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A NEW AND UNUSUAL SPECIES OF *PIPTOCEPHALIS* (MUCORALES)

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A new species, *Piptocephalis pseudocephala*, lacking a true head cell is described and compared with other typical and atypical members of the genus. The merosporangia are borne on terminal enlargements formed at the apices of the ultimate branches of the sporophore.

The genus *Piptocephalis* was established by de Bary (1865) with a single species, *P. freseniana* de Bary. Van Tieghem & Le Monnier (1873) and Van Tieghem (1875) described six additional species and subsequent authors have added a further nineteen species and three varieties (Baijal & B. S. Mehrotra, 1968; Bainier, 1882; Benjamin, 1959, 1963, 1966; Beyma, 1944; Dobbs & English, 1954; Krzemieniewska & Badura, 1954; Kuzuha, 1976; Leadbeater & Mercer, 1957; Mangin, 1899; Marchal, 1891; Matruchot, 1900; B. R. Mehrotra & Kakkar, 1970; B. S. Mehrotra, 1960; B. S. Mehrotra & Baijal, 1964; Mukerji, 1968; Richardson & Leadbeater, 1972; Schroeter, 1886; Vuillemin, 1887, 1902).

The genus is characterized by the production of dichotomously divided sporophores which usually form, at the branch apices, a sterile deciduous head cell bearing many uniseriate merosporangia containing a variable number of spores which remain dry or form a liquid drop at maturity. The deciduous head cell undoubtedly inspired de Bary to call his new genus *Piptocephalis* from the Greek 'pipto', to fall and 'kephale', head.

All known species are reported to be mycoparasitic with little or no axenic growth and having a host range which, except in one species, is apparently restricted to certain species of Mucorales (Bainier, 1907; Berry & Barnett, 1957; Brefeld, 1872; Leadbeater & Mercer, 1957; Matruchot, 1900, 1903; Richardson & Leadbeater, 1972; Van Tieghem, 1875; Van Tieghem & Le Monnier, 1873). The only species known to have a host range outside the Mucorales is the aptly named *P. xenophila* Dobbs & English (etym.: from the Greek 'xeno', a stranger and 'phila', loving) which has been shown to parasitise certain Ascomycetes and Fungi Imperfecti (Dobbs & English, 1954).

Several species of *Piptocephalis* have now been described which do not exhibit all the morphological characteristics of the genus as conceived by de Bary and the earlier students of these fungi. The first of these anomalous species was described by Embree (1962) as belonging to *Chaetocladium* Fresenius (1863) but was transferred to *Piptocephalis* when Benjamin (1963) recognised its true affinities. In this species, *P. benjaminii* (Embree) Benjamin, head cells are lacking, merosporangia are typically monosporous and are borne singly on small apiculi terminating the ultimate branches of the sporophore.

Piptocephalis indica B. S. Mehrotra & Baijal (1964) was described as a new microcephalous species possessing a small heart-shaped head cell, but was subsequently shown (Benjamin, 1966) to lack a true head cell. What had been interpreted by the publishing authors as a head cell was in fact the basal spore of a branched merosporangium which had retained the ability to germinate, a condition similar to that found in many species of *Syncephalis* (Van Tieghem & Le Monnier, 1873; Van Tieghem, 1875), a closely related genus (Benjamin, 1959). Benjamin (1966) described a further monosporous species, *P. unispora* Benjamin, which has a characteristic deciduous head cell. The ultrastructure of this species has been the subject of a detailed study by Jeffries & Young (1975*a*, *b*, 1976*a*, *b*) who came to the conclusion that the typically monosporous merosporangium could be considered as a sporangiospore showing conidial tendencies.

Piptocephalis fimbriata Richardson & Leadbeater (1972), a species with relatively fine and delicate sporophores, possesses a head cell which is lytic at maturity leaving only remnants at the tips of the ultimate branches. The spores of this species are liberated in liquid drops. In *P. minuta* Kuzuha (1976), another species with relatively fine and delicate sporophores, a head cell is completely lacking as in *P. indica*. The simple or sometimes bifurcate merosporangia are produced singly on the apex of each ultimate branch of the sporophore. The species *P. dichotomica* Krzemieniewska &

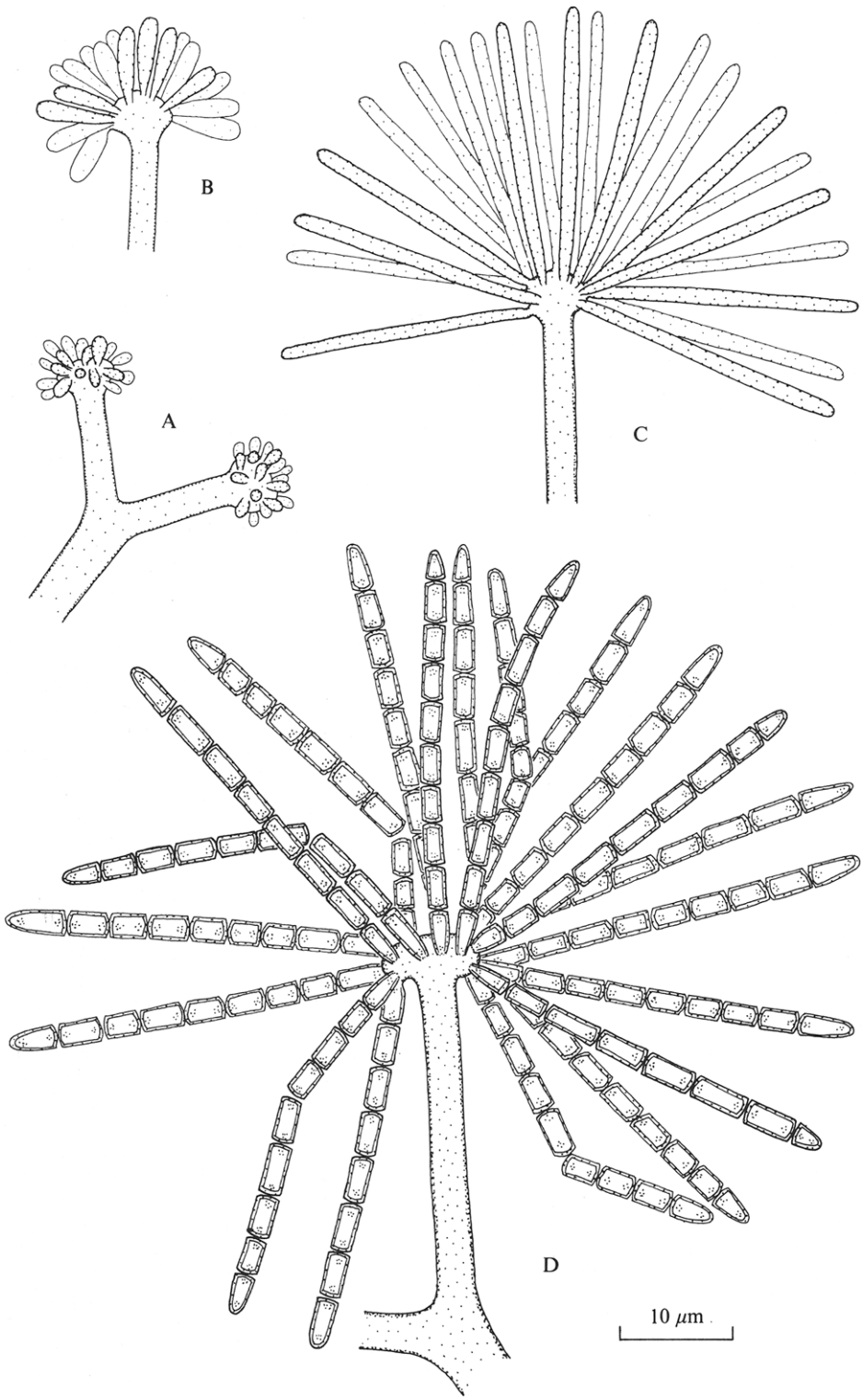

Fig. 1. *Piptocephalis pseudocephala*. A, Terminal dichotomy of sporophore showing initial stages of developing merosporangia (× 1620). B–C, Successive stages in development of merosporangia (× 1620). D. Mature merosporangia on terminal enlargement (× 1620).

Badura (1954) also apparently lacks a head cell as no mention was made of one in the very brief description.

The purpose of this paper is to describe an additional, atypical species of *Piptocephalis* which was isolated from leaf litter. Colours cited with quotation marks are those of Rayner (1970). Following Benjamin (1959), *Cokeromyces recurvatus* Poitras is used as the standard host for this new species.

TAXONOMY

Piptocephalis pseudocephala P. M. Kirk sp. nov. (etym. Greek, 'pseudes', false + 'kephale', head)

Coloniae in *Cokeromyces recurvatus* bubalinum, 6 mm altae; hyphis vegetativis submersis, hyalinis, ramosis, 1–2·5 μm diam, septatescens; septatis simplex; sporophoris erectis, ascendentibus, raro procumbentibus et stoloniformis; stipes principalibus 2–5 μm diam in partis inferioribus, hyalinis, laevis, septatescens; septatis perforare, aperturae cum tubularis extensionis in cursus apicis; stipes principalibus 6–8 μm diam in partis distalis, non septatis, laevis, in aetate indistincte striatis longitudinaliter; fertilis ramis systema constans ex usque ad septem successivus dichotomis qui gradatim brevis et agustis; ramis ultimis 2–60 μm longis, 2–3 μm latis; merosporangiis portatis in amplificationibus terminalibus, deciduis cellulis capitalibus nullis; amplificationibus terminalibus 6–11 μm (med. 8·5 μm) diam, depressis-globosis, incisis et distinctis projecturis formantibus, saepe cum duo distinctis lobis et tum aspectibus bifurcatis, praeditis 11–25 (med. 18) bacilliformis merosporangiis; merosporangiis formantibus (5)8–10(14) (med. 9) cylindricis sporis (2)3·5–4·5(8) × 2(2·5) μm (med. 4 × 2 μm); sporis capitulis reliquis siccis; zygosporis ignotis. Ex folium humus *Fagi sylvaticae* L., Windsor Great Park, Berks., England, lecto et sejuncto a P. M. Kirk (0758), 20 Mar. 1976, IMI 210884 holotypus, RSA 2193 isotypus.

Colonies on *Cokeromyces recurvatus* on MEA after 14 days at 18–20° 'buff', forming a turf up to 6 mm or more deep; vegetative hyphae usually submerged, hyaline, branched, mostly 1–2·5 μm diam, becoming septate; septa simple; sporophores erect or ascending, rarely becoming prostrate and stolon-like; the lower portion of the main stalk 2·5–5 μm diam, hyaline, smooth, becoming septate; septa often perforate, the apertures with tubular extensions in the direction of the apex; the distal portion of the main stalk more robust, 6–8 μm diam, this and the branches of the fertile region non-septate, smooth, becoming indistinctly longitudinally striate in age; the fertile branch system consisting of up to seven successive dichotomies; the primary dichotomy of the fertile branch system usually consisting of either long or short branches; where two long branches, 150 μm to as much as 700 μm in length, are produced, these are followed by four or five successive dichotomies which are progressively shorter and narrower; where short primary branches, up to 50 μm or more in length, are present, either one short and one long or two short, each give rise to two long branches, 140–480 μm or more in length, followed by four or five successive dichotomies which are progressively shorter and narrower; occasionally short or long primary branches are absent, these fertile branch systems consisting of four or five successive dichotomies which are progressively shorter and narrower; ultimate branches 2–60 μm long by 2–3 μm wide; merosporangia borne on terminal enlargements, deciduous head cells absent; terminal enlargements 6–11 μm (average 8·5 μm) diam, depressed-globose, incised and forming distinct projections, often with two distinct lobes and then appearing bifurcate, bearing 11–25 (average 18) slender, rod-shaped merosporangia; the latter forming (5)8–10(14), (average 9) smooth, hyaline (pale brown in mass), cylindrical spores (2)3·5–4·5(8) × 2(2·5) μm (average 4 × 2 μm); spore heads remaining dry; zygospores unknown.

Specimens examined. England. Berks., Windsor Great Park, isolated from Beech (*Fagus sylvatica* L.) leaf litter, 20 Mar. 1976, P. M. Kirk (0758), IMI 210884 Holotype, RSA 2193 Isotype; isolated from Birch (*Betula pedula* Roth.) leaf litter, 20 Mar. 1977, P. M. Kirk (0759), IMI 210863, RSA 2194. Lancashire, Merlewood Research Station, Grange-over-Sands, parasitic on *Mortierella ramanniana* (Möller) Linnemann, isolated from millipede droppings, 27 Nov. 1964, T. F. Hering (J 40), IMI 110529a.

DISCUSSION

In many respects *P. pseudocephala* is a typical member of the genus *Piptocephalis*. It produces erect, dichotomously divided sporophores (Fig. 2E) which form, at the branch apices, many chains of uniseriate merosporangia containing several spores (Figs. 1A–D, 2C). The branching pattern of the sporophore (Fig. 2E) is similar to that found in *P. cylindrospora* Bainier (1882, see Benjamin, 1959, p. 350). The dry-spored nature of the sporing heads and length of the spore chains also recall this species. However, the sporophores are less robust and there are fewer merosporangia in each sporing head than is found in *P. cylindrospora*. The absence of a deciduous head cell which is replaced by a terminal enlargement (Fig. 2A, B) at once distinguishes *P. pseudocephala* from any previously described species. The terminal enlargements resemble the lobed head cells characteristic of the macrocephalous species such

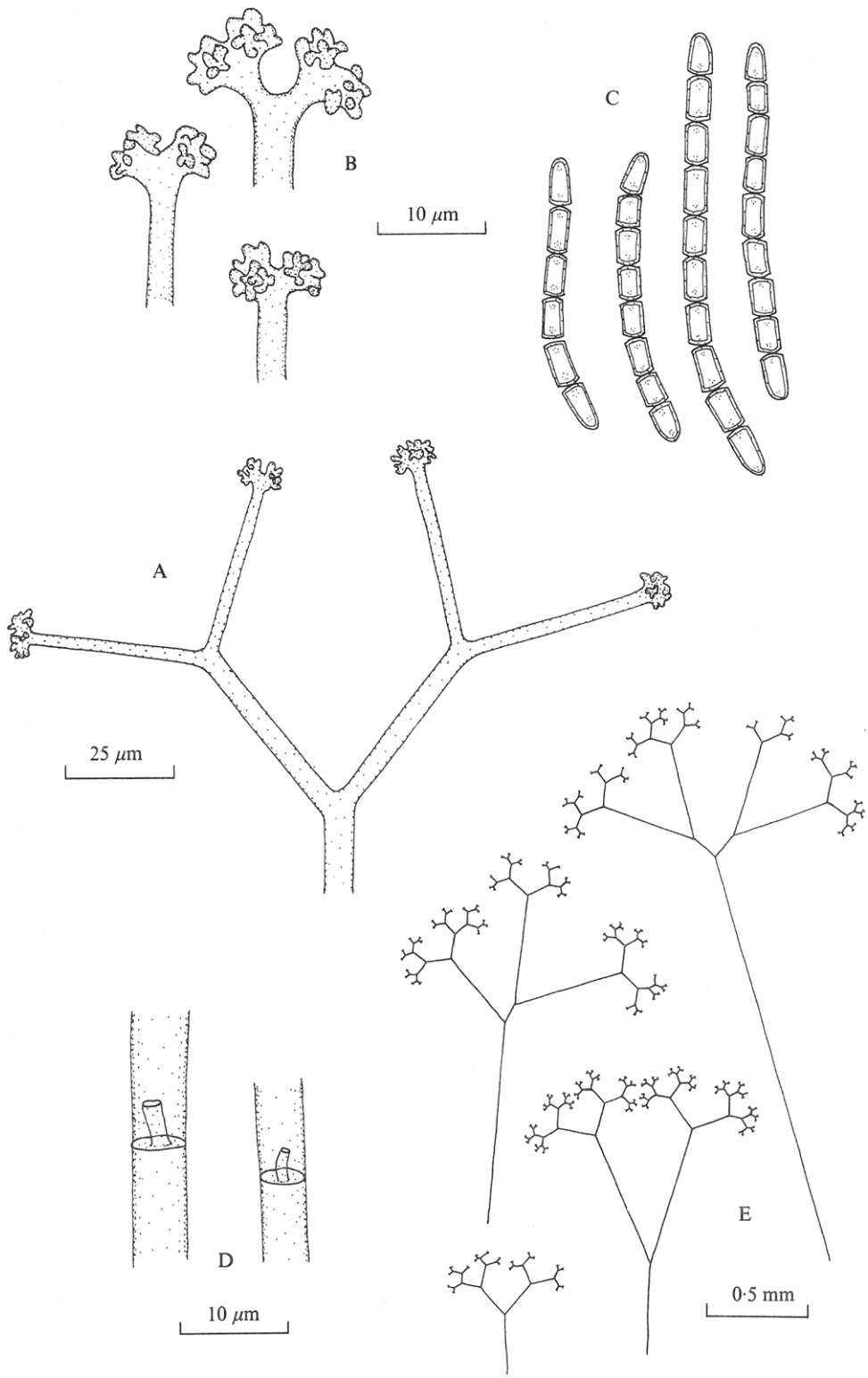

Fig. 2. *Piptocephalis pseudocephala*. A, Ultimate branches of sporophore showing terminal enlargements (×650). B, Terminal enlargements (×1620). C, Chains of spores which often remain intact at maturity (×1620). D, Septa from basal portion of sporophore with tubular extensions (×1620). E, Habit sketch showing variation in the branching pattern of the sporophore (×30).

as the dry-spored *P. arrhiza* Van Tieghem & Le Monnier (1873) and the wet-spored *P. freseniana* but are somewhat smaller in size.

P. pseudocephala, like all other members of the genus, is apparently an obligate mycoparasite. The spores swell on suitable media and produce one to several fine germ tubes but further growth has not been observed unless a susceptible host was present. In the presence of such a host the germ tubes grow in the direction of the host hyphae and on contact may form small appressoria which produce delicate branched haustoria. Subsequent growth establishes the mycoparasite and the colony of the host, in the case of *C. recurvatus*, is almost completely obscured. Vegetative growth and sporulation of the host are apparently unaffected. Dwarf sporophores, similar to those reported for some other species of *Piptocephalis* (Benjamin, 1959; Berry & Barnett, 1957; Leadbeater & Mercer, 1957; Richardson & Leadbeater, 1972) have not been observed in *P. pseudocephala*. An extensive host range investigation has not been carried out.

A further species of *Piptocephalis* lacking a true head cell and bearing merosporangia on a terminal enlargement is known but is not yet formally described (Benjamin, 1959, p. 338). It is characterized by the production of relatively large amounts of aerial mycelium, fine and delicate sporophores and two-spored merosporangia which are liberated in liquid drops (i.e. wet-spored). It is also reported to be a vigorous parasite often preventing host sporulation and reducing vegetative growth. The taxonomy and physiology of this species were studied by Morris (1965).

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