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ADDENDA TO

"THE MEROSPORANGIFEROUS MUCORALES"

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Tieghemiomyces parasiticus sp. nov.

Coloniae in Cokeromyces recurvatus in agar YpSs albae vel in acetate "Pinkish Buff"; hyphis vegetantibus 2–5 μ diam.; sporophoris rectis, levibus, in juvante simplicibus, ramos singulos fertiles divaricatos septatos infra 3 septa in partibus superioribus gerentibus; ramos fertilibus subverticillatis; ramos ultimis fertilibus; extentionibus sterilibus absentibus; sporophoris in acetate ad 3 mm. altis; stipitibus principalibus 325–825 μ altis, 7–10 μ diam.; in cellulis 100–200 μ longis consistentibus; ramosculis sporogenis in 1–3 vel 4 cellulis consistentibus; cellulis sporogenis merosporangia de 2 sporis gerentibus; merosporangiis per gemmascentem gestis; sporis glo0osis vel nonnihil ovoideis, 3–4 μ × 2.5–3 μ, in acetate siccis; zygosporis globosis, hyalinis, de muris crassis, punctatis, 43–58 μ (med. 51 μ) diam., globulos singulos excentricos, 22–31 μ diam., continentibus; muro 5–9 μ (med. 7.4 μ) crasso.

Holotype.—ILLINOIS. Champaign County: Champaign, 26 March, 1959, isolated from mouse dung collected by Mrs. Ethel Dickens (RSA Culture 861). Transfers of the holotype have been deposited in the ATCC, CBS, and CMI.

Like Tieghemiomyces californicus, T. parasiticus parasitizes other Mucorales; the vegetative hyphae of the parasite penetrate the walls of the substrate hyphae of the host and form branched haustoria (Pl. 1c; Pl. 2c) characteristic of the Dimargaritaceae (Benjamin, 1959: p. 364). When grown on ME-YE, T. parasiticus, like its congener, develops slowly but apparently normally without a host. Known members of other genera of the family that have been studied in culture require a host for vigorous growth and sporulation on ordinary

1 Completion of this work was supported by a National Science Foundation grant, NSF G-14275.
agar media although some may develop slowly, albeit aberrantly, in pure culture.

*Tieghemomyces parasiticus* and *T. californicus* are distinguished readily—even when examined at low magnification with a dissecting microscope—by the nature of their fertile branches, for in the former species these structures are less highly ramified than in the latter.

**Plate 1.** *Tieghemomyces parasiticus* Benjamin.—a. Habit sketch showing general characteristics of fruiting structures. X 30.—b. Immature sporophore showing early stages of development of lateral branches. X 300.—c. Mature haustorium. X 1080.—d. Terminal portion of young sporophore showing conformation of developing fertile branches. X 780.—e. Young sporiferous branchlet showing origin of merosporangia from fertile cells. X 1360.—f. Nearly mature fertile branch showing disposition of sporiferous branchlets and merosporangia. X 660.—g. Mature spores. X 1360.
and lack the free terminations so characteristic of *T. californicus* (compare: Benjamin, 1959, Pl. 25a, f–g, and Pl. 26e–f, with Pl. 1a, b, d, and f; Pl. 2a and b). In the type species three, but often four, tiers of fertile branches are formed and two or even three branches may be developed immediately below one or more of the septa in the fertile region (Benjamin, 1959: Pl. 26d–e). In no instance have more than three tiers of single fertile branches been observed in *T. parasiticus* and these, with rare exceptions, are borne one above the other on the same side of the sporophore (Pl. 1b, d; Pl. 2b).

When the sporophore of *T. parasiticus* matures, the stipe, like that of *T. californicus* (Benjamin, 1959: Pl. 26c), separates by circumscissile rupture immediately below the proximal fertile branch system, and, because of intertwined stipe prolongations, a large portion of a given colony of the parasite may be swept away in toto.

The zygospores of *T. parasiticus* (Pl. 2e–f), although averaging about 10% larger, are similar to those of *T. californicus*.

Because of the nature of the fertile branches of *T. parasiticus*, the description of *Tieghemiomyces* given originally (Benjamin, 1959: p. 390) must be emended to include forms with fertile branches lacking free terminations.

The two known species of *Tieghemiomyces* may be separated as follows:

A. Main axes of the fertile branches and often their laterals with sterile prolongations .................................. *T. californicus*
AA. Main axes of the fertile branches and their laterals without sterile prolongations .................................. *T. parasiticus*

**DISPIRA SIMPLEX**

Benjamin

At the time *Dispira simplex* was described (Benjamin, 1959: p. 387) it had not been grown in two-membered culture on agar media. Repeated attempts to cultivate the species in association with *Cokeromyces recurvatus*, *Mucor hiemalis*, and *Mycotypha microspora*—species readily parasitized by other members of the Dimargaritaceae thus far cultured—failed, and the fungus was described from material growing in association with miscellaneous fungi on the original dung substrata. In the fall of 1959, Geoffrey F. Orr, University of California, Los Angeles, succeeded in growing *D. simplex* in mixed culture with a species of *Chaetomium*. Subsequently, the writer has isolated several additional strains of this parasite together with *Chaetomium* associates and has demonstrated that it is, indeed, parasitic on at least one representative of this genus of Ascomycetes. *Dispira simplex* thus joins *Piptocephalis xenophila* (Dobbs and English, 1954) and *Syncephalis wynneae* (Thaxter, 1897) of the Piptocephalidaceae as one of the few members of the merosporangiferous Mucorales known to parasitize non-mucoralean hosts.

No effort has been made as yet to examine the host range of *D. simplex* on *Chaetomium*. Using the keys of Skolko and Groves (1953), I have placed the four strains of *Chaetomium* so far isolated with and used as hosts for the parasite near *C. bostrychodes* Zopf.

Media such as YpSs, PDA, and ME-YE (Benjamin, 1959: p. 322), are very satisfactory for obtaining apparently normal development of *D. simplex* on *Chaetomium*, but all attempts to culture the parasite alone and with the mucor hosts listed above have been negative. No significant changes in the original description of *D. simplex* are necessitated, but it now is possible to describe its zygospores.

In my previous work on merosporangiferous Mucorales (Benjamin, 1959: pp. 386–387), I interpreted the zygospore-like bodies of *D. cornuta*, first described by Ayers (1935), as true zygospores although they are borne terminally on lateral outgrowths of vegetative hyphae; Zygospore-like bodies resembling those of *D. cornuta* are formed readily in cultures of *D. simplex*. In the latter species, these too are borne on robust stalks that vary greatly in length, often reaching a length nearly equal to the diameter of the spore. With
great frequency the spore stalk arises from the point of anastomosis of the tip of one vegeta­
tive hypha to the lateral wall of another so that it is subtended by the apparent juncture of
three hyphae. Conjugation of undifferentiated vegetative hyphae is the typical method of
initiation of zygospores in both the Dimargaritaceae (Benjamin, 1959) and the related
Kickxellaceae (Benjamin, 1958). The zygospore-like bodies of D. simplex, like those of
D. cornuta, are regarded here as true zygospores.

Zygospores of D. simplex (Pl. 2g–h) grown on YpSs are colorless, measure about 20–38
μ (aver. 29 μ) in diameter, and have walls (3–)4–6 μ thick. When mature, each spore
contains one or rarely two or three refractive globules about 9–16 μ in diameter. The mean
diameter of the zygospores of this species is about 25% less than in D. cornuta. Whereas
the exospore of D. cornuta appears minutely punctate (Benjamin, 1959: Pl .22d), the
exospore of D. simplex is marked by relatively large nearly circular depressions measuring
2.5–3 μ in diameter (Pl. 2h).

Cultures of the following isolates of Dispira simplex have been deposited in the ATCC, CBS, and
CMl:

RSA Culture 946.—CALIFORNIA. San Bernardino County: Lake View, August 19, 1959, isolated
from rat dung.

RSA Culture 952.—CALIFORNIA. Riverside County: 3 miles east of Earp, fall, 1959, isolated
from rabbit dung by G. F. Orr.

RSA Culture 1000.—CALIFORNIA. San Bernardino County: 2 miles east of Wheaton Springs,
April 22, 1960, isolated from rat dung.

Dipsacomyces gen. nov.

Hyphis fertilibus septatis; sporocladiis lateralibus stipitatis septatis attenuatis, cellulis
intercalaribus plerumque ordines tranversos vesicularum sporigerarum in superficie una
gerentibus; vesiculis sporigeris elongatis ad apices repente attenuatibus; sporangioliis singu­
lis ellipsoideis-fusiformis, in apices attenuatibus, ad maturitatem in liquido involutis.

Sporocladia pleurogenous, arising as lateral outgrowths of branched, septate aerial
hyphae, stalked, septate, with narrowed apices, the intercalary cells producing pseudophial­
ides arranged in more or less transverse rows on one side; pseudophialides elongate, with
narrowed apices bearing single sporangiola; sporangiola elliptic-fusiform with elongate,
acuminate apices, immersed in liquid at maturity.

(Etym.: διψάκος, the teasel plant + μύκης, fungus)

Type species:

Dipsacomyces acuminosporus sp. nov.

Colonieae albae; hyphis vegetantibus septatis, ramosis, 2–6 μ diam.; hyphis aeriis levi­
bis, ramosis, (1.3–)2.2–4.4(–5.7) μ diam.; stipitibus sporocladiorum levibus, 25–150
(–200) μ longis × 3–5 μ diam., 2–4(–6) cellulis; sporocladiis minute asperulatis, non­
nihil curvatis, 25–55 μ longis × 5–7 μ diam., in 6–13 (med. 9) cellulis consistentibus;
cellulis intercalaribus 2 ordines plerumque tranversos vesicularum sporigerarum in super­
ficie una gerentibus; cellulis terminalibus plerumque sterilibus, attenuatis, 12–30 μ longis;
vesiculis sporigeris elongato-ovalis vel subcylindricis, 4.4–6.6 μ x 2 μ sporangiosporis hyaliniis, levibus, ellipsoides-fusiformis, 19–34 μ (med. 27 μ) longis, 3–4.5 μ diam.; apicibus 11–20 μ (med. 15 μ) longis; zygosporis ignotis.

Colonies developing rapidly on natural substrata, white; vegetative hyphae colorless, septate, branched 2–6 μ wide, producing irregularly branched, septate aerial hyphae that form a more or less dense turf up to 4 mm. high; aerial hyphae delicate, smooth, (1.3–) 2.2–4.4(–5.7) μ in diameter, giving rise to more or less divergent, irregularly disposed sporocladia; sporocladial stipe smooth, 2–4(–6)–celled, 25–150(–200) μ long x 3–5 μ wide, often proliferating and producing one or rarely more additional sporocladia; sporocladia minutely asperulate, slightly curved, 25–55 μ long x 5–7 μ wide, composed of about 6–13 cells (aver. 9) excluding the stipe, the usually sterile terminal cells, 12–20 μ long attenuated, slightly rounded apically; pseudophialides elongate-oval to subcylindric, 4.4–6.6 μ x 2 μ, arranged on one side of the sporocladium in two more or less transverse rows per cell. Sporangiole colorless, smooth, elliptic-fusiform, with elongate-acuminate apices; total length 19–34 μ (aver. 27 μ), greatest width 3–4.5 μ, apices 11–21 μ (aver. 15 μ) long; sporangial wall everywhere adnate to the spore, readily sloughed away at maturity. Zygosporae unknown.

Holotype.—HONDURAS. Vicinity of La Lima, February, 1960, isolated in a soil immersion tube (RSA Culture 1012). Transfers of the holotype have been deposited in the ATCC, CBS, and CMI.

I am indebted to Dr. Roger D. Goos who kindly sent this unusual representative of the Kickxellaceae to me for study.

Bearing a terminal spinous protuberance as long as or longer than the body of the spore (Pl. 3f–h; Pl. 4c–d), the sporangiospore of Dipsacomyces acuminosporus has no counterpart in other known members of the family although certain species of Coemansia, as C. mojavensis (Benjamin, 1958: Pl. 4i), have spores with rudimentary apical spines. When implanted upon media such as YpSs, PDA, CM, or ME-YE (Benjamin, 1959: p. 322), spores of D. acuminosporus germinate readily and growth is relatively rapid under conditions ordinarily prevailing in the laboratory. Production of basal germ tubes by spores of this species (Pl. 3h) recalls Linderina pennispora and Martensiomyces pterosporus rather than Kickxella alabastrina, Spirodactylon aureum, species of Coemansia, and presumably species of Martensiella, where germ tubes arise near the middle of the spores. Only meager vegetative growth occurs on SMA (Standard Mucor Agar, Hesseltine, 1954: p. 362—prepared with 1% rather than 4% dextrose), and D. acuminosporus fails to produce aerial hyphae or to sporulate on this synthetic medium.

Colonies of D. acuminosporus remain white and may reach diameters of 2–3 cm. in five days. The aerial hyphae branch freely and by intertwining soon form a more or less dense turf. Sporulation may begin within 4–5 days or be delayed for a week or more. Also, fruiting may take place abundantly in one portion of a colony and be absent in another. Production of sporocladia usually is initiated in the lower portion of a colony and progresses upward.

As far as structure and development are concerned, the sporocladium of Dipsacomyces acuminosporus (Pl. 3b–e; Pl. 4a–b) is similar to that of species of Coemansia, Martensiella, Martensiomyces, and Spirodactylon. The apparently random development of sporocladia on the fruiting hyphae in D. acuminosporus (Pl. 3a) is quite distinct, however, from the arogenous development of these structures in Coemansia, Martensiella, and Spirodactylon, where the sporocladia become arranged pleurogenously as the fertile axes elongate. The sporocladia of Martensiomyces, although produced successively, typically are borne in terminal umbels.

When the sporangiolum of D. acuminosporus matures, the delicate sporangial membrane separates readily from the spore, and this phenomenon may be demonstrated easily in
Plate 3. *Dipsacomyces acuminosporus* Benjamin.—a. Habit sketch showing general characteristics of fruiting structures. ×50.—b–d. Three immature sporocladias; the stipe of the one shown in fig. d has proliferated and produced a second sporocladium. ×660.—e. Mature sporocladium; the fertile region of the sporocladium has been rotated toward the observer by 90° relative to its position in the previous three figures. ×660.—f. Mature sporangiolum showing separation of the sporangial membrane at a point near the juncture of the body of the spore and its apical projection. ×1360.—g. Mature spore. ×1360.—h. Two germinating spores. ×1360.
liquid mounts. The wall appears always to rupture circumsissilely at a point near the juncture of the body of the spore and its spinous protuberance (Pl. 3f). Upper and lower portions of sporangial walls are illustrated photographically in Plate 4c–d.

The teasel-like appearance of the mature sporocladium when this is observed in face view (Pl. 3e; Pl. 4b) suggested the generic name applied to this singular genus of the Kickxellaceae.

**Plate 4.** *Dipsacomyces acuminosporus* Benjamin.—a. Young sporocladium. X 620.—b. Nearly mature sporocladium. X 620.—c. Three detached sporangiola (below) and several remnants of the terminal portions of sporangial membranes (above). X 1300.—d. Five detached sporangiola; note the distinct sporangial membranes separated slightly from the basal portions of the four spores shown at the left. This is especially clear in the one marked by the arrow. X 1300.
The key to the known genera of the family presented in an earlier paper (Benjamin, 1959: p. 399) may be revised as follows:

A. Sporocladia globoid, nonseptate ...................................................... \textit{Linderina}

AA. Sporocladia elongate, usually attenuated distally, septate .................... B.

B. Spores ellipsoidal, only slightly longer than broad; fertile region of the sporophore coiled ........................................ \textit{Spirodactylon}

BB. Spores elongated, more than twice as long as broad; fertile region of the sporophore not coiled ........................................ \textit{C.}

C. Sporocladia verticillate or umbellate ........................................ \textit{D.}

CC. Sporocladia pleurogenous ........................................ \textit{E.}

D. Sporocladia verticillate, formed simultaneously .................... \textit{Kickxella}

DD. Sporocladia umbellate, formed successively ................................ \textit{Martensiomyces}

E. Sporocladia not formed acrogenously ........................................ \textit{Dipsacomyces}

EE. Sporocladia formed acrogenously ........................................ \textit{F.}

F. Sporangiola borne on the upper surfaces of the sporocladia .............. \textit{Martensella}

FF. Sporangiola borne on the lower surfaces of the sporocladia ............. \textit{Coemansia}


\textbf{LITERATURE CITED}


\textbf{NOTE}

In my earlier paper, "The merosporangiferous Mucorales," \textit{Aliso} 4(2), 1959, the magnifications listed for the following figures should be $\times 1360$, not $\times 1860$: Plate 18, fig. j; Plate 20, fig. c–k; Plate 23, fig. c–i,k; Plate 25, fig. h–l.