

NOTE

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## New records of two *Tulostoma* species from Japan

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**Abstract** As new records from Japan, *Tulostoma adhaerens* and *T. fulvellum* (Tulostomataceae, Agaricales) were described and illustrated based on the specimens collected in Shizuoka Prefecture and Shiga Prefecture, respectively. New Japanese names were proposed as Abata-Keshibouzu-take and Tanemi-Keshibouzu-take for *T. adhaerens* and *T. fulvellum*, respectively, based on their morphological features.

**Key words** Agaricales · *Tulostoma adhaerens* · *Tulostoma fulvellum* · Tulostomataceae

*Tulostoma* Pers. is a very distinct genus in the Tulostomataceae (Agaricales): i.e., it is characterized by the distinct stipe with subglobose spore-sac, well-developed apical ostiole, and thick- to thin-walled septate capillitia. According to Wright (1987), this genus has a worldwide distribution and appears in arid areas or on sandy soil (seaside dune, sea bank, etc.). Seventy-nine species were recognized for the genus (Kirk et al. 2001), but only 5 taxa have been reported from Japan: i.e., *T. brumale* Pers.: Pers., *T. fimbriatum* Fr., *T. fimbriatum* var. *campestre* (Morgan) Moreno, *T. squamosum* Pers., and *T. striatum* G. Cunn. (Yoshimi 1989; Asai 2004). In this study, 2 additional species were recognized from Japan: *T. adhaerens* Lloyd, on sandy soil in the seaside area, Shizuoka Prefecture, and *T. fulvellum* Bres., among moss in a limestone rock area, at Mt. Oike-dake, Shiga Prefecture. In the following description, the macroscopic features are based on fresh materials and microscopic features on the dried materials rehydrated and mounted with 70% ethanol. For the observation of basidiospores under a scanning electron microscope (SEM), a small portion of gleba of the dried matured specimen was directly coated with platinum-palladium in an ion sputter-

coater (Hitachi E-1030; Hitachi, Tokyo, Japan), and observed under a SEM (Hitachi S-800) operating at 15 kV. Specimens examined are deposited in the Natural History Museum and Institute, Chiba (CBM), Japan.

***Tulostoma adhaerens*** Lloyd, Mycological Notes 7: 1199, 1923. Figs. 1–4

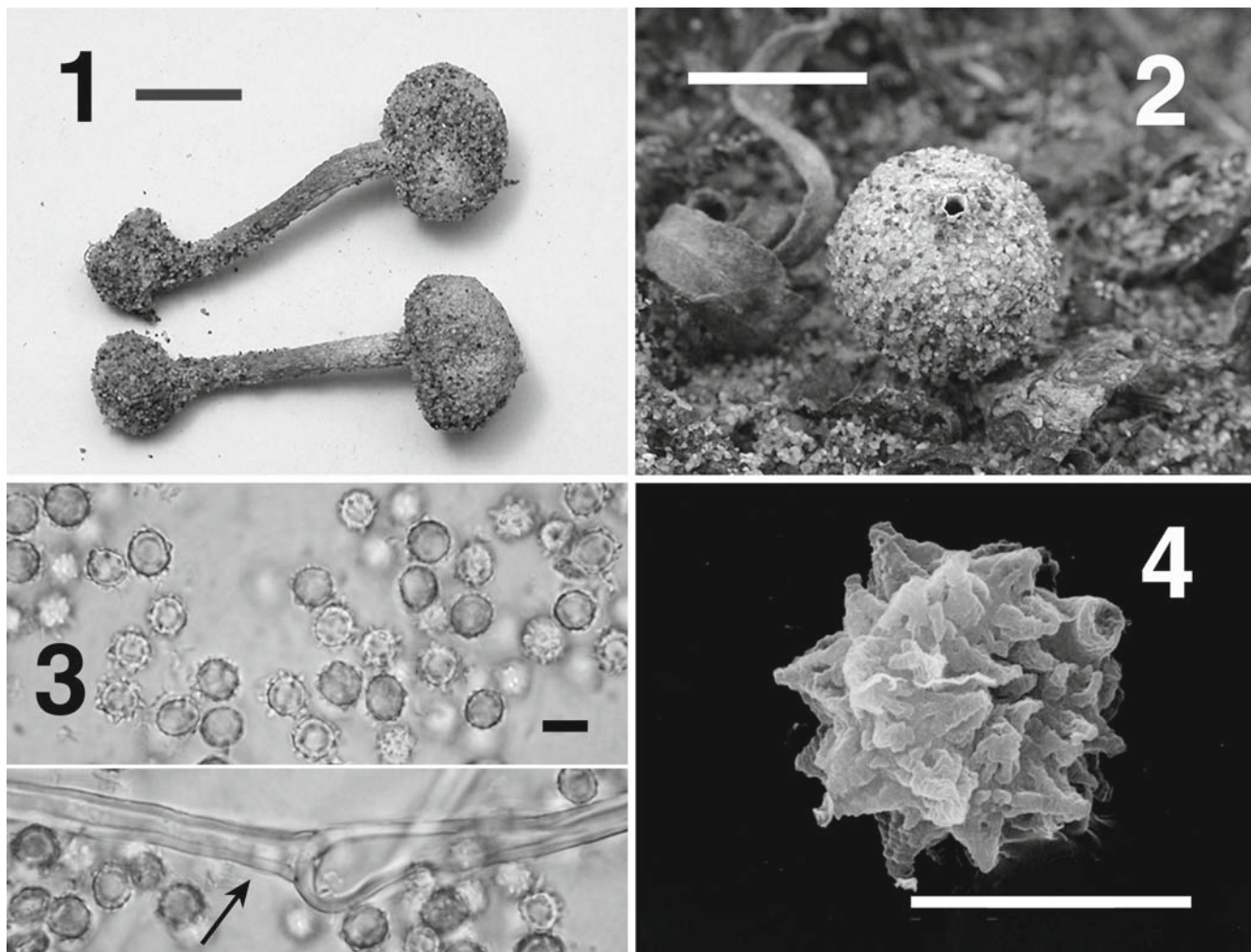
Spore-sac (Figs. 1, 2) globose to subglobose, 10–20 mm wide, 8–16 mm high. Exoperidium dirty brown, a thick layer of hyphae aggregated with sand and soil, persistent at base, falling off either in small irregular fragments or almost entirely from the upper part. Endoperidium dirty white or pinkish-grey, smooth or patchy due to dark scattered remnants of the exoperidium. Ostiole (Fig. 2) slightly projecting, round to elliptical, 0.5–0.9 mm diameter, pale colored. Gleba at first almost white, becoming rusty-brown when mature. Stipe (Fig. 1) light brown to dirty brown, cylindrical, 25–35 × 3–5 mm, woody and tough, rugose-squamose surface, with coarse, appressed scales at the base with conspicuous mycelial bulb. Basidiospores (Figs. 3, 4) brown, globose or subglobose, echinulate under light microscope, 5.0–7.5 μm diameter [6.6 ± 0.7 μm (mean ± SD), *n* = 40] with ornamentation, 4.0–6.0 μm diameter (5.0 ± 0.5 μm) without ornamentation; ornamentation under SEM blunt conical, formed of 4–6 filamentous wall elements united at the apex (Fig. 4). Basidia not observed. Capillitia (Fig. 3, arrow) hyaline to light brown, septate, swelling at the septa, branched, with blunt ends, variable in thickness, 1.5–9.0 μm diameter.

**Habit and habitat.** Basidiomata gregarious, fasciculate or sometimes solitary, on sandy soil of seaside, observed in all seasons in Japan.

**Distribution.** South Africa, Madagascar, Australia, Malaysia (Bottomly 1948; Wright 1987), Japan.

**Specimens examined:** Hamaoka-sakyu, Omaezaki-shi, Shizuoka Pref., Japan, on seaside sandy soil, leg. I. Asai, CBM-FB-36427 (19 Nov. 2005), CBM-FB-36423 (16 Oct. 2005), CBM-FB-36421(2 Jul. 2005), CBM-FB-36420 (25 Jan. 2005), CBM-FB-36419(3 Dec. 2003); Nakatajima-sakyu, Hamamatsu-shi, Shizuoka Pref., Japan, on seaside

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**Figs. 1–4.** *Tulostoma adhaerens* (CBM-FB-36422). **1** Basidiomata. **2** Basidioma in a natural habitat. **3** Basidiospores and capillitium (*arrow*) under light microscope. **4** Basidiospore under scanning electron microscopy (SEM). Bars **1** 1 cm; **2** 1.5 cm; **3, 4** 5  $\mu$ m

sandy soil, leg. I. Asai, CBM-FB-36424 (19 Nov. 2005), CBM-FB-36422 (16 Oct. 2005).

Japanese name: Abata-Keshibouzu-take (“abata” means patchy; the remnants of exoperidium exhibit a characteristic mottled appearance of the spore-sac of this species).

Notes. Wright (1987) included this species in subgenus *Tulostoma* Pers., series *Tubulares* J.E. Wright, section *Hyphales* J.E. Wright because of the exoperidium with a thick layer of hyphae and a tubular or compressed cylindrical ostiole. In this section, 37 species have been recognized (Wright 1987). This species is segregated from the other species in having medium-size (10–20 mm wide) spore-sac with one ostiole, coarsely verrucose to echinulate basidiospores, comparatively persistent remaining exoperidium, swollen capillitia at septa, and ammophilous habit. Morphological characters of the Japanese specimens examined are in good agreement with the original and latter descriptions of *T. adhaerens* (Lloyd 1923; Bottomly 1948; Wright 1987). Basidiospore ornamentation of this species has been described in a variant manner; “granular rough” (Lloyd 1923), “finely but sparsely echinulate” (Bottomly 1948), and “echinulate” (Wright 1987). Wright (1987) added “some

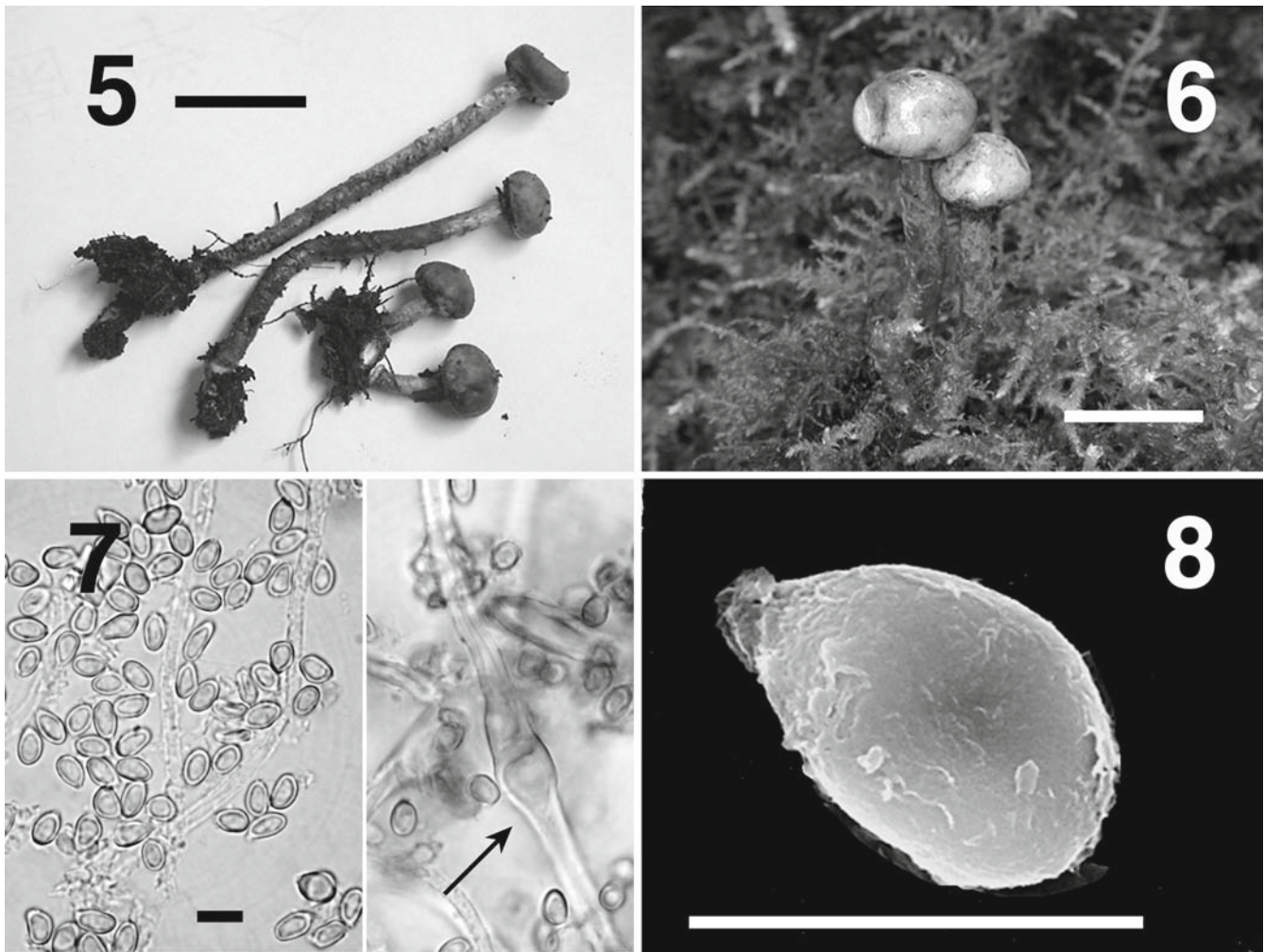
appearing almost reticulate” based on the holo- and isotype specimens. In this study, basidiospores from the Japanese specimens were echinulate to reticulate under the light microscope (Fig. 3). However, the SEM observation revealed that their echinulate or reticulate ornamentations are composed of several spines in coherent fascicles and that each spine is mutually separated at the base.

This species has been confused with *T. brumale* Pers.: Pers. in Japan, but differs in having more coarsely verrucose basidiospores and a smaller size ratio of ostiole to spore-sac diameter than the latter species. This species has been most predominantly found in Shizuoka Pref., Japan.

*Tulostoma fulvellum* Bres. in Petri, Ann. Mycol. 2: 425, 1904. Figs. 5–8

= *Tulostoma armillatum* Bres. in Petri, Ann. Mycol. 2: 422, 1904.

Spore-sac (Figs. 5, 6) globose to subglobose, 7–10 mm wide, 8–12 mm high. Exoperidium dark brown, mixed with soil particles, falling off at the upper part, and persisting only at the base. Endoperidium yellowish-brown to brown,



**Figs. 5–8.** *Tulostoma fulvellum* (CBM-FB-36426). **5** Basidiomata. **6** Basidiomata in a natural habitat. **7** Basidiospores and capillitium (arrow) under light microscope. **8** Basidiospore under SEM. Bars **5** 3 cm; **6** 1.5 cm; **7, 8** 5  $\mu$ m

coarse, finally smooth, somewhat papyraceous when dry. Ostiole (Fig. 6) round to elliptical, fimbriate, plane, conspicuously lighter than the endoperidium. Gleba at first almost white, becoming when matured cinnamon or somewhat lighter. Stipe light to dark brown, cylindrical, 30–60  $\times$  3–5 mm, fibrillose, with appressed squamose-rugose scales, with conspicuous basal mycelial bulb at the base. Basidiospores pyriform or tear-shaped (Figs. 7, 8), smooth, with a bottle-collar-like apiculus, brown, 2.4–3.6  $\mu$ m (mean  $\pm$  SD = 2.7  $\pm$  0.2  $\mu$ m,  $n$  = 40)  $\times$  3.6–4.8 (4.4  $\pm$  0.3  $\mu$ m) excluding apiculus. Basidia not observed. Capillitia (Fig. 7) hyaline to somewhat ochraceous, branched, septate, thick-walled, lumen visible to almost solid, swollen at septa.

**Habit and habitat.** Basidiomata solitary, among moss (*Thuidium kanedae* Sak.) or in humid clayish soils in limestone rock area.

**Distributions.** Germany, France, Italy, Spain, Switzerland (Wright 1987), Japan.

**Specimens examined.** Mt. Oike-dake, Eigenji, Shiga Pref., Japan, CBM-FB-36425 (10 Jun. 2006; leg. M. Mizutani), CBM-FB-36426 (2 July 2006; leg. I. Asai).

**Japanese name:** Tanemi-Keshibouzu-take (“Tanemi” means seed-shaped, from the pyriform or tear-shaped basidiospores that resemble the seeds of apples or persimmons).

**Notes.** Wright (1987) included *T. fulvellum* in subgenus *Tulostoma* Pers., series *Tubulares* J.E. Wright, section *Poculata* Pouzar & Moravic because of the membranous exoperidium, fibrillose-fimbriate ostiole, and scutellate endoperidium. In this section, 13 species have been previously recognized. This species is segregated from the other species in having smooth and pyriform or tear-shaped basidiospores. The species is also distinguished by having hyphal squamose endoperidium and long remaining exoperidium on the spore-sac. Morphological characters of the Japanese specimens examined are in good agreement with the previous descriptions of *T. fulvellum* (Wright 1987; Calonge 1998). This species has been collected from clayish-sandy soils in Europe (Wright 1987), but in Japan it has been found on limestone rock covered with a noncalciphilous moss (*Thuidium kanedae* Sak.). This is the first report of *Tulostoma* collected not only in a limestone rock area but among moss.

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