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GLOMUS ALBIDUS: A NEW SPECIES IN THE ENDOGONACEAE [1]

CHRISTOPHER WALKER [2]

Department of Forestry
Iowa State University, Ames, Iowa 50011

AND

LANDON H RHODES

Department of Plant Pathology
The Ohio State University, Columbus, Ohio 43210

SUMMARY

A new species in the Endogonaceae is described producing spores which fall into the morphological category of "white reticulate spore". The fungus is known to form vesicular-arbuscular mycorrhizae with onion, sorghum, and poplar.

INTRODUCTION

Separate investigations into the Endogonaceae and endomycorrhizae of Iowa and Ohio yielded the same undescribed species. This species has many of the characteristics ascribed to the "white reticulate" spore types of El-Giahmi et al. (1976), Hayman (1978), Mosse (1972), and Mosse & Bowen (1968a, 1968b). The spores are white, have a poorly defined subtending hypha at maturity, appear somewhat "reticulate" when viewed through a compound microscope, and germinate by production of a germ tube through the spore wall. The species is herein named *Glomus albidus* sp. nov. The Ohio isolate was established in pot culture on corn, and specimens from two such cultures were used for the type collection. The paratype is from a field collection from central Iowa.

GLOMUS ALBIDUS Walker and Rhodes sp. nov. Figure 1

Sporocarpia ignota. Chlamydosporae (85-)95-168(-198) x (85-)95-168 (-177) µm, globosae, subglobosae, ovoideae vel irregulares, luce reflexa hyalinae, albae vel albidae, luce transmissa luteae vel testaceae, hypha sustinenti una vel raro hyphis sustinentibus duobus. Tunica sporarum stratis duobus: exteriore 0.5-2 µm crasso, hyalino, ad maturitem fatiscenti et expanso in locos usque ad 8 µm, tum in parte exuto; interiore 0.5-2 µm crasso, flavo, subtiliter lamellato. Hypha affixa (3-)5-15 µm in diam, tunicis duobus, plerumque recta, simplex, et aperta, ad maturitem collabens.

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2. Present address: Forestry Commission, Northern Research Station, Roslin, Midlothian EH25 9SY, Scotland.

Sporocarps unknown. *Chlamydospores* under reflected light hyaline when young, white to off-white at maturity, always appearing yellowish to brownish-yellow by transmitted light through a compound light microscope. Spores with one subtending hypha (rarely with two subtending hyphae), borne singly in the soil on coenocytic hyphae. Mature spores (85-)95-168(-198) x (85-)95-168 (-177) µm, globose to subglobose, occasionally ovoid or irregular: cyanophilous in cotton blue at maturity, slowly and less strongly so in youth; mature spores becoming dull orange to yellow in Melzer's reagent, young spores becoming pink to orange-red.

Spore walls continuous with hyphal walls, clearly double in youth, consisting of an outer hyaline wall 0.5-2 µm thick, and an inner subequal finely laminated wall, light yellow and 0.5-2 µm thick. At maturity, the outer wall crumbling and expanding, becoming as much as 8 µm thick in places and rendering the spore opaque; then partly sloughing, often becoming less than 1 µm thick and having a roughened granular appearance.

Subtending hyphae 2-walled, outer wall thickened at spore base, (3-)5-15 µm wide, usually straight and simple, but sometimes constricted at the spore base or expanded by thickening of the outer wall to become slightly funnel-shaped. Occasionally with a bulging septum 5-20 µm distad of the pore, but usually open. Outer wall up to 0.7 µm thick, sloughing at maturity to leave the inner wall (0.2-0.5 µm thick) unsupported; hypha then shrivelling and collapsing, often becoming difficult to see.

Spore contents of crowded oil droplets, usually becoming angular from mutual pressure to give a reticulate appearance: seemingly sealed off by collapse of the subtending hypha at maturity.

Germination by germ tube penetrating the spore wall. Regrowth of the subtending hypha not observed.

Figure 1. Chlamydospores of *Glomus albidus*

(a) Mature spore (left) and immature spore (right) in juxtaposition.

(b) Young spore of *Gl. albidus*. Note the two distinct walls.

(c) A mature spore with the outer wall expanded (top) and sloughed (base).

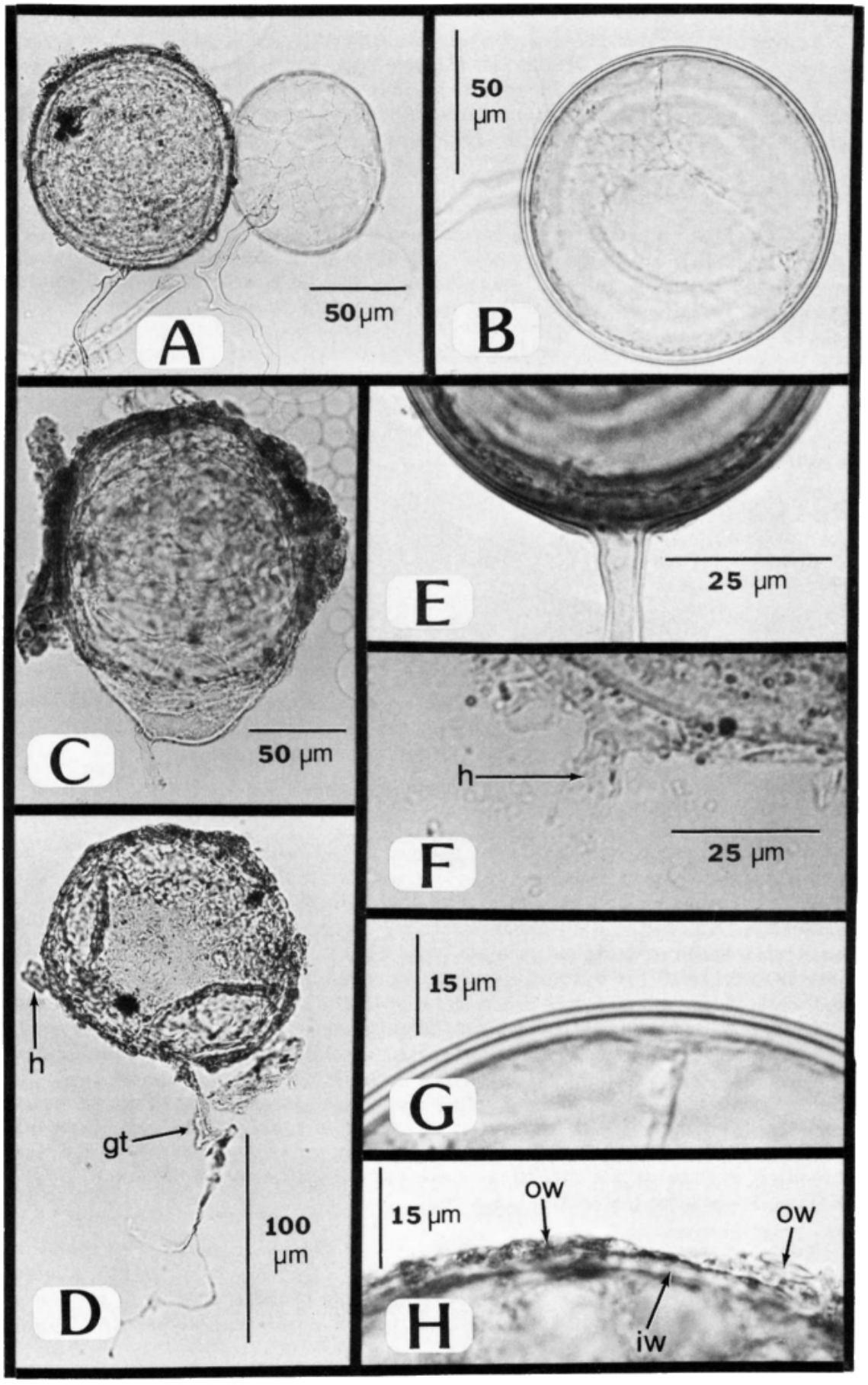
(d) Germinating spore. The germ tube (gt) has grown directly through the spore wall. The collapsed subtending hypha (h) is on the left.

(e) Detail of subtending hypha of a young spore. Note the two walls.

(f) Detail of subtending hypha of an old spore. The outer wall has disappeared and the hypha (h) has almost collapsed.

(g) Wall structure of a young spore. Two layers can clearly be seen.

(h) Wall structure of an old spore. The inner wall (iw) is intact, but the outer wall (ow) has crumbled and is breaking down.


A
50 µm
B
50 µm
C
50 µm
E
25 µm
F
h
25 µm
G
15 µm
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h
gt
100 µm
H
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ow
ow
iw

DISTRIBUTION AND HABITAT

Known from the rhizosphere of winter wheat (*Triticum aestivum* L.) in Ohio, and from around the roots of grasses (*Setaria* spp. and *Bromus inermis* Leyss.) and poplars (*Populus* spp.) in an old meadow site in central Iowa. Found throughout the growing season. Probably also present in winter as resting spores in the soil and mycelium in living roots.

MYCORRHIZAL ASSOCIATIONS

Forming vesicular-arbuscular mycorrhizae with corn (*Zea mays* L.), onion (*Allium cepa* L.), sorghum (*Sorghum vulgare* Pers.), and poplar (*Populus* x *euramericana* (Dode) Guinier). Associated in the field with mycorrhizal roots of poplars, foxtail grasses (*Setaria* spp.), smooth brome (*B. inermis*), and wheat (*T. aestivum*).

ETYMOLOGY

Latin, *albidus*; whitish. Referring to the white to off-white appearance of the spores when viewed by reflected light.

COLLECTIONS EXAMINED

HOLOTYPE: OHIO - Pickaway Co (Collected by L H Rhodes, 6 vi 1977) among roots of winter wheat (*T. aestivum*). Type specimens from two pot cultures on corn (*Zea mays*), Walker #169, (OSC; isotype FH, ISC). *PARATYPE*: IOWA - Marshall Co, Rhodes, at the Iowa State University Rhodes Farm, Walker #179, 23 viii 1978 (ISC).

In addition, specimens from the Rhodes Farm were examined from random soil samples taken every two weeks during the summer and early autumn of 1978 as part of a population dynamics study of endogonaceous spores.

DISCUSSION

Mature spores of *Glomus albidus* are separated from those of other *Glomus* species by their white to off-white color and by their thin-walled, collapsed subtending hyphae. The change of color to yellowish when viewed through a compound microscope is also characteristic. *Gl. gerdemannii* Rose, Daniels & Trappe also has a very delicate subtending hypha, but, unlike *Gl. albidus*, the hypha is thickened for a short distance from the point of attachment. The outer wall of *Gl. albidus* and the middle wall of *Gl. gerdemannii* both appear firm in youth and then swell and break down as the spore matures. However, the breakdown of the former is into granular material, whereas the latter is into flaky pieces of laminations. *Glomus clarus* Nicolson & Schenck, and *Gl. occultus* Walker sp. ined. have hyaline to white spores possessing an outer coat which sloughs off with maturity. Both these species, however, lack the consistently whitish colour of *Gl. albidus* at maturity and have well-defined subtending hyphae at all stages of development (Nicolson & Schenck, 1979; C Walker, Iowa State University, in prep.).

Young spores of *Gl. albidus* are hyaline and can be confused with those of *Gl. occultus*, *Gl. clarus*, and *Gl. pallidus* Hall. *Glomus occultus* has a more complex wall structure than *Gl. albidus*, consisting of three layers, is generally much smaller (35-100 x 40-120 μm), and has a persistent subtending hypha

which lacks an outer wall. The subtending hypha of *Gl. occultus* often is recurved, whereas the subtending hypha of *Gl. albidus* usually is straight. The walls of *Gl. clarus* spores are not of equal thickness, the outer wall being much thicker than the inner. The two walls of young spores of *Gl. albidus* are of almost equal thickness. In addition, young spores of *Gl. clarus* have a thin outer coat, tightly adhering to the outer wall, thus making three layers in all. The description of *Gl. pallidus* indicates that only one, laminated wall is present in that species (Hall, 1977), and even mature spores are much smaller than many of the immature specimens of *Gl. albidus* to be found in a collection. Finally, young spores of *Gl. albidus* have a characteristic pink to orange-red reaction to Melzer's reagent. *Gl. clarus*, *Gl. occultus*, and *Gl. gerdemannii* have no such reaction. The response of *Gl. pallidus* to this reagent is unknown.

Careful observation of a series of spores will allow all stages of development to be studied, making identification easier and more certain.

Glomus albidus is probably one of the "white reticulate" isolates referred to in the literature. However, Hall & Fish (1979) refer to Hayman's (1978) "white reticulate" species, and state that it is not the same as that of Mosse & Bowen (1968a, 1968b). The key of Hall & Fish (1979) indicates that Hayman's spore has projections 12-30 μm high on the outer wall. No such structures occur on *Gl. albidus*, and therefore it is not the same as that observed by Hayman (1978). The "white reticulate" spores described by Mosse & Bowen (1968a) apparently are similar to *Gl. albidus*, but one of us (Walker) has received spores from G D Bowen of an Australian "white reticulate" isolate, and these are not *Gl. albidus*. The "white reticulate" spores of El-Giahmi et al. (1976) and Mosse (1972) look very similar to *Gl. albidus*, but the descriptions are insufficient for conclusive identification. It is possible that several taxa have spores that could fall into the general morphological category of "white reticulate".

Consideration was given to raising a new genus to accommodate chlamydosporic species of the Endogonaceae that germinate through the spore wall, but there are good reasons for not doing so. The germination of many *Glomus* spp. has not been observed, and it therefore would be impossible to place such species to genus if germination mode was used as the sole generic criterion. At least one other species in *Glomus* (*Gl. pallidus*) is known to germinate through the spore wall (Hall, 1977). but in all other respects it clearly is a *Glomus* species. In the genus *Gigaspora*, there are two germination modes viz., with or without compartmentalization of spore contents prior to germ tube egress, but as yet there seems no justification for splitting the genus on germination characteristics. If *Glomus* were separated on such features, the same might justifiably be done for *Gigaspora*. It may be that, as more is learned about members of the Endogonaceae, subgenera will be erected based on mode of germination. The use of such characters for generic delimitation at present would lead to confusion rather than clarification.

Rose et al. (1979) referred to the similarities between *Gl. gerdemannii* and azygosporic species in *Gigaspora* and *Acaulospora*. There are two characteristics of *Gl. albidus* that could similarly be considered as evidence for a link between it and azygosporic species in the family. The germination directly through the spore wall, rather than by regrowth through the subtending hypha, is similar to that of *Gigaspora* and *Acaulospora*; and the reaction to Melzer's reagent is typical of the white-spored species in these two genera. However,

there is no evidence of sexual or pseudosexual structures, such as the thin-walled hyphae on the mother vesicle of *Acaulospora* spp., or the small hyphal projection on the bulbous suspensor-like cell of *Gigaspora*.

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