CORTICOLOUS MYXOMYCETES OF TAIWAN: ON THE BARK OF *PINUS* TREES FROM CENTRAL AND NORTHERN TAIWAN

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(Manuscript received 23 April, 1991; revised version accepted 30 May, 1991)

Abstract: A total of 524 bark samples were collected from five species of *Pinus* trees in the central and northern Taiwan. And 237 corticolous Myxomycetes were then obtained one to two monthes after the preparation of moist-chamber cultures of the bark samples. They distribute in eleven genera, i.e. *Arcyria*, *Clastoderma*, *Comatricha*, *Cribraria*, *Diderma*, *Echinostelium*, *Enerthenema*, *Licea*, *Macbrideola*, *Physarum*, and *Trichia*. The species of the Myxomycetes and their substrate living trees are shown in a table. Among the twenty four species identified seven are new to Taiwan and two are rediscovered for the first time since the publication of Nakazawa's list in 1929. The newly recorded species are *Comatricha acanthodes* Alexop., *C. lurida A.* Lister, *Cribraria confusa* Nann.-Brem., *Licea capitata* B. Ing and Mottugh, *Licea kleistobolus* Martin, *Macbrideola martinii* (Alexop. Beneke.) Alexop., and *Physarum auriscalpium* Cooke. The two rediscovered species are *Arcyria pomiformis* (Leers) Rost. and *Physarum cinereum* (Batsch) Per. A detailed descriptions and pictures of the above nine species are provided. Two specimens of the genera *Diderma* and *Macbrideola* manifesting unusual and unique features may upon further study warrent descriptions as new taxa.

INTRODUCTION

Bark of living trees and vines has been known to be an unique and favorite habital for Myxomycetes. Species of *Juniperus*. *Ulmus*, and *Vitis* were reported to support the greatest number and diversity of corticolous Myxomycetes (Keller 1978; Eliasson *et al.* 1988). And many members of certain genera are restricted to this habitat (Martin and Alexopoulos, 1969; Keller and Brooks, 1976, 1977; Pando and Lado 1988, 1990). Based on the collecting data of the investigating papers of the Myxomycetes in Taiwan, the information on the corticolous Myxomycetes is rather limited (Liu, 1983; Wei and Liu, 1989; Liu *et al*, 1989, 1990). As to the investigation of Myxomycete biota on a certain genus of tree, it obviously is totally lacking. In view of this, a proposition was made to survey the Myxomycetes on bark of a single genus of tree in an attempt to see if the association exists between the taxa of Myxomycetes and the kinds of tree bark.

The genus *Pinus* was selected primarily due to the surface of its bark. The rough surface with laminate accumulation of the bark provides good bed for plasmodia not only to grow but also to form resistant structure when environmental conditions are unfavorable. Five species of *Pinus* that are common in

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Taiwan were chosen because of their abundance. Collection of bark was restricted to the northern and central part of Taiwan due to the time limitation of the grant of this study. This study was supported by the National Science of Council of ROC in Taipei, to which it is acknowledged.

MATERIAL AND METHODS

1. Field collection

Bark samples, 3 from each trunk and at approximately 1.3-1.5 m high above ground, were collected from five species of *Pinus* trees that are common on this island. Each sample was then cut into the size of ca 2 × 3 cm for moist chamber cultures (Gilbert & Martin, 1933). Table 1 shows the collecting data.

Table 1. Collection data

Pinus spp.	Collecting sites (# in map 1)	Altitude	Total no. of tree trunk for bark samples
P. taiwanensis	An-Ma Mt. area (# 5)	2000-2500 m	111
P. massoniana	Huo-Yan Mt area (# 4)	250 m	101
P. thunbergii	Mien-T'ien P'ing, Erh-Tzu P'ing (# 1)	200-300 m	90
P. elliotii	National Ch'ing-Hua Univ. (# 3)	10 m	126
P. luchuensis	Shih-Ting Hsiang, P'ing-Lin Hsiang (# 2)	500-700 m	96

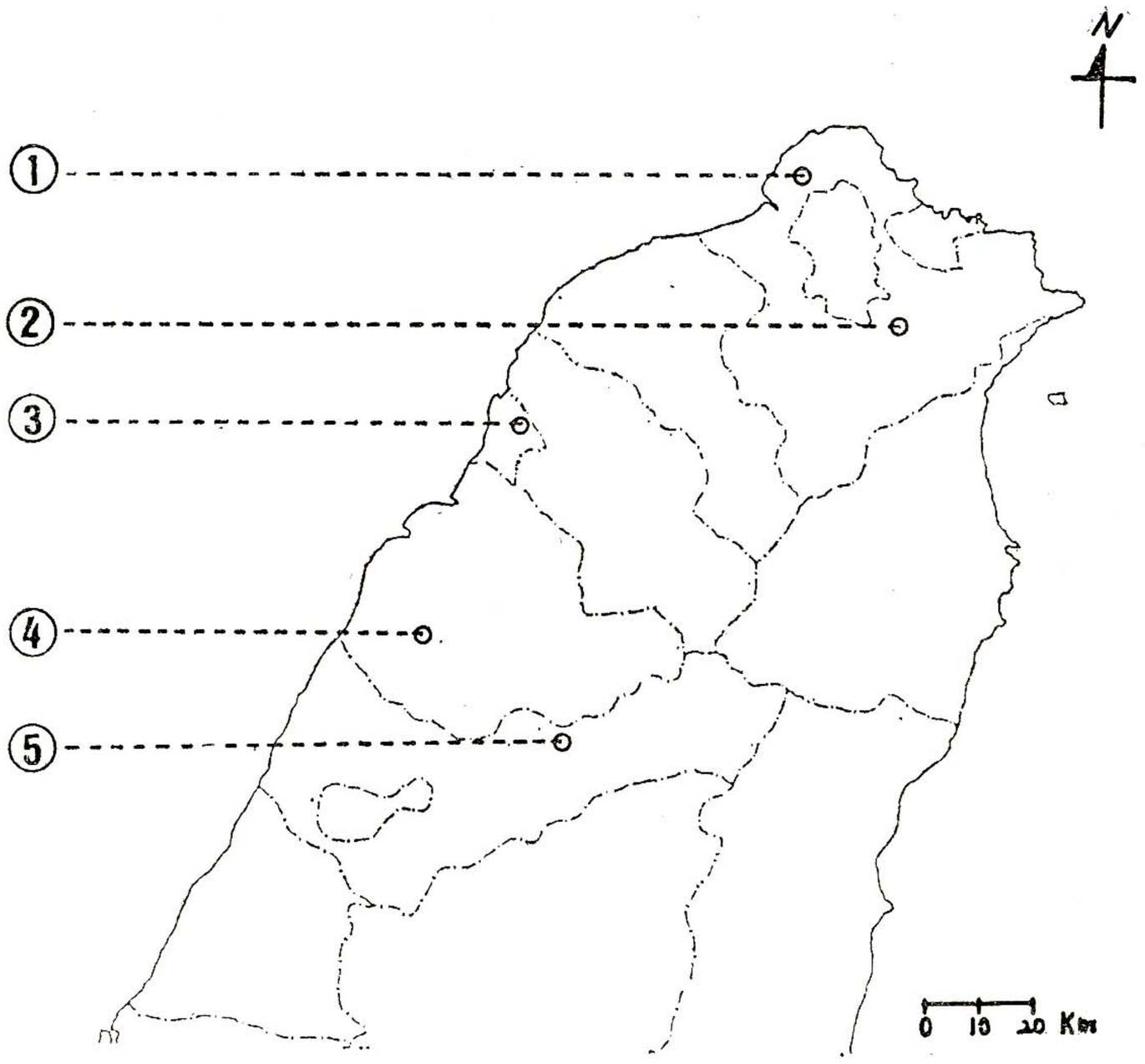
2. Moist-chamber cultures

Mois chambers were prepared immediately or within 3 days after collections of bark samples. It was down by using a 9 cm diameter glass Petri-dish which contains a piece of filter paper (# 1). After being autoclaved, each Petri-dish is aligned on the inside with pieces of bark (upper surface down). Pour sterilized distilled water over the bark and let it soak overnight. Pour off all the water and place the Petri-dishes with aligned bark (upper surface up) to incubate under 25±1°C. Examine periodically for plasmodia or fruiting bodies. Add small amount of water as needed to keep the filter paper moist.

Plasmodia may appear 1-2 weeks after incubation, then reduce moisture in the containers to facilitate frutification. Light illumination may be required for induction of fruiting body formation. If there are no prominent plasmodia, then carefully examine the bark and the chamber under a stereo-microscope (x10-x64) to detect the presence of microscopic fruiting bodies. In general, the bark would produce Myxomycete fruiting bodies within 30 days of incubation if they are available.

3. Identification

For species identification, Martin and Alexopoulos's system (1969) is followed. Several other references are also refered and listed under separate taxa. All specimens are deposited in the Mycology laboratory, Department of Botany, National Taiwan University.



①: *Pinus thunbergii*—Taipei Hsien, Ta-T'ung Mt. Mien-T'ien Ping and Erh-Tzu P'ing
②: *Pinus luchuensis*—Taipei Hsien, Shih-Ting Hsiang and P'ing-Lin Hsiang
③: *Pinus elliotii*—Hsin-Chu City, National Ch'ing-Hua Univ.
④: *Pinus massoniana*—Miao-Li Hsien, Huo-Yan Mt.
⑤: *Pinus taiwanensis*—Tai-Chung Hsien, An-Ma Mt.

Map 1. Geographical location of the five collecting sites.

RESULTS

A total of 237 specimens of Myxomycetes fruiting bodies representing 26 species of 11 genera (Table 3) were obtained. Table 2 shows the frequency of *Pinus* bark producing Myxomycetes fruiting bodies. *Pinus elliotii* is the best of

Table 2. Frequency of *Pinus* tree bark with Myxomycetes

Pinus spp.	Total no. trunk for bark samples	Those producing fructing bodies	Frequency (%)	No. of Taxa
P. Taiwanensis	111	4	3.6%	6 genera 6 species
P. massoniana	101	31	30.7%	6 genera 7 species
P. thunbergii	90	21	23.3%	7 genera 13 species
P. elliotii	126	80	63.5%	6 genera 8 species
P. luchuensis	96	42	43.8%	10 genera 16 species

Table 3. List of corticolous Myxomycetes found on the five species of *Pinus* trees

	P. taiwanensis	*P. massoniana*	*P. thunbergii*	*P. elliotii*	*P. luchuensis*
Order. LICEALES					
Fami. CRIBRARIACEAE					
*1. *Cribraria confusa*	Yes	Yes	Yes	Yes	Yes
2. *Cribraria microcarpa*			Yes		Yes
Fami. LICEACEAE					
*3. *Licea capitata*					Yes
*4. *Licea kleistobolus*			Yes		
5. *Licea operculata*	Yes	Yes			
Order. ECHINOSTELIALES					
Fami. ECHINOSTELIACEAE					
6. *Echinostelium minutum*	Yes		Yes	Yes	Yes
Order. TRICHIALES					
Fami. TRICHIACEAE					
7. *Arcyria cinerea*			Yes	Yes	Yes
†8. *Arcyria pomiformis*				Yes	
9. *Trichia botrytis*					Yes
Order. PHYSARALES					
Fami. DIDYMIACEAE					
10. *Diderma effusum*		Yes	Yes	Yes	Yes
11. *Diderma platycarpum*			Yes		
#12. *Diderma* sp.					Yes
Fami. PHYSARACEAE					
*13. *Physarum auriscalpium*			Yes		
†14. *Physarum cinereum*			Yes	Yes	Yes
15. *Physarum nutans*				Yes	Yes
16. *Physarum roseum*			Yes		
Order. STEMONITALES					
Fami. STEMONITACEAE					
*17. *Comatricha acanthodes*	Yes				
18. *Comatricha aequalis*					Yes
19. *Comatricha elegans*		Yes			
20. *Comatricha laxa*		Yes			Yes
*21. *Comatricha lurida*					Yes
22. *Enerthenema papillatum*	Yes				
23. *Clastoderma debaryanum*		Yes		Yes	Yes
24. *Macbrideola cornea*		Yes	Yes		Yes
*25. *Macbrideola martinii*	Yes		Yes		
#26. *Macbrideola* sp.			Yes		

*: New record #: Unidentified †: Rediscovered species

the five species studied, with 63.55% tree trunk producing Myxomycetes fruiting bodies, while in *Pinus taiwanensis* only 3.6% of tree trunks have Myxomycetes. As to the diversification (species) of Myxomycetes, *Pinus luchuensis* have 16 different species, the one with the most abundant species among the Pinus trees studied.

Of the twenty-six species, seven are new to Taiwan, two are rediscovered for the first time since 1929 (Nakazawa, 1929). The newly recorded species are *Cribraria confusa, Licea capitata, L. kleistobolus, Physarum auriscalpium. Comatricha acanthodes, C. lurida,* and *Macbrideola martinii.* The two rediscovered species are *Arcyria pomiformis* and *Physarum cinereum.* Two specmens belonging to the genera *Diderma* and *Macbrideola* respectively possess distinct characters which await further study before their definite identities can be made. Detailed descriptions of the above nine species are provided below.

Cribraria confusa Nann.-Brem. Yamam. Proc. Kon. Ned. Akad. Wetensch. C, **86:** 212, 213. 1983. (Plate I: 1-4)

Fructification sporangiate, gregarious, total height 0.225-1.10 mm; sporangia globose, orange yellow, 0.075-0.225 mm in diameter (about 1/4-1/5 of total height); stalk slender, tapering, orange yellow to brown, enclosing irregular or granular refuse matter in the lower one third length (from base), refuse matter scarce and finally lacking upward, appearing fibrous transparent in the upper part, deeply furrowed under SEM; hypothallus membranous, transparent, discoid; peridium early evanescent, remaining as a meshed-net and a minute basal disk, basal disk membranous, transparent, from which radiating 9-10 strands of net threads, meshes 4-6 (-7) angled, 25-30 μm, nodes slightly widened, elongated in some, without free ends, the net threads wider at base; dictydine granules all over the disk and the nodes, often scarce and scattered or absent on the threads connecting the nodes; spores in mass orange yellow, pale yellow in transmitted light, globose, 5.5-8.5 μm in diameter, spinulate. Plasmodium unknown.

This species is separated from *Cribraria minutissima* in the absence of a distinct peridial cup, the calyculus, which occupied 1/3-2/3 of the sporangium in *C. minutissima.*

Licea capitata B. Ing & McHugh, Trans. Br. Mycol. Soc. **78:** 439. 1982. (Plate II: 1-4)

Fructifications sporangiate, stipitate, scattered, up to 1 mm in total height; sporangia globose to short ovate, 0.20-0.25 mm in diameter (about 1/3-1/5 of total height), dingy brownish black on the lower part, glossy and yellowish brown on the top of the upper part; stalk long, stout (about 1/3 of sporangial diam.) widest at base (130 μm) and slightly attenuating, brownish black, filled with detritus and refuse matter in dark, hyaline, or various colors; peridium membranous, top part thin, brownish and glossy, rest lower part deposited with detritus and refuse matter as those in the stalk, opaque, dehiscent by a vertical slit at the top thin peridium; hypothallus not prominent; spores dark dingy brown in mass, yellowish in transmitted light, globose, 9-12 μm in diameter, nearly smooth by LM. Plasmodium unknown.

This species and *Licea operculata* are very similar in outer appearance of fruiting bodies and spores. Peridium of both species is opaque with deposition

of refuse matter at the lower part, glossy and thinner at the top region. The way of spore dehiscent is, however, different. In *Licea capitata* the spores are dehisced by a vertical slit while in *L. operculata* by a lid.

Licea kleistobolus Martin, Mycologia 34: 702. 1942. (Plate III: 1-5)

Fructifications sporangiate, sessile, loosely gregarious, urn-shaped, circular or illipsoid in outline, 75-175 μm in diameter, 50-75 μm in height, dark and opaque on the side wall with deposition of refuse matter, glossy, iridescent and transparent on the top; dehiscent by a lid, lid circular discoid in outline, 50-125 μm in diameter, convex, depressed along the margins, bearing on its inner surface blunt, cylindrical outgrowth, with coarse tubercles toward the margin, the upper surface marked by circular depression; margin of the sporangial mouth also marked by a row of tubercles on the inner surface as those on the lid; spores light browhish in mass, pale (brownish yellow) by transmitted light, globose, subglobose, minutely echinulate under high dry lens, by SEM the spore marked closely by low warts or spines, 9-10 (-11) μm in diameter.

The urn-shaped sporangia, the markings of the iridescent and transparent lid are the distinct characters of this species. This species also appears on the bark of *Podocarpus nagi*.

Physarum auriscalpium Cooke, Ann. Lyc. N. Y. 11: 384. 1877. (Plate IV: 1-4)

Fructifications plasmodiocarpous, the plasmodiocarps usually short, curved, or globular as pulvinate, sessile sporangia, 0.3-0.97 mm in diameter, sometimes branching and heaped, or annulate, 0.15-0.175 mm high, light yellow to orange; peridium smooth, membranous, frosted by a thin layer of lime granules, then dotted with yellow (brownish) often anastomosing lime scales (or patches) on the surface, often limeless at base, yellow olivaceous when young, becoming yellow at maturity; capillitium dense, the threads short, hyaline, connecting large, angular yellow lime nodes; spores brownish black in mass, violaceous brown to black brown in transmitted light, globose, 12-13 μm in diameter, spinulate, the spines prominent, about 0.5 μm tall. Plasmodium orange yellow.

This species has been reported as common and ubiquitous in the field as well as on bark in moist chambers (Farr, 1976) and considered as a species which may not be distinct from *Physarum decipiens* (Farr, 1967, 1976; Martin and Alexopoulos, 1969) with which it was confused previously (Farr, 1961). It also resembles *Physarum serpula* in the yellow plasmodiocarpous fruiting body, spore color and wall markings. The way of lime granules covering the peridium of these two species, however, is different. In *P. auriscalpium*, the lime granules aggregate in the form of scale-like and discretely cover the peridium but as a continuous uniform crust in *P. serpula* (Farr, 1976). Spores of our specimen (BY272M66A) are large (12-13 μm) on the rim of the large limit as described in the reference (Martin and Alexopoulos, 1969).

Comatricha acanthodes Alexop., Mycologia 50: 55. 1958. (Plate V: 1-4)

Fructifications sporangiate, total height 0.40-0.55 mm, solitary; sporrangia dark brown, globose, 0.13-0.22 mm in diameter, stipitate; peridium evanescent, but remaining as a discoid collar; stalk slender, about 2/3 of the total height, yellowish and broadest at base, silky black and tapering above, fibrous throughout

in transmitted light; hypothallus membranous, reddish brown; columella protruding the collar, reaching about 1/3 of the sporangium. appearing as a candlestick, from which forking to form capillitium; capillitium dichotomously branched three to four times, black, solid, without anastomosing; spores brown in mass, grayish brown in transmitted light, globose, 12–13 μm in diameter, prominently spiny, with spines up to 1 μm long. Plasmodium unknown.

This species is apparently rare in distribution, except from the type locality, Thasos (in Greece) (Alexopoulos, 1958). Mt. An-Ma (in Taichung Hsien, Taiwan) appears to be the fourth place in the world to have found it. Our specimen was obtained only once on the bark of *Pinus taiwanensis* Hay in moist-chamber cultures. The other two geographical area are Virginia (U.S.A.) (Martin and Alexopoulos, 1969) and Mt. Carmel (in Joara, Isarel) (Binyamini, 1987).

It is different from the tiny species of *Comatricha* in its characteristic capillitium and the large spiny spores. The discoid remains of the peridium at the base of the sporangium is distinct in our specimen, a characteristic not described in the references.

Comatricha lurida A. Lister, Mycet. 119. 1894. (Plate V: 5-6, Plate VI: 1-2)

Fructification sporangiate, 0.6–0.8 mm in total height; sporangia stipitate, globose, purplish black-brown, 0.13–0..22 mm in diameter; peridium fugacious; stalk black, slender, subulate, up to three-fourth of the total height, fibrilar and purplish black by transmitted light, arising from a scanty hypothallus; columella cylindric, purplish brown, reaching to about half the height of the sporangium, dividing at the tip into several stout branches which give rise to the capillitium; capillitium arising from main branches of columella, dividing repeatedly, with few anastomoses and many colorless free ends; spores purplish black in mass, lilacious brown by transmitted light, globose, 8–10 μm in diameter, warted, the warts appearing echinulate under SEM; Plasmodium not observed.

Macbrideola martinii (Alexop. & Beneke.) Alexop., Mycologia 59: 114. 1967 (Plate VI: 3-6)

Fructification sporangiate, scattered, total height 0.275–0.575 mm; sporangia globose, brown, 0.1–0.2 mm in diameter, stipitate; peridium thin, transparent, breaking from the top into shreds and evanescent at maturity; stalk slender, one half to two-third the total height, dark brown to black, hollow (viewed by SEM), at the tip with a discoid remain of the peridium, paler and broader at base; columella purplish black, reaching to the middle of the sporangium and dividing to form capillitium; capillitium branching dichotomously 4-6 times to form pale and rigid free ends, with no anastomoses; spores brown in mass, lilaceous brown by transmitted light, 7–9 μm in diameter, minutely verrucose; plasmodium unknown.

Very similar to *M. cornea*, but it can be distinguished from the latter by two ways. The total height of *M. martinii* is shorter, generally below 0.6 mm, while the total height of *M. cornea* is taller, generaly above 0.6 mm. The second way is by capillitium, in *M. martinii* more rigid at the terminating end area, but in *M. cornea* the free ends are flexuous.

Diderma sp. (Plate VII: 1-6)

Fructification sporangiate, scattered; sporangia sessile, somewhat globose,

0.175–0.350 mm high, 0.3–0.5 mm in diameter, ochraceous to brown; peridium glossy, transparent, smooth, without lime or other depositions; capillitium abundant, purplish brown to purplish red, sparsely and variously branched into fork, tri-fork and multi-fork, the threads 2–3 μm in diameter, usually perforate at the forking parts, the terminate ends dichotoumous, sharp, paler; hypothallus inconspicuous; spores purplish black in mass, violaceous brown by transmitted light, globose, 10–11 μm in diameter, distinctly echinulate; plasmodium not observed.

The specimen possesses a typical didermaceous capillitium. The glossy and limeless peridium is, however, a distinct character not known to any other members of this genus.

Macbrideola sp. (Plate VIII: 1-5)

Fructifications sporangiate, totoal height 0.4–0.6 mm; sporangia globose to pear-shaped, blackish brown, 0.35–0.40 mm in diameter, stipitate; peridium early evanescent; stalk stout, cylindrical, one-half of the total height, black-brown and appearing opaque by transmitted ligh, hollow, perforate at basal part (viewed by SEM); hypothallus discoid, black-brown; columella reaching the middle of the sporangium, balck-brown; capillitium arising from the upper half of the columella, branching dichotonously 3–4 times to form globose nets with free ends, the threads scattered with spines (viewed under SEM); spores brown in mass, violaceous brown by transmitted light, pyriform, 12.5–15.0 μm in diameter, in compact clusters of 3–6 to form a globe of 25 μm in diameter, distinctly warted or echinulate on the exposd area, the warts cylindric when viewed in SEM, ca 0.5 μm high and 0.25 μm in diameter, smooth elsewhere; plasmodium not observed.

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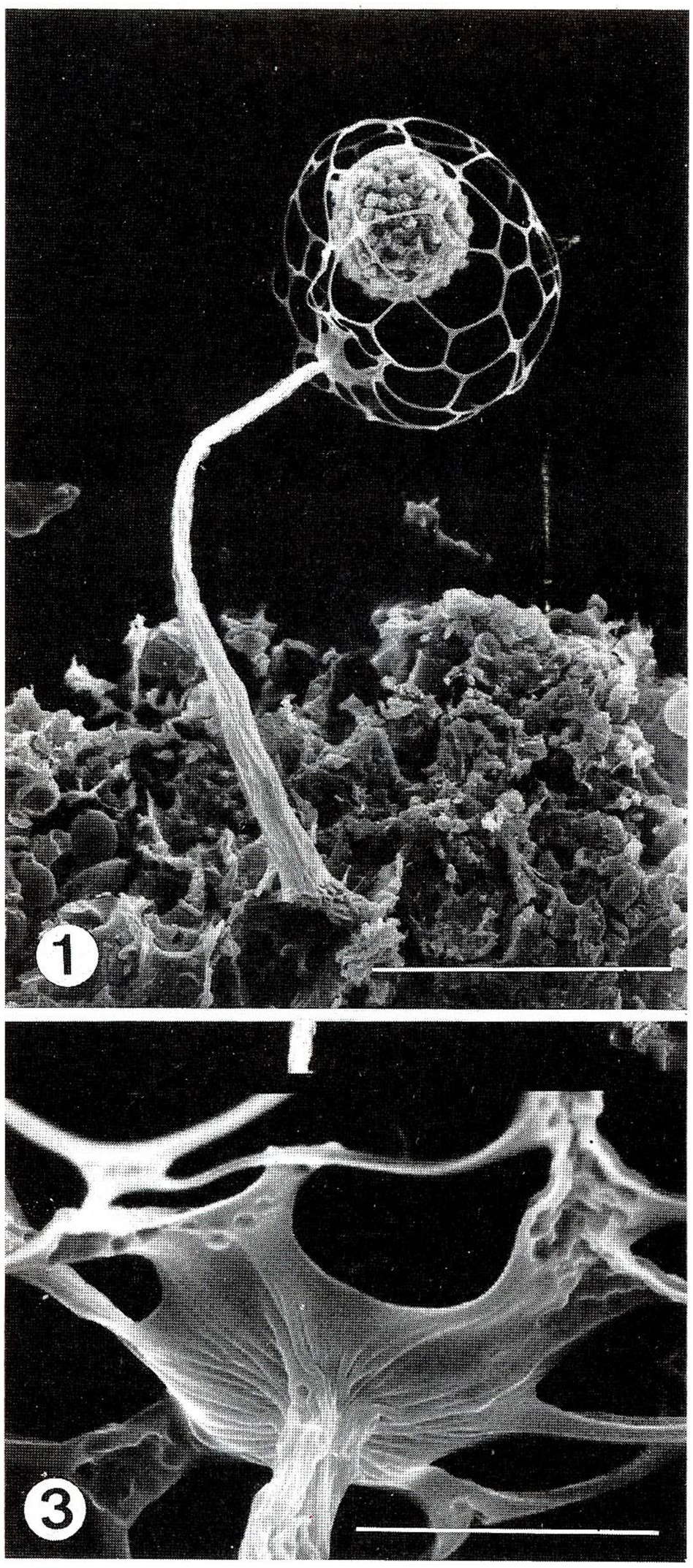
臺灣樹皮黏菌：中北部松屬植物上之黏菌

江 友 中　　劉 錦 憲

摘　　要

以臺灣地區北、中部五個地區所生長的五種松屬植物爲取樣對象，採取樹皮，進行潮濕培養，共取 524 份樣品，觀察期一至二個月，共收得黏菌標本 237 份，經鑑定，分屬於 11 屬 26 種，其學名與樹種來源以表列出，其中七種爲臺灣新記錄種，分別爲 *Cribraria confusa* Nann.—Brem., *Licea capitata* B. Ing & McHuugh, *Licea kleistobolus* Martin, *Physarum auriscalpium* Cooke, *Comatricha acanthodes* Alexop., *Comatricha lurida* A. Lister, *Macbrideola martinii* (Alexop. & Beneke.) Alexop. ; 二種爲只有日本人有採集記錄，至此次調查再發現者，分別爲 *Arcyria pomiformis* (Leers) Rost., *Physarum cinereum* (Batsch) Per.；二種爲未訂名種，分屬於 *Diderma* 和 *Macbrideola* 二屬；本文除詳述新記錄種形態特徵外，並提供圖片以爲參考。



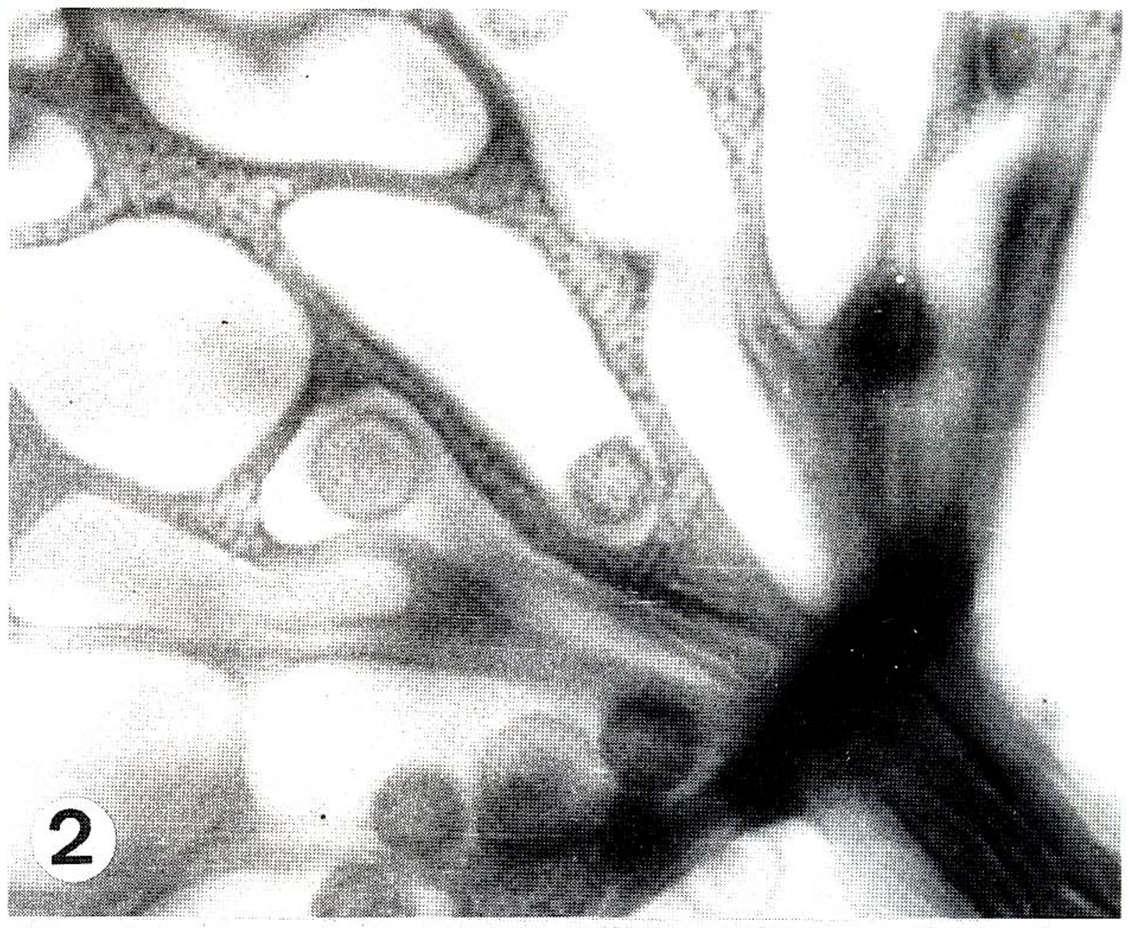


Plate I. *Cribraria confusa*

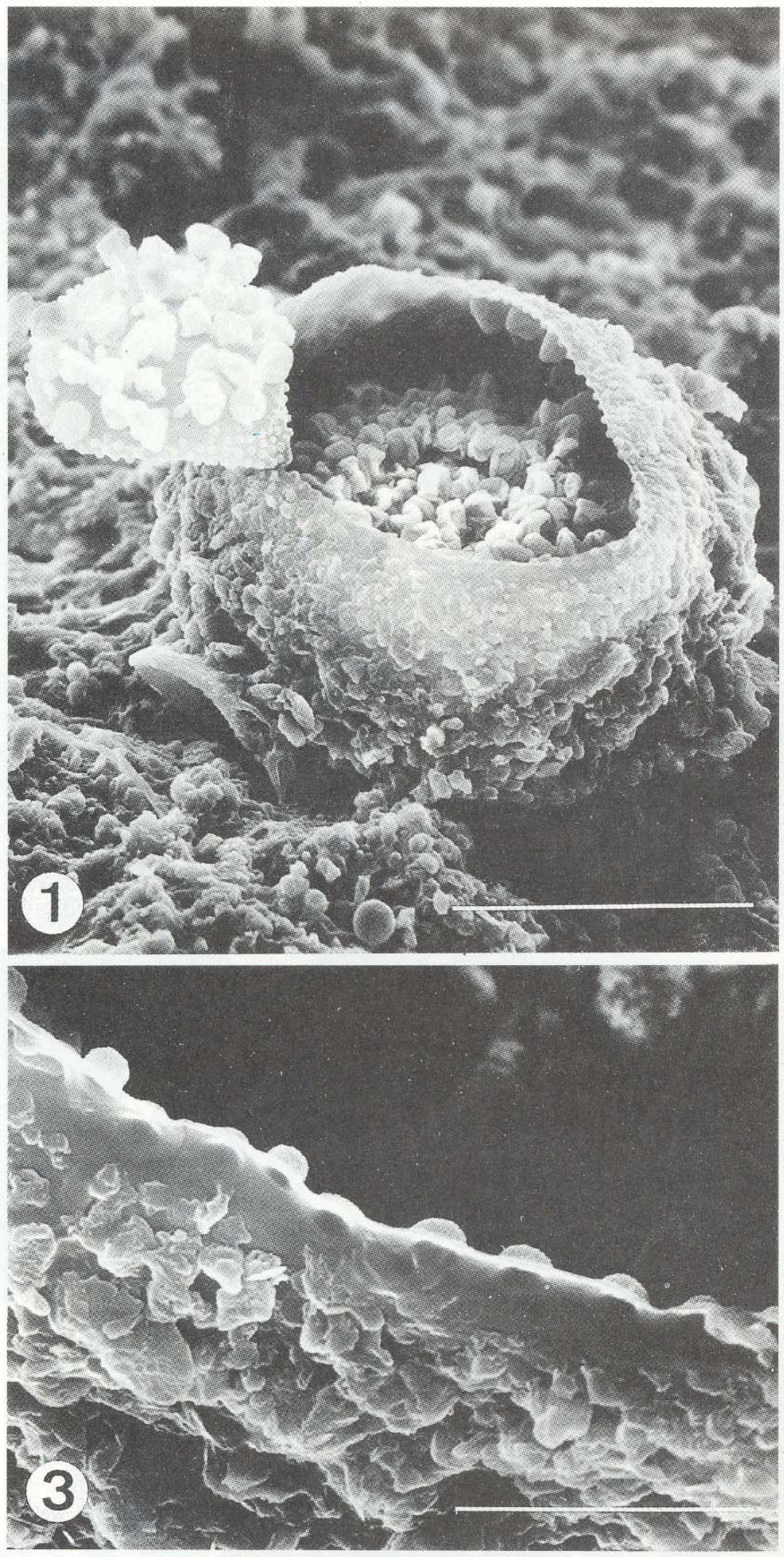
Fig. 1. Fruiting body, bar=100 μm.
2. Peridial net, ×1320.
3. Calyculus, bar=75 μm.
4. Peridial net, showing dictydine granules, bar=10 μm.

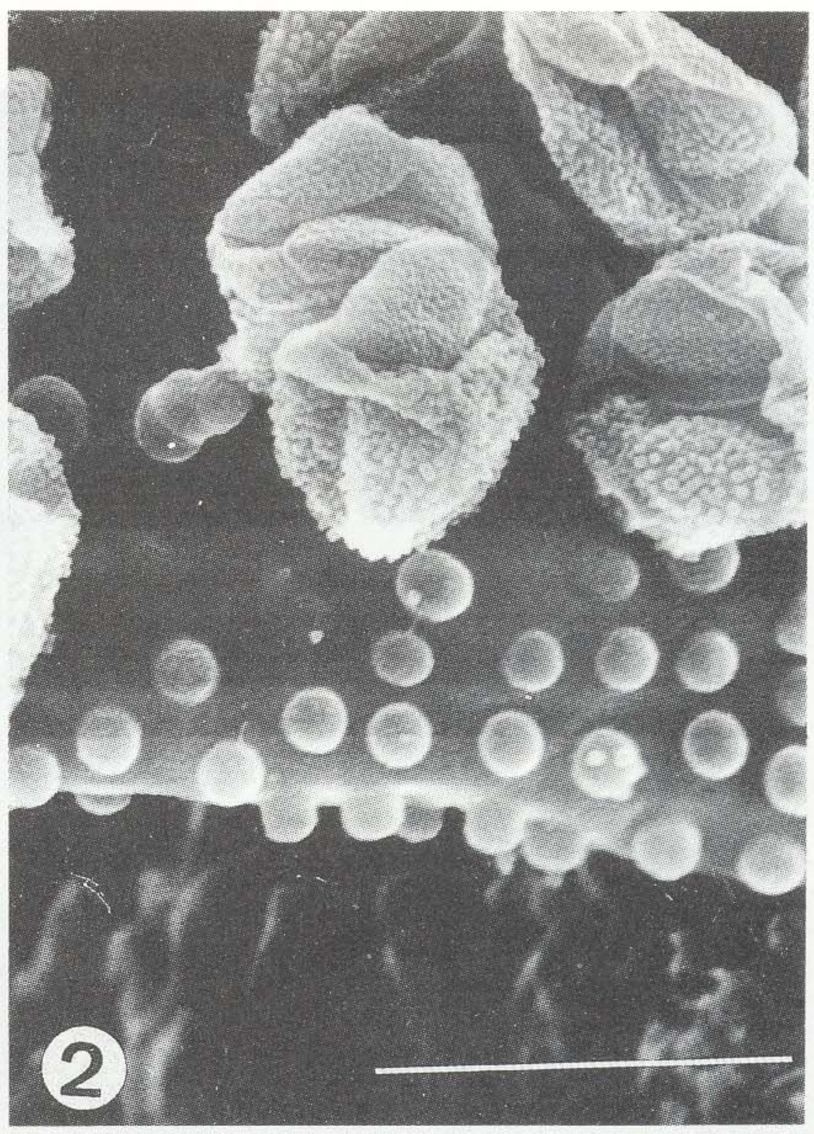
Plate II. *Licea capitata*

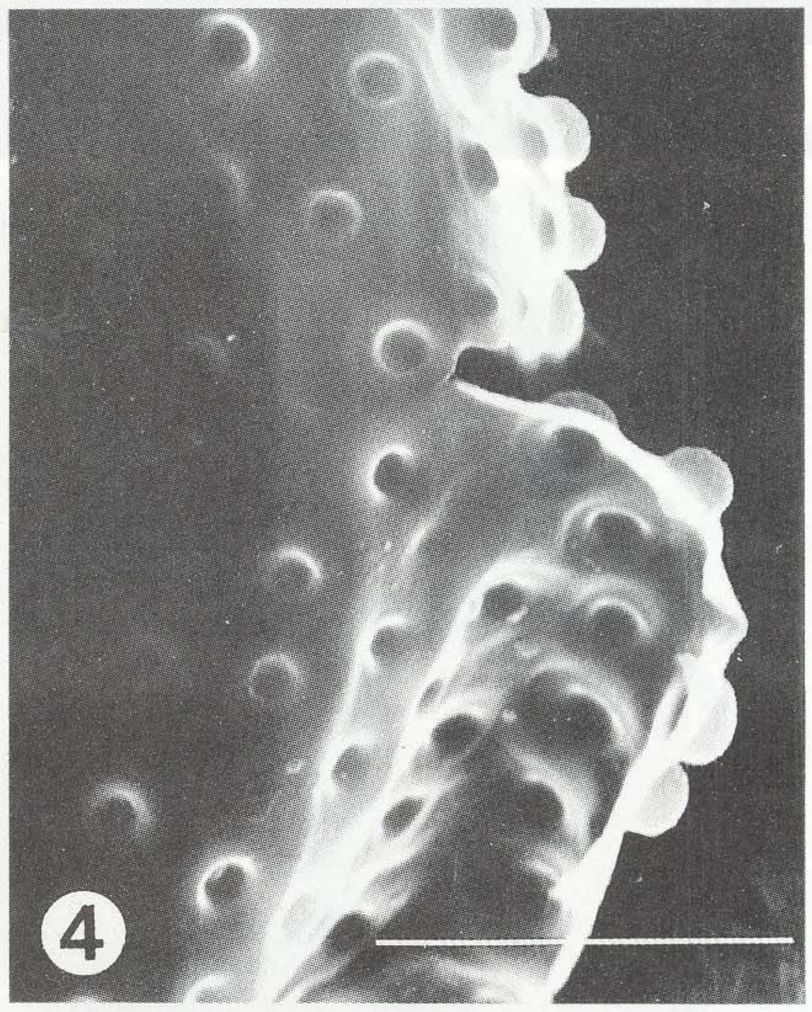
Figs. 1 & 2. Fruiting bodies; 1. ×72, 2. bar=250 μm.

3. Spores, bar=3 μm.

4. Peridium, outer surface, at the top and side, close to upper part of the sporangium, bar=20 μm.







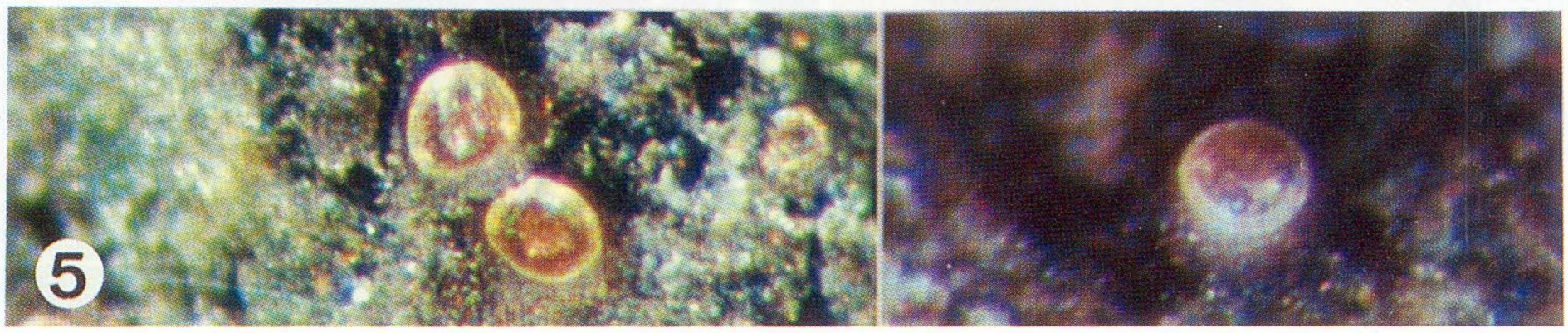
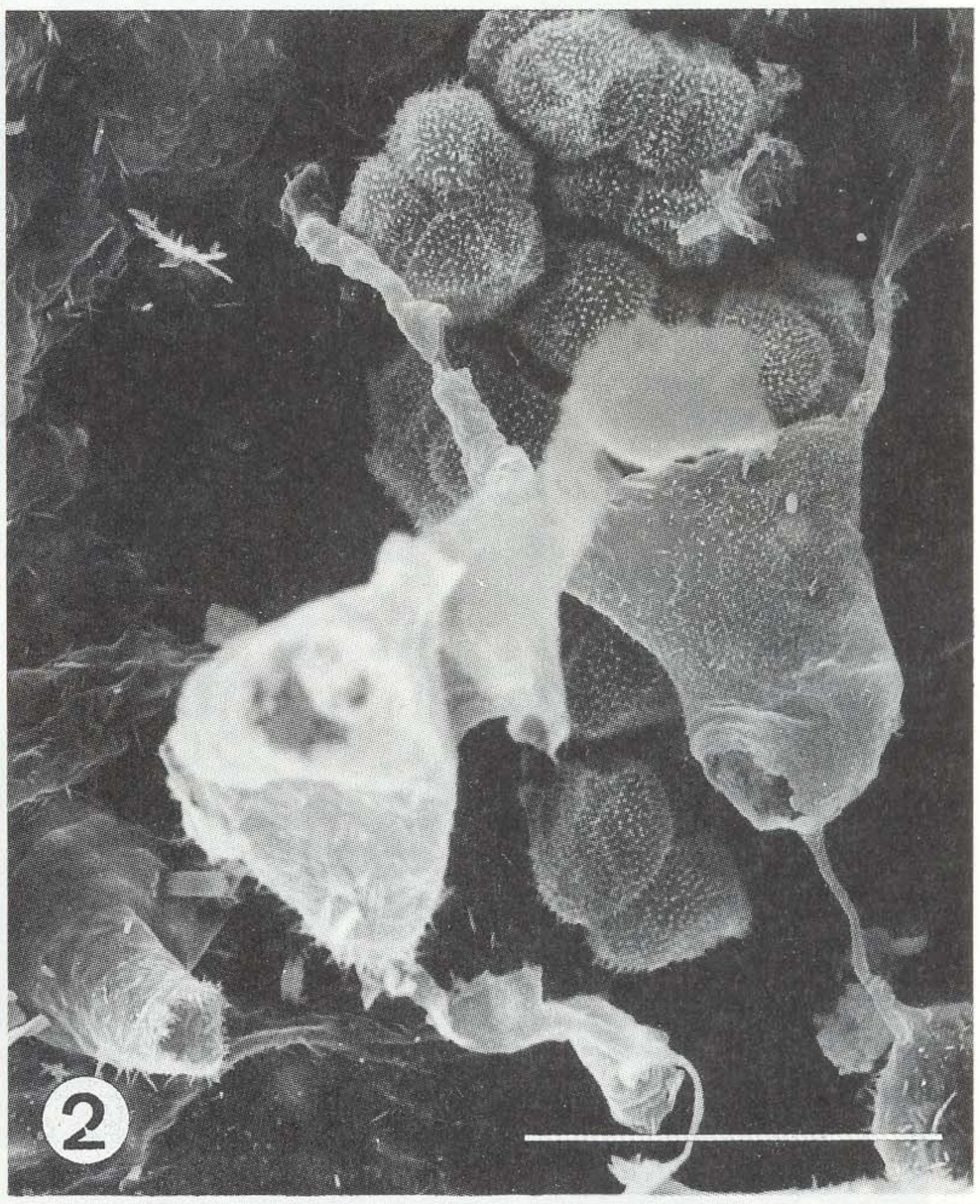
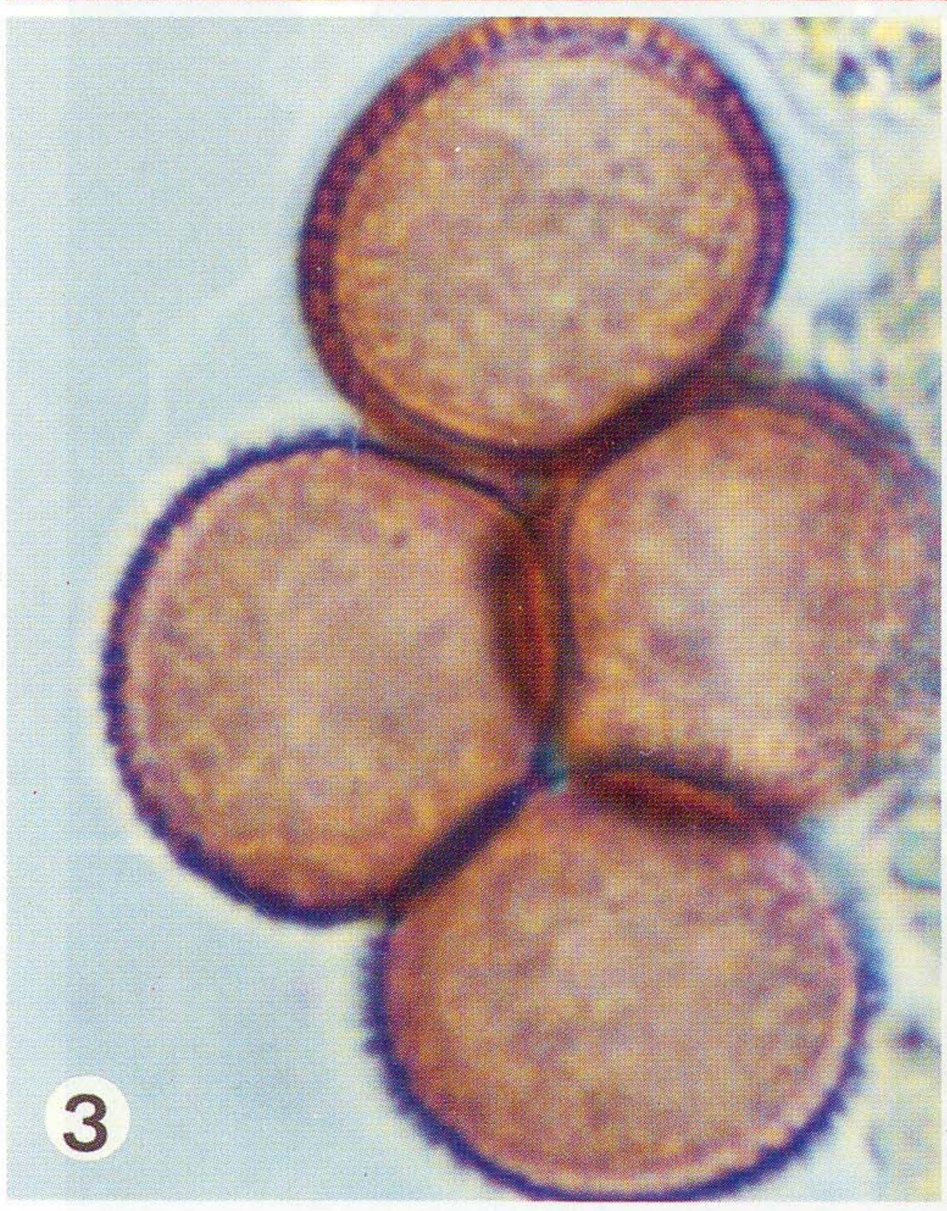


Plate III. *Licea kleistobolus*

Fig. 1. Sporangium, bar=50 μm.
2. Inside surface of lid and spores, bar=8.6 μm.
3. Margin of opening mouth, bar=8.6 μm.
4. Margin of lid (outer surface), bar=6.0 μm.
5. Fruiting bodies, ×172.





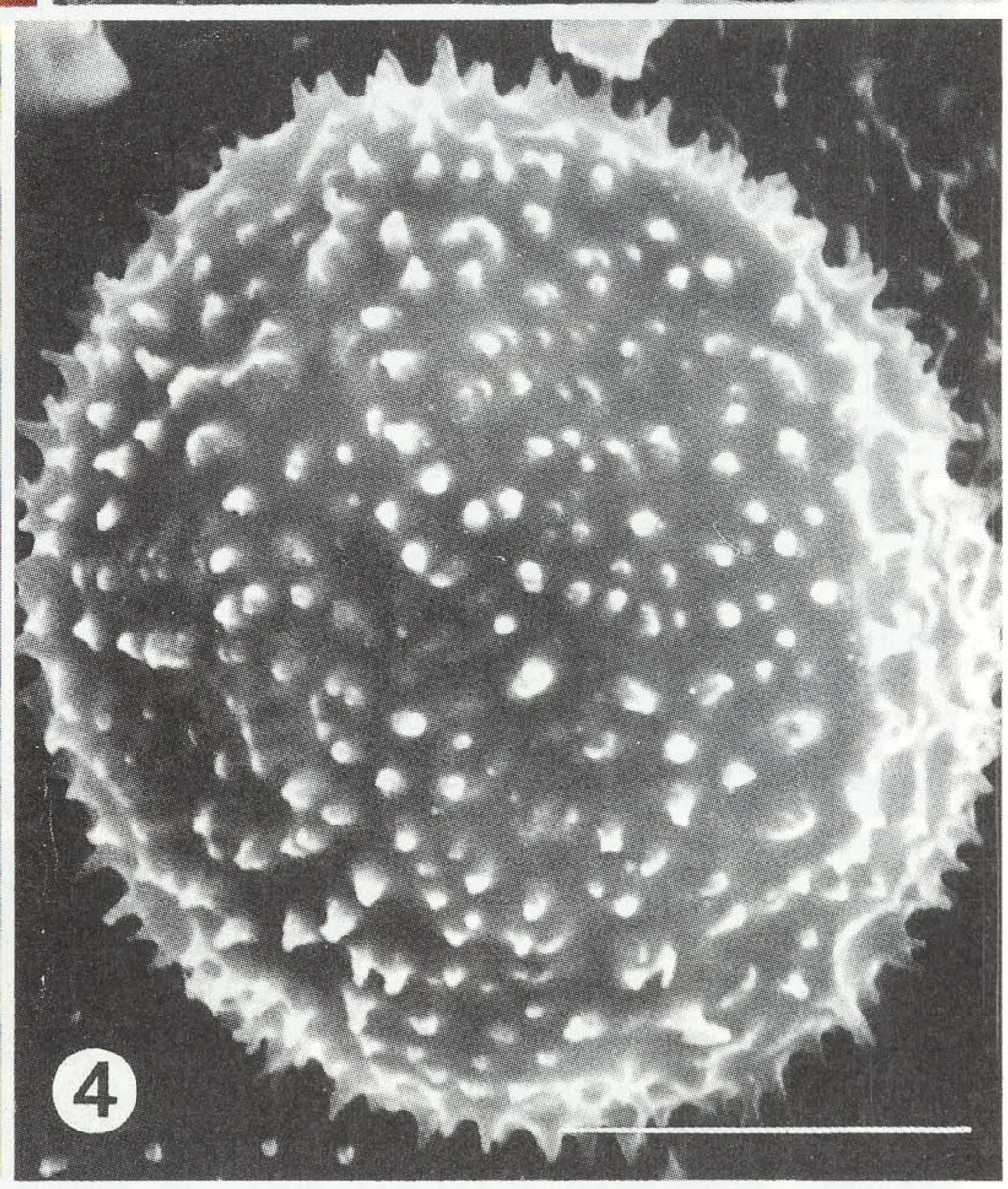
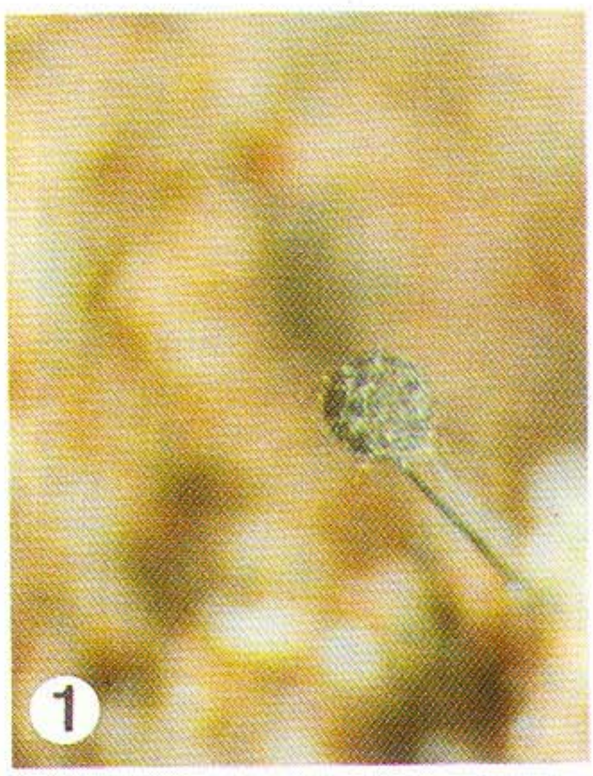
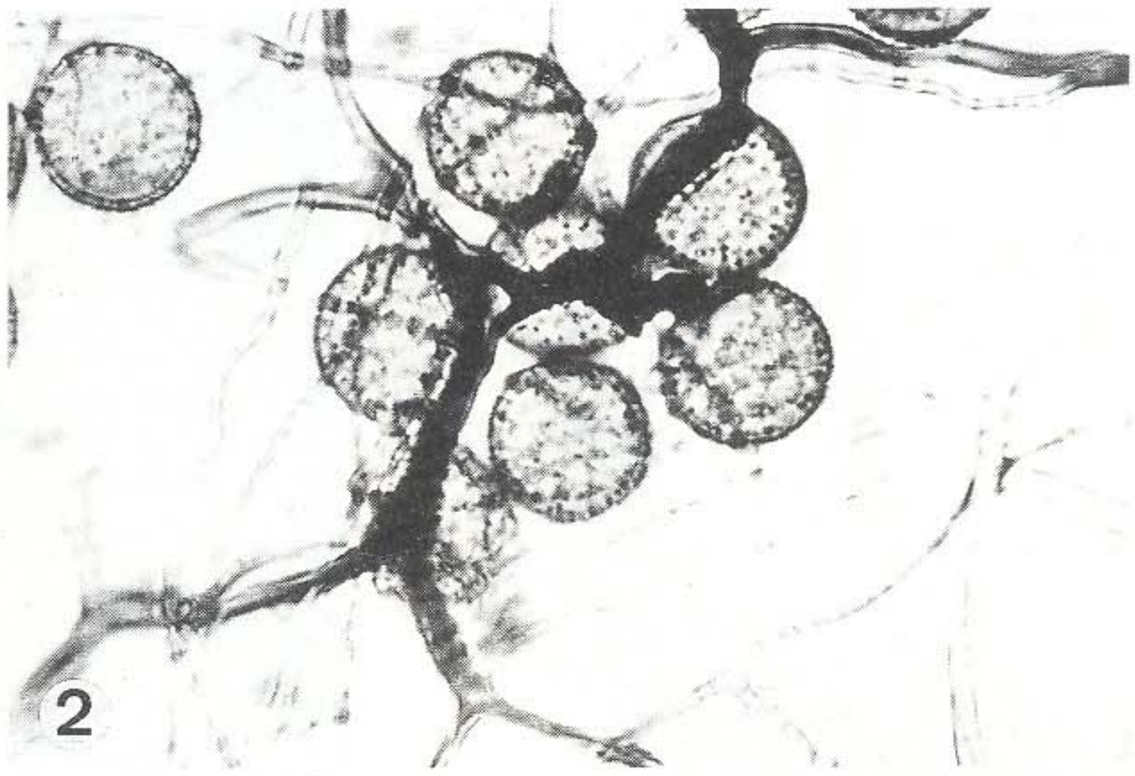
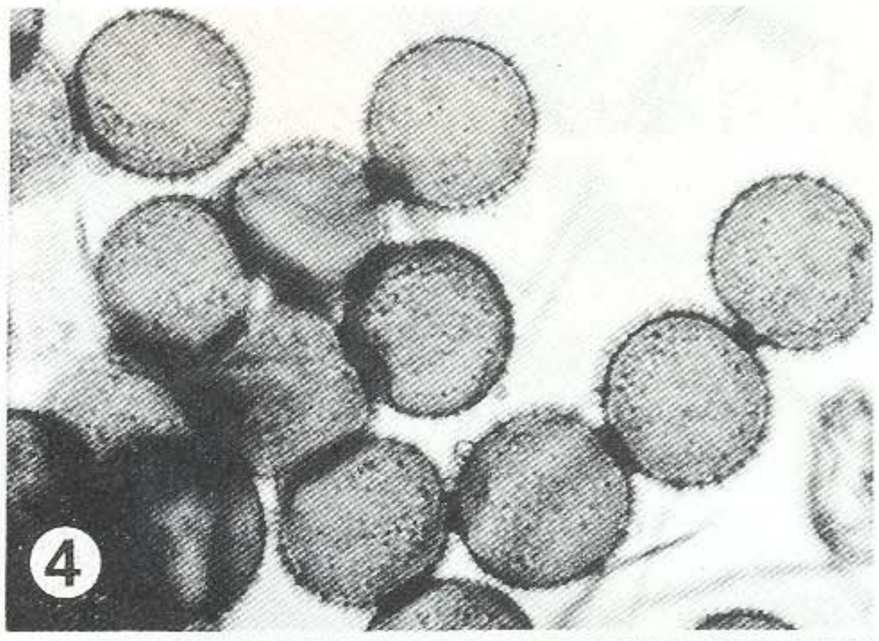


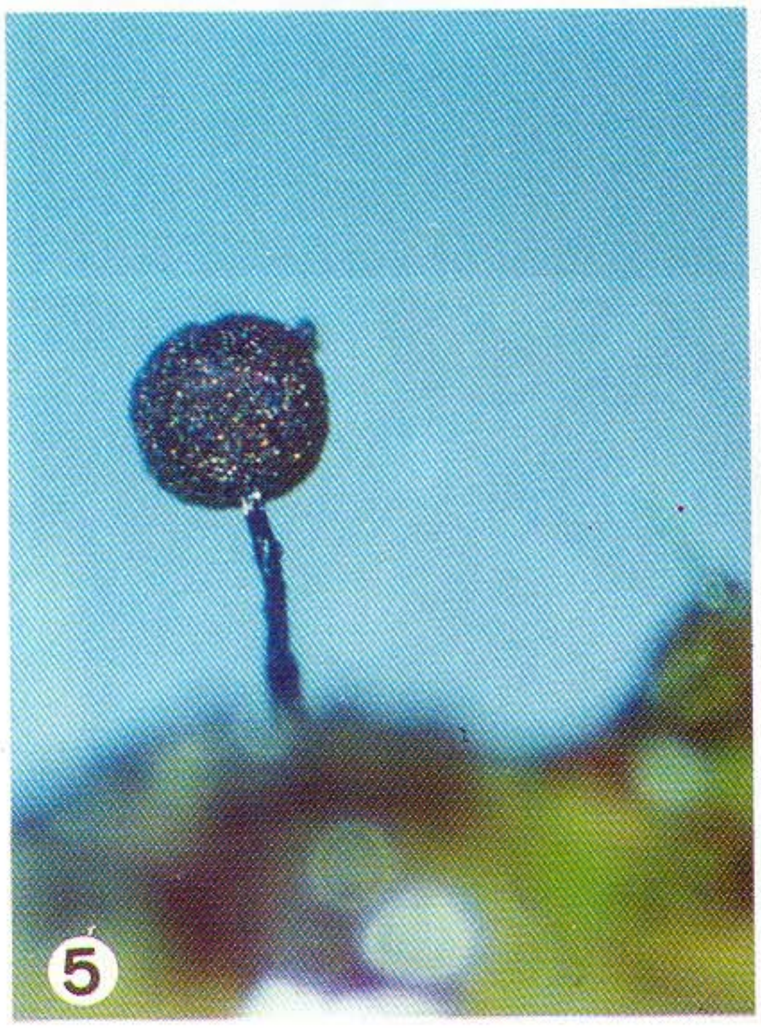
Plate IV. *Physarum auriscalpium*

Fig. 1. Fruiting bodies, ×85.
2. Capillitium, bar=30 μm.
3 & 4. Spores; 3. ×2680, 4. bar=4.3 μm.









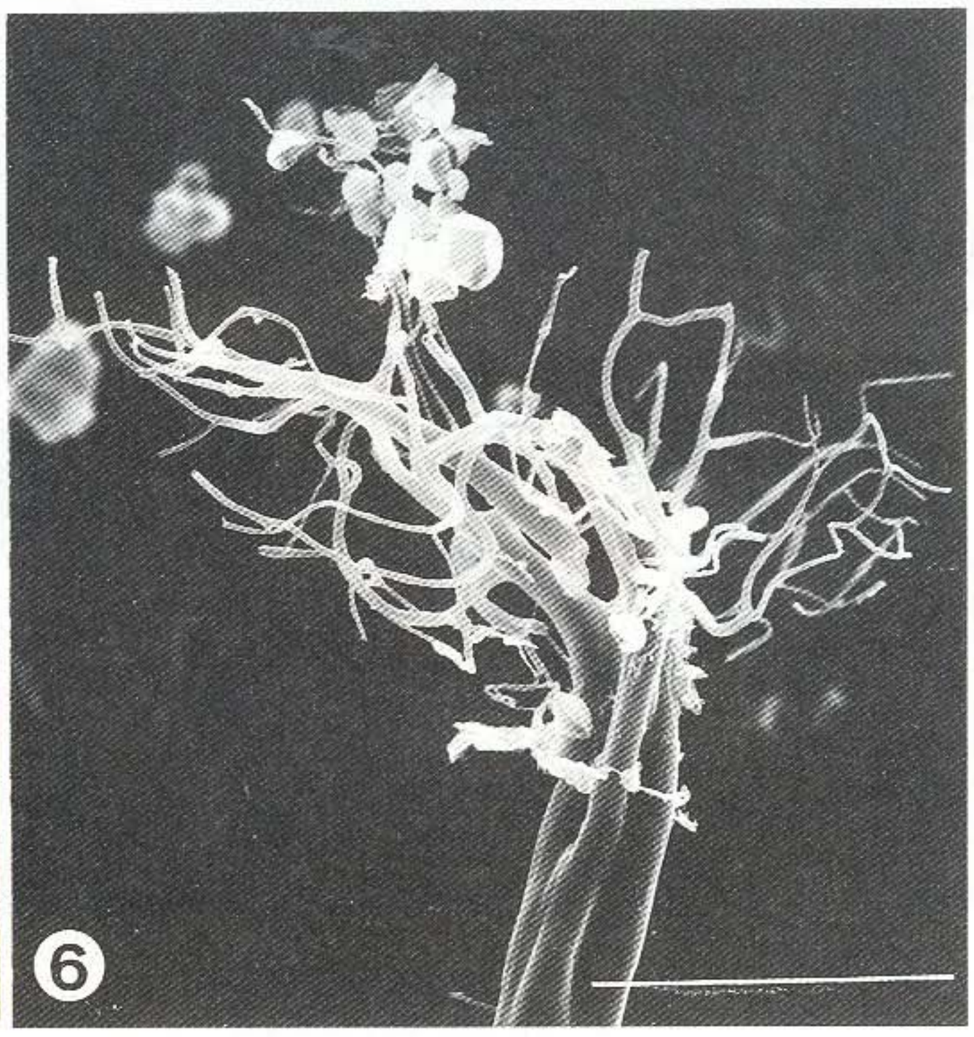
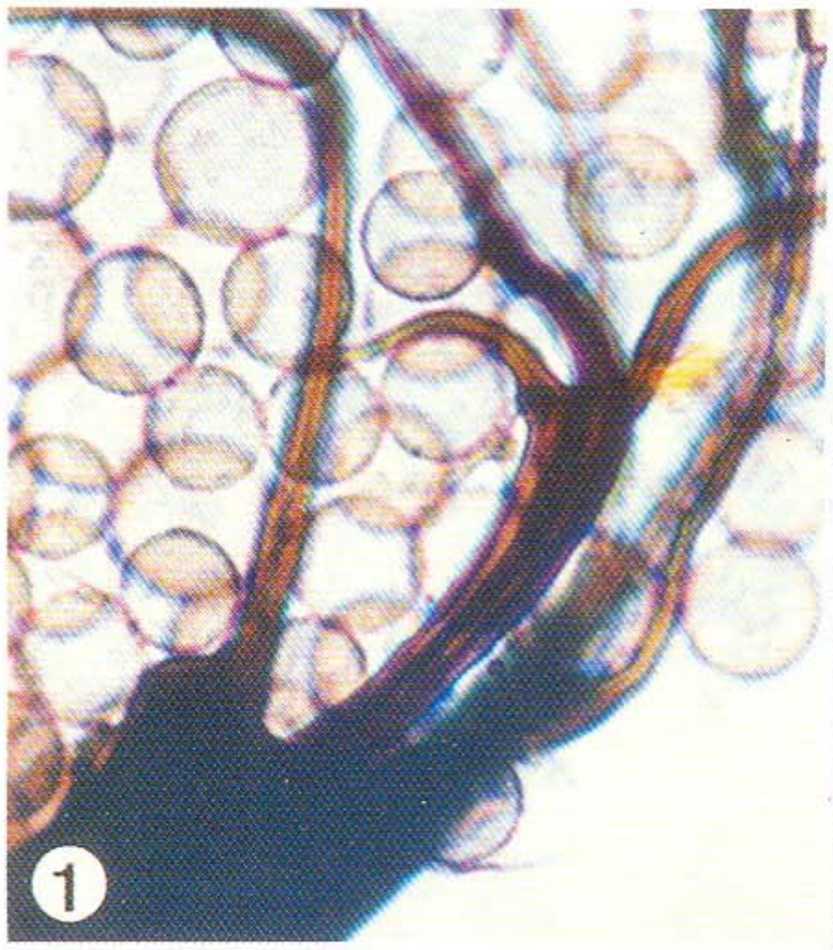
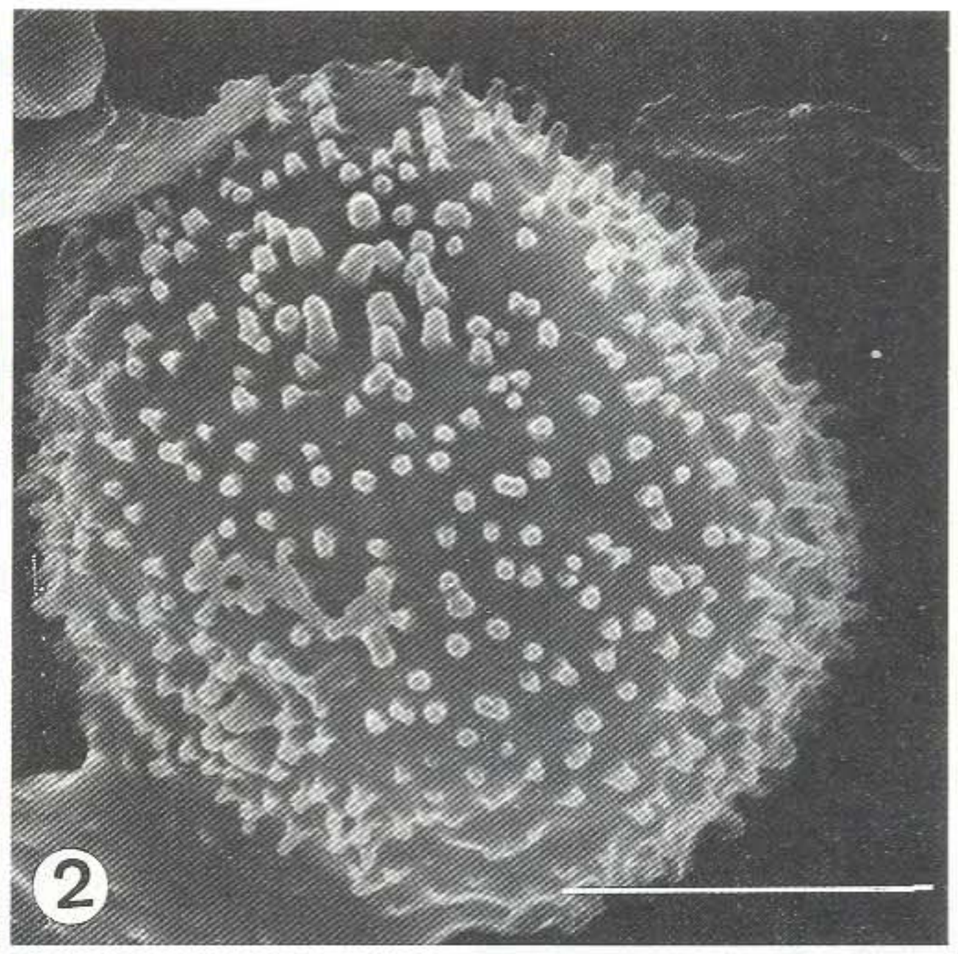
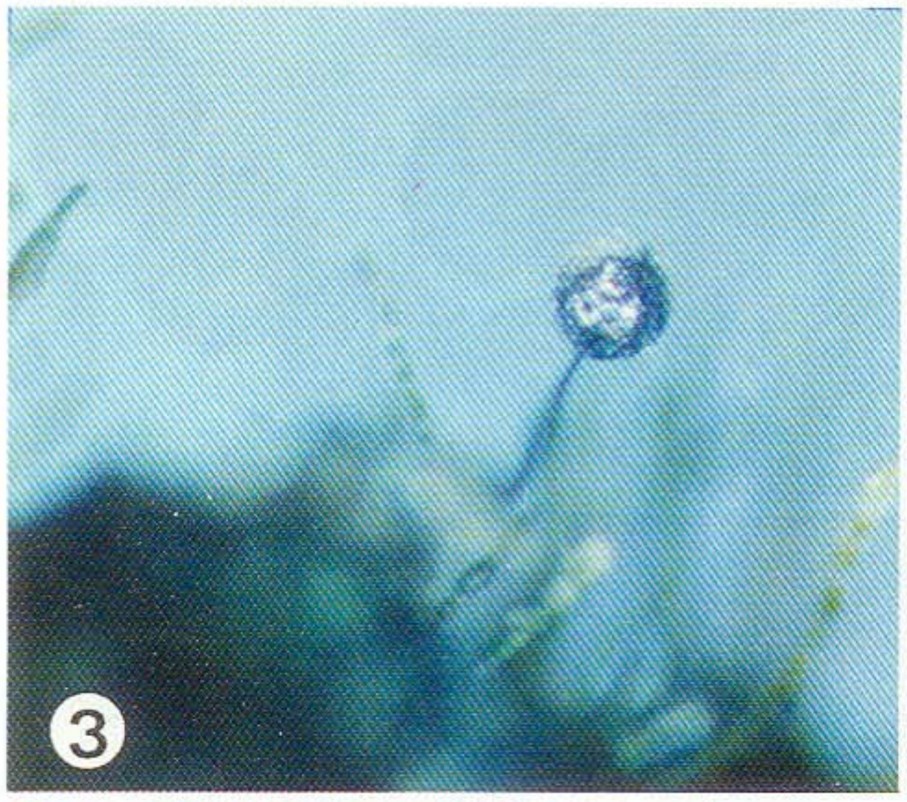
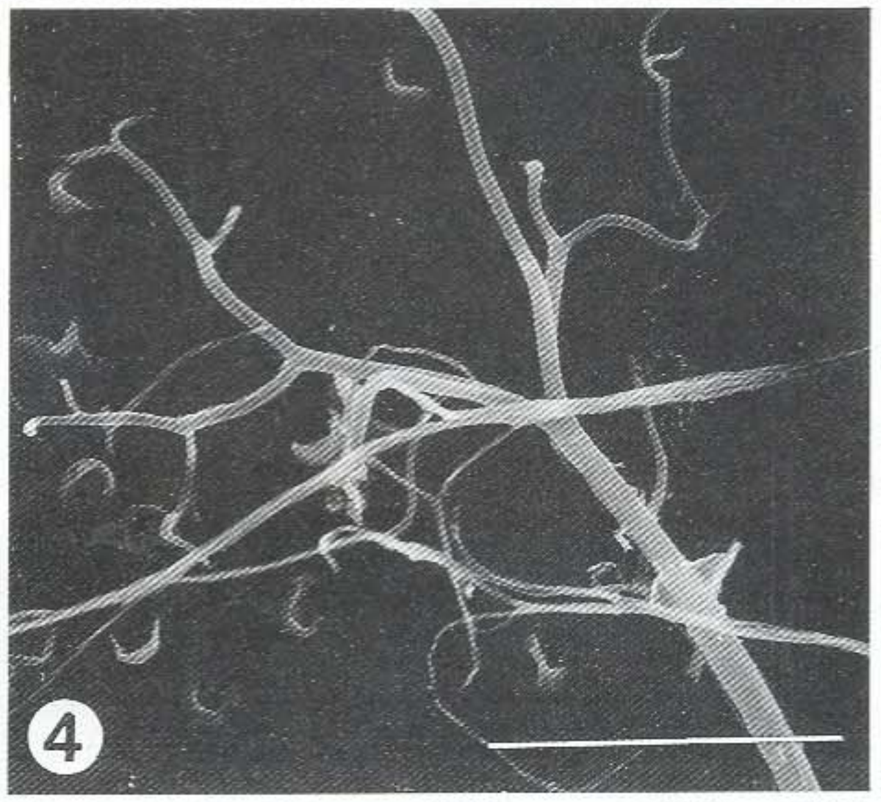


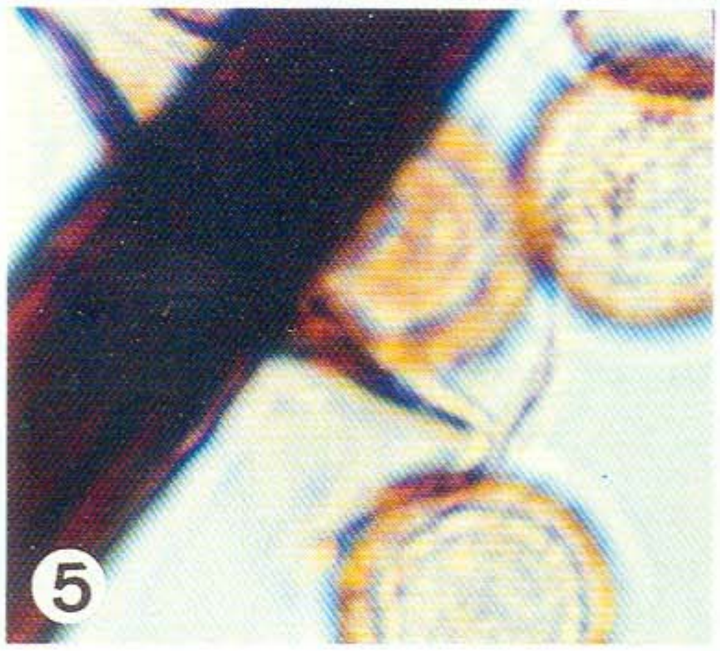
Plate V. Figs. 1-4. *Comatricha acanthodes*
Fig. 1. Fruiting body, ×85.
2. Capillitium, showing the free ends, ×1320.
3 & 4. Spores, ×1320; 3. Surface view, 4. Marginal view.
Figs. 5-6. *Comatricha lurida*
5. Fruiting body.
6. Columella and capillitium, bar=60 μm.











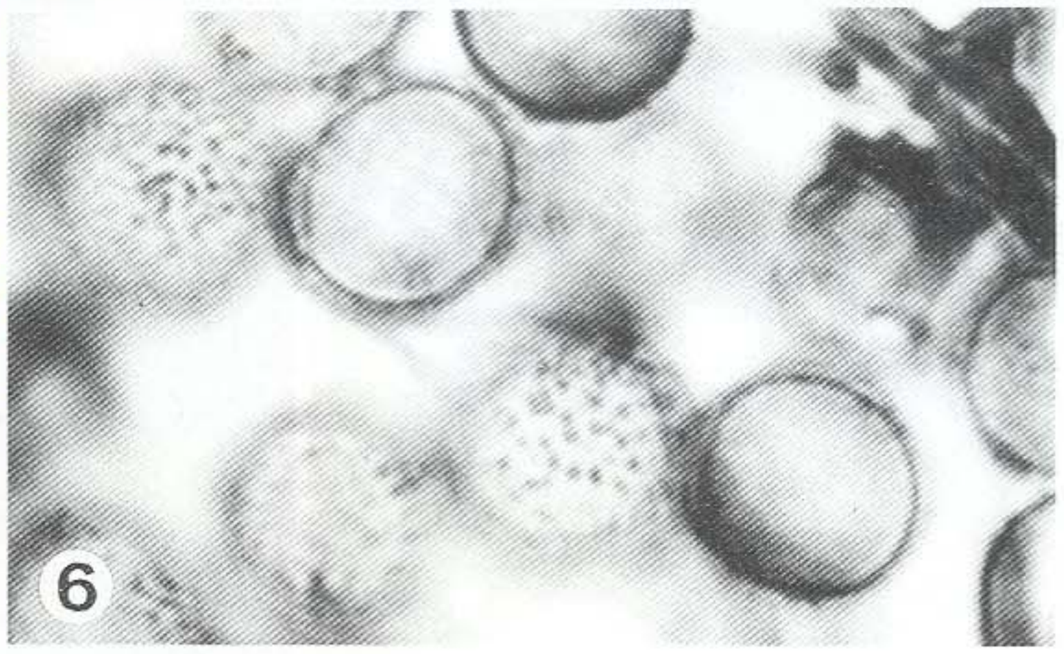
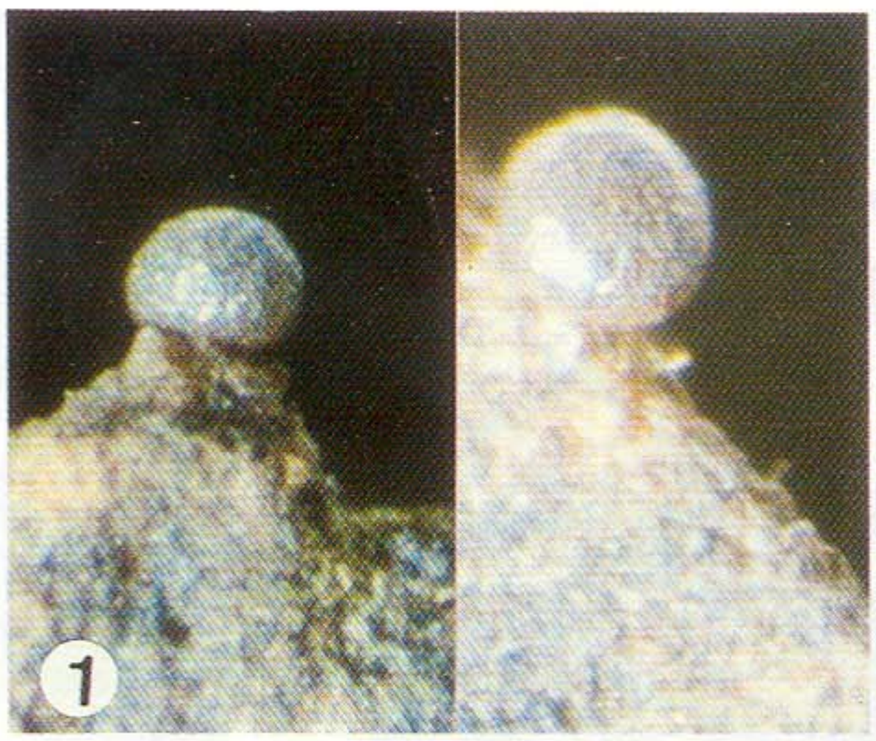


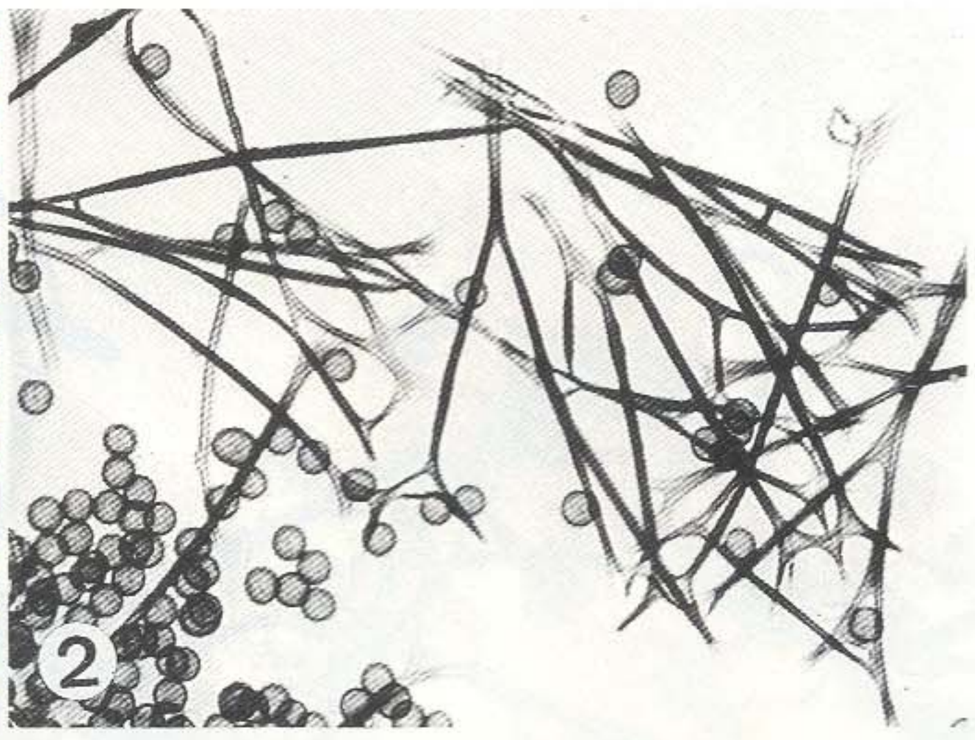
Plate VI. Figs. 1-2. *Comatricha lurida*

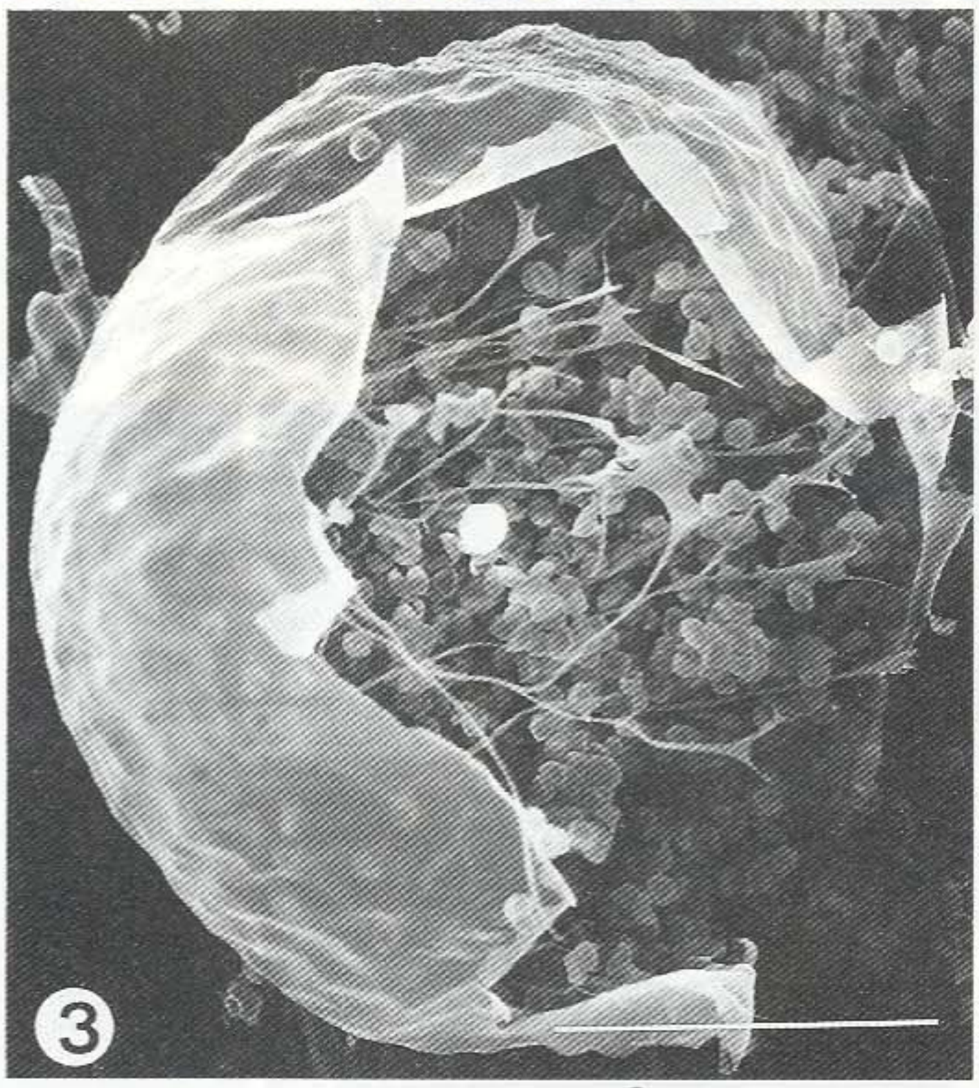
1. Spore, bar=3 μm.
2. Columella, capillitium and spores, ×1072.

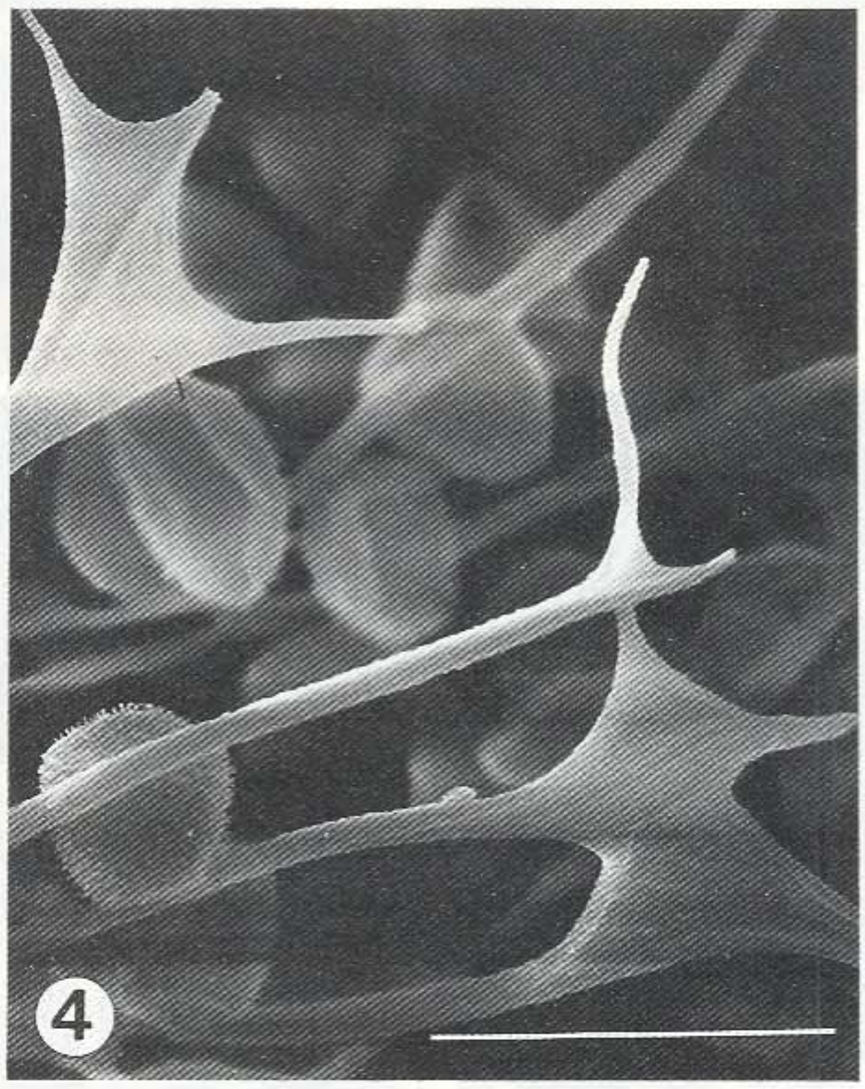
Figs. 3-6. *Macbrideola martinii*

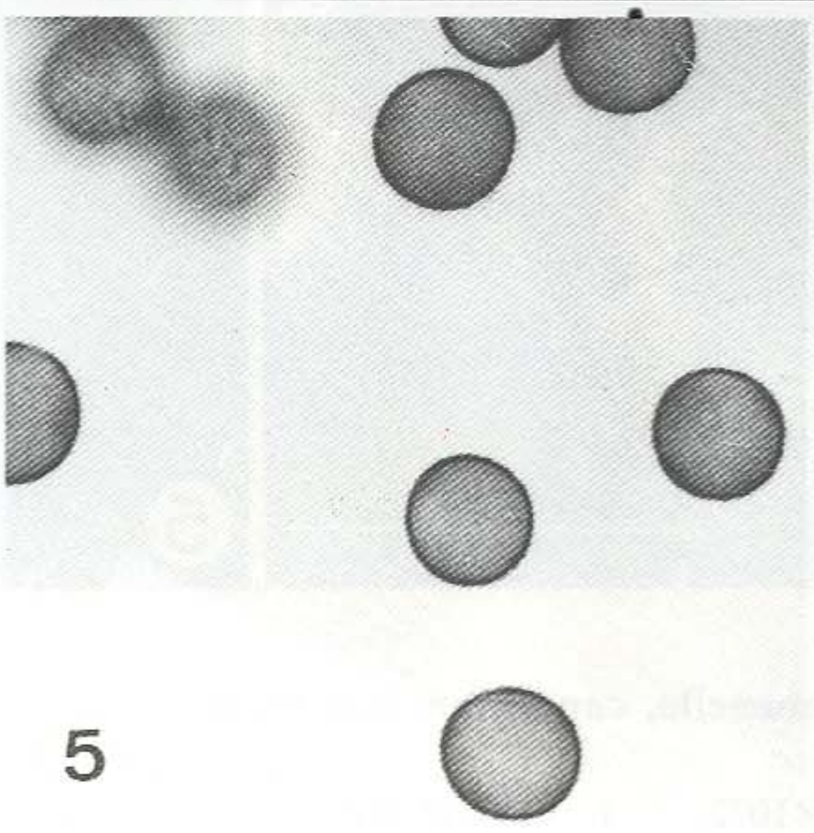
3. Fruiting body, ×85.
4. Columella and capillitium, bar=43 μm.
5. Discoid peridial remains at base of sporangium and spores, ×2680.
6. Spores, optical section, ×2680.











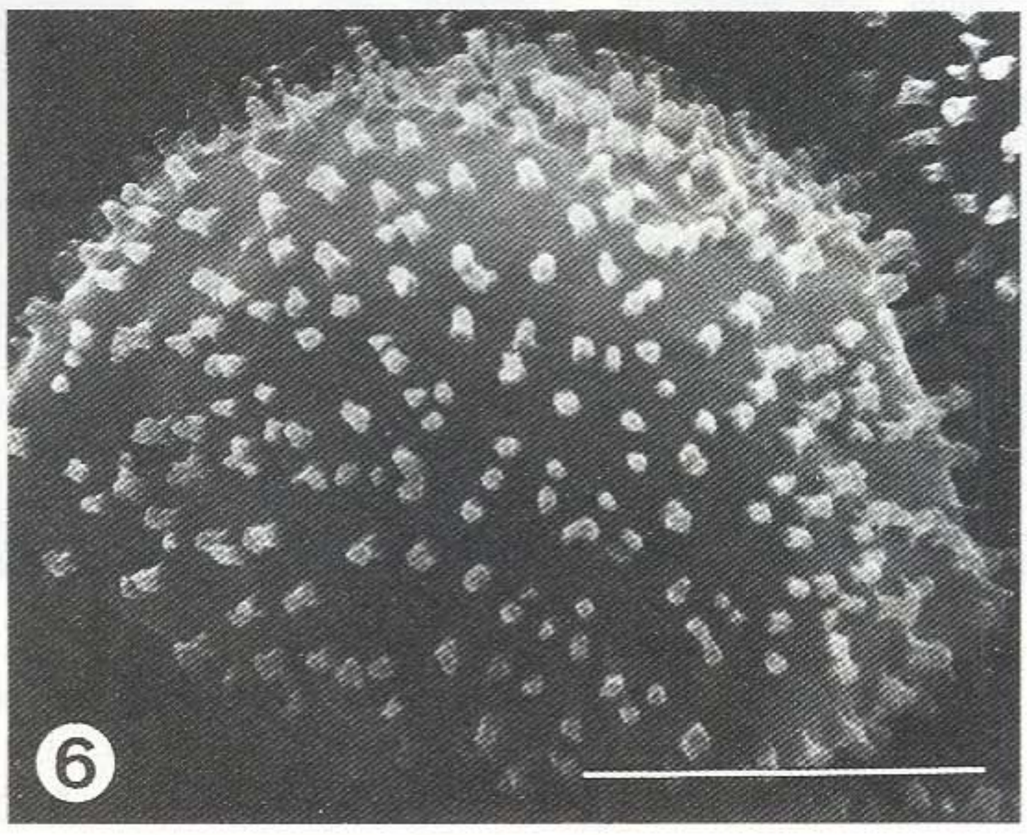
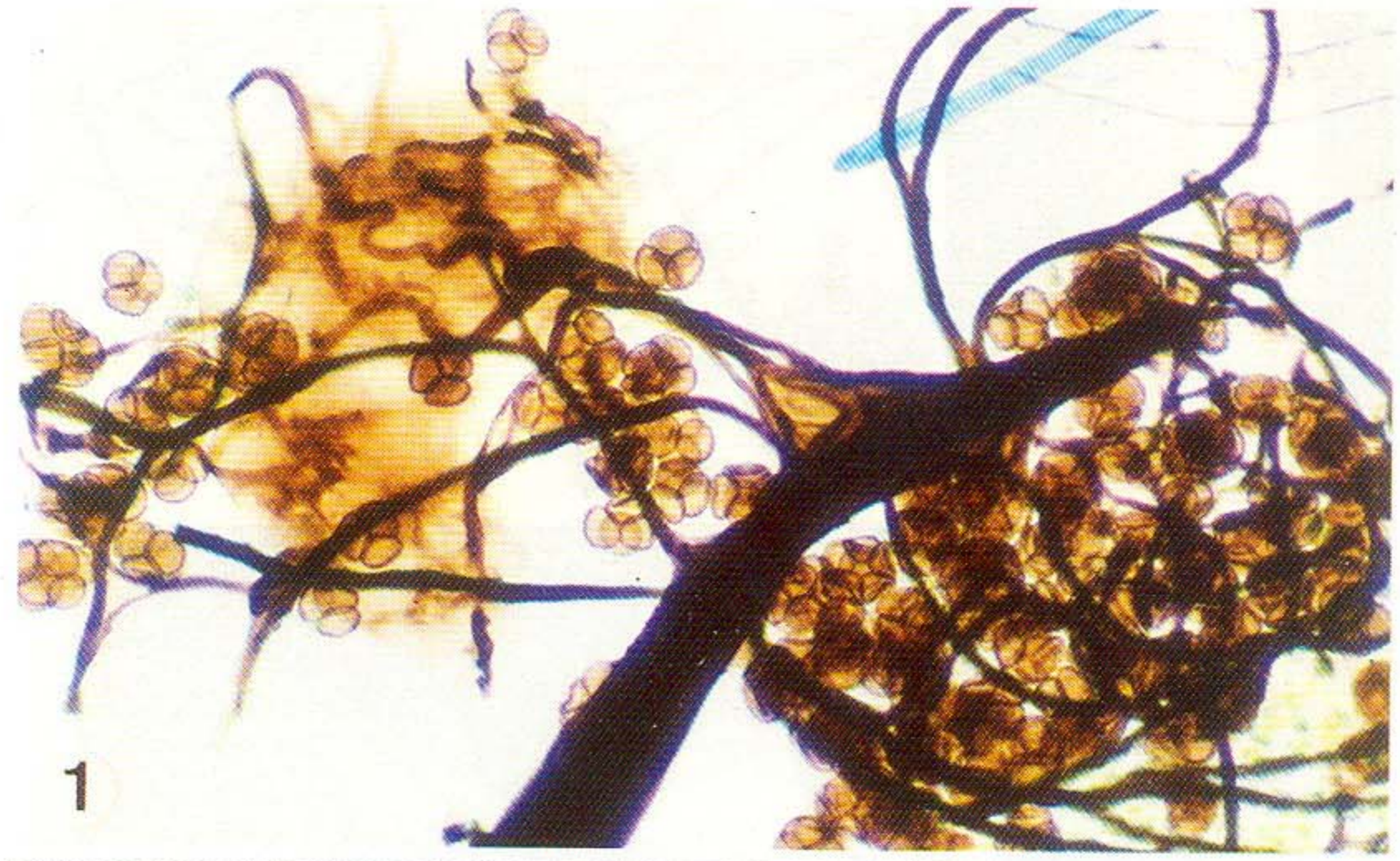
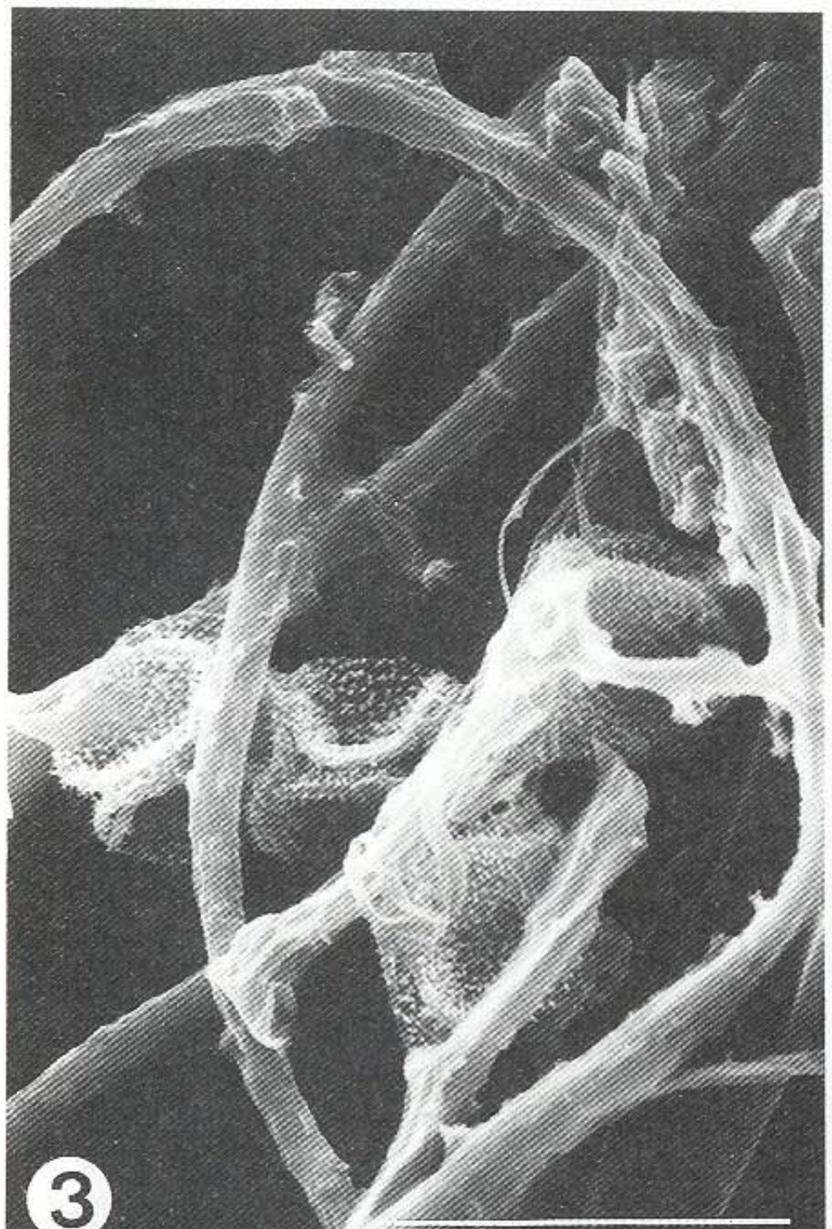


Plate VII. *Diderma* sp.
Figs. 1 & 3. Fruiting bodies; 1. ×80, 3. bar=100 μm.
Figs. 2 & 4. Capillitium; 2. ×536, 4. bar=15 μm.
Figs. 5 & 6. Spores; 5. optical section, ×1072, 6. bar=3 μm.





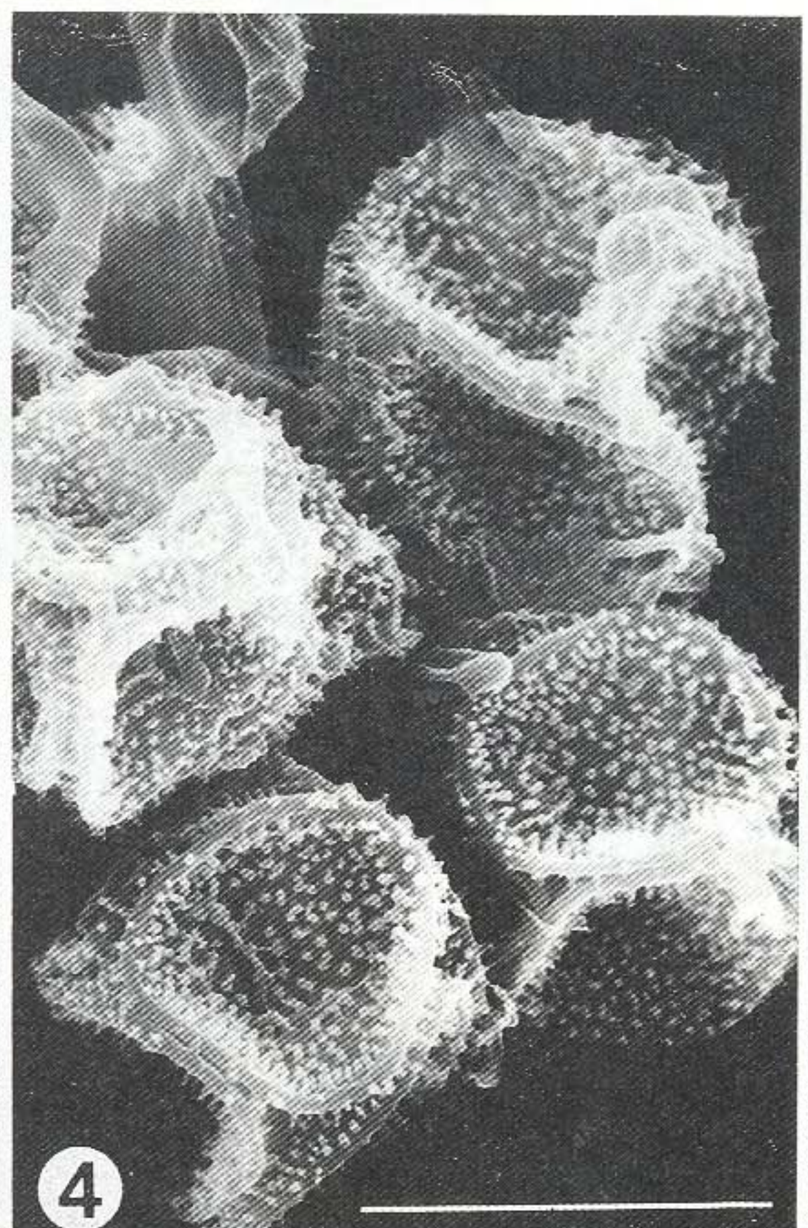


Plate VIII. *Macbrideola* sp.

Fig. 1. Sporangium, showing the columella, capillitium and spores, ×264.

2 & 4. Spore clusters; 2. ×1072, 4. bar=15 μm.

3. Capillitium, bar=25 μm.

5. Surface markings of spores, bar=3 μm.