

The Mosses of Easter Island

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Abstract: The bryophyte flora of Easter Island has been poorly known primarily because few botanists have collected there. In order to increase the knowledge of the flora the two authors collected bryophytes from 12 localities on the island from April 28-May 3, 2000. The small island, which is south of the Tropic of Capricorn, is of volcanic origin and the volcanic soil as well as the destruction of most of the native flora have undoubtedly contributed to the paucity of bryophytes. The present study revealed that the bryophyte flora consists of only a few species, including one unidentifiable member of the Anthocerotaceae, 11 hepatics and 30 mosses. Eighteen mosses are new to the island. Three mosses, *Chenia leptophylla* (Müll. Hal.) R. H. Zander, *Dicranella hawaiiica* (Müll. Hal.) Broth. and *Tortella humilis* (Hedw.) Jennings, are new for Chile, while three, *Fissidens pascuanus* Broth. in Skottsbl., *Ptychomitrium subcylindricum* Thér. and *Trematodon pascuanus* Thér., are presently known to be endemic to Easter Island. Two of the three endemics, *Fissidens pascuanus* and *Ptychomitrium subcylindricum*, were rediscovered on the island. *Fissidens pascuanus* was found with sporophytes for the first time and a revised description of the species is provided.

Introduction

Easter Island (Fig.1) is sometimes considered the world's most isolated island (Samagalski 1990). The small island, which is owed by Chile, is called Isla de Pascua in Spanish or Rapa Nui in Polynesian. It was discovered by the Dutch mariner Jacob Roggeveen who named it Easter

Island after the date of his discovery in April 1772. It has also been given several other names, such as San Carlos, named for King Carlos of Spain, by the first Spanish to land on the island, and Davis's Land, given to it when it was confused with land named by English buccaneer Edward Davis in the 17th century.



Fig. 1. Scenes of Easter Island. A. View of landscape showing rolling hills and ocean in background. B. View of landscape showing small woodland and hills in background. C. View of Rano Raraku quarry where statues (moai) were carved by natives from volcanic basalt. D. View of landscape showing one of many roads leading into interior of island.

According to the last census in 1992 there are only 2,764 inhabitants on the island. There is just one paved road on the island that goes around most of its perimeter but there are numerous dirt roads into the interior making most of the island accessible for botanical collecting. The island was accessible only by ship until recently when planes have been able to use a small landing strip originally built for emergency landings by the U.S. space shuttle.

Geography

Easter Island is a small, hilly volcanic island just south of the Tropic of Capricorn in the Pacific Ocean in the southern part of the Polynesian island group. It is only 117 square km in size and is 23 km in maximum length by 12 km in maximum width. The nearest populated land mass is Pitcairn Island, 1,900 km west, while the South American coast of Chile is 3,700 km to

the east. The island was formed from the lava of three separate volcanic cones of different ages coalesced into a single triangular land mass. Terevaka (Fig. 2 A), the largest volcano rising 652 m above sea level, is in the northern corner of the island, Katiki (Fig. 2 B), is about 400 m, forming the eastern headland of the Poike peninsula and Rano Kau (Fig. 2 C), about 410 m, is in the southwest corner. All three volcanoes are now extinct. Smaller craters include Puna Pau (Fig. 2 D) and Rano Raraku (Fig. 2 E), both of which contain freshwater lakes. The volcanic slopes are mostly gentle except where wave erosion has produced vertical cliffs. Basalt is the chief type of rock found on the island. Rugged lava fields cover much of the island's interior although several areas have soil adequate for cultivation. There are many caves on the island, some small ones in the interior, often called "banana caves" because of the banana plants growing at their entrance. There are also some

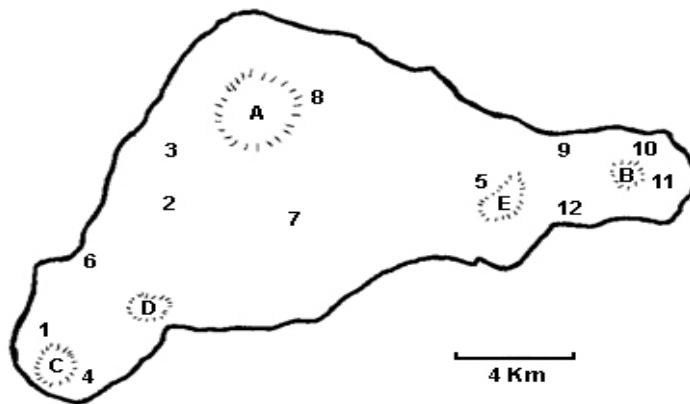


Fig. 2. Map of Easter Island showing collecting localities and volcanoes (A. Terevaka. B. Katiki. C. Rano Kao. D. Puna Pau. E. Rano Raraku).

larger caves along the seaside cliffs which are mostly devoid of bryophytes because of the salt water. The volcanic soil of the island is extremely porous so that water quickly drains underground. There are no permanent streams and there is only one small waterfall in the interior of the island which is usually dry during times of low rainfall. The island is considered part of Region V or the Valparaiso region according to the atlas of Chile (Arzón 1986).

Climate

Winds and ocean currents are responsible for strongly influencing the islands subtropical climate. The hottest months are January and February, while the coolest are July and August. The average maximum summer temperature is 28° C with the average minimum being 15° C . The average winter maximum is 22° C with the average minimum being 14° C. Light showers occur throughout most of the winter, with May being the wettest month, but tropical downpours can occur during all seasons.

Vegetation

The vegetation of Easter Island has been discussed by Skottsberg (1927) who was on the island collecting and observing the vegetation for about two weeks. Most of the island is covered by coarse grasses (e.g., *Agrostis*, *Axonopus*, *Bothriochloa*, *Briza*, *Cenchrus*, *Chloris*, *Danthonia*, *Eleusine*, *Eragrostis*, *Dichelachne*, *Melinis*, *Setaria*, *Sporobolus*, *Stipa*) and *Eucalyptus* groves which were introduced within the past century . It is believed that the island vegetation was much more luxuriant, perhaps including forests with palms (e.g., *Jubaea chilensis*) and conifers. Some plants are endemic, among them the tree species toromiro, *Sophora toromiro* (Fabaceae) and several ferns (e.g., *Thelypteris espinosae*, *Elaphoglossum skottsbergii*, *Polystichum fuentesii*, *Doodia paschalis*). Toromiro became extinct in 1962 but was reintroduced from European-cultivated saplings in 1995 by the National Parks of Chile. More than 60 other trees and shrubs have also been introduced to the island. There are a few lichens, including several crustose species (e.g.,

Graphis) and a few foliose (e.g., *Parmelia*) and fruticose species (e.g., *Cladonia*). However, there are relatively few bryophytes, the plants undoubtedly finding the volcanic rock and porous volcanic soil, as well as the predominance of pines and eucalyptus trees unsuitable for growth.

BRYOPHYTE COLLECTING

There have been few published reports of bryophytes collected on Easter Island. M. F. Fuentes (1913) was apparently the first to visit the island in 1911 for the purpose of collecting plants. Although he collected mostly vascular plants, he also collected two mosses, *Campylopus* sp. and *Papillaria pascuana* Thér. ex Broth. (= *P. crocea* (Hampe) A. Jaeger), and one thalloid liverwort, *Marchantia berteriana* Lehm. & Lindenb. A few years later, in 1917, Carl Skottsberg collected 14 taxa of mosses. Most of his collecting was done in the environs of Rano Kao in the southwest corner of the island. Six species were described as new to science by V. F. Brotherus (1924), namely *Campylopus dicranodontioides* (= *C. vesticaulis* Mitt. in Mell.), *C. hygrophilus* (= *C. vesticaulis* Mitt. in Mell.), *C. saxicola* (hom. illeg. = *C. vesticaulis* Mitt. in Mell.), *C. turficola* (= *C. vesticaulis* Mitt. in Mell.), *Fabronia macroblepharioides* (= *F. jamesonii* T. Taylor), and *Fissidens pascuanus*. Of these, only *Fissidens pascuanus* is known to be endemic to Easter I. The other taxa collected by Skottsberg were *Bryum argenteum* var. *lanatum* (P. Beauv.) Hampe, *Campylopus introflexus* (Hedw.) Brid., *Macromitrium* sp., *Papillaria pascuana* Thér. ex Broth. (= *P. crocea* (Hampe) A. Jaeger, *Philonotis laxissima* Mitt. (= *P. hastata* (Duby) Wijk & Margad.), *Racopilum cuspidigerum* (Schwägr.) Ångstr., *Weissia flavipes* Hook. f. (= *W. controversa* Hedw.), and *Weissia* sp.. Finally, Thériot (1937) reported some additional taxa for the island from a French-Belgium expedition in 1934-1935, namely two new endemic species, *Ptychomitrium subcylindricum* Thér. and *Trematodon pascuanus* Thér., and a sterile *Ceratodon* sp. and *Dicranella* sp. Four specimens of mosses, collected by Carlos Pizani in 1975 at Rano Aroi and Rano Kau, were sent to Dr. Harold Robinson for identification by M. Mahu. These were *Campylopus vesticaulis* Mitt. in Mell., *Papillaria*

crocea (Hampe) A. Jaeger, *Tortella humilis* (Hedw.) Jennings and *Pyrrhobryum spiniforme* (Hedw.) Mitt., which was the only one collected at Rano Kau.

The authors collected bryophytes from 12 localities throughout Easter Island (Fig. 2) during the week of April 28 to May 3, 2000. The hepatics and one Anthocerotaceae were sent to Dr. Riclef Grolle, Friedrich-Schiller-Universität, Jena Germany, for identification. He was able to identify the hepatics, of which there were 10 taxa. *Marchantia berteriana*, collected by Fuentes (l.c.), was not rediscovered and with it the total number of hepatics known for the island is 11. The only Anthocerotaceae plants collected were sterile and without spores rendering them impossible to identify. The results of his findings are being published elsewhere.

Mosses collected on Easter Island by R.R. Ireland and G. Bellolio

All collections are deposited in the Smithsonian Institution (US), while many duplicates are deposited in the Missouri Botanical Garden (MO) and the University of Concepción (CONC). Most of the collection numbers are mosses but there are also some lichens, Anthocerotaceae and hepatics.

COLLECTING LOCALITIES

1. Rano Kao, Mirador, 27° 10' S, 109° 26' W. Alt. 315 m. April 28, 2000. Nos. 30,000-30,025
2. Puna Pao, 27° 08' S, 109° 24' W. Alt. ca. 100 m. April 28, 2000. Nos. 30026-30031
3. Ana Te Pahu (banana caves), 27° 06' S, 109° 24' W. Alt. ca. 100 m. April 28, 2000. Nos. 30032-30053
4. Orongo, 27° 10' S, 109° 26' W. Alt. ca. 307 m. April 29, 2000. Nos. 30054-30055
5. Rano Raraku, 27° 08' S, 109° 17' W. Alt. ca. 210 m. April 29, 2000. Nos. 30056-30068
6. Hanga Roa, 27° 08' S, 109° 25' W. Alt. ca. 50 m. April 30, 2000. Nos. 30069-30083
7. Fundo Vaitea, 27° 08' S, 109° 21' W. Alt. ca. 50 m. April 30, 2000. No. 30084
8. Terevaca & Rano Aroi, 27° 05' S, 109° 22' W. Alt. ca. 470 m. May 1, 2000. Nos. 30085-30116
9. Poike, Maunga Puka Tikei, 27° 06' S, 109° 15' W. Alt. ca. 370 m. May 2, 2000. Nos. 30117-

30128

10. Poike, Nanga Vai Heva, 27° 06' S, 109° 15' W. Alt. 250 m. May 2, 2000. Nos. 30129-30130

11. Vai Atare, 27° 11' S, 109° 25' W. Alt. 200 m. May 3, 2000. Nos. 30131-30142

12. Vai Tara Kaiu, near beach, 27° 03' S, 109° 20' W. Alt. 10 m. May 3, 2000. No. 30143

List of taxa

The mosses were identified by the senior author, with the exception of the genus *Campylopus* which was identified by J.-P. Frahm, Botanisches Institut der Universität Bonn, Germany, *Fissidens*, which was identified by R. A. Pursell, Pennsylvania State University, University Park, PA., and four mosses collected by Carlos Pizani identified by Harold Robinson, Smithsonian Institution. The mosses for Polynesia, which includes Easter Island, have been summarized by Miller *et al.* (1978). An asterisk indicates the taxon is new for the island but has been reported from Chile by He (1998). A double asterisk indicates the taxon is new for Chile. Numbers after each taxon refer to the authors collecting numbers which are listed following each of the localities in the Collecting Localities list. All collections are without sporophytes except where indicated. Specimens collected by other botanists, which were not collected by the present authors but are the only ones known for the island, are included in the list with their name and literature citation, if published, following the taxon. The C. Pizani collections have the collecting locality following his collection number. Nomenclature follows Crosby *et al.* (1999), except for *Campylopus* which follows Frahm (1999).

**Anisothecium hookeri* (Müll. Hal.) Broth. - 30107

**Blindia magellanica* W.P. Schimper in Müll. Hal. ? - 30010

**Brachymenium indicum* (Dozy & Molk.) Bosch & Sande Lac. - 30075 (c. fr.), 30076 (c. fr.)

Bryum argenteum Hedw. (includes var. *lanatum* (P. Beauv.) Hampe) - 30058 (mixed with *Chenia leptophylla*), 30070, 30071

**Bryum* sp. - 30062, 30063, 30064, 30126

**Campylopus clavatus* (R. Br. in Schwägr.) Wils.

in Hook. f. - 30011, 30086, 30090

Campylopus introflexus (Hedw.) Brid. - 30089, 30117

Campylopus vesticaulis Mitt. in Mell. - 30006, 30007, 30008, 30009, 30027, 30087, 30088, 30091, 30118, 30119, 30129, 30133, 30134; Pizani 10616 (Rano Aroi)

**Ceratodon purpureus* (Hedw.) Brid. ? - 30125

***Chenia leptophylla* (Müll. Hal.) R. H. Zander - 30058, 30059, 30060, 30074, 30143

**Dicranella cardotii* (R. Br.) Dixon - 30094, 30095, 30131

***Dicranella hawaiiica* (Müll. Hal.) Broth. ? - 30093

**Ditrichum difficile* (Duby in Moritzi) M. Fleisch. - 30092 (c. fr.)

Fabronia jamesonii T. Taylor - 30032, 30069 (c. fr.)

Fissidens pascuanus Broth. in Skottsberg - 30049, 30097, 30100, 30101, 30102, 30103, 30120, 30121(c. fr.), 30122 (c. fr.), 30123 (c. fr.), 30124 (mixed with *Leptobryum pyriforme*)

**Fissidens pellucidus* Hornsch. forma- 30012, 30013, 30041, 30042, 30043, 30044, 30045 (c. fr.)

**Isopterygium albescens* (Hook. in Schwägr.) A. Jaeger - 30098

**Leptobryum pyriforme* (Hedw.) Wils. - 30039, 30040, 30124 (mixed with *Fissidens pascuanus*)

Macromitrium sp. - Skottsberg (1917).

Papillaria crocea (Hampe) A. Jaeger - Fuentes (1913), Skottsberg (1917), Pizani 10612 (Rano Aroi)

Philonotis hastata (Duby in Moritzi) Wijk & Margad. - 30050

**Pohlia* sp. - 30020, 30047, 30048, 30084

Ptychomitrium subcylindricum Thér. - 30072 (c. fr.)

**Pyrrhobryum spiniforme* (Hedw.) Mitt. - 30085, 30106, Pizani 10615 (Rano Kau)

Racopilum cuspidigerum (Schwägr. in Gaudich. in Freyc.) Ångstr. - 30033, 30034, 30035, 30036, 30037, 30038, 30096, 30105

**Sematophyllum aberrans* (Broth. in Skottsberg.) E. B. Bartram - 30002, 30003, 30004, 30005, 30132 - All c.fr.

- **Sematophyllum brachycladulum* (Broth. in Skotts.) Broth. - 30099 (c. fr.), 30104
 ***Tortella humilis* (Hedw.) Jennings - Pizani 10609 (c. fr.) (Rano Aroi)
Trematodon pascuanus Thér. - Theriot (1937)
Weissia controversa Hedw. - 30000 (c. fr.), 30001, 30046, 30054 (c. fr.), 30130 (c. fr.)

Discussion

Eighteen species of mosses, including two that are new but unidentifiable beyond genus (*Bryum* and *Pohlia*), are added to the bryophyte flora of Easter Island, bringing the total number of mosses known for the island to 30. *Chenia leptophylla*, *Dicranella hawaiiica* and *Tortella humilis* are also new to Chile. Taxa not collected by the authors include, *Papillaria crocea*, *Macromitrium* sp., *Tortella humilis* and *Trematodon pascuanus*. The genus *Pohlia* was never reported for the island while *Bryum* has a variety, *Bryum argenteum* var. *lanatum*, that has been previously reported. One unidentifiable Anthocerotaceae and 11 hepatics are also now known from the island as a result of the recent collections by the authors.

Fissidens pascuanus was collected 11 times in several different localities. The plants collected in one locality at Poike, Maunga Puka Tikei, possessed sporophytes, which are the first ever to be collected. Brotherus (1924), who saw only two collections of the species, neither with sporophytes, placed it in the section *Amblyothallia* Müll. Hal. However, R. Pursell (pers. comm.), who identified our specimens, noted that the species belongs in the section *Semilimbium* Müll. Hal. because of a weak limbidium on the vaginant laminae of the perichaetial leaves (Fig.3 D). Therefore, a complete and more detailed description of this endemic species based on our recent collections is necessary to clarify the important features.

Plants 2-5 (7) mm long, somewhat erect to decumbent, simple. Leaves slightly curled when dry, secund at stem tips, 1-2 mm long, 0.2-0.5 mm wide, elliptic to linear-lanceolate, acute to short-acuminate; margins entire, indistinct border of short, elongate cells present only at base of vaginant laminae of perichaetial leaves; costa prominent, ending a few cells below apex or

percurrent; dorsal lamina ending above leaf insertion or sometimes extending to insertion; vaginant laminae ca. 2/3 the leaf length, nearly equal; cells unistratose, pluripapillose, usually apical and 1-2 adjacent cells smooth, irregularly hexagonal to quadrate or rectangular, median vaginant laminal cells (5) 6-9 (12) μm long. Synoicous. Setae terminal, 1-2 per perichaetium, 2-3 mm long, yellow to reddish with age; capsules 0.3-0.6 mm long, cylindrical when wet, erect to slightly horizontal, often ovate at base and shrunken under mouth when dry; opercula long-rostrate; peristome teeth deeply forked, striate below, spirally thickened above. Spores 9-12 μm , round, minutely papillose. Calyptra mitrate, smooth.

On volcanic rock or soil in small caves, 100-470 m.

Illustrations and SEM photomicrographs: Figs. 3 and 4.

The plants are synoicous but sometimes they appear to be dioicous when some inflorescences contain only a few antheridia that are difficult to find. Ronald Pursell, however, after an extensive examination, determined that all the plants he examined are synoicous

This species is morphologically close to *F. guianensis* Montagne of northern South America, West Indies, Mexico and southeastern United States (Florschütz 1964). *Fissidens pascuanus* differs from it primarily by the entire leaf margins and the weak limbidium that is only present on the vaginant laminae of the perichaetial leaves and has never been observed to be intramarginal as in that species.

Easter Island has 50% of its moss flora in common with Chile (15 taxa) and the about the same percent in common with the Hawaiian Islands (13 taxa) which is approximately twice as far away, i.e., 7,700 km southeast compared to Chile which is 3,700 km east. Those taxa in common with Chile are *Anisothecium hookeri*, *Blindia magellanica*, *Brachymenium indicum*, *Campylopus clavatus*, *C. introflexus*, *C. vesticaulis*, *Ceratodon purpureus*, *Dicranella*

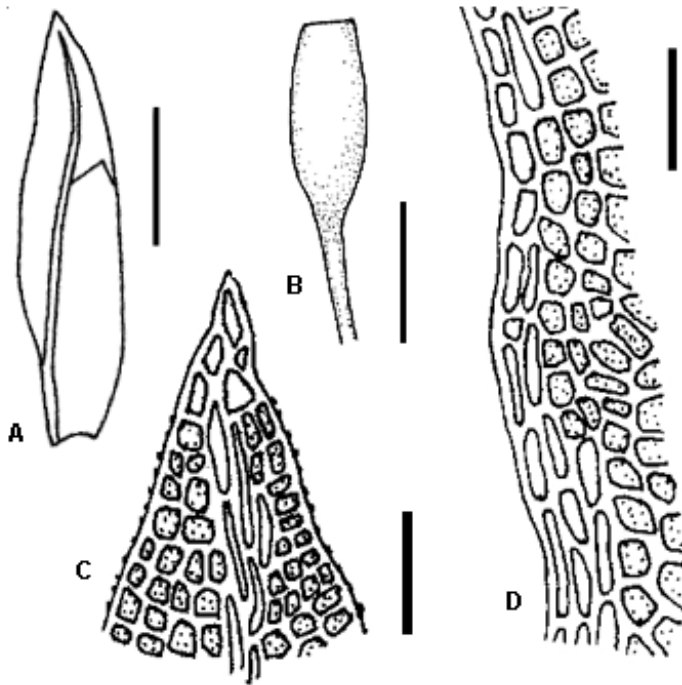


Fig. 3. *Fissidens pascuanus*. A. Leaf. B. Inoperculate capsule (wet). C. Apical leaf cells. D. Basal leaf cells of vaginant lamina of perichaetial leaf. Measurement bar for leaf and capsule = 0.5 mm; for apical and basal cells = 10 μ m. From Ireland & Bellolio 30122, US.

cardotii, *Ditrichum difficile*, *Fabronia jamesonii*, *Leptobryum pyriforme*, *Racopilum cuspidigerum*, *Sematophyllum aberrans*, *S. brachycladulum* and *Weissia controversa*. The taxa in common with the Hawaiian Islands are *Brachymerium indicum*, *Bryum argenteum* var. *lanatum*, *Campylopus introflexus*, *Ceratodon purpureus*, *Chenia leptophylla*, *Dicranella hawaiiica*, *Isopterygium albescens*, *Leptobryum pyriforme*, *Philonotis hastata*, *Pyrrhobryum spiniforme*, *Racopilum cuspidigerum*, *Tortella humilis* and *Weissia controversa*. On the other hand, Easter I. only has 38% of its moss flora in common with the Juan Fernandez Islands which is 300 km closer to those islands (3,400 km) than to mainland Chile (3,700 km). One explanation for the low percentage in common with the Juan Fernandez Islands may be the vascular flora, particularly the trees, on Easter Island was destroyed by the

natives unlike the less disturbed flora on the Juan Fernandez Islands. Also, the Juan Fernandez Islands are farther south than Easter Island and closer to the more diverse flora in that part of Chile making it easier for the wind and birds to carry moss diaspores to the islands. It is worth mentioning that all three endemic species of Easter Island are known to produce sporophytes but wind dispersal of the spores has apparently not played a role in dissemination of the species. On the other hand, further collecting and monographic studies may reveal that all three species occur elsewhere. Finally, it is of interest to note that two species that were previously known to be endemic to the Juan Fernandez Islands (Robinson 1975) also occur on Easter I., namely *Sematophyllum aberrans* and *S. brachycladulum*.

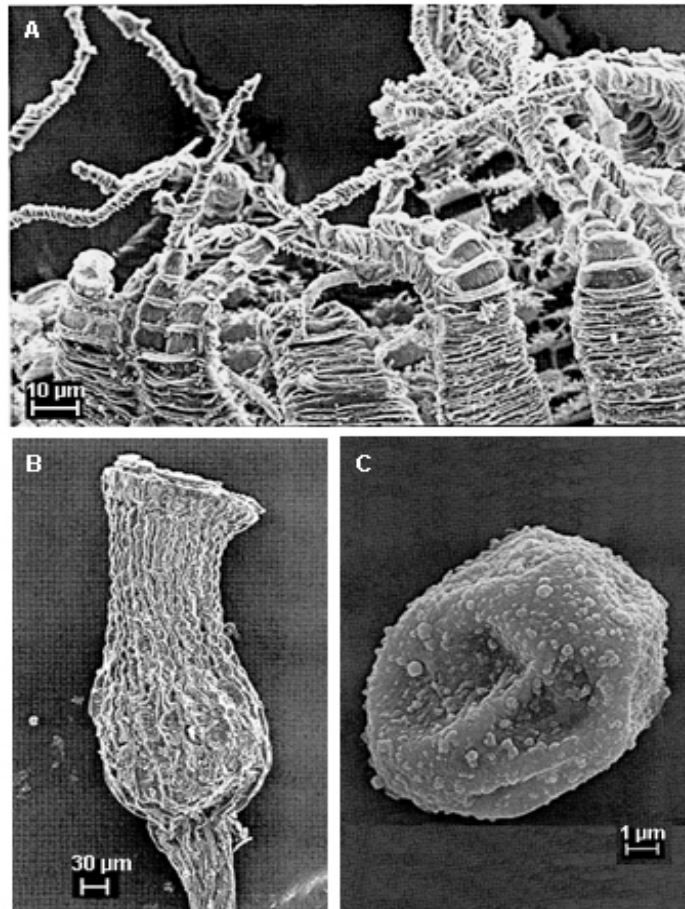


Fig. 4. *Fissidens* (dry). C. S.

ate capsule
JS.

Acknowledgements

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