Some species of *Cordyceps* and its allies on spiders

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Summary. Four species of *Cordyceps* and *Torrubiella* from Japan are described, including *C. nelumboides* sp. nov., *T. arachnophila* f. *alba* f. nov. and *T. leiopus* stat. nov.

Cordyceps nelumboides *Y. Kobayasi & Shimizu*, sp. nov.

Mycelia superficiem hospitis contegentia, pulvinata, tomentosa, albida; hyphis hyalinis, 3–4 μm crassis, multiseptatis, irregulariter curvatis. Phialides ex cellulis terminalibus mycelii oriundae, elongatae, attenuatae. Conidia singularia, ovoidea, hyalina, ca 5 × 3 μm, sine muco. Stroma e parte dorsi hospitis oriundum, singulare, erectum, 5 mm altum. Stipes cylindricus, equalis, carnosus, solidus, 4 mm longus, 0·4 mm crassus, albus, fere levis, cortice destituto; medulla e hyphis hyalinis 3·5–7·5 μm crassis, longitudinaliter et compacte ordinatis contexta; hyphis superficialibus tenuioribus, 2·5–3 μm crassis, multiseptatis verrucosis. Pars fertilis crasso-discoidea, 2 × 0·8 mm, flavescens, superficie leviter convexa, ca. 50 papillata, textu interno ut in stipite, superficie e hyphis irregulariter colligatis, sinuatis, 2·5–3 μm crassis composita; superficies lateralis signis pyriformibus ornata, textu e hyphis 3–3·5 μm crassis, distincte verrucosis composito. Perithecia omnino immersa, rectim inserta, fusoideo-ellipsoidea vel naviculata, interdum curvata, 535–545 × 180–190 μm. Asci 400–450 × 5–6 μm, capitibus 4–4·5 μm diam., articuli ascosporarum ca 5 × 1 μm. (Fig. 1 & 2.)

Status-conidialis: ut in *Hirsutella* phialidibus in pulvino myceliali positis. Sterigmata longa, tenuia, ad cellulam apicalem hypharum procumbentium apicaliter vel lateraliter producta.

Spider, attached to the frond of *Polystichum tripteron.*

JAPAN. Yamagata Pref., Kakurezawa of Shione River, Mogami-Gun, 11 Aug. 1970, *Shimizu* (holotype, TNS).

The specific epithet compares the fertile part of the fungus to the receptacle of the lotus.

Cordyceps cylindrica *Petch* in Trans. Brit. Mycol. Soc. 21: 46 (1937); Mains in Bull. Torrey Bot. Club 81: 495 fig. 3–5 (1954).

Mycelium covering head and abdomen of host, thick, cottony tomentose; hyphae 8·5–12·5 μm, slightly thick-walled, pale brown or almost hyaline, septate, branches extending at right angles, frequently with oblong apical cell (reproductive organ?). *Stroma* single, arising from head of host, fleshy, 3·6 cm long, composed of simple stalk and clavate fertile part. *Stalk* cylindric, equal, soft, fleshy, 2·3 cm long, 2–2·6 mm thick, loosely stuffed, surface pure

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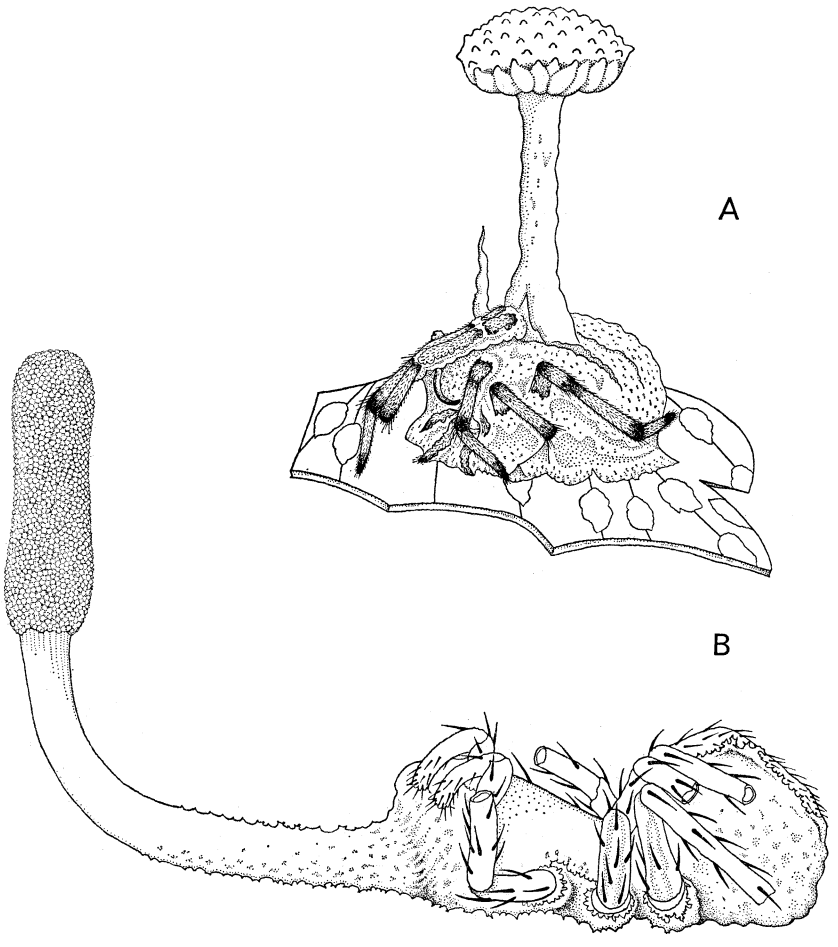

FIG. 1. **A,** *Cordyceps nelumboides*, × 8·5. **B,** *C. cylindrica*, × 3.

white, lower half pubescent, upper half smooth, faintly striate, not glossy; inner tissue soft and loose, then becoming hollow leaving membranous outer layer, without special peridial layer, medullae composed of compact layer of hyaline, septate hyphae, 2·5–4·5 μm thick.

Fertile part abruptly enlarged, cylindric clavate with obtuse end, 1·3 cm long, 3·7–4 mm thick, covered with densely packed innumerable perithecia, viscid, pale ochraceous, density of ostiolae being 4–6 per mm; inner tissue composed of densely bound, septate hyphae, 2·5–3 μm thick; peridial layer rather distinct, ca 200 μm thick, pale brown, composed of irregularly arranged, densely septate hyphae; interperithecial layer composed of loosely and irregularly running hyphae. *Perithecia* almost immersed, fusiform-elliptical or flask-shaped with long neck, 850–1000 × 200–225 μm, wall 10 μm thick, ostiola low, obtuse, 125–150 μm high. *Asci* 4·5–5·5 μm thick, cap 5 μm thick. Secondary ascospores 3–4 × 1·2 μm, with truncate ends. (Figs. 1B & 3.)

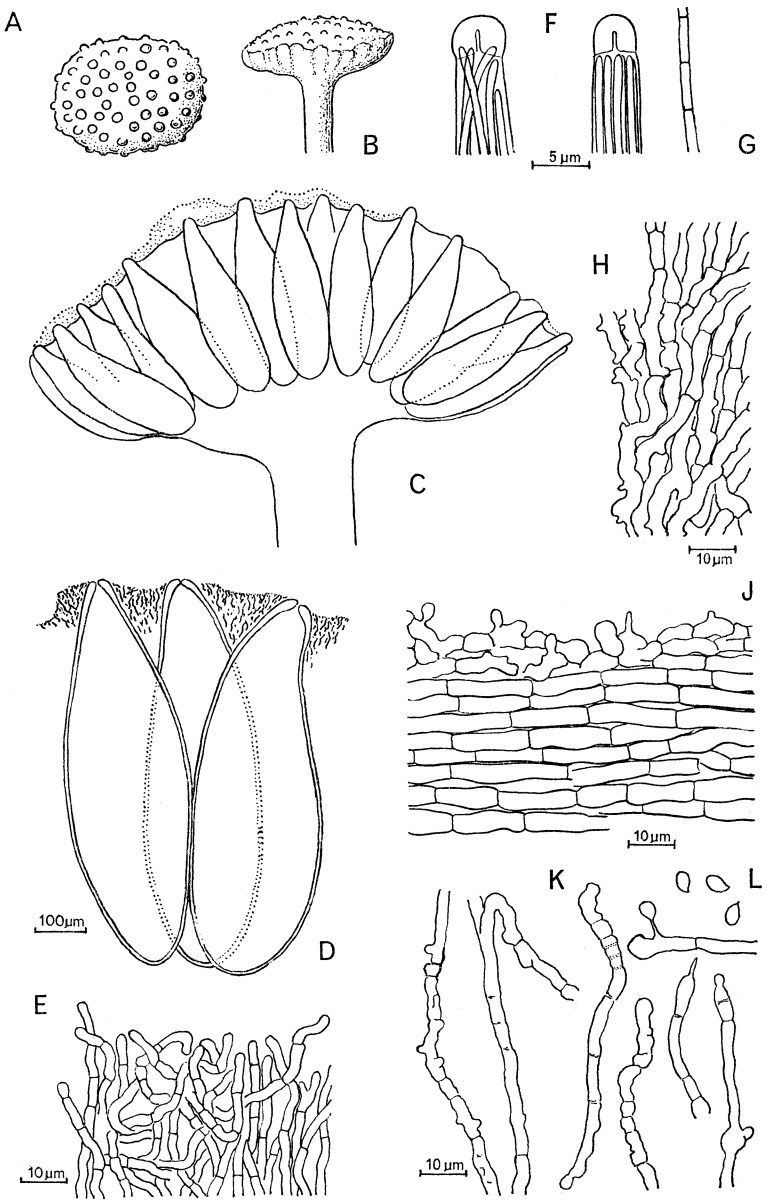

FIG. 2. *Cordyceps nelumboides*. **A,** upper surface of fertile part, × 5·5; **B,** side view; **C,** median section, × 19; **D,** section through perithecia; **E,** interperithecial tissue; **F,** apex of asci; **G,** ascospore; **H,** peridial layer of fertile part; **J,** peridial layer & medulla of stalk; **K,** mycelium on host-body; **L,** conidia on mycelium.

Conidial state: probably *Isaria* (*Paecilomyces*) *atypicola* Yasuda.

Trapdoor spider.

JAPAN. Iriomote Is., near Kampira Water Fall of Urauchi River, 16 July 1971, *Shimizu & Y. Suzuki* 01–2 (TNS).

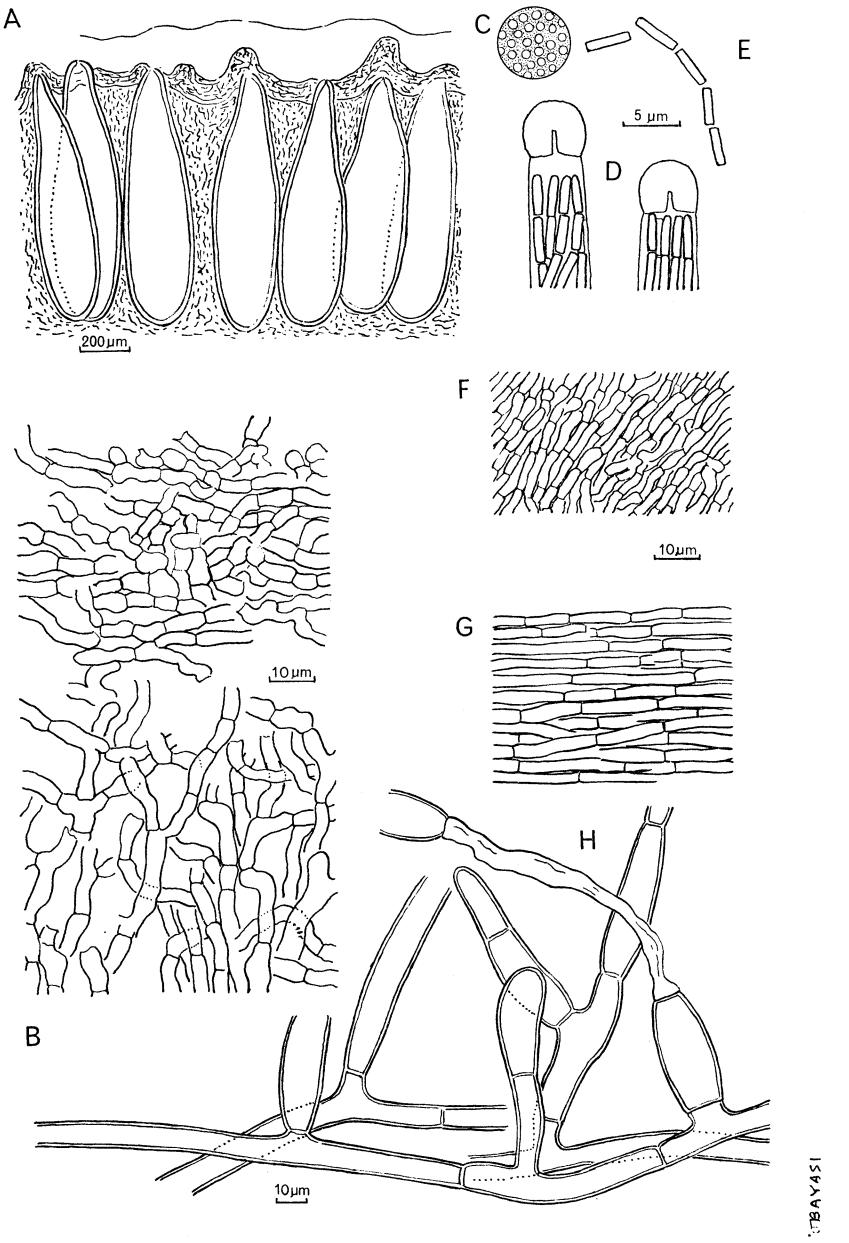

FIG. 3. *Cordyceps cylindrica*. **A,** section through perithecia; **B,** peridial layer and interperithecial tissue of fertile part; **C,** surface view of fertile part showing the density of ostiola; **D,** apex of asci; **E,** secondary ascospores; **F,** medulla of fertile part; **G,** medulla of stalk; **H,** mycelium on host-body.

FIG. 4. *Torrubiella arachnophila* f. *alba*, × 7·5.

The present species was published based on a single specimen collected by D. H. Linder in Trinidad. According to his note, the stalk is white with pale yellow-coloured head when fresh. No asci are found. Compared to the type specimen, the Japanese collection produces slightly smaller perithecia. Petch has suggested that *Isaria atypicola* is the conidial stage of *C. cylindrica*, and the writers have also the same opinion since both of these perfect and conidial species grow on the trapdoor spider and have similar fructifications, except for the fertile part, although no attempt has been made at experimental verification. It is very interesting that *Isaria atypicola* had already been found about forty years ago in neighbouring Ishigaki Is.

Torrubiella arachnophila (*Johnston*) *Mains* in Mycologia 42: 316 (1950).

forma **alba** *Y. Kobayasi & Shimizu*, f. nov.

Mycelium album, peritheciis partim immersis in pulvino mycelii albi. Cetera ut in typo.

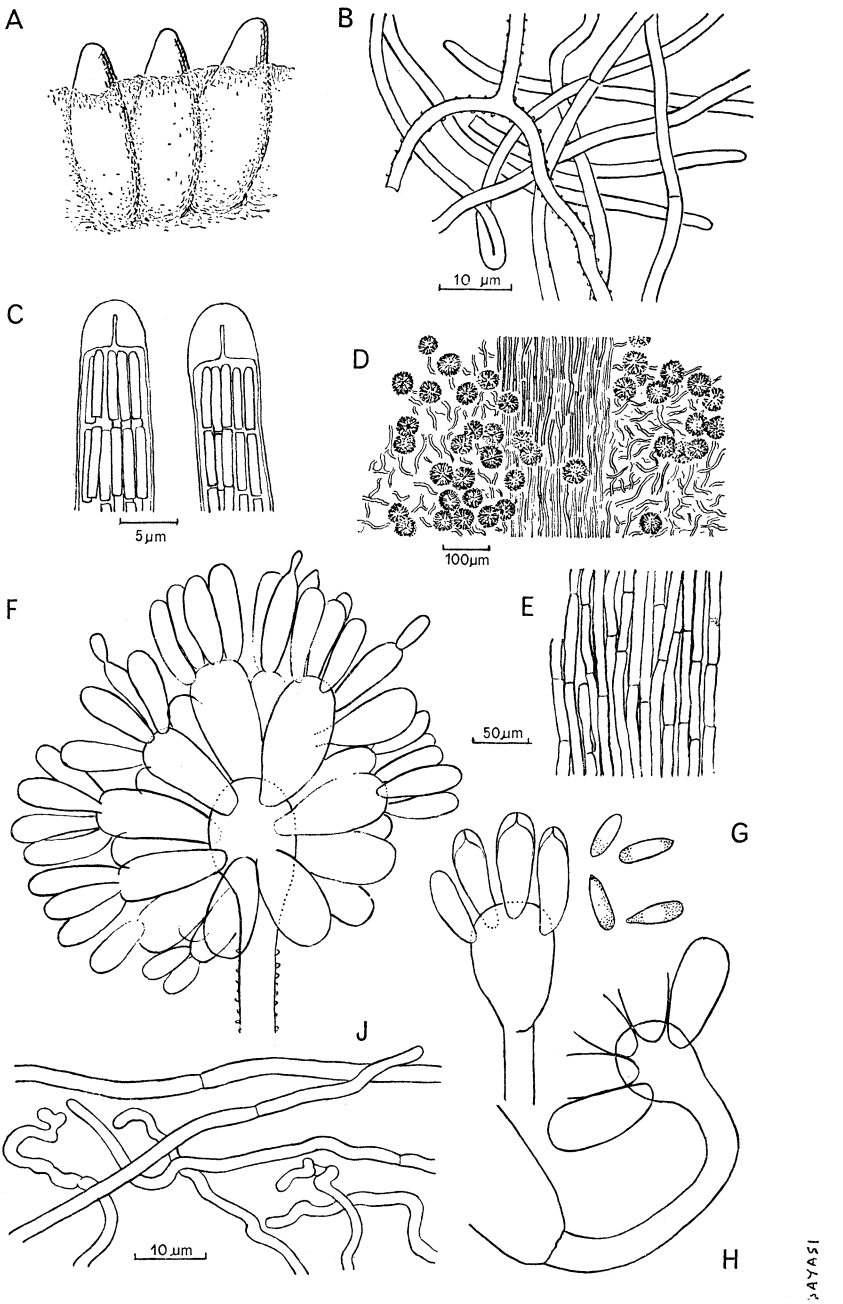

FIG. 5. *Torrubiella arachnophila* f. *alba*. **A,** perithecia, × 23; **B,** hyphae covering perithecia; **C,** apex of asci; **D,** part of synnema; **E,** tissue of synnema; **F,** head of mature sporophore; **G,** phialids & conidia; **H,** terminal cell of sporophore; **J,** mycelium on host-body.

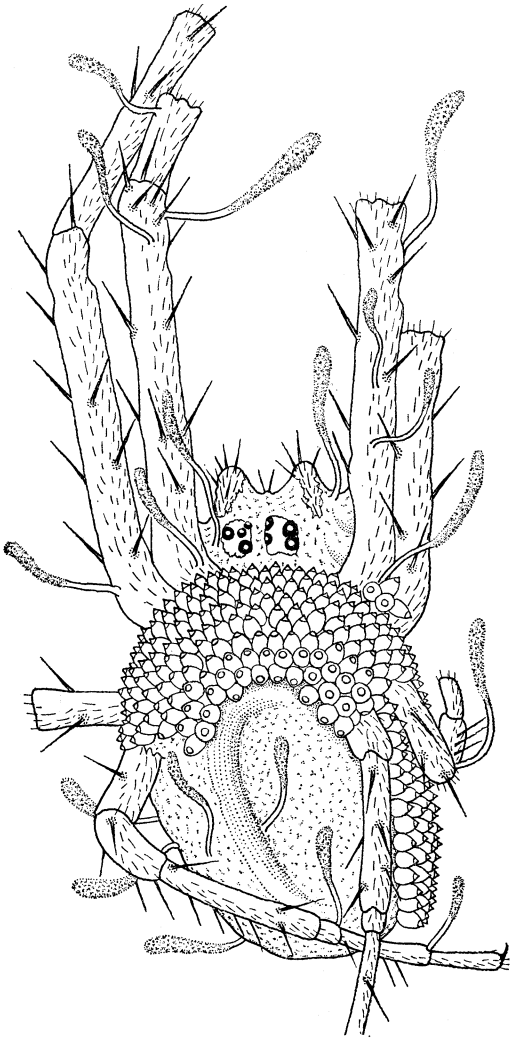

FIG. 6. *Torrubiella leiopus*, × 7·5.

Mycelial mat white, cottony membranous, covering whole host-body, extending to leaf surface as netted membrane; hyphae septate, 1·2–2·5 μm thick, sinuate, sparingly septate, dichotomously branched. *Perithecia* compactly gregarious on the abdominal part of host, almost covered with cottony white hyphal tissue, narrowly ovoid to conoid, 1–1·2 mm long, 250–300 μm in diameter; ostiola naked, conical with obtuse end, dark cinereous, glossy; hyphae covering perithecia loosely bound, sparsely septate, 1·5–2·5 μm thick, dichotomously branched, frequently finely asperulate. *Asci* 6–7 μm thick, with cap 5·5–6 μm in diameter. Secondary ascospores 5–7 × 1·2–1·5 μm. (Fig. 4 & 5.)

Conidial state: *Gibellula pulchra* (Sacc.) Cavara in Att. 1st. Pavia II, 3: 347 (1894); Mains in Mycologia 42: 317, f. 1–4 (1950).

Synnemata, 10 or more, arising from the dorsal side of cephalothrix of host, diffused or erect-patent, simple cylindric, attenuated, wholly covered with heads of conidiophores, 4–5 mm long, 400–800 μm thick, consisting of fasciculate, septate, 10–15 μm thick hyphae; fertile hyphae along outer surface of synnema, 5–8 μm in diameter, frequently finely asperulate. *Conidiophore* arising as long arm of intermediate cell of fertile hyphae or from the apex of elongate fertile hyphae, cylindric, septate, asperulate, 5–8 μm thick, terminal cell abruptly attenuated, 23–28 × 3–4 μm, apical part globosely incrassate, 6–8 μm wide, bearing many prophialides and phialides, forming spherical, violaceous heads, 40–50 μm wide. Prophialides obpyriform, 8–12 × 3–4 μm, bearing several phialides; phialides subcylindric or clavate, 7–10 × 2–2·5 μm, producing single or catenate conidia; conidia fusiform-ellipsoidal, hyaline, 4–6 × 1·5–2 μm.

Spider, attached to the frond of *Adiantum pedatum*.

JAPAN. Yamagata Pref., near Ootori Pond, Asahi Range, 23 Sept. 1963, *Shimizu* 200 (holotypus, TNS).

The typical *T. arachnophila* accompanied with *G. pulchra* has also been found in Japan.

Torrubiella leiopus (*Mains*) *Y. Kobayasi & Shimizu*, stat. & comb. nov.

Torrubiella arachnophila (Johnst.) Mains var. *leiopus* Mains in Mycologia 42: 318 (1950).

Mycelial mat covering whole host-body except for legs, membranous floccose, citron-yellow, hyphae thin-walled, remotely septate, 2–3 μm thick. *Perithecia* gregarious, compact on dorsal side of host-body, thick ovate with papillate apex, 600–700 × 300–400 μm, almost covered with cottony citron-yellow hyphae, hyphae irregularly branched, sparsely septate, 2–3 μm thick; ostiola obtuse conoid, glabrous, pale yellowish brown. Cap of *ascus* 4–5 μm in diameter. Secondary ascospores 5–9 × 1–1·5 μm, truncate at both ends. (Fig. 6 & 7.)

Conidial state: *Gibellula leiopus* (Vuill.) Mains in Mycologia 42: 318, f. 7–12 (1950) (*Gibellula arachnophila* f. *leiopus* Vuill. apud Maubl. in Bull. Soc. Mycol. Fr. 36: 42 (1920)).

Synnemata scattered, arising from mycelial mat and legs of host, cylindric simple, 2–4 mm long, 200–300 μm thick, stalk slender 100–130 μm thick, pale yellowish, fertile part clavate with tufted surface, violaceous; medulla 170–250 μm thick, consisted of hyphae longitudinally and compactly arranged, septate, 2·5–3 μm in diameter. Fertile hyphae loosely attached to surface of synnema, closely septate, frequently asperulate, 2–4 μm thick. *Conidiophore* arising as a lateral arm of intermediate cell of fertile hyphae or on the apex of them, short clavate, obpyriform or rarely cylindric and septate, 11–17(–25) × 3–6 μm, bearing prophialides and phialides, forming wedge-shaped, violaceous head, 25–40 μm thick in side view. Prophialides, several on conidiophore, obovate or fusiform-elliptical, 9–11 × 3–4 μm; phialides 3–5 on prophialide, subcylindric or clavate, 9–10 × 2·5 μm, wall slightly thickened toward apex; conidia singly or in chain on phialide, elliptic fusiform, 5–6 × 1·2–2 μm.

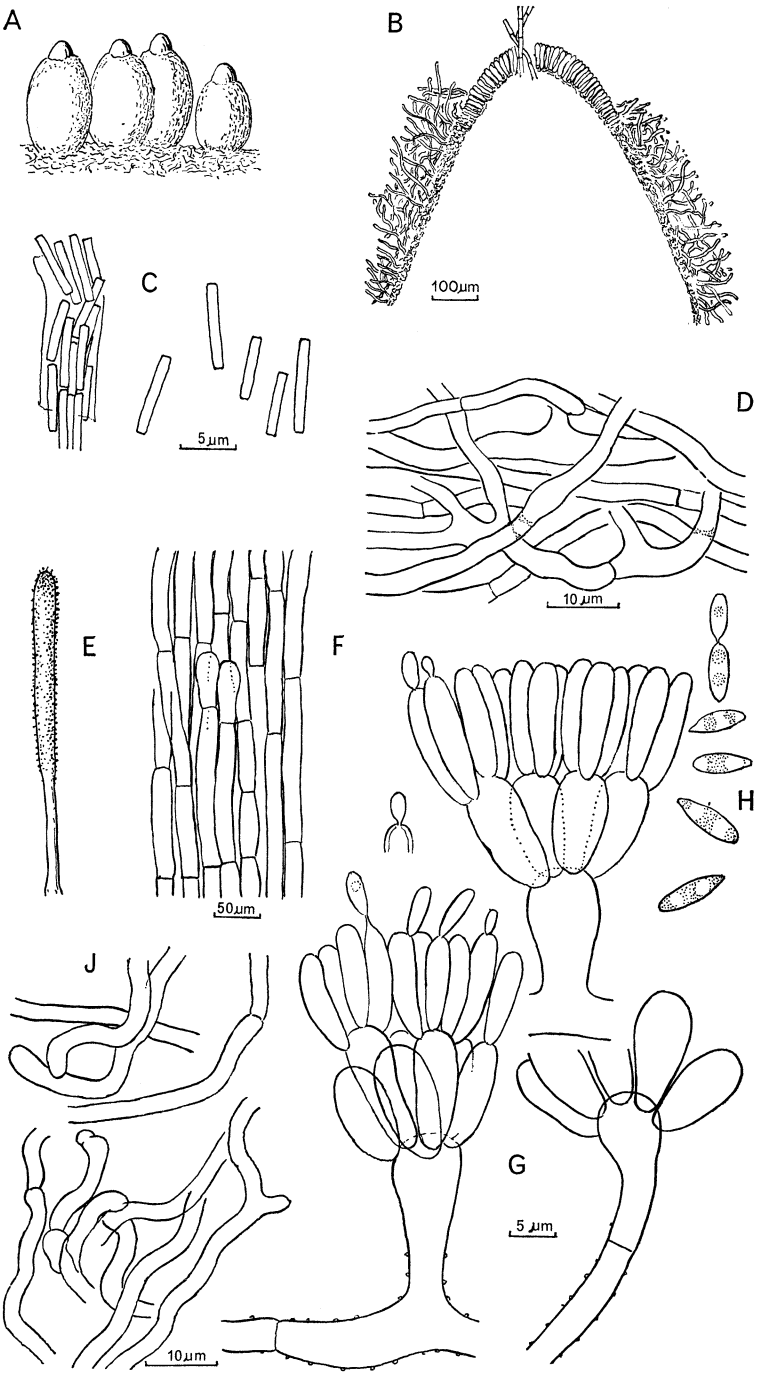

FIG. 7. *Torrubiella leiopus*. **A,** perithecia, × 21; **B**, section through upper part of perithecia; **C,** secondary ascospores; **D,** hyphae covering perithecia; **E,** synnema, × 15; **F,** tissue of synnema; **G,** heads of mature sporophore; **H,** conidia; **J,** mycelium on host-body.

Small spider.

JAPAN. Niigata Pref., along Shikamata River, Kurokawa-mura, 7 Aug. 1966, *Shimizu* 188 (TNS).

Torrubiella leiopus is separated from *T. arachnophila* by the shape and size of the perithecia and the wedge-shaped head of the conidiophore.