Trans. Br. mycol. Soc. **87** (2), 243–248 (1986) *Printed in Great Britain*

TWO NEW SPECIES OF *UMBELOPSIS* FROM SOIL IN AUSTRALIA

By HIN-YUEN YIP

School of Botany, University of Melbourne, Parkville, Victoria 3052, Australia

Umbelopsis swartii and *U. westeae* are described as new species. The former is characterized by tear-shaped sporangiospores, and the latter by oval to clavate sporangiospores with a distinctively thickened wall at the narrower end.

Umbelopsis Amos & Barnett is one of the two genera to which species of the subgenus *Micromucor* of *Mortierella* have been reassigned by von Arx (1982), the other genus being *Micromucor*, which was elevated from its subgeneric status. This treatment has been discussed by Yip (1986). Species in subgen. *Micromucor* are closely related to one another in terms of colony colour and texture, shape of sporangia and sporangiospores, and branching habit of sporangiophores. The separation of these fungi into two genera is therefore unwarranted. The taxonomy of subgen. *Micromucor* is being revised at C.B.S., Baarn, The Netherlands (Gams, pers. comm.). In this revision, the names of all species in the subgenus will be combined in *Umbelopsis*. In anticipation of this forthcoming work, the two new species described here are assigned to *Umbelopsis*.

The fungi were studied using single-spore isolates grown at 20–21 °C in darkness on Malt Extract Agar (MEA) and Difco Cornmeal Agar (CMA). Microscopic features were observed from lactic acid mounts on slides, and from aqueous mounts made in situ near growing margins of cultures on MEA. Lengths of sporangiophores were measured from the in situ mounts by the method described by Parkinson & Grouch (1969) using a camera lucida and an opisiometer. Capitalized colour names and notations in the descriptions are those of Kornerup & Wanscher (1978). The acronyms DAR and VPRI refer respectively to the New South Wales Department of Agriculture, Rydalmere, N.S.W. 2116, Australia, and the Plant Research Institute, Burnley, Victoria 3121, Australia.

Umbelopsis swartii sp.nov. (Fig. 1)

Coloniae in agaro extracto-malti velutinae, mycelio substrati denso, margine expandenti submerso regulari 2–3 mm lato, sporulatione ponderosa sordide rufa. Sporangiophora biformata: alterum procerius, 600–1500 (–2400) μm altum, e radicibus sympodice ramosum, ramis rectis simplicibus, inferne 6–10 μm diam, apicem versus ad (2·5–4 μm) attenuatis; alterum brevius, (60–) 70–95 (–130) μm altum, plerumque simplex, terminaliter recurvum, raro rectum, inferne (5–) 6–10 (–11) μm diam, apicem versus ad (3–) 4–5 (–6) μm attenuatum. Sporangia plus minusve globosa, sordide rufa, tenuitunicata, illis macrosporangiophororum 29–37 (–4) μm diam et microsporangiophororum 19–26 (–29) μm diam, in dehiscentia collariculam relinquentia. Columellae subglobosae, (5–) 6–8 (–10) μm diam. Sporangiospora ovoidea ellipsoidea, 4–5(–6) × (2–)2·5–3 μm, in caudam rectam vel obliquam 1–3 μm longam abrupte attenuata, perpallide rosea. Chlamydospora hyalina, guttulata, rasilotunicata, biformata, ex hyphis substrati cumulate genita; macrochlamydospora plus minusve globosa, (20–) 30–50 (–70) μm diam, parietibus 1–3 μm crassis, intercalaria, raro terminalia; microchlamydospora globosa, (5–) 7–8 (–10) μm diam, parietibus circa 0·2 μm crassis, hyphas subtiles brevesque terminantia.

Secretus e solo in sylva *Eucalypti regnantis* matura, in regione Wallaby Creek, Victoria, Australia, Mense Junio, anno Domini 1985; DAR 53075, holotypus.

Colonies on MEA after 12 d measuring 61–62 mm diam; texture velutinous with a sparse growth of aerial mycelium in the central area; substrate mycelium dense; margins 2–3 mm wide, submerged, regular, sporulation heavy, Reddish White (9A2) in central area, Dull Red (8B3) towards margin. On CMA after 12 d attaining 50–51 mm diam; texture velutinous; substrate mycelium less dense than in MEA; margins 7–10 mm wide, submerged, regular; sporulation light, Dull Red (8B3). *Sporangiophores* arising from primary substrate hyphae which measure 6–15 μm diam, of two kinds according to height: (*a*) tall sporangiophores branching sympodially from a base swollen to 12–20 μm diam; branches erect, unbranched, 6–10 μm diam near base and tapering gradually to 2·5–4 μm diam near tip, 600–1500 (–2400) μm long, septate at wide intervals; (*b*) short sporangiophores common on MEA during initial stages of sporulation but production decreasing with age of colony, absent on CMA, with a swollen base measuring 8–14 μm diam,

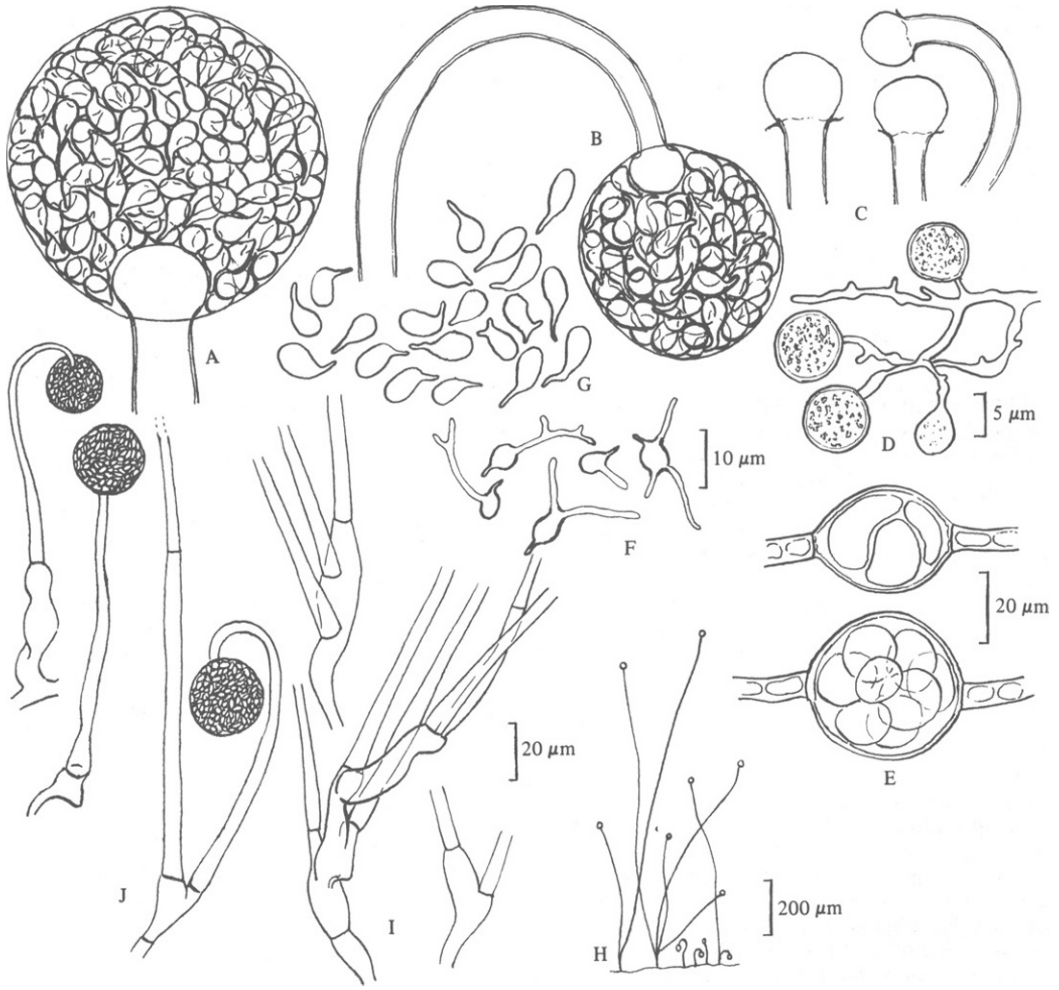

Fig. 1. *Umbelopsis swartii*. (A, B) Sporangia of tall and short sporangiophores; (C) columellae; (D, E) micro- and macrochlamydospores; (F) germinating sporangiospores; (G) sporangiospores; (H) habit sketch; (I) lower portions of tall sporangiophores showing branching habit; (J) short sporangiophores.

usually unbranched, (60–) 70–95 (–130) μm high, (5–) 6–10 (–2) μm diam near the swollen base and tapering to (3–) 4–5 (–6) μm diam near tip, terminal portion recurving or occasionally remaining straight, less frequently one or two tall sympodial branches are produced by the swollen base. *Sporangia* globose to subglobose, measurements of those produced by tall and short sporangiophores are respectively 29–37 (–40) μm diam and 19–26 (–29) μm diam, dull red, walls thin and on dehiscence leaving collarettes. *Columellae* subglobose with the top rounded or slightly flattened, (5–) 6–8 (–10) μm diam. *Sporangiospores* oval, broadly elliptical or elliptical with the narrower end usually tapering abruptly and drawn out to a straight or obliquely held 'tail' which gives the spore a tear-drop appearance, excluding tail 4–5 (–6) × (2–) 2·5–3 μm, tail 1–3 μm long, individually very pale pink, en masse dull red, tails do not develop into germ-tubes during germination of spores. *Chlamydospores* produced by substrate hyphae, hyaline, with smooth wall, guttulate, of two types according to size: macrochlamydospores globose to subglobose, (20–) 30–50 (–70) μm diam, walls 1–3 (–10) μm thick, intercalary, seldom terminal, produced by primary hyphae in increasing numbers in MEA as culture becomes older; microchlamydospores globose, (5–) 7–8 (–10) μm diam, borne terminally on short hyphae of *ca* 1 μm diam which represent second- to fourth-order

laterals of primary hyphae, sometimes with proliferating hyphae, thus appearing intercalary, walls *ca* 0·2 μm thick, abundant in young cultures on MEA but production decreases as colony becomes older, less common in CMA.

Specimens examined: *Umbelopsis swartii* was isolated only once from a dilution plate prepared from soil gathered from a mature forest of *Eucalyptus regnans* Muell. at Wallaby Creek, 70 km north-north-east of Melborne in June 1985. DAR 53075 is the parent culture of identical single-spore isolates DAR 53076 and 53077. Dried material of DAR 53075 is designated as the holotype. These cultures were also deposited as VPRI 12883, 12884 and 12885.

Umbelopsis westeae sp.nov. (Fig. 2)

Coloniae in agaro extracto-malti velutinae, mycelio substrati denso, margine expandenti submerso regulari 2–2·5 mm lato, sporulatione ponderosa sordide rufa. Sporangiophora biformata: alterum procerius, 400–750 (–1120) μm altum, e radicibus sympodice ramosum, ramis rectis simplicibus, inferne (4–) 5–7 (–8) μm diam, apicem versus ad (2–) 3–4 μm attenuatis; alterum brevius, 110–170 (–230) μm altum, plerumque simplex, rectum aut parte terminali ad angulum 45° deflexum, inferne (3–) 4–6 (–9) μm diam, apicem versus ad 2–4 μm attenuatum. Sporangia plus minusve globosa, (18–) 25–31 (–38) μm diam, sordide rufa, tenuitunicata, in dehiscentia collariculam relinquentia. Columellae subglobosae, (3–) 4–6 (–8) μm diam. Sporangiospora ovoidea clavata, ad extremum angustius usque 0·3 μm manifeste incrassato, perpallide rosea. Chlamydospora hyalina, guttulata, rasilotunicata, triformata, ex hyphis substrati genita; macrochlamydospora plus minusve globosa, (18–) 25–30 (–40) μm diam, parietibus 1–3 μm crassis, intercalaria, raro terminalia; mesochlamydospora ovoidea ellipsoidea, (9–) 14–15 (–18) × (9–) 10–13 (–15) μm, parietibus 0·5–1 μm crassis, terminalia aut intercalaria; microchlamydospora globosa, (5–) 6–9 (–14) μm diam, parietibus circa 0·2 μm crassis, hyphas subtiles brevesque terminantia.

Secretus e solo ericaeo, prope oppidum Frankston, Victoria, Australia, anno Domini 1953; DAR 53079, holotypus.

Colonies on MEA after 12 d attaining 54–57 mm diam; texture velutinous; substrate mycelium dense; margins 2–2·5 mm wide, submerged, regular; sporulation heavy, Dull Red (8B3). On CMA after 12 d measuring 59–60 mm diam; texture velutinous with aerial mycelium consisting of sporangiophores interspersed in a sparse growth of hyphae; substrate mycelium less dense than in MEA; margins 3–4 mm wide, submerged, regular; sporulation light, colour indistinct. *Sporangiophores* borne from primary substrate hyphae measuring 4–9 μm diam, of two types according to height. Tall sporangiophores branching sympodially from bases swollen to 7–15 μm diam; branches (4–) 5–7 (–8) μm diam near base and narrowing to (2–) 3–4 μm diam near tip, (350–) 400–750 (–1120) μm long, septate at wide intervals, unbranched. Short sporangiophores with a swollen base measuring 8–11 μm diam, commonly unbranched, occasionally with one or two tall branches inserted sympodially on the swollen base, (3–) 4–6 (–9) μm diam near base, tapering to 2–4 μm diam near tip, 110–170 (–230) μm long, terminal portion curved to an angle of 45° or remaining straight, with or without a septum located at a short distance from tip, common in marginal areas of young or old colonies on MEA, less common on CMA, and in this medium the terminal portion of the sporangiophore is seldom curved. *Sporangia* of both types of sporangiophores globose to subglobose (18–) 25–31 (–38) μm diam, dull red, walls thin and on dehiscence leaving collarettes. *Columellae* subglobose with tops rounded or slightly flattened (3–) 4–6 (–8) μm diam. *Sporangiospores* oval to clavate with wall at the narrower end distinctively thickened to 0·2–0·3 μm, the thickened wall gives the spore a slightly truncated appearance and it often protrudes laterally from the spore, (4–) 5–6 (–8) × 2–2·5 (–3) μm, individually very light pink, en masse dull red. *Chlamydospores* produced by substrate hyphae, with smooth wall, hyaline, guttulate, of three kinds according to size: macrochlamydospores produced by primary hyphae, globose to subglobose (18–) 25–30 (–40) μm diam, walls 1–3 μm thick, intercalary, rarely terminal, abundant in MEA when colony is older, less common in CMA; mesochlamydospores produced by first-order lateral hyphae, oval to elliptical, (9–) 14–15 (–18) × (9–) 10–13 (–15) μm, walls 0·5–1 μm thick, intercalary or terminal, quite common in MEA, not observed in CMA; microchlamydospores produced terminally on short hyphae of *ca* 1 μm diam which represent second- or third-order laterals, globose, (5–) 6–9 (–14) μm diam, walls *ca* 0·2 μm thick, very common in young colony on MEA, but production decreases as the colony becomes older, less common on CMA.

Specimens examined: *Umbelopsis westeae* was isolated on two occasions, in 1953 from a heathland soil near the township of Frankston, Victoria, by Dr S. Ducker, and in June 1985 from soil of the mature forest at Wallaby Creek by the author.

The Frankston culture was maintained in the Botany School, University of Melbourne, from the isolation date until early 1981 by serial transfers on agar slopes; it was then preserved in sterile distilled water. When the culture was first revived, it sporulated heavily and uniformly, and comparison of the author's notes with an illustration of the fungus drawn by Dr H. J. Swart sometime during

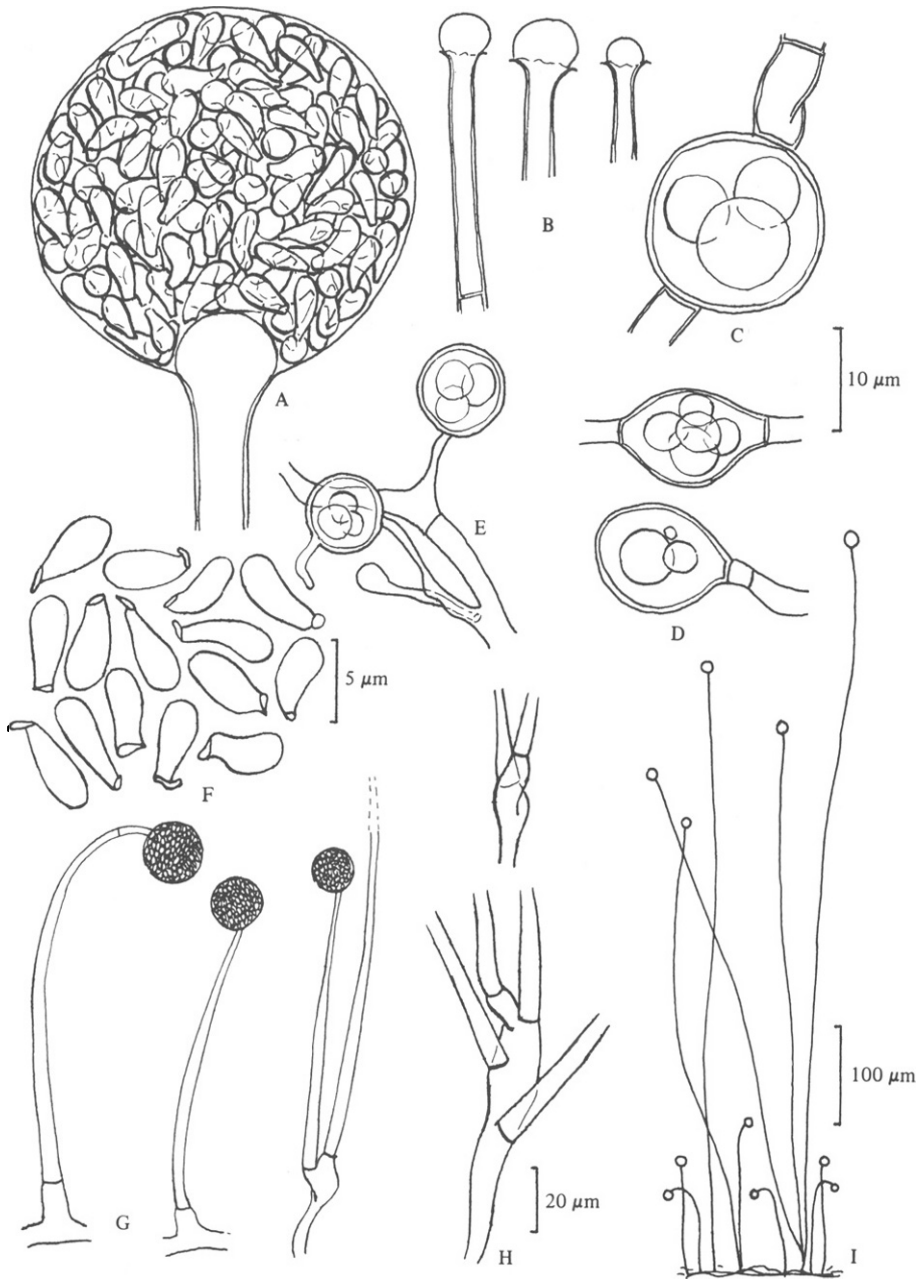

Fig. 2. *Umbelopsis westeae*. (A) Sporangia; (B) columellae; (C, D, E) macro-, meso-, and microchlamydospores; (F) sporangiospores; (G) short sporangiophores; (H) lower portions of tall sporangiophores showing branching habit; (I) habit sketch.

the late 1960s indicated that the culture was morphologically stable. After a few serial transfers on agar the culture, however, segregated into heavy and light sporulating sectors. Microscopic features of all sectors were similar, unlike those of *Mortierella ramanniana* (Möller) Linnem. var. *ramanniana*, which may form spontaneous sectors of *M. ramanniana* var. *autotrophica* Evans (Evans, 1971). Two non-sectoring and heavily sporulating single-spore isolates, DAR 53079 (dried culture as holotype) and DAR 53080 were obtained from the Frankston culture (DAR 53078). These cultures were also deposited as VPRI 12886, 12887, and 12888. The Wallaby Creek isolate of *U. westeae* differs from the type culture by producing sporangiospores with or without the thickened wall at the narrower end of the spore. The parent culture from Wallaby Creek and an identical single-spore isolate were lodged respectively as VPRI 12947 and 12948.

Umbelopsis swartii, *U. westeae*, *U. fusiformis* Yip, and two species of the subgen. *Micromucor*, viz. *Mortierella longicollis* Dixon-Stewart and *M. ramanniana*, with its three accepted varieties (Gams, 1977) are all closely related to one another. These seven fungi have in common two features: pinkish sporangiospores, and sporangiophores which consist of long unbranched branches produced sympodially from a swollen base. Furthermore, these related fungi, with the exception of *M. longicollis*, also produce large, guttulate, thick-walled chlamydospores up to 100 μm diam in abundance. The occurrence of such spores in subgen. *Micromucor* is, however, variable between species and between isolates of the same species (Turner, 1963). The seven related species and varieties of fungi may be differentiated from one another by features of sporangiospores or sporangia. The sporangiospores of *Mortierella ramanniana* varieties *ramanniana*, *angulispora* (Naumov) Linnem., and *autotrophica* are respectively oval to ellipsoidal, angular and globose. *Mortierella longicollis* also has angular spores, but this species is characterized by sporangia with bases extending up to 80 μm into the sporangiophores. The spores of *Umbelopsis fusiformis* are similar in shape to those of *Mortierella ramanniana* var. *ramanniana*, but the former species has fusiform sporangia, whereas those of the latter species are globose. The sporangiospores of the two new species differ from those of each other and also from those of related taxa. *Umbelopsis swartii* has tear-shaped spores, in contrast to those of *U. westeae* which are oval to clavate, with a distinctively thickened wall at the narrower end of the spores.

There is limited information on the short sporangiophores similar to those found in *Umbelopsis swartii* and *U. westeae*, in the subgen. *Micromucor*. Evans (1971) reported the presence of such structures in *Mortierella ramanniana* var. *autotrophica*, but apart from providing measurements of height, other relevant features of the sporangiophores were not furnished. Until further assessment, the taxonomic value of short sporangiophores is uncertain. The short sporangiophores of *U. swartii* and *U. westeae* are, however, characteristic for each of the two species, those of the former are straight or recurved, whereas those of the latter are straight, or curved at an angle of 45°.

The abundance of microchlamydospores in both *U. swartii* and *U. westeae* during the early stages of growth on MEA is striking. These spores borne terminally on short substrate hyphae are reminiscent of the aleuriospores formed by some members of the Hyphomycetes, and are termed gemmae by Linnemann (1941), to differentiate them from macrochlamydospores, which she referred to as giant cells. The abundance of microchlamydospores appears to vary between species and isolates of the same species. *Umbelopsis fusiformis* (DAR 51585, 51605, 51606) and *M. ramanniana* var. *ramanniana* (DAR 45905, 51607) produce microchlamyospores sparsely, and although the type culture of *U. westeae* produce such spores prolifically, a different isolate of the same fungus (VPRI 12947) produces the spores in limited number.

Umbelopsis swartii and *U. westeae* are named respectively for Drs H. J. Swart and Gretna Weste, both of the School of Botany, University of Melbourne where this work was completed. I wish to thank these two outstanding mycologists for their invaluable advice and support during the preparation of this paper. I am grateful to Dr Walter Gams of C.B.S., Baarn, The Netherlands, for advice on taxonomy, and to Mr Peter Robins for rendering the Latin descriptions. This work represents part of a study on the rhizosphere micro-organisms of *Eucalyptus regnans* with research grants provided by the Melbourne Metropolitan Board of Works and the Forests Commission of Victoria.

REFERENCES

ARX, J. A. VON (1982). On Mucoraceae s.str. and other families of the Mucorales. *Sydowia* **35**, 10–36.

BLAKESLEE, A. F. (1915). Linder's roll tube method of separation culture. *Phytopathology* **5**, 68–69.

EVANS, H. E. (1971). Studies on *Mortierella ramanniana*. I. Relationship between morphology and cultural behaviour of certain isolates. *Transactions of the British Mycological Society* **56**, 201–216.

GAMS, W. (1977). A key to the species of *Mortierella*. *Persoonia* **9**, 381–391.

KORNERUP, A. & WANSCHER, J. H. (1978). *Methuen Handbook of Colour*, 3rd edn. London: Eyre Methuen.

LINNEMAN, G. (1941). *Die Mucorineen-Gattung Mortierella* Coemans. G. Fischer, Jena (PflForsch., H23).

PARKINSON, D. & GROUCH, R. (1969). Studies on fungi in a pinewood soil. V. Root mycoflora of seedlings of *Pinus nigra* var. *laricio*. *Revue d'ecologie et de biologie du sol* **6**, 263–273.

TURNER, M. (1963). Studies in the genus *Mortierella*. I. *Mortierella isabellina* and related species. *Transactions of the British Mycological Society* **46**, 262–272.

YIP, H. Y. (1986). *Umbelopsis fusiformis* sp.nov. from a wet sclerophyll forest and a new combination for *Mortierella ovata*. *Transactions of the British Mycological Society* **86**, 334–337.

(*Received for publication 6 March 1986*)