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Acaulospora sporocarpia, a new, sporocarpic species,  
and emendation of the genus Acaulospora  
(Endogonaceae, Zygomycotina)

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Mosse (5) and Gerdemann (2) pioneered the identification of vesicular-arbuscular mycorrhizal (VAM) fungi. They used VAM fungi that produce nonsporocarpic spores on individual hyphae in the host rhizosphere to demonstrate the formation of VAM. Some of these fungi can now be identified as species of Glomus and Gigaspora. It has subsequently been shown that some earlier described sporocarpic species, such as Glomus microcarpum Tul. & Tul. (11) and Glomus macrocarpum Tul. & Tul. (11), are VA mycorrhizal and form nonsporocarpic (ectocarpic) as well as sporocarpic spores. Before recognition of their specialized nutrition and distinctive spore morphology, these fungi were generally referred to the genus Endogone Lk.:Fr. along with a number of what we now know to be non-VAM species (e.g., 9).

When Gerdemann and Trappe (3) reexamined the Endogonaceae, they recognized and separated from Endogone the distinct genera of VAM fungi, Glomus, Acaulospora and Gigaspora, which are differentiated by spore ontology and morphology. No sporocarp-forming species were then known for either of the last two genera. I have recently examined two previously unidentified collections of sporocarpic Endogonaceae and found them to be an undescribed species of Acaulospora.

Acaulospora sporocarpia Berch, sp. nov. (Figs. 1, 2 & 3)

Sporocarpia irregularia, brunneola vel atrobrunnea, usque ad 2.5 x 1.5 x 1.5 cm, sporis nigris luce reflexa. Sporae

lateraliter gestae in hypha cum terminatione inflata globosa, subglobosa vel irregulares et 210-275 x 210-250 um. Sporae ellipsoideae, late fusiformes, subglobosae vel globosae, (140-)160-200(-240) x (125-)150-175(-200) um, atrobrunneae vel nigrae luce transmissa, pedicella singula usque ad 40 um longa et 20-30 um crassa. Sporae tunica stratis duplicibus: exteriore obscure castaneo, 2.5-5 um crasso, lamellato, aspro; interiore hyalino, 7-15 um crasso, lamellato, ubi obtrito aliquando in strata duo secedenti.

Sporocarps irregular, dark-brown, up to 2.5 X 1.5 X 1.5 cm, composed of spores that appear black in incident light, plus sporogenous saccules, hyphal swellings, hyphae and debris.

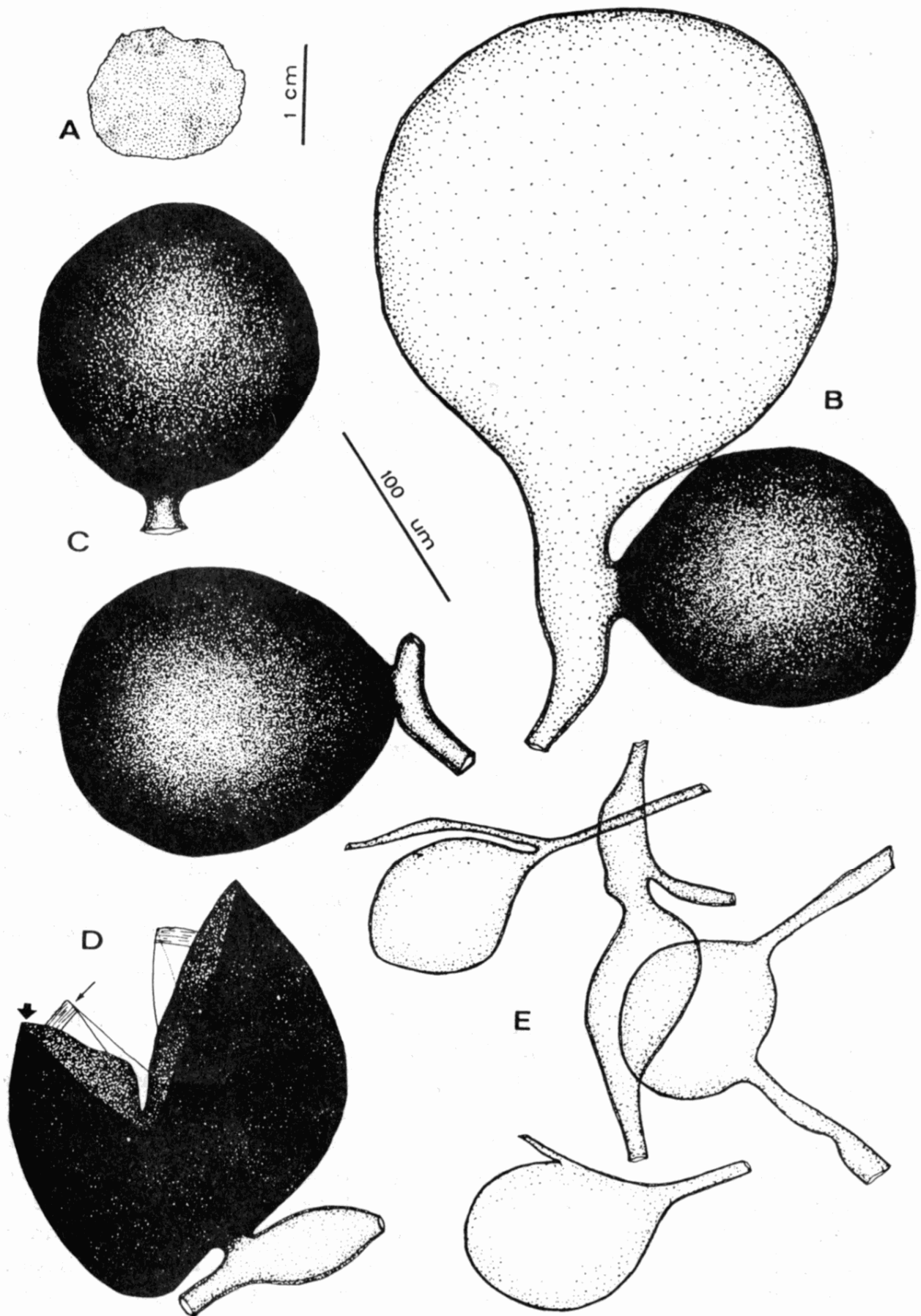
Spores formed laterally on hypha subtending a single, terminal sporogenous saccule. Spores ellipsoid, broadly fusiform, subglobose, or globose, (140-)160-200(-240) X (125-)150-175(-200) um, dark brown or black in transmitted light, borne on a single stalk.

Wall of spore composed of two separable groups: the outer consists of a single wall (wall 1), dark reddish brown in transmitted light, 2.5-5 um thick, laminate, with a rough outer surface; the inner consists of a single wall (wall 2), hyaline, 7-15 um thick, tough, laminate, and sometimes separating into 2 or more layers when crushed.

Stalk continuous with hypha that subtends the sporogenous saccule, may be persistent, brown, up to 40 um long and 20-30 um wide at the point of attachment to the spore.

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Fig. 1. Acaulospora sporocarpia, holotype. A. Cross-section of sporocarp, bar = 1 cm. B, C, D, E, bar = 100 um. B. Dark spore formed laterally on hypha subtending terminal sporogenous saccule. C. Mature spores with remnants of subtending hyphae. D. Crushed spore with dark outer wall broken and hyaline inner wall exposed. E. Terminal, lateral and intercalary hyphal swellings found in sporocarp.



Sporogenous saccule globose, subglobose, or irregular, 210-275 X 210-250 um. Subtending hypha is up to 50 um wide at point of attachment to sporogenous saccule.

Hyphal swellings irregular, subglobose or globose, terminal, lateral or intercalary, and up to 40 um long.

HOLOTYPE: USA, Arizona, Coconino Co., approx. 70 km SW of Winslow, Barrowed Tank, in soil, VIII.1955, D. J. Stouffer, BPI.

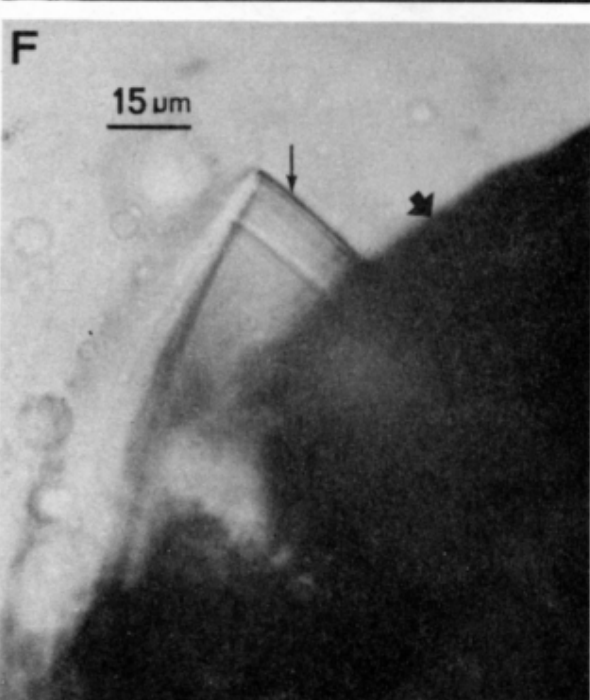
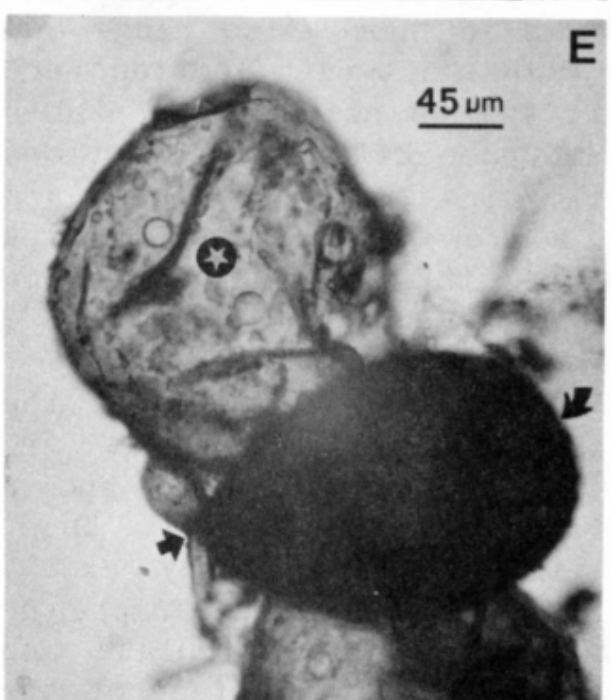
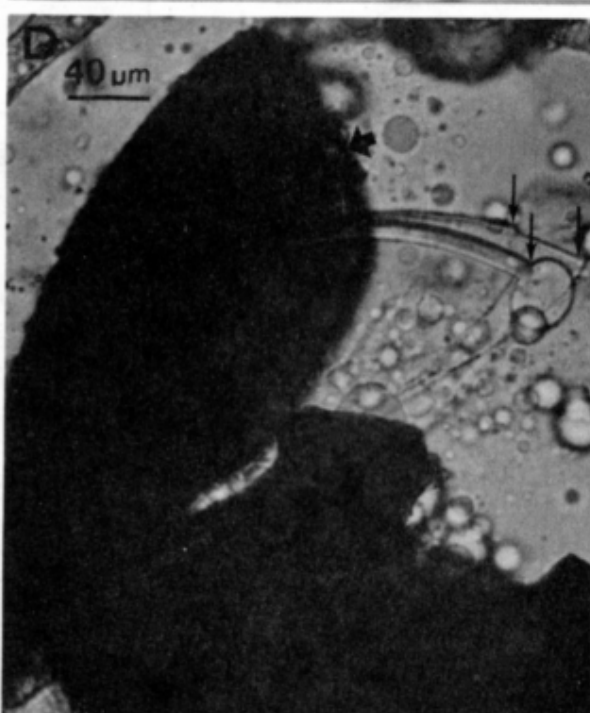
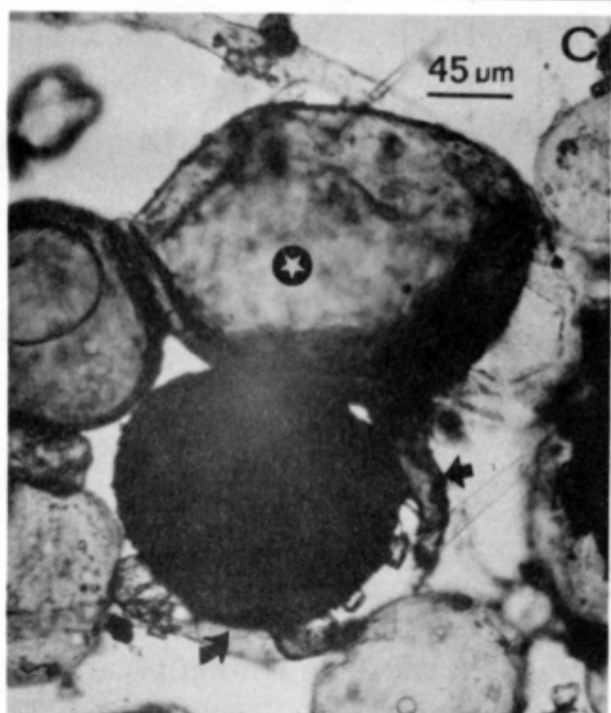
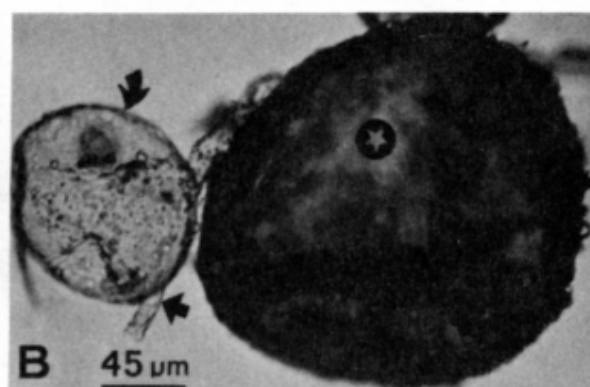
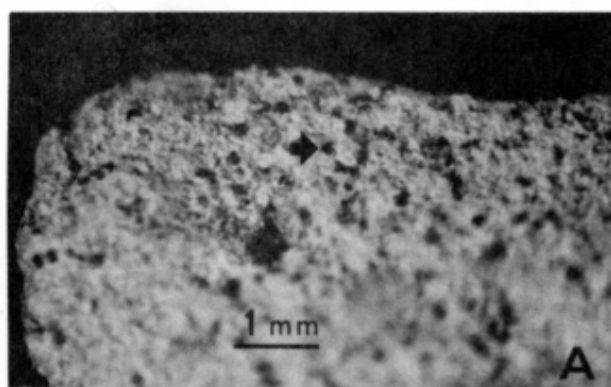
OTHER MATERIAL EXAMINED: West Pakistan, Hyberabad, on the ground, 20.IV.1962, S. Ahmad 15636, IMI 95697.

Because this species is known only from herbarium collections, it has not been possible to determine whether it forms mycorrhizae. The West Pakistan collection is composed of part of a mature sporocarp, a large amount of immature material and debris.

The two collections examined differ in a number of individually minor ways. Spores of the holotype undergo a rapid and distinctive reaction in Melzer's reagent as is common to Acaulospora species: the inner wall changes from hyaline to bright orange-pink or red-purple. No color change was observed for the material from Pakistan under the same conditions. The sporocarp from Pakistan is light brown and the spores do not exceed 190 um. The sporocarps from Arizona are dark brown and the spores attain a maximum length of 240 um. Somewhat different spore size range is by itself not sufficient reason

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Fig. 2. Acaulospora sporocarpia, holotype. A. Section of sporocarp with exposed dark spores embedded in glebal hyphae, bar = 1 mm. B, C, E, bar = 45 um. B. Young spore (curved arrow) forming on hypha (straight arrow) subtending terminal sporogenous saccule. C. Mature, dark spore on hypha (arrow) below terminal sporogenous saccule (star). D. Crushed spore with dark, outer spore wall (large arrow), and layers of hyaline, membranous inner wall (small arrow), bar = 40 um. E. Ellipsoid spore (curved arrow) attached to hypha (straight arrow) subtending terminal, sporogenous saccule (star). F. Crushed spore with broken outer wall (large arrow) and exposed hyaline inner wall (small arrow), bar = 15 um.



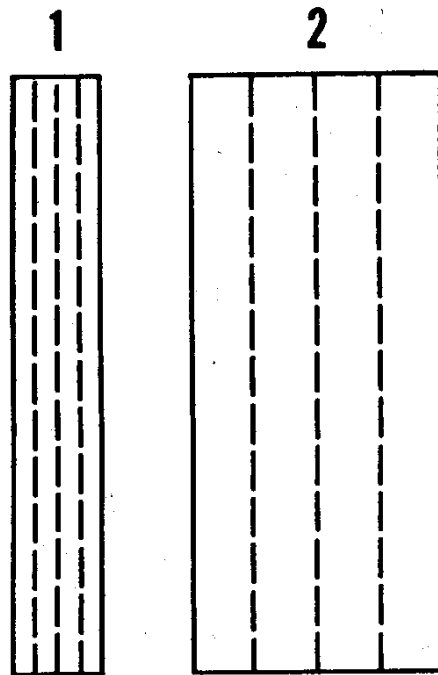


Fig. 3. Murograph of Acaulospora sporocarpia.

to warrant erection of two distinct taxa and may reflect differences in maturity. The difference in reaction to Melzer's reagent is troublesome. Most, if not all, species of Acaulospora react in Melzer's reagent and a collection that does not certainly warrants notice. In combination with the differences in spore size range and sporocarp color, it may seem that the two collections are of different species. However, I know neither how stable this reaction is over time and under different conditions nor how variable sporocarp color and spore size range are in this taxon as I have seen so few collections. Perhaps once fresh material is examined, this situation will be clarified.

Acaulospora sporocarpia is the only known species of the genus to have dark brown to black spores that are somewhat roughened but otherwise not ornamented and a relatively thick, tough, inner wall (Table 1). Thus, ectocarpic spores of this species, should they exist, would be readily identifiable. In A. elegans Trappe & Gerd., the dull, dark brown spores are reticulate and ornamented with spines, and rods (3). The surface of the red-brown to brown-black spores of A. foveata Trappe & Janos is pitted (4). Reticulation and cerebriform folds ornament the brown spores of A. gerdemanni Schenck &

Table 1: Comparison of Acaulospora species.

Species	Spore color	Outer wall group color	Ornamentation		Reference
			Outer wall	Inner wall	
<u>appendicula</u>	yellow cream to orange tan	yellow to brown	roughened warts	smooth	8
<u>bireticulata</u>	light brown	gray green to gray brown	polygonal reticulum	smooth	7
<u>elegans</u>	dull dark brown	brown	spines, rods, reticulation	smooth	3
<u>foveata</u>	red brown to brown black	brown	pitted	smooth	4
<u>gerdemannii</u>	brown	brown	reticulate, cerebriform	alveolate reticulum	6
<u>laevis</u>	yellow brown, red brown or olive brown	yellow brown, red brown	roughened	innermost roughened	3
<u>longula</u>	light yellow	light yellow	smooth	innermost roughened	8
<u>mellea</u>	yellow	golden	smooth	innermost roughened	8
<u>morrowae</u>	yellow	golden yellow	smooth	innermost roughened	8
<u>nicolsonii</u>	hyaline to pale yellow	pale yellow	granular, network	smooth	12
<u>scrobiculata</u>	light olive, light brown	subhyaline, yellow gray	pitted	innermost roughened	10
<u>spinosa</u>	yellow-brown	yellow brown, red brown	spines, rods, partial reticulum	smooth	13
<u>sporocarpia</u>	black	dark red, brown	roughened	smooth	
<u>trappei</u>	subhyaline	subhyaline	smooth	smooth	1
<u>tuberculata</u>	yellow brown, red black	yellow, brown	tubercles	smooth	4

Nicolson (6). The yellow-brown to red-black spores of A. tuberculata Janos & Trappe are covered with tubercles (4).

Schenck et al. (8) discussed the formation of Glomus-like

chlamydospores and thin-walled "vesicle-like" structures by Acaulospora appendicula Spain, Sieverding & Schenck. Acaulospora sporocarpia forms terminal, intercalary and lateral hyphal swellings or "vesicles" in its sporocarps. I do not know whether these structures of A. appendicula and A. sporocarpia are homologous to those of Glomus, and thereby could be thought to link Acaulospora with Glomus as was suggested by Schenck et al. (8).

Acaulospora sporocarpia is the first species of the genus known to produce spores in sporocarps. The term sporocarp is broadly defined here: a spore-producing body that is not necessarily differentiated into distinct tissue layers, may be indeterminate in its growth form, and may encompass debris. In Glomus Tul. & Tul., another member of the Endogonaceae, sporocarp formation is known for some but not all species; others are capable of both types of spore-formation. Given this precedent and the fact that spore development and morphology in A. sporocarpia are similar to those in the nonsporocarpic species of Acaulospora, a new genus is not needed for the sporocarpic forms. To include this taxon in Acaulospora, I emend the generic definition:

Acaulospora Gerdemann & Trappe emend. Berch

Spores produced singly in soil or in sporocarps that may attain several cm in length; spores globose, subglobose, ellipsoid, or broadly fusiform, with oily contents; borne laterally on the subtending hypha of large, terminal, relatively thin-walled, sporogenous saccule. Terminal sporogenous saccule may be up to twice the size of spore; contents transferred to developing spore. Spore composed of essentially two distinct, separable wall groups: at least part of outer is continuous with wall of subtending stalk, may be pigmented, laminated or composed of distinct walls, and variously ornamented; inner is composed of one or more walls that are usually membranous, hyaline, may be laminated, ornamented, and stain pink, red, or purple in Melzer's reagent. Pore in stalk that subtends spore is occluded by part of the outer spore wall group.

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#### REFERENCES

1. Ames, R. N., and R. G. Linderman. 1976. Acaulospora trappei sp. nov. Mycotaxon 3:565-569.
2. Gerdemann, J. W. 1955. Relation of a large soil-borne spore to Phycomycetous mycorrhizal infections. Mycologia 67: 619-632.
3. Gerdemann, J. W., and J. M. Trappe. 1974. The Endogonaceae in the Pacific Northwest. Mycologia Memoirs, No. 5, pp. 1-76.
4. Janos, D. P., and J. M. Trappe. 1982. Two new Acaulospora species from Tropical America. Mycotaxon 15:515-522.
5. Mosse, B. 1953. Fructifications associated with mycorrhizal strawberry roots. Nature 171:974.
6. Nicolson, T. H., and N. C. Schenck. 1979. Endogonaceous mycorrhizal endophytes in Florida. Mycologia 71:178-198.
7. Rothwell, F. M., and J. M. Trappe. 1979. Acaulospora bireticulata sp. nov. Mycotaxon 8:471-475.
8. Schenck, N. C., J. L. Spain, E. Sieverding, and R. H. Howeler. 1984. Several new and unreported vesicular-arbuscular mycorrhizal fungi (Endogonaceae) from Colombia. Mycologia 76:685-699.
9. Thaxter, R. 1922. A revision of the Endogoneae. Proc. Amer. Acad. Arts and Sci. 57:291-351.
10. Trappe, J. M. 1977. Three new Endogonaceae: Glomus constrictus, Sclerocystis clavispora, and Acaulospora scrobiculata. Mycotaxon 6:359-366.
11. Tulasne, L. R., and C. Tulasne. 1845. Fungi nonnulli hypogaei, novi v. minus cognoti. Giorn. Bot. Ital. 2, pt. 1(7/8):55-63.

12. Walker, C., L. E. Reed, and F. E. Sanders. 1984. Acaulospora nicolsonii, a new endogonaceae species from Great Britain. Trans. Brit. Mycol. Soc. 82:360-364.
13. Walker, C., and J. M. Trappe. 1981. Acaulospora spinosa sp. nov. with a key to the species of Acaulospora. Mycotaxon 12:512-521.