightly larger than the medullary cells, cortical cells 15-31 x 21-31 μm , medullary cells 15-25 x 11-16 μm , cells thin walled. Leaves on the main stem remote, obliquely inserted, incurved, asymmetric, distant, 4-lobed, or rarely 3-lobed, 1/2-1/3 lobed of the leaf length; lobes broadly triangulate, acute or sub-obtuse, incurved, 303-417 μm long, 276-406 μm wide, broad at base, sinus wide; leaves on the lateral branched contiguous, distant, obliquely inserted, incurved, 3-4 lobed; apical leaf cells 18-24 x 10-17 μm , thin walled, trigones small; leaf median cells 19-28 x 12-16 μm , thin walled, trigones small, rectangular, quadrate; basal cells 28-51 x 22-28 μm , quadrate sub-quadrate, thin walled, trigones small; cuticle slightly smooth to papillate. Underleaves distant, small, transversely inserted, incurved, 290-330 μm long, 321-369 μm wide, slightly wider than long, 4-lobed, 1/2 lobed of the underleaf length, lobes broadly triangulate, apex acute, or slightly obtuse, sinus wide, cells like the leaves cells. Androecia and gynoecia not seen.

Habitat: Plants grows on moist rocks covered with thin layered of soils in association with *Metacalypogeia* sp., *Lepidozia* sp., *Scapania* sp. and Mosses at 2000-2750 m asl.

Range: India

Distribution in India: *Eastern Himalaya:* Sikkim, West Bengal, Meghalaya, Nagaland*; *Western Himalaya:* Uttaranchal-Dehra Dun.

Specimen examined: Nagaland: Kohima District: Khonoma: KE 10429: 19.03.2011: Kazhuhrii Eshuo.

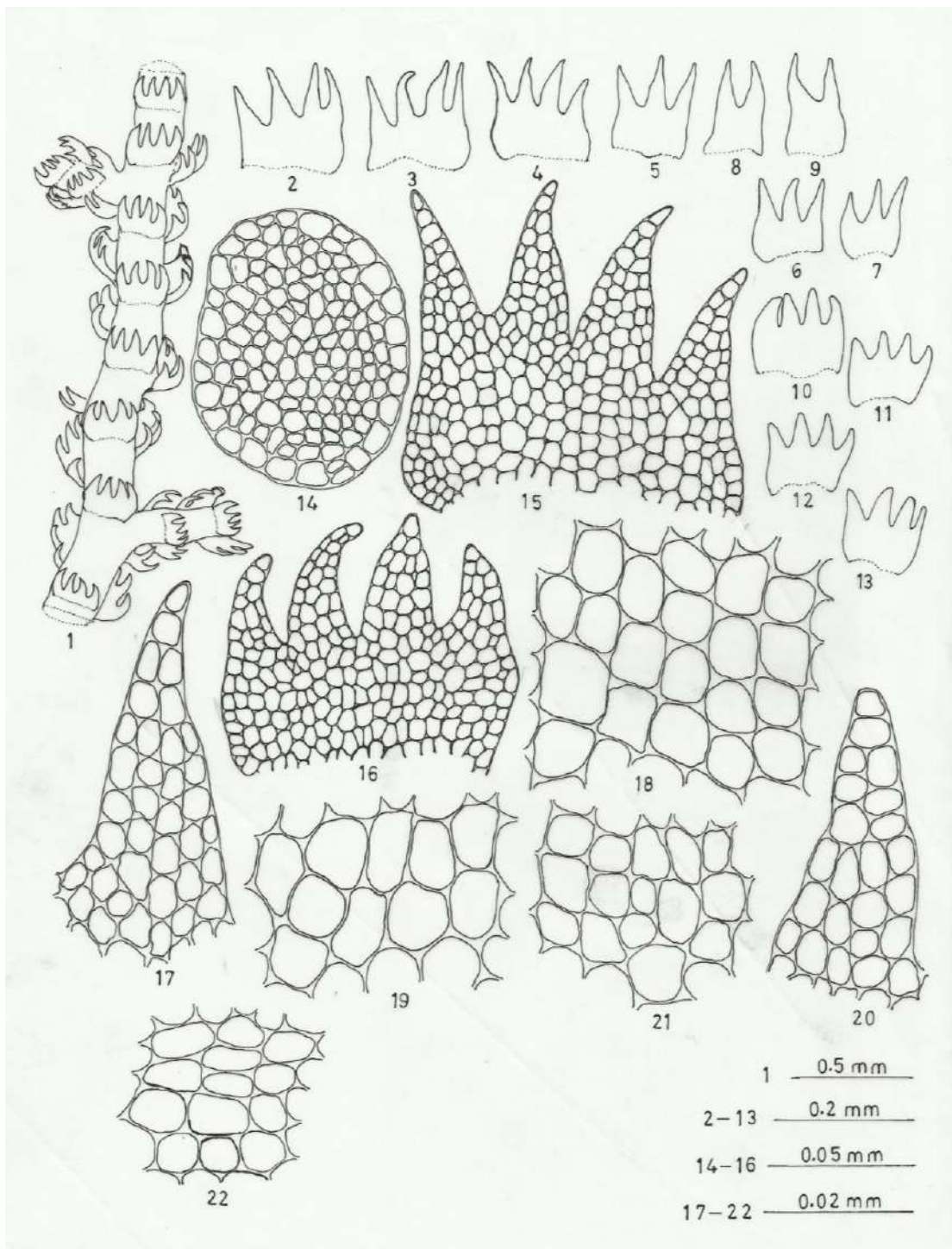


Plate 49. *Lepidozia brevifolia* Mitt., Figures 1-22.

Figs. 1. A portion of plant in ventral view; 2-7. Leaves; 8-9. Leaves near the branch emergence; 10-13 & 15-16. Underleaves; 14. Cross section of stem; 17 & 20 Leaves lobes apical cells; 18. Leaf median cells; 19. Leaf basal cells; 21-22. Underleaf basal cells cells.

FAMILY: LOPHOCOLEACEAE Vanden Berghen

LOPHOCOLEACEAE Vanden Berghen in Robyns, Fl. Gén. Belgique, Bryoph. 1:
208. 1956.

Plants small to large, light green to pale green, branched, branching intercalary, terminal, lateral branches of the *Frullania* and *Plagiochila*-type, ventral branches of the *Bazzania*-type; stolons usually absent. Leaves succubous, 2 lobed or undivided; anisophyllous (isophyllous in *Pachyglossa*); underleaves bifid, frequently with marginal teeth, often connate with leaves. Rhizoids fascicle, hyaline and transparent. Androecia usually on leading axes (sometime on abbreviated lateral or ventral endogenous branches); gynoecia usually on leading axes (sometime on abbreviated lateral or ventral endogenous branches); sporophyte enclosed by shoot calyptras and perianth; perianth 3-keeled with the third keel dorsal, sometimes laterally compressed with the ventral side reduced; capsule ovoid to ellipsoid, capsule wall 4-5 stratose and the epidermal cells with 1-phase ontogeny; gemmae present in few taxa.

Keys to genera of the family Lophocoleaceae:

1. Plant medium to large, light green to pale green, or yellowish green; leaf apex usually bidentate, retuse, rhomboid, ovate; female inflorescence terminal on the main shoot or lateral shoot.....*Lophocolea*.
- 1a. plant medium to large, leaf dentition usually 2-9 at apex; leaf rectangulate, ovate; underleaves often united narrowly to broadly with the adjoining leaves at one or both end; leaves cells often with tri-radiate to nodulose or bulging trigones; female inflorescence on short lateral branched..... *Heteroscyphus*.

Gneus: Lophocolea (Dumort.) Dumort.

Lophocolea (Dumort.) Dumort., Rec. d' Obs., p. 17. 1835.

Plants delicate, in prostrate patches, light or yellowish green to green, dorso-ventral or sometime laterally compressed, small to large sized. Stem sparingly to profusely branched, with lateral, intercalary or postical-intercalary branching, usually dorso-ventrally flattened. Leaves contiguous to imbricate, obliquely to subtransversely inserted on the stem, ovate, oblong, rhomboid-ovate, quadrate or even rectangular, margin entire or dentate; cells undifferentiated, without or with small to large tri-radiate trigones. Oil bodies 2-7 per cell, circular, oval or oblong, finely segmented. Underleaves distant, usually free, small, deeply bilobed, lobed divergent, sinus narrow to wide, 1-6 or more uniseriate cells at apex. Male inflorescence usually terminal or intercalary on main shoot or on equally vigorous lateral branches, usually spicate, bracts in 3-16 pairs, saccate at the base, usually toothed. Female inflorescence usually terminal on main shoot or on short lateral branches; bracts and bracteoles in 1-3 whorls, bracts ovate to oblong, slightly larger than lateral leaves; perianth with or without subfloral innovations, oblong or campanulate, mouth usually tri-plicate, keel smooth or winged. Capsule ovoid, walls 2-6 stratose, cells of the epidermal layer with nodular thickenings on radial and end walls; cells of the innermost layer also with nodular thickenings on the tangential walls. Spores light to yellowish brown, 12-20 μm in diameter, granular, papillose, tri-radiate mark prominent on proximal view; elaters 36- 187 μm long, 8-16 μm wide, with bi-spiral thickenings.

Type: Lophocolea bidentata (L.) Dumort.

Keys to species of the genus *Lophocolea*.

1. Plant prostrate, light green to yellowish green; stem 8-9 cells in diameter, cells undifferentiated; leaves rhomboid-ovate, broadest at base, bidentate, teeth 5-10 cells long, 3-5 cells broad at apex; underleaf distant, lobes 10-14 cells long, 4-7 uniserriate at apex..... *L. bidentata*.
- 1a. Plant light green to pale green; stem 9-10 cells in diameter; leaves bilobed to entire, oblong, ovate, retuse; underleaf distant, lobes 15-18 cells long, 4-7 cells broad at base, 2-4 uniserriate cells at apex..... *L. heterophylla*.

Lophocolea bidentata (L.) Dumort., *Recueil d'Obs. Jungerm.*: 17 (1835).

(Plate 50. Figs. 1-11)

Plant small, delicate, yellowish green to light brownish green, green, dorso-ventral, 15-22 mm long, 1.5-3 mm wide, prostrate, branched, lateral-intercalary, lateral-terminal, dorso-ventrally flattened. Rhizoids hyaline, transparent and arrange in bunch or tuft at the base of underleaves. Stem oval, 0.2-0.4 mm in diameter, 8-9 cells across, cells undifferentiated, thin walls, non-trigonus, 14.3-30.8 μm long and 11-26.4 μm wide. Leaves closely imbricate, obliquely oriented on the stem, alternate to sub-opposite, rhomboid-ovate, 1.5-2.6 mm long, 1.2-2.0 mm wide, apex much narrower than the base, broadest at base, bilobed, lobes parallel to diverging, acute, dentate, bidentate, 5-10 cells long, 3-5 cells broad at base; cells non-trigonus or minute tri-radiate trigones, cells undifferentiated, thin walls, apical cells 17.6-34.1 μm long, 14.3-22.0 μm wide, middle cells 25.3-37.5 μm long, 18.7-33.0 μm wide, basal cells 30.8-44.0 μm long, 22-30.8 μm wide. Oil bodies (-1) 2-5 per cell, circular, elongated, elliptical, finely segmented, 3-11 μm long and 2-5.5 μm wide. Underleaves distant, free, small, 0.48-0.75 mm long, 0.3-0.44 mm wide, deeply bilobed, lobes diverging with wide sinus; lobe 10-14 cells long, 3-5 cells wide, 4-7 uniserriate cells

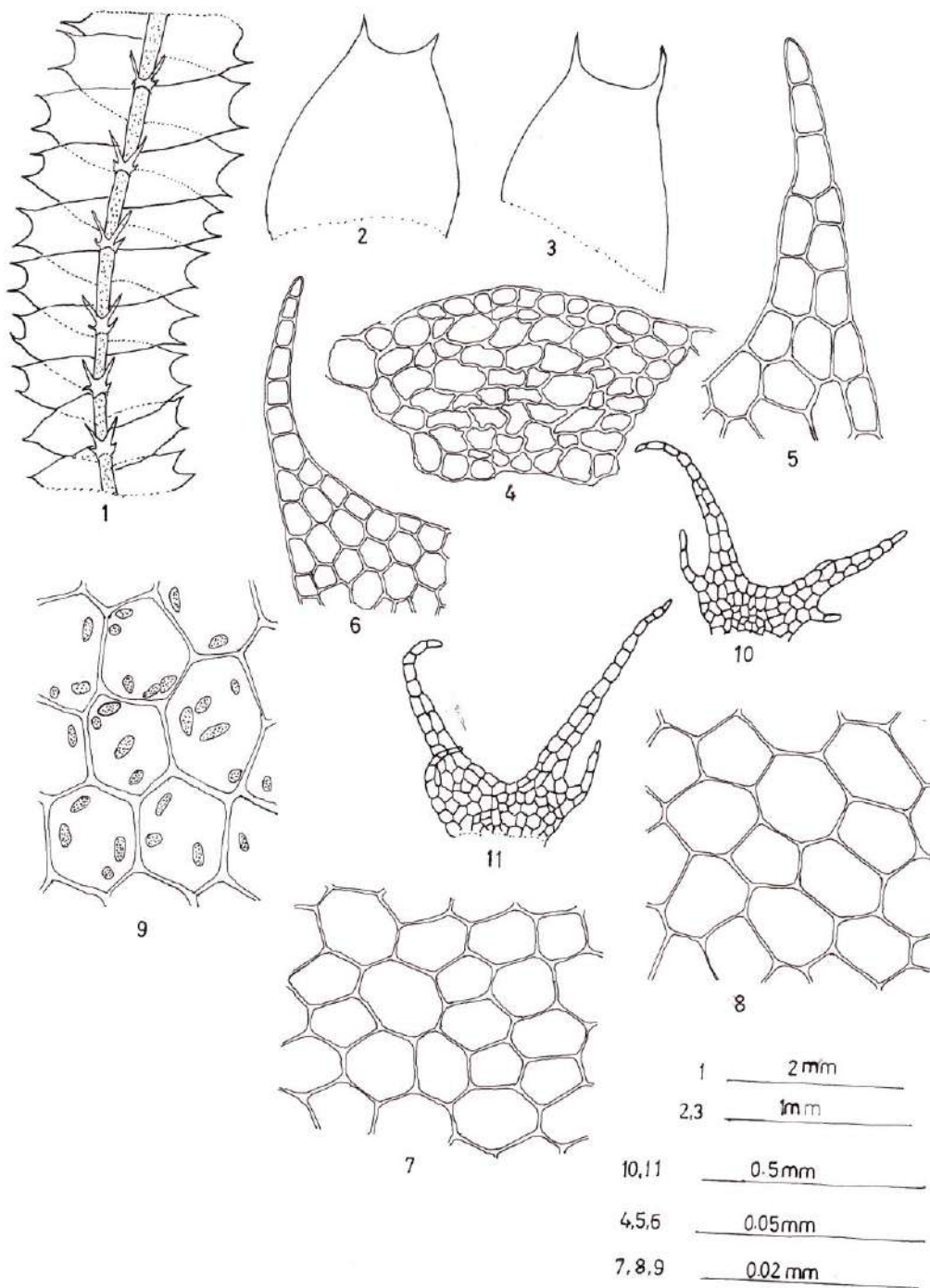


Plate 50. *Lophocolea bidentata* (L.) Dumort., Figures 1-11.

Figs. 1. A portion of plant in ventral view; 2-3. Leaves; 4. Cross section of stem; 5-6. Leaves apical cells; 7. Leaf median cells; 8. Leaf basal cells; 9. Oil bodies; 10-11. Underleaves.

at apex, cells non-trigonous, thin walls, lamina cells 3-4 long, 12-13 cells wide, 1 lateral teeth arise from one or both side, lateral tooth 3-5 cells long. Sporophyte no seen.

Habitat: Plants grow on moist soil (Terricolous) and rocks (saxicolous) in association with Mosses at 1500-1750 m asl.

Range: Europe, North and South America, Australia, Asia Java? Nepal, India.

Distribution in India: *Eastern Hiamalaya:* Sikkim, West Bengal, **Nagaland***.
Western Himalayas: Uttar Pradesh; *South India:* Tamil Nadu.

Specimen examined: Nagaland: Kohima District: Khuzama: KE 10152: 16.11.2009: Kazhuhrii Eshuo.

Lophocolea heterophylla (Schrad.) Dumort., *Recueil d'Obs. Jungerm.*: 17. 1835.

(Plate 51. Figs. 1-13)

Plant medium, delicate, light green to yellowish green, pale green, 15-25 mm long, 2-3 mm wide including leaves, branched, branching lateral-intercalary, sometime lateral-terminal, dorso-ventrally flat, or rarely dorsally compressed. Rhizoids in bunch or tuft at the underleaf bases. Stem circular, 0.15 x 0.18 in diameter, 9-10 cells across; cells undifferentiated, thin walled, non-trigonous, 18.1-29.8 μm long and 8.6-21.2 μm wide. Leaves closely imbricate, bilobed to entire, retuse, to rounded, oblong, quadrate, 1.1-1.3 mm long, 1-1.3 mm wide at base, 0.5-0.8 mm wide at apex, margin entire; cells undifferentiated, thin walled, trigonous, trigones tri-radiate to slightly bulging; apical cells 17.9-28.7 μm long, 16.4-20.6 μm wide, middle cells 19.7-28.7 μm long, 19.2-26.5 μm wide, basal cells 23.3-52.9 μm long, 19.8-31.9 μm wide. Oil bodies 3-5 per cell, circular, elliptical, finely segmented, 3-9 μm long and 3-6 μm wide. Underleaves distant, free, small, 0.35-0.57 mm long, 0.3-0.35 mm wide; deeply bilobed, sinus wide, diverging, 15-18 cells long, 4-7 cells

broad at base, 2-4 uniseriate cells at apex; 1-2 lateral teeth arises from one or both side of the lobes, lateral teeth (-2) 4-8 cells long, 2-4 cells broad at base; a hyaline cell usually present at end of the lobes and teeth cells; cells thin walled, non-trigonous, or indistinct tri-radiate trigones. Dioicous or paroecious. Male inflorescence intercalary or just behind the female inflorescence, male bracts in 3-5 pairs, spicate, 1-1.5 mm long, 0.9-1.2 mm wide, bilobed to retuse; antheridia 1-3 per male bract, stalk biseriate, upto 51.6 μm long, 18.1 μm wide, antheridial body 138.5 x 145.4 μm in diameter. Female inflorescence borne on the main terminal end of the plant, bract and bracteole in one row, bract irregularly dentate, 0.9-1.4 mm long, 0.7-0.9 mm wide; perianth campanulate. Spores no seen.

Habitat: Plants grows on moist soil, rocks covered with thin layer of soil in association with Mosses, *Trocholejeunea* sp., *Lejeunea* sp., at 1060-1700 m asl. Viswema, Kohima, KZR 10112, KZR 10288.

Range: Europe, South and North Africa, North America, Asia-Siberia, Japan, Formosa, Manchuria, Nepal and India.

Distribution in India: *Eastern Himalaya:* Meghalaya-Vishnupur; Sikkim-Singhik; **Nagaland***; *Western Himalaya:* Himachal Pradesh-Simla; Uttar Pradesh-Mussoorie. *South India:* Kerala-Vagavurraj; Tamil Nadu.

Specimen examined: Nagaland: Kohima District: Viswema: KE 10288: 08.08.2010: Kazhuhrii Eshuo; Kohima: KE 10112: 20.07.2009: Kazhuhrii Eshuo

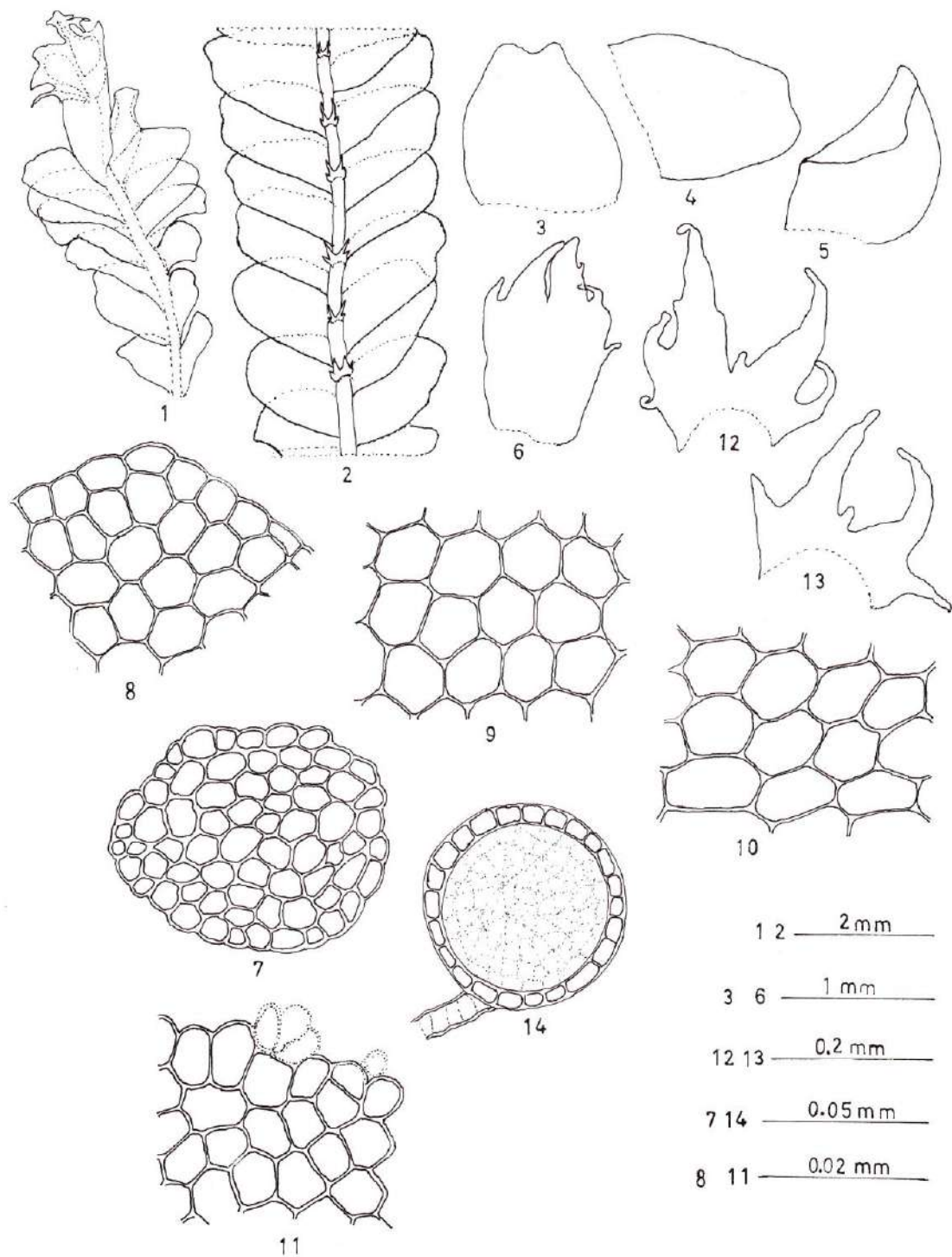


Plate 51. *Lophocolea heterophylla* (Schrad.) Dumort., Figures 1-13.

Figs. 1. A portion of plant in dorsal view with perianth; 2. A portion of plant in ventral view; 3-5. Leaves; 6. Female bract; 7. Cross section of stem; 8. Leaf apical cells; 9. Leaf median cells; 10. Leaf basal cells; 10. Leaf marginal cells with papillae; 12-13. Underleaves; 14. Antheridium.

Genus: *Heteroscyphus* Schiffn.

Heteroscyphus Schiffn., Oesterr. Bot. Zeitschr. 60: 169-173. 1910.

Plants delicate, fragile, in prostrate patches, light or olive green, green, dorso-ventrally or laterally compressed, branched, with lateral-intercalary, lateral-terminal or postical-intercalary branching. Leaves slightly to closely imbricate, or sometime distant, alternate to sub-opposite, transversely spreading, ovate, oblong, rectangular, quadrate, usually with broad base and narrow apex, leaf apex dentate or sometime entire, margin entire or sometime usually covered with gemmae, hyaline papillae present at leaf margin, cells uniformly thin walled or differentiated into outer thick walled, trigones present or absent, trigones tri-radiate, large, nodulose. Underleaves distant, or slightly contiguous, free or united, small to large, reniform, cordate, orbicular, retuse or shortly to deeply bilobed, lobes parallel to diverging, margin smooth or usually dentate. Rhizoids in bunch at the bases of the underleaf. Dioicous. Male inflorescence usually on short lateral-intercalary or sometime on postical-intercalary, bracts 2-14 pairs, small as compared to vegetative leaves, apex usually bi-dentate, sometime pluridentate or 2 or 3 lobed; bracteole relatively smaller, with deeply bilobed apex. Female inflorescence terminal usually on short lateral-intercalary or sometime on postical-intercalary branches lacking vegetative leaves, bracts and bracteole small, in 1-2 whorls; perianth without sub-floral innovation, obovate to broadly campanulate, mouth wide, margin heavily dentate or laciniate; seta 7-11 cells across in diameter; capsule spherical to ovoid, dehiscing into 4-valves, capsule wall 3-5 stratose; cells of the outermost layer with nodular thickenings on radial walls, sometime without thickenings. Spores light brown, 12-16 (-27) μm in diameter, granular to spinulose, tri-radiate mark proximal face thick and ridged, rays

reaching upto the periphery, with similar pattern of thickening; elaters slender, 43-187 μm long, 8-16 μm wide broad, usually with bi-spiral thickening.

Type: Htereoscyphus aselliformis (Reinw. *et al.*) Schiffn.

Keys to species of the genus *Heteroscyphus*.

1. Leaves usually bidentate, stem cells undifferentiated 2
- 1a. Leaves pluridentate, stem cells differentiated into 1-2 outer thick walls..... 4
2. Plant 3-5 mm wide, leaves opposite to sub-opposite, underleaves united with the adjoining leaves by 3-5 cells *H. bescherellei*
- 2a. Plant 0.5-2.5 mm wide, leaves sub-opposite to alternate, underleaf free..... 3
3. Plant medium, leaves dentition 1-3, leaves orbicular..... *H. orbiculatus*
- 3a. Plant small, leaves dentition 2-4, leaves quadrate..... *H. parvus*
4. Leaves dentition 2-6, leave ovate-rectangulate, underleaf lobes 5-8
uniseriate at apex*H. hyalinus*
- 4a. Leaves dentition 4-9, leaves quadrate-rectangulate, underleaf lobes 3-5
uniseriate apex 5
5. Stem 10-12 cells across, leaves dentition 5-9 per leaf..... *H. argutus*
- 5a. Stem 8-10 cells across, leaves dentition 3-5 per leaf..... *H. pandei*

Heteroscyphus bescherellei (St.) Hatt., Bot. Mag. Tokyo, 58: 39. 1944.

(Plate 52. Figs. 1-14)

Plant medium to large, delicate, light green to yellowish green, dorso-ventral, 25-45 mm long, 3-5 mm wide including leaves; branched, usually lateral intercalary branched, lateral-terminal, dorso-ventrally flattened. Rhizoids hyaline, transparent, present mostly at the base of the underleaves in tuft. Stem circular, 10-11 cells across in diameter; cells undifferentiated, thin walled; cortical cells 15.8-24.5 μm long, 14.3-27.5 μm wide, medullary cells 13.3-37.4 μm long, 19.8-30.8 μm wide. Leaves closely

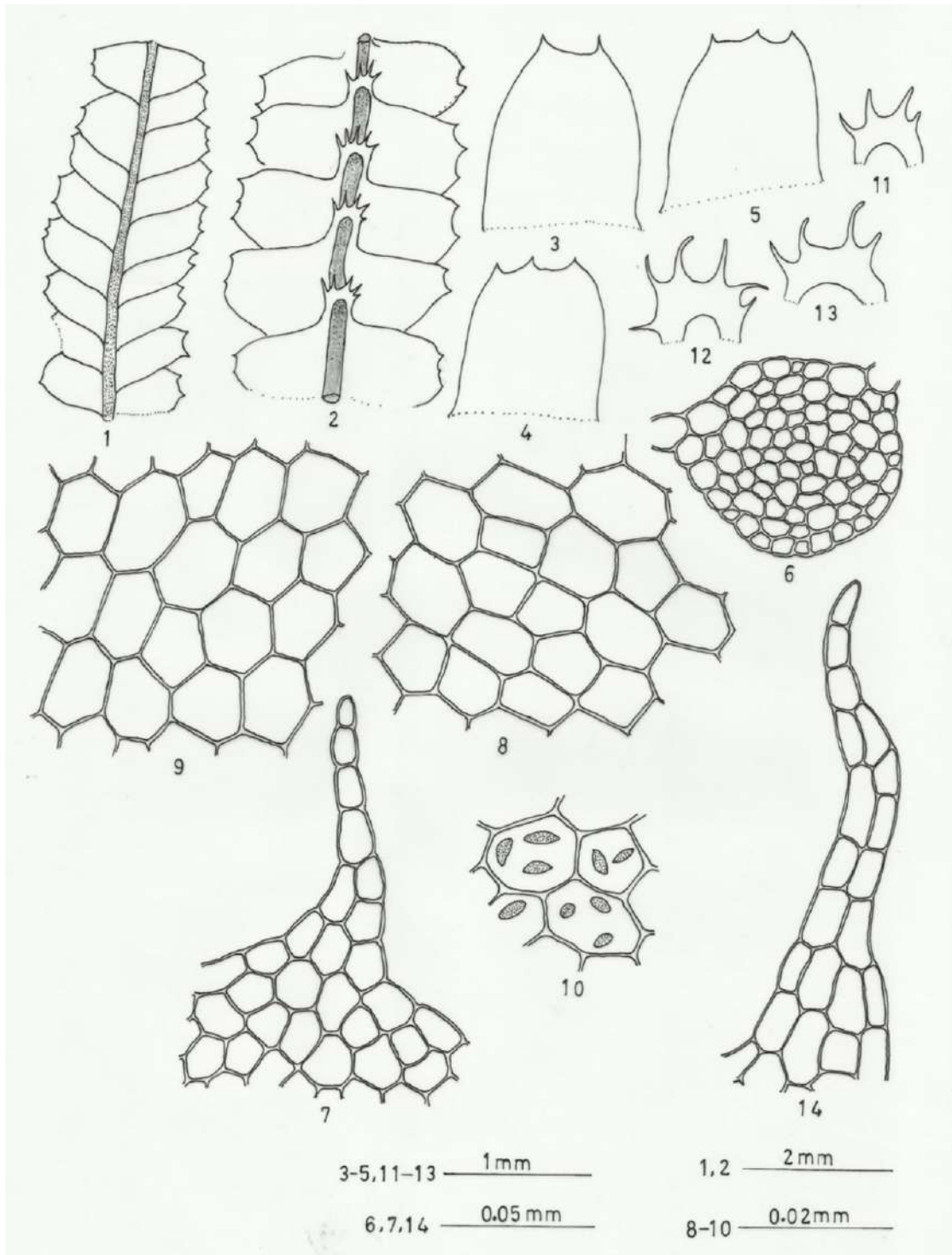


Plate 52. *Heteroscyphus bescherellei* (St.) Hatt., figures 1-14.

Figs. 1. A portion of plant in dorsal view; 2. A portion of plant in ventral view; 3-5. Leaves; 6. Cross section of stem; 7. Leaf apical cells; 8. Leaf median cells; 9. Leaf basal cells; 10. Oil bodies; 11-13. Underleaves; 14. Underleaf apical cells.

imbricate, sub-opposite to opposite, dorsally free but united on ventral side with the adjoining underleaves bases, rectangulate, oblong, ovate, 1.7-2.9 mm long, 1.4-2.5 mm wide, margin entire, apex narrower than the base, denticulate, usually bidentate, 5-8 cells long, 2-3 cells broad at base; cells non-trigonous, apical cells 35.6-54.3 μm long, 22.4-35.7 μm wide, middle cells 37.4-57.5 μm long, 24.2-37.5 μm wide, basal cells 35.2-60.5 μm long, 22-39.6 μm wide. Oil bodies 2-5 per cell, circular, spindle, elliptical, finely segmented, 5.5-13.2 μm long and 3.4-6.6 μm wide. Underleaves distant, united at both side of the adjoining leaves by 3-5 cells, large, 0.65-0.9 mm long, 0.58-0.85 mm wide, bilobed, sinus deep, wide, 1-2 (-3) lateral teeth arises on both side of the underleaves, tooth cells 4-11 long, 2-4 cells broad, 4-6 uniserriate cells at apex, lamina cells 6-8 (-9). Male and female plant no seen.

Habitat: Plant grows on moist soil (terricolous), rocks (saxicolous), and bark of trees (corticolous) in association with *Heteroscyphus* sp., *Jungermannia* sp., *Cephalozia* sp., and Mosses at 900-1700 m asl.

Range: Japan, China, other warm temperate to tropical regions of Asia, extending to Philippines, New Guinea and Australia, Nepal and India.

Distribution in India: *Eastern Himalayas:* Arunachal Pradesh, Meghalaya, Sikkim-Gangtok, West Bengal-Darjeeling, **Nagaland***.

Specimen Examined: Nagaland: Kohima district: Khuzama: KE 10150, KE 10153: 16.11.2009; Kazhuhrii Eshuo; Mokokchung district: Changki: KE 10335: 02.11.2010; Kazhuhrii Eshuo.

Heteroscyphus orbiculatus Srivast. et Srivast., Indian Geocal. 140. 2002.

(Plate 53. Figs. 1-11)

Plant medium, light green to green, yellowish green, dorso-ventral, 10-23 mm long, 1.1-2.3 mm wide including leaves, branched, branching lateral-intercalary,

rarely lateral-terminal, dorso-ventrally flattened. Rhizoids hyaline, transparent which form in bunch or tuft at the underleaf bases. Stem oval, green, 0.25 x 0.19 mm in diameter,, 8-10 cells across; cells undifferentiated, thin walled throughout, 14.9-36.2 μm long, 13.4-26.3 μm wide. Leaves imbricate, sometime distant, alternate to sub-opposite, usually orbicular, quadrate, 0.74-1.1 mm long, 0.6-0.82 (-1.0) mm wide, margin entire, usually broadest at middle, apex rotundate, dentate or sometime entire on the same plant; dentition 1-3 (-4) in number, 1-3 cells long, 1-3 cells broad at base, 1-3 uniserriate cells; cells thin walled, tri-radiate trigones or trigones minute and wanting; cells pentagonal-hexagonal, rhomboidal, rarely rectangular; apical cells 23-33.0 μm long, 16.5-25.3 μm wide, middle cells 25.3-44.0 μm long, 19.8-27.5 μm wide, basal cells 27.5-49.5 μm long and 22-33.0 μm wide. Oil bodies 2-4 (-5) per cell, circular, elliptical, spindle, finely segmented, 2.9-15.4 μm long and 2.9-5.5 μm wide. Underleaves distant, free, small, 0.36-0.42 mm long, 0.21-0.25 mm wide; deeply bilobed, sinus wide, lobes diverging, lobes 6-10 cells long, 2-5(-6) cells broad at base; one lateral tooth arises from one or both the lateral side, tooth cells 2-3 long; lamina cells 2-3(-4) cells long, 8-10 cells wide; cells thin walled, non-trigonus; one hyaline cells often present at the lobe apex and teeth. Male and female inflorescence not found.

Habitat: Plants grows on moist soil and rocks in association with *Cyathodium* sp., *Jungermannia* sp. and Mosses at 1200-1500 m asl.

Range: Endemic to India.

Distribution in India: *South India:* Tamil Nadu; *Western Himalayas:* Himachal Pradesh; *Eastern Himalayas:* Sikkim and Nagaland*.

Specimen examined: Nagaland: Mokokchung District: Mokokchung: KE 10124, KE 10315: Kazhuhrii Eshuo.

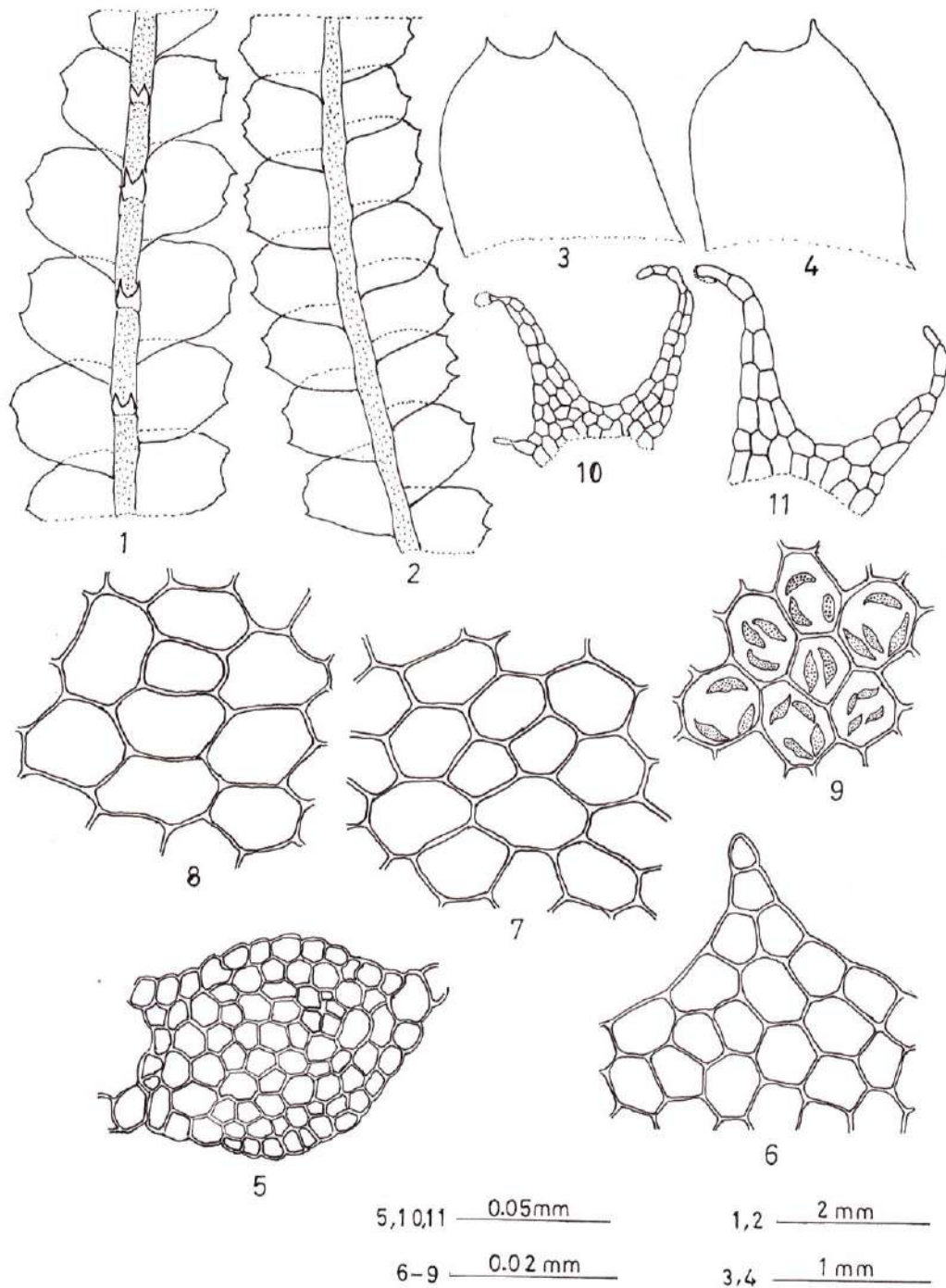


Plate 53. *Heteroscyphus orbiculatus* Srivast. et Srivast., Figures 1-11.

Figs. 1. A portion of plant in ventral view; 2. A portion of plant in dorsal view; 3-4. Leaves; 5. Cross section of stem; 6. Leaf apical cells; 7. Leaf median cells; 8. Leaf basal cells; 9. Oil bodies; 10-11. Underleaves.

Heteroscyphus parvus Srivast. et Srivast., Indian Geocal. 112. 2002.

(Plate 54. Figs. 1-10)

Plant small to medium, light yellowish green, 10-30 mm long, 0.5-1.3 mm wide including leaves, branched, branching intercalary, rarely terminal, dorso-ventrally flattened, widely spreading. Rhizoids in bunch at the bases of the underleaf. Stem oval, circular, 110.9-116.6 x 147-158.4 μm in diameter, 8-9 cells across; cells undifferentiated, thin walled, cortical cells 10.8-24.3 μm long, 10.8-18.8 μm wide; medullary cells 14.6-24.9 μm long, 9.8-17.0 μm wide. Leaves slightly imbricate to contiguous, distant, widely spreading, rectangulate, oblong-ovate, 0.48-0.7 mm long, 0.34-0.63 mm wide; apex rounded, apex usually bidentate, sometime entire, dentition 1-2 per leaf; tooth cells 3-5 cells long, 1 (-2) cells broad at base; leaves cells slightly thicker walls toward 2-3 margin cells, cells non-trigonous; apical cells 14.3-245.1 μm long, 13.1-20.1 μm wide, cells quadrate, rectangular, non-trigonous; median cells 17.3-28.2 μm long, 11.9-23.5 μm wide, cells pentagonal, rectangular to sub-quadrate; basal cells 18.7-34.3 μm long, 15.6-25.3 μm wide, cells pentagonal, sub-quadrate, rectangular; Oil bodies 3-5 (-7) per cell, elliptical, circular, spindle, and finely segmented. Underleaves distant, free, small, 0.16-0.21 mm long, 0.09-0.14 mm wide, lamina cells 1-2 cells long, (-5) 8 cells broad; sinus deep, wide, 4/3 deep, margin entire or rarely 1 tooth arise from the lateral side; 5-8 cells long, 2-3 (-4) cells broad at base, 3-5 uniseriate cells at apex, hyaline papillae present at apex. Fertile plant not seen.

Habitat: Plants grows on moist soil, rocks in association with *Calypogeia* Sp., *Jungermannia* sp., *Marchantia* sp. and Mosses.

Range: Nepal, India.

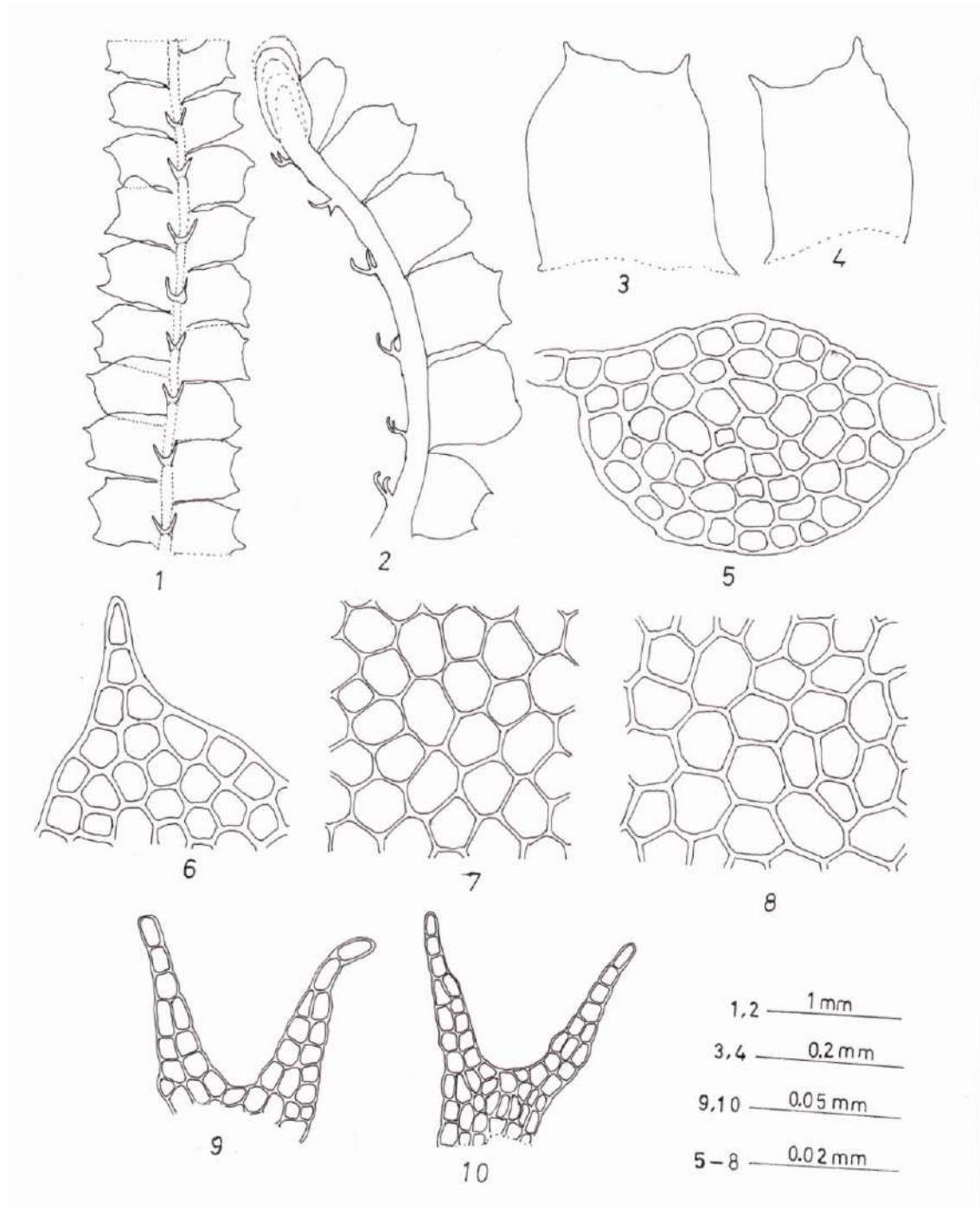


Plate 54. *Heteroscyphus parvus* Srivast. et Srivast., figures 1-10.

Figs. 1. A portion of plant in ventral view; 2. A portion of plant in lateral side view; 3-4. Leaves; 5. Cross section of stem; 6. Leaf apical cells; 7. Leaf median cells; 8. Leaf basal cells; 9-10. Underleaves.

Distribution in India: *Eastern Himalayas:* Sikkim-Singhik, Nagaland*. *Central India:* Madhya Pradesh-Pachmarhi.

Heteroscyphus hyalinus (St.) Srivast et Srivast., Indian Geocal. 118. 2002.

(Plate 55. Figs. 1-9)

Plant medium to large, delicate, light green to yellowish green, dorso-ventral, 20-35 mm long, 3-5.5 mm wide including leaves, branched, branching intercalary, terminal, dorso-ventrally flattened. Rhizoids scarce, in tuft at the base of the underleaves. Stem circular to oval, 11-12 cells across in diameter, cells usually differentiated into 1 or 2 thick outer walls, cortical cells 13.2-26.4 μm long, 17.6-27.5 μm wide, medullary cells 16.5-38.5 μm long, 14.3-33.0 μm wide. Leave slightly to closely imbricate, sub-opposite to opposite, oblong rectangulate, ovate, 1.2-3.5 mm long, 1-2.5 mm wide, margin entire, apex narrower than the base, usually dentate, dentition 2-4 (-6) in number, 3-5 cells long, 2-3 cells broad at base, cells thin walled, cells non-trigonus, marginal cells 27.5-37.4 μm long, 19.8-30.8 μm wide, middle cells 26.5-44.0 μm long, 23.2-33.0 μm wide, basal cells 37.4-60.5 μm long, 30.8-49.5 μm wide. Oil bodies 3-7 per cells, 6.6-14.3 μm long, 4.4-6.7 μm wide, circular, elongate, finely segmented. Underleaves distant, free or rarely united at one end of the leaf, bilobed, 0.6-0.94 mm long, 0.55-0.8 mm wide, sinus deep, wide, 8-17 cells long, 3-6 cells broad at base, 3-5 uniseriate cells at apex, 1-2 tooth on one or both the lateral margin, tooth 4-8 cells long, 1-2 cells broad at base, lamina cells 4-6 cells long, cells thin walled, non-trigonus. Male and female plant no seen.

Habitat: Grows on moist soil (terricolous), on dead and decayed trees and on bark of tree (corticolous) in association with *Riccardia* sp. and Mosses at 1500-2000 m asl.

Range: Nepal, India.

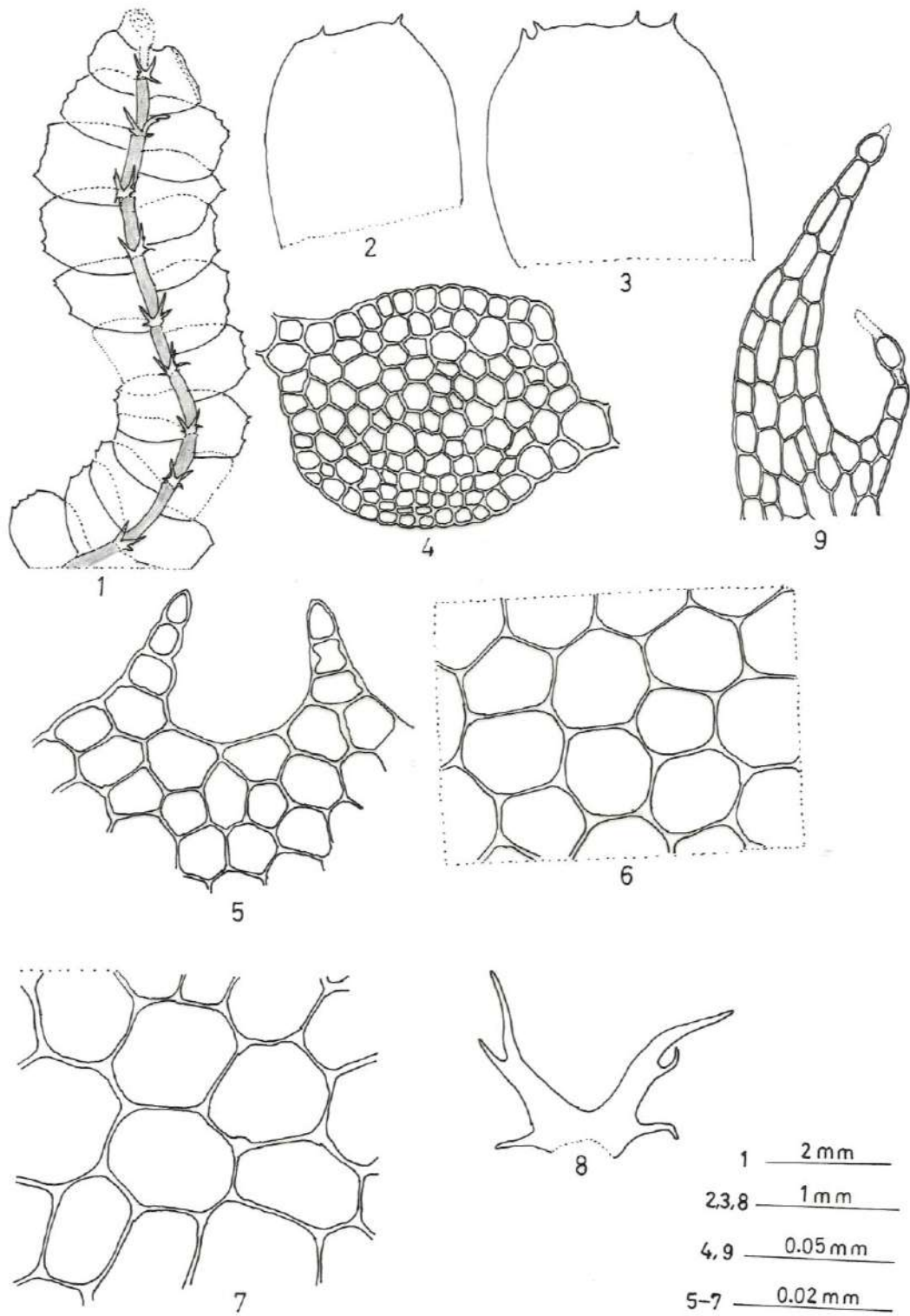


Plate 55. *Heteroscyphus hyalinus* (St.) Srivast et Srivast., Figures 1-9.

Figs. 1. A portion of plant in ventral view; 2-3. Leaves; 4. Cross section of stem; 5. Leaf apical cells; 6. Leaf median cells; 7. Leaf basal cells; 8. Underleaf; 9. Underleaf lobe apical cells.

Distribution in India: *Eastern Himalayas:* Sikkim-Singhik; West Bengal-Kurseong, Mongpo; Meghalaya-Jaintia Hills, **Nagaland***.

Specimen examined: Nagaland: Kohima district: Jotsoma: KE 10058, KE 10059: 14.04. 2009: Kazhuhrii Eshuo.

Heteroscyphus argutus (Reinw., Blume et Nees.) Schiffn., *Osterr. Bot. Zeit.* 60: 172. 1910. **(Plate 56. Figures 1-12)**

Plant medium, delicate, yellowish green to light green, prostrate, dorso-ventral, 25-45 mm long, 2-3.5 mm wide including leaves, branched, branching of lateral intercalary, terminal, dorso-ventrally flattened. Rhizoids hyaline, transparent, numerous on the ventral surface which form a bunch at the base of underleaves. Stem green, oval, 0.2 x 0.5 mm in diameter, 10-12 cells across, cells differentiated into 2 thick cortical cells, 13.2-20.9 μm long, 9.9-22.0 μm wide; medullary cells thin walled, non-trigonal, 13.2-30.8 μm long and 10.1-19.8 μm wide. Leaves closely imbricate, sub-opposite to alternate, quadrate to rectangulate, ovate-rectangulate, 1.5-2.6 mm long, 0.9-2.3 mm wide, margin entire, apex narrower than the base, pluridentate, dentition 5-7 per leaf, 3-5 cells long, 1-2 cells broad at base, 3-4 uniseriate cells at apex; cells non-trigonal, pentagonal to hexagonal; apical cells 22-33.4 μm long, 17.5-27.5 μm wide, middle cells 22-44.0 μm long, 17.5-27.5 μm wide, basal cells 24.2-44.0 μm long and 19.8-33.0 μm wide. Oil bodies (-3) 5- 7 (-9) per cell, 5-12.6 μm long, 3.4-5.2 μm wide, circular, elliptical, finely segmented. Underleaves distant, free, small, 0.3-0.6 mm long, 0.4-0.6 mm wide, bilobed, sinus deep, wide, 5-9 cells long, 3-4 cells broad at base, 3-5 uniseriate cells at apex; lateral tooth arises from each side; lamina cells 2-3 (-4) cells long and (-10) 15 cells wide.

Habitat: Plants grow on moist soil (terrestrial) in association *Phaeoceros* sp., *Jungermannia* sp. and Mosses at 900-1700 m asl.

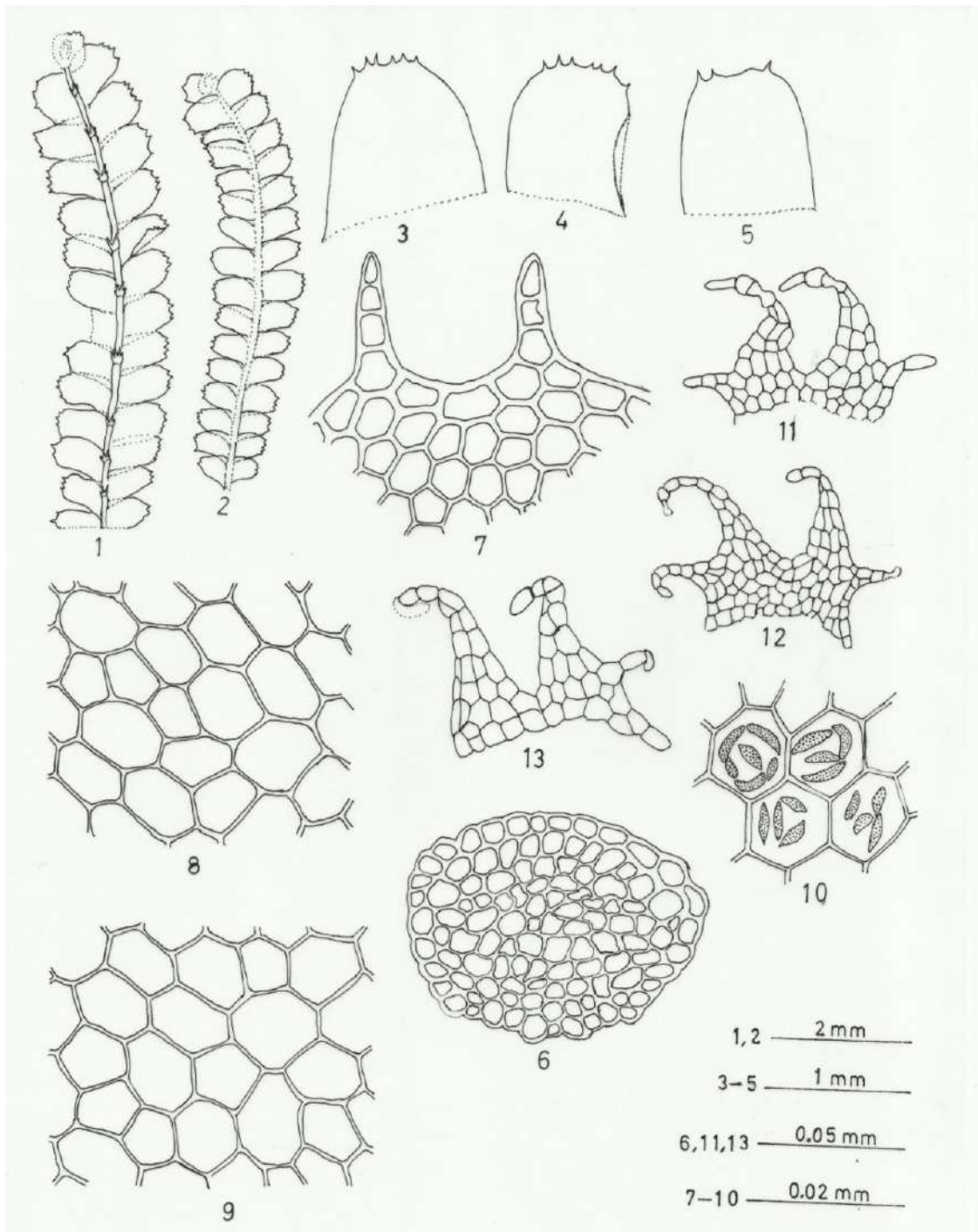


Plate 56. *Heteroscyphus argutus* (Reinw., Blume et Nees.) Schiffn., Figures 1-13
 Figs. 1. A portion of plant in ventral view; 2. A portion of plant in dorsal view; 3-5. Leaves; 6. Cross section of stem; 7. Leaf apical cells; 8. Leaf median cells; 9. Leaf basal cells; 10. Oil bodies; 11-13. Underleaves.

Range: Japan, China, other warm temperate to tropical regions of Asia, New Guinea and Pacific Island, Australia, Java, Nepal and India.

Distribution in India: *Eastern Himalayas:* Assam, Manipur, Meghalaya-Shillong, Sikkim, Gangtok, West Bengal, and Darjeeling. *Western Himalayas:* Himachal Pradesh, Uttar Pradesh. *South India:* Karnataka, Tamil Nadu. Central India: Madhya Pradesh-Pachmarhi.

Specimen examined: Nagaland: Kohima district: Khuzama: KE 10162: 16.11.2009; Kigwema: : Mokokchung district: Changki: KE 10305: 02.11.2010. Kazuhrii Eshuo.

Heteroscyphus pandei Srivast. et Srivast., Linbergia, 15: 1-7. 1990.

(Plate 57. Figs. 1-12)

Plant small to medium, light green to yellowish green, dorso-ventral, 15-35 mm long, 1.5-2.5 mm wide including leaves, branched, branching lateral intercalary, lateral terminal, dorso-ventrally flattened. Rhizoids hyaline, transparent, in tuft at the base of the underleaves. Stem oval, 0.17 x 0.24 mm in diameter, (-8) 9-11 cells across, cells differentiated into outer 1-2 thicker walls, 15.4-28.9 μm long and 11-25.6 μm wide. Leaves imbricate, distant at apex, sub-opposite to alternate, quadrate to rectangulate, oblong, 0.9-1.2 mm long, 0.7-0.84 mm wide, margin entire, apex slightly narrower than the base, denticulate, dentition 2-5 per leaf, 2-6 cells long, 2-3 cells broad at base; cells non-trigonous, pentagonal to hexagonal, apical cells 24.2-34.0 μm long, 17.5-27.5 μm wide, middle cells 25.3-37.5 μm long, 19.8-30.0 μm wide, basal cells 27.5-44.0 μm long and 22-30.4 μm wide. Oil bodies 3-5 (-7) per cell, circular, elliptical, 3-11.5 μm long, 2.5-6.0 μm wide, finely segmented. Underleaves distant, free, small, 0.4-0.54 mm long, 0.3-0.35 mm wide, apex deeply bilobed, lobes diverging with broad sinus, 5-8 cells long, (-2) 3-4 cells broad at base, 3-5 uniserriate

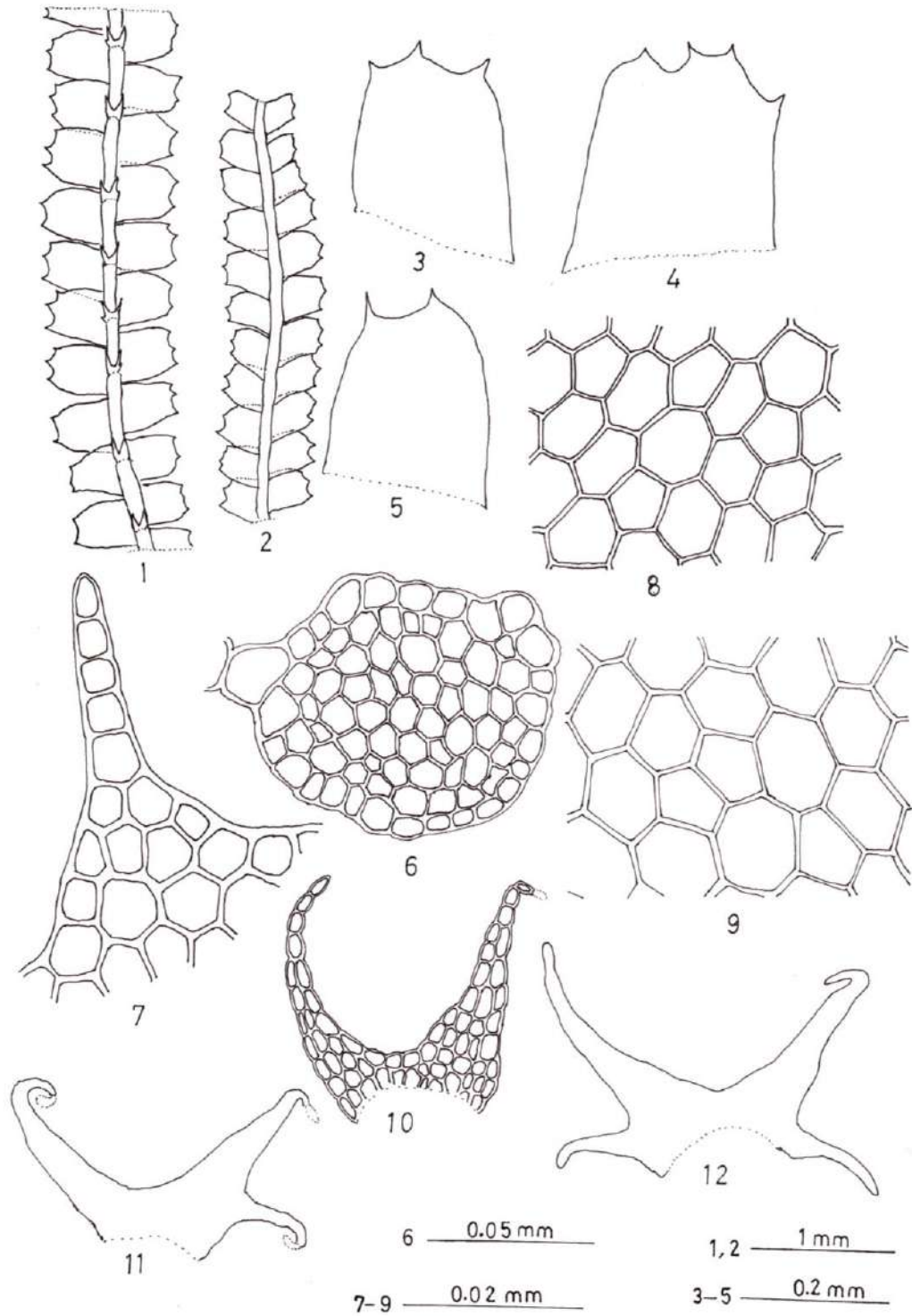


Plate 57. *Heteroscyphus pandei* Srivast. et Srivast., Figures 1-12.

Figs. 1. A portion of plant in ventral view; 2. A portion of plant in dorsal view; 3-5. Leaves; 6. Cross section of stem; 7. Leaf apical cells; 8. Leaf median cells; 9. Leaf basal cells; 10-12. Underleaves.

cells at apex, margin entire, rarely one tooth arise from one or both lateral side, tooth cells 2-4 long; cells non-trigonus, lamina cells 2-3 long and 8 cells wide.

Habitat: Plants grows on moist soil (Terrestrial) in association with *Jungermannia* sp., *Riccardia* sp. and Mosses at 1500-1700 m asl.

Range: Nepal and India.

Distribution in India: *Eastern Himalaya:* Manipur-Kanchipur; Sikkim-Gangtok, Mangan, Nathula Road, Rangrang; West Bengal-Darjeeling Mongpo, **Nagaland***; *Western Himalaya:* Uttar Pradesh-Uttar Kashi (Kotbanglow, Heena).

Specimen examined: Nagaland: Mokokchung District: Mokokchung: KE 10117, KE 10118: 26.08.2009: Kazuhrii Eshuo.

PLAGIOCHILACEAE (A. Jorg.) Müll. Frib. & E. Herzog

PLAGIOCHILACEAE (A. Jorg.) Müll. Frib. & E. Herzog, In Müll Frib., Leberm.

Eur.: 877. 1956.

Plants robust, dark green to pale green, brownish green to reddish green, prostrate to obliquely ascending to erect; free branching, lateral intercalary, terminal or sometimes ventral intercalary. Stem in cross section differentiated into thick-walled cortical layer and thin walled medullary layer. Leaves succubously inserted and oriented, alternate, opposite to sub-opposite; entire or variously dentate, teeth spinose, rarely bilobed or retuse at apex; often weakly-strongly revolute at dorsal margin, broadly-narrowly rounded apex; cells collenchymatous, thin or thick walled, trigonous or absent or minute; cuticle smooth or sometimes verrucose. Underleaves absent or vestigial, in some genera well developed (*Syzygiella* sp.). rhizoids colourless, few, scattered on ventral stem surface. Gemmae present or absent. Dioicous or rarely monoicous. Androecia terminal on main shoot, sometimes on short lateral branches; bracts much smaller than leaves, inflated at base, in 4-15 pairs; bracteoles absent; antheridia 1-3 per bract. Gynoecia on main stem or on branches, with 1 or 2 subfloral innovations; bracts similar to leaves or slightly larger, dentate or entire at margins; bracteoles rarely present. Perianth cylindrical, campanulate, laterally compressed, mouth truncate, entire or bilipped. Seta massive. Capsule ovaoid-ellipsoidal; wall 4-10 layered; cells of outer layer with nodular thickenings on radial walls; inner layer with semi-annular thickenings. Spores smooth or rough. Elaters with uni-bi-spiral thickenings.

Type: Plagiochila (Dumort.) Dumort., *nom.cons.*

Key to the genera of the Plagiochilaceae

1. Leaves seccubous, distant to imbricate, dentate or rarely entire, rhizoids scanty to numerous on ventral stem surface.....*Plagiochila*
- 1a. Leaves opposite and slightly connate, branching predominantly intercalary-postical, rhizoids fasciculate, restricted near the base of the postical leaf.....*Plagiochilion*

Genus: *Plagiochila* (Dumort.) Dumort., *nom.cons.*

Plagiochila (Dumort.) Dumort., Recueil Observ. Jungerm.: 14. 1835.

Plants dark green to brownish green, suberect-erect from creeping rhizomes, branching intercalary, or rarely postical-intercalary. Stem in cross section differentiated into thick walled cortex and thin walled medulla regions. Rhizoids scattered, colourless. Leaves alternate, or moderately imbricate, oblong –ovate, sometimes orbicular, subquadrate or ligulate, decurrent antically and postically on the stem midline and never extend beyond, succubously inserted; margin variuously armed with marginal teeth, cilia, spines or lobe entire or retuse, leaf cells with thin or thick walls, basal cells usually larger, forming a distinct vita area in some species, trigones small to large; cuticle smooth. Underleaves absent or usually vestigial but sometimes large. Asexual reproduction by caducous or fragmentary leaves, or propagules. Male plants usually smaller than the female plants. Dioicous. Androecia terminal or lateral-intercalary, short to long spicate, bracts loosely to closely imbricate; antheridia 1-3 per bract. Gynoecia terminal on main shoot, with or without innovations, female bracts usually larger and more densely toothed than leaves; bracteole absent. Perianth laterally compressed, ovoid, cylindrical, campanulate, or cyathiform, mouth arched to truncate, usually spinose dentate; archeogonia 4-14 at the

base of perianth. Capsule ovoid, splitting into 4 valves; capsule wall 4-8 layered, usually thick walled. Spores usually unicellular, finely granulose, occasionally with precocious spore germination. Elaters large, bi-spiral.

Type: *Plagiochila asplenioides* (L.) Dumort.

Key to the species of the genus *Plagiochila*

1. Rhizoids numerous on ventral stem surface, teeth 16-34 per leaf, vitta cells strongly present, elongate..... *P. semidecurrans*
- 1a. Rhizoids scarce, vitta cells absent..... 2
2. Laves strongly caducous or fragmenting..... 3
- 2a. Laves persistent and non-fragmenting..... 4
3. Leaves strongly caducous, leaf apex slightly bilobed..... *P. defolians*
- 3a. Leaves fragmenting, leaf ape acute, 25-35 teeth per leaf..... *P. parvifolia*
4. Plants filiform, leaf apex bilobed..... *P. corticola*
- 4a. Plants not filiform, leaf apex acute..... 5
5. Leaves dentition 4-15 per leaf..... 6
- 5a. Leaves dentition 12-65 per leaf..... 9
6. Leaves teeth ciliate, falcate, upto 12 cells long..... *P. subtropica*
- 6a. Leaves teeth spinous, 1-8 cells long..... 7
7. Leaves apex bilobed, trigones minute..... *P. sciophila*
- 7a. Leaves apex not bilobed, trigones large, nodulose..... 8
8. Leaf dorsal base moderately decurrent, 4-7 teeth per leaf..... *P. hattorii*
- 8a. Leaf dorsal base long decurrent, 5-9 teeth per leaf..... *P. flexuosa*
9. Marginal teeth 7-15 per leaf, with two prominent large tooth, perianth campanulate, exserted, ventral keel narrowly winged..... *P. nepalensis*
- 9a. Marginal teeth 36-65 per leaf, 1-5 cells long, 1-2 cells broad..... *P. elegans*

Plagiochila semidecurrens (Lehm.et Lindenb.) Lehm.et Lindenb., Spec. Hepat. (fasc. 5): 142. 1843. (Plate 58. Figs. 1-14)

Plant large, plant branched, branching sparse, intercalary, brown in dry herbarium, 30-50 mm long, 3-5 mm wide including leaves. Rhizoids numerous on the ventral surface of the stem and sometime even on dorsal surface of the stem. Stem oval shaped, 0.4 x 0.5 mm in diameter, 16-22 cells across; 4-5 thick cortical cells, 9.9-22.1 µm long, 6.6-13.3 µm wide, medullary cells thin walled, 16.5-27.5 µm long and 13.2-22.0 µm wide. Leaves large, closely imbricate, orbicular-ovate to oblong-ovate, 2-2.7 mm long, 1.8-2.5 mm wide; dorsal leaf base moderately decurrent, ventral leaf base short decurrent, denticulate, dentition greatly varies, 16-30 (-34) teeth per leaf, 1-9 cells long, 1-3 (-4) cells at base; cells trigonous, bulging, nodulose, vita cells present and extend upto the middle of the leaves; apical cells 13.2-22.0 µm long, 8.8-16.5 µm wide, central cells 16.5-30.8 µm long, 11.-16.5 µm wide, vita cells 45-80.0 µm long, 13.2- 19.8 µm wide, rectangular. Male inflorescence intercalary, terminal, 5-7 pairs of male bracts, closely imbricate; spicate, denticulate, 6-9 teeth per male bract, orbicular-ovate, cells trigonous at the margin and basal part but trigones minute in the middle. Female inflorescence terminal, perianth campanulate, large, 5mm long, 2.5 mm broad (5mm wide when spread), denticulate, dentition upto 74 or more teeth per perianth, 1-10 cells long, 1-3 cells broad at base.

Habitat: Plants grows epiphytically on bark of trees with *Plagiochila* sp., *Bazzania* sp., *Lejeunea* sp., and Mosses at 2000-2750 m asl.

Range: Alaska, Bhutan, Sri Lanka, China, Indonesia, Japan, Korea, Nepal, Papua New Guinea, Philippines, Taiwan, Thailand, Vietnam, West Canada, India.

Distribution in India: *Eastern Himalayas:* Assam, Sikkim, West Bengal, Darjeeling, Meghalaya, Nagaland*.

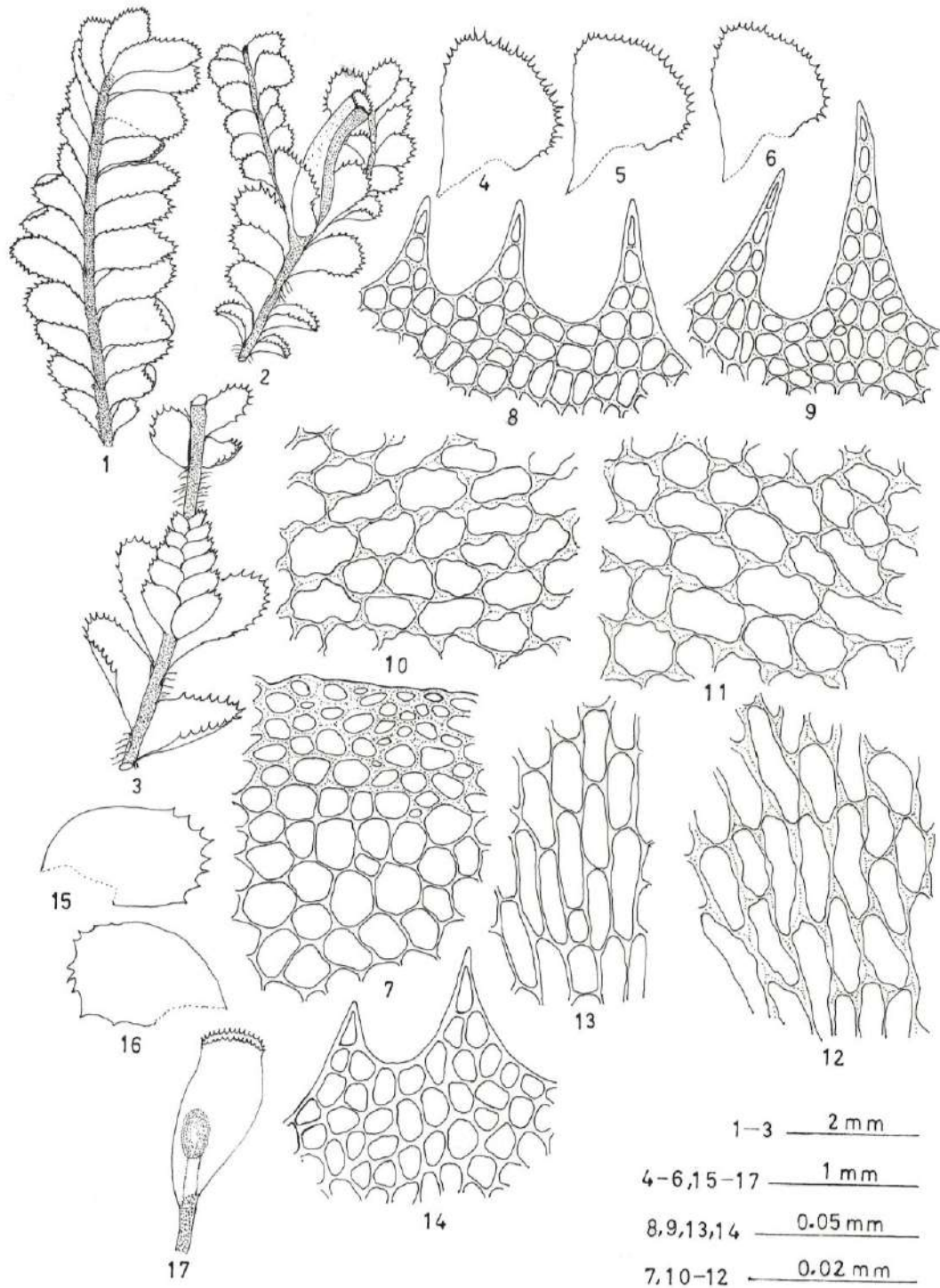


Plate 58. *Plagiochila semidecurrens* (Lehm.et Lindenb.) Lehm.et Lindenb., Figures

1-14.

Figs. 1. A portion of plant in ventral view; 2. Female plant; 3. Male plant; 4-6. Leaves; 7. A portion of stem in cross section; 8-9. Leaves apical cells; 10. Leaf median cells; 11. Leaf basal cells; 12-13. Leaf basal vitta cells; 14. Mela bract apical cells; 15-16. Male bracts; 17. Perianth.

Specimen examined: Nagaland; Kohima District: Khuzama : KE 10160: 16.11.2009:
Kazhuhrii Eshuo.

Plagichila defolians Grolle et M. L. So, Syst. Bot. 23: 459. 1999.

(Plate 59. Figs. 1-12)

Plants medium, light green to yellowish green or yellowish brown, brown in dry herbarium, 35-40 mm long, 2-3.5 mm wide including leaves, scarcely branched, branching intercalary, terminal; rhizoids scanty, confined at the basal part; rhizotomous stalk absent. Stem circular 0.19-0.26 mm in diameter, 12-14 cells across, cortical cells in 2-3 layer, thick-walled, 11-20 x 6-12 μm , medullary cells thin-walled, 14-20 μm ; stem paraphylla absent. Leaves distant to loosely imbricate, caducous, leaves denuded off leaving only scars, with few leaves at apex region, oblong-ovate, 0.9-1.3 mm long, 0.65-0.8 mm wide, widest in the middle; dorsal margin moderately decurrent, arched, ventral base shortly decurrent; leaves dentition 3-7 per leaf, present mostly at leaf apex, tooth spinose, 5-9 cells long, 3-5 uniseriate cells at apex, 2-4 cells broad at base; apical cells 25-35 x 8-18 μm , subapical cells 21-30 x 15-22 μm , median cells 19-30 x 14-24 μm , basal cells 24-37 x 16-25 μm , trigones small, thin-walled throughout, vitta cells absent; cuticle smooth. Oil bodies 5-11 per leaf, oval, spherical to ellipsoidal, 4-12 x 4-6 μm in diameter, finely segmented. Underleaves absent. Male inflorescence terminal or intercalary, closely imbricate, male bracts 7-11 pairs, spicate, apex dentate, 3-5 teeth per leaf, 1 androecium per bract. Gynoecia not seen.

Habitat: Plants grow on moist soils and rocks in association with *Heteroscyphus* sp., *Riccardia* sp., *Plagiochila* sp., *Bazzania* sp. and Mosses at 2000-2700 m at asl.

Range: India and China

Distribution in India: *Eastern Himalaya:* West Bengal-Darjeeling; **Nagaland***.

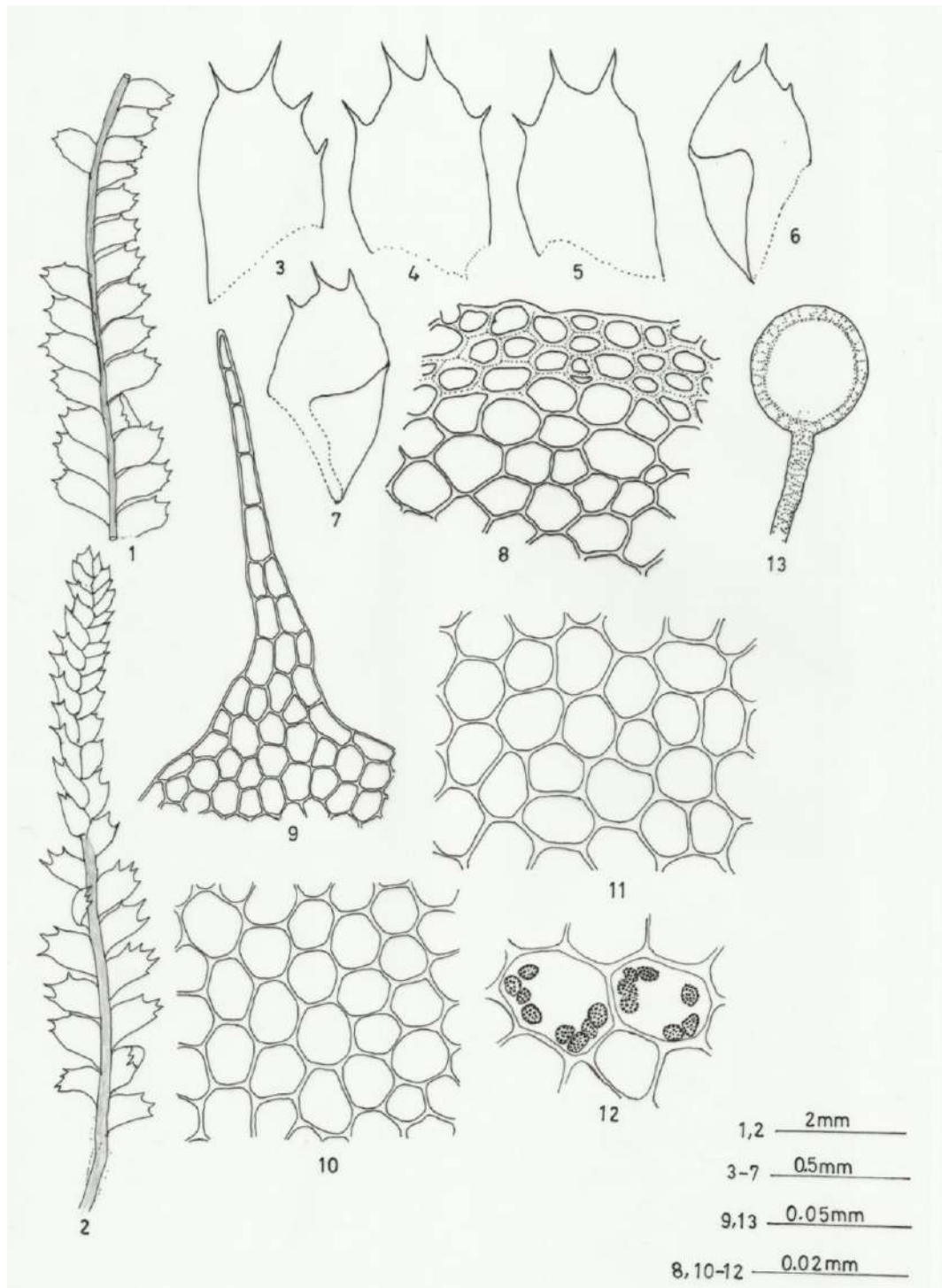


Plate 59. *Plagichila defolians* Grolle et M. L. So, Figures 1-12.

Figs. 1. A portion of plant with denuded leaves; 2. A male plant with terminal inflorescence; 3-5. Leaves; 6-7. Male bracts; 8. A portion of stem in cross section; 9. Leaf apical cells; 10. Leaf median cells; 11. Leaf basal cells; 12. Oil bodies.

Specimen examined: Nagaland: Kohima district: Khonoma: KE 10416: 19.03.2011:
Kazhuhrii Eshuo.

Plagiochila parvifolia Lindenb., Sp. Hepat. (*Plagiochila* fasc. 1): 28. 1839.

(Plate 60. Figs 1-10)

Plant medium to large, 15-35 mm long, 3-4 mm wide including leaves, light green to yellowish green; branched, branching intercalary, basal rhizotomous stalked present; rhizoids sparse, and at the basal rhizotomous stalk. Stem circular, 0.14 x 0.35 mm in diameter, 16-18 cells across, 3-4 thick cortical cells, 13.4-27.8 μm long, 8.7-17.6 μm wide, medullary cells thin walled 16.7-31.9 μm long, 13.2-22.0 μm wide. Stem paraphylla absent. Leaves closely imbricate, easily break off, oblong-ovate, triangulate, 1.4-1.8 mm long, 1.0-1.6 mm wide; decurrent, dorsal leaf base long decurrent, ventral leaf base short to moderate decurrent; apex rounded to truncate; margin denticulate, incurved, teeth present event upto the ventral surface, 7-13 teeth per leaf, present mostly at leaf apex; teeth spinose, 2 (-1)- 5 cells long, 1-3 uniseriate cells at apex, 1-3 cells broad at base; cells trigonous, trigones tri-radiate to bulging; apical leaves cells 17.8-35.2 μm long, 11.5-19.8 μm wide, sub-apical cells 22-31.5 μm long, 14.3-22.4 μm wide, middle cells 20-31.2 μm long, 16.1-22.9 μm wide, basal cells 22-44.0 μm long, 18-29.7 μm wide, thin walled. Vita cells absent; underleaves absent. Sporophyte no seen.

Habitat: Plants grows on bark of trees (corticolous) in association with *Lejeunea* sp., *Frullania* sp., *Plagiochila* sp. and Mosses at 1500-2500 m asl.

Range: India, China, Bangladesh, Bhutan, Japan, Java, Korea, Myanmar, Papua New Guinea, Sri Lanka, Thailand, Philippines, Vietnam, N. America.

Distribution in India: *Eastern Himalaya:* Assam, Manipur, Meghalaya, Sikkim, West Bengal, **Nagaland***.

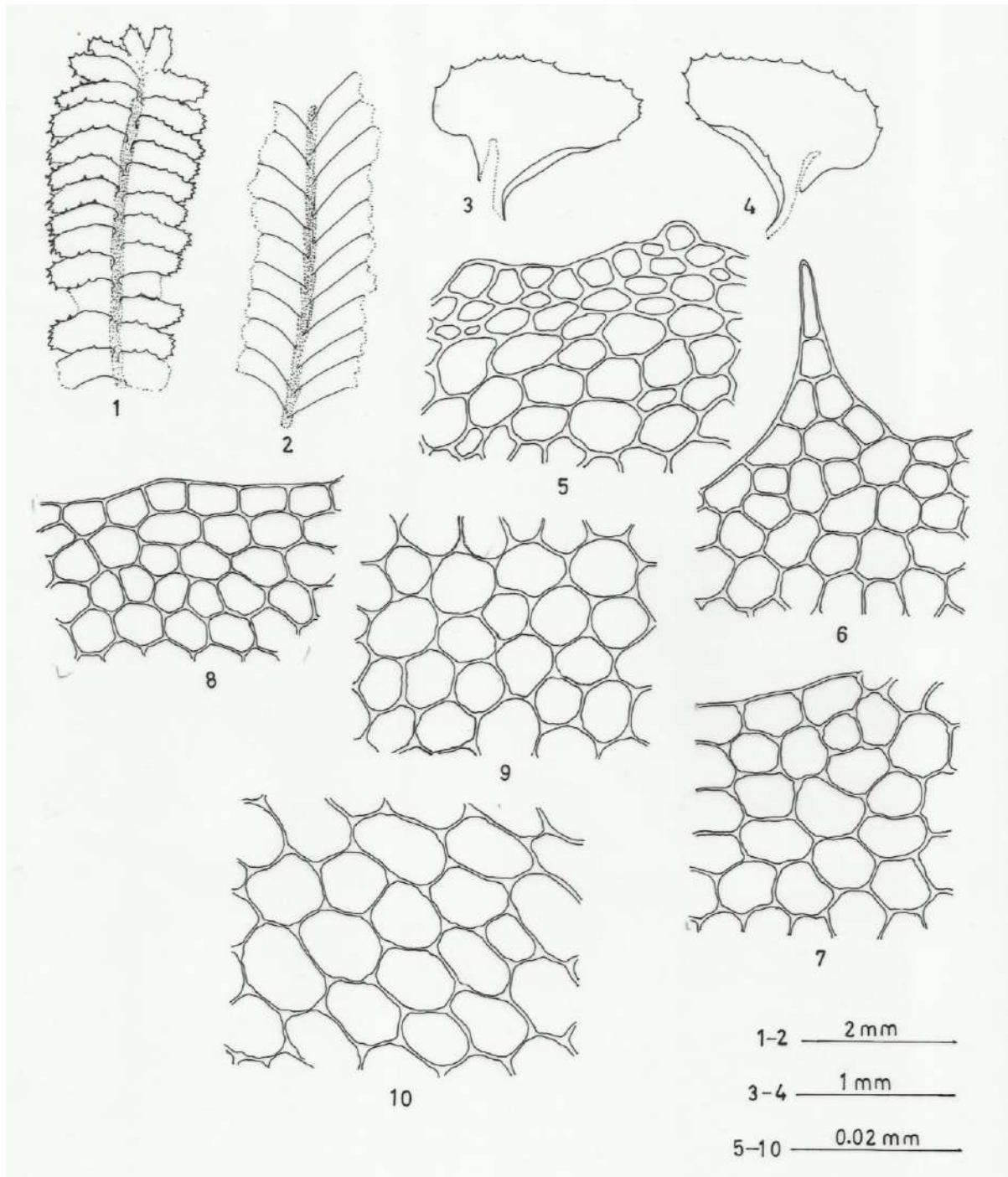


Plate 60. *Plagiochila parvifolia* Lindenb., Figures 1-10.

Figs. 1. A portion of plant in ventral view; 2. A portion of plant with fragmented leaves apical portion; 3-4. Leaves; 5. A portion of stem in cross section; 6. Leaf apical cells; 7. Leaf cells at apical region; 8. Leaf marginal cells; 9. Leaf median cells; 10. Leaf basal cells.

Specienn examined: Nagaland: Kohima District: Kohima: KE 10252: 06.08.2010: Kazhuhrii Eshuo; Khuzama: KE 10089: 01.06.2009: Kazhuhrii Eshuo.

Plagiochila corticola Steph., Mem. Soc. Sci. Nat. Cherbourg **29**: 229. 1847.

(Plate 61. Figs. 1-10)

Plant light green to yellowish green, light brown in dry herbarium, small, 20-30 mm long, 1.5-2 mm wide including leaves, branched, branching intercalary, terminal. Stem oval, 0.17 x 0.12 mm in diameter, 9-10 cells across; 2 thick cortical cells, 12.1-22.0 μm long, 8.8-15.4 μm wide; medullary cells thin walled, larger than the cortical cells, 16.5-27.5 μm long, 12.3-19.8 μm wide. Leaves distant, rarely imbricate, alternate, rectangulate, oblong, apex acuminate, 1-12 mm long, 0.4-0.6 mm wide; bilobed, denticulate, 3-5 dentition at apex; tooth cells 3 (2)-10 cells long, 2-7 cells broad at base, 1-2 uniseriate cells at apex; leaves cells thin walled, rectangulate, trigones minute to tri-radiate; apical cells 22-47.5 μm long, 8-14.5 μm wide; middle cells 22-37.5 μm long, 13.2-22.0 μm wide; basal cells 25.5-43.6 μm long, 13.2-24.1 μm wide. Oil bodies elongate, elliptical, 5-9 per cell, 3-7.5 μm long, 2-3.5 μm wide. Stem paraphylla and underleaves absent. Sporophytes no seen.

Note: Srivastava S. C and Rawat 2007 reported *P. corticola* with numerous rhizoids on the ventral surface. But the specimen which was collected from Khuzama has not seen the occurrence of rhizoids on the ventral surface.

Habitat: Plants grows epiphytically on the bark of trees (corticolous) along with *Plagiochila* sp., *Ptychanthus striatus*, *Bazzania* sp., *Drepanolejeunea* sp. and Mosses at 2000-2750 m asl.

Range: India, Bhutan, China, Nepal.

Distribution in India: *Eastern Himalaya*: Sikkim, West Bengal, Nagaland*.

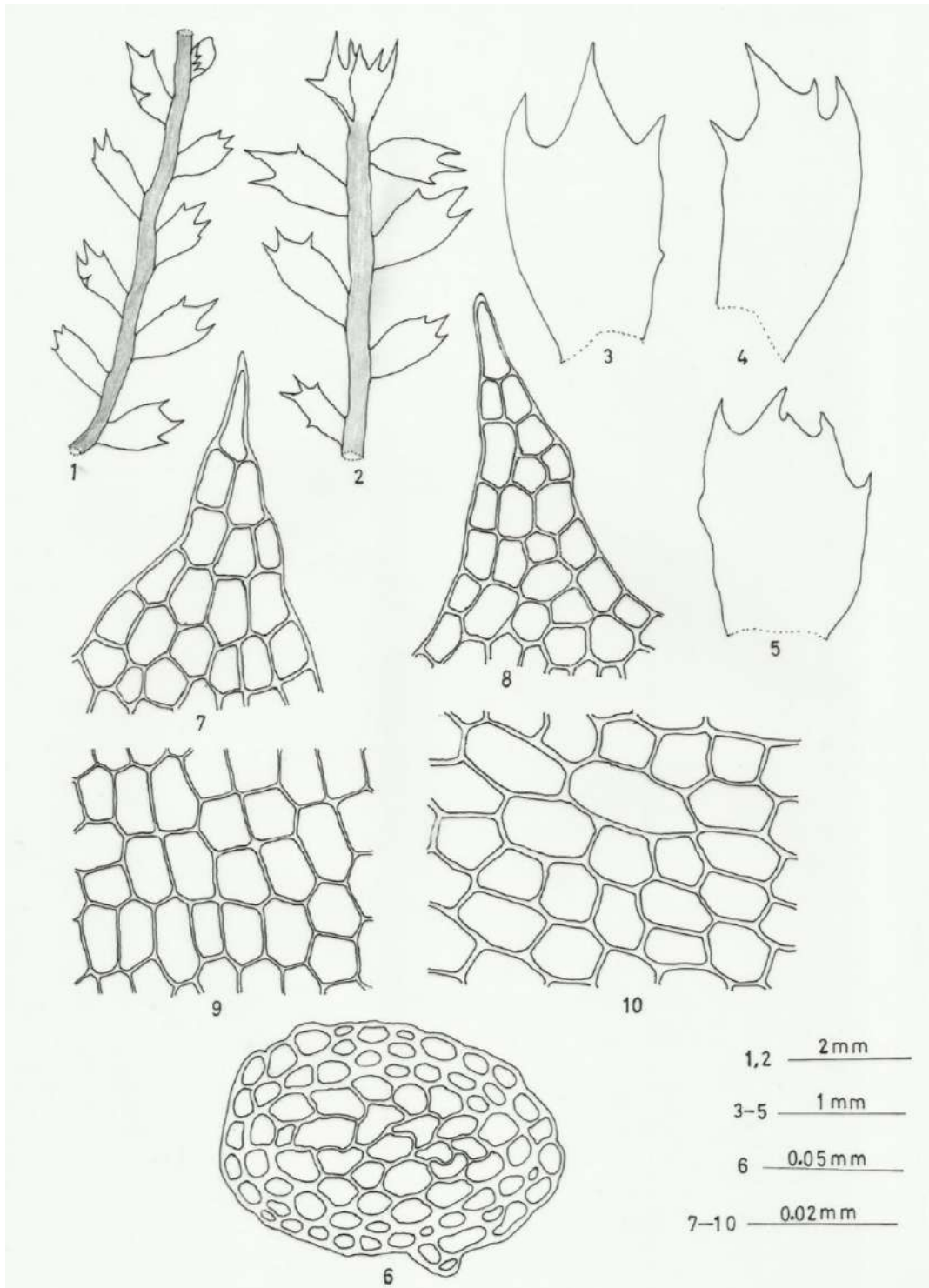


Plate 61. *Plagiochila corticola* Steph., Figures 1-10.

Figs. 1-2. A portion of plants in ventral view; 3-5. Leaves; 6. Cross section of stem; 7-8. Leaves apical cells; 9. Leaf median cells; 10. Leaf basal cells.

Specimen examined: Nagaland: Kohima District: Khuzama: KE 10156: 16.11.2009:
Kazhuhrii Eshuo.

Plagiochila subtropica Steph., Bull. Soc. Roy. Bot. Belgique (1899) 38, Mén. 46.

1900.

(Plate 62. Figs. 1-12)

Plants large, light brownish green to green, in dry herbarium dark brownish to blackish green, upto 25-40 mm long, 3-4 mm wide including leaves, branched, branching intercalary, terminal, pseudodichotomous type. Stem 220 x 250 µm in diameter, 16-17 cells across, cortex in 2-3 thick walled, light brown, 9-19 x 6-14 µm; medullary cells thin walled, 18-32 x 13-25 µm; creeping rhizome present; rhizoids absent on ventral surface of the stem, present on rhizome; paraphylla absent. Leaves closely imbricate, oblong-ovate, triangular, frequently fragmenting, 1.7-2.4 mm long, 1.5-2.4 mm wide at the base; dorsal leaf base long decurrent, covering the stem surface, ventral base short decurrent, dorsal margin falcate, strongly arched; leaf apex truncate, ventral margin almost straight, leaf denticulate, dentition 9-12 per leaf, mostly present at apex, ciliate, 2-12 cells long, 1-3 cells broad at base, 4-9 (-10) uniseriate cells at apex; apical cells distinctly elongated, 48-77 x 8-12 µm; sub-apical cells 21-30 x 14-28 µm; median cells 21-41 x 19-30 µm, basal cells 23-47 x 22-32 µm, cells thin walled; trigones large, nodulose, bulging; vitta cells and underleaf absent. Male inflorescence terminal or intercalary on main shoot or short lateral branched, bracts in 4-6 pairs, closely imbricate, strongly saccate at base, with 6-8 ciliate teeth; antheridia 1-2 per bract. Female inflorescence and sporophytes not seen.

Habitat: Plants grows epiphytically on the bark of tree (corticolous) along with *Plagiochila parvifolia*, *Lejeunea* sp., *Frullania* sp., and Mosses at 1500-1700 m asl.

Range: China, Bhutan, Nepal, Thailand and India.

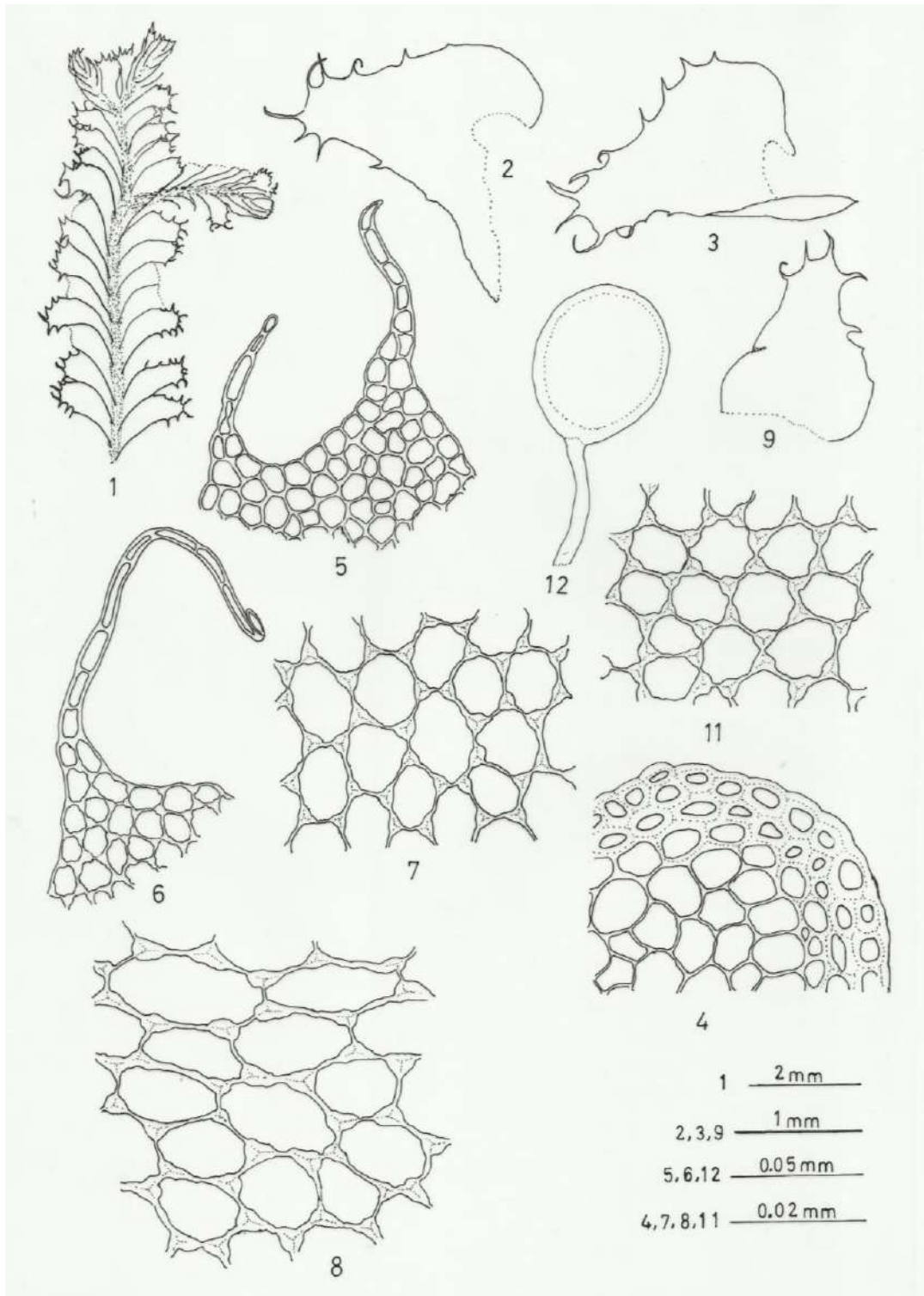


Plate 62. *Plagiochila subtropica* Steph., Figures 1-12.

Figs. 1. A portion of plant in ventral view; 2-3. Leaves; 4. A portion of stem in cross section; 5-6. Leaves apical cells; 7. Leaf median cells; 8. Leaf basal cells; 9. Male bract; 11. Male bract median cells; 12. Antherium.

Distribution in India: *Eastern Himalaya:* Arunachal Pradesh; Sikkim; West-Bengal-Darjeeling; **Nagaland***; *South India:* Kerala; Tamil Nadu.

Specimen examined: Nagaland: Kohima district: Khuzama: KE 10089B: 01.06.2009: Kazhuhrii Eshuo.

Plagiochila sciophila Nees ex Lindenb., Sp. Hep. (*Plagiochila* fasc. 2-4): 100 (1840).

(Plate 63. Figs. 1-14)

Plant medium, light green to light yellowish green, 20-35 mm long, 2-3 mm wide including leaves, branched, branching intercalary, or rarely terminal; pale brown in dry herbarium. Stem circular, 0.2 x 0.26 mm in diameter, 12-14 cells across, cortical cells in 2-3 layers, thick walled, 9.9-29.7 μm long, 6-17.5 μm wide; medullary cells thin walled the basal part of the stem. Leaves imbricate, rectangulate, oblong-ovate, 1.4-2.0 mm long, 0.9-1.3 mm wide; dorsal leaf base moderate decurrent, ventral leaf base short decurrent; denticulate, teeth 7-10 per leaf, teeth present mostly at leaves apex and on ventral margin, 4-12 cells long, 2-6 cells broad at base, 3-5 uniseriate cells at apex, tooth spinose; cells non-trigonous, pentagonal-hexagonal shape, basal cells slightly trigonous, trigones tri-radiate, minute; apical cells 17.6-37.4 μm long, 11-22.0 μm wide, middle cells 22-36.4 μm long, 19.8-27.5 μm wide, basal cells 28.6-43.5 μm long and 22.4-30.8 μm wide. Male and female plant no seen.

Habitat: Plants grows on soils (terricolous) and on barks of trees (corticolous) in association with *Heteroscyphus* sp., *Jungermannia* sp., *Lophocolea* sp. and Mosses at 1600-2300 m asl.

Range: Bhutan, China, Indonesia, Japan, Korea, Malaysia, Nepal, Eastern North America, Pakistan, Papua New Guinea, Samoa, Thailand, Philippines, Vietnam and India.

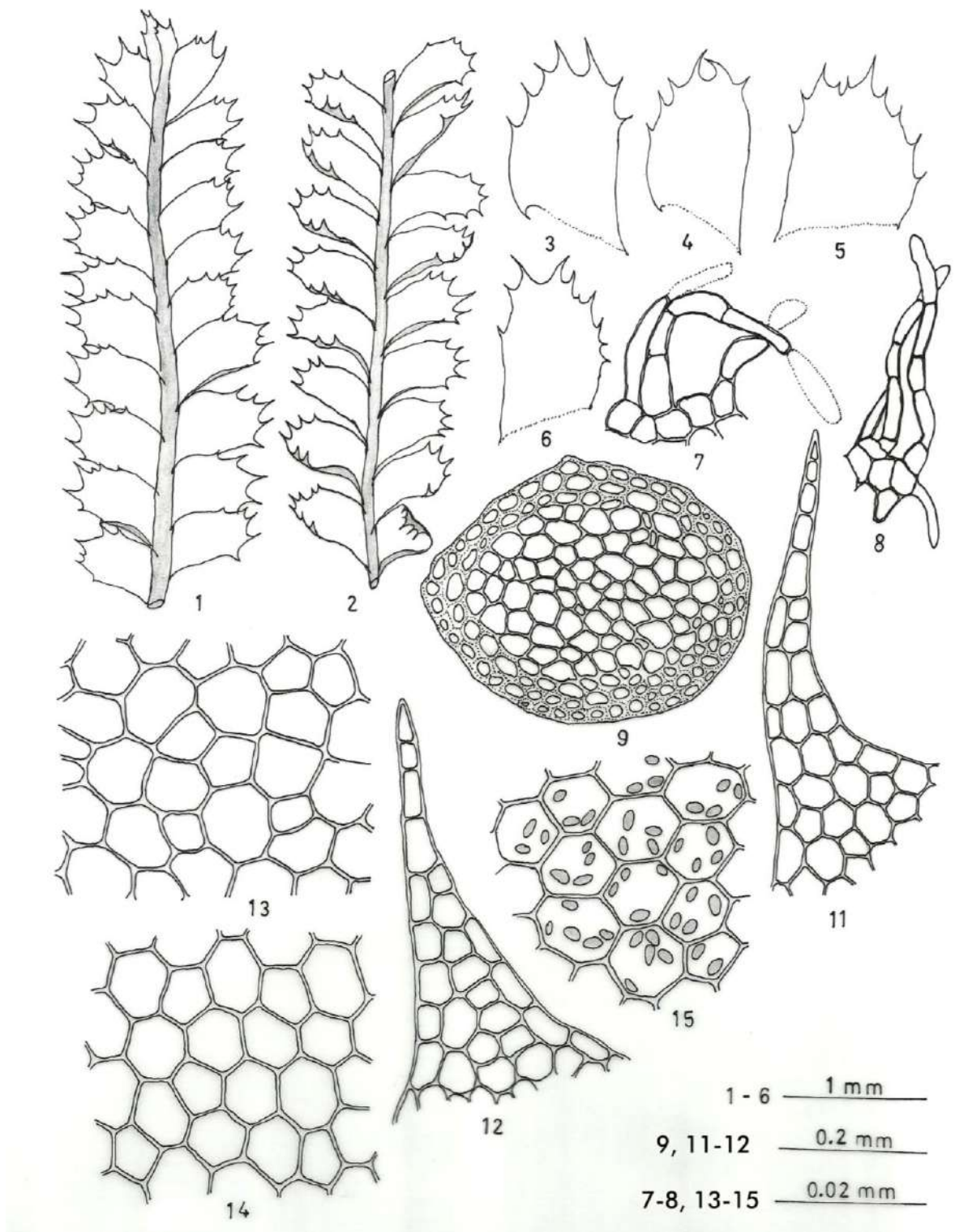


Plate 63. *Plagiochila sciophila* Nees ex Lindenb., Figures 1-14.

Figs. 1-2. A portion of plants in ventral view; 3-6. Leaves; 7-8. Underleaves; 9. Cross section of stem; 10-11. Leaves apical cells; 13. Leaf median cells; 14. Leaf basal cells.

Distribution in India: *Eastern Himalaya:* Assam; Sikkim; Meghalaya; West Bengal-Darjeeling, **Nagaland***; *Western Himalaya;* Uttaranchal; *South India:* South Andaman; Kerala; Tamil Nadu.

Specimen examined: Nagaland: Kohima District: Khuzama: KE 10175, KE 10192: 16.11.2009: Kazuhrii Eshuo.

Plagiochila hattorii Inoue, Bull. Nat. Sci. Mus., Tokyo, ser. B (Bot.) 2(3): 69 (1979).

(Plate 64. Figs. 1-11)

Plant medium, green to deep green, 30-52 mm long, 1-3 mm wide including leaves, branched, branching intercalary, rarely terminal. Stem circular, 0.18-0.25 mm in diameter, 15-16 cells across; 2-3 thick cortical cells, 6.9-15.3 μm long, 5.5-10 μm wide; medullary cells thin walled, larger than the cortical cells, 16.3-22.4 μm long, 7.5-18.3 μm wide. Rhizoids scarce, which are confined at the basal portion of the stem. Leaves imbricate, oblong-ovate, ligulate, triangulate, 1.7-1.9 mm long, 1.1-1.3 mm wide; moderate decurrent on the dorsal leaf base, shortly decurrent on ventral surface; denticulate, teeth confined at the leaves apex, 3-6 teeth per leaf, 2-4 cells long, 1-3 cells broad at base; cells trigonous, trigones tri-radiate to minute; apical cells 15.4-224.3 μm long, 13-21.5 μm wide, middle cells 17.6-32.2 long, 13.2-20.0 μm wide, epidermal cells 15-29.6 μm long, 11.6-20.0 μm wide, basal cells 29.6-40.8 μm long, 20-25.3 μm wide. Leaves oil bodies circular, elliptical medium, 5-9 per cells, 3.5-9.5 μm long and 3.3-4.5 μm wide. Stem paraphylla and underleaves absent. Sporophytes no seen.

Habitat: Plants grows on rocks (Saxicolous) and bark of trees (corticolous) in association with *Metzgeria* sp., *Lejeunea* sp., *Frullania* sp., *Heteroscyphus* sp. and Mosses.

Range: India and Japan

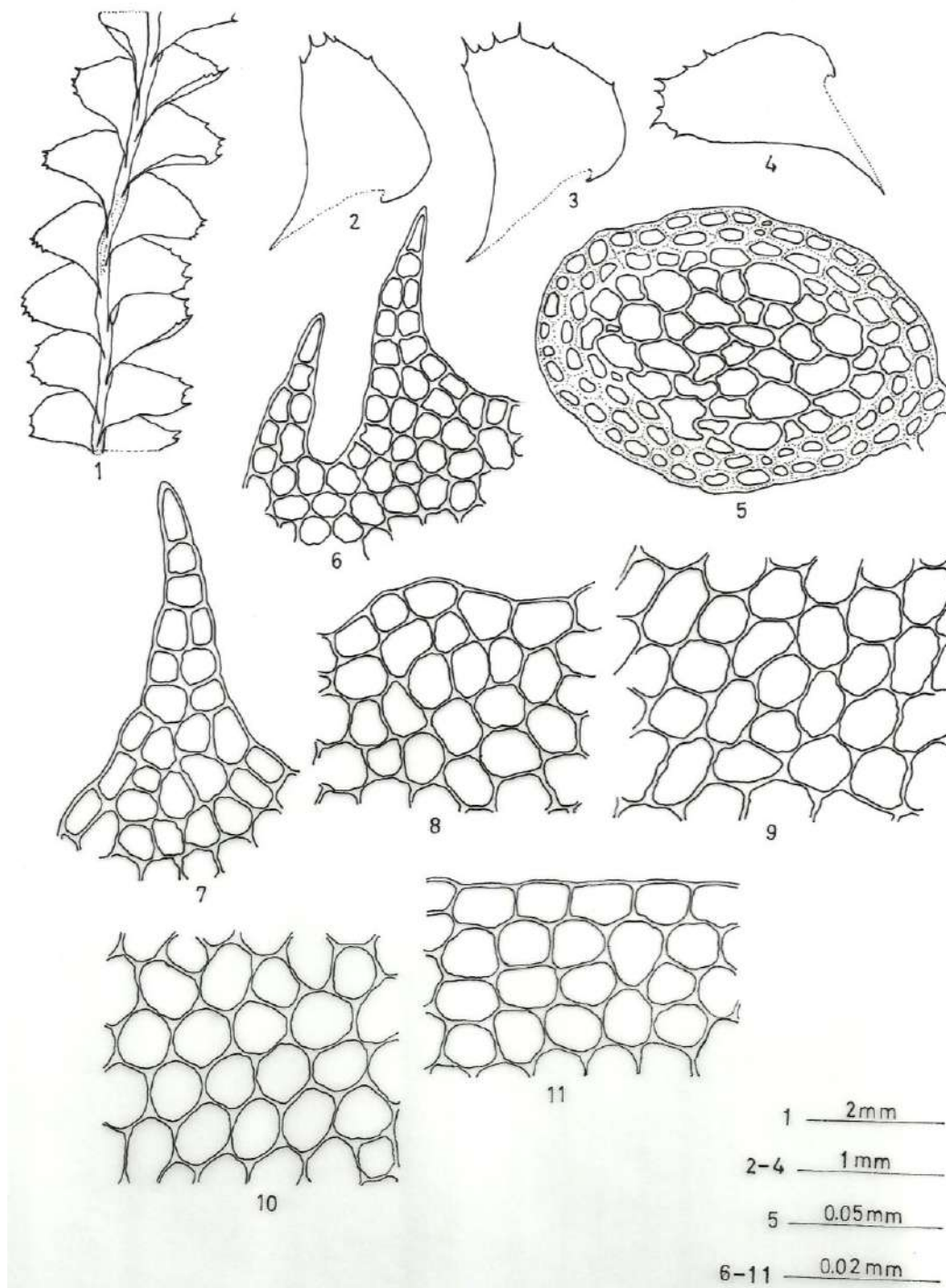


Plate 64. *Plagiochila hattorii* Inoue, figures 1-11.

Figs. 1. A portion of plant in dorsal view; 2-4. Leaves; 5. Cross section of stem; 6-7. Leaves apical cells; leaf cells near the apical region; 9. Leaf basal cells; 10. Leaf median cells; 11. Leaf marginal cells.

Distribution in India: *Eastern Himalaya:* Meghalay and **Nagaland***.

Specimen examined: Nagaland: Kohima district: Kohima-Lower A.G. Colony: KE 10227: 09.03.2010: Kazhuhrii Eshuo; Nerhema: KE 10311: 07.06.2010: Kazhuhrii Eshuo.

Plagiochila flexuosa Mitt., J. Proc. Linn. Soc., Bot. 5: 94. 1860.

(Plate 65. Figs. 1-10)

Plants brown in dry herbarium, upto 60 mm long, 3-4.5 mm wide including leaves, rarely branched, branching lateral-intercalary, creeping rhizomes absent. Stem 0.19-0.25 mm in diameter, cortical cells in 2-3 layer, thick-walled, 16-28 x 7-17 μm , medullary cells thin-walled, 24-46 x 22-29 μm ; rhizoids scanty on aerial shoot. Leaves loosely imbricate, contiguous, oblong-ovate, 1.6-2 mm long, 1-1.4 mm wide, widest at base, dorsal base moderate to long decurrent; ventral base shortly decurrent, not amplicate, margin entire, apex rounded; leaves dentition 5-8 per leaf, tooth spinose, 2-9 cells long, 2-4 uniseriate cells at apex, 1-4 cells broad at base; apical cells 18-35 x 8-18 μm , subapical cells 22-38 x 13-22 μm , median cells 27-38 x 16-25 μm , basal cells 30-48 x 22-30 μm , cells trigones, trigones nodulose, large; vitta cells absent, cuticle smooth. Underleaves absent. Androecia and gynoecia not seen.

Habitat: Plants grow on bark (corticolous) in association with *Frullania* sp., *Lejeunea* sp., *Ptychanthus* sp. and Mosses at 1500-1700 m asl.

Range: India, China, Japan, Bhutan, Nepal, Vietnam, Thailand and Sri Lanka.

Distribution in India: Eastern Himalay: Meghalya-Shillong; Sikkim-East district; West Bengal-Darjeeling; **Nagaland***. South India: Karnataka; Kerala; Tamil Nadu.

Specimen examined: Nagaland: Kohima district: Kigwema: KE 10229: 08.08.2010: Kazhuhrii Eshuo.

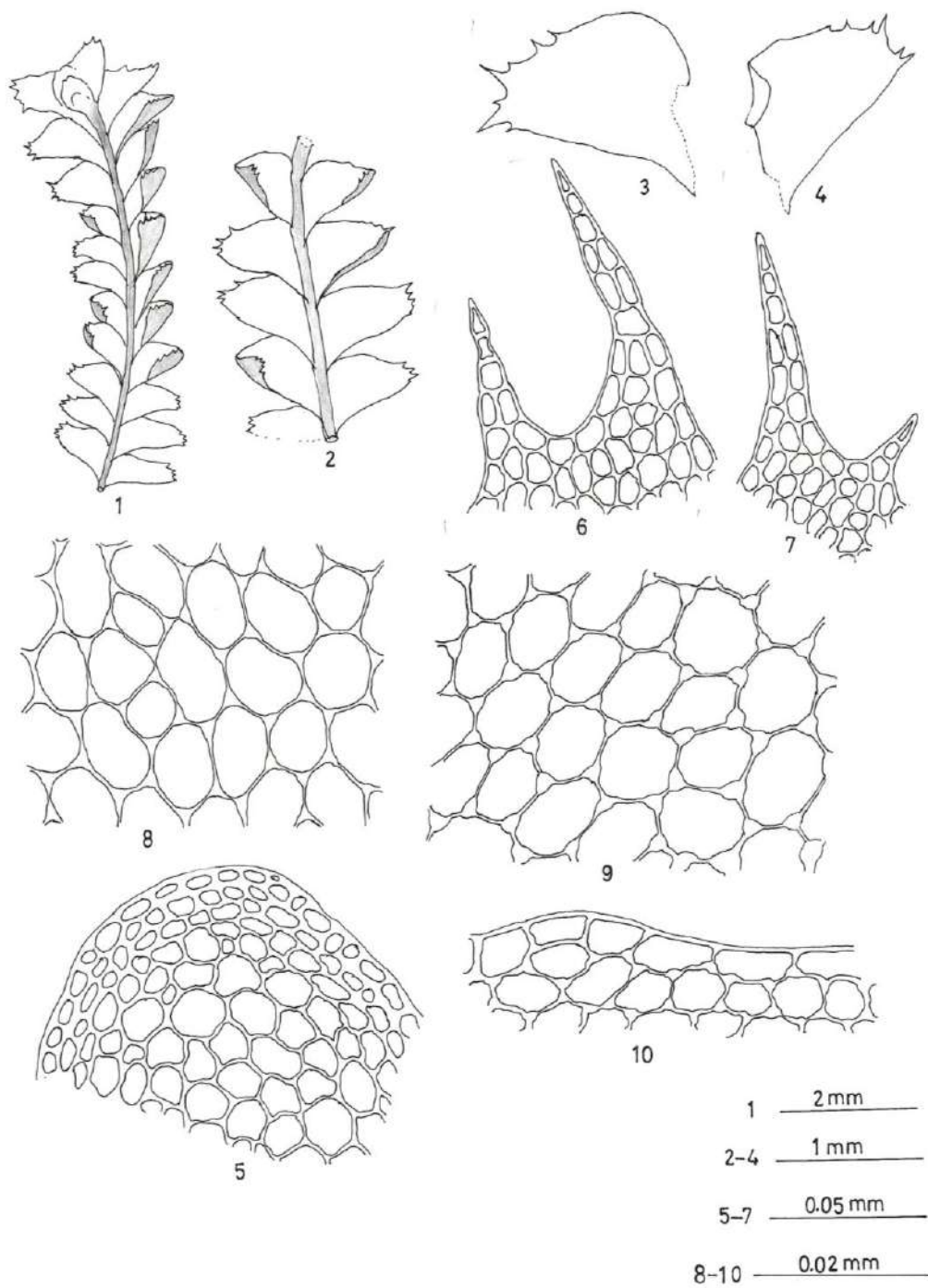


Plate 65. *Plagiochila flexuosa* Mitt., figures 1-10.

Figs. 1-2. A portion of plants in dorsal view; 3-4. Leaves; 5. A portion of stem in cross section; 6-7. Leaf apical cells; 8. Leaf median cells; 9. Leaf basal cells; 10. Leaf marginal cells.

Plagiochila nepalensis Lindenb., Sp. Hepat. (*Plagiochila* fasc. 2-4): 93. 1840.

(Plate 66. Figs. 1-12)

Plant medium to large, erect to prostrate, yellowish green to light green, branched, branching intercalary, terminal, 20-48 mm long, 3-4.5 mm wide including leaves. Rhizotomous branched absent or present, if present the plant arise from the rhizotomous stalked, rhizoids scarce and confined at the base of the rhizotomous stalk. Stem circular to oval, 0.41 x 0.52 mm in diameter, 20-22 cells across, 3-5 thick cortical cells, 4.5-17.5 μm long, 4-13.3 μm wide, medullary cells thin walled, 12-24.2 μm long, 10-18.6 μm wide. Stem paraphylla and underleaves absent. Leaves closely imbricate, oblong-ovate, 2-2.5 mm long, 1.5-2.1 mm wide; dorsal leaf base short decurrent, ventral leaf base short decurrent, ventral margin prominently arched, apex rounded-truncate, ventral base amplicate; teeth 12-15 (19) per leaf, present at apex and ventral margin, spinose, 2-9 cells long, 2-4 cells broad at base, 2-3 uniserriate cells at apex; cells trigonous, trigones nodulose, bulging; apical cells 16.5-44.0 μm long, 12.1-22.0 μm wide, medium cells 16.7-39.6 μm long, 14.5-27.5 μm wide, basal cells 24.2-48.6 μm long and 15.4-28.4 μm wide; vita cells absent; underleaves absent. Oil bodies circular, elongate, small, (-3) 5-7 per cell, 3.5-10.0 μm long, 3-5.5 μm wide. Male inflorescence terminal, male bracts closely imbricate, smaller than the usual leaves, 0.9-1.4 mm long, 0.77-1.0 mm wide; 6-9 pairs of bracts, spicate, inflated; apical cells 17.6-30.8 μm long, 12-22.0 μm wide, middle cells 16.5-39.6 μm long, 12-22.0 μm wide, basal cells 26.4-44.0 μm long and 16.5-27.5 μm wide; antheridia 1-3 per bract. Female inflorescence terminal; bracts 1 pair, similar or slightly larger than the vegetative leaves; perianth campanulate, strongly dentate, keel without wing, large; sporophyte no seen.

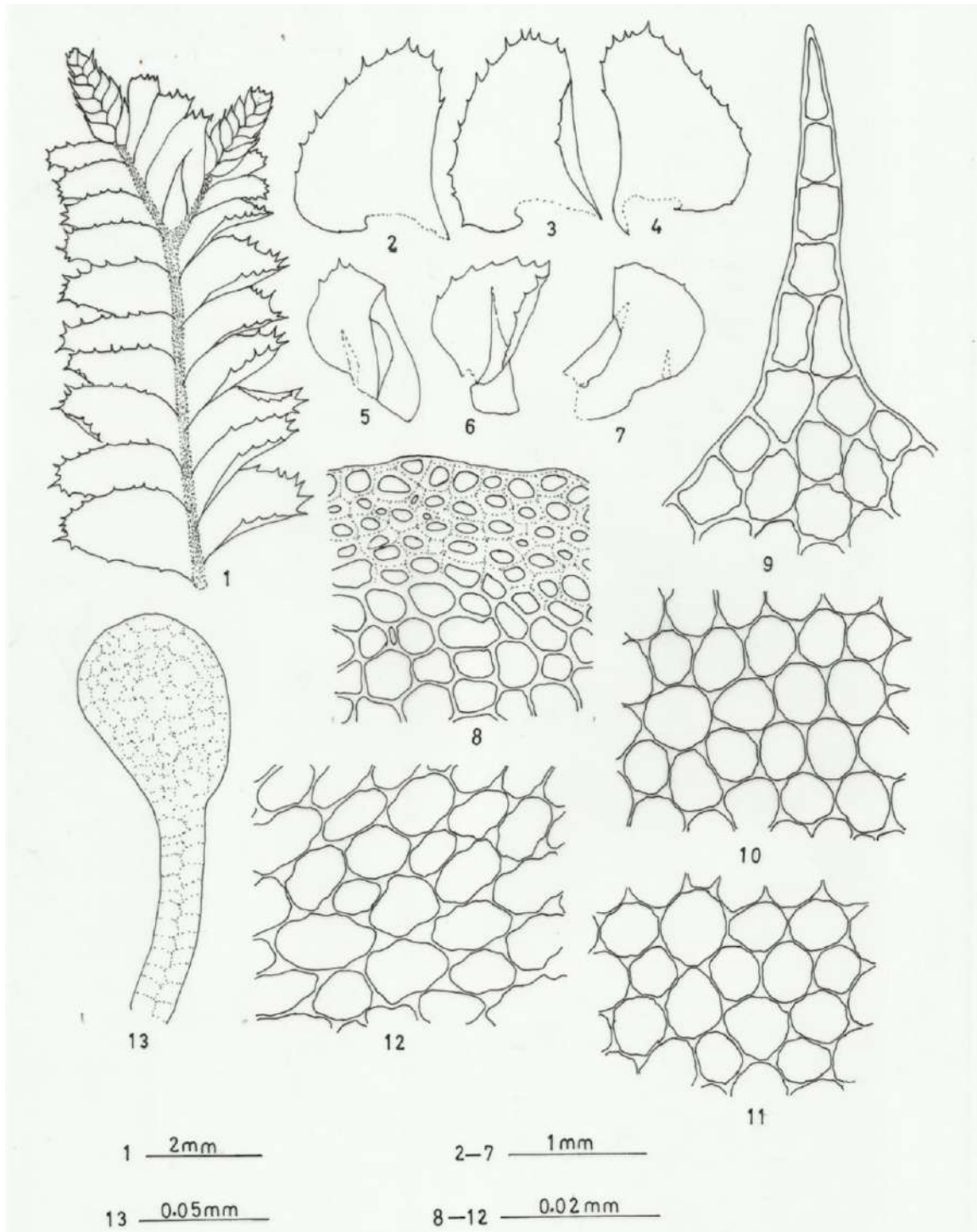


Plate 66. *Plagiochila nepalensis* Lindenb., Figures 1-12.

Figs. 1. A portion of male plant in dorsal view; 2-4. Leaves; 5-7. Male bracts; 8. A portion of stem in cross section; 9. Leaf apical cells; 10. Leaf median cells; 11. Male bract median cells; 12. Leaf basal cells; 13. Antheridium.

Habitat: Plants grows on barks of trees (corticolous) and on rocks (saxicolous) in association with *Plagiochila* sp., *Ptychanthus* sp., *Heteroscyphus* sp., *Lejeunea* sp., *Bazzania* sp. and Mosses at 1600-2700 m asl.

Range: Bhutan, China, Japan, Myanmar, Nepal, Philippines, Thailand, Vietnam and India.

Distribution in India: *Eastern Himalaya:* Assam, Meghalaya, Sikkim, West Bengal, Darjeeling, **Nagaland***; *Western Himalaya:* Himachal Pradesh, Shimla, Uttaranchal; *South India:* Karnataka, Kerala, Tamil Nadu. Palni Hills, Madurai. Kodaikanal.

Specimen examined: Nagaland: Kohima district: khuzama: KE 10158, KE 10159: 16.11.2009: Kazhuhrii Eshuo; Mokokchung District: Longkhum: KE 10146: 12.09.2009: Kazhuhrii Eshuo.

Plagiochila elegans Mitt., J. Proc. Linn. Soc. Bot. 5: 97. 1860. (**Plate 67. Figs. 1-9**)

Plants light green to deep green, robust, 60-80 mm long, 5-9 mm wide including leaves, mostly simple, sparingly branched, branching lateral intercalary, creeping rhizome present; rhizoids scanty on aerial shoot and mostly confined on the rhizotomous stem. Stem circular, green, 0.5-0.6 mm in diameter, cortex in 2-3 cells layer, thick walled, 19-32 x 11-22 μm , medullary cells thin-walled, 20-40 x 16-33 μm ; dorsal stem surface exposed, ventral surface almost completely hidden. Leaves closely imbricate to moderately imbricate, slightly membranous in texture, horizontally spreading, broadly oblong to ovate, 3-4.6 mm long, 3.2-4 mm wide, dorsal margin recurved, base moderately decurrent, ventral base shortly decurrent, amplicate at base, ventral margin arched; whole leaf surface densely spinosely toothed, teeth 36-67 per leaf, 1-4 cells long, 1-2 cells broad at base, terminal leaf cells 28-35 x 10-14 μm , subapical cells 34-42 x 22-34 μm , median cells 32-40 x 22-45 μm , subquadrate to pentagonal, trigones small, tri-radiate or triangular; basal cells 46-96 x

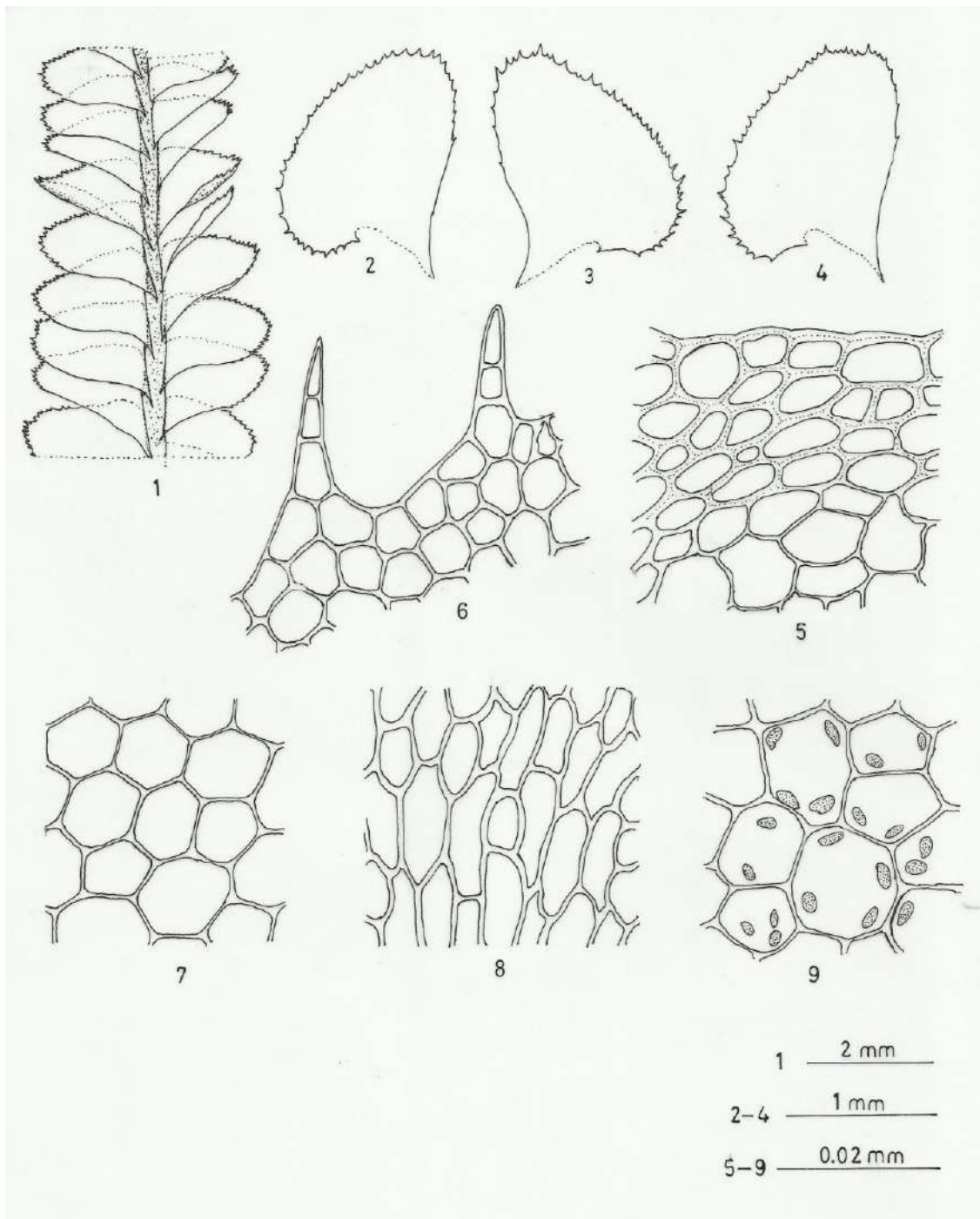


Plate 67. *Plagiochila elegans* Mitt., Figures 1-9.

Figs. 1. A portion of plant in dorsal view; 2-4. Leaves; 5. A portion of stem in cross section; 6. Leaf apical cells; 7. Leaf median cells; 8. Leaf basal cells; 9. Oil bodies.

19-35 μm , basal cells elongate, rectangular, trigones small, thin-walled; cuticle smooth. Oil bodies 2-5 per cell, ovular, spherical, 4-10 μm in diameter, finely segmented. Underleaves and stem paraphylla absent. Androecia and gynoecia not seen.

Habitat: Plants grow on moist rocks (saxicolous), soils (terricolous) in association with *Conocephallum* sp., *Heteroscyphus* sp., *Lophocolea* sp., *Plagiochila* sp. and Mosses at 1700-2000 m asl.

Range: India, China, Bhutan, Nepal, Taiwan.

Distribution in India: *Eastern Himalaya:* Assam; Sikkim; West Bengal-Darjeeling, Nagaland*; *South India:* Karnataka; Tamil Nadu- Ootacamund.

Specimen examined: Nagaland: Kohima district: Khonoma: KE 10418: 19.03.2011: Kazhuhrii Eshuo.

Gneus: *Plagiochilion* S. Hatt.

Plants medium, light brownish green to pale green, brown in dry herbarium, branched, branching postical intercalary, rarely terminal; stem differentiated into cortex and medulla regions. Leaves approximate to distant, opposite, which are postically united at the base, connate, orbicular, ovate to ovate-oblong, entire or minutely dentate, non-decurrent or decurrent at leaves base; leaf cells thin or thick walled, apical and marginal cells usually thick wall with or without trigones, basal cells trigonous, nodulose. Under absent or vestigial in some species. Rhizoids usually fasciculate near the postical base of the leaf; flagelliform shoots present. Dioicous. Male plants usually smaller than the female plant, terminal or intercalary on the stem; bracts strongly saccate, 3-7 pairs; antheridia single per bract. Female inflorescence always terminal on main stem or short lateral branched, with 1-2 subfloral innovations, bracts entire, or irregularly dentate; perianth cylindrical, campanulate, mouth truncate,

irregularly dentate or entire; spores globose, minute papillae on the surface; elaters with bi-spiral thickenings.

Plagiochilion mayebarae S. Hatt., J. Hattori Bot. Lab. 3: 39. 1950.

(Plate 68 & 69. Figs. 1-9 & 1-18)

Plants medium, light green to dull green, brownish green, in dry herbarium blackish brown, 30-45 mm long, 2-3.5 mm wide including leaves, slightly to closely appressed to the stem; branched, branching of postical intercalary, stolons frequent. Stem reddish brown, circular-oval, 2.5 x 3.5 mm in diameter, 12-15 cells across, 3 thick brownish cortical cells, medullary cells thin walled. Rhizoids in fasciculate at the base of the leaves. Leaves slightly imbricate to contiguous, distant, opposite, slightly connate at base, orbicular, ovate, 1.2-1.4 mm long, 1-2 mm wide, not decurrent, margin entire or minutely dentate, 3-5 teeth at leaf apex, 2-4 cells long, 3-4 cells wide at base; leaf cells thin or thick walled, apical cells thick walled, 10-20 μm long, 6-15 μm , trigone minute; median cells 17-34 μm long, 15-23 μm wide, thin wall, trigonous; basal cells 22-36 μm long, 15-27 μm wide, thin walled, trigonous, nodulose, and intermediate thickening present. Underleaves absent. Male plant not seen. Female inflorescence terminal on main stem or on short lateral branched, bracts one pair, oblong-ovate, 1.3-1.8 mm long and 1.2-1.8 mm wide; apex irregularly dentate, tooth 2-4 (-6) cells long, 2-4 cells wide; basal cells trigonous, nodulose, 24-55 μm long, 15-27 μm wide, rectangular; median and apical cells like the lateral leaf cells. Perianth campanulate, 1.6 x 2.5 mm in diameter, mouth irregularly dentate, truncate; spores brownish red, small, circular, spherical, 16 x 18 μm in diameter, globose, granulate, papillate; elaters 131-220 μm long, 7-10 μm in diameter, bi-spiral.

Habitat: Plants grow on bark of trees (corticolous) in association with *Plagiochila* sp., *Bazzania* sp., *Lejeunea* sp., *Ptychanthus* sp. and Mosses at 2000-2750 m asl.

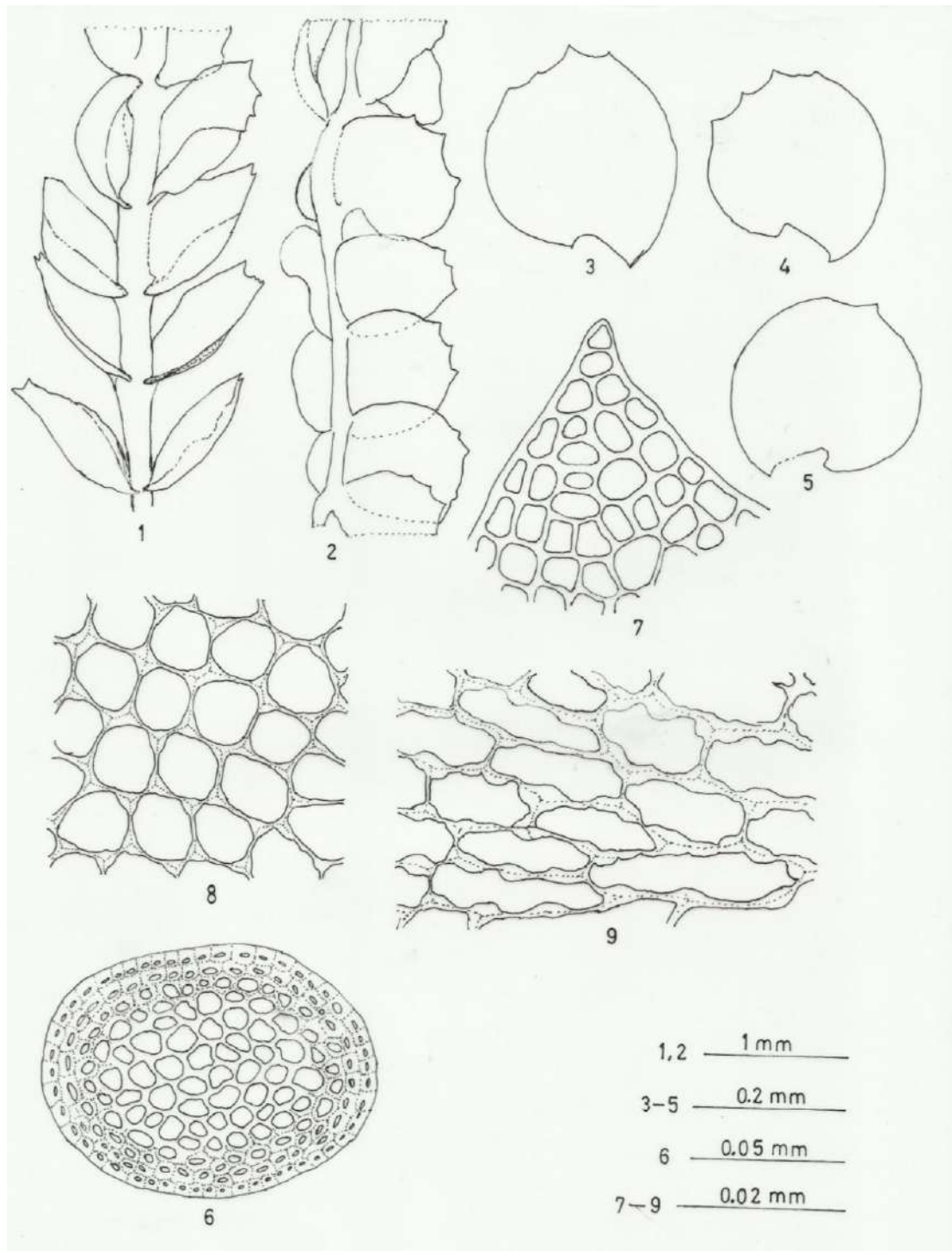


Plate 68. *Plagiochilium mayebarae* S. Hatt., Figures 1-9.

Figs. 1. A portion of stem in ventral view; 2. A portion of stem in lateral side view; 3-5. Leaves; 6. Cross section of stem; 7. Leaf apical cells; 8. Leaf median cells; 9. Leaf basal cells.

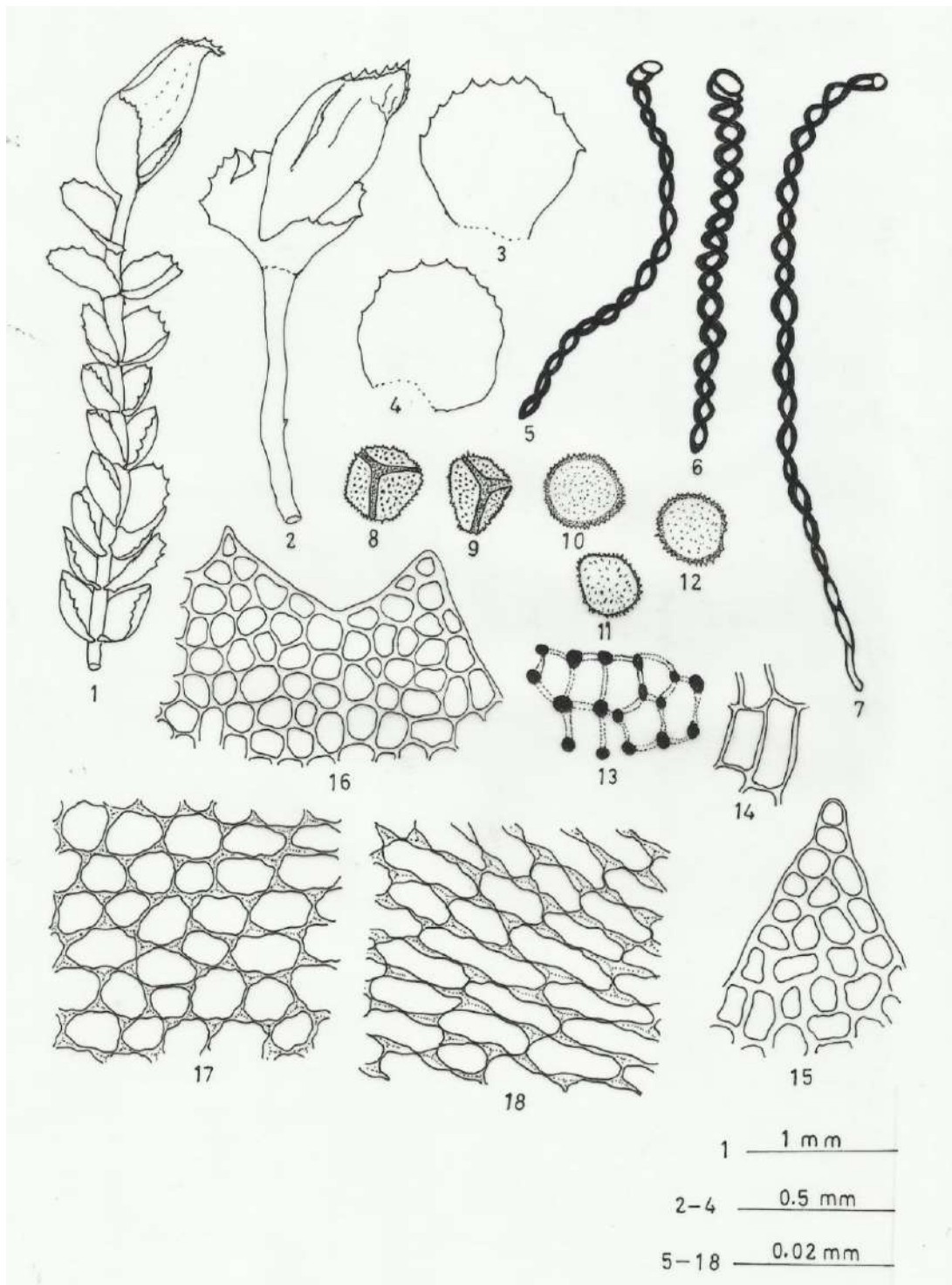


Plate 69. *Plagiochilium mayebarae* S. Hatt., figures 1-18.

Figs. 1. A portion of female plant with perianth; 2. Perianth; 3-4. Female bracts; 5-7. Elaters; 8-12. Spores; 13. Inner layer of capsule walls; 14. Outer layer of capsule walls; 15-16. Female bracts apical cells; 17. Female bract median cells; 18. Female bract basal cells.

Range: Japan, China, Formosa, India (Sikkim-Himalayas).

Distribution in India: *Eastern Himalaya*: Sikkim, **Nagaland***.

Specimen examined: Nagaland: Kohima District: Khuzama: KE 10155: 16.11.2009:
Kazhuhrii Eshuo.

FAMILY: CEPHALOZIACEAE Mig.

CEPHALOZIACEAE Mig., Krypt. Fl. Deutsch., Moose: 465. 1904.

Plant variable in size, usually small. Often soft textured, sometime almost succulent; branches lateral terminal of Frullania type or more frequently ventral-intercalary, occasionally stoloniferous, flagelliform. Leaves succubous, transversely-horizontally inserted, entire or bilobed, tooth at margins, rarely entire; cells collenchymatous. Underleaf absent or if present small, with marginal slime papillae. Rhizoids scattered on ventral portion of the stem. Gemmae present, 1-2 celled. Dioicous or monoicous. Androecia terminal on the main stem or short ventral-intercalary branches; bracts and bracteoles in 3-4 pairs; bracts often reduced, concave to ventricose at base. Gynoecia terminal, on the main branches or short intercalary branches; bracts in 2-3 pairs, similar to bracteoles, gradually larger distally, bifid or emarginated. Perianth cylindrical below with 2 lateral and 1 ventral keel above. Seta elongate, typically of 8 (-9) epidermal and 4 (-5) inner cells rows. Capsule cylindrical-ellipsoidal; wall 2-3 layered; cells of outer layer with nodular or sheet-like thickenings on radial and sometimes also on transverse walls, those on the inner layer usually with semi-annular thickenings. Spores finely granulose, papillose or reticulate. Elaters with bi-spiral thickenings.

Type: Cephalozia (Dumort.) Dumort.

Genus: *Cephalozia* Dumort.

Cephalozia Dumort., Recueil Observ. Jungerm.: 18. 1835.

Plants usually prostrate or creeping, simple or with a few branches; branches postical. Flagelliform branches common; stem in cross section differentiated into cortex and medulla region. Leaves succubous, remote- loosely imbricate, obliquely inserted, flat or slightly concave, never inflated, rotundate-ovate, often decurrent, generally bilobed to 1/2-1/3 of the length of lobes, entire at margins; lobes acute-subacute, subequal; cells large, transparent; oil bodies absent. Underleaves absent or highly reduced. Androecia spicate; bracts larger than leaves, monandrous. Gynoecia generally on short branches, occasionally terminal on main stem; bracts larger than leaves, 3 pairs; bracteole present, free or connate at base with bracts. Perianth elongate, tri-pluriplicate; mouth contracted, shortly lobed; lobe variously armed. Seta usually composed of 8 outer and 4 smaller, inner cells. Capsule long, exserted, cylindrical-ellipsoidal; walls 2 layered; cells of outer layer with nodular thickenings, inner walls with semi-annular thickenings. Spores reddish brown, small. Elaters with bi-spiral thickenings.

Type: *Cephalozia bicuspidata* (L.) Dumort.

Key to species of the genus *Cephalozia*

1. Plant 0.8-1.2 mm wide, stem 6 cells across, cortical cells in 12 radial rows, leaf cells non-trigonal..... *C. darjeelingensis*
- 1a. Plants 0.5-0.6 mm wide, stem 4-5 cells across, cortical cells in 8 radial rows, leaf cells minute trigone, trigones tri-radiate..... *C. hamatiloba*

Cephalozia darjeelingensis Udar et Kumar, Geophytology 6(1): 35-45. 1976.

(Plate 70. Figs. 1-9)

Plants small, prostrate or erect, light green to yellowish green, 6 mm long, 0.8-1.2 mm wide including leaves, branched or unbranched, basal, intercalary; rhizoids transparent, hyaline, present at the ventral surface, scanty, sometime arise from the base of the leaves. Stem circular, 132 x 150 µm in diameter, 6 cells across, cells undifferentiated, thin walls, cortical cells in 12 rows, cortical cells larger than the medullary cells, 20-40 µm long, 13-35 µm wide; medullary cells 15-30 µm long, 12-25 µm wide, cells non-trigonous. Leaves distant, alternate, oblong, ovate, 0.4-0.6mm long, 0.2-0.4mm wide, margin entire, apex acuminate, bifid, ½- ¾ of the leaf lobe, sinus wide to narrow, 2-3 uniseriate cells; apical cells 30-60 µm long, 15-20 µm wide, cells thin walls, non-trigonous; median and basal cells similar, rectangular, hexagonal, thin walls, non-trigonous, 35-65 µm long, 15-35 µm wide. Sporophytes not seen.

Habitat: Plants grow on moist shady areas (terricolous) in association with *Jungermannia* sp., *Heteroscyphus* sp., *Marchantia* sp., *Asterella* sp., *Phaeoceros* sp. and Mosses at 1500-1700 m asl.

Range: India

Distribution in India: *Eastern Himalaya:* Sikkim, **Nagaland***.

Specimen examined: Nagaland: Kohima District: Kohima: KE 10113: 18.03. 2009: Kazhuhrii Eshuo.

Cephalozia hamatiloba Steph. Spec. Hep. 3: 303. 1908. **(Plate 71. Figs. 1-9)**

Plants light green to light yellowish green, small, fragile, upto 12 mm long, 0.5-0.6 mm wide including leaves, branched, branching postical-intercalary, basal or rhizome present. Rhizoids present on the ventral surface of the stem. Stem circular, 99

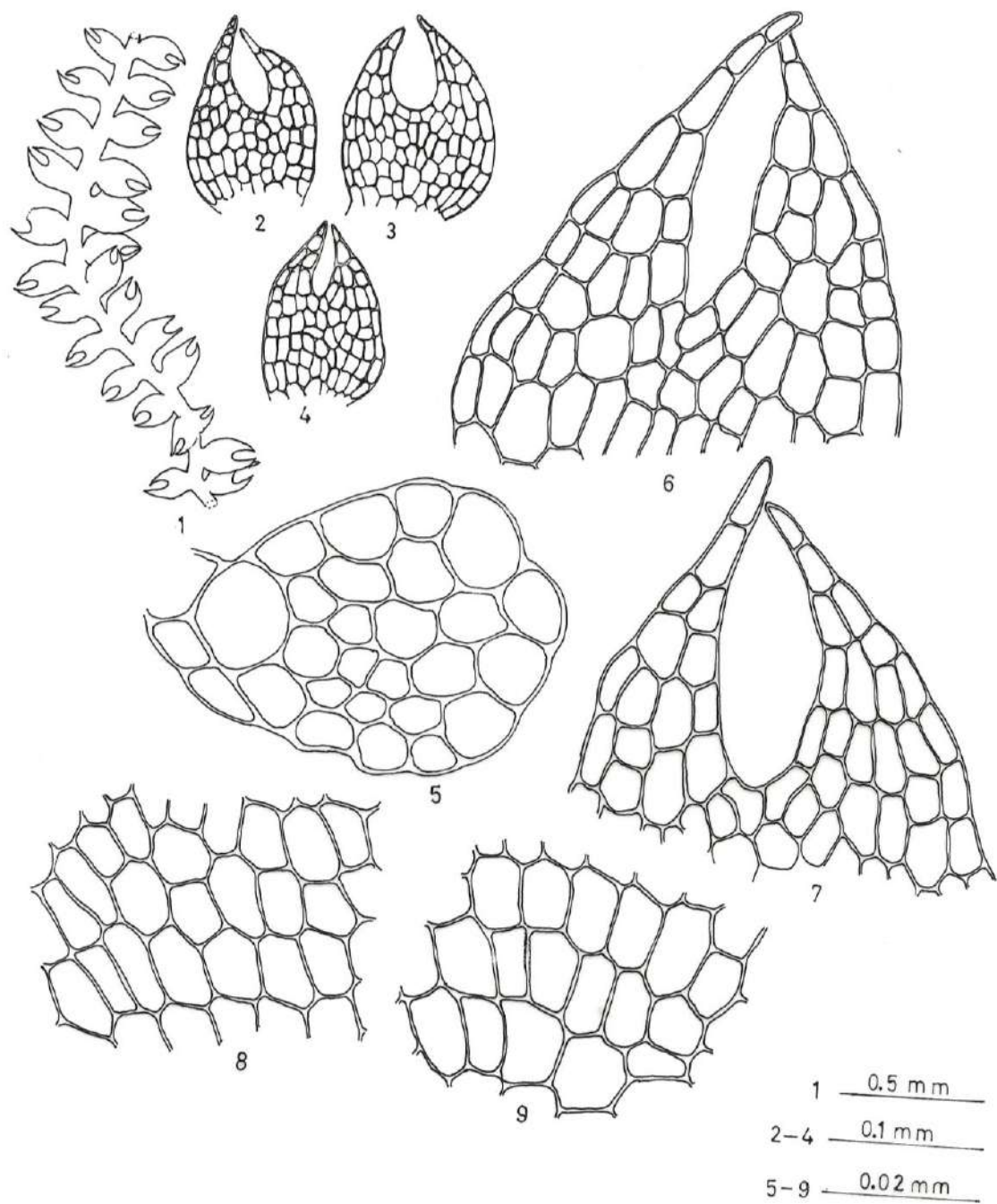


Plate 70. *Cephalozia darjeelingensis* Udar et Kumar, Figures 1-9.

Figs. A portion of plant in dorsal view; 2-4. Leaves; 5. Cross section of stem; 6-7. Leaves apical cells; 8. Leaf median cells; 9. Leaf basal cells.

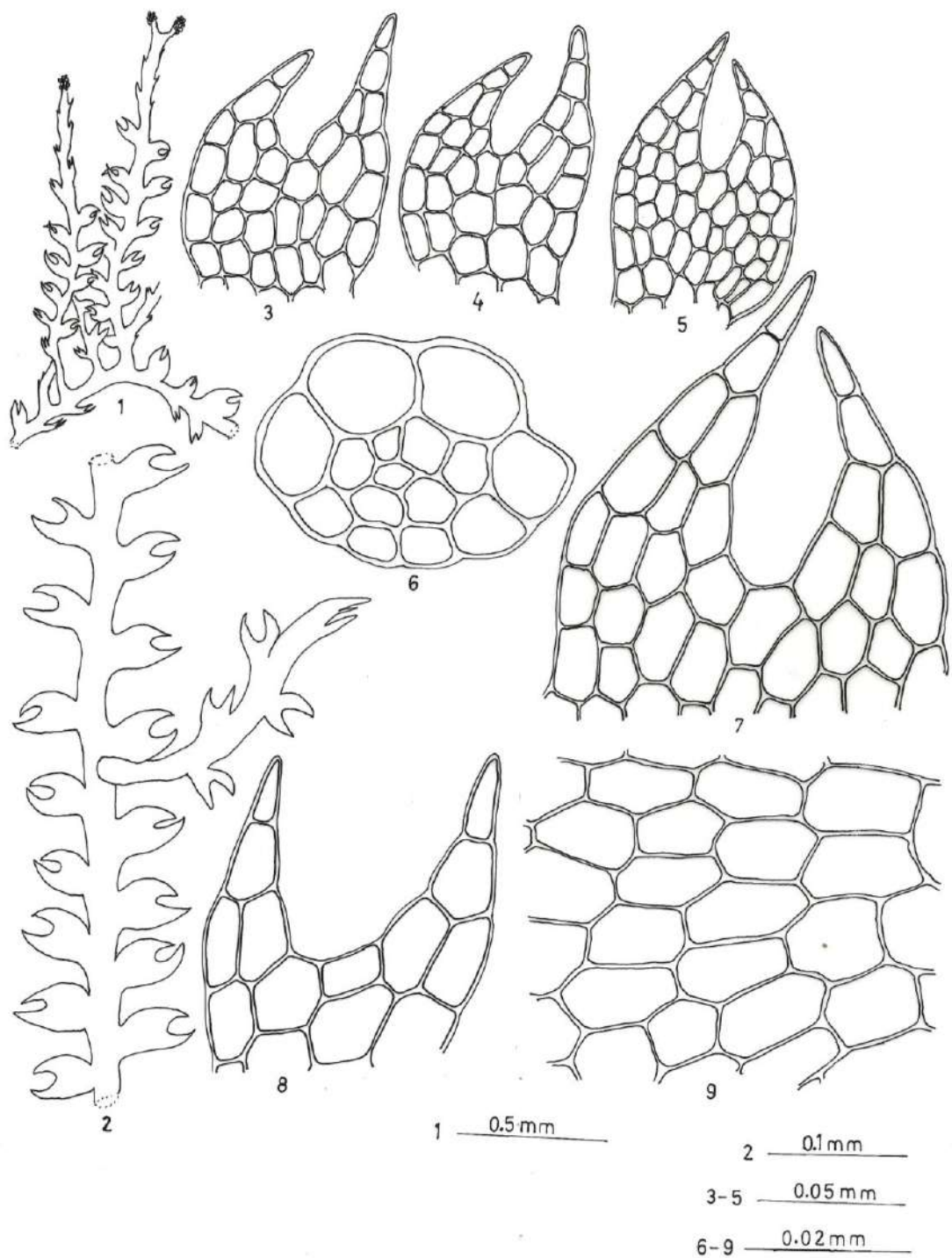


Plate 71. *Cephalozia hamatiloba* Steph., Figures 1-9.

Figs. 1-2. A portion of plants in dorsal view; 3-5. Leaves; 6. Cross section of stem; 7-8. Leaves apical cells; 9. Leaf basal cells.

x 140 µm in diameter, cortical cells large, thin walled, 8 cells in radial rows, 22-44 x 17-27 µm, medullary cells thin walled, 7 cells in radial rows, 14-22 x 10-18 µm. Leaves succubously inserted, distant, alternate, ovate, 0.2-0.36 mm long, 0.15-0.2 mm wide, margin entire, apex acuminate, sinus wide to narrow, obtuse, 1/2 bifid of the lobe length, 2-3 uniseriate cells at apex, apical cells barrel shaped, elongate, 25-44 µm long, 12-22 µm wide, median cells rectangular, pentagonal or sub-quadrangle, 42-67 µm long, 27-45 µm wide, cells thin-walled, trigones minute. Underleaf absent. Gemmae present. Sporophytes not seen.

Habitat: Plants grows on soil (terricolous) in association with *Jungermannia* sp., *Marchantia* sp., *Asterella* sp. and Mosses at 1200-1700 m asl.

Range: India, China, Japan.

Distribution in India: *Eastern Himalaya:* Sikkim, Meghalaya, **Nagaland***.

Specimen examined: Nagaland: Mokokchung District: Longkhum: KE 10137: 12.09.2009: Kazhuhrii Eshuo; Changki: KE 10357: 02.11.2010: Kazhuhrii Eshuo; Uigma: KE 10116: Kazhuhrii Eshuo.

SACAPNIACEAE Mig.

SCAPANIACEAE Mig., Krypt. Fl. Deutsch., Moose: 479. 1904.

Leaves transverse to succubous, complicate bilobed with the dorsal segment smaller than the ventral lobed, or 2-4 lobed, flate to concave or conduplicate, margin toothed to long ciliate or entire. Underleaves usually absent, if present bifid, large; rhizoids scattered. Androecia and gynoecia on leading axes, sporophytes enclosed by a shoot calyptra and perianth, perianth cylindric, dorsiventrally flattened, mouth broad, plicate and contracted; capsule ovoid, spheroidal or ellipsoidal; walls 2-8 stratose; gemmae common, usually stellate.

Key to genera of the family Scapaniaceae

1. Leaves 2 lobed, with the dorsal lobe smaller than the ventral lobe, margin with minute tooth or ciliate, underleaf absent..... *Scapania*
- 1a. Leaves 3-4 lobed, margin with spinous tooth, underleaf present or absent..... 2
2. Leaves 3 lobed, underleaf bifid, with lateral margin many teeth..... *Chandonathus*
- 2a. Leaves 3-4 lobed, underleaf absent..... *Lophozia*

Genus: *Scapania* (Dumaort.) Dumort.

Scapania (Dumort.) Dumort., Recueil Observ. Jungerm.: 14. 1835.

Plants brownish, reddish or purplish green; branches lateral-intercalary, sometime of Frullania type, rarely postical intercalary or Radula type; stem in cross section shows well differentiation into cortex and medulla region; cortical cells in 1-3 (-4) layers, thick walled; medullary cells larger than the cortical cells, thin walled. Leaves succubous, obliquely ventrally inserted, dorsally transverse, somplicate bilobed with dorsal lobe smaller than the ventral lobe, usually dentate or ciliate at margins; lobes separated by a bluntly to sharply folded or often winged keel, entire; cells collenchymatous, sparsely to densely papillose. Underleaves absent. Rhizoids

abundance, scattered. Gemmae present, 1-2 celled, formed in branching fascicles at apex of the upper most leaves. Dioicous. Androecia on main shoots; bracts similar to leaves but concave at base; androecia usually 2-4 per bract, ovoid, with uniseriate stalk. Gynoecia terminal on main stem. Perianth far exerted from bract, dorso-ventrally compressed or subinflated, mouth wide, truncate, elongated, free from bract and calyptra. Capsule dark brown, ovoid-globose; wall 3-7 layered; cells of outer layer with nodular thickenings, inner wall with semi-annular thickenings. Spores coarsely-finely papillose. Elaters with 2-3 spiral thickenings.

Key to species of the genus *Scapania*

1. Plant large, 60-95 mm long, 3.5-7 mm wide, keel very short, cortical cells 3-4 thick layer, margin ciliate dentate throughout, 1-3 cells long..... *S. ferruginea*
- 1a. Plant small, 10-30 mm long, 1-3 mm wide, keel moderate, leaf margin minute dentate or entire.....2
2. Leaves marginal teeth unicellular, cuticle papillose, ventral lobe ovate, apices acute or sub-acute with a point, base decurrent..... *S. parva*
- 2a. Leaf marginal teeth 1-3 cells long, cuticle verrucose or smooth, trigones large or minute, gemmae present..... 3
3. Plant 1.5-2 mm wide, leaves irregularly dentate towards apex, trigones minute or indistinct, leaf lobe cells quadrate..... *S. griffithii*
- 3a. Plants 2-3 mm wide, dorsal lobe large, cuticle verrucose, oil bodies 2-3 per leaf, gemmae bi-celled..... *S. ligulata*

Scapania ferruginea (Lehm. et Lindenb.) Gott., Lindenb. et Nees, Syn. Hepat. 1: 72.

1844.

(Plate 72. Figs. 1-11)

Plant large, light yellowish green, deep green, 70-95 mm long, 3.5-7 mm wide including leaves, overlapping, saxicolous, branched, branching intercalary, terminal. Rhizoids hyaline, numerous on the ventral surface. Stem oval, 0.45 x 0.7 mm in diameter, cells differentiated into thick cortical cells and thin medullary cells; cortical cells 3-4 layers, 12.3-25.8 μm long, 8.5-13.4 μm wide; medullary cells 19.8-28.6 μm long, 11.6-25.2 μm wide. Leaves closely imbricate, dorsal lobes are cordate to reniform, broadly crossing the farther edge of the stem, long decurrent below the level of the base of the keel, ciliate-dentate throughout the margin, keel short and circularly curved. Ventral lobes are widely spreading, convex, ovate, oblong, densely ciliate-dentate throughout the entire margin of the leaves, ciliate-dentate cells 1-5 cells long, 1-2 cells broad at base; apical cells hexagonal to quadrate, rectangular, slightly trigonous, trigones minute, 16.5-27.5 μm long, 11.2-19.8 μm wide; middle cells rectangulate to sub-quadrate, hexagonal, thin walled, tri-radiate trigones, 20-42.4 μm long, 16.5-27.5 μm wide; basal cells rectangulate, sub-quadrate, tri-radiate trigones, 21.2-54.6 μm long, 15.3-31.2 μm wide. Oil bodies 3-6 per cell, circular, spherical, 6.3 x 13.7 μm in diameter, finely segmented.

Habitat: Plants on soil (terricolous) and rocks (saxicolous) in association with *Junegermannia* sp., Mosses and grasses at 1600-2000 m asl.

Range: India, Nepal, Bhutan, China, Indonesia.

Distribution in India: *Eastern Hiamalaya:* West Bengal, Sikkim, Nagaland*; *Western Himalaya:* Himachal Pradesh.

Specimen examined: Nagaland: Kohima District: Khuzama: KE 10157: 16:11.2009:

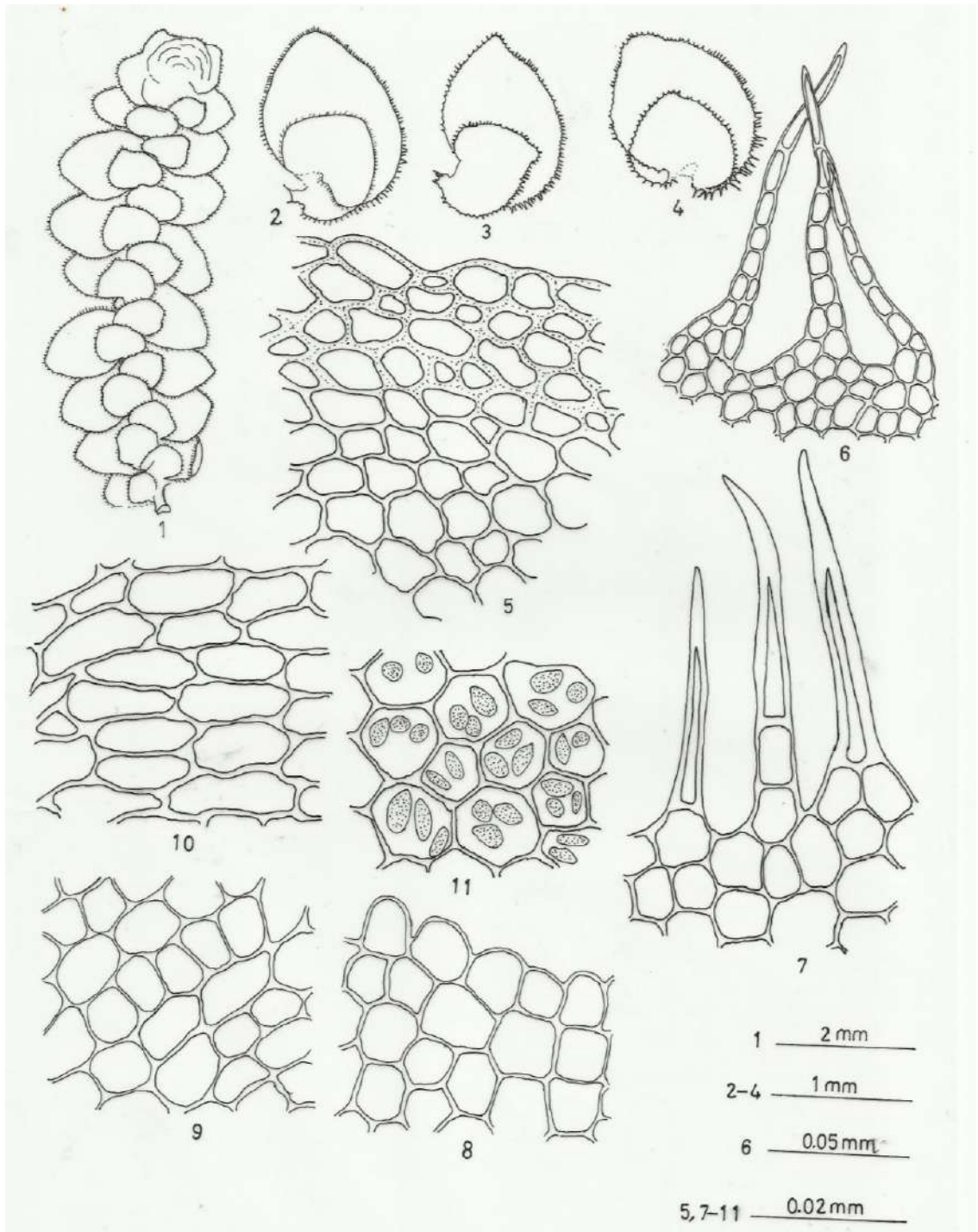


Plate 72. *Scapania ferruginea* (Lehm. et Lindenb.) Gott., Figures 1-11.

Figs. 1. A portion of plant in dorsal view; 2-4. Leaves; 5. A portion of stem in cross section; 6-7. Leaves teeth cells; 8. Leaf apical cells; 9. Leaf median cells; 10. Leaf basal cells; 11. Oil bodies.

Scapania parva Steph., in Mem. Soc. Sci. Nat. Cherbourg 29: 226. 1894 & Sp. Hepat.

4: 142. 1910.

(Plate 73. Figs. 1-13)

Plants medium, erect, reddish brown to greenish brown, 10-30 mm long, 2.5-3.5 mm wide including leaves, rarely branched, intercalary; rhizoids confined at the basal part of the stem. Stem oval, brownish dark red, circular, 3-4 thick cortical cells, 5.7-15.4 μm long 4.9-13.2 μm wide; medullary cells thin walled, 16.2-24.3 μm long, 7.7-17.6 μm wide. Leaves distant to contiguous or sometime imbricate at apex part, ovate, oblong, apex acute, 1/2-2/3th bilobed, bilobed into unequal lobed; dorsal lobed obliquely inserted, ovate, oblong, apex acute, denticulate, 1.1-1.3 mm long, 0.7-0.9 mm wide; ventral lobed oblong, ovate, 1.5-1.8 mm long, 1-1.3 mm long, margin dentate throughout, teeth 1-3 cells long; keeled 1/3-1/2 the length of the ventral lobe, keel 3-4 cells long and 2-3 cells wide; apical cells 8-15.6 μm long, 6.10.5 μm wide, quadrate to sub-quadrate, trigones tri-radiate, cells thin walled, median cells 10-22 μm long, 8-15 μm wide, cells rectangular to quadrate, trigones concave one sided, basal cells 18.9-40 μm long, 10-22 μm wide, cells quadrate, trigones tri-radiate, concave one sided. Cuticle slightly or minutely verrucous. Androecia not seen. Perianth terminal, oblong, 4 mm long, 2.6 mm wide, dorso-ventrally compressed, truncate, denticulate at the mouth, decurved, bracts similar to the adjacent cauline leaves; apical cells 10-15 μm long, 8-12 μm wide, median cells 17-34 μm long, 13-17 μm wide, basal cells 36-109 μm long, 15-31 μm wide, cells rectangular. Elaters brownish red, tri-spiral, 125-150 μm long, 6.6-9.8 μm . Spores brownish red, circular, 9.8-10.3 μm in diameter. Inner walled of sporogonium thickening present.

Habitat: Plants grows on soil (Terricolous) in pure form or in association with Mosses at 2300- 2700 m asl.

Range: India, China, Polynesia (Hawaiian Islands).

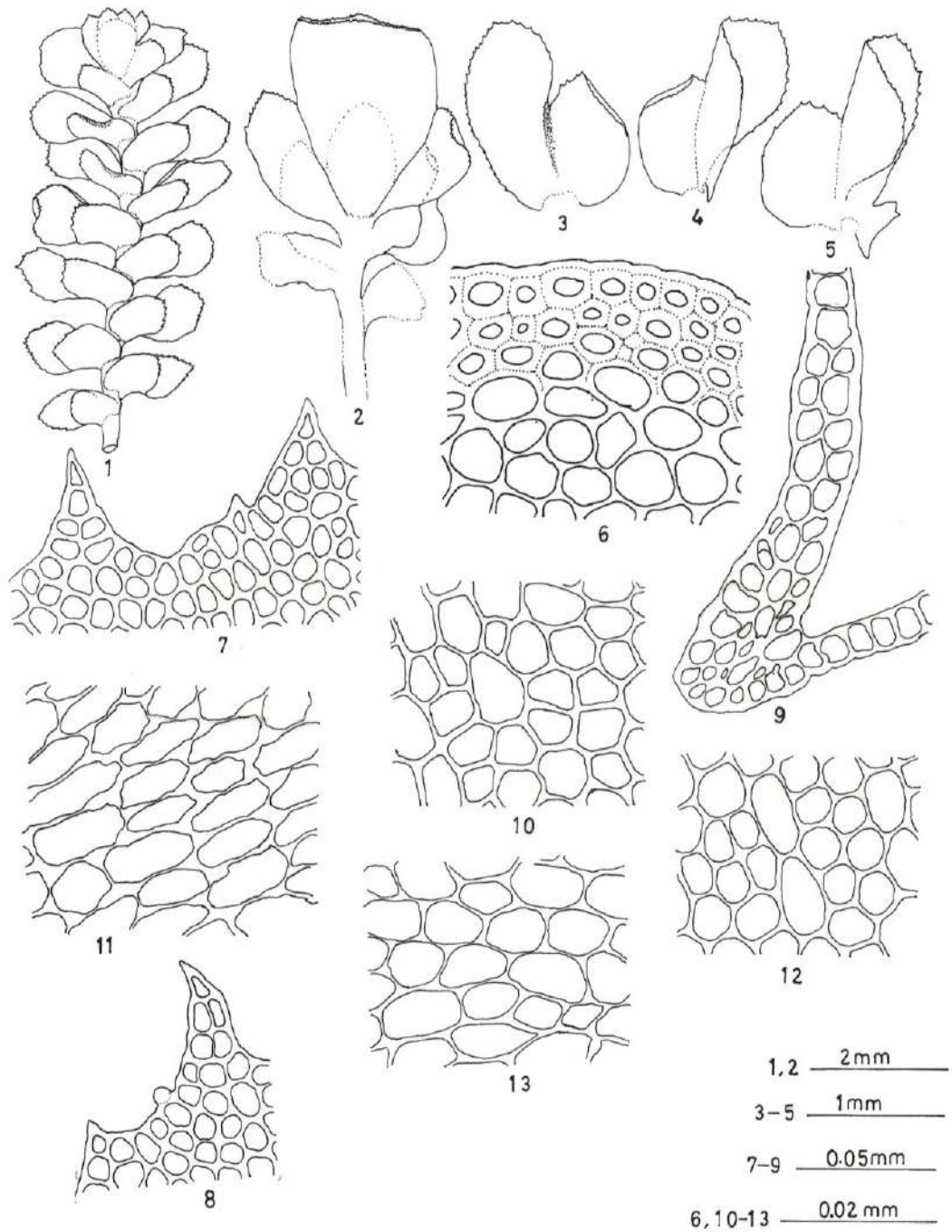


Plate 73. *Scapania parva* Steph., Figures 1-13.

Figs. 1. A portion of plant in dorsal view; 2. A portion of female plant with perianth; 3-5. Leaves; 6. A portion of stem in cross section; 7. Ventral leaf lobe apical cells; 8. Dorsal leaf lobe apical cells; 9. Cross section of leaf keel; 10. Ventral leaf lobe median cells; 11. Ventral leaf basal cells; 12. Dorsal leaf median cells; 13. Dorsal leaf lobe basal cells.

Distribution in India: *Eastern Himalaya:* Sikkim, Meghalaya, **Nagaland***; *Western Himalaya:* Jammu & Kashmir, Himachal Pradesh.

Specimen examined: Nagaland: Kohima District: Khonoma: KE 10471: 19.03.2010: Kazhuhrii Eshuo.

Scapania griffithii Schiffn., Oest. Bot. Zeit. 4: 204. 1899. (Plate 74. Figs. 1-10)

Plant small to medium, 10-15 mm long, 1.5-2 mm wide including leaves, branching intercalary or rarely branched. Rhizoids hyaline and confined at the basal part of the stem. Stem dark brown, oval to spherical, 0.1 x 0.15 mm in diameter, 8-9 cells across, cells differentiated into thick cortical cells and thin medullary cells; cortical cells 2-3 layer, 8-16.3 μm long, 6-10.3 μm wide; medullary cells 14.5-22.0 μm long, 9.1-14.8 μm wide, polygonal, quadrate. Leaves distant to contiguous, slightly imbricate, ovate, acute, denticulate, bilobed, lobes divide into two unequal lobed, keel $\frac{1}{2}$ the length of the ventral lobe, rhomboid, dorsal lobe transversely inserted on the stem, 0.48-0.55 mm long, 0.35-0.42 mm wide; apex acute or acuminate to pointed, margin denticulate, dentition extend even upto the base of the ventral lobe; ventral lobe obovate, oblong, 0.9-1 mm long, 0.5-0.6 mm wide, apex acute, pointed, teeth one cell or sometime more than one cells; apical cells triangulate, sub-quadrate, thin walled, trigones minute, 10.2-15.2 μm long, 6.9-11.0 μm wide; middle cells rectangulate, quadrate, polygonal, thin walled, tri-radiate trigones, trigone minute or indistinct, 12.2-25.8 μm long, 6.9-13.4 μm wide; marginal cells quadrate, rectangulate, thin walled, 8.9-18.9 μm long, 8.2-11.3 μm wide; basal cells larger, rectangulate, polygonal, quadrate, thin walled, reddish, 22-35.2 μm long, 9-16.2 μm wide. Gemmae present at shoot apex. Androecia and gynoecia not seen.

Habitat: Plants grow in soil (terricolous) with *Calypogeia* sp., *Heteroscyphu* sp. and Mosses at 1700-2300 m asl.

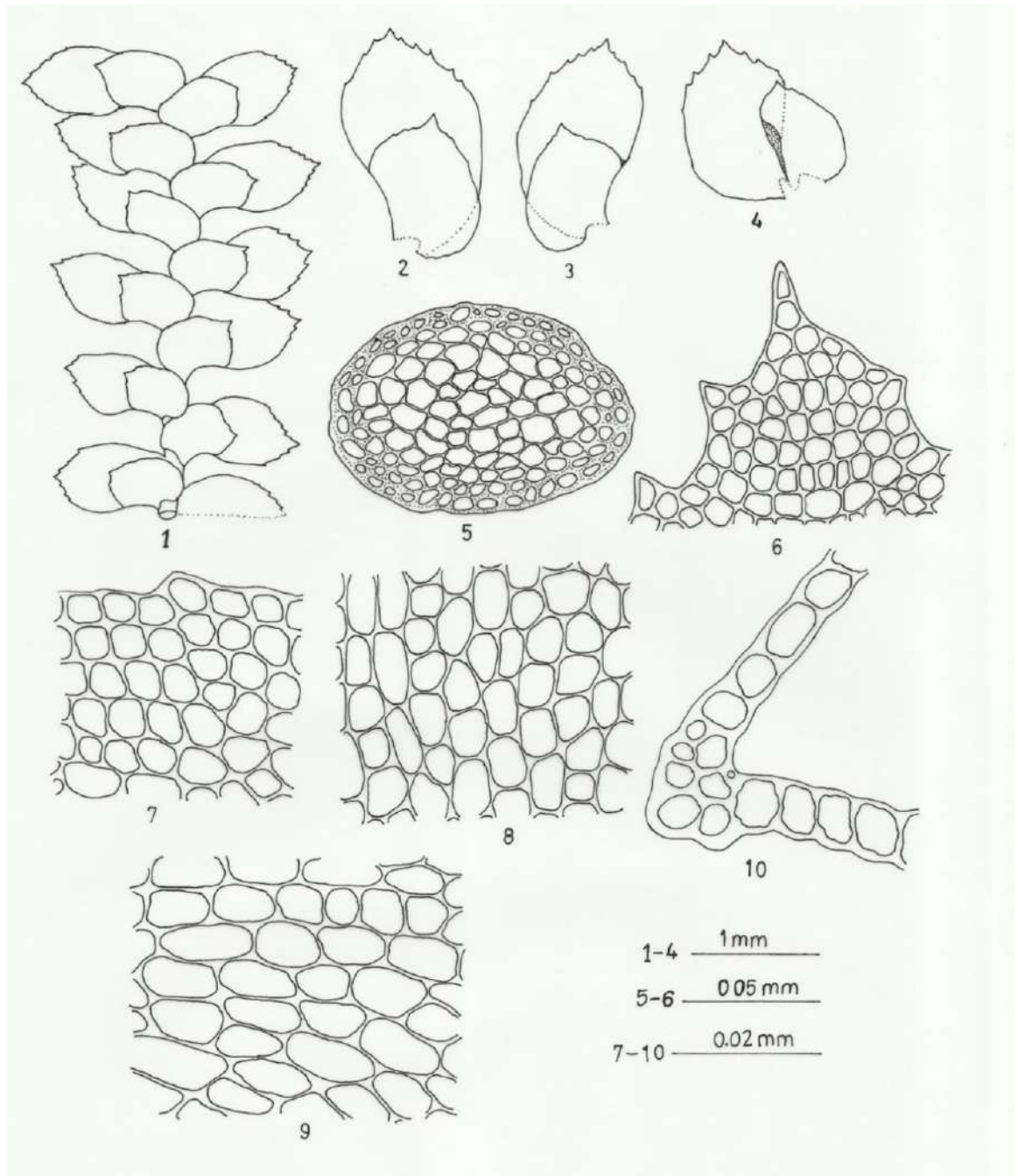


Plate 74. *Scapania griffithii* Schiffn., Figures 1-10.

Figs. 1. A portion of plant in dorsal view; 2-4. Leaves; 5. Cross section of stem; 6. Leaf apical cells; 7. Leaf marginal cells; 8. Leaf median cells; 9. Leaf basal cells; 10. Cross section of leaf keel.

Range: India,

Distribution in India: *Eastern Himalaya:* Sikkim, **Nagaland***; *Western Himalaya:* Himachal Pradesh.

Specimen examined: Nagaland: Kohima District: Khuzama: KE 10174 (B): 16.11.2009: Kazhuhrii Eshuo.

Scapania ligulata Steph., Hedwigia 44: 14. 1904. **(Plate 75. Figs. 1-11)**

Plant erect, prostrate, medium, 10-25 mm long, 2-3 mm wide including leaves, light to pale green, brownish green, branching rare, intercalary, terminal. Rhizoids hyaline, transparent, present at the basal part of the stem. Stem reddish to brownish red, circular, 0.6 x 0.8 mm in diameter, 14-16 cells across, 2-3 (4) thick cortical cells; cortical cells 6.1-14.6 μm long, 5-7.8 μm wide; medullary cells thin walled, larger, hexagonal, quadrate, 14.8-21.3 μm long, 7-17.2 μm wide. Leaves alternate to sub-opposite at apex, distant to slightly imbricate at apex, ovate, bilobed, lobes unequal, keel $\frac{1}{2}$ the length of the ventral lobe, serrate; dorsal lobed 0.9-1.4 mm long, 0.6-0.8 mm wide, ovate, oblong, apex short acuminate, serrate, arching slightly beyond the farther edge of the stem; ventral lobe ovate, oblong, ligulate, 2-3 mm long, 2-2.3 mm wide, apex short acuminate, margin dentate, basal part entire, teeth usually 1-3 cells long, 1-2 cells broad at base; cells thin walled, trigones minute, tri-radiate; apical cells thin walled, quadrate, rectangular, 10-16.5 μm long, 7-13.2 μm wide; middle cells thin walled, quadrate to sub-quadrate, rectangular, 10-18.4 μm long, 8-15.1 μm wide; basal cells rectangulate, quadrate, polygonal, thin walled, 13.6-32.4 μm long, 8.4-16.1 μm wide. Oil bodies 2-4 per cells, circular, round, elliptical, 3.3 x 6.5 μm in diameter. Gemmae borne at the apex of the main stem, gemma oval like, 1-2 cells, 13.2-22.0 μm long, 8-10.0 μm wide. Androecia and gynoecia not seen.

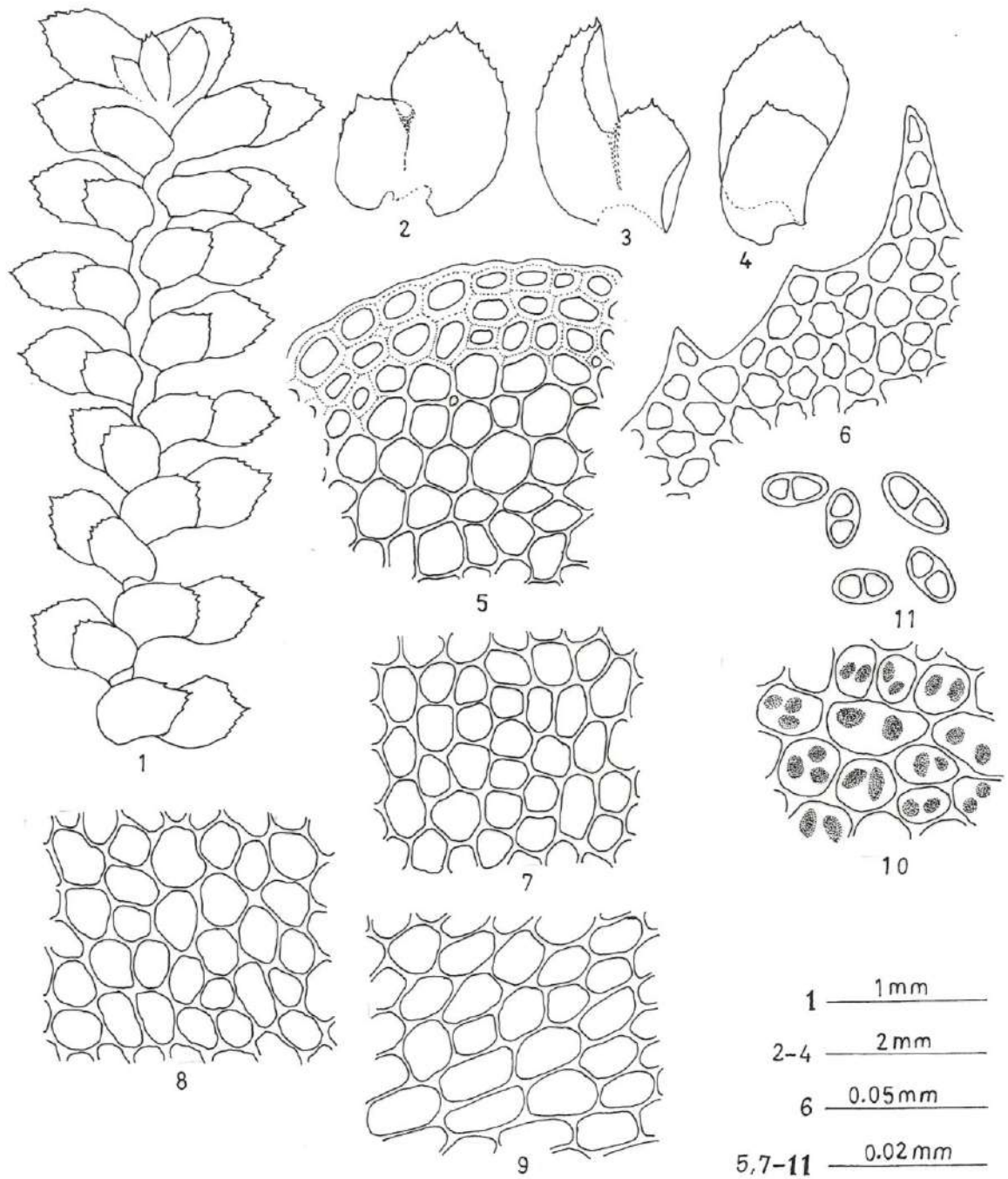


Plate 75. *Scapania ligulata* Steph., Figures 1-11.

Figs. 1. A portion of plant in dorsal view; 2-4. Leaves; 5. A portion of stem in cross section; 6. Leaf apical cells; 7-8. Leaf median cells; 9. Leaf basal cells; 10. Oil bodies; 11. Gemmae.

Habitat: Plants grow on soil (Terricolous) in association with Mosses and small herbs at 1700-2200 m asl.

Range: India, China, Japan

Distribution in India: *Eastern Himalaya:* Sikkim, **Nagaland***.

Specimen examined: Nagaland: Kohima District: Khuzama: KE 10076: 16.11.2009: Kazhuhrii Eshuo

Genus: *Chandonanthus* Mitt.

Chandonanthus Mitt., in J.D. Hooker, Hdb. New Zealand Fl. 2: 750. 1867.

Plants yellowish green to reddish brownish, erect, procumbent or pendulous, branching lateral intercalary, lateral terminal of *Frullania*-type. Stem differentiated into cortex and medulla region. Leaves imbricate, transversely inserted, 2-4 lobed, lobes canaliculated, entire or toothed, lobes unequal, cells trigonous. Underleaves large, deeply lobed, armed with laciniate teeth. Androecia intercalary, bracts similar to leaves, antheridia 2-3 per bract; gynoecia with a single subfloral innovations; bracts and bracteoles similar with lateral leaves and underleaves. Perianth large, emergent, cylindrical, strongly pluriplicate, mouth contacted and ciliate.

Type: *Chandonanthus squarrosus* (Hook.) Mitt.

Chandonanthus hirtellus Mitt., Hook. Handb. New Zealand Fl. 2: 750. 1857.

(Plate 76. Figs. 1-15)

Plant medium, erect, brownish yellowish, 28-43 mm long, 2-2.5 mm wide including leaves; branching rare, intercalary; Rhizoids scarce, confined at the base of the stem. Stem oval, 0.2 x 0.3 mm in diameter, 16-18 cells across, 2-3 thick cortical cells; 6.6-17.6 μm long, 4.5-12.1 μm wide, cells trigonous; medullary cells 16.5- 27.6 μm long, 10-15.5 μm wide, cells trigonous, trigones nodulose. Leaves contiguous, 3-lobes, lobes ovate-oblong, sinus descending upto the base, dorsal lobes larger, median and ventral lobes comparatively smaller, apex acute to acuminate; 1.2-1.5 mm long,

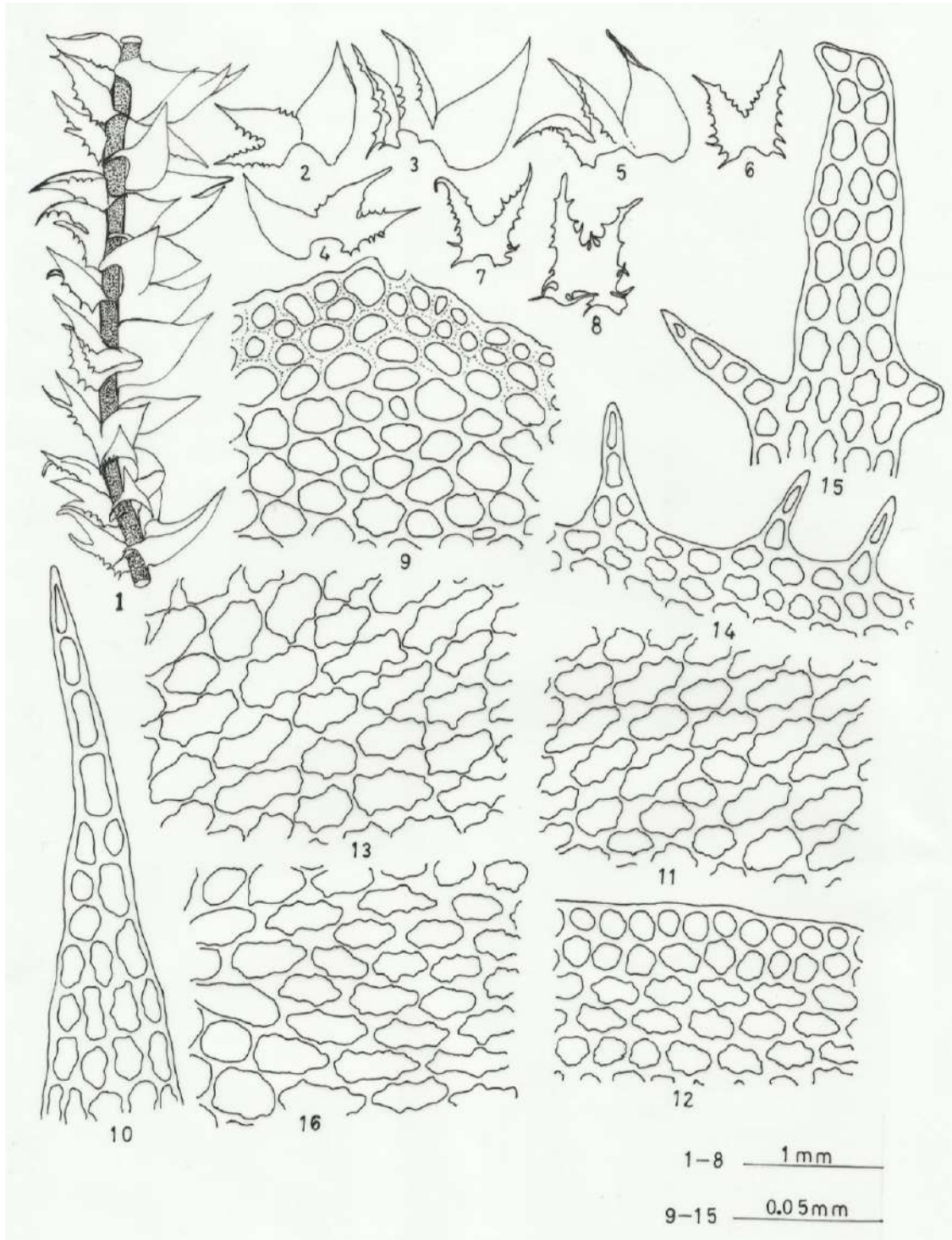


Plate 76. *Chandonanthus hirtellus* Mitt., Figures 1-15.

Figs. 1. A portion of plant in ventral view; 2-5. Leaves; 6-8. Underleaves; 9. A portion of stem in cross section; 10. Leaf apical cells; 11. Leaf median cells; 12. Leaf marginal cells; 13. Leaf basal cells; 14. Leaf marginal teeth cells; 15. Underleaf apical cells; 16. Underleaf basal cells.

0.9-1.1 mm wide, ventral leaves lobes more dentate than the median and the dorsal leaf lobes, 11-14 teeth per ventral leaf lobe, 2-7 (-12) cells long, 1-3 cells broad at base, 2-5 uniseriate cells at apex; 5-9 teeth per median leaf lobe, dorsal lobe entire or 1-2 dentate at basal part; basal cells trigonous, trigones nodulose, bulging, 19-8-36.3 μm long, 8.2-16.5 μm wide; median cells trigonous, trigones nodulose, bulging, 15.4-24.2 μm long, 6.3-11.5 μm wide; epidermal oval-circular, cells trigonous, trigones nodulose, bulging, 7.5-11.4 μm long, 7-12.5 μm wide; apical cells triangular to rectangulate, 15.4-24.3 μm long, 6.3-10.3 μm wide. Underleaves bilobed, denticulate, 0.6-0.7 mm long, 0.4-0.5 mm wide, sinus wide, long, $\frac{3}{4}$ sinus, ratio 4:1, apex acuminate, dentition 22-24 per underleaf, 1-7 cells long, 1-2 (-4) broad at base, cells trigonous and like the lateral leaves cells and numerous teeth covered the entire margin of the underleaf. Androecia and gynoecia not seen.

Habitat: Plants epiphytically on tree bark (corticolous) in association with *Plagiochila* sp., *Bazzania* sp., *Lejeunea* sp. and Mosses at 1700-2500 m asl.

Range: India, Japan, Sri Lanka, Taiwan, Australia, Africa.

Distribution in India: *Eastern Himalaya:* Sikkim, Meghalaya, **Nagaland***.

Specimen examined: Nagaland: Kohima District: Khuzama: KE 10210: 16.11.2009: Kazhuhrii Eshuo.

Genus: *Lophozia* Dumort.

Lophozia Dumort., Rec. D' Obs., p. 17. 1835.

Plants variable, dull olive green to light green, or often blackish to bluish green on drying; stem prostrate, suberect or decurrent. Branching sparing; intercalary or terminal-lateral branching; flagelliferous or stolons absent. Leaves 2-4 lobed; succubous, obliquely inserted ventrally and obliquely to almost transversally dorsally, the leaf plane nearly transverse to the axis to nearly horizontal, but never with dorsal

half of the leaf folded over the ventral. Underleaves absent or large, lobed with cilia. Asexual reproduction by 1-2 celled angulate gemmae. Plants dioecious or paroecious but rarely autoecious. The parichaetial bracts usually larger than the leaves covering perianth at the base; bracteoles smaller than the bracts and usually adnate with one or rarely both bracts. Perianth cylindrical, well developed, exserted, plicate in distal and narrowed distally to a small beak, free from bracts. Capsule ovoid, 2-5 stratose; inner layer with semi-annular thickenings; outer layer with larger cells and coarser nodular thickenings. Stea elongate with numerous longitudinal rows of cells. Spores about 10-18 μm in diameter. Elaters bispiral, 6-9 μm in diameter. Androecia intercalary on main axis, spicate and bracts similar to the leaves in size; antheridia usually 2 or more.

Type: Lophozia ventricosa (Dicks.) Dumort.

Lophozia setosa (Mitt.) Steph., Sp. Hepat. 2: 151. 1901. **(Plate 77. Figs. 1-14)**

Plants prostrate to sub-erect, 30-60 mm long, 2.5-3.0 mm wide including leaves, light yellowish green to green, dull brownish red in dry herbarium; branched, intercalary or rarely terminal. Rhizoids colourless, numerous on the ventral surface of the stem. Stem circular, oval, 11-14 cells, cells undifferentiated, thin walled and non-trigonus. Leaves succubus, tri-lobed, 1.6-2.1 mm long, 1.6-2.5 mm wide, wider than long; lobe apex acuminate, lobe ovate, 4-7 teeth per leaf, middle lobe entire; apical cells 29.4-53.7 μm long, 21.3-34.5 μm wide, thin walled, minute tri-radiate trigones; median cells 30.9-67 μm long, 26.4-37.1 μm wide, thin walled, trigones tri-radiate, quadrate, pentagonal; basal cells 45.6-76 μm long, 23.7-36.9 μm wide, thin walled, tri-radiate trigones. Oil bodies numerous, circular, rounded, homogenous and colourless. Underleaves absent. Male bracts like the lateral leaves or slightly larger,

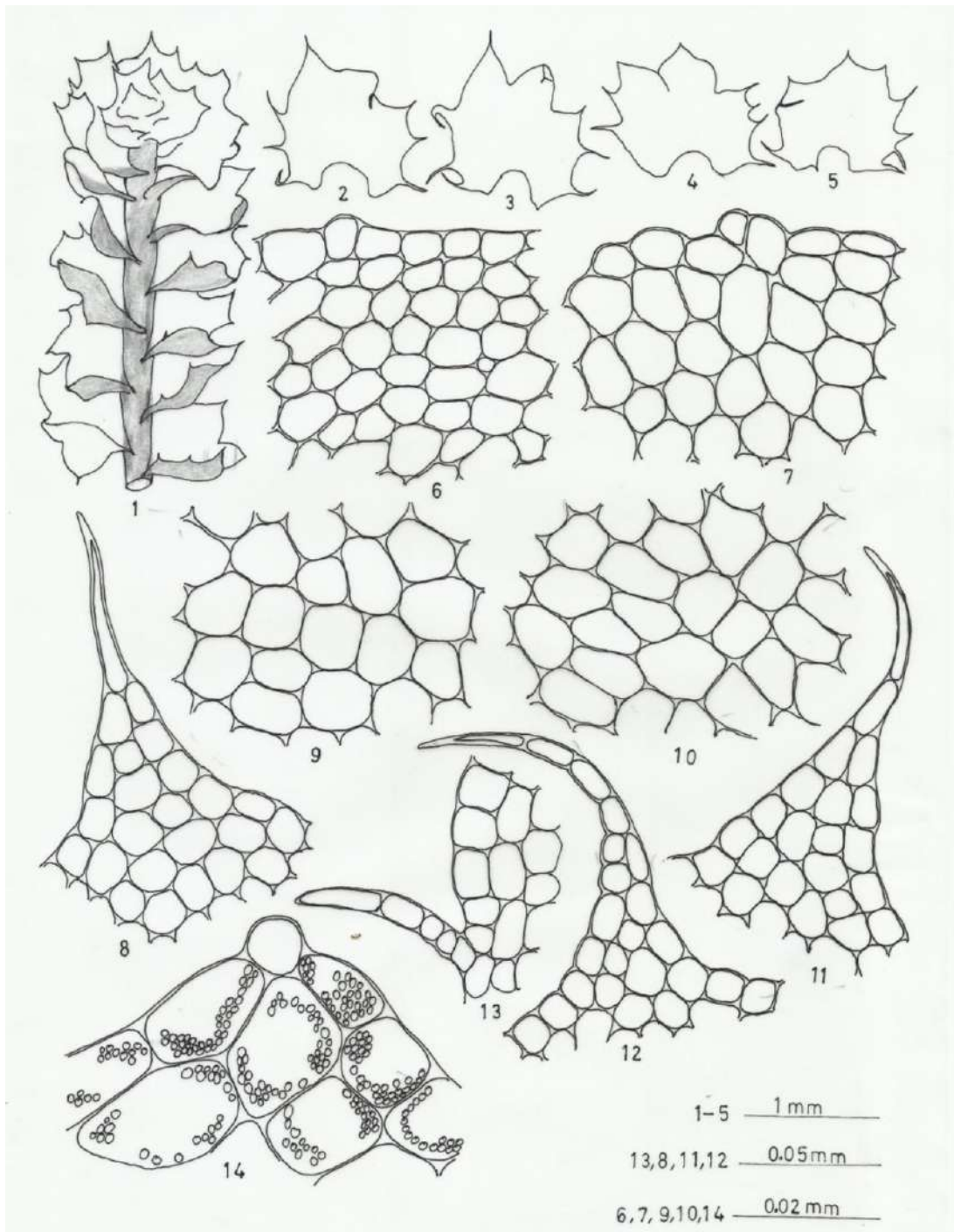


Plate 77. *Lophozia setosa* Mitt., figures 1-14.

Figures 1. A portion of plant in dorsal view; 2-5. Leaves; 6-7. Leaves apical and marginal cells; 8. Leaf apical cells; 9. Leaf median cells; 10. Leaf basal cells; 11-13. Leaves lateral tooth cells; 14. Oil bodies.

borne at the apex part of the stem; 2-3 antheridia per bract. Female plant not seen. Sporophytes not seen.

Habitat: Plants grows on moist soil and rocks along with *Lepidozia* sp., *Scapania* sp., *Metacalypogeia alternifolia* and Mosses at 2500-2700 m asl.

Range: India, Nepal, Bhutan

Distribution in India: *Eastern Himalaya:* Sikkim, **Nagaland***.

Specimen examined: Nagaland: Kohima District: Khonoma: KE 10420: 19.03.2011: Kazhuhrii Eshuo.

FAMILY: CALYPOGEIACEAE (Müll. Frib.) Arnell, Holmb.

CALYPOGEIACEAE (Müll. Frib.) Arnell, Holmb., Skand. Fl. 2(a): 189. 1928.

Plants medium size, light green to bluish-brownish green, sparsely branched, branches usually postical, sexual branches short and determinate in length with reduce leaves. Stem cells undifferentiated into cortical and medulla. Leaves incubous, nearly straight or obliquely inserted, alternate, ovate to elliptical or orbicular, as long as wide, apex entire or bidentate, margin entire. Underleaves bilobed or unlobed, large, suborbicular or ovate. Dioicous or monoicous. Male branches postical, short, compact; androecia spicate, formed of many pairs of 2-3 lobed leaves, each with 1-3 antheridia. Female branches on very short, ventral-intercalary branches with vestigial bracts or scale like bracts and bracteoles. Perianth absent. Sporophyte with seta of numerous rows, outer cells little larger than the inner. Capsule cylindrical, elongate, rarely ovoid, splitting into 4 spirally twisted valves, wall 2 layered, cells with nodulose thickenings. Spores brown, papillose or minutely punctuate. Elaters with bi-trispiral thickenings. Asexual reproduction by means of 1-2 celled ellipsoidal, thin walled greenish gemmae.

Type: Calypogeia Raddi, *nom. cons.*

Key to genera of the family Calypogeiaceae

1. Leaves bidentate, ovate to broadly cordate, underleaf bifid, lobes acute to obtuse, densely rhizoidous..... *Calypogeia*
- 1a. Leaves entire or narrowly bifid, obovate, underleaf entire, incurved, broader than long, rhizoids sparse.....*Metacalypogeia*

Genus: *Calypogeia* Raddi em. Nees

Calypogeia Raddi, Mem. Soc. Ital. Sci. Modena 18: 31. 1818.

Plants green to whitish green or bluish green, prostrate. Stem cells undifferentiated; stem irregularly branched, branches postical intercalary; flagella or stolens normally absent. Rhizoids abundant and confined to the base of the underleaf. Leaves incubous, horizontally oriented, moderately imbricate or contiguous, ovate, ovate-triangular, slightly convex, rounded or entire at apex or minutely bidentate. Underleaves distant, free, bifid, or retuse to unlobed. Cells generally thin walled with trigones, pellucid, smooth or finely verruculose. Oil bodies finely to coarsely segmented, 2-13 per cell. Autoecious or paroecious, or rarely dioicous. Male branches small, spicate, postical intercalary with 2-8 pairs of bracts, closely imbricate; 1-3 antheridia per bract. Gynoecia sub-sessile to sessile, postical intercalary branches, 2-3 pairs, closely imbricate. Perianth absent. Capsule cylindrical, walled 2 layered; outer layer with transverse longitudinal sheet-like thickenings on the tangential walls; inner layer with numerous semi-annular thickenings bands. Spores globose to sub-globose, brownish with wart like papillae over the exine. Elaters free, sub-equal to spores diameter, bi-tri-spiral with blunt ends.

Type: Calypogeia fissa (L.) Raddi

Key to species of the genus *Calypogeia*

1. Plant small, 1.4-2.0 mm wide, leaves apex bifid, underleaf small, gemmae bicelled.....*C. arguta*.
- 1a. Plant medium to large, 2-3.5 mm wide, leaf entire or bifid..... 2
2. Leaves apex bidentate, obvate, oil bodies 3-7 per cell, whitish, underleaf large, with lateral tooth, tooth 3-5 cells long, hyaline papillae at tip..... *C. lunata*.
- 2a. Leaves entire, apex acute, obtuse, obvate-oblong, oil bodies 1-5 per cell, bluish, underleaf medium, lateral tooth absent..... *C. azurea*

Calypogeia arguta Nees et Mont., in Nees, Naturg. Europ. Leberm. 3: 24. 1838.

(Plate 78. Figs. 1-11)

Plant small to medium, light to whitish green, 15-25 mm long, 1.4-1.9 (2) mm wide including leaves, branching rare, intercalary, dorso-ventrally flattened. Rhizoids numerous, hyaline, in bunch at the bases of the underleaf. Stem oval, 0.15 x 0.24 mm in diameter, 7-8 (-9) cells across; cells undifferentiated, thin walled, cortical cells 14-16 in radial rows, larger than the medullary cells, 23-56.9 μm long, 15.5-37.7 μm wide; medullary cells 19-39.6 μm long, 15.2-24.2 μm wide. Leaves imbricate, sub-opposite, ovate, oblong, 0.7-1.2 mm long, 0.6-0.8 mm wide; broadest at middle or just above the basal region of the leaves; apex bifid, sinus narrow to wide, margin entire; cells non-trigonous, thin walled, hexagonal, rectangular to sub-rectangular; apical cells 28.3-48.0 μm long, 20.9-32.9 μm wide; middle cells 37.5-63.8 μm long, 24.3-37.5 μm wide; basal cells 40-66.0 μm long, 30-41.8 μm wide. Oil bodies circular, elliptical, 2-6 (-7) per cell, cluster like a grapes, finely segmented. Underleaves distinct, small, free, 0.2-0.34 mm long, 0.28-0.38 mm wide, broader than long, sinus wide, 1/2-1/3 deep; tooth 2-3 cells long; underleaves cells thin walled, non-trigonous, rectangular, hexagonal. Male plant on the ventral surface near the underleaf, closely

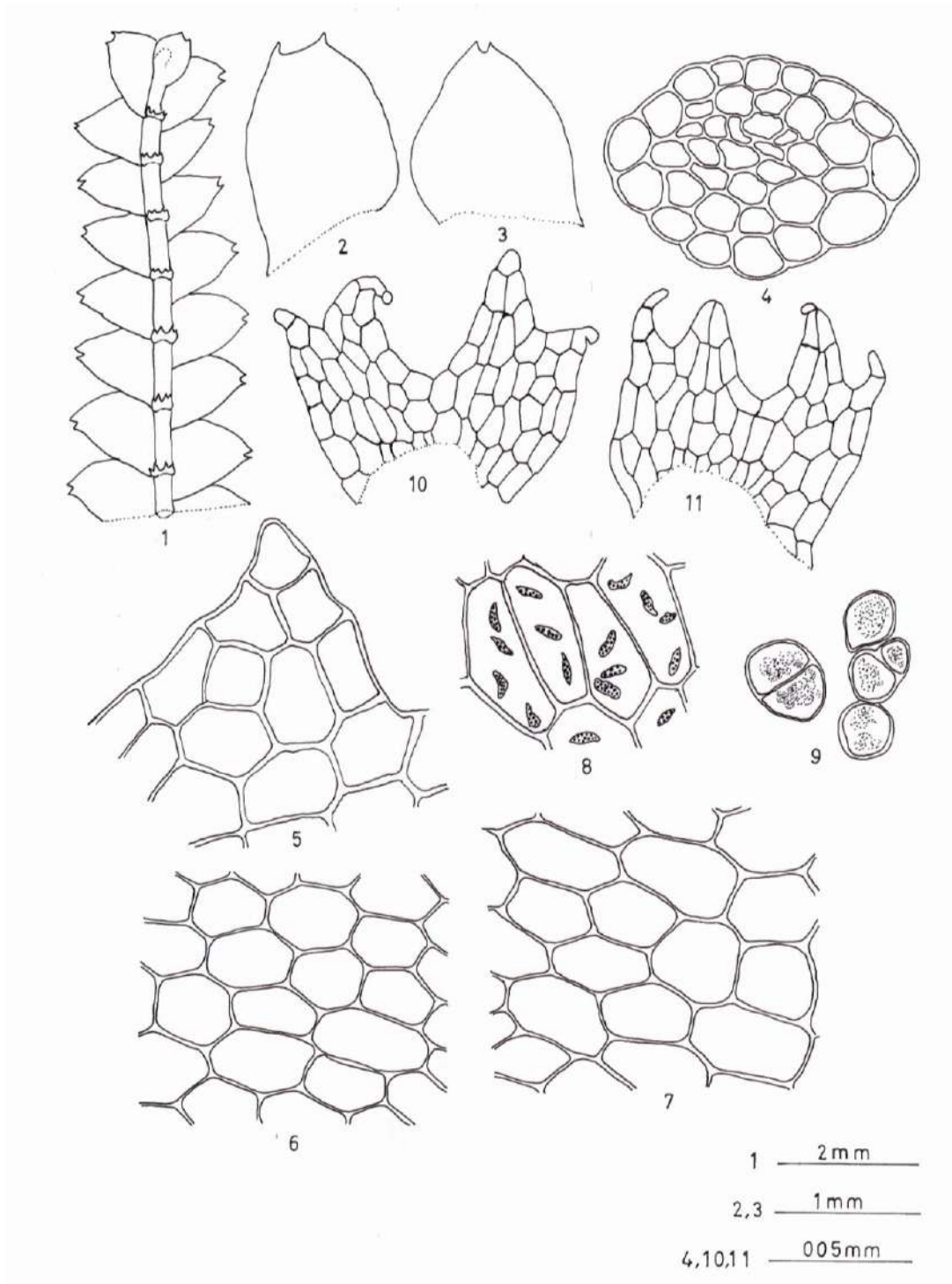


Plate 78. *Calypogeia arguta* Nees et Mont., Figures 1-11.

Figs. 1. A portion of plant in ventral view; 2-3. Leaves; 4. Cross section of stem; 5. Leaf apical cells; 6. Leaf median cells; 7. Leaf basal cells; 8. Oil bodies; 9. Gemmae; 10-11. Underleaves.

packed, sessile to branched, short. Gemmae borne on the apex of the main plant body, gemma two cells.

Habitat: Plants grow on moist shady areas on rocks and soil in association with *Jungermannia* sp., *Marchantia* sp., *Riccardia* sp., *Folioceros* sp., *Heteroscyphus* sp. and Mosses at 900-1500 m asl.

Range: India, China, Java, Korea, Thailand, New Guinea, Africa, Europe, Central America.

Distribution in India: *Eastern Himalaya:* Assam, Meghalaya, West Bengal, Sikkim, Nagaland*; *Central India:* Madhya Pradesh; *South India:* Kerala, Tamil Nadu, Andaman and Nicobar Islands.

Specimen examined: Nagaland: Mokokchung District: changki: KE 10357: 02.11.2010: Kazuhrii Eshuo.

Calypogeia lunata Mitt., Journ. Proc. Linn. Soc. London 5: 107. 1861.

(Plate 79. Figs. 1-11)

Plant medium, whitish green, 15-25 mm long, 2-2.5 mm wide including leaves, fragile, prostrate or sometimes ascending, braching rare, intercalary, rarely terminal, widely spreading. Rhizoids numerous at the bases of underleaf, colourless, transparent, smooth walled and hyaline. Stem oval, brown, 0.15-0.17 x 0.26-0.29 mm in diameter, 9-12 cells across, cells undifferentiated, cortical thin-walled, rectangulate, subquadrate, 22-38.5 μm long, 16.5-26.4 μm wide; lateral cortical cells a little larger, 35.4-45.1 μm long, 24.2-33.5 μm wide; medullary cells thin walled, non-trigonal, quadrate to multi-angulate, 23.1-38.5 μm long, 13.2-24.5 μm wide. Leaves imbricate, sub-opposite to alternate, triangulate, ovate, 1.1-1.2 mm long, 1-1.1 mm wide; apex bifid, bidentate, margin entire, broadest at base; apical tooth triangulate, 2-4 cells long, 3-4 cells broad at base, 1-2 uniseriate cells at apex; cells thin walled, trigonal

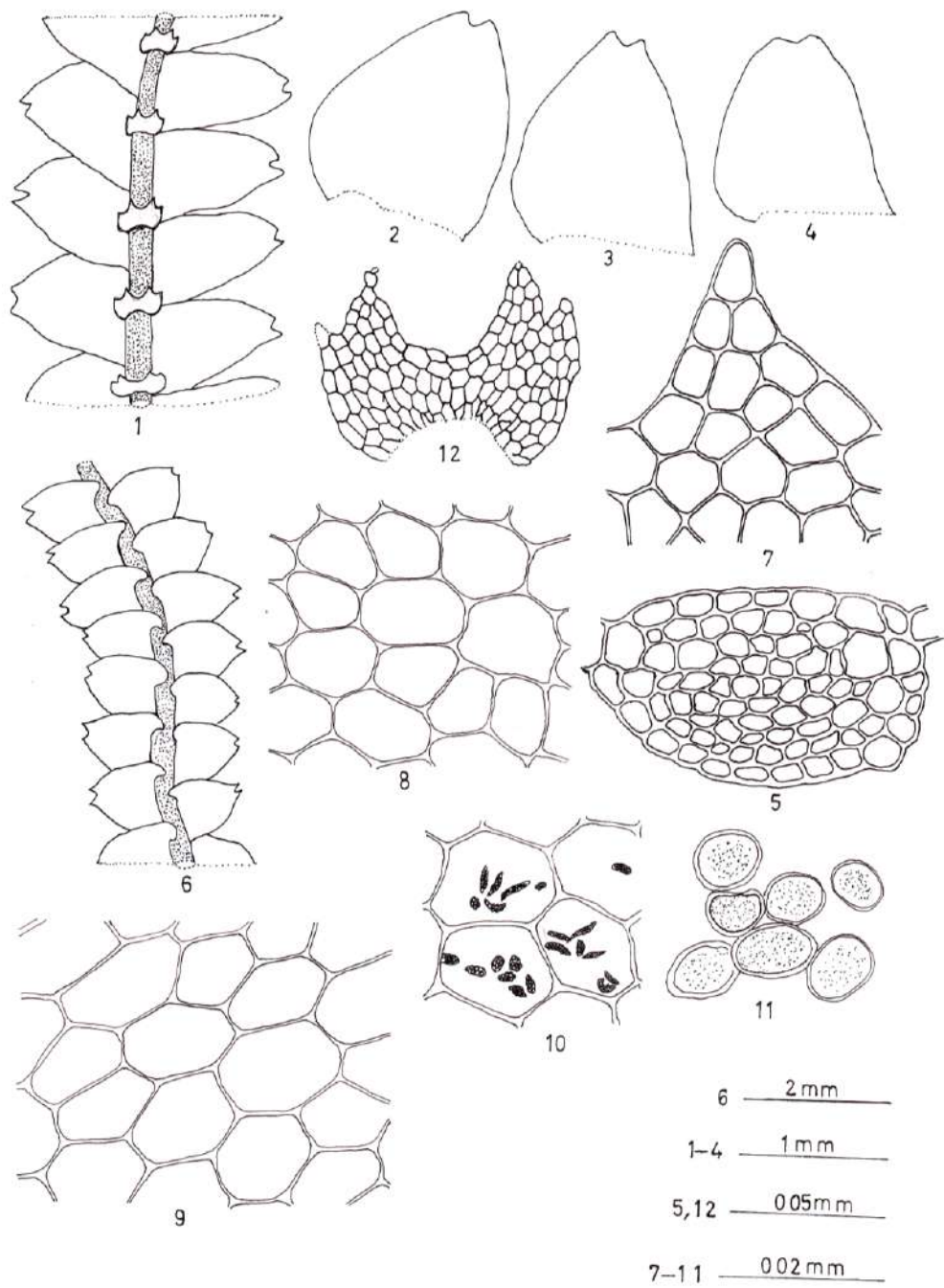


Plate 79. *Calypogeia lunata* Mitt., Figures 1-11.

Figs. 1. A portion plant in ventral view; 2-4. Leaves; 5. Cross section of stem; 6. A portion of plant in dorsal view; 7. Leaf apical cells; 8. Leaf median cells; 9. Leaf basal cells; 10. Oil bodies; 11. Gemmae.

minute, tri-radiate, cells rectangulate to quadrate, subquadrate; apical cells 25.3-35.4 µm long, 16.5-27.5 µm wide, sub-apical cells 27.5-44.0 µm long, 24.2-35.3 µm wide; median cells polygonal, rectangulate to subquadrate, 33.5-57.2 µm long, 27.5-38.5 µm wide; basal cells large, rectangulate, polygonal, 38.5-62.7 µm long, 25.7-41.8 µm wide. Leaves oil bodies 3-7 per cells, elliptical, spherical or sometimes circular, 6.6-14.3 µm long, 3-5.5 µm wide, finely segmented. Underleaves distant, wider than the stem, bilobed, always broader than long, slightly deccurent, sinus wide, subquadrate, 0.4-0.5 mm long, 0.5-0.7 mm wide, sinus ½ deep or more than half of the length, tooth arise from the lateral side, tooth cells 3-5 cells long, 3-4 (-5) cells broad at base, cells slightly trigones, rectangulate, quadrate, polygonal, thin walled, apical cells bearing slime papillae at tip. Gemmae present at shoot apex.

Habitat: Plants grow on moist soils (terricolous), rocks (saxicolous), in association with *Jungermannia* sp., *Cephalozia* sp., and Mosses at 1400-1550 m asl.

Range: India, Nepal, Bhutan, China.

Distribution in India: *Eastern Himalaya:* Sikim, Meghalaya, Assam, West Bengal, Nagaland*; *Western Himalaya:* Uttarankhand

Specimen examined: India: Nagaland: Mokokchung district: Longkhum: KE 10137: 12.09.2009: Kazhuhrii Eshuo.

Calypogeia azurea Stotler et Crotz., Taxon 32: 74. 1983. (Plate 80. Figs. 1-11)

Plant medium, prostrate, green to pale green, bluish green, 20-37 mm long, 2.5-3.2 mm wide including leaves, branched, branching intercalary, terminal, widely spreading, dorso-ventrally flattened. Rhizoids in bunch at the bases of the underleaves and hyaline. Stem oval, 0.18-0.2 x 0.3-0.33 mm in diameter, 9-12 cells across, cells undifferentiated, thin walled, non-trigonus, cortical cells rectangular, smaller than the medullary cells, 13.2-33.0 µm long, 1.32-22.0 µm wide, medullary cells 16.5-41.8

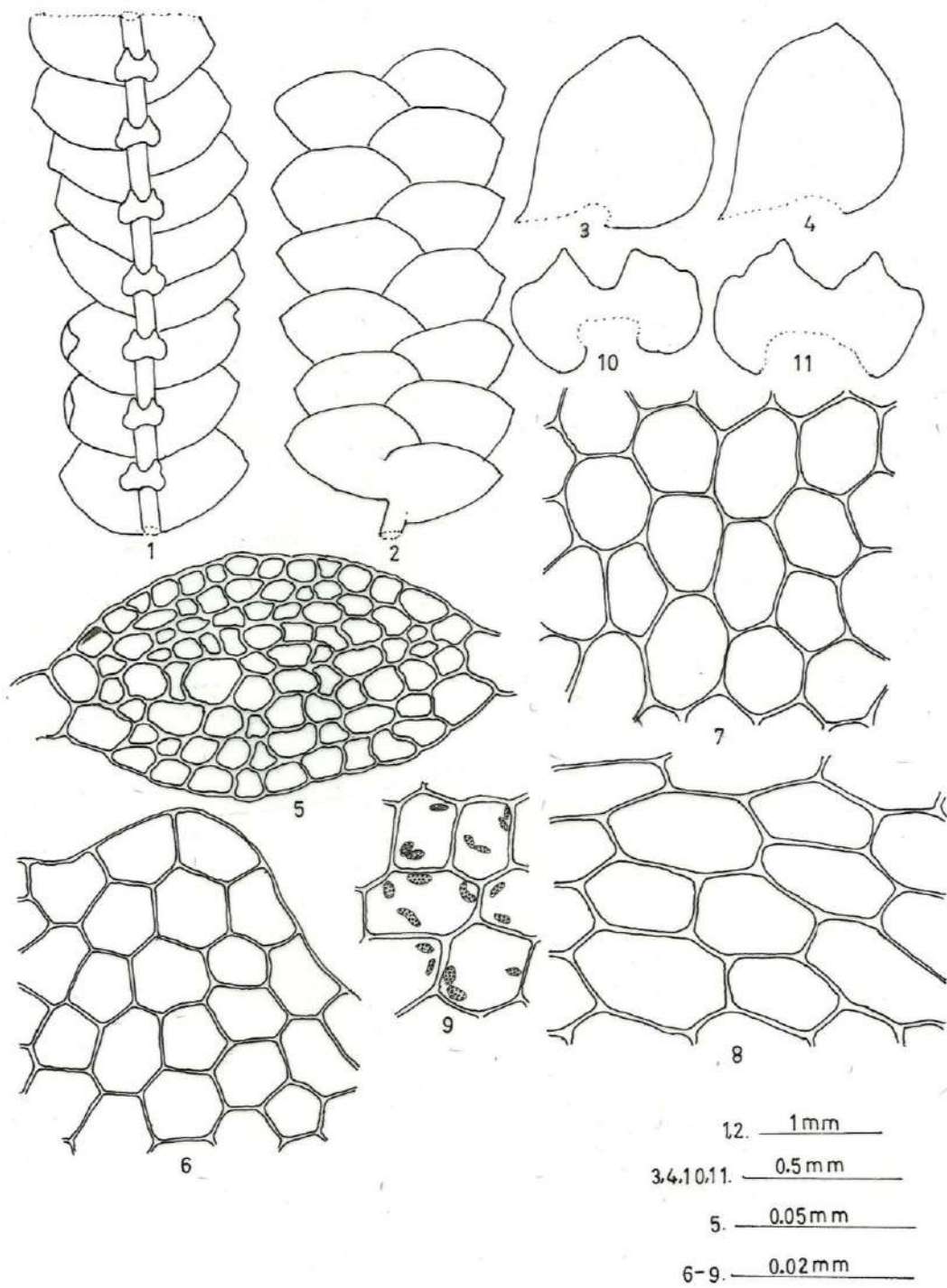


Plate 80. *Calypogeia azurea* Stotler et Crotz., figures 1-11.

Figs. 1. A portion of plant in ventral view; 2. A portion of plant in dorsal view; 3-4. Leaves; 5. Cross section of stem; 6. Leaf apical cells; 7. Leaf median cells; 8. Leaf basal cells; 9. Oil bodies; 10-11. Underleaves.

µm long, 14.3-33.0 µm wide. Leaves closely imbricate, obliquely inserted, ovate-oblong, cordate, shortly decurrent, apex short acute to obtuse, margin entire, 1.8-2.6 mm long, 2.-2.8 mm wide, slightly broader than long, broadest at base; cells thin walled, non-trigonus, hexagonal, polygonal; apical cells 30.8-44.0 µm long, 23.1-35.2 µm wide; middle cells 37.5-66.0 µm long, 25.4-42.9 µm wide, cells thin walled, non-trigonus, hexagonal, polygonal; basal cells thin walled, hexagonal, rectangular to polygonal, non-trigonus, 39.6-70.5 µm long, 25.4-49.5 µm wide. Oil bodies 1-5 per cell, circular, elliptical, spherical, bluish, finely segmented, 4-4-8.8 µm in diameter. Underleaves distant, free, bilobed, margin entire, 0.6-0.7 mm long, 1-1.4 wide, wider than long, orbicular, sinus wide, ½ or more bilobed, sinus lunate-obtuse.

Habitat: Plants grow on moist soil and rocks in association with *Jungermamnnia* sp., *Heteroscyphus* sp., *Riccardia* sp. and mosses at 1700-2500 m asl.

Range: India, Europe

Distribution in India: *Eastern Himalayas:* Meghalaya, Sikkim, West Bengal, Nagaland*; *Western Himalaya:* Uttarakhand; *South India:* Kerala, Tamil Nadu.

Specimen examined: Nagland: Kohima District: Khuzama: KE 10174: 16.11.2009: Kazhuhrii Eshuo.

Genus: *Metacalypogeia* (Hatt.) Inoue

Metacalypogeia (Hatt.) Inoue, J. Hattori Bot. Lab. 21: 231. 1959.

Plants pale green to brownish green, green, prostrate, simple or sparsely branched, branches postical-intercalary. Leaves contiguous to loosely imbricate, alternate to distant, incubous, slightly obliquely spreading, ovate-oblong, bidentate or entire, apex acute or obtuse, cells opaque, thin or thick walled, trigones small to large, often bulging and nodulose; cuticle verrucose to slightly smooth. Underleaves distant, transversely to sinuately inserted, semi-circular, orbicular, reniform, apex recurved,

bilobed or unlobed, wider than long; cells thin to thick walled, trigones small to large. Rhizoids numerous, hyaline, forming fascicles at the bases of the underleaf. Asexual reproduction lacking or absent. Monoicous or dioicous. Male inflorescence small, emerging from axil of the underleaf, bracts in 2-7 pairs, Antheridium single per bract. Perianth absent. Marsupium obovoid to cylindrical, with densely rhizoids. Sporophyte with long seta upto 20 mm long, and about 8 cells in diameter in cross section; capsule oblong, blackish-brown, capsule bi-stratose, inner layer with thin-walled with nodular thickenings on tangential and alternate longitudinal walled. Spores 13-17 μm in diameter, brown, minutely punctuate. Elaters bi-spiral and brown.

Type: Metacalypogeia cordifolia (Steph.) Inoue

Metacalypogeia alternifolia (Nees) Grolle, Oesterr. Bot. Zeitschr. 111: 185. 1964.

(Plate 81. Figs. 1-15)

Plants small to medium, light green to brownish green, upto 40 mm long, 1.5-2.2 mm wide including leaves, branched, branching postical lateral-intercalary, rarely terminal. Rhizoids numerous, forming fascicles at the bases of the underleaf, hyaline and transparent. Stem oval 139-150 x 204-211 μm in diameter, 10-12 cells across in cross section, cortical cells brownish, smaller than the medullary cells, 10-27 x 8-16 μm ; medullary cells 14-30 x 12-18 μm , thin walled, non-trigonus. Leaves contiguous to slightly imbricate, alternate to opposite, ovate-oblong, triangular, 0.8-1.2 mm long, 0.6-0.8 mm wide, apex rounded to truncate, bifid or entire, sinus wide to narrow, margin entire; apical leaf cells 20-35 x 12-21 μm , thin-walled, trigones triangulate, intermediate thickenings absent; median cells ovular to sub-quadrate, 27-49 x 21-30 μm , trigones triangulate, intermediate thickenings absent; epidermal cells rectangular, sub-quadrate, 22-28 x 15-20 μm ; basal cells circular, sub-quadrate, 26-52 x 17-32 μm , trigones triangulate, intermediate thickenings absent; cuticle verrucose. Oil bodies (-

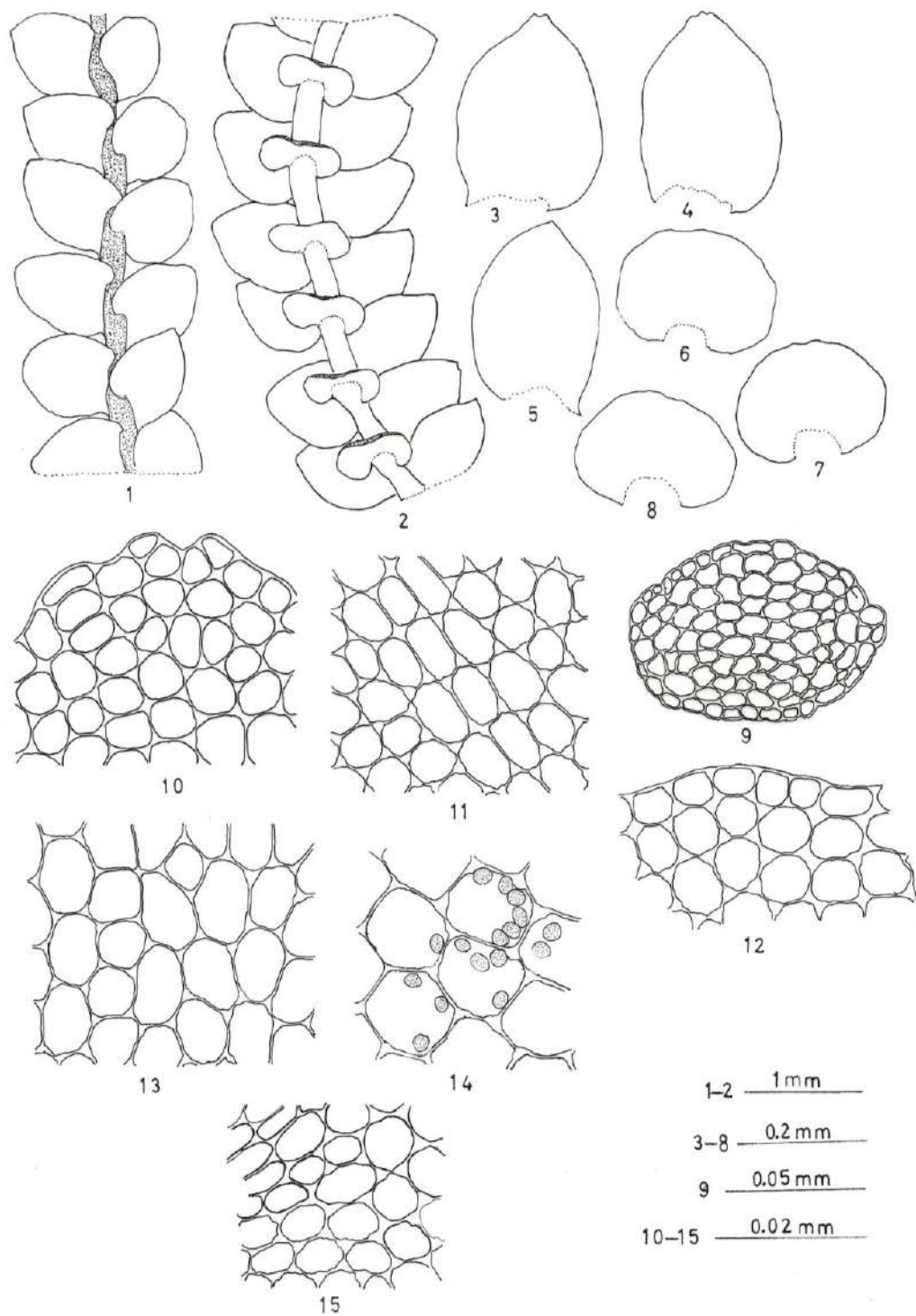


Plate 81. *Metacalypogeia alternifolia* (Nees) Grolle, Figures 1-15.

Figs. 1. A portion of plant in dorsal view; 2. A portion of plant in ventral view; 3-5. Leaves; 6-8. Underleaves; 9. Cross section of stem; 10. Leaf apical cells; 11. Leaf median cells; 12. Leaf marginal cells; 13. Leaf basal cells; 14. Oil bodies; 15. Underleaf basal cells.

4) 5-9 per leaf cell, circular, oval to slightly elliptical, 4-11 x 4-7 µm in diameter, finely segmented. Underleaves large, distant, free, entire, apex rounded, basal cordate, orbicular, reniform, 0.36-4-.042 mm long, 0.7-0.9 mm wide, wider than long, cells trigonous and like the leaves cells. Androecia and gynoecia not seen.

Habitat: Plants grows in moist rocks (saxicolous) in association with *Heteroscyphus* sp., *Scapania* sp., *Jungermannia* sp. and Mosses at 2300-2700 m asl.

Range: India, Bhutan, China, Nepal, Taiwan,

Distribution in India: *Eastern Himalaya:* Meghalaya, West Bengal, **Nagaland***; *Western Himalaya:* Uttar Pradesh, Himachal Pradesh.

Specimen examined: Nagaland: Kohima District: Khonoma: 19.03.2011: KE 10431: Kazhuhrii Eshuo.

FAMILY: JUNGERMANNIACEAE C. Rchb.

Jungermanniaceae C. Rchb., Bot. Damen: 256. 1828.

Plants small-medium, varying from green to blackish green, brownish to purplish; stem erect to creeping; branching either terminal or intercalary. Rhizoids scattered over the ventral side of the stem, hyaline, pinkish. Leaves succubously inserted, or sometime transversely inserted, often alternate, unlobed, entire, cells thin walled, trigonous, trigones small to bulging; cuticle striolate to verrucose; oil bodies 1-25 per cell, underleaves absent or small and lanceolate, unlobed (bilobed in *Notoscyphus*); gemmae present. Monoicous or dioicous. Androecia and gynoecia on leading axes; sporophytes enclosed by a shoot calyptras and perianth; perianth terete, smooth, often plicate near the mouth, eith the mouth contracted or beak; capsule sub-spheroidal to ellipsoidal, with the wall 2- startose; spores brown-reddish brown, finely papillose, rarely irregularly reticulate. Elaters free, tapering at ends, with 1-3 spiral thickenings.

Genus: *Jungermannia* L.

Jungermannia L. Spec. Pl. 1131. 1753

Plants yellowish green to olive green, often tinged with brown, prostrate, ascending to erect, or creeping, branched, branching usually lateral-intercalary, simple. Rhizoids scattered, colourless or brownish present throughout the ventral surface on the postical base of the leaves. Leaves succubous, obliquely – transversely inserted, alternate, orbicular, oblong-rectangular, ovate or oblong-ovate, rounded to retuse apex with entire margin; cells thin-walled, trigones small to bulging, nodulose. Underleaves absent. Gemmae present, usually one-celled, ovoid-ellipsoid or absent. Monoicous or dioicous. Androecia terminal or intercalary, spicate; bracts saccate at base, squarrose, recurved above; antheridia 1-2 per bract with bi-seriate stalk. Gynoecia terminal; bracts similar to leaves; bracteoles absent. Perianth exerted, fusiform, periform, cylindrical or clavate, closed or contracted mouth, sometime beaked, with or without plicae. Capsule ovoid; wall 2-4 stratose; cells of outer layer with nodular thickenings, those of the inner with semi-annular thickenings. Spores light to dark brown, vermiculose. Elaters with bi-spiral thickenings.

Type: *Jungermannia leiantha* Grolle

Key to species of the genus *Jungermannia*

1. Plants erect, stem 10-12 cells across, leaf cells trigonous..... *J. sikkimensis*
- 1a. Plant sub-erect, 8-9 cells across, leaf cells trigones absent..... *J. rubripunctata*

Jungermannia sikkimensis Steph., Spec. Hepat. 6: 92. 1917. (Plate 82. Figs. 1-9)

Plants medium, erect, 5-10 mm long, 2-3 mm wide including leaves, light green to yellowish green, brownish green, branched or unbranched, branching postical-intercalary, postical-basalary, rhizoids numerous on ventral surface and present throughout the entire length of the stem, purplish, hyaline or sometimes transparent. Stem circular to oval shaped, 0.2-0.25 x 0.25-0.3 mm in diameter, 10-12 cells across, thin-walled, non-trigonus, cortical cells slightly smaller than the medullary cells. Leaves succubously inserted, distant, alternate to sub-opposite, oblong-ovate, 1.7-2 mm long, 1.5-1.6 mm wide, apex rounded, entire; marginal cells 22-37 x 18-27 μm thin-walled, trigones small, triangular; median cells 20-30 x 33-49 μm , hexagonal, rectangular, trigones small, thin-walled; basal cells 25-43 x 35-74 μm , sub-quadrate, trigones small, distinct, thin-walled. Oil bodies 2-56 per cell, circular, elliptical, spherical, 5-7 x 6.6-23 μm in diameter, finely to coarsely segmented. Perianth terminal, exserted, fusiform, mouth plicae; female bracts 1 pair, slightly larger than the vegetative leaves. Male inflorescence not seen.

Habitat: Plants grows on moist shady areas (terricolous) along with *Cephalozia* sp, *Fossombronia* sp. and Mosses and herbs at 1400-1600 m asl.

Range: India

Distribution in India: *Eastern Himalayas:* Sikkim, Meghalaya and Nagaland*.

Specimen examined: Nagaland: Kohima district: Kohima: KE 10113: 20.07.2009: Kazhuhrii Eshuo.

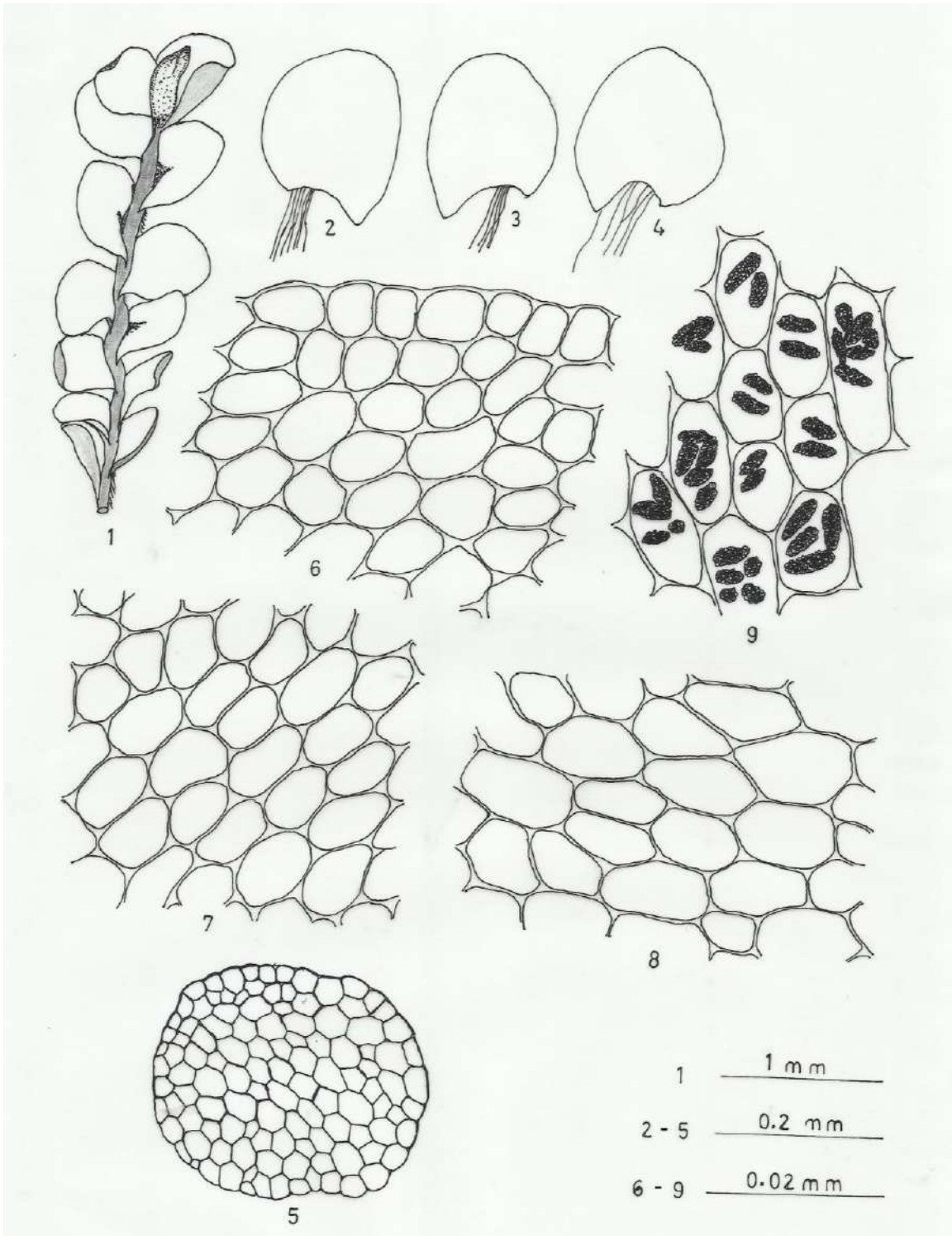


Plate 82. *Jungermannia sikkimensis* Steph., Figures 1-9.

Figs. 1. A portion of plant in dorsal view; 2-4. Leaves; 5. Cross section of stem; 6. Leaf apical cells; 7. Leaf median cells; 8. Leaf basal cells; 9. Oil bodies.

Jungermannia rubripunctata (Hatt.) Amak., J. Hattori bot. Lab. 22: 38. 1960.

(Plate 83. Figs. 1-10)

Plants small to medium, prostrate to erect, light green to yellowish green, 10-20 mm long, 1-2 mm wide including leaves, simple or branched. Rhizoids numerous, present throughout the ventral surface of the stem and near the bases of the leaves, purplish, hyaline or transparent. Stem oval to circular, 0.15-0.2 x 0.15 μm in diameter, 8-9 cells across, cortical cells thin-walled, smaller than the medullary cells, 10-30 x 14-20 μm ; medullary cells thin-walled, 22-44 x 17-30 μm , non-pigmented. Leaves succubously inserted, distant to contiguous, alternate, oblong-ovate, apex rounded to sub-obtuse, posterior margin slightly decurrent, 0.7-0.9 mm long, 0.5-0.6 mm wide; marginal cells 20-40 x 15-25 μm , apical cells 30-40 x 20-25 μm , median cells 35-50 x 25-30 μm , basal cells 55-70 x 25-40 μm , cells thin-walled, non-trigonous. Oil bodies 3 (-2)-8 per cell, elliptical to spherical, circular, spindle-shaped, 6-16 x 4.4-8 μm in diameter, finely to coarsely segmented. Mature sporophyte not seen.

Habitat: Plants grows in moist shady areas (terricolous) along with *Heteroscyphus* sp., *Cephalozia* sp., *Jungermannia* sp. and Mosses and herbs at 1400-1600 m asl.

Range: India. Japan, Nepal.

Distribution in India: *Eastern Himalaya:* Meghalaya, West Bengal-Darjeeling, Nagaland*.

Specimen examined: Nagaland: Kohima district: Kohima: 20.07.2009: KE 10114: Kazuhrii Eshuo:

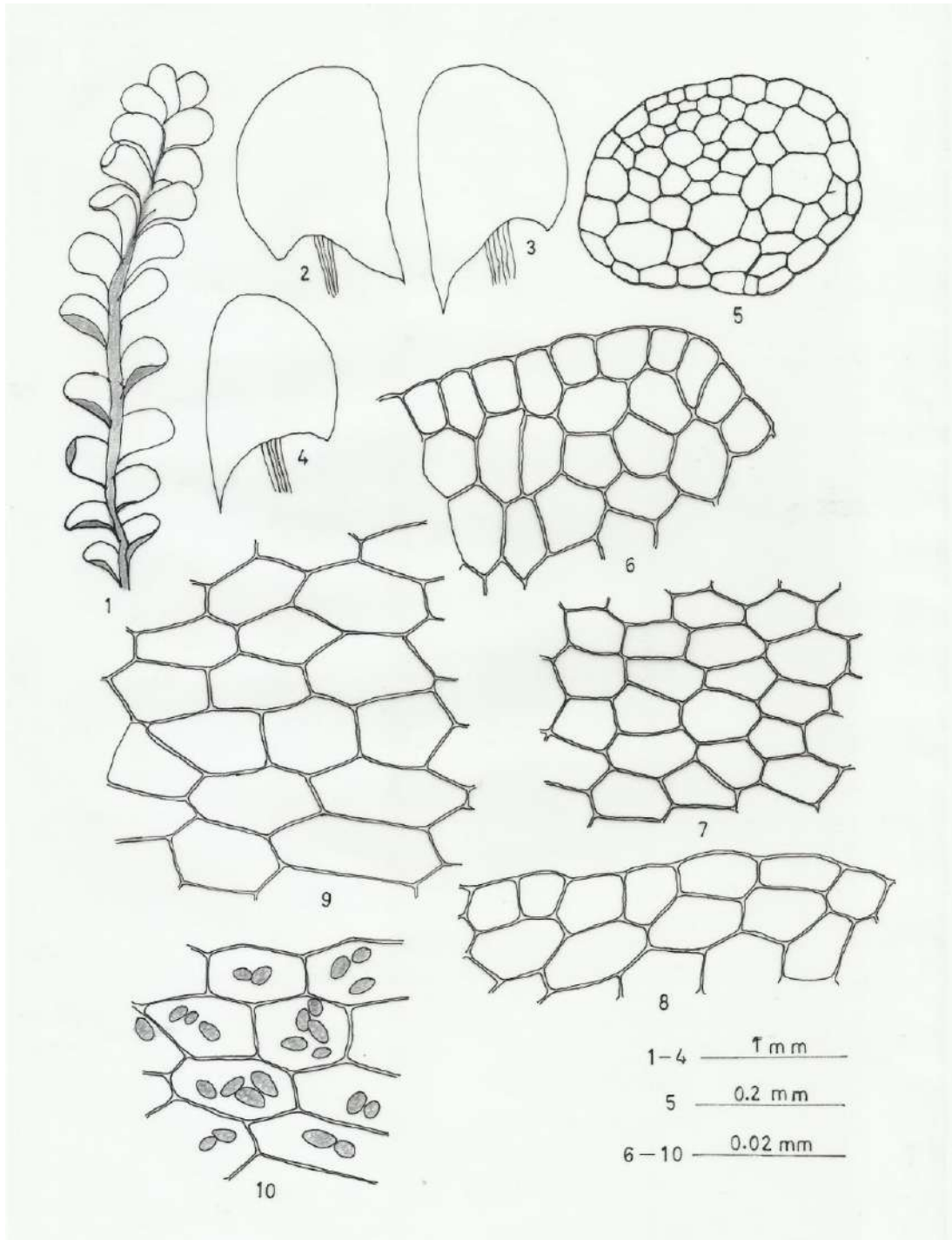


Plate 83. *Jungermannia rubripunctata* (Hatt.) Amak. Figures 1-10.

Figs. 1. A portion of plant in dorsal view; 2-4. Leaves; 5. Cross section of stem; 6. Leaf apical cells; 7. Leaf median cells; 8. Leaf marginal cells; 9. Leaf basal cells; 10. Oil bodies.

SOLENOSTOMATACEAE Stotler & Crand.-Stotl.

Solenostomataceae Stotler & Crand.-Stotl., *Edinburgh J. Bot.* 66 (1): 190. 2009.

Plants small to medium, prostrate to suberect, erect, leaves succubous, undivided or shallowly bilobed, with the margin entire; underleaves usually absent or present in some taxa, small, bifid; rhizoids scatter on ventral surface of the stem, hyaline and transparent. Androecia and gynoecia on leading axes, sporophytes enclosed by a shoot calyptras and stem perigynium perianth complex, sometimes with recipient marsupium development; perianth reduced, terete below, pluriplicate above, with the mouth gradually contracted, rarely beaked. Capsule subspheroidal to ovoid or shortly ellipsoidal, with the walls 2-4 stratose, innerwalls with semianular thickenings.

Type: Solenostoma Mitt.

Key to species of the genus *Solenostoma*

1. Leaves distant, sub-opposite, leaves orbicular, ovate, trigones small to medium, triangular, oil bodies 3-9 per cell..... *S. truncatum*
- 1a. Leaves closely imbricate, leaves ligulate to triangular, trigones large, nodulose, bulging, oil bodies 1-2 per cell..... *S. comata*

Solenostoma truncatum (Nees) R.M. Schust. ex Vana & D.G. Long, *Hepat. Jav.* 29. 1830; Amakwa, J. Hattori *Bot. Lab.* 35: 382. 1972; Vana, J. Hattori *Bot. Lab.* 35: 317. 1972; Vana, J. Hattori *Bot. Lab.* 38: 317. 1974. **(Plate 84. Figs. 1-20)**

Plants light green to green, dull brown in dry herbarium, 20-40 mm long, 1.5-2.5 mm wide including leaves, prostrate, rarely erect, sub-ascending, branched or unbranched, intercalary; rhizoids numerous, hyaline and transparent. Leaves very variable, from orbicular, ovate to nearly sub-quadrate, widely ovate to ligulate, plane or slightly concave, not decurrent, margin entire, apex rounded or truncate or obtuse; apical cells quadrate to rectangular, hexagonal, 41-50 x 30-44 μm , median cells sub-

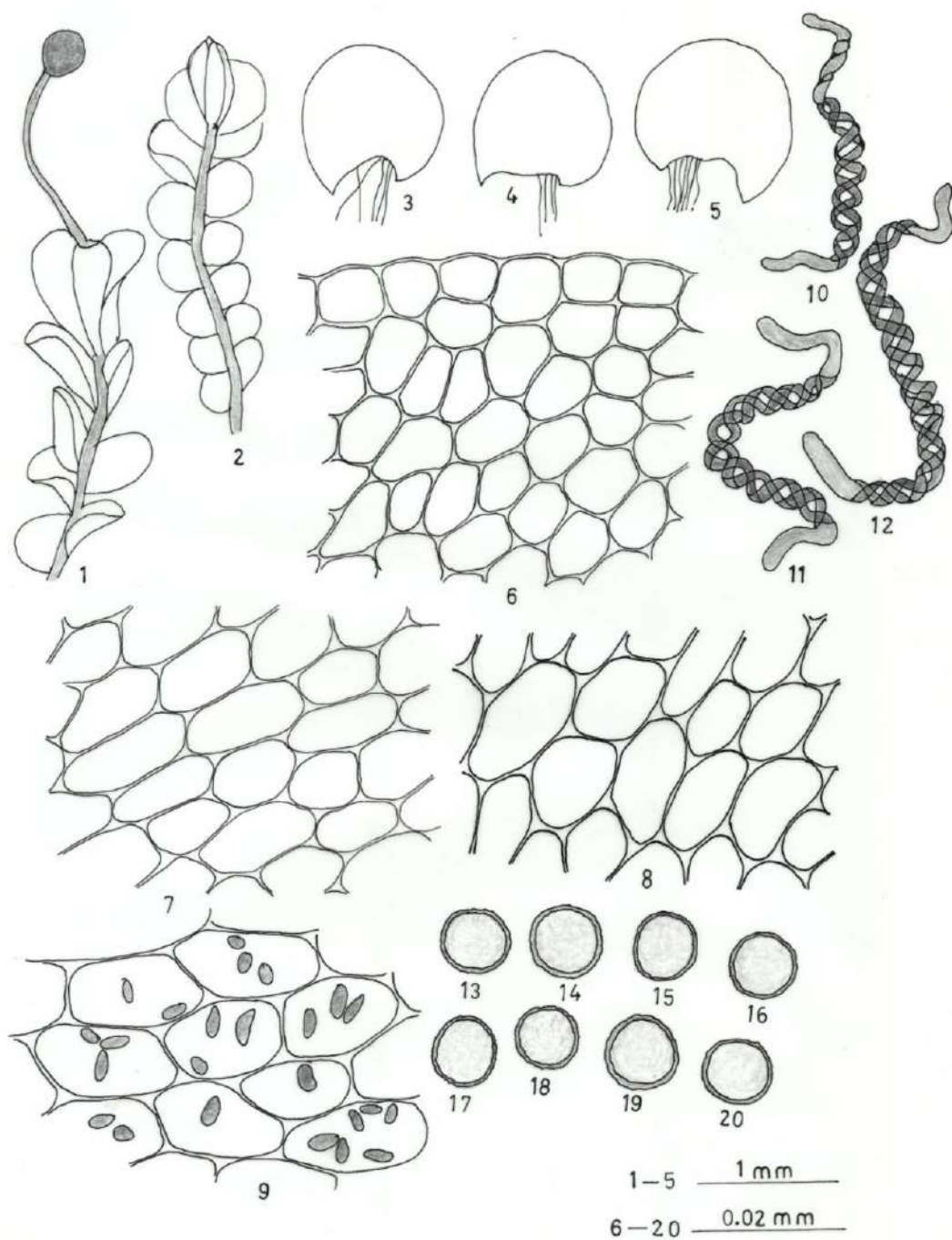


Plate 84. *Solenostoma truncatum* (Nees) R.M. Schust. ex Vana & D.G. Long,

Figures 1-20.

Figs. 1. A portion of plant with sporophyte; 2. A portion of plant in ventryal view; 3-5. Leaves; 6. Leaf apical cells; 7. Leaf median cells; 8. Leaf basal cells; 9. Oil bodies; 10-12. Elaters; 13-20. Spores.

quadrate, hexagonal, 40-70 x 25-45 μm , basal cells sub-quadrate, 60-90 x 35-55 μm , trigones small to medium, cells thin-walled; cuticle verrucose. Oil bodies 3-9 per cell, circular, spherical-elliptical, 6-12 x 5-8 μm in diameter, finely to coarsely segmented. Female bract in one pair, similar to lateral leaves, perianth exerted, seta long, spores light greenish brown, finely papillose, 12-16 μm in diameter; elaters 8-10 μm in diameter, 95-125 μm long, bi-spiral.

Habitat: Plants grows on moist soils and rocks pure patches or in association with *Cephalozia* sp., *Heteroscyphus* sp., *Asterella* sp. and Mosses at 900-1600 m asl.

Range: India, Nepal, Sri Lanka, Java, Borneo, Japan.

Distribution in India: *Eastern Himalaya:* Meghalaya, Sikkim, Assam, West Bengal, Nagaland*.

Specimen examined: Nagaland: Mokokchung District: KE 10123: Khensa: KE 10220: Kazhuhrii Eshuo.

Solenostoma comata (Nees) C. Gao, Hepat. Java. 78. 1830. (Plate. 85. Figs. 1-9)

Plants medium, light green to light yellowish green, 20-40 mm long, 1.5-2.5 mm wide including leaves, branching rare, intercalary, sub-erect to prostrate; rhizoids numerous, in tuft, hyaline or pinkish near the basal part, transparent, arises from the bases of the leaf. Stem ovular, 0.14-0.15 x 0.215-0.228 mm in diameter, 10-13 cells across, differentiated into outer thick cortex and thin medulla region, cortical cells 2-3 layers, brownish red, 10-19 x 13-25 μm , medullary cells 9-16 x 11-22 μm . Leaves closely imbricate, ligulate to triangular, oblong-ovate, 1-1.3 mm long, 0.7-0.85 mm wide, apex rounded, obtuse, or sometime retuse, margin entire, papillose; apical cells 12-25 x 8-18 μm , sub-quadrate, trigones small; median cells 18-36 x 12-22 μm , sub-quadrate, polygonal, trigones medium to large, bulging; basal cells 23-48-19-26 μm , sub-quadrate, trigones large, bulging, nodulose; marginal cells 18-26 x 9-14 μm ,

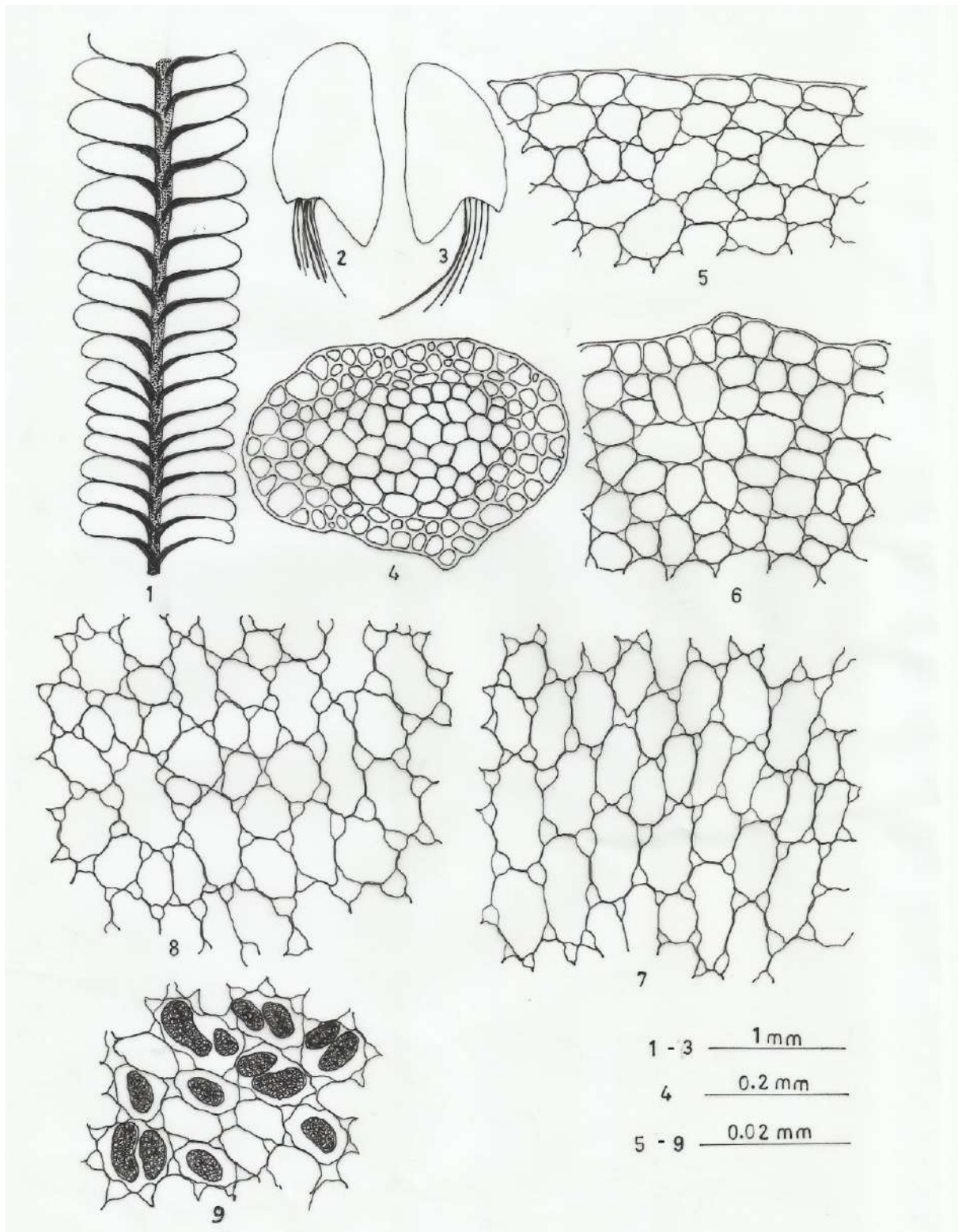


Plate 85. *Solenostoma comata* (Nees) C. Gao, Figures 1-9.

Figs. 1. A portion of plant in ventral view; 2-3. Leaves; 4. Cross section of stem; 5. Leaf marginal cells; 6. Leaf apical cells; 7. Leaf median cells; 8. Leaf basal cells; 9. Oil bodies.

rectangular, trigones small; cuticle papillose. Oil bodies 1-2 per cell, large, 17-32 x 9-17 µm in diameter, finely to coarsely segmented. Male and female inflorescence not seen.

Habitat: Plants grows on moist shady rocks (saxicolous) in association with *Lejeunea* sp., *Jungermannia* sp., *Plagiochila* sp. and Mosses at 900-1300 m asl.

Range: India, Thailand, Sumatra, China, Philippines, Java, Japan and Taiwan.

Distribution in India: *Eastern Himalaya:* Sikkim, Meghalaya, **Nagaland***.

Specimen examined: Nagaland: Mokokchung District: Changki: 02.11.2010: KE 10344: Kazhuhrii Eshuo.

FAMILY: GEOCALYCEAE H. Klinggr.

GEOCALYCEAE H. Klinggr., *Höh. Crypt. Preuss.*: 34. 1858.

Plants small to medium, leaves succubous, undivided or 2-lobed, with the margin entire; underleaves bifid, with the margins entire or toothed (undivided, lanceolate in *Harpanthus*), frequently connate with leaves; rhizoids scattered, but more abundant near the underleaves; branches ventral, of *Bazzania*-type; androecia and gynoecia on abbreviated ventral branches; sporophytes enclosed by a shoot calyptras and hollow marsupium of the *Calypogeia*-type; perianth absent or present at the top of the marsupium, 3-keeled with the third keel ventral; capsules ovoid to cylindrical; walls 2 (4 to 6 layered in *Saccogynidium*) and the epidermal cells with 1-phase of ontogeny; gemmae sometimes present.

Type: Geocalyx Nees

Key to genera of the family Geocalyceae

1. Leaves dentate, cuticles densely papillose, non-triangular..... *Saccogynidium*
- 1a. Leaves entire, cuticle smooth, cells triangular..... *Notoscyphus*

Genus: *Saccogynidium* Grolle

Plants small to medium, light yellowish green to olive green or pale green, prostrate, fragile; leaves succubous, leaf cuticles densely papillose, except for the spinous 1-2 cells at the leaf apex where the cuticle is smooth; 8-20 oil bodies per leaf cell; underleaves plane or somewhat concave with wide lobes and sometimes toothed at the underleaf base; marsupium 4-5 layers of cells; spores twice the diameter of the elater.

Saccogynidium irregularospinum C.H. Gao, T. Cao & M.J. Lai in *Bryologist* 104 (1): 129. 2001. **(Plate 86. Figs. 1-12)**

Plant small, fragile, whitish yellowish green, dorso-ventral, 10-25 mm long, 0.5-1.2 mm wide including leaves, widely spreading, branched, branching intercalary, rarely terminal. Rhizoids hyaline, in bunch at the base of the underleaves. Stem oval, 75.2-79.2 x 108-116.5 μm in diameter, 6 cells across, cortical cells in 12-13 radial rows, thin walled, 17.5-27.6 μm long, cuticle finely papillose; medullary cells thin walled, 10-14 rows of cells, 16.8-26.2 μm long, 9.1-19.1 μm wide, medullary cells smaller than the cortical cells. Leaves distant to contiguous, contiguous to slightly imbricate, orbicular, rectangular, ovate, 0.43-0.47 mm long, 0.48-0.5 mm wide; wider than long, denticulate, dentition 2-4 per leaf or sometime entire; 2-6 cells long, 2-4 uniseriate cells at apex; cells thin walled, non-trigonous, rectangulate, hexagonal; apical cells 21.9-33.7 μm long, 15.2-25.8 μm wide, middle cells 22.1-37.9 μm long, 15.2-26.2 μm wide; basal cells 24.9-42.6 μm long, 20-28.7 μm wide; leaves cuticle finely papillose; leaves oil bodies circular, rounded, 3-7 per cell. Underleaves distant, small, free, 0.22-0.28 mm long, 0.15-0.2 mm wide, sinus wide, deeply bilobed, 8-9 cells wide, 1-2 cells long in lamina; 1 lateral tooth arises from one lobed or sometime both; 4-8 cells long, 2-4 cells broad at base, 2-5 uniseriate cells at apex; cells non-

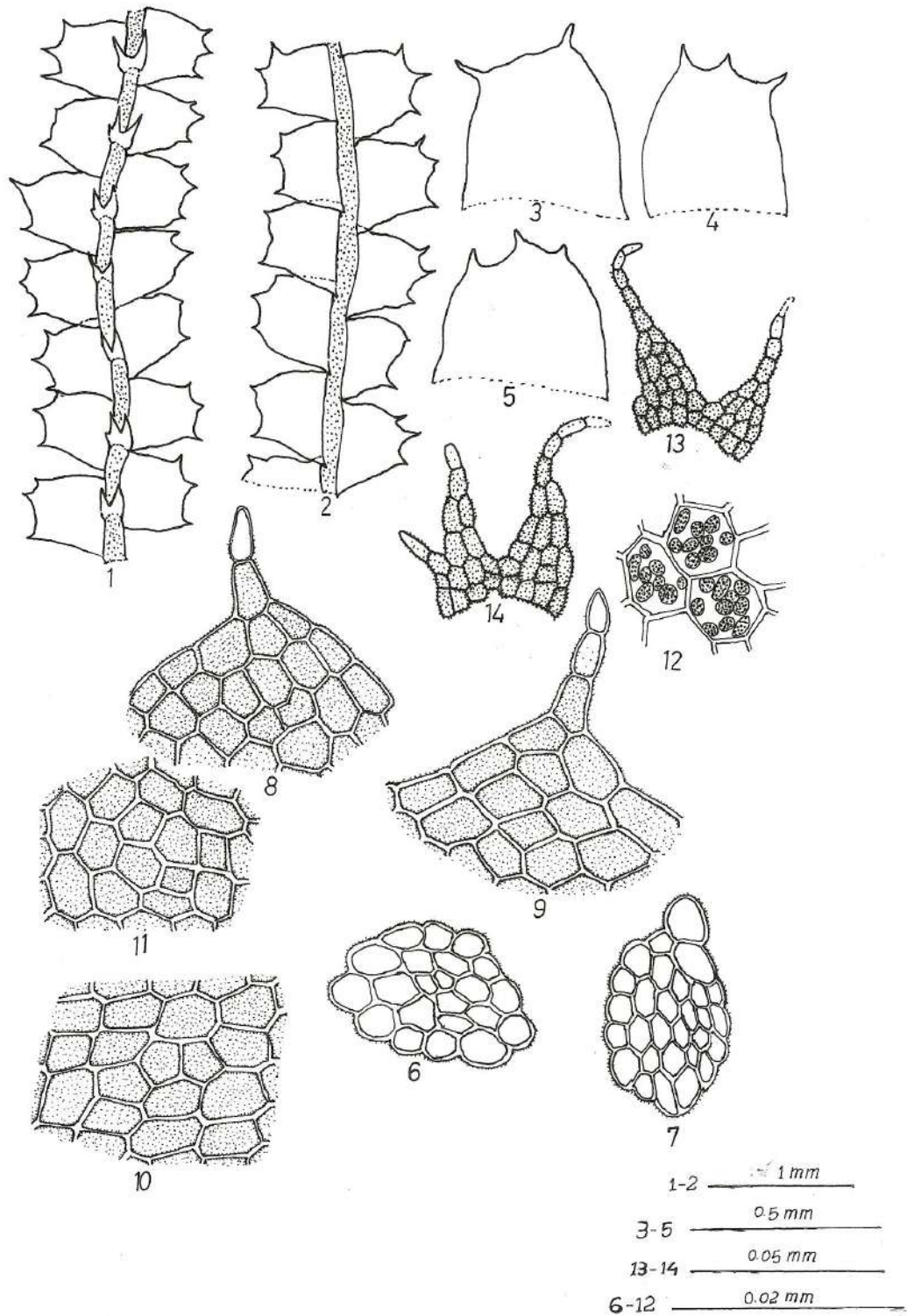


Plate 86. *Saccogynidium irregularospinum* C.H. Gao, T. Cao & M.J. Lai; Figures 1-12.

Figs. 1. Portion of plant in ventral view; 2. Portion of plant in dorsal view; 3-5. Leaves; 6-7. T/S of stem; 8-9. Apical leaves cells; 10. Leaf basal cells; 11. Leaf median cells; 12. Oil bodies; 13-14. Underleaves.

trigonous, thin walled, rectangular, quadrate, hexagonal; cuticles cells finely papillae except at the apical 1 or rarely 2 cells. Androecia and gynoecia not seen.

Habitat: Plants grow on soils (terricolous), on moist rocks (Saxicolous) in association with *Heteroscyphus parvus*, *H. argutus*, *Jungermannia* sp., Mosses along the roadside of moist shady areas at 900-1400 m asl.

Range: India, China.

Distribution in India: *Eastern Himalaya*: Sikkim, **Nagaland***.

Specimen examined: India: Nagaland, Mokokchung district, Changki (2300- 3018 feet): 02.11.2010: KZR 10341: Kazhuhrii Eshuo.

Genus: *Notoscyphus* Mitt.

Notoscyphus Mitt., in Seeman, Fl. Viti. 407. 1871.

Plants light green to light yellowish green, or brownish green, prostrate, sparsely branched, branching ventral intercalary. Stem cylindrical, 7-10 cells across; cortical cells and medullary cells differentiated or undifferentiated, usually thick or thin walled. Leaves imbricate, patent, subopposite to alternate, succubous, broadly ovate-quadrate, apex entire, obtuse, truncate-rotundate or even occasionally retuse, obliquely to subobliquely or horizontally inserted. Leaf cells usually with triangular nodulose trigones, thick or rarely thin walled, underleaves small to medium, 1/2 or more bifid, free, oblong-triangular, sinus obtuse acute, lobes slightly divergent, 4-7 cells long and 2-3 cells wide at base. Rhizoids in bunch at the base of the underleaf. Male inflorescence terminal on short or below the female inflorescence with 4 or more pairs of bracts; male bracts bilobed, ventricose, with dorsal lobules, dorsal lobes, small, oblong with obtuse to rounded apex; ventral lobes large, almost similar to leaves, ovate with obtuse apex. Female inflorescence terminal on short ventral intercalary branches or on main stem. Perianth absent. Stem tip becoming bulbous to

form a pendent perigynium. Perigynium short, fleshy, pendent at right angles to stem. Perichaetial bracts 2-3 pairs, large, irregularly lobed, inner most bracts lacinate, forming a terminal head; bracteoles 1-2 with entire to divided margin.

Type: Notoscyphus lutescens (L. et L.) Mitt.

Notoscyphus darjeelingensis Uadr et A. Kumar, J. Hattorii Bot. Lab. 49: 250. 1981.

(Plate 87. Figs. 1-20)

Plants light yellowish green to light green green, light brown in dry herbarium, small to medium, branched, branching intercalary, 13-24 mm long, 1-1.5 mm wide including leaves. Rhizoids in tuft at the bases of the underleaf, hyaline and transparent. Stem 6-8 cells across, 90-103 x 110-145 µm in diameter, cells thick walled, 11-25 x 11-22 µm in diameter. Leaves imbricate to closely imbricate, slightly appressed, or spreading, oblong-ovate, 0.6-0.8 mm long, 0.5-0.65 mm wide; apex obtuse, rounded, margin entire, leafcells trigonous, trigones tri-radiate to triangular; apical leaf cells 25-34 µm long, 19-29 µm wide, median cells 27-54 µm long, 19-29 µm wide, basal cells 22-55 µm long, 20-28 µm wide, epidermal cells 21-33 µm long and 21-23 µm wide. Oil bodies circular, ellipsoidal, 3-6 per cell, finely to coarsely segmented, 6.3-20.4 x 6.3-10.1 µm in diameter. Underleaves small, distant, free, bifid, 0.3-0.4 mm long, 0.15-0.2 mm wide, deeply bilobed to 3/4 to 4/5 of the underleaf length, sinus deep, narrow, 7-12 cells long, 2-3 cells broad at base, 4-8 inseriate cells at apex, hyaline papilla present at apex, lamina 2-3 (-4) cells long and 7 cells wide, sometime 1-2 lateral tooth arises from the lateral side. Male inflorescence terminal on main shoot, bilobed, bracts in 5-8 pairs, oblong-ovate, 0.6-0.7 mm long, 0.45-0.5 mm wide, apex rounded, obtuse, antheridia 1 per bract; female inflorescence terminal on main stem or on short lateral branch, with 1-2 subfloral innovation, bract in 1-2 (-3)

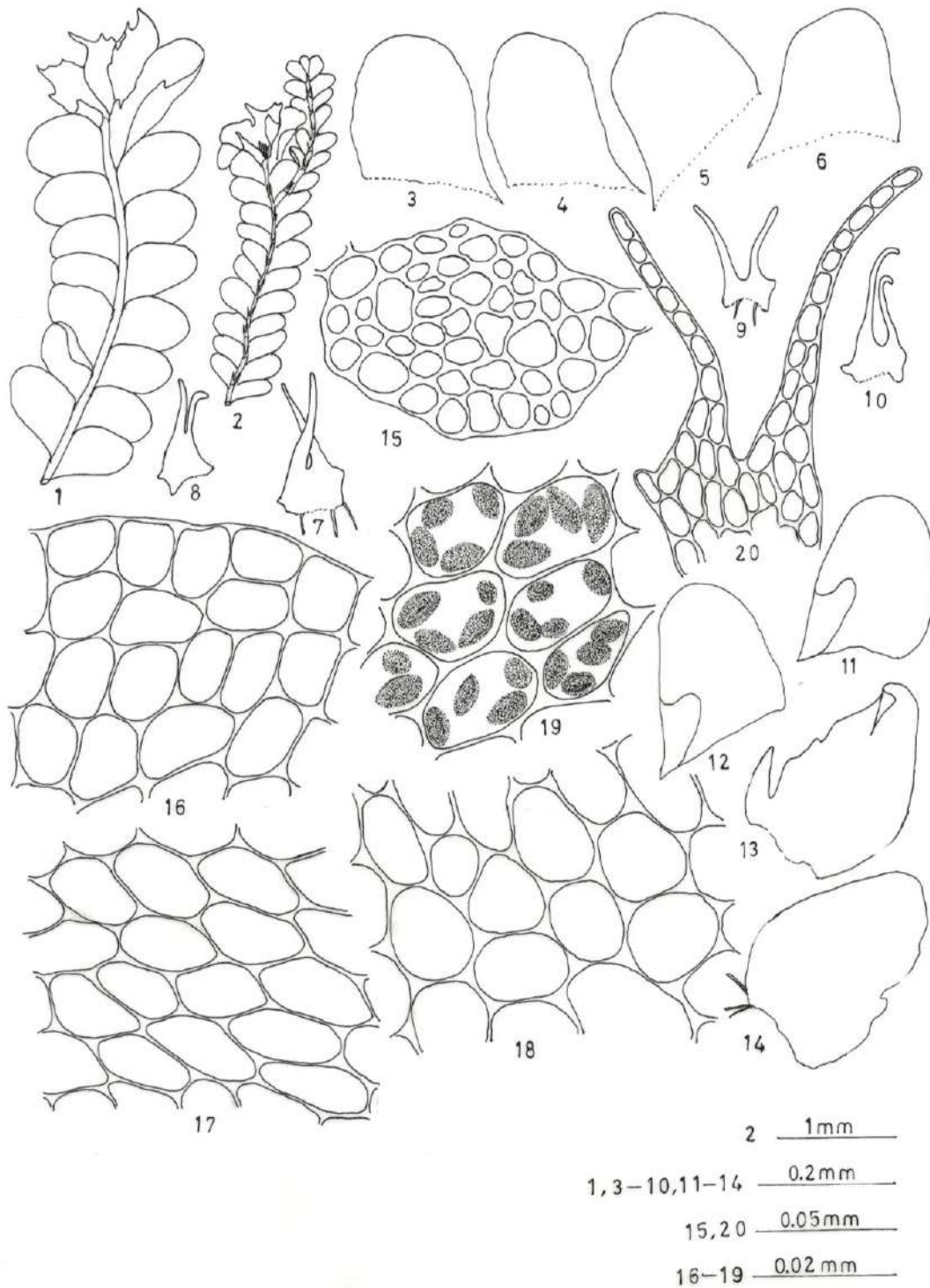


Plate 87. *Notoscyphus darjeelingensis* Uadr et A. Kumar, Figures 1-20.

Figs. 1. A portion of plant indorsal view; 2. A portion of plant in ventral view; 3-6. Leaves; 7-10 & 20. Underleaves; 11-12. Male bracts; 13-14. Female bracts; 15. Cross section of stem; 16. Leaf apical cells; 17. Leaf median cells; 18. Leaf basal cells; 19. Oil bodies.

pairs, oblong-ovate, 1-1.3 mm long, 0.7-0.9 mm wide, margin wavy, bilobed, apex acute, rounded. Mature sporophytes not seen.

Habitat: Plants grows on moist shady soils (terricolous) in association with *Jungermannia* sp., *Heteroscyphus* sp., *Folioceros* sp., *Marchantia* sp. and Mosses.

Range: China, Taiwan, India

Distribution in India: *Eastern Himalaya:* Sikkim, **Nagaland***.

Specimen examined: Nagaland: Mokokchung District: Changki: 02.11.2010: KE 10341: 02.11.2010: Kazhuhrii Eshuo; Yisimyong: KE 10193: 21.09.2009: Kazhuhrii Eshuo.

ORDER- METZGERIALES

ORDER: METZGERIALES Chalaud

Jungermanniales Chalaud, Ann. Bryol. 3: 41. 1930.

Plants thalloid, furcate or pinnately branched, dorsal surface nearly plane or convex, opaque or translucent; thallus entire or lobed; mid-rib plano-convex, biconvex or concavo-convex, laminae broadly multi-stratose to mostly or entirely unistratose; dorsal surface with or without areolae and pores, epidermis uni-stratose, cells thin walled with chloroplasts; internal cells not differentiated, mid-rib present or absent; oil bodies present or absent. Ventral scales delicate, or ephemeral, in one row on each side of the mid-rib. Rhizoids pigmented or hyaline, smooth walled, confined to mid-rib, often scattered across ventral surface and rarely marginal, or replaced by unicellular hairs in Metzgeriaceae. Gemmae present or absent.

Monoicous or dioicous. Gametangia scattered or clustered on dorsal surface of the mid-rib of the main thallus, or on lateral or ventral, or sometime modified branches, immersed or shielded by scale-like lamellae or branch laminae. Antheridia globose-ellipsoidal, with 1-4 seriate stalk; involucre present or absent; sporophyte with reduced foot, elongated seta and globose-clavate capsule. Capsule 2-4 layered; outer layer with or without nodular thickenings on radial walls; inner layer with complete or incomplete semi-annular thickenings on the tangential walls. Spores apolar, free or in tetrads, pigmented or pluricellular and green; elaters long with spiral thickenings.

Key to families of the order Metzgeriales

1. Plants leafy, leave succubous, rhizoids usually pinkish, capsule wall bistratose..... Fossombroniaceae
- 1a. Plant thalloid, rhizoids hyaline, transparent..... 2
2. Thallus fleshy, without differentiated into distinct mid-rib, gemmae usually endogenous, archegonia in cluster..... Aneuraceae
- 2a. Thallus thin, differentiated into distinct mid-rib..... 3
3. Gynoecia anacrogynous on dorsal surface of the thallus, sporophyte enclosed by shoot calyptras, dehiscing into 2 or 4 valves..... Pallaviciniaceae
- 3a. Gynoecia acrogynous cluster, capsule spheroidal with conspicuous basal elaterophore, dehiscing into 4 valves..... Pelliaceae
4. Thallus small and thin, with distinct mid-rib and unistratose wing, 1-2 pairs of hairs at the wing margin..... Metzgeriaceae

FAMILY: PELLIECEAE H. Klinggr.

PELLIACEAE H. klinggr., Höh. Crypt. Preuss.: 13. 1858.

Plants ranging from foliose to thallose, medium to large, gregarious, prostrate, thin or fleshy, light green to light yellowish green, dichotomously branched, or innovating from apex, rarely from ventral surface, with a broad mid-rib, gradually passing into wings, wings multi-stratose at base to uni-stratose towards margin, margin, undulate. Rhizoids numerous on ventral mid-rib; ventral scales absent (in *Pellia* sp.) or present; aggregated towards apex; gemmae absent. Vegetative reproduction by means of innovations from the apex or from the underside of the mid-rib. Dioicous or monoicous. Androecia and gynoecia on dorsal surface of the main thallus; antheridia scattered in 2-3 irregular rows; archegonia in groups of 4-12 within

an involucre. Perianth large, broad, at base, campanulate or inflated cylindrical. Sporophyte consists of foot, seta and capsule. Capsule globose, spherical; walls 2 or more layers with or without annular thickenings; dehiscing into 4 valves (in *Pellia* sp.) or 4-7 valves. Spores large, globose or ellipsoidal, precocious, exine thin, smooth or feebly granulate. Elaterophres basal, distinct. Elaters slender, long, with 2-3 spiral thickenings.

Type: *Pellia* Raddi

Pellia endiviifolia (Dicks.) Dumort., Recueil Observ. Jungerm.: 27. 1835.

(Plate 88. Figs. 1-8)

Thallus green to deep green, 15-30 mm long, 0.4-.08 mm wide, sparingly branched, lobes oblong-linear, weakly undulate, thin, pellucid or translucent. Epidermal cells chlorophyllous, elongate, smaller than the median cells, 21-47 x 12-21 μm ; median cells large, thin walled, 48-82 x 39-62 μm ; upto 8 cells wide at the middle, gradually becoming into many celled lamina and end in a single layer cell at the margin, cells parenchymatous, fibrous thickenings absent in between cells. Rhizoids hyaline and smooth walled. Ventral scales absent. Dioicous. Androecia not seen. Involucre tubular, posterior mouth wide and shortly irregularly toothed. Sporophyte borne singly in each involucre, foot bulbous, seta massive, elongate, 10-50 mm long; capsule green, or brownish green, globose, splitting into 4 valves; capsule wall multi-stratose, cells of outer layer larger, sub-quadrate with strong nodular thickenings at angles; inner walls without thickenings. spores large, ellipsoidal, 93-123 x 58-66 μm in diameter, green, yellowish brown, exine papillate. Elaters slender, long, 12-14 μm in diameter, with bi-tri-spiral.

Habitat: Plants grows on moist soils (terricolous) along with herbs and Mosses at an elevation of 2500-2700 m asl.

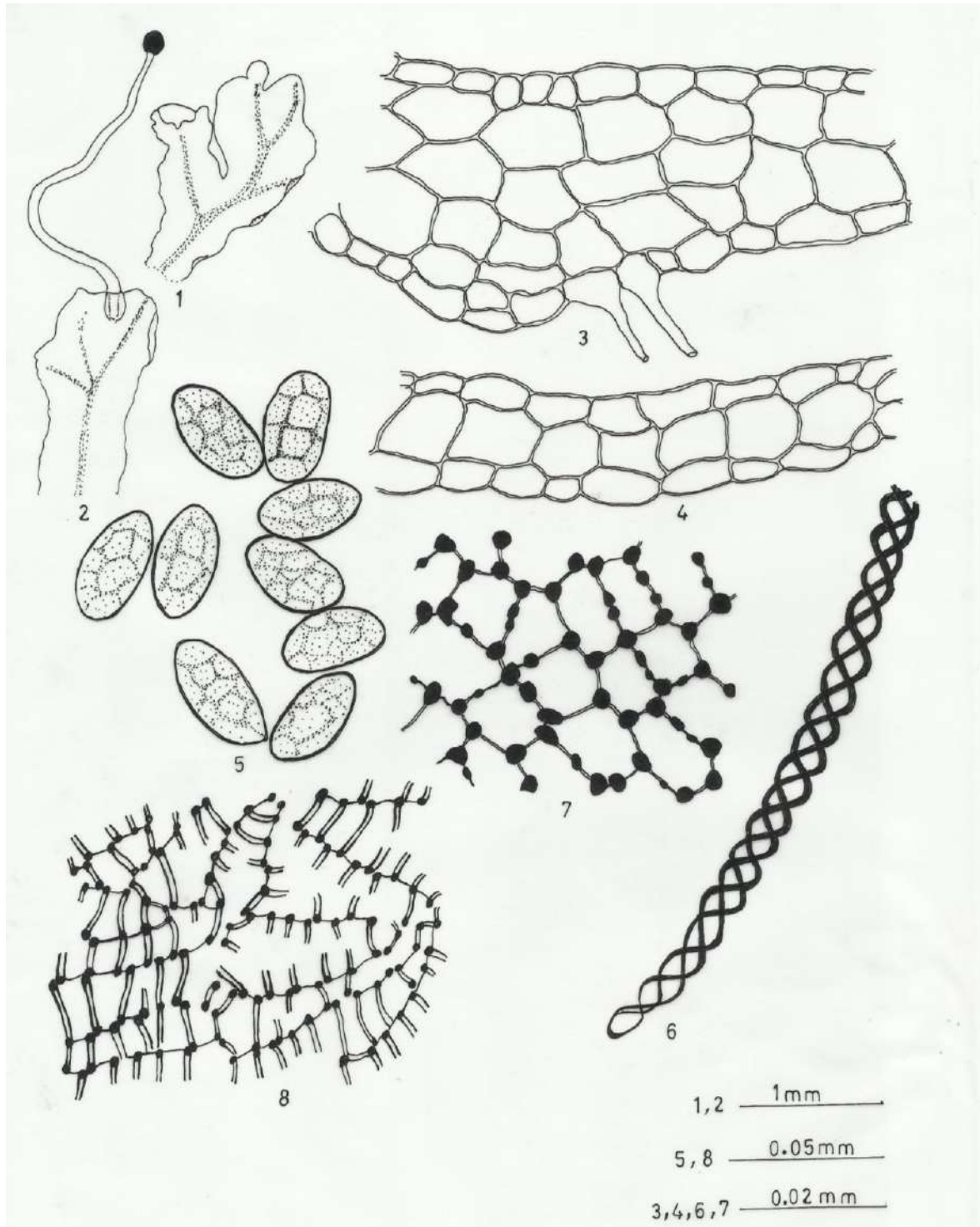


Plate 88. *Peltia endiviifolia* (Dicks.) Dumort., Figures 1-8.

Figs. 1. A thallus in dorsal view; 2. Thallus with a mature sporophyte; 3. Cross section of thallus at mid-rib region; 4. Cross section of thallus wing; 5. Spores; 6. Elater; 7. Cells of outer layer of capsule walls; 8. Cells of inner layer of capsule walls.

Range: India, Pakistan, Nepal, Bhutan, China, Korea, Japan, Turkey, Iran, Africa, Europe, North America.

Distribution in India: *Western Himalaya:* Jammu & Kashmir, Himachal Pradesh, Uttarakhand; *Eastern Himalaya:* West Bengal, Sikkim, Assam and **Nagaland***.

Specimen examined: Kohima district: Khonoma: KE 10451: 19.03.2011: Kazhuhrii Eshuo.

FOSSOMBRONIACEAE Hazslinsky

Fossombroniaceae Hazslinsky, Debat, Fl. Muscin 232, Lyon, 1874.

Plants delicate, foliose to Thallose, green to yellowish green, small to large, solitary or in patches, erect, or prostrate; Rhizoids hyaline or purple. Ventral scales absent (*Fossombronia* sp., *Petalophyllum* sp.), or with minute red scales in two rows on the ventral surface of the thallus (*Sewardiella* sp.). Leaves simple, quadrate to subquadrate, unistratose to multi-stratose at basal cells, succubously oriented, obliquely inserted, irregularly lobes, lobes having mucilage papillae at apex (*Fossombronia* sp.). Monoicous or dioicous. Antheridia globose, shortly stalked, singly on the dorsal surface of the stem or sometime aggregated towards the apex at the young leaves, bracts present or absent (*Fossombronia* sp.); Pseudoperianth campanulate or involucre bell shape, plicate; seta short or long. Capsule spherical, globose, dark brown to blackish, 2-4 layered, dehiscence irregular by the separation of apical portion. Spores globose, exine areolate or irregular lamellae or spines. Elaters with 1-3 spiral thickening.

Type: Fossombronia Raddi

Key to the species of the genus *Fossombronia*

1. Spores brown, 45-56 μm in diameter, spines prominent and pointed, 21-28 spines toward periphery; surface with incomplete reticulation; elaters well developed, 120-136 μm long, 2-3 spiral..... *F. wondraczekii*
- 1a. Spores yellowish brown, 34-50 μm in diameter, spine prominent, 15-19 spines toward periphery; ornamentation or reticulation complete; elaters highly reduced, 40-66 μm long, unispiral..... *F. cristula*

Fossombronia wondraczekii (Corda) Dumort., Rec. d'observ. p. 11 (1835).

(Plate 89. Figs.: 1-15)

Plant yellowish green to green, grows in moist soils, rocks, foliose, fragile, dichotomously branched, stem 4-10 mm long, 2-3.5 mm wide, stem thickened towards apex, dorsally flattened or sometimes slightly appressed, ventrally convex with a hyaline purplish, pinkish dense rhizoids. Stem circular, spherical, cells parenchymatous, thin walled, upper stem cells larger than the middle cells, upper stem cells 42.5-54.4 μm long, 23.2-57.6 μm wide, middle cells 29.8-48.0 μm long, 19.5-32.2 μm wide, sometimes centre cells contain mycorrhiza. Leave simple, succubous, closely arranged toward the apex, margin highly undulate, irregularly lobed, each lobe with a papilla at the apex; cells unistratose except at the basal part where cells are more than one cell thick; cells polygonal, thin-walled, non-trigonous, packed with chloroplasts; apical marginal cells 27.8-40.9 μm long, 15.7-38.7 μm wide; middle cells 40.5-106.3 μm long, 27.9-56.5 μm wide; basal cells 58.7-93.9 μm long and 27.7-46.3 μm wide. Leaves oil bodies many, 15-19 (23) per cell, small, circular, rounded, 2-3.5 μm in diameter, oil bodies smaller than the chloroplasts cells. Capsule spherical, blackish brown, stalked, exserted, capsule wall bistratose, outer walled layer without thickening, thin-walled; inner walled layer with annular thickening bands. Spores

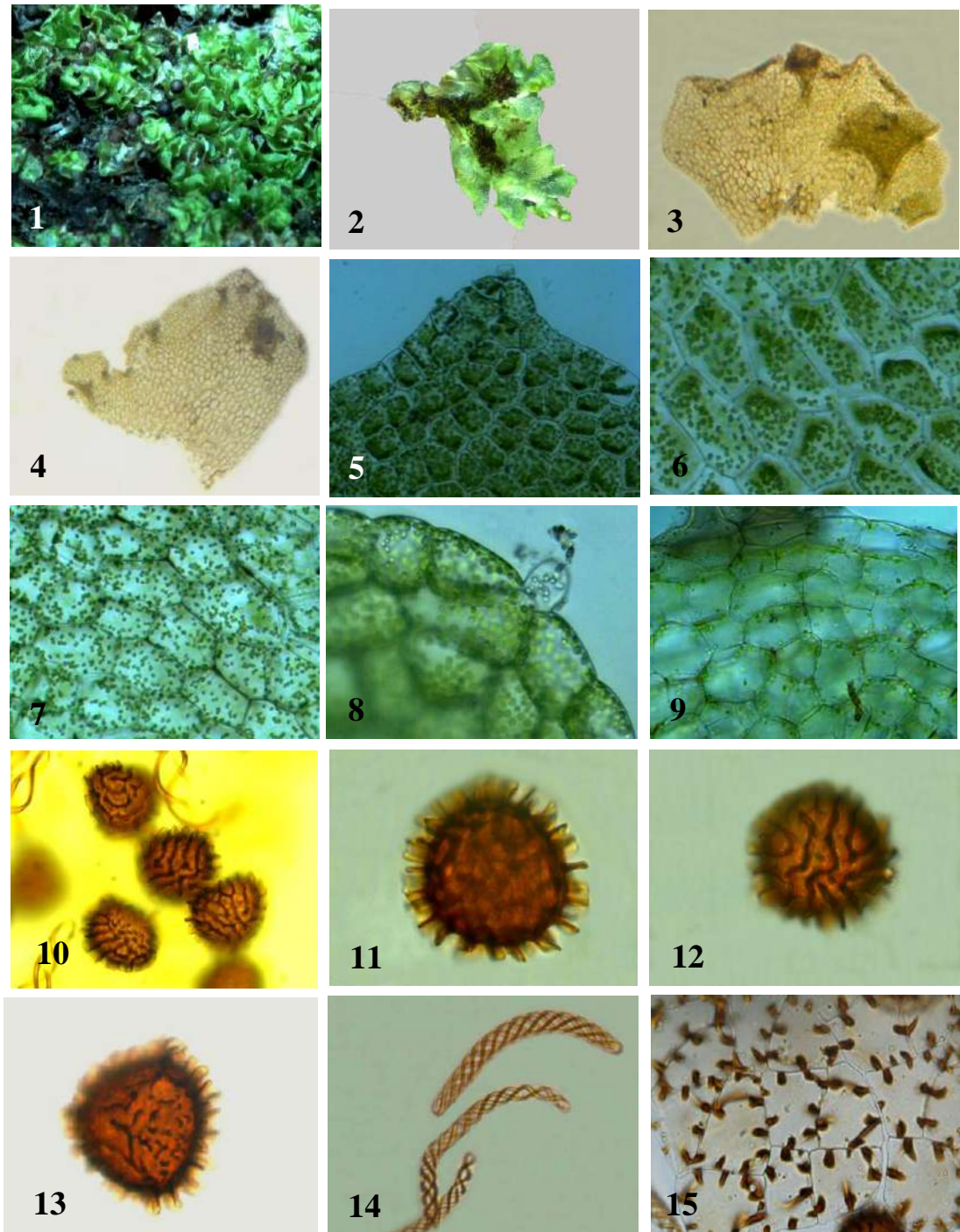


Plate 89. *Fossombronina wondraczekii* (Corda) Dumort., Figures 1-15.

Figures 1-2. Plant showing habit, 2- ventral view; 3-4. Leaves; 5-7. Leaf cells, 5- apical cells, 6-median cells,7-basal cells; 8. Leaf margin showing papilla; 9. T.S of stem cells; 10. Spores; 11. Spore in distal view; 12. Spore in surface view; 13. Spore in proximal view; 14. Elaters; 15. Capsule inner walls.

Scale: 2-4= 1 mm; 5 & 10= 0.2 mm; 6-9 & 11-15= 0.02 mm.

brown, circular, spherical, 44.7-55.8 μm in diameter; distal face showing lamellae, perispore well developed, spine prominent and pointed, 21-28 spines per spores, spines 3.4-9.3 μm long; surface view shows incomplete reticulation. Elaters brownish to yellowish brown, long, 119.7-135.6 μm long, 9.3-13.5 μm wide, 2-3 (-4) spirate, spirals twisted and pigmented.

Habitat: The plant grows on moist soil (terricolous), rocks (saxicolous) in association with *Jungermannia* sp. and Mosses, herbs, grasses at 1400-1600 m asl.

Distribution in India: *South India:* Kodaikanal, Ootacamund and Coonoor. *Eastern Himalayas:* Nagaland**.

Specimen examined: Nagaland: Kohima District: War cemetery: KE 10251: 05.08.2010: Kazhuhrii Eshuo.

Fossombronina cristula Aust., Acad. Philad. 1866, p. 228. (Plate 90. Figs.: 1-15)

Plant light to yellowish green, grows on the moist soil and rocks, foliose, form patches, upto 10 mm long, dichotomously branched, prostrate, sometimes ascending towards apex, dorsally flatten or sometime appressed, ventrally convex with a hyaline purplish to pinkish dense rhizoids. Stem circular, cells parenchymatous, thin-walled, cells larger towards periphery, smaller in the middle or centre, middle cells sometime contain fungal hyphae or mycorrhiza. Leaves succubous, simple, quadrate, margin undulate, thin-walled, irregularly lobed, each lobe with a papilla, at apex; leaves cells unistratose except at the basal part where the cells are more than one cells thick; cells polygonal, thin-walled, non-trigonous; apical marginal cells 28.9-44.5 μm long, 16.5-34.2 μm wide; middle cells 42.2-69.7 μm long, 27.2-55.6 μm wide; basal cells 49.7-89.5 μm long, 28.8-67.9 μm wide. Leaves oil bodies small, circular, granular, many, 17-23 per cell, 2.7-4.5 μm in diameter. Capsule borne at the apex of the main stem or lateral stem, sessile, dark brown, rarely exerted; capsule walled bistratose, cells of

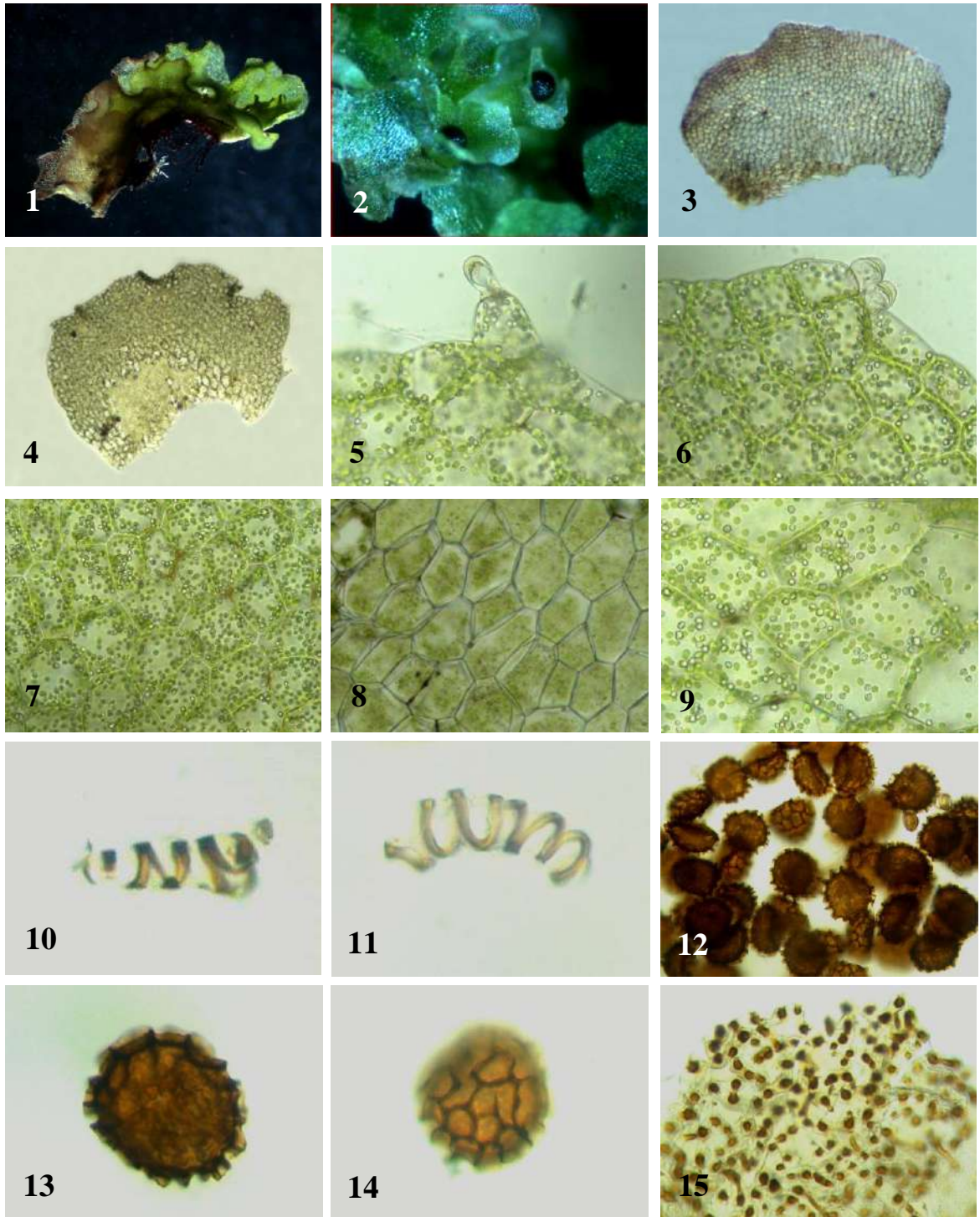


Plate 90. *Fossombronia cristula* Aust., Figures 1-15.

Figs 1-2. Plant showing habit; 3-4. Leaves; 5-8. Cells cells, 5-marginal cells showing pallila, 6-apical cells, 7- median cells, 8-basal cells; 9. Leaves oil bodies; 10-11. Elaters; 12-14. Spores, 13-spore in distal view, 14-spore in surface view; 15. Capsule inner walls.

Scale: 1-4= 1 mm; 12= 0.2 mm; 5-9 & 13-15= 0.02 mm.

outer wall layers without annular thickening, thin-walled; cells of inner wall layers with annular thickening bands. Spores brownish red to yellowish brown, spherical, circular, 33.7-50.2 μm in diameter; spores ornamentation or reticulation complete, perispore well developed, distal face with lamellae forming reticulations, spines prominent, 15-19 spines towards the periphery. Elaters highly reduced, short, usually arched, sometime branched, yellowish brown, unispiral, 40-66 μm long, 13-16.5 μm wide.

Habitat: The plant grows on moist soil (terricolous) and rocks (saxicolous) in association with Mosses, grasses, *Heteroscyphus* sp., *Jungermannia* sp. at 1500-1700 m asl.

Distribution in India: *South India:* kodaikanal, Ootacamund, Bandishola. *Eastern Himalayas:* Meghalaya, **Nagaland***.

Specimen examined: Nagaland: Kohima: Khonoma: KE 10324: 19.03.2011: Kazhuhrii Eshuo; Mokokchung: KE 10115: 20.07.09: Kazhuhrii Eshuo.

PALLAVICIANIACEAE Mig.

PALLAVICINIACEAE Mig., Krypt._Fl. Deutschl., Moose: 423. 1904.1

Plants thallus, prostrate, delicate or thick, forked at tip, thallus wing, sometime with ventral innovations, margin entire or wavy with or without appendages. Mid-rib narrowed, elongated, thickened and pitted cells central strand, lamina one cell thick, wide, cells hexagonal, margin-undulate or with scattered tooth over margin, straight, decurved. Apex broad obtuse-broad to lanceolate or linear. Ventral scales absent (*Pallavicinia* sp.) or present in some genera; rhizoids numerous, on the under side of the mid-rib, pale brown. Dioicous or monoicous. Androecia on discrete clusters or in elongated rows over the thallus mid-rib; Archegonia dorsal on the mid-rib in groups, surrounded by lucinate to entire; pseudoperianth as a ring which becomes a tube

inside the involucre; sporophytes enclosed by a short calyptras and perichaetial pseudoperianth, or by a coelocaulis; capsules cylindrical, wall 2 layered, with or without thickenings, dehiscence 2 or 4 valved, valves coherent at apex. Elaterophores absent; elaters with 2-3 spiral thickenings, medium; spores reticulate or papillose.

Type: Pallavicinia lyellii (Hook.) Carr.

Key to species of the genus *Pallavicinia*

1. Thallus mid-rib 9-10 cells thick, lamina margin entire, apex obtuse, central lignified strand cells 29-32 longitudinal rows of cells.....*P. himalayensis*
- 1a. Thallus mid-rib 13-15 cells thick, lamina margin entire-undulate, apex obtuse, broad, central lignified cells in 36 longitudinal rows.....*P. lyellii*

Pallavicinia himalayensis Schiffn., Kais. Akad. Wien. LXVII.p. 183.

(Plate 91. Figs. 1-5)

Thallose, Dioicous, thallus thin, pale green to yellowish green, mid-rib prominent, rhizoids of smooth walled, brownish to pinkish colour, ventral scale absent, apex lobed, crispate. Dichotomously branched; thallus 9-10 cells wide in the middle and one cell thick toward the margin. Rhizoids numerous on the ventral surface along the mid-rib, hyaline, smooth walled and colourless. Sporophytes not seen.

Habitat: Plants grows on moist soils (terricolous) in association with *Marchantia* sp., *Cyathodium* sp., *Metzgeria* sp., *Jungermannia* sp. and Mosses at 1400-1600 m asl.

Range: India

Distribution in India: *Eastern Himalaya:* Sikkim, Meghalaya, **Nagaland***; *Western Himalaya and South India.*

Specimen examined: Nagaland: Mokokchung district: Mokokchung: KE 10017: Kazhuhrii Eshuo.

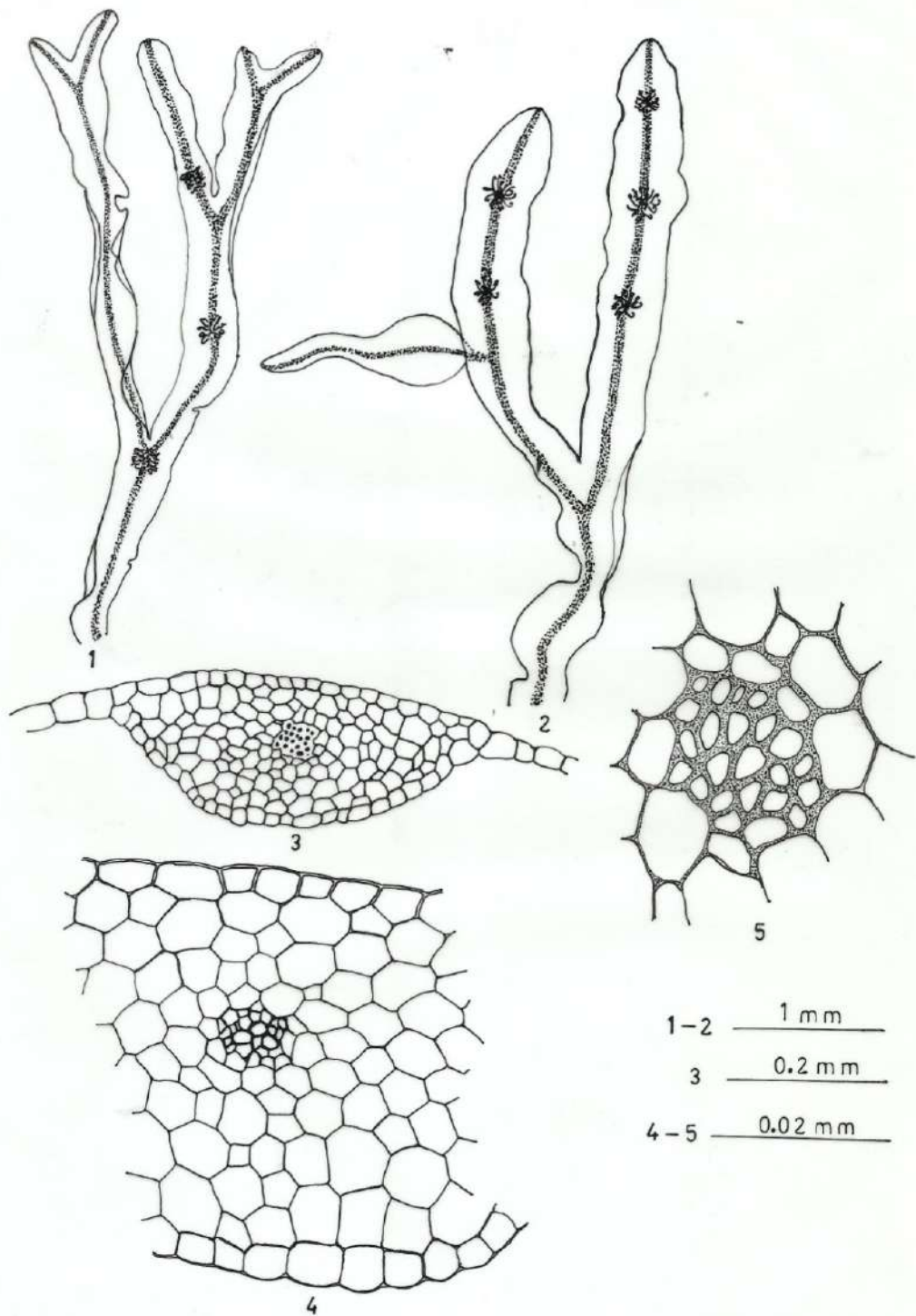


Plate 91. *Pallavicinia himalayensis* Schiffn., Figures 1-5.

Figs. 1-2. Thalli in dorsal view; 3. Cross section of thallus mid-rib; 4. Enlarge view of mid-rib cells; 5. Magnified view of central lignified cells.

Pallavicinia lyellii (Hook.) Gray, Nat. Arr. Brit. Pl. 1: 775. 1821.

(Plate 92. Figs. 1-5)

Thallus light yellowish green to pale green, thin, 30-40 mm long, 4-8 mm wide, simple, mid-rib prominent, usually undulate, flat above, semicircular below, 13-15 cells thick in the middle, passing into the lamina, with a central strand of narrow lignified cells; central lignified strand cells in 36 longitudinal rows, thick walled, 6-12 x 4-10 μm ; marginal cells thin walled, 23-37 x 17-28 μm ; median cells 30-74 x 19-26 μm , 5-6 angled. Rhizoids numerous, pale brown or colourless, hyaline arising from the mid-rib. Sporophytes not seen.

Habitat: Plants grows in moist rocks (xasicolous) and soil (terricolous) in association with *Bazzania* sp., *Marchantia* sp., *Dumortiera* sp., *Jungermannia* sp., *Heteroscyphus* sp. and Mosses at 900-1300 m asl.

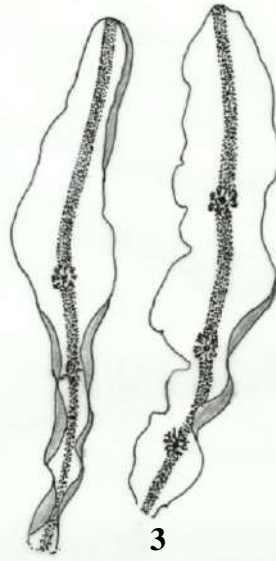
Range: India, Africa, Europe, Java, South America, West Indies, Bermuda, England.

Distribution in India: *Eastern Himalaya:* Meghalaya, **Ngalaand***; *Western Ghats:* Canara, Pachmarhi in Satpura range; *Central India:* Madhya Pradesh.

Specimen examined: Nagaland: Mokokchung district: Changki: KE 10349: 02.11.2010: Kazuhrii Eshuo.

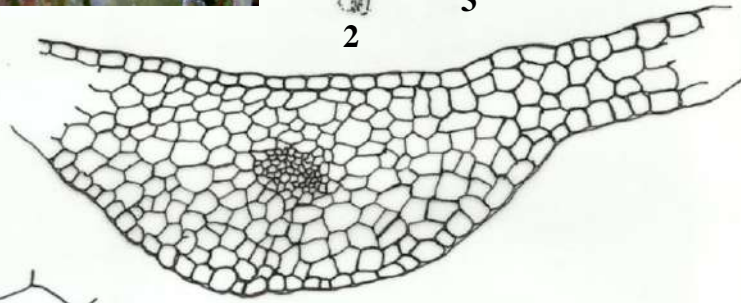


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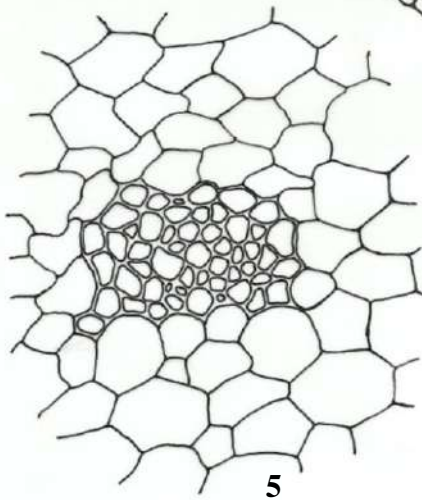


2

3



4



5

2, 3. 1 mm
 4 0.2 mm
 5 0.02 mm

Plate 92. *Pallavicinia lyellii* (Hook.) Gray, Figures 1-5.

Figs. 1. Plants showing habit; 2-3. Thalli in dorsal view; 4. Cross section of thallus mid-rib; 5. Magnified view of thallus mid-rib cells.

FAMILY: METZGERIACEAE H. Klinggr.

METZGERIACEAE H. Klinggr., Höh. Crypt. Preuss.: 10. 1858.

Plants thollose, delicate, narrow, prostrate, pale yellow green to brown green, with free terminal branching ranging from pseudo-dichotomous to monopodial with ventral- intercalary branching from well defined midrib. Midrib prominent, convex with hairs on the ventral surface; epidermal cells in 2 many layers on both the surfaces. Wings unistratose, several cells wide at both side of the midrib, hairs present at margin. Gemmae discoid to elliptical-oblong, borne on the thallus wings, dorsal or ventral side of the midrib, sometime mucilaginous. Monoicous or dioicous. Antheridia branches usually inrolled or incurved, devoid of hairs, ovoid to subglobose sacs, antheridia in 2 rows, shortly stalked, spherical, attached dorsally along the midrib. Archegonia branches cordate-obovate, or elongate, hairs on the margin or on the surfaces, archegonia borne in clusters dorsally. Calyptra massive, hairy on outer surface, pyriform. Sporophyte consisting of foot, seta and capsule. Capsule ovoid or cylindrical, dehiscing by means of 4 valves; walls 2 layered, outer walls with annular thickenings and inner walls with nodular thickenings. Spores small, finely granulate or smooth. Elaters with unispiral thickenings.

Type: Metzgeria Raddi

Key to species of the genus *Metzgeria*

1. Hairs disposed in pairs, hairs falcate or hook-like..... *M. Leptnonuera*
- 1a. Hairs disposed singly, hairs straight..... 2
2. Gemmae absent, thallus wing 12-15 cells wide..... *M. himalayensis*
- 2a. Gemmae present or absent, thallus wing 12-20 cells across..... 3
3. Epidermal cells 2/2-2/3, mid-rib 4-6 cells across, thick walls..... *M. furcata*
- 3a. Epidermal cells 2/2, mid-rib 4 (-5) cells across, thin walls..... *M. lindbergii*

Metzgeria himalayensis Kashyap, J. Bomb. Nat. Hist. Soc. 26: 280. 1917.

(Plate 93. Figs. 1-6)

Thallus green to light yellowish green, prostrate, 10-15 mm long, 0.9-1 (1.2) mm wide, linear, dichotomously branched, apex obtuse; mid-rib prominent, ventral adventitious shoot absent, gemmae absent. Mid-rib distinct, epidermal cells 2/2, inner cells 2-4 layers, thick walled, angular; epidermal cells 33-38 x 8-15 µm, inner cells 17-24 x 8-14 µm. Winged, 12-15 cells wide, non-trigonous, polygonal, 17-33 x 18-30 µm; hairs short to long, straight or rarely falcate, 49-90 µm long, disposed singly at the margin of the wing and the ventral surface of the mid-rib. Sporophytes not seen.

Habitat: Plants grows on moist rocks (saxicolous) in association with Mosses and lichens at 1400-1600 m asl.

Range: India

Distribution in India: *Western Himalaya:* Himachal Pradesh, Uttarakhand; *Eastern Himalaya:* Meghalaya, Nagaland*.

Specimen examined: Nagaland: Mokokchung District: Longkhum: KE 10130: 12.09.2009: Kazhuhrii Eshuo.

Metzgeria leptoneura Spruce, J. hattori Bot. Lab. 56: 532. 1984.

(Plate 94. Figs. 1-6)

Thallus light yellow to light brown, pale whitish in dry herbarium, small, upto 20 mm long, 0.5-1.0 mm wide, dichotomously branched, rhizoids present on the ventral surface of the thallus. Mid-rib prominent, distinct, epidermal cells in 2/2, inner cells 4 cells wide; epidermal cells 35-40 x 12-17 µm, inner cells 14-25 x 7-15 µm; winged, wing cells thin walled, polygonal, 18-37 x 19-32 µm, non-trigonous; marginal long, falcate or hook shaped, J-shaped, disposed in pair at the thallus margin. Sporophytes not seen.

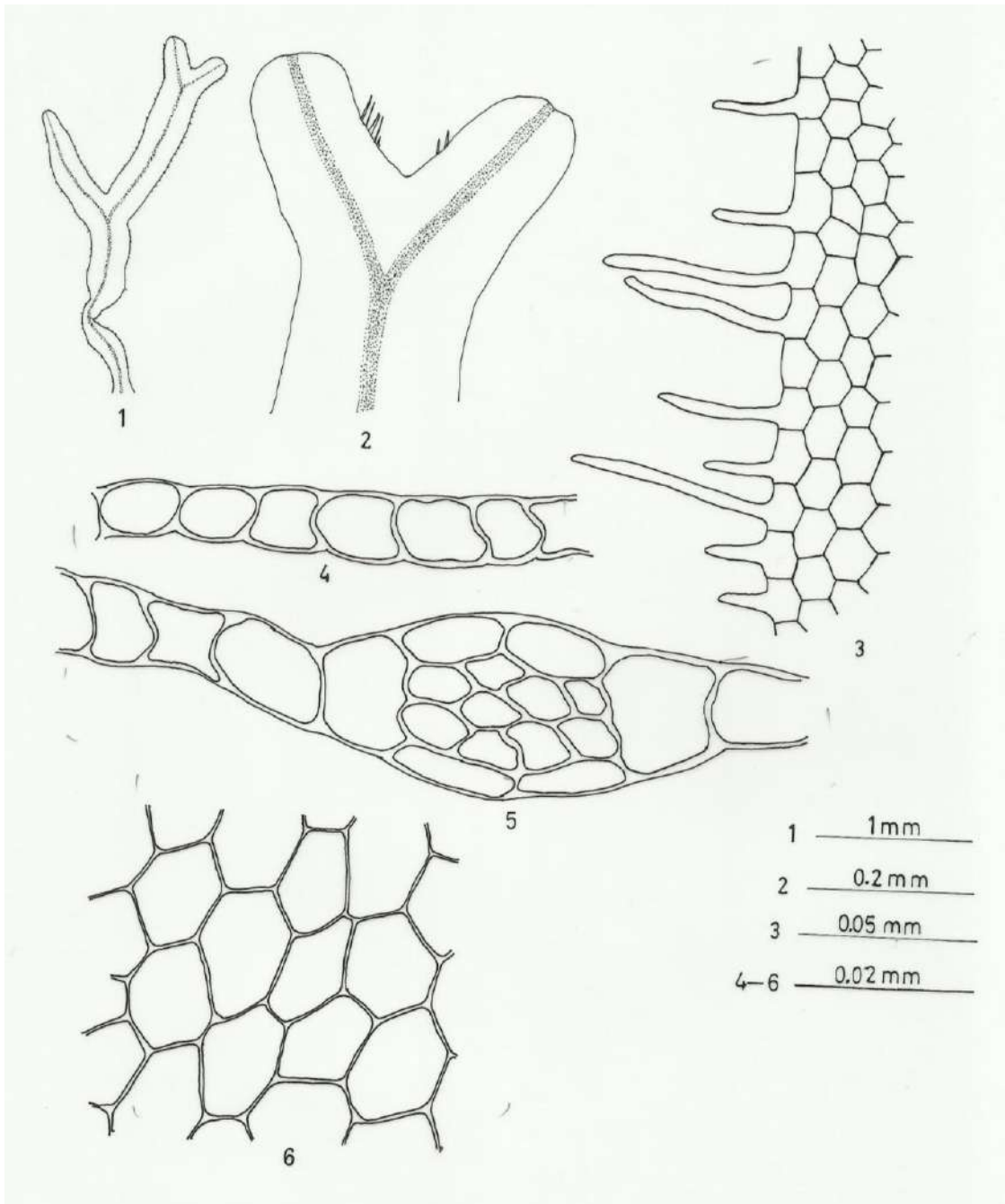


Plate 93. *Metzgeria himalayensis* Kashyap, Figures 1-6.

Figs. 1. A thallus in dorsal view; 2. Enlarged view of thallus; 3. Thallus wing with marginal hairs; 4. Cross section of thallus wing; 5. Cross section of thallus mid-rib; 6. Dorsal view of enlarged thallus cells.

Habitat: Plants grows on the bark of trees (corticolous) in association with *Lejeunea* sp., *Plagiochila* sp. and Mosses at 2000-2700 m asl.

Range: India, Nepal, China, Bhutan, Japan, Sri Lanka, Thailand, Malaysia, Indonesia, Philippines, Korea, Australia, Africa, Europe, North and South America.

Distribution in India: *Western Himalaya:* Himachal Pradesh, Uttarakhand; *Eastern Himalaya:* West Bengal, Sikkim, Meghalaya, Assam, **Nagaland***.

Specimen examined: Nagaland: Kohima District: Khuzama: KE 10.....: 01.11.2008: Kazhuhrii Eshuo.

Metzgeria furcata (L.) Corda, Acta Soc. Fauna Fl. Fenn. 1(2): 42. 1877.

(Plate 95. Figs. 1-7)

Thallus small, green to light yellowish green, 12-17 mm long, 0.7-0.9 mm wide, dichotomy one or rarely two, overlapping, apex broad, obtuse, ventral adventitious shoot absent, gemmae absent. Mid-rib distinct, epidermal cells 2/2, 2/3, inner cells 4 cells wide, thick walled; epidermal cells 20-45 x 8-15 µm, inner cells 10-22 x 9-11 µm; winged, cells thin walled, non-trigonous, polygonal, 28-35 x 18-26 µm; marginal hairs short or long, straight, 32-70 µm long, disposed singly at the margin of the wing. Sporophytes not seen.

Habitat: Plants grow on moist shady rocks (saxicolous) in association with *Plagiochila* sp., *Jungermannia* sp. and Mosses at 1400-1700 m asl.

Range: India

Distribution in India: *Eastern Himalaya:* **Nagaland****; *Western Himalaya:* Jammu & Kashmir.

Specimen examined: Nagaland: Kohima district: Nerhema: KE 10229: 07.06.2010: Kazhuhrii Eshuo.

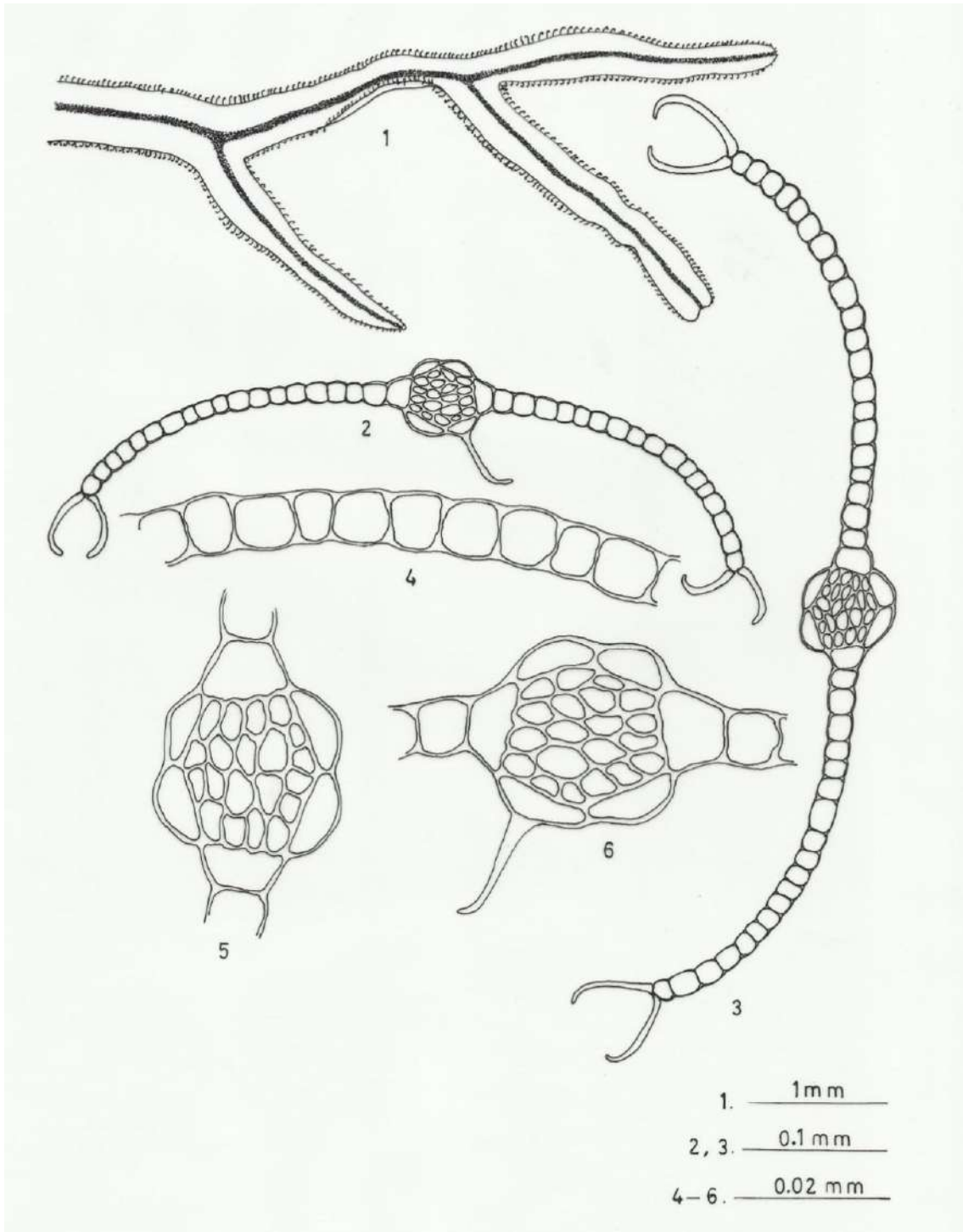


Plate 94. *Metzgeria leptoneura* Spruce, Figures 1-6.

Figs. 1. Thallus in dorsal view; 2-3. Cross section of thallus; 4. A portion of thallus wing in cross section; 5-6. Cross section of thalli mid-rib.

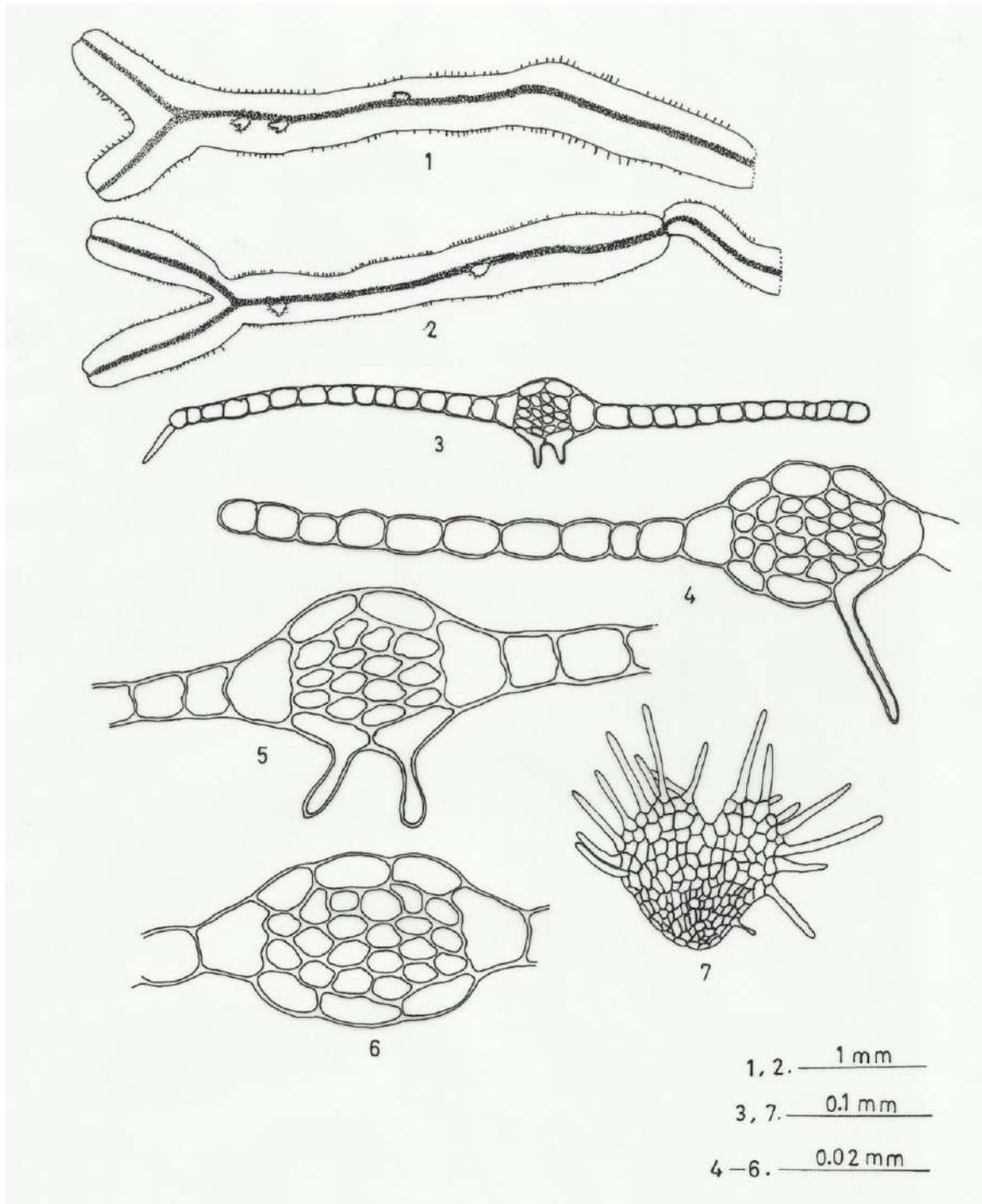


Plate 95. *Metzgeria furcata* (L.) Corda, Figures 1-7.

Figs. 1-2. Thalli in ventral view; 3-4. Cross section of thalli; 5-6. Cross section of thalli mid-rib; 7. Female branch.

Metzgeria lindbergii Schiffn., Denkschr. Kaiserl. Akad. Wiss., Math. Naturwiss. KL.

67: 182. 1898.

(Plate 96. Figs. 1-4)

Thallus small, pale yellow to light brown in dry herbarium, 10-15 mm long, 0.6-1.0 mm wide; dichotomously branched; apices broad, obtuse; marginal hairs disposed singly or in pairs. Mid-rib prominent, epidermal cell 2/2, 3/3 below dichotomy; 5 cells across, epidermal cells 20-41 x 11-25 µm, inner cells 10-26 x 8-17 µm; winged, cells thin walled, non-trigonous, hexagonal-polygonal, wing 13-18 cells wide on either side of the mid-rib. Gemmae absent; sporophyte not seen.

Habitat: Plants grow on bark of trees (corticolous) or on soil (terricolous) in association with *Lejeunea* sp. Mosses at 1700-2000 m asl.

Range: India, Nepal, China, Philippines, Japan, Korea, Malaysia.

Distribution in India: *Western Himalaya:* Himachal Pradesh, Uttarakhand; *Eastern Himalaya:* West Bengal, Sikkim, Assam, **Nagaland***.

Specimen examined: Nagaland: Kohima District: Khuzama: KE 10310B:

16.11.2009: Kazuhrii Eshuo.

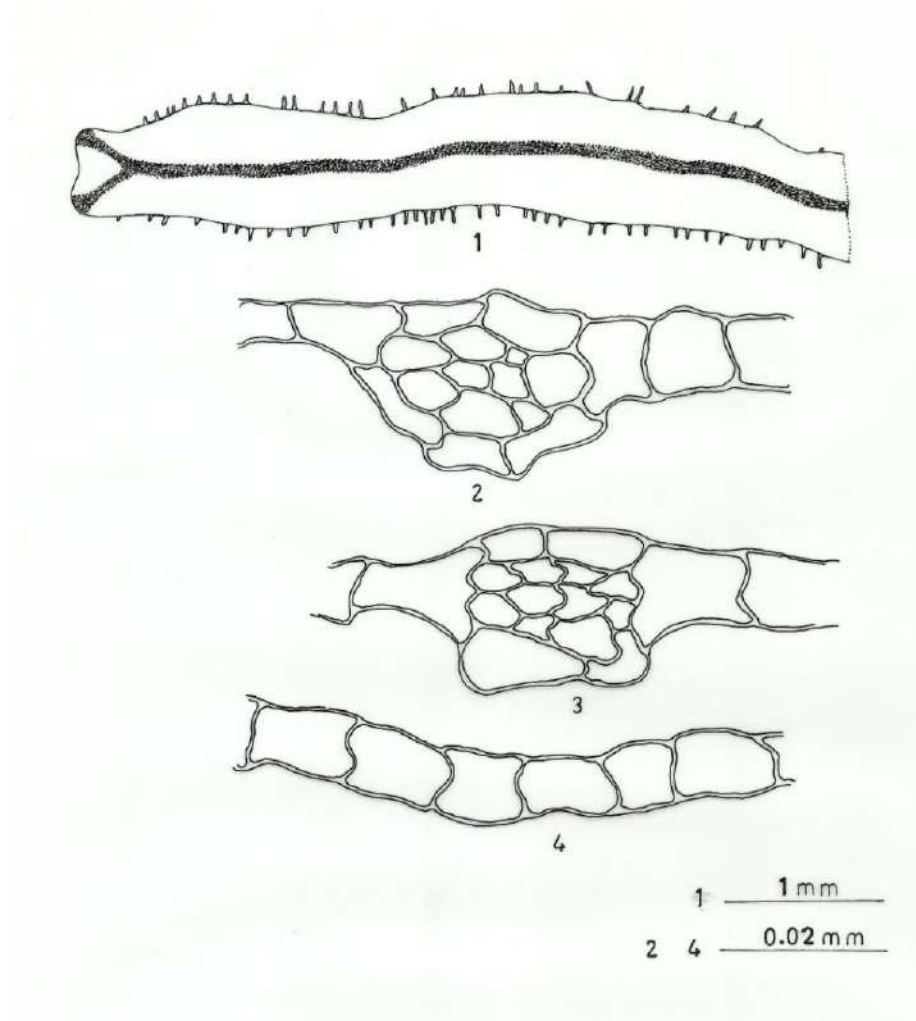


Plate 96. *Metzgeria lindbergii* Schiffn., Figures 1-4

Figs. 1. A portion of thallus in dorsal view; 2-3. Cross section of thalli at mid-rib; 4. Cross section of thallus wing cells.

FAMILY: ANEURACEAE H. klinggr.

ANEURACEAE H. klinggr., Höh. Crypt. Preuss.: 11. 1858.

Thalli simple, prostrate, Chlorophyllose or echlorophyllose, usually deep brown or pale green, slender or wide, usually branched, branching simple pinnate, palmate or sometime irregular; margin entire, or crenulate; apices broad, obtuse or emerginate-truncate sometimes narrow or subacute; mid-rib indistinct. Oil bodis small to large in size, simple, granular, spherical or ovoid, one to many in each epidermal cells. Main axis or main branches about 3-16 (-20) cells thick, wings multi-stratose, which ultimately become uni-stratose at margin. Ventral scale absent; rhizoids present or scarce. Mucilage papillae club shaped, usually present on the ventral surface near the growing surface. Dioicous or monoicous. Antheridial branches slender or wide, branched or unbranched, margin crenulate and somewhat raised; antheridia spherical, usually arranged in two rows or sometimes irregular, immersed singly in each chambers or locules. Archegonial branches lateral, usually short or abbreviated, branched, margin raised, papillose, apices laciniate; archegonia dorsal, usually in two rows. Calyptras large, massive, cylindrical or clavate, outer surface smooth or papillose. Seta 4 or 8-12 celled across. Capsule ovoid or slightly cylindrical, blackish brown, 4 valved, dehiscing from apex toward base; walls 2 layered, except along the line of dehiscence where only one cell thick. Spores areolate or non-areolate, greenish brown to yellowish brown. Elaters yellowish brown, long, with a single broad spiral band thickenings.

Type: Aneura Dumort.

Genus: *Riccardia* Gray

Riccardia Gray, Nat. Arr. Brit. Pl. 1: 679. 1821.

Thallus prostrate or ascending from a rhizomatous base, simple or branched, pinnately to irregularly branched, branches slender, narrow, obtuse, emerginate-truncate to sub-acute apex, margin entire. Mucilage papillae club shaped, on ventral surface near growing point. Rhizoids rare. Stolons absent or present. Gemmae absent or present, if present bicelled and endogenous. Main thallus biconvex, 4-14 cells thick at middle with multistratose wing becoming unistratose at margin. Monoicous or dioicous. Antheridial branched smaller, lanceolate, branched, antheridia spherical in 2 or more pairs arranged in two alternate rows. Archegonial branches lateral, short, or abbreviated; calyptras large, cylindrical, thick, fleshy; capsule deep brown-blackish brown, globose, ovoid or slightly cylindrical; walls bistratose; spores pale yellow or brown, spherical-globose, exine, finely papillose or verrucose. Elaters long with a single spiral band thickenings.

Key to species of the genus *Riccardia*

1. Thallus small, 0.4-0.6 mm wide, pinnately branched.....*R. tinucostata*
- 1a. Thallus 0.6-1.5 mm wide..... 2
2. Thallus margin transparent.....*R. sikkimensis*
- 2a. Thallus margin not transparent.....3
3. Thallus 0.6-0.8 mm wide, 8-12 mm long.....*R. cardotii*
- 3a. Thallus 0.8-1.2 (1.5) mm wide, 8-15 mm long, spores circular, greenish, finely papillose, elaters mono-spiral.....*R. platyclada*

Ricardia tinucostata Schiffn., in Denkschr. Kaiserl. Akad. Wiss., Math.-Naturwiss.

Kl. 67: 166. 1898.

(Plate 97. Figs. 1-9)

Plants thalloid, light to pale green, upto 12 mm long, 0.4-0.6 mm wide, erect to suberect, pinnately branched, branches short, slender, narrowed toward apex; apex rounded, obtuse or subacute, margin entire. Main thallus or axis slightly biconvex in cross section, wing multistratose and ultimately become unistratose towards margin, 4-6 cells thick at middle; branches 4-5 cells thick at middle, wing become 1-2 layer and unistratose at margin; cells pentagonal-hexagonal, subquadrate, 33-60 μm long, 13-38 μm wide, non-trigonous; epidermal cells 10-20 μm long, 7-12 μm wide. Rhizoids present. Stolons and gemmae absent. Monoicous. Antheridial branches narrow or lanceolate, margin crenulate; antheridia globose; archegonial branches short, mature sporophyte not seen.

Habitat: Plants grows on moist rocks (saxicolous), soils (terricolous) in association with *Marchantia* sp., *Phaeoceros* sp., *Jungermannia* sp., *Heteroscyphus* sp. and Mosses at 1500-1700 m asl.

Range: India, Singapore and Java.

Distribution in India: *South India:* Palni Hills, Kerala, Tamil Nadu; *Western Himalayas:* Himachal Pradesh; *Eastern Himalaya:* Sikkim, Meghalaya, **Nagaland***.

Specimen examined: Nagaland: Kohima District: Khuzama, 28-11-2008, KE 10033, KE 10078; Longkhum, 12-09-2009, KE 10142.

Riccardia platyclada Schiffn., Dunkschr. Kaiserl. Akad. Wiss., Math.-Naturwiss. Kl.

67: 167. 1898.

(Plate 98. Figs. 1-5)

Plants small, green to light yellowish green or deep green, pinnately to irregularly branched, 8-15 mm long, 0.8-1.2 (-1.5) mm wide, sub-erect, prostrate, basal part stoloniferous, opaque and fixed to the substratum. Main thallus 5-7 cells

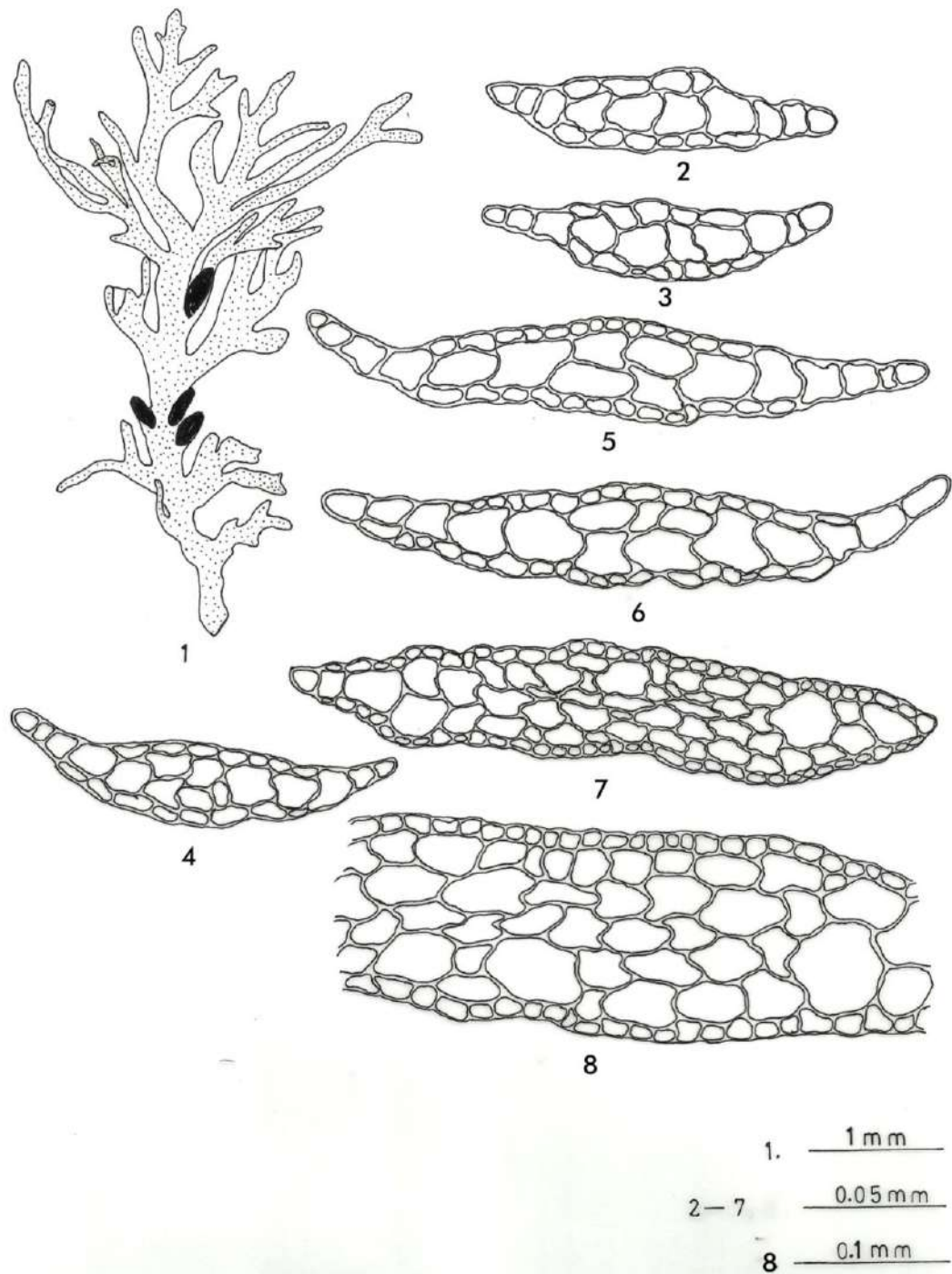


Plate 97. *Ricardia tinucostata* Schiffn., Figures 1-8.

Figs. 1. A thallus with archegonial branch; 2-8. Cross section of thallus; 2-4. Cross section of tertiary thalli; 5-6. Cross section of secondary thalli; 7-8. Cross section of main thalli.

wide thick in the middle, multistratose wing and which gradually end in unistratose at the margin, middle cells 25-45 x 15-23 μm in diameter. Male plants small. Mature androecia not seen. Female larger than the male plants. Sporophytes borne at the basal part of the lateral thallus; seta long, 20-50 mm long, when young it is covered with a white transparent slimy structure; capsule ovular, split into 4 valves, dark brown; capsule walled bi-stratose. Outer layer with semi-annular thickenings, inner layer with indistinct thickenings. Spores circular, greenish brown, granular, 10-14 μm in diameter, finely papillose. Elaters long, brown, 230-350 μm long, 8-12 μm wide at the middle, both ends tapering, with a single spiral band thickenings.

Habitat: Plants grows on moist rocks (saxicolous) and soil (terricolous) along with *Marchantia* sp., *Cephalozia* sp., *Jungermannia* sp. and Mosses at 1500-1700 m asl.

Range: India, Singapore and Java.

Distribution in India: *Central India:* Madhya Pradesh; *Eastern Himalaya:* Nagaland**.

Specimen examined: Nagaland: Kohima District: Khuzama: KE 10173: 16-11-2009: Kazhuhrii Eshuo.

Riccardia sikkimensis (Steph.) Pande et Srivastava, J. Indian Bot. Soc. 37 (3): 417.

1958.

(Plate 99. Figs. 1-5)

Plants light green to green, 8-12 mm long, 0.5-0.8 mm wide, pinnately to irregularly branched, branches short, slender, narrow towards apex, apex rounded or sub-acute, margin entire and transparent. Main thallus in cross section biconvex, 4-5 cells wide in the middle, with multi-stratose wing and ultimate end in uni-stratose at margin, marginal cells 12-30 x 8-15 μm , median cells 26-49 x 20-33 μm ; cells polygonal-hexagonal, thin-walled and non-trigonous. Mature sporophytes not seen.

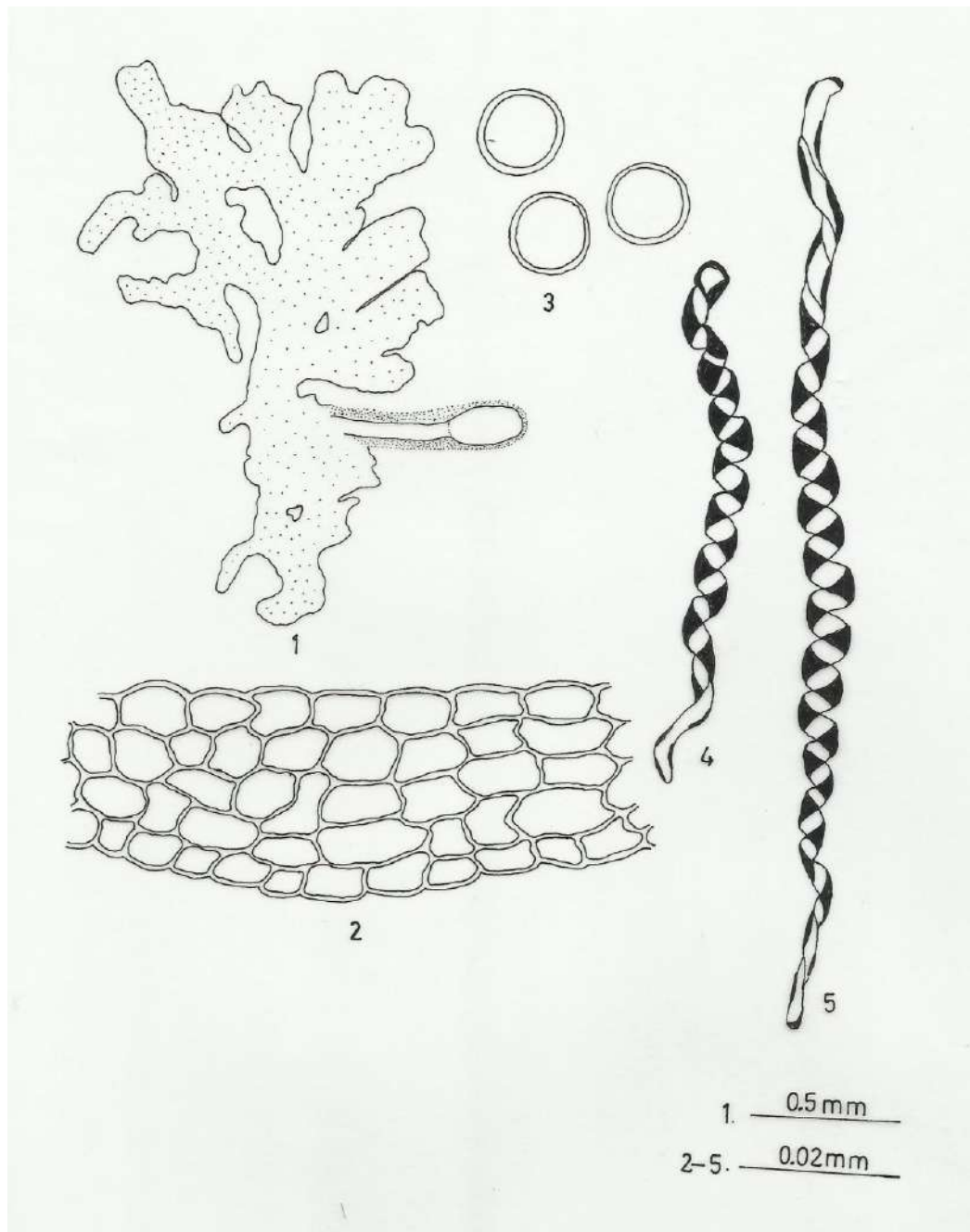


Plate 98. *Riccardia platyclada* Schiffn., Figures 1-5

Figs. 1. A thallus with an archegonial branch; 2. Cross section of thallus; 3. Spores; 4-5. Elaters.

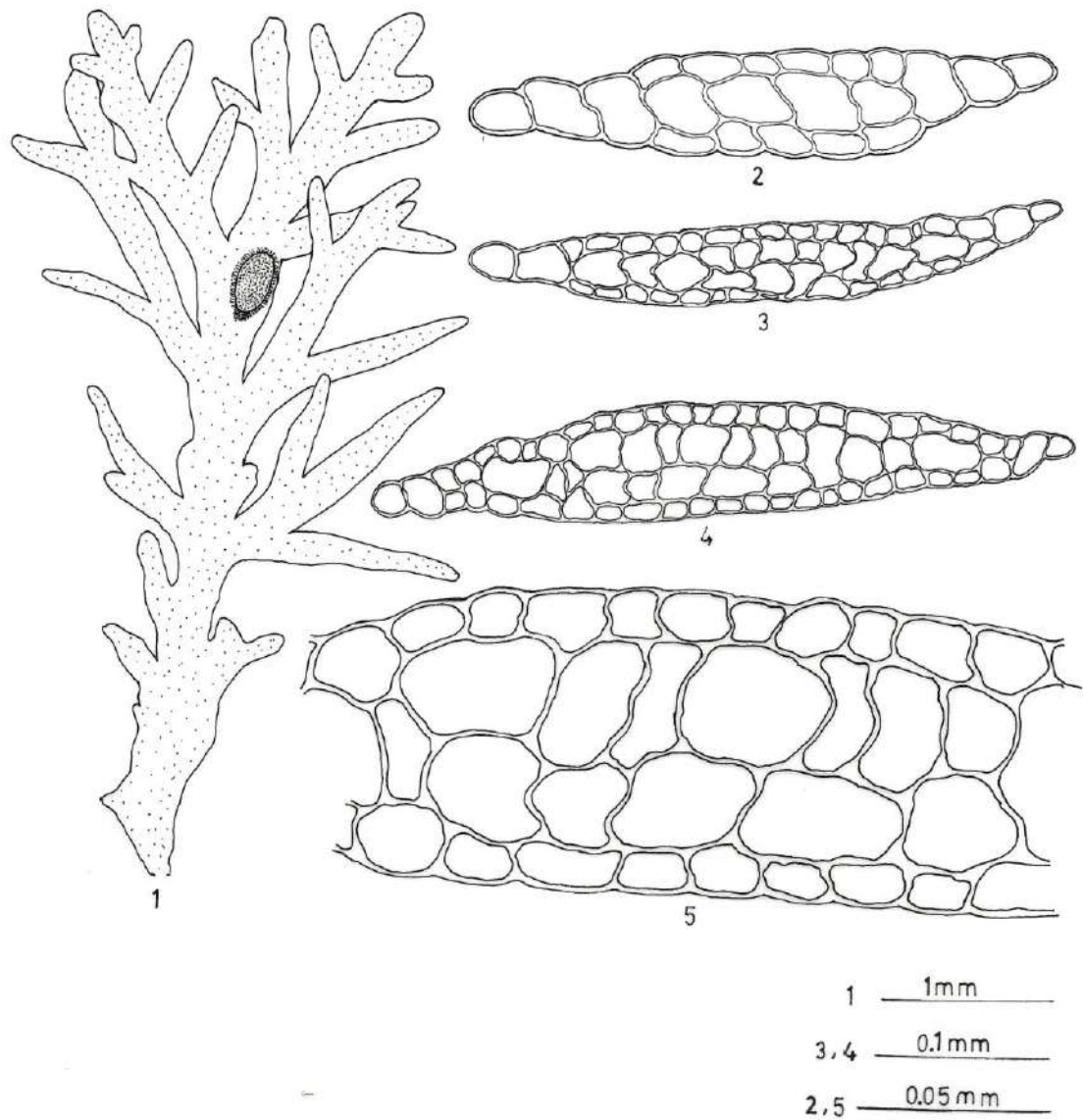


Plate 99. *Riccardia sikkimensis* (Steph.) Pande et Srivastava, Figures 1-5.

Figs. 1. Thallus with an archegonial branch; 2. cross section of tertiary thallus; 3. Cross section of secondary thallus; 4-5. Cross section of main thallus.

Habitat: Plants grows on rocks (saxicolous) near the running stream water along with *Jungermannia* sp., *Heteroscyphus* sp., *Begonia* sp. and Mosses at 900-1400 m asl.

Range: Endemic to India.

Distribution in India: *Eastern Himalaya:* Sikkim, Meghalaya, **Nagaland***.

Specimen examined: Mokokchung District: Changki: 02.11.2011: KE 10342: Kazhuhrii Eshuo.

Riccardia cardotii (Steph.) Pande et Srivastava, J. Indian Bot. Soc. 37 (3): 417. 1958.

(Plate 100. Figs. 1-6)

Plants small, 8-12 mm long, 0.6-0.8 mm wide, branched, branching irregular, secondary branched 0.4-0.6 mm wide; rhizoids scarce and confined at the basal part of the thallus. Cross section of the main thallus shows 4 cells wide in the middle, with multi-stratose wing which ends in uni-stratose at margin, marginal cells 18-28 x 8-12 μm , median cells 36-62 x 28-34 μm , polygonal; secondary branched 3-4 cells wide, 29-49 x 20-34 μm , thin walled, non-trigonous. Androecia and gynoecia not seen.

Habitat: Plants grows in moist shady area (terricolous) and moist rocks (saxicolous) along with *Jungermannia* sp., *Marchantia* sp., and Mosses at 1400-1700 m asl.

Range: Endemic to India.

Distribution in India: *Eastern Himalaya:* Sikkim, Meghalaya, **Nagaland***.

Specimen examined: Kohima District: Kigwema: KE 10305: 08.08.2010: Kazhuhrii Eshuo.

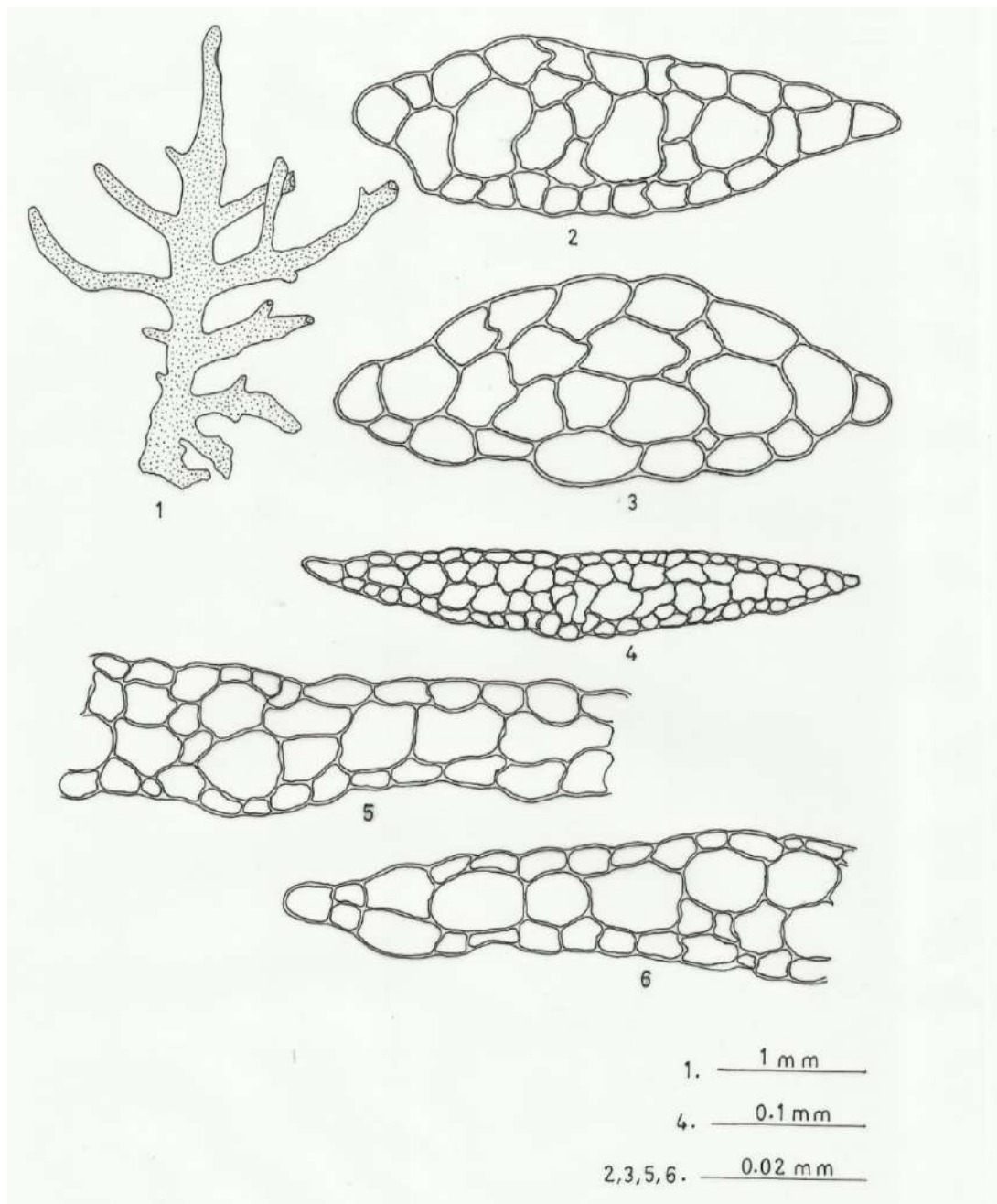


Plate 100. *Riccardia cardotii* (Steph.) Pande et Srivastava, Figures 1-6.

Figs. 1. A thallus; 2-6. Cross section of thalli; 2-3. Cross section of secondary thalli; 4-6. Cross section of main thalli.

ORDER-MARCHANTIALES

ORDER: MARCHANTIALES Limpr.

Marchantiales Limpr., in Cohn. Krypt.-Fl. Schlesien 1: 239, 336. 1877.

Thallus usually differentiated, thallus light yellowish green to green, reddish green, tufted on rocks and soils, dichotomously branched; epidermal with either simple or compound air pores; ventral scales in 1-10 rows, sometime absent, usually with 1-3 appendages; rhizoids usually dimorphid, smooth and tuberculate/pegged rhizoids, in tuft; idioblastic oil cells usually present. Monoicous or dioicous. Antheridia sessile or stalked, stalk with a rhizoidal furrow, antheridial disc terminal, lateral or form a cushion shaped just behind the female receptacle; Antheridium small, globose to sub-globose, shortly stalked. Gynoecea usually terminal, disc or globose; involucre bivalve, cup-shaped, scale-like, or tubular, sometime absent; pseudoperianth present or absent; sporophytes well developed into foot, seta and capsule; capsule walled 1-2 layered; outer layer with annualr or semi-annular thickenings bands, lower part devoid of thickenings. Spores usually spinate or baculate, rarely verucose, lamellate or reticulate; elaters brown, fusiform or robust, with 2-4 spiral thickenings.

Key to families of the order Marchantiales

1. Ventral scales in 2-5 rows, with 1-4 appendages..... 2
 - 1a. Ventarl scales in 1-2 rows or sometime absent 6
2. Gemma cup present on the dorsal surface of the thallus, ventral scales in 2-5 rows, sporophytes on stalked receptacle..... Marchantiaceae
 - 2a. Gemma cup absent, ventral scales present or absent, sporophytes with or without stalked receptacle..... 3
3. Ventral scales in 2 rows, with 1-4 appendages, involucre bi-valve, Pseudoperianth absent (present in *Asterella*)..... Aytoniaceae
 - 3a. Ventral scales in 2 rows, with 1 appendage, pseudoperianth absent or present.....4

- 4. Ventral scales appendage acute to acuminate, sporophyte ventral at thallus apex, spores without spines..... Targioniaceae
- 4a. Ventral scale appendages oblong – ovate to reniform, sporophyte borne dorsally, spores winged..... 5
- 5. Ventral scale appendages lunate to reniform, involucre tubular, pseudoperianth absent..... Conocephalaceae
- 5a. Ventral scales oblong-ovate, involucre bivalve, capsule dehiscing by 4 – 6 irregular valves..... Wiesnerellaceae
- 6. Ventral scale absent or present, sporophytes embedded singly in the thallus, involucre absent, elaters absent..... Ricciaceae
- 6a. Ventral scale indistinct, sporophytes on stalk receptacle or ventral at the thallus apex, elaters present..... 7
- 7. Sporophytes on stalk receptacle, elaters many per capsule, spores fimbriate, air chamber absent..... Dumortieraceae
- 7a. Sporophytes ventral at the thallus apex, elaters few per capsule, spores granulate to spinulate, air chamber present..... Cyathodiaceae

FAMILY: MARCHANTIACEAE Lindl.

MARCHANTIACEAE Lindl., Nat. Syst. Bot., ed 2: 412. 1836.

Thallus dichotomously branched, with a broad mid-rib. Dorsal surface smooth; air-pores compound, barrel-shaped and composed of several superimposed rings of cells. Ventral scales in 2-3 (6) rows, with 1-3 appendages; perigonal chambers aggregated on stalked receptacles. Rhizoids dimorphic, hyaline and form in tuft on the ventral surface along the mid-rib. Gemma cup present (only in *Marchantia* sp.) or absent in other genera. Monoicous or Dioicous. Antheridiophore usually stalked; stalked with 2-4 rhizoidal furrows, with or without air chambers; disc nearly flat, lobed

or unlobed, with or without compound pores. Archegoniophores stalked; stalk with (-1) 2 (-4) rhizoidal furrows, top covered with bristly scales, receptacles stellate to disciform, lobed, lobes 4-10; involucre bivalve or cup shaped; Pseudoperianth present. Capsule dehiscence by irregular valves; wall with annular to spiral thickenings. Spores small, tetrahedral, exine not reticulate. Elaters long, with bispiral thickenings.

Type: Marchantia L.

Genus: *Marchantia* L.

Marchantia L., Sp. Pl. p. 1137. 1753.

Thalloid, dichotomously branched with a prominent mid-rib, usually green to dark green. Gemma cup present on the dorsal surface of the thallus, goblet shaped, with ciliate, lobed or entire margin. Dorsal surface areolate, air-pore simple, barrel-shaped, with 4-7 superimposed rings of cells; storage tissue parenchymatous. Ventral scales in 2-3 rows on each side of the mid-rib, median scales appendiculate, appendages oblong, sub-rotund or obovate, margin ciliate to toothed, others smaller and devoid of appendages. Rhizoids both smooth-walled and tuberculate walled. Dioicous. Male receptacle terminal, stalked, stalk with 2-4 rhizoidal furrows; disc flat, stellately or palmately lobed. Female receptacle stalked, stalk with 2 rhizoidal furrows on the anterior side and air chambers on the posterior side; receptacle flat, hemispherical to convex, distinctly 4-11 lobed. Pseudoperianth present; capsule dehiscing irregularly; with annular thickenings bands. Spores small, tetrahedral, globose. Elaters long, attenuate, with bi-spiral thickenings.

Type: Marchantia polymorpha L.

Key to the species of the genus *Marchantia*

- 1a. Thallus large, 5-8 (-10) mm wide, inner pore cruciate..... 2
- 1b. Thallus medium, 3-5 mm wide, inner pore quadrate or stellate..... 3
- 2a. Appendages of medium scales acute, crenulate or toothed, non-functional female receptacle absent *M. paleacea* subsp. *paleacea*
- 2b. Appendages of medium scale rounded, margin entire or slightly crenulate; female receptacle frequently non-functional *M. paleacea* subsp. *diptera*.
- 3a. Thallus with narrow dark median streak.....*M. linearis*
- 3b. Thallus with a broader dark streak.....*M. papillata* subsp. *grossibarba*

Marchantia paleacea* subsp. *paleacea Bertol., in Opusc. Sci. 1: 242. 1817; Bischl. In Bryophyt. Biblioth. 38: 91. 1989. **(Plate 101. Figs. 1-13)**

Dioicous, thallose, dichotomously branched, overlapping, green to deep green, margin thin, 5-8 mm wide, 15-35 mm long, apex notched. Rhizoids numerous on the ventral surface, smooth walled and pegged walled. Ventral scales brownish red to red, appendiculate, appendages ovate, oblong, entire, 69.5-170.0 µm long and 11.3-50.1 µm wide, scales arranged in two rows on each side of the mid-rib, 6-9 oil bodies on scale appendage. Gemma cup present, many, air-pore simple, crescent shape, 3 cells above the epidermal cells, 6-7 cells in radial rows, 4-6 concentric ring of cells, 91.5-121.3 µm long, 12.7-50.1 µm wide, inner pore cruciate bounded by 4 cells, air-pore 276.6 x 127.2 µm in diameter. Epidermal cells barrel shape, oval, 34.8-85.5 µm long, 38.7-62.6 µm wide. Thallus cells thin walled, pentagonal to hexagonal, 58.4-80.9 µm long and 37.3-68.2 µm wide. Male receptacle borne on the main thallus at apex, stalked, stalk shorter than the female Archegoniophores, 4-6 mm long, lobed, flat disc, lobes may vary from 4-8. Female receptacle borne on the main thallus at apex,

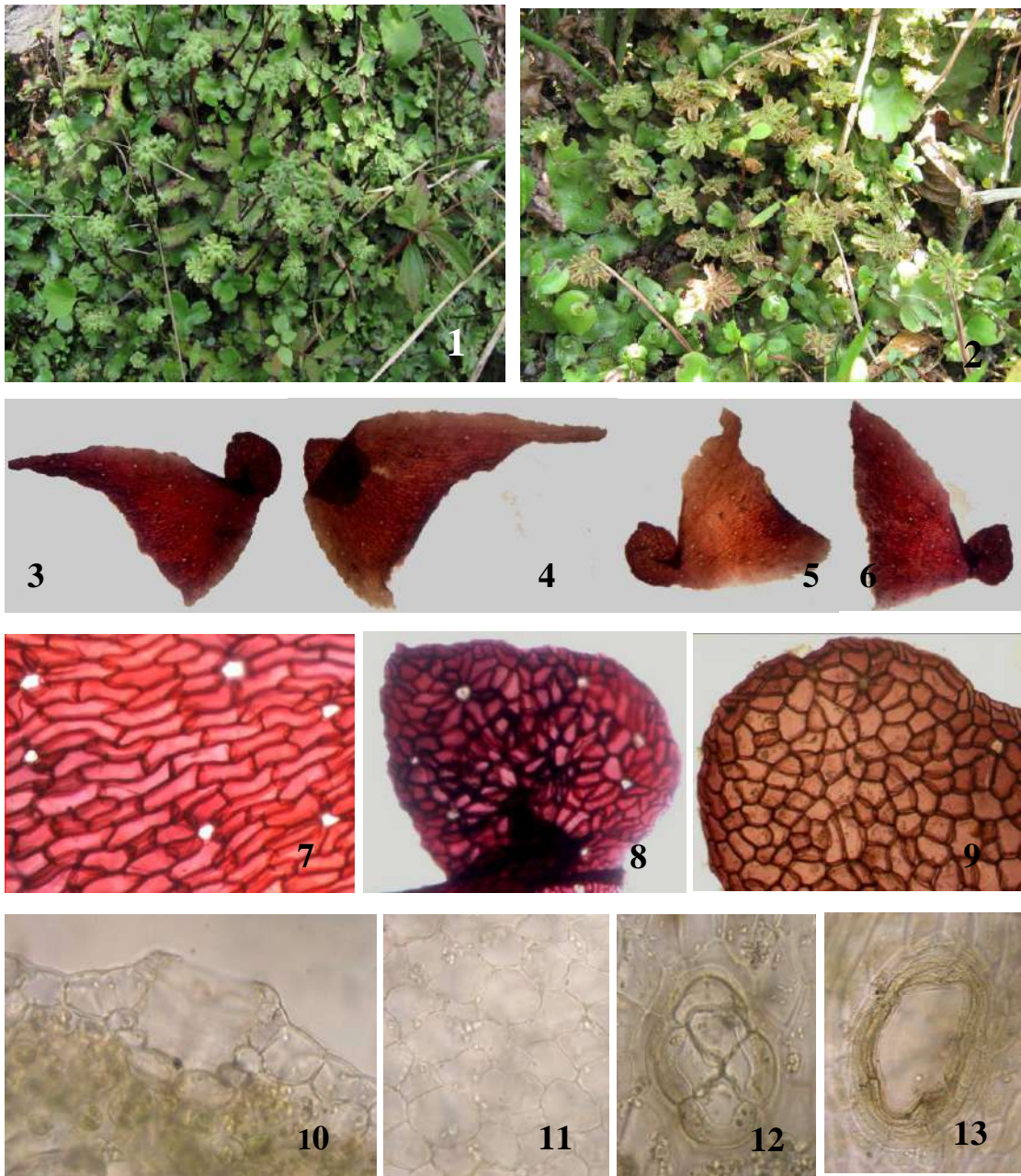


Plate 101. *Marchantia paleacea* subsp. *paleacea* Bertol.; Figures 1-13.

Figs. 1. Showing habit of female plants; 2. Showing habit of male plants; 3-6. Ventral scales; 7. Median cells of ventral scales cells; 8-9. Scales appendages cells; 10. Cross section of thallus showing air-pore; 11. Thallus median cells; 12-13. Dorsal view of air-pore.

Scale: figs. 3-6 = 1 mm; 8-9 = 0.2 mm; 7, 10-13 = 0.02 mm.

stalked, stalk may come up-to 25 mm in height, carpocephalla rounded to sub-globose when young and become flat, disc like, when mature, lobes divided in-to 9 lobes. Male receptacle develops earlier than the female receptacle.

Habitat: Plants grows in moist soils (terricolous) and on rocks (saxicolous) in association with *Phaeoceros laevis*, *Conocephalum* sp., *Marchantia* sp., *Jungermannia* sp. and Mosses at 900-1600 m asl.

Range: India, Bhutan, Nepal, China, Pakistan, Japan, Indonesia, Polynesia, Fiji, Macronesia, Africa, Europe, North & South America.

Distribution in India: *Western Himalaya:* Jammu & Kashmir, Himachal Pradesh, Uttarakhand; *Eastern Himalaya:* West Bengal, Assam, Sikkim, Meghalaya, Nagaland*; *Central India:* Madhya Pradesh; *Western Ghats:* Tamil Nadu.

Specimen examined: Nagaland: Kohima District: Khuzama: KE 10005, KE 10006: June, 2008: Kazuhrii Eshuo; Viswema: KE 10044, KE 10045: 12-03-2009: Kazuhrii Eshuo; Mokokchung District: Changki: KE 10348: 02.11.2010: Kazuhrii Eshuo.

Marchantia linearis Lehm. et Lindenb. Pug. 4: 8; Sp. Hepat. 1: 187. 1900.

(Plate 102. Figs. 1-15)

Thallose, dioicous, dichotomously branched, green to deep green, apex notched toward the dorsal, lobe, gemmae cups present. Rhizoids numerous on ventral surface, two types of rhizoids, smooth-walled and pegged-walled rhizoids, hyaline, transparent. Ventral scales in two rows, appendiculate and non-appendiculate, median scales large, appendage sub-rotund to ovate, margin 1 cell projecting, papillae. Air-pore simple, oval to round shape, 3-4 concentric rings, 7-9 cells in radial rows. Antheridiophore long, borne at the apex. Female receptacle borne on the main thallus of the female plant, stalked, stalk long, lobed, 6-9 lobes.

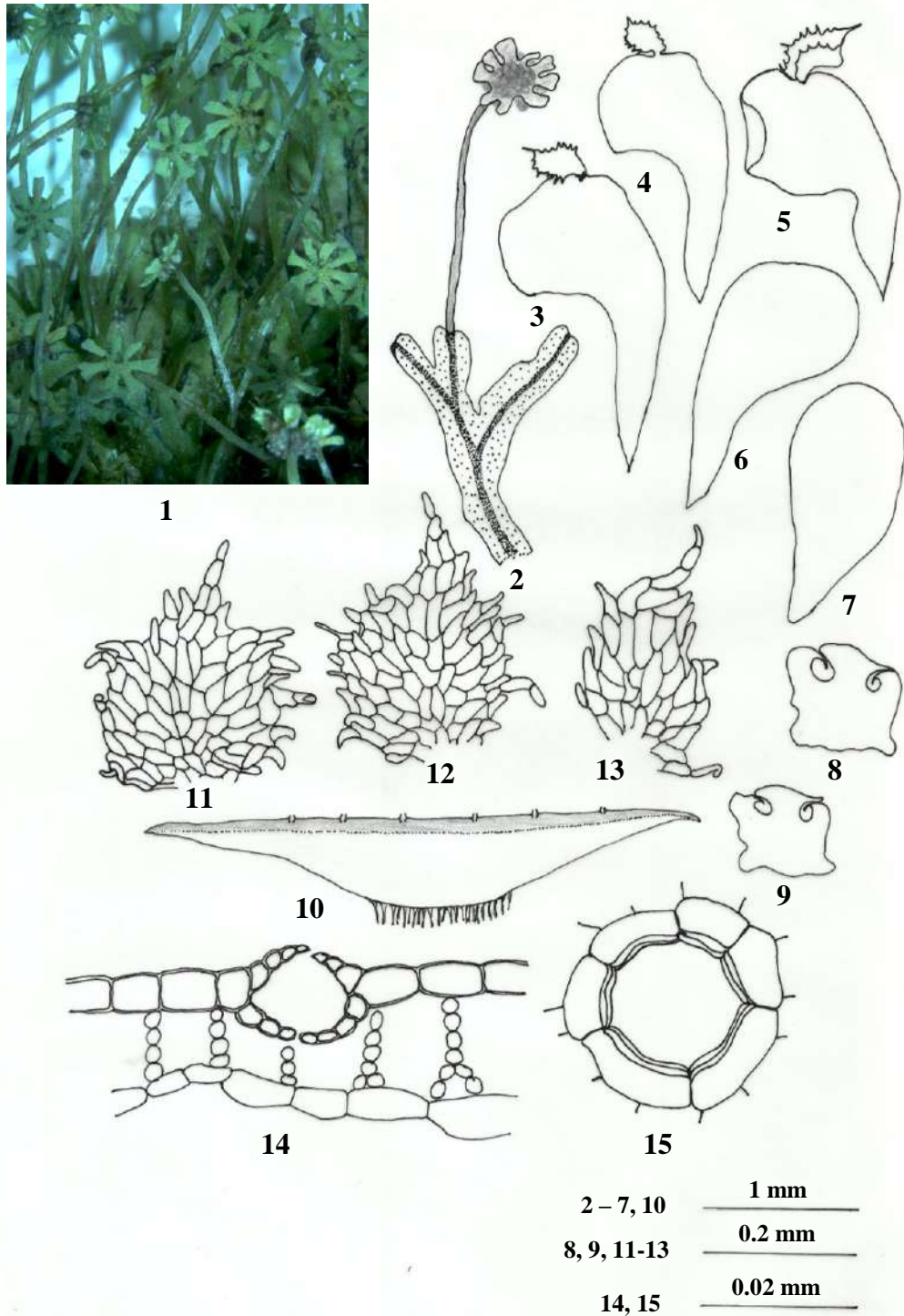


Plate 102. *Marchantia linearis* Lehm. et Lindenb.; Figures 1-15.

Figs. 1. Plants showing habit; 2. Thallus in dorsal view; 3-7. Ventral scales; 8-9. Cross section of archegoniophores; 10. Cross section of thallus; 11-13. Scales appendages cells; 14. Cross section of thallus showing air-pore; 15. Dorsal view of air-pore.

Scale: Figs. 2-7 = 1 mm; 8-10 = 0.2 mm; 11-15 = 0.02 mm.

Habitat: Plants grows in moist soils (terricolous) and on rocks (saxicolous) in association with *Phaeoceros laevis*, *Conocephalum* sp., *Marchantia* sp., *Jungermannia* sp. and Mosses at 1200-1600 m asl.

Range: India, Pakistan, Nepal, Java, Mauritius.

Distribution in India: *Eastern Himalaya:* Assam, Meghalaya, Sikkim, West Bengal, Nagaland*.

Specimen examined: Nagaland: Kohima District: Viswema: KE 10095: 12-03-2009: kazhuhrii Eshuo; Viswema: KE 10104: 01-05-2009: Kazhuhrii Eshuo.

M. paleacea subsp. *diptera* (Nees et Mont.) Inoue, J. Jap. Bot. 64 (7). 1987.

(Plate 103. Figs. 1-16)

Thallose, dioecuous, dichotomously branched, overlapping, forming a thick layer, with the old decayed thalli overlapping the new juvenile plants, air-pore simple, crescent shape, 4-5 concentric rings, circular, middle stellar, apex notched, lobed, margin entire to weakly undulate, thin, brownish green to reddish green at the margin, 20-65 mm long, 6-9 (-12) mm wide, broader at apex, rhizoids in tufts, dimorphic, smooth walled and tuberculate or pegged walled. Ventral scales arranged in two rows on the ventral side of each mid-rib, median scales larger and appendiculate, appendages oblong, margin entire, reddish brown, purplish. Gemma cup numerous on the dorsal surface of the thallus, wall serrate, toothed, 3-4 mm in diameter. Archegoniophore arise from the the apical end in between the lobes, or sometime at lateral, 8-20 mm long, the female archegonia are infertile and fail to produce spores. Antheridiophore borne on the main thallus at apex, stalk 5-16 mm long, surrounded by scales. Spores and elaters not seen.

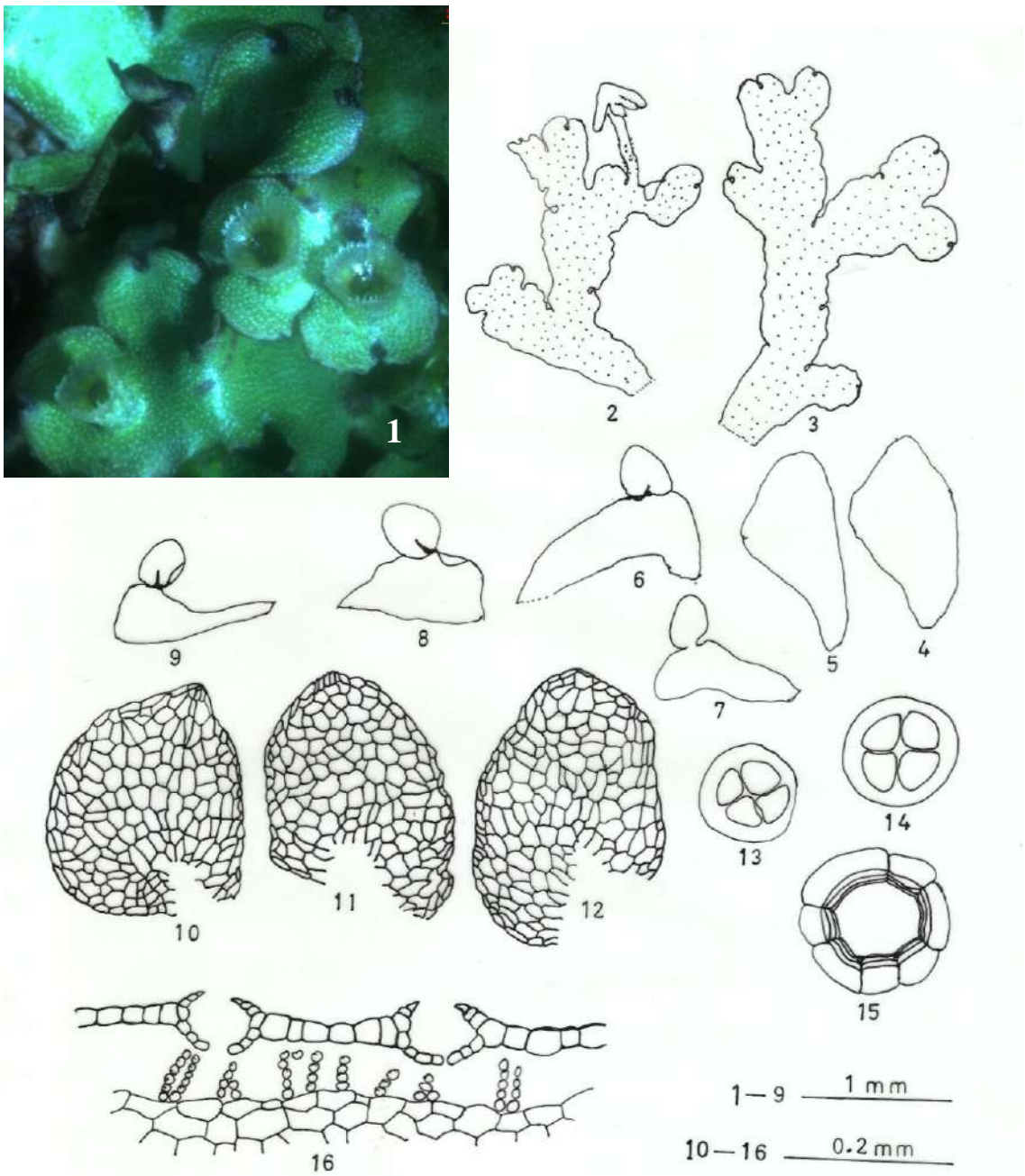


Plate 103. *Marchantia paleacea* subsp. *dipteral* (Nees et Mont.) Inoue, Figures. 1-

16.

Figs. 1. Plantsshowing habit; 2-3. Thalli in dorsal view; 4-9. Ventral scales; 10-12. Scales appendages cells; 13-14. Dorsal view of air-pore; 15. Enlarge view of dorsal air-pore; 16. Cross section of thallus showing air-pores.

Habitat: Plants grows in moist soils and on rocks in association with *Phaeoceros laevis*, *Riccardia* sp., *Marchantia* sp., *Heteroscyphus* sp., *Jungermannia* sp. and Mosses.

Range: India, China, Japan, South Korea, Taiwan

Distribution in India: *Eastern Himalaya: Nagaland**.*

Specimen examined: Nagaland: Kohima District: Khuzama: KE 10061: 28-11-2008: Kazhuhrii Eshuo; Mokokchung District: Mokokchung (Arkong Ward): KE 10110: 04.07.2009: Kazhuhrii Eshuo.

Marchantia papillata Raddi subsp. *grossibarba* (Steph.) Bischl., In Cryptog. Bryol. Lichenol. 10: 78. 1989 & Bryophyt. Biblioth. 38: 210. 1989. (Plate 104. Figs 1-)

Thallose, dichotomous, dioicous, thallus small, apex notched, air-pore simple, dorsal black stripe narrow, Rhizoids in tufts on ventral surface, hyaline, transparent, two types, smooth-walled, pegged-walled. Gemma cup present, toothed on the surface, numerous gemmae present inside the gemma cup. Ventral scales in two rows on each side of the mid-rib, appendiculate, appendages sub-rotund to ovate, toothed, one cells long, brownish to reddish in colour. Male receptacle stalked, disc like, flat, lobed, 5-8 lobes, stalk shorter than the female stalk. Female receptacle long, disc like, flat, lobed, 6-9 lobes, spores brown in colour, walnut like, elaters long, brownish red, bi-spiral, vermiform.

Habitat: Plants grows on moist soil (terricolous) in association with *Phaeoceros* sp., *Dumortiera hirsuta*, mosses and herbs at 900- 1600 m asl.

Range: India, Bangladesh, Bhutan, China, Myanmar, Afghanistan, Sri Lanka, Thailand.



Plate 104. *Marchantia papillata* Raddi subsp. *grossibarba* (Steph.) Bischl., Figures 1-6.

Figs. 1. Showing plant habit; 2. Female plants (archigoniophores); 3. Male plants (antheridiophores); 4. Showing spores dehiscence; 5. Elaters; 6. Spores.

Scale: 2-3= 1 mm; 4=0.5 mm; 5-6= 0.02 mm.

Distribution in India: *Western Himalaya:* Himachal Pradesh, Kashmir; *Central India:* Madhya Pradesh; *Eastern Himalaya:* Arunachal Pradesh, Assam, West Bengal, Sikkim, Meghalaya, Nagaland, Punjab; *Western Ghats:* Tamil Nadu.

Specimen examined: Nagaland: Mokokchung District: Mokokchung: KE 10106: 20.06.2009: Kazhuhrii Eshuo; Changki: KE 10346, KE 10347: 02.11.2010: Kazhuhrii Eshuo; Kohima District: Kigwema: KE 10269: 08.08.2010: Kazhuhrii Eshuo.

FAMILY: AYTONIACEAE Cavers

AYTONIACEAE Cavers, *New Phytol.* 10: 42. 1911.

Plant xeromorphic. Dichotomously branched, branches often ventral; lobes oblong, obcordate to quadrate. Dorsal surface smooth, flat, epidermis often collenchymatous; pore simple, slightly elevated, surrounded usually by 2-4 concentric rings of cells. Air chambers in several layer, obliquely septate, photosynthetic filament absent; ventral tissue well developed. Ventral scales 2 rows on each side of the mid-rib, purplish, with oil-cells, appendiculate, bearing 1-2 lanceolate or ovate lanceolate appendages. Dioicous or monoicous. Male receptacle sessile, cushion shaped; antheridia scattered along the mid-rib thallus. Female receptacle dorsal or terminal on the thallus apex, stalked, stalk with or without rhizoidal furrow; disc 2-7 lobed, with air chambers and compound pore on upper side. Involucres undivided; Pseudoperianth absent or present (*Asterella* sp.). capsule globose, dehiscing by a transverse suture, unistratose; cells without annular thickenings. Spores areolate or inflated papillae, margin winged. Elaters usually with bi-tri-spiral thickenings (thickenings absent in species of *Plagiochasma*).

Type: *Aytonia* J.R. Forst. & G. Forst.

Key to the genera of family Aytoniaceae

1. Plants small to medium, 5-25 mm long, giving a strong fishy smell when crushed,
Pseudoperianth present, elaters with thickening..... *Asterella*
- 1a. Plant large or small, not fishy smell when crushed, pseudoperianth absent..... 2
2. Plant large, 4-8 mm wide, male receptacle sessile, horse-shoe shaped, elaters
without or with thickenings..... *Plagiochasma*
- 2a. Plant small, 2.5-4 mm wide, male receptacle sessile, oval or disc shaped, elaters
with 2-3 spiral thickenings..... *Mannia*

Genus: *Asterella* P. Beauv.

Asterella P. Beauv., in F. Cuvier, Dict. Sci. Nat. 3: 257. 1805.

Plants thalloid, dichotomously branched, green to light yellowish green, margin thin, reddish pink, giving a strong fishy smell when crushed/bruised. Air pores simple, slightly convex, with 1-3 superimposed concentric rings of cells, each ring of 4-6 (8) cells in radial rows, thin walls, without trigones. Air chambers large, scattered oil cells present, storage tissue well developed. Ventral scales in 2 rows, purplish, appendiculate, appendages 1-2, with entire margin or hyaline papillae. Dioicous or monoicous. Antheridia on raised cushions on dorsal surface of main or lateral ventral branches, just behind the stalk of the female receptacle. Female receptacles stalked, stalk with one rhizoidal furrow, terminal, or on short ventral lateral branches. Involucres membranous; pseudoperianth conspicuous, tubular, white to purple. Capsule shortly pedicelled, globose, dehiscing at apex as a single, well-defined piece. Wall single layered without annular thickenings. Spores reticulate to lamellate, tetrahedral, yellow to yellowish brown. Elaters with uni-bi-spiral thickenings.

Type: Asterella tenella (L.) P. Beauv.

Key to the species of the genus *Asterella*.

1. Male receptacle just behind the female receptacle, female receptacle at apex on the main dorsal thallus, carpocephalla flat *A. khasyana*
- 1a. Male receptacle at apex on the main thallus, female receptacle on short ventral lateral branches, carpocephalla sub-globose..... *A. multiflora*

Asterella khasyana (Griff.) Pandé, K.P. Srivast. & Sultan Khan. J. Hattori

Bot. Lab. 11: 7, 1954 '*khasiana*'.

(Plate 105. Figures. 1-12)

Thallose, monoicous, dichotomously branched, thallus small to medium, 5- 10 mm long, 2 - 3 (4) wide; light green, margin thin, reddish pink, apex notched; give a strong fishy smell when bruised/crushed. Rhizoids hyaline, two types of rhizoids, smooth walled 17.6 – 23.4 μm in diameter and pegged walled 13.7 - 20.5 μm in diameter. Ventral scales reddish to purple, appendiculate, lanceolate, appendage 1 or rarely 2, acuminate, long; apical cells 41.9 - 62.6 μm long, 16.5 - 37.4 μm wide; scales cells 44.5 - 99.4 μm long and 19.8 - 46.2 μm wide and scales arranged in one row on each side of the mid-rib. Air pores visible like dots on the dorsal surface, air pore large, 19.4 x 31.2 μm in diameter; 3 - 4 concentric ring of cells, 6 - 7 cells in radial row, innermost cells 16.2 - 27.5 μm long, 6.3 - 10.2 μm wide. Epidermal cells thin-walled, non-trigonous, 28.1 - 48.3 μm long, 16.2 - 27.4 μm wide. Androecia cushion like, which are borne on the main thallus just behind the stalk of an archegoniophore. Archegoniophore borne on the main thallus in between the notched, stalked, 2 - 6 mm long. Carpocephallum disc like, flat, lobed, 1 - 4 lobes; pseudoperianth distinct, whitish, 2 - 3 mm long; sporogonium 2.1 x 2.5 mm in diameter. Spores yellow to orange in colour, winged, numerous, large, 77.3 - 92.4 μm in diameter, alveolate, proximal and distal surface with dissimilar sculpturing. Elaters

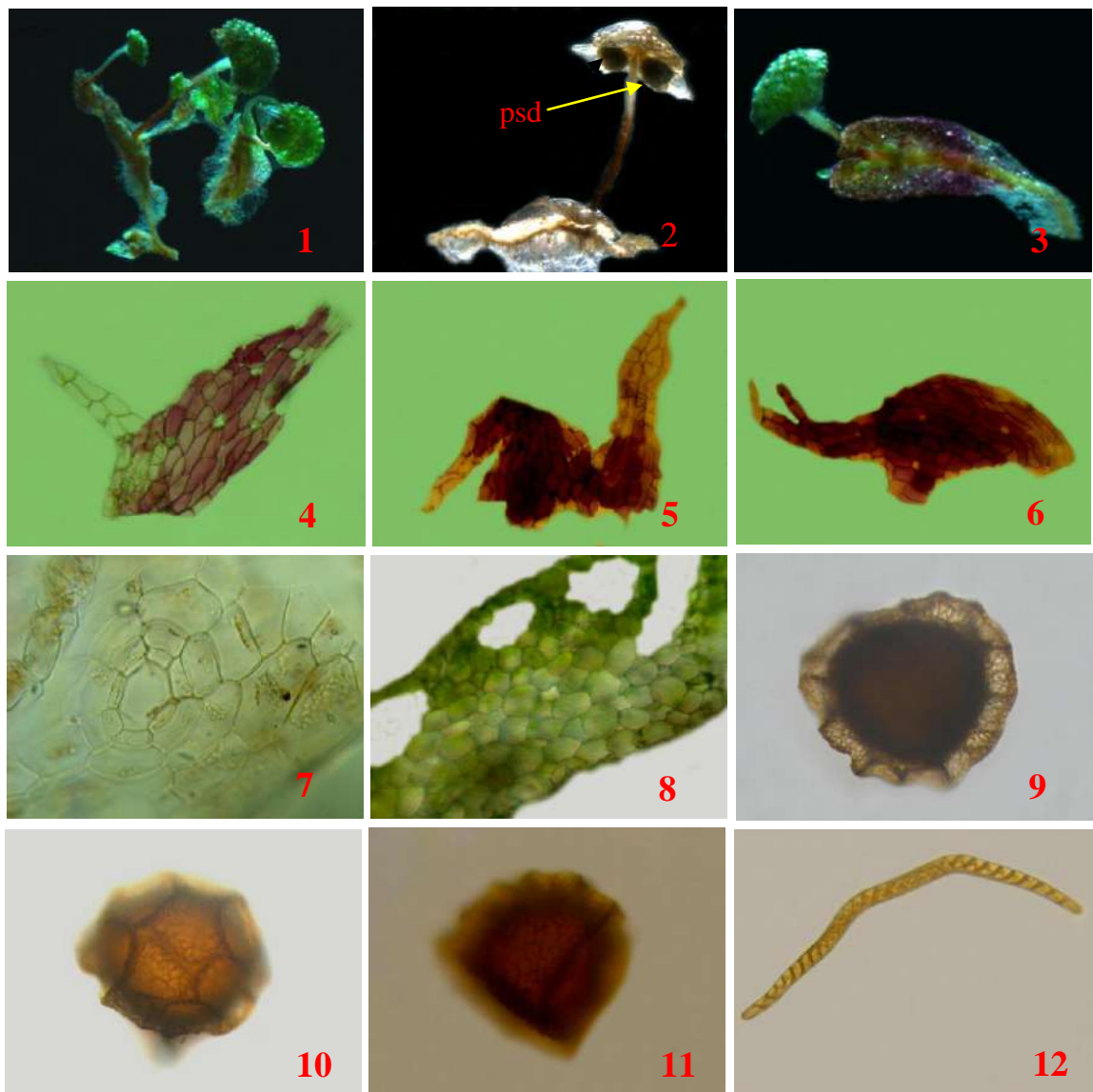


Plate 105. *Asterella khasyana* (Griff.) Pandé, K.P. Srivast. & Sultan Khan, figures 1-

12

Figs. 1-3. A fertile plant showing archegoniophore, 2- mature plant showing carpocephalum with two Pseudoperianth containing sporogonium, 3- showing thallus ventral view; 4-6. Scales; 7. Air-pore seen from above; 8. Cross section of thallus cells; 9-11. Spores, 9- spore in distal view, 10- spore in surface view and 11- spore in proximal view; 12. Elater. Psd= Pseudoperianth.

Scale: 1-6= 1 mm; 7-8= 0.2 mm; 9-12 = 0.02 mm.

bright yellow, long, vermiform, bi-spiral, 10.5 – 12.3 μm in diameter and upto 250.9 μm long.

Habitat: Plant grows on moist damp soils (terricolous), rocks (saxicolous), and shade places or in open sites in association with mosses, herbs, leafy liverworts, *Targionia* sp., *Marchantia* sp. at 1200-1700 m asl.

Range: India, Pakistan, Nepal, Bhutan, China, Thailand, Indonesia, Philippines.

Distribution in India: *Western Himalaya:* Himachal, Uttarakhand, Jammu & Kashmir; *Eastern Himalaya:* West Bengal, Sikkim, Assam, Meghalaya, **Nagaland***; *Central India:* Madhya Pradesh.

Specimens examined: Nagaland: Khuzama, Viswema, Kigwema, Kohima, Jotsoma, Longkhum, 14.10.2008, 12.09.2009, 08.08.2010, Leg. Kazhuhrii Eshuo, KE 10001, KE 10021, KE 10016, KE 10033, KE 10208, KE 10276, KE 10322. Det. Kazhuhrii Eshuo.

Asterella multiflora (Steph.) Kachroo, J. Hattori Bot. Lab. 19: 3. 1958.

(Plate 106. Figs. 1-12)

Thallose, dichotomously branched, thallus medium, 5 - 28 mm long, 2 - 4 mm wide; green to light green, margin reddish, thin, rounded and shallowly notched at apex, overlapping. Give a fishy smell when bruised/crushed. Rhizoids hyaline, two types of rhizoids, smooth walled 12.3 - 25.1 μm in diameter and pegged walled 10.5 - 16.5 μm in diameter. Ventral scales purple to reddish, appendiculate, appendages 1 - 2 per scale, acuminate, lanceolate, apex filiform; cells 18.2 - 67.3 μm long and 13.3 - 26.2 μm wide, scales arranged in one row on each side of the mid-rib; scales present mostly at the apex and near the stalk of the archegoniophore. Air pores visible as white dots on the dorsal surface, large, 19.2 - 36.5 μm in diameter; 3 - 5 concentric ring of cells, 6 - 7 cells in radial row, innermost cells 14 - 18.4 μm long and 6.5 - 10.3

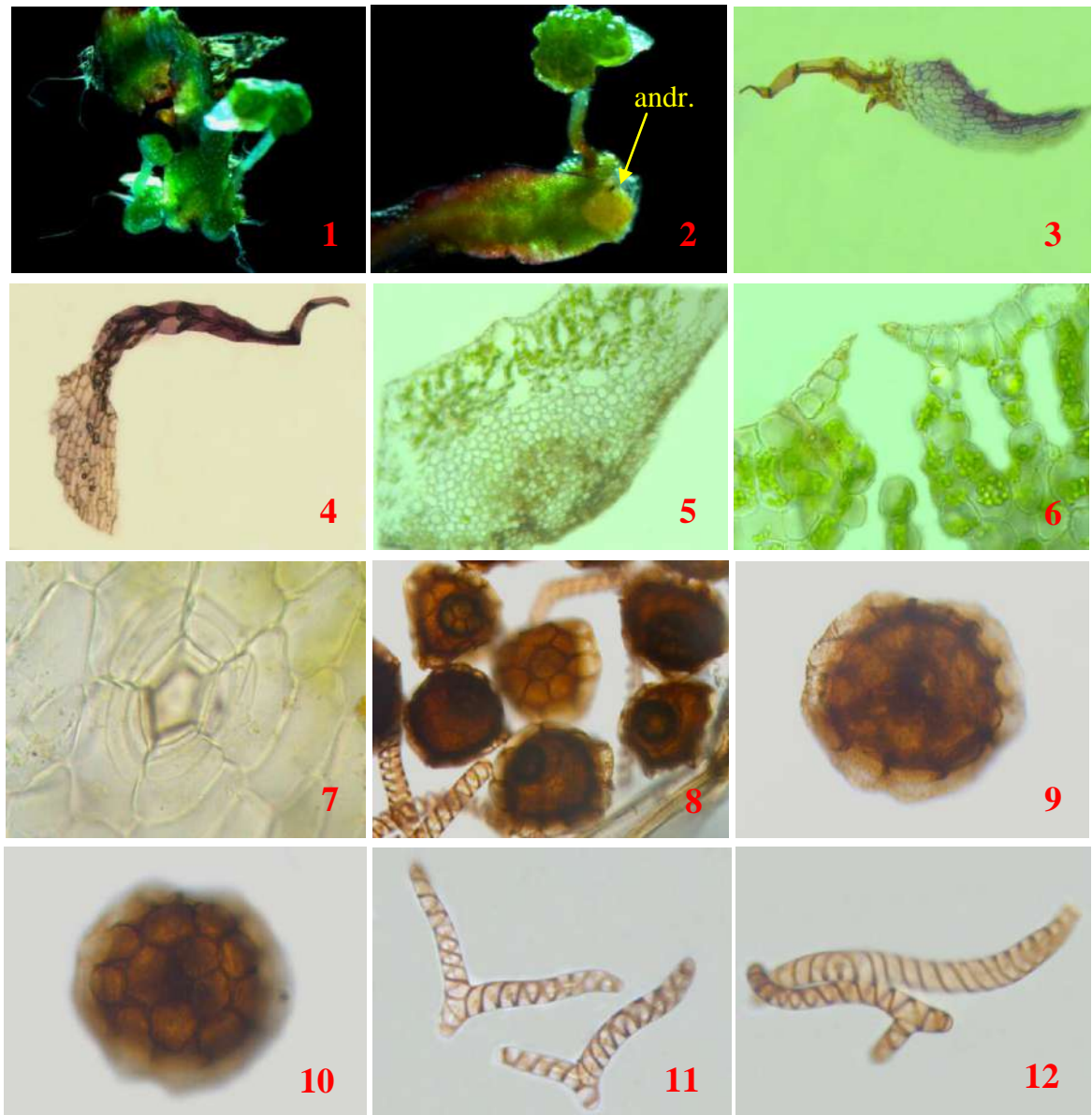


Plate 106. *Asterella multiflora* (Steph.) Kachroo, Figures 1-12

Figs. 1-2. Showing plant habit with female fructification, 2- showing male fructification at thallus apex; 3-4. Scales; 5-6. Cross section of thallus cells, 6- showing epidermal air-pore cells; 7. Air-pore seen from above; 8-10. Spores, 9- spore in distal view, 10- spore in surface view; 11-12. Showing elaters in different shapes; andr= androecium;

Scale: 1-4 = 1 mm; 5= 0.2 mm; 6-12 = 0.02 mm.

µm wide. Epidermal cells oval to barrel shape, compactly packed, 16.5 – 27.4 µm long and 21 - 30.3 µm wide. Thallus cells pentagonal to hexagonal, non-trigonus, thin walled, 20.8 - 33.4 µm long and 14 - 30.4 µm wide. Androecia cushion like, which are borne on the main thallus at the apex, slightly covered by apex scales. Archegoniophores are borne on the short lateral branches, stalked, 3 - 8 mm long. Carpocephallum rounded, sub-globous when young and become flat when mature; lobed, 1 – 4 lobes; pseudoperianth distinct, white to pinkish, 2 - 3 mm long; 1 - 2 archegoniophore borne on the fertile plant. Spores brownish to orange in colour, winged, 58 - 73.3 x 74 - 92.7 µm in diameter, proximal and distal view no much differentiation. Elaters brownish red, orange red, 13.1 - 14.5 µm in diameter, bi-spiral, branched, various structures, Y - shape, V - shape or T - shape, vermiform, 116.2 - 161.4 µm long.

Habitat: Plant grows on moist soils (terricolous), moist rocks (saxicolous) in association with mosses, herbs, grass, leafy liverworts at 900-1400 m asl.

RANGE: Pakistan, Nepal, China (Sichuan, Yunnan), India.

Distribution in India: *Western Himalaya:* Himachal Pradesh, Uttaranchal, Punjab; *Eastern Himalaya:* West Bengal, Sikkim, Assam, Nagaland*.

Specimens Examined: Nagaland: Changki: KE 10036, KE 10108: 12.11.2008: Kazhuhrii Eshuo.

Genus: *Plagiochasma* Lehm. & Lindenb.

Plagiochasma Lehm. & Lindenb., Lehm., Nov. Strip. Pug. 4: 13. 1832.

Plants thallose, large, caespitose, patches green. Gemmae absent. Dorsal surface not distinctly divided into polygonal areas. Dorsal epidermis distinct, pale or colourless, 1 cell thick, cells thin walled, with more or less distinct trigones. Air chambers more or less divided by supplementary walls and several layers deep in

median region, green filaments generally absent. Air pore simple, minute or larger, superimposed by 4-6 concentric rings of cells, each rings are 2-3 cells, thick walled, ventral tissue ncells thin walled. Ventral scales in one rows on each side of the midrib, appedaged, appendages 1-2 or rarely 3, ovate, lanceolate or acute to acuminate, slightly constricted at the base with entire margin. Male receptacle sessile, usually horse-shoe shaped, well defined with simple pores and fringe of brachlets, dorsal, female receptacle sessile when young, stalked at maturity, stalk arising from the dorsal side of the thallus, without a rhizoidal furrows, scales at the base and apex, disc convex, lobes more or less distinct, often apiculate, archegonia singly borned. Involucre large, inflated, bivalve, entire, pseudoperianth wanting. Capsule short, opening by an indistinct lid. Capsule wall one layered, thin walled, without annular thickenings bands. Spores tetrahedral, winged margined, large, yellowish. Elaters short, bi-tri-spiral, yellowish, sometimes uniformly thickened without spirals.

Type: Plagiochasma cordatum L. et L.

Plagiochasma appendiculatum Lehm. & Lindenb., in Lehm., Nov. Strip. Pug. 4: 14.

1832.

(Plate 107. Figs. 1-9)

Thallus large, thallose, light green to green or deep green, dichotomously branched, overlapping, 10-35 mm long, 4-8 mm wide, lobes oblong to obcordate, margin purple, thin, wavy, ascending-crenulate. Dorsal surface smooth, air-pore simple, elevated, surrounded by 3-4 concentric rings of 6-8 cells each, storage tissue prominent. Ventral surface purple, scales in 2 rows, 1 row on each side of the mid-rib, broadly lunate, reaching half way to the margin; appendiculate, appendage 1 per scale, large, oblong, rotund to sub-rotund, reddish brown or sometime hyaline. Monoicous. Male receptacle horse-shoe shaped, situated in the median region of the thallus; ostiole prominent; antheridia scattered. Female receptacle not seen.

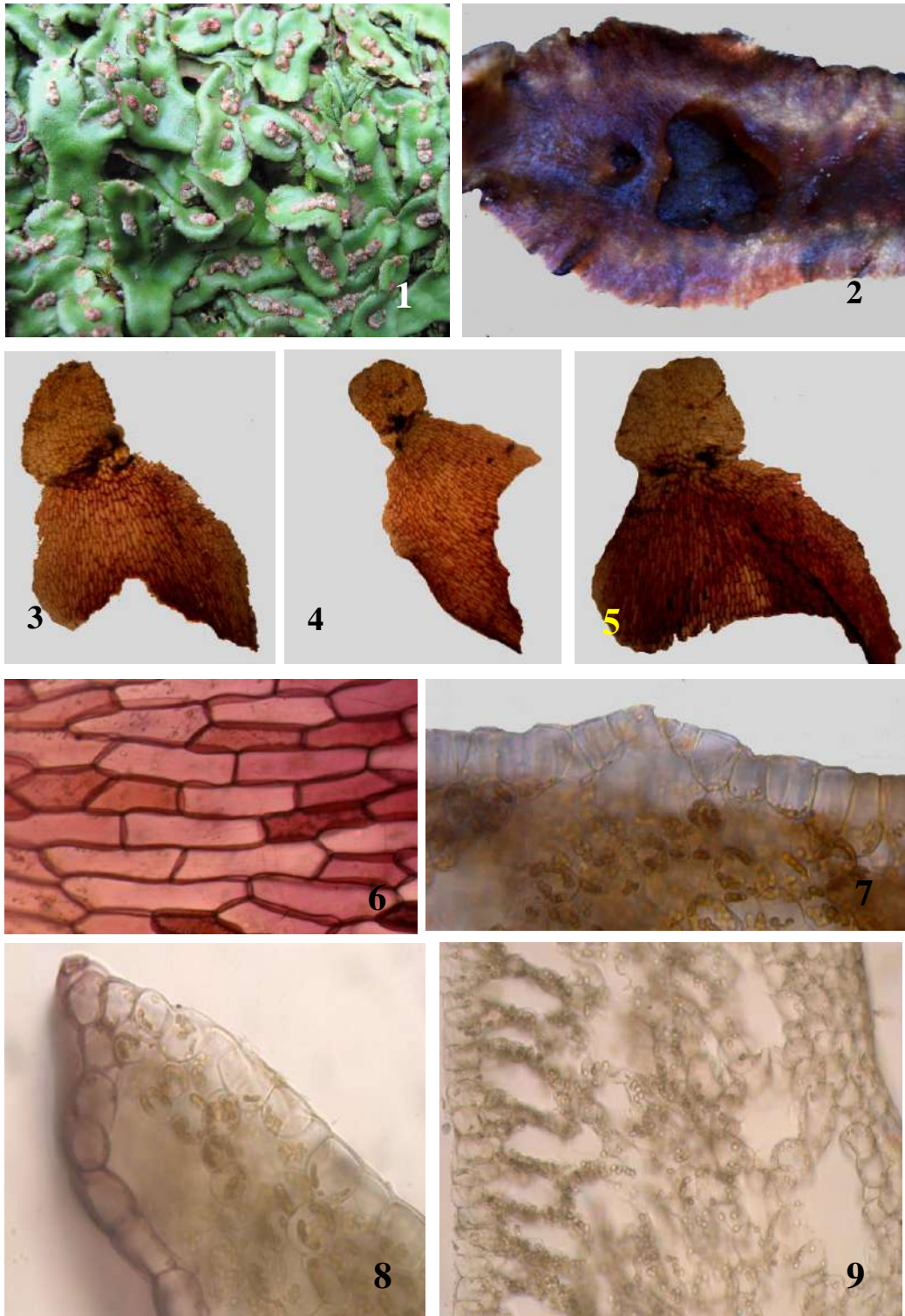


Plate 107. *Plagiochasma appendiculatum* Lehm. & Lindenb., Figures 1-9.

Figs. 1. Plants showing habit; 2. Thallus in dorsal view; 3-5. Ventral scales; 6. Median scale cells; 7. Cross section of thallus showing air-pore; 8. Cross section of thallus margin; 9. Cross section of thallus.

Scale: 2-5 = 1 mm; 8-9 = 0.2 mm; 6-7 = 0.02 mm.

Habitat: Terricolous, saxicolous, grows in association with *Marchantia paleacea*, *M. linearis*, *Jungermannia* sp., *Phaeoceros* sp., and Mosses.

Range: India, Pakistan, Afghanistan, Nepal, Bhutan, China, Bangladesh, Myanmar, Indonesia, Philippines, Vietnam, Arabia, Yemen and Africa.

Distribution in India: *Eastern Hinalaya:* Sikkim, West Bengal, Assam, Meghalaya, Punjab, Rajasthan, **Nagaland***; *Western Himalaya:* Himachal Pradesh; Central India: Madhya Pradesh; *Western Ghats:* Maharashtra and Tamil Nadu.

Specimen examined: Nagaland: Kohima District: Kohima: KE 10040: 13.10.2008; KE 10249: 08.08.2010: Kazuhrii Eshuo; Mokokchung District: Changki: KE 10334: 02.11.2010: Kazuhrii Eshuo.

Genus: *Mannia* Opiz.

Thallus green to dark green, 2-5 mm wide, dichotomously branched with apical and latero-ventral innovations; lobes linear to lingulate, margin usually entire. Dorsal surface smooth, epidermis delicate to strongly collenchymatous, or thick-walled with oil-cells; epidermal pore simple, slightly elevated, surrounded by 1 or 2 (-3) concentric rings of 5-7 cells each. Air chambers in 2 to several layers, slightly to copiously sub-divided by supplementary, complete or incomplete partitions; assimilatory filaments absent; storage tissue with oil-cells, without sclerenchyma tissues. Ventral scales in 2 rows, asymmetrically crescentic, with 1-3, narrow, tapering appendages. Gemmae absent.

Monoicous or dioicous. Antheridia immersed in small, sessile, discoid to oval discs near the median line of the thallus, sometime developing in ill-defined groups towards the apices of the main thallus branches or in apical notches of short lateral or ventral innovations. Female receptacle terminal, situated in apical notche of a leading

or stipitate latero-ventral thallus segment, stalked; stalk with single rhizoidal furrow, often scaly at base; disc strongly inflated, hemispherical to subglobular, not or barely lobed; lobes typically 3-4, areolate; involucre membranous; pseudoperianth absent. Capsules globose, yellowish to chestnut brown, dehiscing by separation of discrete, circular apical lid; wall cells without thickenings. Spores coarsely areolate to papillate. Elaters with 2-3 spiral thickenings.

Type: Mannia androgyna (L.) A. Evans

Mannia indica (Steph.) Kachroo, J. Hattori Bot. Lab. 19: 4. 1958.

(Plate 108. Figs. 1-7)

Thallose, green to deep green, brownish green, 15-30 mm long, 4-6 mm wide, dichotomously branched, lobes obovate, lanceolate, apex rounded, margin reddish brown, thin, entire, undulate, not crispate. Rhizoids numerous, smooth walled and tuberculate walled, 17-22 μm wide, hyaline and transparent. Ventral scales in two rows, one in each side of the mid-rib, reddish pink, pink, appendiculate, appendages 1-2 per scale, linear, apex acute, oil bodies many, 7-12 per scale. Storage cells parenchymatous, hexagonal, pentagonal, 21-42 x 13-27 μm ; air-pore simple, 1-2 cells elevated, air-pore compact; photosynthetic bodies/cells arrange in a single row. Monoicous or dioicous. Male plant not seen or borne on the main thallus dorsal surface, sessile, cushion shaped; female receptacle stalked; stalk 4-15 mm long, carpocephallum globose when young, wart, stalk covers with scales, terminal or sometime lateral ventral shoot apex, mature spores and elaters not seen.

Habitat: Plants grow on moist rocks (saxicolous), on concrete retaining walls along with *Plagiochasma appendiculatum*, *Marchantia* sp. and Mosses at 900-1300 m asl.

Range: India, Africa, Europe.

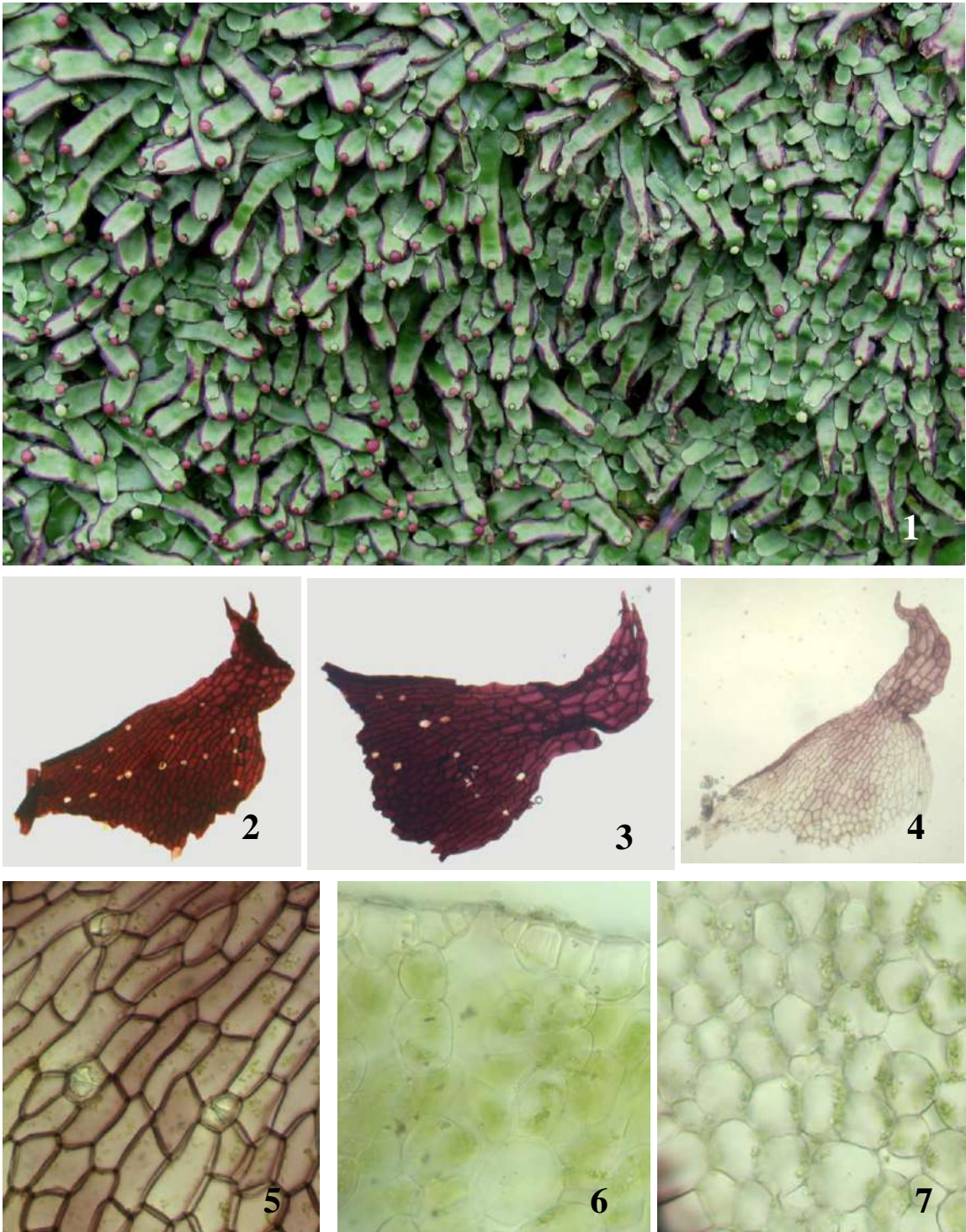


Plate 108. *Mannia indica* (Steph.) Kachroo, Figures 1-7.

Figs. 1. Plants showing habit; 2-4. Ventral scales; 5. Median cells of ventral scale; 6. Cross section of thallus with air-pore; 7. Median cells of thallus.

Scale: 2-4 = 1 mm; 5-7 = 0.02 mm.

Distribution in India: *Western Himalaya:* Himachal Pradesh, Uttarakhand, Punjab, Uttar Pradesh, Rajasthan; *Eastern Himalaya:* **Nagaland****.

Specimen examined: Nagaland: Mokokchung District: Changki: KE 10333: 02.11.2010: Kazuhrii Eshuo.

FAMILY: CONOCEPHALACEAE Müll. Frib, ex Grolle
CONOCEPHALACEAE Müll. Frib, ex Grolle, J. Bryol. 7: 207. 1972.

Thallus medium to large, dichotomously branched, dark green to light yellowish green, or purple at margin. Dorsal surface strongly areolate, pore conspicuous, elevate, simple, surrounded by several rings of cells. Air-chamber singled-layered; storage tissue parenchymatous with pitted walls. Ventral scales in 2 rows, with 1 appendage, appendage orbicular, subcircular; gemmae and tubers present or absent. Dioicous. Male receptacle without stalk, sharply delimited by a deep gutter, somewhat elevated, usually ellipsoidal in outline; conoidal opening of the antheridial chambers. Female receptacle remaining sessile until maturity of the spores, terminal; stalked, stalk 5-10 mm long with a single rhizoidal furrow, air chamber absent, disc conical, very shallowly 6-8 lobed. Involucres tubular; Pseudoperianth absent. Seta remaining short; capsule obovoid-ellipsoid, dehiscing by irregularly valves, unistratose, cells of the walls with annular thickenings. Spores globose-obvoid, pale brown, delicately papillose. Elaters short, often with pointed ends, with 2-3 spiral thickening.

Type: Conocephalum Hill, nom. cons.

Key to species of the genus *Conocephalum*

1. Thalli gemmaeprous, 15-35 mm long, repeated branched, carpocephalum more or less clavate..... *C. japonicum*
- 1a. Thalli not gemmaeprous, large, 90-170 mm long, dichotomously branched, carpocephalum conical..... *C. conicum*
- Conocephalum japonicum*** (Thunb.) Grolle, J. Hattori Bot. Lab. 55: 501. 1984.

(Plate 109. Figs. 1-12)

Thallose, dichotomously branched, green to light green, margin thin, recurved, irregular, 15-35 mm long, 5-10 mm wide. Rhizoids hyaline, transparent, smooth-walled 26.4 - 31 μm in diameter, pegged walled 16.5 – 19.6 μm in diameter. Ventral scale smalls, one row on each side of the mid-rib, distant, reddish. At the apex numerous gemmae/sporophytes are borne which are brown to blackish colour when mature, green when young, disc like, born on ladle shape. These gemmae germinate into new sporophytic plant body. Air-pore large, seen as white dots on the dorsal surface, 4 - 5 concentric rings of cells, 6 - 7 radial rows of cells and 5 -6 cells above the epidermal cells. Sporophytes no seen.

Habitat: Plants grows on moist rocks, soil in association with *Marchantia* sp., *Phaeoceros* sp. and other herbs.

Range: India, Nepal, Bhutan, Taiwan, Japan, Korea, China, East Siberia.

Distribution in India: *Eastern Himalaya:* Sikkim, West Bengal (Darjeeling), Arunachal Pradesh, **Nagaland***.

Specimen examined: Nagaland: Kohima District: Khuzama: Viswema: KE 10041: 12.03.2009: Kazhuhrii Eshuo.

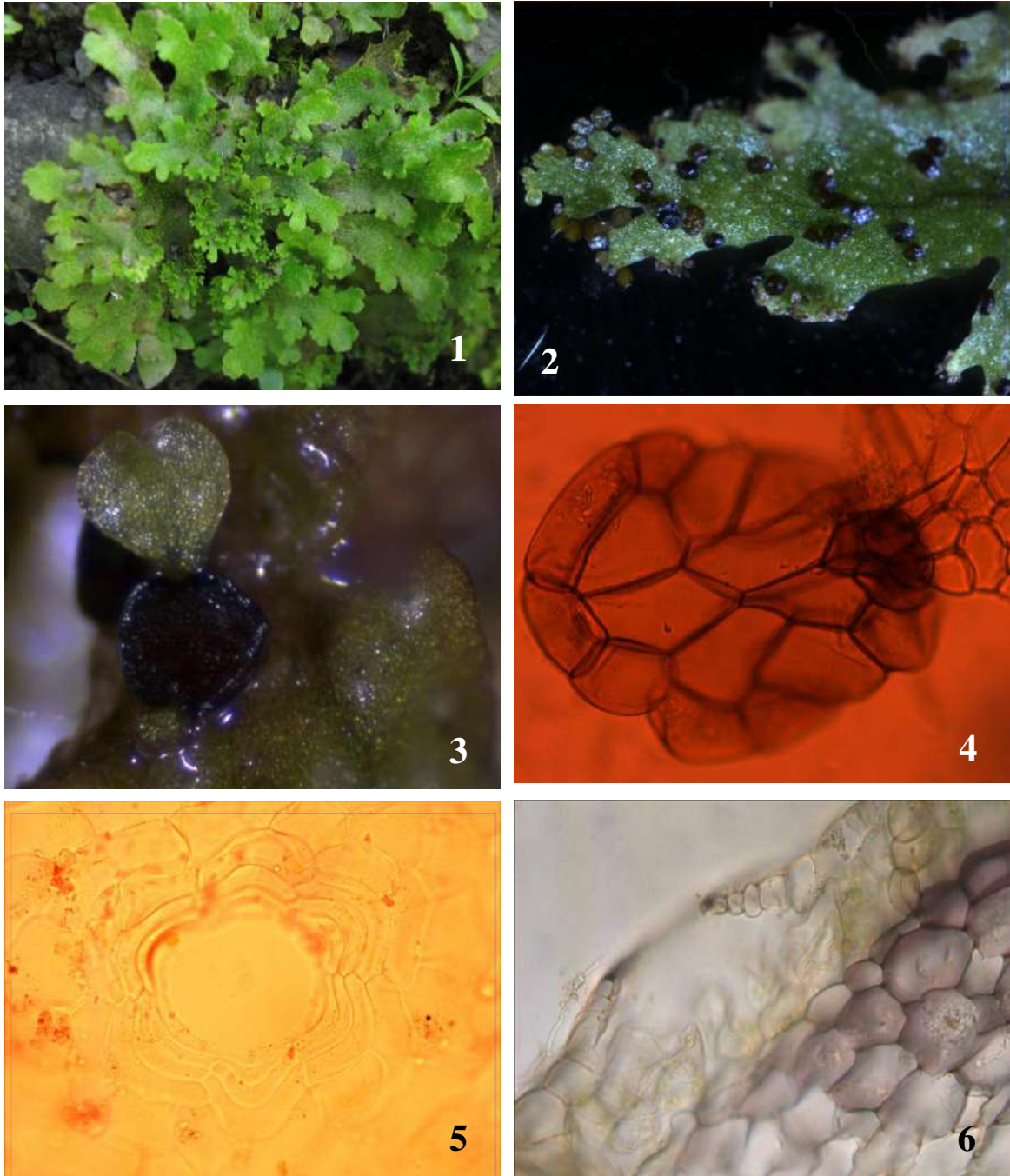


Plate 109. *Conocephalum japonicum* (Thunb.) Grolle, Figures 1-6.

Figs. 1. Plants showing habit; 2. Mature thallus showing gemmae; 3. Gemmae developing from the thallus; 4. Ventral scale; 5. Air-pore seen from front; 6. Cross section of thallus with air-pore.

Scale: 1 mm, 3 = 0.5 mm; 4-6 = 0.02 mm.

Conocephalum conicum (L.) Dumort., Comment. Bot.: 115. 1822.

(Plate 110. Figs. 1-8)

Thallus large, light green to green, dull green, dichotomously branched, 90-170 mm long, 5-15 mm wide, air-pore seen as white dots on the dorsal surface of the thallus. Rhizoids numerous on the ventral surface; smooth walled, 17-25.7 μm wide; pegged walled, 17.7-23.5 μm in diameter. Ventral scales arranged in one row on each side of the mid-rib; distant, appendiculate on young thalli, orbicular, oblong, rounded, pinkish to reddish. Air pore 7-9 cells in radial rows; 3-4 concentric rows of cells; 7-10 cells above the epidermal cells; pore large, inside the pore hair like papillae are present. Epidermal cells barrel like, compactly packed, 16.7-36.9 μm long, 14.3-28.1 μm wide. Thallus cells non-trigonous, thin walled; hexagonal to pentagonal, rectangulate, large, 24.9-54.3 μm long, 24.5-40.5 μm wide. Reproductive structure i.e male receptacle covered by scales, sessile to short stalk, rhizoids of pegged walled abundantly covers the male receptacle; female receptacle not seen.

Habitat: The plant grows on moist rocks (saxicolous) in association with moss.

Range: India, Pakistan, Nepal, Bhutan, China, Japan, Korea, Macronesia, Europe, North Africa, North America.

Distribution India: *Western Himalaya:* Jammu & Kashmir, Himachal Pradesh, Uttarakhand; *Eastern Himalaya:* West Bengal (Darjeeling), Sikkim, Nagaland (Dziikou, Japfu Peak, Khonoma-Present study area).

Specimen examined: Nagaland: Kohima District: Dzukou: KE 10221: 30.05. 2010: Kazhuhrii Eshuo; Japfu Peak: KE 10378, KE 10387: 17.03. 2011: Kazhuhrii Eshuo; Khonoma: KE 10413: 19.03.2011: Kazhuhrii Eshuo.

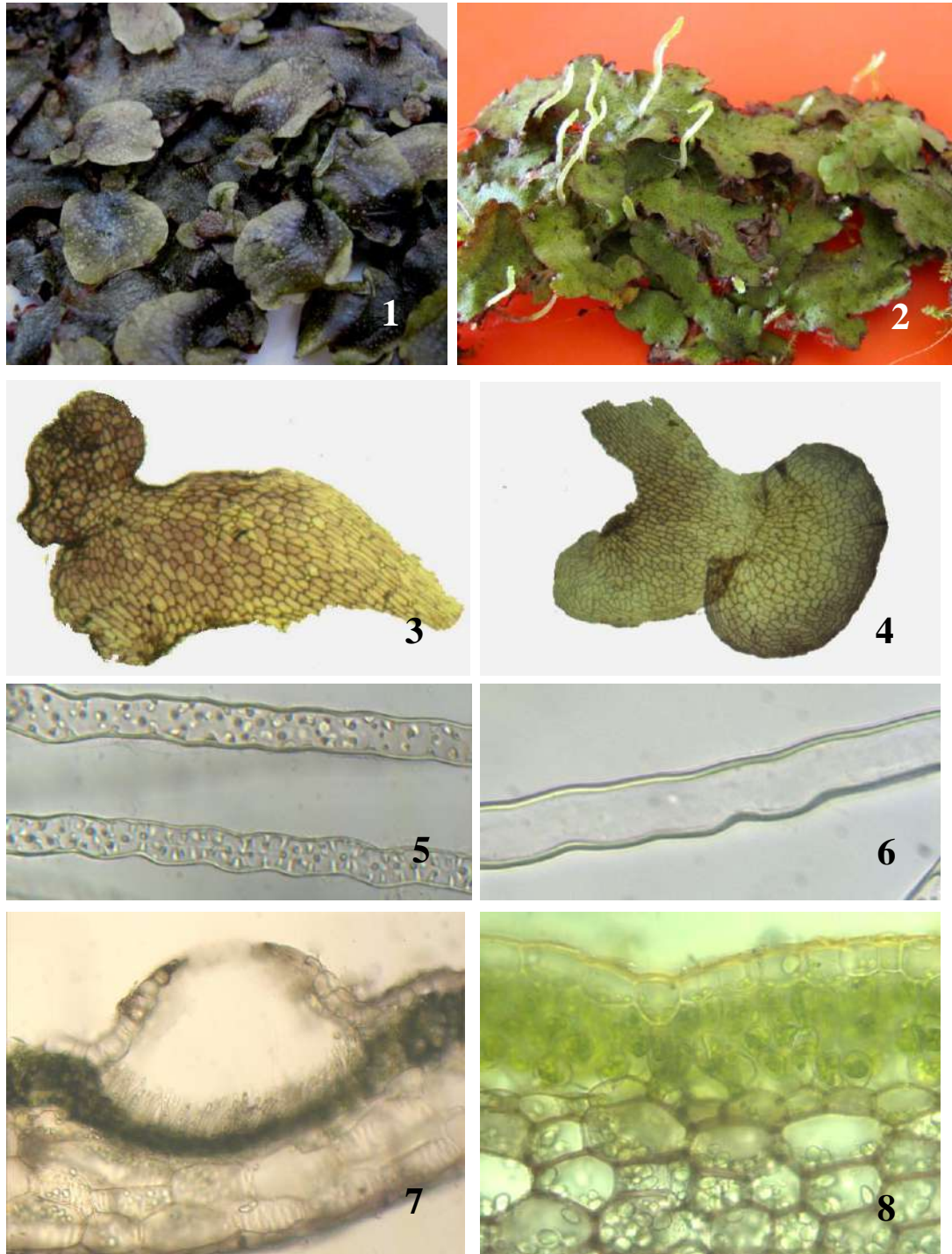


Plate 110. *Conocephalum conicum* (L.) Dumort., Figures 1-8.

Figs. 1-2. Plants showing habit; 3-4. Ventral scales; 5. Tuberculate rhizoids; 6. Smooth wall rhizoid; 7. Cross section of thallus with air-pore; 8. Cross section of thallus.

Scale: 1-2 = 5 mm; 3-4 = 1 mm; 5-8 = 0.02 mm.

FAMILY: CYATHODIACEAE Müll Frib.

CYATHODIACEAE Müll Frib. Lebermoose 2 (Suppl. 2): 182. 1940.

Plant small to large, thin, light green to yellowish green, green, dichotomously branched, fan shaped or strapped shaped, with deeply incised apex. Dorsal surface rarely covered with hairs, cells single layer; ventral cells single cell separated by a thin partition. Air chamber in one layer, rarely more than one layer; mid-rib absent, ventral scales reduce, small; rhizoids dimorphic, tubers may or may not be present. Gemmae absent. Monoicous or dioicous, antheridiophore sessile or stalked, stalk if present with a shallow rhizoidal furrow; antheridial discs terminal, lateral or at the point of dichotomy, cushion shaped or disc shaped, or in the neighbourhood of the involucre, (in monoicous species); Antheridium small, globose-sub globose, shortly stalked, lodged singly in Antheridium chamber, ostioles papillose. Involucres usually ventral, near the growing point as in *Targionia*, rarely projecting beyond the thallus apex, bivalve or tumbler shaped, or even tubular. Capsule globose-subglobose, capsule wall single layer, with annular thickening bands on the upper half of the capsule and lower half devoid of them. Spores usually spinate or baculate, rarely verrucose, lamellate or reticulate. Elaters less in number than the spores per capsule, brown, fusiform or robust, with bi-tri spiral thickening.

Type: Cyathodium Kunze

Genus: *Cyathodium* Kunze

Cyathodium Kunze, in Lehm., Nov. Strip. Pug. 6: 17. 1834.

It is a monogeneric family and therefore, the characters of the family will suffice even the characters of the genus.

Key to the species of the genus *Cyathodium*

1. Plants with hairy involucre, rim bordered with colourless elongated cells, spores spinate, elaters more than 4 per capsule..... *C. aureonites*
- 1a. Plant without hairy involucre, rim bordered with brownish elongated cells, spores granulate, elaters 4 per capsule..... *C. smaragdinum*

Cyathodium aureonites (Griff.) Mitt., J. Linn. Bot. Soc. 22: 298-328. 1887.

(Plate 111. Figs. 1-6)

Plant light green to green when young, turn to yellowish green when mature, dichotomously divided, fan shaped, densely overlapping, forming an irregular rosette, grows on moist rocks, cemented walls, on moist dump soils. Rhizoids numerous on ventral surface and on the female receptacles, hyaline, of two types, thin-walled straight, and thick-walled sinuate. Scale on the ventral small, minute, hyaline. Air-pore large, 2-4 concentric ring of cells, 4-7 cells in radial rows; epidermal cells thin-walled, polygonal to sub-quadrate. Midrib absent. Androecia not seen. Female plant broad, with more than 5 involucre per thallus; involucre hairy, borne at the base of the sinus between apical lobes of the thallus, involucre united with the thallus; globose, the rim bordered with colourless elongated cells. Sporophyte 1 or rarely 2 in each involucre; capsule more or less spherical to sub-spherical. Spores spherical, circular, isopolar, blackish brown, 46.5-57.2 μm in diameter, densely covered with spines; spines 4.4-6.6 μm long, 1.3-2 μm wide. Elaters few, brownish-black, long, vermiform like; bi-spiral at both end and tri-spiral in the middle, 15.5-17.6 μm in diameter, more than 300 μm long.

Habitat: Plants grow on moist shady areas (terricolous) in association with *Asterella* sp. and Mosses at 1200-1700 m asl.

Range: India; Africa; Java; Vietnam.

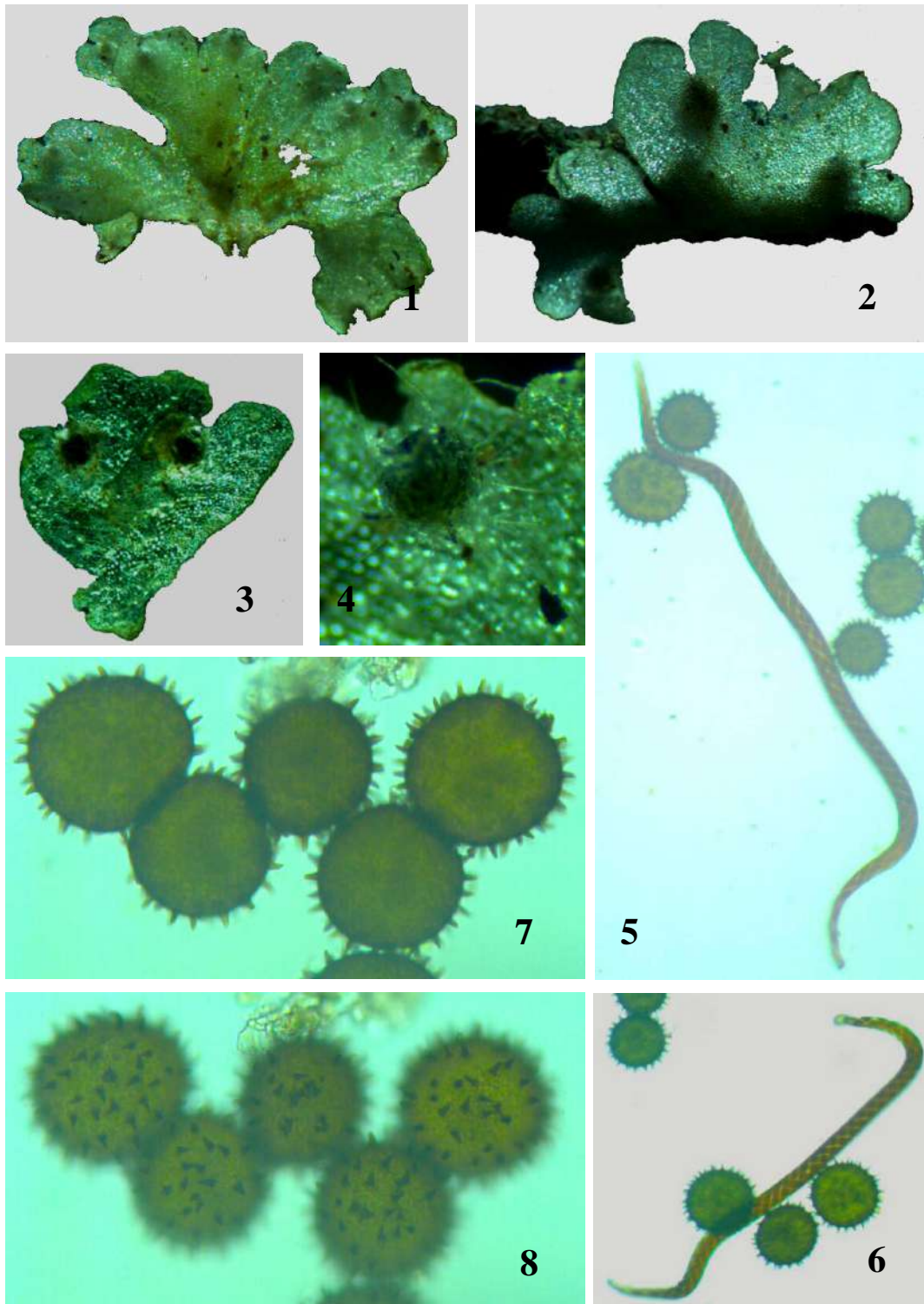


Plate 111. *Cyathodium aureonites* (Griff.) Mitt., Figures 1-8.

Figs. 1-2. Thalli in dorsal view; 3. Thallus in ventral view; 4. Enlarge view of sporogonium on thallus; 5-6. Elaters; 7. Spores in distal view; 8. Spores in surface view.

Scale: 1-3 = 1 mm; 4 = 0.5 mm; 5-8 = 0.02 mm.

Distribution in India: *South India:* Bombay, Malabar Hills, Pratabgarh, Khandala; *Western Himalaya:* Mussoorie, Dehra Dun; *Eastern Himalaya:* Assam, West Bengal, Darjeeling, Sikkim, **Nagaland***.

Specimen examine: Nagaland: Kohima District: Viswema: KE 10260: 10.10.2010: Kazhuhrii Eshuo.

Cyathodium smaragdinum Schiffn., Ann. Jard. Buitez. 2. Ser. Supple. 3: 480. 1909.

(Plate 112. Figs. 1-9)

Plant light green to green, thallose, dichotomy 1 or 2, overlapping, thin, fragile, medium to large, 5-12 mm long, 2.5-6 (8) mm wide, grows on moist rocks, cemented walled, damp moist concrete retention walls, fan-like in shape, margin irregularly notched. Rhizoids numerous on ventral surface and on the female receptacles, hyaline, of two types, thin-walled straight, and thick-walled sinuate. Scale small, hyaline. Midrib absent. Thallus thin, only 2 layer of cells, upper and lower epidermis, central region hollow. Air-pore large, 72.7-111.7 x 116.2-206 μm in diameter; 3-4 concentric ring of cells, 6-7 cells in radial rows. Male plant not seen; female plant present; involucre borne in between 2 short apical lobes, obovoid, bivalved, the rim cells brown elongated without hairs. Capsule ovoid, circular, brownish cells with out without thickening bands on the tangential walls; capsule walls single layered, cells of upper half with annular thickening and lower half without thickening, thin walled. Spores spherical, circular, rounded, blackish brown, 45.3-50.6 μm in diameter, granulate. Elater few, 4 elaters per capsule, long, vermiform like, 16.5-18.6 μm in diameter, upto 540 μm long, dark band thickening present, bi-trispiral.

Habitat: Plants grows on moist rocks (saxicolous) or concrete retaining walls in association with *Marchantia* sp., *Cephalozia* sp. and mosses at 1200-1600 m asl.

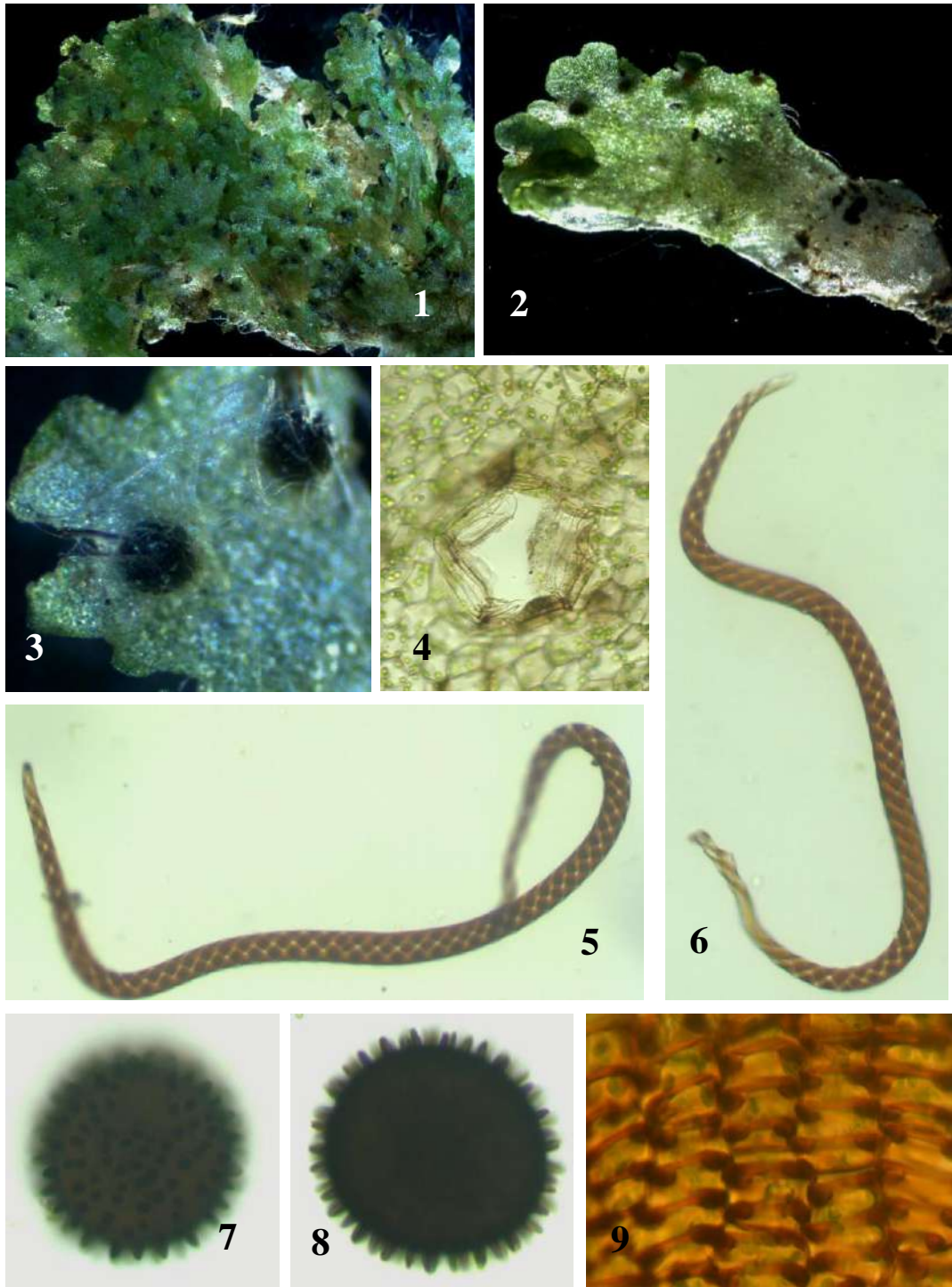


Plate 112. *Cyathodium smaragdinum* Schiffn., Figures 1-9.

Figs. 1-2. Thalli in dorsal view; 3. Thallus in ventral view; 4. Air-pore seen from above; 5-6. Elaters; 7. Spore in surface view; 8. Spore in distal view; 9. Inner layer of capsule wall.

Scale: 1-3 = 1 mm; 4= 0.2 mm; 5-9= 0.02 mm.

Range: India; Burma; Japan; Sri Lanka; Vietnam: Africa.

Distribution in India: *South India:* Bombay, Elephanta Acves, khandala, Malabar Hills, Panchgani, Pratabgarh; *Eastern Himalaya:* **Nagaland****.

Specimen examined: Nagaland: Mokokchung District: Mokokchung: KE 10317: 02.10.2010: Kazhuhrii Eshuo.

FAMILY: RICCIACEAE Rchb.

RICCIACEAE Rchb., Bot. Damen: 255. 1828.

Thallose, differentiated, dichotomously branched, form a complete or incomplete rosette, air pores simple or with absent air pore; ventral scales in two rows or several rows or absent, idioblastic oil cells absent (present in *Ricciocarpos*), perigonal chambers embedded dorsally in the thallus; scattered; sporophytes embedded singly in the thallus, involucre absent, pseudoperianth absent, elater absent, capsulecleistocarpous, specialized asexual structure absent.

Type: Riccia L.

Key to the genera of the family Ricciaceae

1. Plants completely aquatic habit, rhizoids in the form of scales, spores black, opaque, proximal and distal view indistinct..... *Ricciocarpos*
- 1a. Plants terrestrial, rhizoids smooth walls and tuberculate walls, spores yellowish brown to dark brown, proximal and distal view prominent..... *Riccia*

Genus: *Ricciocarpos* Corda

Thallus flat, dorsiventral, dichotomously branched, lobes oblong; rhizoids absent; scale densely present, margin toothed, idioblastic oil cells present; mid-rib prominent and runs throughout the thallus length, perigonal chambers embedded dorsally in the thallus; sporophytes embedded singly in the thallus, spores black, opaque, distal and proximal surface indistinct; elater absent.

***Ricciocarpos natans* (L.) Corda, Naturalientausch 651. 1829. (Plate 113. Figs. 1-6)**

Thallose, dichotomously branched, aquatic, floating in water, green to light green, 50-10 mm long, 2.2-3.5 mm wide, 4.5-5.5 mm wide at dichotomy. Mid-rib prominent and extend upto the whole length of the thallus. Rhizoids absent, instead a long scales are present on the ventral surface which helps the plants to float in water, margin toothed. Scales purplish to pinkish red, fertile plant grows on stagnant water. Monoicous or dioicous. Antheridia embedded in globose shape of the thallus. Archegonia borne on the ventral surface of the thallus, capsule globose, circular, spores opaque, black, 58-64 x 48-60 μm in diameter, wing absent, granular, proximal and distal surface indistinct.

Habitat: Aquatic

Range: India

Distribution in India: *Eastern Himalaya:* Assam, Manipur, **Nagaland***; *Western Himalaya:* Jammu & Kashmir.

Specimen examined: Nagaland: Kohima district: Viswema: KE 10022, KE 10027: 06.10.2008: Kazhuhrii Eshuo.

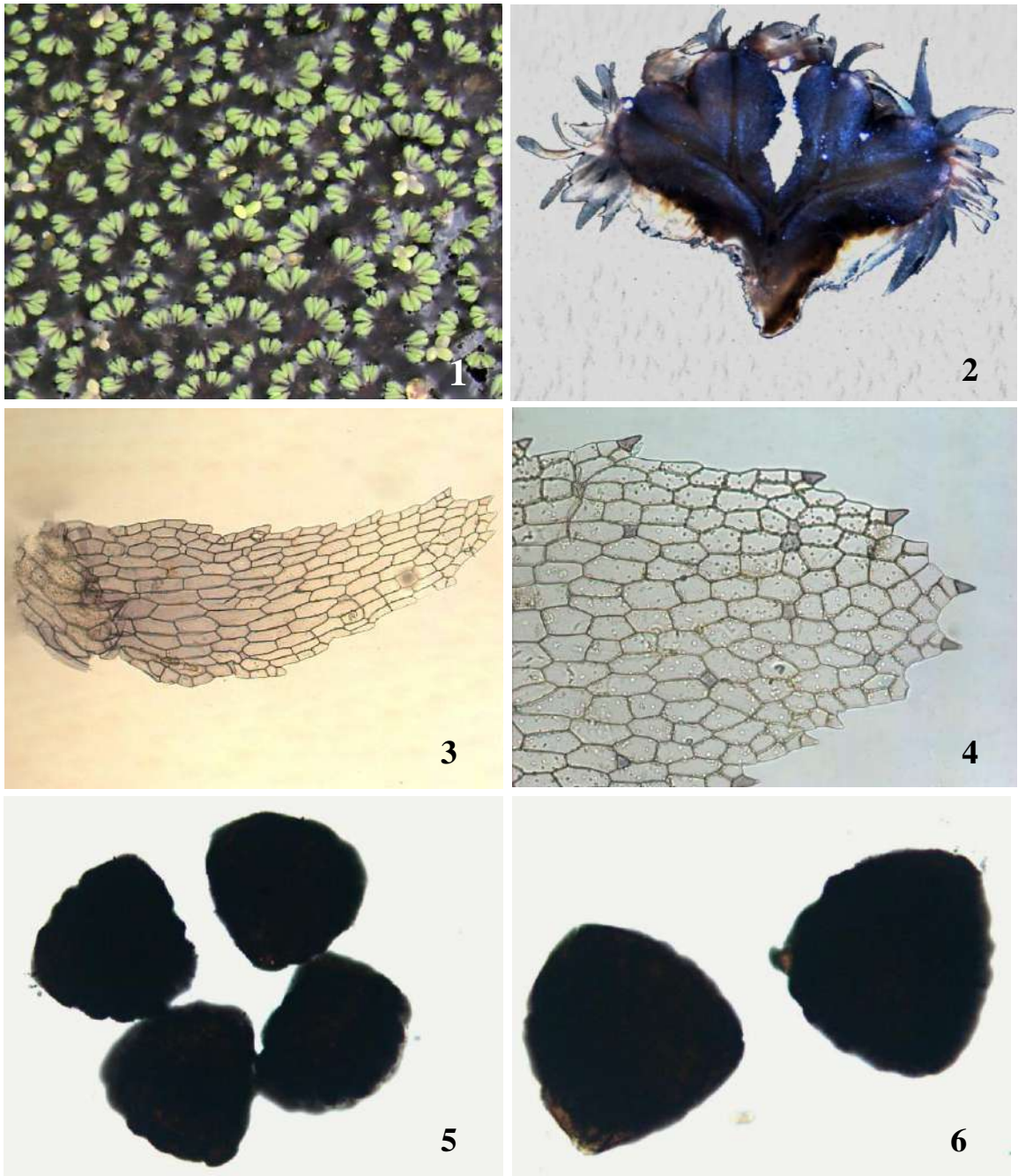


Plate 113. *Riccio carpos natans* (L.) Corda, Figures 1-6.

Figs. 1. Plants showing habit; 2. A single thallus showing ventral scales; 3. Ventral scale; 4. Ventral scale apical cells; 5-6. Spores.

Scale: 2-3 = 1 mm; 4 = 0.2 mm; 5-6 = 0.02 mm.

Genus: *Riccia* L.

Riccia L., Sp. Pl. 1138. 1753.

Terrestrial, or rarely aquatic, thallose, prostrate, 1-2 dichotomously branched, forming a rosettes or semi-rosettes, sometime forms a gregarious mats, fleshy, thick in most cases, lobes short or long, linear to ovate, generally with a longitudinal dorsal groove or sulcus. Thallus with a distinct, usually persistent epidermis and relatively loosely organised aerenchyma layer of polyhedral chambers in 2-4 irregular layers with storage tissue feebly developed (*Ricciella*-type); or without a continuous epidermis, aerenchyma-chlorenchyma layer comprising regularly and ventrally oriented rows of cells leaving between them narrow, vertical, canal-like air chambers, with relatively massive ventral, compact tissue (*Euriccia*-type); margin naked, or sometimes armed with unicellular papillae or cilia. Ventral scales often violet to purplish, originating usually in a single row, but with the widening of the thallus normally tearing in two. Rhizoids reduced in aquatic forms, common in terrestrial forms, both smooth and tuberculate walled; apical tubers occasionally present.

Monoicous or dioicous. Antheridia sunken into thallus acropetally, usually with an elevated, tubular ostiole formed over Antheridium. Sporogonium sunken in the thallus without any specialized mode of dispersal; capsule wall unistratose, colourless. Spores variable in shape, sculpture and colour, occasionally remaining coherent in tetrads.

Type: Riccia glauca L.

Key to species of the genus *Riccia*

1. Thallus Ricciella-type, forming incomplete rosette, capsule in 1-3 per thallus in single row, spores 50-78 μm in diameter..... *R. heubeneriana*
 - 1a. Thallus Euriccia-type, forming a complete or incomplete rosette..... 2
2. Thallus 1.5-2.5 mm wide, forming complete rosette, spores dark brown, 76-90 μm in diameter, winged..... *R. pathankotensis*
 - 2a. Thallus 2.5-3.5 mm wide, form a complete or semi-rosette..... 3
3. Capsule arranged in 1-2 rows, spores with a distinct proximal face, spores 73-87 μm in diameter, 6-9 reticulation..... *R. gangetica*
 - 3a. Capsule arranged in 2-3 rows, spores with indistinct proximal face, blackish brown, 80-105 μm in diameter..... *R. beyrichiana*

Riccia heubeneriana Lindenb., in Nova Acta Phys.-Med. Acad. Caes. Leop. –Carol.

Nat. Cur. 18: 504. 1836.

(Plate 114. Figs. 1-6)

Thallose, dichotomously branched, light green to light yellowish green, 10-15 mm long, 0.6-1 (-1.5) mm wide, usually forming incomplete rosette; thalli long, linear, ribbon-shaped, narrow, margin entire. Mid-rib indistinct, apex obtuse, apical notch indistinct, apex recurved. Thallus in cross section shows upper large, air chambered photosynthetic zone with globose upper epidermal cells and lower highly reduced storage zone. Monoicous. Capsule prominent on the ventral surface, 1-3 in single row; dark brown, globose; capsule wall hyaline without thickenings. Spores yellowish red or yellowish brown, subglobose to triangular, proximal and distal view distinct, spores 50-70 x 56-78 μm in diameter; winged, wing 5-11 μm wide, margin entire.

Habitat: Plants grow on soil (terricolous) in pure patches forming an incomplete rosette at 1400-1700 m asl.

Range: India, China, Japan, Korea, Europe, Africa, North America.

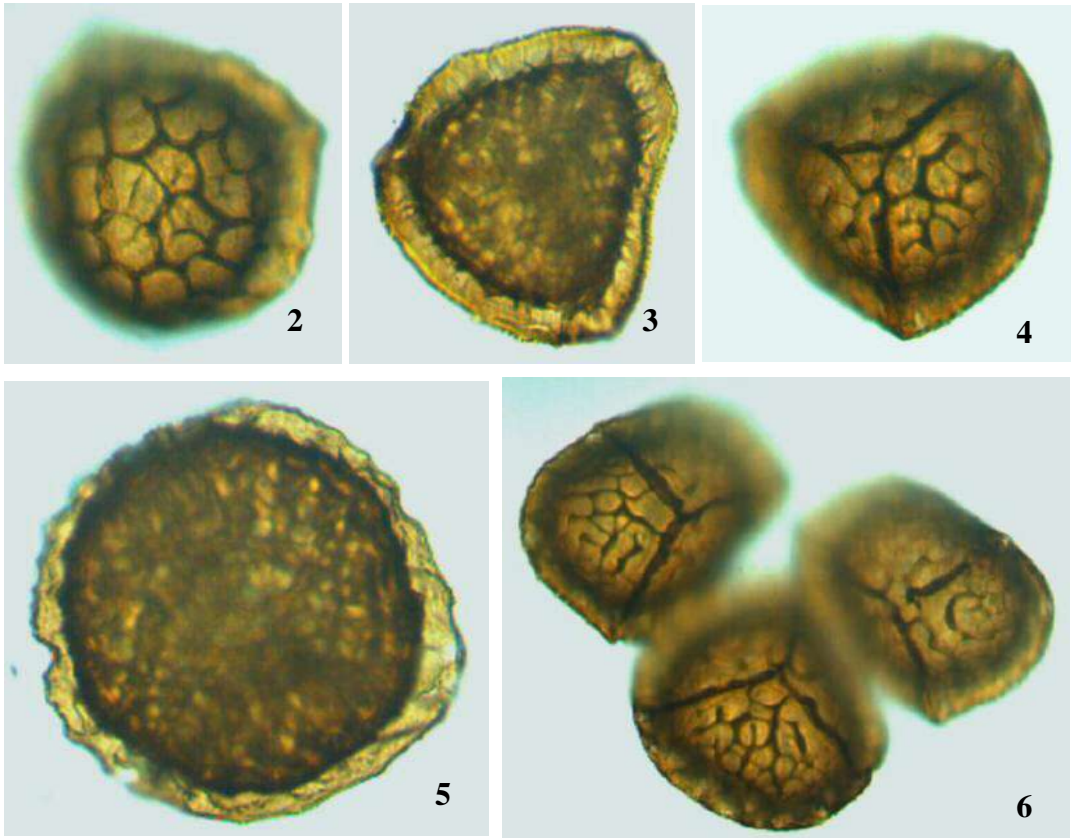


Plate 114. *Riccia huebeneriana* Lindenb., Figures 1-6.

Figs. 1. Plants showing habit; 2-6. Spores; 2. Spore in surface view; 3 & 5. Spores in distal view; 4 & 6. Spores in proximal view.

Scale: 1 = 5 mm; 2-6 = 0.02 mm.

Distribution in India: *Eastern Himalaya:* Manipur, Assam, Sikkim, West Bengal, Nagaland*; *Central India:* Madhya Pradesh; *Western Ghats:* Karnataka.

Specimen examined: Nagaland: Kohima District: Kohima: KE 10247: 05.08.2010: Kazhuhrii Eshuo.

Riccia gangetica Ahmad., Curr. Sci. 11: 433. 1942. (Plate 115. Figs. 1-5)

Thallose, light green to deep green, dichotomously branched, 5-12 mm long, 2-2.5 (-3) mm wide, forming a semi rosettes, 1-2 furcate; thalli oblong to oblong-ovate, sulcus prominent, apex obtuse, deeply notched, margin slightly undulate. Thallus in cross section differentiated into compact upper photosynthetic zone, globose to sub-globose epidermal cells and a compact parenchymatous, multi-storage zone, internal thallus of *Euriccia*-type. Monoicous. Capsule prominent on the ventral surface, 2-4 per thallus, arranged singly or 2 rows, dark brown, globose; capsule wall unistratose without thickenings. Spores brownish to reddish brown, blackish brown, anisopolar, globose to sub-globose, 73-82 x 74-87 µm in diameter, 6-9 reticulation, 5-18 x 3-10 µm wide, tri-radiate mark prominent on proximal view, winged; wing 6-11 µm wide, margin slightly undulate or entire.

Habitat: Plants grows on soil (terricolous) in association with mosses and herbs forming an incomplete rosette at 1400-1700 m asl.

Range: India and Indonesia.

Distribution in India: *Western Himalaya:* Himachal Pradesh, uttarakhand; *Eastern Himalaya:* West Bengal, Meghalaya, Punjab, Rajasthan, Nagaland*; *Central India:* Madhya Pradesh; *Western Ghats:* Maharashtra, Tamil Nadu.

Specimen examined: Nagaland: Kohima District: Kohima War Cemetery: KE 10248: 08.0.2010: kazhuhrii Eshuo; Mokokchung District: Mokokchung: KE 10506: 23.09.2011: Kazhuhrii Eshuo.



Plate 115. *Riccia gangetica* Ahmad., Figures 1-5.

Figs. 1. Plants showing habit; 2. Thallus in dorsal view; 3-5. Spores; 4. Spore in distal view; 5. Spore in proximal view.

Scale: 1 = 5 mm; 2 = 1 mm; 3-5 = 0.02 mm.

Riccia pathankotensis Kashyap, J. Bombay Nat. Hist. Soc. 24: 349. 1916.

(Plate 116. Figs. 1-5)

Thallose, light green to green, dichotomously branched, 2-4 dichotomy, 6-10 mm long, 1.5-2.5 mm wide, forming a complete rosette, lobes linear, sulcus prominent, apex rounded or truncate, margin thick and entire. Thallus in cross section differentiated into a compact upper photosynthetic zone, with globose to sub-globose epidermal cells and a compact parenchymatous, storage cells, internal thallus of *Euriccia*-type. Monoicous. Capsule prominent on ventral surface, arranged in 2-3 rows in acropetal; capsule wall hyaline and without thickenings. Spores dark brown or blackish brown, globose, 76-82 x 78-90 μm in diameter, distal surface reticulate with 5-8 reticulation, reticulation 5-10 x 6-16 μm with across, winged; wing 4-9 with wide, with interrupted crenulate margin.

Habitat: Plants grows on moist soil (terricolous) along with Mosses and herbs forming a complete rosette at 1400-1600 m asl.

Range: India and Pakistan.

Distribution in India: *Western Himalaya:* Himachal Pradesh, Uttarakhand; Punjab & West Rajasthan; *Eastern Himalaya:* **Nagaland****.

Specimen examined: Nagaland: Kohima district: War cemetery: KE 10246: 05.08.2010: Kazuhrii Eshuo.

Riccia beyridiana Hampe in Lehm., Nov. Strip. Pug. 7: 1. 1838. (Plate 117. Figs. 1-)

Thallose, green to pale dark green, dichotomously branched, 8-15 mm long, 3-5 mm wide, forming a complete rosette or sometimes incomplete rosette, apex rounded or obtuse, lobes linear, margin entire, ventral margin surface reddish, thin; rhizoids numerous, pegged and smooth walled, hyaline. Thallus in cross section differentiated

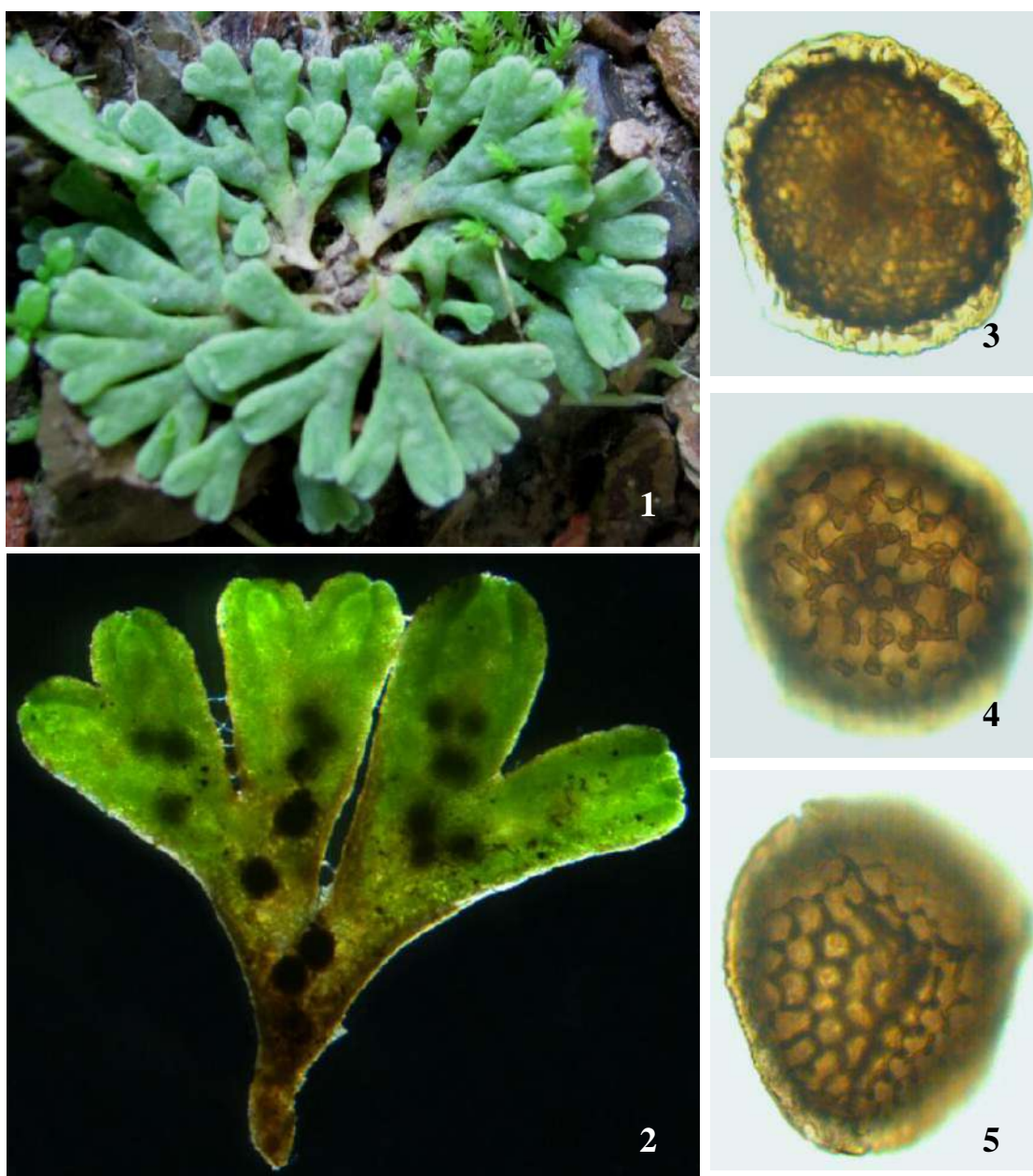


Plate 116. *Riccia pathankotensis* Kashyap, figures 1-5.

Figs. 1. Plants showing habit- a rosette; 2. Thallus in dorsal view; 3. Spore in distal view; 4. Spore in surface view; 5. Spore in proximal view.

Scale: 1 = 5 mm; 2 = 1 mm; 3-5 = 0.02 mm.

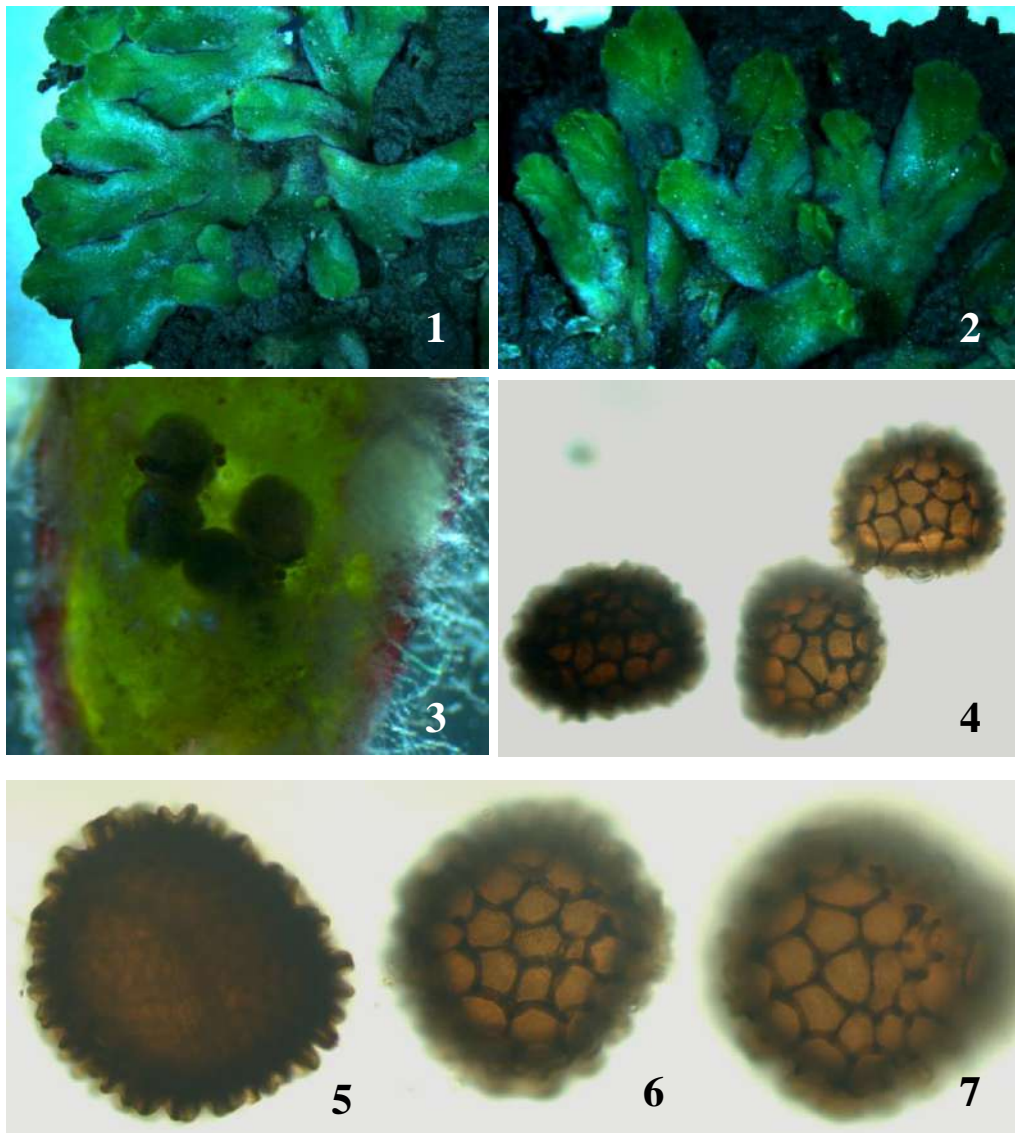


Plate 117. *Riccia beyridiana* Hampe in Lehm., Figures 1-7.

Figs. 1-2. Plants showing habit; 3. Thallus in ventral view showing sporogonia; 4-7. Spores; 5. Spore in distal view; 4, 6-7. Spores in surface view.

Scale: 1-3 = 1 mm; 4-7 = 0.02 mm.

into compact upper photosynthetic zone, with globose to sub-globose epidermal cells and a compact parenchymatous, storage cells, internal thallus of *Euriccia*-type. Capsule prominent on ventral surface, arranged in 2-4 rows in acropetal succession; capsule walled hyaline and without thickenings walls. Spores blackish brown, globose, 80-105 µm in diameter, distal surface with 5-8 reticulation, winged, wing 20-27 with interrupted crenulate margin, spinose to retuse; proximal face indistinct.

Habitat: Plants grows on moist open soil along with Mosses and herbs.

Range: India, Pakistan, Macronesia, Europe, North Africa, north maerica.

Distribution in India: *Western Himalaya:* Himachal Pradesh; *Eastern Himalaya:* Meghalaya, **Nagaland***.

Specimen examined: Nagaland: Mokokchung District: Mopungchuket: KE 10217: 23.09.2009: Kazhuhrii Eshuo.

FAMILY: WIESNERELLACEAE Inoue

WIESNERELLACEAE Inoue, III. Jap. Hepat. 2: 192. 1976.

Thallus differentiated, with simple air pore, ventral scales in 2 rows, with 1 appendage, perigonial chambers aggregated in terminal cushions on the dorsal thallus, sporophytes on stalked receptacles, with the receptacle bearing compound air pores and the stalk with 2 rhizoids furrows; involucre bivalve, pseudoperianth absent, seta remaining short, capsule dehiscence by 4 to 6 valves; specialize asexual structure absent.

Wiesnerella denudata (Mitt.) Steph., Sp. Hepat. 1: 154. 1899.

(Plate 118. Figures 1-8)

Thallose, green to deep green or light yellowish green, 15-30 mm long, 7-11 mm wide, dichotomously branched, margin wavy, undulate, lobes oblong-quadrate, notched at apex. Dorsal surface with distinct areolae, air-pore visible as white dots on the dorsal surface, air-pore 30-55 x 18-28 μm in diameter, surrounded by 2-4 concentric rings of 6-8 cells in radial rows. Ventral surface brownish green, scales in two rows, one row in each side of the mid-rib, hyaline, or light pinkish, large, appendiculate, sub-rotounded, hyaline papillae or projection present on the margin of the appendages, apex rounded and constricted. Rhizoids hyaline and colourless. Mid-rib narrow, distinct and gradually passing into the wing of the thallus. Monoicous. Male receptacle sessile, forming a circular cushion, borne just behind the stalk of the female receptacle. Female receptacle stalked, stalk 8-13 (-15) mm long, terminal, arising from a notch; receptacle convex, lobed, 3-5 (-7) lobes; pseudoperianth absent. Capsule spherical, exserted, dehiscing by 4 valves; capsule walled bi-stratose, outer layer with semi-annular thickenings at angles, inner layer without annular thickenings at angles. Spores light brown, globose, circular, 30-37 μm in diameter, winged, wavy, wing 3-5.4 μm long, tri-radiate mark distinct on proximal view. Elaters narrow, long, 200-400 μm long, 6-8 μm wide, bispiral.

Habitat: Plants grows on moist rocks (saxicolous) and soil (terricolous) in association with *Conocephalum conicum*, *Dumortiera hirsuta*, *Plagiochila* sp., and Mosses at 1600-1800 m asl.

Range: India, Nepal, Bhutan

Distribution in India: *Eastern Himalaya:* Sikkim, **Nagaland***; *Western Himalaya:* Dulchi, Kumaon.

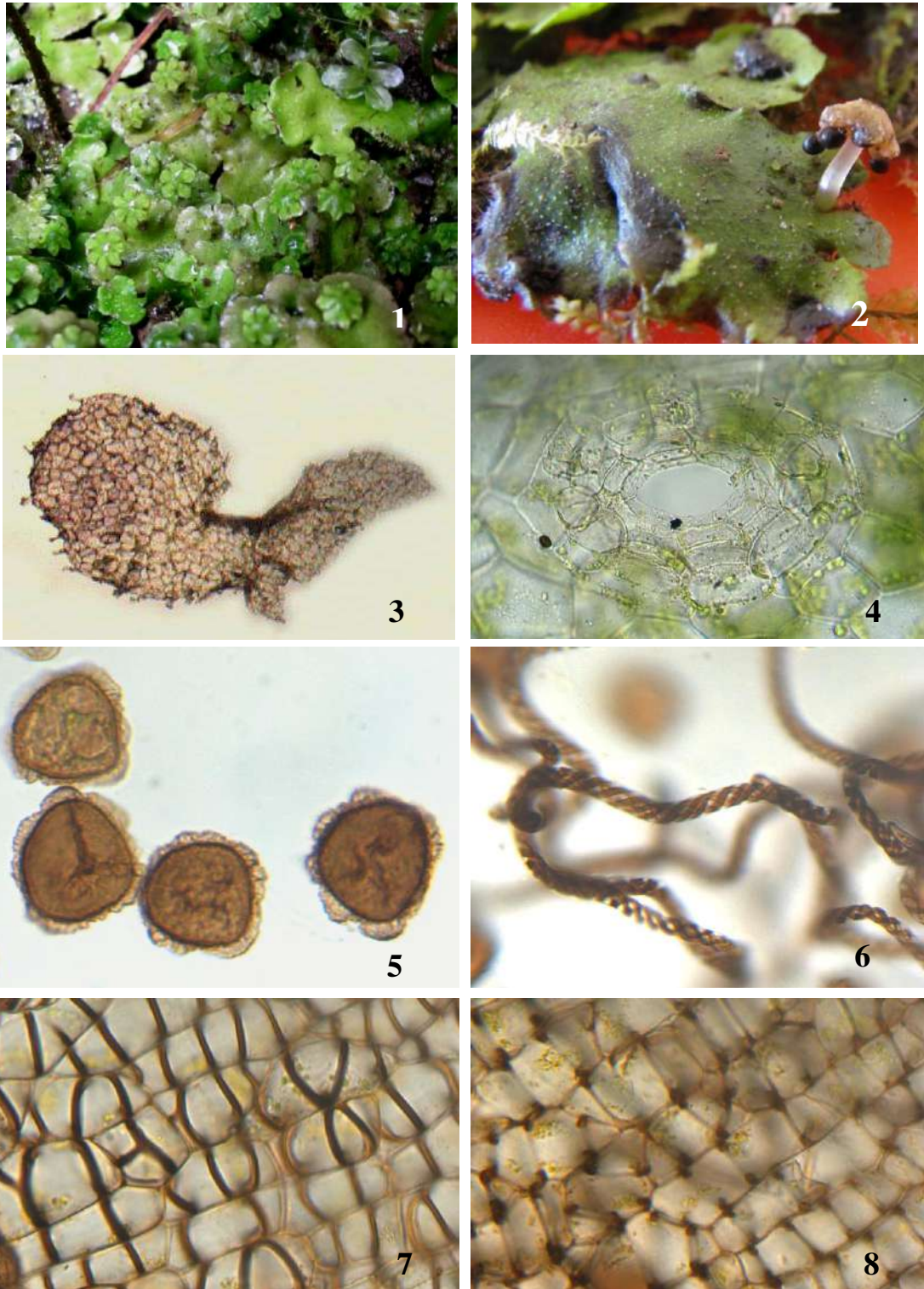


Plate 118. *Wiesnerella denudata* (Mitt.) Steph., Figures 1-8.

Figs. 1. Plants showing habit; 2. Female thallus with sporophytes; 3. Ventral scale; 4. Air-pore seen from above; 5. Spores; 6. Elaters; 6. Inner layer of capsule walls; 8. Outer layer of capsule walls.

Scale: 1 = 5 mm; 2 = 1 mm; 3 = 0.2 mm; 4—8 = 0.02 mm.

Specimen examined: Nagaland: Kohima District: Khonoma: KE 10413: 19.03.2011:
Kazhuhrii Eshuo.

FAMILY: TARGIONIACEAE Dumort.

TARGIONIACEAE Dumort., Anal. Fam. Pl.: 68, 70. 1829.

Thallose, dichotomously branched, light green to dark green, lobes linear, with margin reddish to pinkish purple, dorsal surface smooth, areolate; air pores simple, distinct, ventral scales in two rows on each side of the mid-rib, with 1 appendage, appendage acute, lanceolate; perigonal chambers embedded in irregular groups dorsally on the thallus or on short ventral branches; sporophytes ventral at the thallus apex; involucre bivalve; pseudoperianth absent; seta remaining short, capsule dehiscence by irregular lid and valves; specialized asexual structure absent.

It is a monogeneric family and therefore the characters of the family will suffice the genus character as well.

Targionia hypophylla L., Spec. Plant. Ed. 1: 1136. 1753. (Plate 119. Figs. 1-20)

Plants thalloid, dichotomously branched, light yellowish green to dark green, margin brownish red, 8-15 mm long, 3-5 mm wide, dichotomously branched, lobes obovate, margin entire or undulate; rhizoids numerous on ventral surface, smooth and tuberculate walled. Ventral scales in two rows, one row on each side of the ventral midrib, purple-red, reddish brown, appendiculate, appendages linear-lanceolate. Air chamber simple, air-pore visible as whit dots on the dorsal surface; 2-4 cells high; surrounded by 2-4 superimposed concentric rings of cells, each ring with 5-8 cells in radial row; median storage cells 19-35 x 12-27 μm , hexagonal, pentagonal, thin walled and non-trigonal. Dioecious. Male plant not seen. Female receptacle sessile, involucre bivalve, situated ventrally at apex. Capsule blackish brown, dark brown, globose, ovoid; capsule dehiscing by demarcated lid, capsule walls with semi-annular

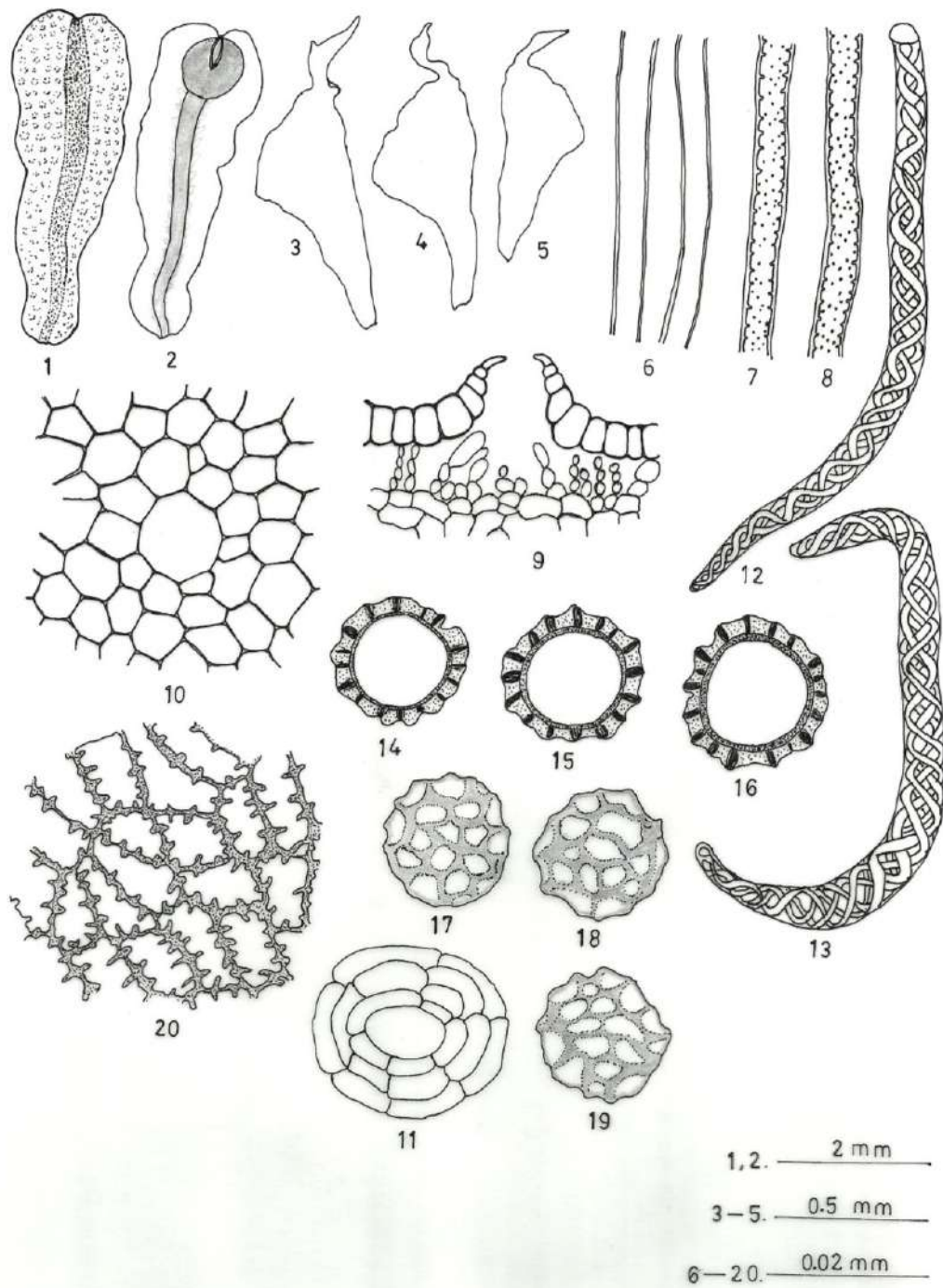


Plate 119. *Targionia hypophylla* L., Figures 1-20.

Figs. 1. Thallus in dorsal view; 2. Thallus in ventral view; 3-5. Ventral scales; 6. Smooth walls rhizoids; 7-8. Tuberculate walls rhizoids; 9. Cross section of thallus with air-pore; 10. Thallus median cells; 11. Air-pore; 12-13. Elaters; 14-16. Spores in distal view; 17-19. Spores in surface view; 20. Inner layer of capsule walls.

to annular thickenings, sometimes hyaline without thickenings. Spores dark brown, deep brown, globose, 50-62 μm in diameter, reticulate on both distal and proximal faces. Elaters brown, long, vermiform, 170-250 μm long, 8-14 μm wide, with bi-tri-spiral thickenings.

Habitat: Plants grows on moist soil (terricolous), on moist concrete retaining walls along with *Marchantia* sp., *Dumortiera* sp., *Asterella* sp., *Riccia* sp and Mosses at 1200-1700 m asl.

Range: India, China, Bhutan, Japan, Korea, Australia, New Zealand, Polynesia, Africa, Europe, North & South America.

Distribution in India: *Western Himalaya:* Himachal Pradesh; Uttarakhand; *Eastern Himalaya:* West Bengal, Sikkim, Meghalaya, Punjab, West Rajasthan and **Nagaland***; *Central India:* Madhya Pradesh; *Western Ghats:* Kerala and Tamil Nadu.

Specimen examined: Nagaland: Kohima district: Kohima: KE 10250: 05.08.2010: Kazhuhrii Eshuo; Kigwema: KE 10276: 08.08.2010: Kazhuhrii Eshuo: Mokokchung district: Longkhum: KE 10132: Kazhuhrii Eshuo.

FAMILY: DUMORTIERACEAE D.G. Long

DUMORTIERACEAE D.G. Long, Edinburgh J. Bot. 63: 260. 2006.

Thallus weakly differentiated into layers, with vestigial air chambers and air-pores absent or few near the apical thallus region, or when present air-pore is simple. Ventral scale absent or minutes or vestigial without appendages. Rhizoids dimorphic, hyaline and colourless. Perigonial chambers on stalked receptacles, with the receptacles lacking air-pores and the stalk with 2 rhizoid furrows. Sporophytes on stalked receptacles, with the receptacles bearing a few open air chambers and a stalk with 2 rhizoid furrows; involucre tubular, opening by a slit; pseudoperianth absent;

seta remain short or elongate at maturity; capsule dehiscing by irregular valves, walls bistratose; specialized asexual structures absent.

Type: Dumortiera Nees

Dumortiera hirsuta (Sw.) Reinw., Blume et Nees, Nov. Acta Leop. Carol. Nat. Cur.

12: 410. 1824.

(Plate 120. Figs. 1-6)

Thallose, dioecious, dichotomously branched, thallus large, deep green to light green, pale brownish green, 20-35 mm long, 5-10 (-15) mm wide, thallus thin, margin curved, undulate; apex oblong, retuse, notched, ventral mid-rib prominent, rhizoids of only smooth-walled, ventral scales absent. Air chamber absent, mid-rib prominent below; scale absent or highly reduced. Male receptacle not seen. Archegoniophore stalked, stalk long, carpocephalum flat, large, hairy; capsule reddish brown, capsule walls hexagonal, columnar, 2 or more stratose. Spores light yellowish colour, bean shaped, surface rough. Elaters long, large, yellowish colour, mono- bi-spiral.

Habitat: Plants grow on moist shady areas in association with *Marchantia* sp., *Cyathodium* sp., *Jungermannia* sp., *Heteoscyphus* sp. and Mosses at 900-1700 m asl.

Range: India, Nepal, Japan, Korea, Philippines, Sri Lanka, Indonesia, Polynesia, Africa, Europe, North and South America.

Distribution in India: *Esatern Himalaya:* Sikkim, West Bengal, Assam, Arunachal Pradesh, Meghalaya, **Nagaland***; *Western Himalaya:* Himachal Pradesh, Uttarakhand; *Central India:* Madhya Pradesh; *Western Ghats:* Tamil Nadu.

Specimen examined: Nagaland: Kohima District: Jotsoma: KE 10052: 18.03.2009: Kazhuhrii Eshuo; Viswema: Ke 10048: 12.03.2009: Kazhuhrii Eshuo; Mokokchung District: Mokokchung: 10008: 29.010.2008: Kazhuhrii Eshuo; Changki: KE 10327: 02.11.2010: Kazhuhrii Eshuo.

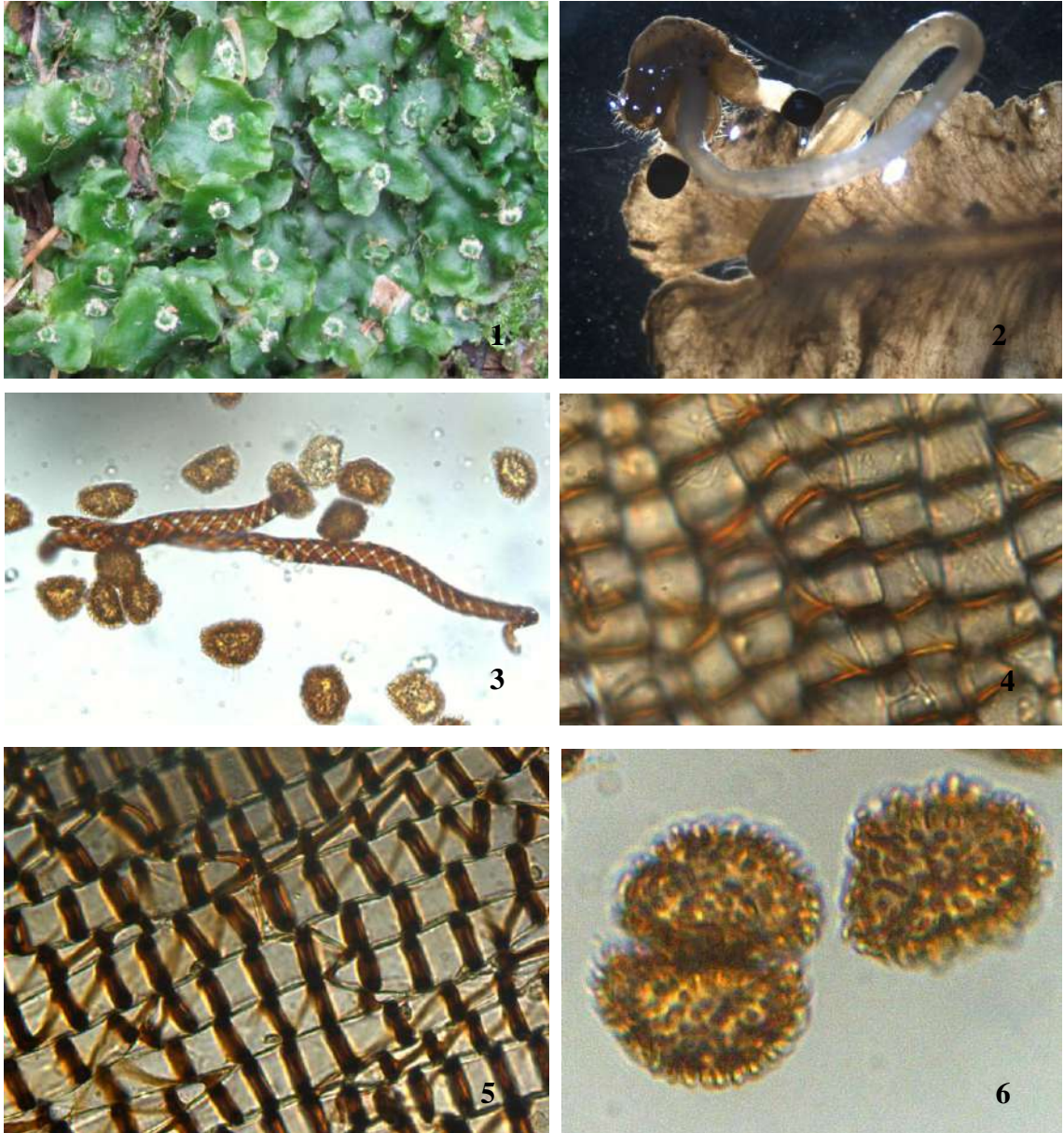


Plate 120. *Dumortiera hirsuta* (Sw.) Reinw., Blume et Nees, Figures 1-6.

Figs. 1. Plnats showing habit; 2. Mature female thallus with sporophyte; 3. Spores and elater; 4. Outer layer of capsule walls; 5. Inner layer of capsule walls; 6. Spores.

Scale: 1 = 5 mm; 2 = 1 mm; 3-6 = 0.02 mm.

ORDER-ANTHOCEROTALES

ORDER: ANTHOCEROTALES Limpr.

Anthocerotales Limpr., in Cohn. Krypt.-Fl. Schlesien 1: 239. 1877.

Plants thallose, prostrate or sub-erect to erect, with or without mid-rib, mostly terricolous, sometimes epiphytic; variable in morphology, bearing spongy bodies (gemmae), thallus internally spongy, rarely compact, epidermal cells with 1-4 large chloroplasts, of various shapes, pyrenoids bodies small or indistinct; Nostoc colonies usually uniformly disposed in the thallus, or sometimes absent. Rhizoids simple, smooth-walled; ventral scales absent. Monoicous or dioicous. Androecia irregularly distributed or arranged along the median line of the thallus; chamber two layered; androecia endogenous, 2-64 or more per chamber, with a short or long stalk and club-shaped or sub-globose to globose body. Archegonia embedded in the thallus; involucre erect, cylindrical-oblong-cylindrical, slightly broader toward base, smooth or crenulate at mouth, sometimes ridged or lamellate, spongy or compact. Sporogonia horn-like or needle-like, usually indeterminately long, cylindrical or ellipsoidal with acute apex; foot bulbous, capsule dehiscing into 2-valved; capsule 4-6 layered, stomatiferous or not; columella persistent (except in *Notothylas*). Spores yellowish brown to dark brown, blackish, spiny, minutely papillate, baculate, vermiculate, or reticulate over distal surface, or sometimes smooth, tri-radiate mark distinct or indistinct unsculptured stripe along both sides of the ray; pseudo-elaters brown, yellowish brown, short, stout to vermiform, thin-walled to thick-walled with a central narrow dark lumen, or unspirally thickened with rounded-tapering ends, sometimes adhered to columella.

Key to families of the order Anthocerotales

1. Thallus spongy, with schizogenous cavities, jacket cells in 4 tiers, spores dark brown to black, proximal tri-radiate mark distinct or indistinct, pseudo-elaters unbranched, dark lumen present absent..... Anthocerotaceae
- 1a. Thallus compact, without schizogenous cavities, jacket cells not in 4 tiers, spores light yellowish green, proximal tri-radiate mark distinct, pseudo-elaters branched or unbranched, short, stout..... Phaeocerotaceae

FAMILY: ANTHOCEROTACEAE (Gray) Trevisan em. Bharad.

ANTHOCEROTACEAE (Gray) Trevisan em. Bharad., in Recent Advances in
Cryptogamic Botany: 149. 1981.

Thallus prostrate to sub-erect, usually spongy, bearing with numerous schizogenous cavities in 1-3 layers, with large chloroplast, distinct pyrenoid, Nostoc colonies usually present; rhizoids smooth walled. Antheridia club-shaped, 4-45 or even more per androecial chamber, with 4 tiered cells in the jacket layer. Epidermal layer of capsule wall stomatiferous; wall 4-6 layered, cells outer layer rectangulate, with conspicuous thickened radial end walls. Spores brown to dark coloured or black with conspicuous sculptured sporoderm, proximal faces of spores with a distinct and bold or poorly developed tri-radiate mark. Pseudo-elaters 1-4 celled, short and thin-walled or extensively long, vermiform and thick-walled, bearing a dark continuous lumen.

Genus: *Folioceros* Bharad.

Folioceros Bharad., Geophytology 1 (1): 9. 1971.

Plants terricolous, thalloid, spongy in nature, pinnately lobed, variable in forms, expansively long, with crenulate-deeply dissected margin, with or without subsessile spongy bodies on the dorsal surface of the thallus, lamellate or smooth, upper

epidermal layer with usually 1 chloroplast per cell, variable in shape; pyrenoid body usually distinct and aggregated. Rhizoids numerous on the ventral surface of the thallus, simple, and smooth walled. Thallus cells with large schizogenous cavities in 1-3 layers. Androecia irregularly distributed along the median margin line, usually bulging, with 4-60 or more per androecial chamber; antheridia usually club-shaped or longly globose with 4 tiered jacket elongated cells. Involucre cylindrical-oblong, erect, narrowed above and broad at base, smooth or crenulate at mouth, surface of involucre smooth, or sometimes with lamellate. Monoicous or dioicous. Capsule erect, indeterminately long, bivalve, dehiscing from apex downwards, capsule wall 4-6 layered, stomatiferous, cells of the outer epidermal layer rectangulate, with radial end wall thickenings, columella constantly present. Spores brown, smoky or black, 27-50 μm in diameter, with baculate or spinulate ornamentation, proximal faces with poorly developed tri-radiate mark, tri-radiate rays always in contact with sculpturing. Pseudo-elaters 1-4 celled, vermiform, upto 630 μm long with a continuous dark narrow lumen, smooth or highly irregular, sometimes branched.

Type: Folioceros assamicus Bharad.

Key to species of the genus *Folioceros*

1. Spores baculate, laevigate, pseudo-elaters 80-250 μm long..... *F. kashyapii*
- 1a. Spores baculate, spinulate, pseudo-elaters 300-525 μm long..... *F. paliformis*

Folioceros paliformis D.K. Singh, Bull. Bot. Surv. India 29(1-4): 170-180. 1987.

(Plate 121. Figs. 1-11)

Plants green to deep green, 10-20 mm long, 3-8 mm wide, dichotomously branch, spongy, with 1 -3 layers of mucilage chambers; rhizoids numerous, smooth walled, colourless and hyaline. Dioicous. Androcia chamber arranged along the median line in

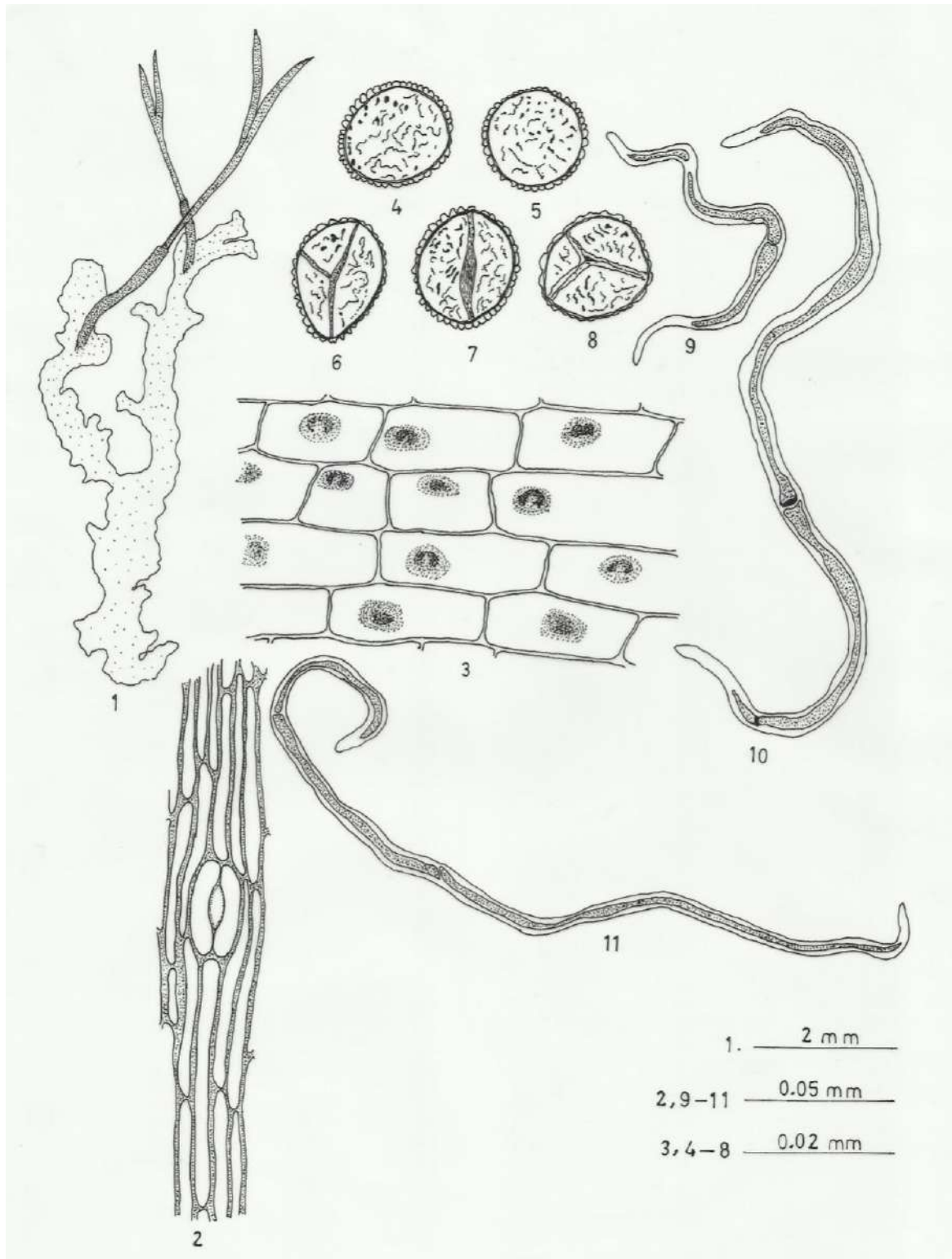


Plate 121. *Folioceros paliformis* D.K. Singh, Figures 1-8.

Figs. 1. Thallus in dorsal view; 2. Cells of epidermal layer of capsule walls with stomata; 3. Chloroplasts in upper epidermal cells of the thallus; 4-5. Spores in surface view; 6-8. Spores in proximal view; 9-11. Pseudoelaters.

a single row over the dorsal surface of the thalli. involucre short, 3-5 mm long, cylindrical; stomatiferous, stomata surrounded by 2 reniform guard cells surrounded by 6 much longer epidermal thickened radial end walls; capsule wall 4-6 layered. Spores like brown, baculate, 32-36 μm in diameter, proximal faces indistinct, tri-radiate mark not prominent; pseudo-elaters long, vermiform, 300-525 μm long, with a continuous dark narrow lumen, smooth and unbranched.

Habitat: Plants grows on moist soils in association with *Marchantia* sp., *Jungermannia* sp., *Riccardia* sp. and Mosses.

Range: India

Distribution in India: *Eastern Himalaya:* Arunachal Pradesh, Nagaland*.

Specimen examined: Nagaland: Kohima District: Kigwema: KE 10287: 08.08.2010: Kazuhrii Eshuo; Viswema: KE 10530: 10.07.2012: Kazuhrii Eshuo.

Folioceros kashyapii (Srivast.) Srivastava et Asthana, The Bryologist 92(2): 219-224. 1989. (Plate 122. Figs. 1-14)

Plants light green to yellowish green, deep green, thallose, thallus margin lobed, exhibit irregular lobbing, longer than broad, thallus spongy, having mucilage chambers; epidermal layer of the thallus with a single chloroplast, more or less circular to rectangular. Involucres spongy, cylindrical, broad at base, narrow at mouth, smooth at mouth. Sporophytes erect to sub-erect, stomatiferous, 55-65 x 26-30 μm in diameter, with 2 reniform guard cells surrounded by 6 more much longer epidermal cells having thickened radial end walls, cells of the epidermis 95-130 μm long or more in length. Spores light brown, smoky in colour, 32-36 μm in diameter, baculate, baculae 2 μm in height, 1.5 μm in width, tri-radiate mark rarely seen or

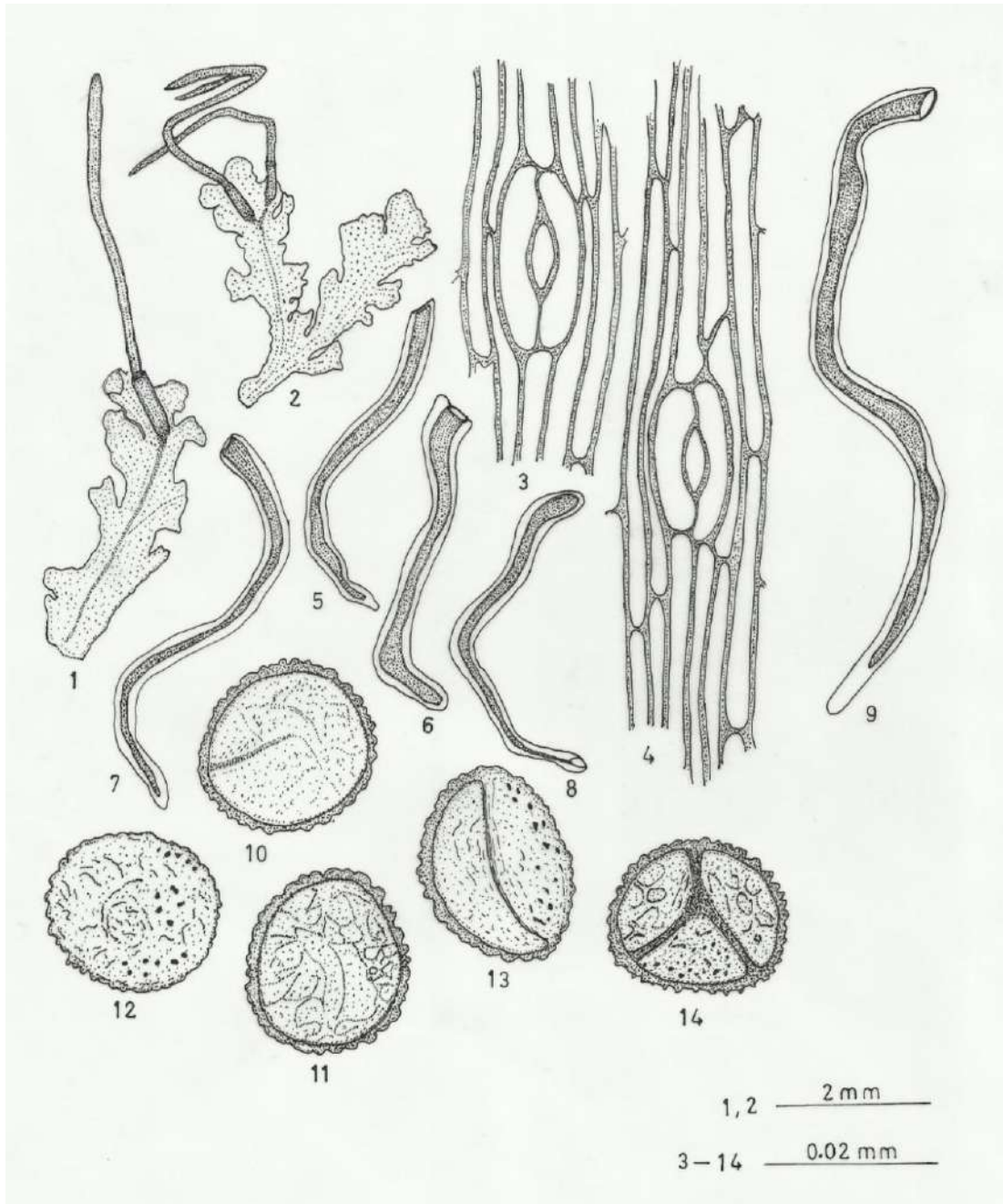


Plate 122. *Folioceros kashyapii* (Srivast.) Srivastava et Asthana, Figures 1-14.

Figs. 1-2. Thalli in dorsal view; 3-4. Cells of epidermal layer of capsule walls with stomata; 5-9. Pseudoelaters; 10-12. Spores in surface view; 13-14. Spores in proximal view.

indistinct. Elaters narrow and long, brown, 80-250 µm long, 5-8 µm in width, vermiform, tapering toward apex, with a dark thick lumen of variable width.

Habitat: Plants grows on moist soils and rocks cover with thin llayer of soil in association with *Jungermannia* sp., *Marchantia* sp., *Heteroscyphus* sp., *Phaeoceros* sp. and Mosses.

Range: India

Distribution in India: *Central India:* Madhya Pradesh (Chota Mahadeo, Pachmarhi); *Eastern Himalaya:* **Nagaland***.

Specimen examined: Nagaland: Mokokchung district: Changki: 02.11.2010: KE 10339: Kazuhrii Eshuo; Kohima District: KE 10042: 12.03.2009: Kazuhrii Eshuo.

FAMILY: PHAEOCEROTACEAE Bharad.

PHAEOCEROTACEAE Bharad., in Recent Advances in cryptogamic Botany: 149.

1981.

Thalli prostrate to sub-erect, thalli usually compact without schizogenous cavities. Antheridia globose to sub-globose with irregular arrangement of jacket cells (not in 4 tiers), ranging from 1 – 8 per androecial chamber. Epidermal layer of the capsule wall stomatiferous or non-stomatiferous. Spores pale yellow to yellowish green with minute sculpturing; proximal faces marked with distinct to weakly developed tri-radiate rays. Pseudo-elaters pale yellow to light brown, thin-walled, composed of 1-4 (-5) cells with or without unispirally thickened elaters.

Genus: *Phaeoceros* Prosk.

Phaeoceros Prosk., Bulletin of the Torrey Botanical Club 78 (4): 346. 1951.

Plants terricolous, thalloid, green to light green, prostrate to sub-erect, often deeply lobed, margin wavy, rarely crenulate, sometimes with tubers. Thalli compact, 3 – 12 cells thick in the middle region without mucilage chambers; upper epidermal

layer usually with a single chloroplast per cell; Nostoc colonies irregularly distributed or absent. Rhizoids simple, smooth-walled. Monoicous or dioicous. When monoicous, usually prodandrous, androecia sub-spherical, scattered and slightly raised over the dorsal surface with 2-8 antheridia per androecial chamber; antheridia globose to sub-globose, jacket cells irregularly arranged, shortly stalked, stalk with quadriseriate cells. Involucre cup-shaped to cylindrical, usually smooth at mouth, compact, 3-6 cells thick across. Capsule dwarf and stout to narrowly cylindrical, upto 10 mm long, dehisces apically into 2 valves at maturity. Capsule wall 4-6 layered, cells of the epidermal layer thickened, rest of the capsule layer devoid of thickenings, epidermal layer stomatiferous, stomata with two reniform guard cells, surrounded by 5-6 rectangular epidermal cells. Spores yellow to yellowish green, with a prominent equatorial crossitudo, ranging from 33 – 56 µm in diameter, sporoderm minutely granulose-papillose or hump like projections, sometimes bearing lamellate markings, proximal faces with distinct tri-radiaate mark, each triangular face sometimes possesse rounded depression in the centre. Pseudo-elaters light brown, thin-walled, slender, or stout, 1-4 celled, sometimes stumpy, often branched.

Type: Phaeoceros laevis (L.) Prosk

Key to species of the genus *Phaeoceros*

1. Monoicous, proximal surface of the spores with thin tri-radiate mark, bordered by tubercles in the form of stripe..... *P. carolinianus*
- 1a. Dioicous, proximal surface of the spores with thick tri-radiate mark, not distinctly bordered by tubercles in the form of stripe..... *P. laevis*

Phaeoceros carolinianus (Michx.) Prosk., in Bull. Torrey Bot. Club 78: 347. 1951.

(Plate 123. Figs. 1-20)

Plants green to light green, prostrate, 8-12 mm long, 4-8 mm wide, dichotomously branched, fanning to towards apex, base narrow, broadly obovate, dorsal surface lamellate, chloroplast 1 per cell, more or less globose. Rhizoides numerous, smooth walled, colourless and hyaline. Monoicous. Androcia scattered, usually 2-5 androcia per androcial chamber, androcia globose without tier jacket cells. Involocres compact, cylindrical, up to 4-5 mm long, smooth, narrow towards mouth; capsule erect, 15-45 mm long, stomatiferous, stomata 3-10 sq. mm, each stomata 68-80 x 45-50 μ m in diameter, with 2 reniform guard cells surrounded by 6-7 much longer having uniformly thickened radial walls; dehiscing by splitting into 2 valves. Spores yellowish green, 34-40 μ m in diameter, with a prominent equatorial crossidoid; sporoderm minutely papillate, granulose, proximal face marked with thin and slightly wavy tri radiate mark, tri radiate rays with fimbriate border on both sides; pseudo-elaters light yellow, 1-4 celled, thin walled, sometimes branched stout and short.

Habitat: Plants grow on moist soil (terricolous) in association with *Asterella* sp., *Marchantia* sp., *Ricardia* sp., *Jungermannia* sp. and Mosses at 900-1700 m asl.

Range: India, Nepal, Bhutan, China, Sri Lanka, Myanmar, Japan, Korea, Melanesia, Macronesia, Australia, Polynesia, Africa, Europe, North and South America.

Distribution in India: *Western Himalaya:* Himachal Pradesh, Uttarakhand; *Eastern Himalaya:* West Bengal, Sikkim, Arunachal Pradesh, Punjab, **Nagaland***; *Central India:* Madhya Pradesh; *Western Ghats:* Tamil Nadu.

Specimen examined: Nagaland: Kohima District: Kedima: KE 10079: 03.01.2009; Mokokchung District: Longkhum: KE 10136: 12.09.2009: Kazuhrii Eshuo.

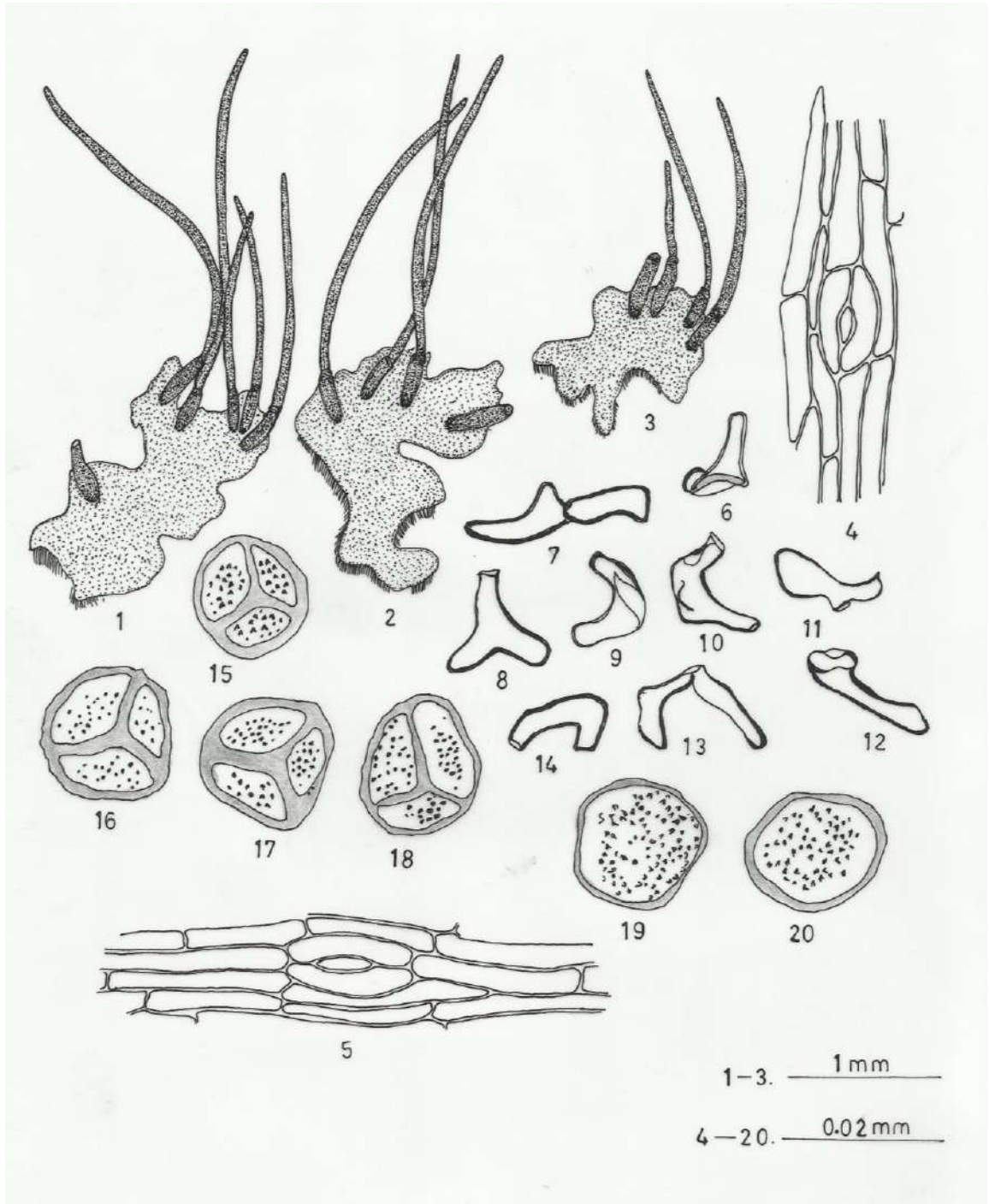


Plate 123. *Phaeoceros carolinianus* (Michx.) Prosk., Figures 1-20.

Figs. 1-3. Thalli in dorsal view; 4-5. Cells of epidermal layer of capsule walls with stomata; 6-14. Pseudoelaters; 15-18. Spores in proximal view; 19-20. Spores in surface view.

Phaeoceros leavis (L.) Prosk., in Bull. Torrey Bot. Club 78: 347. 1951.

(Plate 124. Figs. 1-18)

Plants green or light green to yellowish green, dichotomously branch, 8-15mm long 4-6mm wide, fanning towards apex, apex broad, base narrow, dorsal surface lamellate, margin smooth, wavy, chloroplast 1 per cell; rhizoides numerous, smooth walled, colourless and hyaline. Dioicous. Androecia not seen. Involucres compact, cup shape to cylindrical, 4-6 mm long, smooth or lamillate, smooth at mouth; capsule erect, stomatiferous, stomata 6-9 per sq mm with 2 reniform guards cells surrounded by 6 or more much longer epidermal cells having uniformly thicken radial walls; dehiscing by splitting into 2 valves. Spores yellowish green, globose to subglobose, 34-45 μm in diameter, with a prominent equatorial crossitudo. Sporodren minutely papillate, granulose, proximal face mark with distinct thin tri radiate mark, tri radiate reaching to the equatorial crossitudo; pseudo-elaters thin, light brown, short, stout and broad, 1-4 (-5) celled.

Habitat: Plants grows on soil (terricolous) in association with *Marchantia* sp., *Riccardia* sp., *Asterella* sp., *Targionia* sp. and Mosses at

Range: India, Nepal, Pakistan, China, Jaqpan, Phillippines, Turkey, Nepal, Europe, North America.

Distribution in India: *Eastern Himalaya:* West Bengal, Sikkim, Arunachal Pradesh, Meghalaya, Punjab and Rajasthan, **Nagaland***; *Western Himalaya:* Himachal Pradesh, Uttarakhand; *Western Ghats:* Maharashtra, Karnataka, Kerala, Tamil Nadu.

Specimen examined: Nagaland: Kohima District: Kedima: KE 10079: 03.01.2009: Kazhuhrii Eshuo; Jakhama: KE 10288: 08.08.2010: Kazhuhrii Eshuo; Mokokchung District: Chuchuyimpang: KE 10119: 04.08.2009: Kazhuhrii Eshuo.

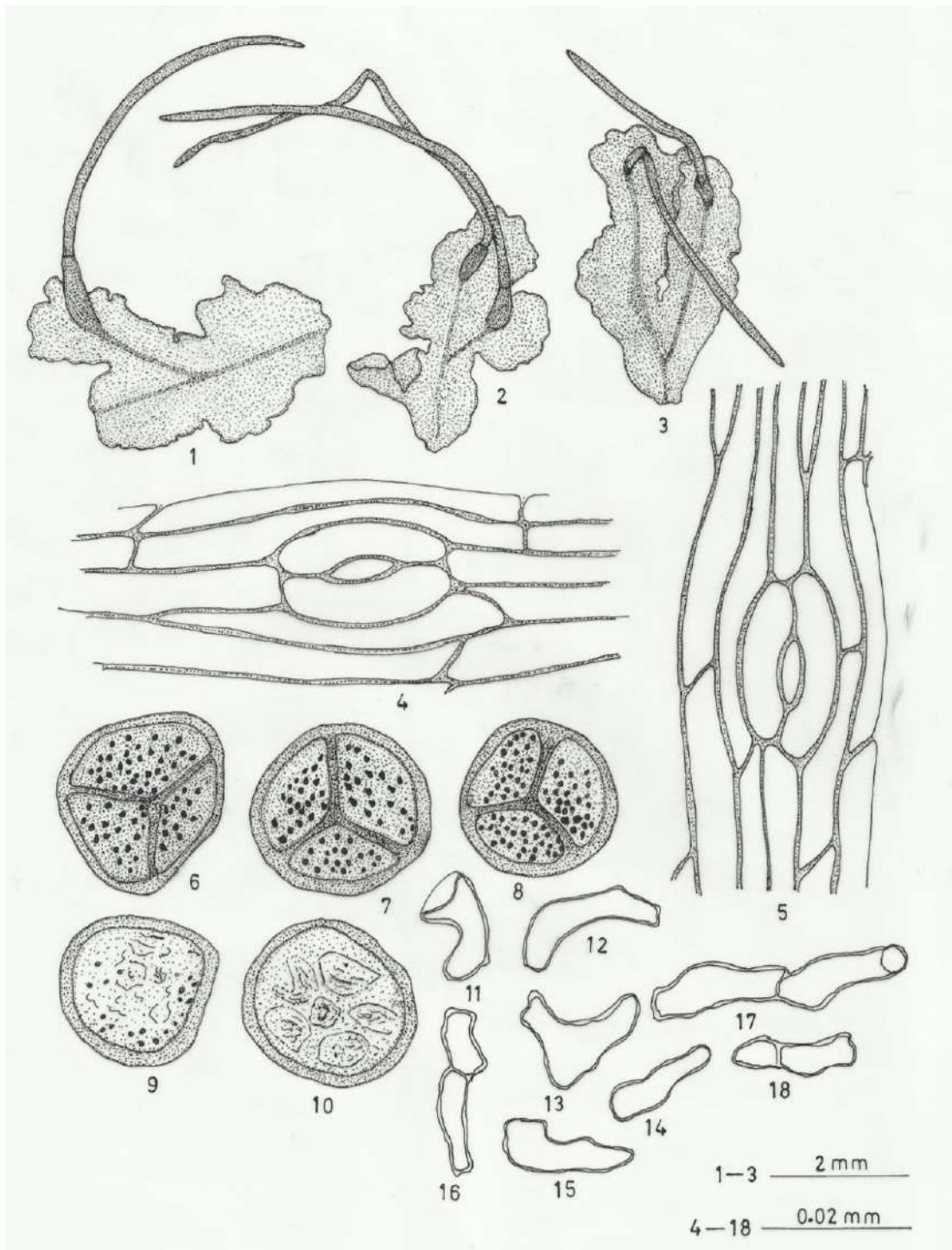


Plate 124. *Phaeoceros leavis* (L.) Prosk., Figures 1-18.

Figs. 1-3. Thalli in dorsal view; 4-5. Cells of epidermal layer of capsule walls with stomata; 6-8. Spores in proximal view; 9-10. Spores in surface view; 11-18. Pseudoelaters.

CHAPTER - IV
DISCUSSION AND CONCLUSION

India is one of the 34 biodiversity hotspot of the world represented by Western Ghats (share with Sri Lanka), Himalayas (share with Nepal, Tibet, China, Pakistan) and Eastern Himalayas (Share with Indo-Burma). The biological diversity especially plant diversity of India particularly the Eastern Himalayas is well known by the statement made by Hooker (1904) where he stated “*The flora of India is more varied than that of any other country of an equal area in the eastern hemisphere, if not in the globe*”. The richness and most luxuriant growth of plant diversity in this region may be due to varied climatic condition, habitat, topography, abundance rainfall and couple with hot and cold atmosphere.

North East India region is one of the hottest hotspot as many endemic species are present and maximum anthropogenic activities are taking place. This region has less chances of plant migration to other regions of the world due to topographic barriers. Nagaland is located in the North eastern region of India with a total area of about 16,579 square kilometres. The total forest covered area in Nagaland state is 21.60% (2009-10 report). The state of Nagaland exhibit a distinct summer season from March to May, rainy seasons from June to October, and dry winter seasons from November to February. The climate is of monsoonic with warm moist summer and cool dry winter. The state receives rainfall almost throughout the year and due to these moist climatic conditions, it favours the luxuriant growth of bryophytic plants especially the Liverworts and Hornworts in the state. The rich bryological diversity in the state of Nagaland could be due to various biological factors like varied topography, warm climate, rainfall, moderate temperature, moist atmospheric condition, high humidity, etc.

The present investigation on Liverworts and Hornworts of Kohima and Mokokchung districts of Nagaland state reveals the occurrence of 123 taxa, 50 genera

and 31 families (**Table-1 & Fig. 1**). This accounts for 17.42 % of the total Indian liverworts and hornworts in just about 0.08 % of the total geographical area of the country (total liverworts and hornworts is 700 according to Dandotiya *et al.* 2011). The present investigation reveals that the order Jungermanniales is represented by 16 families, viz., Calypogieiaceae, Cephaloziaceae, Frullaniaceae, Geocalyceae, Herbertaceae, Jubulaceae, Jungermanniaceae, Lejeuneaceae, Lepidoziaceae, Lophocoleaceae, Plagiochilaceae, Porellaceae, Radulaceae, Scapaniaceae, Solenostomaceae and Trichocoleaceae. The highest genera in the order Jungermanniales is represented by Lejeuneaceae i.e. 11 genera and 9 families, viz., Cephaloziaceae, Frullaniaceae, Herbertaceae, Jubulaceae, Jungermanniaceae, Porellaceae, Radulaceae, Solenostomaceae and Trichocoleaceae are represented by a single genus each. The highest number of species was found in the genus *Plagiochila* represented by 10 species while 13 genera, viz., *Chandonanthus*, *Drepanolejeunea*, *Frullanooides*, *Lophozia*, *Leptolejeunea*, *Lopholejeunea*, *Notoscyphus*, *Jubula*, *Plagiochilion*, *Ptychanthus*, *Spruceanthus*, *Trichocolea* and *Tuzibeanthus* are represented by a single species each.

The order Marchantiales is represented by 8 families, viz., Aytoniaceae, Conocephalaceae, Cyathodiaceae, Dumortieraceae, Marchantiaceae, Ricciaceae, Targioniaceae and Wiesnerellaceae. The highest genera under the order Marchantiales is represented by families Aytoniaceae i.e. 3 genera, follow by Ricciaceae i.e 2 genera and the other six families are represented by a single genus each. The highest number of species was found in 2 genera, viz., *Marchantia* and *Riccia* and each genus is represented by 4 species each and 6 genera, viz., *Dumortiera*, *Mannia*, *Plagiochasma*, *Ricciocarpos*, *Targionia* and *Wiesnerella* are represented by a single species each.

The order Metzgeriales is represented by 5 families, Viz., Aneuraceae, Fossombroniaceae, Metzgeriaceae, Pallaviciniaceae and Pelliaceae and all the five families are represented by a single genus each. The highest number of species was found in 2 genera, viz., *Metzgeria* and *Riccardia* and each species is represented by 4 species each and genus *Pellia* is represented by a single species.

The order Anthocerotales is represent by 2 families, viz., Anthocerotaceae and Phaeocertaceae and each family is represented by a single genus each. The 2 genera, viz., *Folioceros* and *Phaeoceros* is represented by 2 species each under the order Anthocerotales.

Out the 123 taxa investigated, Kohima district is represented by 102 taxa which account for 82.92 % of the total investigated taxa and Mokokchung district is represented by 56 taxa which account for 45.52 % of the total investigated taxa in the state of Nagaland. It is found that 30 taxa were found commonly occurring in both the districts of Kohima and Mokokchung and 63 taxa were found only in Kohima district while 18 species were found to occur only in Mokokchung district (**Fig-2 & 3**).

In Kohima district, thalloid liverworts is represented by 25 taxa, leafy liverworts is represented by 73 taxa and hornworts is represented by 4 taxa while in Mokokchung district, thalloid liverworts is represented by 23 taxa, leafy liverworts is represented by 30 taxa and hornworts is represented by 3 taxa respectively (**Fig.- 6 & 7**).

On the basis of the habitats, liverworts and hornworts of Kohima and Mokokchung districts are classified into 5 categories as under:

1. Growing on soil – **Terricolous**, 2. Growing on rocks – **Saxicolous**, 3. Growing on barks – **Corticolous**, 4. Growing on leaves – **Foliicolous** and 5. Growing on water - **Aquatic**. Depending upon their habitats of occurrence of liverworts and hornworts, it has been found that in Kohima district, Corticolous species are predominant, whereas in Mokokchung district, it is found that the Terricolous species are predominant in the investigated localities (**Fig.- 4 & 5**). All the 5 habitats, viz., Corticolous, Terricolous, Saxicolous, Foliicolous and Aquatic have been found in Kohima district. However, Foliicolous and Aquatic taxa were absent in Mokokchung district. The dominance of corticolous taxa in Kohima district could be attributed due to high forests area covered (77.83 % as compare to 17.94 % in Mokokchung district), more moist climatic conditions, due to high rainfall, etc. The present study found out that the diversity of bryophytic taxa are more in primary forest than the secondary forest. This result is contrasting to that of the angiospermic taxa where the diversity is more in the young and developing.

The present investigation on liverworts and hornworts flora of Kohima and Mokokchung districts, Nagaland reveals 13 species new records to Eastern Himalayan bryoflora (**Table - 2**) and 14 species new records to North East India region (**Table - 3**) and 117 taxa new to the state of Nagaland. A thorough survey of literature reveals that the Liverworts and Hornworts flora of Nagaland state in general and Kohima and Mokokchung districts in particular has not been documented properly and the published work on Liverworts and Hornworts is scanty except Udar and Asthana (1985), Nath *et al.* (2011), Chaturvedi and Chaturvedi (2007). This is the first authentic documentation of Liverworts and Hornworts in the state. It will give a break through in future prospect of bryophytes, particularly the liverworts and hornworts in the state of Nagaland.

Table-1: Depicting the total numbers of species identified are listed below:

SL.NO	FAMILIES	GENUS	SPECIES
1	ANEURACEAE	<i>Riccardia</i>	<i>R. tenuicostata</i> Schiffn. <i>R. sikkimensis</i> (Steph.) Pande et Srivastava <i>R. cardotii</i> (Steph.) Pande et Srivastava <i>R. platyclada</i> Schiffn.
2	PHAEOCEROTACEAE	<i>Phaeoceros</i>	<i>P. laevis</i> L. Prosk. <i>P. caroliana</i> (Michx.) Prosk.
3	ANTHOCEROTACEAE	<i>Folioceros</i>	<i>F. kashyapii</i> Srivastava et Asthana <i>F. paliformis</i> D.K. Singh
4	AYTINIACEAE	<i>Asterella</i> <i>Plagiochasma</i> <i>Mannia</i>	<i>A. khasyana</i> (Griff.) Pandé, K.P. Srivast. & Sultan Khan. <i>A. multiflora</i> (Steph.) Kachroo <i>P. appendiculatum</i> Lehm. & Lindenb. <i>M. indica</i> (Steph.) Kachroo
5	FOSSOMBRONACEAE	<i>Fossombronia</i>	<i>F. wondraczekii</i> (Corda) Dumort. <i>F. cristula</i> Aust.
6	MARCHANTIACEAE	<i>Marchantia</i>	<i>M. papiliata</i> (Steph.) Bischl. <i>M. paleacea</i> Bertol. <i>M. linearis</i> Lehm. et Lindenb. <i>M. paleacea</i> subsp. <i>diptera</i> (Nees et Mont.) Inoue
7	DUMORTIERACEAE	<i>Dumortiera</i>	<i>D. hirsuta</i> Reinw. Bl. et Nees
8	CONOCEPHALACEAE	<i>Conocephalum</i>	<i>C. japonicum</i> (Thunb.) Grolle <i>C. conicum</i> (L.) Dumort.
9	METZGERIACEAE	<i>Metzgeria</i>	<i>M. himalayensis</i> Kashyap <i>M. lindbergii</i> Schiffn. <i>M. leptonura</i> Spruce <i>M. furcata</i> (L.) Corda
10	PALLAVICINIACEAE	<i>Pallavicinia</i>	<i>P. himalayensis</i> Schiffn. <i>P. lyellii</i> (Hook.) Gray
11	RICCIACEAE	<i>Ricciocarpus</i> <i>Riccia</i>	<i>R. natans</i> Corda <i>R. gangetica</i> Ahmad <i>R. pathankotensis</i> Kashyap <i>R. huebeneriana</i> Lindenb. <i>R. beyrichiana</i> Hampe in Lehm.
12	TARGIONIACEAE	<i>Targionia</i>	<i>T. hypophylla</i> L.

13	CYATHODIACEAE	<i>Cyathodium</i>	<i>C. aereonitens</i> (Griff.) Mitt. <i>C. smaragdinum</i> Schiffn.
14	PELLIACEAE	<i>Pellia</i>	<i>Pellia endiviifolia</i> (Dicks.) Dumort.
15	WIESNERELLACEAE	<i>Wiesnerella</i>	<i>W. denudata</i> Inuoe
16	CALYPEGEIACEAE	<i>Calypegeia</i>	<i>C. lunata</i> Mitt. <i>C. arguta</i> Nees et Mont. <i>C. azurea</i> Stotler et Crotz.
17	CEPHALOZIACEAE	<i>Cephalozia</i>	<i>C. darjeelensis</i> Udar et Kumar <i>C. hamatiloba</i> Steph.
18	FRULLANIACEAE	<i>Frullania</i>	<i>F. arecae</i> (Spreng.) Gottsche <i>F. ericoides</i> Nees <i>F. nepalensis</i> (Spreng.) Lehm, & Lindenb. <i>F. muscicola</i> Steph. (Nees) Mont. <i>F. physanta</i> Mitt. <i>F. squarrosa</i> Dumort. <i>F. rotundupula</i> Steph. <i>F. galeata</i> (Reiwn., Nees & Blume) Dumort. <i>F. retusa</i> Mitt.
19	HERBERTACEAE	<i>Herbertus</i>	<i>H. dicrana</i> (Taylor) Trevis. <i>H. aduncus</i> (Dicks) Gray <i>H. armitanus</i> (Steph.) H.A. Mill.
20	JUNGERMANNIACEAE	<i>Jungermannia</i>	<i>J. sikkimensis</i> (Steph.) Vana & D.G. Long <i>J. rubripunctata</i> (S. Hatt.) Amak.
21	LEJEUNEACEAE	<i>Lejeunea</i> <i>Drapenolejeunea</i> <i>Leptojejeunea</i> <i>Frullanoides</i> <i>Trocholejeunea</i> <i>Ptychanthus</i> <i>Spruceanthus</i> <i>Tuzibeanthus</i> <i>Cololejeunea</i>	<i>L. flava</i> (Sw.) Nees <i>L. obscura</i> Mitt. <i>L. tuberculosa</i> Steph. <i>L. cavifolia</i> (Ehrh) Lindb. <i>D. augustifolia</i> (Mitt.) Grolle <i>L. elliptica</i> (Lehm. & Lindenb.) Schiffn. <i>F. tristis</i> (Steph.) Van Slageren <i>T. infuscata</i> (Mitt.) Verd. <i>T. sandvicensis</i> (Gottsche) Mizut. <i>P. striatus</i> (Lehm. & Lindenb.) Nees <i>S. semirepandus</i> (Nees) Verd. <i>T. chinensis</i> (Steph.) Mizut. <i>C. latilobula</i> (Herzog) Tixier <i>C. spinosa</i> (Horik.) S. Hatt. <i>C. ceratilobula</i> (P.C. Chen) R.M.

		<i>Lopholejeunea</i> <i>Cheilolejeunea</i>	Schust. <i>C. lantiloba</i> Steph. <i>L. abortiva</i> (Mitt.) Steph. <i>C. imbricata</i> (Nees) S. Hatt. <i>C. subopaca</i> (Mitt.) Mizut.
22	LEPIDOZIACEAE	<i>Bazzania</i> <i>Lepidozia</i>	<i>B. ovistipula</i> (St.) Abeyw. <i>B. himalayana</i> (Mitt.) Schiffn. <i>B. praerupta</i> (Reinw., Blume et Nees) Strev. <i>B. sikkimensis</i> (Steph.) Herzog. <i>B. tricrenata</i> (Wahlenb.) Trevis. <i>B. appendiculata</i> (Mitt.) S. Hatt. & Mirzut. <i>B. tridens</i> (Reinw. Blume et Nees) Trevis. <i>L. brebefolia</i> Mitt. <i>L. wallichiana</i> Gottsche
23	LOPHOCOLEACEAE	<i>Lopholcolea</i> <i>Heteroscyphus</i>	<i>L. bidentata</i> (L.) Dumort. <i>L. heterophylla</i> (Schrad.) Dumort. <i>H. hyalinus</i> (Steph.) A. Srivast. & S.C. Srivast. <i>H. bescherellei</i> (Steph.) S. Hatt. <i>H. pandei</i> A. Srivast. & S.C. Srivast. <i>H. argutus</i> (Nees) Schiffn. <i>H. orbiculatus</i> A. Srivast. & S.C. Srivast. <i>H. parvus</i> A. Srivast. & S.C. Srivast.
24	PORELLACEAE	<i>Porella</i>	<i>P. campylophylla</i> (Lehm. & Lindenb.) Trevis. <i>P. obtusata</i> var. <i>macraloba</i> (Steph.) S. Hatt. & Zhang <i>P. perrottetiana</i> (Mont.) Trevis. <i>P. plumosa</i> (Mitt.) Inoue <i>P. caespitans</i> (Steph.) S. Hatt.
25	PLAGIOCHILACEAE	<i>Plagiochila</i>	<i>P. corticola</i> Steph. <i>P. hattorii</i> Inoue <i>P. nepalensis</i> Lindenb. <i>P. parvifolia</i> Lindenb. <i>P. sciophila</i> Nees ex Lindenb. <i>P. semidecurrens</i> (Lehm. et Lindenb.) Lehm. et Lindenb. <i>P. subtorpica</i> Steph. <i>P. flexuosa</i> Mitt.

		<i>Plagiochilon</i>	<i>P. elegans</i> Mitt. <i>P. defolians</i> Grolle et M.L. So <i>P. meyebarae</i> S. Hatt.
26	TRICHOLOLEACEAE	<i>Trichocolea</i>	<i>T. tenera</i> Udar et Singh
27	SCAPANACEAE	<i>Scapania</i> <i>Chandonanthus</i> <i>Lophozia</i>	<i>S. ferregenii</i> (Lehm. et Lindenb.) Gottsche <i>S. ligulata</i> Steph. <i>S. graffithii</i> Schiffn. <i>S. parva</i> Steph. <i>C. hirtellus</i> (F. weber) Mitt. <i>L. setosa</i> (Mitt.) Steph.
28	RRADULACEAE	<i>Radula</i>	<i>R. madagascariensis</i> Gottsche <i>R. obscura</i> Mitt. <i>R. javanica</i> Gottsche
29	JUBULACEAE	<i>Jubula</i>	<i>J. hutchinsiae</i> subsp. <i>javanica</i> (Steph.) Verd.
30	SOLENOSTOMACEAE	<i>Solenostoma</i>	<i>S. truncatum</i> (Nees) R.M. Schust. ex Vana & D.G. Long <i>S. comatum</i> (Nees) C. Gao
31	GEOCALYCACEAE	<i>Saccogynidium</i> <i>Notoscyphus</i>	<i>S. irregularospinum</i> C.H. Gao, T. Cao & M.J. Lai <i>N. darjelingensis</i> Udar & A. Kumar

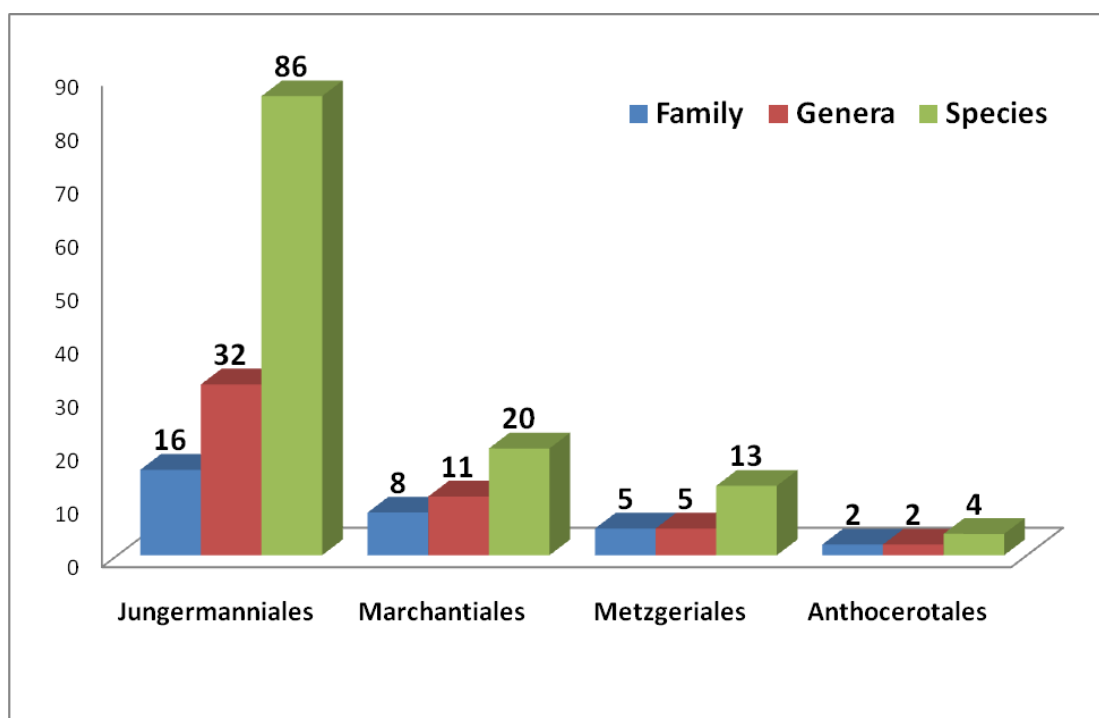


Fig. 1: Showing the total number of taxa distribution in both Kohima and Mokokchung districts, Nagaland.

Table-2: Depicting the names of Liverworts taxa new to Eastern Himalayas (13 species).

Sl. No	Name of the taxa	Locality of occurrence
1	<i>Fossombronia wandraczekii</i> (Corda) Dumort.	Kohima
2	<i>Cyathodium smaragdinum</i> Schiffn.	Mokokchung
3	<i>Frullania squarrosa</i> Dumort.	Jakhama
4	<i>Tuzibeanthus chinensis</i> (Steph.) Mizut.	Khonoma
5	<i>Porella otusata</i> var. <i>macroloba</i> (Steph.) S. Hatt. & Zhang	Longkhum, Kigwema, Khonoma
6	<i>Porella perrottetiana</i> (Mont.) Trevis.	Kigwema
7	<i>Porella caespitans</i> (Steph.) S. Hatt.	Khonoma
8	<i>Metzgeria furcata</i> (L.) Corda	Nerhema
9	<i>Marchantia paleacea</i> subsp. <i>diptera</i> (Nees et Mont.) Inoue	Khuzama, Mokokchung
10	<i>Riccardia platyclada</i> Schiffn.	Khuzama
11	<i>Frullania galeata</i> (Reiwn., Nees & Blume) Dumort.	Mopungchuket
12	<i>Mannia indica</i> (Steph.) Kachroo	Changki
13	<i>Riccia pathankotensis</i> Kashyap	Kohima

Table-3: Depicting the names of Liverworts taxa new to North East India region (14 species).

Sl.No	Name of the Taxa	Locality of Occurrence
1	<i>Saccogynidium irregularospinum</i> C.H. Gao, T. Cao & M.J. Lai	Changki
2	<i>Herbertus armitanus</i> (Steph.) H.A. Mill.	Khonoma
3	<i>Conocephalum japonicum</i> (Thunb.) Grolle	Khuzama, Viswema
4	<i>Riccardia platyclada</i> Schiffn.	Khuzama
5	<i>Wiesnerella denudata</i> Inuoe	Khonoma
6	<i>Lejeunea obscura</i> Mitt.	Khuzama
7	<i>Porella caespitans</i> (Steph.) S. Hatt.	Khonoma
8	<i>Heteroscyphus orbiculatus</i> A. Srivast. & S.C. Srivast.	Mokokchung
9	<i>Heteroscyphus parvus</i> A. Srivast. & S.C. Srivast.	Changki
10	<i>Frullania physanta</i> Mitt.	Khonoma
11	<i>Riccia heubeneriana</i> Lindenb.	Kohima
12	<i>Lophozia setosa</i> (Mitt.) Steph.	Khonoma
13.	<i>Herbertus aduncus</i> (Dicks) Gray	Khuzama
14	<i>Notoscyphus darjelingensis</i> Udar & A. Kumar	Changki

Fig.-2. Showing the distribution of taxa in district wise.

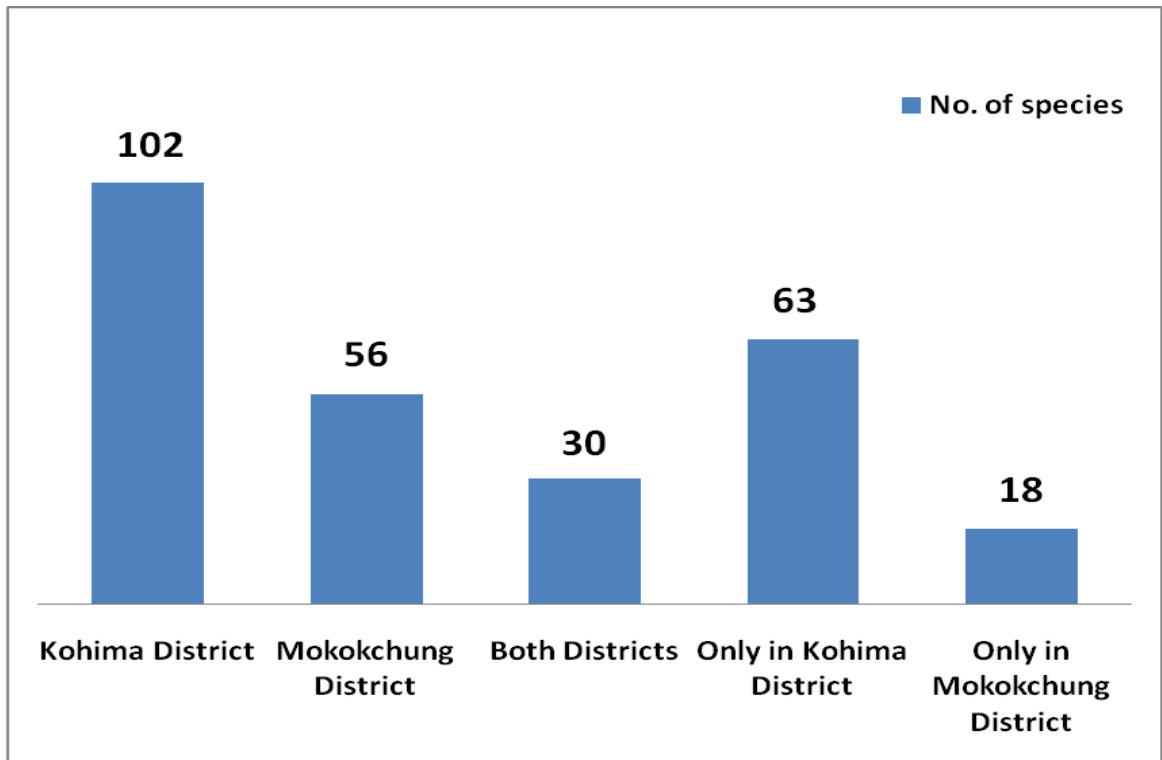


Fig. – 3. Showing the distribution of taxa in district wise.

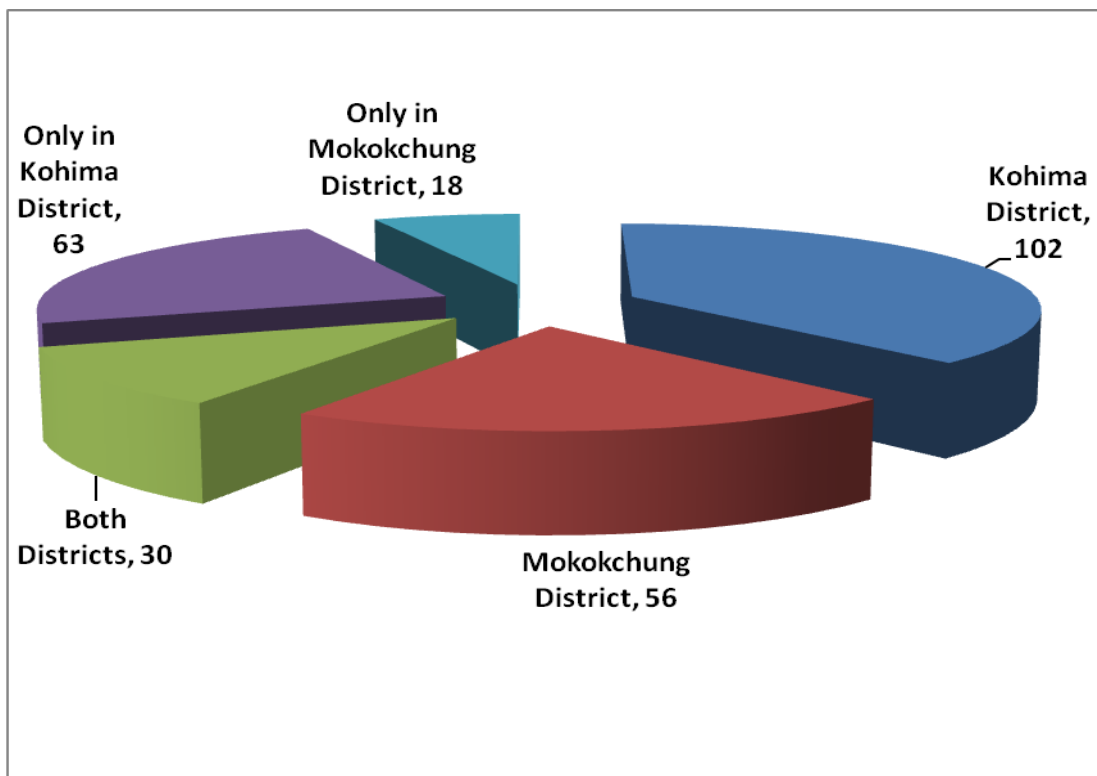


Fig. – 4. Showing the habitats distribution of liverworts and hornworts taxa in Kohima district, Nagaland.

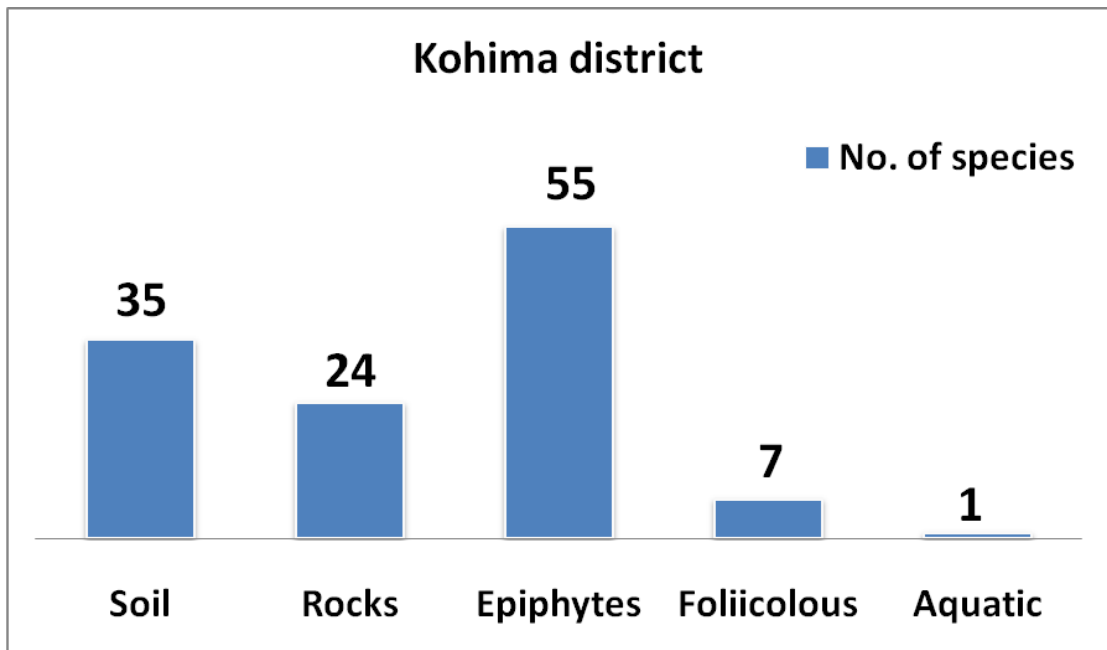


Fig. – 5. Showing the habitats distribution of liverworts and hornworts taxa in Mokokchung district, Nagaland.

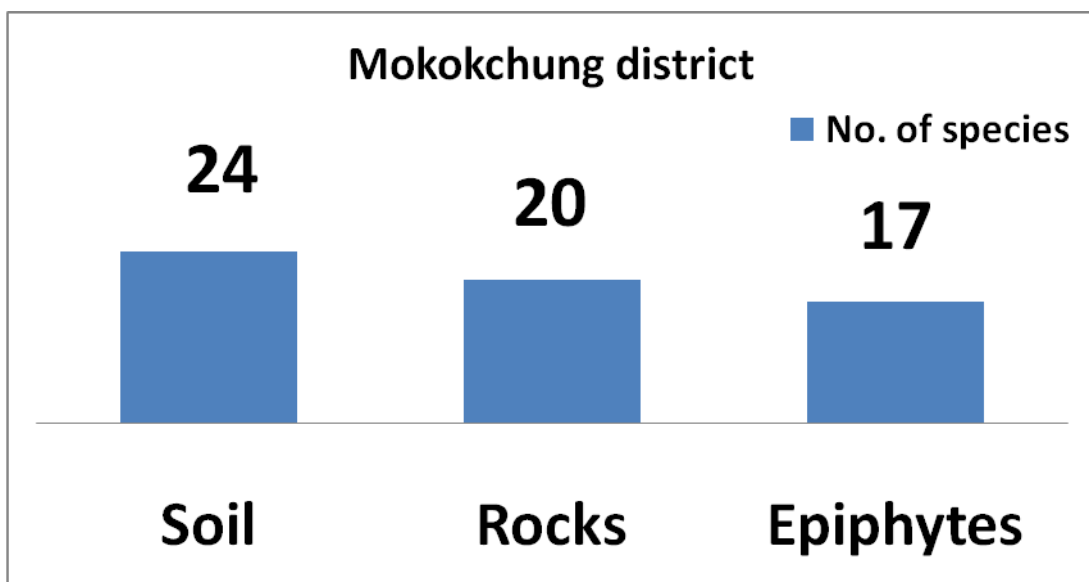


Fig. - 6. Showing the distribution of Thalloid Liverworts, Leafy Liverworts and Hornworts in Kohima district, Nagaland.

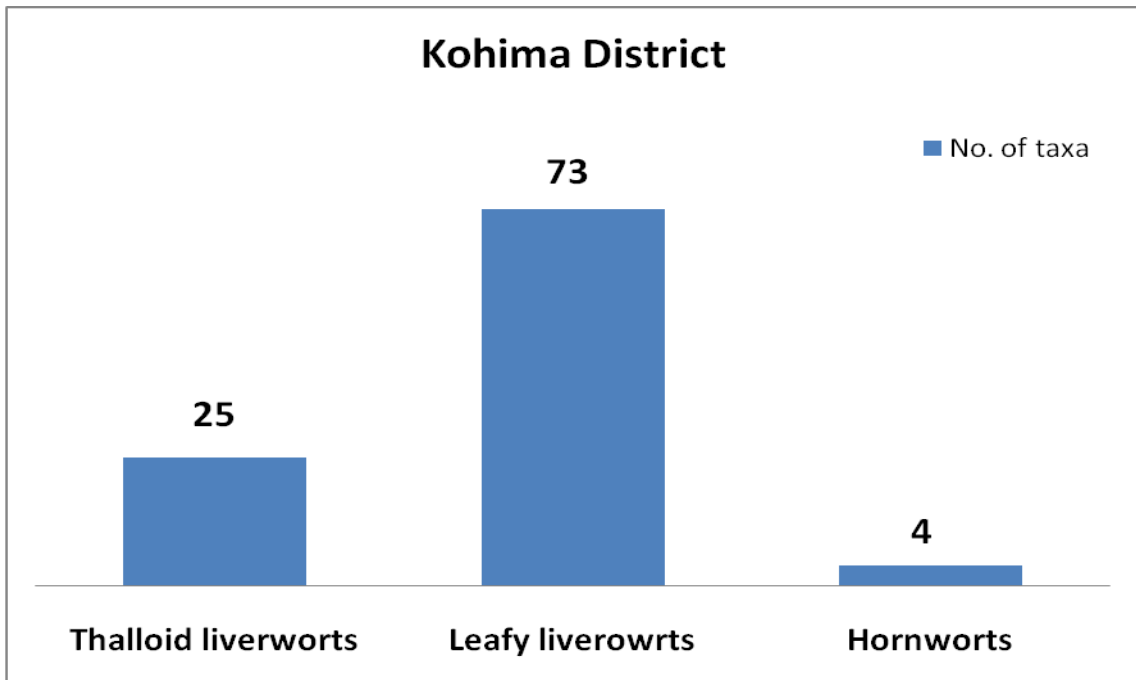
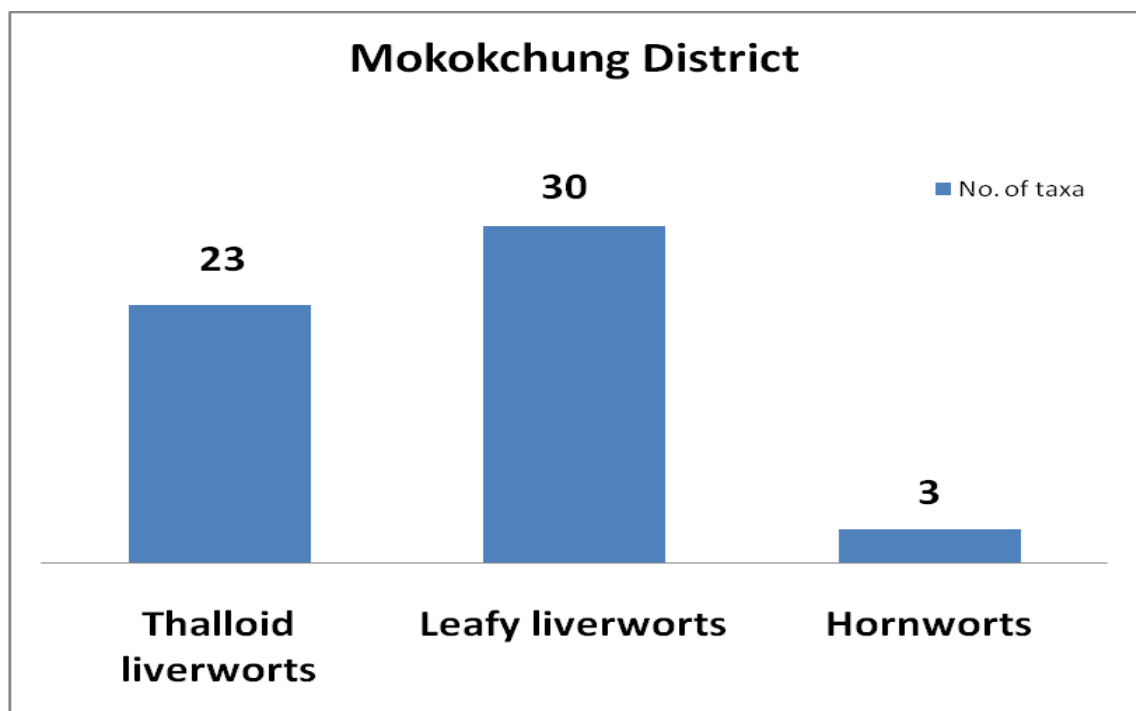


Fig. 7. Showing the distribution of Thalloid Liverworts, Leafy Liverworts and Hornworts in Mokokchung District, Nagaland.



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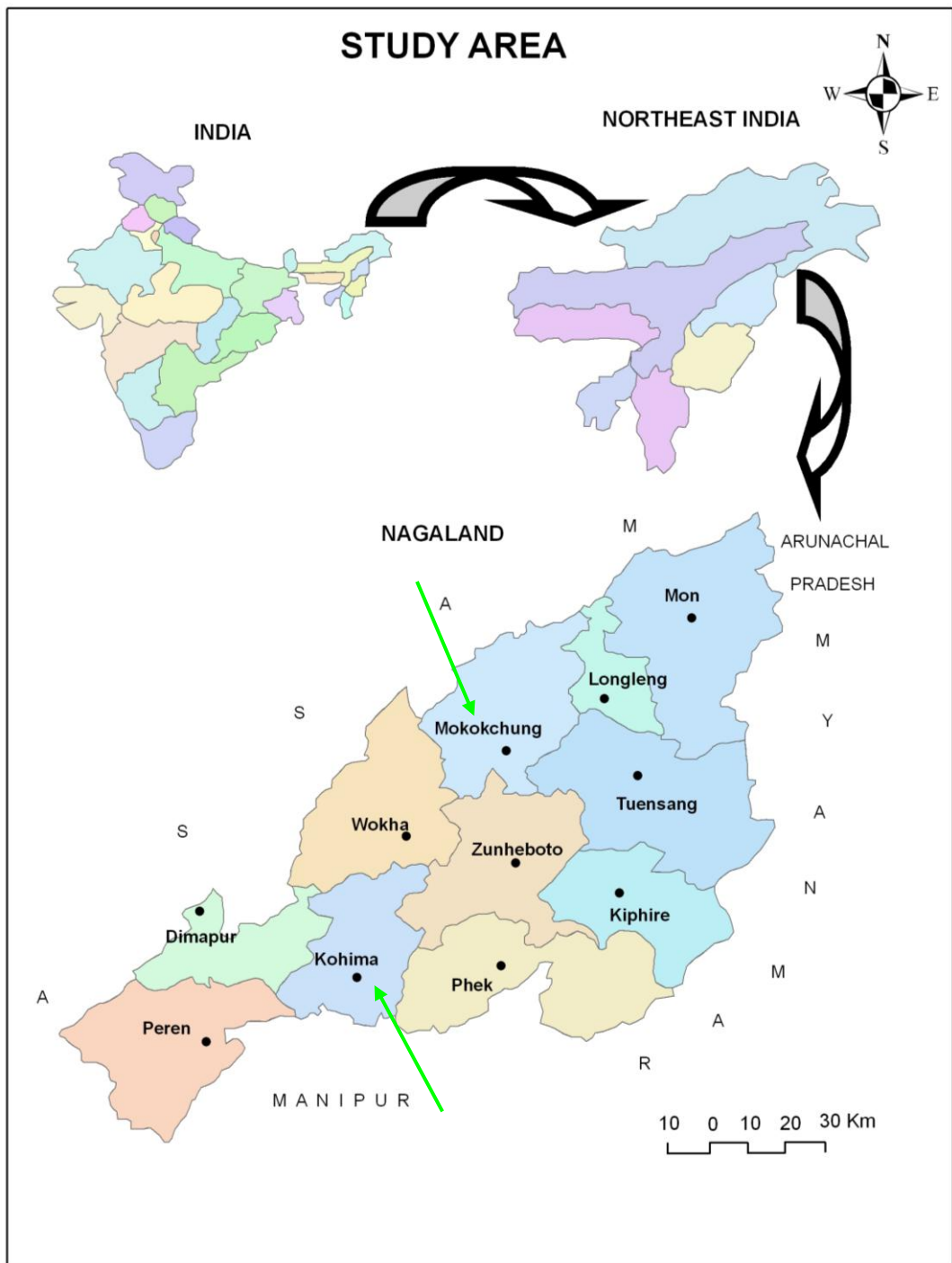
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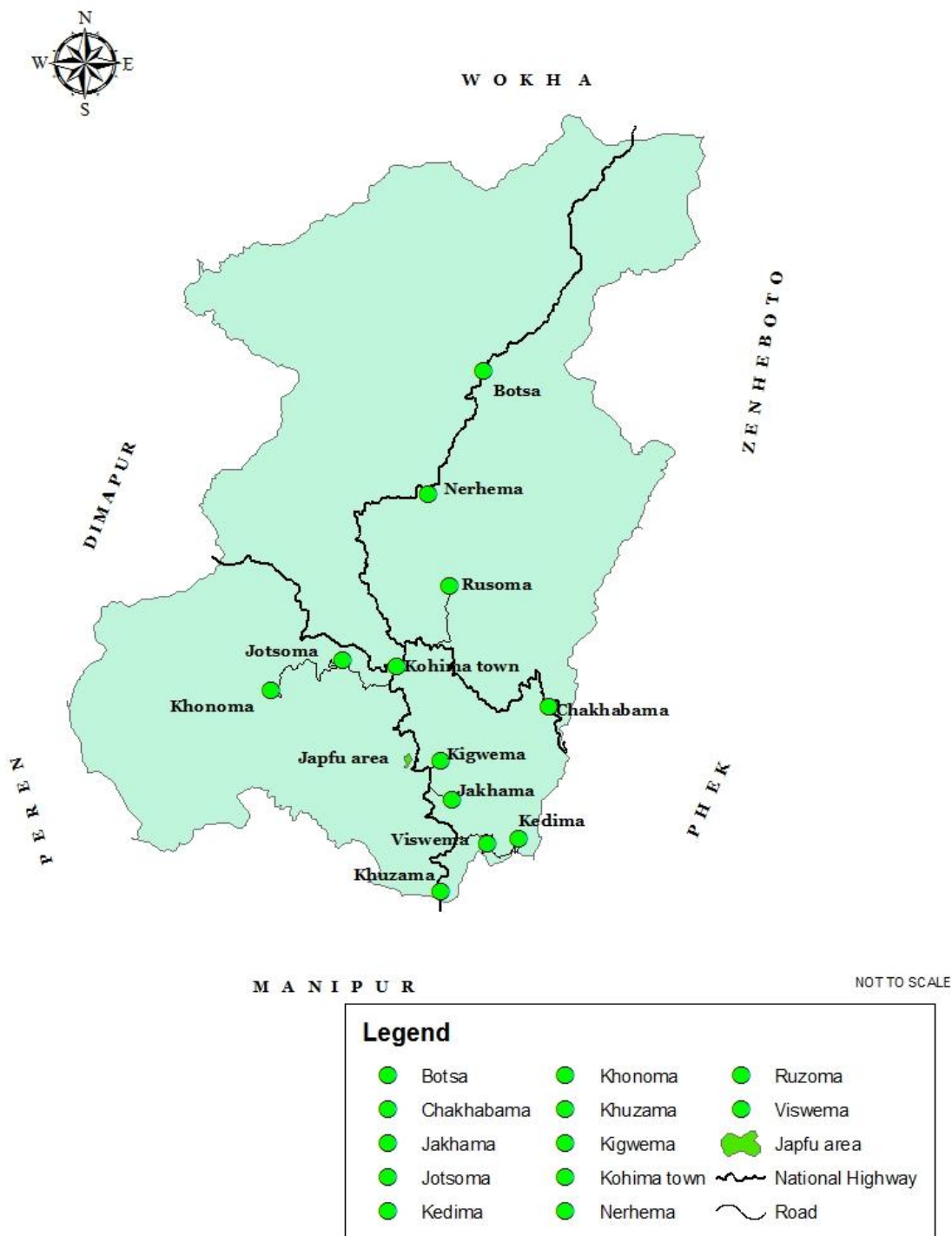
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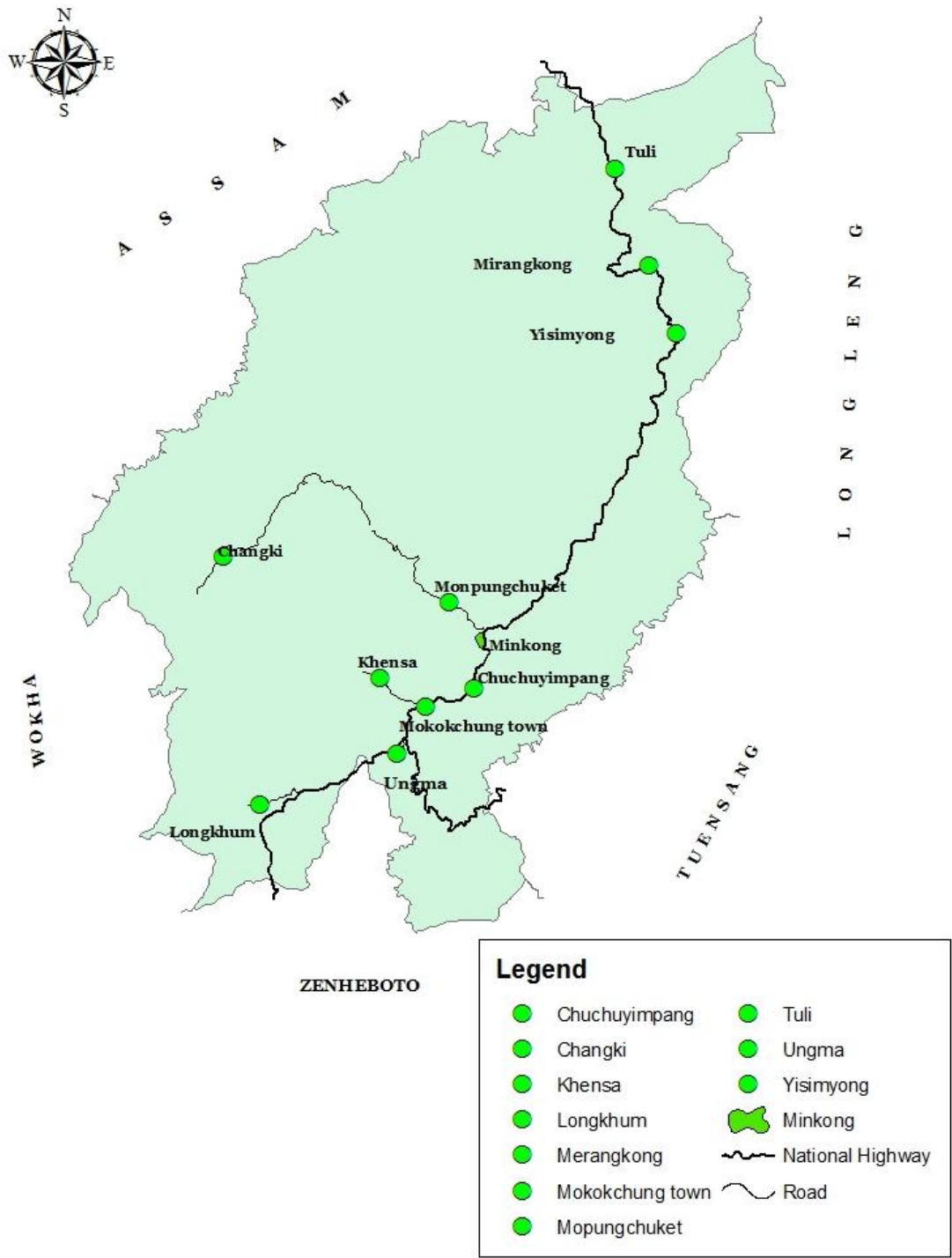
Map 1. Showing the Study area; green arrow point to the present study area

KOHIMA DISTRICT



Map 2. District map of Kohima showing the collection localities

MOKOKCHUNG DISTRICT



NOT TO SCALE

Map 3. District map of Mokokchung showing the collection localities

Table-1: Depicting the total numbers of species identified are listed below:

SL.NO	FAMILIES	GENUS	SPECIES
1	ANEURACEAE	<i>Riccardia</i>	<i>R. tenuicostata</i> Schiffn. <i>R. sikkimensis</i> (Steph.) Pande et Srivastava <i>R. cardotii</i> (Steph.) Pande et Srivastava <i>R. platyclada</i> Schiffn.
2	PHAEOCEROTACEAE	<i>Phaeoceros</i>	<i>P. laevis</i> L. Prosk. <i>P. caroliana</i> (Michx.) Prosk.
3	ANTHOCEROTACEAE	<i>Folioceros</i>	<i>F. kashyapii</i> Srivastava et Asthana <i>F. paliformis</i> D.K. Singh
4	AYTINIACEAE	<i>Asterella</i> <i>Plagiochasma</i> <i>Mannia</i>	<i>A. khasyana</i> (Griff.) Pandé, K.P. Srivast. & Sultan Khan. <i>A. multiflora</i> (Steph.) Kachroo <i>P. appendiculatum</i> Lehm. & Lindenb. <i>M. indica</i> (Steph.) Kachroo
5	FOSSOMBRONACEAE	<i>Fossombronia</i>	<i>F. wondraczekii</i> (Corda) Dumort. <i>F. cristula</i> Aust.
6	MARCHANTIACEAE	<i>Marchantia</i>	<i>M. papiliata</i> (Steph.) Bischl. <i>M. paleacea</i> Bertol. <i>M. linearis</i> Lehm. et Lindenb. <i>M. paleacea</i> subsp. <i>diptera</i> (Nees et Mont.) Inoue
7	DUMORTIERACEAE	<i>Dumortiera</i>	<i>D. hirsuta</i> Reinw. Bl. et Nees
8	CONOCEPHALACEAE	<i>Conocephalum</i>	<i>C. japonicum</i> (Thunb.) Grolle <i>C. conicum</i> (L.) Dumort.
9	METZGERIACEAE	<i>Metzgeria</i>	<i>M. himalayensis</i> Kashyap <i>M. lindbergii</i> Schiffn. <i>M. leptonura</i> Spruce <i>M. furcata</i> (L.) Corda
10	PALLAVICINIACEAE	<i>Pallavicinia</i>	<i>P. himalayensis</i> Schiffn. <i>P. lyellii</i> (Hook.) Gray
11	RICCIACEAE	<i>Ricciocarpus</i> <i>Riccia</i>	<i>R. natans</i> Corda <i>R. gangetica</i> Ahmad <i>R. pathankotensis</i> Kashyap <i>R. huebeneriana</i> Lindenb. <i>R. beyrichiana</i> Hampe in Lehm.
12	TARGIONIACEAE	<i>Targionia</i>	<i>T. hypophylla</i> L.

13	CYATHODIACEAE	<i>Cyathodium</i>	<i>C. aereonitens</i> (Griff.) Mitt. <i>C. smaragdinum</i> Schiffn.
14	PELLIACEAE	<i>Pellia</i>	<i>Pellia endiviifolia</i> (Dicks.) Dumort.
15	WIESNERELLACEAE	<i>Wiesnerella</i>	<i>W. denudata</i> Inuoe
16	CALYPEGEIACEAE	<i>Calypegeia</i>	<i>C. lunata</i> Mitt. <i>C. arguta</i> Nees et Mont. <i>C. azurea</i> Stotler et Crotz.
17	CEPHALOZIACEAE	<i>Cephalozia</i>	<i>C. darjeelensis</i> Udar et Kumar <i>C. hamatiloba</i> Steph.
18	FRULLANIACEAE	<i>Frullania</i>	<i>F. arecae</i> (Spreng.) Gottsche <i>F. ericoides</i> Nees <i>F. nepalensis</i> (Spreng.) Lehm, & Lindenb. <i>F. muscicola</i> Steph. (Nees) Mont. <i>F. physanta</i> Mitt. <i>F. squarrosa</i> Dumort. <i>F. rotundupula</i> Steph. <i>F. galeata</i> (Reiwn., Nees & Blume) Dumort. <i>F. retusa</i> Mitt.
19	HERBERTACEAE	<i>Herbertus</i>	<i>H. dicrana</i> (Taylor) Trevis. <i>H. aduncus</i> (Dicks) Gray <i>H. armitanus</i> (Steph.) H.A. Mill.
20	JUNGERMANNIACEAE	<i>Jungermannia</i>	<i>J. sikkimensis</i> (Steph.) Vana & D.G. Long <i>J. rubripunctata</i> (S. Hatt.) Amak.
21	LEJEUNEACEAE	<i>Lejeunea</i> <i>Drapenolejeunea</i> <i>Leptojejeunea</i> <i>Frullanooides</i> <i>Trocholejeunea</i> <i>Ptychanthus</i> <i>Spruceanthus</i> <i>Tuzibeanthus</i> <i>Cololejeunea</i>	<i>L. flava</i> (Sw.) Nees <i>L. obscura</i> Mitt. <i>L. tuberculosa</i> Steph. <i>L. cavifolia</i> (Ehrh) Lindb. <i>D. augustifolia</i> (Mitt.) Grolle <i>L. elliptica</i> (Lehm. & Lindenb.) Schiffn. <i>F. tristis</i> (Steph.) Van Slageren <i>T. infuscata</i> (Mitt.) Verd. <i>T. sandvicensis</i> (Gottsche) Mizut. <i>P. striatus</i> (Lehm. & Lindenb.) Nees <i>S. semirepandus</i> (Nees) Verd. <i>T. chinensis</i> (Steph.) Mizut. <i>C. latilobula</i> (Herzog) Tixier <i>C. spinosa</i> (Horik.) S. Hatt. <i>C. ceratilobula</i> (P.C. Chen) R.M.

		<i>Lopholejeunea</i> <i>Cheilolejeunea</i>	Schust. <i>C. lantiloba</i> Steph. <i>L. abortiva</i> (Mitt.) Steph. <i>C. imbricata</i> (Nees) S. Hatt. <i>C. subopaca</i> (Mitt.) Mizut.
22	LEPIDOZIACEAE	<i>Bazzania</i> <i>Lepidozia</i>	<i>B. ovistipula</i> (St.) Abeyw. <i>B. himalayana</i> (Mitt.) Schiffn. <i>B. praerupta</i> (Reinw., Blume et Nees) Strev. <i>B. sikkimensis</i> (Steph.) Herzog. <i>B. tricrenata</i> (Wahlenb.) Trevis. <i>B. appendiculata</i> (Mitt.) S. Hatt. & Mirzut. <i>B. tridens</i> (Reinw. Blume et Nees) Trevis. <i>L. brebefolia</i> Mitt. <i>L. wallichiana</i> Gottsche
23	LOPHOCOLEACEAE	<i>Lopholcolea</i> <i>Heteroscyphus</i>	<i>L. bidentata</i> (L.) Dumort. <i>L. heterophylla</i> (Schrad.) Dumort. <i>H. hyalinus</i> (Steph.) A. Srivast. & S.C. Srivast. <i>H. bescherellei</i> (Steph.) S. Hatt. <i>H. pandei</i> A. Srivast. & S.C. Srivast. <i>H. argutus</i> (Nees) Schiffn. <i>H. orbiculatus</i> A. Srivast. & S.C. Srivast. <i>H. parvus</i> A. Srivast. & S.C. Srivast.
24	PORELLACEAE	<i>Porella</i>	<i>P. campylophylla</i> (Lehm. & Lindenb.) Trevis. <i>P. obtusata</i> var. <i>macraloba</i> (Steph.) S. Hatt. & Zhang <i>P. perrottetiana</i> (Mont.) Trevis. <i>P. plumosa</i> (Mitt.) Inoue <i>P. caespitans</i> (Steph.) S. Hatt.
25	PLAGIOCHILACEAE	<i>Plagiochila</i>	<i>P. corticola</i> Steph. <i>P. hattorii</i> Inoue <i>P. nepalensis</i> Lindenb. <i>P. parvifolia</i> Lindenb. <i>P. sciophila</i> Nees ex Lindenb. <i>P. semidecurrens</i> (Lehm. et Lindenb.) Lehm. et Lindenb. <i>P. subtorpica</i> Steph. <i>P. flexuosa</i> Mitt.

		<i>Plagiochilon</i>	<i>P. elegans</i> Mitt. <i>P. defolians</i> Grolle et M.L. So <i>P. meyebarae</i> S. Hatt.
26	TRICHOLOLEACEAE	<i>Trichocolea</i>	<i>T. tenera</i> Udar et Singh
27	SCAPANACEAE	<i>Scapania</i> <i>Chandonanthus</i> <i>Lophozia</i>	<i>S. ferregenii</i> (Lehm. et Lindenb.) Gottsche <i>S. ligulata</i> Steph. <i>S. graffithii</i> Schiffn. <i>S. parva</i> Steph. <i>C. hirtellus</i> (F. weber) Mitt. <i>L. setosa</i> (Mitt.) Steph.
28	RRADULACEAE	<i>Radula</i>	<i>R. madagascariensis</i> Gottsche <i>R. obscura</i> Mitt. <i>R. javanica</i> Gottsche
29	JUBULACEAE	<i>Jubula</i>	<i>J. hutchinsiae</i> subsp. <i>javanica</i> (Steph.) Verd.
30	SOLENOSTOMACEAE	<i>Solenostoma</i>	<i>S. truncatum</i> (Nees) R.M. Schust. ex Vana & D.G. Long <i>S. comatum</i> (Nees) C. Gao
31	GEOCALYCACEAE	<i>Saccogynidium</i> <i>Notoscyphus</i>	<i>S. irregularospinum</i> C.H. Gao, T. Cao & M.J. Lai <i>N. darjelingensis</i> Udar & A. Kumar

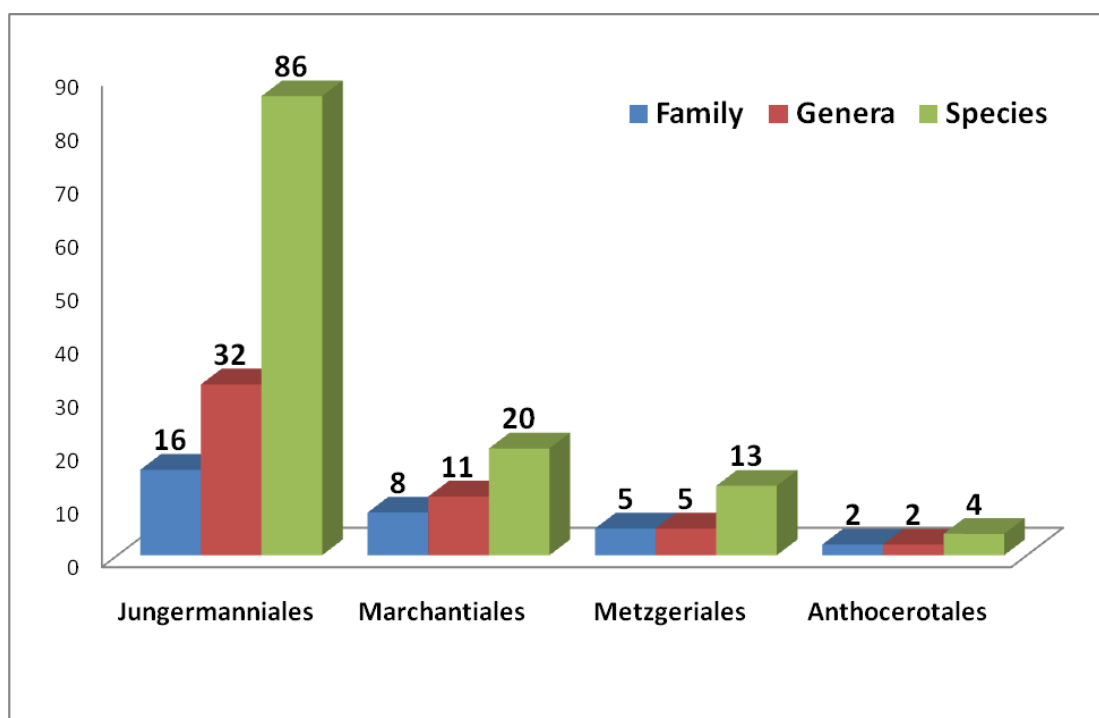


Fig. 1: Showing the total number of taxa distribution in both Kohima and Mokokchung districts, Nagaland.

Table-2: Depicting the names of Liverworts taxa new to Eastern Himalayas (13 species).

Sl. No	Name of the taxa	Locality of occurrence
1	<i>Fossombronia wandraczekii</i> (Corda) Dumort.	Kohima
2	<i>Cyathodium smaragdinum</i> Schiffn.	Mokokchung
3	<i>Frullania squarrosa</i> Dumort.	Jakhama
4	<i>Tuzibeanthus chinensis</i> (Steph.) Mizut.	Khonoma
5	<i>Porella otusata</i> var. <i>macroloba</i> (Steph.) S. Hatt. & Zhang	Longkhum, Kigwema, Khonoma
6	<i>Porella perrottetiana</i> (Mont.) Trevis.	Kigwema
7	<i>Porella caespitans</i> (Steph.) S. Hatt.	Khonoma
8	<i>Metzgeria furcata</i> (L.) Corda	Nerhema
9	<i>Marchantia paleacea</i> subsp. <i>diptera</i> (Nees et Mont.) Inoue	Khuzama, Mokokchung
10	<i>Riccardia platyclada</i> Schiffn.	Khuzama
11	<i>Frullania galeata</i> (Reiwn., Nees & Blume) Dumort.	Mopungchuket
12	<i>Mannia indica</i> (Steph.) Kachroo	Changki
13	<i>Riccia pathankotensis</i> Kashyap	Kohima

Table-3: Depicting the names of Liverworts taxa new to North East India region (14 species).

Sl.No	Name of the Taxa	Locality of Occurrence
1	<i>Saccogynidium irregularospinum</i> C.H. Gao, T. Cao & M.J. Lai	Changki
2	<i>Herbertus armitanus</i> (Steph.) H.A. Mill.	Khonoma
3	<i>Conocephalum japonicum</i> (Thunb.) Grolle	Khuzama, Viswema
4	<i>Riccardia platyclada</i> Schiffn.	Khuzama
5	<i>Wiesnerella denudata</i> Inuoe	Khonoma
6	<i>Lejeunea obscura</i> Mitt.	Khuzama
7	<i>Porella caespitans</i> (Steph.) S. Hatt.	Khonoma
8	<i>Heteroscyphus orbiculatus</i> A. Srivast. & S.C. Srivast.	Mokokchung
9	<i>Heteroscyphus parvus</i> A. Srivast. & S.C. Srivast.	Changki
10	<i>Frullania physanta</i> Mitt.	Khonoma
11	<i>Riccia heubeneriana</i> Lindenb.	Kohima
12	<i>Lophozia setosa</i> (Mitt.) Steph.	Khonoma
13.	<i>Herbertus aduncus</i> (Dicks) Gray	Khuzama
14	<i>Notoscyphus darjelingensis</i> Udar & A. Kumar	Changki

Fig.-2. Showing the distribution of taxa in district wise.

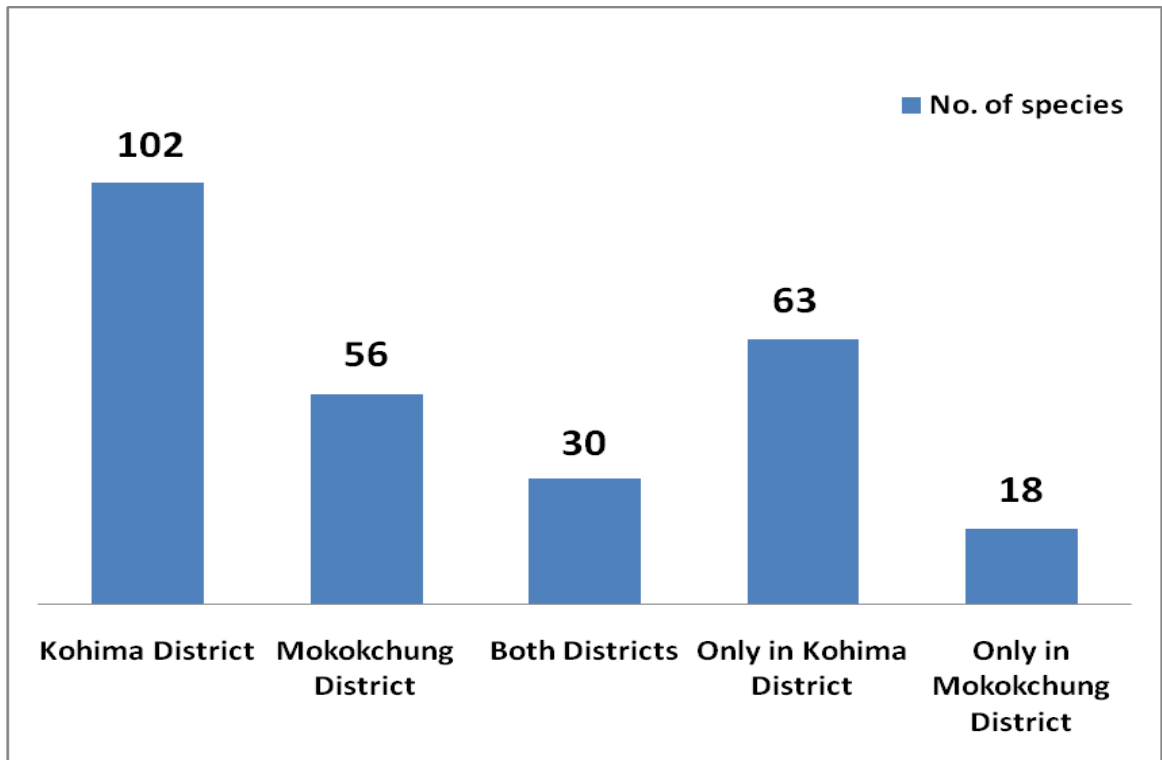


Fig. – 3. Showing the distribution of taxa in district wise.

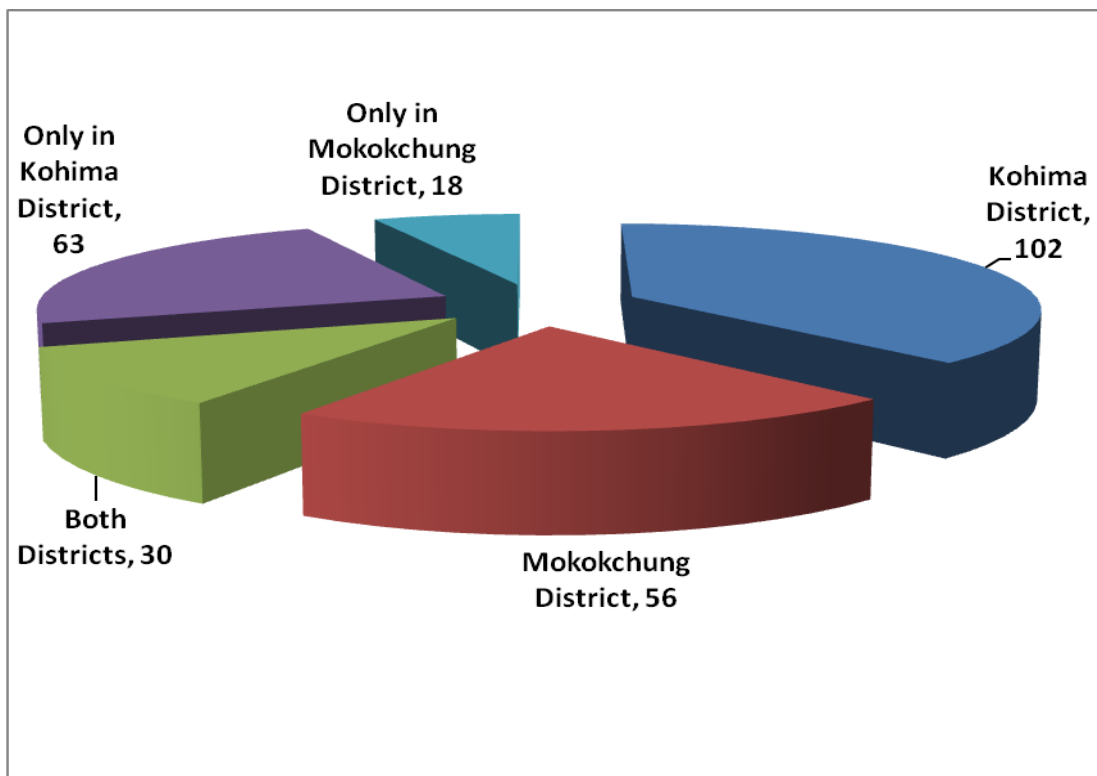


Fig. – 4. Showing the habitats distribution of liverworts and hornworts taxa in Kohima district, Nagaland.

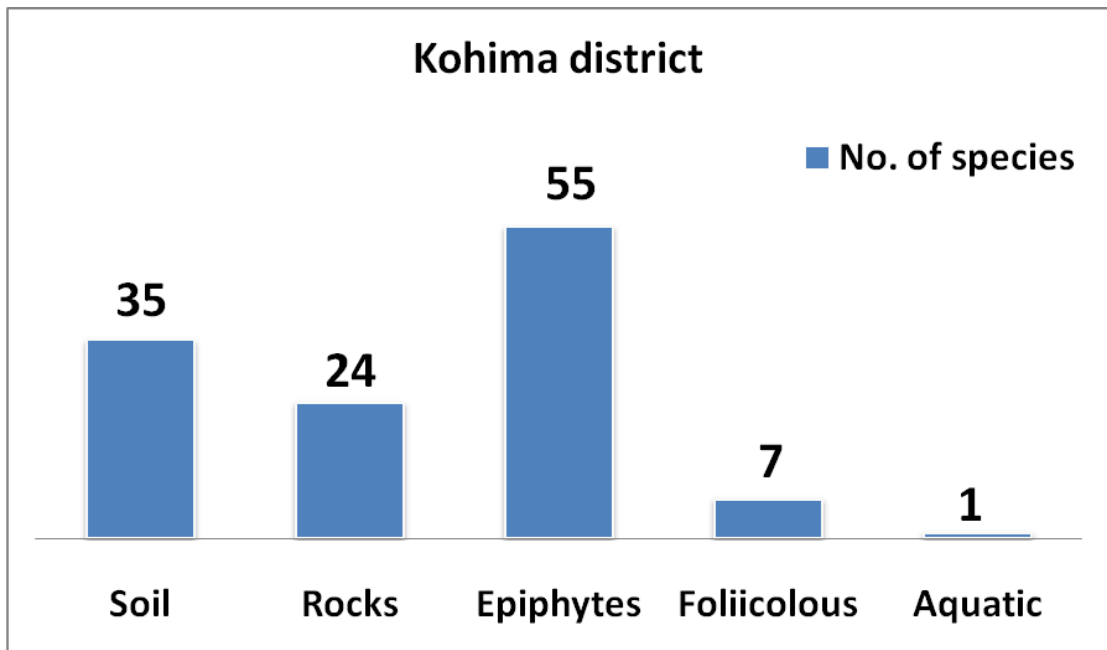


Fig. – 5. Showing the habitats distribution of liverworts and hornworts taxa in Mokokchung district, Nagaland.

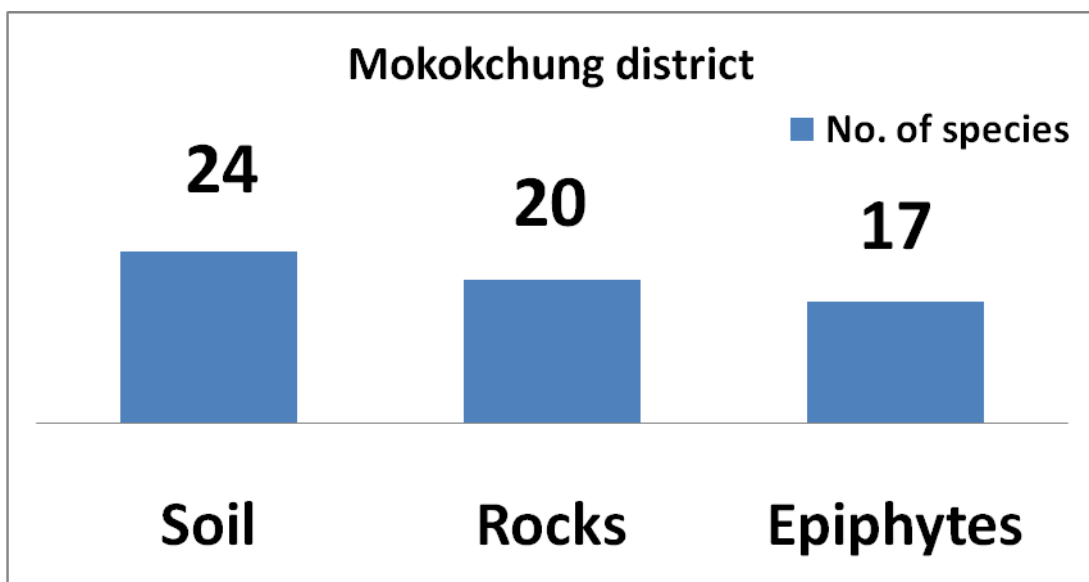


Fig. - 6. Showing the distribution of Thalloid Liverworts, Leafy Liverworts and Hornworts in Kohima district, Nagaland.

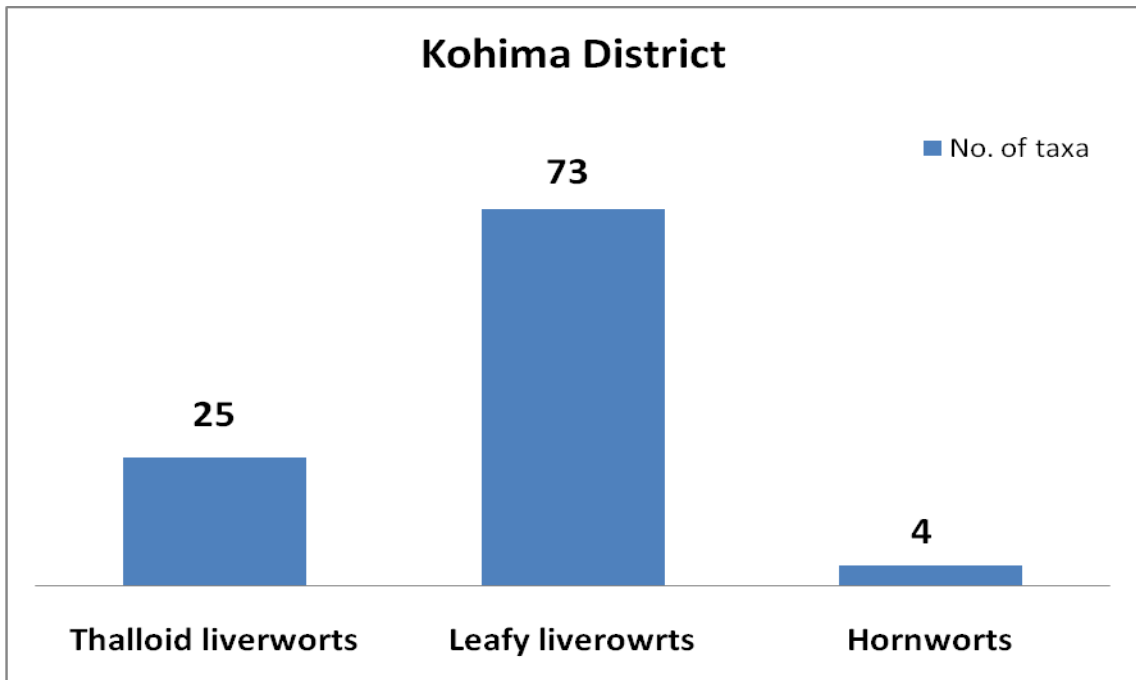


Fig. 7. Showing the distribution of Thalloid Liverworts, Leafy Liverworts and Hornworts in Mokokchung District, Nagaland.

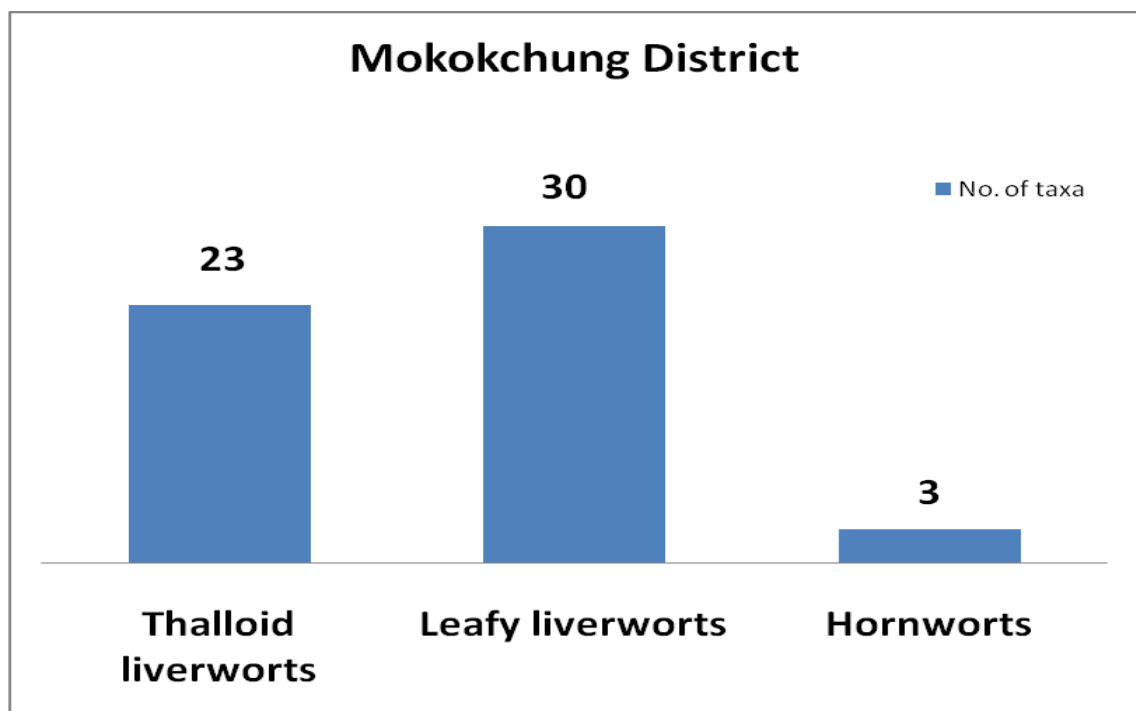


Photo Plate I.



Figures 1-6. Showing collection sites.

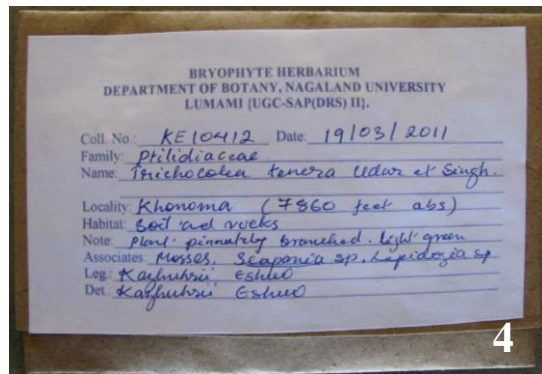
1. Viswema; 2. Viswema & Jakhama border; 3-4. Changki; 5-6. Japfu Peak.

Photo Plate II.



Figures 7-9. Showing Collection sites at Khonma

Photo Plate III.



Figures 1-4. Showing methods of preservation of specimens.

Figs. 1. Preservation of specimen in 70% alcohol solution with 20% glycerine; 2. Preservation of packets in brown paper; 3. Temporary preservation in zip polythene bags; 4. Sample of complete packet.

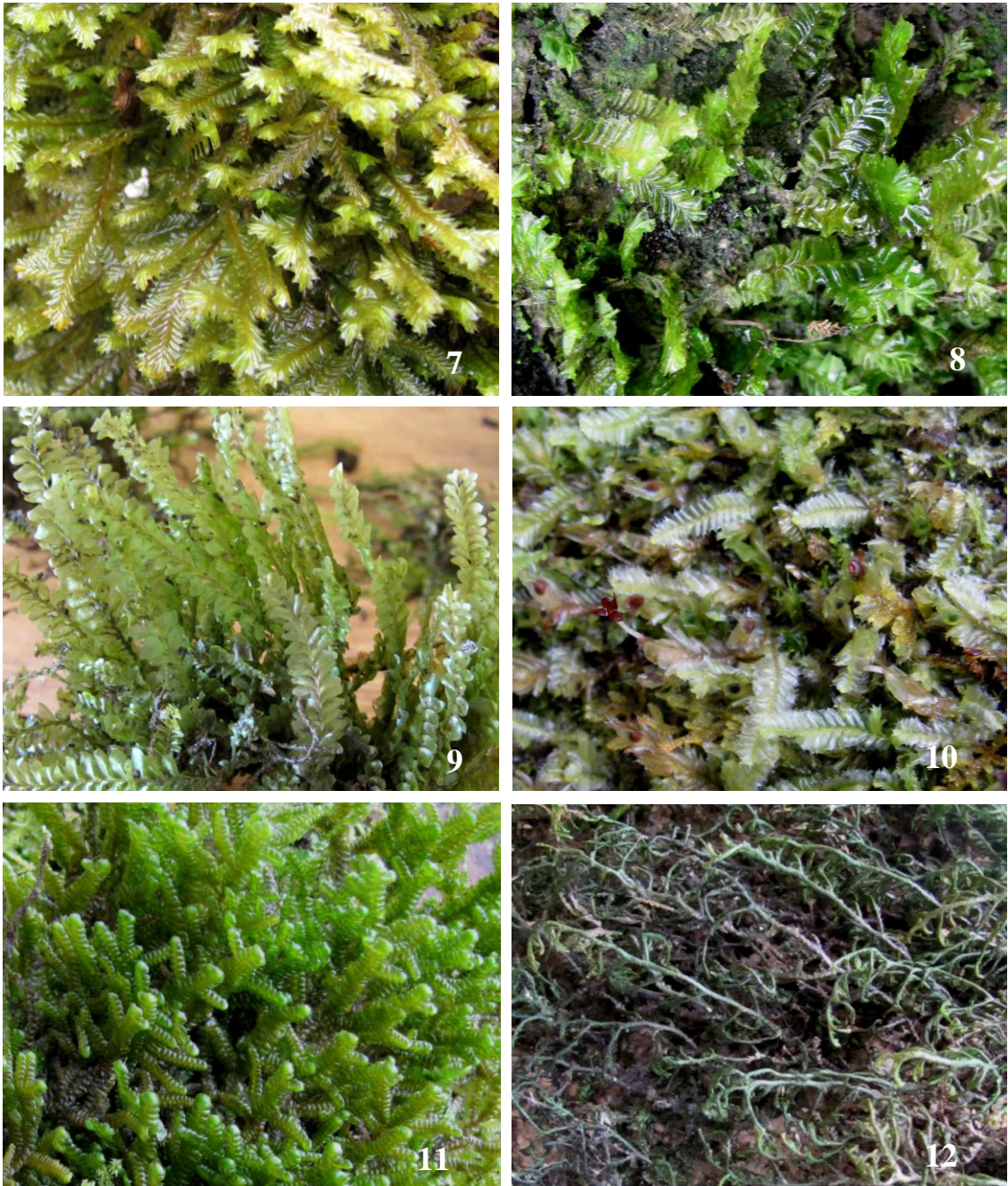
COLOUR PHOTO PLATES

Photo Plate IV.



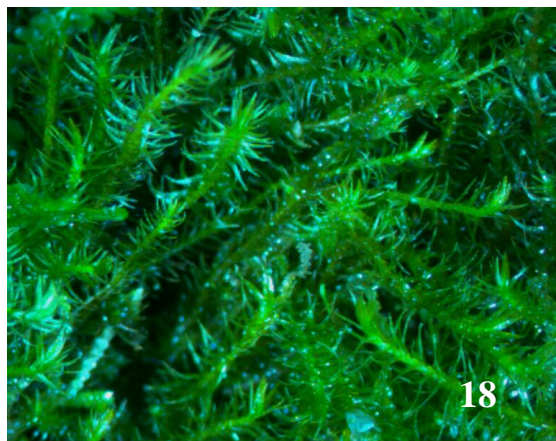
Figs. 1. *Lejeunea flava* (Sw.) Nees; 2. *Lejeunea tuberculosa* Steph.; 3. *Trocholejeunea sandvicensis* (Gottsche) Mizut.; 4. *Lophozia setosa* (Mitt.) Steph.; 5. *Frullania arecae* (Spreng.) Gottsche; 6. *Scapania parva* Steph.

Photo Plate V.



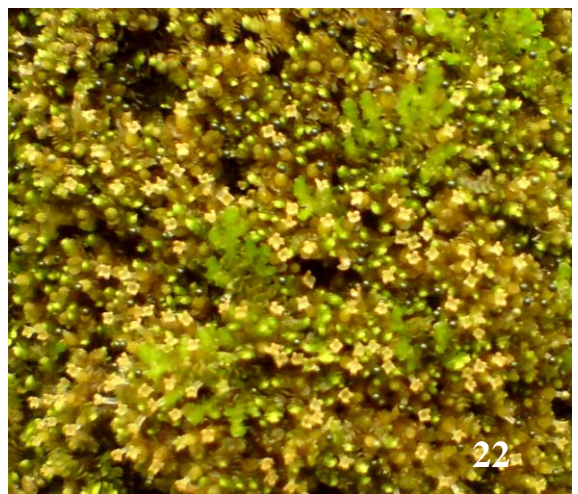
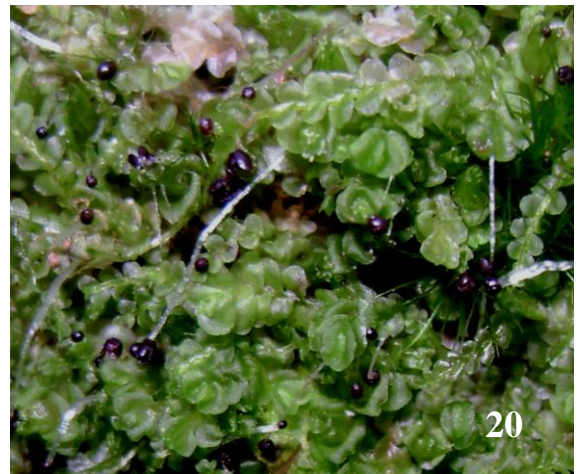
Figs. 7. *Plagiochila nepalensis* Lindenb.; 8. *P. parvifolia* Lindenb.; 9. *P. elagens* Mitt.; 10. *Lophocolea bidentata* (L.) Dumort.; 11. *Porella obtusata* var. *macroloba* (Steph.) S. Hatt. & Zhang; 12. *P. perrottetiana* (Mont.) Trevis.

Photo Plate VI.



13. *Heteroscyphus parva* A. Srivast. & S.C. Srivast.; 14. *H. argutus* (Nees) Schiffn.; 15. *Jungermannia sikkimesis* (Steph.) Vana & D.G. Long; 16. *Bazzania tridens* (Reinw. Blume et Nees) Trevis.; 17. *B. sikkimensis* (Steph.) Herzog.; 18. *Herbertus aduncus* (Dicks) Gray

Photo Plate VII.



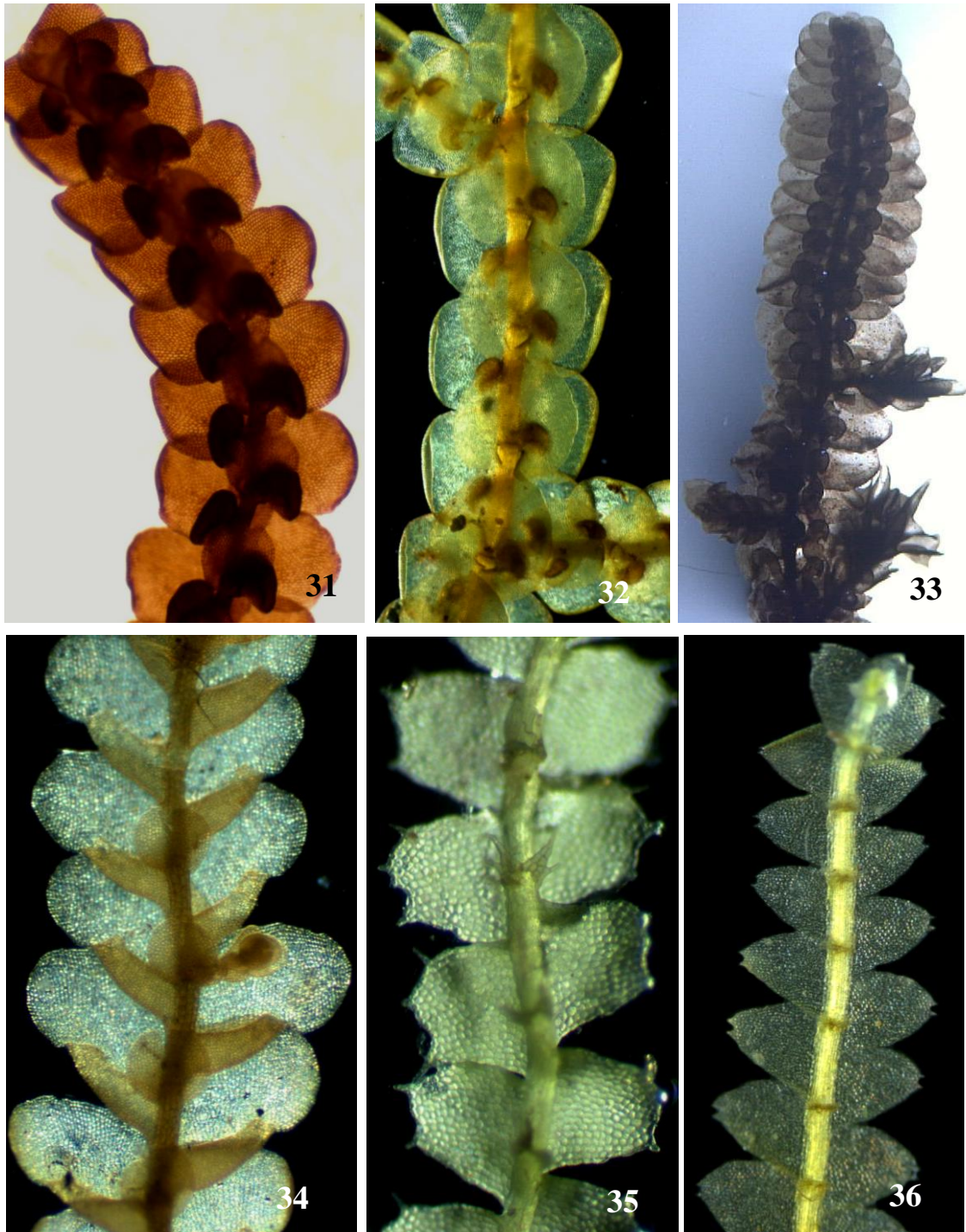
19. *Trichocolea tenera* Udar et Singh; 20. *Solenostoma truncatum* (Nees) R.M. Schust. Ex Vana & D.G. Long; 21. *S. comatum* (Nees) C. Gao; 22. *Frullanoides tristis* (Steph.) Van Slageren; 23. *Chandonanthus hirtellus* (F. Weber) Mitt.; 24. *Ptychanthus striatus* (Lehm. & Lindenb.) Nees

Photo Plate VIII.



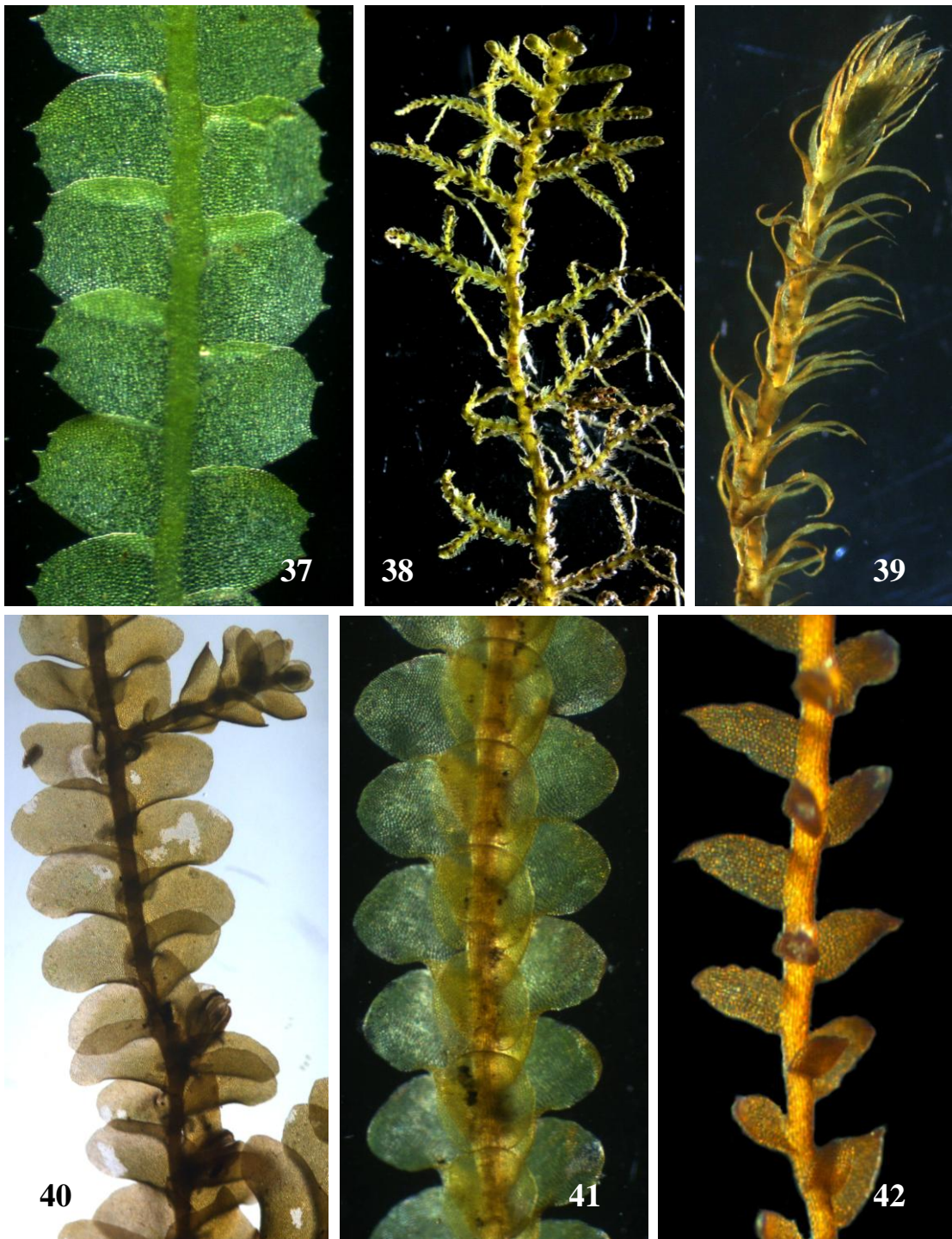
25. *Notoscyphus darjeelingensis* Udar & A. Kumar; 26. *Porella caespitans* (Steph.) S. Hatt.; 27. *P. plumosa* (Mitt.) Inoue; 28. *Lopholejeunea abortiva* (Mitt.) Steph.; 29. *Jubula hutchinsiae* subsp. *javanica* (Steph.) Verd.; 30. *Radula javanica* Gottsche

Photo Plate IX.



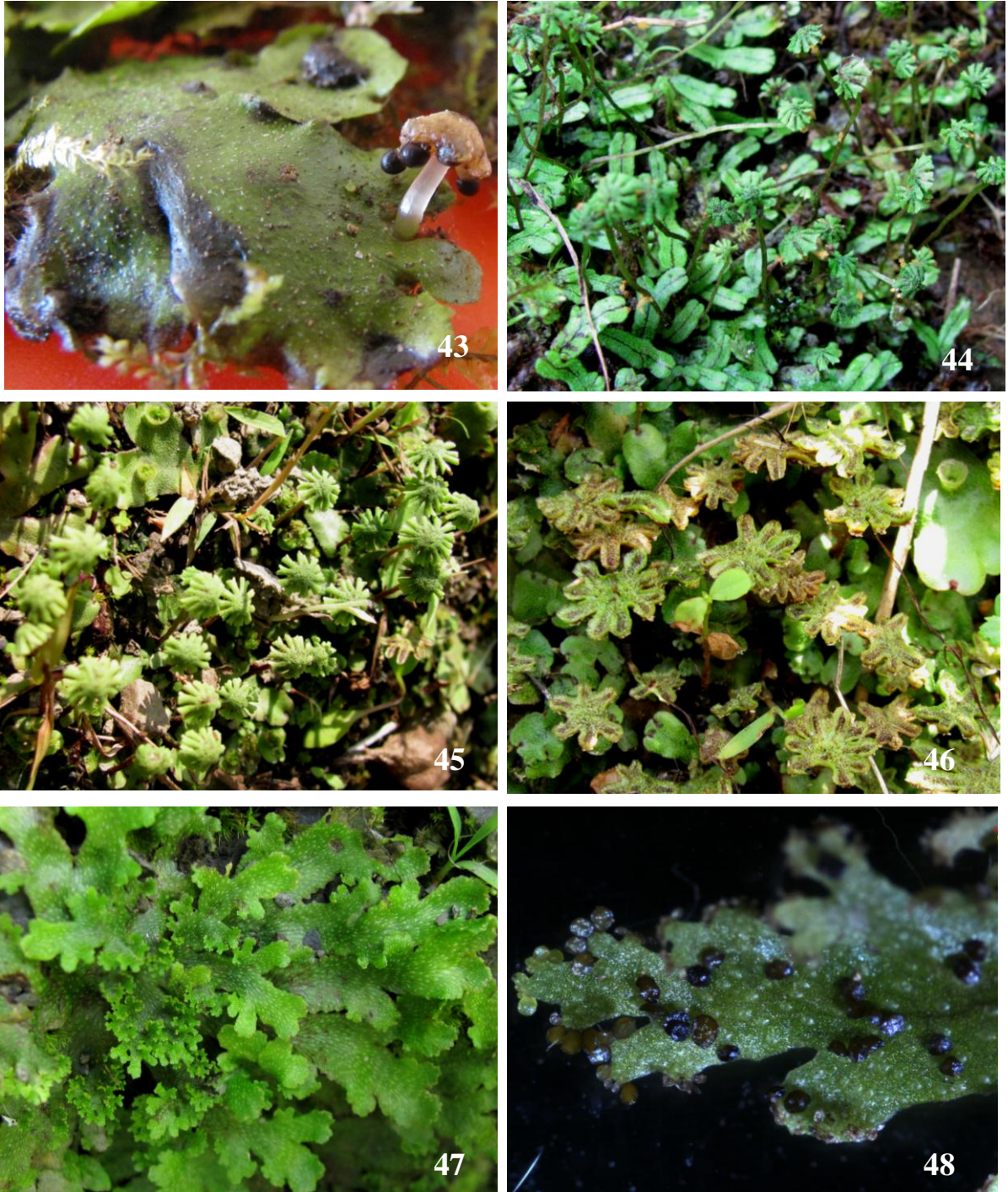
31. *Frullania nepalensis* (Spreng.) Lehm. & Lindenb.; 32. *F. squarrosa* Dumort.; 33. *F. galeata* (Reinw., Nees & Blume) Dumort.; 34. *Cheilolejeunea imbricata* (Nees) S. Hatt.; 35. *Saccogynidium irregularospinum* C.H. Gao, T. Cao & M.J. Lai; 36. *Calypogeia arguta* Nees et Mont.

Photo Plate X.



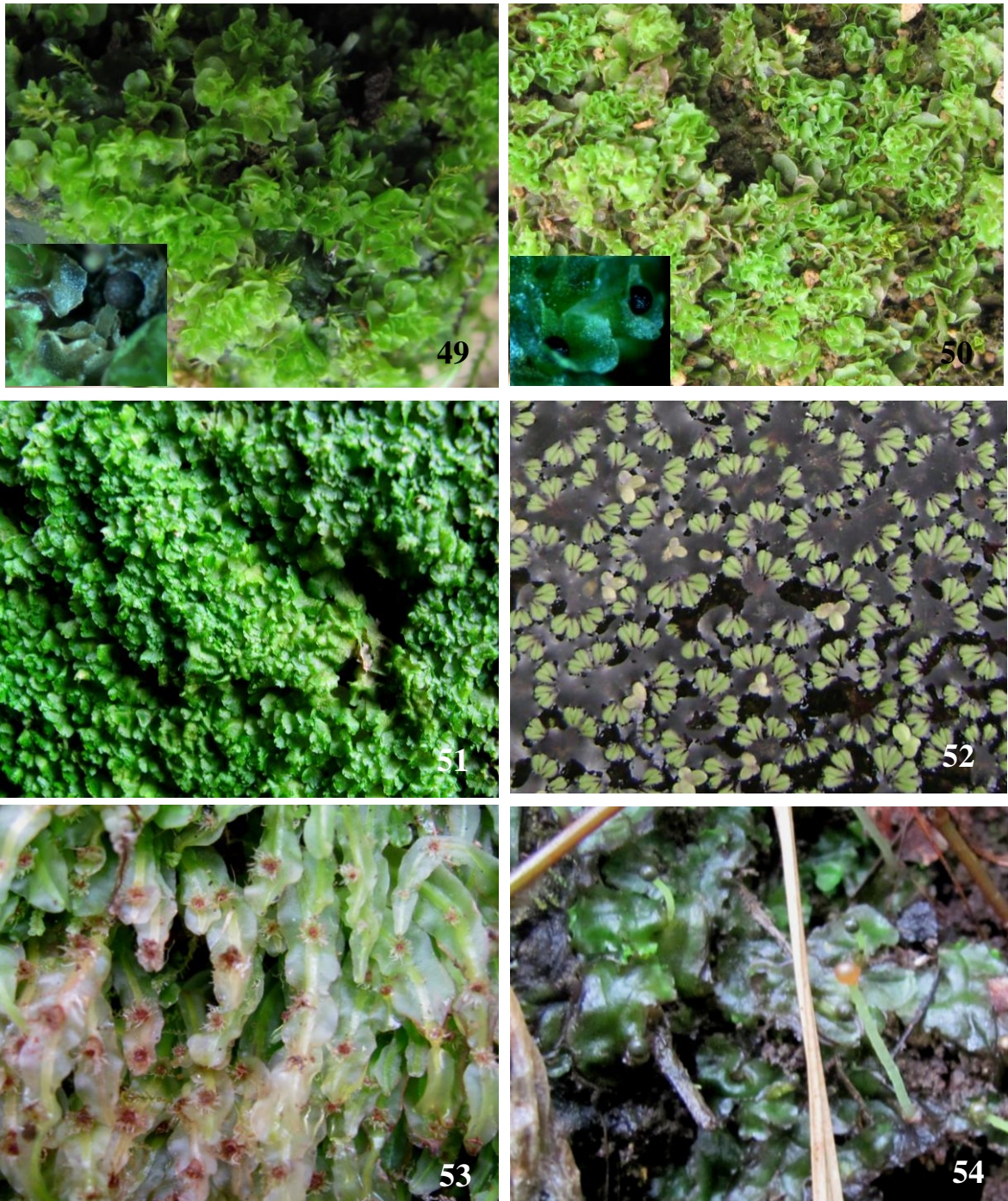
37. *Heteroscyphus orbiculatus* A. Srivast. & S.C. Srivast.; 38. *Lepidozia brevifolia* Mitt.; 39. *Herbertus armitanus* (Steph.) H.A. Mill.; 40. *Tuzibeanthus chinensis* (Steph.) Mizut.; 41. *Trocholejeunea infuscatua* (Mitt.) Verd.; 42. *Bazzania tricrenata* (Wahlenb.) Trevis.

Photo Plate XI.



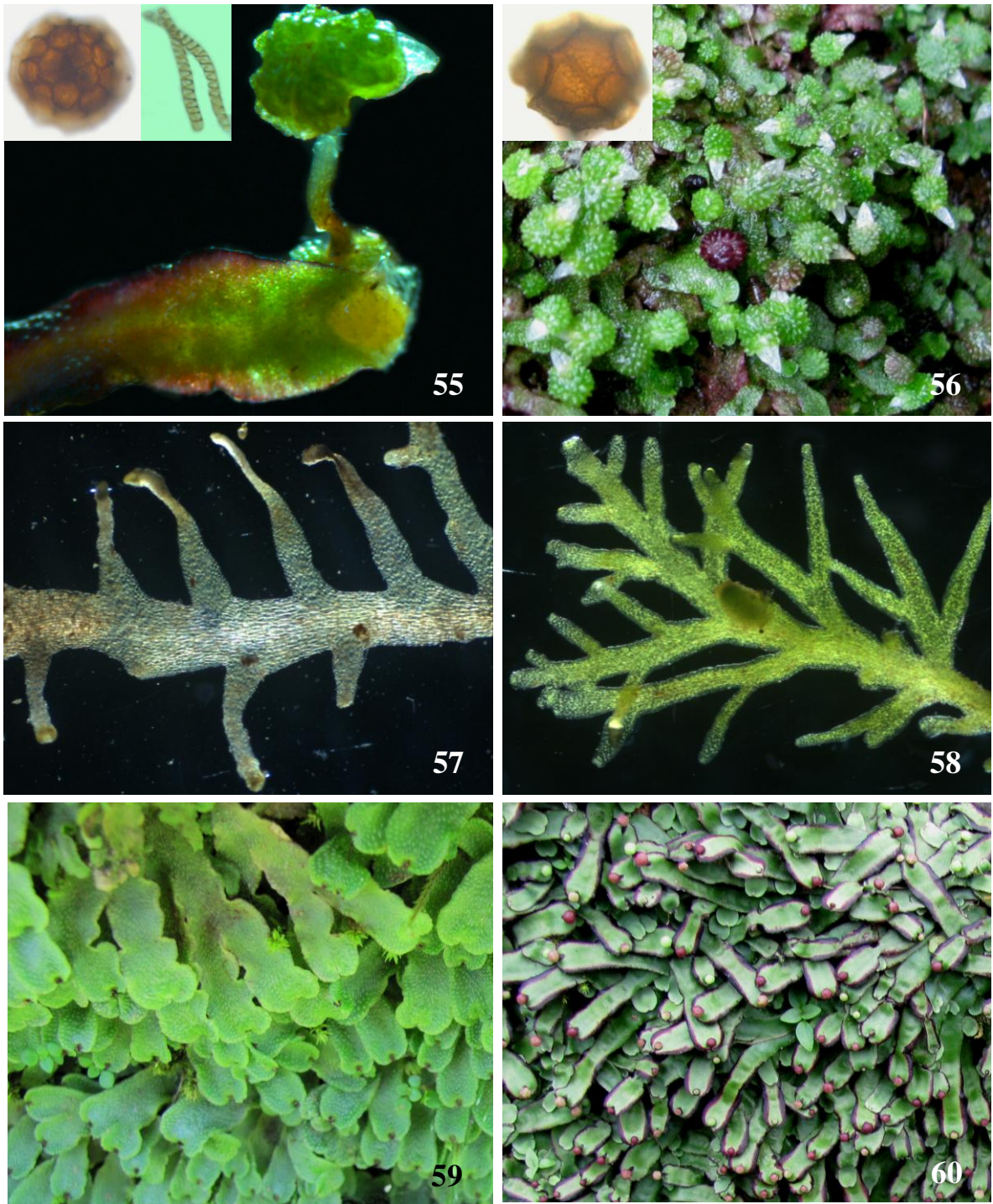
Figs. 43. *Wiesnerella denudata* Inuoe; 44. *Marchantia papiliata* (Steph.) Bischl., 45. *M. paleacea* Bertol. subsp. *paleacea* female plant; 46. *M. paleacea* Bertol. subsp. *paleacea* male plant; 47 & 48. *Conocephalum japonicum* (Thunb.) Grolle.

Photo Plate XII.



Figs. 49. *Fossombronia wondraczekii* (Corda) Dumort.; 50. *F. cristula* Aust., 51. *Cyathodium smaragdinum* Schiffn.; 52. *Ricciocarpos natans* Corda; 53. *Pallavicinia lyellii* (Hook.) Gray; 54. *Pellia endiviifolia* (Dicks.) Dumort.

Photo Plate XIII.



Figs. 55. *Asterella multiflora* (Steph.) Kachroo; 56. *A. khasyana* (Griff.) Pandé, K.P. Srivast. & Sultan Khan.; 57. *Riccardia cardotii* (Steph.) Pande et Srivastava; 58. *R. sikkimensis* (Steph.) Pande et Srivastava; 59. *Targionia hypophylla* L.; 60. *Mannia indica* (Steph.) Kachroo.

Photo Plate XIV.



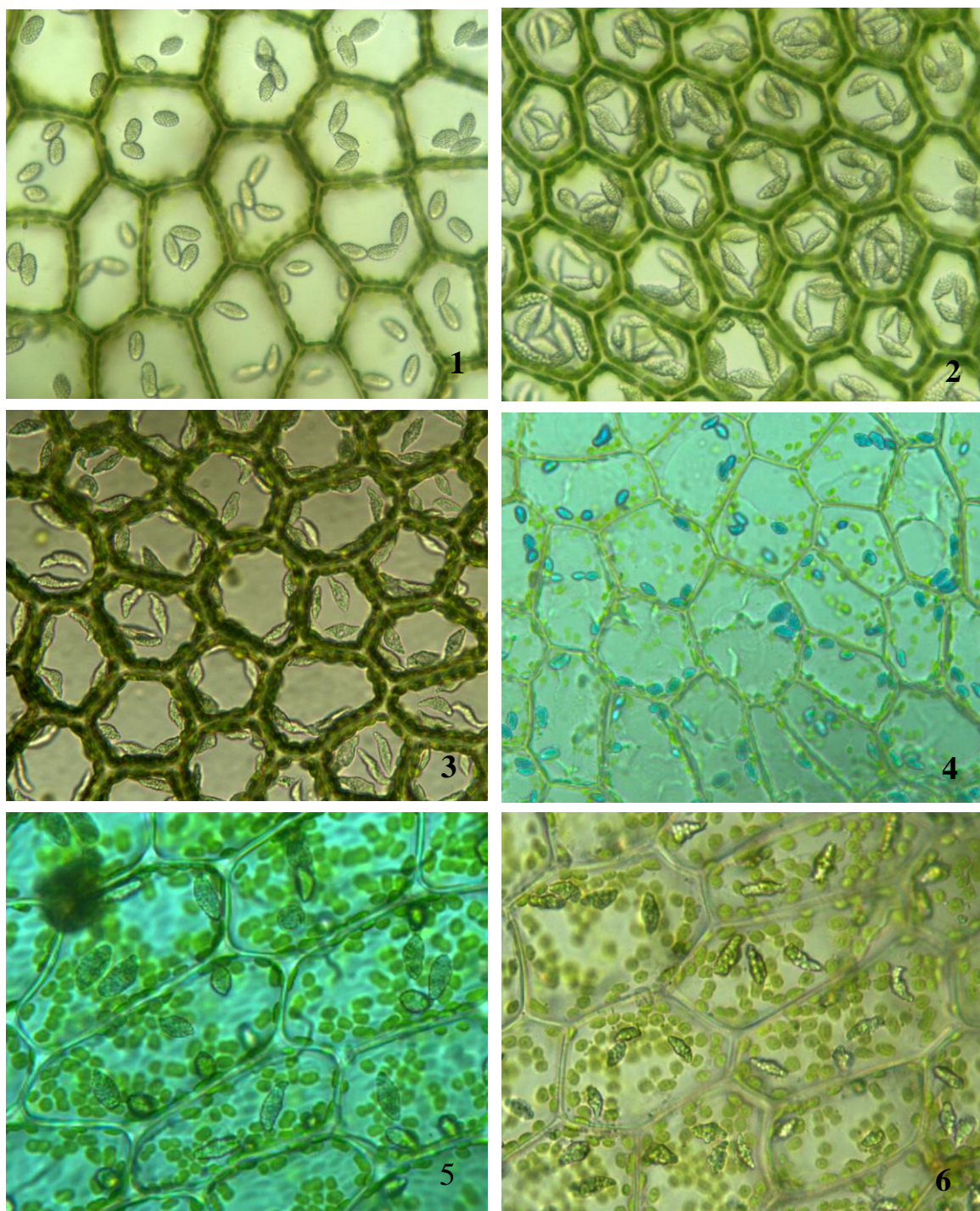
Figs. 61. *Riccia pathankotensis* Kashyap; 62. *R. gangetica* Ahmad.; 63. *R. huebeneriana* Lindenb.; 64. *Dumortiera hirsuta* Reinw. Bl. et Nees; 65. *Conocephalum conicum* (L.) Dumort.; 66. *Plagiochasma appendiculatum* Lehm. & Lindenb.

Photo Plate XV.



Figs. 67. *Phaeoceros laevis* L. Prosk.; 68. *Folioceros paliformis* D.K. Singh

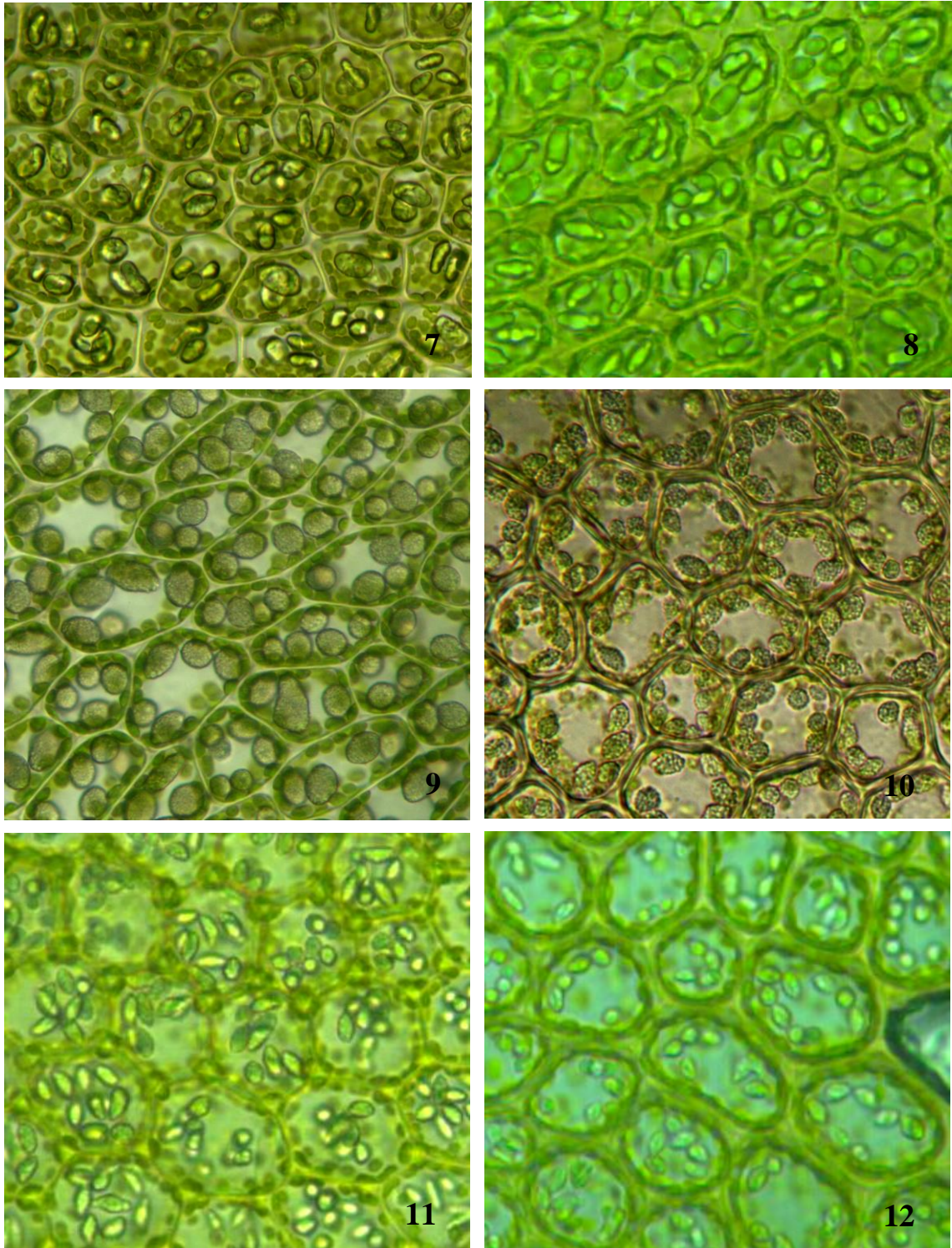
Photo Plate XVI.



Figs. 1 – 6. Oil bodies.

1. *Heteroscyphus beschellei* (St.) Hatt.; **2.** *Heteroscyphus argutus* (Reinw., Blume et Nees.) Schiffn.; **3.** *Heteroscyphus orbiculatus* Srivast. et Srivast.; **4.** *Calypogeia azurea* Stotler et Crotz.; **5.** *Jungermannia truncata* **6.** *Calypogeia arguta* Nees et Mont.

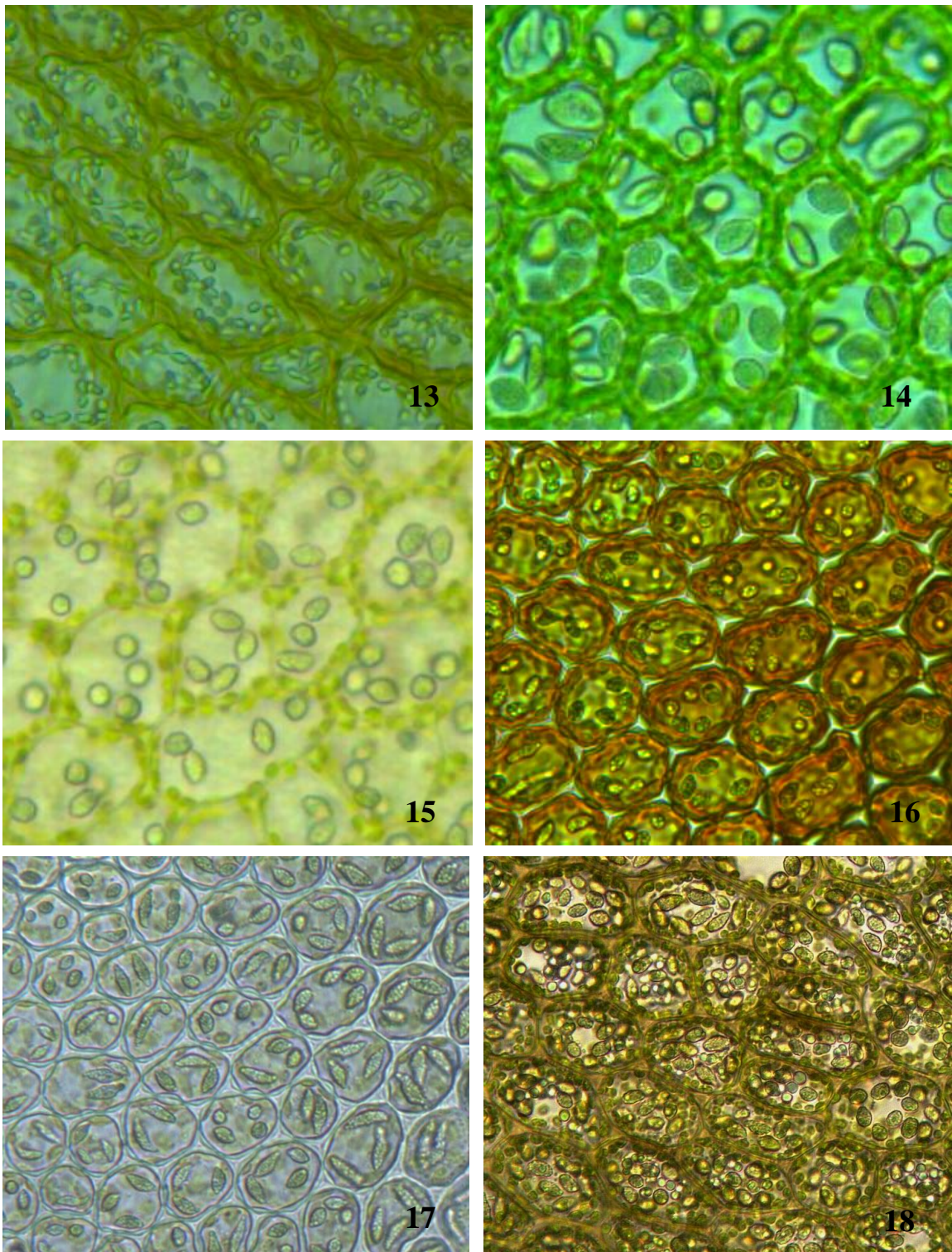
Photo Plate XVII.



Figs. 7 – 12. Oil bodies.

7. *Bazzania tridens* (Reinw. Blume *et* Nees) Trevis.; 8 *Bazzania praerupta* (Reinw., Blume *et* Nees) Trev. ; 9. *Notsoscyhus darjeelingsis* Udar & A. kumar 10. *Plagiochila defolians* Grolle *et* M. L. So; 11. *Plagiochila hattorii* Inuo; 12 *Plagiochila nepalensis* Lindenb.

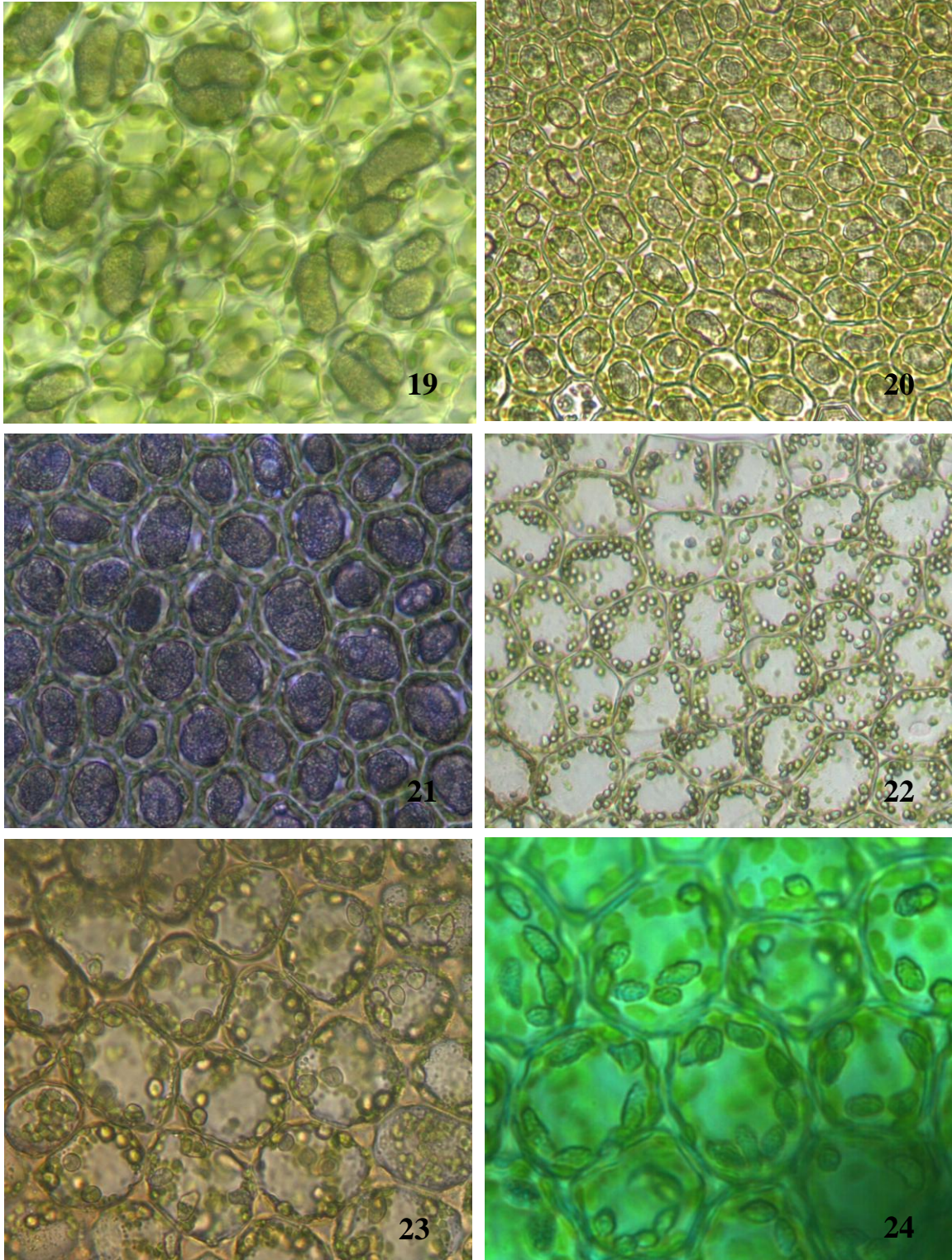
Photo Plate XVIII.



Figs. 13 – 18. Oil Bodies.

13. *Trcholejeunea sandvicensis* (Gottsche) Mizut. 14. *Scapania ferrugenia* (Lehm. et Lindenb.) Gottsche, Lindenb. et Nees 15. *Lophocolea heterophylla* (Schrad.) Dumort. 16. *Frullania ericoides* (Nees) Mont. 17. *Lejeunea tuberculosa* Steph. 18. *Jubula hutchinsiae* subsp. *javanica* (Steph.) Verd.

Photo Plate XIX.



Figs. 19 - 24. Oil bodies.

19. *Sololenostoma comatum* (Nees) C. Gao; 20. *Radula obscura* Mitt. 21. *R. javanica* Gottsche 22. *Lophozia setosa* Mitt.; 23. *Metacalypogeia alternifolia* (Nees) Grolle 24. *Frullania arcae* Mitt.