

A NEW SPECIES OF SPOROCARPIC GLOMALES FROM SOUTH AFRICA

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Glomus avelingiae sp. nov. RC Sinclair is described and illustrated from collections made from the rhizosphere of an indigenous fruit-bearing tree, *Vangueria infausta* Burch. subsp. *infausta* near Cullinan, South Africa. Sporocarp morphology is presented as an important diagnostic feature.

Key words: Glomales, *Glomus*, sporocarp, arbuscular mycorrhizal fungi, South Africa.

Introduction

The order, Glomales was created to include all soil-borne fungi which form arbuscules in obligate mutualistic association with terrestrial plants (Morton and Benny, 1990). As an asexually reproducing species designated by morphology (form- or morph-species), a physiological prerequisite can create dilemma's, however sufficient morphological and habitat characteristics facilitate recognition of fungi from this order. Nonetheless, records of collections of arbuscular mycorrhizal (AM) fungi from South Africa are few. A collection of an *Endogone* Link:Fr species (Hattingh, 1972) was later identified as *Acaulospora laevis* Gerdemann & Trappe (Coetzee, 1982). Coetzee named a second collection of *A. laevis* from a different locality "with reservations" (pers. comm.) which is now deposited in the Pretoria Mycological Herbarium (PREM 45880). AM fungi have been collected from sand dunes in one of South Africa's neighboring countries, Namibia. These specimens have been sent to C. Walker in the UK for positive identification (K. Jacobson, pers. comm.). Some additional samples from Namibia are being pot cultured at the International Collection of Arbuscular and Vesicular-Arbuscular Mycorrhizal Fungi (INVAM) in West Virginia (Morton *et al.*, 1993) for study. Hoffman and Mitchell (1986) recognized four different "types" of AM fungi associated with *Acacia saligna* (Labill.) Wendl., an invader plant of the sensitive fynbos biome of the south-western Cape of South Africa but these fungi were not identified to species level. The present authors contributed to a recent report where some common AM fungi were identified (Gaur *et al.*, 1999) however, no taxonomic work, particularly from regionally important biomes in southern Africa, has been accomplished thus far.

Investigations begun at the University of Pretoria, have concentrated on the isolation and identification of indigenous species of AM fungi from the region. In this process, a new sporocarpic species in the sub-order Glomineae, family Glomaceae has

been discovered. Spore size, color and in particular, wall layer characteristics are used to distinguish this taxon in the Glomaceae. Ontogenetic sequence in wall layer development has been investigated in several taxa in the genus *Glomus* (Stürmer and Morton, 1997), increasing the evidence of polyphyly in this apparently heterogenous taxon. Spore age differences within the sporocarp in our collection has enabled investigation of spore ontogeny. Sporocarp morphology, known only in a few of the taxa in this family, is described here with an implication to the taxonomic usefulness of this characteristic.

Materials and Methods

Glomus avelingiae is described herein from a fresh, field-collected specimen. Microscopic investigations of sporocarp morphology and spore wall structure were done on specimens mounted in lactophenol, polyvinyl-lactic acid-glycerin and polyvinyl-lactic acid-glycerin with 1:1 (v/v) Meltzer's reagent. Thin sections (1.2 and 2 μm) were made of the sporocarp and studied with the transmission electron microscope. Light microscope examinations of the sectioned specimens were made with the aid of toluidine blue o staining. Color was determined with the use of the INVAM color chart (obtained from INVAM: 401 Brooks Hall, PO Box 6057, West Virginia University, Morgantown, WV, 26506-6057).

Taxonomic Part

Glomus avelingiae RC Sinclair, *sp. nov.* (Fig. 2 A-H)

[Etymology: this species is named in honour of its collector, Dr. Theresa Aveling.]

Sporocarpia epigaea, luteobrunnea vel pallide brunnea, irregulariter elliptica et modice convoluta, 1.0-1.2 X 1.8-2.2 mm, interdum materiam alienam aliquantum retinentia. Peridium nullum. Pagina sporocarpium crenulata ob chlamydoformas expositas. Chlamydoformae in sporocarpio contiguae et fortuito dispositae, cum hyphis 8-10 μm crassis. Chlamydoformae maturae et immaturae valde approximatae repertae. Chlamydoformae maturae globosae vel subglobosae 64-80 μm , cum uno pariete quadristrato: strato intimo flexili, minus quam 0.5 μm crasso; strato medio laminato, pallide luteobrunneo, 1.6-2.4 μm crasso; duobus extimis subhyalinis, saepe ut videtur uno 0.6-0.8 μm crasso; immaturae bistratae. Hypha subtendens 8-10 μm lata, cylindrica, ad 5-7 μm angustata ad basin chlamydoformae, cum septo usque ad 1.5 μm crasso. Hoc septum interdum ad 4 μm infra basin sporae extensum, e strato medio laminato compositum. Chlamydoformae stratum medium deorsum extensum per 6-10 μm in hypha subtendenti.

Epigaeus sub *Vangueria infausta* subsp. *infausta* Burch., prope viae latus, circa 10 km ad septentrio-occidentem e pago Cullinan dicto, Gauteng Provincia, South Africa, 10 November 1994, T.A.S. Aveling, PREM 55918, holotypus.

Sporocarp epigeous, yellowish brown to pale brown, irregularly elliptical and moderately convoluted, 1.0-1.2 x 1.8-2.2 mm, sometimes retaining small amounts of

foreign material. **Peridium** absent. **Sporocarp surface** crenulate due to exposed chlamydospores. Sporocarp hyphae 8-10 μm wide, bundled together, intertwined, coursing through the spore mass. Spores formed as determinate swellings of tips of sporogenous hyphae. **Chlamydospores** arranged in sporocarp adjacent to each other and random throughout. Mature and immature chlamydospores occurring in close proximity to each other. Mature chlamydospores globose to subglobose, 64-80 μm in diameter with one wall of four layers: innermost layer flexible, less than 0.5 μm thick; middle layer laminate, pale yellowish brown, 1.6-2.4 μm thick; outer bi-layer, subhyaline, 0.6-0.8 μm thick, often appearing as one layer. Juvenile chlamydospores have 2 layers. **Subtending hypha** 8-10 μm wide, 2-layered, cylindrical, narrow at the base of the chlamydospore to 5-7 μm , having a septum up to 1.5 μm thick. Septum in the subtending hypha composed of the middle laminate layer, sometimes extending 4 μm below the point of attachment at the spore base. Middle layer of the spore extending down the subtending hypha 6-10 μm .

In the rhizosphere near the soil surface beneath *Vangueria infausta* Burch. subsp. *infausta*; South Africa.

Collections examined: from the rhizosphere near the soil surface beneath *Vangueria infausta* Burch. subsp. *infausta*, near roadside approximately 10 km northwest of Cullinan, Gauteng Province, 10 November, 1994, T.A.S. Aveling, PREM 55918, holotype. An isotype has been sent to C.M.I., Kew for deposition.

Sporocarp color is 0-40-100-0 and chlamydospore color is 0-20-60-0 using the INVAM colour chart. There was no reaction by any of the spore wall layers or hyphae in the presence of Meltzer's reagent. The most commonly occurring mature spore size is 72 μm . A bar graph of the mature spore size range is provided (Fig. 1). A graphic presentation is made of some of the salient characteristics in this species (Fig. 2).

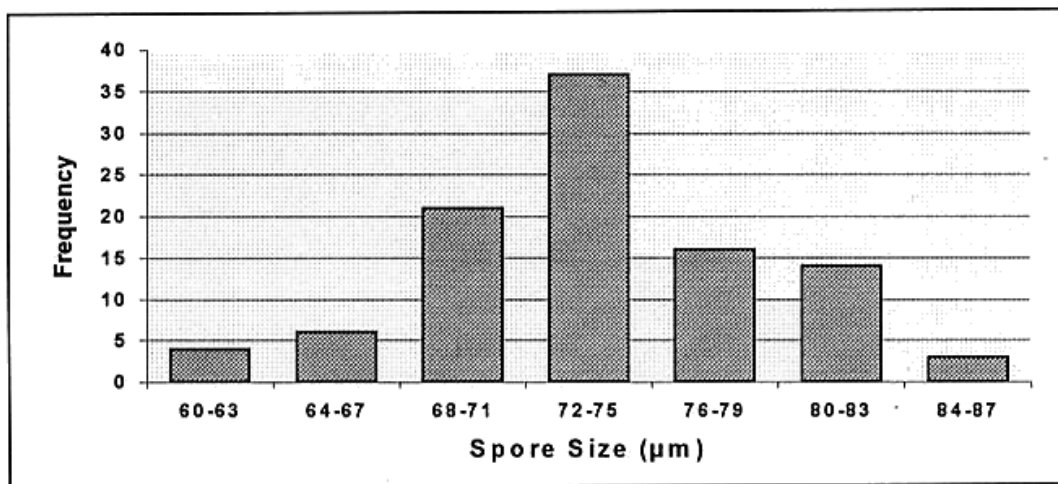


Fig. 1. Spore size range from a random selection of 100 mature spores.

Discussion

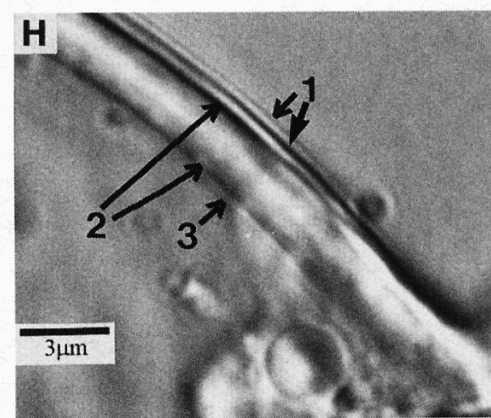
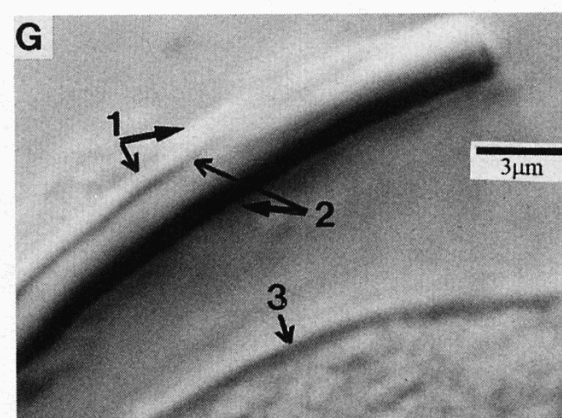
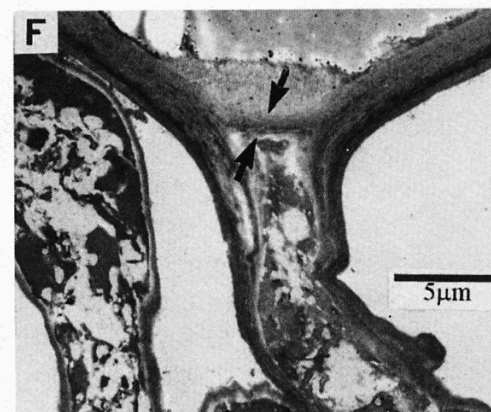
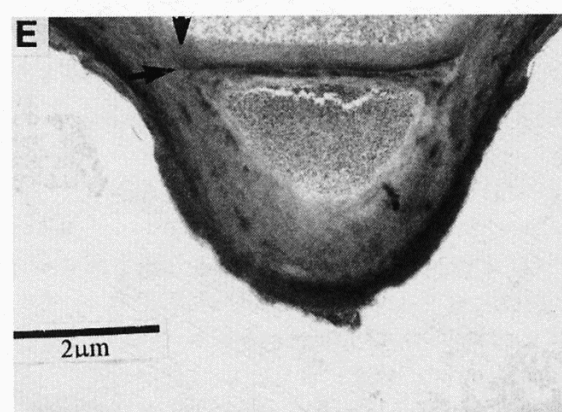
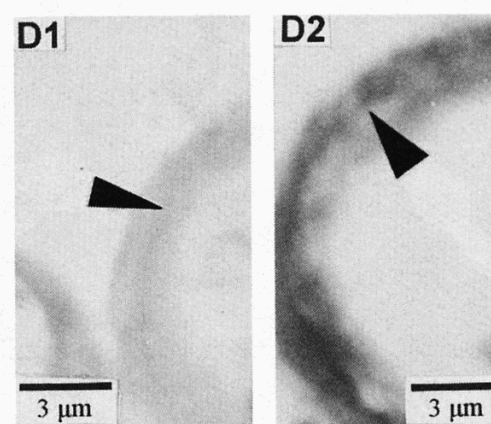
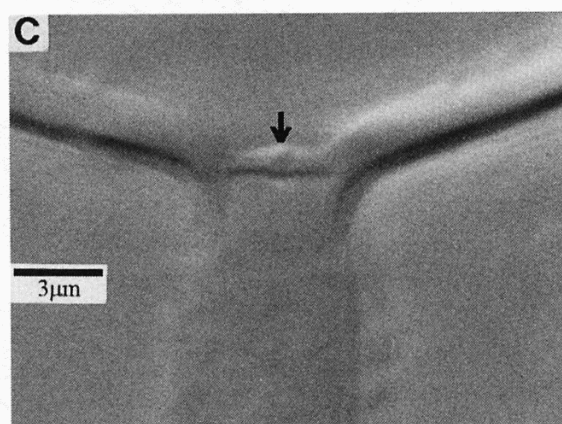
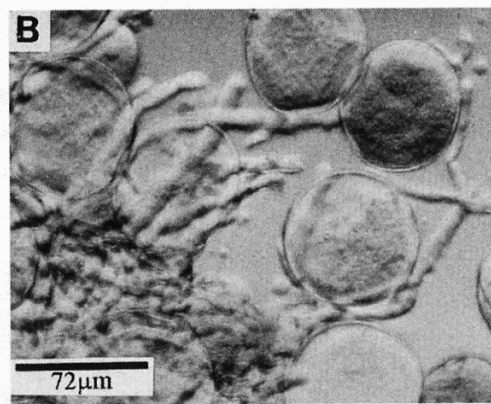
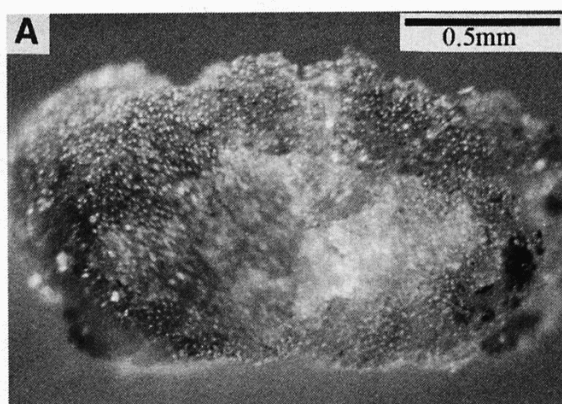
The most juvenile stage in *G. avelingiae* presented similarities to the second group described by Stürmer and Morton (1997) where the spore and hyphal wall are comprised of two layers i.e. a mucilaginous layer and a semiflexible hyaline layer. Differentiation proceeded by the appearance of a thin laminate layer and concurrent differentiation of two colorless laminae on the exterior and a thin flexible inner layer. Transmission electron microscopy provided less obvious differentiation of the layers in this species which further supports the conclusions of other authors (Maia *et al.*, 1993; Morton, 1996) that the spore wall in the Glomales is a single structure. The spore wall is differentiated into regions of unequal density and composition that are often more easily distinguished with a light microscope.

The main characteristics distinguishing *G. avelingiae* from other members in the genus *Glomus* is the spore size and wall structure and the true septum in the subtending hyphae formed from part of the laminated layer of the spore wall. The only other species with spores described having similar size range and wall layering is *Glomus fragile* (Berkeley & Broome) Trappe & Gerdemann. According to the description by Gerdemann and Trappe (1974) this species also has a septum at the hyphal attachment and is similar in spore shape, size, color and the configuration of the two relatively thin wall layers. However, no double layering of the outer layer is mentioned, nor is the thin inner flexible layer. Sporocarp formation has not been described in *G. fragile*. Material of *G. fragile*, known only from the type locality, was unavailable for examination. *G. avelingiae* is known only from the type locality.

The formation of the sporocarp in *G. avelingiae*, with bundled hyphae intertwining the spore mass, is distinct in its apparent randomness. This, as opposed to the orderly structure seen in other sporocarpic Glomales (Wu, 1993) from similar habitats suggests a genetic governance, contrary to the implication made by Morton (1988) that it is environmentally determined. We feel that sporocarp developmental morphology has taxonomic significance as does the ontogenetic sequence of chlamyospore morphology.

Asexuality in the Glomales is a cardinal genetic feature, as it is in the asexually reproducing Mitosporic fungi (formerly Deuteromycetes). Genetic isolation as a result of the loss of sexual recombination should be a factor in a low diversity which appears to be the case in the Glomales with so few taxa recognized. This is apparently not

Fig. 2 A-H. *Glomus avelingiae* A. Sporocarp; B. Chlamyospores surrounded by interwoven hyphae; C. Septum at subtending hyphal attachment; D1 & D2 . Juvenile stage of spore development indicating double layer; E & F. Transmission electron micrograph demonstrating contribution of laminate layer to subtending hyphal septum; F. Transmission electron micrograph depicting differentiated layers in spore wall and septum as opposed to the less differentiated double layer in the distal portion of the subtending hyphal wall; G & H. Oil immersion light micrograph demonstrating multiple layers of the spore wall.



the case in the Mitosporic fungi which have perhaps the largest diversity of all the groups of fungi. In the Glomales the subterranean habit enforcing a low dispersal potential and the obligate dependence on a plant may have served to physically restrict gene flow more so than in the Mitosporic fungi. However as evidence mounts, it is likely that even the most subtle morphological difference will define distinct lineages in this group of fungi.

Acknowledgements

Financial support from the National Research Foundation is acknowledged. We thank Dr. H.F. Glen of the National Botanical Herbarium of South Africa, N.B.I., Pretoria, for reviewing the latin diagnoses. We thank Prof Mike J Wingfield, Director of the Forestry and Agricultural Biotechnology Institute, University of Pretoria for reviewing the manuscript. We also thank Alan Hall and CF vd Merwe of the University of Pretoria Unit for Electron Microscopy for help with the transmission electron micrographs.

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