

Taxonomic studies on new or critical fungi of non-pathogenic Onygenales 2

Shun-ichi Udagawa¹⁾ and Shigeru Uchiyama^{2)*}

¹⁾ Nodai Research Institute, Tokyo University of Agriculture, 1–1–1, Sakuragaoka, Setagaya-ku, Tokyo 156–8502, Japan

²⁾ Exploratory Research Laboratories, Tsukuba Research Institute, Banyu Pharmaceutical Co., Ltd., 3, Ookubo, Tsukubashi, Ibaraki 300–2611, Japan

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Six new taxa of soil-borne onygenalean fungi are described and illustrated: *Amauroascus javanicus*, *Myxotrichum emodense*, *M. retardatum*, *Nannizziopsis patagonica*, *Spiromastix princeps* and *S. sphaerospora*.

Key Words—ascmycetes; Onygenales; soil fungi; systematics.

This is the second in a series of papers dealing with taxonomy of non-pathogenic Onygenales (Udagawa and Uchiyama, 1999). Continued isolations of onygenalean fungi from soils have yielded additional new taxa belonging to the genera *Amauroascus*, *Myxotrichum*, *Nannizziopsis* and *Spiromastix*, and they are herein described and illustrated. Details of the methods have been given elsewhere (Udagawa et al., 1993; Uchiyama et al., 1995b). Color descriptions referred to with the letters M and R correspond to the color charts of Kornerup and Wanscher (1978) and Rayner (1970), respectively.

Taxonomy

Amauroascus javanicus Udagawa et Uchiyama, sp. nov.

Figs. 1, 3–5

Coloniae in agaro “YpSs” tarde crescentes, floccosae, ad centrum elevatae, plus minusve radiatim sulcatae, ex mycelio basali coacto tenuiter constantes, albae vel flavo-albae, ascomatibus abundantibus formantes; reversum flavo-album vel luteolum.

Ascomata superficialia, dispersa vel saepe confluentia, globosa vel subglobosa, 200–420 μm diam, alba, tarde maturescentia; hyphae peridii hyalinae, delicatae, rectae vel flexuosae, tenues et leves, septatae, 1.5–2.5 μm diam, ramosae et anastomosantes, plerumque telaperidio formantes; appendicula nulla. Asci 8-sporei, ovoidei vel pyriformes, (10.5–)12–14 \times 8–10.5 μm , evanescentes. Ascosporeae hyalinae, globosae vel subglobosae, 4–5 μm diam, microtuberculatae et irregulariter punctatae.

Mycelio vegetativo ex hyphis hyalinis, ramosis, levibus, septatis, 1.5–3 μm diam composito. Anamorphosis abest.

Holotypus: SUM 3123; colonia exsiccata in cultura

ex solo sativo, Jogjakarta, Java, in labada, 14.III.1994, a S. Uchiyama isolata et ea collectione fungorum Musei et Instituti Historiae Naturalis Chiba (Natural History Museum and Institute, Chiba, Japan; CBM) conservata.

Etymology: Latinized from the place-name, referring to the type locality.

Colonies on YpSs agar growing restrictedly, attaining a diam of 14–15 mm in 14 d at 25°C, floccose, centrally raised, more or less radially sulcate, consisting of a thin basal felt, white to Yellowish White (M. 4A2), producing abundant ascomata in a thin layer on the felt with a loose network of aerial hyphae; reverse Yellowish White (M. 4A2) or Pale Luteous (R). Colonies on OA growing restrictedly, attaining a diam of 14–15 mm in 14 d at 25°C, deeply floccose, wrinkled and sulcate, consisting of a thin basal felt, white to Yellowish White (M. 3A2); ascomata scattered on the felt, loosely covered by aerial hyphae; reverse Pale Yellow (M. 4A3) or Primrose (R). Colonies on PYE growing slowly but more rapidly than on YpSs, attaining a diam of 20–22 mm in 14 d at 25°C, wrinkled and centrally raised, radially sulcate, consisting of a tough mycelial felt bearing a flocculent aerial mycelium, white to Yellowish White (M. 1A2); ascomata absent; reverse Light Orange (M. 5A5–6) or Safran to Luteous (R).

Ascomata superficial, discrete or often confluent, globose to subglobose, 200–420 μm in diam, white, consisting of clusters of asci with dense peridial hyphae which are not differentiated from surrounding vegetative mycelium, maturing within 21–28 d; peridial hyphae hyaline, delicate, straight or flexuous, thin and smooth-walled, septate, 1.5–2.5 μm in diam, branched and anastomosed, forming a telaperidium but sometimes scanty; appendages not seen. Asci 8-spored, singly borne on a short stipe, ovoid or pyriform, (10.5–)12–14 \times 8–10.5 μm , evanescent. Ascospores hyaline, globose to subglobose, 4–5 μm in diam, with a rather thick wall, microtuberculate and irregularly punctate.

* Corresponding author. Fax: +81–298772029; e-mail: utiyamasg@banyu.co.jp

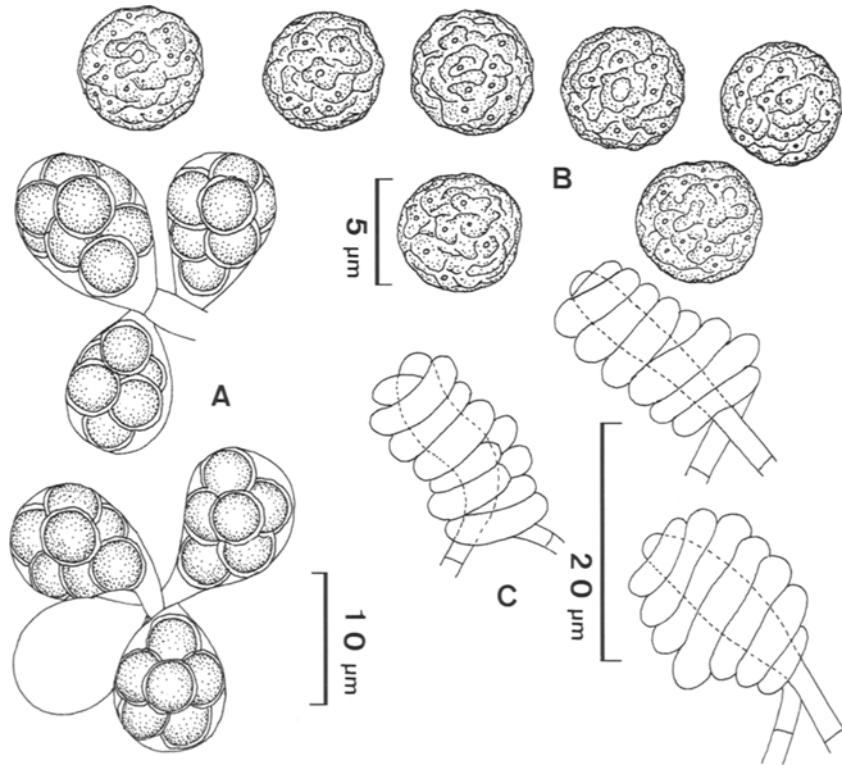


Fig. 1. *Amauroascus javanicus* (SUM 3123).
A. Asci. B. Ascospores. C. Ascumatal initials.

Vegetative mycelium consisting of hyaline, branched, smooth-walled, septate, 1.5–3 µm diam hyphae; ascumatal initials consisting of an elongate side branch from an aerial hypha, around which another hypha arising from the neighboring cell tightly coils several times; anamorph lacking.

Cellulolytic.

At 37°C, growth is extremely reduced.

Holotype: SUM 3123, a dried culture isolated from soil in paddy field near Borobudur, Jogjakarta, Central Java, Indonesia, 14 March 1994, col. S. Uchiyama (CBM).

Other material examined for a comparison: *Amauroascus niger* Schröter SUM 3124, a dried culture isolated from soil in palm forest, Phuket, Phuket Province, Thailand, 12 December 1996, col. S. Uchiyama.

Note: Based upon the ornamentation of the ascospores, the known species of *Amauroascus* may be roughly separated into: (1) a typically reticulate subgroup represented by *A. kuehni* von Arx, and (2) an irregularly reticulate to verrucose-tuberculate subgroup, which includes three species, *A. mutatus* (Quélet) Rammeloo, *A. niger*, and *A. purpureus* T. Ito et Nakagiri (Currah, 1985; Cano and Guarro, 1989; Ito and Nakagiri, 1995). *Amauroascus javanicus* differs markedly from *A. mutatus* and *A. purpureus* in ascospore color, size, and ornamentation: the ascospores of *A. mutatus* are brownish, 6–8.7 µm in diam, and verrucose-tuberculate; and those of *A. purpureus* are hyaline to pale brown, 2.8–3.2 µm in

diam (excl. rims), and irregularly reticulate with frilled rims. It is also distinct from *A. niger*, which has red-brown ascospores with irregularly punctate-reticulate ornamentation (Fig. 6) and a *Malbranchea* anamorph.

***Myxotrichum emodense* Udagawa et Uchiyama, sp. nov.**
Figs. 2, 7–15

Coloniae in "OA" restrictae, tenues, ex mycelio vegetativo submerso constantes, granulares, abundantibus ascomatibus formantes, primo griseo-flavae, deinde viridi-griseae vel olivaceo-nigrae; conidiogenesis moderata; reversum obscure viride vel griseo-olivaceum.

Ascomata superficialia, saepe confluentia, valde griseo-brunnea vel fere nigra, globosa vel subglobosa, appendiculis exclusis 40–120 µm diam. Hyphae peridii olivaceo-brunneae vel valde olivaceo-brunneae, incrassatae, septatae, 1.5–2 µm diam, asperulatae, ramosae et anastomosantes, reticulo laxo formantes; appendices spiniformes, atrobrunneae, rectae vel leviter curvatae, usque 70–120 µm longae, prope basin 1.5–2 µm diam, ramosae cum 1–2 ramulis, septatae, asperulatae, apice acutae vel obtuse rotundatae. Asci 8-sporei, ovoidei vel pyriformes, 9–12 × 6.5–8 µm, brevi-stipitati, evanescentes. Ascosporeae hyalinae, ellipsoideae-fusiformes, 4.5–6.5 × 2.5–3 µm, utrinque subacuminatae, leviter striatae.

Anamorphosis: *Oidiodendron* sp. Conidiophora erecta, ex mycelio basali vel hyphis aeris oriunda, inferne recta, superne ramosa; stipites olivaceo-brunnei vel atrobrunnei, vulgo 25–200 × 1.5–2.5 µm, septati, incras-

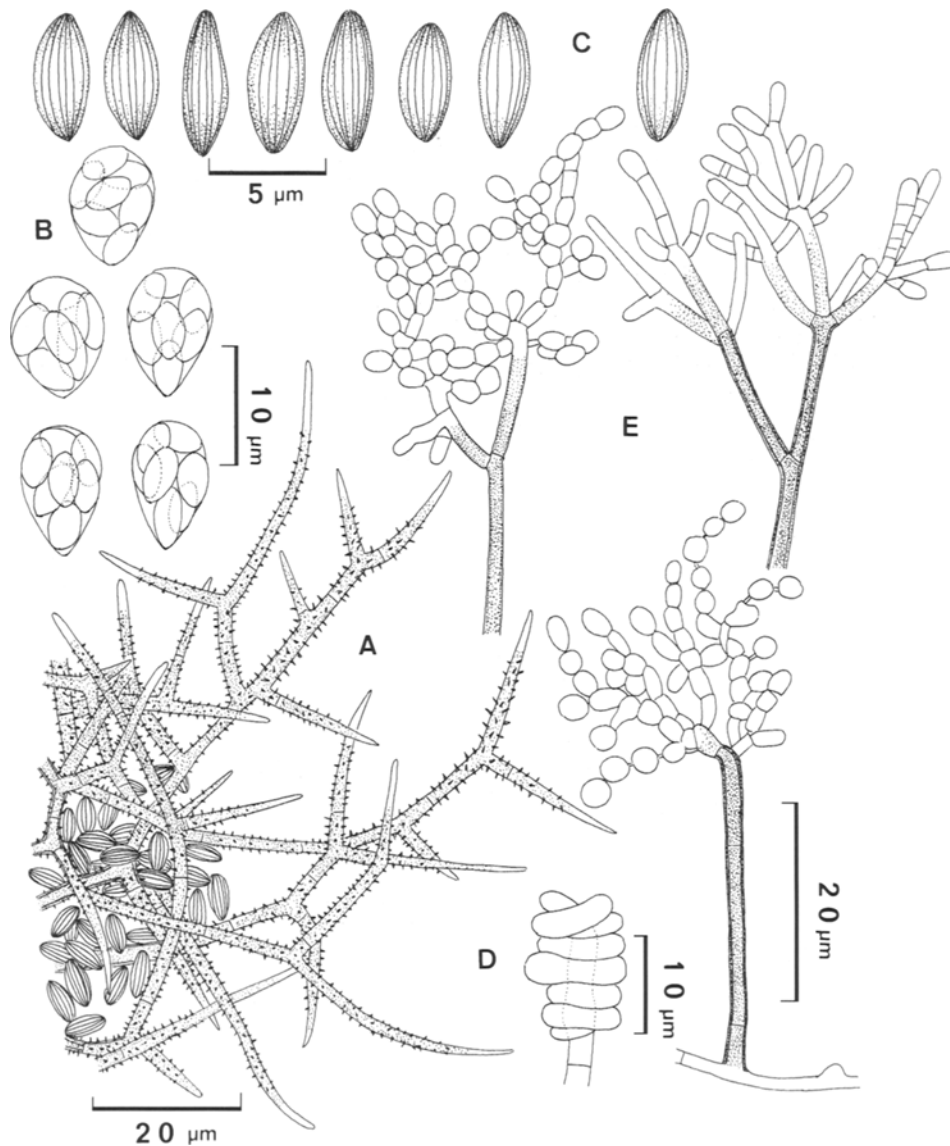


Fig. 2. *Myxotrichum emodense* (SUM 3125).

A. Margin of ascoma showing appendages. B. Asci. C. Ascospores. D. Ascomatal initial. E. Conidiophores, conidiogenous hyphae and conidia.

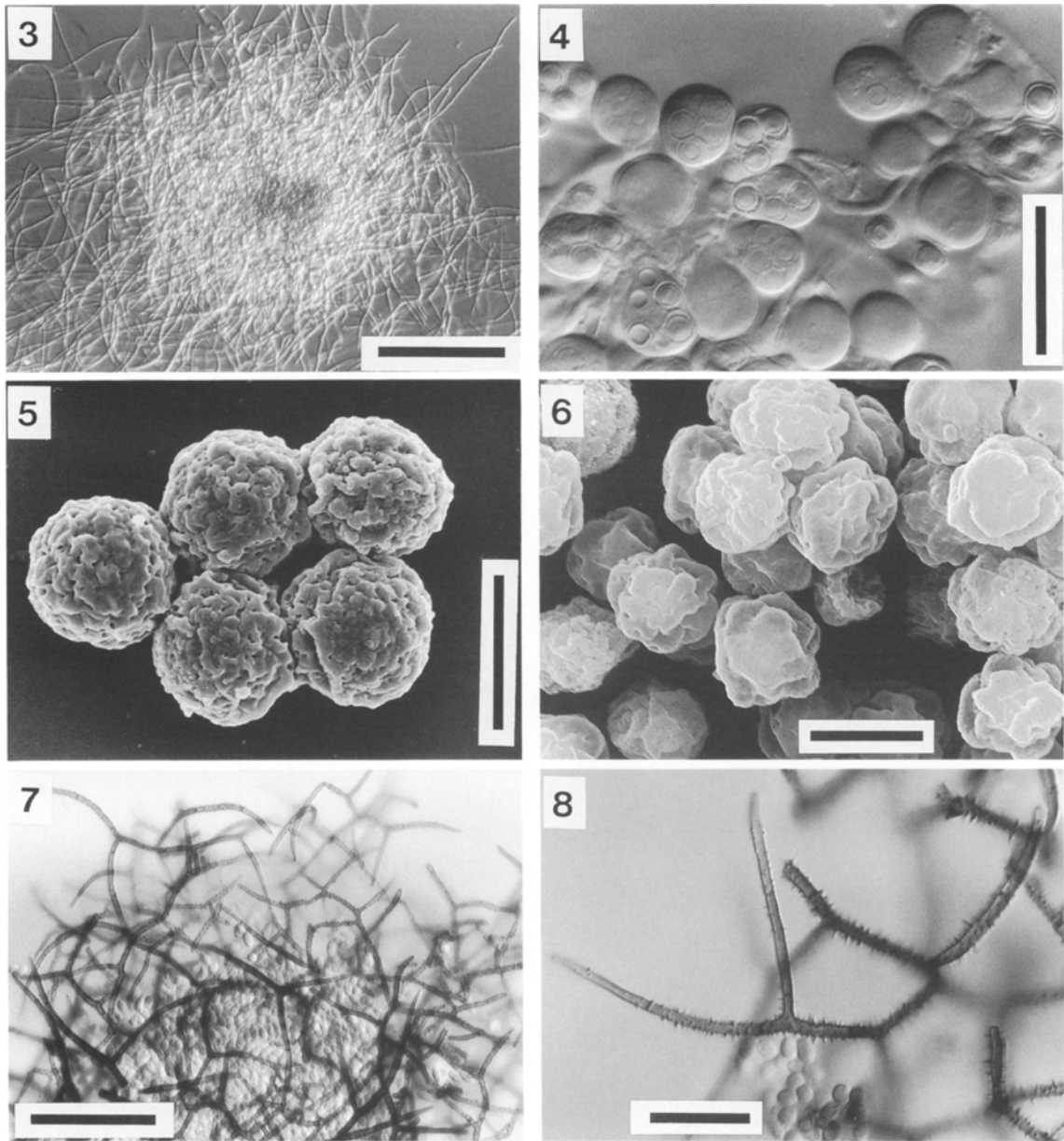
sati, leves vel interdum nodosi; rami hyalini vel dilute olivaceo-brunnei, $10\text{--}60 \times 2\text{--}2.5 \mu\text{m}$, leves, repetite ramificantes. Hyphae conidiogenae terminales, hyalinae, cylindratae, $1.2\text{--}1.5 \mu\text{m}$ diam. Conidia schizogena, hyalina, subglobosa, ovoidea, ellipsoidea vel brevicylindrata, $1.5\text{--}3.5 \times 1.5\text{--}2 \mu\text{m}$, fere levia, ad basim vel utrinque truncata.

Holotypus: SUM 3125; colonia exsiccata in cultura ex solo pascuo, Chumoa, in Nepalia, 30.IV.1995, a S. Uchiyama isolata et ea CBM conservata.

Etymology: Greek, *emodensis*=The Himalayas, referring to the type locality.

Colonies on OA growing restrictedly, attaining a diam of 28–30 mm in 28 d at 25°C, thin, with submerged vegetative mycelium, granular in appearance due to the production of abundant ascomata, intermixed with

aerial hyphae and conidial heads, at first Greyish Yellow (M. 1B3), becoming Greenish Grey (M. 26F2) or Olivaceous Black (R); conidiogenesis moderate; exudate small, clear; reverse Dull Green (M. 30E3) or Grey Olivaceous (R). Colonies on PCA growing restrictedly, attaining a diam of 21–22 mm in 28 d at 25°C, floccose, plane, with thin vegetative mycelium, producing limited ascomata on the substratum and abundant conidial heads, Greenish Grey (M. 30C2) or Smoke Grey (R); exudate absent or limited; reverse uncolored to Brownish Grey (M. 4D2) or Smoke Grey (R). Colonies on PYE growing rather restrictedly, attaining a diam of 25–27 mm in 21 d at 25°C, floccose, conspicuously wrinkled and radially sulcate, raised up to 5 mm high, consisting of a tough basal felt, off-white to Pale Yellow (M. 4A3) or Buff (R); ascomata not produced; conidiogenesis



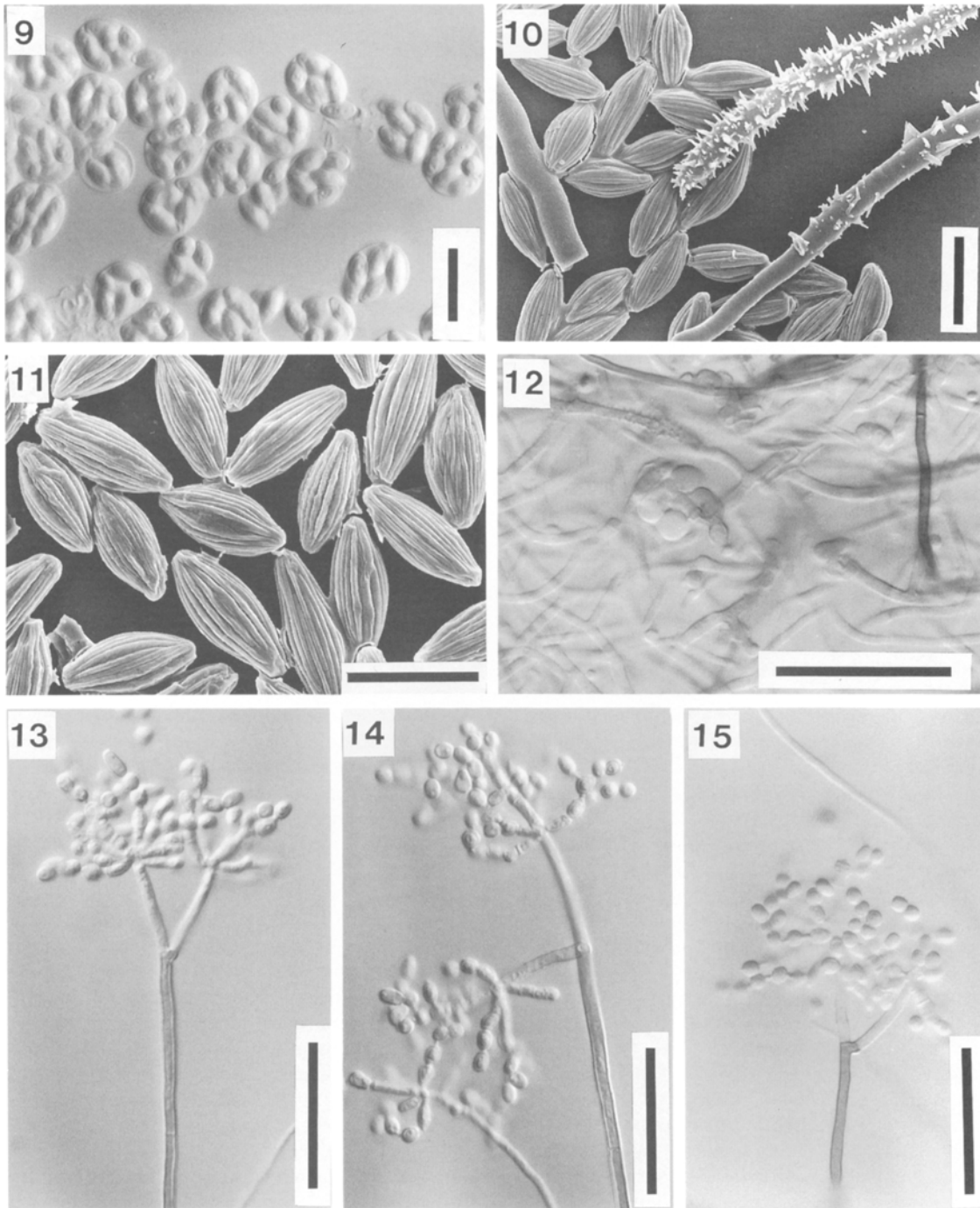
Figs. 3–8. *Amauroascus javanicus*, *A. niger* (SUM 3124), and *Myxotrichum emodense*. 3–5. *Amauroascus javanicus*. 3. Ascoma. 4. Asci. 5. Ascospores (SEM). 6. *Amauroascus niger*. Ascospores (SEM). 7, 8. *Myxotrichum emodense*. 7. A part of ascoma. 8. Appendages. Scale bars: 3, 7 = 100 μm ; 4, 8 = 20 μm ; 5, 6 = 5 μm .

absent; exudate large, clear; reverse Greyish Orange (M. 6B5) or Cinnamon (R).

Ascomata superficial, often confluent, dark grayish brown to almost black, with a white to pale yellow centrum, globose to subglobose, 40–120 μm in diam excl. appendages, maturing within 28 d. Peridial hyphae olive brown to dark olive brown, thick-walled, septate, not inflating at the septum, 1.5–2 μm in diam, smooth to asperulate, branched and anastomosed to form a loosely reticulate network, with internal branches with free ends terminating in a circinate or spirally coiled tip, peripherally ending in spine-like appendages. Appendages dark

brown, straight but often slightly curved, up to 70–120 μm long, 1.5–2 μm in diam near the base, bearing a few, short, side branchlets, septate, coarsely asperulate, terminating in a hyaline, pointed or bluntly rounded end. Asci 8-spored, ovoid to pyriform, 9–12 \times 6.5–8 μm , short-stipitate, evanescent. Ascospores hyaline, ellipsoid-fusiform, 4.5–6.5 \times 2.5–3 μm , subacuminate at both ends, finely striate.

Vegetative mycelium consisting of hyaline, branched, septate, smooth-walled, 1–3 μm diam hyphae. Ascomatal initials appear as swollen side branches arising from aerial hyphae, which soon coil and form a com-



Figs. 9–15. *Myxotrichum emodense*.

9. Asci. 10, 11. Ascospores (SEM). 12. Ascomatal initial. 13–15. Conidiophores, conidiogenous hyphae and conidia. Scale bars: 9 = 10 μm ; 10, 11 = 5 μm ; 12–15 = 20 μm .

pact mass.

Anamorph: *Oidiodendron* sp. Conidiophores macro-nematous, mononematous, erect, arising from vegetative mycelium or aerial hyphae, straight below, branching at the top to produce an arborescent, olivaceous brown head; stipes olivaceous brown to dark brown, 25–200 μm or more in length, 1.5–2.5 μm in diam, straight,

septate, thick-walled, smooth or sometimes with black nodes; branches hyaline to pale olivaceous brown, 10–60 \times 2–2.5 μm , smooth-walled, repeatedly re-branched, frequently forming a verticilloid whorl of 4–6 narrow conidiogenous hyphae. Conidiogenous hyphae terminal on branches or on conidiophores, hyaline, cylindrical, 1.2–1.5 μm in diam, fragmenting to form conidial chains,

at maturity broken out. Conidia schizogenous, separating readily, hyaline, pale grayish green in mass, subglobose, ovoid, ellipsoidal or short cylindrical, $1.5\text{--}3.5 \times 1.5\text{--}2 \mu\text{m}$, almost smooth-walled, truncate at one or both ends, connectives sometimes visible between the conidia.

Weakly cellulolytic.

At 15°C , colonies on OA show about half of the growth at 25°C ; ascomata and conidia are produced. At 37°C , growth is nil.

Holotype: SUM 3125, a dried culture isolated from grassland soil, Chumoa (alt. 2,950 m), Eastern Nepal, Nepal, 30 April 1995, col. S. Uchiyama (CBM).

Note: The similarity of *M. emodense* to *M. arcticum* Udagawa, Uchiyama et Kamiya (Udagawa et al., 1994) is shown by the ascomata with spine-like, asperulate appendages and the presence of an *Oidiodendron* anamorph state that is morphologically close to *O. griseum* Robak (Barron, 1962). In the anamorph of *M. arcticum*, however, some conidiophores form a geniculate head with single conidia produced over the surface. In a recent comparative study of morphological and molecular data using the nuclear rDNA, Hambleton et al. (1998) have suggested a close relationship between *M. arcticum* and *O. griseum*, although more strains need to be examined before any judgment concerning conspecificity is made. *Myxotrichum emodense* differs from *M. arcticum* in having smaller ascomata with a white to pale yellow centrum ($150\text{--}250 \mu\text{m}$ in diam in the latter) and longer appendages (up to $50 \mu\text{m}$ long in the latter), and ascoma development in 25°C culture.

The new species also resembles *M. ochraceum* Berk. et Br. var. *frigidum* Uchiyama, Kamiya et Udagawa (Uchiyama et al., 1995c) in the peridial hyphae with internal coiled branches and spine-like appendages, but *M. ochraceum* var. *frigidum* is readily distinguishable by its very short, smooth-walled, appendages, narrowly fusiform ascospores, and lack of an *Oidiodendron* anamorph.

***Myxotrichum retardatum* Udagawa et Uchiyama, sp. nov.** Figs. 16–22

Coloniae in "OA" valde restrictae, plus minusve zonatae, ex mycelio basali tenui constantes, granulares, abundantibus ascomatibus formantes, griseo-rubineae vel obscure virides vel livido-vinaceae vel olivaceo-griseae; reversum atropurpureum vel brunneo-vinaceum.

Ascomata superficialia, saepe confluentia, valde olivaceo-brunnea vel fere nigra, globosa vel subglobosa, appendiculis exclusis $100\text{--}160 \mu\text{m}$ diam. Hyphae peridii atrobrunneae, incrassatae, septatae, ad septum interdum constrictae, $2.5\text{--}5 \mu\text{m}$ diam, asperulatae vel leves, ramosae et anastomosantes, reticulo formantes; appendices spiniformes, atrobrunneae vel fere nigrae, apicem versus pallescentes, breves, $20\text{--}55 \times 1.5\text{--}2.5 \mu\text{m}$, rigidae, non ramosae, inferne 1–2-septatae, leves, apice hyalinae et acutae. Asci 8-spori, ovoidei vel pyriformes, $7.5\text{--}10.5 \times 7\text{--}9.5 \mu\text{m}$, brevi-stipitati, evanescentes. Ascosporae hyalinae, ellipsoideae-fusiformes, interdum non aequilaterae, $4\text{--}5.5\text{--}(6.5) \times 2.5\text{--}3 \mu\text{m}$, utrinque subacumina-

tae, leviter striatae.

Mycelio vegetativo ex hyphis hyalinis, ramosis, septatis, levibus, $1\text{--}3 \mu\text{m}$ diam composito. Anamorphosis abest.

Holotypus: SUM 3126; colonia exsiccata in cultura ex solo sylvae, Alberta, in Canada, 25.IX.1994, a S. Uchiyama isolata et ea CBM conservata.

Etymology: Latin, *retardatus*=slow, referring to the slow development of the ascomata on the medium.

Colonies on OA growing very restrictedly, attaining a diam of 16–18 mm in 42 d at 15°C , more or less zonate, consisting of a thin basal mycelium with granular surface due to the production of abundant ascomata, at first white, then Greyish Ruby to Dull Green (M. 12D3–28E3) or Livid Vinaceous to Olivaceous Grey (R); margins broad, thin, submerged; exudate abundant, vinaceous; reverse Dark Purple (M. 14F3) or Brown Vinaceous (R). Colonies on PYE growing very restrictedly, attaining a diam of 14–15 mm in 35 d at 15°C , funiculose, radially sulcate, centrally raised up to 6 mm high, consisting of a thick mycelial felt, with inconspicuous aerial hyphae, Orange White (M. 5A2) or Buff (R); ascomata not produced; exudate absent; reverse Greyish Red (M. 7B5) or Apricot (R).

Ascomata superficial, often confluent, dark olive brown to almost black, with a white centrum, globose to subglobose, $100\text{--}160 \mu\text{m}$ in diam excl. appendages, maturing within 42 d. Peridial hyphae dark brown, thick-walled, septate, sometimes constricted at the septum, $2.5\text{--}5 \mu\text{m}$ in diam, coarsely asperulate to smooth, branched and anastomosed to form a reticulum, ending in spine-like appendages. Appendages dark brown to nearly black, paling toward the apex, short, $20\text{--}55 \mu\text{m}$ long, $1.5\text{--}2.5 \mu\text{m}$ in diam near the base, rigid, straight, unbranched, 1–2-septate at the lower part, smooth, terminating in a hyaline pointed end. Asci 8-spored, ovoid to pyriform, $7.5\text{--}10.5 \times 7\text{--}9.5 \mu\text{m}$, short-stipitate, evanescent. Ascospores hyaline, ellipsoid-fusiform, sometimes inequilateral, $4\text{--}5.5\text{--}(6.5) \times 2.5\text{--}3 \mu\text{m}$, more or less acuminate at both ends, finely striate.

Vegetative mycelium consisting of hyaline, branched, septate, smooth-walled, $1\text{--}3 \mu\text{m}$ diam hyphae. Ascumatal initials appear as swollen side branches arising from aerial hyphae, which coil and form a compact mass. Anamorph lacking.

Weakly cellulolytic.

At 25°C , colonies on OA are smaller than those grown at 15°C ; ascomata not produced. At 37°C , growth is nil.

Holotype: SUM 3126, a dried culture isolated from forest soil, Johnstone Valley, Banff National Park, Alberta, Canada, 25 September 1994, col. S. Uchiyama (CBM).

Note: *Myxotrichum retardatum* closely resembles *M. ochraceum* var. *frigidum* (Uchiyama et al., 1995c) in having ascomata with short (up to $30 \mu\text{m}$ in the latter species), spine-like, smooth-walled appendages, showing psychrophilic growth (poor growth at 25°C), and lacking an *Oidiodendron* anamorph state. However, *M. retardatum* may be distinguished from the latter by the white

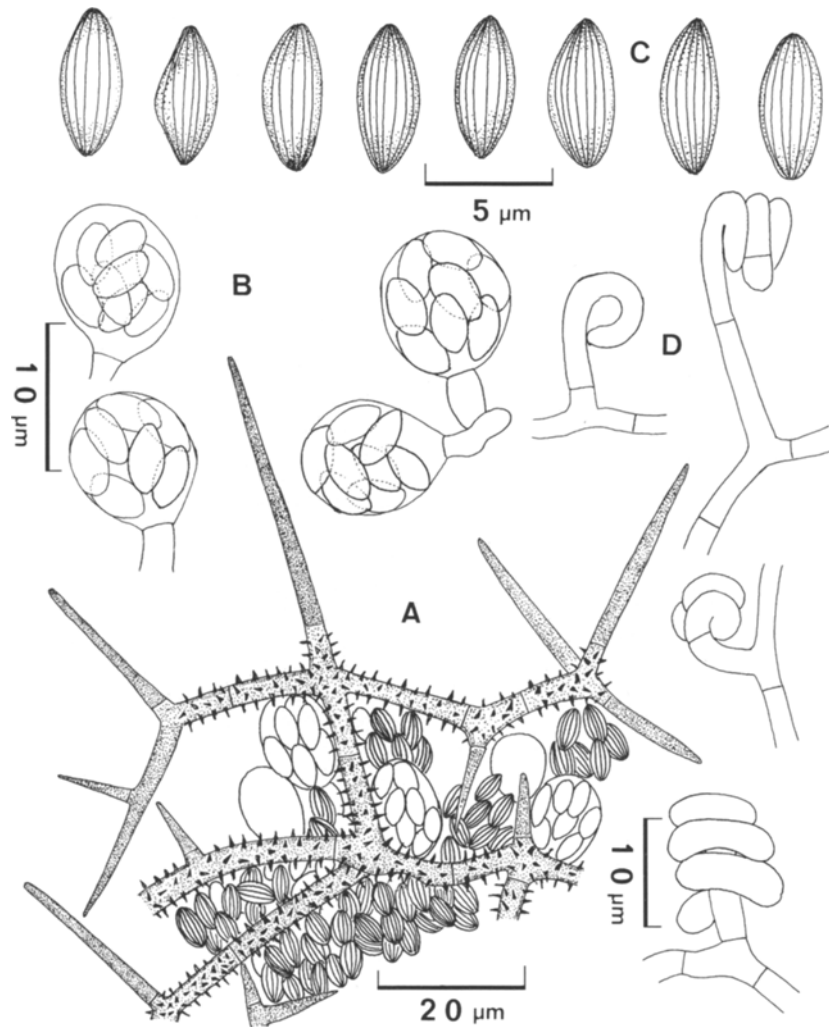


Fig. 16. *Myxotrichum retardatum* (SUM 3126).

A. Margin of ascoma showing appendages. B. Asci. C. Ascospores. D. Ascumatal initials.

centrum of its ascomata and the absence of internal coiled branches on peridial hyphae. In addition, *M. retardatum* produces asperulate peridial hyphae and somewhat broader ascospores.

Nannizziopsis patagonica Udagawa et Uchiyama, sp. nov. Figs. 23, 26–29

Coloniae in "OA" effusae, floccosae, planae, ex mycelio vegetativo submerso et hyphis aeriis laxis constantes, ascomatibus abundantibus formantes, albae; conidiogenesis conspicua; reversum dilute flavum.

Ascomata superficialia, discreta vel confluentia, globosa vel subglobosa, appendiculis inclusis 180–280 µm diam, alba sed ad centrum dilute flavo-brunnea; tarde maturescentia. Hyphae peridii hyalinae, tenues et leves, septatae, 1.5–3 µm diam, ramosae et anastomosantes, reticulo laxo formantes; appendices hyalinae, rectae, paulo septatae, leves, ad apicem plus minusve inflatae. Asci 8-spori, late clavati vel pyriformes, 20–25 × 11–14 µm, brevi-stipitati, evanescentes. Ascosporae dilute flavae, globosae vel subglobosae, 5–6 µm diam,

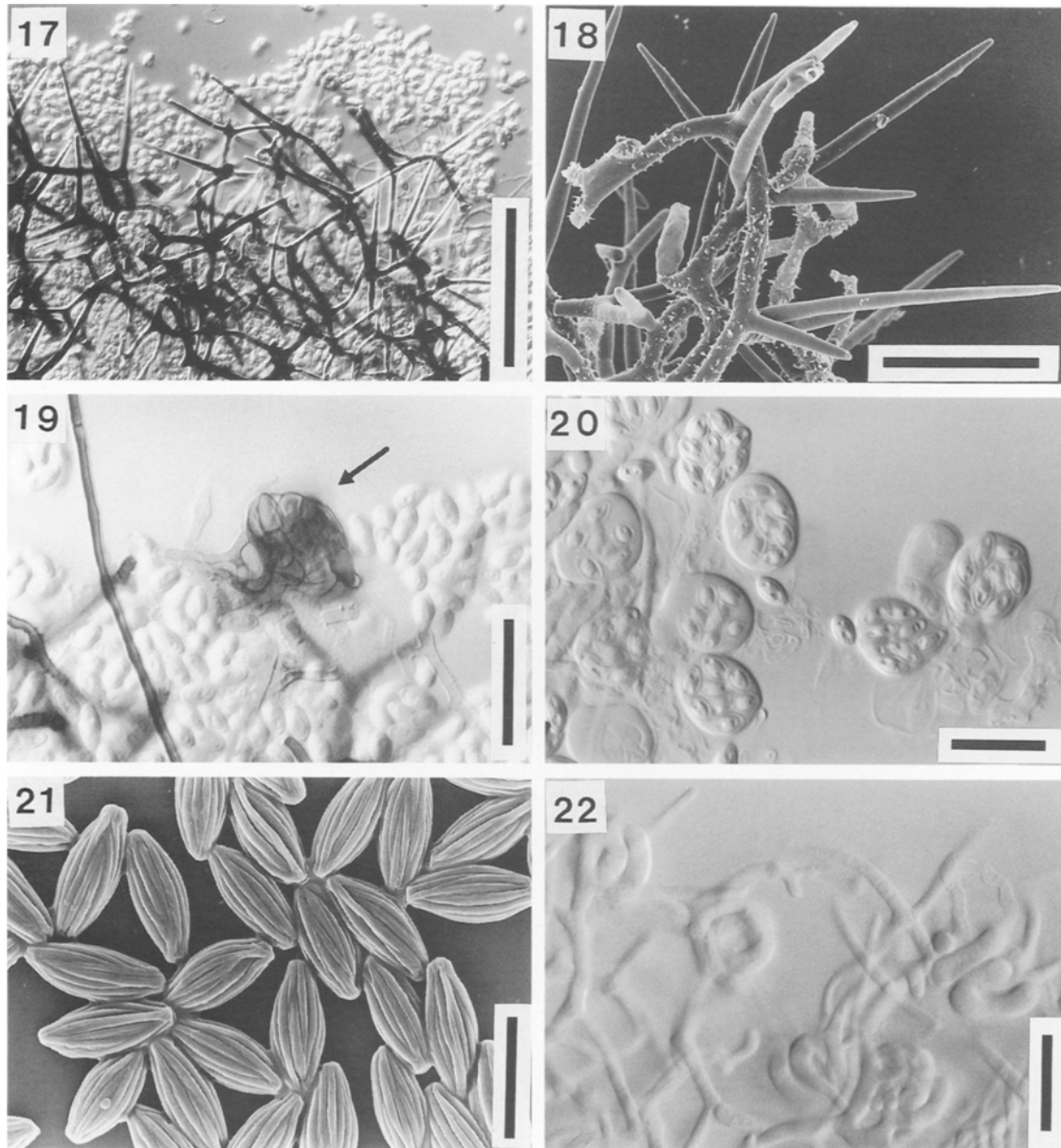
incrassatae, regulatim reticulatae.

Anamorphosis: *Chrysosporio* similis. Conidiophora micronemata. Aleurioconidia terminalia vel lateralialia, sessilia vel brevi-pedicellaria, vulgo solitaria, hyalina, unicellularia, pyriformia vel obovoidea, 5–12 × 2.5–6 µm, ad basim truncata, aliquantum incrassata et levia. Arthroconidia hyalina, cylindracea vel doliiformia, 4.5–12 × 2–3 µm, levia.

Holotypus: SUM 3122; colonia exsiccata in cultura ex solo sativo, Patagonya, in Tucumania, 3.I.1996, a S. Uchiyama isolata et ea CBM conservata.

Etymology: Latin, *patagonicus*, referring to the Patagonia region in Argentina, the type locality.

Colonies on OA spreading broadly, up to 70 mm in diam in 21 d at 25°C, floccose, plane, with vegetative mycelium submerged and loose aerial hyphae, producing abundant ascomata and conidia, white in color; reverse Pale Yellow (M. 4A3). Colonies on PCA spreading broadly, attaining a diam of 60 mm in 21 d at 25°C, floccose, more or less radially sulcate, thin, consisting of a submerged vegetative mycelium and sparse white aerial



Figs. 17–22. *Myxotrichum retardatum*.

17. A part of ascoma. 18. Appendages (SEM). 19. Internal coiled branch (arrow) of peridial hypha. 20. Asci. 21. Ascospores (SEM). 22. Ascomatal initials. Scale bars: 17=50 μm ; 18, 19=20 μm ; 20, 22=10 μm ; 21=5 μm .

hyphae, producing abundant ascomata in the submarginal aerial growth, white to Pale Yellow (M. 2A3) or somewhat Primrose (R); margins irregular, thin; conidiogenesis abundant; exudate clear, scattered at center; reverse uncolored or Greyish Brown (M. 11E3) to Vinaceous Grey (R) in central colony areas. Colonies on PYE growing more rapidly, up to 60 mm or more in diam in 21 d at 25°C, floccose, plane, consisting of a tough basal felt, white to Yellowish White (M. 3A5) or Primrose (R); ascomata not produced; conidiogenesis sparse; reverse Olive Brown to Dark Violet (M. 4D4–15F8) or Greenish Olivaceous to Purple-Slate (R).

Ascomata superficial, discrete or confluent in small

clusters, globose to subglobose, 180–280 μm in diam incl. appendages, white, with a pale yellowish brown centrum, surrounded by wefts of loose aerial hyphae and conidia, maturing within 21 d. Peridial hyphae hyaline, thin and smooth-walled, septate, 1.5–3 μm in diam, branched and anastomosed to form a loose reticuloperidium, extending outwards to hyphal appendages; appendages borne as free apices of the peridial hyphae, a few septate, smooth-walled, more or less swollen above to a rounded end. Asci singly borne, 8-spored, broadly clavate to pyriform, 20–25 \times 11–14 μm , short-stipitate, evanescent. Ascospores pale yellow, globose to subglobose, 5–6 μm in diam incl. ridges, consisting of a central

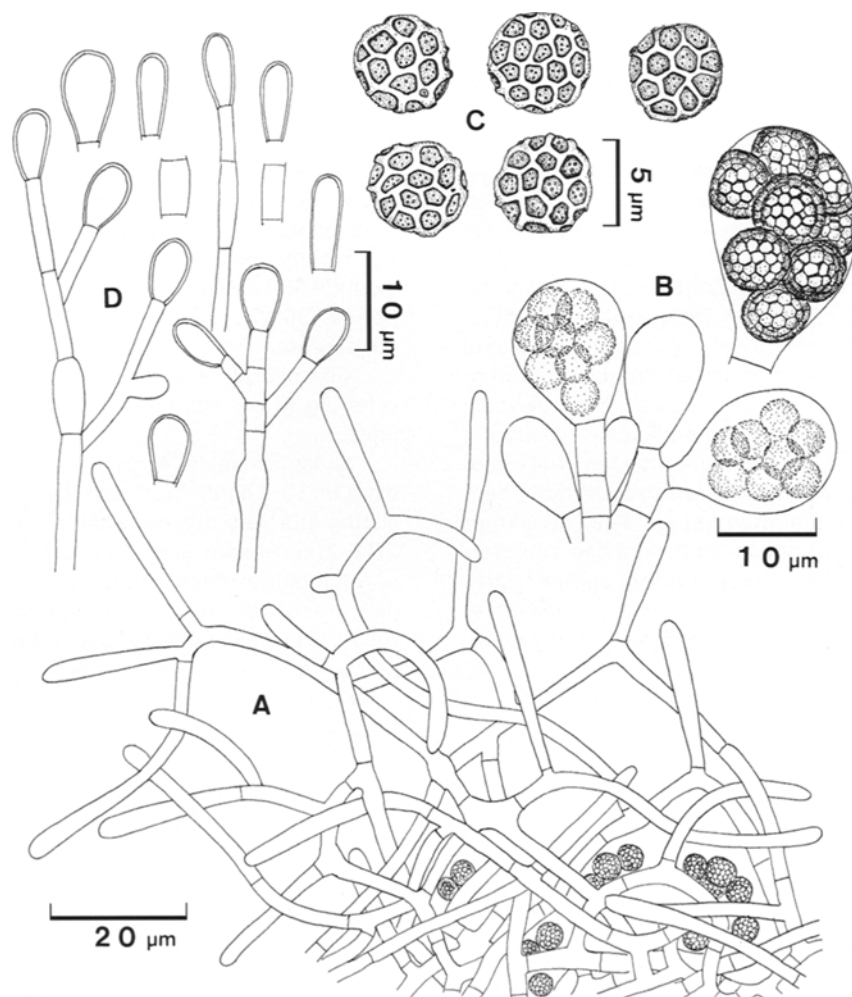


Fig. 23. *Nannizziopsis patagonica* (SUM 3122).

A. Margin of ascoma showing appendages. B. Asci. C. Ascospores. D. Conidiogenous cells and conidia.

body and thick-walled ridges, regularly reticulate.

Vegetative mycelium consisting of hyaline, branched, septate, thin and smooth-walled, 1–4 µm diam hyphae; racquet hyphae present; ascomatal initials develop as swollen, thick-walled branches from aerial hyphae.

Anamorph: *Chrysosporium*-like. Conidiophores micronematous. Aleurioconidia terminal or lateral, sessile or on short pedicels, usually solitary, hyaline, one-celled, pyriform or obovoid, 5–12 × 2.5–6 µm, truncated and with distinct basal scars, somewhat thick and smooth-walled. Arthroconidia less common, hyaline, cylindrical to barrel-shaped, 4.5–12 × 2–3 µm, truncated at both ends, smooth-walled.

Weakly keratinolytic.

At 37°C, growth is less rapid and ascomatal production is reduced.

Holotype: SUM 3122, a dried culture isolated from cultivated soil, Patagonia, Argentina, 3 January 1996, col. S. Uchiyama (CBM).

Note: Species of the genus *Nannizziopsis* Currah ap-

pear to be most closely related to *Amauroascus* Schröter, *Arachnotheca* von Arx, and *Auxarthron* Orr et Kuehn (Guarro et al., 1991). Common features include globose or nearly globose ascospores with a relatively thick, often reticulate-alveolate wall. The only distinctive characters of *Nannizziopsis* are the white (or light-colored) ascomata, rather differentiated peridium consisting of a network of loosely interwoven hyaline hyphae and simple hyphal appendages.

In comparison with the four *Nannizziopsis* species described since 1985, *N. patagonica* differs from *N. vriesii* (Apinis) Currah (Currah, 1985) and *N. hispanica* Cano et Guarro (Guarro et al., 1991) primarily in the larger dimensions of the asci and ascospores; unlike the new taxon, *N. albicans* (Apinis) Guarro, Cano et DeVroey has large ascomata with undifferentiated peridial hyphae and somewhat smaller ascospores (Guarro et al., 1991); and *N. mirabilis* Uchiyama, Kamiya et Udagawa is characterized by smooth to roughened, clavate, septate appendages that are constricted at septa, and hyaline ascospores ornamented with spiral bands (Uchiyama et al.,

1995a).

Spiromastix princeps Udagawa et Uchiyama, sp. nov.

Figs. 24, 30–36

Coloniae in "PCA" restrictae, floccosae, planae, ex mycelio basali coacto valde tenuiter constantes, abundantibus ascomatibus formantes, olivaceae vel olivaceo-griseae vel fumosae; reversum aureum vel brunneum vel umbrinum.

Ascomata superficialia, discreta vel confluentia, globosa vel subglobosa, interdum irregularia, appendiculis exclusis 120–280 μm diam, griseo-brunnea vel atrobrunnea. Hyphae peridii hyalinae, irregulariter ramosae, saepe curvae vel contortae, tenues, leves, reticulo laxo formantes, ad extremum appendicibus instructae; appendices bifformes: (1) breves, sinuatae vel contortae, dilute brunneae, saepe dichotome ramosae, remote septatae, leves, superne incurvatae vel spirales; (2) extensae, brunneae vel atrobrunneae, non ramosae vel interdum prope basin ramosae et saepe tortae, sed pro parte maxima rectae vel parum undulatae, leves, incrassatae, 120–160 \times 2.5–3 μm , superne gradatim contractae.

Asci 8-spori, globosi vel ovoidei vel pyriformes, 6.5–9.5 \times 5.5–7 μm , dilute flavi, evanescentes. Ascospores flavae vel dilute brunneae, oblatae, 3.5–4 \times 2–2.5 μm , crista aequatoria lata praeditae, cum superficie minute punctata et anguste sulcata.

Mycelio vegetativo ex hyphis hyalinis, ramosis, delicatis, levibus vel subtiliter asperatis, septatis, 1–2 μm diam composito. Anamorphosis abest.

Holotypus: SUM 3127; colonia exsiccata in cultura ex solo, Masai Mara National Reserve, Narok, Rift Valley, Kenya, 31.VII.1996, a S. Uchiyama isolata et ea CBM conservata.

Etymology: Latin, *princeps*=most distinguished, referring to the peculiar character of ascomatal appendages.

Colonies on PCA growing restrictedly, attaining a diam of 13–14 mm in 21 d at 25°C, floccose, plane, consisting of a very thin mycelial felt, Olive to Olive Grey (M. 2D3–2) or Smoke Grey (R) in color due to the production of abundant ascomata borne in loose aerial hyphae; margins arachnoid, thin; exudate abundant, Pale Yellow (M. 3A3); reverse Golden Yellow to Brown (M. 5B7–6E5) or

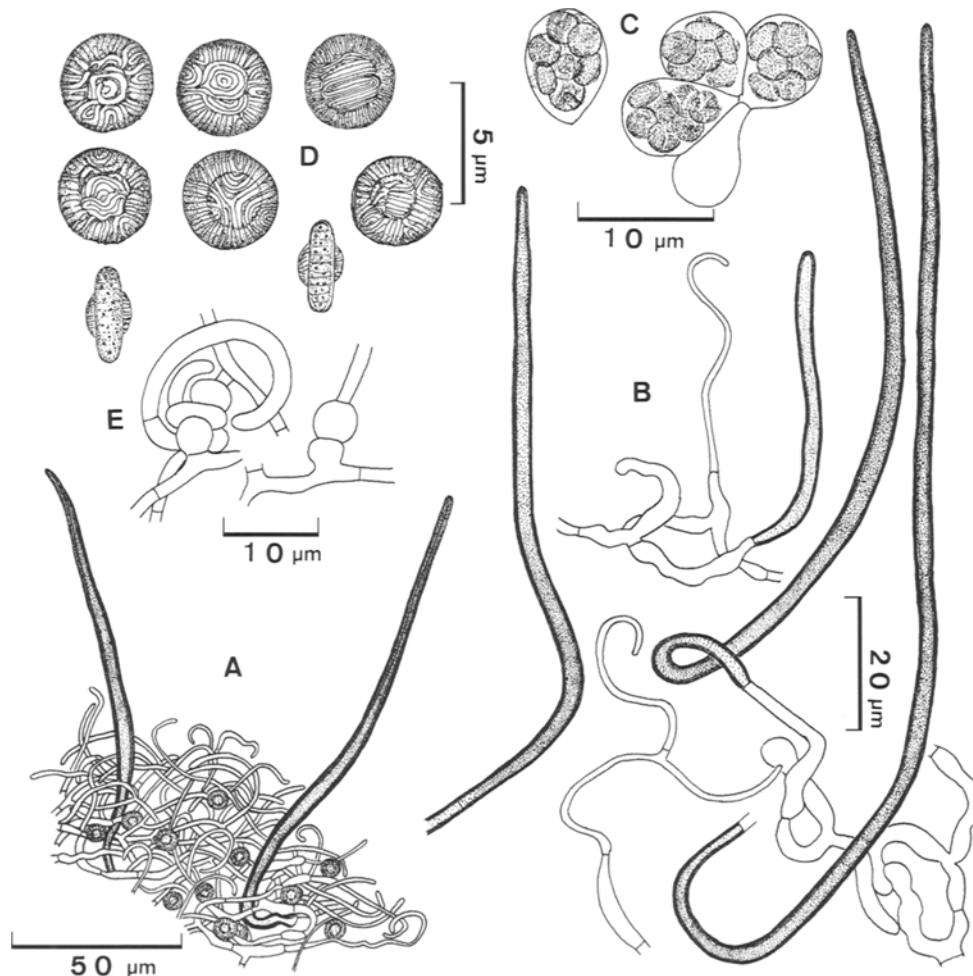


Fig. 24. *Spiromastix princeps* (SUM 3127).

A. Margin of ascoma showing appendages. B. Two kinds of appendages. C. Asci. D. Ascospores. E. Ascomatal initials.

Luteous to Umber (R). Colonies on PYE growing even more rapidly, attaining a diam of 16–17 mm in 21 d at 25°C, radially wrinkled and buckled, raised up to 5 mm high, floccose, consisting of a thick mycelial felt, Orange (M. 5A6) or Luteous (R); margins abruptly narrow; reverse Reddish Brown (M. 8F6) or Blood Colour (R), with surrounding agar similarly colored.

Ascomata superficial, discrete or confluent, globose to subglobose, sometimes irregular in shape, 120–280 μm in diam excl. appendages, grayish to dark brown, Brownish Red (M. 9C8) by transmitted light, maturing within 21–28 d; centrum yellow. Peridial hyphae hyaline, irregularly branched, often curved or contorted, thin-walled, smooth, forming a loose network and ending partly in short slender appendages and partly in elongate appendages: (1) short appendages sinuous or contorted, pale brown, often dichotomously branched, remotely septate, smooth, somewhat thick-walled, up to 32 μm

long and 1–1.5 μm in diam, apically incurved or coiled; (2) elongate appendages brown to dark brown, usually unbranched but sometimes branched and often twisted near the base, mostly straight or slightly undulate, smooth, thick-walled, 100–160 \times 2.5–3 μm , gradually tapering toward the pointed apex. Asci singly borne, 8-spored, globose to ovoid or pyriform, 6.5–9.5 \times 5.5–7 μm , very short-stipitate, pale yellow, evanescent. Ascospores yellow to pale brown, oblate, 3.5–4 \times 2–2.5 μm , with a broad equatorial rim and polar thickenings, narrowly sulcate with linear ridges and finely punctate over the entire surface.

Vegetative mycelium consisting of hyaline, branched, delicate, smooth to finely roughened, septate, 1–2 μm diam hyphae; racquet hyphae absent; ascomatal initials arising as a side knob on a hypha, developing by fusion of apical segments of two initials and becoming irregularly coiled or contorted, then surrounded by hyphae

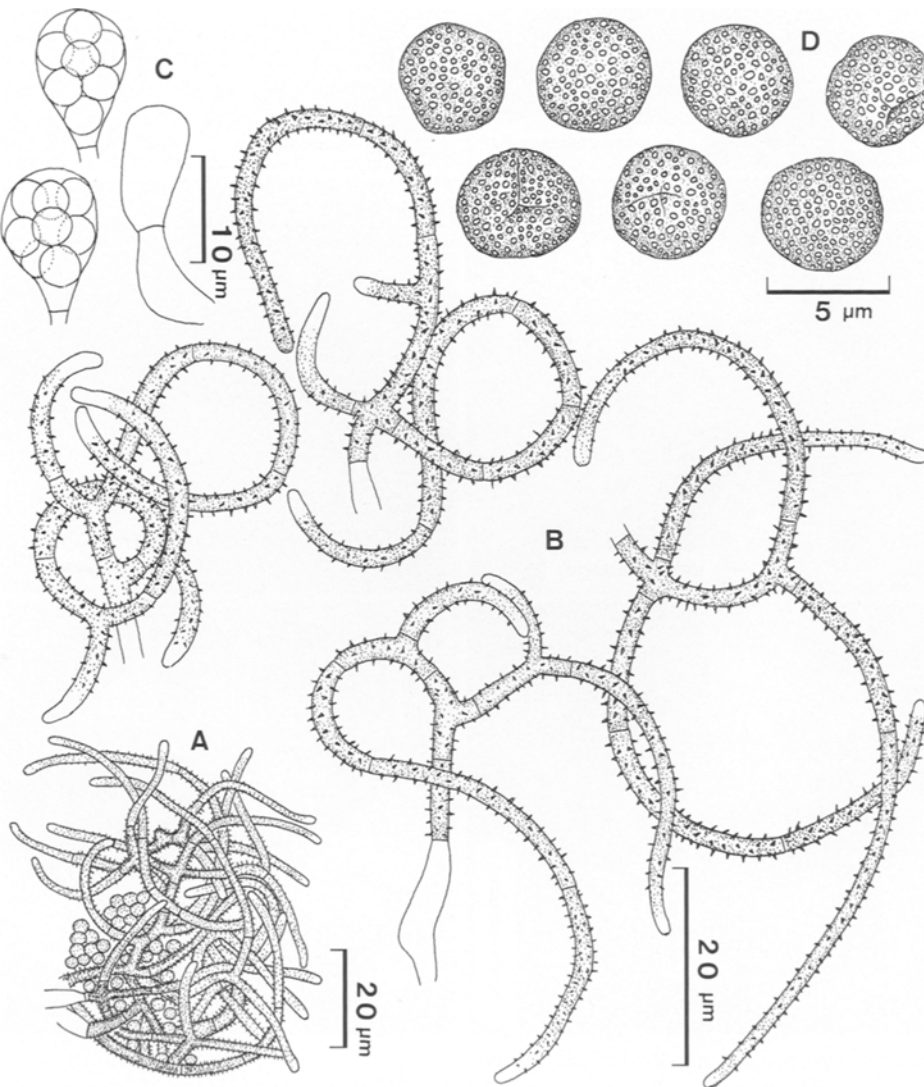


Fig. 25. *Spiromastix sphaerospora* (SUM 3128).

A. Margin of ascoma showing appendages. B. Appendages. C. Asci. D. Ascospores.

arising from the neighboring cells. Anamorph lacking.

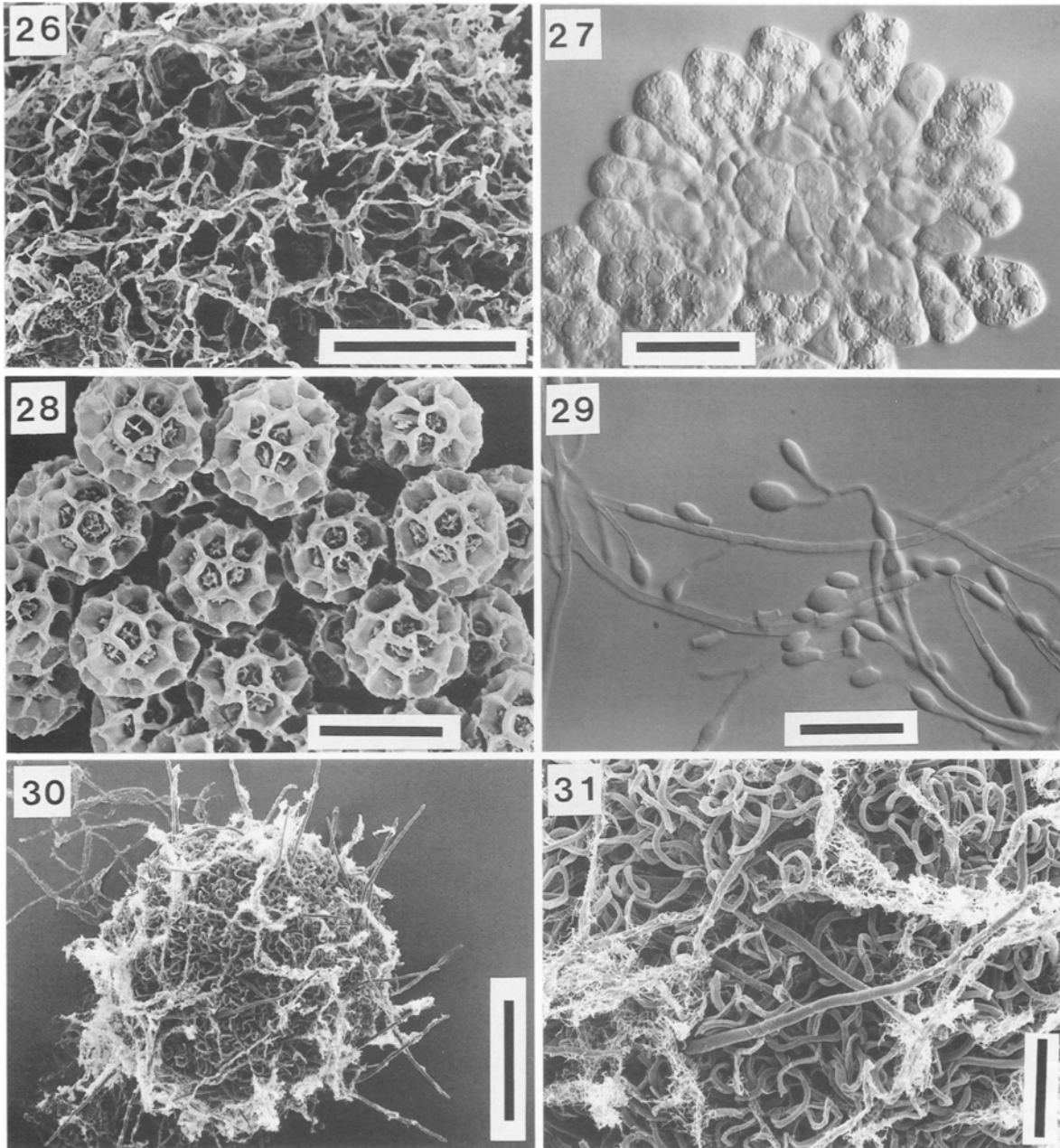
Weakly keratinolytic.

At 37°C, growth rate is rather reduced and ascomata are not observed.

Holotype: SUM 3127, a dried culture isolated from soil, Masai Mara National Reserve, Narok, Rift Valley, Kenya, 31 July 1996, col. S. Uchiyama (CBM).

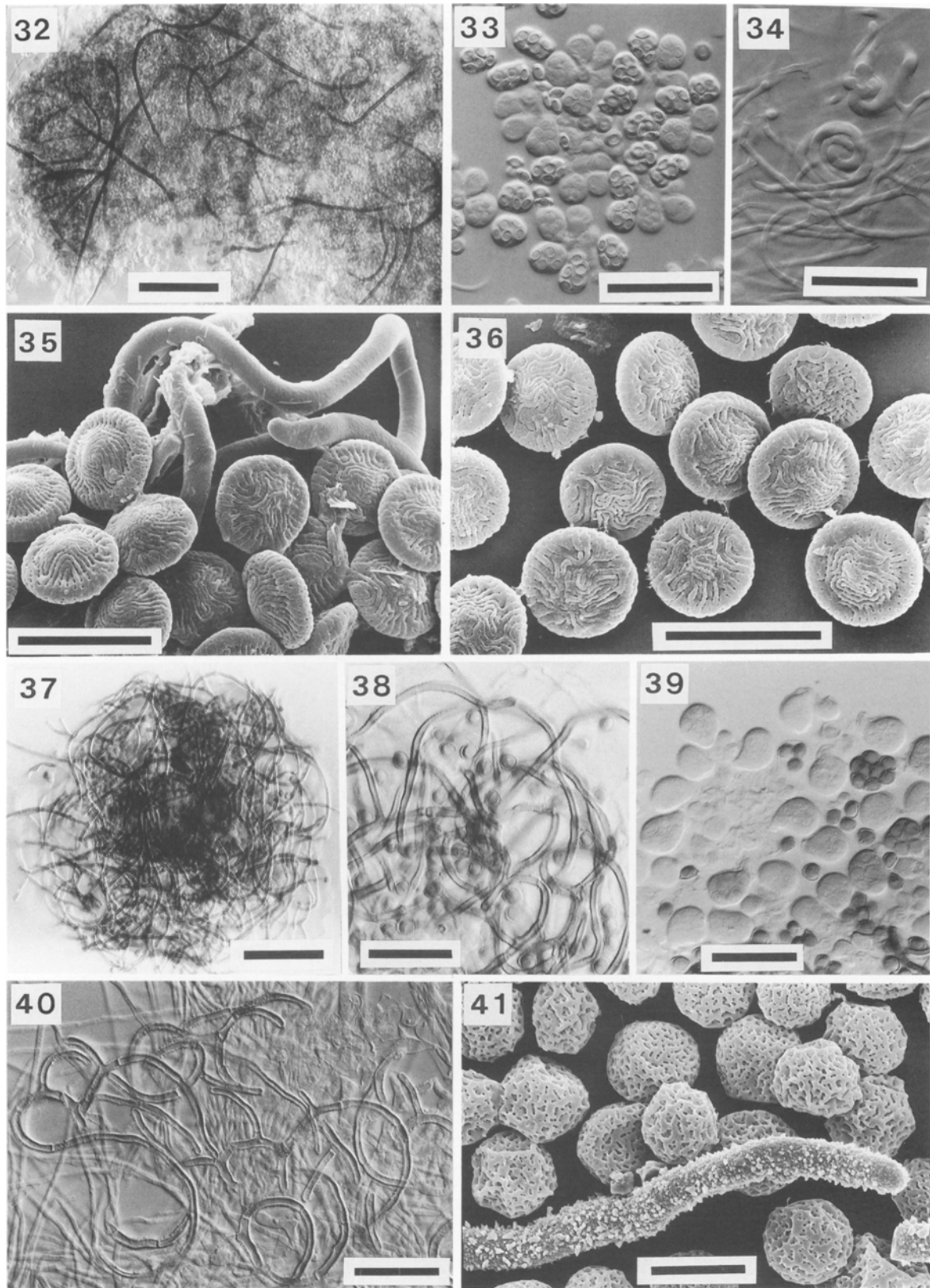
Note: *Spiromastix princeps* is quite distinct from other species of the genus in having two kinds of asco-

matal appendages. Like *S. warcupii* Kuehn et Orr (the type species), the hitherto known species are characterized by brownish ascomata, rather delicate peridial hyphae with few branched, thick-walled, curved, wavy or helical appendages and small, oblate, minutely punctate ascospores (Kuehn and Orr, 1962; Currah and Locquin-Linard, 1988; Guarro et al., 1993; Uchiyama et al., 1995d). Another new species in this paper, *S. sphaerospora* Udagawa et Uchiyama, also has the same



Figs. 26–31. *Nannizziopsis patagonica* and *Spiromastix princeps*.

26–29. *Nannizziopsis patagonica*. 26. Peridial hyphae. 27. Asci. 28. Ascospores (SEM). 29. Conidiogenous cells and conidia. 30, 31. *Spiromastix princeps*. 30. Ascoma (SEM). 31. Appendages (SEM). Scale bars: 26, 27, 29, 31 = 20 μm ; 28 = 5 μm ; 30 = 100 μm .



Figs. 32–41. *Spiromastix princeps* and *S. sphaerospora*.

32–36. *Spiromastix princeps*. 32. Ascoma. 33. Asci. 34. Ascomatal initials. 35. Short appendage and ascospores (SEM). 36. Ascospores (SEM). 37–41. *Spiromastix sphaerospora*. 37. Ascoma. 38. Appendages. 39. Asci. 40. Initial stage of ascoma. 41. Appendage and ascospores (SEM). Scale bars: 32, 37=50 μm ; 33, 34, 38–40=20 μm ; 35, 36, 41=5 μm .

characteristics in the appendages.

Arx (1987), in his re-examination of the Eurotiales, placed *Spiromastix* in an uncertain position but suggested its inclusion in the Gymnoascaceae sensu Arx, although in current treatment it is considered to belong to the Onygenaceae (Currah, 1985, 1988; Hawksworth et al., 1995). The position of *Spiromastix* within the Onygenaceae is uncertain, because Sugiyama et al. (1999) showed that the data from SSD rDNA sequence analysis of *S. warcupii* do not support a phylogenetic relationship between *Spiromastix* and other fungi of the Onygenaceae. Sequence data for the other species are needed in order to evaluate the exclusion of this genus from the Onygenaceae.

Spiromastix sphaerospora Udagawa et Uchiyama, sp. nov. Figs. 25, 37–41

Coloniae in "PCA" celeriter crescentes, floccosae, planae, ex mycelio basali coacto tenuiter constantes, abundantibus ascomatibus formantes, rubro-griseae vel viridi-griseae; reversum griseo-rubineum vel vinoso-lividum.

Ascomata superficialia, discreta vel confluentia, globosa vel subglobosa, appendiculis inclusis (75–)150–250 μm diam, brunneo-rubra vel valde rubinea. Hyphae peridii hyalinae vel brunneae, irregulariter ramosae, curvae vel contortae, incrassatae, asperatae, remote septatae, intertextae, 1.5–3 μm diam, reticulo laxo formantes, ad extremum appendicibus gracilibus instructae; appendices dilute brunneae vel brunneae, simplices vel pauciramosae, parum curvae vel sinuatae, fere aseptatae, incrassatae, asperatae, 28–110 \times 1.5–2(–3) μm , ad apicem plus minusve inflatae. Asci 8-sporei, subglobosi vel ovoidei vel pyriformes, 9–13.5 \times 8–10 μm , brevi-stipitati, hyalini vel dilute flavo-brunnei, evanescentes. Ascospores dilute brunneae vel brunneae, globosae vel subglobosae, 4–5 \times 3.5–5 μm , subtiliter reticulatae-punctatae, interdum leviter porcatae.

Mycelio vegetativo ex hyphis hyalinis, ramosis, delicatis, levibus, septatis, 1–2(–4) μm diam composito. Anamorphosis abest.

Holotypus: SUM 3128; colonia exsiccata in cultura ex solo, Kagoshima, in Japonia, 14.I.1996, a S. Uchiyama isolata et ea CBM conservata.

Etymology: Greek, *sphaero*-=globose and *-spora*=spore, referring to the ascospore morphology.

Colonies on PCA growing rather rapidly, attaining a diam of 26–30 mm in 21 d at 25°C, floccose, plane, consisting of a thin basal felt, producing abundant ascomata, obscured by the overlying aerial hyphae, Reddish Grey to Greenish Grey (M. 12C2-26E2) or Pale Vinaceous to Pale Olivaceous Grey (R); margins irregularly dissected; reverse Greyish Ruby (M. 12D3) or Livid Vinaceous (R). Colonies on PYE growing rapidly, 35–36 mm in 21 d at 25°C, velvety to floccose, plane, consisting of a thin mycelial felt, white to Greenish Grey (M. 28B2); ascomata not produced; reverse Violet Brown (M. 10F5) or Dark Vinaceous (R).

Ascomata superficial, discrete or confluent in small clusters, globose to subglobose, (75–)150–250 μm in

diam incl. appendages, at first white, becoming Brownish Red to Dark Ruby (M. 8C8–12F4), maturing within 21 d; centrum brownish red. Peridial hyphae hyaline to brown, irregularly branched, curved or contorted, thick-walled, at first smooth, becoming asperulate, remotely septate, interwoven, 1.5–3 μm in diam, forming a loose network, ending in slender appendages; appendages arising from the peridial hyphae as free end of branches, incurved or extending outwards, pale brown to brown, simple or with a few branches, slightly curved or wavy, almost aseptate, thick-walled, coarsely roughened, 28–110 \times 1.5–2(–3) μm , more or less swollen at rounded tip but not helical. Asci singly borne, 8-spored, subglobose to ovoid or pyriform, 9–13.5 \times 8–10 μm , short-stipitate, hyaline to pale yellowish brown, evanescent. Ascospores pale brown to brown, globose to subglobose, 4–5 \times 3.5–5 μm , thick-walled, with surface finely reticulate-punctate, sometimes with slightly sinuous low ridges up to 1 μm thick.

Vegetative mycelium consisting of hyaline, branched, delicate, smooth-walled, septate, 1–2 μm diam hyphae, often swollen up to 4 μm in diam as internal knobs; racquet hyphae present; ascomatal initials arising as a lateral knob on a hypha, developing by fusion of apical segments of two initials, and becoming irregularly and closely coiled or contorted, then surrounded by hyphae arising from the neighboring cells. Anamorph lacking.

Weakly keratinolytic.

At 37°C, growth rate is increased but ascomatal formation is reduced.

Holotype: SUM 3128, a dried culture isolated from soil of an athletic field, Fukiagehama, Kaseda-shi, Kagoshima Pref., Japan, 14 January 1996, col. S. Uchiyama (CBM).

Note: The brownish ascomata with delicate peridial appendages, which are slightly curved or wavy, and finely reticulate-punctate ascospores of *S. sphaerospora* indicate its close relationship with *S. warcupii* and its allies (Kuehn and Orr, 1962; Currah and Locquin-Linard, 1988; Guarro et al., 1993). However, these species differ markedly in other characteristics, e.g., smooth-walled appendages and small, oblate ascospores (up to 4 μm in length and up to 2.5 μm in width). The new taxon is also distinct from *S. saturnispora* Uchiyama, Kamiya et Udagawa (Uchiyama et al., 1995d), which has smooth-walled appendages and oblate ascospores with an equatorial rim.

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