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Zoosporic Phycomycetes from Hispaniola*

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Summary. Forty-five taxa of zoosporic Phycomycetes are recorded from Hispaniola (Dominican Republic) based on 34 samples collected by the senior author in December—January 1969/70. New species are *Entophlyctis obscura, Phlyctochytrium parasitans, P. mucosum, Blyttiomyces harderi, Rhizophlyctis tropicalis, Chytriomyces multioperculatus.*

It was Harder (1937, 1939a) and his students Sörgel (1941, 1952) (Harder and Sörgel, 1938; Harder, 1939) and Nabel (1939b), etc., who initiated investigations on zoosporic fungi from Hispaniola, working on material primarily from the Dominican Republic. The floristic information obtained by Sörgel (1941) was recorded primarily at the generic level although a few forms recovered were the subjects of further, intensive study, notably *Blastocladiella variabilis*, Harder and Sörgel (1938) and *Rhizidiomyces bivellatus* Nabel (1939). Sörgel's (1941) studies included fungi from West Indian, South and Central American sites, the more than 300 soil samples mostly collected by Harder, included 201 from Hispaniola, 182 of them were from the Dominican Republic, and 20 from Haiti. In more recent years Scott (1960) has given us information (primarily on saprolegniaceous and pythiaceous forms) on 16 fungi from Haiti.

The present contribution is based upon 76 soil samples and 4 of intertidal beach sand collected in the Dominican Republic by the senior author from 29 December 1969—3 January 1970. The samples were collected in small plastic envelopes and processed in the laboratory in the usual fashion making use of various types of baits, a procedure now standard in such investigations (Sparrow, 1960).

* Supported in part by N. S. F. Grant GB 3333. It was originally hoped to collect species of Physoderma on Hispaniola but none was found during the few days available for exploration.

** I am indebted to Prof. I. Bonnelly de Calventi, Director, Inst. de Biologia marina, Univ. Autonoma de Santo Domingo, for many courtesies.

Collecting Sites

The following numbers cited in the text identify collecting localities and dates of collection:

1. Uncultivated field adjoining Hotel Embajedor XII. 29. 69. S. D. (Santo Domingo).
2. Polo field adjoining Hotel Embajedor, S. D. XII. 30. 69.
3. Base of tree, Dept. Agriculture Building Park, S. D. XII. 31. 69.
4. Base of banana trees, ground, Hotel Embajedor, S. D. I. 1. 70.
5. Base of Ficus as at No 4. I. 1. 70.
6. Base of rock ledge, grounds, No 4. I. 1. 70.
7. Disturbed roadside soil by cockpit, 12 K west of S. D. I. 1. 70.
8. Base of tree near beach at "Central Rio Haina". I. 1. 70.
9. Side of driveway, "Mahogany House", San Cristobal. I. 1. 70.
10. Opposite side from No 9. I. 1. 70.
11. Under cycad by No 9. I. 1. 70.
12. Between cycads at No 9. I. 1. 70.
13. By rainwater container at No 9. I. 1. 70.
14. Same.
15. Lawn, new Trujillo house, San Cristobal. I. 1. 70.
16. Base of palm, driveway, at No 15. I. 1. 70.
17. Damp stream bed, Rio Nigua near San Cristobal. I. 2. 70.
18. Plantation, Loyola Polytechnical School, San Cristobal. I. 2. 70.
19. Plantations of CNIA near laboratory, San Cristobal. I. 2. 70.
20. Same as No 19, but in maize fields north of laboratory. I. 2. 70.
21. Bed of stream, 19 km NW of S. D. on Carretara Duarte. I. 2. 70.
22. Flood plain of Rio Haina with small stream above dam, 40 km from S. D. on Carretara Duarte. I. 2. 70.
23. Damp soil in wagon tracks across small effluent from mill of Central Ingenio Catarey near village of Villa Altagracia, 60 km from S. D. I. 2. 70.
24. Damp soil behind raised bank of irrigation ditch beneath bananas and sugarcane. 63 km from S. D. on Carretara Duarte. I. 1. 70.
25. Flower bed of Cafe Santiago. I. 2. 70. (A. G. S. coll.)
26. Flower bed monument grounds, high hill overlooking Santiago. I. 2. 70. (A. G. S.)
27. Flower bed at bus stop, Bonao. I. 2. 70. (A. G. S.)
28. Beneath native trees, Santo Cerro. I. 2. 70. (A. G. S.)
29. Shallow, black soil on top of coral rock beneath Zamia opposite Embassy Beach beyond Boca Chica. I. 3. 70.
30. Garden soil, hotel grounds, Boca Chica. I. 3. 70.
31. Beneath trees across road from No 30. I. 3. 70.
32. Beneath brush on hillside, opposite Hotel Boca Chica. I. 3. 70.
33. Intertidal beach sand, Embassy Beach. I. 3. 70. (2 samples.)
34. Embassy Beach, seaweed. I. 3. 70. (2 samples.)

Fungi Recovered

1. *Olpidium* sp. Saprophytic in pine pollen. Localities: 18; 22; 29.
2. *Rhizophydium sphaerotheca* Zopf. Saprophytic on pine pollen. Localities: 7; 17; 19.
3. *Rhizophydium elyensis* Sparrow. Saprophytic on pine pollen. Localities: 2; 12; 16; 22; 24; 25.

4. *Entophlyctis obscura* n.sp. Saprophytic in pine pollen. Localities: 27; 28.

It was first supposed that this was *Olpidium pendulum* Zopf or *O. appendiculatum* Karling. In these fungi the cyst of the "infecting" zoospore persists and in Zopf's (1887) and our material functioned as a discharge papilla. When studied in unifungal culture, however, the Dominican fungus proved to be eucarpic, belonging to that small group of species in *Entophlyctis* in which the zoospore cyst functions in that manner. Barr (1971) has recently, in connection with a study of *E. confervae-glomeratae* (Cienk.) Sparrow, discussed these species as has also Booth (1971).

Stages in development from the active zoospore are shown in Fig. 2, C—G, and follow a well-known pattern which need not be elaborated here. The thallus is strongly (almost exclusively) monaxial. The rhizoids are sparingly branched and noticeably blunt-ended, somewhat as in *Entophlyctis heliformis* (Dang.) Ramsbottom. Noteworthy is the production at the point of attachment of the rhizoidal axis to the sporangial base of a pronounced ring, or probably ring and membrane of wall material.

As the reproductive rudiment matures it becomes nearly spherical (Fig. 2, H) 15.5—33.5 μm in diameter, oval or broadly ellipsoidal, 18—50 × 10—31 μm, or less often slightly irregular (Fig. 2, N) or elongate-saccate (Fig. 2, P), with thin, hyaline wall and colorless contents. The persistent zoospore cyst (Fig. 2, G, I) 3—5, 5 × 2.5—3.0 μm, is colorless and stains deeply with phloxine and aniline-blue.

At full maturity the sporangium contents are shot through with evenly-spaced small, colorless globules and by the usual process become cleaved out into numerous zoospores. During this maturation process the epibiotic zoospore cyst contents change from granular to clear and the sporangial protoplasm beneath it retreats somewhat (Fig. 2, I) to present a concave upper surface over which a membranous endooperculum is formed (Fig. 2, J). Coincident with the latter process the apex of the cyst gelatinizes to form a small pore through which a globule of material escapes, expands, and dissolves into the outside medium (Pl. 2, J—M). Just prior to zoospore discharge they press snugly against the under face of the endooperculum which when it suddenly dehisces they spew forth with great speed, the endooperculum disappearing in the process. The zoospores are elongate, 4.5 × 2.5 μm with a posteriorly directed flagellum which because of a nearly 90° turning of the spore body appears sub-apically attached (Fig. 2, A, O). 1 to 4 min globules are in the body. Such a flagellum-body relationship has been reported in other chytrids.

As the swimming spore comes to rest the body becomes spherical and usually undergoes various amoeboid changes in shape (Fig. 2, A) before finally encysting.

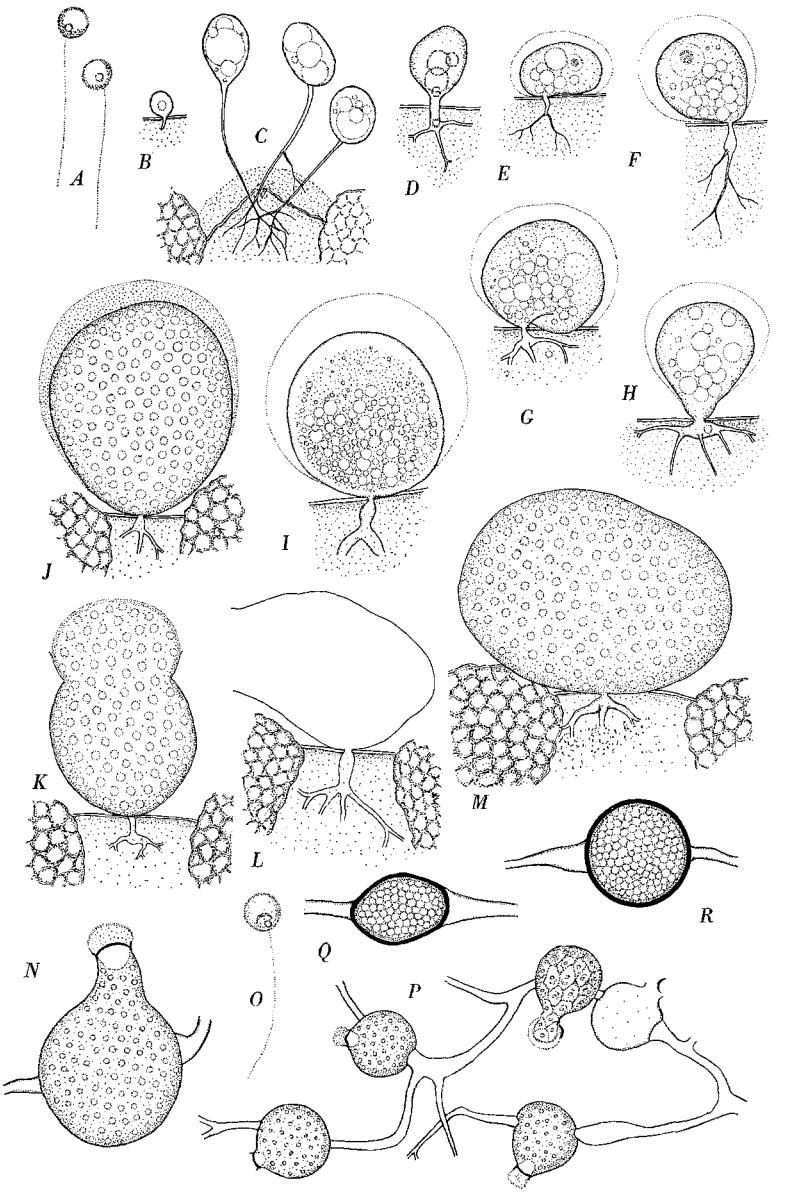

Fig. 1

Resting spores, apparently asexually formed, were spherical, 10 to 29 μm in diameter with moderately thick smooth, colorless wall and, were always, like the sporangium, attached to the epibiotic zoospore cyst either directly (Fig. 2, S) or by a long stalk as in *Olpidium pendulum* (Fig. 2, R). No germination was observed.

The eucarpic nature of this fungus was difficult to establish, even in stained preparations of pollen grains. Furthermore, it appears that the rhizoidal system has a pronounced tendency to deliquesce or disintegrate as Barr (1971) found it did in *E. confervae-glomeratae* within the same substratum. Unlike the latter fungus, however, in which no distinct septum separated rhizoid from sporangium, the Dominican organism always formed the ring of wall material which was clearly discernable at the base of both sporangia and resting spore (Fig. 2, H, R). Cook (1966) reports a similarly evanescent vegetative system in *E. reticulospora*, parasitic in desmids.

Both Barr (1971) and Booth (1971) have initiated experimental morphological studies on single-spore isolates of well-defined species of *Entophlyctis* and are attempting to answer the question asked over many years by all students of these simple fungi, as to just what are the morphological and biological criteria of taxonomic worth. Our species may in the future be found to lack the distinctiveness we believe it possesses in its zoospore and basal septum, and to a lesser degree its endooperculum. We are regarding it nonetheless as a distinctive taxon.

Entophlyctis obscura n. sp. Sporangium spherical, 15.3—33.5 μm in diameter, or oval to broadly ellipsoidal, 18.0—50.0 μm × 10.0—31.0 μm, contents colorless, wall smooth, hyaline; epibiotic cyst of zoospore persistent and functioning as a discharge tube. Rhizoidal system sparingly branched, tips of elements blunt, arising from a single axis at base of sporangium which is marked by a conspicuous and persistent ring or disc of wall material; evanescent at maturity of sporangium. Zoospores

Fig. 1. *A—M Phlyctochytrium mucosum* on pine pollen; *N—R Cladochytrium* sp. on cellophane and lense paper. *A—M Phlyctochytrium mucosum* n. sp. *A* Zoospores; *B* encysted zoospore; *C* three nonsessile germlings developing on pollen grain, note globules; *D* nearly sessile young thallus; *E—I* maturing thalli showing gelatinous halo; *J* nearly mature sporangium with halo which will shortly dissolve as it has in *M*; *K* discharging sporangium; the halo has dissolved and the thin sporangium wall slowly bulges out carrying with it the mass of zoospores; *L* empty sporangium with broad lateral discharge pore; *M* mature sporangium without halo; note absence of a specialized discharge papilla. *N* mature sporangium of *Cladochytrium* sp. showing distal gelatinous plug, endooperculum and concavity of non-sporogenous gelatinous material; *O* zoospore, showing globule and arc (nuclear cap?) in contents; *P* portion of polycentric thallus showing mature and discharging sporangia with endoopercula (*P* × 220; all others × 560)

narrowly ellipsoidal or oblong, 4.5×2.5 μm, with an apically or subapically attached, posteriorly directed flagellum 18.5—20 μm long, and 1—4 min globules in body; becoming spherical and undergoing amoeboid movement prior to encystment; discharged forcibly upon dehiscence of an endooperculum through an apical pore in persistent zoospore cyst. Resting spore endobiotic apparently asexual, spherical, 10—29 μm in

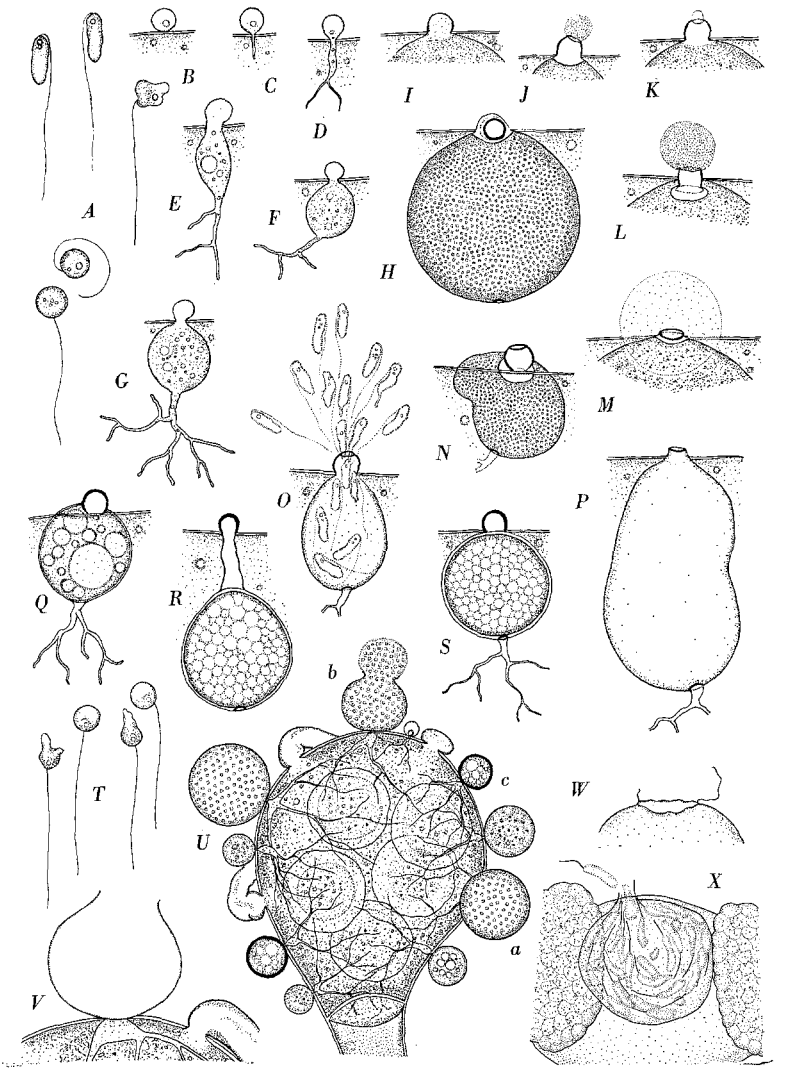

Fig. 2

diameter with a moderately thick, colorless wall and globular contents; sessile on or attached by a stalk to the persistent epibiotic zoospore cyst; germination not observed.

Saprophytic in pine pollen bait, soil, Dominican Republic.
Collected: F. K. Sparrow.
Type: Fig. 2, H—S.

Entophlyctis obscura sp.nov.

Sporangium sphaericum, 15.5—33.5 μm diam. aut ovale ad late ellipsoidoum, 18.0—50.0×10.0—31.0 μm; contentum sine colore, membrana levis hyalinaque; cysta zoosporae epibiotica, persistens et velut tubus dimissionis fungens. Systema rhizoidale parce ramosum, cacumina elementorum obtusa, ex singulo axe ad basim sporangii quod anulo discove conspicuo persistente materiae membranae signatur enascenta, evanescens dum sporangium maturescit. Zoosporae anguste ellipsoideae oblongaeve, 4.5—2.5 μm, flagellum in aut sub apice affixum, postice directum, 18.5—20 μm long., et 1—4 globulos minutos in corpore habentes; zoosporae sphaericae factae et motum amoeboideum subeuntes ante encystimentum; valde depulsae cum endooperculum per porum apicalem in cysta zoosporae persistente dehiscit. Spora quiescens endobiotica ut videtur asexualis, sphaerica, 10—29 μm diam., membranam sine colore, modice crassam et contentum globulosum habens; in cysta epibiotica persistens zoosporae sessilis aut cauliculo affixa; germinatio non observata.

Habitatio: Planta in esca pollinis pini, saprophytica in solo in loco Dominican Republic dicto, per F. K. Sparrow collecta. Planta typica Fig. 2, H—S.

Fig. 2. *A—S Entophlyctis obscura* n.sp.; *T—W Phlyctochytrium parasitans* n.sp. *A* Actively swimming and amoeboid zoospores showing shapes and flagellar attachment; *B—G* early stages in thallus development; note persistence of zoospore cyst; *H* and *N* mature sporangia; in *H* the rhizoidal system has disappeared but the basal point of attachment is clearly visible; *I—M* stages in transformation of zoospore cyst into a discharge tube; in *L—M* the gelatinous exudate from cyst is being dispersed in the medium; *O* forceful discharge of zoospores from sporangium; *P* empty sporangium; *Q* young resting spore thallus; *R* mature resting spore with point of rhizoidal attachment visible; *S* resting spore with persistent rhizoidal system. *T* zoospores of *Phlyctochytrium parasitans* n.sp.; *U* thalli, mature and discharging zoosporangia and resting spores of *Phlyctochytrium parasitans* parasitic on oogonium of *Achlya flagellata*; note absence of a well-defined discharge papilla on mature sporangium at *a*; discharge of spore mass at *b*; resting spore at *c*; *V* discharged sporangium wall; *W* a part of shriveled wall is seen; *X Anisolpidium* sp. in pollen grain; discharging elongate zoospores. Compare with Fig. 7, *I* (all ×560)

5. *Diplophlyctis buttermerensis* Willoughby. On onion skin bait. Locality: 22.
6. *Phlyctochytrium reinboldtae* Persiel. On pine pollen bait. Localities: 3; 28.

   Dormant sporangia with thick, golden-brown walls as well as active zoosporangia were formed in abundance.
7. *P. punctatum* Koch. Pine pollen bait. Localities: 4; 5; 7; 9; 11; 16; 18; 19; 20.
8. *P. irregulare* Koch. Pine pollen bait. Locality: 22.
9. *Phlyctochytrium parasitans* n.sp. Parasitic on eggs of *Achlya flagellata*. Locality: 24.

In its method of development sporangial shape, size, and method of zoospore discharge *P. parasitans* resembles *P. indicum* Karling (1964a) found as a saprophyte on pine pollen bait in India. The Dominican fungus is distinct, however, in its complete lack of a discharge papilla on the spherical sporangium and only approaches the pyriform or citriform shape of *P. indicum* after discharge (Fig. 2, U, V). The zoospores were discharged in a mass upon the softening of a broad apical area of sporangium wall which quickly deliquesced and released them into the surrounding medium. Fragments of the wall sometimes persisted around the broad orifice (Fig. 2, W). The rhizoidal system was extensive and emerged from a moderately developed subsporangial apophysis. Resting spores were borne like the sporangia and provided with a similar endobiotic system and were spherical, 5—13.0 μm in diameter with a smooth, moderately thick brown wall and compactly globular contents (Fig. 2, U c).

Aside from its apophysate rhizoidal system, the fungus resembles morphologically and in its parasitic habit on saprolegnian eggs *Rhizophydium carpophilum* (Zopf) Fischer. It strikingly resembles the apophysate chytrid ascribed to Zopf's species by Coker (1923) and may be identical with it.

All attempts to transfer this fungus to pine pollen failed. We consider it to be strictly a parasite.

Phlyctochytrium parasitans n.sp. Sporangium at maturity completely spherical, 12—40 μm in diameter with a thin, colorless wall; without a distinct discharge papilla. Rhizoidal system delicate, much-branched, arising from a pyramidal or tuberous moderately developed subsporangial apophysis. Zoospores spherical, 3.5 μm in diameter with a small nearly basal colorless globule and more central arc-like structure in body, and posterior flagellum; discharged en masse upon swelling out and subsequent bursting of a distal portion of sporangium wall. Resting spore borne like sporangia, spherical, 5—13.0 μm in diameter with moderately

thick brown wall; contents compactly multiglobular; germination not observed.

Parasitic on oospheres of *Achlya flagellata*. Dominican Republic. Collected: F. K. Sparrow.
Type: Fig. 2, T—U.

Phlyctochytrium parasitans sp. nov.

Sporangium maturum omnino sphaericum, 12—40 μm diam., membranam levem tenuem sine colore habens, sine papilla dimissionis evidente. Systema rhizoidale delicatum ramosissimumque ex apophyse pyramidali tuberosave, modice evoluta subsporangiali enascens. Zoosporae sphaericae, 3.5 μm diam., globulam parvam fere basalem, sine colore, atque structuram arciformem proprius, centrum in corpore, et flagellum posterius habentes; zoosporae in una massa dimissae cum pars distalis membranae sporangii tumescit, deinde se rumpit. Spora quiescens velut sporangium producitur, sphaerica, 5—13.0 μm diam. membranam fuscam modice crassam habens; contentum spisse multiglobosum; germinatio non observata.

Habitatio: Planta in oospheris *Achlyae flagellatae* parasitica, in loco Dominican Republic dicto reperta; per F. K. Sparrow collecta. Planta typica Fig. 2, T—U.

10. *Phlyctochytrium mucosum* n. sp. On pine pollen bait. Locality: 16.

The weak development of the subsporangial apophysis in this species makes its precise generic disposition questionable. The validity of Schroeter's genus Phlyctochytrium as an entity distinct from Rhizophydium which lacks an apophysis but is otherwise the same has been raised in the past by various investigators. This is well illustrated by comparing the subsporangial proximal rhizoidal systems of Fig. 1, D—M. Unfortunately, combining *Phlyctochytrium* and *Rhizophydium* would result in one already unwieldy, poorly-defined mass of species being combined with another, also numerous, of like features[1]. Extensive studies of individual isolates like those of Barr and others may point to a solution of this vexing problem. Particularly attention should be directed to the mucous sheath or "corona" found in this and several other species not only of true chytride but in at least one anisochytrid as well (see *Rhizidiomyces coronus* Karling, 1968a, b), where it is always considered a distinction of specific worth.

As may be seen in Fig. 1, D—G, some thalli have a tendency to develop asymmetrically whereas others (Fig. 1, H—K), are symmetrical

1 See Karling (1971) where *Chytridium* spp. with apophyses are placed in a new genus *Diplochytridium*.

or nearly so. Sometimes the sporangia are prostrate, as in Fig. 1, L, M. During development there is a noticeable tendency for the lower $^1/_2$—$^2/_3$ of the sporangial rudiment to be filled with numerous grayish globules of varied size (Fig. 1, E—I). At this time, too, the gelatinous halo is most apparent and as the sporangium approaches maturity fades away (Fig. 1, K, M).

The mature sporangium is nearly spherical, obpyriform, oval, or broadly ellipsoidal and sometimes appears prostrate. There is no papilla (in contrast to *P. indicum* and *P. megastomum* which it resembles) and at discharge of the zoospores the thin wall slowly bulges out carrying with it a mass of passive zoospores (Fig. 1, K) which soon disperse individually. The latter (Fig. 1, A) are spherical 3.5—4.0 μm with a single nearly basal colorless globule and long flagellum. They usually settle down on the surface of the pollen grain and penetrate it (Fig. 1, B) by a tube, but occasionally, may develop at some distance from the substratum (Fig. 1, C). Apophysis development is variable in extent.

Phlyctochytrium mucosum n.sp. Sporangium obpyriform, 15—35 μm high by 10—23 μm in diameter, to oval or broadly ellipsoid and prostrate and 10—40 μm long by 6—25 μm in diameter; surrounded during development by a gelatinous halo which disappears at maturity; lacking a discharge papilla. Rhizoidal system variable in extent, the elements attenuate, arising from a weakly developed, occasionally absent subsporangial, endobiotic apophysis. Zoospores spherical, 3.5—4.0 μm in diameter with a single, nearly basal colorless globule and posterior flagellum; discharged en masse upon the bulging out and subsequent bursting of a broad apical or (in prostrate sporangia) lateral portion of sporangium wall. Resting spores not observed.

Saprophytic on pine pollen bait, Dominican Republic.
Collected by F. K. Sparrow.
Type: Fig. 1, J—M.

Phlyctochytrium mucosum sp.nov.

Sporangium obpyriforme, 15—35 μm alt. 10—23 μm diam., ad ovale aut late ellipsoideum et prostratum, 10—40 μm long., 6—25 μm diam.; sporangium evolvens corona gelatinosa circumdatur, quae sporangio maturo evanescit; papilla dimissionis nulla. Systema rhizoidale spatio varians, elementis attenuatis, ex apophyse endobiotica subsporangiale parum evoluta, interdum absente enascontibus. Zoosporae sphaericae 3.5—4.0 μm diam., singulum globulum fero basale sine colore, atque flagellum posterius habentes; zoosporae in una massa emissae cum pars lata apicalis aut (in sporangiis prostratis) lateralis membranae sporangii tumescit, deinde rumpit. Sporae quiescentes non observatae.

Habitatio: Planta in esca pollinis pini saprophytica, in loco Dominican Republic dicto, per F. K. Sparrow collecta.

11. *Blyttiomyces harderi* n.sp. Parasitic on sporangia of *Rhizophlyctis (Karlingia) rosea.* Localities: 1; 32.

This fungus (Fig. 3, A—I) is noteworthy not only for its parasitic depredations but also for its relatively large size (up to 60 × 78 μm) and massive apophysis from which an intricate series of rhizoids arises (Fig. 3, D—I). It is the second species of this genus we have encountered parasitic on this same ubiquitous soil chytrid. The first, *Blyttiomyces rhizophlyctidis*, Dogma and Sparrow (1969) from the continental United States (Maryland) resembles the present one only in the pale orange coloration of its contents. Features of the Dominican fungus are apparent from the following description.

Blyttiomyces harderi n.sp. Sporangium saccate and irregular in outline because of the presence of 2—7 strongly elevated broadly conical discharge tubes surmounted by discharge papillae; 17—60 μm high by 12—78 μm broad, wall colorless, rigid; contents coarsely granular often minutely granular at maturity, pale orange-colored; apiculus solid, conspicuous, on upper part of sporangium, its appendiculum hyaline. Rhizoidal system extensive, richly branched, somewhat stubby and knarled, arising from a massive apophysis 6.5—26 × 5.5—17 μm. Zoospores spherical, 3.5—4.0 μm in diameter with 18 μm long posterior flagellum and several minute, pale orange-colored granules in body; escaping through 2—7 pores formed upon dissolution of apex of discharge papillae. Resting spores not observed.

Parasitic on sporangia of *Rhizophlyctis (Karlingia) rosea.* Dominican Republic. Collected by F. K. Sparrow.

Type: Fig. 3, I.

Blyttiomyces harderi sp.nov.

Sporangium saccatum atque ambitu irregulare ob 2—7 tubos dimissionis valde elevates atque late conicos, per papillas dimissionis superpositos; sporangium 17—60 μm alt., 12—78 μm lat., membrana sine colore, rigida; contentum grosse granulosum, maturum saepe minute granulosum, pallide luteum; apiculus solidus, conspicuus, in parte sporangii superiore, appendiculo hyalino. Systema rhizoidale amplum ramosissimum, breviculum nodosumque, ex apophyse solida, 6.5—26 × 5.5—17 μm enascens. Zoosporae sphaericae, 3.5—4.0 μm diam., flagellum posterius, 18 μm long., atque aliquot granulas pallido luteas in corpore habentes; zoosporae per 2—7 poros formatos cum apex papillarum dimissionis dissolvitur, emergentes. Sporae quiescentes non observatae.

Habitatio: Planta in sporangiis *Rhizophlyctis (Karlingiae) roseae* parasitica, in loco Dominican Republic dicto, per F. K. Sparrow collecta. Planta typica Fig. 3, I.

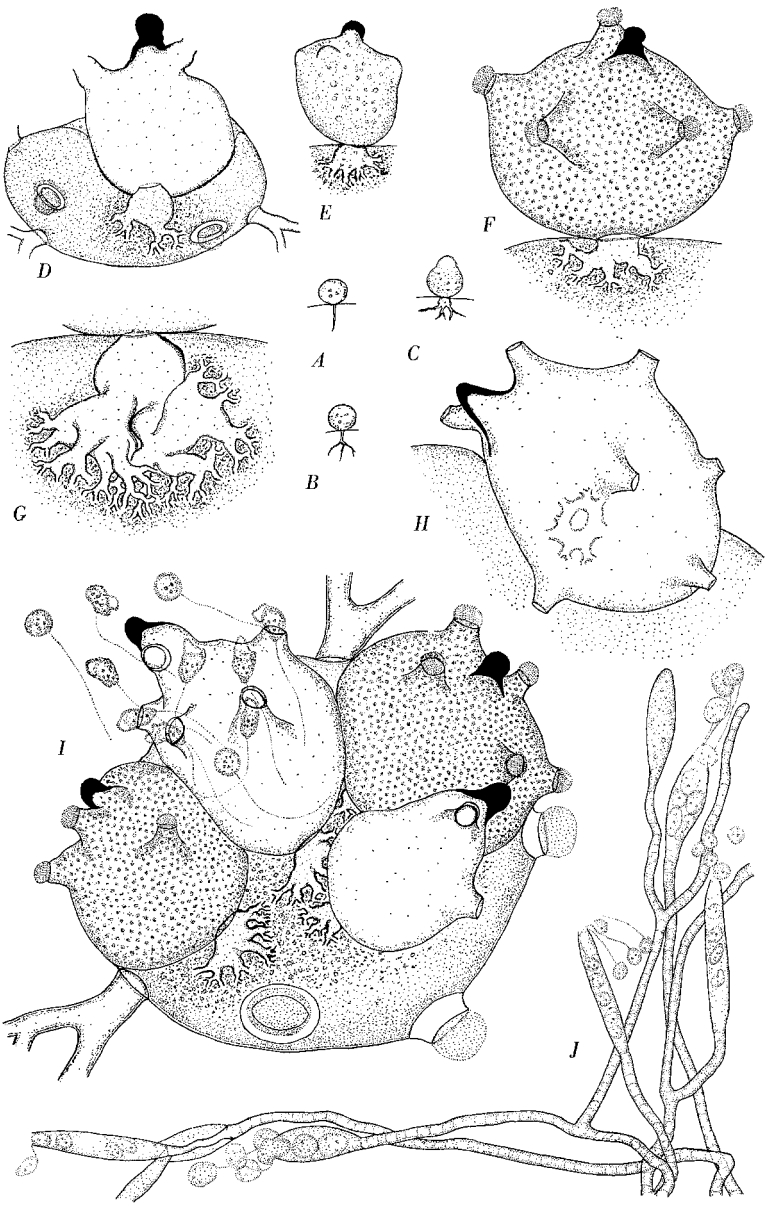

Fig. 3

Early stages in establishment of thallus (Fig. 3, A—C) indicate rudiments of both apiculus and apophysis are early laid down (Fig. 3, C), as in other species of the genus.

It is a pleasure to dedicate this species to Professor Dr. R. Harder who, with his students, has contributed so significantly to our knowledge of the distribution of zoosporic fungi throughout the world and in particular to the Phycomycetes of Hispaniola.

12. *Rhizophlyctis ingoldii* Sparrow. On chitin bait. Locality: 21.

13. *Rhizophlyctis hyalina* (Karling) Sparrow. On lense paper bait. Localities: 1; 2; 6; 19; 32.

The zoosporangia were like those of *R. rosea* but were hyaline. The zoospores were 3—3.5 μm in diameter and in our material had 1-several very minute colorless globules rather than a single large one.

14. *Rhizophlyctis tropicalis* n.sp. On lense paper and onion skin baits. Locality: 22.

The proper taxonomic disposition of a rhizophlytoid fungus, indeed, any chytrid, has become increasingly difficult since with numerous world-wide collections, the full range of forms as they occur in nature gradually becomes more apparent. Criteria which have hitherto served to differentiate classical genera such as Rhizidium, Rhizophlyctis, etc., are no longer sufficient to withstand the impact of observed variations found in individual species in single-spore culture or in the diversity of these newly discovered forms from remote, hitherto unexplored areas. The numerous floristic papers of Karling and Willoughby are noteworthy here as well as the experimentally-oriented ones of Barr and Miller *et al.* We can only hope that the rapidly accumulating data on all rhizidiaceous fungi will soon be collated and modern taxonomic guide lines established. A start has been made by the junior author (Dogma, 1970) to disentangle some elements of the Karlingia-Rhizophlyctis complex, but much more must be done.

Fig. 3. *A—I Blyttiomyces harderi* n.sp. parasitic on *Karlingia rosea*; *J Monoblepharella* sp. *A—C* young stages in establisment of thallus; *D* empty sporangium on parasitized host showing heavy-walled apiculus, two discharge tubes and apophysis from which arises a rhizoidal system; *E—F* nearly mature sporangia; *G* details of strongly developed rhizoidal system at base of a subsporangial apophysis; *H* empty sporangium with 7 discharge tubes visible; plexus of rhizoids visible beneath; *I* endooperculate sporangium of host with 4 parasites on it, one of which is discharging its zoospores. *J Monoblepharella* sp.; mass of hyphae bearing sporangia of two sorts, producing zoospores of two different sizes; note that this is an association, and no evidence for sporangia of the two types being formed on the same hypha could be found (*A—I* × 560; *J* × 160)

In the Dominican fungus (Fig. 4, A—M) ovoid zoospores with 10 or more minute somewhat basally disposed globules rather than a single one are formed. The lack of a conspicuous globule is to be found in other congeneric unipored forms as *R. lovetti* Karling, *R. fuscis* Karling (a fungus almost identical with monocentric forms of Catenophlyctis) and *R. boninensis* Kobayasi and Konno. At germination it is usual for a portion of the unexpanded body of the zoospore to persist (Fig. 4, D, J, K)

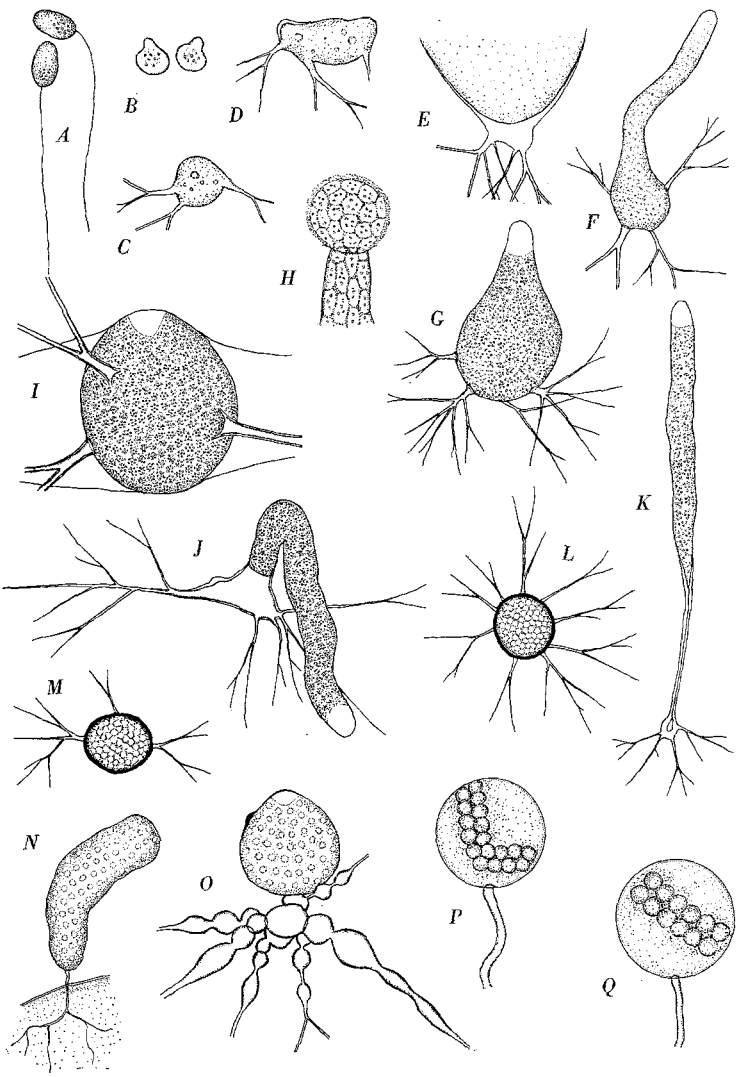

Fig. 4

on the developing thallus as in *R. bonseyi* Sparrow (1965) and *R. oceanis* Karling (1969). Occasionally the thallus may arise from the tube of the germinated zoospore. Rhizoids emerge from several places on the reproductive rudiment and are frequently rather thick-walled (Fig. 4, E, I, K). The sporangium at maturity may be spherical, ovoid or narrowly elongate (Fig. 4, F, G, I—K) with a single sessile discharge papilla (Fig. 4, I) or one terminating a discharge tube (Fig. 4, G). The functional papilla is always characterized, as in *R. oceanis* by a conspicuous concavity of translucent material beneath (Fig. 4, I—K). The sporangial contents proper are dull greyish and granular. At discharge the apical wall of the papilla gives way and the translucent material, followed by the spore mass emerges. The latter forms a motionless spherical mass no doubt completely enveloped in the first-emerged slime. At all events, individual zoospores on the periphery soon initiate movement and break away, followed by others of the mass.

Spherical or oval resting spores with thickened, smooth brown walls, globular contents and varying number of rhizoidal axes were formed, apparently asexually. Their germination was not observed.

Rhizophlyctis tropicalis, sp.nov. Sporangium spherical, 30—80 μm in diameter, ovoid, 45—70×30—55 μm or elongate 60—80×8—15 μm, developed wholly or partially from the body of the encysted zoospore, or occasionally from the germ tube of zoospore; wall smooth, thin, colorless, with dull grey granular contents except for translucent area beneath the single discharge papilla. Rhizoidal system arising from several axes on sporangium, the elements thick-walled. Zoospores ovoid, 5×3.5 μm, with 10 or more minute dull, colorless basal globules and a 30 μm long posterior flagellum; escaping upon opening of tip of discharge papilla and emerging in a compact mass surrounded by the translucent papillar

Fig. 4. *A—M Rhizophlyctis tropicalis* n.sp. on lense paper and onion skin. *N Chytriomyces* sp.; *O Catenochytridium carolinianum*; *P* and *Q Sorodiscus cokeri*. *A* zoospores; *B* two zoospores germinating on a slide; *C* and *D* early stages in thallus development; in *D* a part of unexpanded thick cyst wall of zoospore is seen at left; *E* base of a thallus showing emerging of one cluster of rhizoids; *F* immature sporangium with long discharge tube; *G* nearly mature sporangium; *H* zoospores moving passively out of discharge pore enveloped in gelatinous material probably from prominent papilla; *I—K* variously shaped sporangia; in *J* and *K* thick-walled remains of zoospore cyst visible; *L* and *M* resting spores. *N Chytromyces* sp. on pine pollen; mature sporangium; note lack of a discharge papilla. *O Catenochytridium carolinianum* on onion skin; sporangial thallus showing compound apophysis, rhizoidal catenulations and up near discharge papilla of sporangium, remnant of cyst wall of zoospore. *P* and *Q Sorodiscus cokeri*; groups of resting spores ("cystosori") in sporangia of *Pythium* sp.; *A—E, L, and M* ×560; *F—K* ×220; *N* and *O* ×560. *P* and *Q* ×370

material. Resting spore spherical, 9.5—19.0 μm in diameter or ovoid and 10—20×6.5—17 μm, with a thick brown smooth wall and compact globular contents; apparently asexually formed; germination not observed.

Saprophytic on lense paper and onion skin bait. Dominican Republic. Collected by F. K. Sparrow.
Type: Fig. 4, A—M.

Rhizophlyctis tropicalis sp.nov.

Sporangium sphaericum, 30—80 μm diam., ovoideum, 45—70× 30—55 μm, aut elongatum 60—80×8—15 μm, e corpore zoosporae incystatae, interdum, autem e tubo germinali zoosporae omnino aut ex parto evolutum; membrana levis, tenuis, sine colore, contento obscure cinereo granuloso nisi areolae translucentes infra singulam papillam dimissionis. Systema rhizoidale ex aliquot axibus in sporangio enascens, elementis pachydermatis. Zoosporae ovoideae, 5×3.5 μm, 10 vel plures globulos basales minutos habetes sine colore, atque flagellum posterius 30 μm long. habentes; zoosporae cum cacumen papillae dimissionis dehiscit exsilientes atque in massa compacta materia papillari translucente circumdata emergentes. Spora quiescens sphaerica 9.5—19.0 μm diam., aut ovoidea 10—20×6.5—17 μm membranam fuscam crassamque atque contentum globulosum compactum praebens, ut videtur, asexualiter formata: germinatio non observata.

Habitatio: Planta in charta ad purgandas lentes utilis atque in membrana caepae ut esca posita saprophytica. In loco Dominican Republic dicto, per F. K. Sparrow collecta. Planta typica Fig. 4, A—M.

15. *Karlingia rosea* Johanson

The junior author has recently (1970) completed a series of studies from single-spore cultures of 90 isolates of endooperculate forms resembling *Rhizophlyctis rosea*. He has found that endooperculation is a constant feature maintained over many cultural generations. Hence, if endooperculation is to be accepted as a character of generic significance and he feels it should, then we must apply the binomial *Karlingia rosea* to the endooperculate ubiquitous rhizophlyctoid soil fungus. When such a structure is not found, as in the recent instance recorded in Kobayasi and Konno (1969) it would seem desirable to use *Rhizophlyctis rosea* (de Bary and Woronin) Fischer.

The problems inherent in using endooperculation as a character of generic distinction are many. One instance is given in this paper in the discussion of *Cladochytrium* sp.

16. *Chytriomyces* 2307 Persiel. Pine pollen bait. Localities: 29; 31.

17. *Chytriomyces* sp. Pine pollen bait. Locality: 24.

Very few examples of this fungus were found. The sporangia were clavate to somewhat cylindrical and usually slightly curved and 15 to $33 \times 5-10$ μm. They were generally borne on a short extramatrical stalk which gave rise within the pollen grain to a sparingly branched rhizoidal system (Pl. 4, N). No discharge papilla was observed. At zoospore discharge a convex operculum 4—5 μm diameter was dehisced and allowed the passive mass of spores to emerge. The latter were spherical, 4—4.5 μm in diameter with a long posterior flagellum. No resting spores were seen.

The fungus is similar to one described from California by Sparrow (1968) and tentatively referred to *C. poculatus* Willoughby. From the studies of the junior author, Willoughby's species appears to be a complex of two distinct species and until the matter is resolved no specific identification will be given the Dominican fungus.

18. *Chytriomyces multioperculatus* n.sp. Saprophytic on pine pollen bait. Locality: 29.

The development and morphological features of this distinctive epibiotic chytrid in unifungal culture are shown in Plate 5. The mature zoosporangia are nearly spherical (Pl. 5, G, I, J, L), and by reason of the formation of 1—10 or more slightly elevated discharge pappilae angular, 9.5—40 μm high by 10—18 μm wide, others appear laterally compressed and oval (Pl. 5 H), or pyriform and $20-43 \times 13.5-32$ μm. They are predominantly sessile on the pollen grain but may also be stalked (Fig. 5, J, K). Occasionally stalked pygmies are found (Fig. 5 M, N). The rhizoidal system which is composed of sparingly branched tapering elements arises from a well-defined subsporangial apophysis.

The striking feature of this fungus is the production of numerous (up to 10 or more) discharge papillae the apices of which during the later stages of sporangial maturation become circumcisely dehisced but remain attached by a narrow raised collar of inner wall material to the discharge orifice. A similar development of the discharge papilla is seen in the operculate *Karlingiomyces dubius* by Willoughby (1957) and Dogma (1970) and in the inoperculate *Rhizophlyctis oceanis* (Karling, 1969). These precociously separated structures in the Dominican fungus at sporangial discharge, which is explosive and violent, dehisce as exo-opercula allowing the zoospores to be "squirted" out in sudden fashion through the orifices. The zoospores emerge with their flagellum wrapped around the body in "watch-spring" fashion and lie quiescent for a time before rotation of the body seems to free the flagellum which then becomes active. The opercula which are thin-walled, smooth and 3—7 μm in

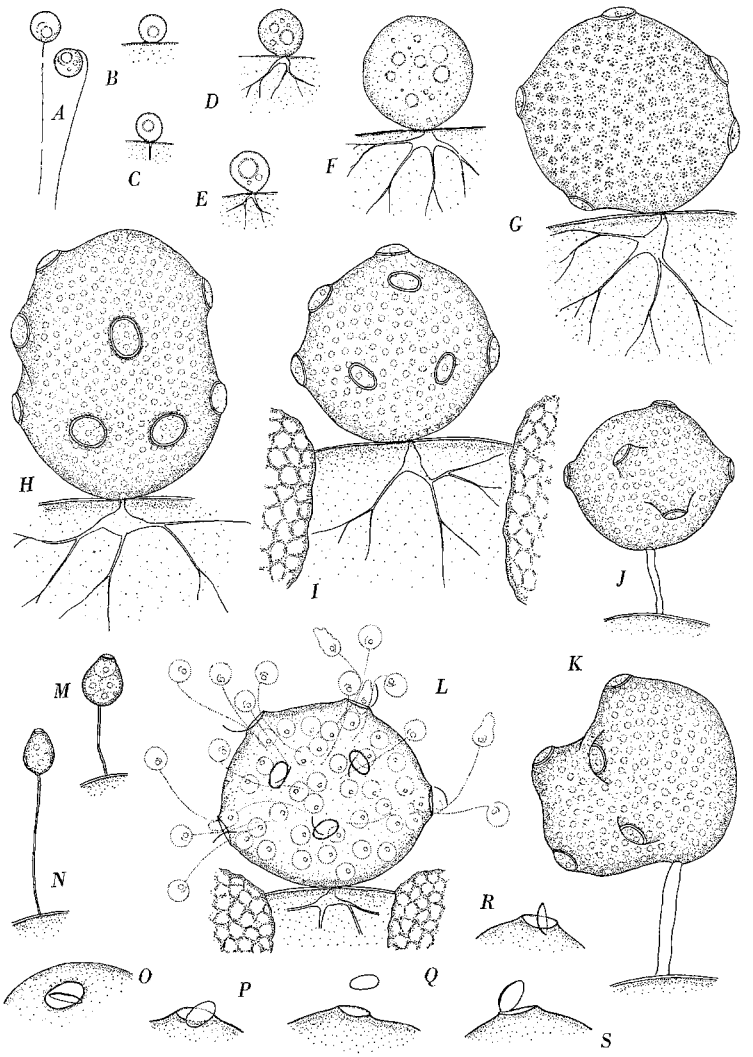

Fig. 5. *Chytriomyces multioperculatus* n. sp. on pine pollen. *A* Zoospores with prominent globule and arc (nuclear cap ?) in body; *B—F* stages in establishment and early development of thallus; *G—I* mature sporangia with true opercula surrounded by dehiscence zone surmounting discharge pores. *J* and *K* stipitate mature sporangia; *L* discharging sporangium, showing opercula and zoospores; *M* and *N* dwarf stipitate single-operculate forms; *O—S* discharge pores with hinged or free opercula. All ×560

diameter are either completely separated from the rim of the orifice produced at dehiscence or remain hinged to it.

The zoospores are spherical, 3.5—4.0 μm in diameter with a large colorless somewhat basal globule, several smaller ones and a darker arc-like structure, possibly the nuclear cap (Fig. 5, A). The posterior flagellum is about 20 μm in length. No resting spores were observed.

Multioperculate chytrids appear to be very rare, *Chytriomyces mortierellae* Persiel (1960), *Chytridium* on mucor Willoughby (1958), being ones that come to mind. Lacking resting spores, we cannot be certain if our fungus belongs in Chytriomyces or Chytridium, which are outside the substratum in the former genus and inside in the latter. We are placing it in Chytriomyces. We further feel that the placing of a multi-operculate form in Chytriomyces does no violence to the generic concept anymore than a varying number of discharge pores does in Rhizophydium or Phlyctochytrium.

Chytriomyces multioperculatus n.sp. Sporangia sessile, occasionally stalked, spherical, subspherical, or somewhat angular, 9.5—40 μm high by 10—38 μm wide, oval to pyriform, 20—43 × 13.4—32 μm; wall smooth, colorless; contents globular at maturity; with up to 10 or more slightly elevated discharge papilla surmounted by opercula. Rhizoids sparingly branched, tapering, arising from one or more places on a subtriangular or spindle-shaped apophysis. Zoospores spherical, 3.5—4 μm in diameter, uniguttulate with lunate body and posterior flagellum 20 μm long; discharged forcefully, fully formed, with flagellum curved around body upon dehiscence of opercula. Resting spores not observed.

Saprophytic on pine pollen, Dominican Republic.
Collected by F. K. Sparrow.
Type: Fig. 5.

Chytriomyces multioperculatus sp.nov.

Sporangia sessilia interdum stipitata, sphaerica, subsphaerica aut paululum angularia, 9.5—40 μm alt., 10—38 μm lat., ovalia ad pyriformia, 20—43 μm × 13.4—32; membrana levis, sine colore; contentum maturum globosum; sporangia usque ad 10 vel plures papillas paululum elevatas dimissionis, operculo superatas, habentia. Rhizoidea parce ramosa attenuata, ex uno vel pluribus loculis in apophyse subtriangulari aut fusiformi enascentia. Zoosporae sphericae 3.5—4 μm diam., uniguttalatae, corpore lunato, flagello posteriore 20 μm long. praeditae; zoosporae violenter dimissae, perfecte formatae, flagello circum corpus curvato cum operculum dehiscit. Sporae quiescentes non observatae.

Planta in polline pini saprophytica in loco Dominican Republic dicto, per F. K. Sparrow collecta.

19. *Catenochytridium carolinianum* Berdan. On onion skin bait. Locality: 22.

The sporangia (Fig. 4, O) were pyriform to ovoid, 35—43 × 30—35 μm with a conspicuous sub-apical solid portion of unexpanded zoospore cyst on wall. The zoospores escaped *en masse* following the dehiscence of an operculum which remained attached to rim of an 8—15 μm in diameter discharge orifice.

20. *Cladochytrium replicatum* Karling. On onion skin bait. Localities: 21; 22.

21. *Cladochytrium* sp. Lense paper-cellophane bait; dead grass bait. Localities: 9; 16; 18; 19; 20—24.

The strongly polycentric thallus of this chytrid a portion of which is shown in Fig. 1, P, lacked spindle-shaped swellings unassociated with sporangia. The latter were pyriform, 18—25 μm in diameter with minutely globular contents. They were terminal or intercalary and each was provided with a single sessile or elevated discharge papilla beneath which was seen a concave area of non-sporogenous material as earlier observed in *Rhizophlyctis tropicalis*. At maturity (Fig. 1, N) the apex of the papilla was provided with a prominent gelatinous plug beneath which was a slightly convex endooperculum. The latter structure capped the distal boundary of the aforementioned clear zone. At varying times prior to zoospore discharge the conspicuous gelatinous plug dissolved in the water, leaving the endooperculum terminal in the apex of the discharge apparatus surrounded by a projecting collar or rim of wall material. At discharge, the endooperculum was pushed aside or detached and carried up by the emerging zoospores. These escaped en masse apparently embedded in the subapical expanding clear material. The latter soon dissolved in the water, the zoospores assumed individual motility and swam away. They were spherical, 4.5 μm in diameter, with a small basal globule, prominent dark arc-like body and posterior flagellum 30 μm long (Fig. 1, O). They were capable of either rapid swimming or amoeboid movement. Resting spores (Fig. 1, Q, R) were abundant, intercalary, spherical, 10—21 μm in diameter, or oval to ellipsoidal and 14—25 × 8—16 μm, with a thick smooth brownish wall and compact globular contents. Germination was not observed. Nowakowskiella sp. Karling (1968b) and Cladochytrium Kobyasi and Konno (1970) closely approximate our fungus.

We refer this fungus to Cladochytrium rather than to Nowakowskiella where it might at first seem better placed, because no exooperculum, a feature of Schroeter's genus, is formed. To do this, however, is to do some violence to the status of Cladochytrium which upon the evidence

of many investigators has no endooperculum save in *C. crassum* Hillegas. If we are to follow the trend established with the segregation of endooperculate rhizophlyctoid forms from Rhizophlyctis, then this fungus, should stand as a polycentric counterpart of Karlingia and be placed in a new genus along with *C. crassum.*

22. *Nowakowskiella hemisphaerospora* Shanor. On lense paper and cellophane baits. Locality: 22; 24.

This species is easily identified by the unique resting spores. The discharge apparatus is like that of the preceding fungus except that no distal hyaline plug of gelatinous material is formed and dispersed. The operculum here is part of the *outer* wall of the discharge papilla and when it dehisces the zoospores emerge *en masse* surrounded by the material of the subapical clear zone.

23. *Nowakowskiella elegans* (Nowak.) Schroeter. Lense paper bait. Localities: 17; 20; 24.

Like the preceding, an exooperculate, polycentric fungus.

24. *Catenophlyctis variabilis* Karling. Snake skin bait.

We have encountered two types of keratinophilic fungi which apparently can be embraced under this binomial. The first of these is the strongly polycentric organism depicted in Karling, 1965. This is an easily recognizable entity and exceedingly common on such a bait as snake skin cast. We have found this in the following localities: 1; 2; 4; 5; 6; 8; 9; 10; 12; 17; 19; 21; 22; 23; 24; 26; 29; 30; 32.

The second is a monocentric form somewhat resembling *Rhizophlyctis fuscis* Karling (1964b) in zoospores, and method of zoospore discharge. Some thalli also resemble those of *R. lovetti* in their somewhat asymmetrical, fusiform appearance.

Localities: 1—3; 13—19; 21; 23; 27; 30; 31.

25. *Allomyces javanicus javanicus* Kniep. Hempseed bait. Localities: 7; 19 (only on snake skin); 23.

26. *A. arbuscula* Butler. Hempseed bait. Localities: 23; 25.

27. *Allomyces* sp. (Sporophyte only). Hempseed bait. Localities: 7; 19; 21; 22; 29.

28. *Monoblepharella endogena* Sparrow. Hempseed bait. Locality: 22.

This locality, a damp stream bed tributary to the Rio Haina by the dam, was rich in members of the Monoblepharidales.

Monoblepharella endogena bore abundant clavate endogenous oospores and siliquiform zoosporangia.

From this same site the complex of monoblepharid hyphae bearing discharging zoosporangia shown in Fig. 3, J was found. It will be noted that the swarmers produced are unlike in size. The hyphae of the few examples of this association found were so intertwined that it could not

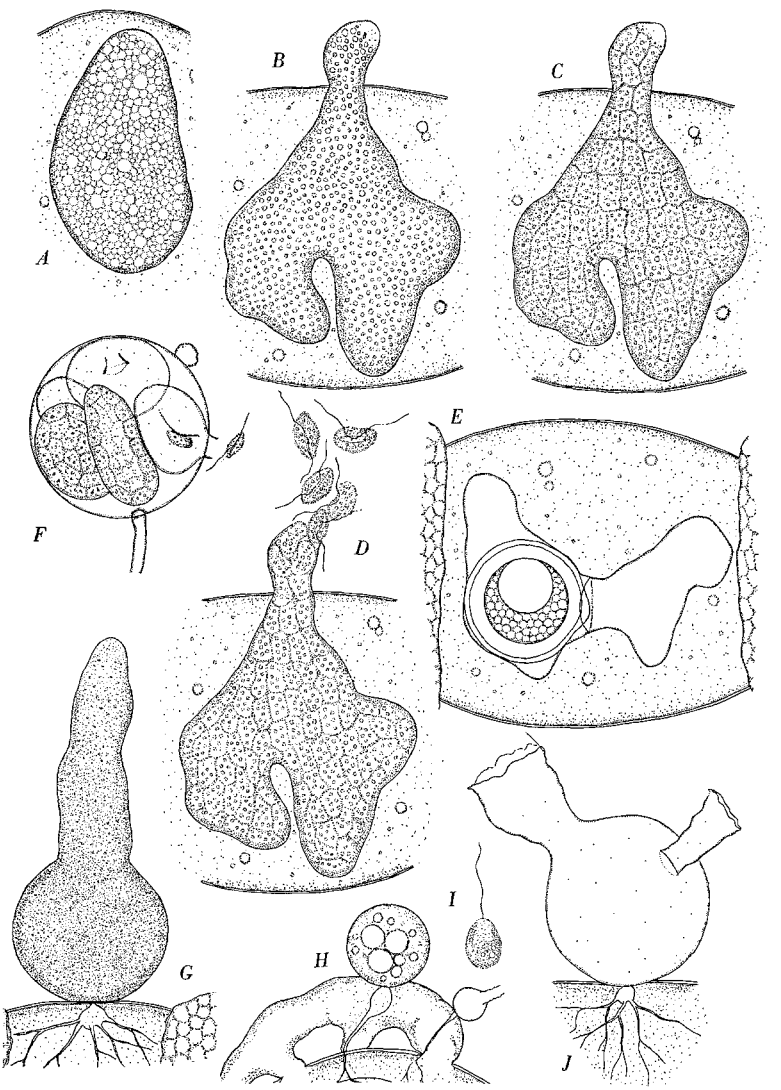

Fig. 6

be said the two types of swarmers arose from the same mycelium. They were, however, closely associated. No instance of fusion of the two-sized swarmers was witnessed and just what they represented was not clear but it does raise the interesting possibility of anisogamy, a type of sexuality one step removed from what is now known in Gonapodya and Monoblepharella.

29. *Rhizidiomyces apophysatus* Zopf. Parasitic on oogonia of *Achlya flagellata*. Localities: 22; 24; 29.

The fungus was grown in unifungal culture on pine pollen where it produced normal plants (Fig. 6, G) except that a few formed more than one discharge tube (Fig. 6, J). The apophysate nature of the vegetative system was maintained. It was later induced to grow on a strain of *Achlya americana* collected at the U. of M. Biological Station (Fig. 6, H), infection by zoospores (Fig. 6, I) being recognizable after 24 h.

Zoospore formation took place outside the sporangium at the orifice of the discharge tube. Although no discrete vesicle was seen to surround the extruded mass, it was briefly enveloped by the expanded wall of the tube apex. Young sporangia occasionally bore an unexpanded portion of the zoospore cyst.

30. *Anisolpidium* sp. Saprophytic in pine pollen bait. Locality: 28.

Too little is known about this fungus (Fig. 2, X) as yet to say more than that it forms its zoospores completely within the spherical, olpidioid 30—45 μm in diameter sporangium within the pollen grain and that these undergo vigorous motility before discharge. They emerge successively by flagellar action through a discharge tube which is nearly sessile with the wall of the pollen grain. Outside they swim away at once as narrow bodies (5×2 μm) dorsally furrowed from which, so far as could be determined, a single anterior flagellum emerged. Considering the apparently grooved nature of the zoospore, biflagellation was suspected but a second flagellum was never observed. No other stages were seen.

Fig. 6. *A—E Lagenidium pygmaeum* in pine pollen; *F L. pythii* on Pythium; *G—J Rhizidiomyces apophysatus* on *Achlya* and pine pollen. *A* young, as yet unlobed thallus; *B* maturing zoosporangium showing apex of discharge tube becoming clear of granulations; *C* same with endogenously cleaved out zoospores; *D* discharge of fully mature biflagellate zoospores; no vesicle is present; *E* mature oospore lying loosely in a lobed thallus; adjacent cell has functioned as an antheridium. *F Lagenidium pythii*, empty, mature, and discharging sporangia in swollen sporangium of Pythium. *G—J Rhizidiomyces apophysatus*; *G* nearly mature sporangium transferred to pine pollen; *H* young thallus and discharged dwarf sporangium grown on oogonium of *Achlya americana* from inoculum from pine pollen; *I* anteriorly uniflagellate zoospore; *J* empty sporangium with 2 functional discharge tubes. All ×560

31. *Anisolpidium saprobium* Karling[2]. In pine pollen bait. Locality: 16; 30; 24; 31.

This fungus has fairly recently (1968a) been fully described by Karling from Pitcairn Island. Up to 6 spherical, 15—38 μm in diameter endobiotic sporangia devoid of any specialized vegetative system were found in the body of the pollen grain (Fig. 7, A). Within 15 min after immersing such grains in fresh water discharge tube growth is initiated. Usually this is unbranched 65—113 × 5—7 μm and grows out a varying distance beyond the wall of the substratum (Fig. 7, C). Occasionally it may branch (Fig. 7, B) in which case only one branch is functional. After a varying number of hours the coarsely granular contents emerge in an amorphous continuous stream from the tube and form a mass at the orifice where they at once begin a centripetal cleavage into zoospores (Fig. 7, D, E—G, H). Occasionally the emerging protoplasmic mass may be nearly separated into "blobs" of different sizes (Fig. 7, F) and occasionally a mass may remain within the sporangium and is converted into a zoosporangium (Fig. 7, K, left) giving an appearance of internal proliferation. The zoospores are broadly ovoid, 5.5 × 3.5 μm, with an anterior flagellum 6.5—7.0 μm long (Fig. 7, I and J).

No resting spores were seen. It was noted however, that long-quiescent thalli themselves seem likely to act in this manner since a change of water, will stimulate them to function as zoosporangia.

This fungus has heretofore been reported only from Pitcairn Island in Oceania. To the Dominican record we can add a third, namely on pine pollen, Walled Lake, Michigan, May 9, 1952 (coll. T. Westerdale). A truly cosmopolitan organism!

32. *Sorodiscus cokeri* Goldie-Smith. Parasitic in sporangia of *Pythium* spp. Localities: 7, 24, 25; 32.

The plates of resting spores (Fig. 4, P, Q) in hypertrophied sporangia were unmistakable.

33. *Achlya flagellata* Coker. Hempseed bait. Localities: 22; 24.

34. *A. americana* Humphrey. Hempseed bait. Locality: 22.

35. *A. orion* Coker and Couch. Hempseed bait. Locality: 22.

36. *Brevilegnia variabilis*. Hempseed bait. Locality: 24.

37. *Aphanomyces laevis*. Snake skin bait. Localities: 3, 17.

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2 We are maintaining Karling's binomial for this fungus until the validity of Canteriomyces is ascertained.

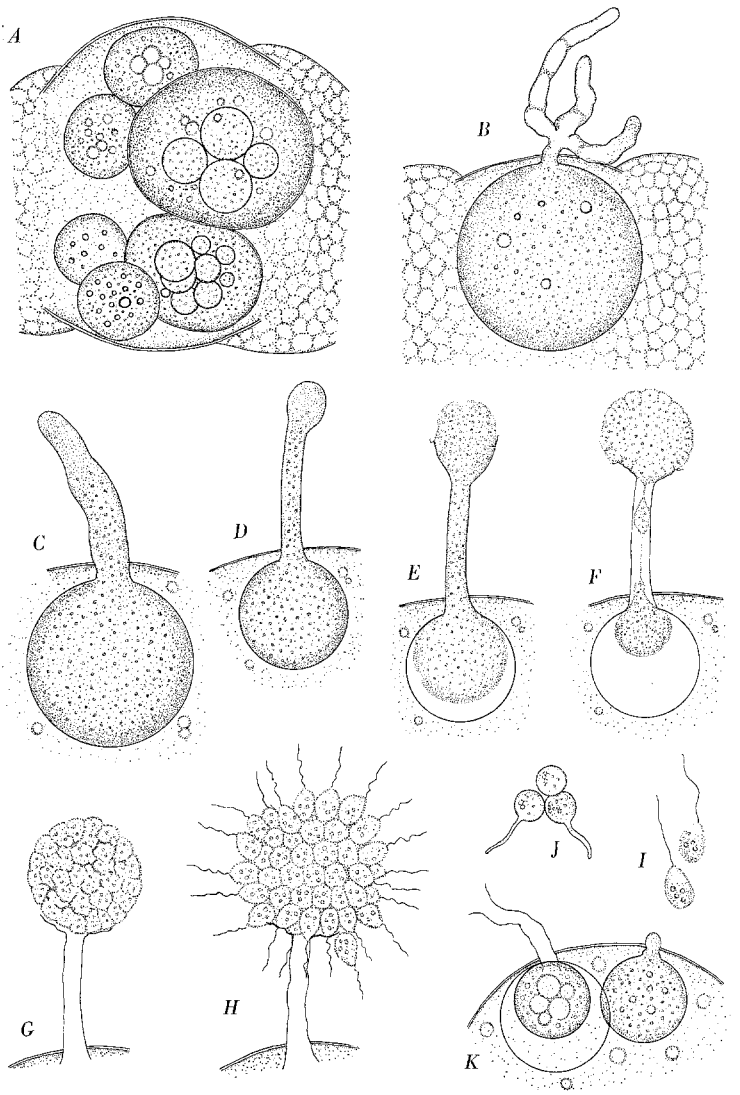

Fig. 7. *Anisolpidium saprobium*, on pine pollen. *A* Thalli in various stages of maturity; *B* maturing thallus which has formed a branched discharge tube; only one branch will be functional; *C* mature thallus; *D*—*H* stages in exogenous maturation of zoospores at orifice of discharge tube; note remnants of apical wall of discharge tube at orifice; *I* anteriorly uniflagellate zoospores; *J* zoospores germinating on slide; *K* thallus on right initiating discharge tube formation; on left a new thallus is growing from remnant of protoplasm left within a previously evacuated sporangium. All ×560

38. *A. laevis* var. *keratinophilus*. Ookubu and Kobyasi. Hair used as bait. Localities: 20; 22; 23; 24.

A. laevis var. *keratinophilus* is a spectacular fungus both in the ease and rapidity with which it consumes the hair, and in the abundance of sex organs it produces. The senior author has encountered it in samples of soil from various African sites and in Cuba. It will no doubt be shown to be a distinct taxon.

39. *Brevilegniella keratinophilia* Dick. Hair used as bait. Localities: 7; 17; 18.

Dick (Comm.) has recently placed this and certain species of Aphanomycopsis in a new family, the Brevilegniellaceae.

Various undetermined Saprolegniaceae, some belonging to Dictyuchus, Thraustotheca and Brevilegnia were also collected.

40. *Olpidiopsis karlingae* Karling. Parasitic on *Rhizophlyctis rosea*. Localities: 1; 7; 9; 17; 26.

41. *O. gracile* (Butler) Karling. Parasitic on *Pythium* sp. Localities: 9; 16.

42. *Lagenidium pygmaeum* Zopf. On pine pollen bait. Localities: 4; 20; 22; 24.

Thalli in unifungal culture were variable in shape being ovate, spherical to irregular, $23-30 \times 12-20$ μm, mostly lobate and almost filled the body of the pollen grain (Fig. 6, A, B). With the onset of nonsexual reproduction, a broad discharge tube was formed which penetrated the pollen grain wall and extended for about 8—10 μm to the outside. Meanwhile, the compactly globular, strongly refringent contents underwent a series of changes which eventuated in their becoming finely granular with uniformly distributed small globules (Fig. 6, B). The tip of the discharge tube formed a conspicuous clear area (Fig. 6, B, C). Cleavage proceeded in a centripetal manner from the periphery to delimit more or less uniform-sized areas, the future zoospores. These furrows then become indistinct to reappear just prior to discharge. At initiation of zoospore discharge the apex expands for a moment, then bursts and the zoospores escape rapidly, fully formed (Fig. 6, D). The zoospores were laterally biflagellate and 5×3 μm, the flagella being equal, or nearly so in length.

Sexual reproduction was abundant in this material. Pairs of small like-sized ($8 \times 20-25$ μm) saccate thalli functioned as gametangia, and the whole process which culminated in a thick-walled oospore 13—15 μm in diameter being formed in the receptive thallus (Fig. 6, E) was exactly as Zopf (1887) has described it.

Our material in its method of zoospore formation differed somewhat from Zopf's. He described mass evacuation of sporangium contents and final formation of zoospores within a vesicle.

43. *Zoophagus insidians* Sommerstorff. Parasitic (predacious) on various genera of rotifers. Locality: 22.

44. *Thraustochytrium striatum* Schneider. Pine pollen bait. Locality: 34.

45. *Schizochytrium aggregatum* Goldstein and Belsky. Locality: 33.

In addition to this fungus, another much larger one with segments and aggregations consistently twice those of *S. aggregatum* was found.

References

Barr, D. J. S.: Morphology and taxonomy of *Entophlyctis confervae-glomeratae* (Chytridiales) and related species. Canad. J. Bot. **49**, 2215—2222 (1971).

Booth, T.: Problematical taxonomic criteria in the Chytridiales: comparative morphology of 10 *Entophlyctis* isolates. Canad. J. Bot. **49**, 977—987 (1971).

Coker, W. C.: The Saprolegniaceae, with notes on other water molds. Chapel Hill: Univ. North Carolina Press 1923.

Cook, P. M.: *Entophlyctis reticulospora* sp.nov. a parasite of Closterium. Trans. Brit. Mycol. Soc. **49**, 545—550 (1966).

Dogma, I. J., Jr.: A developmental, morphologic, and taxonomic study of some monocentric Chytridiomycetes. Dissertation, Univ. of Mich. 1970.

Dogma, I. J., Jr., Sparrow, F. K.: A hyperparasitic *Blyttiomyces*. Mycologia (N. Y.) **61**, 1149—1158 (1969).

Harder, R.: Über das Vorkommen von Chitin und Cellulose und seine Bedeutung für die phylogenetische und systematische Beurteilung der Pilze. Nachrichten Ges. wiss. Göttingen, Math.-Physik. Kl., Fachgruppe VI (Biol.) (N. F.) **3**, 1—7 (1937).

Harder, R.: Untersuchungen an mikroskopischen Erdpilzen der dominikanischen Republik. I. (Same title as 1937). Veröff. Deutsch-Dominikanischen Tropenforschungsinstituts **1**, 110—117 (1939a).

Harder, R.: Untersuchungen an mikroskopischen Erdpilzen der Dominikanischen Republik. II. (Same title as above and same text but *Blastocladiella* substituted for *Rhopalomyces*). Veröff. Deutsch-Dominikanischen Tropenforschungsinstituts **1**, 120—127 (1939b).

Harder, B., Sörgel, G.: Über einen neuen planoisogamen Phycomyceten mit Generationswechsel und seine phylogenetische Bedeutung. Nachrichten Ges. Wiss. Göttingen, Math.-Physik. Kl., Fachgruppe VI (Biol.) (N. F.) **3**, 119—127 (1938).

Karling, J. S.: Indian chytrids I. Eucarpic monocentric species. Sydowia **17**, 285—296 (1964a).

Karling, J. S.: Indian chytrids. III. Species of *Rhizophlyctis* isolated on human fibrin film. Mycopath. et Mycol. Appl. **23**, 215—222 (1964b).

Karling, J. S.: *Catenophlyctis*, a new genus of the Blastocladiaceae. Amer. J. Bot. **52**, 133—138 (1965).

Karling, J. S.: Zoosporic fungi of Oceania. I. J. Elisha Mitchell Sci. Soc. **84**, 166—178 (1968a).

Karling, J. S.: Zoosporic fungi of Oceania. V. Cladochytriaceae, Catenariaceae, and Blastocladiaceae. Nova Hedwigia **15**, 191—201 (1968b).

Karling, J. S.: Zoosporic fungi of Oceania. VII. Fusions in *Rhizophlyctis*. Amer. J. Bot. **56**, 211—221 (1969).

Karling, J. S.: On *Chytridium* Braun, *Diplochytridium* N. G. and *Canteria* N. G. (Chytridiales). Arch. Mikrobiol. **76**, 126—131 (1971).

Kobyasi, Y., Konno, K.: Enumeration of the watermoulds found in Chichijima, Bonin Islands. Bull. Nat. Sci. Museum, Tokyo **12**, 725—733 (1969).

Kobyasi, Y., Konno, K.: Watermoulds isolated from soil in Tsushima Island (I.). J. Jap. Bot. **45**, 325—337 (1970).

Nabel, K.: Über die Membrane niederer Pilze, besonders von *Rhizidiomyces bivellatus*, nov. spez. Arch. Mikrobiol. **10**, 515—541 (1939).

Persiel, I.: Beschreibung neuer Arten der Gattung *Chytriomyces* und einiger seltener niederer Phycomyceten. Arch. Mikrobiol. **36**, 283—305 (1960).

Scott, W. W.: A study of some soil-inhabiting Phycomycetes from Haiti. Virginia J. Sci., N. S. **11**, 19—24 (1960).

Sörgel, G.: Über die Verbreitung einiger niederer Phycomyceten in Erden Westindiens. Beih. Bot. Zbl. Abt. B **61**, 1—32 (1941).

Sörgel, G.: Über mutmaßliche phylogenetische Zusammenhänge bei niederen Pilzen, insbesondere den Blastocladiales. Biol. Zbl. **71**, 385—397 (1952).

Sparrow, F. K., Jr.: Aquatic phycomycetes. Second Edit. Ann Arbor, Mich.: Univ. Mich. Press 1960.

Sparrow, F. K., Jr.: The occurrence of *Physoderma* in Hawaii, with notes on other Hawaiian Phycomycetes. Mycopath. et Mycol. Appl. **25**, 119—143 (1965).

Sparrow, F. K., Jr.: *Physoderma hydrocotylidis* and other interesting Phycomycetes from California. J. Elisha Mitchell Sci. Soc. **84**, 62—68 (1968).

Willoughby, L. G.: Studies on soil chytrids. II. On *Karlingia dubia* Karling. Trans. Brit. Mycol. Soc. **40**, 9—16 (1957).

Willoughby, L. G.: Studies on soil chytrids. III. On *Karlingia rosea* Johanson and a multi-operculate chytrid parasite on Mucor. Trans. British Mycol. Soc. **41**, 309—319 (1958).

Zopf, W.: Über einige niedere Algenpilze (Phycomyceten) und eine neue Methode, ihre Keime aus dem Wasser zu isolieren. Abh. Naturforsch. Ges. Halle **17**, 77—107 (1887).

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