

CHAPTER 39

LEPTOLEGNIA de Bary
Bot. Zeitung (Berlin) 46:609. 1888

Monoecious. Sporangia long, filamentous, cylindrical, occasionally branched; sometimes renewed by internal proliferation. Spores dimorphic; positioned in the sporangium in a single row; elongate on release from the sporangium, but then folding to become pyriform and swimming before encysting. Gemmae lacking. Oogonia lateral; spherical to subspherical. Oogonial wall unpitted; smooth or ornamented. Oogonial stalks unbranched or branched; of various lengths. Oospores eccentric; single; filling the oogonium or nearly so. Antheridial branches, when present, androgynous, monoclinal, or diclinous. Antheridial cells simple; attached laterally or apically.

Type species: *Leptolegnia caudata* de Bary, Bot. Zeitung (Berlin) 46:631, pl. 9, fig. 5. 1888.

The spores of *Leptolegnia* species, like those of *Saprolegnia*, are motile at discharge. They are in a single row in the filamentous sporangium (as in *Aphanomyces*), and are elongate, but this shape changes as they emerge from the orifice (Chapter 8). The oospores of some *Leptolegnia* species differ from those of most other water molds because they often fill the oogonial cavity (and sometimes even project into protuberances and irregularities in the oogonial wall). In some respects the pattern of oosporogenesis in *Leptolegnia* species also is unlike that in representatives of other genera (Chapter 9).

Two species of *Aphanomyces*, *A. daphniae* (Prowse, 1954a) and *A. patersonii* (Scott, 1956) are reported to have a *Leptolegnia*-like behavior of primary spores. When the incubation temperature exceeds 20 °C, the spores in both of these species emerge as elongate cells from the sporangia but instead of encysting and clustering in an achlyoid fashion (as would be expected of a species of *Aphanomyces*), the emerging spores bend as in *Leptolegnia* to form apically biflagellate planonts. Prowse (1954a) suggested that *Aphanomyces* may have been derived from an ancestral *Leptolegnia* stock through suppression of motility in the primary spore.

Key to the species of *Leptolegnia*

- 1. Oospores eccentric 2
- 1. Oospores subeccentric 3
 - 2. Oogonia provided with low, sometimes inconspicuous papillae, or wall is merely strongly irregular, crenulate, or wavy; antheridial branches androgynous or monoclinal *L. eccentrica* (p. 662)
 - 2. Oogonia densely provided with prominent

- papillae and long, cylindro-conic, straight or hamate projections; antheridial branches declinous *L. chapmanii* (p. 663)
3. Oogonia smooth, but wall often extended into a short beak at point of attachment to antheridal cells *L. caudata* (p. 664)
3. Oogonia ornamented 4
4. Antheridial apparatus lacking; oospore filling the oogonial cavity including the space within hollow wall ornamentations *L. subterranea* (p. 666)
4. Antheridial apparatus hemihypogynous; oospore generally not filling the oogonium, but if so, not projecting into the wall ornamentations *L. hemihypogyna* (p. 667)

Leptolegnia eccentrica Coker and Matthews
 In, Coker, J. Elisha Mitchell Sci. Soc. 42:215, pl. 33. 1927
 (Figure 103 E-K)

Monoecious. Mycelium moderately extensive, diffuse; hyphae slender, sparingly branched. Sporangia filamentous; curved and irregular; unbranched or branched; renewed in a basipetalous fashion or cymosely; primary, unbranched ones 108-1140 X 4-9 μm . Spores dimorphic; in a single row in the sporangium; discharge and behavior leptolegnoid; primary spore cysts 7-9 μm in diameter. Gemmae lacking. Oogonia lateral, infrequently terminal; spherical, subspherical, or slightly irregular or asymmetrical; (16-) 22-28 (-43) μm in diameter, including wall ornamentations. Oogonial wall unpitted; wall provided densely with low, sometimes inconspicuous, broad irregularities or crenulations, and occasionally additionally with small papillae. Oogonial stalks ($1/3$ -) $1-1\frac{1}{3}$ (-2) times the diameter of the oogonium, in length; slender; slightly irregular, often curved, unbranched. Oospores eccentric; spherical to broadly oval; single in an oogonium and filling it; wall thick and apparently layered; (14-) 20-26(-38) μm in diameter; germination not observed. Antheridial branches, when present, androgynous or monoclinal (terminal oogonia); slender, usually short, curved or slightly irregular; unbranched; persisting. Antheridial cell simple; small, bent-clavate; persisting; apically appressed; sometimes hemihypogynous; fertilization tubes not observed.

Small, irregularly roughened or papillate oogonia containing a single, eccentric oospore mark this species (Fig. 103 E, F, J). The antheridial branches of *Leptolegnia eccentrica* are androgynous (Fig. 103 J) but there are some hemihypogynous antheridial cells (Fig. 103 H, K, M, N) as in *L. hemihypogyna* (a species also having irregularly roughened oogonial walls). The oospores of the latter, however, are subeccentric while those of *L. eccentrica* are eccentric (expersate, according to Howard, 1971; rejected as a type by Dick, 1971b).

We are not at all certain that the nature of the oospore wall in *Leptolegnia eccentrica* is fully characterized. In the original description Coker (*loc. cit.*) wrote that the wall consisted of a "...dark outer portion, lighter irregular central portion and a clear inner portion." In her account of the species, V. D. Matthews (1927) described the oospore wall in essentially the same fashion. The specimens we have seen do not exhibit such a complicated wall structure. Indeed, it is usually difficult to see the outer boundary of the oospore itself because of the irregular nature of the oogonial wall. Further study of the oospore wall in *L. eccentrica* -- aided by electron microscopy -- is needed to characterize and interpret its structure. Admittedly, there is in the oospores of *L. eccentrica* an aspect not wholly unlike the configuration of some of the thick-walled "resting spores" in species of *Leptolegniella* (see Huneycutt, 1952).

In the interest of nomenclature, it should be mentioned that Coker was the sole author of the paper in which *Leptolegnia eccentrica* was first described, but no author for the species was designated (presumably it was Coker). The authors of the species were first mentioned by Coker and Matthews (1937:30).

CONFIRMED RECORDS: -- UNITED STATES: Coker (*loc. cit.*); V. D. Matthews (1927:5, pl. 3; 1935:308).

RECORDED COLLECTIONS: -- UNITED KINGDOM: Dick (1962, 1963, 1966); Dick and Newby (1961). UNITED STATES: T. W. Johnson (1956a). YUGOSLAVIA: Ristanović (1973).

SPECIMENS EXAMINED: -- BRAZIL (2), UNITED STATES (1), RLS.

Leptolegnia chapmanii Seymour
Mycologia 76:670, figs. 1-14. 1984
(Figure 104)

"Monoecious. Mycelium diffuse, extensive; hyphae slender, sparingly branched. Sporangia filamentous, seldom elongate and narrowly naviculate; often branched; terminal on principal hyphae or on lateral branches; 70-420 X 15-40 μ m. Spores dimorphic; in a single row, or in two or three rows in midsection of naviculate sporangia; discharge and behavior leptolegnoid; primary spores cylindrical; primary cysts 13-15 μ m in diam, secondary ones 10-14 μ m in diam. Gemmae abundant; variable in shape, but often large and swollen; generally papillate or provided with cylindrical protuberances; lateral, rarely terminal or intercalary; single. Oogonia lateral, rarely terminal or intercalary; spherical, obpyriform, or obovate; (26-) 38-42 (-63) μ m in diam, exclusive of wall ornamentations. Oogonial wall unpitted; densely ornamented with short, papillate projections, or with slender, elongate, straight or curved ones. Oogonial stalks ($1/4$ -) $1/2$ - $3/4$ (- $1 1/4$) times the diameter of the oogonium, in length; stout; straight; seldom curved or branched. Oospores rarely maturing; subeccentric or eccentric with oil globule surrounded by ooplasm; spherical; 1-2 (-3) per oogonium and generally filling it; (18-) 36-40 (-52) μ m in diam; germination not observed. Antheridial branches, when present, declinous, monoclinal, or androgynous; slender, branched or

unbranched; persisting; often only one per oogonium. Antheridial cells simple; tubular or short-clavate, sometimes strongly bent; seldom persisting; laterally appressed; fertilization tubes not observed." (Seymour, *loc. cit.*)

Nomenclature of this species, a pathogen of mosquito larvae, warrants a review statement. The taxon was first known as *Leptolegnia* sp. (Seymour, 1976). Under this designation, the fungus was used by McInnis and Zattau (1982) in their study on infection, host response, and biological control, as well as in a later publication (Zattau and McInnis, 1987) on infection and etiology. *Leptolegnia chapmanii*, as *Leptolegnia* sp., was studied by McInnis *et al.* (1985) in tests on susceptibility and host range. Nnakumusana (1986a-c) published on this *Leptolegnia* -- designated as *Leptolegnia* sp. and *Leptolegnia* SC-1 -- in a series of articles on infection and host susceptibility. In 1987, in a continuation of the investigation on host range and temperature responses, Nnakumusana (with Seymour) used the epithet *ornata*. Seymour, however, pointed out in 1988 that this name had been used provisionally and then only in manuscript. The name *ornata* has no status; *L. chapmanii* is the validly published designation.

The lateral, hyphal swellings (Fig. 104 C) and the predominantly ornamented oogonia (Fig. 104 A, B, D-I) set this species off from all others in the genus. Oogonia, rarely formed by colonies on hempseed or by mycelium within mosquito larvae, contain a single, generally eccentric oospore (Fig. 104 A, E) strikingly reminiscent of oospores in species of *Aphanomyces*. Some presumed mature oospores, however, are subeccentric (Fig. 104 B), such as those in *Leptolegnia caudata* (Fig. 103 D) and *L. hemihypogyna* (Fig. 103 M). At spore release, sporangial behavior is characteristically leptolegnioid even though some sporangia may have spores in more than one row.

The sexual apparatus of *Aphanomyces phycophilous* (Weatherwax, 1914: figs. 2-4) bears an unmistakable resemblance to that of *Leptolegnia chapmanii* (Fig. 104 G). As the asexual stage of Weatherwax's species is unknown, any supposed alliance of the two taxa would be purely conjectural. Additionally, the *Aphanomyces* is known only from conjugate algae.

Leptolegnia chapmanii is the only species of the genus known to invade and destroy mosquito larvae. In addition to its occurrence in *Aedes triseriatus*, it has been recovered from larvae of *Ae. aegypti* (D. Roberts; Louisiana) and *Culex* sp. (T. McInnis; South Carolina), and has also been found in North Carolina. An account of parasitism and pathogenicity of *L. chapmanii* appears in Chapter 30, as do treatments of other water molds known to occur in mosquitoes (*see also*, Rioux and Achard, 1956).

CONFIRMED RECORD: -- UNITED STATES: Seymour (1976:115 *et seq.*, figs. 1, 4-6).

SPECIMENS EXAMINED: -- UNITED STATES (3) RLS.

Leptolegnia caudata de Bary
Bot. Zeitung (Berlin) 46:631, pl. 9, fig. 5. 1888
(Figure 103 A-D)

Monoecious. Mycelium delicate, moderately dense; hyphae slender, sparingly to moderately branched. Sporangia filamentous, curved, irregular, or straight; usually unbranched, infrequently branched; renewed in a cymose fashion; 201-960 X 14-19 μm . Spores dimorphic; in a single row in the sporangium; discharge and behavior leptolegnoid; primary spore cysts 12-14 μm in diameter. Gemmae lacking. Oogonia lateral, rarely terminal; spherical to subspherical; (23-) 39-40 (-47) μm in diameter. Oogonial wall unpitted; smooth; usually protruding slightly in a beak-like fashion at its juncture with the antheridial cell. Oogonial stalks ($1/2$ -) 1-2 times the diameter of the oogonium, in length; stout, straight or slightly irregular; unbranched. Oospores subeccentric; spherical or subspherical; single in an oogonium and usually filling it; (22-) 30-37(-44) μm in diameter; germination not observed. Antheridial branches diclinous; slender, sometimes very short; usually slightly irregular or sinuous; unbranched or infrequently branched; persisting. Antheridial cells broadly clavate; usually bent; persisting; apically attached; fertilization tubes not observed.

Leptolegnia caudata can be distinguished from other taxa in the genus by the characters recorded in the key to species. Because individual isolates of *L. caudata* may be extremely sporadic in the production of the asexual and sexual apparatus, it is likely that the species is often overlooked. A specimen collected from a mat of algae in Iceland (Howard *et al.*, 1970) produced oogonia in gross culture, but then failed to do so in subculture. Apinis (1929a) reported finding a specimen of *L. caudata* that produced abundant oogonia and antheridia.

De Bary (*loc. cit.*) did not describe the entire process of spore behavior in *Leptolegnia caudata*; credit for first recording the events in this aspect of its reproduction goes to Coker (1909; 1923). The pattern of change in spore shape during emergence was confirmed by J. N. Couch (1924a) working with an unidentified species (but probably was *L. caudata*), and by A. C. Matthews in 1932. At discharge, the spores are elongate and laterally biflagellate. Once outside the orifice, they slowly fold such that they become triangular in outline, and then pyriform. Once the folding is completed, these primary spores are apically biflagellate (*see* Chapters 7, 8).

The antheridial cells of *Leptolegnia caudata* are attached in a manner recalling *Achlya subterranea* (Fig. 64 B, F). Once the cell adheres to the oogonial wall, there is a slight expansion of that wall outward at the point of contact. The result is a beak-like extension (Fig. 103 C, D). Coker (1923) noted that if the antheridial cell was pulled from its attachment to this "beak" a circular opening was left in the wall; we have not observed this condition clearly enough to be certain if it occurs consistently in our isolates.

Petersen (1909a, 1910) reported that *Leptolegnia caudata* attacked the crustacean *Leptodora kindtii*. He also believed that the saprolegniaceous fungus found by P. E. Müller (1868) on *Leptodora hyalina* Lillj. was probably a *Leptolegnia*. As Müller had described clavate reproductive cells in his specimens, it is unlikely that Petersen was correct.

The report of *Leptolegnia caudata* by S. Ito (1936) appears to be a misidentification. Illustrations provided by him are of *L. subterranea* or *L. eccentrica*, not de Bary's species.

CONFIRMED RECORDS: -- BRITISH ISLES: Swan (1898: pl. 1, figs. 1,2); Willoughby (1970: pl. 2, figs. b, f, g). CANADA: Maestres (1977:151, 152, figs. 56, 57). CZECHOSLOVAKIA: Cejp (1959a:111, fig. 29). DENMARK: Petersen (1909a:381, fig. 2; 1910:521, fig. 2). GERMANY: de Bary (*loc. cit.*). INDIA: Mer *et al.* (1981:388, figs. 1-6). JAPAN: Kobayashi and Ôkubo (1954:566, fig. 7); Nagai (1931:29, pl. 7, figs. 12-17). LATVIA: Apinis (1929a:209, 210). MIDDLE EUROPE: Migula (1903:73, pl. 2B, fig. 5). PEOPLE'S REPUBLIC OF CHINA: Er (1973:38). UNITED STATES: Beneke (1948b:54); R. L. Butler (1975: figs. 57-60); Coker (1909:263, pl. 16; 1923:158, pl. 54); A. C. Matthews (1932: pls. 26, 27); Scott (1962:9); Wolf (1944:37, pl. 4, fig. 27. Cited as reported in a paper by Lounsbury, in 1929; not a published account). USSR: Naumov (1954:61); Shkorbatov (1927:80).

RECORDED COLLECTIONS: -- BRITISH ISLES: Dick (1966); Newton (1971); Ramsbottom (1915a); Willoughby and Pickering (1977). CANADA: Dick (1970, 1971c); Maestres and Nolan (1978). DENMARK: P. E. Müller (1868)(?). FINLAND: Häyrenä (1955, 1956). GERMANY: Höhnk (1956a); Schlösser (1929). ICELAND: Howard *et al.* (1970). JAPAN: S. Ito and Nagai (1931); Okane (1981); Ookubo (1954); Suzuki (1961b, 1961f); Suzuki and Hatakeyama (1960). NEW ZEALAND: Karling (1966f). PEOPLE'S REPUBLIC OF CHINA: Skvortzow (1925: 433)(?). SOUTH AMERICA: Beneke and Rogers (1962); Karling (1981). UNITED STATES: Clausz (1970, 1974); J. N. Couch (1932); Crane and Vermillion (1966); K. B. Raper (1928); A. W. Ziegler (1958b), USSR: Logvinenko and Meshcheryakova (1971); Mil'ko and Belyakova (1968); V. Miller (1906). YUGOSLAVIA: Ristanović (1970a).

SPECIMENS EXAMINED: -- ICELAND (2), TWJ. SOUTH AMERICA (1), RLS. MWD (1).

Leptolegnia subterranea Coker and Harvey
In Harvey, J. Elisha Mitchell Sci. Soc. 41:158, pl. 19. 1925
(Figure 103 T-V)

Monoecious. Mycelium limited, relatively dense; hyphae slender, sparingly branched. Sporangia filamentous, curved and slightly irregular; unbranched or branched; renewed in a basipetalous or cymose fashion; primary, unbranched ones 200-983 x 9-12 µm. Spores dimorphic; in a single row in the sporangium; discharge and behavior leptolegnoid, sometimes aplanoid; primary spore cysts 11-15 µm in diameter. Gemmae lacking. Oogonia usually sparse; terminal or lateral; spherical, or subspherical to irregular or asymmetrical; immature ones sometimes proliferating; (20-) 38-48 (-57) µm in diameter, including wall ornamentations. Oogonial wall unpitted; predominantly sparsely or densely papillate, or with some long, cylindrical or conical projections, or merely wavy or crenulate; projections often not evenly distributed over the wall surface; infrequently smooth. Oogonial stalks $1/2$ -2 times the diameter of the oogonium, in

length; slender, straight, slightly curved, or irregular; unbranched. Oospores subeccentric; noticeably thick-walled; of the same shape as the oogonium; single and filling it, including the cavities within the wall projections; germination not observed, Antheridial apparatus lacking.

The general form of some of the oogonia of *Leptolegnia subterranea* is like the configuration of *L. caudata* (compare Fig. 103 A, T). The oospore structure, too, is the same (subeccentric) for both these species. In *L. subterranea*, however, the oogonia are predominantly ornamented (Fig. 103 T-V), the oospore wall is conspicuously thickened, and the oospore is not free in the oogonial cavity as it is in *L. caudata* or *L. hemihypogyna*. The absence of any antheridial apparatus, of course, immediately distinguishes *L. subterranea* from the remaining members of the genus (although others may be provided only sparsely with antheridial filaments). The oogonial wall projections in *L. subterranea* appear to be quite variable in density and prominence.

In our limited specimens, the oogonia are generally papillate to crenulate; Coker and Harvey reported strongly papillate ones, and illustrated some with large, cylindrical projections.

CONFIRMED RECORDS: -- ICELAND: Howard *et al.* (1970:66, fig. 4). UNITED STATES: Beneke (1948b:55); J. V. Harvey (*loc. cit.*).

RECORDED COLLECTIONS: -- JAPAN: S. Ito (1936:92, fig. 38)(?). OCEANIA: Karling (1968b). UNITED STATES: Beneke and Schmitt (1961); Coker (1927); J. N. Couch (1927); J. V. Harvey (1925b, 1930); C. E. Miller (1965); Scott (1960b).

SPECIMENS EXAMINED: -- ICELAND (1), NORWAY (1), TWJ.

Leptolegnia hemihypogyna Seymour
(Mycotaxon 91:1-10, figs. 1-11. 2005.
(Figures 103 L-S, W-Y)

Monoecious. Mycelium dense, moderately extensive; hyphae slender, sparsely branched, (8-)10-14 (-24) μm in diameter. Sporangia filamentous, rarely branched; 20-280 \times 8-24 μm . Spores dimorphic; in a single row in the sporangium; discharge and behavior leptolegnoid; primary ones cylindrical, up to 18 μm long; secondary ones reniform; cysts 9-14 μm in diameter. Gemmae lacking. Oogonia lateral or terminal, rarely

intercalary; spherical or slightly irregular; (24-) 26-29 (-34) μm in diameter, including wall ornamentations. Oogonial wall pitted under area of antheridial cell attachment; smooth, irregular, or sparsely provided with short, broad projections or papillae. Oogonial stalks generally less than the diameter of the oogonium, in length; stout or slender, straight or slightly curved; rarely branched. Oospores subeccentric; spherical, rarely ovoid; single in an oogonium, and usually not filling it; (22-) 24-26 (-31) μm in diameter; germination not observed. Antheridial branches usually hemihypogynous, in old or contaminated cultures, androgynous, monoclinal or hypogynous; persisting. Antheridial cells simple; apically or laterally appressed; persisting; fertilization tubes present, usually not persisting.

Holotype: Fig. 103 L-S, W-Y; Accession Nr. MS 243, Randall Library Special Collection, Univ. of North Carolina at Wilmington (USA), isolated from island soil, Rio Negro, Manaus, Brazil, 25 February 1978.

The configuration of the sexual apparatus of *Leptolegnia hemihypogyna* is somewhat unstable in culture. In old cultures (staling water) or in water containing soil or organic debris the fungus produces oogonia that are for the most part smooth and spherical or obpyriform (Fig. 103 X, Y). The antheridial apparatus is generally well developed, and androgynous (Fig. 103 X, Y) or monoclinal branches predominate (fig. 103 W). In axenic culture, in fresh water, on the other hand, prior to the accumulation of staling products, the fungus often produces irregular or ornamented oogonia (Fig. 103 L, O, P-S) attended generally by hemihypogynous antheridial cells (Fig. 103 L-P).

Leptolegnia hemihypogyna shares with *L. caudata* and *L. subterranea* the characteristic of subeccentric oospores. There is no antheridial apparatus in *L. subterranea*, and *L. caudata* has only declinal antheridial branches. One of the chief features of recognition for the new taxon is its hemihypogynous antheridial cells.

SPECIMENS EXAMINED: -- SOUTH AMERICA (3), RLS

Leptolegnia sp.

Citations designated by an asterisk (*) record unidentified *Leptolegnias* from fish or fish eggs.

BRITISH ISLES: -- Forbes (1935b); Hallett and Dick (1981); O'Sullivan (1965); Willoughby (1962, 1974, 1978*); Willoughby and Collins (1966); Willoughby *et al.* (1984); Wood and Willoughby (1986). CANADA: Dick (1970); Nolan (1983). INDIA: Mer *et al.* (1980); Prabhuji (1979); G. C. Srivastava [1967a:290, pl. 4, fig. 3 (? spores reported to be released as apically biflagellate, pyriform cells); 1967b]; G. C. Srivastava and R. C. Srivastava (1976b*); R. C. Srivastava (1976*). JAPAN: Suzuki (1960a); Suzuki and Nimura (1960). MADIERA: Höhnk (1962). SOUTH AMERICA: Beneke and Rogers (1962); Sörgel (1941). UNITED STATES: Clausz (1970, 1974); Farr and Paterson (1974); Jaffe (1986: in *Xiphinema rivesi* Dalmasso; *X. americanum* Cobb; *Dorylaimida* nematodes);

Nesom (1969); Scott, Seymour and Warren (1963); M. W. Ward (1939); A. W. Ziegler (1952: pl. 1, fig. 4; 1958b). WEST INDIES: Sörgel (1941). SHORELINE, ATLANTIC OCEAN: Artemchuk (1981).

IMPERFECTLY KNOWN SPECIES OF *LEPTOLEGNIA*

Leptolegnia baltica Höhnk and Vallin

Veröff. Inst. Meeresf., Bremerhaven 2:220, 1 unnumbered plate; text figs. 2, 3. 1953

Monoecious. Mycelium intra- and extramatrical; hyphae moderately stout; branched. Sporangia filamentous, unbranched or branched, tapering distally; renewed in a basipetalous manner. Spores probably dimorphic; in a single row in the sporangium; discharge and behavior apparently leptolegnoid; quiescent ones 9.5-16.8 μm in diameter. Oogonia lateral; spherical or subspherical; (22.6-) 27-35.1 (-40.5) μm in diameter. Oogonial wall unpitted; smooth. Oogonial stalks short. Oospores subeccentric(?); spherical; one per oogonium, and filling it; (21.6-) 24.3-27 (-32.4) μm in diameter; germination not observed. Antheridial branches declinous. Antheridial cells subglobose or short and broadly clavate; attached obtusely to oogonial wall. (Adapted from Höhnk and Vallin, *loc. cit.*)

This species, first described as *Leptolegnia* sp. (Vallin, 1951), is known only from the Gulf of Bothnia, where it was found infecting the planktonic copepod *Eurytemora hirundoides*. There are two descriptions of the fungus (Vallin, 1951; Höhnk and Vallin, *loc. cit.*) but neither is complete and the species is thus yet to be properly circumscribed.

Spore discharge in *Leptolegnia baltica* is reported (Vallin, 1951) to be leptolegnoid, that is, the spores are released as oval to elongate cells, but they then bend and become apically biflagellate and pyriform. Vallin (1951: fig. 7d) reported and illustrated triangular and laterally biflagellate cells in the specimens he had collected. Some of the sporangia of *L. baltica* are irregular and branched, but its tortuous, irregular ones are not typical of fungi in de Bary's genus. To remove *L. baltica* from *Leptolegnia* on such scanty evidence would be unjustified.

Insofar as can be determined from the available descriptive matter (Vallin, 1951; Höhnk and Vallin, *loc. cit.*) the sexual apparatus of the fungus in the copepod is characteristic of *Leptolegnia caudata*. Höhnk and Vallin described the oospores as eccentric, yet we judge from the illustrations that they were subeccentric. The actual oospore type is still in doubt, but quite possibly both types occur just as they do in *L. ornata*. An antheridial cell of *L. baltica* is shown by Vallin (1951, fig. 7f) attached to a protrusion from the oogonial wall as is characteristic of *L. caudata* (Fig. 103 C), and this suggests a closer affinity to de Bary's species than is evident in the account by Höhnk and Vallin (*loc. cit.*).

Scott (1962:9), following T. W. Johnson and Sparrow (1961), doubted that *Leptolegnia baltica* was correctly assigned generically, but Dick (1973) did not exclude the species from de Bary's genus. Alderman (1976) recognized that certain characteristics of

L. baltica seemed to place it intermediate between *Leptolegnia* and *Leptolegniella* (Dick, 1971a). This species must be reexamined in the living condition and redefined more precisely before its taxonomic position is settled.

CONFIRMED RECORD: -- SWEDEN: Vallin (1951: 142, figs. 1-7); Höhnk and Vallin (*loc. cit.*).

Leptolegnia piligena (Ookubo and Kobayasi) Karling
Mycologia 60:279. 1968

Leptolegniella piligena Ookubo and Kobayasi, Nagaoa 5:4, fig. 3. 1955.

Monoecious. Mycelium mostly intramatrical; hyphae slender, rarely branched, somewhat contorted and irregular. Sporangia filamentous, branched or unbranched; irregular and contorted. Spores dimorphic; in a single row in the sporangium; discharge and behavior leptolegnoid; primary ones (motile?), 10 μm in diameter. Gemmae not observed. Oogonia terminal or lateral; globose or subglobose; 20-30 μm in diameter. Oogonial wall unpitted; smooth. Oogonial stalks 50-60 μm long; curved or irregular. Oospores spherical; one per oogonium and filling it; 18-25 μm in diameter; germination not observed, Antheridial branches monoclinal, rarely androgynous; irregular, branched, and conspicuously lobed; attached apically to the oogonial wall. (Adapted from Ookubo and Kobayasi, *loc. cit.*)

On the assumption that Ookubo and Kobayasi (*loc. cit.*) described *Leptolegniella piligena* from a unifungal specimen, we agree with Karling (*loc. cit.*) and Scott, Seymour and Warren (1963:14) that this species is better assigned to *Leptolegnia*. Ookubo and Kobayasi stated that their species behaved as in *Leptolegnia* in spore behavior, and was like members of that genus in its sexual stage. Indeed, the affinity of the fungus with *Leptolegniella* rests only in the substratum on which it grew (human hair) and the depauperate nature of its mycelium. In spite of the fact that the species has branched, irregular sporangia (not "typical" of *Leptolegnia* as that genus ordinarily is defined), all of its other characteristics point unmistakably to an alliance with de Bary's genus (Dick, 1961:201, also saw for this taxon a position in *Leptolegnia*).

There are certain critical features of *Leptolegnia piligena* that must be discovered before its status is assured. Chiefly among these characters are the structure of the mature oospore, and the nature of the antheridial cells. As illustrated by Ookubo and Kobayasi (*loc. cit.*, fig. 3 D-G) the oospores appear to be eccentric, but the large globule(?) in each is depicted as being surrounded by the ooplasm. Neither Ookubo and Kobayasi (*loc. cit.*) nor Karling (*loc. cit.*) mention oospore type. Precisely how the antheridial cells are structured also is not discussed in the foregoing two accounts. We suggest that it will be necessary to grow *L. piligena* in axenic culture before it can be circumscribed properly. The characteristics of the species must be defined precisely enough so that it may be distinguished clearly from *Aphanomyces keratinophilus*, a water mold that commonly is collected when hair is used as bait in gross cultures.

CONFIRMED RECORDS: -- CZECHOSLOVAKIA: Cejp (1959b:136, figs. 7, 8).
JAPAN: Ookubo and Kobayasi (*loc. cit.*). OCEANIA: Karling (*loc. cit.*).
RECORDED COLLECTION: -- JAPAN: Suzuki (1961f).

EXCLUDED TAXA

Leptolegnia bandoniensis Swan
Irish Naturalist 7:32, pl. 1, figs. 3-7. 1898

This species is too ill-defined to retain, and in all probability was characterized from a mixed culture. The sporangia in the material Swan (*loc. cit.*, pl. 1, fig. 4) described seem to have been leptolegnoid, but the chlamydospores, may have been oogonial initials. The oospore structure of *Leptolegnia bandoniensis* was not described by Swan (*loc. cit.*, pl. 1, fig. 6), but he did show multioosporous oogonia. Such are not at all characteristic of *Leptolegnia*.

Ramsbottom's (1915a) report of *Leptolegnia bandoniensis* from Britain appears to be a repetition of Swan's published record from Ireland.

Leptolegnia marina Atkins
J. Mar. Biol. Assoc. U.K. 33:622, figs. 1-5. 1954

While this is a valid taxon, it is not a member of *Leptolegnia* or of the family Saprolegniaceae; Dick (1971a) has assigned D. Atkins' species to the Leptolegniellaceae. Alderman (1976: figs. 9.51-9.53) and T. W. Johnson and Pinschmidt (1963:413 *et seq.*) followed T. W. Johnson and Sparrow (1961) in retaining *L. marina* in *Leptolegnia*. We believe this no longer is tenable, and accept Dick's disposition of the species.

Leptolegnia pontica Artemchuk
Novosti Sistem. Nizhn. Rast., Akad. Nauk, Leningrad, USSR, p. 77, figs. 1-12. 1968

The fungus described as this species in ova of *Balanus improvisus* Darwin and *B. eburneus* Darwin is not saprolegniaceous. Perhaps its affinities are with the Leptolegniellaceae, but the species is most likely to have been circumscribed from a mixed culture or population. Although the fungus was said to produce apically biflagellate spores, the illustrations depict the endogenous formation and release of a "chlamydospore"-like cell. Curiously, the oogonia of *Leptolegnia pontica* were described as having a smaller diameter than that of the oospores. A later publication by Artemchuk (1981) does not clarify the status of this organism.

Leptolegnia sp. Indoh
Mag. Nat. Hist., Tokyo 38:88, figs. 3, 4. 1941

Although the sporangia of this unidentified watermold were filamentous, it is not clear from Indoh's account that spore discharge was leptolegnoid. The description attributes only one oospore (type not specified) to each oogonium, but one of the illustrations (Indoh, *loc. cit.*, fig. 4) shows an oogonium with at least six oospheres. We believe *Leptolegnia* sp. was described from a mixed culture, and its identity cannot now be determined.