

Two new species of *Talaromyces* from Taiwan and Japan

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Two new species of *Talaromyces*, isolated from soils in Taiwan and Japan, are described and illustrated. *Talaromyces eburneus*, associated with a *Geosmithia* anamorph, is characterized by off-white colony on oatmeal agar, small pale yellow ascomata, and subglobose to ovoid ascospores with a smooth wall. *Talaromyces muroii* is characterized by restricted growth on Czapek agar, luteous ascomata, which are initiated by paired gametangia like those seen in members of the series *Flavi*, ellipsoidal and nearly smooth ascospores, and the absence of an anamorph.

Key Words—Eurotiales; *Geosmithia eburnea*; Japan; soil fungi; Taiwan; *Talaromyces eburneus*; *Talaromyces muroii*.

Among members of the Trichocomaceae in the Eurotiales (Malloch and Cain, 1972, 1973), intrageneric relationships in *Talaromyces* C. R. Benjamin are of considerable interest and controversy because the species of *Talaromyces* have been recognized as a heterogeneous group based on variation of anamorphic characters—a single teleomorph with three distinct anamorphs: *Penicillium* subgenus *Biverticillium*, *Paecilomyces*, and *Geosmithia* (Taylor et al., 1990; LoBuglio and Taylor, 1993; LoBuglio et al., 1993; Pitt, 1993). Our continuing interest in the taxonomy of *Talaromyces* prompted the recent isolation of the several new taxa in association with anamorphs assignable to *Penicillium* and *Paecilomyces* (Yaguchi et al., 1992, 1993 a, b; Takada and Udagawa, 1993; Udagawa, 1993; Udagawa et al., 1993; Udagawa and Suzuki, 1994).

In this paper we describe two new species of *Talaromyces*, which were isolated from soil samples collected in Taiwan and Japan, in connection with a survey of soil-borne ascomycetes as producers of fungal metabolites useful to the pharmaceutical industry. The first species is characterized by the development of a *Geosmithia* anamorph, whereas all isolates of the second have no anamorph. Holotypes of these species have been deposited in the herbarium at the Natural History Museum and Institute, Chiba, Japan (CBM).

Talaromyces eburneus Yaguchi, Someya et Udagawa, sp. nov. Figs. 1, 2

Coloniae in agaro Czapekii tarde effectae. Coloniae in agaro "Czapek-yeast extract" (CYA) restrictae, velutinae vel floccosae, planae, ex mycelio basali coacto paulo compacto constantes, ascomatibus limitatis formantes, eburneae; conidiogenesis moderata, viridi-grisea vel viridi-glaucosa; reversum griseo-viridi vel atroherbaceum. Coloniae in agaro maltoso (MEA) restrictae, velutinae, radiatim sulcatae, ex mycelio basali coacto tenuiter con-

stantes, ascomatibus gradatim formantes, eburneae; conidiogenesis sparsa vel moderata; reversum incoloratum vel bubalinum. Coloniae in agaro farinae avenaceae paulo effusae, plus minusve rugosae, ex mycelio basali coacto tenuiter constantes, pulveraceae, ascomatibus et fructificationibus conidicis abundantibus formantes, eburneae; reversum luteolum vel primulinum.

Ascomata plerumque discreta, non ostiolata, dilute flava, tarde maturescentia, globosa vel subglobosa, (30–) 70–125 μm diam, mollia, mycelio hyalino subtili obiecta; paries ex hyphis laxis ramosis hyalinis vel dilute flavis incrustatis septatis compositus. Asci 8-sporei, singulariter portati, subglobosi vel ovoidei vel pyriformes, 10.5–13(–15) \times 8–9.5(–11) μm , evanescentes. Ascosporae dilute flavae, subglobosae vel plus minusve ovoideae, 4–5 \times 4–4.5 μm , incrassatae, leves sed interdum foveolatae. Status anamorphus: *Geosmithia eburnea*.

Ubiquinonum majus: Q-10 (H₂).

Holotypus PF 1151, colonia exsiccata in cultura ex solo, Taipei, in Taiwan, 1968, a T. Yaguchi isolata et ea collectione fungorum, Musei et Instituti Historiae Naturalis Chiba (CBM) conservata.

Etymology: from Latin, *eburneus* = ivory white, referring to the colony color.

Anamorphosis: *Geosmithia eburnea* Yaguchi, Someya et Udagawa, anam. nov.

Conidiophora ex mycelio basali vel hyphis aeriis oriunda; stipites plerumque 120–350 \times 2–3.5 μm , interdum 28–80 μm longi, conspicue vel subtiliter asperati, hyalini, septati. Penicilli monovercillati vel biverticillati vel terverticillati. Rami 15–27.5 \times 2.5–3.5 μm , subtiliter asperati. Metulae 2–6 verticillatae, 10.5–18.5 \times 2–3.5 μm , subtiliter asperatae. Phialides cylindricae, adpressae, 2–8 verticillatae, (8–)10–16 \times 2–3 μm , leves vel subtiliter asperatae. Conidia hyalina, primum cylindrica vel cuneata, 2.5–5 \times 1–1.5(–2.5) μm , deinde saepe tumescencia, ellipsoidea vel ovoidea, 2.5–4 \times 2–3 μm , levia, in catenis

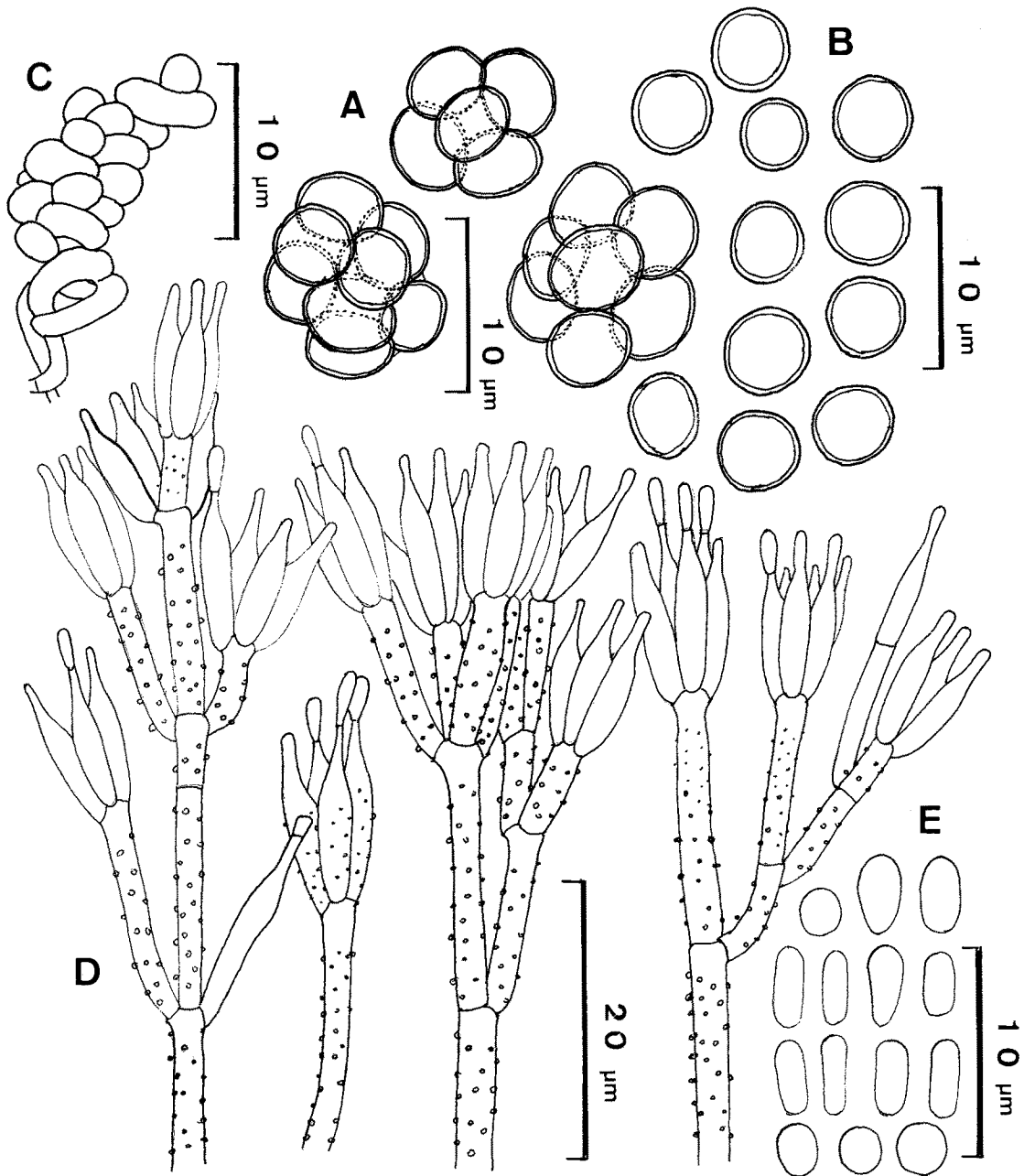


Fig. 1. *Talaromyces eburneus*, PF 1151.

A. Asci; B. Ascospores; C. Ascomatal initial; D. Penicilli; E. Conidia.

longis plus minusve columnaribus connexa. Status teleomorphus: *Talaromyces eburneus*.

Holotypus PF 1151, loc. cit.

Colonies on Czapek agar growing slowly, attaining a diam of 20 mm in 7 days at 25°C, more or less floccose, plane, thin, vegetative mycelium submerged, producing a loose aerial growth, off-white in color; ascomata absent; conidiogenesis sparse, inconspicuous; reverse Yellowish White (M. 1A2, after Kornerup and Wanscher, 1978). Colonies on CYA growing restrictedly, attaining a diam of 14–16 mm in 7 days at 25°C, velvety to floccose, plane, consisting of a rather compact basal felt, producing limit-

ed ascomata and interwoven aerial hyphae, off-white in color; conidiogenesis moderate, Greenish Grey (M. 29B2) or Greenish Glauous (after Rayner, 1970); margins thin, entire; reverse Greyish Green (M. 29E5) or Dark Herbage Green (R). Colonies on MEA growing restrictedly as on CYA, velvety, radially sulcate, consisting of a thin basal felt, off-white; ascomata slowly developed; conidiogenesis sparse to moderate, colored as on CYA but not influencing the colony appearance; margins thin, submerged; exudate small, clear; reverse uncolored or Buff (R). Colonies on oatmeal agar growing rather rapidly, attaining a diam of 25–26 mm in 7 days and 60 mm in

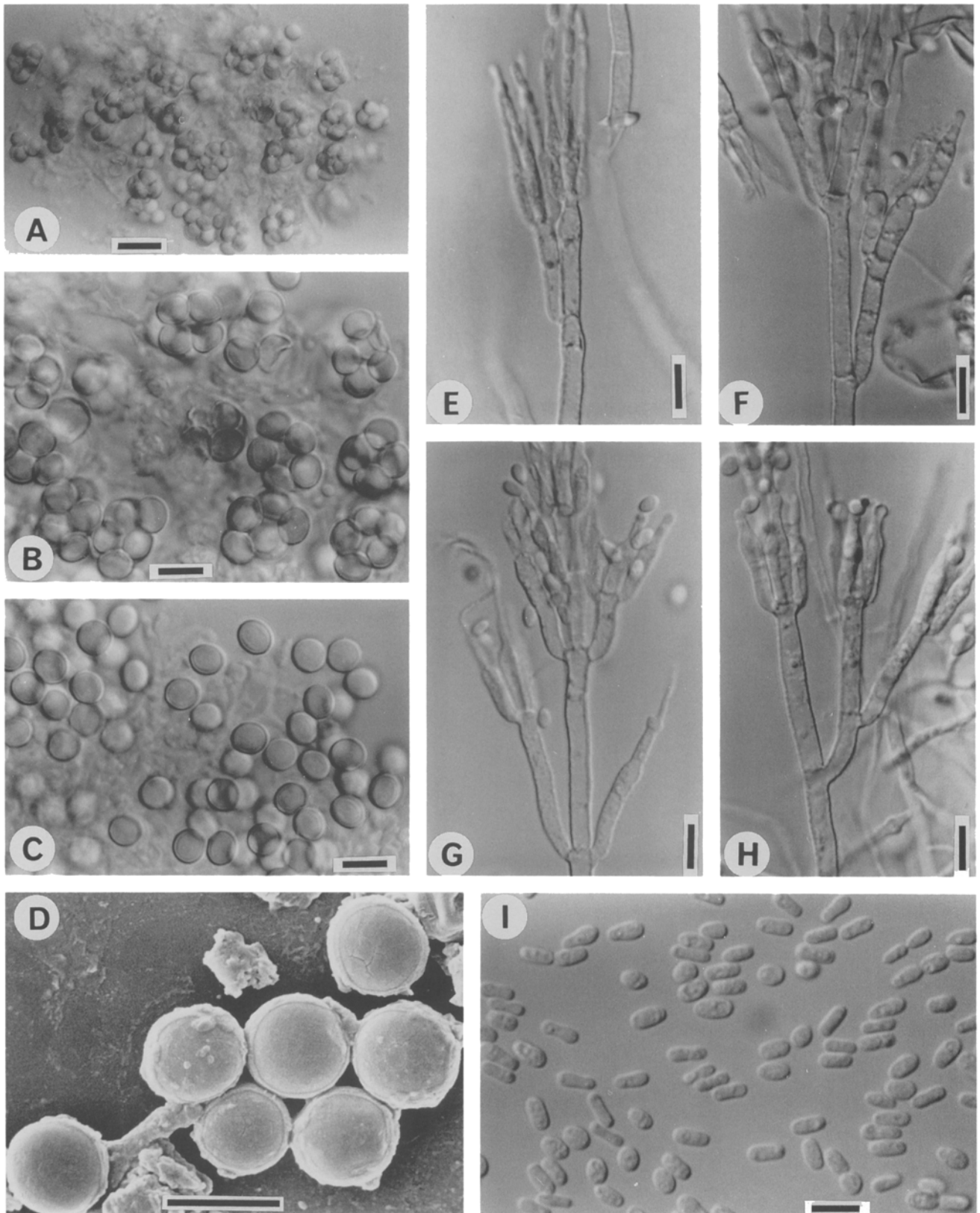


Fig. 2. *Talaromyces eburneus*, PF 1151.

A. Ascoma; B. Asci; C. Ascospores; D. Ascospores (SEM); E to H. Penicilli; I. Conidia.
Scale bars for A = 10 μm and for B to I = 5 μm.

14 days at 25°C, more or less wrinkled, consisting of a thin basal felt, becoming powdery in appearance due to the development of abundant ascomata and profuse conidia, off-white in color; margins thin, submerged, entire; exudate small, clear; odor slightly musty; reverse Pale Yellow (M. 3A3) or Primrose (R). Colonies on cornmeal agar growing restrictedly, attaining a diam of 18–19 mm in 7 days at 25°C, plane, thin, vegetative mycelium submerged, floccose, producing scattered ascomata; conidiogenesis moderate, off-white; reverse uncolored or Pale Yellow (M. 1A3).

Ascomata mostly discrete, non-ostiolate, pale yellow, maturing slowly within 28 to 35 days, globose to subglobose, (30–)70–125 µm in diam, soft, scarcely covered by hyaline, delicate mycelium; ascomatal wall consisting of loose, branched, hyaline to pale yellow, encrusted, septate hyphae. Ascomatal initials consisting of a swollen branching hypha but often indistinctive. Asci 8-spored, borne singly, subglobose to ovoid or pyriform, 10.5–13(–15) × 8–9.5(–11) µm, evanescent. Ascospores pale yellow, subglobose to more or less ovoid, 4–5 × 4–4.5 µm, thick-walled, smooth but occasionally with foveolations, with an equatorial thickening (under SEM).

Conidiophores arising primarily from the basal mycelium, but also as perpendicular branches from aerial and trailing hyphae or the main axis of conidiophore; stipes mostly 120–350 × 2–3.5 µm, sometimes 28–80 µm long when borne as the branches, conspicuously to finely roughened, hyaline, septate. Penicilli monoverticillate to biverticillate, or terverticillate. Rami 1–2 per stipe, 15–27.5 × 2.5–3.5 µm, finely roughened. Metulae mostly appressed verticils of 2–6, 10.5–18.5 × 2–3.5 µm, finely roughened. Phialides cylindrical, appressed, 2–8 in the verticil, (8–)10–16 × 2–3 µm, smooth or finely roughened, tapering to a pointed conidium-bearing tip. Conidia hyaline, at first cylindrical or wedge-shaped, 2.5–5 × 1–1.5(–2.5) µm, later often swelling to ellipsoidal or ovoid, 2.5–4 × 2–3 µm, smooth-walled, borne in long, more or less columnar chains up to 250 µm or more in length.

Major ubiquinone: Q-10 (H₂).

At 37°C, colonies on CYA growing more rapidly, attaining a diam of 38–40 mm in 7 days, Yellowish White to Greenish White (M. 3A2–30A2); conidiogenesis heavy, off-white; reverse and agar Yellowish Brown (M. 5F6) or Fawn (R).

Specimen examined: PF 1151 (holotype), in dried culture isolated from soil, Taipei, Taiwan, 1968, by T. Yaguchi.

Talaromyces eburneus becomes the third *Talaromyces* teleomorph known to produce a *Geosmithia* anamorph (Stolk and Samson, 1972; Pitt, 1979). *T. eburneus* differs from the two known species, *T. bacillisporus* (Swift) C. R. Benjamin (anam. *G. swiftii* Pitt) and *T. emersonii* Stolk (anam. *G. emersonii* (Stolk) Pitt), in having much larger ascospores and in several other characteristics, as shown in Table 1.

Talaromyces muroii Yaguchi, Someya et Udagawa, sp. nov. Figs. 3, 4

Coloniae in agar Czapekii restrictae. Coloniae in "CYA" paulo effusae, velutinae vel parum floccosae, plus minusve planae, ex mycelio basali coacto tenuiter constantes, albae, ascomatibus reductis formantes; reversum dilute aurantiacum vel brunneum vel bubalinum. Coloniae in "MEA" effusae, velutinae, planae, ex mycelio basali coacto tenuiter constantes, ascomatibus abundantibus formantes, ad centrum flavae vel electrinae, ad marginem albae vel aurantio-griseae vel vinaceo-bubalinae; conidiogenesis nulla; reversum brunneo-aurantiacum vel roseo-bubalinum vel ferrugineum. Coloniae in agar farinae zaeae effusae, planae, tenues, ex mycelio vegetativo submerso constantes, granulares, ascomatibus copiose formantes, dilute flavae vel flavae vel electrinae; conidiogenesis nulla; reversum incoloratum vel luteolum. Coloniae in agar farinae avenaceae paulo restrictae, planae, ex mycelio basali coacto tenuiter constantes, granulares, ascomatibus abundantibus formantes, flavae vel griseo-flavae vel electrinae; conidiogenesis nulla; reversum griseo-aurantiacum vel ochraceum.

Ascomata discreta vel confluentia, non ostiolata, lutea, prompte maturescentia, globosa vel subglobosa,

Table 1. Differential characteristics of *Talaromyces* species with a *Geosmithia* anamorph.

	<i>T. eburneus</i>	<i>T. bacillisporus</i>	<i>T. emersonii</i>
Growth on CYA (7 days, 25°C)	14–16 mm	12–18 mm	None
Colony color (oatmeal agar)	Ivory-White	Vinaceous-Buff	Vinaceous-Tawny
Ascomata (µm)	Pale Yellow, 30–125	Yellow, 80–150	Reddish to Orange Brown, 50–300
Ascospores (µm)	Subglobose to ovoid, 4–5 × 4–4.5, smooth	Globose, 3.5–4.5, spinose	Subglobose to ovoid, 3.5–4 × 2.8–3.5, smooth
Conidiophores (µm)	30–350 × 2–3.5	20–60 × 2–3	35–200 × 2.5–4.5
Penicilli	Monoverticillate to biverticillate or terverticillate	Monoverticillate to biverticillate	Biverticillate to terverticillate
Conidia (µm)	Cylindrical to ovoid, 2.5–5 × 1–2.5 and 2.5–4 × 2–3	Cylindrical to ellipsoidal, 3–4.5 × 1.2–1.5(–3) or 4–5 × 1–1.2(–1.5)	Cylindrical to ellipsoidal, 3.5–5(–10) × 1.5–2.7 or 3.5–4(–6) × 1.5–2

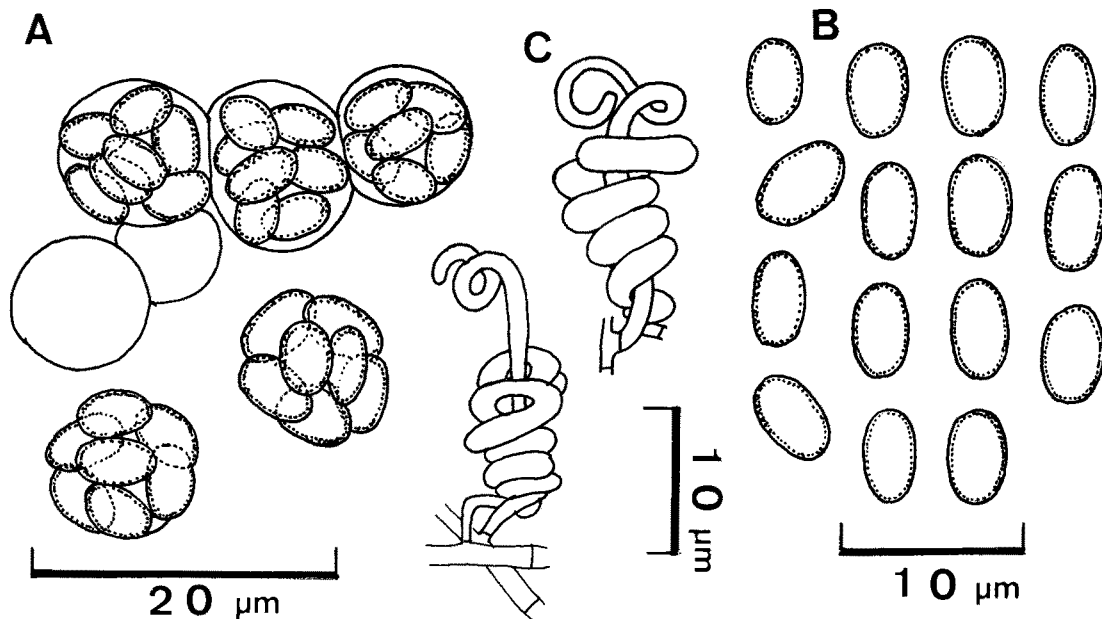


Fig. 3. *Talaromyces muroii*, PF 1153.
A. Asci; B. Ascospores; C. Ascomatal initials.

160–360 μm diam, mollia, hyphis radiatis flavis incrustatis tortis ramosis septatis usque 65–200 μm longis obtecta; paries ex hyphis laxis flavis incrustatis intertextis septatis compositus. Asci 8-spori, breviter catenulati, globosi vel ovoidei, 9–12 \times 7.5–10 μm , evanescentes. Ascospores hyalinae vel dilute flavae, ellipsoideae, 4.5–6(–7) \times 2.5–3.5(–4) μm , leves vel interdum obtuse asperatae. Anamorphosis abest.

Ubiquinonum majus: Q-10 (H_2).

Holotypus PF 1153, colonia exsiccata in cultura ex solo, Chingpu, Hualien, in Taiwan, 21.ix.1993, a T. Yaguchi isolata et ea collectione fungorum, Musei et Instituti Historiae Naturalis Chiba (CBM) conservata.

Etymology: The species is named after Mr. Tetsuo Muroi, Japanese mycologist.

Colonies on Czapek agar growing restrictedly, attaining a diam of 9–10 mm in 14 days at 25°C, with surface producing white aerial hyphae only. Colonies on CYA growing rather rapidly, attaining a diam of 16–18 mm in 7 days and 45–48 mm in 14 days at 25°C, velvety to slightly floccose, more or less plane, consisting of a thin basal felt, producing white aerial hyphae; ascomata very reduced and not affecting the colony appearance; exudate clear, scattered; reverse Pale Orange to Brown (M. 5A3–7E4) or Buff to Fawn (R). Colonies on MEA spreading broadly, attaining a diam of 32 mm in 7 days and 60 mm in 14 days at 25°C, velvety, plane, consisting of a thin basal felt, producing abundant ascomata, centrally Yellow to Reddish Brown (M. 3B6–8D4) or Amber to slightly Brick (R); margins thin, broad, white to Orange Grey (M. 6B2) or Vinaceous Buff (R); conidiogenesis absent; exudate and odor usually lacking; reverse Brownish Orange to Reddish Brown (M. 6C4–9D5) or Rosy Buff to Rust (R). Colonies on cornmeal agar growing rapidly, attaining a diam of 17–21 mm in 7 days and 58–60 mm in

14 days at 25°C, plane, thin, with vegetative mycelium submerged, granular in appearance due to the numerous production of ascomata in a layer, Pale Yellow to Yellow (M. 3A3–3A6) or Pure Yellow to Amber (R); conidiogenesis absent; reverse uncolored or Dull Yellow (M. 3B4) or Pale Luteous (R). Colonies on oatmeal agar growing rather restrictedly, attaining a diam of 16–18 mm in 7 days and 36 mm in 14 days at 25°C, plane, consisting of a thin basal felt, with surface granular in appearance; ascomata abundantly produced, Yellow to Greyish Yellow (M. 3A7–4B6) or Amber (R); conidiogenesis absent; reverse Greyish Orange (M. 6B6) or Ochreous (R).

Ascomata discrete or confluent, non-ostiolate, Luteous (R), maturing fairly rapidly in 14 days or more, globose to subglobose, 160–360 μm in diam, soft, loosely covered by radiate, yellow-encrusted, more or less twisted, branched, septate hyphae up to 65–200 μm long; ascomatal wall composed of a loose network of yellow densely interwoven hyphae measuring 2–3 μm in diam. Ascumatal initials conspicuous, appearing as two branches of the aerial hyphae, consisting of cylindrical, somewhat sinuous hyphae, 16–20 \times 2–2.5 μm , around which similar thick hyphae coil tightly several times. Asci 8-spored, in short chains, globose to ovoid, 9–12 \times 7.5–10 μm , evanescent. Ascospores hyaline to pale yellow, ellipsoidal, 4.5–6.5(–7) \times 2.5–3.5(–4) μm , smooth-walled or very obtusely roughened (under SEM). Anamorph not produced on common media including CY20S, MY20 and MY5–12 agars.

Major ubiquinone: Q-10 (H_2).

At 37°C, growth-rate is increased and ascomata are rapidly developed. At 45°C, growth is nil.

Specimens examined: PF 1153 (holotype), a dried culture derived from an isolate of soil, Chingpu, Hualien County, Taiwan, 21 September 1993, isolated by T.

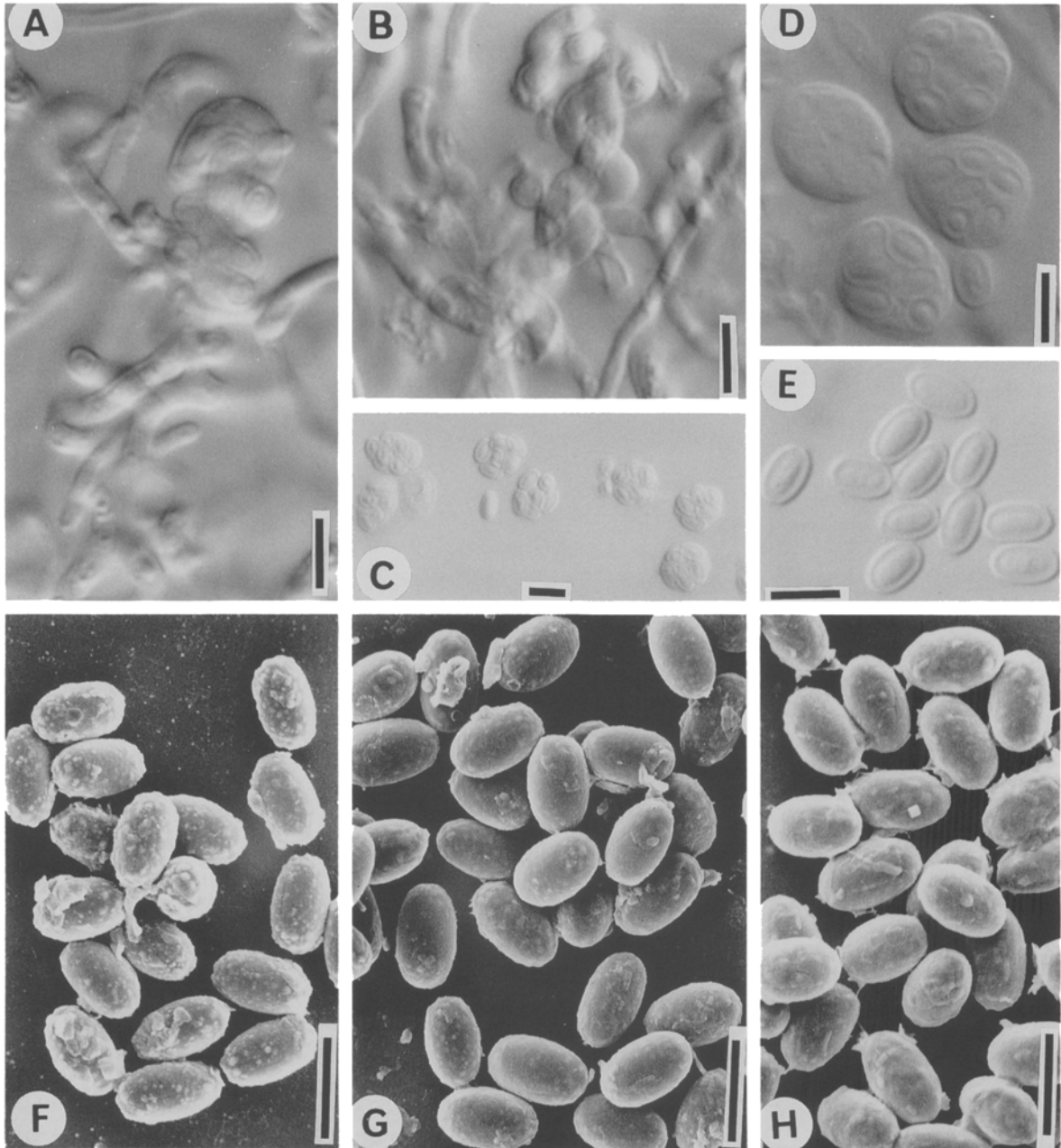


Fig. 4. *Talaromyces muroii*, SUM 3032, PF 1152 and PF 1153. A-F. SUM 3032. A, B. Ascomatal initials; C, D. Asci; E. Ascospores; F. Ascospores (SEM). G. PF 1152. Ascospores (SEM). H. PF 1153. Ascospores (SEM). All scale bars = 5 μ m.

Yaguchi; PF 1152, a dried culture derived from an isolate of soil, Yangmingshan, Yangming National Park, Taipei, Taiwan, 8 October 1967, isolated by T. Yaguchi; and SUM 3032, a dried culture derived from an isolate of soil, Kaminaka, Oshiki-gun, Fukui Prefecture, Japan, 14 March 1976, isolated by T. Muroi.

Talaromyces muroii is characterized particularly by its restricted growth upon Czapek agar, luteous ascomata, strongly ellipsoidal ascospores with an almost smooth wall and by the absence of a *Penicillium* anamorph. The species is regarded as belonging in the series *Flavi* (the

type species *T. flavus* (Klöcker) Stolk et Samson) of the section *Talaromyces* (Stolk and Samson, 1972; Pitt, 1979). Such placement is based upon four primary considerations: (1) colonies on MEA at 25°C usually exceed 30 mm in diam after 7 days, (2) mycelium is usually yellow colored, (3) growth at 37°C is good, and (4) cylindrical initials of the ascomata developed as paired gametangia are strongly suggestive of *T. flavus*. Within the series *Flavi*, *T. muroii* resembles *T. helicus* (Raper et Fennell) C.R. Benjamin var. *helicus* in its production of almost smooth ascospores, but differs from that species

in the pattern of its ascomatal initials (coiled helix-like in *T. helicus* var. *helicus*), the large dimensions of its ascospores ($2.5\text{--}4.5 \times 2\text{--}2.8 \mu\text{m}$ in *T. helicus* var. *helicus*) and the absence of an anamorph.

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