

Acaulospora koskei, a new species in Glomales from Poland

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Acaulospora koskei sp. nov. is described and illustrated. This fungus was recovered from the root zone of plants colonizing maritime sand dune soils of the Słowiński National Park, Poland. Spores of *A. koskei* are orange white to reddish orange, globose to subglobose, (80–) 183 (–340) μm diam or irregular, 140–210 \times 200–260 μm . Spore wall structure consists of six walls arranged in three groups. Its muronym is A (ELM*)B(M)C(MM). The innermost walls of groups A and C stain in Melzer's reagent. *Acaulospora koskei* formed vesicular–arbuscular mycorrhizas in pot cultures with *Sorghum sudanense*.

Examination of soil samples collected under dune plants colonizing the active deflation hollows of the Słowiński National Park, Poland, revealed spores of an undescribed species of *Acaulospora* Gerd. & Trappe.

Soils were sampled from a depth of 5–30 cm. Spores were extracted by wet sieving and decanting (Gerdemann & Nicolson, 1963). Pure pot cultures of this fungus were established (Błaszowski, 1992) with *Coleus blumei* Benth., *Sorghum sudanense* (Piper) Staph. and *Zea mays* L. as host plants. Plants were grown in a greenhouse at 18–27 °C with 12 h photoperiod (combined incandescent and cool white fluorescent light) and watered twice a week. Pot cultures were harvested after six months, spores extracted, roots stained (Phillips & Hayman, 1970) and examined for the presence of mycorrhizas. Wall structure, staining reactions and dimensions of spores and spore walls were determined from examination of at least 100 spores crushed in polyvinyl alcohol/lactic acid/glycerol, PVLG (Omar, Bolland & Heather, 1979) and a mixture of PVLG and Melzer's reagent (1:1, v/v). Wall descriptions and terminology follow those suggested by Walker (1983) and Walker, Reed & Sanders (1984). Spore colour was determined under a dissecting microscope on freshly collected specimens immersed in water. Colour names are from Kernerup & Wanscher (1983). Specimens have been preserved in PVLG and deposited in the Department of Plant Pathology (DPP), Academy of Agriculture, Szczecin, Poland, and in the herbarium at Kew (K). Spelling of scientific names follows Walker & Trappe (1993). Classification is that of Morton & Benny (1990).

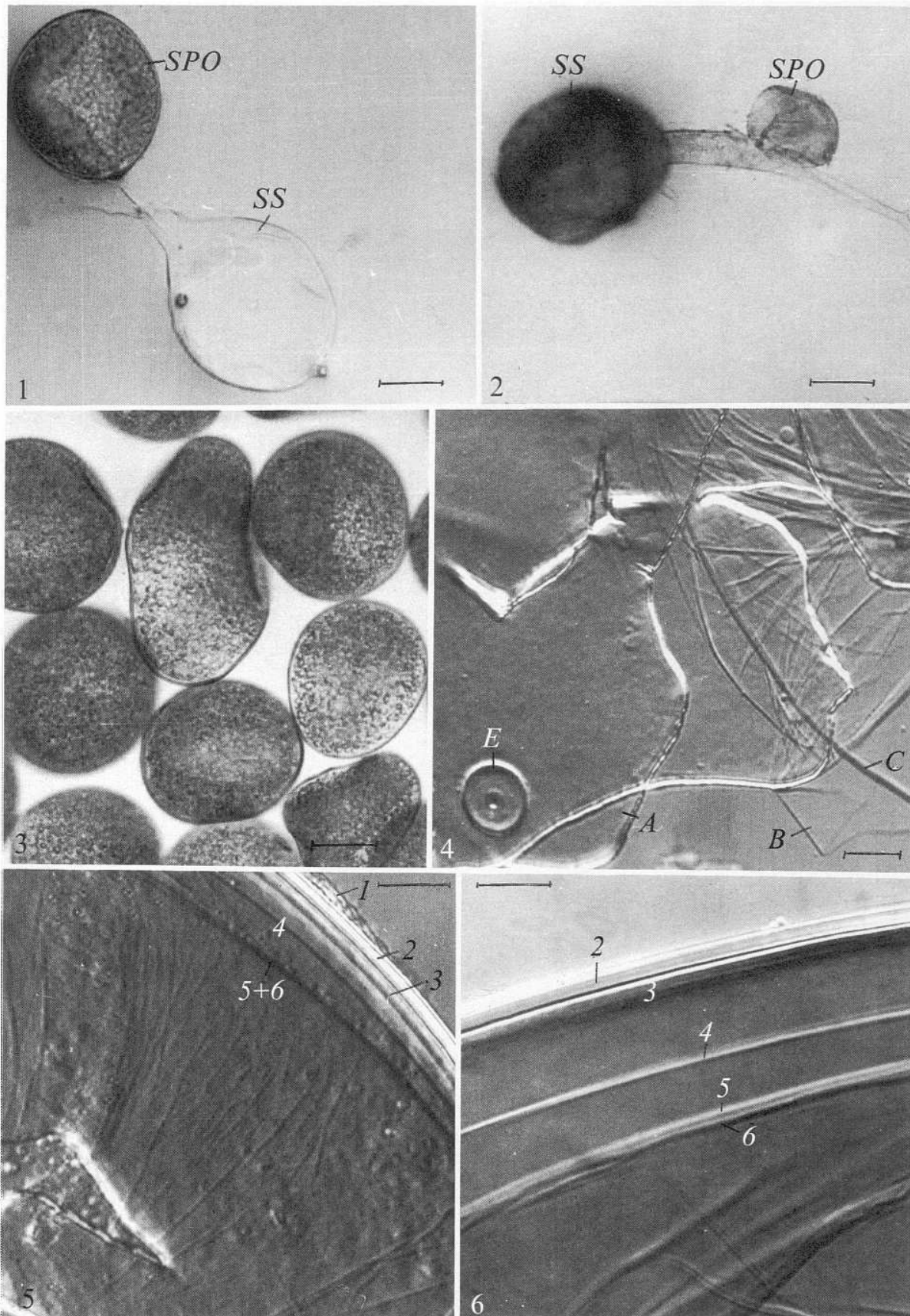
Acaulospora koskei Błaszowski, sp. nov. (Figs 1–9)

Sporae singulare in solo efformatae, lateraliter gestae ad collum sacculi sporangiferi. Sacculus sporangifer hyalinus vel pallide luteus, globosus vel subglobosus, 75–320 μm diam.; collum 38–110 μm longum, attenuatum ab 30–45 μm diam. ad sacculi sporangiferi ad 25–30 μm diam. ad sporam. Sporae aurantiaco-albae vel rubricoso-

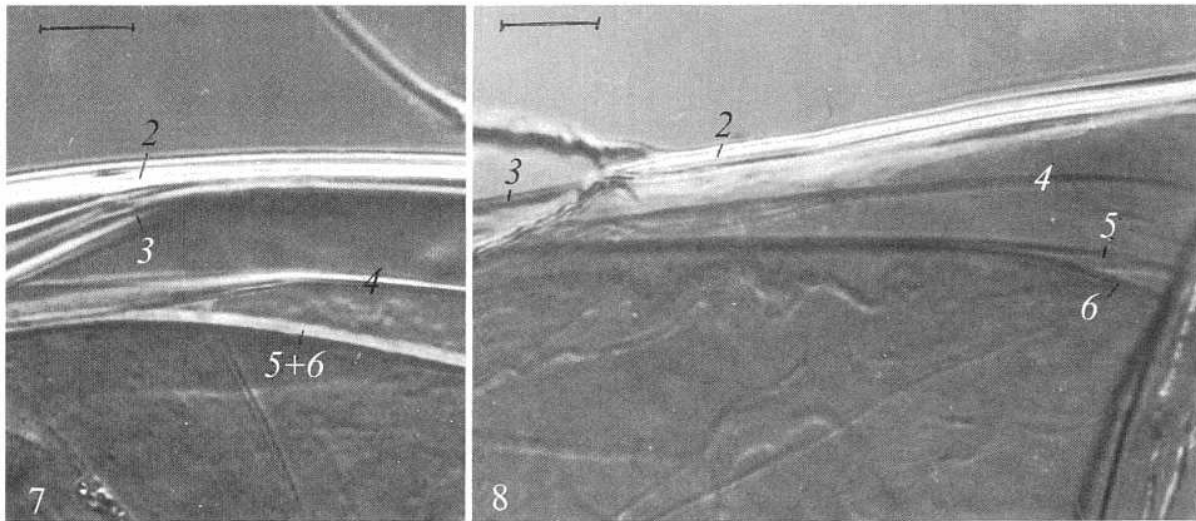
aurantiicae, globosae vel subglobosae, (80–) 183 (–340) μm diam., aliquando irregulare, 140–210 \times 200–260 μm , ad sacculi per subcollum, ca 0.5–1 μm in altitudinem affixae, abiens lacuna 17.5–35 μm diam. Tunica sporae e stratis sex in turmis tribus. Turma externa e stratis tribus (strata 1–3); uno caduco, hyalino, ca 0.5 μm crasso; duobus laminato, aurantiaco-albo vel rubricoso-aurantiaco, (1.2–) 2.3 (–3.2) μm crasso; tribus membranaceo, hyalino, (0.7–) 1.2 (–1.7) μm crasso, in solutione Melzeri rubricoso-aurantiaco. Turma media e strato uno (stratum 4), membranaceo, hyalino, (0.5–) 0.8 (–1) μm crasso. Turma interna e stratis duobus (strata 5, 6); quinque membranaceo, hyalino, (0.7–) 1.1 (–1.2) μm crasso; sex membranaceo, hyalino, (0.5–) 0.8 (–1) μm crasso, in solutione Melzeri roseo. Formans vesicular–arbusculares mycorrhizae.

Holotypus: Poland, Słowiński National Park, beneath *Ammophila arenaria* Link, 10 Oct. 1991, J. Błaszowski, DPP 1941.

Sporocarpis unknown. Spores formed singly in the soil; laterally on the neck of a sporiferous saccule (Figs 1, 2); orange white (5A2) when young to reddish orange (7A8) when mature; globose to subglobose; (80–) 183 (–340) μm diam.; sometimes irregular (Fig. 3), 140–210 \times 200–260 μm , attached to the saccule by a small collar (Fig. 4), ca 0.5–1 μm high, surrounding a pore, 17.5–35 μm diam. Spore wall structure (Figs 4–9) of six walls (1–6) in three groups (A, B, C). Group A consisting of three walls (walls 1–3). Wall 1 evanescent, hyaline, ca 0.5 μm thick before disintegration, closely attached to wall 2. Wall 2 laminated, smooth, orange white (5A2) to reddish orange (7A8), (1.2–) 2.3 (–3.2) μm thick. Wall 3 membranous, hyaline, (0.7–) 1.2 (–1.7) μm thick, usually tightly adherent to wall 2, staining reddish orange (7B8) in Melzer's reagent. Group B of a hyaline, (0.5–) 0.8 (–1) μm thick, membranous wall (wall 4). Group C consisting of two smooth, hyaline adherent membranous walls (walls 5, 6). Wall 5 (0.7–) 1.1 (–1.2) μm thick. Wall 6 (0.5–) 0.8 (–1) μm thick, reacting to become pastel pink (11A4) in Melzer's reagent. Spore contents of hyaline oil droplets. Sporiferous saccule (Figs 1, 2) hyaline to light yellow (3A5); globose to subglobose; 75–320 μm diam.; neck 38–110 μm long, tapering from



Figs 1–6. *Acaulospora koskei*. **1.** Intact spore (SPO) with sporiferous saccule (SS), bright-field microscopy (BFM). Bar, 50 μ m. **2.** Sporiferous saccule (SS) with developing spore (SPO), BFM. Bar, 50 μ m. **3.** Intact spores, BFM. Bar, 50 μ m. **4.** Crushed spore in PVLG showing wall groups A, B and C; elevated collar (E) surrounding a pore is visible, differential interference contrast (DIC). Bar, 25 μ m. **5** and **6.** Wall structure of spores crushed in PVLG, DIC; numbers indicate spore wall arrangement (see Fig. 9). Bars, 10 μ m.



Figs 7 and 8. *Acaulospora koskei*. Numbers indicate spore wall arrangement (see Fig. 9). 7. Crushed spore in PVLG, DIC. Bar, 10 μ m. 8. Crushed spore in Melzer's reagent, DIC. Bar, 10 μ m.

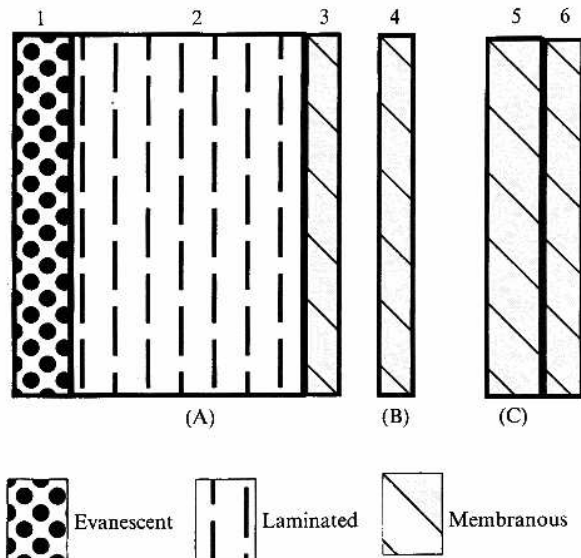


Fig. 9. Murograph of the wall structure of *Acaulospora koskei* (after Walker 1983). Arabic numerals indicate each wall in order from outer to inner wall; letters indicate wall groups.

30–45 μ m diam. at the saccule to 25–30 μ m diam. at the point of spore attachment. Saccule wall of a hyaline, smooth, 1.8–3 μ m thick layer. Saccule collapsing at maturity and usually becoming detached in mature spores.

Specimens examined: holotype: Poland, Slowiński National Park, under *A. arenaria*, 10 Oct. 1991, J. Błaszowski, DPP 1941; isotypes: J. Błaszowski, DPP 1942–1950 and two slides at K.

Other materials examined: all from the Slowiński National Park, collected by J. Błaszowski on 10 Oct. 1991 under: *Agrostis stolonifera* L., DPP 1951–1958; *Carex arenaria* L., DPP 1968, 1969; *Corynephorus canescens* (L.) P. B., DPP 1970; *Juncus articulatus* L., DPP 1966, 1967; *J. balticus* Willd., DPP 1959–1961; *Linaria odora* Chavan, DPP 1962–1965.

Etymology: in honour of Dr R. E. Koske, University of Rhode Island,

U.S.A., in recognition of his contribution to the study of arbuscular mycorrhizal fungi.

Distribution and habitat: *Acaulospora koskei* was found in 12 of the more than 500 soil samples examined from 143 localities in Poland. This species was associated only with dune plants colonizing the humid active deflation hollows of the Slowiński National Park. However, it was not found in dry sites adjacent to the hollows. Spores of *A. koskei* were found beneath *A. stolonifera*, *A. arenaria*, *C. arenaria*, *C. canescens*, *J. articulatus*, *J. balticus* and *L. odora*. The fungi accompanying this species were an undescribed *Acaulospora* sp., *Glomus aggregatum* N. C. Schenck & Smith emend. Koske, *G. constrictum* Trappe, *G. etunicatum* Becker & Gerd., *G. pustulatum* Koske et al., an undescribed *Glomus* sp., *Scutellospora armeniaca* Błasz., and *S. dipurpurea* J. B. Morton & Koske. The chemical properties of the soils in which *A. koskei* occurred were: pH, 5.8–7; NO₃ (mg/l), 19–81; P, 4–14; K, 3–20; Mg, 11–40; Na, 3–21; Cl, 13–25; KCl, 0.1–0.7; Corg (%), 0.1–1.2 (Piotrowska, 1991).

Mycorrhizal associations: *Acaulospora koskei* formed vesicular–arbuscular mycorrhizas in pot culture with *S. sudanense*. Attempts to form mycorrhizas in pot culture with *C. blumei* and *Z. mays* were unsuccessful. The fungus was associated in the field, but was not proven mycorrhizal, with *A. stolonifera*, *A. arenaria* and *J. articulatus*.

Most field-collected spores of *A. koskei* lacked the sporiferous saccule. However, presence in spores of a small collar surrounding a pore confirm their membership of the genus *Acaulospora*.

The evanescent wall 1 is very thin and rarely occurs in spores recovered from the dune soils investigated. Examination of both field- and pot-collected spores revealed wall 1 to be the remnant of the wall of the sporiferous saccule neck. The laminae of wall 2 are very thin and tightly adherent to each other. Therefore, this wall may be mistakenly considered a unit wall. The use of Nomarski differential interference contrast optics is helpful in resolving the laminae of this wall. The membranous wall 3 may be tightly adherent to wall 2 and is poorly visible in unstained spores lightly crushed in PVLG. Vigorous spore crushing usually separates walls 2 and 3.

However, the staining reaction of wall 3 in Melzer's reagent helps to reveal its presence. Wall 4 is a typical membranous wall. The membranous walls 5 and 6 are smooth and easily separated in lightly crushed spores. The recognition of the innermost wall 6 is significantly facilitated by its staining reaction in Melzer's reagent.

Under a dissecting microscope, spores of *A. koskei* most resemble in size, colour and shape those of *A. laevis* Gerd. & Trappe and *A. capsicula* Blaszk. Examination of the attachment of spores to the sporiferous saccule readily separates these species. *A. laevis* forms sessile spores, whereas those of *A. capsicula* are attached to the saccule neck by a raised collar (Blaszkowski, 1990; Gerdemann & Trappe, 1974). Spores of *A. koskei* have however, a much lower collar than those of *A. capsicula*.

Species of *Acaulospora* forming smooth, coloured spores of a wall structure similar to that of *A. koskei* are *A. capsicula*, *A. longula* Spain & N. C. Schenck, *A. mellea* Spain & N. C. Schenck, *A. morrowiae* Spain & N. C. Schenck, and *A. thomii* Blaszk. (Blaszkowski, 1988, 1990; Schenck, Spain & Howeler, 1984). Spores of these species have three and two walls in the outermost wall group and the innermost wall group, respectively. Presence of the innermost amorphous wall in spores of *A. capsicula*, *A. morrowiae*, and *A. thomii* (Blaszkowski, 1990; Morton, 1986) readily distinguishes them from *A. koskei* spores which have an innermost membranous wall. *Acaulospora longula* produces 5-walled spores lacking the membranous wall 4 of *A. koskei*. Spores of *A. mellea* have three inner membranous walls similar in position to those of *A. koskei*. However, the penultimate wall in the former species is beaded (vs. smooth in *A. koskei*). In addition, spores of *A. longula*, *A. mellea*, and *A. morrowiae* are smaller.

Acaulospora gedanensis Blaszk. produces yellow spores with two smooth adherent membranous walls in the innermost wall group C (Blaszkowski, 1988). However, the outer wall group A in this species consists of an evanescent wall adherent to a laminated wall. A typical unit wall forms wall group B. None of the walls react in Melzer's reagent and spores are much smaller.

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