

Unexpected cryptic species diversity of undescribed, white sequestrate *Russula* spp. ("Koishi-take") found from Japan

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Purpose: Sequestrate fungi, which include truffles and truffle-like fungi, have evolved in various mushroom-forming fungal lineages in Basidiomycota and Ascomycota. The cosmopolitan mushroom-forming genus, *Russula*, also includes multiple lineages of sequestrate fungi across the genus. However, the diversity of sequestrate *Russula* spp. in Asia is poorly known thus far. In the last decade I have collected various sequestrate *Russula* fruitbodies throughout Japan, especially a number of white, compact, truffle-like ones domestically known as "Koishi-take (pebble-mushroom)." This study aims to clarify the diversity within this sequestrate *Russula* and its allies and to infer their geological origin based on phylogenies.

Methods: Fruitbodies of the sequestrate *Russula* ("Koishi-take" and its relatives) were collected from subtropical, temperate and subarctic Fagaceae forests throughout Japan and were used for phylogenetic analyses based on nuclear rRNA gene. Phylogeographical analyses were conducted with the Mesquite software. Morphological observation was based on standardized methods.

Results and conclusions: The sequestrate *Russula* (Koishi-take) specimens formed a sister clade (= the "Lithogaster" clade) to the clade that included North American "*R. adulterina*", *Cystangium idahoensis* in *Russula* s. str. Despite the high morphological homogeneity of the "Lithogaster" clade members, they were unexpectedly diverged into five species- or subspecies-level lineages. Only one of the five lineages, which were collected in temperate-subarctic Fagaceae forests, were morphologically distinct from other lineages. The clade had the highest species-level diversity in temperate evergreen *Quercus-Castanopsis* forests in the Kyushu - Northern Ryukyu region of Japan, and the phylogeographic analysis suggested that they might have been originated there.