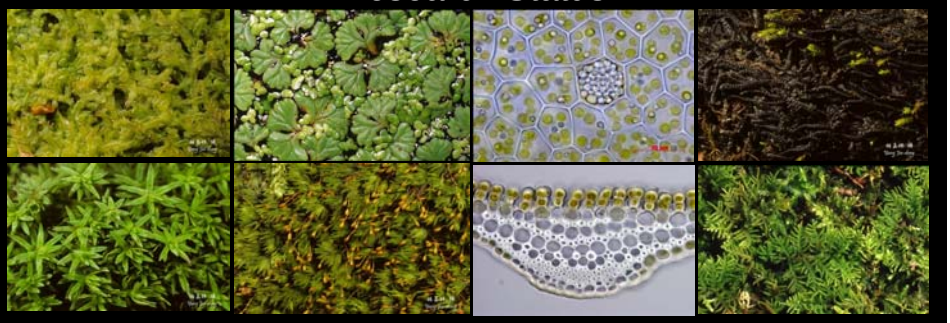
Bryophytes Diversity of Taiwan and Research Status



Jia-Dong Yang
Endemic Species Research Institute,
Council of Agriculture

特有生物研究保育中心

成立於1992年7月1日

為推動生物多樣性保育、調查、研究及教育之政府研究單位

自我介紹

楊嘉棟

＊80年高考二級林業技術科
＊行政院農業委員會
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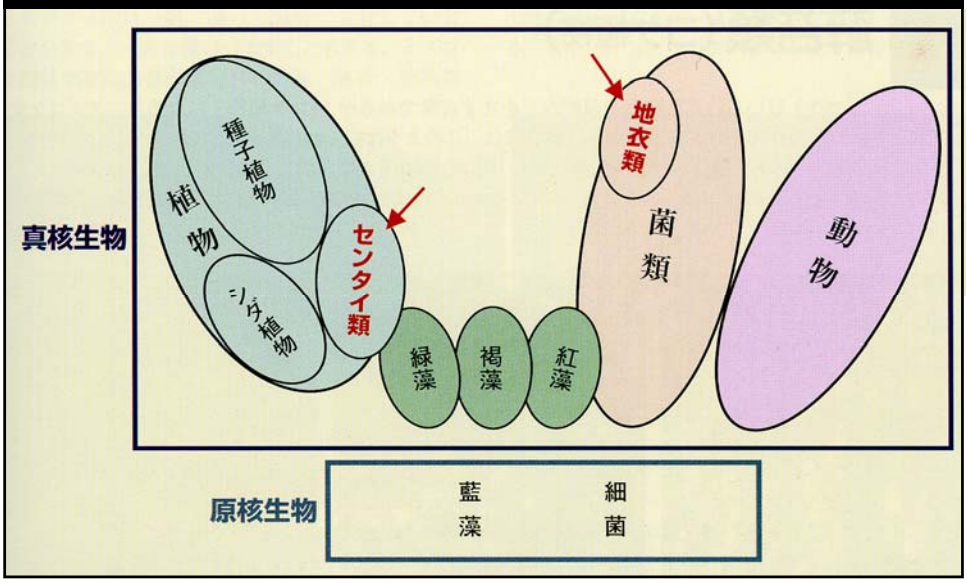
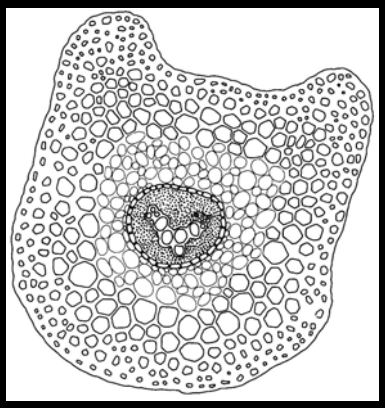
2025/7/29

何謂苔蘚

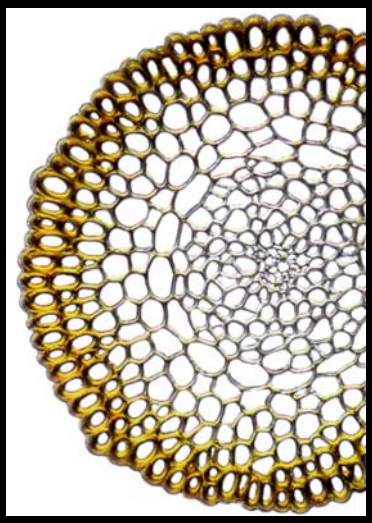


何謂苔蘚

- 無維管束



蕨類莖橫切

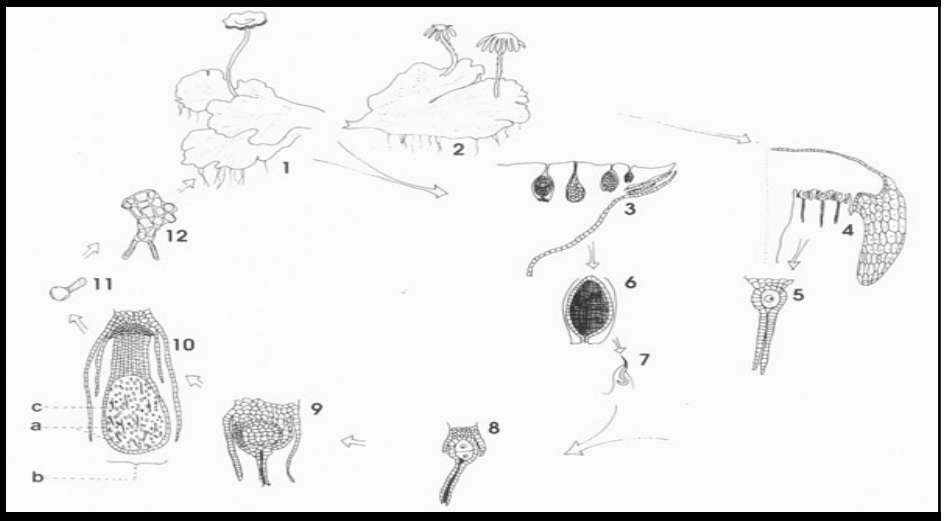


苔類莖橫切

5

何謂苔蘚

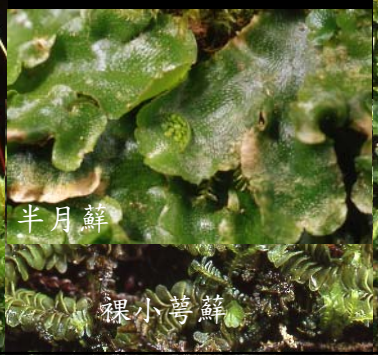
- 配子體世代較為顯著



6

- 苔蘚植物包括苔類(mosses), 蘚類(liverworts)和角蘚類(hornworts)


細葉真苔

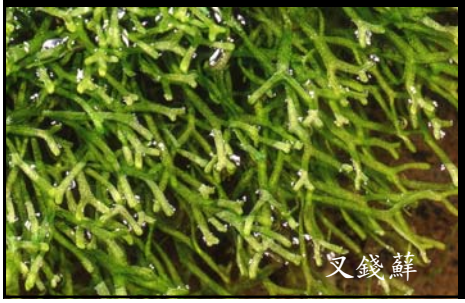

半月蘚

裸小葶蘚

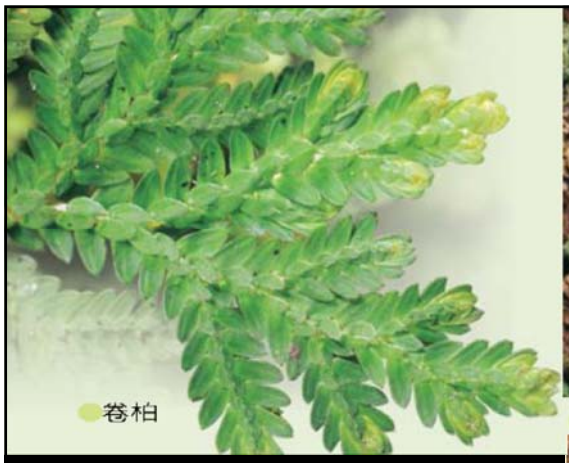

葉角蘚

- 全世界約有159科859屬12, 800種的苔類, 69科370屬8, 029種的蘚類和3科9屬390種的角蘚類

(Crosby *et al.*, 2000; Yano and Gradstein, 1997; Schofield, 1985)


叉錢蘚


浮蘚



長得很像卻不一樣!!
自然界中還有許多長得很像苔蘚卻不是苔蘚的生物，例如藻類、地衣及蕨類的卷柏等，都常被誤認為是苔蘚。

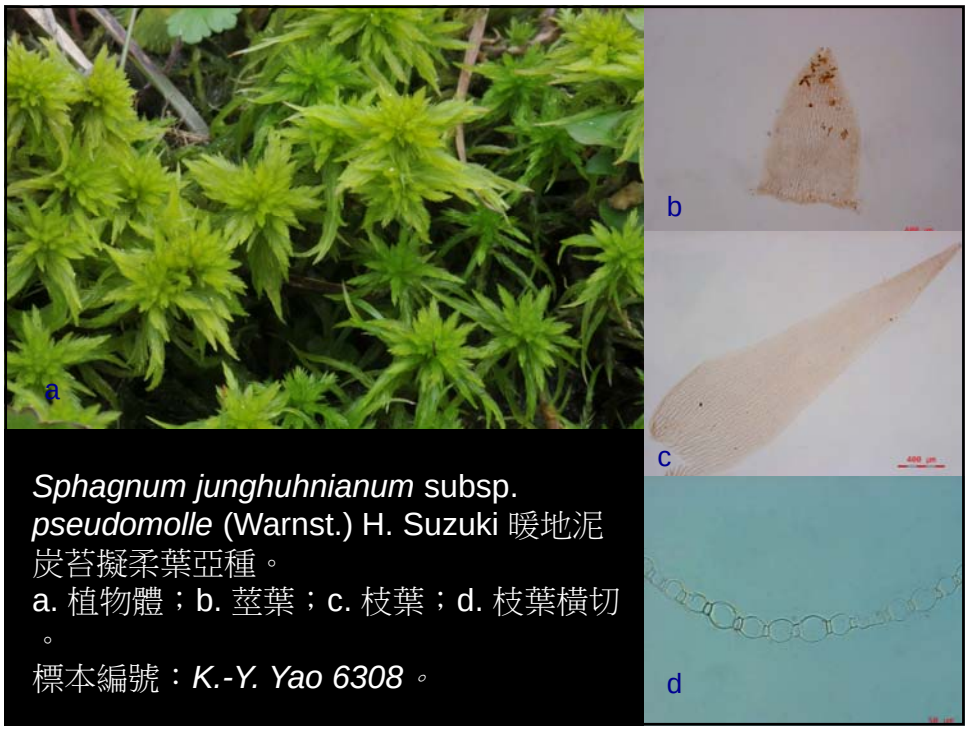
苔蘚家族解析

- 苔類為莖葉體，可區分為直立和匍匐生長兩大類型，葉片通常無側葉、腹葉之分且不開裂為裂片狀，常具有1或2條中肋。
- 蘚類則有莖葉體和片狀體兩種形態，莖葉體蘚類葉片通常有側葉、腹葉之分且開裂為裂片狀，不具中肋；片狀體蘚類又可區分為簡單型和複雜型兩大類，複雜型片狀體蘚類其組織分化，表面通常具有氣孔，內部具有氣室和同化絲；相對而言，簡單型片狀體蘚類其組織未分化，植物體通常略呈半透明狀。
- 角蘚類皆為片狀體，通常呈半透明而略帶果凍般的質感，彷若藻類，而其角狀的孢子體為其最明顯的特徵。
- 只有蘚類的細胞中具有油體，含有許多萜類化合物，故揉捏一小段蘚類植物體，常可聞到一股略帶刺激性的揮發氣味。

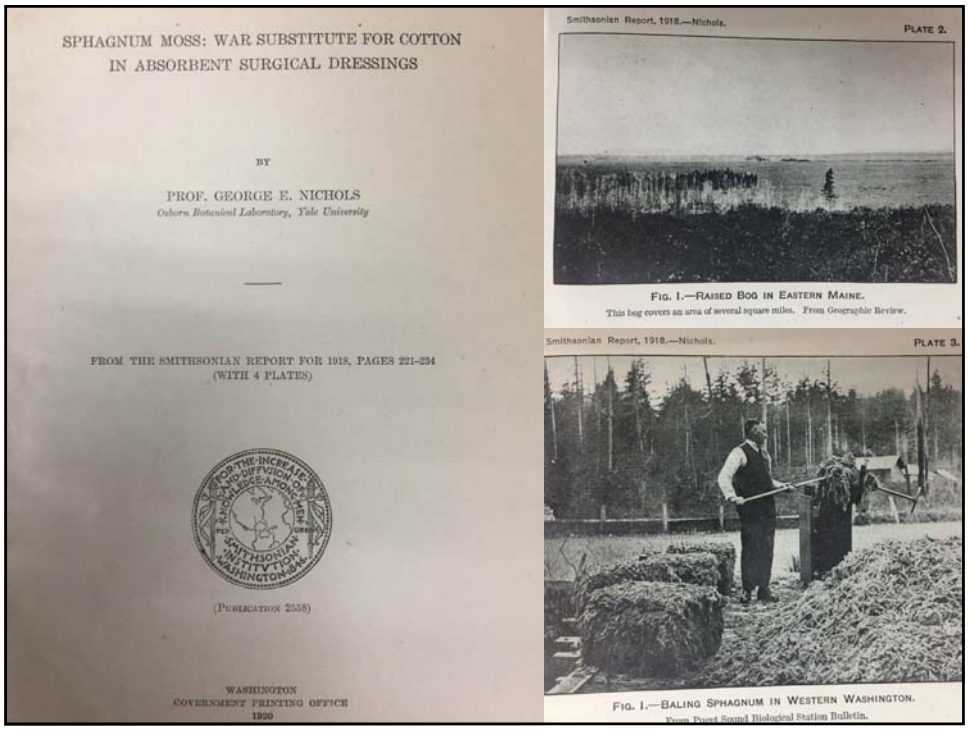
10

mosses
苔　　類

Sphagnum junghuhnianum
暖地泥炭苔



Sphagnum junghuhnianum subsp. *pseudomolle* (Warnst.) H. Suzuki 暖地泥炭苔擬柔葉亞種。
a. 植物體；b. 莖葉；c. 枝葉；d. 枝葉橫切。
標本編號：*K.-Y. Yao 6308*。



SPHAGNUM MOSS: WAR SUBSTITUTE FOR COTTON IN ABSORBENT SURGICAL DRESSINGS

BY

PROF. GEORGE E. NICHOLS
Osborn Botanical Laboratory, Yale University

FROM THE SMITHSONIAN REPORT FOR 1918, PAGES 221-234
(WITH 4 PLATES)

(PUBLICATION 2558)

WASHINGTON
GOVERNMENT PRINTING OFFICE
1920

Smithsonian Report, 1918.—Nichols. PLATE 2.

FIG. 1.—RAISED BOG IN EASTERN MAINE.
This bog covers an area of several square miles. From Geographic Review.

Smithsonian Report, 1918.—Nichols. PLATE 3.

FIG. 1.—BALING SPHAGNUM IN WESTERN WASHINGTON.
From Puget Sound Biological Station Bulletin.

FIG. 2.—PICKING OVER SPHAGNUM AT MCGILL UNIVERSITY, MONTREA
From Journal of the New York Botanical Garden.

PLATE 45
A class of University of Washington women working on the first 50,000 sphagnum pads.

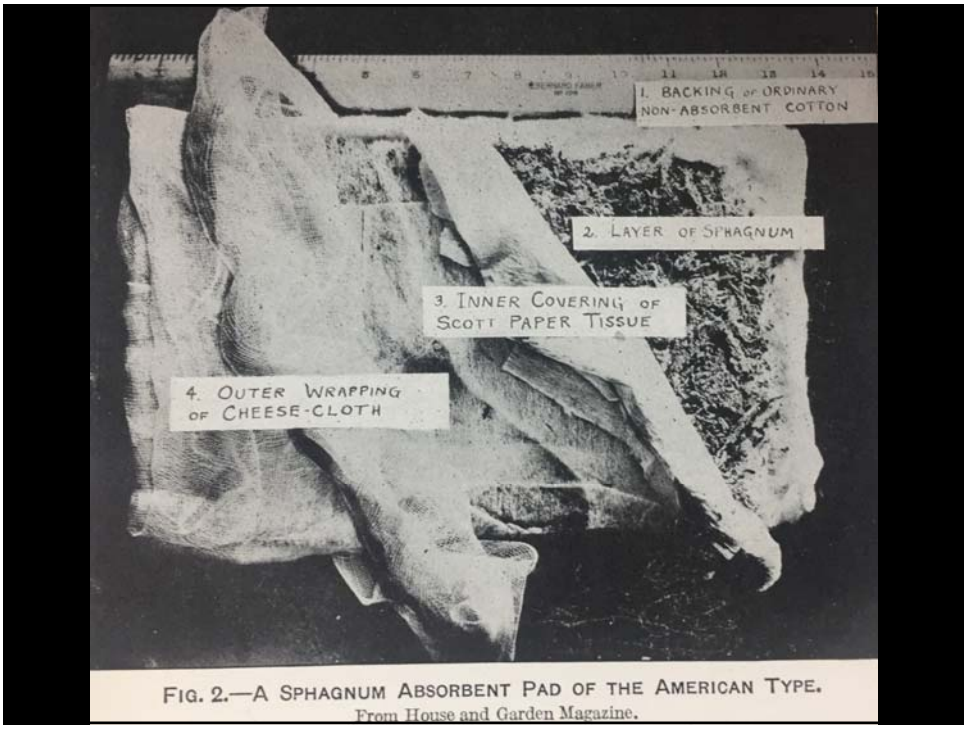
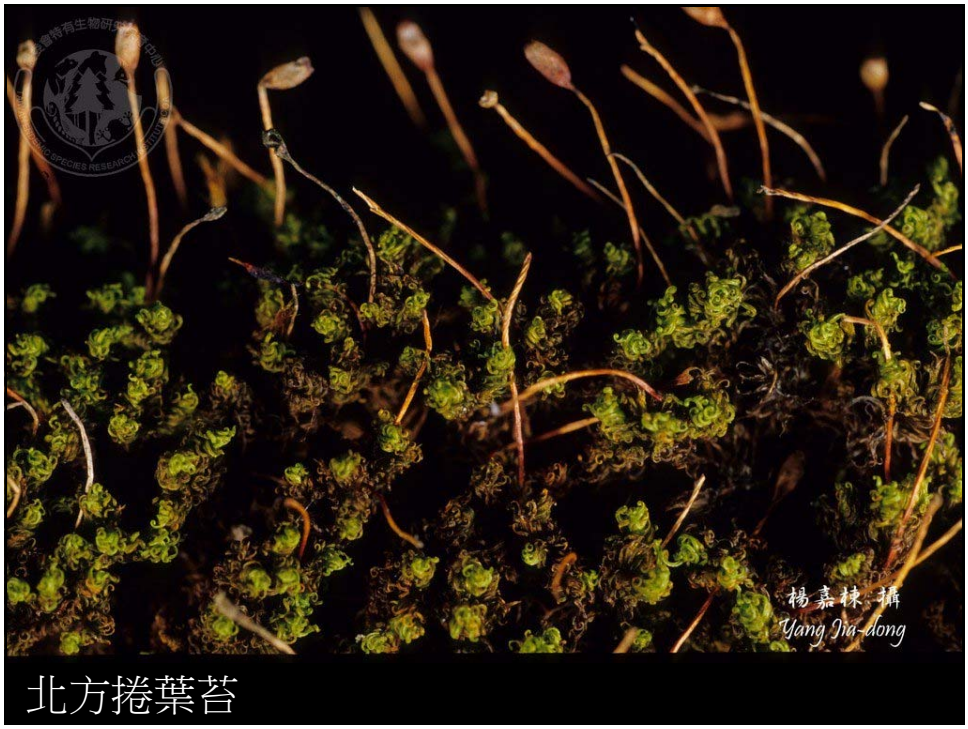


FIG. 2.—A SPHAGNUM ABSORBENT PAD OF THE AMERICAN TYPE.
From House and Garden Magazine.

尼斯小金髮苔

Pogonatum neesii

銀葉真苔 *Bryum argenteum*



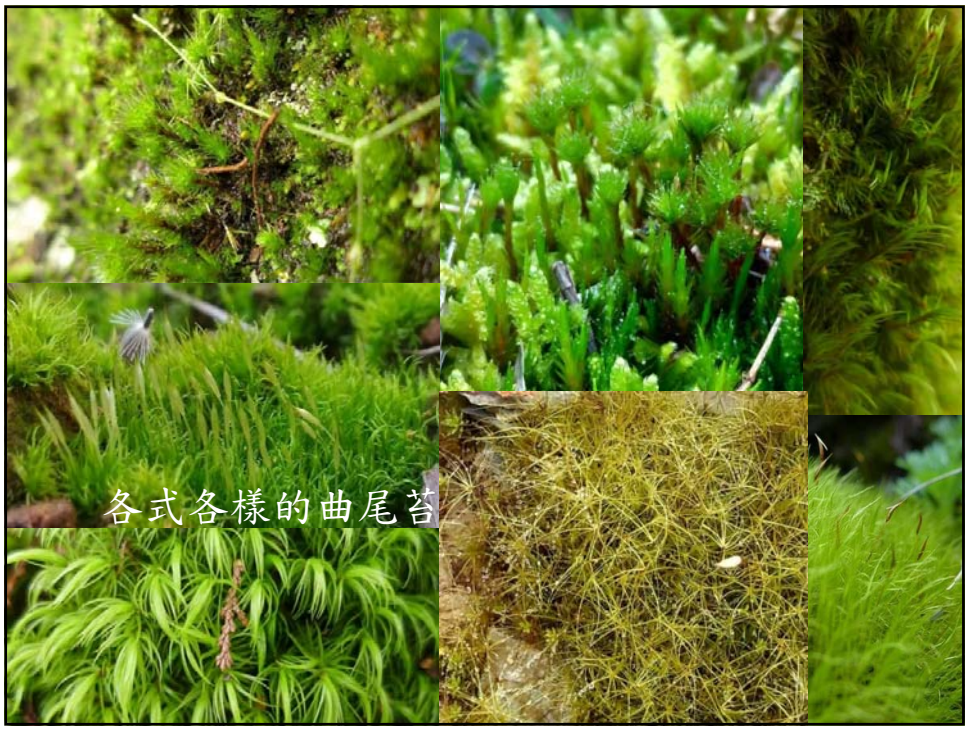
北方捲葉苔

Fissidens mangarevensis 曲肋鳳尾苔

黃鳳尾苔*Fissidens ziggelianus*

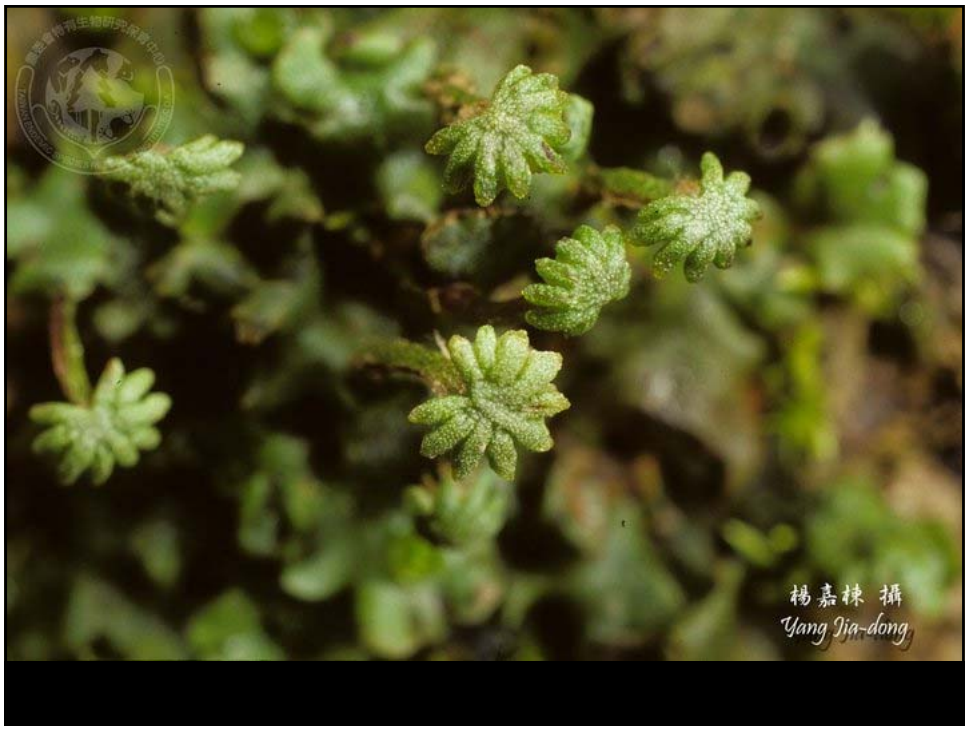
菲律賓粗枝苔

鱗葉苔

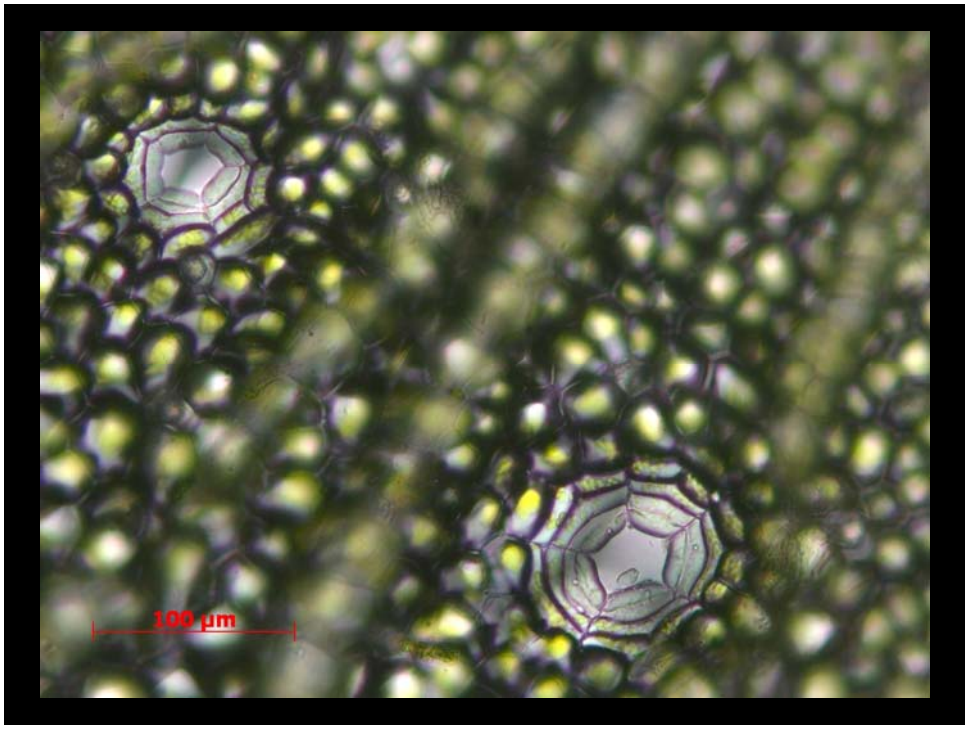


liverworts
蘚　　類

地錢*Marchantia polymorpha*



蛇蘚*Conocephalum conicum*



毛地錢*Dumertiera hirsuta*

叉蘚 *Metzgeria* sp.

帶葉蘚 *Pallavicinia ambigua*

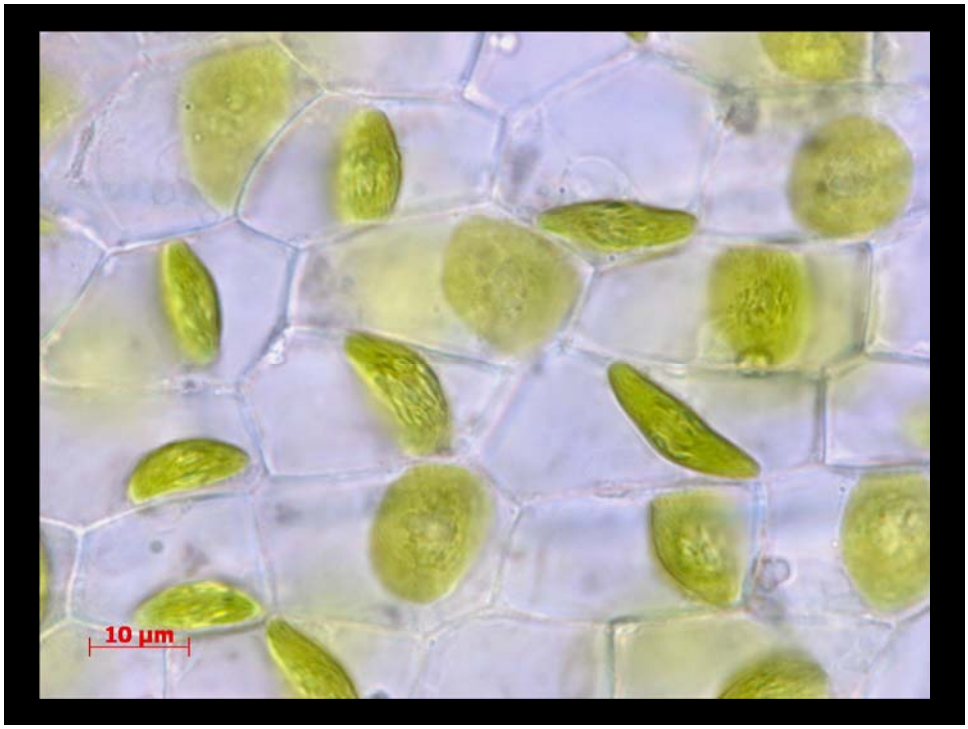
燭台蘚 *Haplomitrium mnioides*

三裂鞭蕨 *Bazzania tridens*

四齒異萼蘚 *Heteroscyphus argutus*

瓦氏指葉蘚 *Lepidozia wallichiana*

hornworts
角蘚類


10 µm

臺灣苔蘚植物的多樣性

- 臺灣約有66科261屬872種的苔類, 52科117屬515種的蘚類和 3 科 6屬19種的角蘚類

(Chiang *et al*., 2001；Higuchi and Lin, 2004; Lin, 2000,Wang *et al*., 2010)

表一 臺灣地區苔蘚種數與其他地區之比較

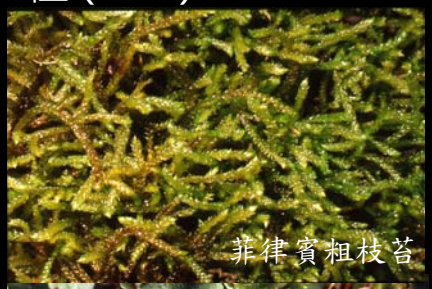
	面積 (×1, 000 ㎢)	屬	種
臺灣	36	384	1,406
中國	9,556	564	3,460
日本	377	466	1,882
北美	19,780	330	1,900
英國	314	300	1,059

(曹同等, 2000; BFNA*, 2008; Chaing *et al.,* 2001; Higuchi and Lin, 2004; Iwatsuki, 2004; Lin, 2000a; Paton, 1999; Piippo,1990; Redfearn *et al.*, 1996; Smith, 2006; Yamada and Iwatsuki, 2006)

臺灣苔蘚的地理親緣關係

- 1. 東亞區系: 約 475 種 (35%)


三裂鞭蘚


菲律賓粗枝苔

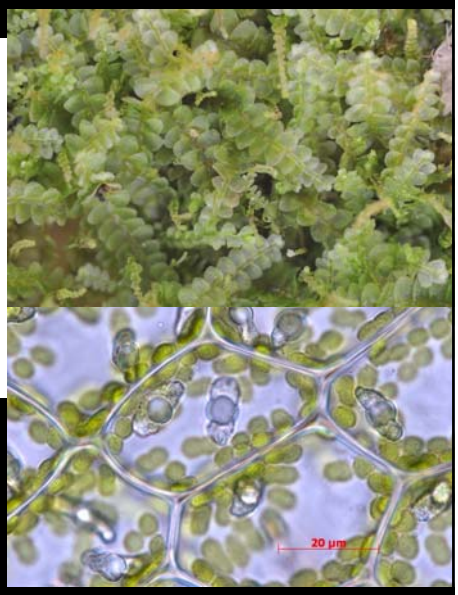

淺刻地錢


毛邊光萼蘚


小蛇蘚


灰羽苔

Calypogeia japonica
Stephani
日本護蒴蘚



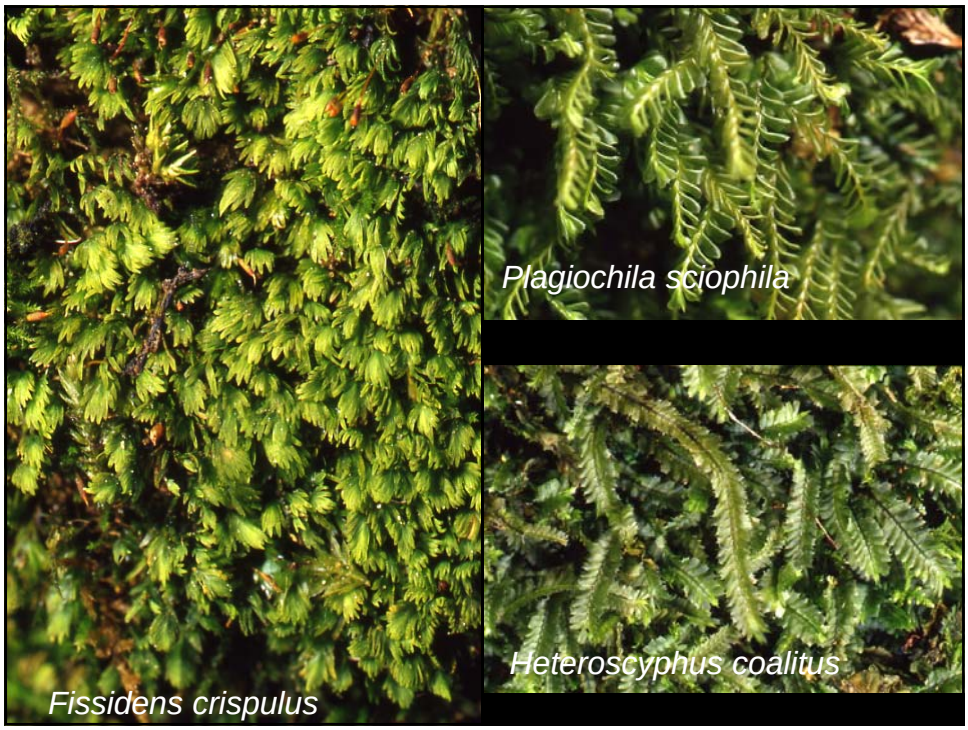
Phytogeographical Elements in Taiwan

- 2. Palaeotropical: about 326 taxa (24%)

Philonotis thwatesii

Lepidozia wallichiana

Pogonatum neesii



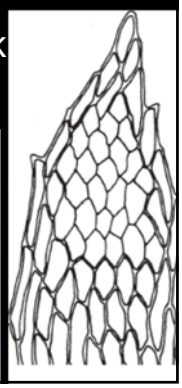
Phytogeographical Elements in Taiwan

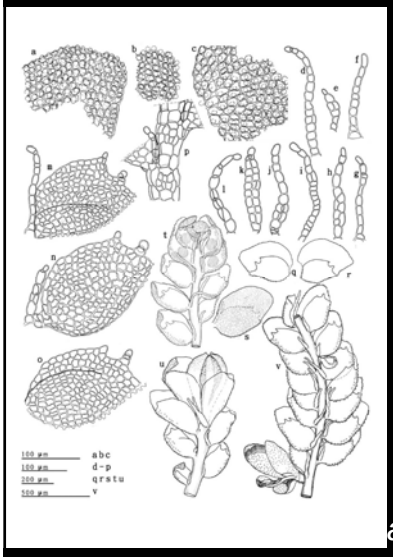
- 3. Circumboreal: about 177 taxa (13%)

Phytogeographical Elements in Taiwan

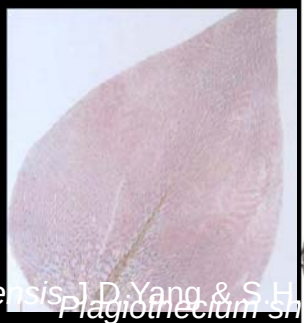
- 4. Endemic: about 95 taxa (7%)

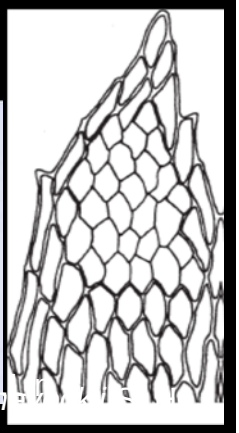
- *Plagiothecium shevockii* S. He, Novon 18(3): 344, 2008.
- TYPE:Taiwan: Miaoli Co., Shei-Pa National Park, near the Cui-chi, on metamorphic rock underhang, 3,600 m, 26 Apr. 1999, J. Shevock 18109





- 雪霸棉苔
- 南湖大山疣鱗蘚





anensis J.D.Yang & S.H. [illegible]

Plagiothecium sh [illegible]

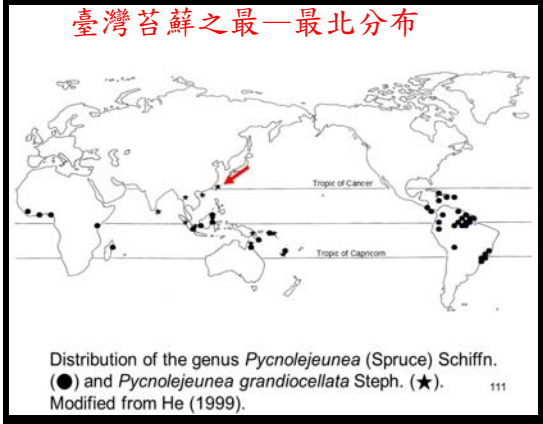
Phytogeographical Elements in Taiwan

- 5. Cosmopolitan : about 68 taxa (5%)

Tricocolea tomentella

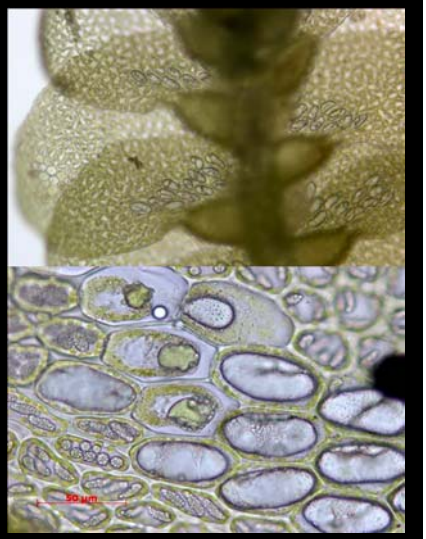
Hookeria acutifolia

臺灣苔蘚之最—最北分布



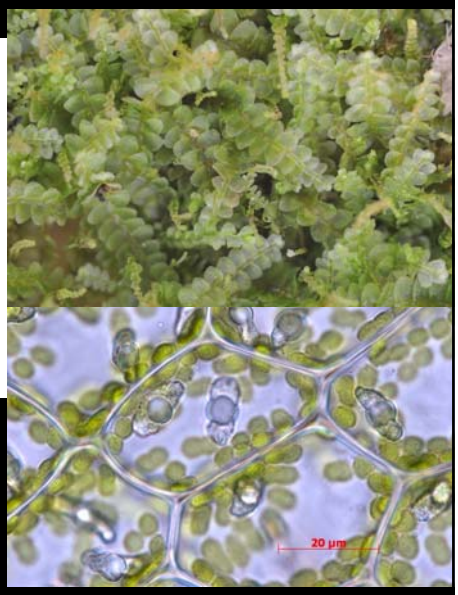
Distribution of the genus *Pycnolejeunea* (Spruce) Schiffn. (●) and *Pycnolejeunea grandiocellata* Steph. (★). Modified from He (1999).

巨胞密鱗蘚

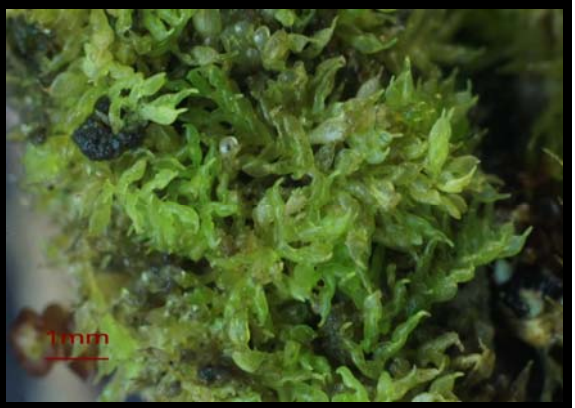


臺灣苔蘚之最—最南分布

Calypogeia japonica
Stephani
日本護蘋蘚



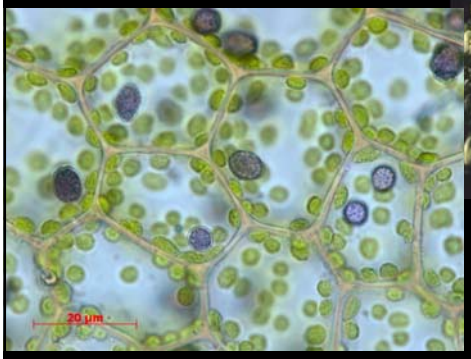
臺灣苔蘚之最—東亞首見



Colura calyptrifolia (Hook.) Dumort.

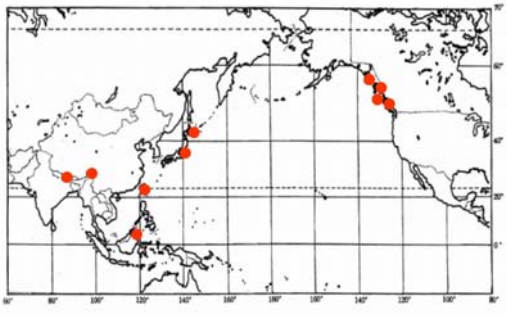
僧帽管葉蘚

臺灣苔蘚之最—間斷分布



Calypogeia aeruginosa Mitt.
銅綠護蒴蘚

臺灣苔蘚之最—最神的苔蘚



Distribution of *Takakia lepidozioides*

Takakia lepidozioides S.Hatt. & Inoue
藻苔(高木苔、神苔)

Summary

- 1.The proportion of bryophytes floristic elements occurring in Taiwan:
- East Asiatic 35%
- Palaeotropical 24%
- Circumboreal 13%
- Endemic 7%
- Cosmopolitan 5%
- East Asiatic-N. American 3%
- Others 13%

（Chiang, 1998a; Higuchi and Lin, 2004; Lin, 2000a）

Summary

- 2.The affinity of the bryophyte flora in Taiwan is closely related to that of Japan and Mainland China.

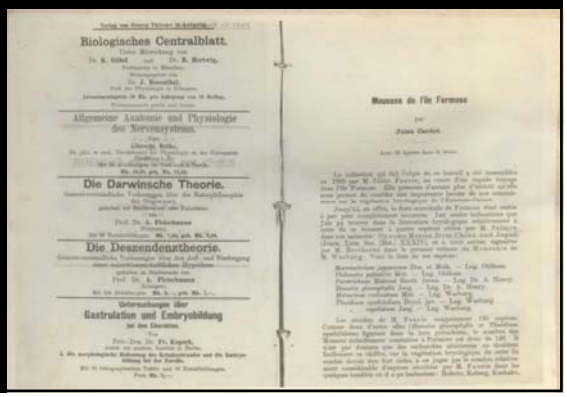
Summary

- 3. The level of endemism for Taiwan's bryophytes is about seven to eight percent. In contrast, the level of endemism in vascular plant is about 25% in Taiwan. The low endemism may be due to the long-distance dispersal abilities of bryophytes.

Brief History of Bryophytes Research in Taiwan

- The earliest survey of bryophytes of Taiwan could be traced back to Richard Oldham's expedition in 1864.
- Augustine Henry (1893-1895) and Urbain Jean Faurie (1903, 1913-1915) gathered plants, including bryophytes.

- Jules Cardot published the first important paper on the moss flora of Taiwan, " Mousses de l'île Formose" in 1905, based on Faurie's collections. This paper listed 130 species of mosses from Taiwan.


Biologisches Centralblatt.

Allgemeine Anatomie und Physiologie des Nervensystems.

Die Darwinsche Theorie.

Die Deszendenztheorie.

Untersuchungen über Gastrulation und Embryobildung

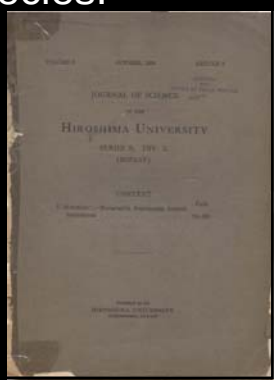
Mousses de l'île Formose

- F. Stephani published in his “ Species Hepaticarum” during 1900-1924, and 24 liverworts species of Taiwan which were based on the collections made by Faurie, Henry and Miyake.

- Hisahiko Sasaoka published “A list of Taiwan mosses” in 1928, according with Brotherus and Okamura’s relative researches. He listed 277 species of mosses collected from Taiwan.

- Akira Noguchi published series of paper “Contributions to the moss flora of Formosa” and “Contributions to the moss flora of Japan and Formosa” during 1934-1937.

- Yoshiwo Horikawa visited Taiwan four times from 1932 to 1934, and published the “Monographia Hepaticarum Australi-Japonicarum” in 1934. In which, a total of 246 species liverworts from Taiwan were reported, including 207 new species.



- Other important researcher: Herzog (1955), Wang (1960-1970), Nakanishi (1963), Iwatsuki & Sharp (1965), Inoue (1966-1988), Ando (1968), Chung (1973), Lai (1976-), Lin (1970-), Chiang (1981-)

Summary

- The earliest survey of bryophytes of Taiwan: Richard Oldham in 1864.
- Most of the floristic studies were made by Japanese bryologists, such as Y. Horikawa and A. Noguchi.
- Since 1960, the Taiwanese bryologists have started to collect and study bryophytes.

Research Status

Current Status of Herbaria

- Tunghau University (TUNG): 40,000 specimens, mostly collected by Dr. S. H. Lin
- Taiwan University (TAI): 36,000 specimens
- National Museum of Natural Science (TNM): 15,000 specimens
- Taiwan Museum (TAIM): 1,800 specimens, mostly collected by Dr. C. K. Wang
- Endemic Species Research Institute (TAIE): 40,000 specimens

Bryophytes Inventory

- I have started to promote the bryophytes inventory in Taiwan since 2004.
- It is fully supported and sponsored by Endemic Species Research Institute and Council of Agriculture.

Aims of the Project

- inventory and specimen collection of Taiwan's bryophytes
- reveal more species previously never recorded in Taiwan
- providing information on habitat, ecology and distribution
- establish database of bryophytes

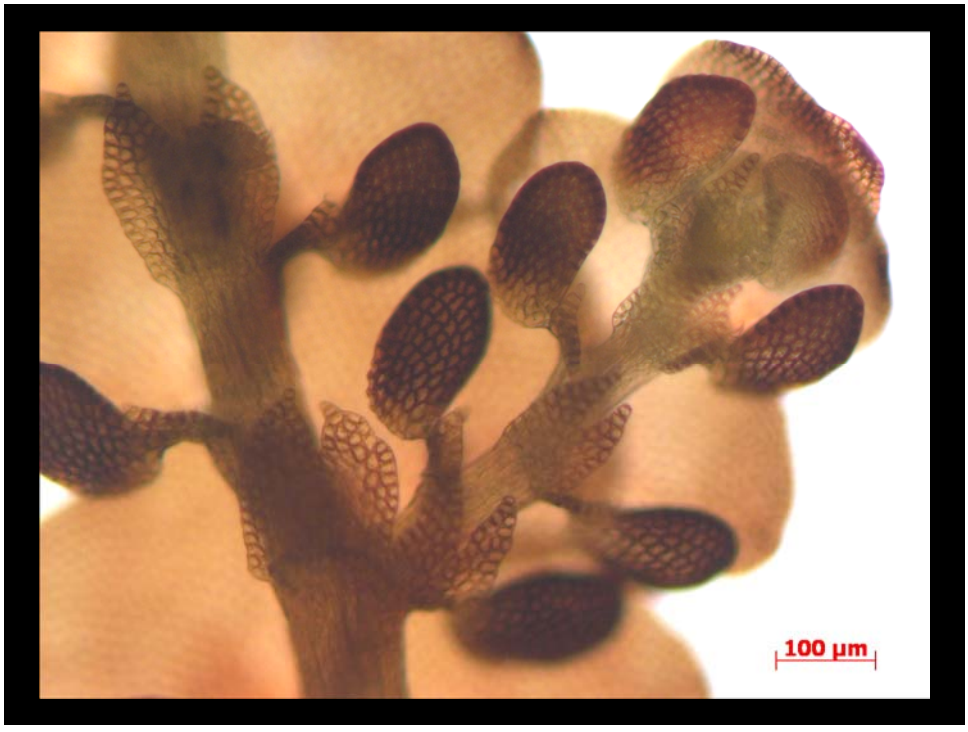
Specialized structures for water storage

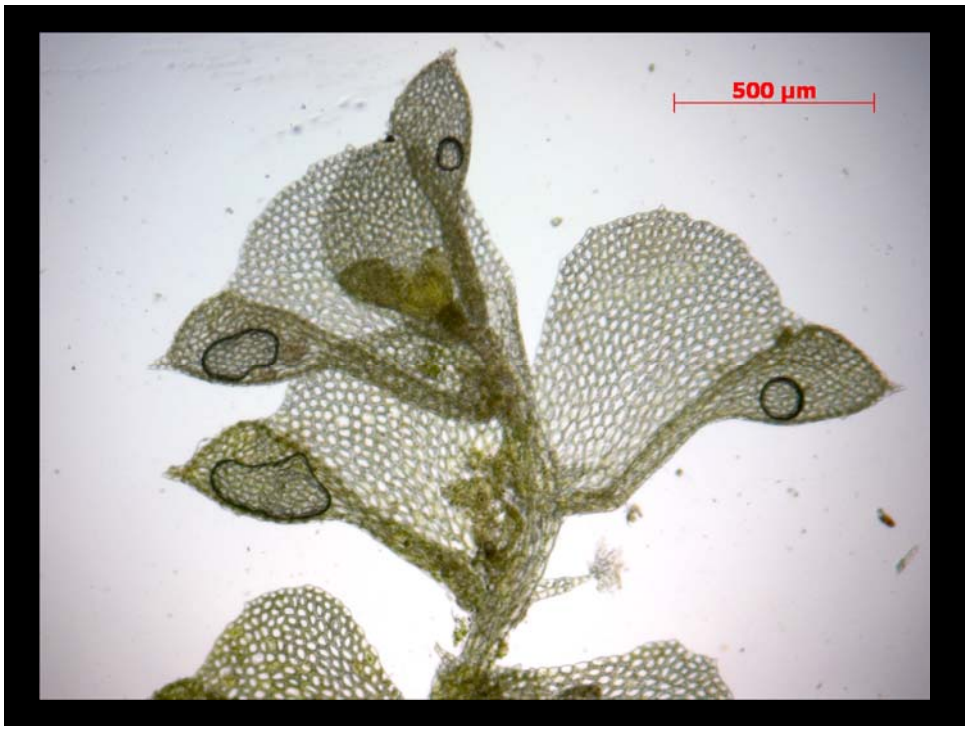
Pleurozia acinosa

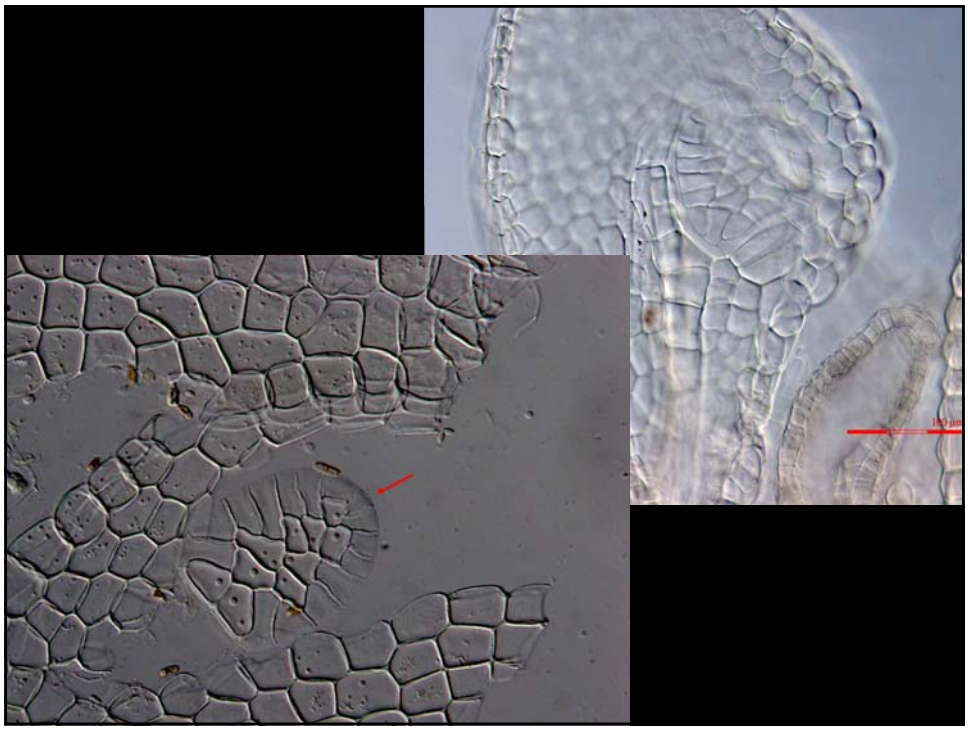
南亞紫葉蘚

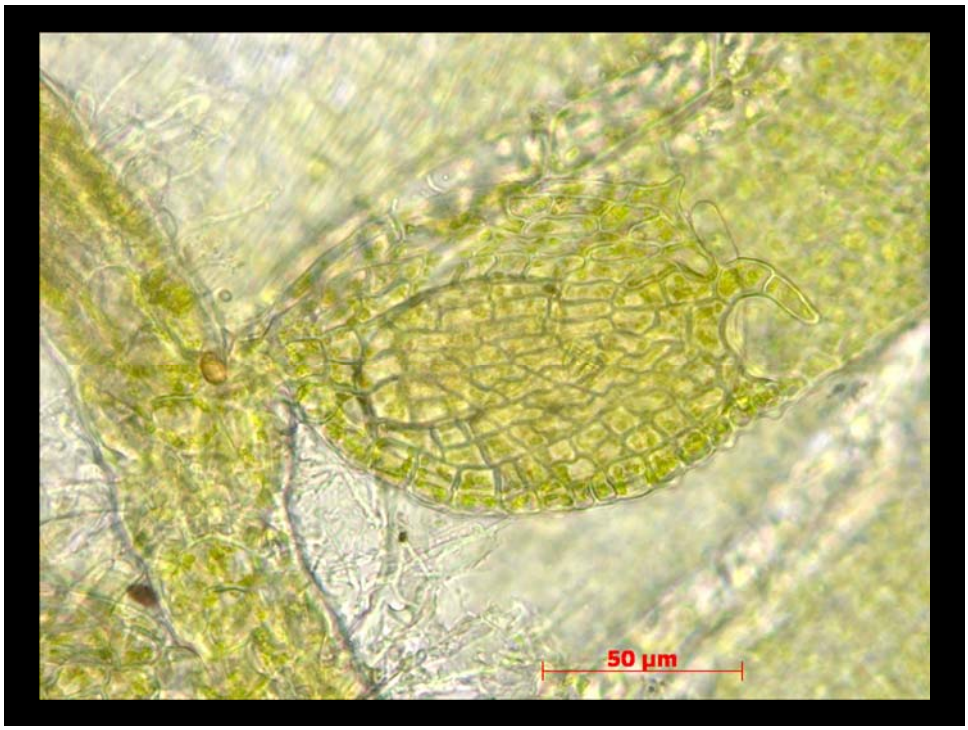
Tuyamaella molischii 鞍葉蘚


100 µm


100 µm

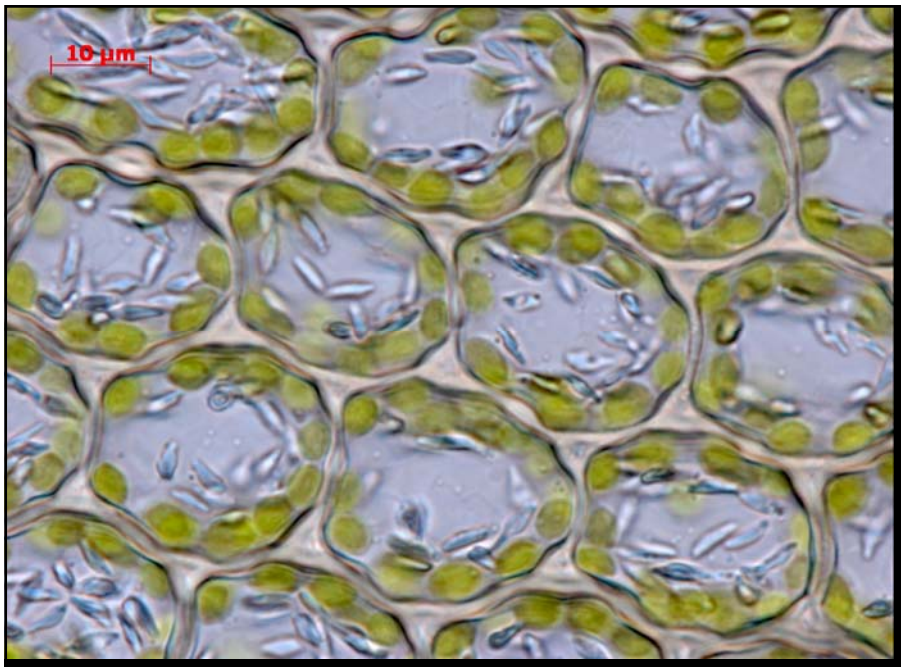

500 µm



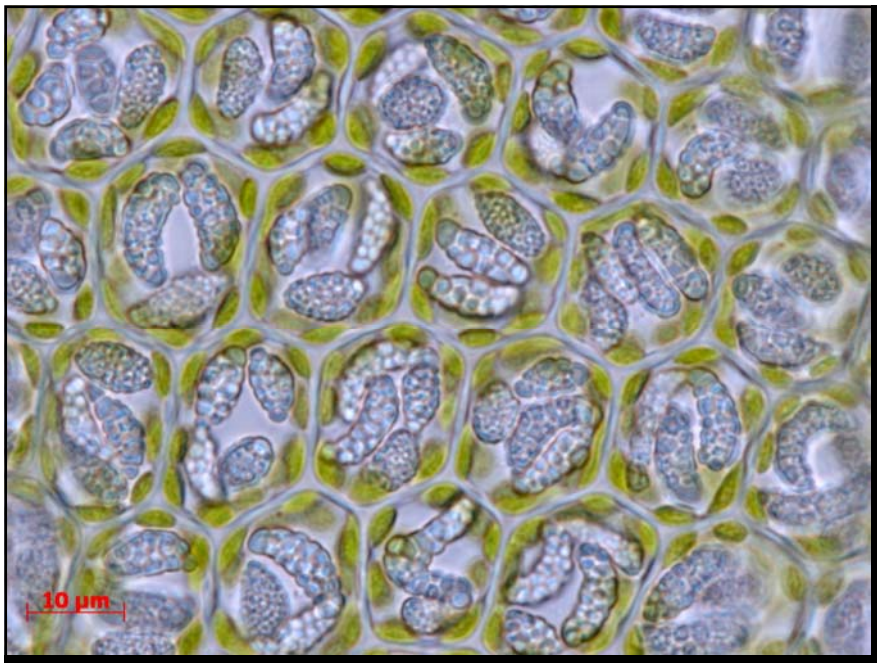

50 µm


50 µm

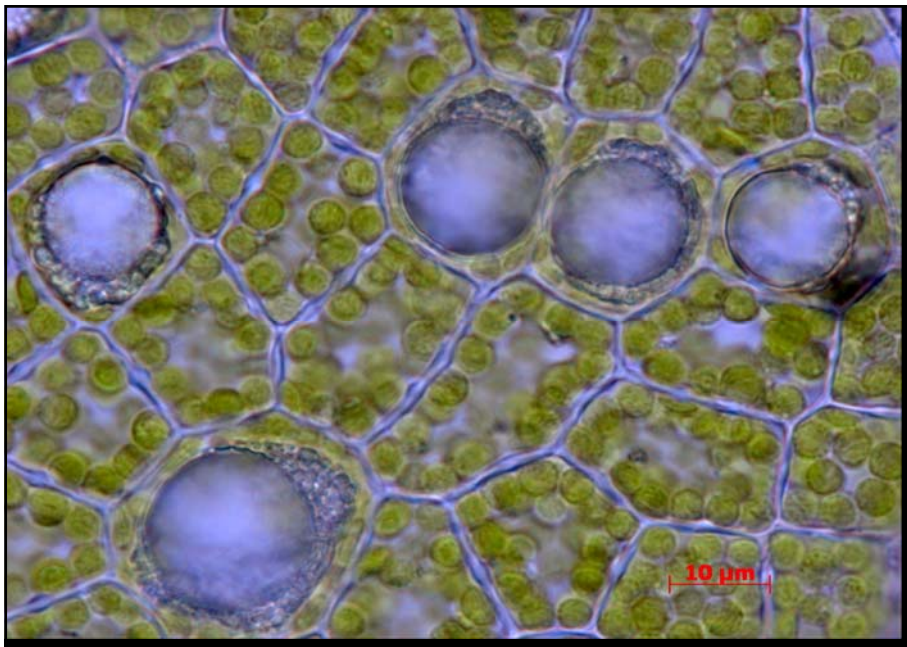
Oil-bodies and ocelli



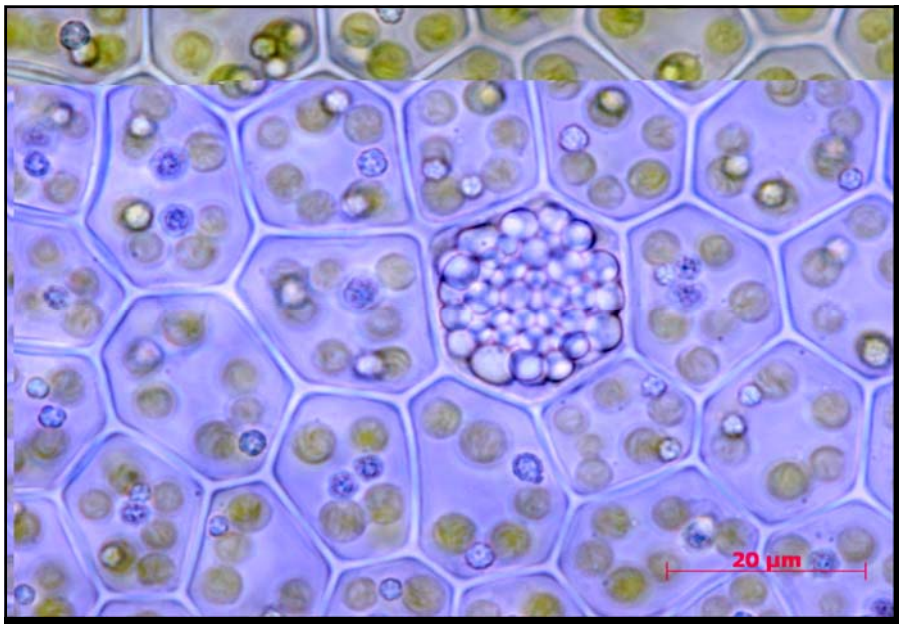
Trocholejeunea sandvicensis



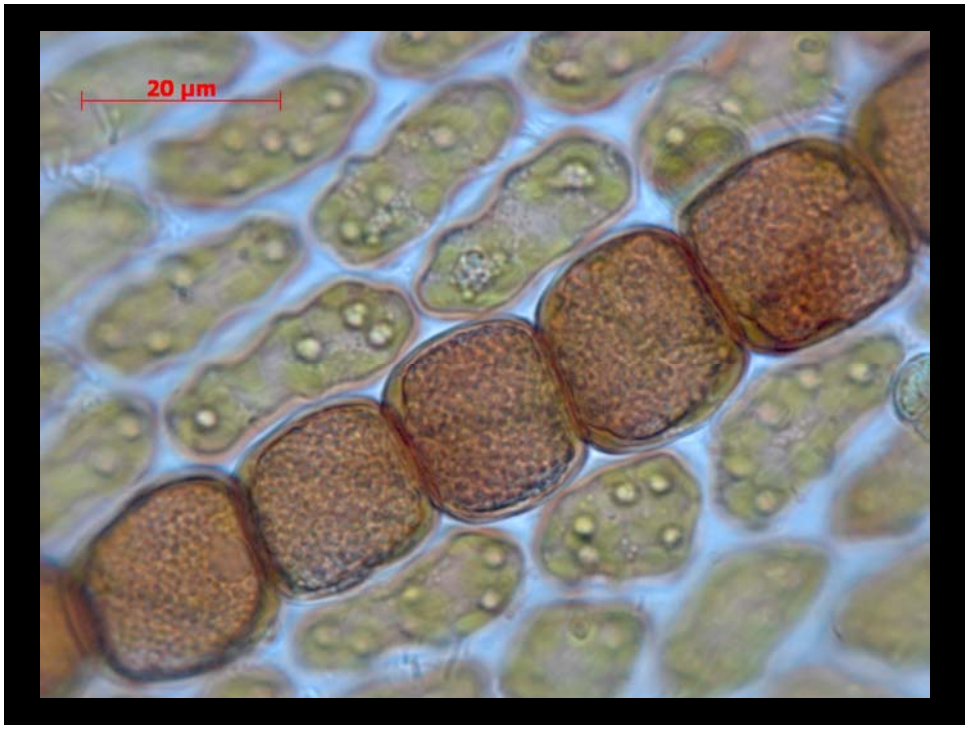
Cheilolejeunea ventricosa

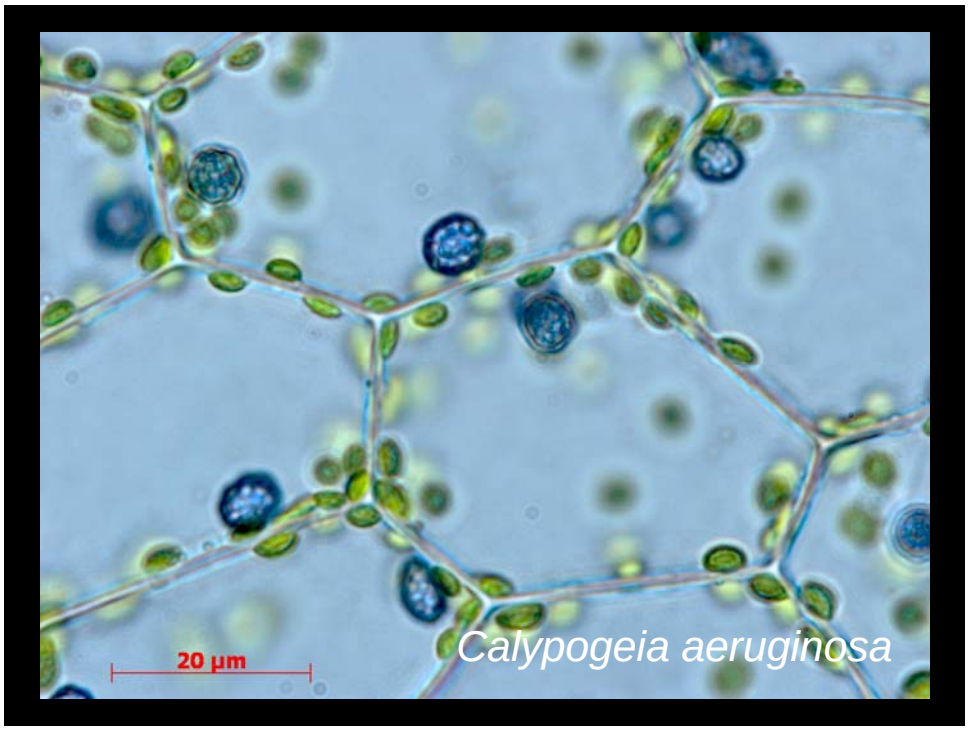


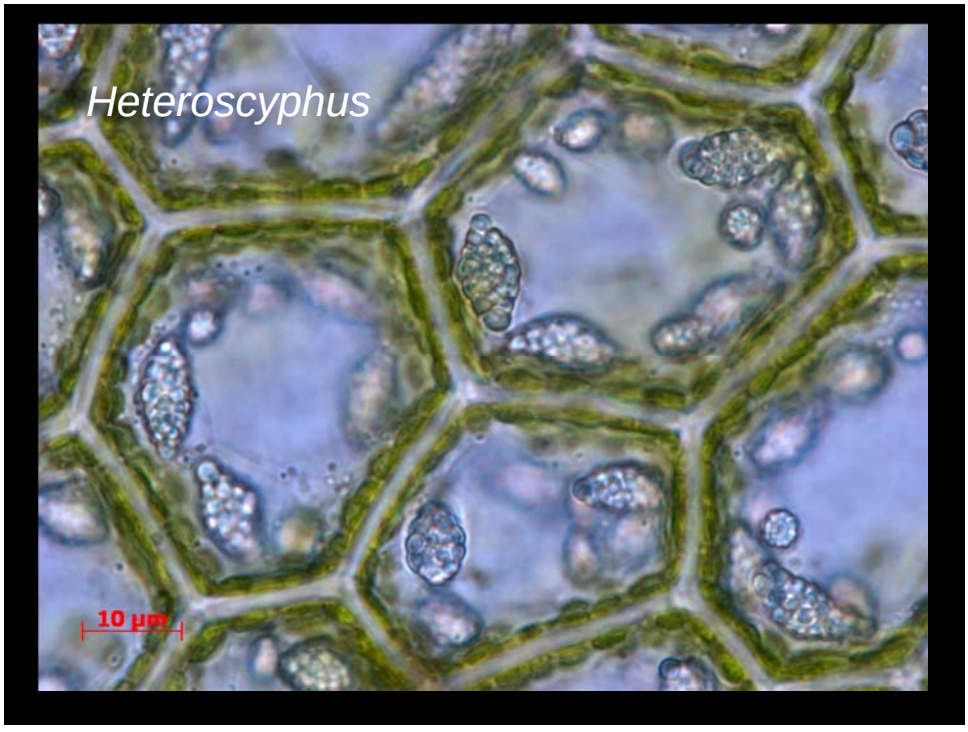
Leptolejeunea elliptica

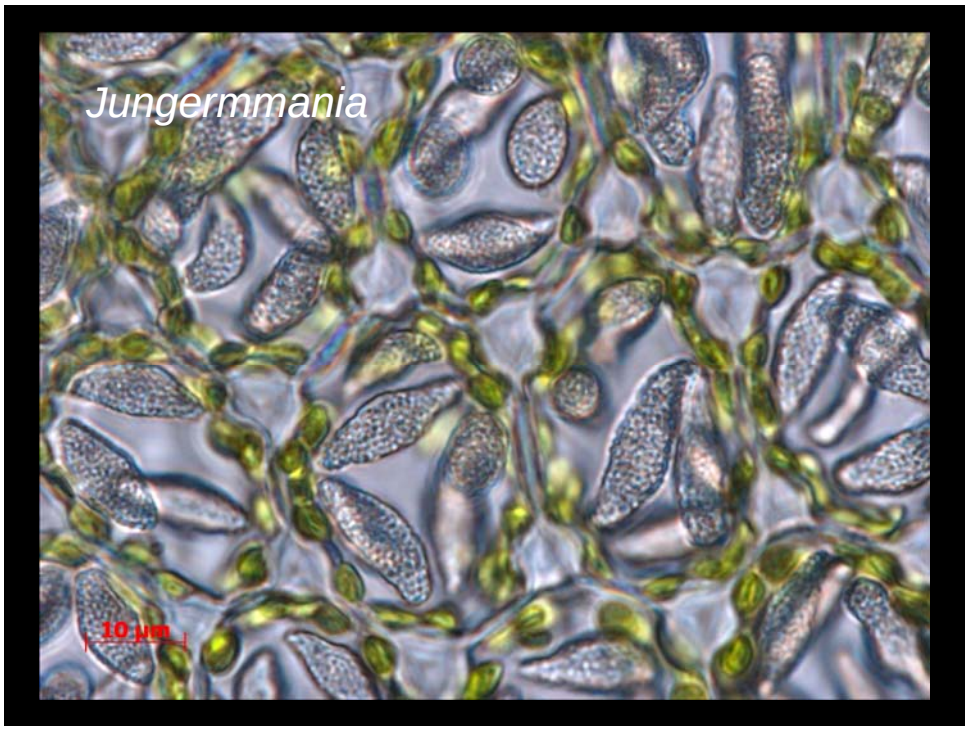


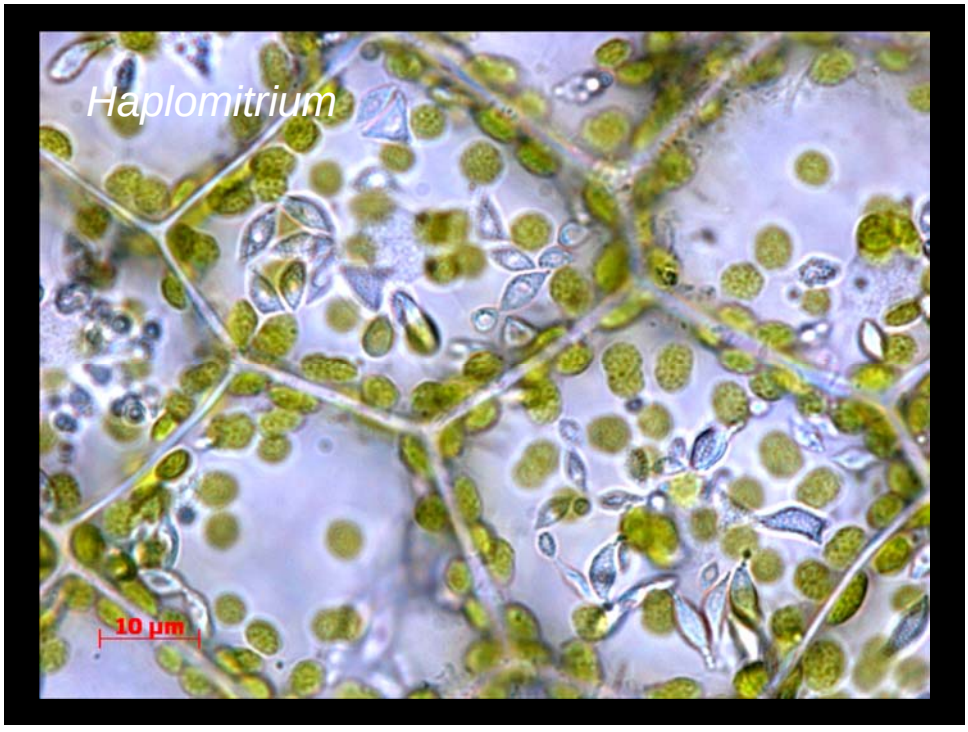
Diplaciolejeunea cavifolia

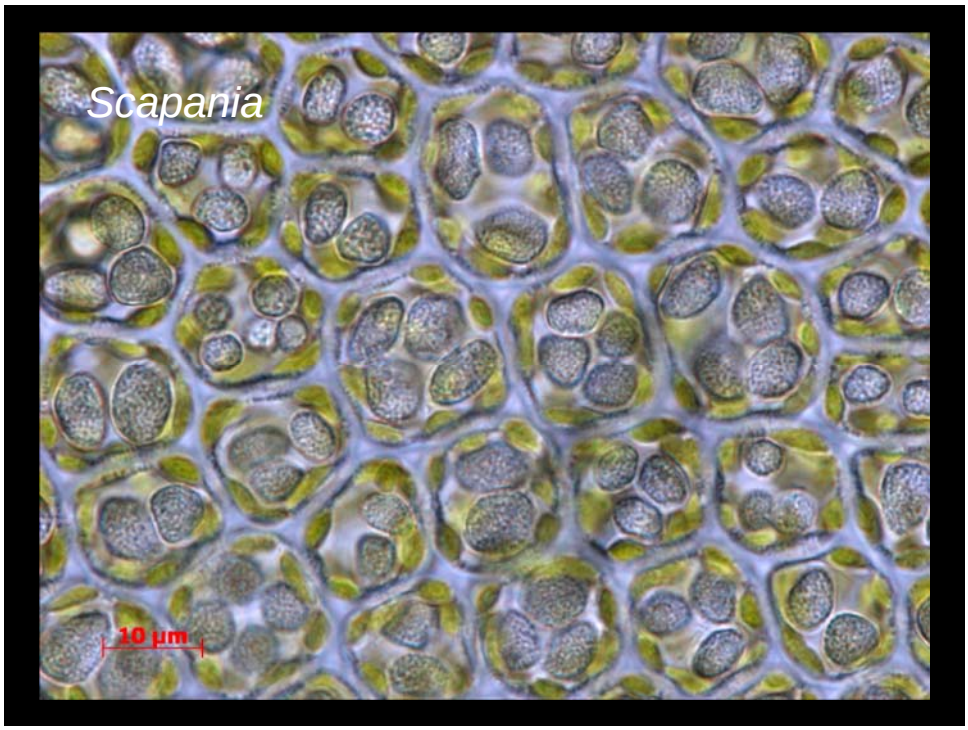



20 µm
Calypogeia aeruginosa

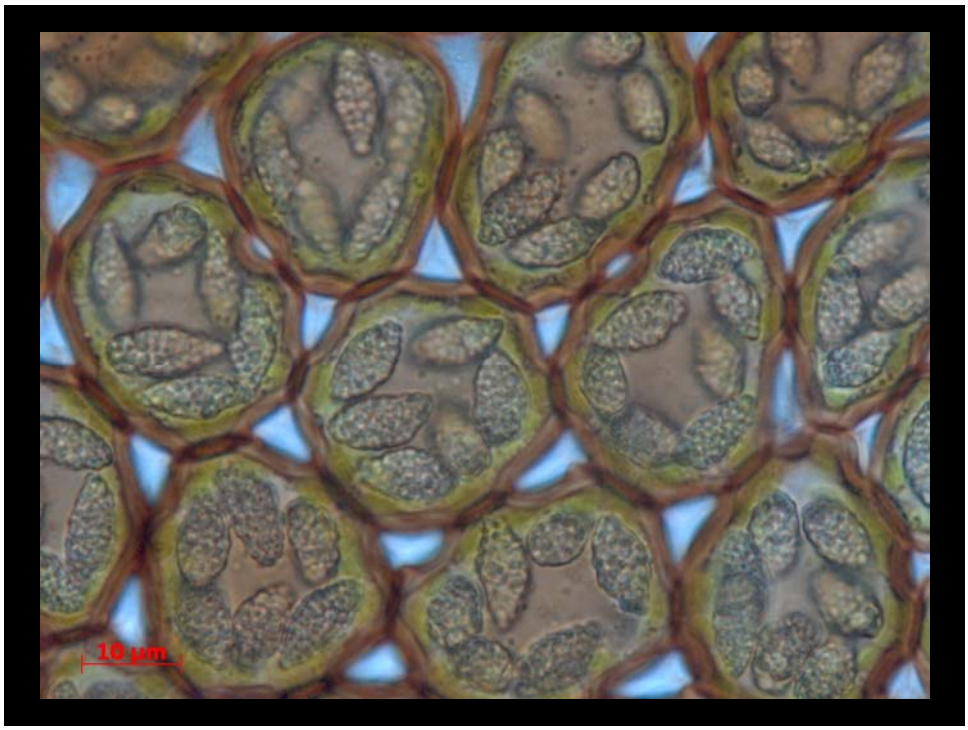

Heteroscyphus
10 µm

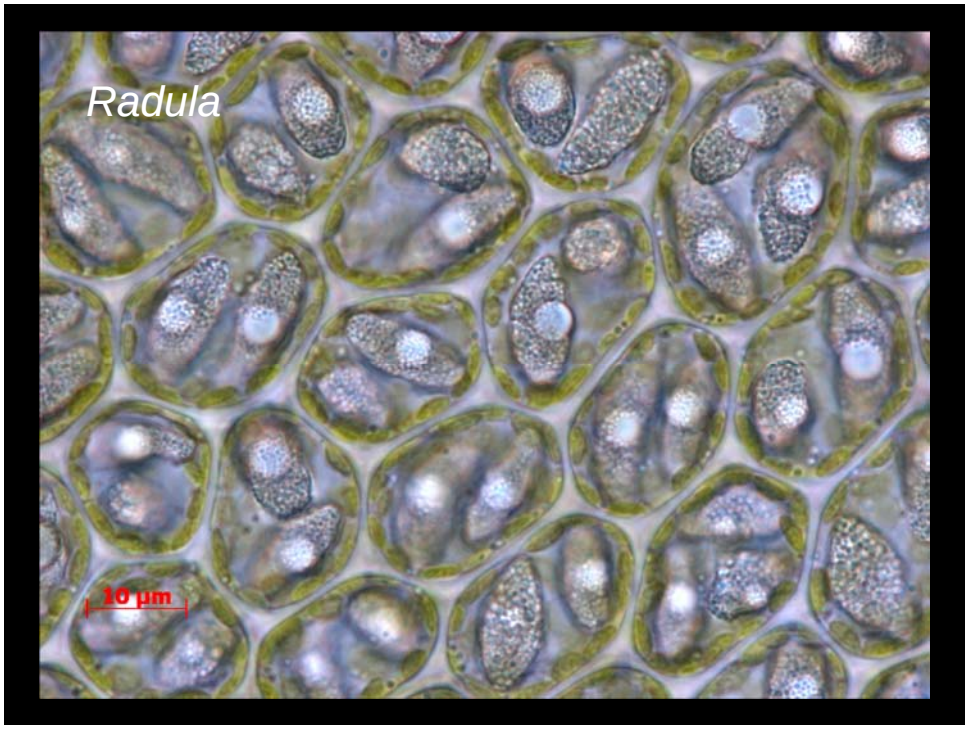

Jungermmania
10 µm

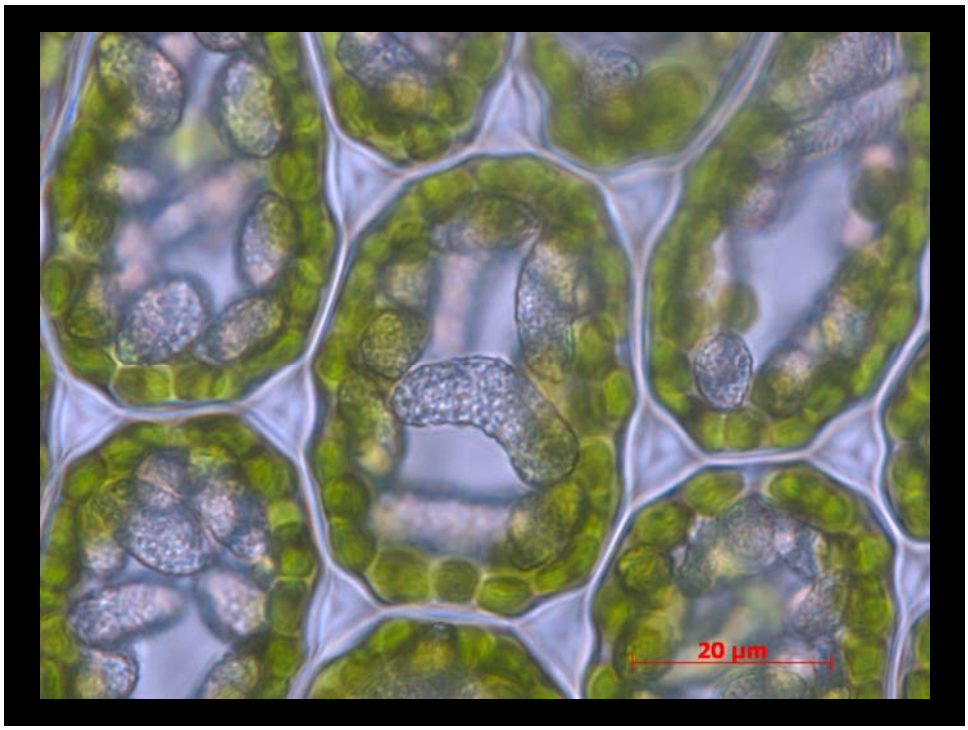

Haplomitrium
10 µm

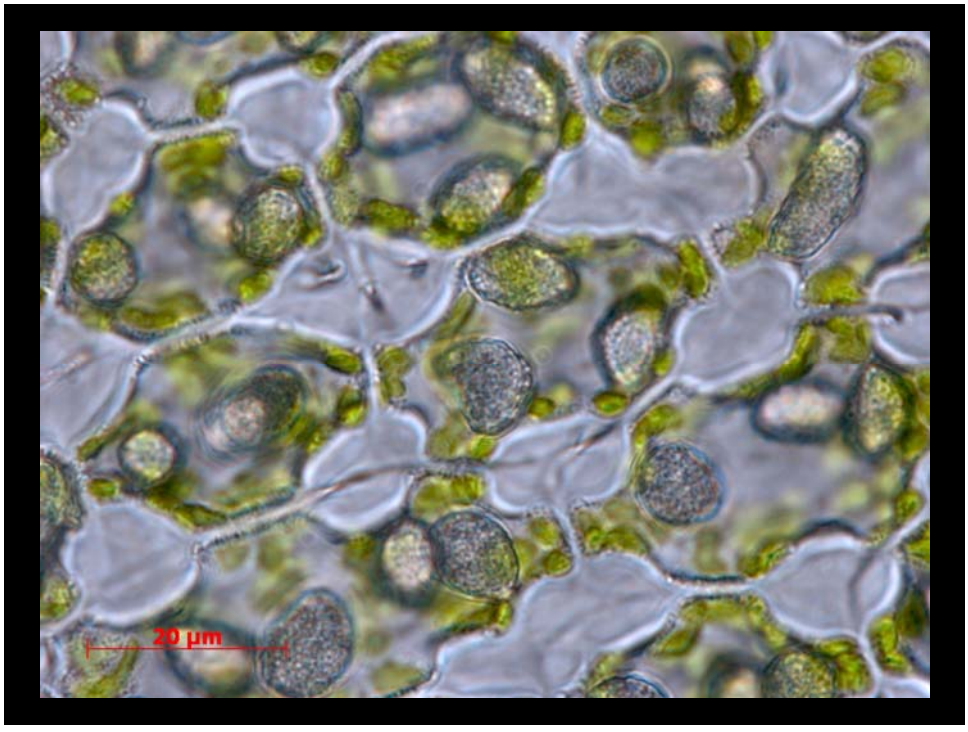


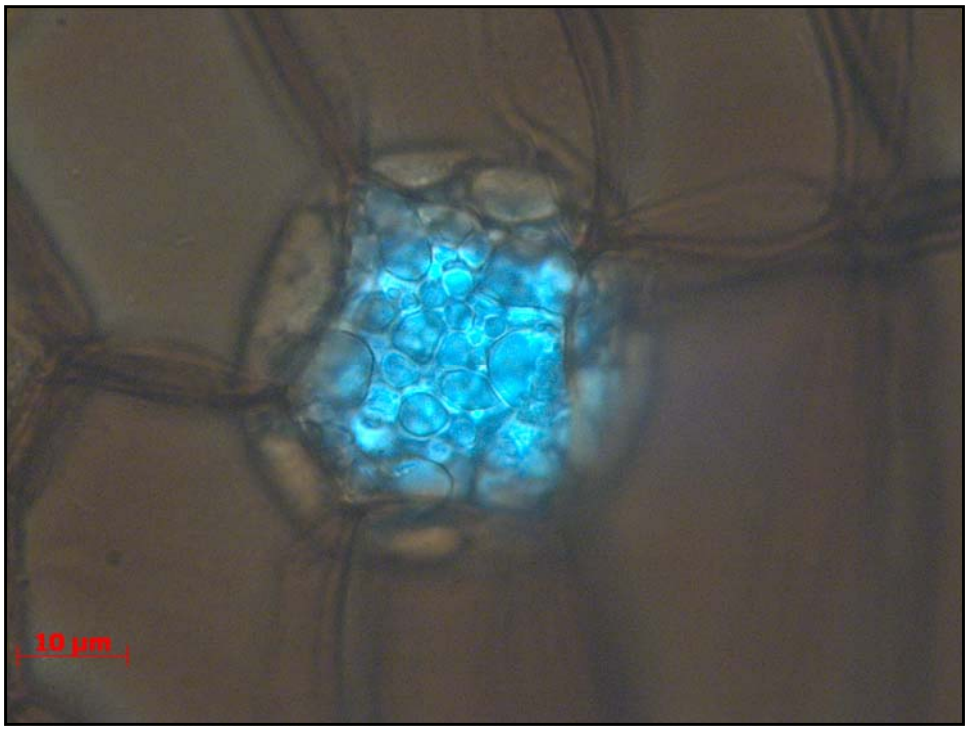
Pycnolejeunea grandiocellata


10 µm


Radula
10 µm

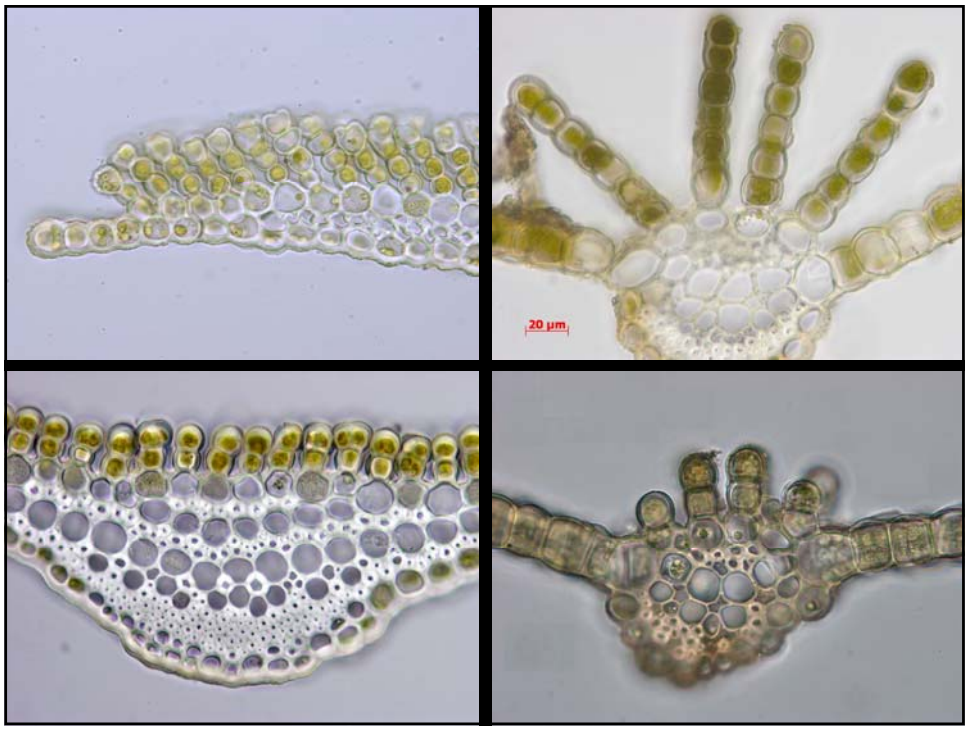

20 µm

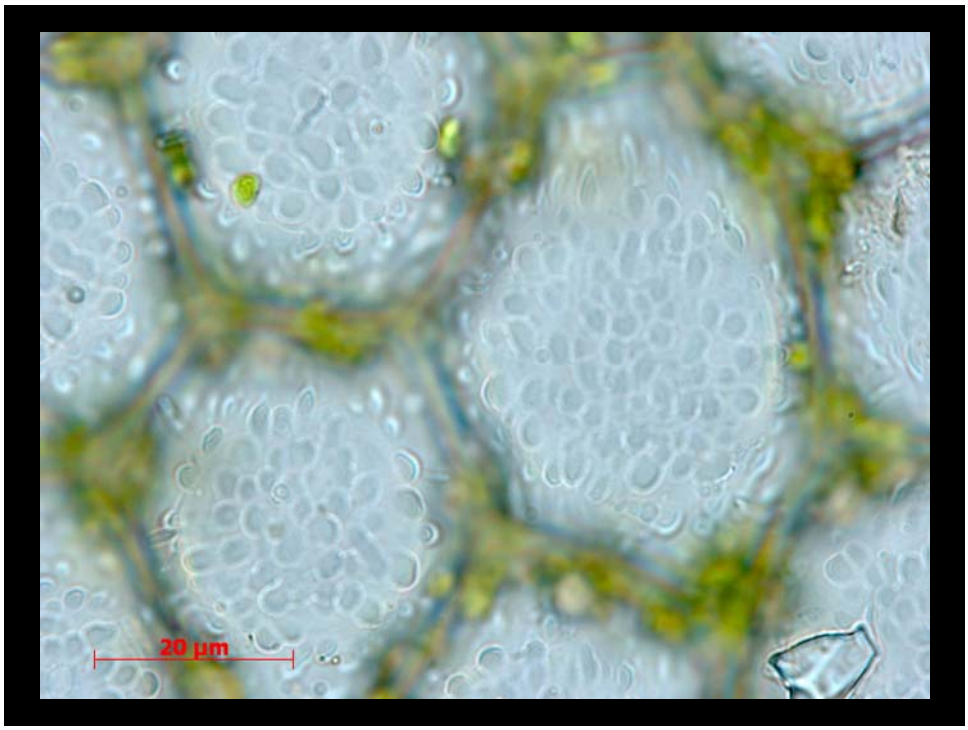

20 µm

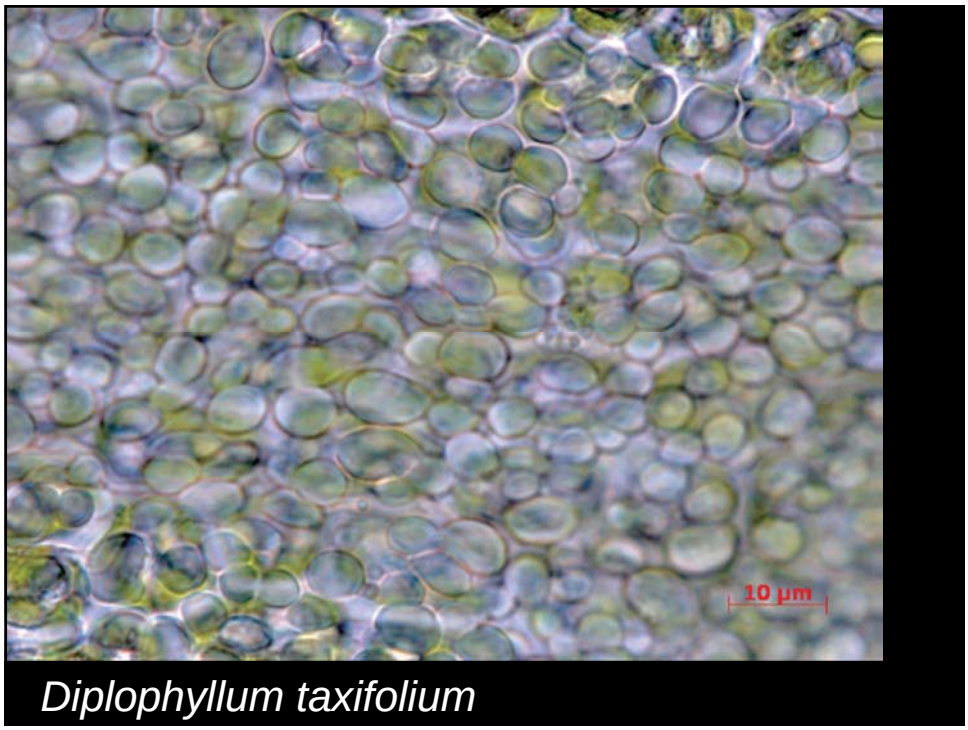


Surface structure of leaves

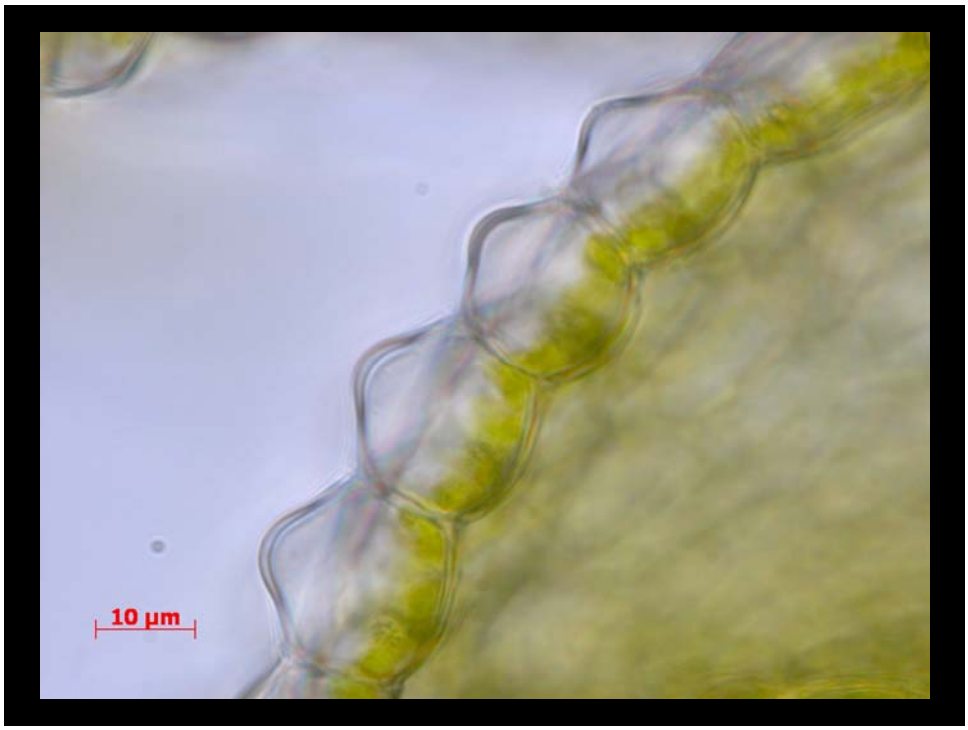

楊嘉棟攝
Yang Jia-dong

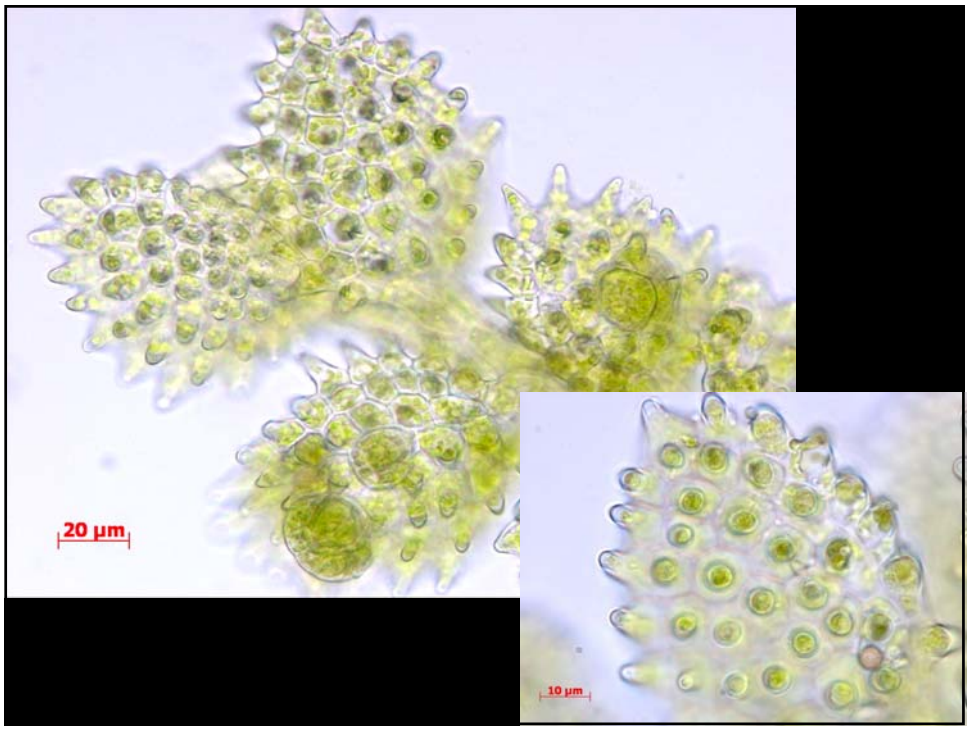

20 µm

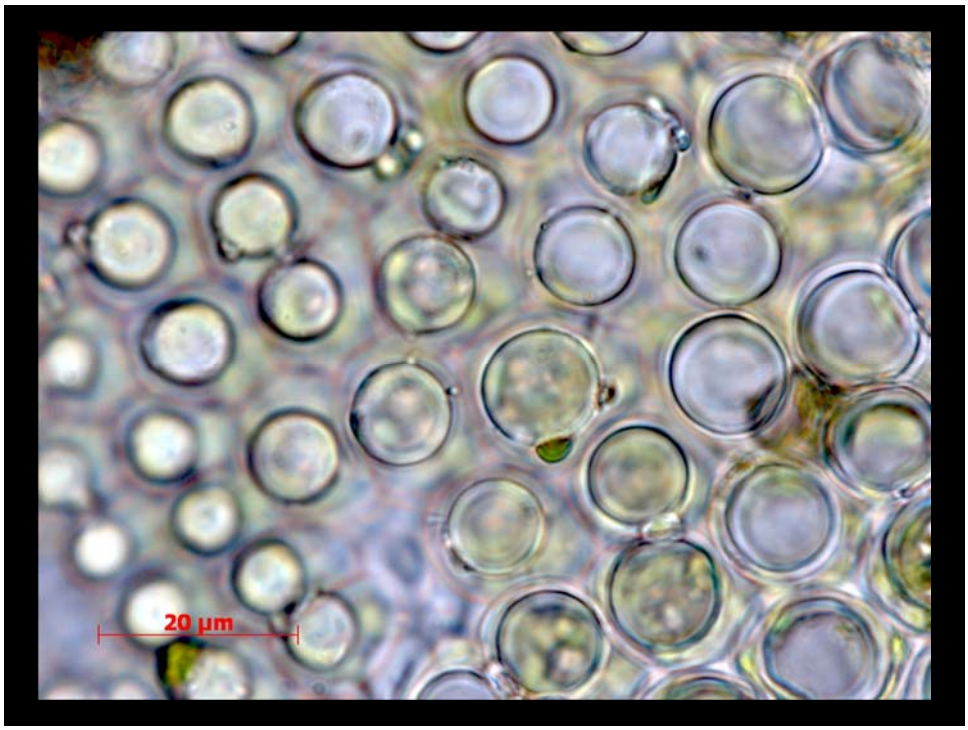




Diplophyllum taxifolium


10 µm

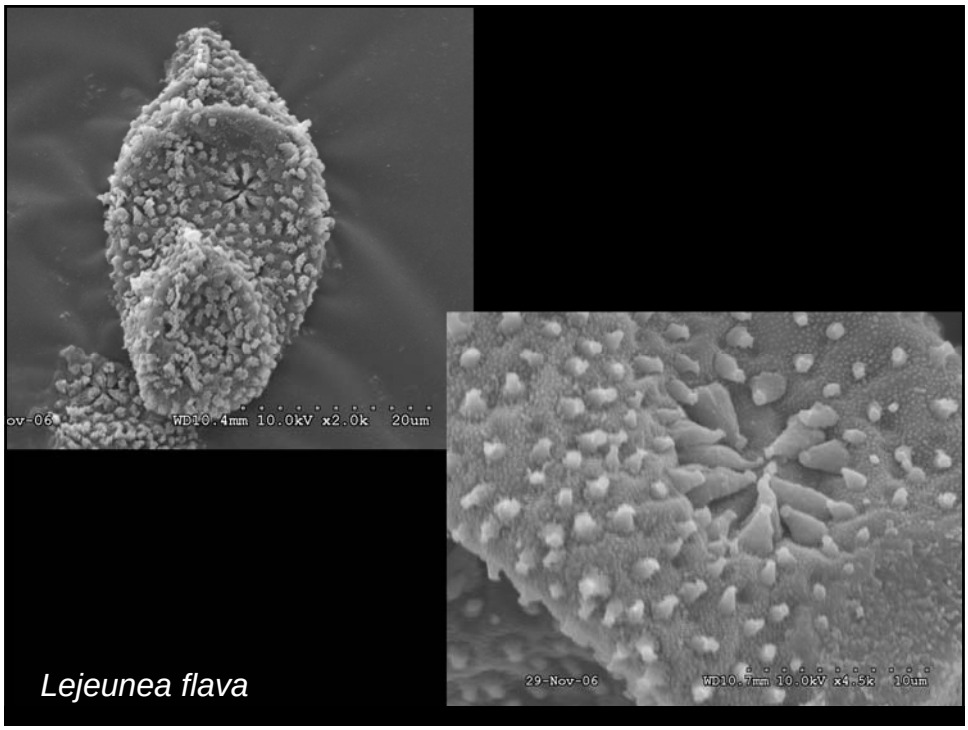

20 µm
10 µm



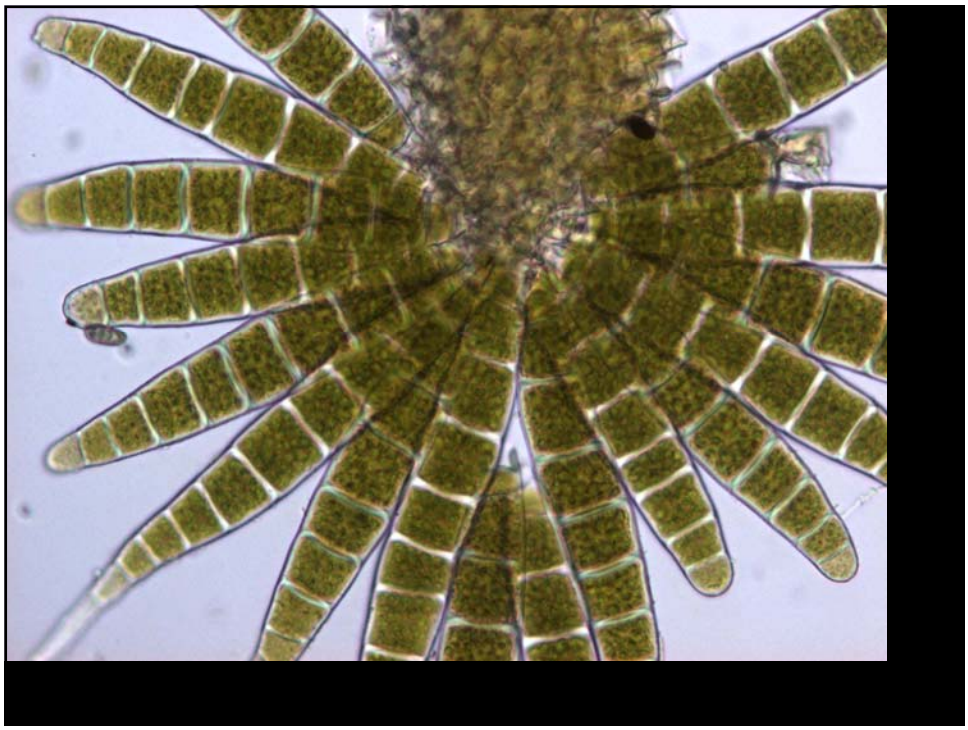
Diaspores


20 µm

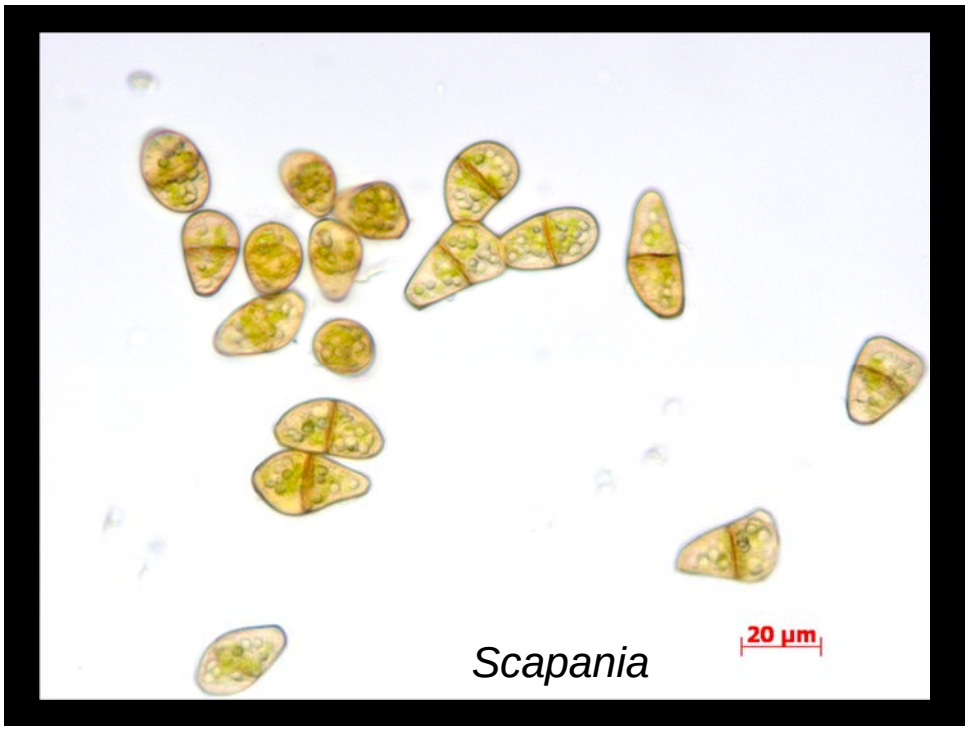

20 µm



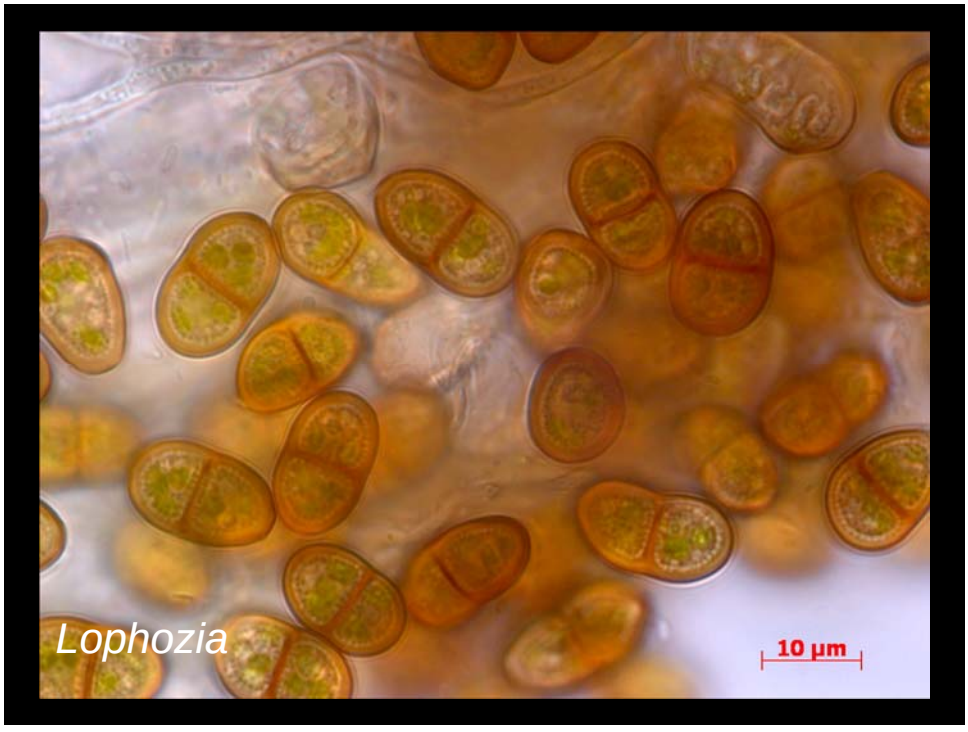
Lejeunea flava



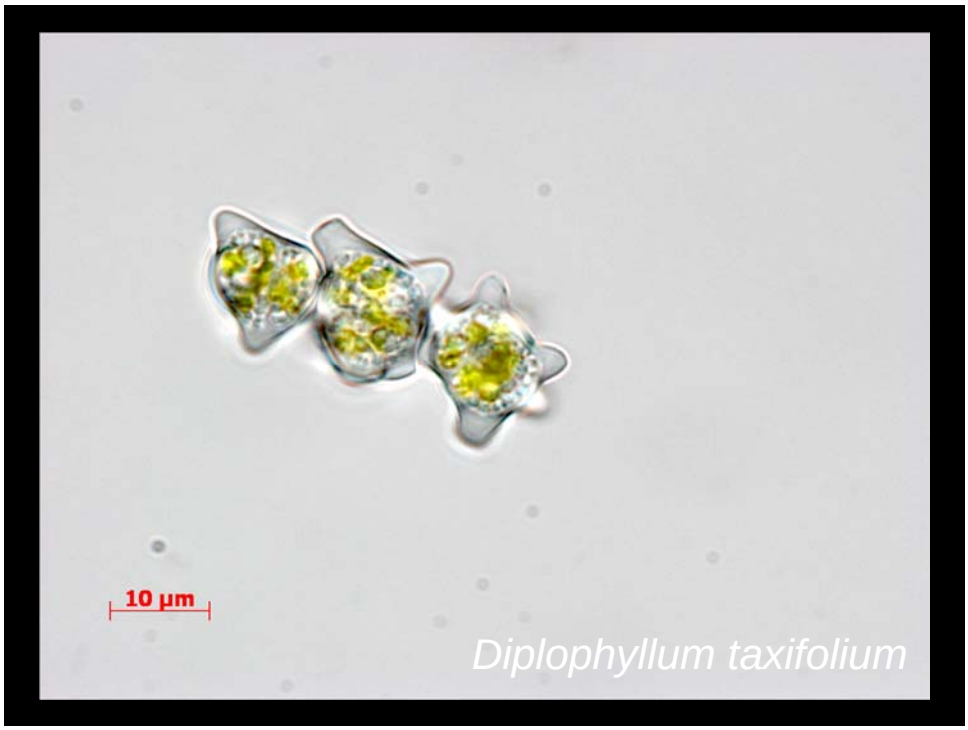

10 µm



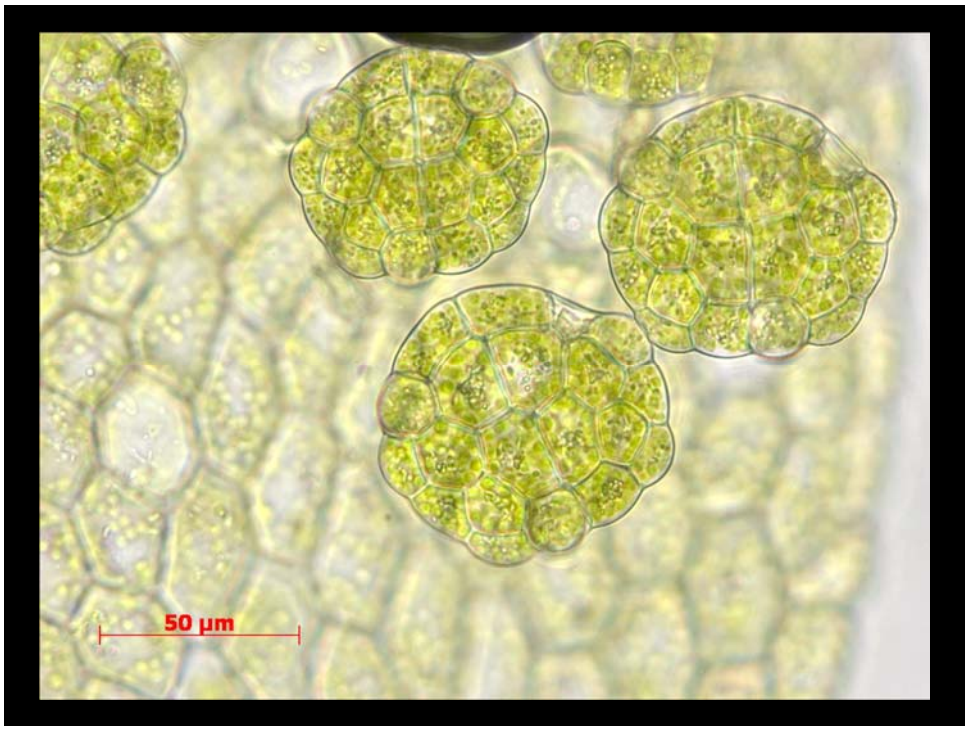
Scapania

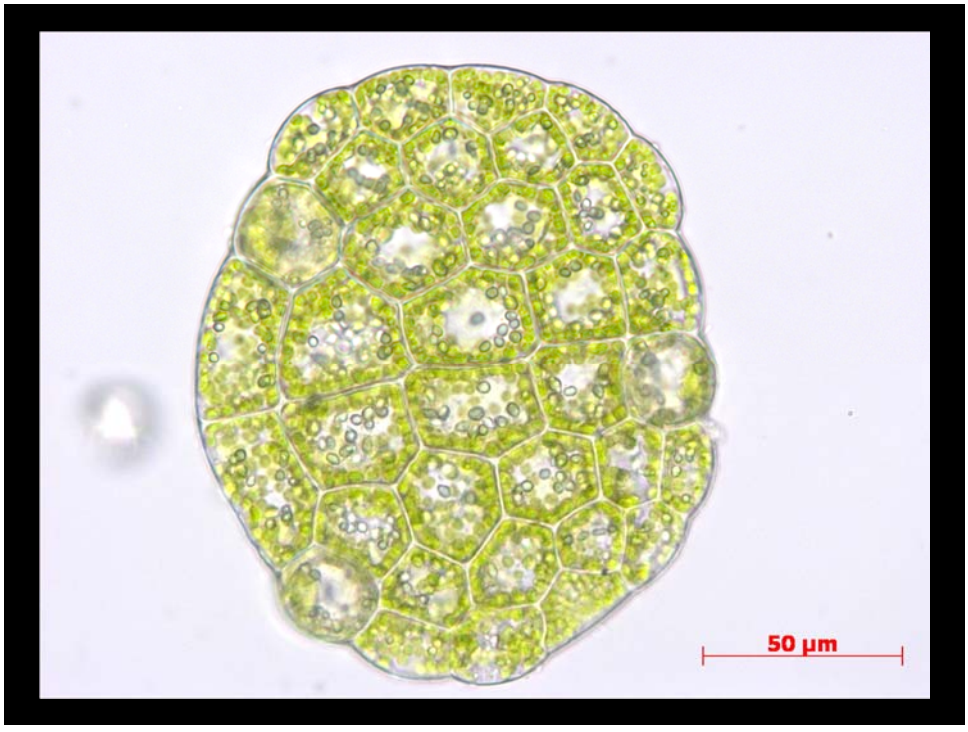


Lophozia

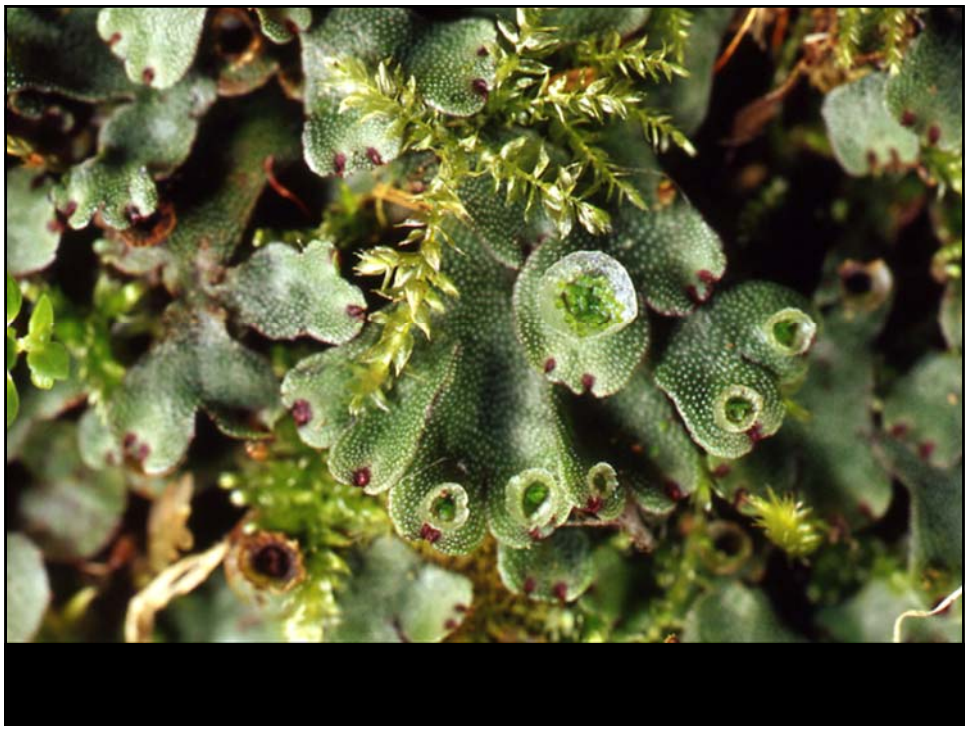

10 µm
Diplophyllum taxifolium


50 µm


50 µm


50 µm

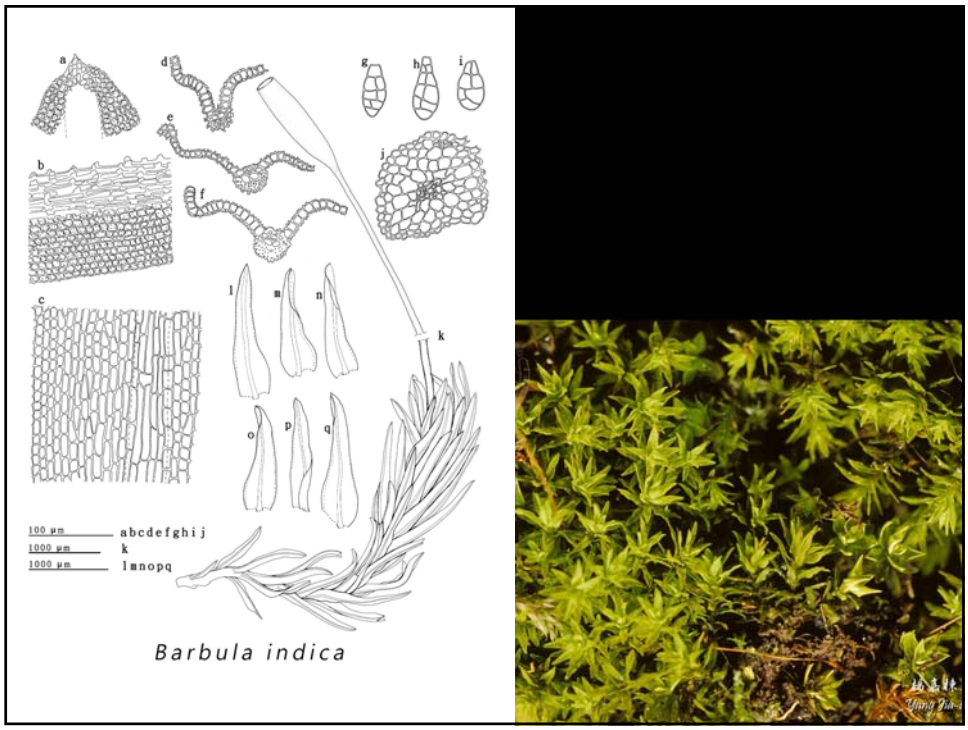
2022/5/11 *Lunulania cruciata*（L.）Dum. 半月蘚 121

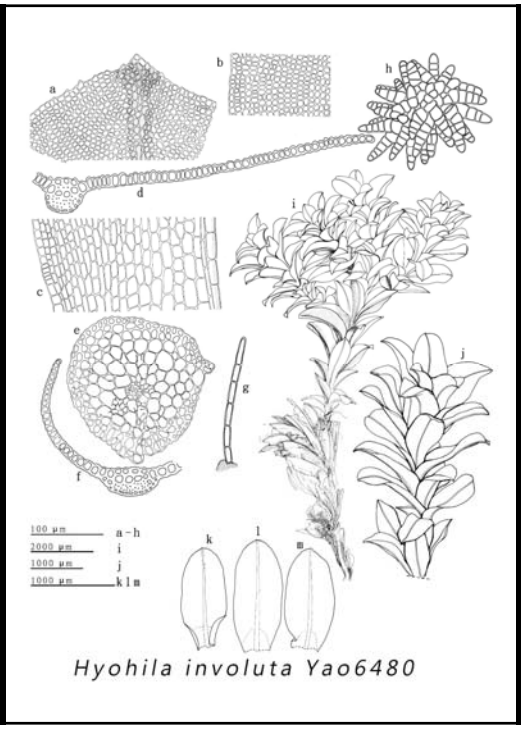


Future Works

- completing the bryoflora of Taiwan in the immediate future
- conducting a continuing inventory program
- enhancing the training of young bryologists
- encouraging international collaboration

Fig. 17. *Schistostega pennata*. a. Habit. b. Portion of shoot showing ecostate leaves joined together at base and distichous except at tips of fertile shoots. c. Leaf from sterile shoot. d. Protonematal branch with globose reflective cells and 2 terminal gemmae. e. Gymnostomous capsule. f. Exothecial cells. (From Crum & Anderson, 1981)





Hyohila involuta Yao6480


葉尖
葉緣
葉基
葉
長肋疣壺苔 Gymnostomiella longinervis


葉尖
葉緣
葉基
莖橫切
葉橫切
背捲對齒苔
Didymodon vinealis

Leptolejeunea (Spruce) Schiffn.

Leptolejeunea is characterized by (1) plants small to medium-size, light green, yellowish green to dull green, with a strong odor when fresh, (2) branching of the *Lejeunea*-type, (3) leaf cells large, thin-walled, trigones distinct with nodulose intermediate thickenings, (4) leaf lobes more or less shrinking when dry, distant or approximate, the lobe elliptical to ovate, the apex rounded, obtuse or acute-apiculate, the margin entire to dentate, (5) underleaves often with a large, adhesive rhizoid disc, bifid with very slender, upright or diverging lobes, the lobes 2-4 cells long and 1(-2) cells wide, lamina with a conspicuous border of six large outer cells surrounding the smaller inner cells, insertion line almost straigh, (6) truncate apex of leaf lobule with obsolete second tooth and unicellular, straight first tooth, (7) oil bodies small, few per cell, simple or composed of a few droplets, (8) presence of ocelli in leaf lobe, (9) gynoecia on short branches, without innovations, (10) perianths inflated 5-keels above, the keels extending into short, horn-like projections, (11)vegetative reproduction by cladia.

A pantropical genus (ca. 25 spp.). Seven species in Taiwan

Key to Species

1. Ocelli scattered over the leaf lobes, lobules and underleaves……4. *L. picta*
1. Ocelli only present in leaf lobes……2
2. Leaf lobe fan-shaped; lobes of underleaf always 2 cells wide at base……3
2. Leaf lobe ovate, elliptical, oblong, or oblong-ovate; lobes of underleaf usually 1 cells wide at base……4
3. Leaf lobe entire to crenate, sometime with tooth at apex……1. *L. apiculata*
3. Leaf lobe always with 3-5 teeth……3. *L. emarginata*
4. Leaf lobe oblong, margins serrate; lobe cells with large trigones and intermediate thickenings……*L. maculata* (Mitt.) Schiffn.
4. Leaf lobe ovate, ovate-oblong, margins entire; lobe cells usually with small trigones and intermediate thickenings……5
5. Leaf lobe ovate to elliptical, apex acute to obtuse; leaf lobules rarely reduced; plants usually dark brown when dried……2. *L. elliptica*
5. Leaf lobe ovate-oblong, apex rounded to truncate; leaf lobules reduced frequently; plants usually pale yellow to yellowish brown when dried……6
6. Apex of leaf lobe rounded; leaf lobule slightly reduced; intermediate thickenings indistinct……*L. truncifolia* Steph.
6. Apex of leaf lobe usually truncate; leaf lobule strongly reduced; intermediate thickenings distinct……*L. epiphylla* (Mitt.) Steph.

1. **Leptolejeunea apiculata** (Horik.) S.Hatt., J. Hattori Bot. Lab. 5: 46 (1951).
Drepanolejeunea apiculata Horik., J. Sci. Hiroshima Univ., Ser. B, Div. 2, Bot. 2: 266 (1934).

Pl. Photo

Plants medium-size, yellowish to pale green when fresh, brown in dried. Stems up to 1.8 cm long, irregularly branched. Leaf lobes contiguous to distant, fan-shaped or long obovate, about 0.8 mm long, usually apiculate at apex, margins entire to crenate, sometimes with blunt teeth at apex. Lobule large, oblong, 1/2-3/5 as long as the lobe, strongly inflated, free lateral margin incurved, first tooth obtuse, consisting of one oblong cell, second tooth obsolete, hyaline papilla at the proximal side of first tooth, keel slightly arched, smooth. Underleaves distant, small, 3-4 times as wide as the stem, deeply bilobed, lobes lanceolate, 3-4 cells long, 2 cells wide at base. Cells of leaf-lobes, thin-walled, trigones and intermediate thickenings distinct, oil bodies small, ocelli irregularly scattered, suprabasal ocellus 1, large. Diocious. Perianth obovate, nearly truncate at apex, sharply 5-keeled above, keels smooth, horn-shaped. Asexual reproduction by cladia, usually abundant.

Habitat: Epiphyllous, on the leaves of ferns, trees and shrubs.

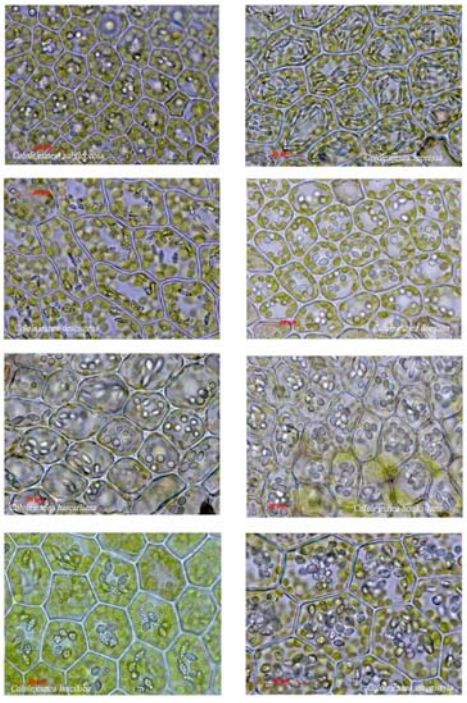
Range: China, Japan (Ryukyu) and Taiwan.

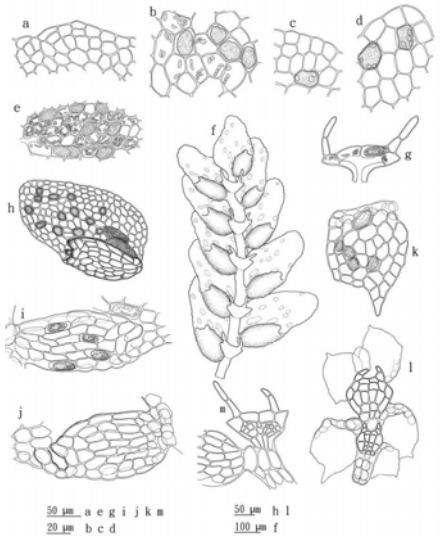
Specimens examined: TAOYUAN: Shihmen Reservoir, 350 m, 4 Jun 2007, *J.-D. Yang 3999* (TAIE).

2. **Leptolejeunea elliptica** (Lehm. & Lindenb.) Schiffn. in Engler & Prantl, Nat. Pflanzenfam. 1 (3): 126 (1893)

Photo

Plants small to medium, light green sometime with bluish hue in fresh, dark brown when dried. Stems up to 1.8 cm long, irregularly branched. Leaf lobes contiguous to distant, ovate to obliquely elliptical, about 0.5 mm long, apex obtuse to subacute, margins entire. Lobule oblong to ovate, 1/3-1/2 as long as the lobe, inflated, free lateral margin slightly incurved, first tooth obtuse, composed of one oblong cell, second tooth obsolete, hyaline papilla at the proximal side of first tooth, keel slightly arched, smooth. Underleaves distant, deeply bilobed, lobes (2-) 3-4 cells long, 1 cell wide, rarely 2 cells at base. Lobe cells thin-walled, trigones and intermediate thickenings small but distinct; oil bodies 3-9 per cell, nearly homogeneous; ocelli irregularly scattered, sometimes arranged in a non-continuous longitudinal series, suprabasal ocellus 1, usually larger. Autoicous. Androecia on a short or long branch, terminal; gynoecia on short lateral branches, bract lobe and bracteole margins entire.





g. 1. *Leptolejeunea picta* Hara. a & c: Marginal cells of leaf lobes. b & e: Median cells with ocelli and oil bodies of leaf lobes. d: Apex cells leaf lobe. f: Portion of sterile plant, ventral view. g & m: Underleaves. h: Leaf, ventral view. I & j: Leaf lobules. k: Leaf of cladium. Cladium, ventral view. All drawn from *J.D. Yang 473-fg*.

◎ 賞苔蘚小叮嚀

- 1.輕鬆的登山健行穿著加上一顆喜愛親近自然的心，若能隨身攜帶一個10倍放大鏡更佳。
- 2. 在區內規劃之步道周邊賞苔蘚，並遵守相關規定，注意安全。
- 3. 不任意刮取或挖採苔蘚、攀折植物，以減低對生態的衝擊。
- 4. 苔蘚植物對環境極為敏感，愛它就把它留在原地，不要帶回家。

Thanks

for

your attention