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New species of dictyostelid cellular slime moulds from Australia

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Abstract. During the 2001–2006 field seasons, samples for isolation of dictyostelid cellular slime moulds were collected at several localities in Queensland, the Northern Territory, Western Australia and Victoria. The majority of these samples were collected from the soil–litter layer on the ground, but some additional samples were obtained from the layer of organic matter ('canopy soil') associated with the bases of vascular epiphytes on the trunks and branches of trees in the tropical forests of northern Queensland. Many of the forms recovered from these samples could be assigned to described taxa, including such cosmopolitan species as *Dictyostelium mucoroides*, *Polysphondylium pallidum*, *P. violaceum* and *D. giganteum*. However, several others appear to represent new species, and eight of these (*D. boomeransporum*, *D. flexuosum*, *D. granulosum*, *D. myxobasis*, *D. radiculatum*, *D. rotatum*, *P. australicum* and *P. stolonicoideum*) are described herein. The large number of apparently undescribed forms suggests that the dictyostelid biota of Australia is relatively distinct when compared with that of any other continent.

Introduction

Dictyostelid cellular slime moulds (dictyostelids) are single-celled, eukaryotic, phagotrophic bacterivores usually present and often abundant in terrestrial ecosystems. These organisms represent a normal component of the microflora in soils and play a role in maintaining the natural balance that exists between bacteria and other microorganisms in the soil environment. For most of their life cycle, dictyostelids exist as separate, independent, amoeboid cells (myxamoebae) that feed on bacteria, grow, and multiply by binary fission. When the available food supply within a given microsite becomes depleted, numerous myxamoebae aggregate to form a structure called a pseudoplasmodium, within which each cell maintains its individual integrity. The pseudoplasmodium then produces one or more fruiting bodies (sorocarps) bearing spores. Dictyostelid fruiting bodies are microscopic and rarely observed except in laboratory culture. Under favourable conditions, the spores germinate to release myxamoebae, and the life cycle begins anew (Raper 1984).

The continent of Australia, with a total extent of ~7 682 300 km^2, covers ~5% of the earth's land area. Most of the continent is low, flat and dry; deserts, dry grasslands and woodlands are the predominant vegetation types. There have been few reports of dictyostelids from Australia. In an unpublished MSc thesis, Robson (1978) reported eight different forms that were recovered from samples collected in New South Wales, the Australian Capital Territory and Queensland. These consisted of a member of the *D. mucoroides* complex, *D. minutum*, *D. purpureum*, a form similar to *D. lacteum*, an unknown form suggestive of *D. polycephalum*, another unknown form with brown pigmentation, *Polysphondylium pallidum* and *P. violaceum.* Later, Hohl (pers. comm. with J. Landolt) isolated three species (*D. mucoroides*, *P. pallidum* and *P. violaceum*) from samples collected in Queensland. In what apparently represents the first publication dealing specifically with Australian dictyostelids, albeit not from the continent itself, Stephenson *et al*. (1998) reported *D. mucoroides* var. *stoloniferum* from subantarctic Macquarie Island. Collectively, these studies provided relatively little data on the distribution and occurrence of dictyostelids in Australia. The primary objective of the present study was to carry out surveys for these organisms at several localities throughout the continent in an effort to develop the first appreciable body of information on what is an understudied group for this region of the world.

Materials and methods

The surveys that yielded the records reported in the present paper were carried out during a period extending from May 2001 to March and April of 2004, with a few additional samples obtained in June 2006. Samples were collected from more than 30 localities and/or habitats that represented a variety of different vegetation types in Queensland, the Northern Territory, Western Australia and Victoria. Particular emphasis was placed on the tropical forests of northern Queensland. The majority of samples were collected from the soil–litter layer on the ground, but some additional samples were obtained from

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the layer of organic matter ('canopy soil') associated with the bases of vascular epiphytes on the trunks and branches of trees in the tropical forests of northern Queensland (Stephenson and Landolt 1998; Stephenson *et al*. 2004). Some of these samples were collected at heights of more than 20 m above the forest floor. The number of samples obtained at a particular collecting locality ranged from one to 20–25. All samples were placed in sterile plastic bags and returned to the laboratory. Samples were processed as soon as possible following collection, by the procedures described by Cavender and Raper (1965). A final soil dilution of either 1 : 10 or 1 : 25 was used for all samples. Culture plates were incubated under diffuse light at 10–25°C. Each plate was carefully examined at least once a day for several days, following appearance of initial aggregations and the location of each aggregate colony marked. When necessary, particular isolates were subcultured to facilitate identification. Nomenclature used herein follows that of Raper (1984).

Results

The 223 samples collected during the entire survey effort yielded a total of 697 clones. Many of these could be assigned to described taxa, including such cosmopolitan species as *D. mucoroides*, *P. pallidum*, *P. violaceum* and *D. giganteum*. However, a significant number of others appear to represent species new to science, eight of which are described below. An isolate of each of these was deposited in the American Type Culture Collection (ATCC) in Manassas, Virginia. At ATCC, all of the isolates were placed in liquid nitrogen vapor to preserve them in a metabolically inactive state.

Taxonomy

Dictyostelium boomeransporum Cavender, Vadell, J.C. Landolt et S.L. Stephenson, *sp. nov.*

Sorocarpia in agaro nonnutricio cum *E. coli* ad 20°C culta plerumque fasciculata, erecta vel prona vel decumbentia, sigmoidea, extremitate inferiore interdum prostrata, 0.5–1 mm alta, raro altioria, parum phototropica, interdum ramulis irregulariter dispositis. Sorophorum e serie cellularum unica constans, parte superiore muco denso et cellulis lateralibus non differentiatis saepe interrupta. Apices oblongi vel piliformes (2–5 µm). Sori parvi globosi albi 30–60 µm in diametro, sporis non facile discedentibus. Bases clavatae, in cellula apiculata unica terminantes, ubi solitariae pulvino minuto muci densi fusci insidentes, 5–7 µm in diametro. Sporae propriae, longe ellipticae, saepe curvata ad instar 'boomerang' praesertim in culturis veterioribus, vulgo granulis polaribus cohaerentibus, 4–9.5 × 2–3.5 µm (mediana magnitudine 7.42 × 2.66 µm), plerumque 6.5–8 × 2.5–3 µm. Sorogena fasciculata elongata sigmoidea irregularia. Aggregationes parvae irregulares, rivulis tenuibus dendroideis in rivulos maiores pseudoplasmodiales coeuntibus, 400–800 µm in diametro, ordinatione sustenta donec sorogena praecocia oriuntur. Myxamoebae parvae vacuolis parvis, 5–8 × 4–5 µm, uniformes fuscae.

Holotypus: Australia: Queensland: School for Field Studies on the Atherton Tablelands near Yungaburra, 17°12′19″S, 145°40′47″E, July 2002, isolate K26B (MYA-3802 in ATCC).

Sorocarps generally clustered, erect, prone to decumbent, sigmoid, sometimes prostrate at the lower end, height 0.5–1 mm, rarely more, slightly phototropic, sometimes with irregularly spaced branches, when cultured at 20°C on non-nutrient agar with *E. coli* (Fig. 1*G*). Sorophore consisting of one tier of cells, often with the upper part interrupted by dense slime and undifferentiated lateral cells (Fig. 1*D*). Tips oblong to piliform (2–5 µm) (Fig. 1*D*). Sori small, globose, white, 30–60 µm diam, with spores that do not detach easily. Bases clavate, terminated in one apiculate cell, when solitary occurring on a minute cushion of dense dark slime, 5–7 µm diameter (Fig. 1*C*). Spores distinctive, long elliptical, often curved and boomerang-shaped, especially in older cultures, generally with consolidated polar granules, 4–9.5 × 2–3.5 µm (median: 7.42 × 2.66 µm), commonly 6.5–8 × 2.5–3 µm (Figs 1*E*, 3). Clustered sorogens elongated and sigmoid, irregular (Fig. 1*B*). Aggregations small, irregular, with thin dendroid streams that converge into larger voluminous pseudoplasmodial streams, 400–800 µm diam, the pattern maintained until early sorogens arise (Figs 1*A*, *B*, 2). Myxamoebae small, with small vacuoles, 5–8 × 4–5 µm, uniform and dark (Fig. 1*F*).

Distribution and ecology

Dictyostelium boomeransporum was isolated from a sample of ground soil collected in a complex mesophyll vine forest located on a very wet uplands site on the Atherton Tablelands. This is the only known locality for the species.

Etymology

Refers to the shape of a 'boomerang', a hunting tool of the natives of Australia, known worldwide.

Notes

Dictyostelium boomeransporum is unique as a result of the combination of its small size, type of aggregation, and the shape of the spores. The spores are very large when one takes into consideration the small sorocarp size. Moreover, the spores are relatively long and thin (4–9.5 × 2–3.5 µm, median 7.42 × 2.66 µm) as compared to those of the larger, well known PG+ species *D. aureostipes*, in which the spores are mostly 5–6.9 × 2.5–3.6 µm. Many of the spores also become boomerang-shaped in older cultures. This feature is seen occasionally in other species but not to the same degree. The dense streams that form a very pronounced pseudoplasmodium (Fig. 2) are also distinctive.

Dictyostelium flexuosum Cavender, Vadell, J.C. Landolt et S.L. Stephenson, *sp. nov.*

Sorocarpia culta in agaro nonnutricio cum *E. coli* ad 20°C fasciculata vel solitaria, plerumque erecta, 0.4–1.8 mm alta, debilia eramosa, sorophoris helicoideis. Sorophora e serie

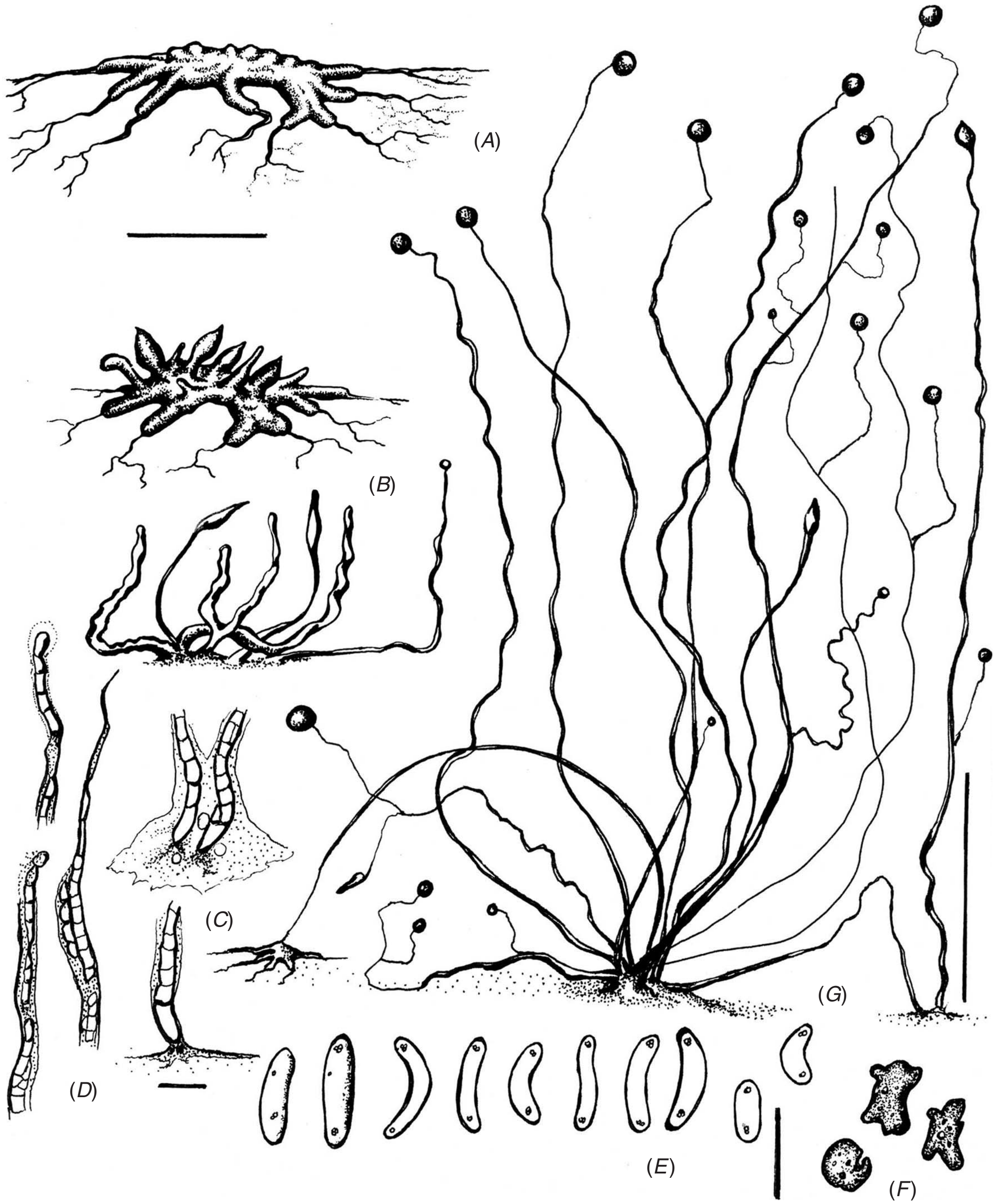
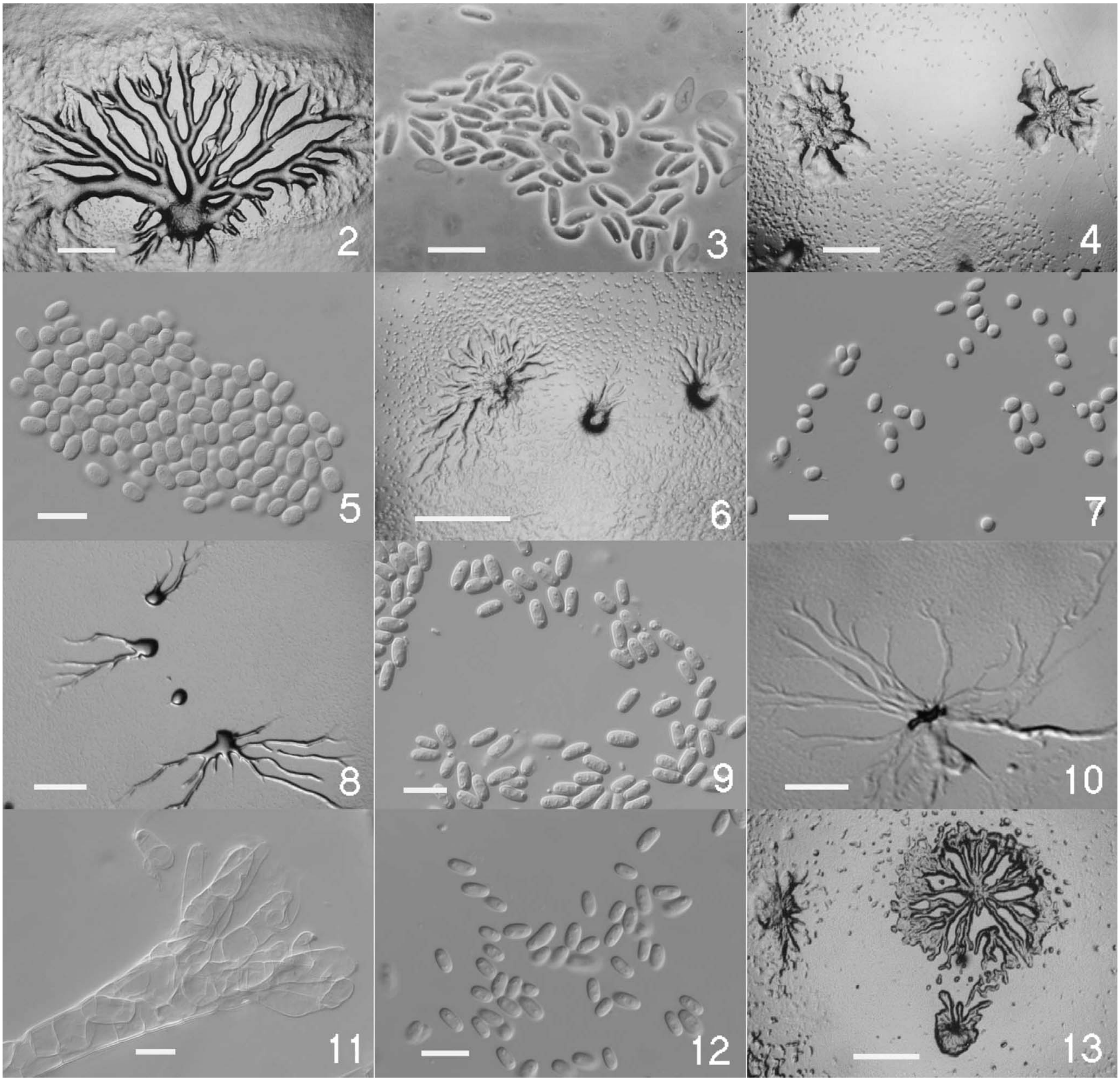


Fig. 1. Features of *Dictyostelium boomeransporum*. (*A*) Aggregations with thin terminal streams that frequently form voluminous central streams. (*B*) Early clustered (above, within a late aggregation) and late (below) sigmoid sorogens. (*C*) Clustered unicellular clavate bases with supporter cells (above) and a simple clavate base with a dense matrix of slime (below). (*D*) Uniseriate interrupted sorophores and piliform tip (right). (*E*) Elliptical boomerang-shaped spores with consolidated polar granules. (*F*) Myxamoebae. (*G*) Tightly clustered sorocarps, with stoloniferous habit (left and right). Scale bars: *A*, *B* = 250 µm; *C*, *D* = 8 µm; *E*, *F* = 7 µm; *G* = 0.3 mm.

cellularum unica constantia, irregularia, saepe angustata usque ad 2 µm in quibusdam partibus. Bases rotundae vel clavatae cellulis sustinentiis arcte affixis, pulvino muci densi refractilis, 10–40 µm in diametro. Cellulae sustinentes interdum basem magnam 50–70 µm in diametro formantes. Apices simplices vel compositi (3–10 µm), interdum obtusi. Sori globosi albo-hyalini 100–150 µm in diametro, sporis non facile discedentibus. Sporae minimae latae elliptico-oblongae, granulis multis incohaerentibus per totum corpus dispositis, 3.5–5 × 3–4 µm (mediana magnitudine 4.52 × 3.63 µm),



Figs 2–13. Morphological features of the new species of dictyostelids from Australia. **Fig. 2.** Aggregation of *Dictyostelium boomeransporum*. Note the dentritic streams. Scale bar = 100 µm. **Fig. 3.** Long and frequently curved PG+ spores of *D. boomeransporum*. Scale bar = 10 µm. **Fig. 4.** Two small, irregularly mounded aggregations of *D. flexuosum*. Scale bar = 0.5 mm. **Fig. 5.** Relatively small spores of *D. flexuosum*. Note the widely distributed, numerous unconsolidated granules. Scale bar = 10 µm. **Fig. 6.** Small, irregularly radiate aggregations of *D. granulosum*. Scale bar = 0.5 mm. **Fig. 7.** Spores of *D. granulosum*. Note the relatively small size and the mostly polar, unconsolidated granules. Scale bar = 10 µm. **Fig. 8.** Radiate aggregations of *D. myxobasis*. Note the dendroid streaming. Scale bar = 0.5 mm. **Fig. 9.** Relatively large elliptical spores of *D. myxobasis*. Note the prominent polar granules. Scale bar = 10 µm. **Fig. 10.** Flattened radiate aggregation of *D. radiculatum*. Note the numerous dendroid streams. Scale bar = 0.5 mm. **Fig. 11.** Well developed digitate, crampon-like base of a sorophore in *D. radiculatum*. Scale bar = 10 µm. **Fig. 12.** Elliptical spores of *D. radiculatum,* usually with prominent polar granules. Note the variable size of the spores. Scale bar = 10 µm. **Fig. 13.** Small aggregation of *D. rotatum*. Note the numerous blunt, short streams. Scale bar = 0.3 mm.

plerumque 4.5 × 3 µm. Microcystae praesentes granulis 1–2. Sorogena parva primum helicoidea, demum elongata, recurvantia et nutantia. Massa muci luteoli remanens juxta sorogena et bases sorocarpiorum maturorum. Aggregationes primum parvae, 150–250 µm in diametro, tumulos irregulares facientes et dense dispositae, dein aliquot rivulos breves adquirentes. Aggregationes parvae conjungentes in unam aggregationem majorem, 400–800 µm in diametro.

Myxamoebae densae vacuolo singulo, 7–15 × 5–6 µm, e sporis sororum superiorum interdum germinantes.

Holotypus: Australia: Victoria: Jehosaphat Gulley in Kinglake National Park 50 km NE of Melbourne, 37°32′13″E, 145°21′06″E, March 2004, isolate AV4B (MYA-3807 in ATCC).

Sorocarps clustered to solitary, mostly erect, height 0.4–1.8 mm, weak, unbranched, with helicoidal sorophores,

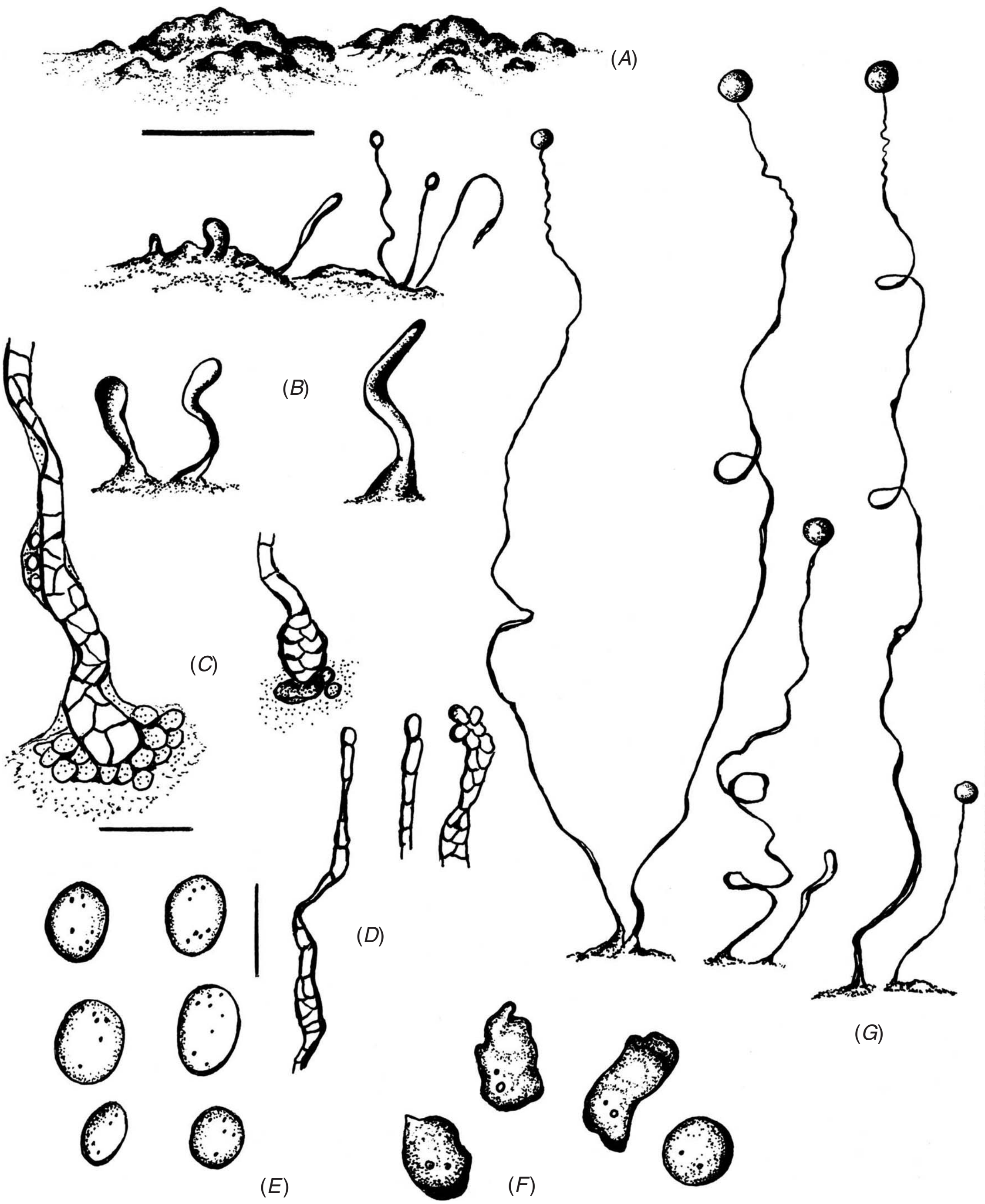


Fig. 14. Features of *Dictyostelium flexuosum*. (*A*) Early irregular mound-like aggregations. (*B*) Early (above) and late (below) sorogens with dense masses of slime at the bases. (*C*) Round to clavate bases, each with supporter cells and a cushion of refractile slime. (*D*) Simple oblong (left) and amorphous compound (right) tips. (*E*) Wide elliptical–oblong spores with sparse unconsolidated granules. (*F*) Myxamoebae (left, middle) and microcyst (right). (*G*) Helicoidal clustered (left) and solitary (right) sorocarps. Scale bars: *A*, *B* = 0.4 mm; *C*, *D* = 25 µm; *E*, *F* = 5 µm; *G* = 0.4 mm.

when cultured at 20°C on non-nutrient agar with *E. coli* (Fig. 14*G*). Sorophores consisting of one tier of cells, irregular, often narrowed to 2 µm at certain sections, with supporter cells alongside; curved and with a dense layer of slime at certain points, then helicoidal and sigmoid. Bases round to clavate, with tightly attached supportive cells and, when smaller, with a cushion of dense refractile slime, 10–40 µm diameter. Supporter cells may form a large base 50–70 µm diameter (Fig. 14*C*). Tips simple to compound (3–10 µm), sometimes obtuse (Fig. 14*D*). Sori globose, white–hyaline, 100–150 µm diameter, not allowing the spores to be freed easily. Spores very small, wide, elliptical–oblong, with numerous unconsolidated granules spaced throughout the spore body, 3.5–5 × 3–4 µm (median: 4.52 × 3.63 µm), mostly 4.5 × 3 µm (Figs 5, 14*E*). Microcysts present, these with 1–2 granules present. Sorogens small, at first helicoid and then elongated and curved upside down (Fig. 14*B*). A mass of yellowish slime remaining adjacent to the sorogens and the bases of mature sorocarps. Aggregations small at first, 150–250 µm diameter, forming irregular mounds and densely settled, then acquiring some short streams (Fig. 4). Small aggregations join to form a larger one 400–800 µm diameter (Fig. 14*A*). Myxamoebae dense, with one vacuole, 7–15 × 5–6 µm, they may germinate from spores in the upper sori (Fig. 14*F*).

Distribution and ecology

Dictyostelium flexosum was isolated from a sample of ground soil collected in a forest dominated by *Eucalyptus regnans*. This is the only known locality for this species. However, habitats similar to the type locality occur elsewhere in south-eastern Australia, so it seems likely that the species will be recorded from other localities if the appropriate surveys are carried out.

Etymology

Refers to the helicoidal development and sorocarp architecture that resembles a spring.

Notes

Dictyostelium flexuosum can be distinguished from any other species by the helicoid habit of its sorophore and sorogens, the refractile unconsolidated granules of the small, oblong spores and by the dense yellowish slime at the base. In contrast to *D. boomeransporum*, the spores are smaller and more oval, with a dispersed granulation. The aggregation is also markedly different, being much more mound-like with only short streams.

Dictyostelium granulosum Cavender, Vadell, J.C. Landolt et S.L. Stephenson, *sp. nov.*

Sorocarpia in agaro nonnutricio cum *E. coli* ad 20°C culta plerumque laxe fasciculata, erecta vel prona, 0.25–1 mm alta, debilia eramosa, plerumque cadentia in mucum basalem et pro fundamento sorocarpiorum recentiorum se gerentia. Sorophora e serie cellularum unica constantia, irregularia, saepe angustata usque ad 2 µm in quibusdam partibus. Bases cellulis sustinentibus affixis separatisque et matricibus muci densis refractilibus instructae, 35–40 µm. Apices simplices (3–4 µm), saepe obtusi extremitatibus piliformibus. Sori globosi albo–hyalini 40–60 µm in diametro, sporis non facile discedentibus. Sporae parvae latae elliptico-oblongae, granulis multis incohaerentibus interdum in magna parte corporis dispositis sed plerumque polaribus, 5–6.5 × 3–4 µm (mediana magnitudine 5.34 × 3.50 µm), plerumque 5 × 3.5 µm. Microcystae praesentes, ad aequatorem irregulariter dehiscentes. Sorogena parva irregularia, demum elongata, massam densam ad bases sorocarpiorum relinquentia, sorocarpia tenentem et soros a se magis separatos fieri sinentem. Aggregationes primum parvae, 150–250 µm in diametro rivulis brevibus, dein amplitudinem ultimam tarde attingentes, irregulariter radiatae rivulis dendroideis. Aggregationes parvae conjungentes in unam aggregationem majorem, 400–800 µm in diametro. Myxamoebae densae vacuolo singulo, 7–12 × 4–5 µm, per tempora longa remanentes non aggregatae.

Holotypus: Australia: Western Australia: Shannon National Park 300 km S of Perth, 34°46′59″S, 116°11′30″E, June 2003, isolate MF5A (MYA-3809 in ATCC).

Sorocarps mostly loosely clustered, erect to prone, height 0.25–1 mm, weak, unbranched, when cultured at 20°C on non-nutrient agar with *E. coli* (Fig. 15*I*). Sorocarps often fall in the basal slime, serving as a support for later sorocarps. Sorophores consisting of one tier of cells, irregular, often narrowed to 2 µm in certain sections. Bases with attached and detached supportive cells and refractile dense matrices of slime, 35–40 µm (Fig. 15*C*). Tips simple (3–4 µm), often obtuse and with piliform ends (Fig. 15*D*). Sori globose, white–hyaline, 40–60 µm diameter, not allowing the spores to be freed easily. Spores small, wide, elliptical–oblong, with numerous unconsolidated granules sometimes spaced throughout much of the spore body, but mostly at the poles, 5–6.5 × 3–4 µm (median: 5.34 × 3.50 µm), mostly 5 × 3.5 µm (Figs 7, 15*E*). Microcysts present, these dehiscing irregularly at the equator (Fig. 15*F*, *G*). Sorogens small and irregular, then elongated, leaving behind a dense mass that remains at the base of the sorocarps, holding them together and allowing a progressive separation of sori (Fig. 15*B*, *I*). Aggregations small at first, 150–250 µm diameter, with short streams, then slowly acquiring their final size, irregularly radiate, with dendroid streams. Small aggregations join to form a larger one 400–800 µm diameter (Figs 6, 15*A*). Myxamoebae dense, with one vacuole, 7–12 × 4–5 µm, remaining unaggregated for long periods (Fig. 15*H*).

Distribution and ecology

Dictyostelium granulosum was isolated from a sample of ground soil collected in a mixed *Eucalyptus* forest in Western Australia. Although *D. granulosum* is currently known only from the type locality, mixed *Eucalyptus* forests are widespread in Australia, which suggests that the species might occur in other localities.

Etymology

Refers to the refractile granules of the spores.

Notes

Dictyostelium granulosum resembles *D. myxobasis* in its extremely slimy nature; however, it can be distinguished from

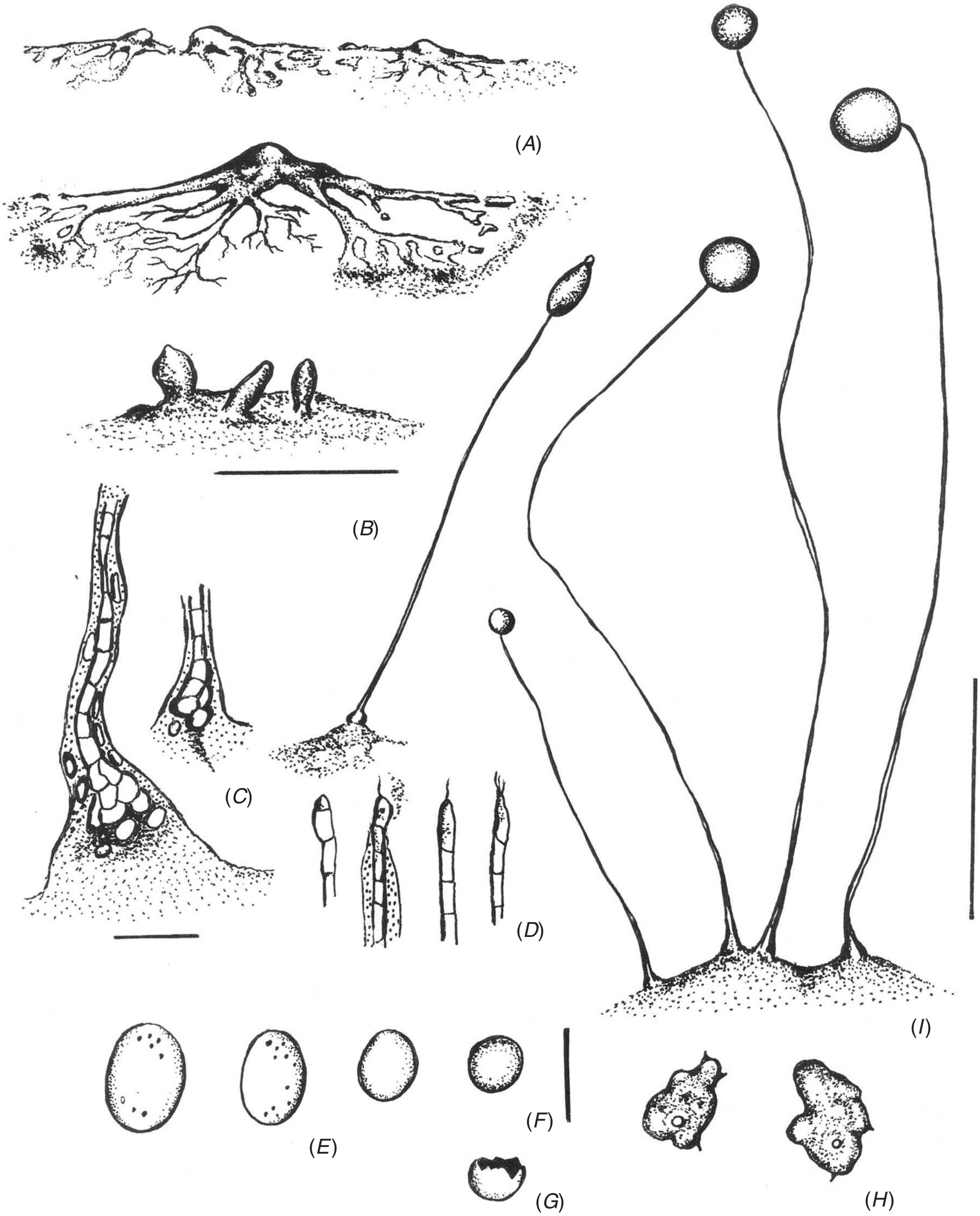


Fig. 15. Features of *Dictyostelium granulosum*. (*A*) Early (above) and late (below) irregularly radiate aggregations. (*B*) Early (above) and late (below) sorogens with dense masses of slime at the bases. (*C*) Round irregular bases with supporter cells. (*D*) Piliform simple tips. (*E*) Elliptical–oblong spores with sparse unconsolidated refractile granules. (*F*) Microcyst. (*G*) Microcyst capsule. (*H*) Myxamoebae. (*I*) Loosely clustered unbranched sorocarps. Scale bars: *A*, *B* = 0.3 mm; *C*, *D* = 35 µm; *E*–*H* = 5 µm; *I* = 0.25 mm.

any other species by the combination of refractile unconsolidated granules, oblong spores and the dense slime of the small, loosely clustered sorocarps. The spores most resemble those *D. flexuosum*, but the aggregation is much different, developing a radiate form (Fig. 6).

Dictyostelium myxobasis Cavender, Vadell, J.C. Landolt et S.L. Stephenson, *sp. nov.*

Sorocarpia in agaro nonnutricio cum *E. coli* ad 20°C culta solitaria vel fasciculata, prona vel decumbentia, interdum sorophora inferiore prostrata, 0.7–2 mm alta, aliquando ramosa, infirme phototropica. Sorophorum irregulare, a basi rotundata vel plana (25–45 µm) ad apicem flexuosum compositum vel simplicem (4–8 µm) sensim angustatum, parte sub apicem dilatata. Bases plerumque fibris cellulosi refractilis in matrice mucosa densa plicata intermixtis. Sori globosi albo-hyalini 90–140 µm in diametro. Sporae elliptico-oblongae, granulis polaribus prominentibus, contento heterogeneo, 6–9 × 2.5–4 µm (mediana magnitudine 7.08 × 3.21 µm), plerumque 7 × 3 µm, longitudinalitre dehiscentes et valvas duas aequales arcte affixas relinquentes. Sorogena solitaria vel fasciculata perelongata, massam mucosam juxta bases sorocarpiorum maturorum relinquentia. Aggregationes primum parvae, e tumulis rotundatis rivulis paucis brevibus constantes, dein amplitudinem ultimam tarde attingentes, irregulariter radiatae rivulis dendroideis. Aggregationes parvae interdum in unam aggregationem majorem, 400–1000 µm conjungentes. Myxamoebae densae vacuolo singulo magno centrali, 7–8 × 4–5 µm.

Holotypus: Australia: Queensland: Australian Canopy Crane S of Cape Tribulation, 16°06′13″S, 145°26′48″E, June 2003, isolate NT2A (MYA-3817 in ATCC).

Sorocarps solitary to clustered, prone to decumbent, sometimes with a prostrate lower sorophore, height 0.7–2 mm, occasionally branched, weakly phototropic, when cultured at 20°C on non-nutrient agar with *E. coli* (Fig. 16*H*). Sorophore irregular, slightly tapered from the round to plane base (25–45 µm) to the compound to simple flexuous tip (4–8 µm), subtip area enlarged (Fig. 16*D*). Bases commonly with refractile cellulose fibres intermixed within a dense pleated matrix of slime (Fig. 16*C*). Sori globose, white–hyaline, 90–140 µm diameter. Spores elliptical–oblong, with prominent consolidated polar granules, heterogeneous content, 6–9 × 2.5–4 µm (median: 7.08 × 3.21 µm), mostly 7 × 3 µm (Figs 9, 16*E*). Spores dehiscing longitudinally, leaving two closely attached equal valves (Fig. 16*F*). Sorogens solitary or clustered, very elongated, leaving behind a slimy mass that remains adjacent to the bases of mature sorocarps (Fig. 16*B*, *H*). Aggregations small at first, consisting of round mounds with a few short streams, then slowly acquiring final size, irregularly radiate, with dendroid streams (Fig. 8). Small aggregations may join to form a larger one, 400–1000 µm diameter (Fig. 16*A*). Myxamoebae dense, with one large central vacuole, 7–8 × 4–5 µm (Fig. 16*G*).

Distribution and ecology

Dictyostelium myxobasis was isolated from a sample of 'canopy soil' collected at the base of a birds-nest fern growing on an unidentified tree in a complex mesophyll vine forest at the Australian Canopy Crane site. This is the only known locality for the species. As is the case for other species recovered from the canopy soil microhabitat, *D. myxobasis* is also likely to occur in ground microhabitats. This species was recovered from the same set of samples that yielded *Polysphondylium australicum*.

Etymology

Refers to the slimy mass occurring at the bases and lower portions of sorogens.

Notes

Dictyostelium myxobasis can be distinguished from any other species by the combination of its particularly slimy base, the unusual type of aggregation and development, consolidated PG+ spores and the type of spore dehiscence. This species also develops a radiate aggregation similar to that found in *D. boomeransporum* and *D. granulosum*. However, the dense pseudoplasmodium of the former species does not develop, while the relatively large PG+ spores differentiate it from the latter.

Dictyostelium radiculatum Cavender, Vadell, J.C. Landolt et S.L. Stephenson*, sp. nov.*

Sorocarpia culta in agaro nonnutricio cum *E. coli* ad 20°C fasciculata vel solitaria, plerumque erecta, 0.3–1.5 mm alta, plerumque eramosa, soris citrinis vel brunneis et sorophoris caeruleo-violaceis. Sorophora plerumque recta, duas cellulas crassa, interdum curva et ramis brevibus (70–200 µm) instructa. Bases projecturis digitiformibus in pulvino muci refractilis et muco denso tectae, 50–90 µm in diametro. Digitationes magnae plerumque 2–5, 1–2 cellulas crassae, dichotomae, bene evolutae. Apices irregulariter capitati compositi, curvi, matrice muci densa tecti, sporis parvis affixis, cellula parva unica terminantes, 3–15 µm. Sori globosi flavo-citrini vel ex brunneo caerulei, 100–350 µm in diametro. Sporae ellipticae vel oblongae, plerumque granulis polaribus magnis incohaerentibus, interdum granulis per totum corpus dispositis, 5–11 × 2.5–4.5 µm (mediana magnitudine 6.78 × 4.29 µm), plerumque 6–8 × 3–4 µm, dehiscentes et vestigium sigmoideum a polo ad polum extendentem relinquentes. Microcystae praesentes, 4–5 µm. Sorogena parva, conica vel dolabriformia, dein elongata apiculata. Aggregationes regulares radiatae, rivulis dendroideis amplis complanatis, dein prominentibus brevibus, 400–900 µm. Myxamoebae agiles, forma typica vacuolis aliquot, 7–15 × 3–5 µm.

Holotypus: Australia: Queensland: Mt Lewis 35 km S of Julatten, 16°33′12″S, 145°16′25″E, June 2003, isolate ML5A (MYA-4248 in ATCC).

Sorocarps solitary to clustered, mostly erect, height 0.3–1.5 mm, generally unbranched, with citrine to brown sori and blue-violet sorophores, when cultured at 20°C on non-nutrient agar with *E. coli* (Fig. 17*G*). Sorophores generally straight, two cells thick, sometimes curved and with short branches (70–200 µm). Bases typically crampon-like, on a cushion of refractile slime and with a cover of dense slime, 50–90 µm diameter (Fig. 11). Digitations large, generally 2–5 present, 1 or 2 cells thick, dichotomous and well developed (Fig. 17*D*). Tips compound and irregularly capitate, curved, covered with dense matrix of slime, with attached small spores, ending in one small cell, 3–15 µm (Fig. 17*C*). Sori globoid, yellowish-citrine to brown-blue, 100–350 µm diameter. Spores elliptical to oblong, mostly with large consolidated polar granules; some with spaced granules throughout the spore body, 5–11 × 2.5–4.5 µm (median: 6.78 × 4.29 µm), mostly 6–8 × 3–4 µm (Figs 12, 17*E*). Spores

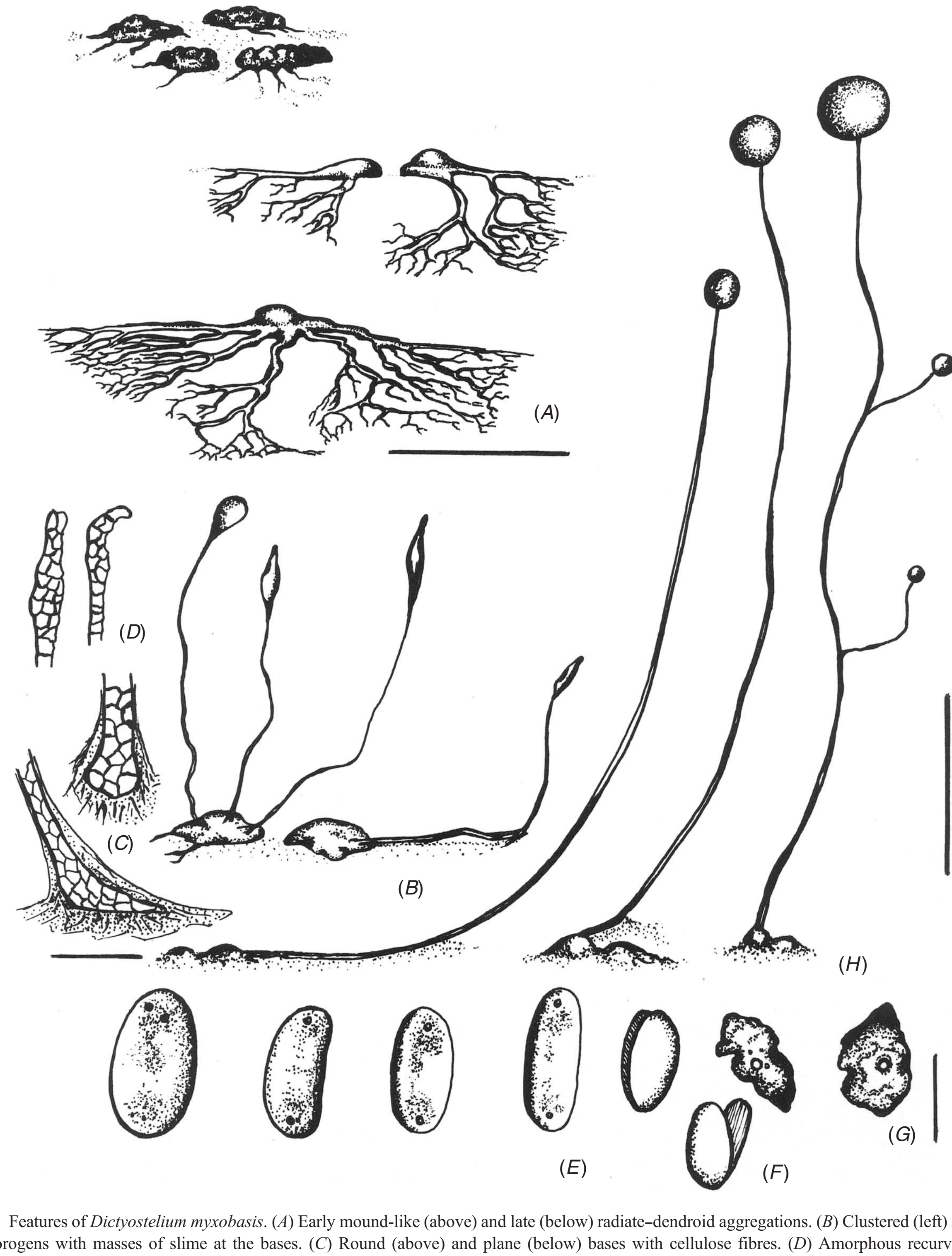


Fig. 16. Features of *Dictyostelium myxobasis*. (*A*) Early mound-like (above) and late (below) radiate–dendroid aggregations. (*B*) Clustered (left) and solitary (right) sorogens with masses of slime at the bases. (*C*) Round (above) and plane (below) bases with cellulose fibres. (*D*) Amorphous recurved tips. (*E*) Elliptical–oblong spores with unconsolidated granules. (*F*) Spore capsules. (*G*) Myxamoebae. (*H*) Unbranched (left) and branched sorocarps. Scale bars: *A*, *B* = 0.5 mm; *C*, *D* = 20 µm; *E*–*G* = 5 µm; *H* = 0.35 mm.

dehiscing to leave a sigmoid trace from pole to pole (Fig. 17*H*). Microcysts present, 4–5 µm (Fig. 17*I*). Sorogens small, coniform to dolabriform (shaped like the head of an axe), then elongated and apiculate (Fig. 17*B*). Aggregations regular, radiate, with flattened and ample dendroid streams, then with short prominent streams, 400–900 µm (Figs 10, 17*A*).

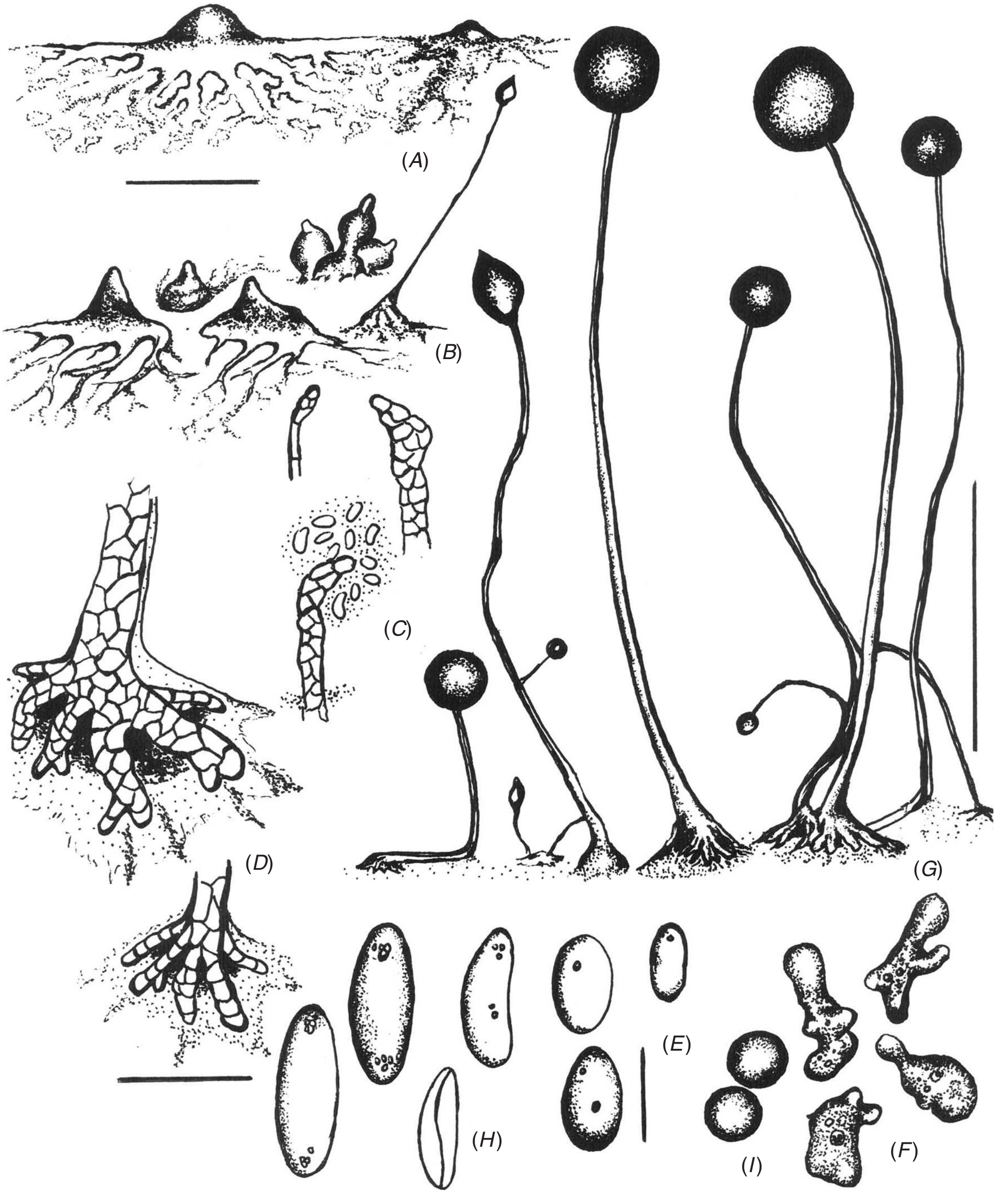


Fig. 17. Features of *Dictyostelium radiculatum*. (*A*) Aggregation with ample plane dendroid ended streams. (*B*) Early solitary sorogens (left) and late sorogens (right); clustered sorogens above. (*C*) Curved tip with dense slime. (*D*) Well developed cellular crampon bases. (*E*) Elliptical spores with consolidated and unconsolidated polar granules. (*F*) Myxamoebae. (*G*) Different sorocarp habits: lower prostrate section of a sorocarp (left), solitary erect unbranched (middle), tightly clustered and branched sorocarps (right). (*H*) Spore capsule. (*I*) Microcysts. Scale bars: *A*, *B* = 300 µm; *C*, *D* = 40 µm; *E*, *F*, *H*, *I* = 5 µm; *G* = 0.5 mm.

Myxamoebae active and very typical in appearance, with several vacuoles, 7–15 × 3–5 µm (Fig. 17*F*).

Distribution and ecology

Dictyostelium radiculatum was isolated from a sample of ground soil collected in a simple microphyll vine forest situated on a wet highlands site. This is the only known locality for the species.

Etymology

Refers to the root-like crampon base.

Notes

The crampon base is the most outstanding diagnostic feature of this species. *D. radiculatum* is similar to *D. coeruleostipes* Raper et Fennell in the bluish coloration of the sorophore but can be distinguished from this species by the relatively larger crampon base, smaller sorocarps and slightly larger spores.

Dictyostelium rotatum Cavender, Vadell, J.C. Landolt et S.L. Stephenson, *sp. nov.*

Sorocarpia in agaro nonnutricio cum *E. coli* ad 20°C culta fasciculata vel solitaria, plerumque erecta, 1–2 mm alta, debilia, plerumque ramis longis, interdum sorophoris helicoideis. Sorophora e serie cellularum unica constantia, curva, typice ramis magnis sigmoideis. Bases rotundae vel planae cellulis sustinentibus (etiam bases unicellulares) et pulvino muci densi refractilis, 10–50 µm in diametro, flabellis muci e matrice densa pulvini exeuntibus. Apices simplices 3–6 µm. Sori globosi albo-hyalini 90–160 µm in diametro, post collabentes sporis affixis. Sporae elliptico–oblongae, granulis multis incohaerentibus per totum corpus dispositis, maximis ad polos, 4.5–7 × 2.7–4 µm (mediana magnitudine 5.28 × 3.4 µm), plerumque 5 × 3.5 µm, minimae fere rotundae. Microcystae praesentes, 4–5 µm in diametro. Sorogena parva, dein irregulariter elongata recurvantia et nutantia. Massa muci juxta sorogena et bases sorocarpiorum maturorum remanens, tecta membrana vel implicatione telae simili e partibus virgulo similibus constante, virgulis 0.7 × 1–3 µm, interdum ad extremitates suas conjunctis, corpora intertexta 30 µm formantibus. Aggregationes radiatae, ad classem 'violaceum' pertinentes, primum discontinua, dein rivulis exterioribus recurvatis in circulo anastomosantibus, formam rotae similem cuspidibus vel radiis adquirentibus, 400–800 µm in diametro. Myxamoebae vacuolo magno singulo, 6–12 × 4–6 µm.

Holotypus: Australia: Queensland: Australian Canopy Crane S of Cape Tribulation, 16°06′13″S, 145°26′48″E, June 2002, isolate QC2C (MYA-3820 in ATCC).

Sorocarps solitary to clustered, mostly erect, height 1–2 mm, weak, generally with long branches, sometimes with helicoidal sorophores, when cultured at 20°C on non-nutrient agar with *E. coli* (Fig. 18*I*). Sorophores consisting of one tier of cells; curved and typically with sigmoid large branches. Bases round to plane, with supportive cells (even when one celled) and with a cushion of dense refractile slime, 10–50 µm diameter (Fig. 18*C*). Bases also have aprons of slime coming out of the dense cushion matrix. Tips simple, 3–6 µm (Fig. 18*D*). Sori globose, white-hyaline, 90–160 µm diameter, with attached spores after collapsing. Spores elliptical-oblong, with numerous unconsolidated granules spaced trhoughout the spore body, the largest at the poles, 4.5–7 × 2.7–4 µm (median: 5.28 × 3.4 µm), mostly 5 × 3.5 µm, the smallest almost round (Figs 18*E*, 21). Microcysts present, 4–5 µm diameter (Fig. 18*F*). Sorogens small, then irregularly elongated and curved upside down (Fig. 18*B*). A mass of slime remaining adjacent to sorogens and at the bases of mature sorocarps; this mass covered by a film or web-like tangle of rod-like structures mixed with undifferentiated cells. Each rod-like structure 0.7 × 1–3 µm, sometimes united by their ends, forming interwoven structures of 30 µm (Fig. 18*H*). Aggregations radiate, of the 'violaceum' type, discontinuous at first, then with recurved, outer streams anastomosed in a circle acquiring a wheel-like shape with spikes or rays, 400–800 µm diameter (Figs 13, 18*A*). Myxamoebae with one large vacuole, 6–12 × 4–6 µm (Fig. 18*G*).

Distribution and ecology

Dictyostelium rotatum was isolated from a sample of ground soil collected in a complex mesophyll vine forest situated on very wet but well drained lowlands site. The species is not yet known from any other locality. Two of the other species described in this paper were recovered from samples of canopy soil collected at this same site.

Etymology

Refers to the wheel-like aggregation.

Notes

Dictyostelium rotatum can be distinguished from any other species by the combination of the typical wheel-like aggregation, refractile unconsolidated granules that are larger at the poles of the ovoid spores, and by the dense slime matrix at the bases, covered by a trama of cells and rods. The spores are oval in shape and thus similar to those of *D. flexuosum* and *D. granulosum*, but they are larger in size. The aggregation is also quite different, as the streams may break up into smaller segments collectively described as a 'violaceum' type (Fig. 18*A*). While still radiate, the aggregation can also assume a distinctive wheel-like form (Fig. 13).

Polysphondylium australicum Cavender, Vadell, J.C. Landolt et S.L. Stephenson*, sp. nov.*

Sorocarpia in agaro nonnutricio sub luce diffusa ad 20–24°C culta solitaria vel fasciculata, subtilia, erecta aut prona vel prostrata, 3–4.5 mm alta, plerumque verticillis 2–3 sororum lateralium hyaline–alborum nodis irregulariter dispositis instructa. Sorophora superiora subtilia sed prope basin majora flavaque. Sori laterales sorocarpiorum prostratorum plerumque collabentes et iterum initium culminationis faciens. Omne verticillum ramis brevibus 1–5 (plerumque 2–4) vulgo 500–850 µm longis, ramis majoribus usque ad 950 µm longis, instructum. Rami superiores interdum sine soris; alia sorocarpia sine soris terminalibus, alia sine verticillis sed soris terminalibus gaudentia. Sori terminales 150–250 µm in diametro, sori laterales parum minores, 120–200 µm. Segmentum terminale elongatum e serie cellularum unica constans, 0.2–0.4 mm longum. Verticilla 800–1000 µm *inter se* distantia. Sporae ellipticae vel oblongae hyalinae granulis polaribus magnis incohaerentibus, magnitudine variabilissimae, plerumque 9 × 4–4.5 µm (mediana magnitudine 8.54 × 4.28 µm), maxima magnitudinis variatione 6–11 × 3–5 µm, longitudinalitre dehiscentes. Bases a latere clavatae vel rotundatae, multicellulares, 35–50 µm in diametro. Aggregationes ad classem 'violaceum' pertinentes, regularissimae radiatae, rivulis multis tenuissimis in rivulis anastomosantibus

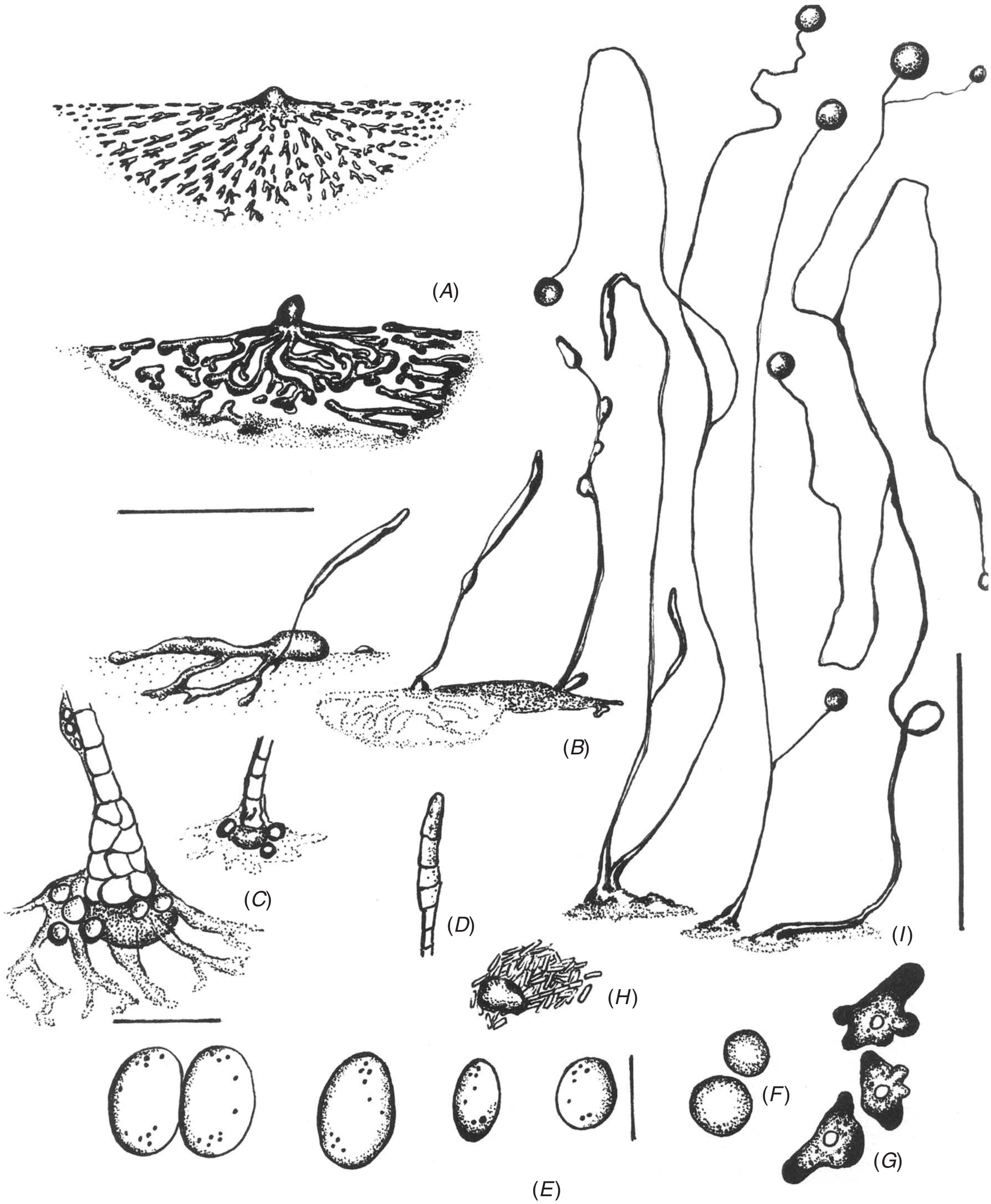


Fig. 18. Features of *Dictyostelium rotatum*. (*A*) Early discontinued 'violaceoum' type (above) and wheel-like late aggregation (below). (*B*) Early (left) and late (right) sorogens with dense masses of slime at the bases and well developed aprons. (*C*) Round to plane bases with supporter cells and well developed aprons of slime (left) and a uniseriate simple base (right), both with cushions of refractile slime and supporter cells. (*D*) Simple oblong tip. (*E*) Elliptical–oblong spores with sparse unconsolidated granules. (*F*) Microcyst. (*G*) Myxamoebae. (*H*) Cover film of the matrix of slime found at the base of a sorocarp. (*I*) Different sorocarp habits: branched cluster (left), solitary (middle) and with a prostrate lower portion (right). Scale bars: *A*, *B* = 0.3 mm; *C*, *D*, *H* = 30 µm; *E*–*G* = 5 µm; *I* = 0.5 mm.

0.3–1.3 mm longis terminantibus. Sorogena praecocia e centro cuiusque aggregationis plerumque orientia, oblonga, ad medium constricta, forma regulari. Sorogena serotina multo magis elongata, ad apices formam sorogenorum praecocium retinentia. Myxamoebae magnae vacuolis 1–2 et nodulis vel corpusculis refringentibus, 10–20 × 10–15 µm. Microcystae praesentiae 7 µm in diametro. Cystae multicellulares irregulares 45–60 µm in diametro etiam in sorophoro inferiore.

Holotypus: Australia: Queensland: Australian Canopy Crane S of Cape Tribulation, 16°06′13″S, 145°26′48″E, June 2003, isolate NB1AP (MYA-3833 [as *Polysphondylium luteo-stipes*] in ATCC).

Sorocarps solitary to clustered, delicate, erect, prone to prostrate, height 3–4.5 mm, commonly with 2 or 3 whorls of hyaline–white lateral sori, nodes irregularly spaced, when cultivated on nonnutrient agar at 20–24°C under diffuse light. Upper sorophores delicate but become larger and yellow near the base. Lateral sori of prostrate sorocarps typically collapsing, after which culmination begins anew. Each whorl with 1–5 short branches (mostly 2–4), length generally 500–850 µm, larger branches up to 950 µm long (Fig. 19*H*). Upper branches may lack sori; some sorocarps may lack terminal sori, while others may lack whorls but not the terminal sori. Terminal sori 150–250 diameter. Lateral sori slightly smaller, 120–200 µm. Terminal segment elongated and consisting of one tier of cells (length 0.2–0.4 mm). Distance between whorls 800–1000 µm. Spores elliptical to oblong, hyaline, with large unconsolidated polar granules, extremely variable in size, mostly 7.5–9 × 4–4.5 µm (median 8.54 × 4.28 µm), but ranging from 6–11 × 3–5 µm (Figs 19*D*, 23). Spores dehiscing longitudinally (Fig. 19*G*). Bases laterally clavate to round, multicellular, 35–50 µm diameter (Fig. 19*C*). Aggregations of the ‘violaceum’ type, very regular, radiate, with a large number of extremely thin streams terminating in anastomosed streams, these 0.3–1.3 mm long (Figs 19*A*, 22). Early sorogens generally arising from the centre of each aggregation, oblong, strangled at the middle and regularly shaped (Fig. 19*A*). Late sorogens much more elongated and retaining the shape of the early sorogens at the tips (Fig. 19*B*). Myxamoebae large, with 1 or 2 vacuoles and refringent nodules or corpuscles, 10–20 × 10–15 µm (Fig. 19*E*). Microcysts present, 7 µm diameter (Fig. 19*F*). Multicellular irregular cysts also present on the lower sorophore, these 45–60 µm diameter.

Distribution and ecology

Polysphondylium australicum was isolated from a sample of ‘canopy soil’ collected at the base of a birds-nest fern growing on an unidentified tree in a complex mesophyll vine forest at the Australian Canopy Crane site. This is the only known locality for the species, which is likely to occur in both aerial and ground microhabitats.

Etymology

Refers to the continent of Australia, where the species was first collected.

Notes

Polysphondylium australicum differs from any other species mainly by the thin regularly radiated streams, large spores with large unconsolidated polar granules, large typical myxamoebae, large branches and the yellow lower sorophores. This is one of the largest members of the genus, and the overall dimensions are closer to those of *P. violaceum* than *P. pallidum.* The spores are also large, exceeding those of *P. violaceum* and about the same size as those of *P. candidum.* The yellowish lower sorophores as well as the large branches are also distinctive features.

Polysphondylium stolonicoideum Cavender, Vadell, J.C. Landolt et S.L. Stephenson, *sp. nov.*

Sorocarpia solitaria vel fasciculata, subtilissima, erecta sigmoidea prona decumbentia vel prostrata, 1–4 mm alta, plerumque verticillis 2–7 sororum lateralium parvorum hyalino-alborum nodis irregulariter dispositis instructa. Sorophora superiora subtilia, prope basin plerumque coremiformia. Sori laterales sorocarpiorum prostratorum repentium in agaro nonnutricio sub luce diffusa ad 20–24°C culti plerumque collabentes et iterum crescentes. Omne verticillum ramis brevibus 1–5 (plerumque 2–4) vulgo 200–350 µm longis, ramis majoribus usque ad 400 µm longis, instructum. Rami superiores interdum sine soris, terminis tenuissimis piliformibus (1–2 µm). Sori terminales 80–100 µm in diametro, sori laterales minores, 40–80 µm in diametro; sori sporas (plurimo majorum excepto) retinentes per matricem muci densam. Segmentum terminale elongatum (0.1–0.6 mm). Verticilla 300–600 µm *inter se* distantia. Sporae ellipticae vel oblongae hyalinae granulis polaribus magnis incohaerentibus irregulariter dispositis, plerumque 5.5–6.5 × 3–4 µm (maxima magnitudinis variatione 4.5–8 × 3–4.2 µm). Bases rotundatae, 1–2-cellulae, 5–15 µm, vagina mucosa densa refractile et fibris cellulosis; separatae a superficie agari, craterem in ea relinquunt. Aggregationes ad classem ‘violaceum’ pertinentes, radiatae, rivulis 1–2 primariis amplis myxamoebas e nebula cellularum legentibus, dein rivulis truncatis brevibus, 0.2–0.6 mm longis. Sorogena praecocia oblonga forma regulare. Sorogena serotina multo magis elongata decumbentia. Myxamoebae vacuolis 1–2, areis refractilibus.

Holotypus: Australia: Queensland: School for Field Studies near Yungaburra, 17°12’19″S, 145°40′47″E, July 2002, isolate K12A (MYA-3835 in ATCC).

Sorocarps solitary to clustered, very delicate, erect-sigmoid, prone, decumbent to prostrate, height 1–4 mm, commonly with 2–7 whorls of hyaline–white small lateral sori, nodes irregularly spaced; upper sorophores delicate and commonly coremiform near the base (Fig. 20*H*). Lateral sori of prostrate-creeping sorocarps collapse and regrow, starting anew, when cultivated on nonnutrient agar at 20–24°C under diffuse light (Fig. 20*I*). Each whorl with 1–5 short branches (mostly 2–4), length generally 200–350 µm, larger branches up to 400 µm long (Fig. 20*H*). Upper branches may lack sori, ending in extremely thin piliform termini (1–2 µm). Terminal sori 80–100 diameter. Lateral sori smaller, 40–80 µm diameter. Sori retain spores by a dense slime matrix, except for most of the larger spores. Terminal segment elongated (0.1–0.6 mm). Distance between whorls 300–600 µm. Spores elliptical to oblong, hyaline, with large unconsolidated polar granules irregularly spaced, mostly 5.5–6.5 × 3–4 µm (range: 4.5–8 × 3–4.2 µm) (Figs 20*F*, 26). Bases round, 1- or 2-celled, 5–15 µm, with a dense refractile slime sheath and cellulose fibres. The base, when detached from the agar surface, leaves

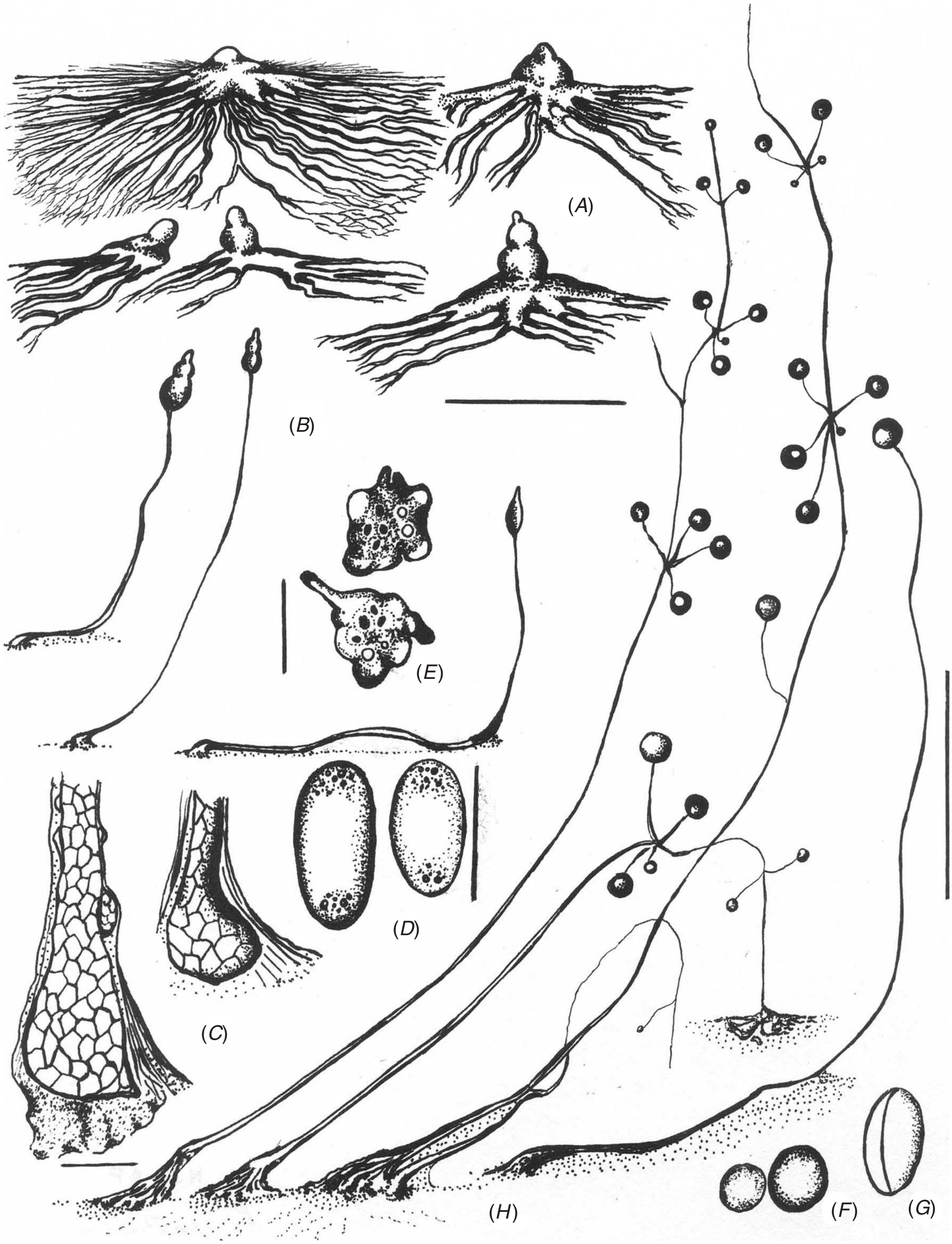


Fig. 19. Features of *Polysphondylium australicum*. (*A*) Aggregations of the 'violaceum' type with fine well developed streams. (*B*) Late solitary sorogens. (*C*) Round-apiculate to clavate bases. (*D*) Elliptical–oblong spores with prominent unconsolidated polar granules. (*E*) Myxamoebae with small vacuoles and refractile areas. (*F*) Microcysts. (*G*) Spore dehiscence. (*H*) Different sorocarp habits: solitary and prone (left), decumbent and clustered (middle) and with lower prostrate portion (right). Scale bars. *A*, *B* = 500 µm; *C* = 30 µm; *D*, *G* = 7 µm; *E*, *F* = 10 µm; *H* = 0.7 mm.

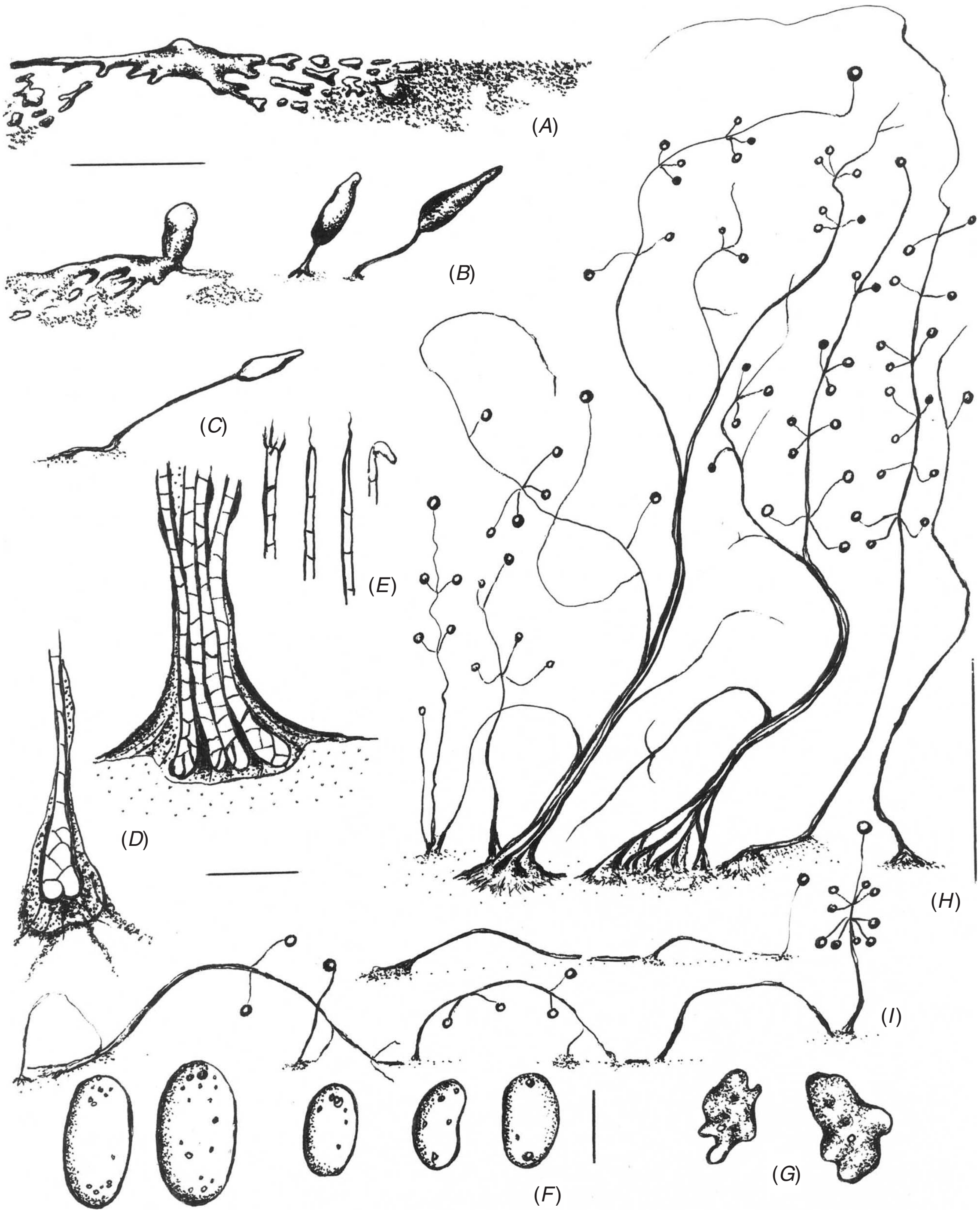
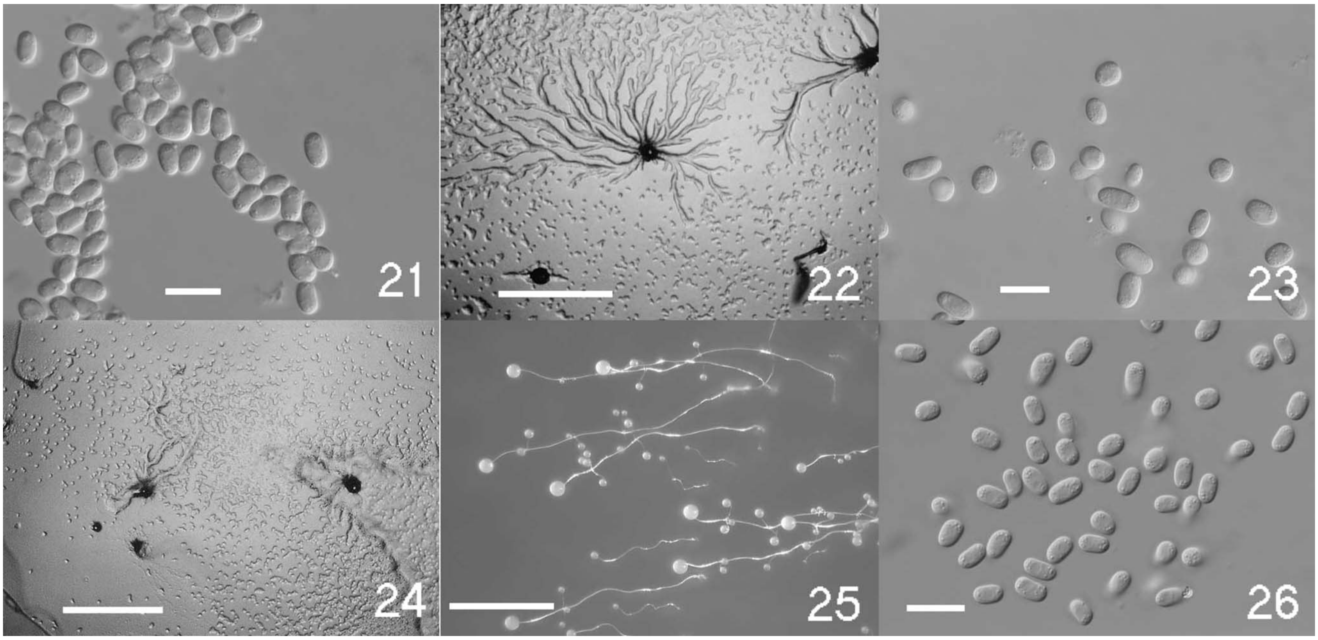


Fig. 20. Features of *Polysphondylium stolonicoideum*. (*A*) Aggregation with short partite streams. (*B*) Early solitary sorogens. (*C*) Late prone to decumbent sorogen. (*D*) Two-celled base with cellulose fibres and aprons of dense slime (below) and coremiform bases producing a crater on the agar surface. (*E*) Thin piliform tips. (*F*) Large (left) and small (right) spores with large and small irregularly positioned granules. (*G*) Myxamoebae. (*H*) Different habits of the mature sorocarps: coremiform (left) and solitary-sigmoid (right). (*I*) Stoloniferous behaviour of the sorocarps (right). Scale bars: *A*–*C* = 300 µm; *D*, *E* = 25 µm; *F*, *G* = 5 µm; *H*, *I* = 0.3 mm.

a crater on it (Fig. 20*D*). Aggregations of the 'violaceum' type, radiate, with one or two main ample streams that collect myxamoebae from a nebula of cells, then with truncated short streams, 0.2–0.6 mm long (Figs 20*A*, 24). Early sorogens oblong and regularly shaped (Fig. 20*B*). Late sorogens much more elongated and decumbent



Figs 21–26. Morphological features of the new species of dictyostelids from Australia. **Fig. 21.** Elliptical spores of *Dictyostelium rotatum*. Note the prominent, unconsolidated polar granules. Scale bar = 10 µm. **Fig. 22.** Aggregations of *Polysphondylium australicum*. Note the fairly regular radiate streaming. Scale bar = 0.5 mm. **Fig. 23.** Spores of *P. australicum*. Note the large unconsolidated polar granules. Scale bar = 10 µm. **Fig. 24.** Aggregations of *Polysphondylium stolonicoideum*. Note the few main streams and numerous truncated short streams. Scale bar = 0.5 mm. **Fig. 25.** Decumbent sorocarps of *P. stolonicoideum*. Note that these are often prostrate and stoloniferous. Scale bar = 1.0 mm. **Fig. 26.** Oblong spores of *P. stolonicoideum*. Note the conspicuous unconsolidated polar granules. Scale bar = 10 µm.

(Figs 20*C*, 25). Myxamoebae with 1 or 2 vacuoles, with refractile areas (Fig. 20*G*).

Distribution and ecology

Polysphondylium stolonicoideum was isolated from a sample of ground soil collected in a complex mesophyll vine forest situated on a very wet uplands site. It is currently known only from the type locality. *P. stolonicoideum* was recovered from the same set of samples that yielded *D. boomeransporum*.

Etymology

Refers to the stoloniferous habit of decumbent sorocarps.

Notes

Polysphondylium stolonicoideum differs from any other species mainly by the strong tendency to become decumbent, prostrate and then stoloniferous, sometimes with four or more sorocarps being formed succesively in this manner. It also has small spores that attach to each other while the larger ones are commonly free. Bases and sorophores are frequently tightly coremiform while the sorophore tips elongate. Some of the dimensions are close to those of *P. pallidum.* However, *P. pallidum* does not produce an elongating sorophore tip.

Discussion

The samples that yielded the eight species described herein as new were collected from several localities throughout Australia; however, large areas of the continent have yet to be surveyed for dictyostelids. The very fact that northern Queensland, the region of Australia that has been investigated most intensively, produced six of the eight new species would seem particularly noteworthy. First, it seems likely that the highest overall biodiversity of dictyostelids occurs in the tropical forests characteristic of the north-eastern and north–central parts of Australia. Second, on the basis of the same data, it can be expected that several other novel forms will be discovered in other regions of the continent when more detailed sampling is carried out.

As noted in the comments provided for each of the new species, two examples (*D. myxobasis* and *P. australicum*) were isolated from samples of 'canopy soil' collected well above the ground. The soil–humus layer on the forest floor is considered to represent the primary microhabitat for dictyostelids (Raper 1984), but results obtained from several previous studies carried out in the Neotropics (Stephenson *et al*. 2004) and New Zealand (Cavender *et al*. 2002) provided clear evidence that these organisms also occur, sometimes in appreciable numbers, in canopy soil. Since the samples considered in the present study came from only a few localities in a relatively small area of northern Queensland, this aspect of the ecological distribution of dictyostelids in Australia certainly warrants more study.

The large number of apparently undescribed forms recovered suggests that the dictyostelid biota of Australia is relatively distinct when compared with that of any other continent. However, the occurrence of at least some new species was not surprising. Vadell and Cavender (2007), who studied the dictyostelids of a region of Argentina located at ~25°S latitude, reported that 44% of the species and varieties they recovered were not yet known from any region of the northern hemisphere. In an earlier study carried out in New Zealand, Cavender *et al*. (2002) found that 4 of the 13 species they recorded (all four of which were described as new) were apparently restricted to that region of the southern hemisphere. In Tierra del Fuego and Patagonia, Cavender *et al*. (2005) isolated a total of nine species, and six of these were new. The general picture that emerges from a consideration of these data is that the assemblage of dictyostelids present in the southern hemisphere includes an appreciable number of forms that do not seem to occur in the northern hemisphere, and our data conform to this same general pattern. Vadell and Cavender (2007) hypothesised that the difference in species composition between the two hemispheres may be the result of different evolutionary histories and/or different natural selection factors.

Several of the new species from Australia are characterised by morphological features unlike anything reported previously for dictyostelids, with *D. rotatum* (in which the typical aggregation has a wheel-like pattern) and *D. boomeransporum* (with its 'boomerang-shaped' spores) being particularly distinctive. On the basis of observations made when transferring particular isolates from one culture to the next, several of the new species appear to produce sori in which the spores have less of a tendency to disperse than is generally the case for dictyostelids. This same situation was noted by Vadell and Cavender (2007), who indicated that some of their new species from Argentina produced sori with dense slime that limited spore dispersal. Not only do the sori contain dense slime, but many of the new species of *Dictyostelium* (*D. myxobasis*, *D. flexuosum*, *D. granulosum*, *D. radiculatum* and *D. rotatum*) from Australia also have a dense slime layer surrounding the base of the sorocarp. These features are not unique to the dictyostelids of the southern hemisphere but may be relatively more common than in the northern hemisphere. Vadell and Cavender (2007) also pointed out that the proportion of species with polar spore granules (PG+) seems to be higher in the southern than in the northern hemisphere. All eight of the species described herein had this feature. Molecular studies of the dictyostelids (Schaap *et al*. 2006) have suggested that PG+ species may represent a basal group in the phylogeny of the group. As such, the occurrence of a high proportion of PG+ species in the southern hemisphere may indicate that early evolution in the dictyostelids took place there. This and other questions relating to various aspects of the dictyostelids can be answered only when more data are available.

Acknowledgements

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