

Taxonomic Studies on Dictyostelids. 2. Review of the Voucher Specimens of *Dictyostelium brevicaule*, *D. mucoroides*, and *D. sphaerocephalum* Prepared by E. W. Olive and Preserved in the Farlow Herbarium (FH)

Hiromitsu Hagiwara

Department of Botany, National Science Museum, Amakubo 4–1–1, Tsukuba, 305–0005 Japan

E-mail: h-hagiwa@kahaku.go.jp

Abstract A total of 30 voucher specimens used in Olive (1901) were examined. Of these, 3 specimens were labeled as *Dictyostelium brevicaule*; 15, as *D. mucoroides*; and 12, as *D. sphaerocephalum*. The lectotype of *D. brevicaule* was designated in this study, and this species was arranged in the synonymy of *D. mucoroides*. The group of the specimens labeled as *D. mucoroides* could not be distinguished from that of the specimens labeled as *D. sphaerocephalum* not only with regard to the spore size but also other characters. Moreover, both the groups comprised 4 or more taxa each including 2 common taxa. These results confirmed the statement in Olive (1902), “it may prove desirable to unite these two variable species.”

Key words: cellular slime molds, dictyostelids, *D. brevicaule*, E. W. Olive, taxonomy.

In 1869, *Dictyostelium mucoroides* Brefeld was described as the first species of dictyostelid cellular slime molds, commonly known as dictyostelids. After 32 years, E. W. Olive compiled the information on 11 species of dictyostelids into a monograph that included 5 new taxa (Olive, 1901). The voucher specimens used in the monograph were preserved in the cryptogamic herbarium, namely, the Farlow Herbarium (FH), at Harvard University (Olive, 1902). Since then, however, no attention was focused on these specimens in studies on dictyostelids, although the monograph was referred to as a historically important work (Raper, 1984).

In 1979, I borrowed all the specimens prepared by Olive from the FH and examined them in detail. Previously, I had designated the lectotypes of *Polysphondylium pallidum* Olive and *D. purpureum* Olive (Hagiwara, 1989, 1992). As a part of this study on Olive’s specimens, I reviewed a total of 30 voucher specimens belonging to 3 white species of *Dictyostelium*, namely, *D. brevicaule* Olive, *D. mucoroides* and *D. sphaero-*

cephalum (Oud.) Sacc. & March.

Dictyostelium brevicaule was described as a new taxon that differs from the species *D. mucoroides* and *D. sphaerocephalum* in its small sorocarps with rather rigid sorophores that bear sori of a comparatively large size (Olive, 1901). Further, Olive (1901) distinguished *D. mucoroides* from *D. sphaerocephalum* mainly with regard to the spore size, although he stated “it may prove desirable to unite these two variable species.” After more than 80 years, *D. sphaerocephalum* was completely separated from *D. mucoroides* based on not by the spore size but by the branching of sorocarps, migration of pseudoplasmodia, and the presence of the sorophore collar, and subsequently, both the species were redescribed (Raper, 1984). Additionally, *D. brevicaule* was arranged in a synonymy of *D. mucoroides* (Raper, 1984). In Raper (1984), however, the original illustrations of *D. mucoroides* were misunderstood in two respects, namely, macrocyst-like structures were regarded as true macrocysts and the size of sorocarps was

mistakenly counted one order higher.

In Hagiwara (1984), *D. mucoroides* and *D. sphaerocephalum* were reviewed based on their original descriptions and illustrations, and *D. mucoroides* was redescribed on the basis of isolates obtained from its type locality. Further *D. sphaerocephalum* was arranged in a synonymy of *D. mucoroides*. The review suggested that the concept of *D. mucoroides* in Raper (1984) was radically distinct from *D. mucoroides* in itself and that, on the other hand, the concept of *D. sphaerocephalum* in Raper (1984) fitted *D. mucoroides* in itself. In this study, the taxonomic treatments of *D. mucoroides* and *D. sphaerocephalum* were in accordance with Hagiwara (1984), not Raper (1984).

Materials

The voucher specimens used by Olive (1901) were preserved in the Farlow Herbarium (FH), Harvard University, U.S.A. Among these, 30 specimens that belonged to 3 white species of *Dictyostelium* were examined. Of the 30 specimens, 3 specimens were labeled as *D. brevicaulis*; 15, as *D. mucoroides*; and 12, as *D. sphaerocephalum*. Their conditions, dates of preparation, and origins are listed in Table 1.

Results and Discussion

Dictyostelium brevicaulis Olive, Proc. Amer. Acad. Arts Sci., 37: 340, 1901.

Three specimens were examined. Their conditions and sorocarp morphology were as follows.

#20 (Figs. 1A & 1B)

Sorocarps small, tangled (Fig. 1B), unbranched or irregularly branched; sorophores gradually tapering from thick bases to thick tips; sori white to yellowish; spores elliptical, usually 1.5–1.8 times longer than broad, mostly $4.7\text{--}5.8 \times 2.9\text{--}3.6 \mu\text{m}$ (n=5).

#21 (Figs. 1C–1H)

Sorocarps small, often with minute satellite

sorocarps (Fig. 1D), unbranched or irregularly branched; sorophores gradually tapering from thick bases to thick tips (Figs. 1E–1G); sori white; spores elliptical, usually 1.5–1.8 times longer than broad (Fig. 1H), mostly $4.9\text{--}5.9 \times 2.9\text{--}3.4 \mu\text{m}$ (n=12).

4-21-'97 (Figs. 2A–2D)

Two sorocarps were mounted. A mount solution dried up.

Sorocarps minute, unbranched (Fig. 2C); sorophores thin, consisting of single tiers of cells, 0.56–0.74 mm in length, 10.5–12 μm in diam near the base, 4–5 μm in diam near the tip; sorophore bases clavate (Fig. 2D), spores elliptical, clearly less than 2.0 times longer than broad (Fig. 2B).

The above mentioned 3 specimens were judged as syntypes of *D. brevicaulis* based on their dates of preparation and/or origins. One of these specimens, i.e., Specimen #21, was designated as a lectotype in this study, because its sorocarp morphology fitted the original description of *D. brevicaulis* (Olive, 1901). Of all the 3 specimens, it was preserved in the best condition.

Specimen #21 was identified as *D. mucoroides* based on the small sorocarps, thick sorophores (Fig. 1E), and thick spores (Fig. 1H). Therefore, *D. brevicaulis* was arranged in the synonymy of *D. mucoroides*.

Branching near the sorophore base and the occurrence of minute satellite sorocarps along with the main sorocarp were observed in Specimen #21. These characteristics have been described in the illustrations of *D. mucoroides* (Oudemans, 1895; Hagiwara, 1984).

The sorocarps of Specimen 4-21-'97 were smaller than those of the original description of *D. brevicaulis* (Olive, 1901). Their thin sorophores and spore shape suggested that Specimen 4-21-'97 was *D. minutum* Raper; however, the spore size (Fig. 2B) was clearly larger than that of *D. minutum*. If this specimen and Specimen #20 originated from the same isolate, it is probable that small sorocarps were prepared for

Table 1. List of the specimens examined in this study.

Species name	Specimen	Condition	Date of preparation	Origin
<i>D. brevicaule</i>	Dry			
	#20	on agar	June 4, 1898	on sheep dung, Cambridge, Massachusetts, U.S.A., collected by E. W. Olive
	#21	on agar	–	on goat dung, Cambridge, Massachusetts, U.S.A.
<i>D. mucoroides</i>	Slide			
	4-21-'97	in glyc. eosin	Apr. 21, 1897	on sheep dung
	Dry			
	#22	on agar	–	on horse dung, Cambridge, Massachusetts, U.S.A.
	#23	on agar	–	on decaying Polyporus, Cambridge, Massachusetts, U.S.A., collected by G. R. Lyman
	#24	on agar	–	on rabbit dung, Cambridge, Massachusetts, U.S.A., collected by E. W. Olive
	#25	on agar	Apr. 1, 1899	on sheep dung, Cambridge, Massachusetts, U.S.A., collected by E. W. Olive
	#26	on dung	Jan. 23, 1897	on horse dung, collected by E. W. Olive
	#27	on agar	June 2, 1898	on dog dung, Cambridge, Massachusetts, U.S.A., collected by E. W. Olive
	#28	on agar	–	on ass dung, Liberia, Africa, collected by E. W. Olive
	#29	on dung	Nov. 2, 1897	on horse dung, Cambridge, Massachusetts, U.S.A., collected by F. O. Grover
	Slide			
	1-12-'97	in glyc.	Jan. 12, 1897	on horse dung, Cambridge, Massachusetts, U.S.A.
	3-17-'97	in glyc. eosin	Mar. 17, 1897	on dog dung
	12-28-'97	in glyc. eosin	Dec. 28, 1897	on Liberian ass dung
	1-18-'01	–	Jan. 18, 1901	on deer dung, New York, U.S.A.
	3-10-'01	–	Mar. 10, 1901	on muskrat, Stony Brook, Massachusetts, U.S.A.
	11-22-'01	–	Nov. 22, 1901	on agarics, Cambridge, Massachusetts, U.S.A., collected by A. F. Blakeslee
	(no date)	in glyc.	–	on paper, collected by T. Cawb.
	<i>D. sphaerocephalum</i>	Dry		
#33		on agar	–	on rat dung, Boston, Massachusetts, U.S.A.
#34		on agar	–	on sea turtle dung, Cambridge, Massachusetts, U.S.A.
#35		on agar	–	on deer dung, New York, U.S.A.
#36		on agar	Apr. 28, 1897	on bush cat dung, Liberia, Africa, collected by E. W. Olive
#37		on agar	–	on mouse dung, Cambridge, Massachusetts, U.S.A.
#38		on agar	June 2, 1898	on toad dung, Cocomanut Grove, Florida, U.S.A., collected by R. Thaxter
Slide				
4-5-'97		in glyc. eosin	Apr. 5, 1897	on mouse dung, Cambridge, Massachusetts, U.S.A.,
4-7-'97		–	Apr. 7, 1897	on bush cat dung, Liberia, Africa
6/5/97		–	June 5, 1897	on rat dung, Boston, Massachusetts, U.S.A.
12-21-'97		–	Dec. 21, 1897	on bird dung, Center Ossipee, New Hampshire, U.S.A.
4-18-'99		in glyc. eosin*	Apr. 18, 1899	on turtle dung
1-18-'01		–	Jan. 18, 1901	on deer dung, New York, U.S.A.

* acid Delafield's haematoxylin following osmic fumes

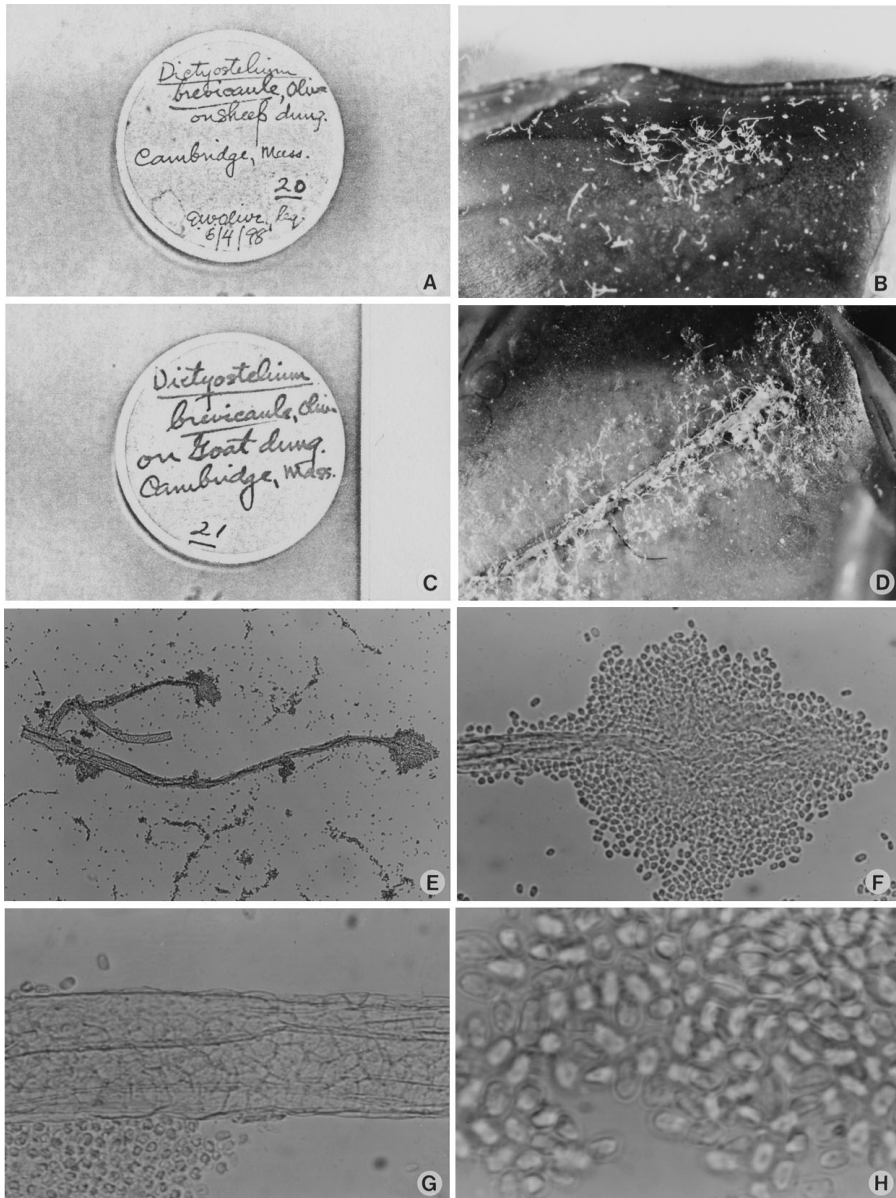


Fig. 1. *Dictyostelium brevicaulis*. A, B. Specimen #20. A. Label of the specimen box. B. Growth habit. $\times 9$. C–H. Specimen #21. C. Label of the specimen box. D. Growth habit. $\times 9$. E. Sorocarp with a branch near the base. $\times 45$. F. Terminal part of the sorocarp in Fig. E. $\times 280$. G. Basal part of the sorocarp in Fig. E. $\times 450$. H. Spores. $\times 1130$.

Specimen 4-21-'97.

Dictyostelium mucoroides Brefeld, Abh. Senckenberg. Naturf. Ges., 7: 85, pls. 1–3, 1869.

Fifteen specimens were examined. Their conditions and sorocarp morphology were as fol-

lows.

#22 (Figs. 3A–3E)

Sorocarps large, tangled (Fig. 3B); sorophores gradually tapering from thick bases to thin tips (Figs. 3C & 3D), 50 μm near the base, 8–10 μm

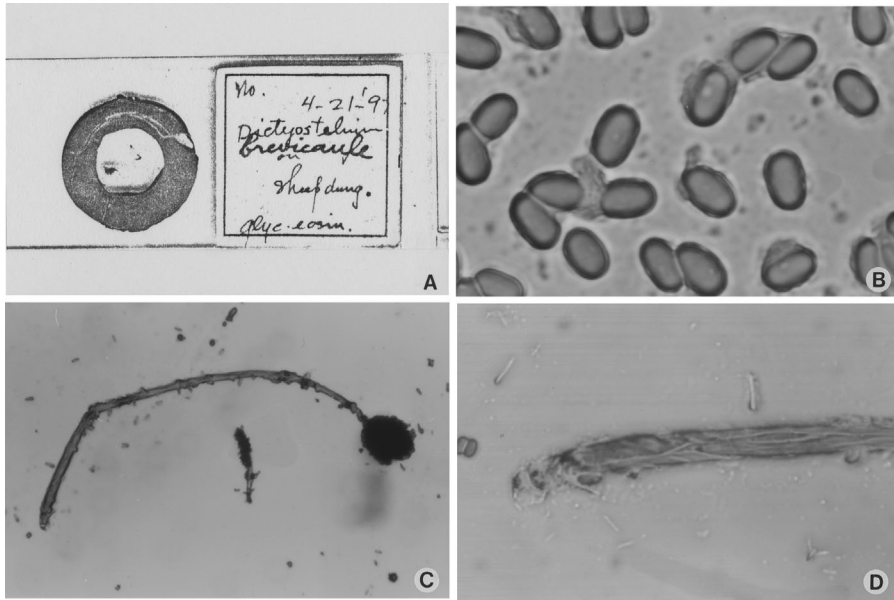


Fig. 2. *Dictyostelium brevicaule*. Specimen 4-21-'97. A. Label of the slide specimen. B. Spores. $\times 1130$. C. Sorocarp. $\times 113$. D. Basal part of the sorocarp in Fig. C. $\times 450$.

near the tip; sori white to yellowish; spores elliptical, nearly 2 times longer than broad (Fig. 3E), $5.6\text{--}6.9 \times 2.9\text{--}3.3 \mu\text{m}$ ($n=2$).

#23 (Figs. 3F–3I)

Sorocarps medial, tangled (Fig. 3G); sorophores gradually tapering from bases to thin tips, $25\text{--}29 \mu\text{m}$ in diam near the base, $4.5\text{--}7.5 \mu\text{m}$ in diam near the tip; sorophore tips capitata (Fig. 3H); sori yellowish brown; spores elliptical, usually 1.5–1.8 times longer than broad (Fig. 3F), mostly $5.2\text{--}6.7 \times 3.2\text{--}4.1 \mu\text{m}$ ($n=20$).

#24 (Figs. 4A & 4B)

Sorocarps very large, tangled (Fig. 4B); sorophores gradually tapering from thick bases to thin tips, $27.5\text{--}55 \mu\text{m}$ in diam near the base, $5\text{--}9.5 \mu\text{m}$ in diam near the tip; sori white to yellowish; spores elliptical, clearly more than 2 times longer than broad.

#25 (Figs. 4C–4F)

Sorocarps small (Fig. 4D), unbranched or irregularly branched; sorophores gradually taper-

ing from thick bases to thick tips (Fig. 4E), $20\text{--}50 \mu\text{m}$ in diam near the base; sori yellowish brown; spores elliptical, usually 1.5–1.7 times longer than broad (Fig. 4F), mostly $4.4\text{--}5.3 \times 2.8\text{--}3.3 \mu\text{m}$ ($n=12$).

#26 (Figs. 4G, 4H & 5G)

Sorocarps small (Fig. 4H); sorophores gradually tapering from thick bases to thick tips, $32.5\text{--}47.5 \mu\text{m}$ in diam near the base, $15\text{--}20 \mu\text{m}$ in diam near the tip; sori yellow; spores elliptical, usually 1.7–2.0 times longer than broad (Fig. 5G), mostly $4.9\text{--}5.8 \times 2.7\text{--}3.2 \mu\text{m}$ ($n=12$).

#27 (Figs. 5A, 5B & 5H)

Sorocarps large, tangled (Fig. 5B); sorophores gradually tapering from bases to thin tips, $12.5\text{--}37.5 \mu\text{m}$ in diam near the base, $5.5\text{--}7.5 \mu\text{m}$ in diam near the tip; sori white to yellowish; spores elliptical, usually 1.6–2.1 times longer than broad (Fig. 5H), mostly $4.4\text{--}5.8 \times 2.5\text{--}3.0 \mu\text{m}$ ($n=10$).

#28 (Figs. 5C & 5D)

Sorocarps medial (Fig. 5D); sorophores

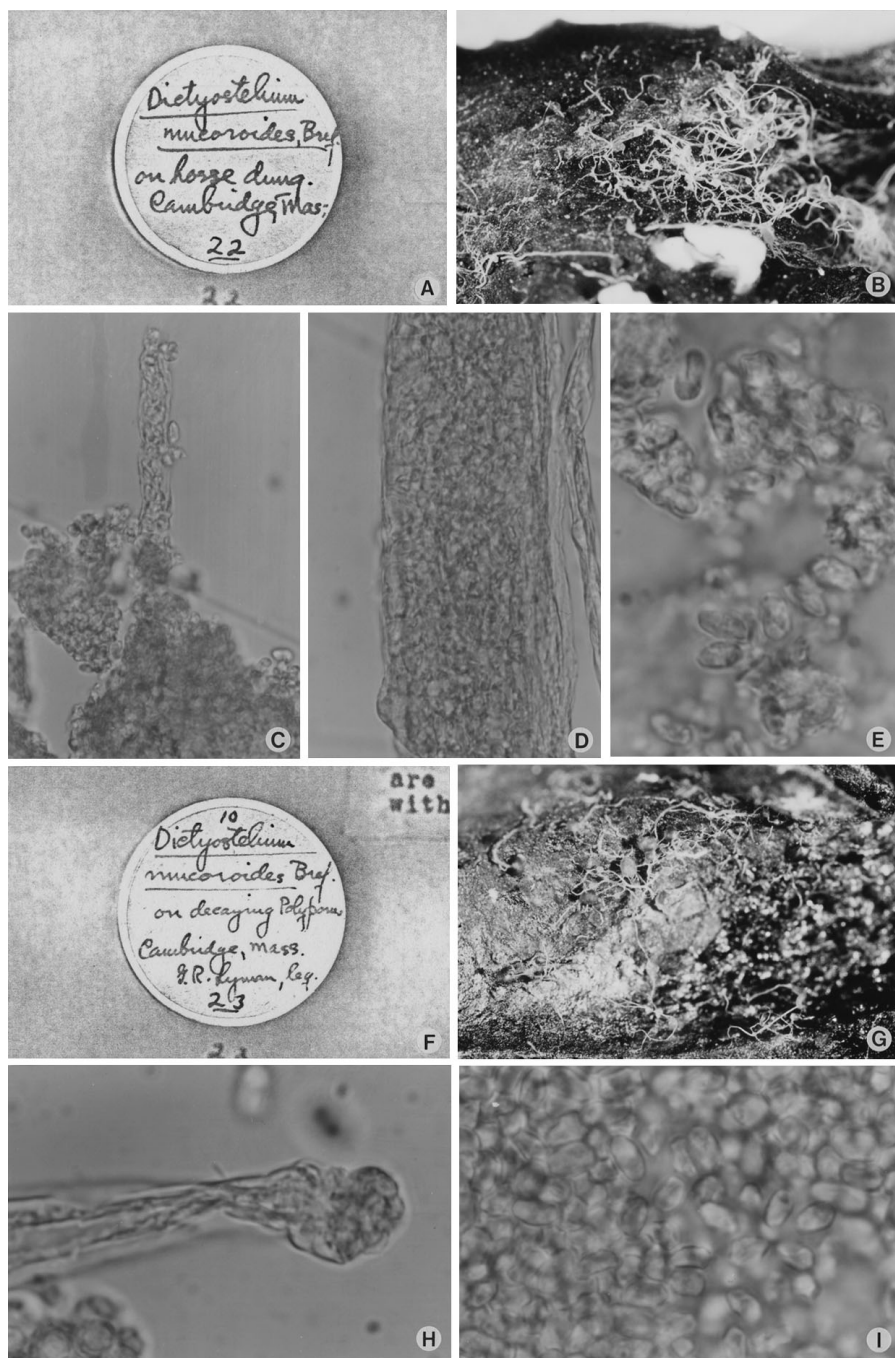


Fig. 3. *Dictyostelium mucoroides*. A–E. Specimen #22. A. Label of the specimen box. B. Growth habit. $\times 9$. C. Sorophore tip. $\times 450$. D. Part of a sorophore near the base. $\times 450$. E. Spores. $\times 1130$. F–I. Specimen #23. F. Label of the specimen box. G. Growth habit. $\times 9$. H. Sorophore tip. $\times 1130$. I. Spores. $\times 1130$.

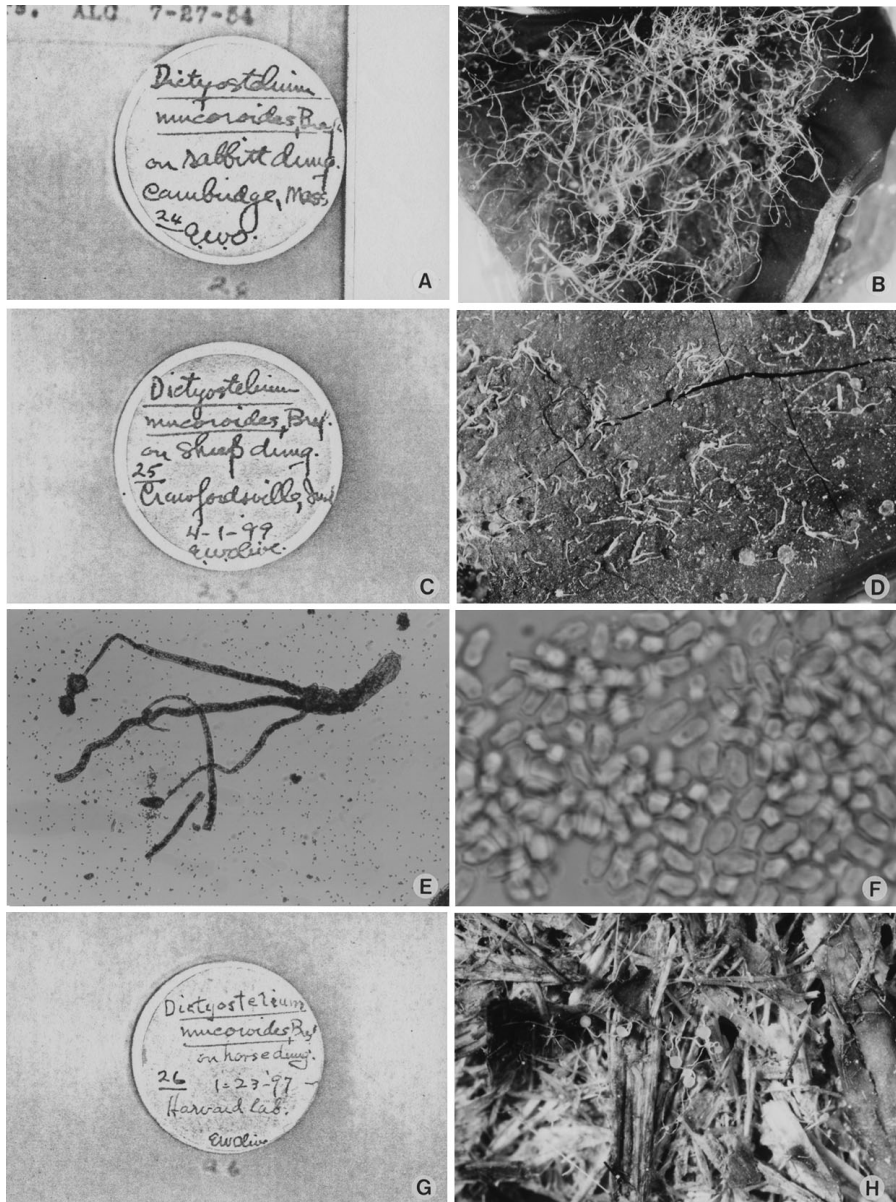


Fig. 4. *Dictyostelium mucoroides*. A–B. Specimen #24. A. Label of the specimen box. B. Growth habit. $\times 9$. C–F. Specimen #25. C. Label of the specimen box. D. Growth habit. $\times 9$. E. Sorocarp with two branches near the base. $\times 45$. F. Spores. $\times 1130$. G, H. Specimen #26. G. Label of the specimen box. H. Growth habit. $\times 9$.

gradually tapering from bases to thin tips; sori white to yellowish; spores elliptical, clearly less than 2 times longer than broad (Fig. 5I), $5.0\text{--}5.4 \times 3.0\text{--}3.2 \mu\text{m}$ ($n=2$).

#29 (Figs. 5E, 5F & 5J)

Sorocarps large, tangled (Fig. 5F); sorophores gradually tapering from bases to thin tips, $27.5 \mu\text{m}$ in diam near the base, $9 \mu\text{m}$ in diam near the tip; sori white to yellowish; spores elliptical, usually 1.6–1.9 times longer than broad (Fig. 5J), mostly $5.9\text{--}7.1 \times 3.4\text{--}3.9 \mu\text{m}$ ($n=11$).

1-12-'97 (Figs. 6A–6C)

A cluster of three sorocarps was mounted. A mount solution dried up.

Sorocarps small, unbranched or irregularly branched (Fig. 6C); sorophores gradually tapering from thick bases to thick tips (Fig. 6C); spores elliptical to oblong, clearly less than 2 times longer than broad (Fig. 6B).

3-17-'97 (Figs. 6D & 6E)

Two sorocarps were mounted. A mount solution dried up and the sorocarps were molded.

Spores elliptical to oblong, nearly 2 times longer than broad (Fig. 6E).

12-28-'97 (Figs. 6F & 6G)

Two sorocarps were mounted. A mount solution dried up.

Sorocarps large, unbranched; sorophores 4.7–5.6 mm in length, gradually tapering from thick bases to thin tips, 45 μm in diam near the base, 3–5 μm in diam near the tip; spores elliptical, clearly less than 2 times longer than broad (Fig. 6G).

1-18-'01 (Figs. 7A–7D)

One sorocarp was mounted.

Sorocarp small, unbranched, with a basal disk (Fig. 7C); sorophore 1.7 mm in length, gradually tapering from a thick base to a thick tip (Fig. 7C), 100 μm in diam near the base, 50 μm in diam near the tip; basal disk large (Fig. 7D), 500 μm in diam; spores elliptical, usually 2.1–2.5 times longer than broad (Fig. 7B), mostly 7.5–8.9 \times 3.33.8 μm (n=20).

3-10-'01 (Figs. 7E–7I)

One immature sorocarp was mounted and mature spores clung onto its sorophore.

Sorocarp large, unbranched; sorophore 3.7 mm in length, gradually tapering from thick base to thin tip (Figs. 7G–7I), 45 μm in diam near the base, 8.5 μm in diam near the tip; spores elliptical, usually 2.1–2.4 times longer than broad (Fig. 7F), mostly 6.6–7.6 \times 2.9–3.4 μm (n=11).

11-22-'01 (Figs. 8A–8E)

Three or more sorocarps and several macrocyst-like structures (Fig. 8E) were mounted.

Sorocarps large, unbranched; sorophores 2–7 mm or more in length, gradually tapering from bases to thin tips (Figs. 8C & 8D), 18–30 μm in diam near the base, 5–7.5 μm in diam near the tip; sorophores tip capitate (Fig. 8C); spores elliptical, usually 1.7–2.0 times longer than broad (Fig. 8B), mostly 5.2–6.2 \times 2.8–3.5 μm (n=20). Macrocyst-like structures 13–31 μm in diam.

(no date) (Figs. 8F–8J)

One sorocarp was mounted.

Sorocarp minute, with a branch near the base (Fig. 8J); sorophore 0.7 mm in length, gradually tapering from a thick base to a thick tip (Fig. 8H), 27.5 μm in diam near the base, 12.5 μm in diam near the tip, having a collar (Fig. 8I); spores elliptical, usually 1.4–1.7 times longer than broad (Fig. 8G), mostly 3.9–4.6 \times 2.5–3.0 μm (n=20).

A note written on the slide label, namely, “stalk 100 μ ” (Fig. 8F), is incomprehensible.

Specimens #22 and *12-28-'97* were identified as *D. giganteum* Singh on the basis of their large sorocarps, thick sorophore bases, thin sorophore tips, and thick spores. Specimens #23, #28, #29, and *11-22-'01* were identified as *D. brefeldianum* or its related species on the basis of their medial or large sorocarps, moderately thick sorophore bases, thin sorophore tips, and thick spores. Of these, two specimens, i.e., Specimens #23 and *11-22-'01*, probably belonging to *D. brefeldianum* because their sorophore tips were capitate. Although macrocyst-like structures were identified in Specimen *11-22-'01*, macrocysts have not been observed in *D. brefeldianum*. Specimens #24, #27, and *3-10-'01* were identified as *D. firmibasis* Hagiwara or its related species on the basis of their large sorocarps, thick sorophore bases, thin sorophore tips, and thin spores. *D. firmibasis* have not been found in North America. Specimens #25, #26, and *(no date)* were identified as *D. mucoroides* based on their small sorocarps, thick sorophores, and thick

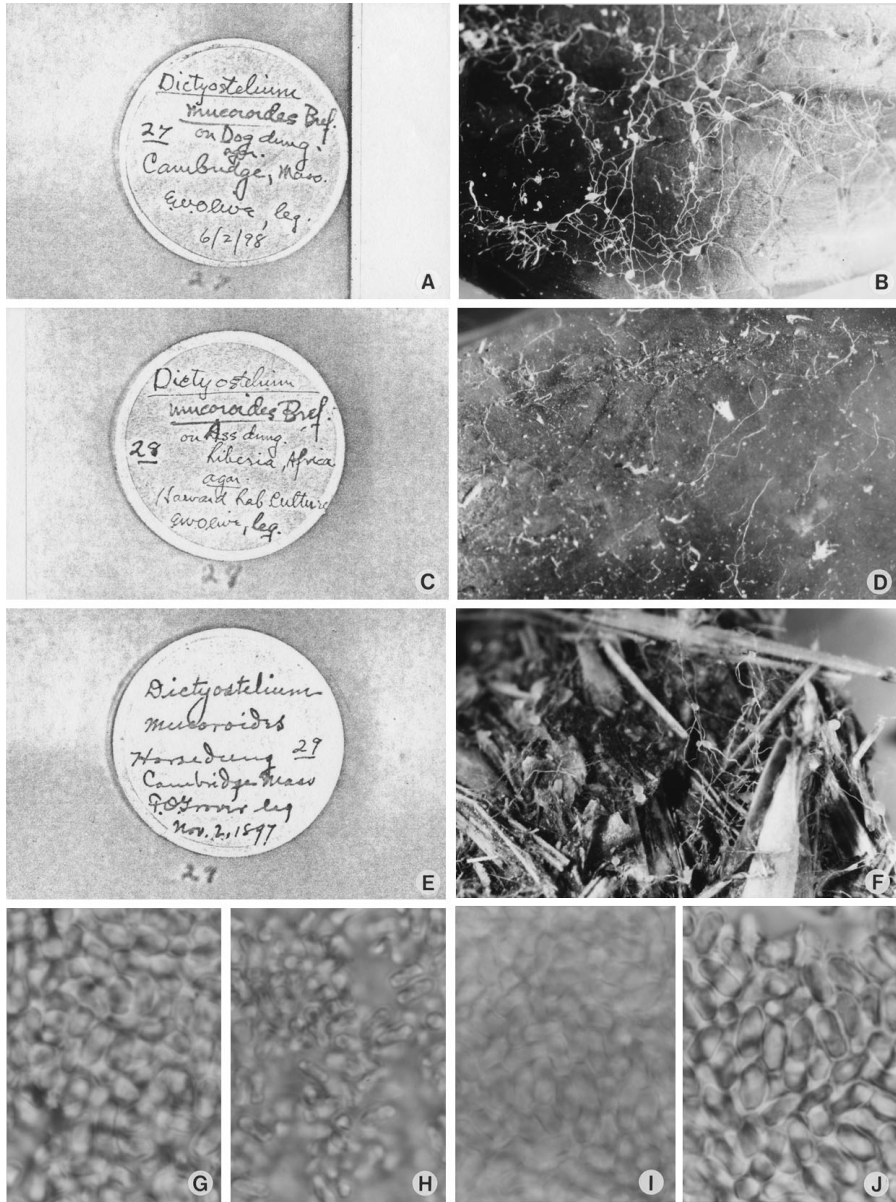


Fig. 5. *Dictyostelium mucoroides*. A, B. Specimen #27. A. Label of the specimen box. B. Growth habit. $\times 9$. C, D. Specimen #28. C. Label of the specimen box. D. Growth habit. $\times 9$. E, F. Specimen #29. E. Label of the specimen box. F. Growth habit. $\times 9$. G. Spores of Specimen #26. $\times 1130$. H. Spores of Specimen #27. $\times 1130$. I. Spores of Specimen #28. $\times 1130$. J. Spores of Specimen #29. $\times 1130$.

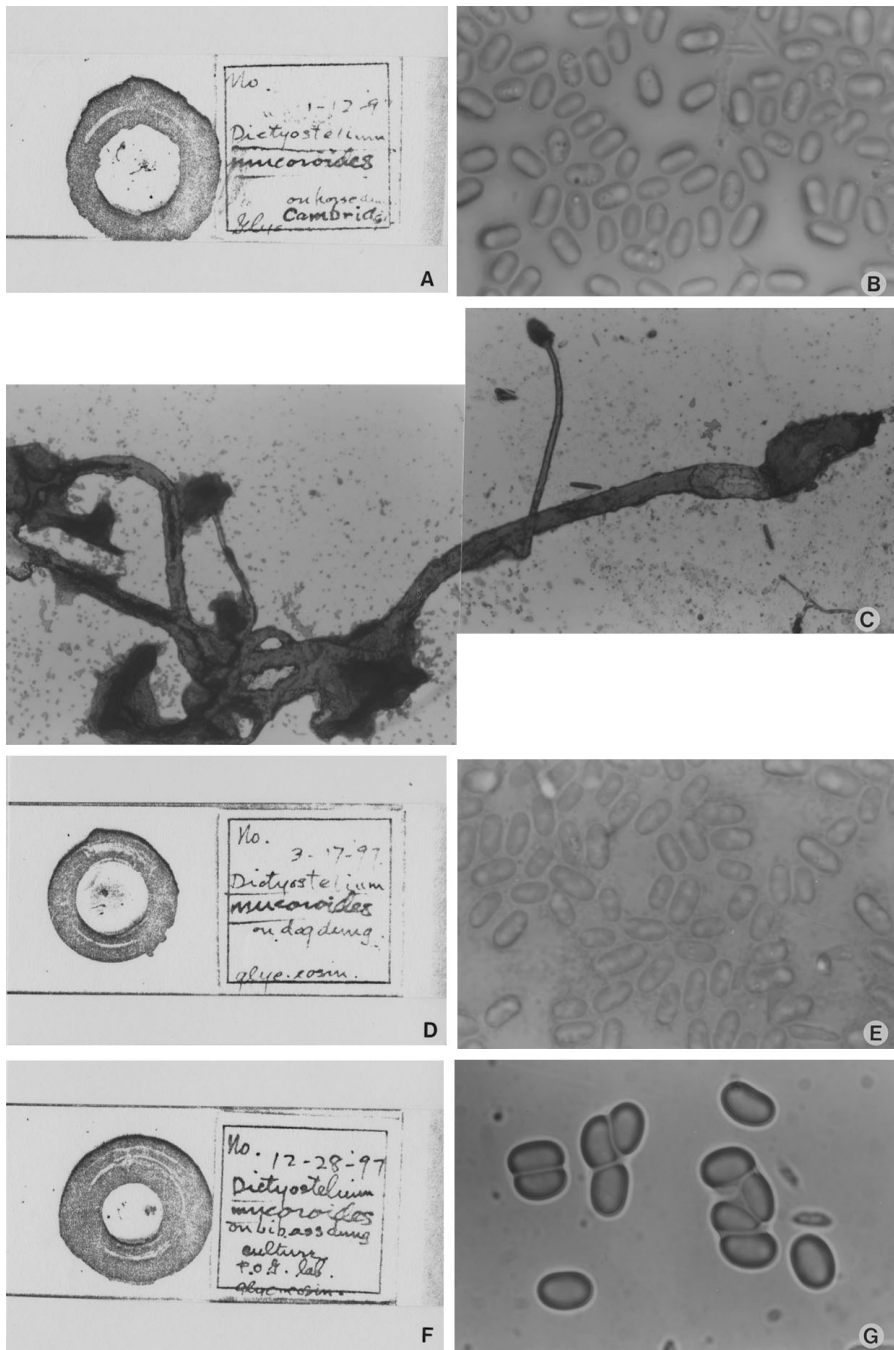


Fig. 6. *Dictyostelium mucoroides*. A-C. Specimen 1-12-'97. A. Label of the slide specimen. B. Spores. $\times 1130$. C. Three sorocarps growing together. $\times 45$. D, E. Specimen 3-17-'97. D. Label of the slide specimen. E. Spores. $\times 1130$. F, G. Specimen 12-28-'97. F. Label of the slide specimen. G. Spores. $\times 1130$.

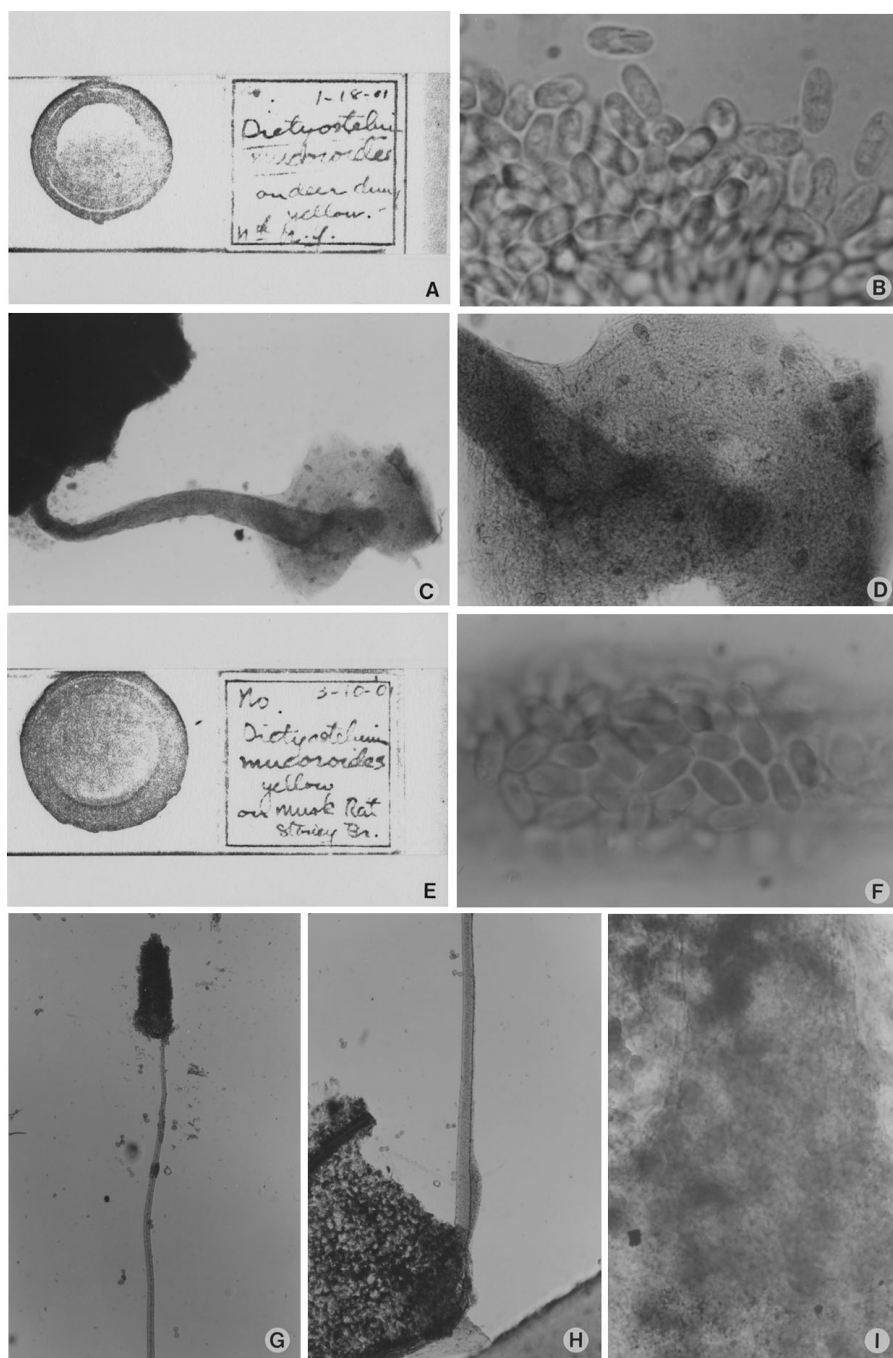


Fig. 7. *Dictyostelium mucoroides*. A-D. Specimen 1-18-'01. A. Label of the slide specimen. B. Spores. $\times 1130$. C. Sorocarps with a large basal disk. D. Basal part of the sorophore in Fig. C. $\times 280$. E-I. Specimen 3-10-'01. E. Label of the slide specimen. F. Spores. $\times 1130$. G. Upper part of a sorophore. $\times 45$. H. Lower part of a sorophore. $\times 45$. I. Basal part of the sorophore in Fig. H. $\times 280$.

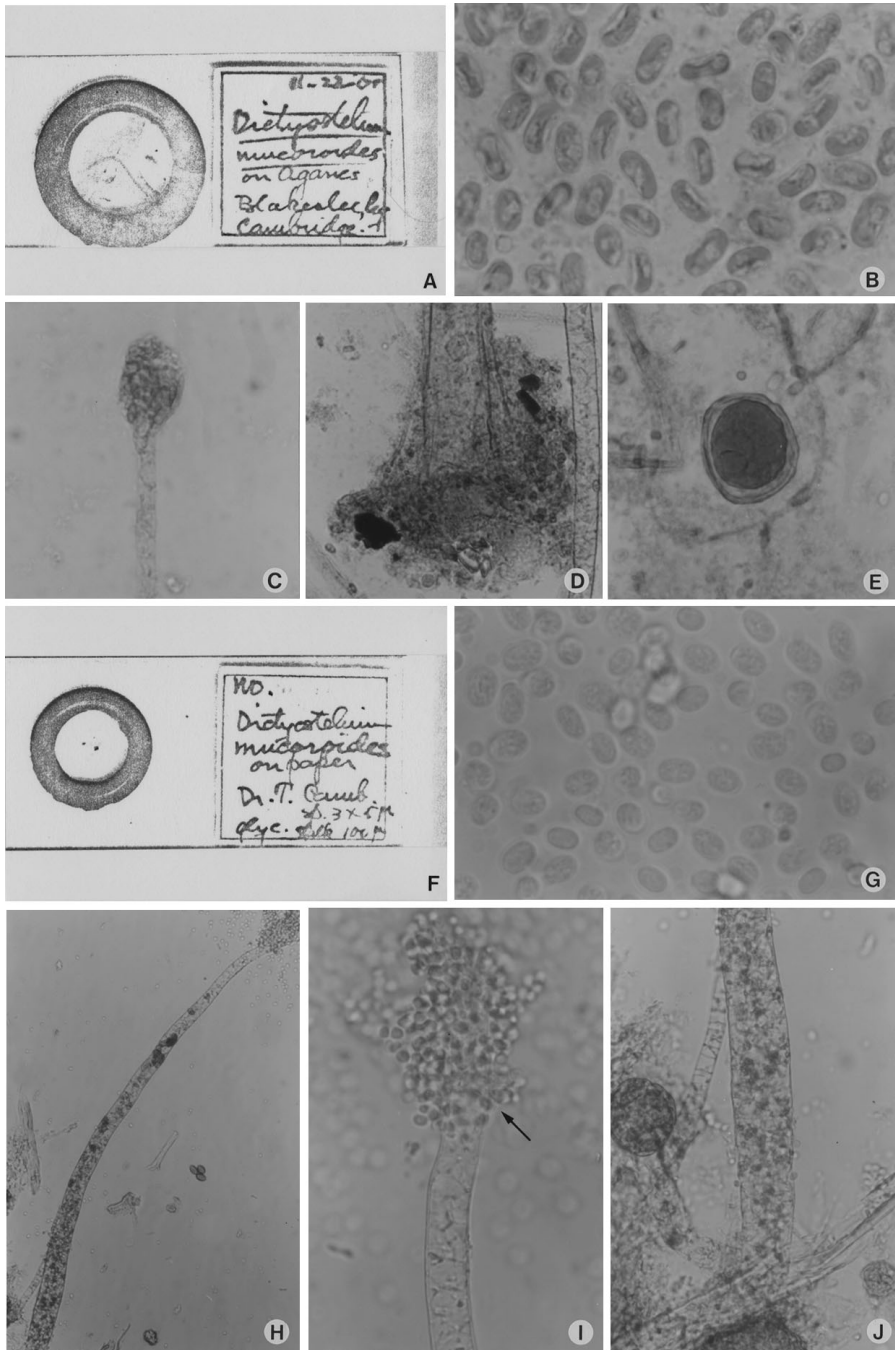


Fig. 8. *Dictyostelium mucoroides*. A–E. Specimen 11-22-'01. A. Label of the slide specimen. B. Spores. $\times 1130$. C. Sorophore tip. $\times 450$. D. Sorophore base. $\times 280$. E. Macrocyst-like structure. $\times 450$. F–J. Specimen (no data). F. Label of the slide specimen. G. Spores. $\times 1130$. H. Sorophore. $\times 113$. I. Sorophore tip with a collar (arrow). $\times 450$. J. Sorophore base with a branch. $\times 280$.

spores. Specimen 1-18-'01 was identified as *D. discoideum* Raper based on its large basal disk and spore size. Specimen 3-17-'97 could not be identified because other than the spore shape, all its morphological characteristics were obscure.

Dictyostelium sphaerocephalum (Oud.) Sacc. & March., Bull. Soc. Roy. Bot. Belg., 24: 74, pl. 3, 1885.

Twelve specimens were examined. Their conditions and sorocarp morphology were as follows.

#33 (Figs. 9A, 9B & 9G)

Sorocarps medial, tangled (Fig. 9B); sorophores gradually tapering from bases to thin tips, 22.5–32.5 μm in diam near the base, 4.5–7.5 μm in diam near the tip; sori yellow to yellowish brown; spores elliptical, usually 1.8–2.1 times longer than broad (Fig. 9G), mostly 6.3–8.0 \times 3.4–4.1 μm (n=20).

#34 (Figs. 9C, 9D & 9H)

Sorocarps small, delicate, tangled (Fig. 9D); sorophores gradually tapering from bases to thin tips, consisting of single tiers cells, 11.5–15 μm in diam near the base, 2.5–5.5 μm in diam near the tip; sori white; spores elliptical, usually 1.8–2.1 times longer than broad (Fig. 9H), mostly 6.0–7.0 \times 3.1–3.5 μm (n=9).

#35 (Figs. 9E, 9F & 9I)

Sorocarps medial, tangled (Fig. 9F); sorophores gradually tapering from somewhat thick bases to thin tips, 40 μm near the base, 5–10 μm near the tip; sori yellow to yellowish brown; spores elliptical, usually 1.6–2.1 times longer than broad (Fig. 9I), mostly 5.0–5.9 \times 2.7–3.3 μm (n=20).

#36 (Figs. 10A, 10B & 10E)

Sorocarps large, tangled (Fig. 10B); sorophores gradually tapering from bases to thin tips, 16.5–25 μm in diam near the base, 5 μm in diam near the tip; sori yellow to yellowish brown; spores elliptical, mostly 1.6–1.9 times longer than broad (Fig. 10E), mostly 5.4–6.7 \times 3.2–3.8 μm (n=12).

#37 (Figs. 10C, 10D, 10F & 10G)

Sorocarps large, tangled (Fig. 10D); sorophores gradually tapering from thick bases to thin tips (Fig. 10F), 25–42.5 μm in diam near the base, 5–10 μm in diam near the tip; sori yellowish brown; spores elliptical, usually 1.6–1.9 times longer than broad (Fig. 10G), mostly 5.8–6.8 \times 3.3–3.8 μm (n=20).

#38 (Figs. 11A–11E)

Sorocarps medial, tangled, unbranched or irregularly branched (Fig. 11B); sorophores gradually tapering from bulbous bases to thin tips (Figs. 11C & 11D), 21–32.5 μm in diam near the base, 6 μm near the tip; sori white to yellowish; spores elliptical, nearly 2 times longer than broad (Fig. 11E), 6.6 \times 3.4 μm (n=2).

4-5-'97 (Figs. 11F & 11G)

Several sorocarps were mounted. A mount solution dried up and the sorocarps were molded.

Spores elliptical, less than 2 times longer than broad (Fig. 11G).

4-7-'97 (Figs. 11H & 11I)

Two sorocarps were mounted. A mount solution dried up.

Spores elliptical, less than 2 times longer than broad (Fig. 11I).

6/5/'97 (Figs. 12A–12E)

One sorocarp was mounted.

Sorocarp very large, branched (Fig. 12E); sorophore more than 8 mm in length, gradually tapering from a thick base to a thick tip, 60 μm in diam near the base, 22.5 μm in diam near the tip; spores elliptical, usually 2.0–2.4 times longer than broad (Fig. 12B), mostly 6.4–8.1 \times 3.0–3.6 μm (n=20).

12-21-'97 (Figs. 12F & 12G)

Two sorocarps were mounted. A mount solution dried up and the sorocarps were molded.

Spores elliptical, clearly less than 2 times longer than broad (Fig. 12G).

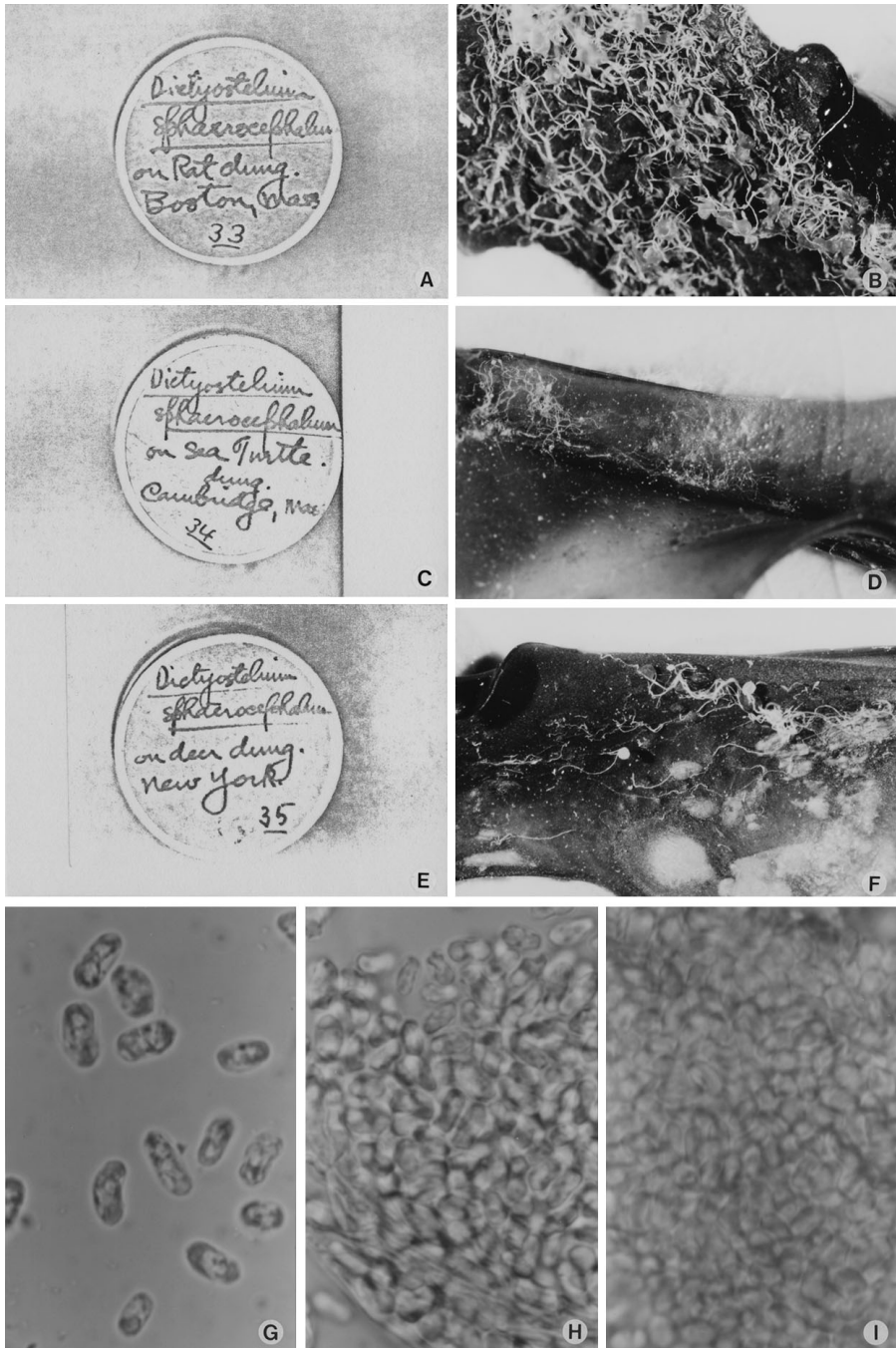


Fig. 9. *Dictyostelium sphaerocephalum*. A, B. Specimen #33. A. Label of the specimen box. B. Growth habit. $\times 9$. C, D. Specimen #34. C. Label of the specimen box. D. Growth habit. $\times 9$. E, F. Specimen #35. E. Label of the specimen box. F. Growth habit. $\times 9$. G. Spores of Specimen #33. $\times 1130$. H. Spores of Specimen #34. $\times 1130$. I. Spores of Specimen #35. $\times 1130$.

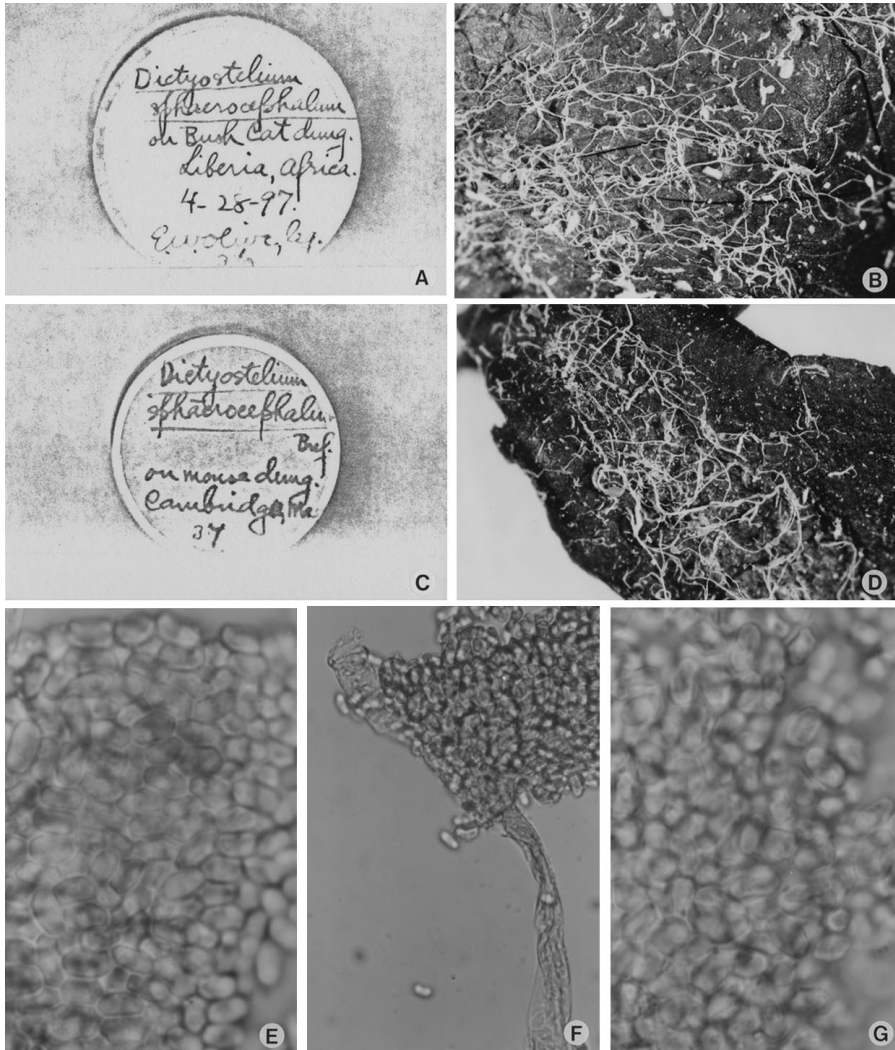


Fig. 10. *Dictyostelium sphaerocephalum*. A, B. Specimen #36. A. Label of the specimen box. B. Growth habit. $\times 9$. C, D. Specimen #37. C. Label of the specimen box. D. Growth habit. $\times 9$. E. Spores of Specimen #36. $\times 1130$. F. Sorophore tip of Specimen #37. $\times 450$. G. Spores of Specimen #37. $\times 1130$.

4-18-'99 (Figs. 12H & 12I)

One immature sorocarp was mounted.
Sorocarp small, delicate (Fig. 12I).

tip; spores elliptical, usually 1.7–2.1 times longer than broad (Fig. 13B), mostly $6.3\text{--}7.4 \times 3.4\text{--}4.0 \mu\text{m}$ ($n=20$).

1-18-'01 (Figs. 13A–13F)

Five sorocarps were mounted.
Sorocarps large, unbranched or irregularly branched; sorophores 4.1–6.1 mm in length, gradually tapering from thick bases to thin tips (Figs. 13C & 13D), $32.5\text{--}57.5$ (-75) μm in diam near the base, $5\text{--}6.5$ (-25) μm in diam near the

Specimens #33, #35, and #36 were identified as *D. brefeldianum* or its related species on the basis of their medial or large sorocarps, moderately thick sorophore bases, thin sorophore tips, and thick spores. However, Specimen #35 showed the presence of fairly thick sorophore bases. Specimens #37 and 1-18-'01 were

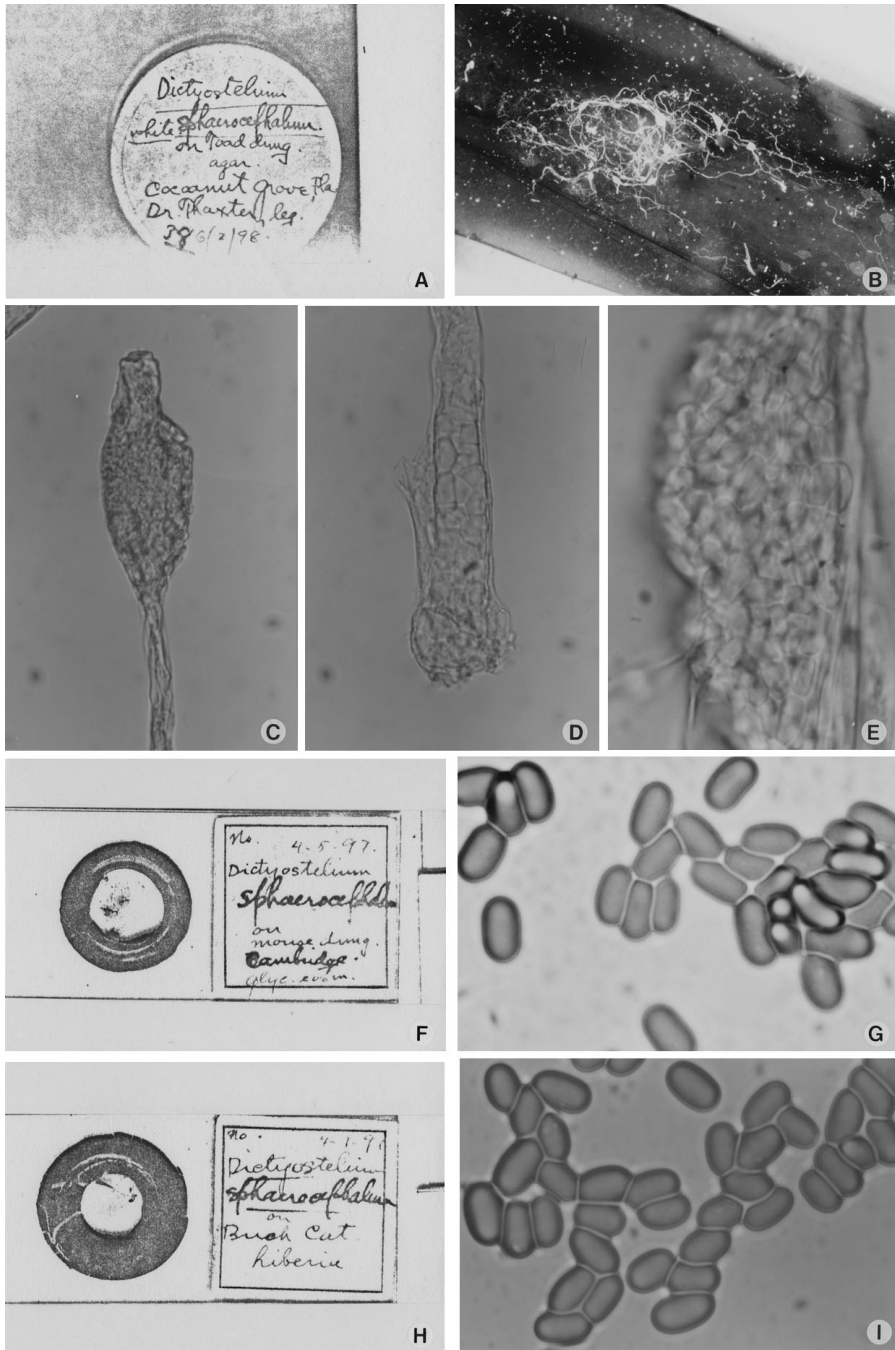


Fig. 11. *Dictyostelium sphaerocephalum*. A–E. Specimen #38. A. Label of the specimen box. B. Growth habit. $\times 9$. C. Sorophore tip. $\times 450$. D. Sorophore base. $\times 450$. E. Spores. $\times 1130$. F, G. Specimen 4-5-'97. F. Label of the slide specimen. G. Spores. $\times 1130$. H, I. Specimen 4-7-'97. H. Label of the slide specimen. I. Spores. $\times 1130$.

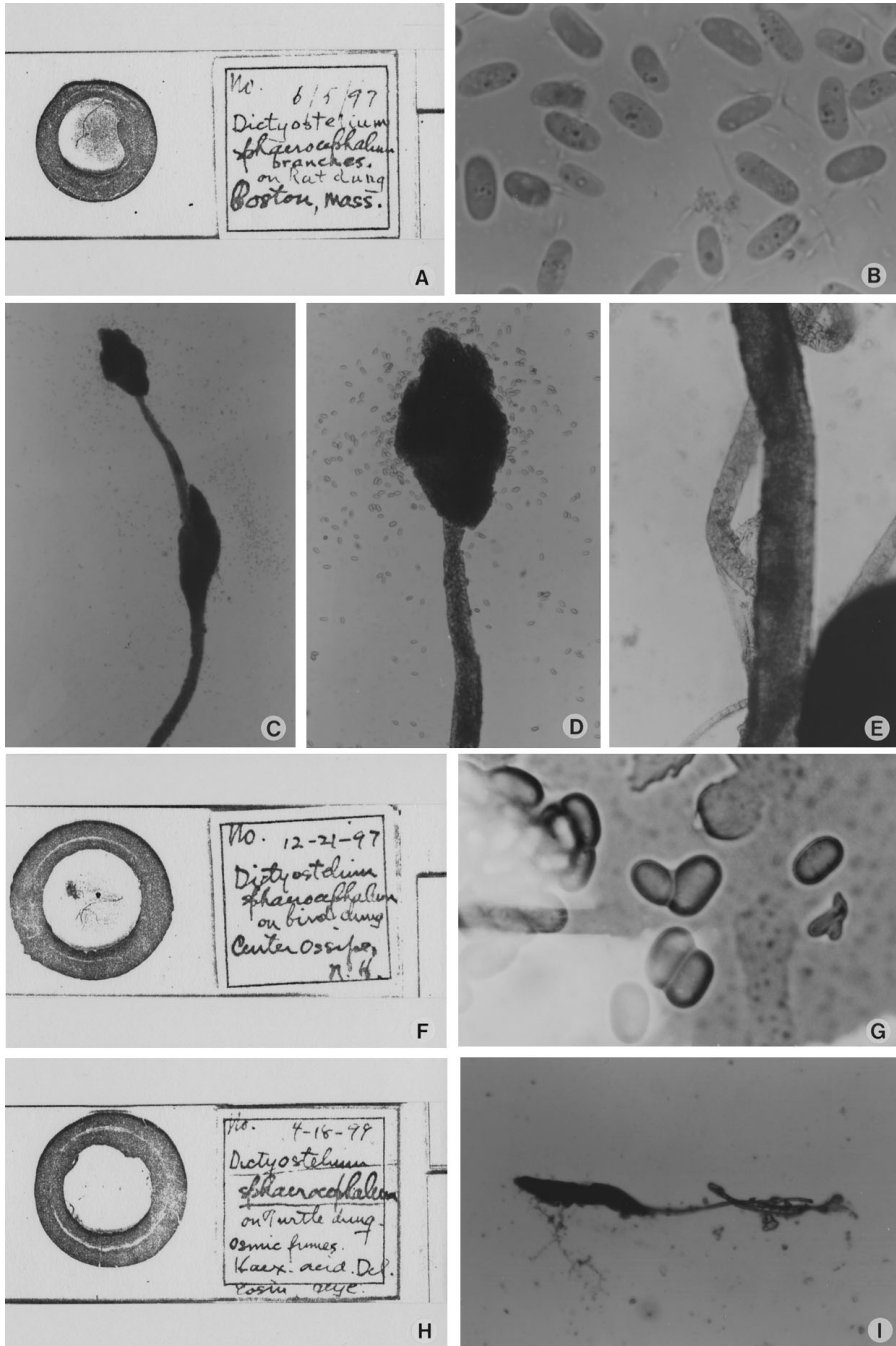


Fig. 12. *Dictyostelium sphaerocephalum*. A-E. Specimen 6/5/97. A. Label of the slide specimen. B. Spores. $\times 1130$. C. Terminal part of a sorophore. $\times 45$. D. Sorophore tip. $\times 113$. E. Basal part of a sorophore with a branch. $\times 113$. F, G. Specimen 12-21-'97. F. Label of the slide specimen. G. Spores. $\times 1130$. H, I. Specimen 4-18-'99. H. Label of the slide specimen. I. Sorocarp. $\times 45$.

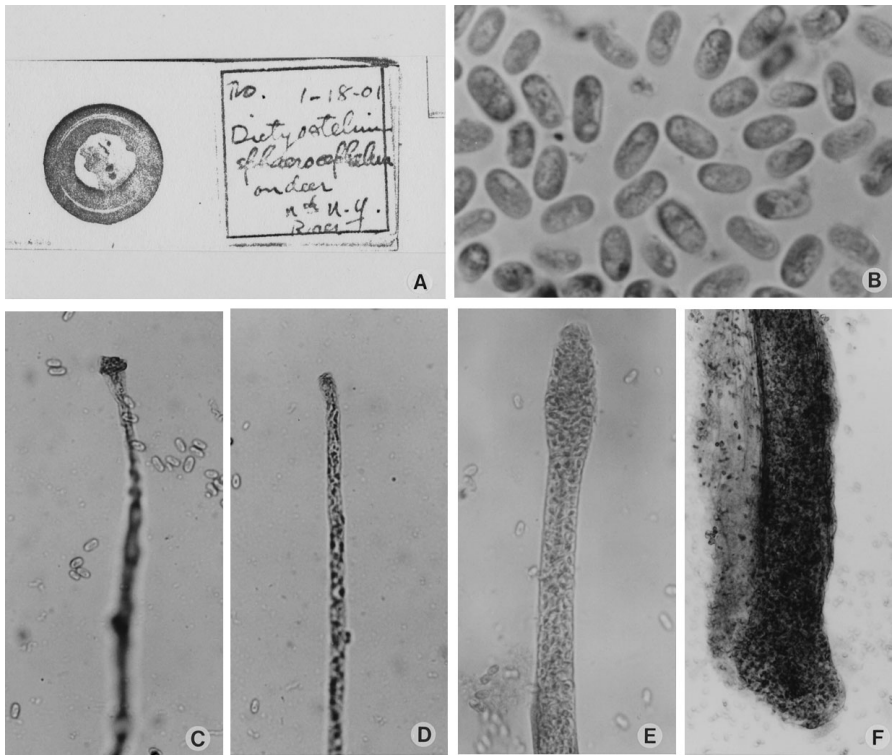


Fig. 13. *Dictyostelium sphaerocephalum*. A–F. Specimen 1-18-'01. A. Label of the slide specimen. B. Spores. $\times 1130$. C, D. Sorophore tips. $\times 280$. E. Exceptionally thick sorophore tip. $\times 280$. F. Exceptionally thick sorophore base. $\times 113$.

identified as *D. giganteum* on the basis of their large sorocarps, thick sorophore bases, thin sorophore tips, and thick spores. If both the Specimens #35 and 1-18-'01 have originated from the same isolate, it is probable that Specimen #35 belongs to *D. giganteum*. Specimen #38 was identified as *D. aureo-stipes* Cavender, Raper & Norberg based on its large sorocarp with several branches and a bulbous sorophore base. Specimen 6/5/'97 was identified as *D. septentrionalis* Cavender based on its very large sorocarp with a thick sorophore and large spores. The five other specimens could not be identified. Of the unidentified specimens, Specimen #34 showed the following distinct characteristics: its small sorocarps were considerably delicate and its sorophores consisted of single tiers of cells. Therefore, it may belong to *D. monochasioides* Hagiwara.

The results of the identification of all the specimens examined in this study are listed in Table 2. The 3 specimens labeled as *D. brevicaulis* were identified to belong to a single taxon, *D. mucoroides*. The group of 15 specimens labeled as *D. mucoroides* could not be distinguished from the group of 12 specimens labeled as *D. sphaerocephalum* not only with regard to their spore size but also in other characters. Moreover, both the groups comprised 4 or more taxa, i.e., the specimens in the former group were identified to belong to *D. brefeldianum* or its related species, *D. discoideum*, *D. firmibasis* or its related species, *D. giganteum*, and *D. mucoroides*. On the other hand, specimens of *D. aureo-stipes*, *D. brefeldianum* or its related species, *D. giganteum*, and *D. septentrionalis* were identified in the latter group. *D. giganteum* and *D. brefeldianum* or its related species were recognized in both the groups. Therefore, both the groups were not tax-

Table 2. Summary of the results of identification in this study.

Species name in Olive (1901)	Specimen	Identification
<i>D. brevicaule</i>	Dry	
	#20	<i>D. mucoroides</i>
	#21	<i>D. mucoroides</i>
<i>D. mucoroides</i>	Slide	
	4-21-'97	<i>D. mucoroides</i>
	Dry	
	#22	<i>D. giganteum</i>
	#23	<i>D. brefeldianum</i> or its related species
	#24	<i>D. firmibasis</i> or its related species
	#25	<i>D. mucoroides</i>
	#26	<i>D. mucoroides</i>
	#27	<i>D. firmibasis</i> or its related species
	#28	<i>D. brefeldianum</i> or its related species
	#29	<i>D. brefeldianum</i> or its related species
<i>D. sphaerocephalum</i>	Slide	
	1-12-'97	<i>D. mucoroides</i>
	3-17-'97	unidentified
	12-28-'97	<i>D. giganteum</i>
	1-18-'01	<i>D. discoideum</i>
	3-10-'01	<i>D. firmibasis</i> or its related species
	11-22-'01	<i>D. brefeldianum</i> or its related species
	(no date)	<i>D. mucoroides</i>
Dry		
#33	<i>D. brefeldianum</i> or its related species	
#34	unidentified (cf. <i>D. monochasioides</i>)	
#35	<i>D. brefeldianum</i> or its related species (cf. <i>D. giganteum</i>)	
#36	<i>D. brefeldianum</i> or its related species	
#37	<i>D. giganteum</i>	
#38	<i>D. aureo-stipes</i>	
Slide	4-5-'97	unidentified
	4-7-'97	unidentified
	6/5/97	<i>D. septentrionalis</i>
	12-21-'97	unidentified
	4-18-'99	unidentified
	1-18-'01	<i>D. giganteum</i>

onomically classified into two groups. These results confirmed the statement in Olive (1902), "it may prove desirable to unite these two variable species."

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