

Jahnula species from North and Central America, including three new species

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Abstract: Three new species of loculoascomycetes collected from freshwater habitats in North America are described as new species of *Jahnula* (Jahnulales, Dothideomycetes). All three share these morphological features: hyaline to blackish translucent, membranous ascomata with subtending, wide, septate brown, spreading hyphae; peridia composed of large angular cells; hamothecium of septate pseudoparaphyses; 8-spored, clavate to cylindrical asci; and 1-septate, broadly fusiform, brown, multiguttulate ascospores. Four additional species, *J. aquatica*, *J. bipolaris*, *J. potamophila*, and *J. seychellensis*, are reported for the first time from the western hemisphere.

Key words: Ascomycetes, aquatic fungi, submerged wood, systematics

INTRODUCTION

During investigations of the geographical distribution patterns and biodiversity of ascomycetes in freshwater habitats along latitudinal gradients from North to Central and South America, we encountered numerous species of *Jahnula* Kirschst (Jahnulales, Dothideomycetes). The type species of *Jahnula*, *J. aquatica* (Plöttner and Kirschst.) Kirschst. was described based on a specimen collected from Germany. Most species of *Jahnula* described subsequently, however, have been reported from the Old World throughout the Asian and Australian tropics (Hyde 1993, Hyde and Wong 1999, Pang et al 2002, Pinruan et al 2002). One exception is *J. poonythii* K.D. Hyde and S.W. Wong, a species that originally was described and reported from Mauritius (Hyde and Wong 1999) and recently reported by Gonzalez and Chavarria (2005) from a freshwater source in Mexico. In this paper we describe and illustrate three new species and report and describe four additional species of *Jahnula* for the first time from the western hemisphere.

MATERIALS AND METHODS

Submerged woody debris was collected from lotic and lentic freshwater habitats along latitudinal gradients in North America, with sites in Alaska and Florida representing latitudinal extremes within North America. Tropical samples also were collected in Costa Rica. Samples were placed in zippered plastic bags containing paper towels, returned to the laboratory, and incubated in plastic storage boxes with moistened paper towels at ambient temperatures (ca. 24 C) under 12/12 h (light/dark) conditions. Water temperature, pH and latitude and longitude were measured and recorded in the field and are presented in the specimen examined sections.

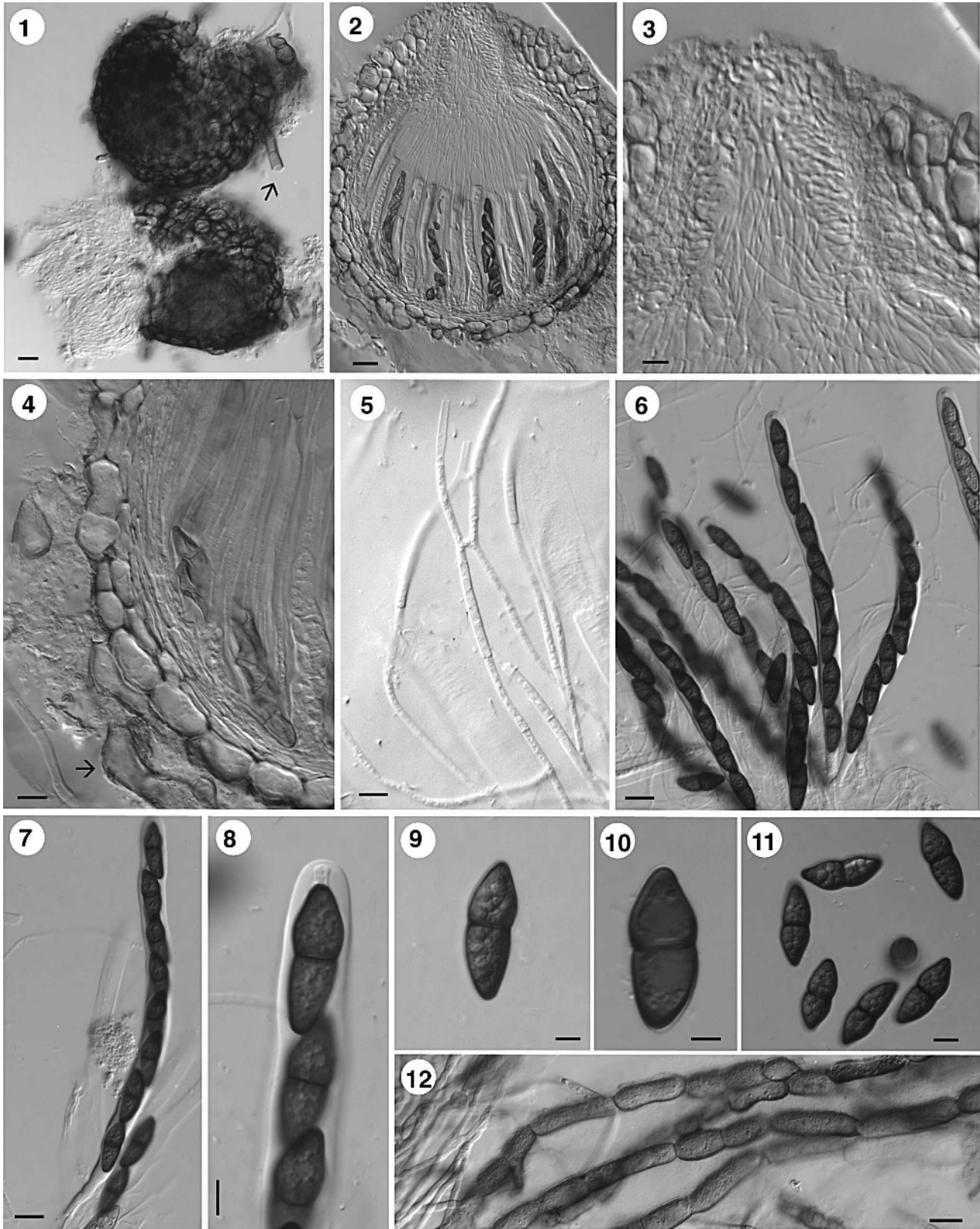
Samples were examined with a dissecting microscope immediately after collection and periodically over the subsequent 12 mo. Crush mounts of ascomata were made in distilled water that was replaced with glycerin (100%) or lactic acid (85%) containing azure A. India ink or aqueous nigrosin was added to water mounts to reveal gelatinous sheaths on or around ascospores. Measurements were made of material mounted in glycerin (100%) or lactic acid containing azure A. Lactic acid containing azure A or glycerin was used to preserve squash mounts with the double-cover glass method (Volkman-Kohlmeyer and Kohlmeyer 1996). Cultures were obtained and maintained according to the procedures described by Fallah and Shearer (2001).

Ascomata were fixed and sectioned with a modification of Huhndorf's technique (Huhndorf 1991, Fallah and Shearer 2001). Micrographs were obtained with a Spot RT digital camera mounted on an Olympus microscope equipped with Nomarski interference and phase optics. Specimens were deposited in the Herbarium of the University of Illinois (ILL). Collector's names are abbreviated: JLA (Jennifer L. Anderson), JLC (J. L. Crane), CB (Christopher Brown), ANM (Andrew N. Miller), CMP (Cathy M. Pringle), HAR (Huzefa A. Raja), CAS (Carol A. Shearer), RW (Rebecca Wulffen).

TAXONOMY

- Jahnula aquatica* (Plöttner and Kirschst.) Kirschst.,
Ann Mycol 34:196. 1936. FIGS. 1–12
≡ *Amphisphaeria aquatica* Plöttner and Kirschst., Verh.
Bot Ver Prov Brandenb 48:52. 1906.
≡ *Melanopsamma aquatica* (Plöttner and Kirschst.)
Kirschst., Krypt. Fl Brandenb 7:226. 1911.

Ascomata 345–380 × 265–330 μm, hyaline when young, becoming translucent black with age, membranous, globose to subglobose, ostiolate, papillate, superficial to partially immersed in wood, scattered, attached to adjacent ascomata by broad, brown, superficial, stoloniferous hyphae (FIGS. 1–2). Neck 60–95 × 74–80 μm, periphysate; periphyses short, hyaline (FIG. 3). Peridium 20–30 μm wide, of *textura*



FIGS. 1–12. *Jahnula aquatica*. 1. Squash mount of ascomata. Arrow indicates subtending hypha (R68-2). 2. Longitudinal section through ascoma (R68-1). 3. Papillae showing periphyses (R68-1). 4. Peridium (R68-1). 5. Pseudoparaphyses (R68-1). 6–8. Asci (R68-1). 9–11. Ascospores (R68-1). 12. Mycelium from culture (R68-1). Bars: 1 = 40 μm ; 2, 3, 6 = 20 μm ; 4, 5, 7–12 = 10 μm .

angularis in surface view, in longitudinal section peridial wall 3–4 cell layers wide, composed of an outermost layer of large, moderately thick-walled brown cells, and an inner layer of elongated, flattened, thin-walled hyaline cells (FIG. 4). Pseudoparaphyses septate, narrow, 1.5–2 μm wide, hyaline, filiform, branched and anastomosing above the asci (FIG. 5). Asci 105–215 \times 10–20 μm , fissitunicate, cylindrical, pedicellate (FIGS. 6–7), with an apical chamber and eight, overlapping uniseriate ascospores (FIG. 8). Ascospores 30–40 \times 10–12 μm , brown to dark brown, ellipsoidal-fusiform, 1-septate, constricted at the septum, upper cell broader than basal cell, multiguttulate, without a gelatinous sheath or appendages (FIGS. 9–11).

Colonies on peptone yeast extract glucose (PYG) agar growing slowly, dark brown to black, effuse; hyphae thick-walled, septate and constricted at the septa (FIG. 12); cells of the hyphae cylindrical to subglobose; no anamorph observed.

Specimens examined. USA. ILLINOIS: Salt Fork Association Lake (SFA Lake), a manmade private lake ca. 16 miles east of Urbana, 40°05'00"N, 87°48'50"W, UTM 16 435946E, 4992530N, water temperature 16.5 C, pH 7, on submerged, decorticated wood, 15 Oct 2002, *HAR, R68-1*. TENNESSEE: Hamilton County, Tennessee River, Tennessee River Gorge Trust, 15 miles west of Chattanooga, 35°08'95"N, 85°39'97"W, UTM 16 620500mE, 3891557mN, water temperature 18 C, pH 6.5, on submerged, decorticated wood, 29 Mar 2005, *HAR, JLC*, and *ANM, F75-1*; Great Smoky Mountains National Park, Cades Cove, 11-mile Loop, Abrams Creek, 35°35'36"N, 83°50'42"W, UTM Zone 17 242232mE, 3942559mN, water temperature 17 C, pH 5, on soft, decorticated, submerged wood, 21 Jun 2005, *HAR* and *ANM, R68-2*.

Known distribution. Germany, Hong Kong, South Africa, Thailand, USA (IL, TN).

Comments. The general characteristics of the specimens of *J. aquatica* from the USA (IL, TN) agree with the descriptions reported by Hawksworth (1984) and Hyde and Wong (1999). For collections of *J. aquatica* from Germany and South Africa, periphyses were not reported. In our collections (FIG. 3) short hyaline periphyses radiate from the inner cells of the ascomal neck into the ostiole. Although the pseudoparaphyses were described by Hawksworth (1984) and Hyde and Wong (1999) as trabeculate, septa were clearly visible in our material (FIG. 5). Our collections of *J. aquatica* are more similar to those of the lectotype material selected by Hawksworth (1984) than to the South African collections examined by Hyde and Wong (1999).

***Jahnula bipileata* Raja et Shearer sp. nov. FIGS. 13–23**

Ascomata 395–400 \times 200–205 μm , subglobose, obpyriformia, ostiolata, papillata, immersa ad super-

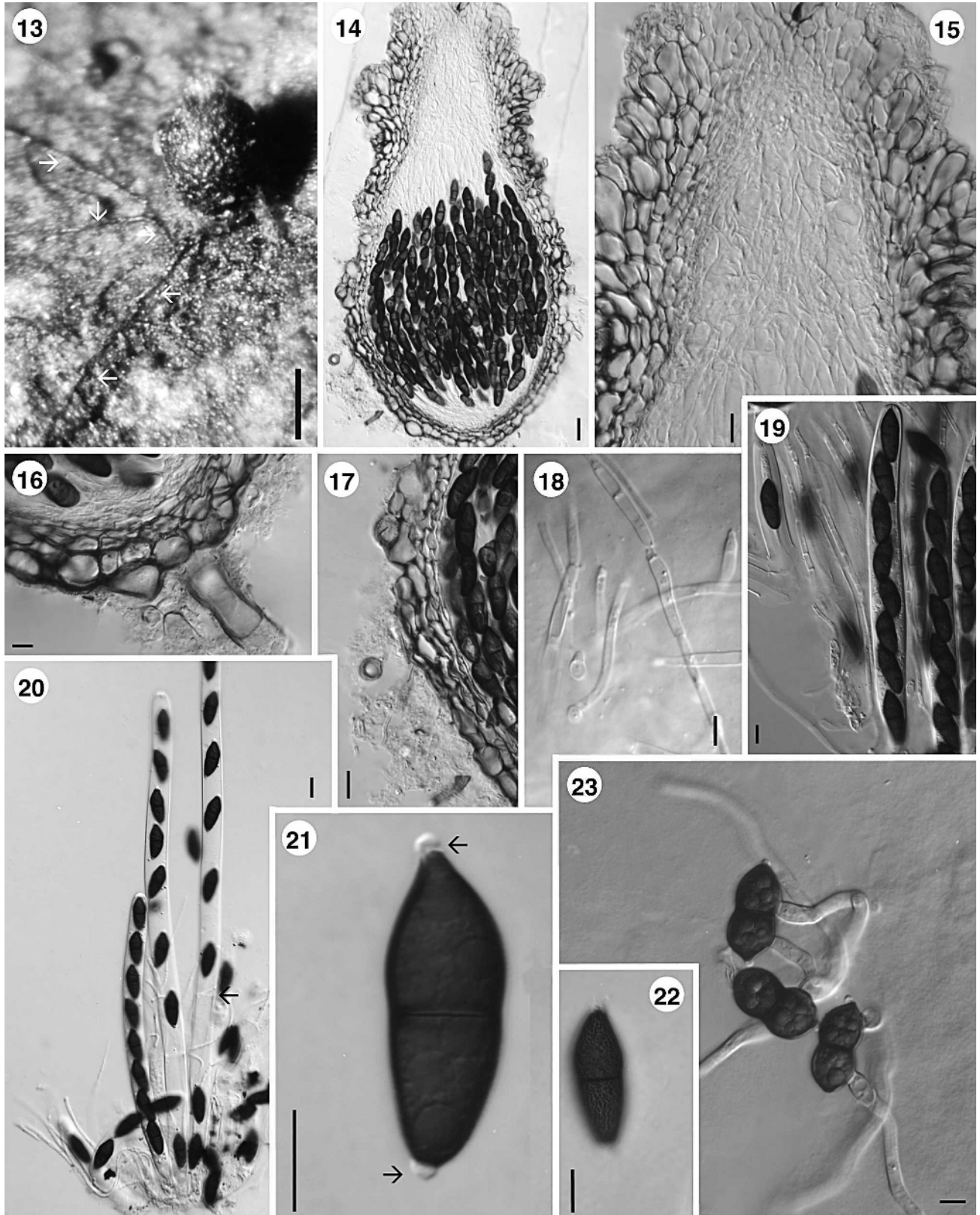
ficialia, horizontalia. Rostrum 100–150 \times 70–85 μm , hyalinum. Peridium 20–30 μm latum, 3–4 cellulae crassum, bistratosum. Pseudoparaphyses cellulosa, hyalinae, 2–3 μm latae. Asci 170–220 \times 10–17 μm , fissitunicati, cylindrici, octospori, uniseriati. Ascospores 25–30 \times 9–10 μm , ellipsoideae–fusiformes, brunneae, uniseptatae, cellula apicali leviter inflata, cellula basali attenuata, granulata, hyalina calyptra 1–2 \times 2–3 μm , bipolare.

Ascomata on wood 395–400 \times 200–205 μm , black translucent, membranous, subglobose to obpyriform, ostiolate (FIGS. 13, 14), superficial with partially immersed base, upright to slightly horizontal, scattered, connected to the substrate by broad, brown, septate, superficial stoloniferous hyphae (FIGS. 13, 16). Neck 100–150 \times 70–85 μm , pale brown, central; wall of the neck composed of short outwardly diverging globose to cylindrical cells (FIG. 15). Peridium 20–30 μm thick, in longitudinal section composed of 3–4 cell layers; inner layer of laterally compressed, hyaline to subhyaline, isodiametric cells, outer layer of large, darkened, moderately thick-walled, globose to angular cells 30–34 \times 20–24 μm (FIGS. 16, 17). Pseudoparaphyses 2–3 μm wide, septate, slightly constricted at the septa, hyaline, filamentous, branching and anastomosing above the asci (FIG. 18). Asci 170–220 \times 10–17 μm (mean = 197 \times 15 μm , n = 20), basal, fissitunicate, cylindrical, pedicellate, with or without an apical chamber; endoascus extending to 2 \times the length of the ectoascus, with eight, overlapping uniseriate ascospores (FIGS. 19, 20). Ascospores 25–30 \times 9–10 μm (mean = 29 \times 10 μm , n = 50), broadly ellipsoidal to fusiform, dark brown, 1-septate, slightly constricted at the septum, upper cell slightly broader and more apiculate than the lower cell, rough-walled in an irregularly striated pattern (FIG. 22), with hyaline caps at both apices, up to 2 \times 2–3 μm , lacking a sheath (FIGS. 21, 23).

Single-spore isolates produced dark brown colonies with effuse growth on cornmeal agar (CMA, Difco). Colonies on potato-dextrose agar (PDA, Difco) and Emerson's yeast extract, soluble starch (YPSS) agar immersed and diffuse, producing a brown pigmentation of the surrounding agar. Colonies growing slowly on CMA, PDA, and YPSS reaching ca. 1–2 mm diam in 30–40 d; no anamorph observed.

Etymology. *Bipileatus* (*bi* = two, *pileatus* = cap-like) refers to the hyaline cap-like structure on the two poles of the ascospore.

Specimens examined. USA. FLORIDA: Apalachicola National Forest, swampy area of Whitehead Lake, 30°24'07"N, 84°48'12"W, UTM Zone 16 711030mE, 3365373mN, water temperature 29 C, pH 7.5, on submerged, decorticated wood, 13 Jul 2004, *HAR* and *CB, F49-1* (ILL). HOLOTYPE.



FIGS. 13–23. *Jahnula bipileata* from the holotype. 13. Ascoma on submerged wood. Arrows indicate the subtending superficial hyphae. 14. Longitudinal section through ascoma. 15. Neck showing subglobose divergent cells. 16. Longitudinal section through ascomal base showing subtending hyphae. 17. Peridium. 18. Pseudoparaphyses. 19. Asci. 20. Fissionate

Known distribution. USA (FL).

Comments. The general characteristics of *J. bipileata* fit within the concept of the genus *Jahnula*. *Jahnula bipileata* is superficially most similar to the type of the genus, *J. aquatica*, in having cylindrical asci with dark brown, 1-septate ascospores (Hawksworth 1984, Hyde and Wong 1999). The new species however differs from *J. aquatica* in having ascomata with a long, cylindrical neck rather than a short papilla. The neck is distinctive and composed of globose to elongated cells that are directed outward (FIG. 15). The ascospores of *J. bipileata* are irregularly striated, rough-walled and possess a hyaline cap at the ends of the ascospore apices (FIG. 21), features not observed in *J. aquatica*.

The hyaline caps on the ascospore apices of *J. bipileata* do not cover germ pores; germination occurs from the lateral walls of the ascospores (FIG. 23).

Jahnula bipolaris (K.D. Hyde) K.D. Hyde, Nov Hedwig 68:494. 1999. FIGS. 24–34

≡ *Ascagilis bipolaris* K.D. Hyde. Aust Syst Bot 5:111. 1992.

Ascomata 340–400 × 245–290 μm, globose to obpyriform, immersed to partially immersed in the substrate (wood), hyaline when young, becoming black translucent with age, membranous, with subtending and superficial stoloniferous hyphae, ostiolate, papillate (FIGS. 24, 25). Neck short, with short, inwardly growing, hyaline periphyses; apical region of the outer wall of the neck lined with angular cells. Peridium ca. 30 μm wide, tissue of *textura angularis* to *globosa* in surface view (FIG. 25), in longitudinal section ca. six cell layers wide, innermost layer of hyaline, thin-walled, compressed cells, outermost layer of large, moderately thick-walled, pigmented, angular cells (FIG. 26). Pseudoparaphyses septate, 3–4 μm wide, hyaline, anastomosing. Asci 210–340 × 30–45 μm, fissitunicate (FIGS. 30, 31), broadly cylindrical to obclavate, short pedicellate, with an apical chamber 4–6 × 7–8 μm and eight ascospores, which are overlapping uniseriate at ascus apex and base and 2–3 seriate in the middle (FIGS. 27, 28). Ascospores 45–55 × 18–20 μm (mean = 46 × 19 μm, n = 20), ellipsoidal to fusiform or slightly flattened on one side, light brown, 1-septate, slightly constricted at the septum, multiguttulate; with gelatinous pads ca. 10–11 diam, 2–3 μm high at the ascospore apices (FIGS. 29, 32), and a region around the apices staining black in nigrosin (FIG. 34); gelatinous pads

expanding in water, staining blue in aqueous nigrosin (FIG. 33); with an oval to circular gelatinous sheath ca. 6–8 μm wide at the septum within the asci (FIG. 29) that disappears on discharge and contact with water or glycerin (FIG. 34).

Colonies on (PYG) dark brown, diffuse, mycelium septate and thick-walled; no anamorph observed.

Specimens examined. COSTA RICA: Heredia, La Selva Biological Station, Salto A60, 10°24'43"N, 84°1'0"W, UTM Zone 16, 826666mE, 1152499mN, water temperature 26 C, pH 5.5, on submerged, decorticated wood, 17 May 2000, *JLA* and *RWA421-1*. Sura 60, 10°25'48"N, 84°1'32"W, UTM Zone 16, 825685mE, 1154486mN, on submerged, soft, decorticated wood, water temperature 25 C, pH 5, 18 May 2000, *JLA* and *RWA421-2*. Panteno, 10°25'8"N, 84°0'22"W, UTM Zone 16 827814mE, 115391mN, on submerged, decorticated wood, water temperature 25 C, pH 5.5, 19 May 2000, *JLA* and *RWA421-3*. Sura 100, 6 Feb 2001, *CMP A421-4*.

Known distribution. Australia, Costa Rica, Hong Kong, Malaysia, Thailand.

Comments. Hyde (1992) originally described *J. bipolaris* (K.D. Hyde) Hyde as a new genus, *Ascagilis* K.D. Hyde. Hyde and Wong (1999) subsequently transferred the species to *Jahnula* and placed *Ascagilis* in synonymy with *Jahnula*. Our specimen agrees well with the protologue description and illustrations of *J. bipolaris* with one exception. We did not observe the minute ascospore wall roughening reported by Hyde (1992).

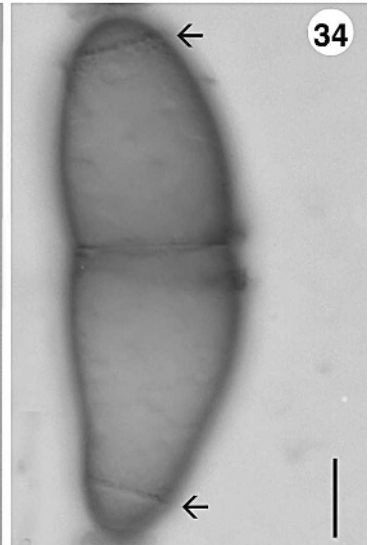
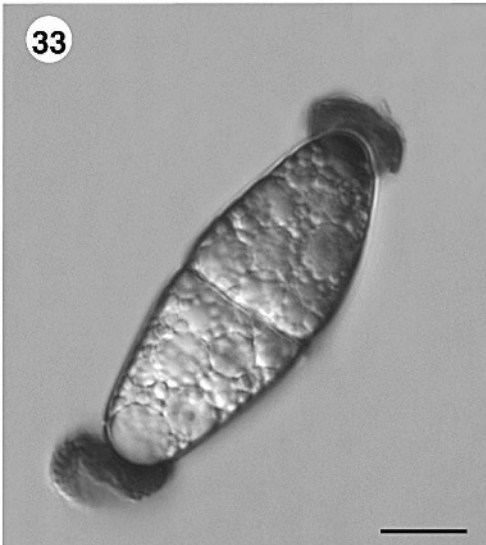
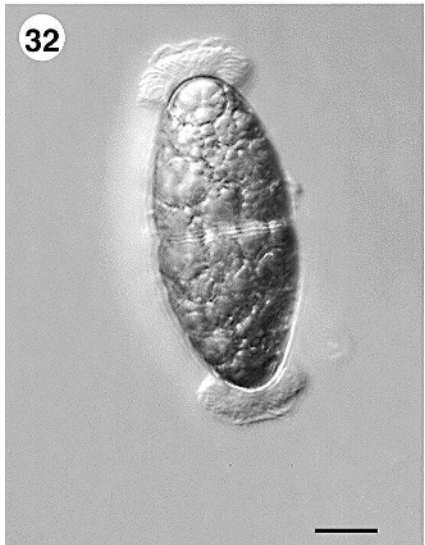
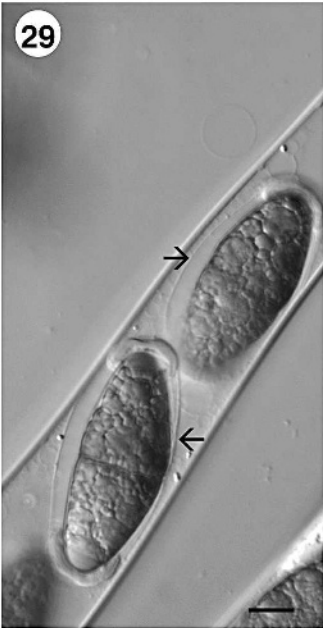
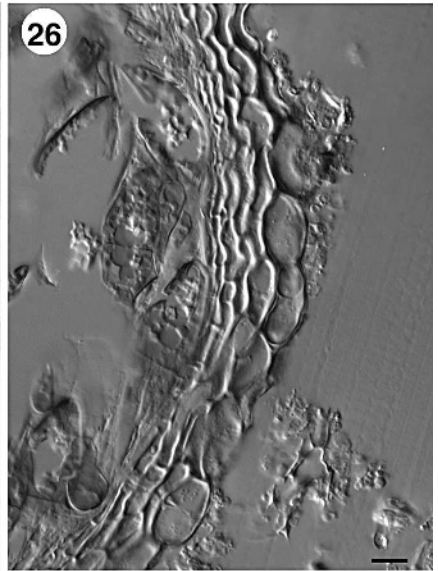
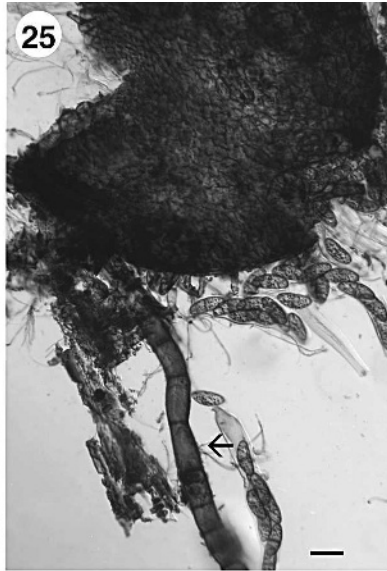
This is the first report of *J. bipolaris* from the New World tropics. This species, however, appears to be distributed fairly widely within the tropics based on this and other reports (Hyde and Goh 1997, 1998; Ho et al 2001, 2002; Tsui and Hyde 2004; Sivichai pers comm).

Jahnula potamophila K.D. Hyde and S.W. Wong. Nov Hedwig 68:499. 1999. FIGS. 35–44

Ascomata 445–455 × 410–427 μm, globose to subglobose (FIG. 35), scattered, immersed to partially immersed in wood, hyaline, with subtending, and superficial, stoloniferous brown hyphae ca. 30 μm wide (FIG. 38), ostiolate, papillate. Papilla 52–55 × 63–67 μm, central, tapered toward the apex; periphyses not observed (FIG. 37). Peridium ca. 50–58 μm wide, *textura angularis* in surface view; in longitudinal section, 4–6 cell layers thick, innermost layer of hyaline, thin-walled, compressed cells 22–

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ascus dehiscence. Arrow indicates separation of endoascus and ectoascus. 21. Ascospore with hyaline bipolar caps. Arrow indicates caps. 22. Ascospore with irregular wall roughening. 23. Germinating ascospores, note the germ tube emerging laterally from the ascospore walls. Bars: 13 = 200 μm; 14, 19, 20 = 20 μm; 15–18, 21–23 = 10 μm.



24 μm wide, outermost layer of large, moderately thick-walled angular cells 25–30 μm wide (FIG. 36). Pseudoparaphyses 2–3 μm wide, septate, slightly constricted at the septa, hyaline, anastomosing above and among the asci. Asci 218–220 \times 30–38 μm , fissitunicate, broadly cylindrical, pedicellate, with an apical chamber, and eight ascospores, which are 2–3 seriate at the base and uniseriate toward the ascus apex (FIGS. 40–42). Ascospores 48–60 \times 20–26 μm , 1-septate, broadly ellipsoidal-fusiform, light brown to brown, multiguttulate, with a gelatinous sheath surrounding the ascospore; sheath with protuberances at the ends and along the ascospore, appearing wavy in outline (FIGS. 43–44).

Specimens examined. Costa Rica: Heredia, La Selva Biological Station, Salto A60, 10°24'43"N, 84°1'0"W, UTM Zone 16, 826666mE, 1152499mN, water temperature 26 C, pH 5.5, on submerged, decorticated wood, 17 May 2000, JLA and RW, A420-1; Piper, on submerged decorticated wood, 6 Feb 2001, CMP, A420-2.

Known distribution. Australia, Costa Rica.

Comments. Our collections of *J. potamophila* agree with the protologue description and illustrations (Hyde and Wong 1999). Measurements are similar to those of the type specimen with only minor differences. The characteristic features of *J. potamophila* are a wide peridial wall (50–58 μm) (FIG. 36), and light brown, multiguttulate ascospores that possess a gelatinous sheath which appears wavy in outline (FIGS. 43–44).

Jahnula rostrata Raja et Shearer sp. nov. FIGS. 45–52

Ascomata in ligno 207–264 \times 147–150 μm , globose ad subglobose, superficialia, ostiolata, rostrata. Rostrum 38–40 \times 30–32 μm . Peridium 36–38 μm latum, 3–4 cellulae crassum, bistratosum. Pseudoparaphyses cellulosa, hyalinae, 3–4 μm latae. Asci 152–190 \times 32–40 μm , fissitunicati, clavati, octospori, biseriati. Ascospores 32–45 \times 12–15 μm , ellipsoideae-fusiformes, brunneae, uniseptatae, irregulariter striatae, gelatinosae.

Ascomata 207–264 \times 147–150 μm , hyaline and translucent when young becoming translucent brown to black at maturity, globose to subglobose, solitary, scattered, superficial on wood, connected by stoloniferous hyphae ca. 15–19 μm wide (FIGS. 45–46); ostiolate, papillate. Neck 38–40 \times 30–32 μm , com-

posed of subglobose cells diverging from the ostiole; periphyses not observed (FIG. 48). Peridium 36–38 μm wide, in longitudinal section 3–4 cell layers wide, innermost layer of hyaline cells compressed laterally, outermost layer of large, moderately thick-walled, isodiametric cells (FIGS. 46–47). Pseudoparaphyses 3–4 μm wide, septate, hyaline, anastomosing above the asci (FIG. 49). Asci 152–190 \times 32–40 μm , basal, fissitunicate, clavate, short pedicellate, with an apical chamber and eight, overlapping biseriata ascospores (FIG. 50). Ascospores 32–45 \times 12–15 μm , ellipsoidal or broadly fusiform, dark brown, 1-septate, slightly constricted at the septum, upper cell of ascospore broader than lower cell, rough-walled in an irregularly striated pattern (FIG. 51), multiguttulate, with or without a thin gelatinous sheath (FIG. 52).

Spores did not germinate on antibiotic water agar.

Specimens examined. USA. FLORIDA: Ocala National Forest, Lake George, 29°13'1"N, 81°35'14"W, UTM Zone 17, 442930mE, 323395mN, water temperature 28 C, pH 6.7, on submerged, decorticated wood, 16 Jul 2004, HAR and CB, F4-1. (ILL). HOLOTYPE.

Additional specimens examined. FLORIDA: Apalachicola National Forest, Big Gully Creek, 30°15'00"N, 85°10'54"W, UTM Zone 16, 671740mE, 3347836mN, water temperature 27 C, pH 6.6, on submerged, decorticated wood, 12 Jul 2004, HAR and CB, F4-2.

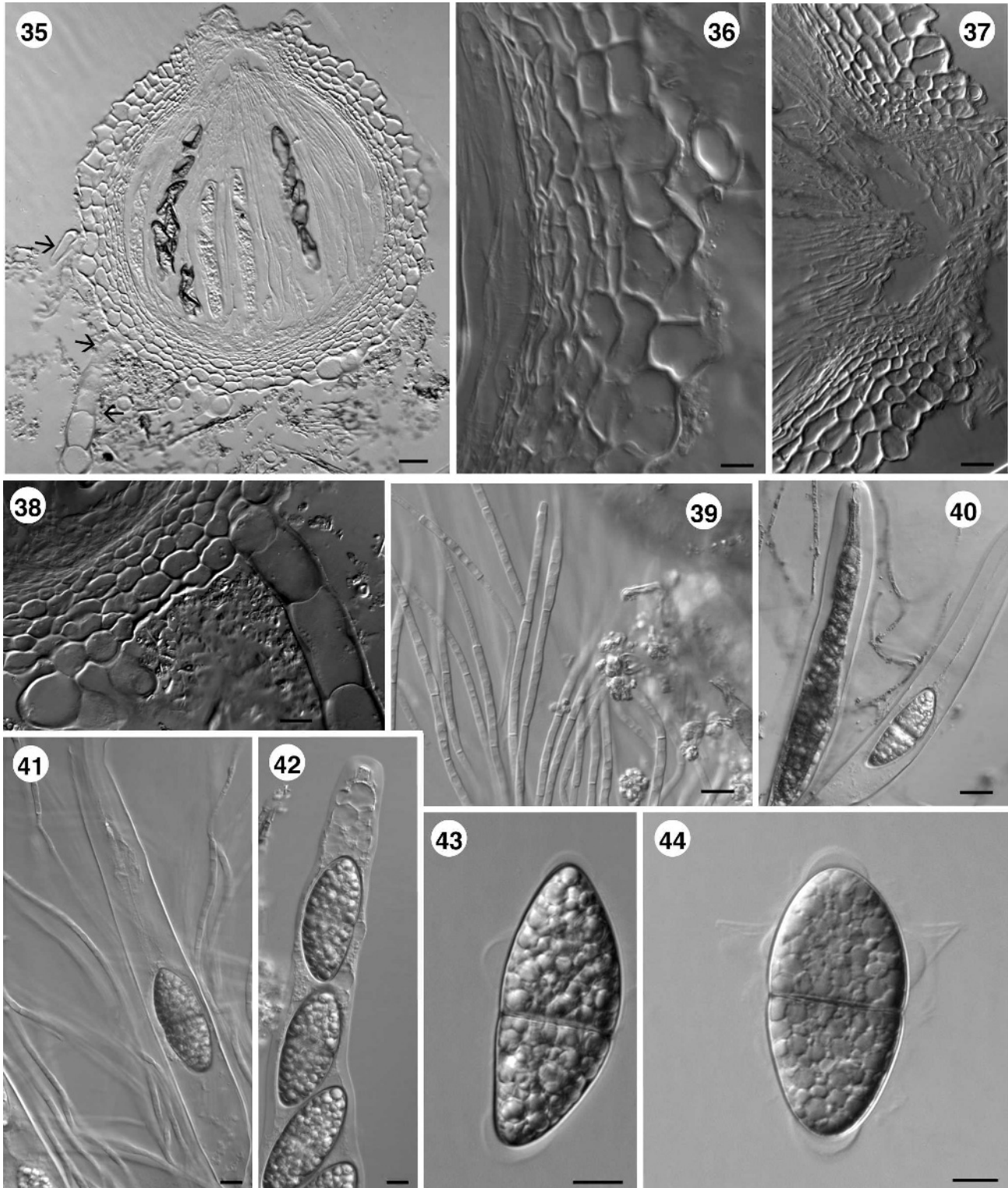
Known distribution. USA (FL).

Etymology. *Rostrum* = “provided with a neck”, in reference to the ascomata with a neck.

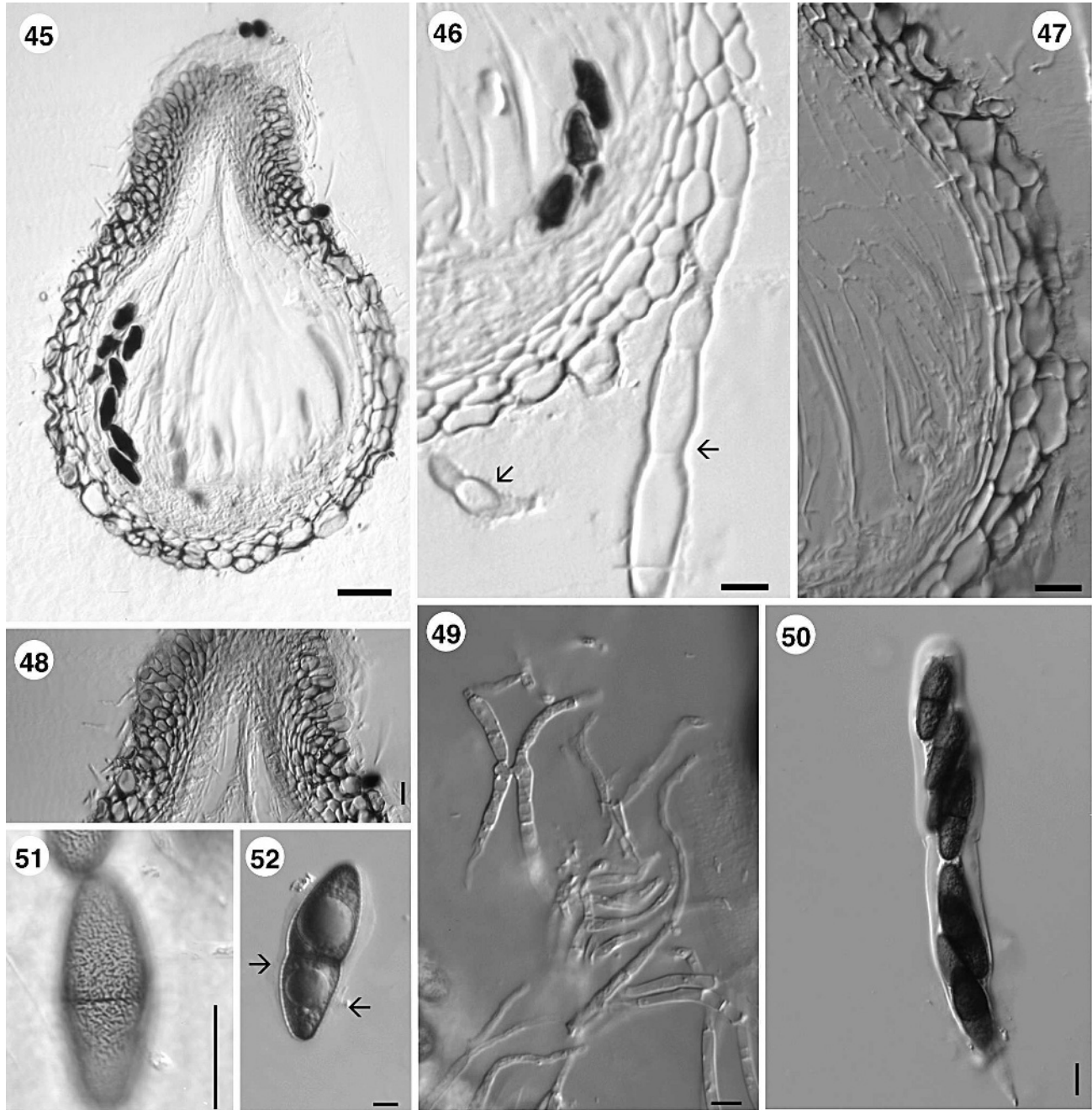
Comments. This species is most similar to *J. granulosa* in having rough-walled ascospores with or without a thin gelatinous sheath. It differs in several features, however. *Jahnula rostrata* has a neck with walls composed of short divergent hyphae (FIG. 48), while *J. granulosa* has a short papilla lacking divergent hyphae (Hyde and Wong 1999). In addition the asci of *J. rostrata* are clavate as opposed to obclavate in *J. granulosa* and shorter (150–190 μm in *J. rostrata*, compared to 220–270 μm in *J. granulosa*). The ascospores of *J. rostrata* are longer and narrower than those of *J. granulosa* and wall roughening occurs in a striate pattern in *J. rostrata* as opposed to an all-over granular pattern in *J. granulosa*. These differences warrant the establishment of a new species.

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FIGS. 24–34. *Jahnula bipolaris* (A421-1). 24. Longitudinal section through ascoma. 25. Squash mount of ascoma. Arrow shows subtending hyphae. 26. Peridium. 27. Ascus with pseudoparaphyses. 28. Ascus. 29. Ascospores in ascus. Arrow indicates gelatinous sheath. 30. Apical pore in the endoascus. 31. Fissitunicate ascus. 32. Ascospore in water showing expanding bipolar appendages. 33. Bipolar appendages stained in aqueous nigrosin. 34. Ascospore in glycerin. Arrow indicates bipolar apical ring, which was stained with aqueous nigrosin. Bars: 25 = 40 μm ; 24, 28, 31 = 20 μm ; 26–30, 32–34 = 10 μm .



FIGS. 35–44. *Jahnula potamophila* (A420-1). 35. Longitudinal section through ascoma. Arrows with subtending hypha. 36. Peridium. 37. Papillae. 38. Longitudinal section through ascomal base showing subtending hyphae. 39. Pseudoparaphyses. 40–41. Ascus. 42. Ascus apical chamber. 43–44. Ascospores with wavy gelatinous sheath. Bars: 35 = 40 μ m, 36–44 = 10 μ m.



FIGS. 45–52. *Jahnula rostrata* from the holotype. 45. Longitudinal section through ascoma. 46. Longitudinal section of ascomal base. Arrows showing subtending hyphae. 47. Peridium. 48. Neck showing the divergent cells. 49. Pseudoparaphyses. 50. Ascus. 51. Ascospore. 52. Ascospore with thin gelatinous sheath. Bars: 45–48, 50 = 20 μ m; 49, 51, 52 = 10 μ m.

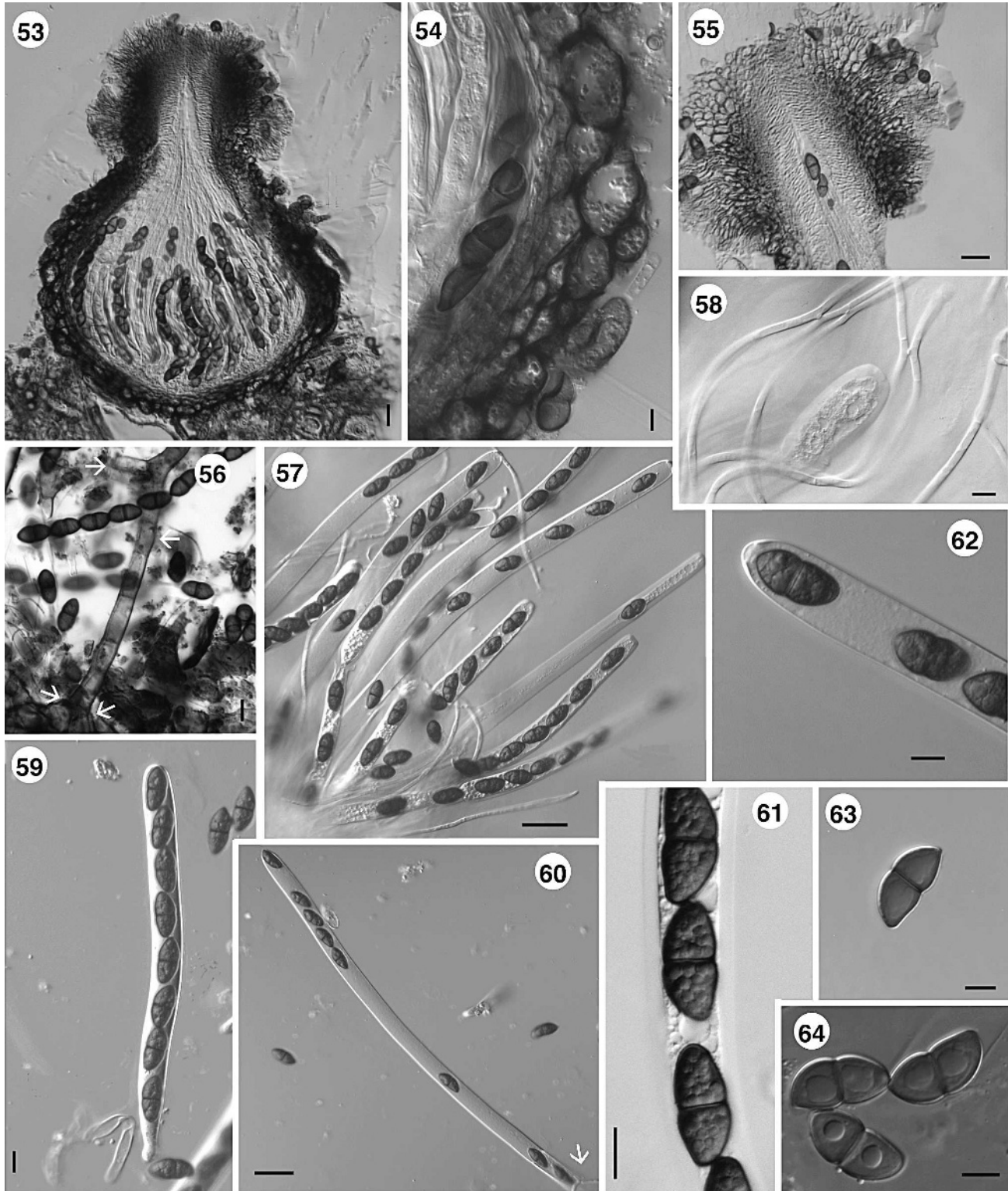
Jahnula sangamonensis Shearer et Raja sp. nov.

FIGS. 53–64

Ascomata 468 \times 345 μ m, globosa vel obpyriformia, immersa vel superficialia, brunnea vel nigra, ostiolata, rostrata. Rostrum 116–120 \times 60–65 μ m, brunneum, periphysatum. *Peridium* 40–44 μ m latum, 4–6 cellulae crassum, bistratosum. *Pseudoparaphyses* cellulosa, hyalinae, filamentosae, anastomosi, 2–3 μ m latae. *Asci* 164–200 \times 15–20 μ m, fissitunicati, cylindranei,

endoasci extendi in aqua 270–500 μ m, octospori, uniseriati. *Ascosporae* 20–28 \times 10–12 μ m, ellipsoideae-fusiformes, brunneae, uniseptatae, guttulate.

Ascomata 468 \times 345 μ m, globose to obpyriform, reddish brown to black, partially immersed in wood, ostiolate, papillate (FIG. 53) with subtending brown, septate hyphae ca. 160 \times 8 μ m that attach the base of the ascomata to the wood (FIG. 56). Neck 116–120 \times 60–65 μ m, central, with reddish brown periphyses;



FIGS. 53–64. *Jahnula sangamonensis*. 53. Longitudinal section through ascoma (A-402-1). 54. Peridium (A-402-1). 55. Neck showing periphyses (A-402-1). 56. Squash mount of ascoma (A-482-1). Note arrows showing the point of attachment of subtending hyphae to ascomal wall. 57. Fissitunicate asci (A482-1). 58. Anastomosing pseudoparaphyses (A-402-1). 59. Ascus (A-402-1). 60. Fissitunicate dehiscence (A-482-1). Note the arrow showing the point of emergence of the long endoascus. 61–64. Ascospores (A-402-1). Bars: 53 = 40 μ m; 56, 57, 59, 60 = 20 μ m; 54, 58, 61–64 = 10 μ m.

wall of the neck composed of chains of elongated cells diverging from the ostiolar canal (FIG. 55). Peridium 40–44 μm thick, *textura angularis* in surface view, in longitudinal section, peridial wall 4–6 cell layers wide; inner layer composed of thin-walled, narrow, flattened, elongated, subhyaline cells 11–16 \times 4–5 μm , outer layer of large, moderately thick-walled isodiametric, brown cells 14–34 \times 15–20 μm , (FIG. 54). Pseudoparaphyses 2–3 μm wide, septate, hyaline, anastomosing above the asci (FIG. 58). Asci 164–200 \times 15–20 μm (mean = 186 \times 16 μm , $n = 10$), fissitunicate, endoascus extending in water to ca. 270–500 μm in length, cylindrical, with an apical chamber, pedicellate, (FIG. 57, 59, 60, 62) with eight, overlapping uniseriate ascospores. Ascospores 20–28 \times 10–12 μm (mean = 24 \times 11 μm , $n = 50$), broadly ellipsoidal, 1-septate, constricted at the septum, dark brown, with or without minute verruculose ornamentation, multiguttulate, without a sheath (FIGS. 61, 63, 64).

Colonies on PYG agar diffuse, dark brown in the center, and hyaline toward the periphery; hyphae septate, thick-walled; no anamorph observed.

Etymology. In reference to the Sangamon River, where this species was first collected.

Specimens examined. USA. ILLINOIS: Piatt County, Robert Allerton Park, Sangamon River 40°0'14"N, 88°38'46"W, UTM 16 360584mE, 4429466mN, on submerged, decorticated wood, 25 Oct 1999, CAS, A-402-1. (ILL). HOLOTYPE.

Additional specimens examined. USA. ILLINOIS: Piatt County, Robert Allerton Park, Sangamon River, 40°13'47"N, 88°22'35"W, UTM 16 382895mE, 4454176mN, on submerged, decorticated wood. CAS, A482-1 (ILL). ARKANSAS: Poinsett County, St Francis River, at public boat landing, 35°31'57"N, 90°25'27"W, UTM Zone 15, 733550mE, 3934959mN, water temperature 8 C, pH 5, on submerged, partially decorticated wood, 27 Dec 1993, CAS and JLC, A188-1.

Known distribution. USA (AR, IL).

Comments. *Jahnula sangamonensis* is morphologically most similar to *J. poonythii* K.D. Hyde and S.W. Wong. However *J. sangamonensis* differs from *J. poonythii* in ascomal morphology. The ascomata of *J. sangamonensis* have a short but prominent neck, the inner wall layer of which has reddish-brown periphyses and the outer wall of which is composed of elongated globose to subglobose cells that diverge (FIGS. 53–55). The asci and ascospores of *J. sangamonensis* are similar to those of *J. poonythii* except that the ascospores of *J. sangamonensis* are shorter than those of *J. poonythii*. Despite the similarity in size, the asci of the two species are different in that the endoasci of *J. sangamonensis* extend up to 500 μm long in water (FIGS. 57, 60). This feature has not been reported for the type species by Hyde and Wong (1999) or by Gonzalez

and Chavarria (2005), who reported *J. poonythii* from Mexico.

Jahnula seychellensis K.D. Hyde and S.W. Wong, Nov Hedwig 68:504. 1999. (FIGS. 65–74)

Ascomata 272–300 \times 365–380 μm , pale reddish brown, globose, flattened at the base, ostiolate, short papillate, sessile, superficial, with subtending broad, brown, septate, stoloniferous hyphae (FIGS. 65, 68). Papilla 32–35 \times 80–85 μm , apex lined with elongated subglobose cells (FIG. 65). Peridium 30 μm wide; in longitudinal section 4–5 cell layers thick, composed of an inner layer of elongated moderately thick-walled hyaline cells, and an outer layer of large, moderately thick-walled, pigmented cells (FIG. 66). Pseudoparaphyses 3–4 μm wide, hyaline, septate, slightly constricted at the septa (FIG. 67), anastomosing above the asci. Asci 158–268 \times 26–32 μm , fissitunicate, obclavate, sessile, with an apical chamber (FIGS. 69–70), and eight, 2–3 seriate ascospores. Ascospores 38–44 \times 12–20 μm , (mean = 39 \times 15 μm , $n = 20$), broadly ellipsoidal, 1-septate, slightly constricted at the septum, light brown, multiguttulate; apical cell of the ascospore broader than basal cell (FIG. 73) and mammiform (FIG. 74), lower cell tapering and rounded toward the base; with gelatinous pads on the ascospore apices (FIG. 71); gelatinous pads stain blue in aqueous nigrosin (FIG. 72).

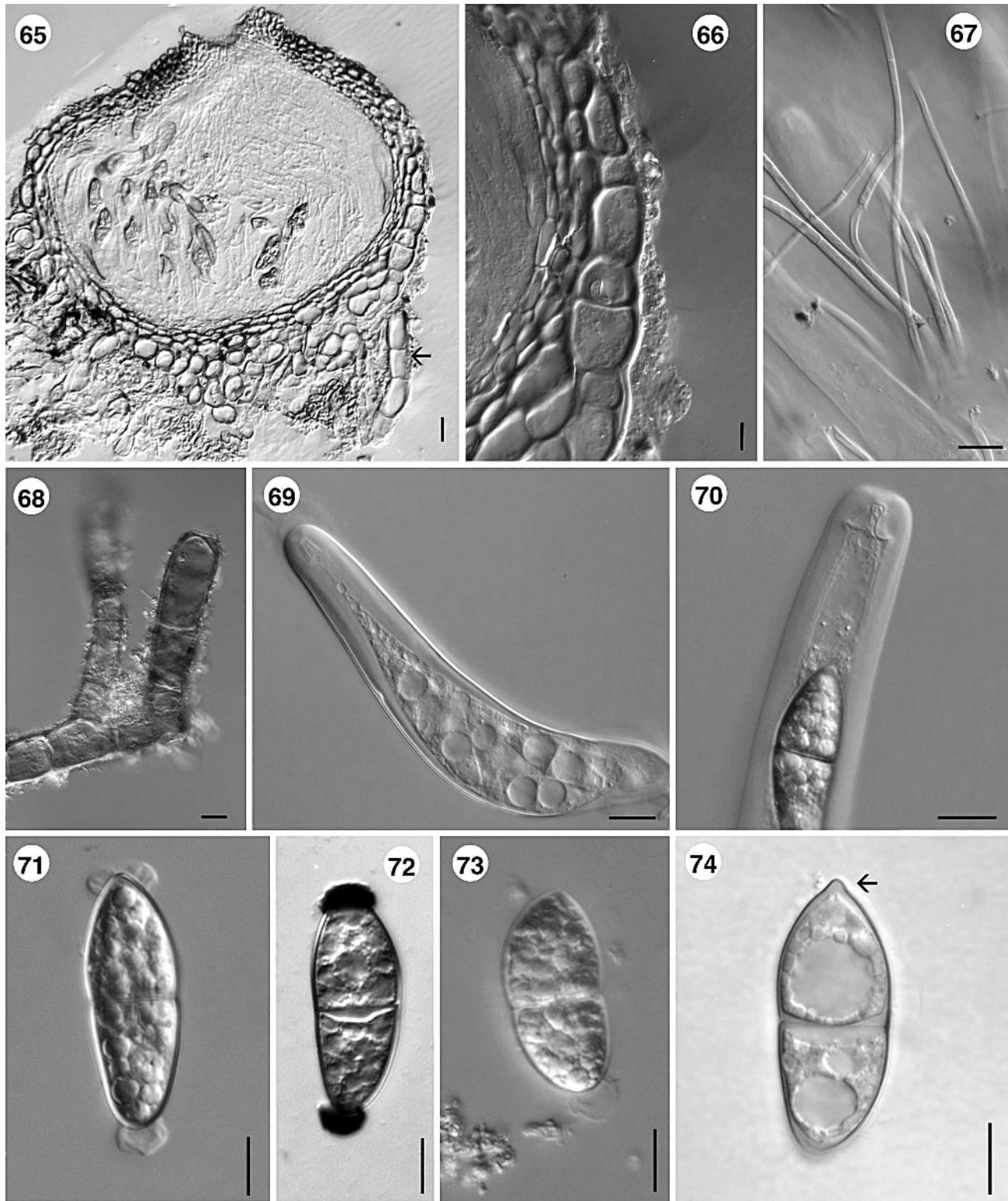
Specimens examined. Costa Rica: La Selva Biological Station, Sura 60, 10°25'48"N, 84°1'32"W, UTM Zone 16, 825685mE, 1154486mN, on submerged, corticated wood, CMP, A492-1.

Known distribution. Costa Rica, The Seychelles, Philippines, Thailand.

Comments. The specimen from Costa Rica is conspecific with *J. seychellensis* K.D. Hyde and S.W. Wong (Hyde and Wong 1999) from The Seychelles. Hyde and Wong (1999) in their original description of *J. seychellensis* described the ascospores as being dimorphic, with large light brown and small dark brown ascospores. In our collections we did not find distinctly dimorphic ascospores. However there were some minor differences in color and size of ascospores (FIGS. 71–74), but this was due possibly to differences in developmental stage. *Jahnula seychellensis* is similar to *J. bipolaris* in many respects, including ascospore appendage and ascus morphology. They differ however in ascomal and ascospore shape.

DISCUSSION

Three new species and four existing species of *Jahnula* are reported herein for the first time from



FIGS. 65–74. *Jahnula seychellensis* (A492-1). 65. Longitudinal section through ascoma. Arrow showing subtening hyphae. 66. Peridium. 67. Pseudoparaphyses. 68. Subtening hyphae. 69. Young ascus. 70. Ascus apical chamber. 71–74. Ascospores with bipolar pads. Note arrow showing mammiform ascospore apex. Bars: 65 = 40 μm , 66–74 = 10 μm .

the western hemisphere. An additional species, *J. poonythii* K.D. Hyde and S.W. Wong, also was reported from Mexico (Gonzalez and Chavarria 2005). These reports indicate that the genus is more widely distributed longitudinally than previously thought. All species except *J. aquatica* and *J. sangamonensis*, have been collected exclusively from subtropical or tropical regions or during the summer in temperate regions and thus can be considered primarily warm water taxa. The outlier is the type of the genus, which has been collected from latitudes ranging from 60°N to 30°S. All of the species of *Jahnula* and its sister taxon, *Aliquandostipite*, have been reported from softened, decomposed wood in wet or aquatic habitats.

Species in the genus *Jahnula* are similar in morphology with respect to a relatively large number of characters. The ascomatal wall of all *Jahnula* species consists of large angular to globose cells with a large lumen (ca. 4–10 µm wide) and the cells in the outer layer have moderately thickened walls (FIGS. 4, 17, 26, 36, 47, 54, 66). Hawksworth (1984) considered the large diameter of the peridial cells of *J. aquatica* to be the most remarkable diagnostic character of the genus. He considered this characteristic to be more compatible with a wet rather than xeric habitat, and indeed all species currently described in *Jahnula* and *Aliquandostipite* have been reported from wet or aquatic habitats.

The cells at the base of the ascomata of all species of *Jahnula* produce broad, brown, thick-walled hyphae that spread across the substrate and often connect adjacent ascomata. These broad hyphae initially were considered to be algal associates (Hyde and Wong 1999) but more recently Pinruan et al (2002) considered this unlikely. The material we have examined clearly indicates that these thick filaments are connected to and/or develop from peridial cells and hence are fungal. Further these large, brown hyphae are produced in cultures derived from single ascospores of *Jahnula* species. These repent, connecting hyphae may play an important role in colonizing and holding fungi onto softened wood in wet or aquatic habitats. In some species of both *Aliquandostipite* (Inderbitzen et al 2001) and *Jahnula* (Pang et al 2002) ascomata are borne erect on long, broad, brown, aerial hyphae similar to the large repent hyphae found in all *Jahnula* and *Aliquandostipite* species. Whether all taxa in the Jahnulales are capable of producing aerial stalked hyphae and whether the expression of this potential is environmentally controlled is unknown.

Although the degree of ascomal pigmentation varies among species, the ascomata are generally translucent and membranous. The hamathecium

consists of septate pseudoparaphyses (cellular sensu Barr 1987) that branch and anastomose above the asci. Hawksworth (1984), in his examination of the type specimen of *J. aquatica*, interpreted the pseudoparaphyses as being trabeculae, but this might have been because the pseudoparaphyses of *J. aquatica* are the most narrow of all the *Jahnula* species and the septa are difficult to see (FIGS. 2–5). The asci are basal, fissitunicate and have an apical chamber. Generally the endoasci of some species enlarge considerably in water to discharge spores. Ascospores are 1-septate, multiguttulate and pigmented.

In 1984 Hawksworth considered *J. aquatica*, then monotypic, to be a remarkable aquatic pyrenomycete and suggested that mycologists look for more species in aquatic habitats. Since that time 13 additional species have been discovered from aquatic habitats worldwide (Hyde 1993, Hyde and Wong 1999, Pang et al 2002, Pinruan et al 2002, this paper). Molecular studies have demonstrated that *Jahnula* occurs in the same well supported clade as *Aliquandostipite* (Pang et al 2002, Campbell and Shearer 2003). Pang et al (2002) established a new order, Jahnulales, for this clade based on molecular data. Additional molecular studies using more taxa are warranted to determine the evolutionary relationships of the Jahnulales with other orders of ascomycetes and to determine the evolution of various morphological characters among species of Jahnulales.

ACKNOWLEDGMENTS

We thank Andrew N. Miller, Jennifer L. Anderson, Lee Crane and Rebecca Wulffen for assistance with collecting. J.L. Anderson also is thanked for technical assistance. Our thanks go to Christopher Brown for assistance with isolate measurements and collecting. We appreciate permission granted by Apalachicola National Forest and Ocala National Forest rangers for permission to collect in the forests and by Dr Cathy M. Pringle, La Selva Biological Station, to collect at La Selva, Costa Rica. We thank A. N. Miller, Alberto M. Stchigel and two anonymous reviewers for helpful comments on the manuscript. We thank Somsak Sivichai (Biotec, Thailand) and Astrid Ferrer for discussions on morphological characters of *Jahnula* in culture. Financial support of this study by the National Science Foundation (NSF Grant No. DEB 03-16496), and National Institutes of Health (NIH Grant No. R01GM-60600) is gratefully acknowledged.

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