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***Glomus mume* and *Kuklospora spinosa*: two new species of *Glomeromycota* from China**

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ABSTRACT — Two new arbuscular mycorrhizal fungal species, *Glomus mume* (*Glomerales*) and *Kuklospora spinosa* (*Diversisporales*), were isolated from rhizosphere soil of *Prunus mume* in China. *Glomus mume* resembles *G. taiwanense*, but differs by its spore walls swelling to a globose to subglobose structure in or near the middle of the spore apex. *Kuklospora spinosa* resembles *K. colombiana* but differs by the fine spines covering the middle-layer of the outer spore wall.

KEY WORDS — morphotaxonomy, Guizhou, Szechwan, HMAS

Introduction

During a survey of arbuscular mycorrhizal fungi associated with *Prunus mume* (Siebold) Siebold & Zucc. (*Rosaceae*) in China, spores of an undescribed species of *Glomus* Tul. & C. Tul. were found in the soil samples collected from the Maolan National Nature Reserve (25°14'–25°18'N 107°56'–108°10'E) of subtropical woodland in southeast Guizhou province. A second undescribed species, representing *Kuklospora* Oehl & Sieverd., was found in the soil samples collected from the brushy mountain of Muli county (27°58'N 101°15'E) in Szechwan province. The two arbuscular mycorrhizal fungi are described herein as *Glomus mume* and *Kuklospora spinosa*, based on spore morphology.

Materials & methods

Soils were collected from the rhizosphere of *Prunus mume*, from 5–20 cm soil depth. The soil samples of ca. 1000 g were placed in sterilized cotton-cloth bags, labeled, and

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air-dried in shade. Then they were cleaned from plant debris, sieved with a 2 mm sieve, stored at 4°C, until processed.

Spores were isolated according to Gerdemann & Nicolson (1963) with the wet sieving and decanting method as modified by Daniels & Skipper (1982). Arbuscular mycorrhizal fungal spores were identified following the descriptions of Schenck & Pérez (1988), Morton & Redecker (2001), and more recent species descriptions of *Glomeromycota*. We follow the classification proposed and summarized by Oehl et al (2011). Colors were referred to <http://invam.caf.wvu.edu/otherinfo/articles/colorchart.jpg>, the INVAM color chart. Specimens were deposited at the Herbarium Mycologicum Academiae Sinicae (HMAS) in Beijing.

Taxonomy

Glomus mume B.P. Cai, Jun Y. Chen, Q.X. Zhang & L.D. Guo, **sp. nov.** PLATE 1:A–C

FUNGAL NAME 570036

Differs from *Glomus taiwanense* by its spore walls swelling to a globose to subglobose structure, in or near the middle of the spore apex.

TYPE: China, Guizhou, Libo, Maolan National Nature Reserve, from the rhizosphere of *Prunus mume*, 17 Sep. 2005 (Holotype, HMAS143348).

ETYMOLOGY: Referring to the plant species with which this fungus was originally associated.

SPOROCARPS yellow-brown (20–20–20–0) to dark brown (0–30–40–0), globose to subglobose, 350–600 × 380–650 µm, with spores formed radially in a single, tightly packed layer around a central plexus of hyphae. Peridium absent. Spores clavate, cylindro-clavate, triangular or irregular, 90–165 × 30–50 µm, tapering to a cylindrical subtending hypha 6–12 µm. Chlamydospore wall laminate, yellow-brown (20–20–20–0) to dark brown (0–30–40–0), 1.5–4 µm thick on the side walls, swelling to a globose to subglobose structure, 13–20 × 15–25 µm, in or near the middle of the spore apex, and thickened to 3–7 µm at spore base. Spore base at hyphal attachment with a small pore, open or occluded by wall thickening. Reaction to Melzer's reagent not distinctive.

ECOLOGY — Spores of *Glomus mume* were isolated from soil sampled from the rhizosphere of *Prunus mume* growing at 700–800 m a.s.l in the karst forest area of southwest China (25°19'N 107°57'E). The chemical properties of the soil sample were: pH 6.62, organic matter 146.27 g.kg⁻¹, total N 6.5 g.kg⁻¹, organic N 0.51 g.kg⁻¹, total P 0.48 g.kg⁻¹, organic P 0.025 g.kg⁻¹, and exchangeable K 0.13 g.kg⁻¹.

Glomeralean species occurring with *G. mume* were *Claroideoglomus etunicatum* (W.N. Becker & Gerd.) C. Walker & A. Schüssler, *Funneliformis geosporus* (T.H. Nicolson & Gerd.) C. Walker & A. Schüssler, *Glomus australe* (Berk.) S.M. Berch, *G. clavispurum* (Trappe) R.T. Almeida & N.C. Schenck, *G. multicaule* Gerd. & B.K. Bakshi, *G. rubiforme* (Gerd. & Trappe) R.T. Almeida & N.C. Schenck, and *Septoglomus deserticola* (Trappe et al.) G.A. Silva et al.

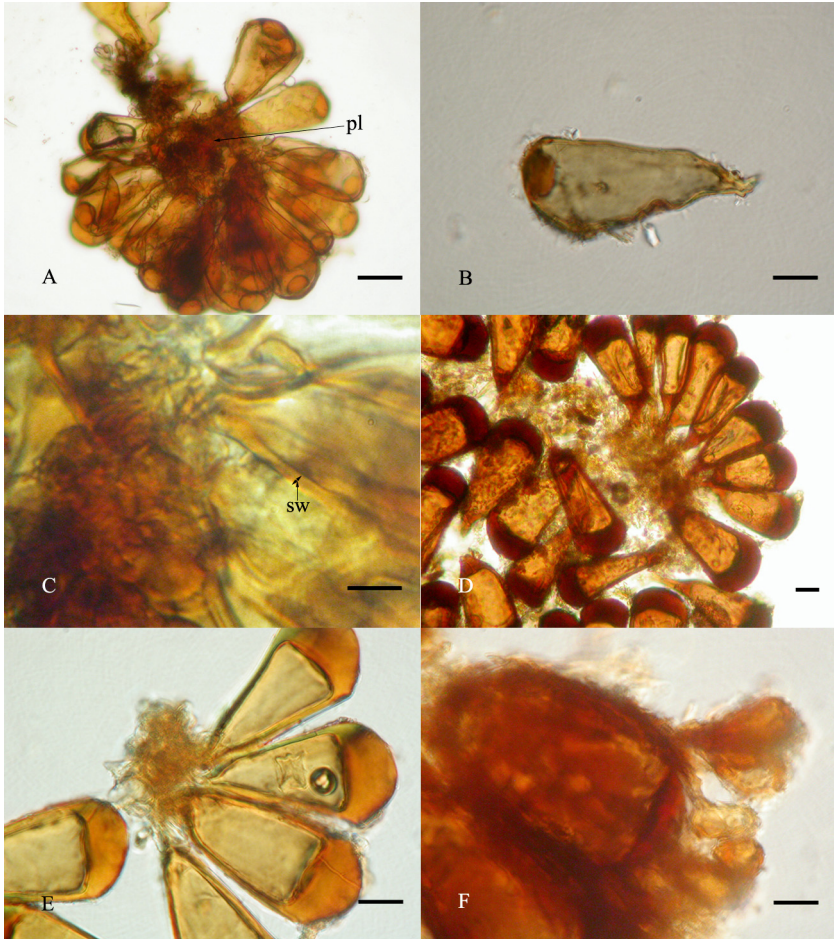


PLATE 1. *Glomus mume* and morphologically similar species. *Glomus mume*: A. Broken sporocarp showing the central hyphal plexus (pl) in Melzer's reagent; B. Spore in Melzer's reagent; C. Structure of the spore wall (sw) in Melzer's reagent. *Glomus clavisporum*: D. Portion of the sporocarp. *Glomus taiwanense*: E. Portion of the sporocarp. *Glomus liquidambaris*: F. Spores with "paraphysis-like" structures. Scale bars: A, B, D, E, F = 20 μ m; C = 10 μ m.

Kuklospora spinosa B.P. Cai, Jun Y. Chen, Q.X. Zhang & L.D. Guo sp. nov. PLATE 2

FUNGAL NAME 570037

Differs from *Kuklospora colombiana* by fine spines covering the middle-layer of the outer spore wall.

TYPE: China, Szechwan, Muli country, from the rhizosphere of *Prunus mume*, 5 Sep. 2005 (Holotype, HMAS142950).

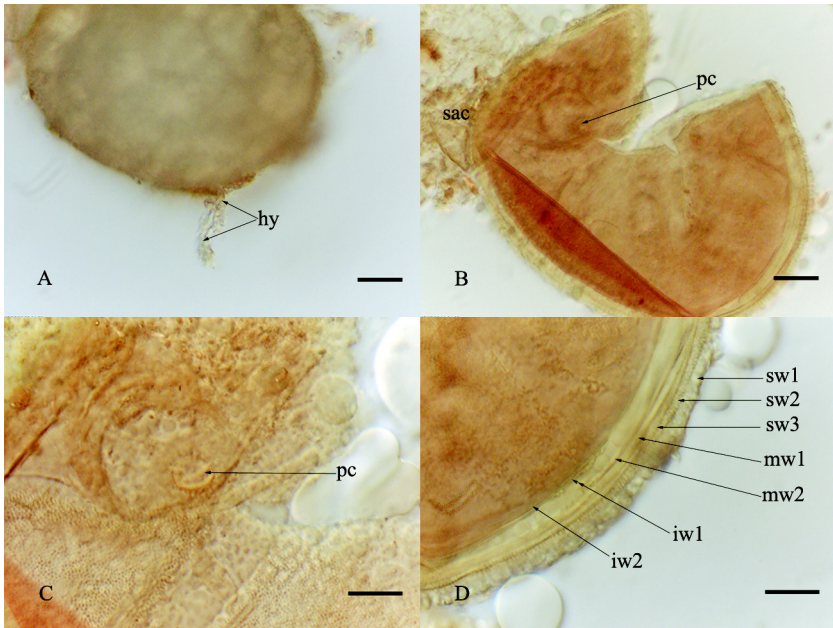


PLATE 2. *Kuklospora spinosa*. A. Spore with a distal hypha (hy) in water; B. Spore connections to the sporiferous saccule (sac) and the cicatrix proximal to saccule (PC) in Melzer's reagent; C. Cicatrix proximal to saccule (PC) in Melzer's reagent; D. Broken spore with three-layered outer wall (sw1–3), two layers of the middle wall (mw1 & mw2) and the inner wall (iw1 & iw2); iw2 stained by Melzer's reagent. Scale bars: A, B = 20 μ m; C, D = 10 μ m.

ETYMOLOGY: Latin, *spinosa*, referring to the ornamentation on the surface of the outer laminate spore wall layer (sw2).

SPOROCARPS unknown. Spores formed by inflating the hyphal stalk in some distance to a terminally or intercalary formed sporiferous saccule. Spores hyaline, subhyaline to yellowish-white (0–10–20–0), globose to subglobose, 100–250 μ m diam. Spores have three walls: an outer spore wall (sw), a middle wall (mw) and an inner wall (iw). The outer wall (sw) tri-layered (sw1, sw2 and sw3): sw1 hyaline, 1–1.5 μ m thick, evanescent, usually completely degraded or sloughed in mature spores; sw2 laminate, yellowish-white (0–10–20–0), 3–5 μ m thick, covered with fine spines, 2–3 high \times 0.5 μ m in diam, which grow into sw1; sw3 hyaline, 0.5–1 μ m thick, tightly adherent to sw2, usually separated from sw2 in Melzer's reagent, reaction to Melzer's reagent not distinctive. The middle wall (mw) hyaline, bilayered (mw1 and mw2), thin, less than 1 μ m thick, no reaction in Melzer's reagent. The inner wall (iw) bilayered (iw1 and iw2): iw1 membranous, granular, beaded, 0.5–1 μ m thick, granules sometimes scattering in crushed spores; iw2 plastic, 0.5–1 μ m thick, staining pink (0–30–20–0) to

reddish purple (0–40–60–10) in Melzer's reagent. Sporiferous saccule hyaline, globose, 90–150 µm diam, collapsing at maturity and leaving a cicatrix proximal to saccule and a distal hypha or cicatrix. Cicatrix proximal to saccule, 8–15 µm diam, distal hypha, 1.5–3 µm wide at the spore base. Wall of sporiferous saccule bilayered, 1.5–3 µm thick.

ECOLOGY — Spores of *Kuklospora spinosa* were isolated from soil sampled under *Prunus mume* growing at 2450–3100 m a.s.l. in the brushy mountain of southwest China (27°58'N 101°15'E). The chemical properties of the soil sample from which *G. mume* was isolated were: pH 6.48, organic matter 56.32 g.kg⁻¹, total N 2.5 g.kg⁻¹, organic N 0.15 g.kg⁻¹, total P 0.48 g.kg⁻¹, organic P 0.037 g.kg⁻¹, and exchangeable K 0.2 g.kg⁻¹.

Glomeralean species occurring in the same samples were *Acaulospora tuberculata* Janos & Trappe, *Claroideoglomus claroideum* (N.C. Schenck & G.S. Sm.) C. Walker & A. Schüssler, *C. luteum* (L.J. Kenn. et al.) C. Walker & A. Schüssler, *Diversispora trimurales* (Koske & Halvorson) C. Walker & A. Schüssler, *Funneliformis geosporus*, *F. mosseae* (T.H. Nicolson & Gerd.) C. Walker & A. Schüssler, *Glomus clavisporum*, and *Septoglomus deserticola*.

Discussion

Glomus mume is morphologically similar to *G. clavisporum*, *G. taiwanense* (C.G. Wu & Z.C. Chen) Y.J. Yao, *G. liquidambaris* (C.G. Wu & Z.C. Chen) Y.J. Yao, and *G. coremioides* (Berk. & Broome) D. Redecker & J.B. Morton. The sporocarpic spores of *G. mume* can be easily separated from these four species by the swelling in the middle of the spore apex (PLATE 1A, B). The spore wall of *G. clavisporum* is 1–1.5 µm thick at the sides, thickened to 17–25 µm at the apex and to 5–8 µm at the base (Wu & Chen, 1987; Almeida & Schenck, 1990; PLATE 1D). Spore wall of *G. taiwanense* is 1–1.5 µm thick at the sides, thickens to 4–25 µm at the apex and to 1–5.5 µm at the base (Wu & Chen, 1987; Almeida & Schenck, 1990; PLATE 1E). Spore wall of *G. liquidambaris* is 2–5 µm thick at the sides, thickens to 7.5–25 µm at the apex and to 6–10 µm at the base, and the prominent characteristic of this latter species is a “paraphysis-like” structure protruding from the central plexus of hyphae to the outer part of the sporocarp (Wu & Chen, 1987; Almeida & Schenck, 1990; PLATE 1F). Spore wall of *G. coremioides* is 2–2.5 µm thick, up to 4 µm thick near the spore base (Almeida & Schenck, 1990).

Kuklospora was erected by Sieverding & Oehl (2006), to accommodate two species previously described in *Entrophospora*: *K. colombiana* (Spain & N.C. Schenck) Oehl & Sieverd. and *K. kentinensis* (C.G. Wu & Y.S. Liu) Oehl & Sieverd. *Kuklospora spinosa* has a morphology typical for the genus based on the formation of spores within the stalk of the sporiferous saccule and the presence of a beaded inner wall layer (iw1). Spores of *K. spinosa* differ clearly

from those of *K. colombiana* and *K. kentinensis* in size, colour, and outer spore wall ornamentation.

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