Some Zoosporic Fungi of New Zealand. X.

Blastocladiales

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With Plates XXIX—XXXI

So far as it is known the order Blastocladiales is represented in New Zealand by several species of the Catenariaceae, Coleomomycetaceae and Blastocladiaceae. These include four species of the Catenariaceae, one of the Coleomomycetaceae and four of the Blastocladiaceae which the author isolated and identified from soil samples in various parts of the country. Among these, two are new species.

Catenariaceae and Coleomomycetaceae

Catenaria verrucosa sp. nov.

Fungus saprophyticus. Thallus polycentricus, eucarpicus, endobioticus. Sporangia obpiriformia, 20—25 ×28—31 μ piriformia, 30—39 × 42—52 μ, citriformia, 29—35 × 38—40 μ, irregularia vel elongata terminalia vel intercalaria, hyalina, levia, saepe isthmis cohaerentia, canali curvulo, recto vel leniter contorto, 10—13 μ lato, 20—100 μ longo praedita. Zoosporae ignotae. Sporae perdurantes globosae, 17—25 μ diam. vel ovoideae, 15—20 × 18—24 μ, pariete verrucoso, fusco, 1.8—2.3 μ crasso, plasmate grosse granuloso, globulis nonnullis splendidis intermixtis farctae. Germinatio ignota.

Thallus polycentric, rhizomyceliod. Sporangia terminal or intercalary, hyaline, smooth, obpyriform, 20—25 × 28—40 μ, pyriform 30—39 × 42—52 μ, citriform, 29—35 × 38—40 μ, or elongate and sometimes irregular in shape; connected by isthmuses of varying lengths and diameters; exit canal curved, straight or slightly contorted, 10—13 μ diam., by 20—100 μ long. Motile zoospores unknown. Resting spores spherical, 17—25 μ diam., or ovoid, 15—20 × 18—24 μ, with a dirty-brown verrucose wall, 1.8—2.3 μ thick; content coarsely granular with a few interspersed refractive globules; apparently formed by contraction of the content of swellings and its investment with a wall; lying free in hyaline vesicles or swellings; germination unknown.

Saprophytic in snake skin in soil sample AKC.

This species was observed only once, and unfortunately all but one of its sporangia were empty so that it was impossible to determine the size, shape and structure of the zoospores. However, a few quiescent globular and apparently degenerating zoospores were present in one sporangium (fig. 1B), and in them occurred a dense lunate body which was similar to a nuclear cap as in other species of *Catenaria*.

The thallus is typically polycentric and rhizomycelioid (fig. 1) with terminal and intercalary sporangia, connecting isthmuses, and rhizoids. So far as it is known it differs primarily from other species by its smaller verrucose resting spores. These may occur in terminal and intercalary swellings, and the one shown in figure 1A looks as if it had been formed in an incipient sporangium which had begun to form an exit canal. Sometimes, the spores occured in tandem as shown in figure 2.

Catenaria anguillulae Sorokin, 1876. Ann. Sci. Nat. Bot. VI, VI, 4: 67, pl. 3, fig. 6—28.

Saprophytic in bleached corn leaves and snake skin in soil samples WK3 and ATVG.

Catenophlyctis variabilis Karling, 1965. Amer. J. Bot. 52: 134, figs. 1—12.

Perirhiza endogena Karling, 1946. Amer. J. Bot. 33, suppl. 3: 219.

Phlyctorhiza variabalis Karling, 1947. Amer. J. Bot. 34: 27, figs. 1—48.

Saprophytic in snake skin, bleached corn leaves, onion skin and fibrin film in all but 7 of the soil samples described in the first paper of this series on the zoosporic fungi of New Zealand.

This is the most widely distributed and common species of the Blastocladiales found in New Zealand. It occurred in cellulosic as well as in keratinic substrata, but it was more abundant on the latter substratum. Polycentric as well as monocentric thalli occurred in most cultures.

Catenomyces persicinus Hanson, 1944. Torreya 44: 30; 1945, Amer. J. Bot. 32: 431—438, 52 figs.

Saprophytic in bleached corn leaves and cellophane in soil sample HBJF.

Coelomomyces dodgei (?) Couch and Dodge, 1947. J. Elisha Mitchell Sci. Soc. 63: 71, pl. 16, fig. 1; pl. 20, fig. 1.

Parasitic in larvae of *Anopheles* sp. in a tub of rain water, Bot. Dept., University of Otago, Dunedin.

The identity of this New Zealand fungus is not certain, but inasmuch as the resting sporangia (fig. 3) were similar in size and shape to those reported for *C. dodgei* it is identified tentatively as much. Only resting sporangia were present in the larvae.

Blastocladiaceae

Blastocladiella novae-zeylandiae sp. nov.

Saprophytica. Thallus monocentricus eucarpicus, e sporangio extramatricali et rhizoideis, in matrice evolutis, radiantibus vel basilaribus constans. Sporangia extramatricalia, apophysata, non-apophysata, vel appendiculata, globosa 20—125 μ diam., ovoidea, 14—40 × 20—85 μ, vel ad basim leniter applanata, interdum irregularia, papillulis 1—8, paulatim elongatis et in tubulos rectos, curvulos vel contortos 8—12 μ latos, 20—25 μ longos transformatis aucta. Rhizoidea matura usque 5—15 μ lata, 110—400 μ longa, a sporangio ipso septo disjuncta. Zoosporae ovoideae vel oblongae et elongatae, 5.5—6.5 × 8.5—9.9 μ, granulis 3—8 luteo-aurantiacis et nucleis 1, raro 2 conspicue pileatis praeditae, tubulo apice deliquescente liberatae, primum quietae, mox tarde discedentes et vagantes, uni-raro biflagellatae; flagellum 33—38 μ longum. Sporae perdurantes plerumque plasmatis contractione in vesicula globosa eaque pariete aureo-brunneolo, 1.6—3 μ crasso levi induto ortae, globosae, 22—92 μ diam. vel ovoideae, 26—32 × 40—54 μ, globulis luteo-aurantiacis farctae.

Thallus monocentric, eucarpic consisting of an extramatrical sporangium with intramatrical radially oriented or basally attached rhizoids. Sporangia usually appendiculate, apophysate or non-apophysate, predominantly spherical, 20—125 μ diam., ovoid, 14—40 × 20—85 μ, or slightly flattened at the base, with 1—8 exit papillae which slowly elongate to become straight, curved or contorted canals, 8—12 μ in diam. by 20—50 μ long. Rhizoids usually arising from several, up to 8 points on the sporangia, often from only one; main axes 5—15 μ diam., branching frequently and extending for distances of 110 to 400 μ. Zoospores ovoid to oblong and elongate, 5.5—6.6 × 8.5—9.9 μ, with up to 8 yellowish-orange granules and a conspicuous nuclear cap; liberated by deliquescence of tip of exit canals; initial mass of zoospores surrounded by a thin layer of matrix or temporary vesicular membrane and remaining quiescent for a short while, slowly separating and becoming actively motile; remaining zoospores emerging singly in succession; eventually coming to rest and encysting as cytospores. Resting spores usually formed by the contraction of the contents of a globular vesicle and its investment with a golden-brown, 1.6—3 μ thick, smooth, non-punctate wall, spherical 22—92 μ diam., or ovoid, 26—32 × 40—54 μ; filled with yellowish-orange globules of fairly uniform sizes, occupying part or rarely all of surrounding vesicle; germination unknown.

Saprophytic on bleached corn leaves and snake skin in soil samples ATHP, ATK, OAL and OWL.

This species is strikingly similar to *B. britannica* except for its appendiculate sporangia, slightly larger zoospores with yellowish-orange granules and smooth-walled, non-punctate resting spores. In the latter respect its resting spores are similar to those of *B. laevisperma* Couch and Whiffen (1942) and *B. microcystogena* Whiffen (1946).

The zoospores of *B. novae-zeylandiae* (fig. 4, 5) are similar in structure and behavior to those of other species. Occasional binucleate, biflagellate (fig. 6) zoospores occur and appear to be the result of unequal cleavage in the sporangium. At least, no evidence of fusion has been observed. After a period of motility the zoospores come to rest, round up, and become cystospores (fig. 7). These may germinate in water at the edge of the substratum (fig. 8—10) by the formation of one or more germ tubes which become the rudiments of the rhizoidal axes. In most cases observed the cytospore does not expand equally in all directions as it becomes the rudiment of the incipient sporangium, but buds out slightly or unequally, leaving an unexpanded portion of the cystospore wall. This portion usually becomes thick-walled and can be identified later as an appendage on the sporangium and the vesicle which bears the resting spore (fig. 11—14, 17, 18, 20—22, 24, 26, 28). A similar type of development and the presence of an appendage has recently been described by Canter and Willoughby (1964) in *B. anaboenae*. In other instances, the cystospore body expanded equally in all directions, resulting in non-appendiculate sporangia and vesicles (fig. 15, 16, 19, 23, 25, 27, 29).

The developmental stages of the thalli and sporangia, protoplasmic transformations (fig. 15, 16, 20—22), and maturation within the sporangia, and cleavage are similar to those of other species and need not be described again. However, it may be noted that occasionally the sporangia are apophysate (fig. 12, 13), stalked and septate (fig. 17), and may develop from 1 to 8 exit canals (14—18) of variable lengths and diameters. The canals begin as conspicuous papillae (fig. 15) and may gradually elongate into straight, curved or contorted tubes (fig. 16—18, 22). In most appendiculate sporangia with one exit canal the latter developed in close proximity to the appendage (fig. 14, 17, 18, 21, 22) as Canter and Willoughby found in *B. anaboenae*, but in no cases observed did the appendage develop into an exit papilla or tube. Also noteworthy is the development of thalli almost fully extramatrically (fig. 14, 17) with only the terminal branches of the rhizoids in the substratum.

Occasional thick-walled bodies (fig. 19) were found on corn leaves, and at first these were believed to be resting spores. However, these were not lying in vesicles like most of the resting spores observed, and after mounting in fresh charcoal water they "germinated" within 3 to 5 hours. Inasmuch as they germinated readily whereas true resting spores could not be induced to germinate by various treatments, the author regards the bodies shown in figures 19—22 as relatively dormant sporangia instead of resting spores. In germination the wall appears to become thinner in a local region, and after a while a broad papilla projects through this region (fig. 20). In some cases it appeared to burst through the wall and was somewhat similar in appearance to the tip of an endosporangium. Gradually during the course of 2 hours the papilla elongated into a tube (fig. 21) and become filled with protoplasm. In one dormant sporangium the exit canal became irregular and contorted as shown in fig. 22.

The development of the resting-spore thalli is similar to that of the sporangial thalli up to a certain stage, but later it becomes distinguishable by the denser content of the globular portion. Eventually, the content begins to contract from the periphery (fig. 23, 24) and becomes enveloped by a recognizable membrane (fig. 25). The latter becomes a distinct wall (fig. 26), and as the spore mature it becomes fairly thick and golden-brown. Most of the spores observed so far occupied only a part (fig. 27, 29) or most (fig. 26) of the vesicle in which they were formed. In a few cases the spore filled the vesicle to the extent that it was difficiult to differentiate between the wall of the spore and that of the vesicle (fig. 28). In such cases the two walls appeared to be almost continuous. At maturity the spores are filled with yellowish-orange globules of fairly uniform sizes, and particularly noteworthy is the smooth, non-punctate golden-brown wall. Spores were repeatedly crushed, washed and emptied of their contents to determine the sculpturing of the wall, but in no cases was it found to be punctate. Repeated attemps to induce germination of spores by various treatments have been made in the course of two years, but these have been unsuccessful.

Blastocladiella simplex Matthews, 1937. J. Elisha Mitchell Sci. Soc. 53: 194, pls. 20, 21.

Saprophytic on houseflies in a tub of rain water, Bot. Dept., University of Otago, Dunedin.

Blastocladiella microcystogena Whiffen, 1946, J. Elisha Mitchell Sci. Soc. 62: 57, pl. 7, fig. 1—5.

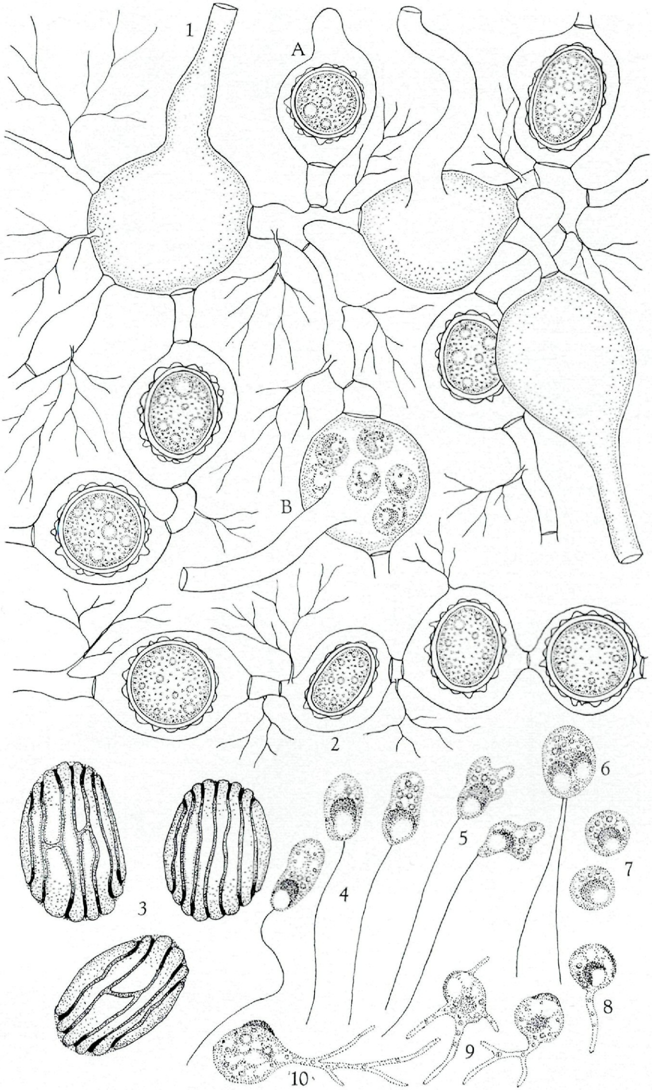
Saprophytic on bleached corn leaves in soil samples AK, CWRG, CWR, and CBG.

The New Zealand specimens of this species were similar to those described by Whiffen from Texas except that the resting sporangia did not attain the same dimensions. The largest ones observed were only 43 μ in diameter.

Blastocladiella britannica Hornstein and Cantino, 1961. Trans. Brit. Mycol. Soc. 44: 197, pl. 15, fig. b—g.

Saprophytic on bleached corn leaves and snake skin in soil samples AK, ARVAT.

The thalli of the New Zealand specimens were similar to those de-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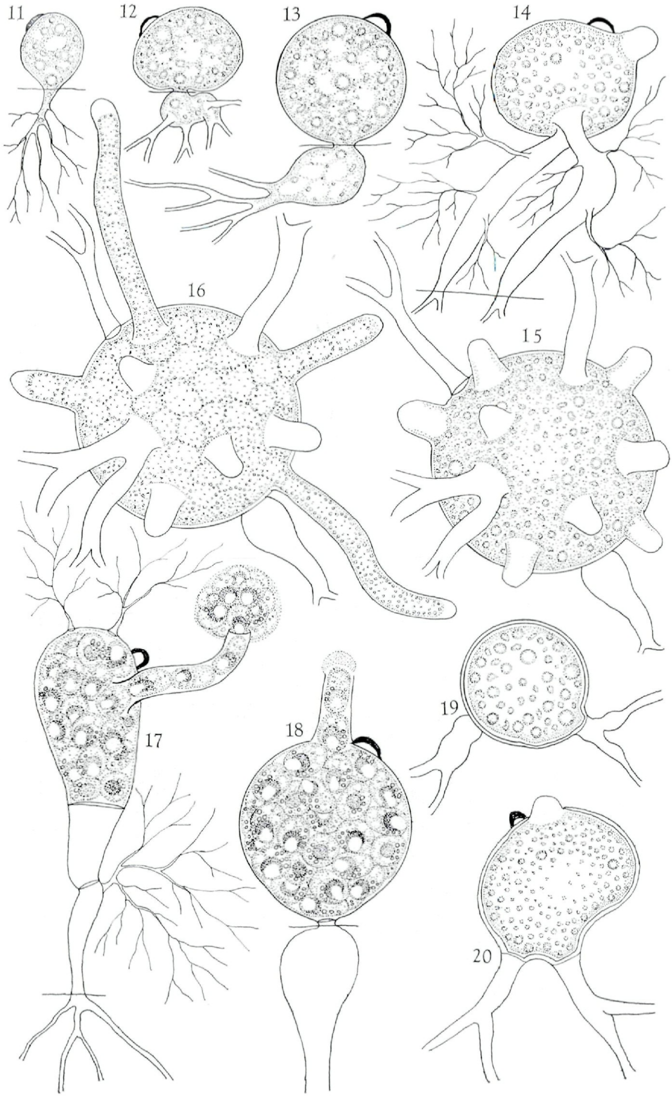
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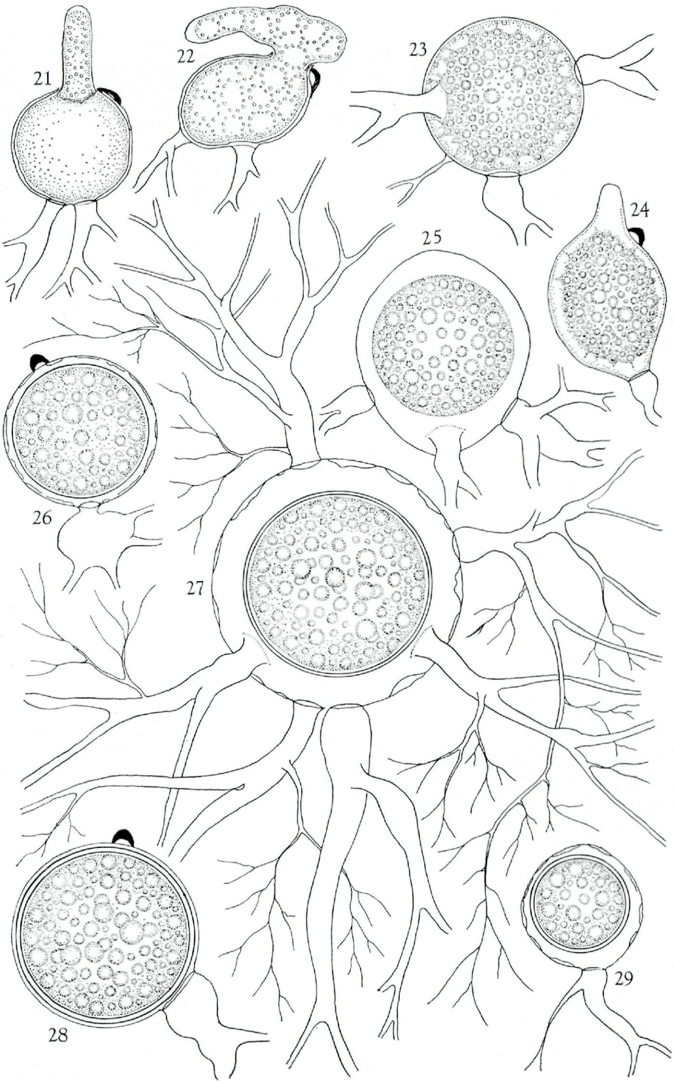
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scribed by Willoughby (1959) in England. The sporangia were predominantly spherical to subspherical, up to 135 μ in diameter, sometimes with as many as 7 rhizoidal axes arising from the periphery and with up to 10 exit canals. The latter began as prominent papillae and gradually elongated to form short, broad, 10 μ at the base by 7.5—9 μ high, or long 8—10 × 20—80 μ, exit canals. Monorhizoidal thalli occurred fairly often, and in some of these the basally attached rhizoidal axes varied from 25 to 45 μ in greatest diameter. Occasionally, stalked sporangia with a cross septum occurred. The resting spores were spherical, 20—135 μ in diameter, or ovoid, 36—52 × 48—75 μ, with a light-brown punctate wall. Quite frequently, they occupied only a portion of the hyaline vesicle in which they were formed. In the development of such spores the contents of the vesicles contracted and became invested with a punctate wall. In other cases the spore filled the vesicle to the extent that it was difficult to differentiate between the two walls. Despite extended and various attemps to induce germination the results were negative.

Particularly noteworthy in relation to the Blastocladiaceae is the fact that no species of *Allomyces* have been isolated and identified so far in New Zealand soils. The various substrata, baits, techniques and procedures commonly used in isolating species of this genus were employed by the author on the soil samples, but these yielded no positive results. If *Allomyces* is lacking in New Zealand it is extraordinary because this genus is nearly world-wide in distribution. It has been reported several times in southeast Asia and recently Jeffrey and Willoughby (1964) found it in Australia. In view of this the author believes that further studies will reveal its presence in New Zealand.

Summary

Among the Blastocladiales four species of the Catenariaceae, one of the Coelomomycetaceae and four of the Blastocladiaceae were identified in New Zealand. Two of these, *Catenaria verrucosa* and *Blastocladiella novae-zeylandiae,* are described as new species.

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Explanation of Figures.

Fig. 1—2. *Catenaria verrucosa*. Fig. 1. Portion of rhizomycelium with empty terminal and intercalary sporangia and four verrucose resting spores. Fig. 2. Four resting spores in tandem.

Fig. 3. Resting spores of *Coelomomyces dodgei* (?).

Fig. 4—29. *Blastocladiella novae-zeylandiae*. Fig. 4. Oblong and ovoid zoospores. Fig. 5. Amoeboid zoospores. Fig. 6. Large biflagellate zoospore with two nuclei and nuclear caps. Fig. 7. Cystospores. Fig. 8—10. Germination of cystospores in water at edge of substratum. Fig. 11. Young thallus with appendage. Fig. 12, 13. Incipient apophysate sporangia with appendages. Fig. 14. Largely extramatrical thallus. Fig. 15. Spherical sporangium with four radially oriented rhizoidal axes and eight exit papillae or short necks. Fig. 16. Same sporangium five hours later; four of the necks have elongated into exit tubes. Fig. 17. Largely extramatrical stalked, septate thallus; initial zoospore mass at exit orifice. Fig. 18. Subspherical sporangium a few seconds before dehiscence; tip of exit tube has deliquesced. Fig. 19. Fairly thick-walled dormant sporangium. Fig. 20. Early stage in germination of a similar sporangium, wall has become thin near the appendage and an exit papilla is developing. Fig. 21. Later stage in the germination of a similar sporangium; exit canal appears to have burst through the sporangium wall. Fig. 22. Similar sporangium with a contorted exit canal. Fig. 23, 24. Early stages in resting spore formation; protoplasm is contracting. Fig. 25. Later stage; contracted protoplasm enveloped by a thin membrane. Fig. 26. Later stage; protoplasm enveloped by a definite thin wall and occupying most of the vesicle. Fig. 27. Polyrhizoidal thallus with a large-mature thick-walled resting spore which occupies only a portion of the vesicle. Fig. 28. Resting spore filling vesicle almost completely. Fig. 29. Small resting spore.