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Polish Glomales

X. *Acaulospora dilatata* and *Scutellospora dipurpurascens*

Janusz Błaszkowski

Department of Plant Pathology, Academy of Agriculture, Słowackiego 17, PL-71434 Szczecin, Poland

Abstract. Spores of *Acaulospora dilatata* and *Scutellospora dipurpurascens* found in Poland are described and illustrated and their occurrence and distribution are characterized and mapped. Spores of *Acaulospora dilatata* from Poland do not differ from those originally described in the United States of America. The germination shield found in a number of spores is described and illustrated, and compared with that occurring in members of the genus *Scutellospora. Acaulospora dilatata* was found in five of the 303 soil samples taken from around the roots of *Ammophila arenaria* colonizing maritime sand dunes of the Słowinski National Park. Polish specimens of *S. dipurpurascens* are similar in size, wall structure, and reaction in Melzer's reagent to those described from the type localized in the United States of America. However, some spores from Poland have a thicker wall, greater sporogenous cells, and are somewhat darker coloured. They were recovered from 34 soils sampled from forests, gardens, sand dunes, and both cultivated and uncultivated soils. *S. dipurpurascens* was commonly associated with different plants of the Hel Peninsula and occurred regularly among the roots of *Ammophila arenaria* growing in the Słowinski National Park. Both species were found for the first time in Poland and are probably new to Europe.

Key words: Glomales – *Acaulospora* – *Scutellospora* – Taxonomy – Poland

Introduction

Morton (1986) described *Acaulospora dilatata* as forming small and deep yellow spores ornamented with puncticulate pits. The spores have a five-walled structure, in which the innermost wall is elastic and amorphous in lactophenol-based mountants. *Acaulospora dilatata* was originally recovered from around the roots of *Antropogon virginicus* L., *Danthonia spicata* Beaur., *Festuca arundinacea* Schreb., and *F. rubra* L. growing in low pH and high alumunium soils at two sites in West Virginia.

According to Morton and Benny (1990), *Scutellospora dipurpurascens* Morton & Koske forms brightly coloured, 5-walled spores, of which the two innermost walls stain dextrinoid to dark purple in Melzer's reagent. The staining reaction of the penultimate coriaceous wall was discovered for the first time among *Scutellospora* species and was considered diagnostic. The innermost wall of this species is also amorphous. *S. dipurpurascens* was found in the rhizosphere of *F. arundinacea* in several unmanaged pastures and on a partially reclaimed coal strip-mine site in West Virginia.

Examination of soil samples taken from under plants growing in different localities in Poland revealed spores similar to those of *Acaulospora dilatata* and *S. dipurpurascens.* However, in some collections, spores of the latter fungus differ somewhat from those discovered in the United States of America. Both species were only previously known from the localities listed by Morton (1986) and Morton and Koske (1988). Therefore, the aim of the work described in this paper was to characterize morphological features of collected specimens and to show their distribution in Poland.

Materials and methods

Soils from each site (Table 1, Fig. 19) were sampled at a depth of 5–30 cm. Spores were collected by wet sieving and decanting (Gerdemann and Nicolson 1963). Morphological features of spores were examined on specimens mounted in polyvinyl alcohol/lactic acid/glycerol (PVLG) (Koske and Tessier 1983). The wall terminology used in this paper follows that proposed by Walker (1983, 1986) and Morton (1986). The phrase "sporiferous saccule" was borrowed from Walker et al. (1984), and the terms "sprogenous cell" and "sporophore" are according to Spain et al. (1989). Spore colour was examined under a dissecting microscope on fresh specimens immersed in water. Colours were determined according to the Methuen "Handbook of colour" (Kornerup and Wanscher 1983). The spelling of scientific names is according to Almeida (1989) and Walker (1991), and the classification is that

Correspondence to: J. Błaszkowski

Table 1. Frequency of occurrence of *Acaulospora dilatata* and *Scutellospora dipurpurascens* in Poland and chemical properties of soil samples from which these species were isolated. Values in parentheses refer to *Acaulospora dilatata*

Plant species	Locality and its number (see Fig. 19)	Date of collection	No. of spores per 100 g dry soil	Chemical properties					
				pH	NO_3	P	K	Mg	Cl
						($mg\ l^{-1}$)			
Ammophila arenaria	Chałupy, 236	7. 07. 89	6	4.6	12	9	5	13	18
	Łeba, 260–264,		4(4), 10, 9(10), 82(20)	6.2–	8–	6–	7–	11–	24–
	291, 293	1. 08. 89	25, 14(3), 3(3)	6.9	14	11	10	19	26
Artemisia campestris	Władysławowo, 255	27. 07. 89	4	5.7	10	7	10	8	16
Calluna vulgaris	Chałupy, 198	28. 09. 88	7	5.2	85	24	68	85	40
Crataegus monogyna	Jastrzebia Góra, 114	30. 10. 87	1	4.2	56	19	24	24	30
	Kuźnica, 117	20. 08. 87	1	5.0	42	15	31	43	22
	Chałupy, 254	27. 08. 89	3	5.8	70	23	54	45	35
Festuca arundinacea	Chałupy, 201	28. 08. 88	6	4.9	160	22	80	270	120
Helictotrichon pubescens	Chałupy, 163	4. 06. 88	243	6.2	24	20	22	24	30
Holcus lanatus	Chałupy, 162	4. 06. 88	1	6.5	240	26	138	362	78
Juniperus communis	Kampinos National Park, 98	26. 07. 86	22	5.1	10	14	9	2	13
Molinia cerulea	Miasteczko Śląskie, 303	9. 09. 89	256	5.4	45	18	36	20	16
Rosa canina	Mrzeżyno, 128	22. 09. 87	49	4.5	60	8	26	20	23
	Chałupy, 253	26. 08. 89	6	6.0	110	27	45	40	28
Rubus idaeus	Żelistrzewo, 120	22. 08. 87	1	6.5	19	12	26	21	39
Salix triandra	Hel, 175	28. 09. 88	7	5.4	95	39	48	18	15
Thuja occidentalis	Hel, 112	20. 08. 87	45	4.7	48	15	10	24	20
	195	28. 09. 88	5	5.0	46	19	12	15	24
	247	5. 08. 89	17	6.1	59	17	22	31	18
	248	5. 08. 89	8	5.3	47	19	39	30	28
	Przelewice, 186	25. 08. 88	2	5.6	110	63	232	39	52
	246	20. 07. 89	1	5.8	125	54	247	48	31
	259	21. 09. 89	4	6.1	140	47	120	38	44
Triticum secalum	Lipki, 282	24. 07. 89	6	5.6	70	63	120	18	23
Triticum vulgare	Lipki, 206	3. 08. 88	3	5.5	70	53	102	22	24
Unknown grass	Władysławowo, 94	29. 07. 86	10	4.7	24	21	22	15	16
	Kampinos National Park, 99	26. 07. 86	75	5.1	10	14	9	2	13
	100	26. 07. 86	1	5.8	20	17	20	2	9

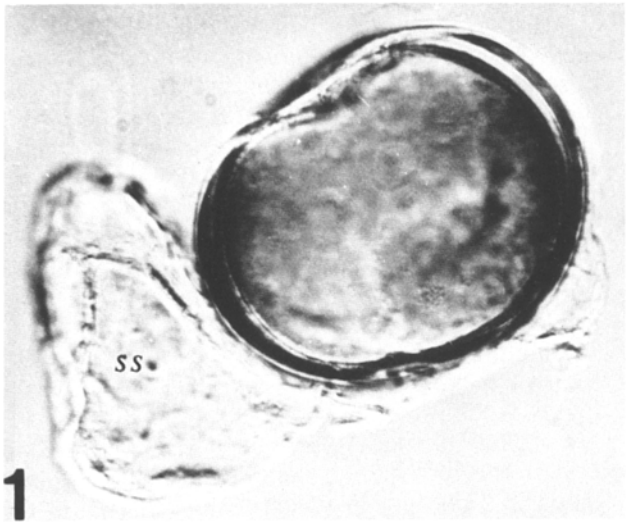
of Morton and Benny (1990). Specimens were preserved in 5% formalin and PVLG and deposited in the Department of Plant Pathology (DPP), Academy of Agriculture, Szczecin, Poland.

Results

Acaulospora dilatata Morton (Figs. 1–12, 19)

Spores borne singly in the soil, laterally on the neck of a sporiferous saccule. Spores amber yellow (4A6) to Chinese yellow (4A7); globose to subglobose; (90–) 104 (–120) μm in diameter; sometimes ovoid; 80–115 × 100–140 μm, attached to the saccule by a slightly raised collar, 0.7–2.2 μm wide × 0.5–1.5 μm long, surrounding a hole 3.4–4.9 μm in diameter. *Spore wall structure* of five walls (1–5) in three groups (A, B, C). Group A consisting of an amber yellow (4A6) to Chinese yellow (4A7), (2.9–) 3.7 (–4.7) μm thick laminated wall (wall 1), ornamented with round pits, 0.5–1.2 μm in diameter, randomly distributed and variable in number. Group B composed of two hyaline, tightly adherent unit walls (walls 2, 3), 0.8–1.2 and 0.5–0.7 μm thick, respectively. Group C consisting of two hyaline adherent walls (walls 4, 5). Wall 5 membranous, beaded, (0.5–) 0.7 (–1.0) μm thick. Wall 6 amorhpous, 5–8 μm thick in PVLG, (1.5–) 2.0 (–2.5) μm thick and beetroot purple (13D8) in Melzer's reagent. Spores contain hyaline oil droplets. *Sporiferous saccule* hyaline to light yellow (3A8); globose to subglobose; 80–110 μm in diameter; neck 50–90 μm long, tapering from 12–16 μm in diameter at the saccule to 8–11 μm in diameter at the point of spore attachment. Saccule collapsing at maturity and usually detached among mature spores. *Germination shield* hyaline to pale yellow (3A3); circular or somewaht elliptic; 60.0–62.5 × 65.0–70.0 μm; formed by a centrifugally rolled hypha, (7.1–) 9.5 (–12.0) μm in diameter, sometimes broadened up to 20.8 μm in diameter at the end; circular germ tube ini-

Fig. 1–6. *Acaulospora dilatata. Numbers* indicate spore wall arrangement
Fig. 1. Intact spore with sporiferous saccule (*SS*), Nomarski interference contrast (NIC). ×442
Fig. 2. Spore surface with small pits (*arrows*), NIC. ×442
Fig. 3. Crushed spore in polyvinyl alcohol/lactic acid/glycerol showing wall groups A, B, and C, NIC. ×442
Fig. 4. Plastic nature of wall 6, NIC. ×442
Fig. 5. Inner walls of a crushed spore, NIC. ×923
Fig. 6. Coiled hypha of germination shield ended with a distention containing a germ hole (*h*) in a plan view, NIC. ×923



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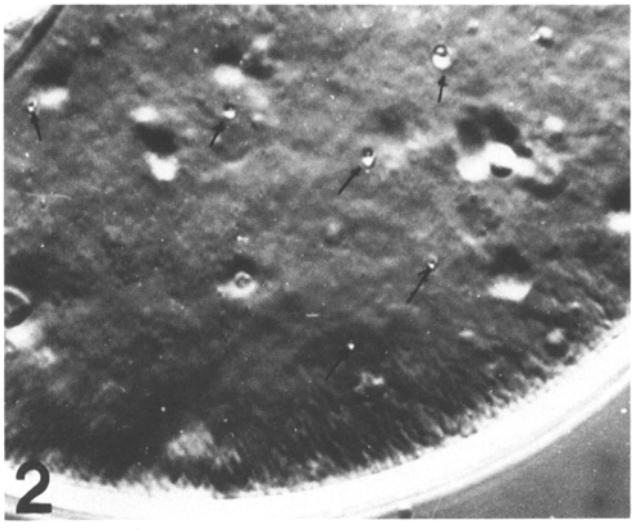

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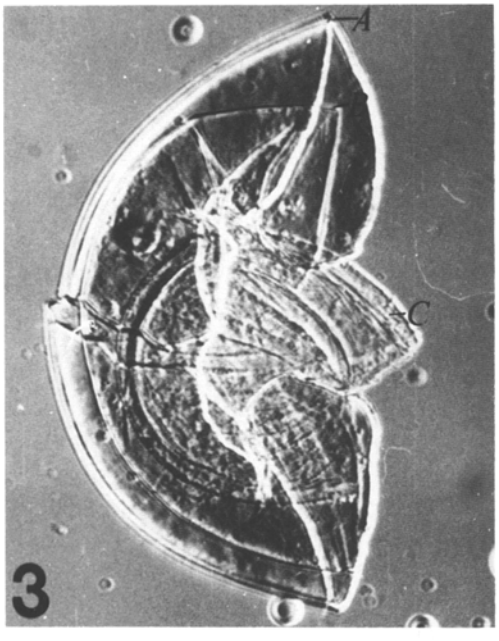

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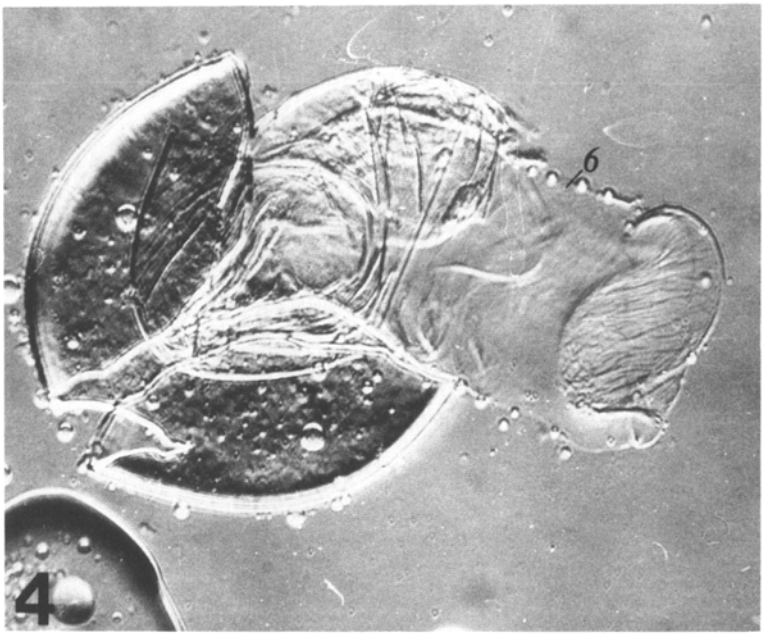

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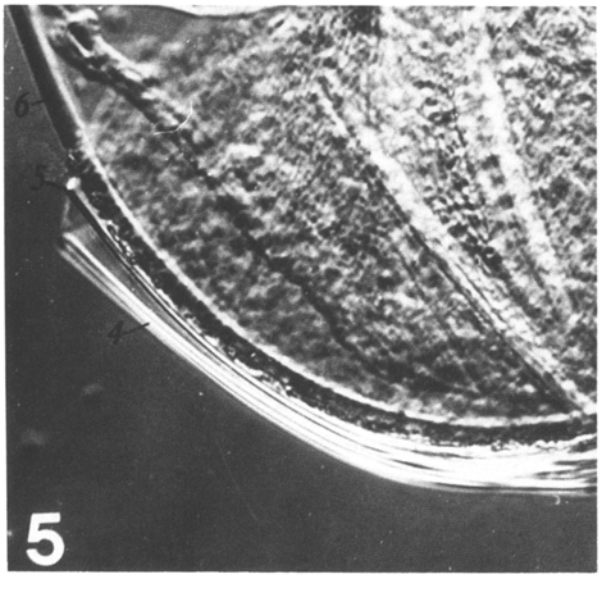

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tial, (2.1–) 2.9 (–3.4) μm in diameter present at some distance from the hyphal end; germination shield positioned between the semi-rigid unit wall 4 and the beaded membranous wall 5.

Spores occurred in five of the 303 soil samples examined. Found only among the roots of *Ammophila arenaria* colonizing maritime sand dunes of the Słowinski National Park. Spore densities per 100 g dry soil ranged from 4 to 20 (mean 80). The proportions of spores in total populations recovered ranged from 7.5 to 45.5% (mean 23.3%). Isolated together with 2–5 other species of arbuscular mycorrhizal fungi, including *Acaulospora lacunosa* Morton, *Gigaspora gigantea* (Nicol. & Gerd.) Gerd. & Trappe, *Glomus constrictum* Trappe, *Glomus etunicatum* Becker & Gerd., *Glomus microaggregatum* Koske et al. (occurring inside *S. dipurpurascens* spores), *S. dipurpurascens,* and an unknown *Scutellospora* sp. The chemical properties of soil samples from which *Acaulospora dilatata* was recovered and other data are listed in Table 1 under the locality numbers 260, 262, 263, 291, and 293. Details of the collections examined are given in Table 1; specimens were deposited as: 1567–1595 (DPP).

Spores of *Acaulospora dilatata* may be readily distinguished from other species of the genus by their spore wall structure. Wall 1 is laminated and always possesses small pits (Fig. 2), which are usually difficult to detect under a light microscope. Their number varies from few to many per spore, depending on the fungal isolate. The pits usually are as deep as the wall thickness and resemble narrow canals connecting the surface of the spore with the inside. They are best seen at the spore margin. Thus, the pits sometimes resemble those formed by mycoparasites, but are more regular in plan view and are not associated with so-called "lignituber-like ingrowths" described from *Glomus* and *Sclerocystis* species (Koske 1985).

Other species of the genus *Acaulospora* forming pitted spores are *A. cavernata* Błaszk. (Błaszkowski 1989), *A. foveata* Trappe & Janos (Janos and Trappe 1982), *A. lacunosa* Morton (Morton 1986), *A. paulinae* Błaszk. (Błaszkowski 1988), and *A. scrobiculata* Trappe (Trappe 1977). However, the pits in these other species are more numerous and more regularly distributed. In addition, some pits in *A. lacunosa* spores have raised cone-shaped edges, and spores of *A. cavernata* and *A. foveata* are darker, greater, and have a different wall structure (Błaszkowki 1989; Walker, personal communication) compared to *A. dilatata.*

The structure of the wall group B in *A. dilatata* spores is difficult to resolve and is similar to that of spores of *A. cavernata, A. lacunosa,* and *A. paulinae.* Two thin semi-rigid unit walls (Fig. 5) forming this group tightly adhere to each other and rarely separate. Thus it often appears that this group consists of a single wall. Only forcible crushing of many spores occasionally leads to separation of these walls. Wall 2 is always somewhat thicker than wall 3.

The innermost wall group of *A. dilatata* spores is also similar to that of *A. lacunosa* spores. In addition, *A. paulinae* has a beaded membranous wall adherent to an amorphous innermost wall. However, in the original description of *A. paulinae,* the innermost wall was mistakenly interpreted as a unit wall. The actual muronym of this species is A(ELo) B(UU) C(MbA).

The germination shield in spores of *A. dilatata* differs significantly in appearance, mode of development, and location from that formed by species of *Scutellospora.* The germination shield in *Scutellospora* is most often a circular to elliptic layer with a margin nicked by both shallow and deep incisions, the latter dividing the shield into several lobes, each with a germ tube initial resembling a hole. The lobes create compartments seen in a cross-sectional view. This layer may be a highly flexible membrane in some species, but in others may be brittle. According to Walker and Sanders (1986), the germination shield forms from a protrusion through a hole in an inner membranous wall plasma membrane, which then extends, and produces lobes at the end of which germ tube initials appear. However, in spores of *A. dilatata,* the shield is formed by rolled hypha (Figs. 6, 7), the beginning of which is in the centre of the shield and the end at its margin. In all examined specimens, the rolled hypha divides the germination shield into four zones. The hyphal end in a plan view may be arched or irregularly broadened. At a short distance from the hyphal end, a single circular germ tube initial is present, usually surrounded by a somewhat raised collar and a granular material on the periphery (Figs. 6, 7). The broadened hyphal end sometimes has a deep incision forming a lobe. However, no germ tube initial was observed in this lobe. The margin of the shield usually is smooth, although it may sometimes be slightly nicked by shallow incisions (Fig. 8). The hypha forming the shield is tubular and filled with a hyaline to pale yellow (3A3) granular material (Fig. 9). In a cross-sectional view, such a rolled hypha is visible as circular or elliptic compartments tightly adherent to each other (Fig. 10).

The formation of the germination shield between the semi-rigid unit wall 4 and the beaded membranous wall 5 in spores of *A. dilatata* is also unique, in that the germination shield in species of *Scutellospora* is always associated with a coriaceous or membranous inner wall (Morton and Benny 1990).

Fig. 7–12. *Acaulospora dilatata. Numbers* indicate spore wall arrangement

Fig. 7. Coiled hypha of germination shield ending with a germ hole (*h*) in aplan view, NIC. ×923

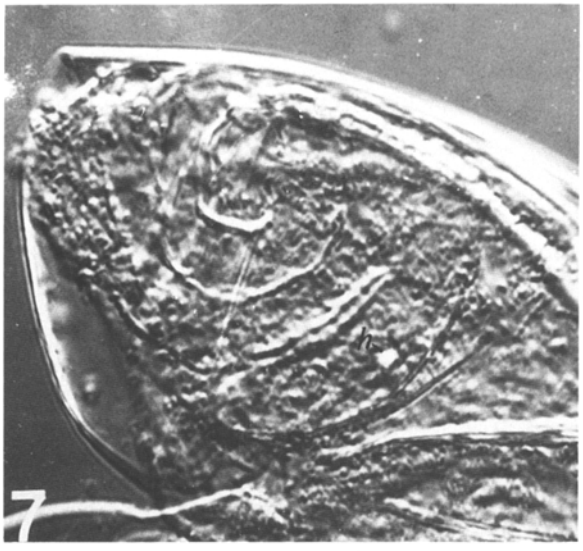
Fig. 8. Slightly nicked margin of germination shield positioned under wall 4 in wall group B, NIC. ×923

Fig. 9. Granular material pushed from the hypha of germination shield of a vigorously crushed spore, NIC. ×923

Fig. 10. Germination shield in a cross view; circular and elliptic compartments (*arrows*) between wall groups B and C are seen, NIC. ×548

Fig. 11. Partially disappeared germination shield of a germinating spore, NIC. ×923

Fig. 12. Germ tubes of the spore shown in Fig. 11, NIC. ×923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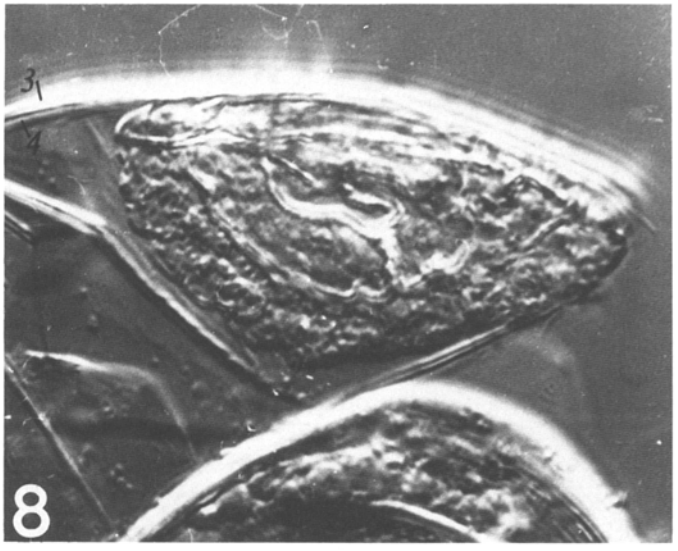
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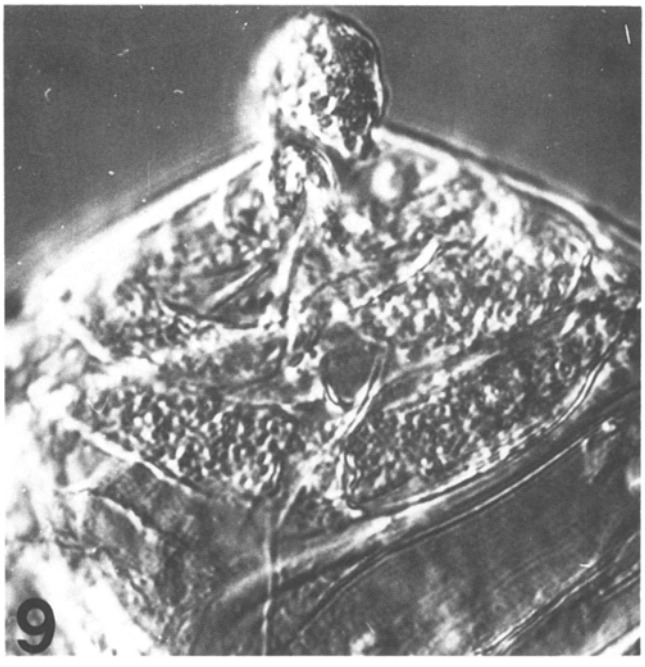
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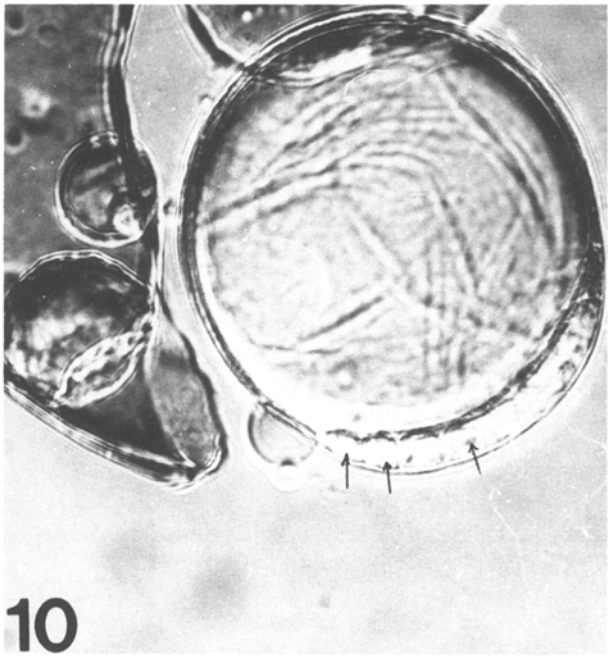
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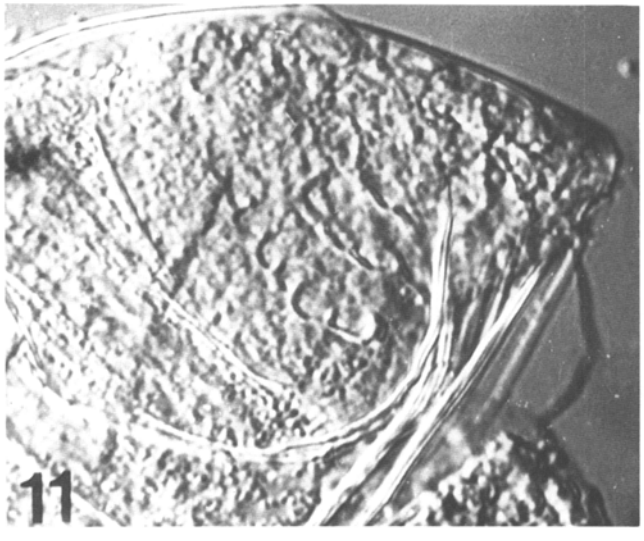
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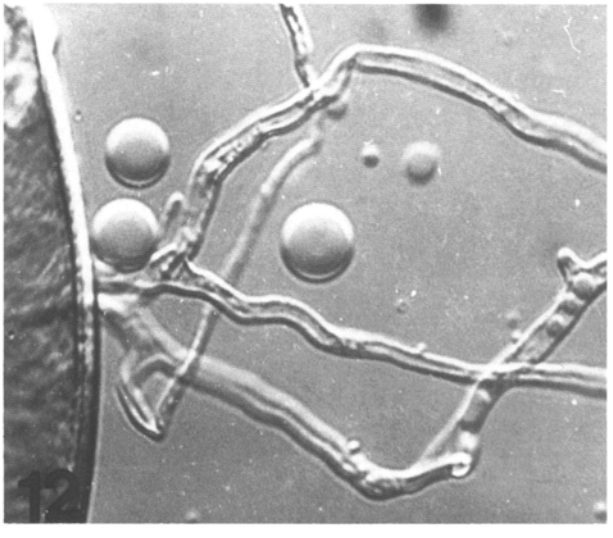
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In contrast to the germination shield formed by species of *Scutellospora,* that of *A. dilatata* gradually disappears in germinating spores (Fig. 11). In spores with extensive germ tubes, granular material is usually visible at the place where the shield occurred. Thus, the shield and its content are probably used as an energetistic material during germination and it is ephemeral.

Inner-wall compartments associated with germ tubes were first observed in *Acaulospora laevis* Gerd. & Trappe (Mosse 1970), although they were also found later in other species of this genus (Morton 1990; Morton and Benny 1990). According to Morton (1990), the germination structure in *Acaulospora* is not an outgrowth homologous with the germination shield in *Scutellospora* because of the absence of a discoid shape in plan views and the difference in location. However, the structure in *A. dilatata* is discoid before disintegration and plays a role similar to that of the germination shield in *Scutelospora,* despite the difference in the mode of development. Therefore, the term "germination shield" seems to properly characterize both the shape and role of this structure. The position of the germination shield in *Scutellospora* depends on the position of a coriaceous wall (in species having this wall) with which it is associated (Błaszkowski 1991; Morton personal communication). The association of the germination shield with the innermost semi-rigid unit wall of *A. dilatata* spores suggets functional similarity between this wall and the coriaceous wall of *Scutellospora* spores. Because of their greater thickness and rigidity, these walls probably more effectively protect the germination shield from abiotic and biotic stresses than do the thinner and more delicate membranous walls. Species with two inner semi-rigid unit walls and species with the germination shield sandwiched between two coriaceous walls are the most developmentally advanced fungi in the genera *Acaulospora* and *Scutellospora,* respectively (Morton and Benny 1990).

Scutellospora dipurpurascens Morton & Koske (Figs. 13–19)

Spores borne singly in the soil or in roots, terminally on a bulbous sporogenous cell; pastel yellow (2A4) to brownish-yellow (5A8); globose to subglobose; (160–) 214 (–260) μm in diameter; sometimes ovoid; 185–260 μm. *Spore wall structure* of five walls (1–5) in two groups (A, B). Group A consisting of three tightly adherent walls (walls 1–3). Wall 1 unit, hyaline, (0.5–) 0.8 (–1.0) μm thick, inseparable from wall 2. Wall 2 laminated, pastel yellow (2A4) to brownish-yellow (5C8), (2.9–) 7.1 (–11.0) μm thick. Wall 3 membranous, hyaline, 0.5–1.0 μm thick, separating from wall 2 in crushed spores. Group B consisting of two hyaline, closely adjacent walls (walls 4, 5). Wall 4 coriaceous, (0.7–) 2.1 (–2.9) μm thick, staining dull red (9B4) in Melzer's reagent. Wall 5 amorphous, up to 14 μm thick in PVLG, 1.5–3.0 μm thick and beetroot purple (13D8) in Melzer's reagent, separable from wall 4. *Sporogenous cell* borne terminally on a sparsely septate sporophore; ovoid to clavate; (22.5–) 47.6 (–52.6) μm broad; concolorous with spore wall 2; walls (1.1–) 5.7 (–7.5) μm thick at the spore base, thinning distally to 1.0–2.0 μm. A hyphal peg up to 57.5 μm long × 5.0–7.5 μm wide often arises from the sporogenous cell and projects towards the spore base. *Sporophore* formed of a hyaline to pale yellow (2A3–4), septate hypha, 11.5–19.5 μm in diameter; walls 0.6–0.9 μm thick; hypha simple with a single sporogenous cell. *Germination shield* hyaline; ovoid or irregular; 70–85 × 115–137 μm with deep folds partitioning 5–7 lobes with smooth margins, formed on wall 3. One to three hyaline, 2.0–7.5 μm in diameter germ tubes emerge from the germination shield. *Auxiliary cells* borne in soil in loose clusters of 2–8; hyaline to pale yellow (2A2); pyriform to irregular; 22.5–32.5 × 37.5–47.5 μm; produced on coiled hyphae, 2.5–6.5 μm in diameter, concolorous with auxiliary cells.

Spores were found in 34 soil samples, occurring in forests, gardens, sand dunes, cultivated and uncultivated soils. Commonly associated with different plants of the Hel Peninsula, including *C. vulgaris.* Regularly recovered from around the roots of *Ammophila arenaria* colonizing maritime sand dunes of the Słowinski National Park. Spore densities in 100 g dry soil were 1–256 (mean 27.9). The proportions of spores in total populations recovered were 0.3–77.4% (mean 20.9%). The numbers of associated species of other arbuscular mycorrhizal fungi ranged from 1–10. Associated species were of the genera *Acaulospora* (8 spp.), *Entrophosphora* (1 sp.), *Gigaspora* (1 sp.), *Glomus* (14 spp.), and *Scutellospora* (2 spp.). Also isolated together with zygospores of *Endogone flammicorona* Trappe & Gerd. (Endogonaceae) and chlamydospores of *Complexipes moniliformis* Walker emend. Yang & Korf (Ascomycetes) probably associated with mycorrhizae of neighbouring *Pinus sylvestris* L. The chemical properties of soil samples from which *S. dipurpurascens* was isolated are listed in Table 1.

The spores characterized in this paper are very similar to those of *S. dipurpurascens* in size, wall structure, and reaction in Melzer's reagent but differ in wall thickness, dimensions of the sporogenous cell, and somewhat in colour. The shape dimensions of auxiliary cells produced by the two fungi are also different.

The spores found in Poland have five walls organized in two groups (Figs. 14–16). *S. dipurpurascens* has a similar spore wall structure (Morton and Benny 1990), despite the fact that the outer wall group A was

Fig. 13–18. *Scutellospora dipurpurascens. Numbers* indicate spore wall arrangement

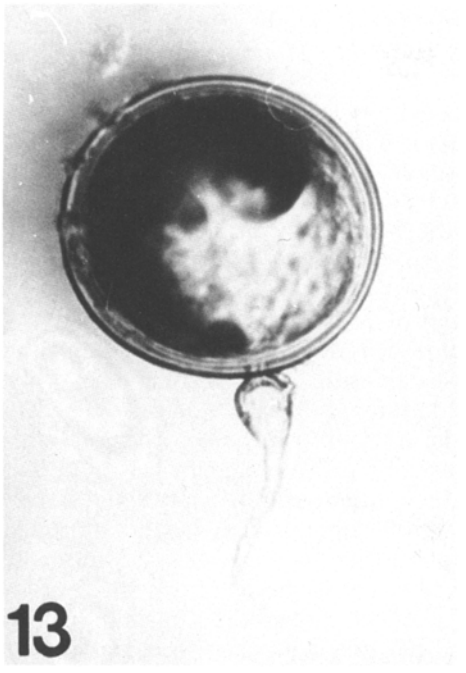
Fig. 13. Intact spore, bright-field microscopy (BFM). ×209

Fig. 14. Wall structure of a crushed spore in polyvinyl alcohol/lactic acid/glycerol, NIC. ×410

Figs. 15, 16. Wall structure of crushed spores in Melzer's reagent, BFM. ×634

Fig. 17. Fragment of sporogenous cell and walls 1–4, NIC. ×923

Fig. 18. Germination shield (*gs*), NIC. ×923



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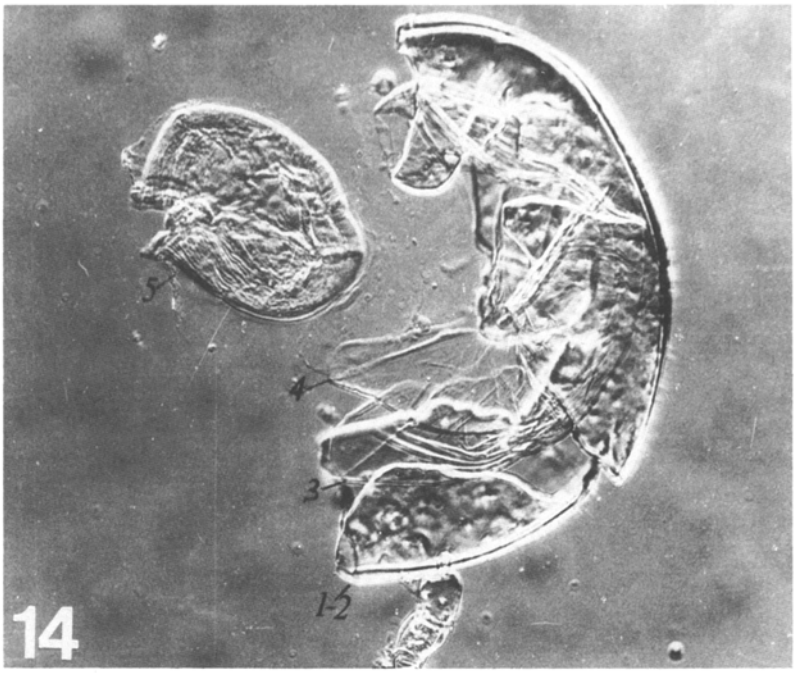

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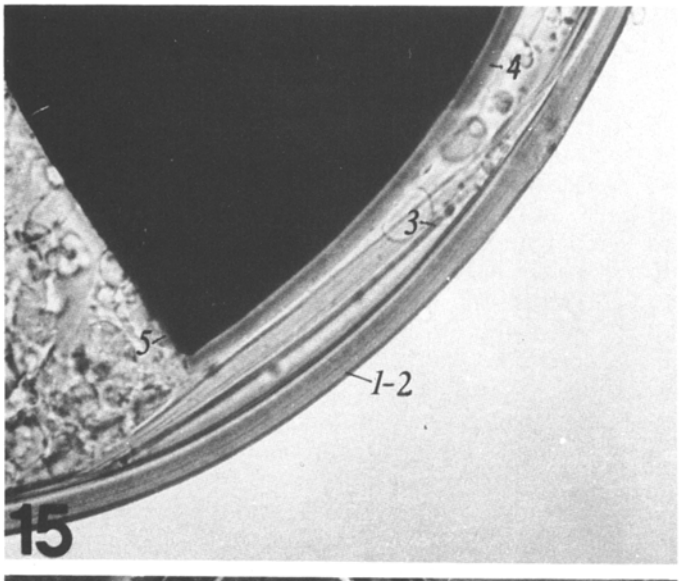

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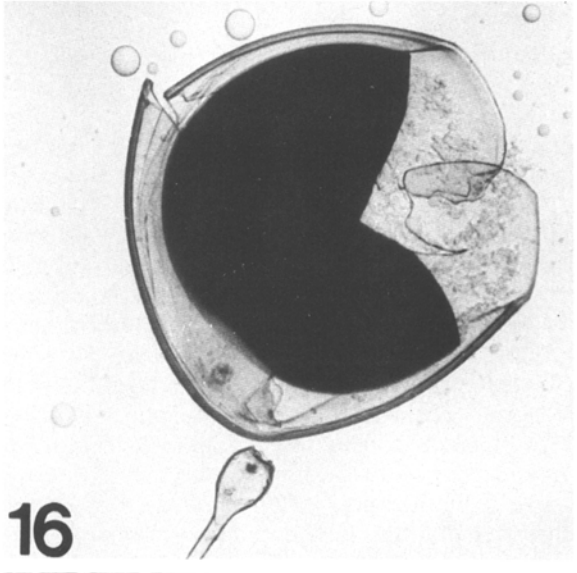
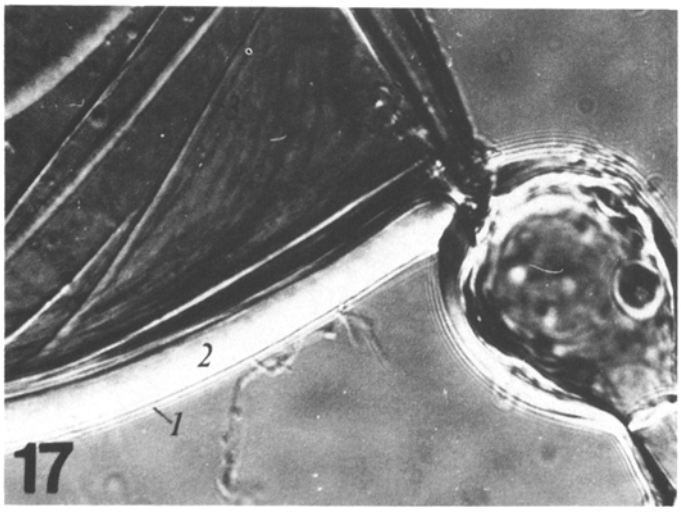


16



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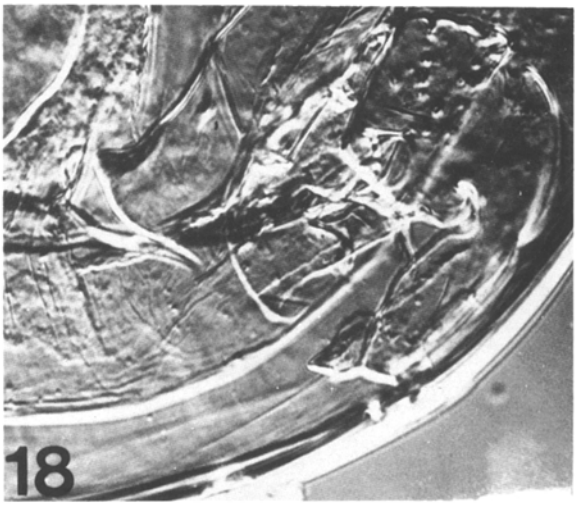

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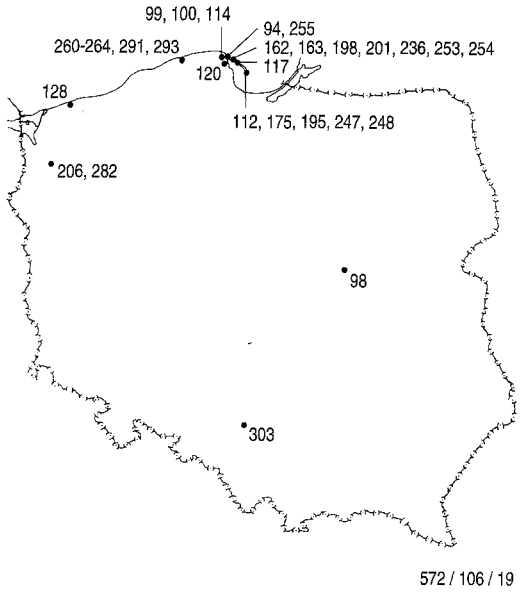

Fig. 19. Distribution of *Acaulospora dilatata* and *Scutellospora dipurpurascens* in Poland. The *numbers* represent the localities listed in Table 1

originally described as two-walled (Morton and Koske 1988). The outermost thin unit wall 1 is more obvious with Nomarski interference optics. It is probably formed by all species of *Scutellospora* and is more visible when spores germinate (Morton and Benny 1990; Mortion, personal communication). The outer walls are of similar types in collections from Poland and the United States of America. Wall 3, a membranous wall, usually tightly adheres to wall 2 and may be difficult to see in some specimens. The innermost amorphous wall is variable in thickness when spores are crushed in PVLG. The reaction in Melzer's reagent of the penultimate coriaceous wall of examined spores is also distinctive and was considered a diagnostic feature of *S. dipurpurascens* (Morton and Koske 1988). The range of spore wall thickness of specimens from Poland is much wider than that estimated for spores of *S. dipurpurascens.* In *S. dipurpurascens* spores, the laminated wall 2 is 3–5 μm thick and the coriaceous wall 4 is 1–1.5 μm thick (Morton and Koske 1988), whereas their thicknesses are 2.9–11.0 μm and 1.2–3.7 μm, respectively, in spores found by the author. Only specimens recovered from maritime sand dunes of the Słowinski National Park (Table 2) have all walls within the range of thickness given in the original description of this species.

The sporogenous cells of spores from Poland are generally larger than those of *S. dipurpurascens* (mean 47.6 μm versus 26–30 μm broad) and the wall is thicker (mean 5.7 μm versus 2–4 μm). Exceptions are specimens from the Słowinski National Park and to some extent those from Przelewice (Table 2), which possess spores with sporogenous cells of dimensions similar to those reported by Morton and Koske (1988).

S. dipurpurascens forms yellow to greenish-yellow spores, which darken to yellow-brown after storge for more than 2 months in formalin or lactophenol (Morton and Koske 1988). Fresh spores collected by the author were usually brownish-yellow. Brighter spores were more frequently found in sandy soils or maritime sand dunes. A soil sampled from around the roots of *T. occidentalis* at Hel in 1987 (no. 112) additionally contained raw umber (5F8) spores of this species. However, specimens collected from the same site in 1988 and 1989 were all brighter and, therefore, this colour was excluded from the description presented here.

S. dipurpurascens characterized by Morton and Koske (1988) produces more regularly shaped and smaller auxiliary cells than *S. dipurpurascens* found in Poland, but the cells are too variable within any given taxon to be suitable criteria for distinguishing species (Morton, personal communication).

Brightly coloured spores of *S. dipurpurascens* are comparable with those of *S. calospora* (Nicol. & Gerd.) Walker & Sanders and *S. pellucida* (Nicol. & Schenck) Walker & Sanders (Koske and Walker 1986), and those with a darker colour may resemble spores of *S. aurigloba* (Hall) Walker & Sanders (Hall 1977), *S. erythropa* (Koske & Walker) Walker & Sanders (Koske and Walker 1984), *S. tricalypta* (Herr. & Ferr.) Walker & Sanders (Ferrer and Herrera 1981), *S. arenicola* Koske & Halvorson (Koske and Halvorson 1989), and *S. scutata* Walker & Dieder. (Walker and Diederichs 1989). Although *S. pellucida, S. arenicola,* and *S. scutata* have a coriaceous wall adherent to an amorphous wall in the innermost wall group, the penultimate coriaceous wall stains in Melzer's reagent only in spores of *S. dipurpurascens.* Furthermore, all the species mentioned differ from *S. dipurpurascens* in the structure of the outermost wall group.

Table 2. Morphological characters of *Scutellospora dipurpurascens* spores from selected localities of Poland (based on 30 spores from each collections). Walls 1, 3, and 5 are similar in thickness in all collections and are, therefore, excluded from this comparison

Locality and its number (see Fig. 19)	Wall thickness (μm)		Dimensions of sporogenous cell (μm)		Spore colour
	Wall 2	Wall 4	width	wall thickness	
Hel, 195	(6.1–) 7.6 (–11.0)	(1.2–) 2.1 (–2.9)	(43.0–) 44.4 (–52.5)	(3.7–) 6.2 (–7.5)	Maize yellow (4A6)
Przelewice, 246	(2.9–) 6.6 (–10.5)	(1.5–) 2.3 (–3.7)	(22.5–) 29.0 (–34.5)	(1.1–) 3.4 (–5.1)	Pastel yellow (2A4)
Łeba, 263	(2.9–) 4.3 (– 5.1)	(0.7–) 1.0 (–1.5)	(22.5–) 26.8 (–30.0)	(1.2–) 2.8 (–4.2)	Yellowish-white (3A2) to pale yellow (3A3)
Miasteczko Śląskie, 303	(6.9–) 7.6 (– 8.3)	(1.2–) 1.9 (–2.5)	(35.0–) 38.6 (–40.0)	(4.4–) 5.4 (–6.1)	Butter yellow (4A5) to yolk yellow (4B8)

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