

Taxonomic studies on new or critical fungi of non-pathogenic Onygenales 1

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From recent isolates of microfungi on soil materials collected at several localities in the world, five new taxa of the Onygenales are described and illustrated. A new monotypic genus, *Kraurogymnocarpa lenticulospora*, is proposed. New species are described in *Amauroascus*, *Aphanoascus*, and *Arachnomyces*. A new variety of *Pseudogymnoascus roseus* is also proposed.

Key Words—ascomycetes; *Kraurogymnocarpa*; Onygenales; soil fungi; systematics.

As shown by the monographic treatment of Currah (1985), the order Onygenales (Ascomycota) consists of four families: Arthrodermataceae, Gymnoascaceae, Myxotrichaceae, and Onygenaceae. Members of the Arthrodermataceae usually occur as parasitic forms on the skin and hair of mammals, including humans, and some of the Onygenaceae, notably species of *Ajellomyces* (*A. capsulata* (Kwon-Chung) McGinnis et Katz and *A. dermatitidis* McDonough et Lewis) are important as human pathogens. However, most members of the Gymnoascaceae, Myxotrichaceae, and Onygenaceae are not pathogenic either to humans or to animals, and are found on soil, animal dung, vegetable debris, or other organic wastes. One other major human pathogenic fungus, *Coccidioides immitis* Rixford et Gilchrist, is not known to produce a teleomorphic stage or macroconidia, but it does produce arthroconidia that are similar to those of some non-pathogenic members of the Onygenales, and the data from DNA sequence analysis by Bowman and Taylor (1993) and Pan et al. (1994) have shown that *Ucinocarpus reesii* Sigler et Orr is the closest relative of *C. immitis* among the non-pathogenic members of the Onygenales. Thus increasing interest is being shown in the taxonomic and phylogenetic relationships between the pathogenic and non-pathogenic Onygenales.

During the past decade, our designed isolation technique using soil plate method incorporating selective agents (e.g., phenol and cycloheximide) has yielded a wealth of new onygenean materials for taxonomic study. Our recent attempts to isolate, culture, identify, and consider teleomorph-anamorph connections in this fungal group have advanced significantly. This contribution is part of a study lying within the aspects of tradi-

tional taxonomy of some recent collections of the non-pathogenic Onygenales. A final resolution of phylogenetic relationships within the Onygenales and related taxa will require the integration of information from non-morphological data obtained by molecular methods.

Materials and Methods

Living cultures were used for all macroscopic and microscopic observations. The strains were cultivated in glass Petri dishes in a light incubator (Sanyo, model MIR 153) at 15, 25, and 37°C under artificial daylight. The methods used are detailed in previous papers (Udagawa et al., 1993; Uchiyama et al., 1995).

Taxonomy

Kraurogymnocarpa Udagawa et Uchiyama, gen. nov.

Ascomata discreta vel confluentia, plus minusve globosa, flavo-viridia vel obscure viridia. Hyphae peridii flavo-brunneae, asperulatae, incrassatae, septatae, ramosae et anastomosantes, completo-reticulo formantes, postea facile disarticulatae, ad extremum spinis brevibus et appendicibus elongatis formantes. Appendices strictae vel parum curvatae, simplices, raro septatae, inferne dilute brunneae et asperulatae, superne hyalinae et leves, ad apicem acutae. Asci 8-spori, subglobosi vel ovoidei vel pyriformes, evanescentes. Ascospores unicellulares, flavae, lenticulares, duabus cristis aequatorialibus praeditae, aculeatis-tuberculatis convexis ornatae. Anamorphosis abest.

Species typica: *Kraurogymnocarpa lenticulospora* Udagawa et Uchiyama.

Etymology: Greek, *krauro* = fragile; *gymnocarpa* = with the fruit naked, referring to the characteristics of the ascomata with disarticulated peridial hyphae.

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Ascomata discrete or confluent, more or less globose, yellowish green to dull green. Peridial hyphae yellowish brown, asperulate, thick-walled, septate, branched and anastomosed to form a reticuloperidium, readily disarticulating in age, with free ends forming short spines and elongate appendages. Appendages straight or slightly curved, simple, hardly septate, pale brown and asperulate below, hyaline and smooth above, with a pointed apex. Asci 8-spored, subglobose to ovoid or pyriform, evanescent. Ascospores unicellular, yellow, lenticular, with two equatorial crests and with convex surface aculeate-tuberculate. Anamorph lacking.

Kraurogymnocarpa lenticulospora Udagawa et Uchiyama, sp. nov. Figs. 1–9

Coloniae in agar cum decocto tuberorum et carotaram (PCA) aliquanto tardae, floccosae, tenues, ex mycelio vegetativo submerso constantes, ascomatibus abundantibus formantes, obscure virides vel flavo-virides; reversum laete flavum vel olivaceo-brunneum.

Ascomata superficialia, discreta vel saepe confluentia, globosa vel subglobosa, appendiculis inclusis 160–250 μm diam, viridi-flava vel obscure viridia. Hyphae peridii flavo-brunneae, asperulatae, incrassatae, septatae, 2–6 μm diam, ramosae et anastomosantes, completoreticulo formantes, postea disarticulatae, ad extremum spinis brevibus et aliquot appendicibus elongatis formantes; spinae breves asperulatae, brunneae, pauciseptatae, 6–16 μm longae, apicem versus angustatae et pallescentes; appendices elongatae strictae vel parum curvatae, simplices, raro septatae, inferne dilute brunneae et asperulatae, superne hyalinae et leves, 30–70 \times 2–2.5 μm , ad apicem acutae. Asci 8-sporei, non catenati, subglobosi vel ovoidei vel pyriformes, 10–14 \times 8–10 μm , brevi-stipitati, hyalini vel dilute flavi, evanescentes. Ascospores dilute flavae, lenticulares, 5–6 \times 3–4 μm (sine cristis 3.5–4 μm longae), duabus cristis aequatoribus late separatis circa 1 μm latis praeditae, aculeatis-tuberculatis convexis ornatae.

Mycelio vegetativo ex hyphis hyalinis vel flavis, ramosis, levibus vel incrustatis, septatis, 2–5 μm diam composito. Anamorphosis abest.

Holotypus: SUM 3117; colonia exsiccata in cultura ex solo, Toyama, in Japonia, 15.X.1995, a S. Uchiyama isolata et ea collectione fungorum Musei et Instituti Historiae Naturalis Chiba (Natural History Museum and Institute, Chiba, Japan; CBM) conservata.

Etymology: Latin, *lenticulosporus* = lens-shaped spores, referring to the characteristics of the ascospores with two equatorial crests.

Colonies on PCA growing rather slowly, attaining a diam of 28–32 mm in 21 d at 25°C, floccose, thin, with vegetative mycelium submerged, raised in central areas due to the production of abundant ascomata, Dull Green (M. 27D3, after Kornerup and Wanscher, 1978) or Yellow-green (Rayner, 1970); margins thin, broad, Yellow (M. 3A6) or Pure Yellow (R); exudate limited, clear; reverse Light Yellow to Olive Brown (M. 3A5–4D5) or Pure Yellow to Greenish Olivaceous (R). Colonies on PYE growing rapidly, 43–45 mm in diam in 21 d at 25°C,

more or less velvety, radially sulcate, depressed in central areas, consisting of a thin mycelial felt, Yellow (M. 3A7); ascomata not produced; reverse Greyish Red (M. 7B3) or Saffron (R).

Ascomata superficial, discrete or often confluent, globose to subglobose, 160–250 μm in diam incl. appendages, greenish yellow to dull green, maturing within 21 d; centrum 145–185 μm in diam, yellow to yellowish brown. Peridial hyphae yellowish brown, asperulate, thick-walled, septate, 2–6 μm in diam, not constricted or swollen at the septum, branched and anastomosed, forming a reticulate network which becomes disarticulated at the septum in age, with free apices forming short spines and a few elongate appendages; short spines asperulate, brownish, a few septate, 6–16 μm long, somewhat tapering and paling towards the apex; elongate appendages straight or slightly curved, simple, pale brown and asperulate near the base, aseptate or 1-septate in the lower part, hyaline and smooth-walled above, 30–70 \times 2–2.5 μm , with an abruptly narrow, pointed apex. Asci 8-spored, singly borne, subglobose to ovoid or pyriform, 10–14 \times 8–10 μm , very short-stipitate, hyaline to pale yellow, evanescent at maturity. Ascospores pale yellow, lenticular, 5–6 \times 3–4 μm incl. the crests, consisting of a central body 3.5–4 μm with two widely separate, ruffled equatorial crests about 1 μm wide and with convex surface showing an aculeate-tuberculate ornamentation under the SEM.

Vegetative mycelium consisting of hyaline to yellow, branched, smooth or encrusted with yellowish granules, septate, 2–5 μm diam hyphae; racquet hyphae present; anamorph lacking; ascomatal initials arising from two adjacent cells of the same hypha or separate hyphae and becoming closely appressed to one another to give a club-shaped central initial and a coiling hypha.

Weakly cellulolytic.

At 37°C, growth is nil.

Holotype: SUM 3117; a dried culture isolated from soil, Oosawano-machi, Kaminiikawa-gun, Toyama Pref., Japan, 15 Oct. 1995, col. S. Uchiyama (CBM).

Other specimen examined: SUM 3118; a dried culture isolated from forest soil, Mt. Tsukuba, Tsukuba-shi, Ibaraki Pref., Japan, 17 Mar. 1998, col. S. Uchiyama.

Note: The monotypic genus *Kraurogymnocarpa* is characterized by yellowish green ascomata, reticuloperidium with a disarticulating structure, bivalvate ascospores, and a weakly cellulolytic activity. According to the monograph and the key published by Currah (1985, 1988) for the Onygenales, the new genus might be included in the Gymnoascaceae with those genera having light colored ascomata, various types of ascomatal peridia, and hyaline or brightly colored, oblate ascospores. Their ascospores are often with polar and/or equatorial thickenings, smooth-walled or somewhat irregular to lumpy, but never punctate or striate. Many of the species in the Gymnoascaceae do not produce an anamorph, and are neither strongly cellulolytic nor keratinolytic.

Ascomata of *K. lenticulospora* are similar to those of *Gymnoascus* Baranetzky in being net-like without enlarging

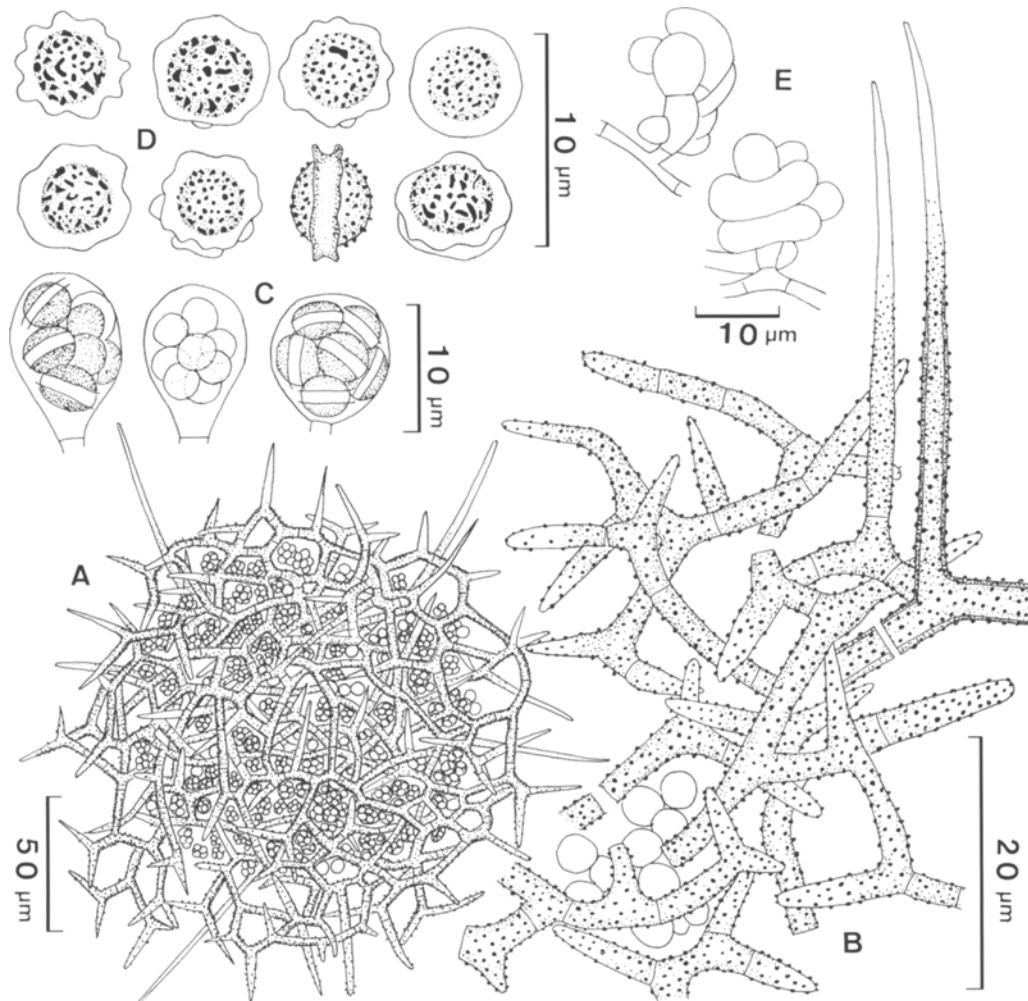


Fig. 1. *Kraurogymnocarpa lenticulospora* (SUM 3117).

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

gements or swellings at the septa on the peridial elements. Short spine-like ends of the peridial hyphae are also similar to those of *Gymnoascus*, although the elongate appendages of ascomata suggest a superficial relationship with *Auxarthron* Orr et Kuehn in the Onygenaceae (Orr et al., 1963a, b). The peridial elements of these two genera differ from those of *K. lenticulospora* in having less tendency to disarticulate, and the ascospores are not bivalvate. *Shanorella spirotricha* Benjamin, the only genus of the Gymnoascaceae-Onygenaceae so far known, can be characterized by its disarticulating peridium which is divided into a series of thick-walled, curved, or Y-shaped hyphal fragments at maturity (Benjamin, 1956). *Shanorella* differs in having bright yellow ascomata with coiled appendages and oblate minutely pitted ascospores.

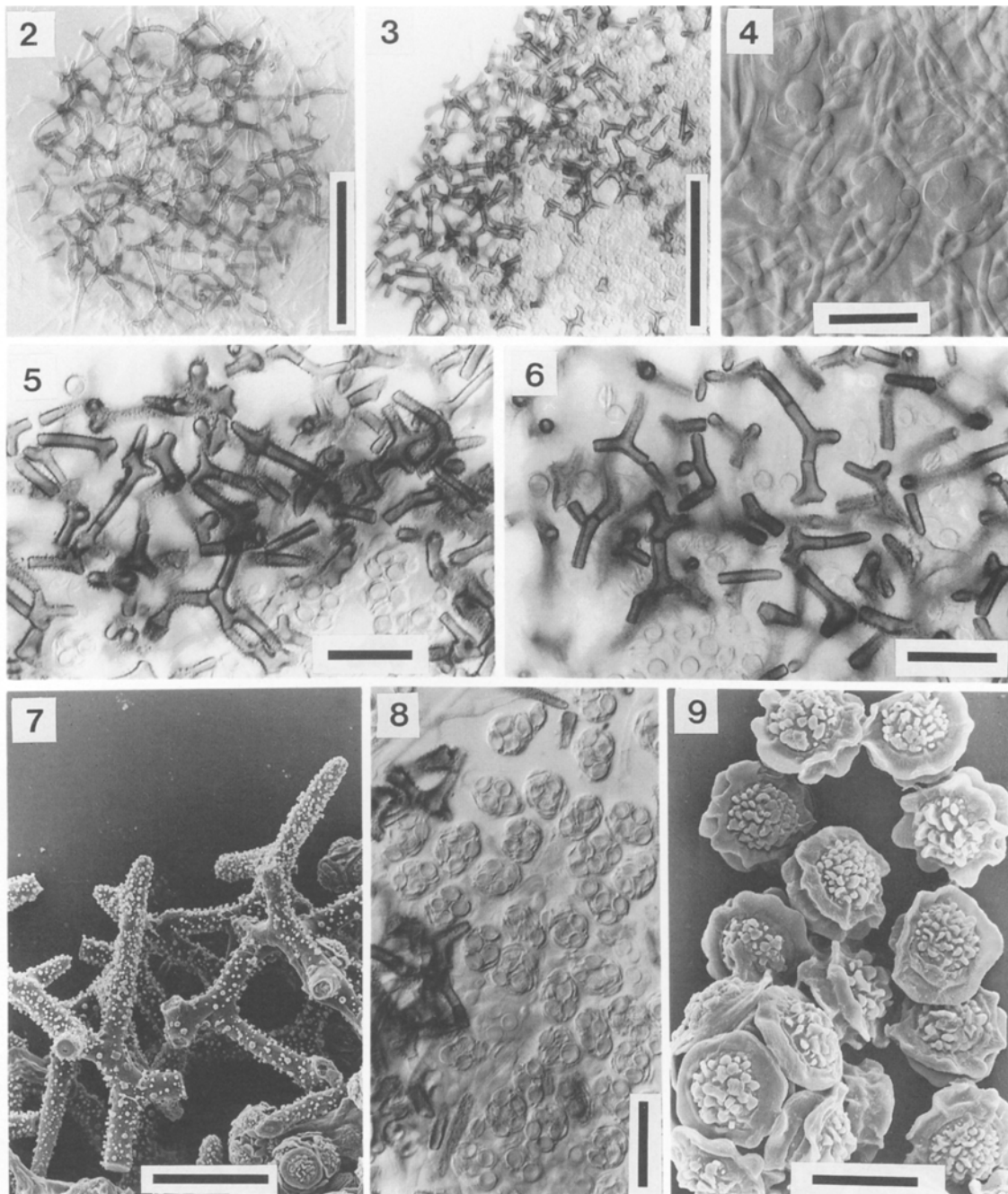
Amauroascus malaysianus Udagawa et Uchiyama, sp. nov. Figs. 10–17

Coloniae in agar farinae avenaceae mixto (OA) plus minusve celeriter crescentes, aliquanto floccosae, planae

vel zonatae, tenues, ex mycelio vegetativo submerso constantes, ad centrum ascomatibus abundantibus formantes, albae vel flavo-albae vel primulinae; conidiogenesis modesta; reversum incoloratum.

Ascomata superficialia, discreta vel saepe confluentia, globosa vel subglobosa, 250–400 µm diam, alba vel cremea, tarde maturescentia. Hyphae peridii hyalinae, delicatae, intertextae, tenues, leves, septatae, 1–2.5 µm diam, ramosae et anastomosantes, plerumque telaperidio formantes. Asci 8-sporei, non catenati, ovoidei vel pyriformes, 9–10.5 × 7–9 µm, hyalini, evanescentes. Ascosporae hyalinae vel stramineae, globosae vel subglobosae, 3–4(–4.5) µm diam, punctatae vel reticulatae.

Anamorphosis: *Malbranchea* sp. Hyphae fertiles ex hyphis aeriis orientes, saepe irregulariter multi-ramosae; hyphae primariae 2–4 µm diam, leves, ramis fertilibus et arthroconidiis et aleurioconidiis formantes. Arthroconidia intercalaria hyalina, levia, cylindracea, 4–20(–24) × 1.5–3 µm, utrinque truncata, interdum inflata. Aleurioconidia numerosa, hyalina, levia, ovoidea, ellipsoidea, cuneiformia vel clavata, 2.5–6.5(–14) × 1.5–



Figs. 2–9. *Kraurogymnocarpa lenticulospora*.

2. Ascoma. 3, 5–7. Disarticulated peridial hyphae (7: SEM). 4. Ascomatal initials. 8. Ascus. 9. Ascospores (SEM).
Scale bars: 2, 3 = 100 μm ; 4–6, 8 = 20 μm ; 7 = 10 μm ; 9 = 5 μm .

4 μm , ad basim truncata.

Holotypus: SUM 3119; colonia exsiccata in cultura ex solo horti, Johore Bahru, Malaysia, 29.XI.1993, a S. Uchiyama isolata et ea CBM conservata.

Etymology: Latinized from the name Malaysia, referring to the country of the type locality.

Colonies on OA growing rather rapidly, attaining a diam of 36–37 mm in 14 d at 25°C, somewhat floccose,

plane or zonate, thin, consisting of a submerged vegetative mycelium, producing ascomata in fairly dense clusters in central areas, white to Yellowish White (M. 1A2) or Primrose (R); conidiogenesis moderate; reverse uncolored. Colonies on PYE growing rather rapidly, 28–29 mm in 14 d at 25°C, floccose, plane or zonate, consisting of a thin basal felt, with surface developing rather dense mycelial growth, white to Yellowish White (M.

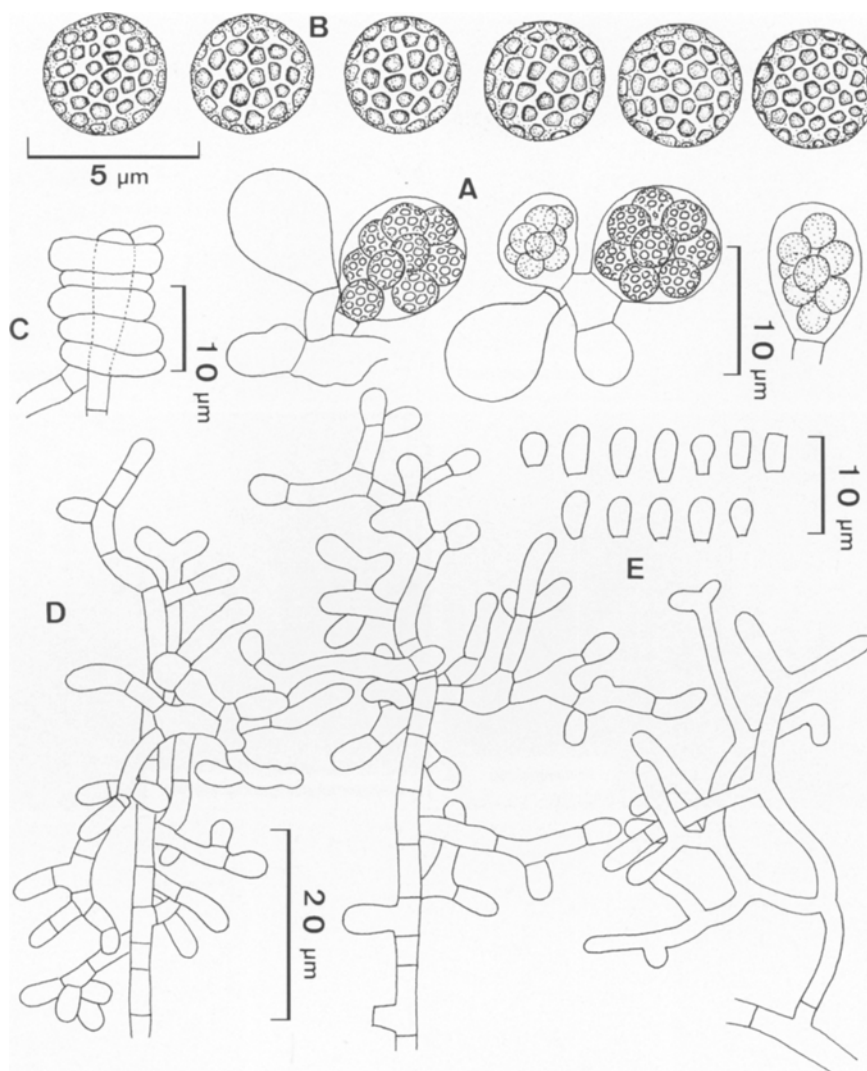


Fig. 10. *Amauroascus malaysianus* (SUM 3119).

A. Asci. B. Ascospores. C. Ascumatal initial. D. Conidiogenous cells and conidia. E. Conidia.

1A2); ascomata not produced; conidiogenesis abundant in central areas; reverse Light Orange to Brownish Orange (M. 5A5-C6).

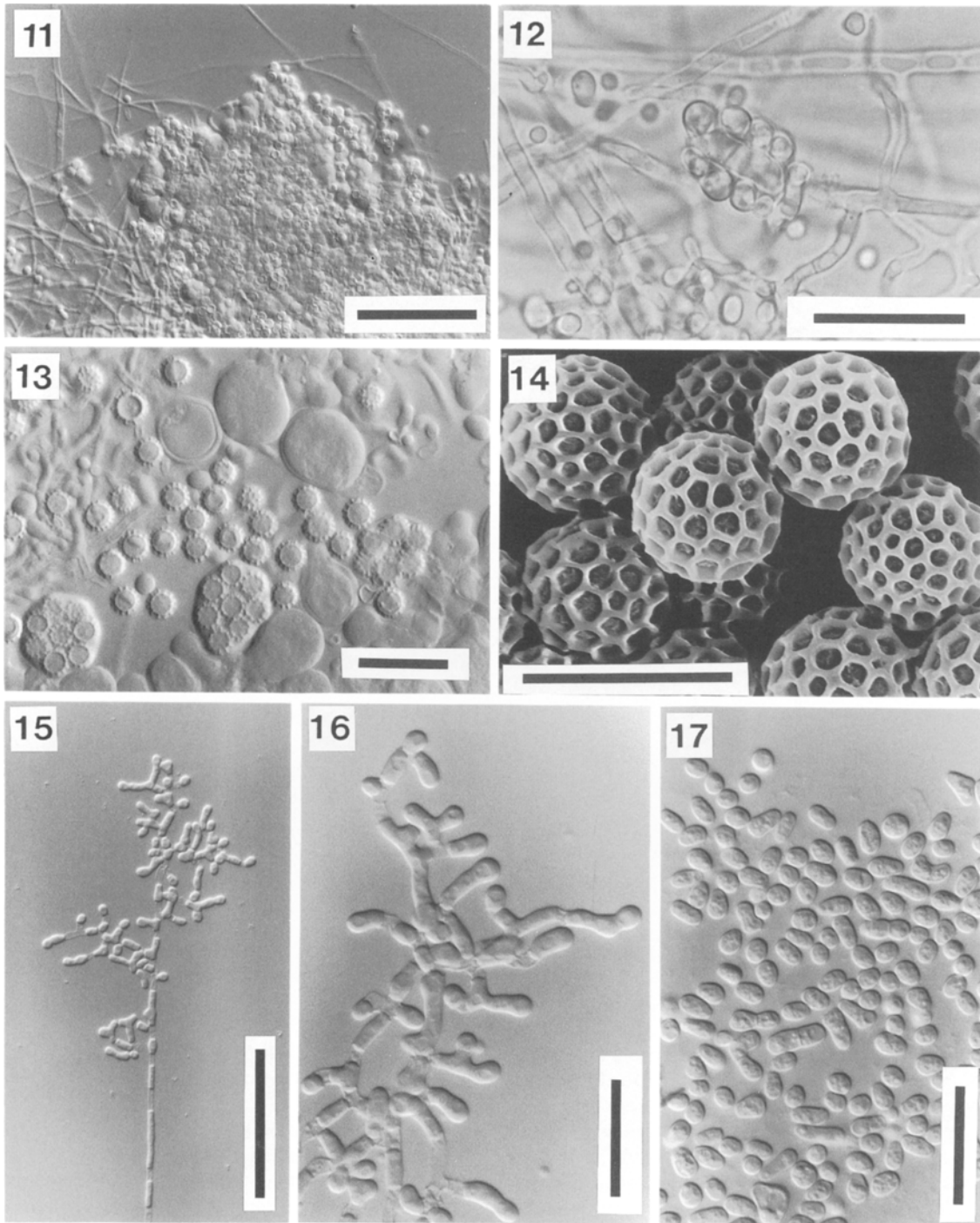
Ascomata superficial, discrete or often confluent, globose to subglobose, 250–400 μm in diam, white to cream, consisting of clusters of asci with loose peridial hyphae which are not differentiated from surrounding vegetative mycelium, maturing within 21 d. Peridial hyphae hyaline, delicate, interwoven, thin and smooth-walled, septate, 1–2.5 μm in diam, branched and anastomosed, forming a telaperidium. Asci 8-spored, singly borne, ovoid or pyriform, 9–10.5 \times 7–9 μm , evanescent. Ascospores hyaline to somewhat straw-colored, globose to subglobose, 3–4(–4.5) μm in diam incl. the ridges, with surface punctate-reticulate.

Vegetative mycelium consisting of hyaline, branched, smooth-walled or slightly asperulate, septate, 1–3 μm diam hyphae; racquet hyphae present, up to 7 μm in diam near the septum; ascumatal initials consisting of an

elongate side branch from aerial hypha around which another hypha arising from the neighboring cell coils tightly several times.

Anamorph: *Malbranchea* sp. Fertile hyphae arising as long side branches from aerial hyphae or as terminal branches of aerial hyphae, often forming an irregular tree-like multiple-branching structure; primary hyphae 2–4 μm in diam, smooth-walled, bearing fertile branches, intercalary arthroconidia and terminal aleurioconidia; branches irregularly and repeatedly re-branched, straight or curved, deflected. Intercalary arthroconidia hyaline, smooth-walled, cylindrical, 4–20(–24) \times 1.5–3 μm , truncated at the ends, sometimes swollen, integrated into terminal aleurioconidia. Aleurioconidia formed terminally or directly on the sides of the fertile hypha, numerous, hyaline, smooth-walled, variable in shape, ovoid to ellipsoidal, cuneiform or clavate, 2.5–6.5(–14) \times 1.5–4 μm , truncated at the base.

Keratinolytic.



Figs. 11–17. *Amauroascus malaysianus*.

11. A part of ascoma. 12. Ascomatal initial. 13. Asci and ascospores. 14. Ascospores (SEM). 15, 16. Conidiogenous cells and conidia. 17. Conidia.

Scale bars: 11, 15=50 μm ; 12, 16, 17=20 μm ; 13=10 μm ; 14=5 μm .

At 37°C, growth is nil.

Holotype: SUM 3119, a dried culture isolated from garden soil, near Abu Bakar Mosque, Johore Bahru, Johore State, Malaysia, 29 Nov. 1993, col. S. Uchiyama (CBM).

Note: The genus *Amauroascus* Schröt. is characterized by having ascomata with a loosely interwoven peridium of undifferentiated hyphae and globose punctate-reticulate ascospores. *Chrysosporium*-like anamorphs with aleurioconidia (terminal holothallic conidia)

and arthroconidia occur in several species of *Amauroascus*. The genus is often placed in a separate family, the Amauroascaceae in the Eurotiales (Arx, 1987) or the Ascodesmidaceae (=Amauroascaceae) in the Pezizales (Kimbrough, 1989; Eriksson and Hawksworth, 1993). However, Currah (1994) stated that the position of *Amauroascus* in the Onygenaceae is supported by the punctate ascospores, keratinolytic abilities and the arthroconidial anamorphs. *Amauroascus* and *Auxarthron* appear to be closely related. The distinguishing feature between these two genera seems only to be the differentiation in the peridial hyphae of *Auxarthron* species. The anamorphs of *Amauroascus* and *Auxarthron* such as *Amauroascus burundensis* Vidal, Cano et Guarro, *A. mutatus* (Quélet) Rammeloo, *A. niger* Schröt., *A. tropicalis* Cano, Guarro et R. F. Castañeda, *Auxarthron conjugatum* (Kuehn) Orr et Kuehn etc. are assigned to *Malbranchea* (Sigler and Carmichael, 1976; Currah, 1985; Cano and Guarro, 1989; Cano et al., 1996).

A diagnostic key to the species of *Amauroascus* was recently provided by Cano and Guarro (1989). They accepted 8 species, but *A. echinulatus* (Dutta et Ghosh) von Arx must be excluded from the genus because the echinulate ascospore ornamentation is atypical from the *Amauroascus* concept (Currah, 1985); later additions were presented by Ito and Nakagiri (1995) and Cano et al. (1996).

Amauroascus malaysianus is most similar to *A. kuehni* von Arx in having hyaline to pale yellow, small, globose, punctate-reticulate ascospores (fide Currah, 3.5–4.2 μm ascospores in *A. kuehni*), but distinct from the latter in the white to cream coloration of ascomata and the presence of a *Malbranchea* anamorph. Cano et al. (1987) reported that their isolates of *A. kuehni* from Spanish soil (FMR 924, FMR 2110) produced *Malbranchea*-type conidia. For *Arachniotus reticulatus* Kuehn (= *Amauroascus kuehni*), however, Kuehn (1957) described the anamorph as hyaline oidia (probably aleurioconidia) which measure 2.0–2.8 \times 2.8–8.4 μm . Our observations on *A. kuehni* ATCC 64725 resulted only in the production of aleurioconidia as the anamorph of *A. kuehni*.

Amauroascus malaysianus also bears a superficial resemblance to *A. burundensis* in such characters as white ascomata, regularly reticulate ascospores and a *Malbranchea* anamorph. *Amauroascus burundensis* differs by rather light yellow, asperulate peridial hyphae, brownish ascospores, and finely echinulate conidia.

Aphanoascus boninensis Udagawa et Uchiyama, sp. nov. Figs. 18–26

Coloniae in agar "YpSs" expansae, floccosae, planae, ex mycelio basali coacto et massa hyphae lanata constantes, ascomatibus abundantibus formantes, brunneo-griseae vel vinoso-bubalinae; conidiogenesis modesta vel abundans; reversum incoloratum vel flavo-album vel aliquanto stramineum.

Ascomata in massam mycelialem aggregata, non ostiolata, brunneo-aurantiaca, globosa vel subglobosa, 450–950 μm diam. Peridium ex strato hyphae com-

pacto constans, "textura intricata," raro membranaceum. Asci 8-sporei, non catenati, globosi vel subglobosi vel ovoidei, 11–13 \times 9–12 μm , evanescentes. Ascosporeae hyalinae vel dilute flavo-aurantiaca, oblatae, 5–7 \times 4–4.5 μm , incrassatae, subtiliter foveatae.

Mycelio vegetativo ex hyphis hyalinis, ramosis, tenuibus, levibus, septatis, 1.5–4 μm diam composito.

Anamorphosis *Chrysosporio* similis. Conidiophora micronemata. Aleurioconidia vulgo terminalia vel lateralia, sessilia vel brevi-pedicellaria, solitaria, hyalina vel dilute flava, unicellularia, pyriformia vel obovoidea, 5–9.5 \times 3.5–6.5 μm , ad basim truncata, primo levia et tenuia, deinde incrassata et verrucosa. Arthroconidia hyalina vel dilute flava, cylindracea vel doliiformia, levia.

Holotypus: SUM 3120; colonia exsiccata in cultura ex solo, Ogasawara, in Japonia, 3.VI.1995, a S. Uchiyama isolata et ea CBM conservata.

Etymology: Latin, *boninensis*, pertaining on the Bonin Islands (Ogasawara Islands), the type locality.

Colonies on YpSs agar spreading rapidly, attaining a diam of 85 mm or more in 21 d at 25°C, floccose, plane, consisting of a thin basal mycelium and woolly hyphal mass, producing abundant ascomata within a dense tomentose layer of vegetative hyphae, Brownish Grey (M. 8D2) or Vinaceous Buff (R); margins thin, submerged; conidiogenesis moderate to abundant; exudate scattered, dull red; reverse uncolored to Yellowish White (M. 4A2) or somewhat Straw (R). Colonies on OA as on YpSs in rate of growth and general colony pattern but becoming Dull Red (M. 9B3) or somewhat Salmon (R) due to the formation of ascomata; margins Yellowish White (M. 4A2) in color of aerial hyphae; reverse Greyish Orange (M. 6C3) or Vinaceous Buff (R). Colonies on PYE growing rapidly, 60–64 mm in diam in 21 d at 25°C, floccose, more or less wrinkled, producing abundant conidia, white to Orange White (M. 5A2) or Buff (R); ascomata not produced; reverse Brownish Orange (M. 6C7) or Umber (R).

Ascomata slowly developing as clusters in an arachnoid mycelial mass, non-ostiolate, brownish orange, globose to subglobose, 450–950 μm in diam, maturing within 21–28 d. Peridium consisting of a compact hyphal layer measuring 30–45 μm thick, "textura intricata," rarely membranaceous (only seen in SUM 3121); hyphae hyaline to pale yellowish brown, branched and anastomosed, thin and smooth-walled, 1.5–3 μm in diam, with numerous ampulliform swellings up to 14 μm in diam. Asci 8-spored, singly borne, globose to subglobose or ovoid, 11–13 \times 9–12 μm , evanescent. Ascospores hyaline to pale yellowish orange, oblate, 5–7 \times 4–4.5 μm , thick-walled, finely pitted under the SEM.

Vegetative mycelium consisting of hyaline, branched, thin and smooth-walled, septate, 1.5–4 μm diam hyphae; racquet hyphae present; ascomatal initials about 18 μm in diam, globose, terminal or lateral, giving rise to numerous dichotomously branched ascogenous hyphae.

Anamorph: *Chrysosporium*-like. Conidiophores micronematous. Aleurioconidia terminal or lateral, sometimes intercalary, sessile or on short pedicels, solitary, hyaline to pale yellow, one-celled, pyriform or ob-

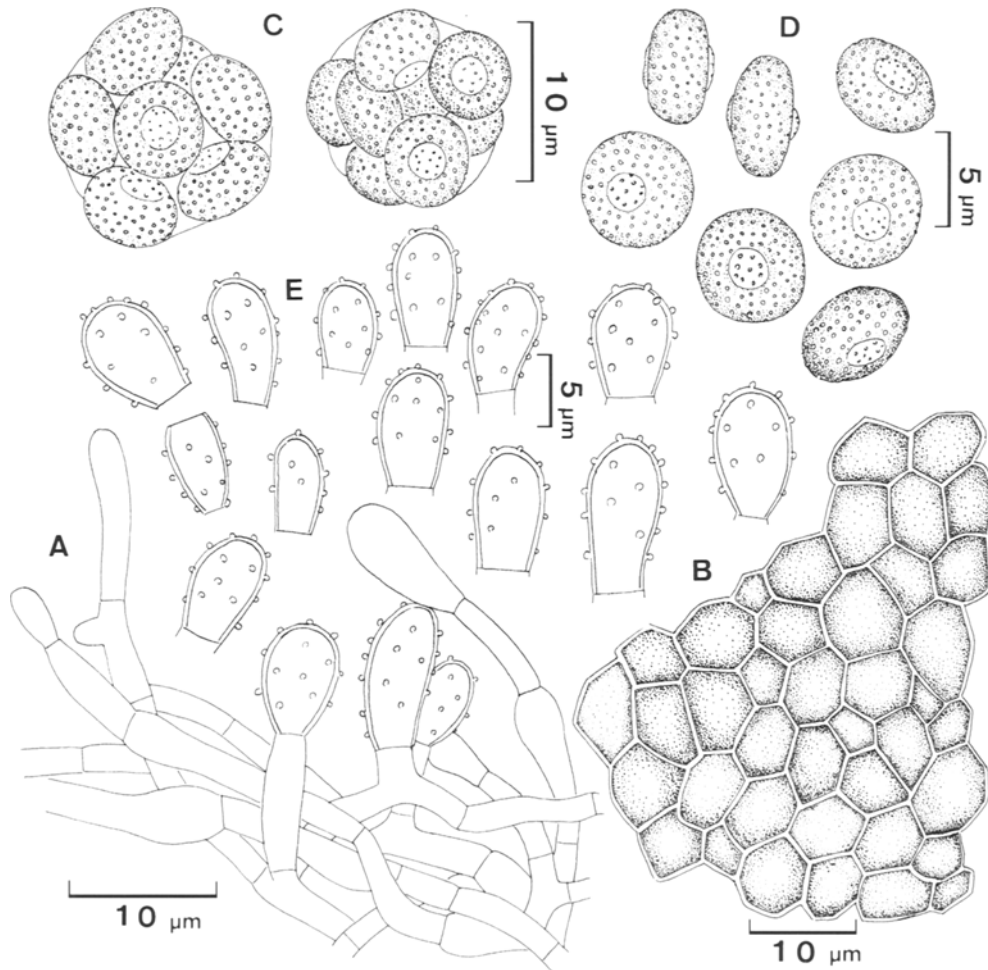


Fig. 18. *Aphanoascus boninensis* (SUM 3120, 3121).

A. Margin of ascoma (SUM 3120). B. Ascomatal peridium (SUM 3121). C. Asci (SUM 3120). D. Ascospores (SUM 3120). E. Conidia (SUM 3120).

ovoid, $5-8 \times 3.5-6.5 \mu\text{m}$, truncated and with broad basal scars, at first smooth and thin-walled, becoming thick-walled and verrucose with projections reaching a maximum length of $2 \mu\text{m}$. Arthroconidia less abundant, hyaline to pale yellow, cylindrical to barrel-shaped, smooth-walled.

Keratinolytic.

At 37°C , colonies on YpSs agar are slightly larger than those at 25°C , and similar in conidial formation; ascomata are not produced.

Holotype: SUM 3120, a dried culture isolated from soil of poultry farm, Chichijima Island, Ogasawara-mura, Tokyo Pref., Japan, 3 June 1995, col. S. Uchiyama (CBM).

Other specimen examined: SUM 3121, a dried culture isolated from orchard soil, between Yenpu and Santimen, Pingtung, Hsien, Taiwan, 15 Nov. 1997, col. S. Uchiyama.

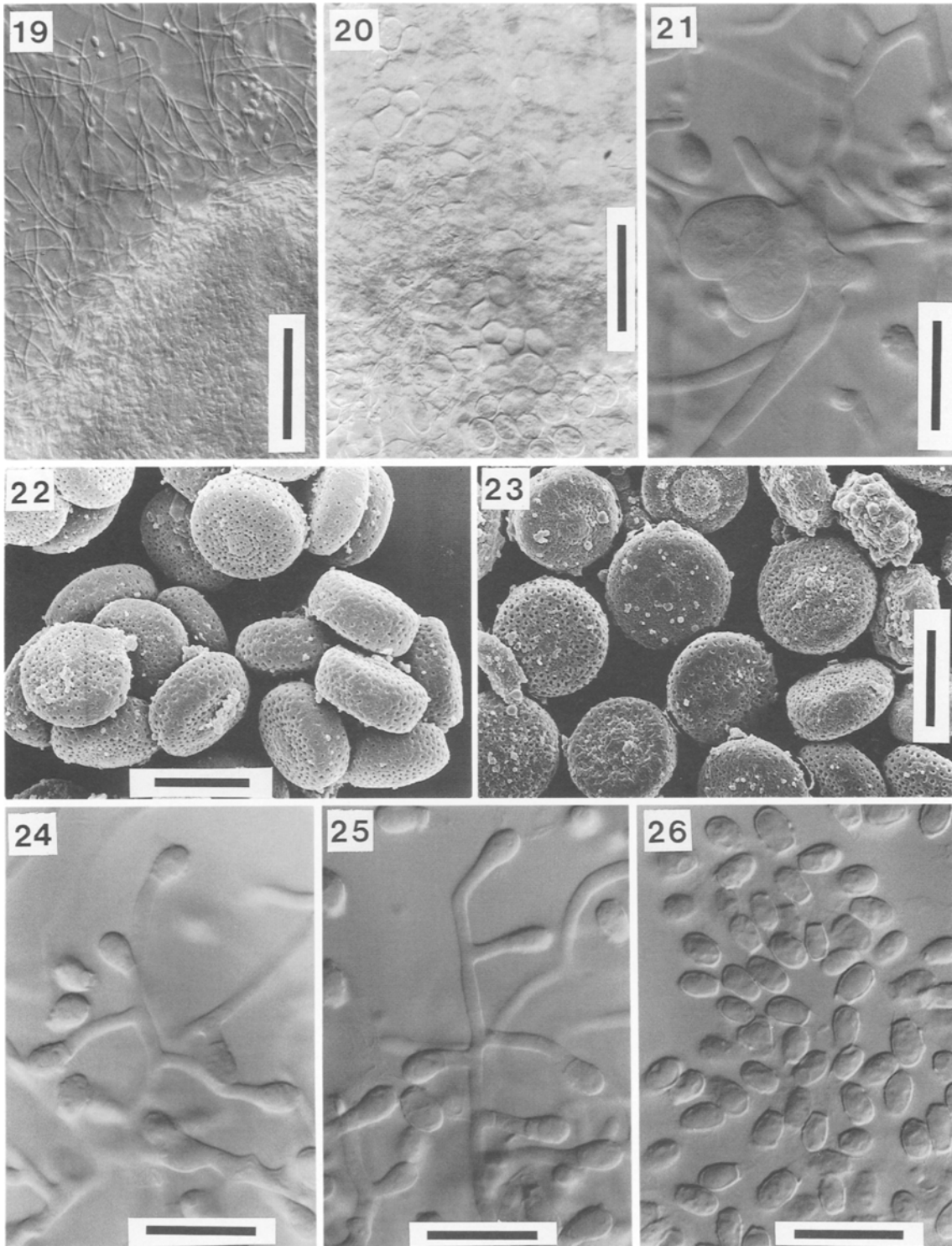
Note: *Aphanoascus boninensis*, characterized by tomentose ascomata which are usually in clusters under a dense layer of hyphae, absence or reduced development of a membranaceous peridium and oblate finely pit-

ted ascospores, is unique in the genus (Cano and Guarro, 1990; Cano et al., 1990). The only species of *Aphanoascus* with reduced ascomatal peridium is *A. mephitalis* (Malloch et Cain) Cano et Guarro, but it differs from the new species in having smaller ascospores ($3-4 \times 2-3 \mu\text{m}$), smooth-walled cylindrical arthroconidia and in reduced growth at 37°C (Malloch and Cain, 1971; Currah, 1985; Cano and Guarro, 1990). It is also somewhat similar to *A. hispanicus* Cano et Guarro in ascospore morphology, but differs in its reduced development of true peridium of ascomata, and in having larger ascospores ($4.2-5 \times 2.2-3 \mu\text{m}$ in *A. hispanicus*) and verrucose aleurioconidia (Cano and Guarro, 1990).

***Arachnomyces gracilis* Udagawa et Uchiyama, sp. nov.**

Figs. 27-34

Coloniae in "PCA" tardae, floccosae, irregulariter sulcatae, ex mycelio basali coacto tenuiter constantes, flavo-albae vel griseo-virides vel stramineae; ascomata flavo-viridia vel griseo-brunnea, dispersa, cum hyphis aeriis et conidiis abundantibus oblecta; reversum atrobrunneum vel atrolatericum.



Figs. 19–26. *Aphanoascus boninensis*.

19. Margin of ascoma (SUM 3120). 20. Ascomatal peridium (SUM 3121). 21. Ascomatal initial (SUM 3120). 22. Asci (SEM, SUM 3120). 23. Ascospores (SEM, SUM 3120). 24, 25. Conidiogenous cells and conidia (SUM 3120). 26. Conidia (SUM 3120).

Scale bars: 19=100 μm ; 20=20 μm ; 21, 24–26=10 μm ; 22, 23=5 μm .

Ascomata superficialia, dispersa, non ostiolata, rubro-brunnea, globosa vel subglobosa, appendiculis exclusis 250–385 μm diam, cum hyphis tomentosis obtecta, appendiculata; peridium tenue, 4–6 μm crassum, membranaceum, ex “textura angularis” et “textura epidermoidea” compositum; appendices rubro-brunneae, plus minusve sinuatae, 500–1600 μm longae, prope basin 10–14 μm diam, ad medium 3–4 μm diam, crassitunicatae, leves sed saepe nodosae. Asci 8-sporei, hyalini vel dilute flavo-brunnei, globosi vel ovoidei, 5.5–7(–8) \times 5–6.5 μm , evanescentes.

Ascospores dilute brunneae, oblatae, 2.8–3.2 \times 1.5–2 μm , paene leves.

Anamorphosis: *Malbranchea* sp. Hyphae fertiles saepe arcuatae, repete ramosae. Arthroconidia hyalina, cylindrica vel doliiformia, interdum curvata, 3–8 \times 2–3 μm , levia vel asperulata, utrinque vulgo truncata. Arthroconidia ex hyphis principalibus hyalina, cylindrica, 2.5–10 \times 1.5–3 μm , levia vel plus minusve asperulata.

Holotypus: SUM 3046; colonia exsiccata in cultura ex solo, in Uganda, 9.II.1996, a S. Uchiyama isolata et ea CBM conservata.

Etymology: Latin, *gracilis*=slender, referring to the character of ascomatal appendages.

Colonies on PCA growing restrictedly, attaining a diam of 28–30 mm in 35 d at 25°C, floccose, irregularly

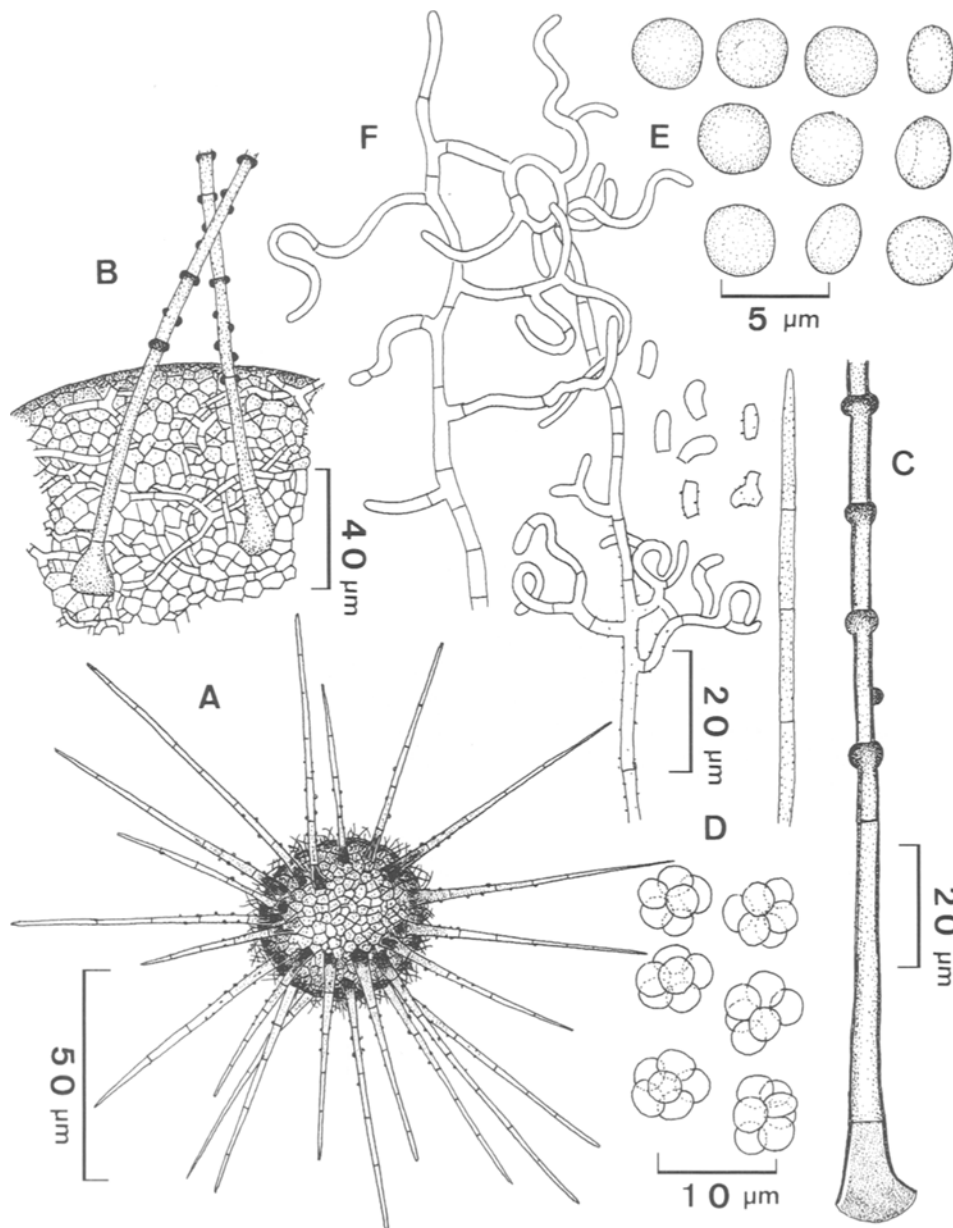
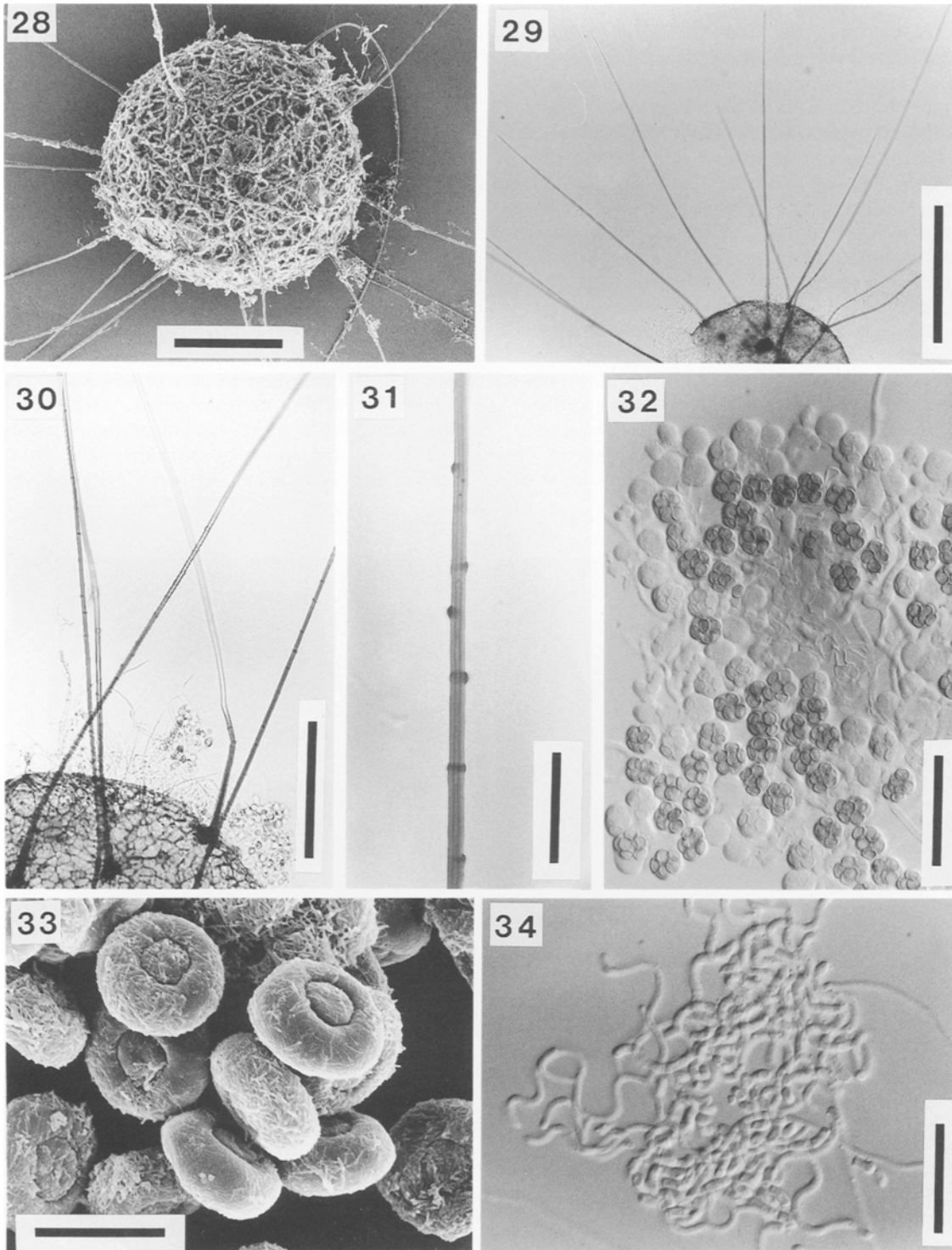


Fig. 27. *Arachnomyces gracilis* (SUM 3046).

A. Ascoma. B. Ascomatal peridium. C. Appendage. D. Asci. E. Ascospores. F. Conidiogenous cells and conidia.



Figs. 28–34. *Arachnomyces gracilis*.

28. Ascoma (SEM). 29, 30. Ascomatal peridium. 31. A portion of appendage, showing nodose wall. 32. Asci. 33. Ascospores (SEM). 34. Conidiogenous cells and conidia.

Scale bars: 28, 30=100 μm ; 29=200 μm ; 31, 32, 34=20 μm ; 33=3 μm .

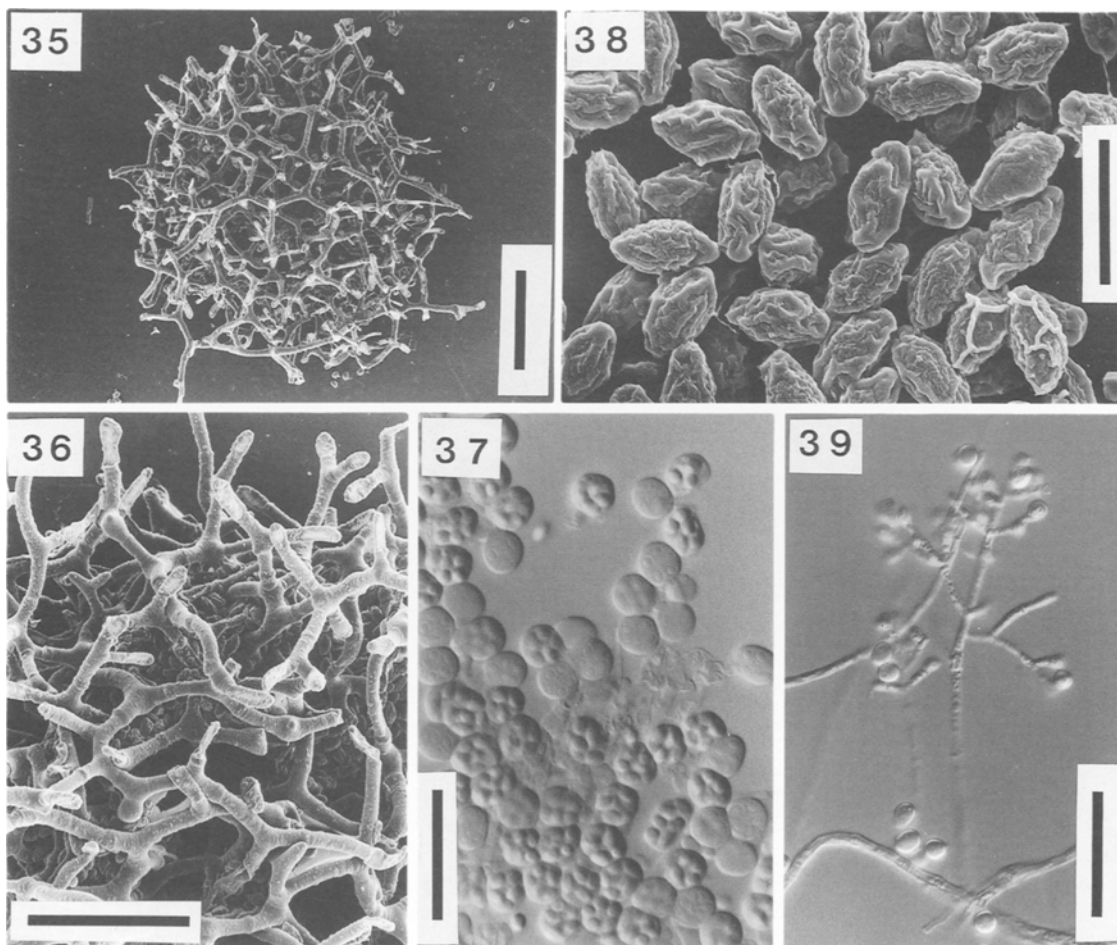
sulcate, consisting of a thin basal felt, with scattered ascomata as yellowish green to grayish brown patches, loosely covered by white aerial hyphae and abundant conidia, Yellowish White (M. 4A2) to Greyish Green (M. 1C3) or Straw (R); margins dissected, submerged; exudate limited, brownish orange; reverse Dark Brown (M. 8F4) to Dark Brick (R) at center becoming lighter toward the margin. Colonies on PYE growing restrictedly, attaining a diam of 24–27 mm in 28 d at 25°C, floccose, radially sulcate, becoming Light Orange (M. 6A5) or Saffron to Buff (R) with the development of pigmented mycelium and scattered conidia; ascomata not produced; reverse Dark Brown (M. 9F5) or Blood Colour (R).

Ascomata superficial, scattered, non-ostiolate, reddish brown, globose to subglobose, 250–385 μm in diam excl. appendages, covered by a loose network of yellowish green to brown, branched, septate, often roughened, 2–5 μm diam, tomentose hyphae, with 15–20 straight appendages uniformly scattered over entire surface; peridium thin, 4–6 μm thick, membranaceous, composed of an outer layer of “textura angularis” with pale brown cells measuring 4–15 \times 3–10 μm , and an inner layer of

“textura epidermoidea” with hyaline, thin-walled cells; appendages arising from the outer wall of the peridium, reddish brown, more or less sinuous, 500–1600 μm long, 10–14 μm diam near the base, 3–4 μm diam at the middle, fading above toward straight apex, thick-walled, smooth or often nodose. Asci 8-spored, hyaline to pale yellowish brown, globose to ovoid, 5.5–7(–8) \times 5–6.5 μm , singly borne on ascogenous hyphae, evanescent at maturity; paraphyses absent. Ascospores pale brown, oblate, 2.8–3.2 \times 1.5–2 μm , nearly smooth under the LM and micro-scabrous under the SEM, germinating from two polars.

Vegetative mycelium composed of hyaline, branched, septate, smooth-walled, 1–2 μm diam hyphae; racquet hyphae present; ascomata initials firstly produced as a coiled branch of the hypha.

Anamorph: *Malbranchea* sp. Fertile hyphae arising as lateral branches, often arcuate or sinuous and branching repeatedly to form dense clusters. Arthroconidia hyaline, cylindrical or barrel-shaped, sometimes curved, 3–8 \times 2–3 μm , smooth-walled to asperulate, truncated at both ends or rounded at one end. Arthroconidia formed



Figs. 35–39. *Pseudogymnoascus roseus* var. *ornatus* (SUM 3051).

35. Ascoma (SEM). 36. Margin of ascoma (SEM). 37. Asci. 38. Ascospores (SEM). 39. Conidiogenous cells and conidia. Scale bars: 35, 36=50 μm ; 37, 39=20 μm ; 38=5 μm .

on the straight primary hyphae, hyaline, cylindrical, 2.5–10 × 1.5–3 µm, smooth-walled to slightly asperulate.

Cellulolytic.

At 37°C, growth is nil.

Holotype: SUM 3046, a dried culture isolated from soil in old termitarium, collected between Masaka and Mbarara, Uganda, 9 Feb. 1996, col. S. Uchiyama (CBM).

Note: The genus *Arachnomyces* Masee et E. S. Salmon was recently reviewed by Abbott et al. (1996); four species were accepted and keyed out, viz., *A. nitidus* Masee et Salmon, *A. sulphureus* Masee et Salmon, *A. minimus* Malloch et Cain and *A. nodosetosus* Sigler et Abbott (anam. *Onychocola canadensis* Sigler) (Masee and Salmon, 1902; Malloch and Cain, 1970; Sigler et al., 1994). However, they overlooked two others that had previously been described by Indian workers: *A. minutus* Singh et Mukerji and *A. validus* Singh et Mukerji (Singh and Mukerji, 1978). Of these, *A. minutus* appears to be the most similar to *A. gracilis* in the long and tapering, straight appendages of ascomata and small ascospores. In several respects, these two fungi can be easily separated one another: in *A. minutus*, the ascomata are very small (70–100 µm in diam) and ascomatal appendages are 700–850 × 3–3.5 µm at the base. *Malbranchea* anamorphs with cylindrical, alternate, rhexolytic arthroconidia are common in the Gymnoascaceae, Myxotrichaceae, and Onygenaceae (Sigler and Carmichael, 1976; Currah, 1985, 1988), but *A. gracilis* is the first species of the genus known to produce a *Malbranchea* morph.

***Pseudogymnoascus roseus* Raillo var. *ornatus* Udagawa et Uchiyama, var. nov. Figs. 35–39**

A typo differt ascosporis irregulariter lobatis vel reticulatis.

Holotypus: SUM 3051; colonia exsiccata in cultura ex solo, Oita, in Japonia, 11.X.1996, a S. Uchiyama isolata et ea CBM conservata.

Etymology: Latin, *ornatus*=decorated, referring to the character of ascospores.

Colonies on PCA growing rapidly, attaining a diam of 35–36 mm in 21 d at 15°C, floccose to funiculose, plane, consisting of a thin submerged vegetative mycelium, producing abundant ascomata, at first white, becoming Brownish Orange to Brownish Grey (M. 6C3–7D2) or Rosy Buff to Fawn (R); conidiogenesis moderate, intermixed with ascomata; reverse Greyish Orange (M. 5B3).

Ascomata often confluent, globose to subglobose, more or less depressed above, 135–280 µm in diam excl. the appendages, brownish orange, maturing within 21 d. Peridial hyphae hyaline to dark brown, often thick-walled, smooth to slightly roughened, septate, 2.5–6.5 µm in diam, branched and anastomosed, often swollen at the internodes, forming a reticuloperidium; appendages simple, short, straight as free ends of peridial hyphae, brown to pale brown, finely roughened, 20–54 × 2.5–3(–4) µm, with a subhyaline, roughened end. Asci 8-spored, subglobose to ovoid or pyriform, 6.5–9 × 5.5–7 µm, evanescent. Ascospores hyaline to pale yellow, ellipsoidal or fusiform, (2.5–)3–4 × 2–2.5 µm, more or less acuminate at both ends, irregularly lobate-reticu-

late under the LM and the SEM.

Mycelium composed of hyaline, branched, septate, thin and smooth-walled, 1–3 µm diam hyphae; racquet hyphae absent; ascomatal initials consisting of coiled ascogonia.

Anamorph: *Geomyces* sp. Conidiophores little differentiated, erect from aerial hyphae, hyaline, 12–40 × 1.5–2 µm, thin and smooth-walled, branched and fertile above in dendroid fashion. Conidia borne by rhexolytically dehiscing; aleurioconidia terminal or lateral, ob-ovoid, cuneiform or ellipsoidal, 3–5 × 1.5–3.5 µm, with a broad basal scar, hyaline, thin and smooth-walled; intercalary arthroconidia alternate, barrel-shaped or cylindrical, 4–9 × 1.5–2 µm, hyaline, thin and smooth-walled.

Cellulolytic.

At 37°C, growth is nil.

Holotype: SUM 3051; a dried culture isolated from soil, Hiji-machi, Hayami-gun, Oita Pref., Japan, 11 Oct. 1996, col. S. Uchiyama (CBM).

Note: *Pseudogymnoascus roseus* var. *ornatus* is readily distinguished from the type variety by the difference in ascospore ornamentation. Like some strains of the type variety and some species in the Myxotrichaceae, ascomatal production is temperature-dependent. When grown at 25°C, the colony is thoroughly conidial, but if kept below 20°C, since the new variety is adapted to low temperatures, it is predominantly ascomatal. The type variety is widespread and of common occurrence in soil (Samson, 1972; Orr, 1979; Domsch et al., 1980; Currah, 1985).

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