Penicillium koreense sp. nov., Isolated from Various Soils in Korea

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Penicillium species can be isolated from various environments, such as food, indoors, and soil. They are widespread and known to play diverse roles and functions in nature [8]. The genus is divided into two subgenera (Aspergilloides and Penicillium) and 25 sections [4]. Members of the section Lanata-Divaricata in subgenus Aspergilloides are mainly soil inhabitants, generally produce spreading colonies, and have strongly divaricate conidiophores. Many species of this section have a tolerance to heavy metals, and some species have been proven to be efficient biosorbent agents in the bioleaching of copper, zinc oxide, nickel, and lead [1, 4, 6, 11]. The taxonomy of Penicillium section Lanata-Divaricata was re-established by Houbraken and Samson [4], and a few new species were recently added by Houbraken et al. [3] and Mansouri et al. [7].

During studies on Penicillium species from Korean soils, strains belonging to the subgenus Aspergilloides were frequently isolated. Among those strains, four isolates belonging to section Lanata-Divaricata could not be assigned to any described species. Therefore, we describe these strains here as a new species based on morphological and molecular characteristics.

Four strains were isolated from soils of various regions: KACC 47721 was isolated from a bamboo field soil in Goryeong in Gyeongbuk province, KACC 47720 was isolated from a maize field soil in Yeongi in Chungnam province, KACC 47722 was isolated from a coniferous forest soil in Daejeon, and KACC 46682 was isolated from a hot pepper field soil in Hongcheon in Gangwon province in Korea. β-Tubulin [2] and rDNA-ITS [12] sequences were generated from the four strains, and the other species sequences in Penicillium sect. Lanata-Divaricata were obtained from GenBank [3, 4, 7] (Table S1). The sequences of β-tubulin and rDNA-ITS were combined, and the combined sequences were aligned with MAFFT ver. 7 [5]. The maximum likelihood (ML) tree was made using the GTRGAMMA model (1,000 bootstrap replications) in RAxML (randomized accelerated maximum likelihood) software ver. 8.0.2 [10] and is shown in Fig. 1. The four strains clustered into a group and were clearly differentiated from the other species of section Lanata-Divaricata (Fig. 1). The DNA sequences of the new species were registered in the GenBank database of NCBI.

Macroscopic descriptions of the four strains were based on 7 day growth cultures on malt extract agar (MEA), Czech yeast extract agar (CYA), creatine sucrose agar (CREA), and oatmeal agar (OA) at 25°C in darkness, and additionally on CYA incubated at 4°C, 30°C, and 37°C. For ascospore formation, the fungal isolates on OA were incubated for 2 weeks. The colony size, color, sporulation, and soluble pigment were observed. Microscopic slides were prepared with 85% lactic acid from colonies growing on the MEA, and observed with light microscopy (Zeiss Axioscope, Germany).

Macroscopic analysis showed spreading colonies on all examined agar media, and microscopic analysis showed monoverticillate conidiophores with occasionally a divaricate branch (Fig. 2). The data confirm the phylogenetic placement of the strains in section Lanata-Divaricata. The phylogenetic tree based on β-tubulin and ITS sequences showed that the strains were the most closely related to *P. raperi*. The homology between the strains and *P. raperi* CBS 281.58 was 95.1% (β-tubulin). The unidentified strains differed from *P. raperi* in having longer and thicker stipes (200–800 × 2.0–3.0 µm) and thicker phialides (8.0–11.5 × 3.0–4.0 µm), whereas *P. raperi* has shorter and thinner stipes (less than 25 µm long and 1.3–1.5 µm diam.) and thinner phialides (7.0–9.0 × 1.8–2.2 µm) [9]. Based on the above data, the four strains represent a new species in the section Lanata-Divaricata in subgenus Aspergilloides, and it is named as *Penicillium koreense* sp. nov. as it was isolated from various regions in Korea.

**Taxonomy**

*Penicillium koreense* S.B. Hong, D.H. Kim & Y.H. You, sp. nov. Fig. 2. In section Lanata-Divaricata in subgenus Aspergilloides. Mycobank (MB808759).

Etymology: N.L. neut adj. *koreense*, pertaining to Korea, from where the novel fungal species was isolated.

Colony diameters after 7 days at 25°C (in mm): CYA 32–
Phialides ampulliform with a distinct neck (8.0–TCREA, no exudate, poor growth (KACC 47721 reverse orange-brown, sporulation moderate to strong. On apices up to 3.0–5.0 µm, vesicle bearing 6–10 phialides. Phialides ampulliform with a distinct neck (8.0–11.5 × 3.0–4.0 µm). Conidia smooth or finely rough-walled, globose to broadly ellipsoidal 2.5–3.5 (2.9 ± 0.2) × 2.0–3.0 (2.5 ± 0.1).

Type strain: KACC 47721, isolated from a bamboo field soil in Goryeong, Korea. The culture is preserved in a metabolically inactive state (lyophilization and liquid nitrogen storage) in Korean Agricultural Culture Collection (coniferous forest soil).

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References