STRUCTURE AND HYPERPARASITISM OF A NEW SPECIES OF *GIGASPORA*

M. BHATTACHARJEE, K. G. MUKERJI
Department of Botany, University of Delhi, Delhi, India

J. P. TEWARI
Biological Sciences Electron Microscopy Laboratory, University of Alberta, Edmonton, Alberta, Canada T6G 2E9

AND W. P. SKOROPAD
Department of Plant Science, University of Alberta, Edmonton, Alberta, Canada T6G 2P5

Several samples of soil collected from a wheat field in Wazirabad, Delhi, situated near the river Yamuna, when wet-sieved and decanted (Gerdemann & Nicolson, 1963), yielded a white-spored species of *Gigaspora*. This isolate differs from all the known species of this genus and is described here as new.

Gigaspora candida sp. nov. (Figs 1–11)

Azygosporae singillatim in solo inventae, albae, globosae, 200–300 μm diam (maximum partem 230 μm); tunica sporarum levis, e duabus lamellis distincte manifestis in azygosporis fractis; lamella externa 1 μm crassa et cum paucis laminis, lamella interna usque and 6 μm crassa. Cellula instar suspensoris azygosporae adiuncta, alba, globosa – subglobosa, 30–50 μm diametro, unido cribro creta plerumque disiuncta. Vesiculae in solo natae non separatae.

Azygospores found singly in soil, white, globose, 200–300 μm diam (average 230 μm); spore wall smooth, 2-layered, the two layers distinctly visible in fractured azygospores, outer layer 1 μm thick and with a few laminations, inner layer up to 6 μm thick. Suspensor-like cell attached to the azygospore, white, globose to sub-globose, 30–50 μm diam, usually detached during wet sieving. Soil-borne vesicles not isolated.

The type collection was isolated from wheat field soil from Wazirabad, Delhi, March 1980 and deposited in the Mycological Herbarium, Department of Botany, University of Delhi as DU/KMB 494 Leg. Mita Bhattacharjee.

This species can be readily identified as belonging to the azygosporic genus *Gigaspora* because the spore is borne terminally on a bulbous suspensor-like cell (Figs 1, 4; Gerdemann & Trappe, 1974). *G. candida* closely resembles *G. calospora* (Nicol. & & Gerd.) Gerdemann & Trappe (Gerdemann & Trappe, 1974). However, the colour of azygospores in *G. calospora* ranges from pale yellow to greenish yellow, while in *G. candida* they are always white, thus providing the basis for the specific epithet. Also, the structure of the wall of the azygospore is different in these two species. The two known white-spored species, *G. margarita* Becker & Hall and *G. gilmorei* Trappe & Gerdemann apud Gerdemann & Trappe (Gerdemann & Trappe, 1974; Becker & Hall, 1976), also differ from *G. candida* in structure of the wall of the azygospore.

For the study of wall structure, air-dried, osmium-vapour fixed, and gold-coated azygospores of *G. candida* were examined in a Cambridge Stereoscan 150 scanning electron microscope (SEM). Some of the azygospores were fractured with a needle before being coated with gold. This proved to be a worthwhile exercise since it led to a

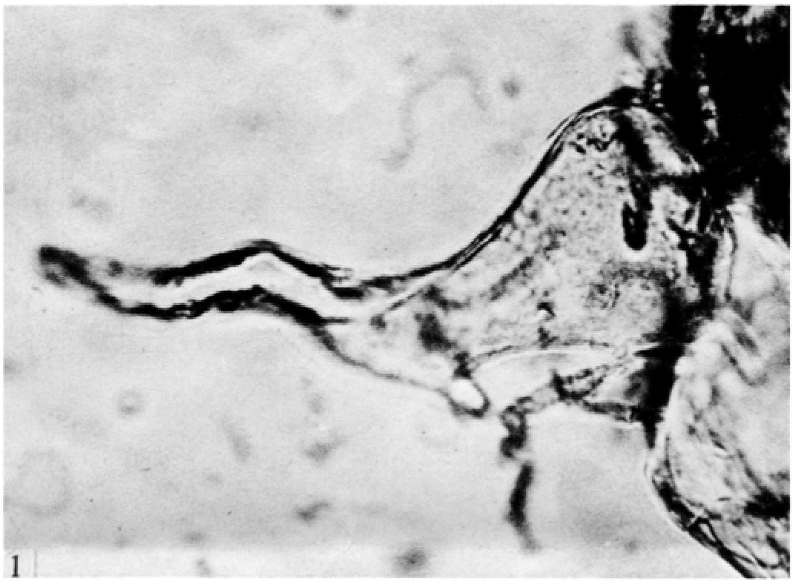
Gigaspora candida azygospores.

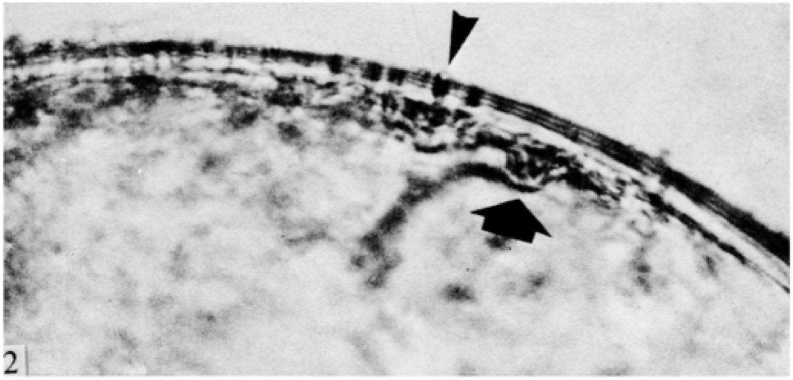
Figs. 1–3 light micrographs; Figs 4–11 S.E.M.

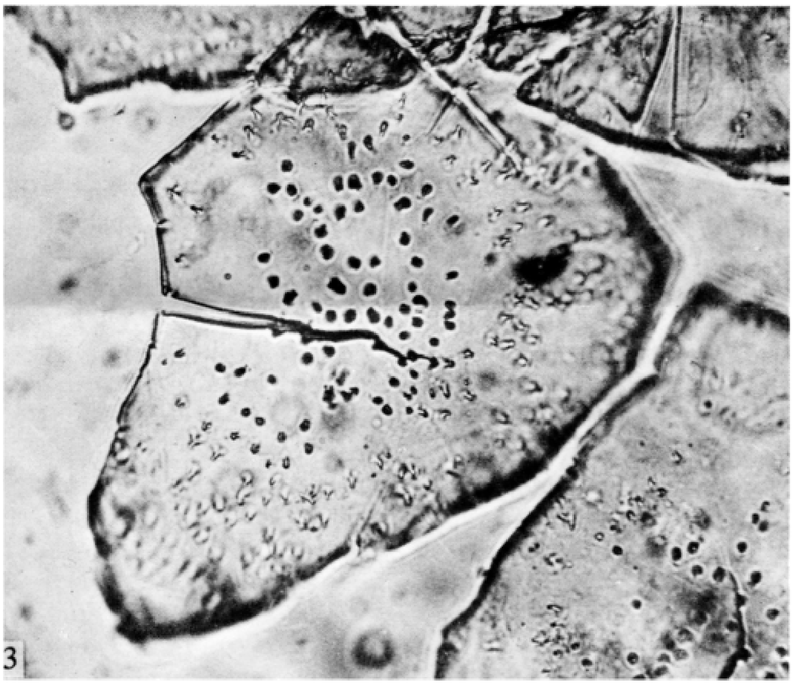
Fig. 1. Bulbous suspensor-like cell (×675).

Fig. 2. Cross-sectional view of the wall. Note the 2 layers in the wall. The outer layer shows a few laminations. Also note the transverse fissures (arrowhead) and internal projections (arrow) in the wall (×714).

Fig. 3. View of the wall in a macerated mount showing apparent echinulations. Compare with Figs 5–11. (×500.)


1


2


3

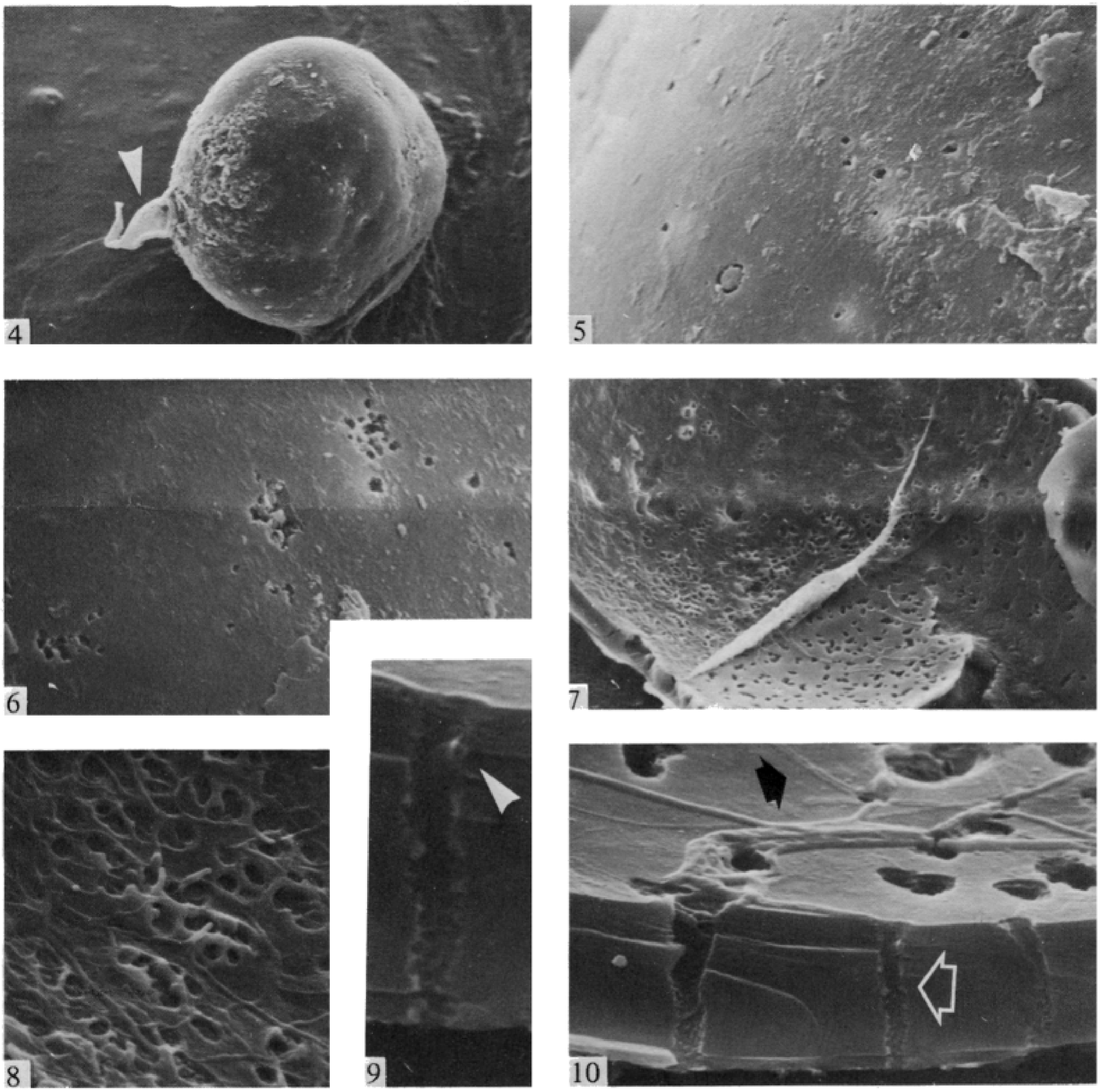


Fig. 4. Whole azygospore borne terminally on a bulbous suspensor-like cell (arrowhead) (× 135).

Figs 5, 6. Outer surface of the cell wall showing perforations dispersed singly (Fig. 5) or in groups (Fig. 6). (5 × 1500; 6 × 2260.)

Figs 7, 8. Inner surface of the wall showing perforations. Note the extensive hyphal growth on this aspect of the cell wall. (7 × 425; 8 × 1700.)

Figs 9, 10. Cell wall showing the inner surface and the cross-sectional views. Note the hyphal growth on inner surface of the cell wall. Two collapsed hyphae are indicated by a solid arrow in Fig. 10. The perforations are seen to traverse both the outer and inner cell wall layers. One of the perforations (hollow arrow in Fig. 10, this area is enlarged in Fig. 9) shows a hypha (arrowhead in Fig. 9) traversing it. (9 × 6250; 10 × 2625.)

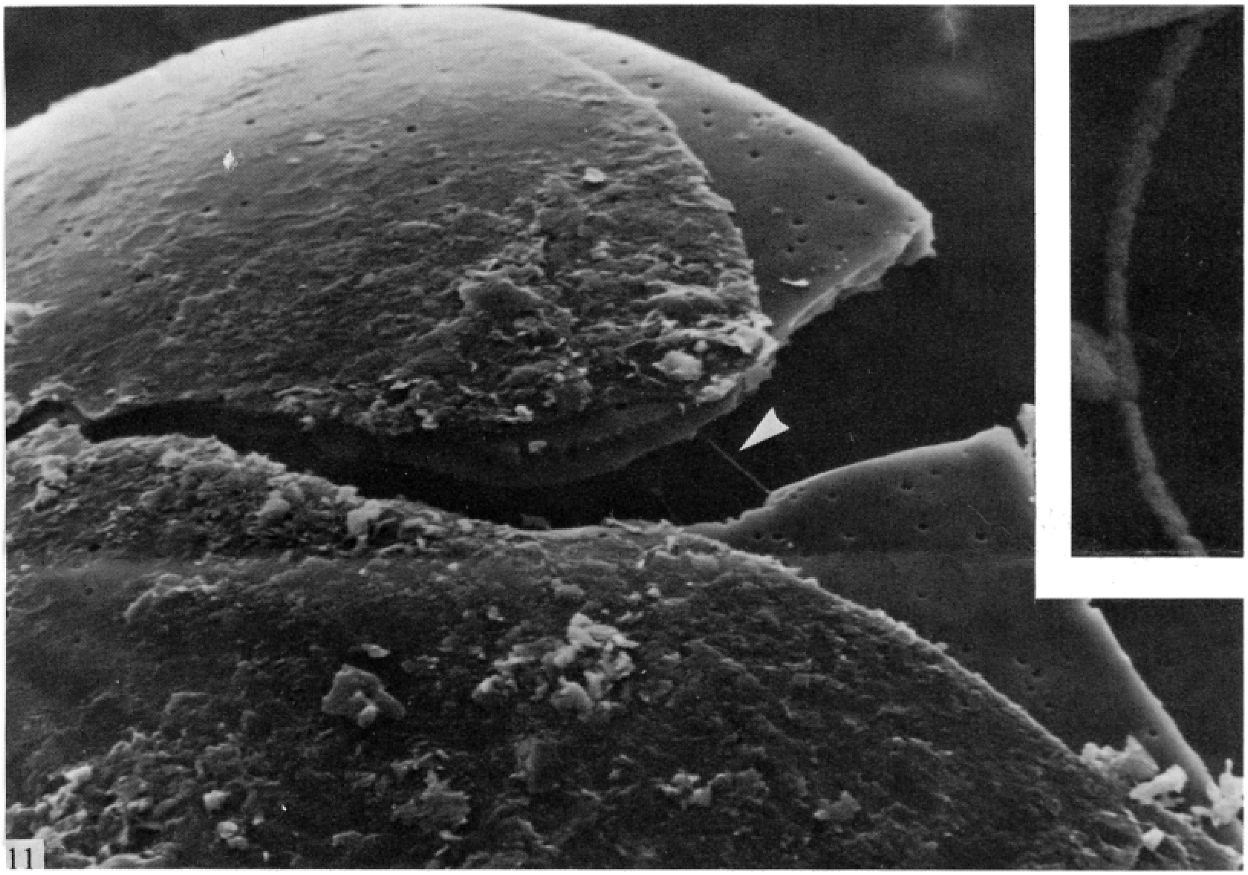


Fig. 11. A fractured azygospore showing the two wall layers. The outer surfaces of both the layers have perforations. Note the possible actinomycetous fruiting structure marked by an arrowhead and enlarged in the inset. (11 × 900; inset × 7800.)

correct interpretation of some of the structural details that would have been misinterpreted if the azygospores were examined only by light microscopy. For example, light micrographs of the cell wall show transverse fissures in cross-sectional views in whole mounts (Fig. 2) and apparent echinulations in macerated mounts (Fig. 3). These were interpreted as perforations in the cell wall by scanning electron microscopy (Figs 5–11). Also, the 2-layered substructure of the wall was seen clearly by scanning electron microscopy (Figs 9–11).

The perforations in the cell wall appeared to be caused by the parasitic action of soil microorganisms since its inner surface showed numerous hypha-like structures (Figs 8, 10), often passing through these perforations (Fig. 9). The perforations were either dispersed or in groups (Figs 5–8, 11) and varied in size indicating that more than one type of parasite may have been involved. The light micrographs also revealed internal projections in the wall (Fig. 2), which could be reaction zones (Tsuneda, Skoropad & Tewari, 1976) produced by the host in response to the hyperparasite. A few sporulating structures of an actinomycete-like organism were found associated with the azygospores (Fig. 11).

The present study, besides recognizing a new species, has brought to light the usefulness of employing more than one technique for interpreting fungal structures. The extensive parasitism of *G. candida* indicates that the endogonaceous fungi, like any other organisms, also form a link in the universal food-chain continuum. While there are several reports of hyperparasitized endogonaceous fungi (see Ross & Ruttencutter, 1977; Daniels & Menge, 1980), the ecological significance of this association has just begun to be realized. This phenomenon may be responsible for limiting the natural populations of these fungi (Ross & Ruttencutter, 1977) and may also explain some of the erratic results obtained in the various experiments involving pot cultures of these fungi (Daniels & Menge, 1980). More studies on this association are, however, desirable in view of the importance of these fungi in agriculture, forestry, and revegetation of disturbed areas (Rhodes, 1980; Sanders, Mosse & Tinker, 1975).

Thanks are gratefully acknowledged to Mr G. Braybrook, Department of Entomology, University of Alberta for helping with use of the scanning electron microscope.

REFERENCES

BECKER, W. N. & HALL, I. R. (1976). *Gigaspora margarita*, a new species in the Endogonaceae. *Mycotaxon* **4**, 155–160.

DANIELS, B. A. & MENGE, J. A. (1980). Hyperparasitism of vesicular-arbuscular mycorrhizal fungi. *Phytopathology* **70**, 584–588.

GERDEMANN, J. W. & NICHOLSON, T. H. (1963). Spores of mycorrhizal *Endogone* species extracted from soil by wet sieving and decanting. *Transactions of the British Mycological Society* **46**, 235–244.

GERDEMANN, J. W. & TRAPPE. J. M. (1974). The Endogonaceae of the Pacific Northwest. *Mycologia Memoirs* **5**, 71–6.

RHODES, L. H. (1980). The use of mycorrhizae in crop production systems. *Outlook on Agriculture* **10**, 275–281.

ROSS, J. P. & RUTTENCUTTER, R. (1977). Population dynamics of two vesicular-arbuscular endomycorrhizal fungi and the role of hyperparasitic fungi. *Phytopathology* **67**, 490–496.

SANDERS, F. E., MOSSE, B. & TINKER, P. B. (eds) (1975). *Endomycorrhizas*. Academic Press, New York.

TSUNEDA, A., SKOROPAD, W. P. & TEWARI, J. P. (1976). Mode of parasitism of *Nectria inventa* on *Alternaria brassicae*. *Phytopathology* **66**, 1056–1064.