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STUDIES ON DANISH FRESHWATER PHYCOMYCETES

AND NOTES ON THEIR OCCURRENCE PARTICULARLY RELATIVE TO THE HYDROGEN ION CONCENTRATION OF THE WATER

BY

AAGE LUND

WITH 39 FIGURES

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INTRODUCTION

The Danish freshwater Phycomycetes have previously been treated by H. E. Petersen in Journal de Botanique 17, 1903; in Botanisk Tidsskrift 29, 1909; and in Annales mycologici 8, 1910 (English translation of the Danish paper in Bot. Tidsskr.). These papers contain observations on the biology and distribution in Denmark of 32 Oomycetes and 39 chytridiaceous fungi together with systematical notes. In addition P. Obel has published physiological investigations on some species of water moulds in Videnskabelige Meddelelser fra den Naturhistoriske Forening, København 1910, and in Annales mycologici 8, 1910.

The present paper is the result of some investigations on the freshwater Oomycetes[1] (excluding the *Ancylistaceae*) carried out from 1930 to the autumn of 1932. Among the Danish papers on these fungi Petersen's investigations have been of special importance for my studies. Almost all the aquatic habitats investigated for Oomycetes by Petersen are situated in north-eastern Sealand; only relatively few are in Jutland, and most of these are in the neighbourhood of Laven (central Jutland). My samples too have in great part been procured from north-eastern Sealand, but in addition collections were made in the regions near Svejbæk (central Jutland); Skørping (north-eastern Jutland); in certain parts of Thy (north-western Jutland); and in the neighbourhood of Hjørring (northern Jutland).

The results of my investigations were originally embodied in an answer to a prize question proposed by the University of Copenhagen in 1931 which was awarded a gold medal by the University in 1933. The present paper is in the main identical with the prize essay. On certain points it is somewhat abridged, in other respects more detailed; slight changes also have been made in the order of presentation of the material.

The work was carried out at the Botanical Laboratory of the University, Copenhagen. The late Professor C. H. Ostenfeld, director of the Laboratory in 1930, very generously provided the necessary facilities.

I desire here to express my most cordial thanks to the Rask-Ørsted Foundation for a grant rendering possible the translation into English of this paper, and to the Botanical Excursion Fund and the Japetus Steenstrup Fund for financial aid towards the excursion expenses incident to the collections.

[1] In addition the chytridiaceous genus *Macrochytrium* v. Minden, which shows points of resemblance to the Oomycetes, is also mentioned.

I. Methods of Collection and Culture.

The aquatic Oomycetes generally live saprophytically on vegetable and animal substances contained in fresh water; parasites are more rarely found in this group, and then only facultative parasites.

In collecting these Phycomycetes, such substrata in the water — mainly plant substrata — were primarily sought for upon which fungi were directly visible. The natural substrata mostly preferred by the water moulds in this country are twigs (of *Alnus, Fraxinus, Betula, Quercus, Populus, Picea, Abies,* less commonly *Aesculus, Fagus,* and *Pinus,* rarely *Salix*), fish, insects, and the like. (See also Petersen 1909, p. 358; 1910, p. 504).

In certain of the localities investigated (such as many bogs and similar places) only a very few suitable substrata were present; the fungi occurring here often escape immediate notice. Hence samples of soil, plant remains or living plants (mostly *Sphagnum*) were collected in such places (and also in many other localities). When the samples were placed in water with hempseed in the laboratory, a luxurious phycomycetous flora was generally produced within a few days.

The method of placing bait in aquatic habitats, as indicated by v. Minden (1915, 1916), Kanouse (1925a, 1927), and in less degree by Apinis (1929) and Sparrow (1933), was also adopted. Particularly apples have proved to be an excellent substratum for certain water moulds. These fruits were put into fine-meshed wire envelopes in order to prevent their destruction by birds and the like. When they were taken up, usually after 4—6 weeks, they were more or less covered with fungi.

In the laboratory the twigs, apples etc. collected were washed in water in order to remove bacteria and other contaminating organisms. Then these substrata as well as the samples of soil and other samples were placed in glasses with water, shallow dishes containing 300—350 cc. of water being employed in most cases. At first ant-eggs were then placed floating on the water; later on, only hempseed was used because these seeds do not putrefy as quickly as ant-eggs, and because the fungi apparently develop better on them. To begin with unsterilised tap-water was used in the cultures; later sterilised tap-water only was employed. In this way contamination by spores or hyphae of Phycomycetes possibly present in the water was avoided. Still, in the writer's experience, tap-water does not contain such fungi at all; I have several times placed hempseed in unsterilised tap-water and no water moulds appeared, even after 14—20 days.

According to my observations, the Phycomycetes which are able to thrive on hempseed in water belong to the following genera: *Pythiopsis, Saprolegnia, Aplanes, Isoachlya, Achlya, Dictyuchus, Thraustotheca, Apodachlya, Pythiomorpha* in part, *Pythium,* and *Pythiogeton* in part. The following are only able to live on twigs, fruits, and the like: *Sapromyces, Rhipidium, Gonapodya, Blastocladia, Monoblepharis* (only on twigs), *Pythiomorpha* in part, and *Pythiogeton* in part.

The cultures were often much contaminated by bacteria, *Saccharomycetes,* protozoa, etc. These organisms sometimes form a dense coating on the water, particularly in the cultures with apples, because the water moulds present there are generally accompanied by numerous other organisms; further, fungi from the air, mostly species of *Penicillium*, will sometimes form a thick layer on those parts of the apples which project above the surface of the water. In such cases the water in the culture dishes was often renewed several times.

Many species were also grown in pure culture on agar, thus on 1) malt extract agar (3 % malt extract, 1.5 % agar), 2) hempseed agar (25 g. hempseed carefully crushed, 15 g. agar, 1000 cc. tap-water). By transferring a sporangium or bits of mycelium to the agar-plate, a mycelium appeared in a few days; by this proceeding, or by repeated transfers to fresh agar, a pure culture was as a rule obtained.

II. Species observed.

In this section all the water moulds found in Denmark are mentioned, certain species, new to Denmark, being described in more detail. Four of these are established as new species, viz. *Saprolegnia pseudocrustosa, Apodachlya seriata, Blastocladia angusta, Pythiogeton uniforme. Saprolegnia monoica* var. *glomerata* Tiesenhausen is considered to be a distinct species, and is called *Saprolegnia glomerata.* Other species have only been recorded once or a few times previously; thus the following, which have been described from America, have not hitherto been reported from Europe: *Pythiopsis Humphreyana, Saprolegnia delica, Achlya Klebsiana, Achlya caroliniana, Rhipidium parthenosporum, Blastocladia gracilis.*

For the Oomycetes reported by Petersen and by Obel and also found by myself, my data of collection are given, other observations being added in some cases. — Eleven species formerly recorded from Denmark (*Saprolegnia anisospora, S. semidioica, Isoachlya monilifera* (= *Saprol. monilifera*), *Achlya polyandra* (= *A. gracilipes*), *Leptolegnia caudata, Aphanomyces scaber, Aph. coniger, Leptomitus lacteus, Monoblepharis macrandra* (= *M. polymorpha* var. *macrandra*), *Pythium Daphnidarum*, and *Pyth. de Baryanum*) did not occur in my collections; in these cases references to Petersen's and Obel's papers are supplied.

According to the interrelationship of the water moulds the *Monoblepharidaceae* the *Blastocladiaceae*, and the *Gonapodyaceae*, should probably have been dealt with at the beginning of the paper, the *Saprolegniaceae* and the *Leptomitaceae* later on. The arrangement of the families given here has been adopted for practical reasons.

The localities are designated by numbers referring to the list of localities given at the end of the paper.

1. Saprolegniaceae.

Mycelium consisting of filamentous hyphae without constrictions. Zoospores with two cilia. Oogonia with one or several oospores.

The distinction of the genera in this family is chiefly based upon the zoosporangia and the zoospores. It is true that the distinguishing characters in some cases are somewhat confusing. In *Aplanes,* for instance, the sporangia frequently proliferate internally as in *Saprolegnia,* whereas the hyphae are stout and vigorous as commonly in *Achlya*; the zoospores often sprout within the sporangia. The sporangial characters in *Isoachlya* are likewise rather confounding; the secondary sporangia are formed either by proliferation as in *Saprolegnia,* or by lateral branching as in *Achlya.* Coker (1923, p. 135) has described a peculiar water mould, *Achlya dubia,* in which the sporangia and zoospores are partly as in *Achlya,* and partly as in *Thraustotheca.*

Key to the Genera.

I. Zoospores usually escaping through a common pore of the sporangium[1].
  1. Zoospores monoplanetic. Sporangia mostly short, often forming clusters *Pythiopsis* p. 6.
  2. Zoospores diplanetic. Sporangia usually cylindrical.
    A. Zoospores[1] swimming away as soon as liberated. Sporangia mostly renewed by internal proliferation.
      a. Sporangia thicker than the hyphae, proliferating. Zoospores in several rows . . . . *Saprolegnia* p. 7.
      b. Sporangia not thicker than the hyphae, proliferating. Zoospores in a single row . . . . *Leptolegnia* p. 19.
      c. Sporangia thicker than the hyphae, rarely produced, often proliferating. The behaviour of the zoospores not very well known; they frequently sprout in the sporangium . . . . *Aplanes* p. 19.
      d. Sporangia thicker than the hyphae, renewed by proliferation or by lateral branching. Zoospores in several rows . . . . . . *Isoachlya* p. 21.
    B. Zoospores encysting in a hollow sphere at the mouth of the sporangium. Sporangia mostly renewed by lateral branching.
      a. Sporangia thicker than the hyphae. Zoospores in several rows *Achlya* p. 22.
      b. Sporangia not thicker than the hyphae. Zoospores generally in a single row . . . . *Aphanomyces* p. 29.

II. Zoospores not escaping through a common pore of the sporangium.
  1. Zoospores liberated singly through openings in the side wall of the sporangium . . . . *Dictyuchus* p. 30.
  2. Zoospores liberated by disintegration of the sporangium wall . . . . *Thraustotheca* p. 32.

Pythiopsis de Bary. Bot. Zeit. 46, p. 609, 1888.

Sporangia mostly short, sometimes elongated, thicker than the hyphae, the secondary ones usually formed by lateral branching. Zoospores monoplanetic, swimming away as soon as discharged.

[1] Not well known in *Aplanes.*

Pythiopsis Humphreyana Coker. Mycologia 6, p. 292, pl. 148, 1914; in The Saprolegniaceae p. 20, pl. 2, 1923. — Fig. 1.

Oogonia spherical, 39—45 μ in diameter, sometimes oval, 45—69 × 33—45 μ, wall smooth without pits, terminal on main hyphae or racemosely on lateral branches, often two in clusters. Oospores eccentric, containing one or several oil drops, 30—33 μ in diameter, 1, or rarely 2 or 3, in an oogonium. Antheridial branches androgynous, arising from the oogonial stalks not far from the oogonia. Antheridial tube often distinct.

On ant-eggs and agar it developed many oogonia. Sporangia were not observed with certainty, but nevertheless my plant seems to be identical with *Pythiopsis Humphreyana*.

The structure of the oospores was described by COKER (1914) as centric; in 1923 he says: "They were reported as centric in the original description, but we are not now sure of this." The mature oospores which I have seen were eccentric.

Localities: 49 ($^3/_3$ 31). — 51 ($^{14}/_4$ 31). — 63? ($^8/_3$ 31). — 111? ($^{10}/_2$ 31). On twigs.

Distribution: N. America, Denmark.

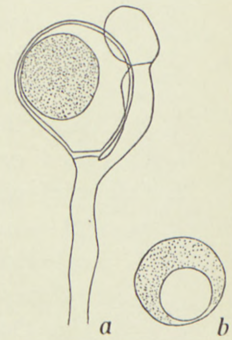

Fig. 1. *Pythiopsis Humphreyana*. *a*, Oogonium with antheridium; *b*, Oospore. — × 430.

Saprolegnia Nees v. Esenbeck. Nova Acta Acad. Leop. 11, p. 513, 1823.

Sporangia cylindrical, thicker than the hyphae, secondary ones formed by internal proliferation. Zoospores in several rows, leaving the sporangium through an apical pore, at once swimming away.

The following are the most important characters by which the species of *Saprolegnia* are distinguished: 1) position of the oogonia, 2) presence or absence of pits and outgrowths of the oogonial wall, 3) number and size of the oospores, 4) origin of the antheridia when present.

Key to the Species.

I. Oogonial wall smooth (except in *S. latviaca*), pitted or unpitted. Oospores centric (in *S. anisospora* they are sometimes said to be eccentric).
  1. Oogonial wall without pits or with — mostly inconspicuous — pits. Oogonia single or more rarely in chains. Antheridia present, usually diclinous .... *Diclina Group.*
    A. Antheridia diclinous.
      a. Antheridia on all the oogonia.
        α. Oogonial wall unpitted or with few pits. Oogonia usually terminal on main hyphae, or intercalary or in chains. Only one kind of zoospores .... *S. diclina* p. 9.
        β. Oogonial wall unpitted. Oogonia terminal on main hyphae or on lateral branches or intercalary, rarely in chains. Zoospores of two kinds .... *S. anisospora* p. 9.

γ. Oogonial wall with few or numerous pits. Oogonia terminal on main hyphae or on side branches (or intercalary). Only one kind of zoospores .... *S. pseudocrustosa* p. 9.

b. Antheridia not on all the oogonia.

α. Oogonial wall with fairly numerous — sometimes inconspicuous — pits. Antheridia mostly present .... *S. crustosa* var. *II* p. 10.

β. Oogonial wall with conspicuous pits. Antheridia only on a small number of the oogonia .... *S. crustosa* var. *III* p. 11.

B. Antheridia diclinous or — rarely — androgynous. Oogonial wall unpitted or with a few pits .... *S. delica* p. 11.

2. Oogonial wall often with conspicuous pits. Oogonia single. Antheridia present — mostly androgynous — or absent .... *Monoica Group.*

A. Antheridia on all the oogonia. Oogonial wall smooth.

a. Oogonial stalks usually straight.

α. Oogonial wall with numerous pits; oogonial stalks as a rule short. Oospores 16—22 μ in diameter .... *S. monoica* p. 12.

β. Oogonial wall unpitted or with few pits. Oogonial stalks rather long. Oospores 25—27.5 μ in diameter. Antheridial branches from the main hyphae or from the oogonial stalks, rarely diclinous *S. monoica* var. *montana* p. 12.

γ. Oogonial wall unpitted or with few pits. Oospores large, usually about 30 μ in diameter. Oogonia commonly on main hyphae *S. litoralis* p. 13.

δ. Oogonial wall with few pits. Oospores about 22 μ in diameter. Antheridia androgynous or diclinous .... *S. semidioica* p. 14.

b. Oogonial stalks often bent or contorted. Oospores 25—27.5 μ in diameter, 5—20, usually about 6 in an oogonium. Antheridial branches as a rule from the main hyphae, rarely diclinous .. *S. glomerata* p. 14.

B. Antheridia absent or, when present, not on all the oogonia. Oogonial wall smooth or with papillae.

a. Oogonial wall smooth.

α. Antheridia on part of the oogonia .... *S. mixta* p. 15.

β. Antheridia absent (or on a few oogonia) .... *S. ferax* p. 16.

b. Oogonial wall with outgrowths. No antheridia ...... *S. latviaca* p. 16.

3. Oogonial wall pitted or unpitted. Oogonia single or in chains. Branched antheridia generally absent .... *Hypogyna-Torulosa Group.*

A. Oogonia generally single. Usually hypogynous cells and upgrowths from below into the oogonia .... *S. hypogyna* p. 17.

B. Oogonia generally in chains. No hypogynous cells.

a. Oogonia mostly elongated .... *S. torulosa* p. 17.

b. Oogonia mostly spherical .... *S. variabilis* p. 18.

II. Oogonial wall with blunt outgrowths, unpitted. Oospores subcentric..... *S. asterophora* p. 19.

Saprolegnia diclina Humphrey. Transact. Am. Phil. Soc. 17, p. 109, pl. 17, figs. 50—53, 1893. — *Saprolegnia dioica* de Bary. Bot. Zeit. 46, p. 619, pl. 10, figs. 12—13, 1888. — Petersen in Bot. Tidsskr. 29, p. 377, fig. I, c, 1909; in Ann. myc. 8, p. 519, fig. I, c, 1910.

Reported by PETERSEN from 7 localities in northern Sealand; also mentioned by OBEL (1910 a, p. 195; 1910 b, p. 422). I have found this species in the following localities: 1 ($^{20}/_{5}$ 31, $^{5}/_{11}$ 31). — 13 ($^{8}/_{6}$ 31). — 16 ($^{9}/_{6}$ 31). — 31 ($^{31}/_{8}$ 31). — 45 ($^{10}/_{5}$ 32). — 46 ($^{29}/_{8}$ 31).

Distribution: N. America, Switzerland, Germany, Denmark, Latvia, Finland, Lapland, Japan.

Saprolegnia anisospora de Bary. Bot. Zeit. 46, p. 619, pl. 9, fig. 4, 1888.

This species is mentioned from Denmark by OBEL (1910 a, p. 189; 1910 b, p. 422) who used it in his experiments on the sexual reproduction in the *Saprolegniaceae*. Not observed by me.

Distribution: N. America, Germany, Denmark, Latvia, Japan.

Saprolegnia pseudocrustosa A. Lund, n. sp. — Fig. 2.

Oogonia globosa, 70—91 μ diam., rarius ovalia, terminalia vel lateralia, rarius intercalaria; membrana hyalina, poris paucis vel pluribus munita. Oosporae centricae, 22.4—28 μ diam., 4—20 in quoque oogonio. Rami antheridiales diclini.

Hyphae slender and delicate. Sporangia cylindrical, the secondary ones formed by proliferation. Zoospores set free as usual in *Saprolegnia*. Gemmae mostly regular, pyriform to clavate or somewhat irregular. Oogonia spherical, 70—91 μ in diameter, sometimes oval, terminal on main hyphae or on lateral branches that are 1 to 4 times as long as the diameter of the oogonia, rarely intercalary. Oogonial wall smooth, colourless, with few or numerous pits; sometimes an ingrowth into the oogonium is present. Oospores centric, 22.4—28 μ, usually 25 μ in diameter, 4—20, often 12—18, in an oogonium. Antheridial branches diclinous, often winding about the oogonia.

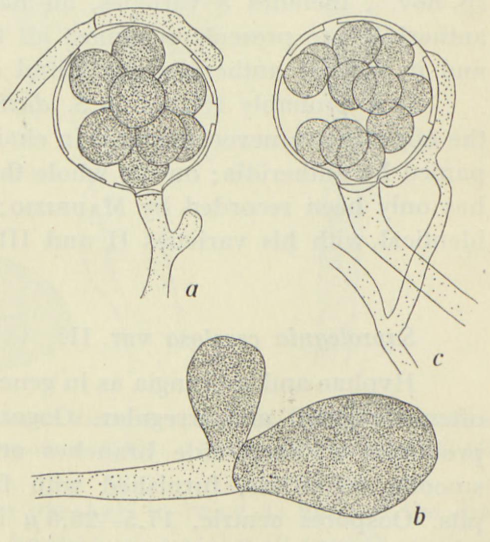

Fig. 2. *Saprolegnia pseudocrustosa* n. sp. *a* and *c*, Oogonia with antheridia; *b*, Gemma. — × 344.

This fungus attained a vigorous growth on hempseed in water. On agar it developed numerous sexual organs, which apparently did not differ from those grown on hempseed.

It is characterised by the following features. The oogonia are mostly produced terminally on main hyphae as well as on lateral branches; the oogonial wall is furnished either with few or with numerous pits; the antheridia are diclinous, present on all oogonia.

It belongs to the *Diclina* group, which includes *S. diclina* Humphrey, *S. crustosa* Maurizio, *S. Kauffmaniana* Pieters, *S. stagnalis* Tiesenhausen, *S. anisospora* de Bary, and *S. delica* Coker. (*S. spiralis* Cornu and *S. furcata* Maurizio probably belong to the *Monoica* group).

My plant is most nearly allied to *S. crustosa* Maurizio, and especially to var. I. It differs from this species in the absence of typical racemosely arranged oogonia and in the colour of the oogonial wall, which is said to be yellowish in *S. crustosa* var. I; moreover, according to Maurizio's description, the oogonial stalks seem to be shorter than in *S. pseudocrustosa*, and the oospores smaller (19.5—22 μ, the smallest 12 μ); as to the frequency of the antheridia Maurizio says: "die meist vorhandenen Antheridien"; in my plant antheridia are always present.

S. pseudocrustosa differs from *S. stagnalis* Tiesenhausen in the straight and longer oogonial stalks, in larger oogonia and oospores (*S. stagnalis*: 12—22.5 μ), and in the greater number of the latter; furthermore *S. stagnalis* is said always to have numerous pits in the oogonial wall.

Localities: 48 ($^{21}/_{10}$ 31, isolated from clay).

Saprolegnia crustosa Maurizio. Zeitschr. f. Fischerei u. deren Hilfswiss. Mitt. d. Deutsch. Fischerei-Ver. 7, p. 52, 1899.

This species, called by Maurizio "Sammelspecies der Saprolegnia crustosa sp. nov.", includes 3 varieties, all having antheridia of diclinous origin. In var. I antheridia are present on almost all the oogonia, var. II has numerous antheridia, and in var. III antheridia are found only on about one-third of the oogonia.

It is probably related to *S. diclina* (as well as to the preceding species), but the oogonia are never arranged in chains, and only a part of the oogonia are accompanied by antheridia; on the whole the general habit is quite different. — Hitherto it has only been recorded by Maurizio; I have found two fungi which I suppose are identical with his varieties II and III.

Saprolegnia crustosa var. II.

Hyphae and sporangia as in general in *Saprolegnia*. Gemmae of different shapes, often elongated and irregular. Oogonia spherical, 60—105 μ in diameter or oval, produced on short side branches or terminally on main hyphae. Oogonial wall smooth, colourless, furnished with fairly numerous — sometimes inconspicuous — pits. Oospores centric, 17.5—26.6 μ in diameter, 2 to about 20 in an oogonium. Antheridial branches diclinous, present on most of the oogonia; fertilizing tubes often distinct.

In MAURIZIO's description the pits of the oogonial wall are said to be not numerous, and he finds — though rarely, it is true — intercalary oogonia.

Localities: 38 ($^{11}/_{7}$ 32, isolated from twigs). — 101 ($^{6}/_{8}$ 32, isolated from soil).

Distribution: Switzerland, Denmark.

Saprolegnia crustosa var. III.

Hyphae and sporangia as usual. Gemmae elongated, terminal or in rows. Oogonia mostly spherical, 60—147 μ in diameter, borne on short, often somewhat bent, side branches or on main hyphae, rarely intercalary. Oogonial wall smooth, with conspicuous pits. Oospores 24—27 μ in diameter, 2—15 in an oogonium. Antheridial branches diclinous, only present on a small number of the oogonia.

Localities: 85 ($^{4}/_{7}$ 32, on a dead fish).

Distribution: Switzerland, Denmark.

Saprolegnia delica Coker. The Saprolegniaceae p. 30, pls. 5 and 6, 1923. — Fig. 3, a—b.

Hyphae as usual; sporangia cylindrical, proliferating; gemmae of various shapes. Oogonia spherical, 42—100 μ, averaging about 70 μ in diameter, more rarely

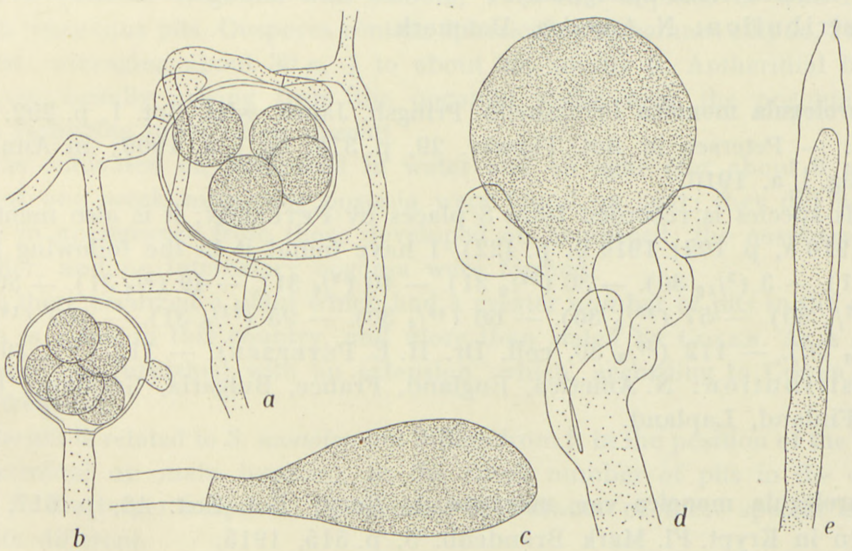

Fig. 3. *Saprolegnia delica.* *a*, Oogonium with androgynous and diclinous antheridia, × 344; *b*, Oogonium, × 254. *Saprolegnia litoralis.* *c*, Gemma, × 344; *d*, Young oogonium, × 344; *e*, Proliferating sporangia, × 344.

pyriform, produced on side branches that are one half to twice as long as the diameter of the oogonia, or terminally on main hyphae; oogonial wall smooth, without pits or with very few pits. Oogonia sometimes formed inside the empty sporangia, and then cylindrical. Oospores centric, 25—35 μ, most of them about 27 μ, in diameter, 1—20, mostly 2—8. Antheridial branches diclinous, rarely androgynous.

This fungus was cultivated on hempseed in water and on agar for about 3 months; after two days young oogonia were found on agar.

My observations agree in all essentials with Coker's description of *S. delica*. In one of my cultures the number of the oospores was generally greater than in the other cultures, and greater than reported by Coker.

Systematically it must be placed in the *Diclina* group, being nearest *S. diclina* and *S. anisospora*, but the oogonia are never arranged in chains, the oogonial wall is sometimes pitted, and the oospores are often larger; only one kind of zoospores. However, it is also reminiscent of species in the *Monoica* group, thus of *S. monoica* var. *montana* and *S. semidioica*; the antheridia of these species, however, are mostly of androgynous origin, and they also differ from *S. delica* in the size of the oospores.

I have only found this fungus in bogs. On one occasion it was accompanied by *Sapromyces Reinschii*, *Gonapodya polymorpha*, and *Achlya racemosa* var. *stelligera*; in some other cultures it occurred in company with *Aplanes androgynus* and *Pythiomorpha undulata*.

Localities: 4 ($^{8}/_{11}$ 31, isolated from *Sphagnum*). — 5 ($^{5}/_{4}$ 32, isolated from a rhizome of *Menyanthes*). — 21 ($^{10}/_{6}$ 31, isolated from *Sphagnum* and soil). — 22 ($^{10}/_{6}$ 31, isolated from *Sphagnum*).

Distribution: N. America, Denmark.

Saprolegnia monoica Pringsheim. Pringsh. Jahrb. wiss. Bot. 1, p. 292, pls. 19—20, 1858. — Petersen in Bot. Tidsskr. 29, p. 378, fig. I, a, 1909; in Ann. myc. 8, p. 519, fig. I, a, 1910.

This species is recorded from 8 places by Petersen; it is also mentioned by Obel (1910 a, p. 192; 1910 b, p. 422). I have found it in the following localities: 1 ($^{20}/_{5}$ 31). — 3 ($^{5}/_{10}$ 30). — 30 ($^{31}/_{8}$ 31). — 40 ($^{9}/_{6}$ 31). — 49 ($^{3}/_{3}$ 31). — 50 ($^{3}/_{3}$ 31). — 52 ($^{27}/_{9}$ 30). — 57 ($^{20}/_{8}$ 30). — 60 ($^{14}/_{4}$ 30). — 95 ($^{11}/_{6}$ 31). — 102 ($^{19}/_{4}$ 30). — 107 ($^{10}/_{8}$ 30). — 112 ($^{23}/_{3}$ 30, coll. Dr. H. E. Petersen). — 115 ($^{20}/_{9}$ 30).

Distribution: N. America, England, France, Bulgaria, Germany, Denmark, Latvia, Finland, Lapland.

Saprolegnia monoica var. **montana** de Bary. Bot. Zeit. 46, p. 617, 1888. — v. Minden in Krypt. Fl. Mark Brandenb. 5, p. 515, 1915.

Hyphae slender and flaccid. Sporangia as in general. Gemmae oblong. Oogonia spherical, 72.5—87.5 μ in diameter, terminal on main hyphae or on side branches that are one to several times as long as the diameter of the oogonia; oogonial wall smooth, unpitted or with few pits. Oospores centric, 25—27.5 μ in diameter, 3—15. Always several antheridial branches, most of them androgynous, arising from the main hyphae or from the oogonial stalks, rarely diclinous; winding about the oogonia.

It differs from the typical *S. monoica* in the unpitted or only slightly pitted wall, in the larger oospores, and in its general habit — according to DE BARY especially in its slender branching.

S. monoica var. *montana* should perhaps be considered to be a distinct species, as suggested by v. MINDEN.

Hitherto it has only been recorded from Germany by DE BARY and v. MINDEN. It seems to occur especially in bogs; I have found it in such a locality, and v. MINDEN has collected it in similar places ("Moorsümpfen der Lüneburger Heide und des Borsteler Moors bei Hamburg"); DE BARY found it in mountain lakes.

Localities: 14 ($^{8}/_{6}$ 31, isolated from soil and *Sphagnum*).

Distribution: Germany, Denmark.

Saprolegnia litoralis Coker. The Saprolegniaceae p. 54, pls. 15 and 16, 1923. — Apinis in Acta Horti Bot. Univ. Latv. 4, p. 216, text fig. 2, 1929. — Fig. 3, c—e.

Hyphae and sporangia typical; the latter formed rather sparingly. Gemmae spherical or clavate, often in chains. Oogonia spherical, 50—99 μ in diameter or sometimes — when terminating the main hyphae — oval, 87—117 × 67—82 μ, terminal on main branches, less commonly on side branches, rarely intercalary; sometimes formed inside empty sporangia; in some of the oogonia an ingrowth from the partition wall is present. Oogonial wall smooth, as a rule unpitted or with few pits, rarely with numerous pits. Oospores centric, spherical or sometimes elliptic, 24—33.8 μ in diameter, averaging about 30 μ, 1 to about 20, mostly 6. Antheridial branches androgynous, usually arising from the oogonial stalks near the oogonia, rarely diclinous; fertilizing tubes often present.

It was cultivated on hempseed in water and on agar (for about 6 months). After about one week numerous oogonia were found on agar; they did not differ essentially in appearance from those developed on hempseed; the oospores were a little smaller, and no intercalary oogonia were formed.

Once there occurred a plant which had a greater number of pits in the oogonial walls than is usual in this country, and more than stated by COKER. As a rule the oogonia were not furnished with an extension, which, according to COKER, should be fairly frequent.

S. litoralis is related to *S. monoica* but differs from it in the position of the oogonia (mostly terminal on main hyphae), in the small number of pits in the oogonial wall, and in the larger oospores; the general appearance of these species is on the whole quite different.

It occurs chiefly in bogs, often accompanied by *Aplanes* and *Pythiomorpha undulata*. In one case it was found strongly attacked by *Olpidiopsis Saprolegniae* Cornu sensu Fischer.

Localities: 2 ($^{20}/_{5}$ 31, isolated from soil and twigs). — 7 ($^{11}/_{6}$ 32, isolated from *Sphagnum*). — 10 ($^{11}/_{5}$ 32, $^{6}/_{7}$ 32, isolated from *Sphagnum*). — 15 ($^{8}/_{6}$ 31, isolated from twigs). — 16 ($^{9}/_{6}$ 31, isolated from sand). — 18 ($^{9}/_{6}$ 31, isolated from

Sphagnum). — 24 ($^{11}/_{6}$ 31, isolated from *Sphagnum*). — 34 ($^{2}/_{9}$ 31, isolated from *Sphagnum*). — 37 ($^{3}/_{5}$ 31, on twigs of *Betula*). — 39 ($^{13}/_{5}$ 32, isolated from *Sphagnum*).

Distribution: N. America, Denmark, Latvia.

Saprolegnia semidioica H. E. Petersen. Bot. Tidsskr. 29, p. 378, fig. I, f, 1909; in Ann. myc. 8, p. 519, fig. I, f, 1910.

This species, which I have not observed, was found in a lake in Jutland by PETERSEN.

Distribution: Denmark.

Saprolegnia glomerata (Tiesenhausen) A. Lund. — *Saprolegnia monoica* var. *glomerata* Tiesenhausen. Arch. f. Hydrobiol. u. Planktonkd. 7, p. 277, figs. 6—8, 1912. — Coker in The Saprolegniaceae p. 51, pls. 4 and 13, 1923. — Fig. 4.

Hyphae slender and delicate. Sporangia mostly cylindrical, proliferating abundantly. Gemmae more or less elongated. Oogonia spherical or subspherical, 70—98 μ in diameter, produced mostly on short side branches, which are usually bent, sometimes contorted, rarely straight, one half to twice as long as the diameter of the oogonia, less commonly terminally on main hyphae, rarely intercalary. Sometimes oogonia are formed inside the empty sporangia, they are then cylindrical. Oogonial wall smooth, thin, colourless, unpitted or with inconspicuous pits, at times with numerous conspicuous pits. Oospores centric, 25—27.5 μ in diameter, 5—20, generally about 6, almost always filling the oogonium. Mostly several antheridial branches on each oogonium, usually androgynous, arising from the main hyphae or rarely from the oogonial stalks, less frequently diclinous, often winding about the oogonia. Fairly often irregularly contorted side branches occur (antheridial branches?).

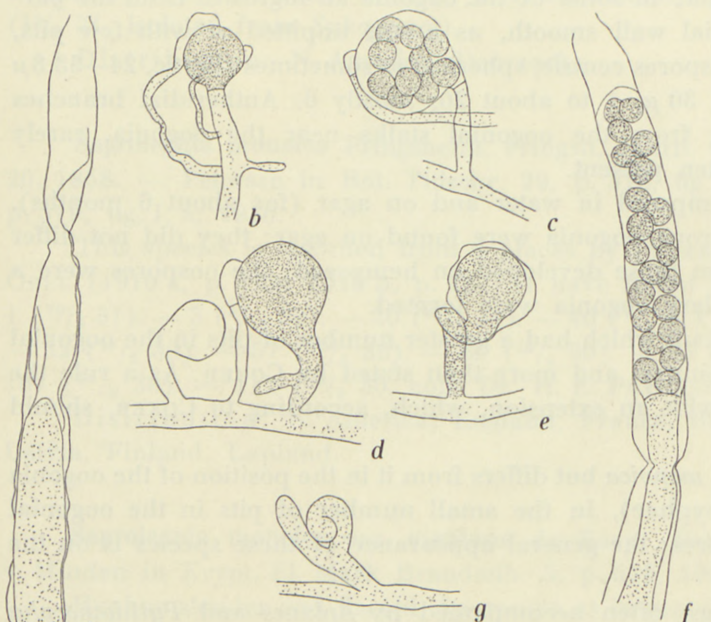

Fig. 4. *Saprolegnia glomerata*. *a*, Proliferating sporangia; *b*, Young oogonium with androgynous antheridia; *c*, Oogonium with diclinous antheridium; *d*, An abortive oogonium and a young one; *e*, Young oogonium on contorted stalk; *f*, Cylindrical oogonium in an empty sporangium; *g*, Contorted side branch. — × 155.

The oogonia produced on agar did not seem to differ from those formed on hempseed in water.

This fungus is probably identical with *S. monoica* var. *glomerata* Tiesenh.; in my opinion it should be regarded as a distinct species.

It is also reported by Coker; and Apinis (1929, p. 213) likewise mentions a *Saprolegnia* which seems to correspond to Tiesenhausen's description; it is, however, referred by him to *S. furcata* Maurizio, syn. *S. monoica* var. *montana* Tiesenh. I do not think that these species are identical, (thus, according to Maurizio, the antheridia of *S. furcata* are always androgynous), but they are undoubtedly closely related. Altogether, the *Monoica* group includes several species which bear great resemblance to each other but which, on the other hand, possess certain — sometimes not very conspicuous — distinguishing characters. The following species have been described as belonging to this group: *S. monoica* Pringsh., *S. monoica* var. *montana* de Bary, *S. monoica* var. *vexans* Pieters, *S. glomerata* (Tiesenh.) Lund, *S. furcata* Maurizio, *S. spiralis* Cornu, *S. Tokugawana* Emoto, *S. semidioica* Petersen, *S. retorta* Horn, *S. litoralis* Coker, *S. paradoxa* Maurizio, *S. megasperma* Coker, *S. mixta* de Bary, *S. ferax* (Gruith.) Thuret, *S. esocina* Maurizio, *S. floccosa* Maurizio, *S. lapponica* Gäumann.

S. glomerata is probably very nearly allied to *S. spiralis* and *S. retorta* (besides to the above named *S. furcata* and to *S. monoica*), both of these being closely related, if not identical. In *S. spiralis* the oogonia are mostly ovate and more frequently intercalary; it also differs from the present species by the origin of the antheridia (often arising from the oogonial stalks), and by the smaller number of oospores.

Localities: 49 ($^5/_4$ 32, isolated from old leaves and other plant substances in the water).

Distribution: N. America, Switzerland, Denmark, Latvia.

Saprolegnia mixta de Bary. Bot. Zeit. 41, p. 56, 1883; ibid. 46, p. 617, 1888.

This species, distinguished by having antheridia on part of the oogonia only, and thus partly reminiscent of *S. ferax* and other related species, partly of *S. monoica*, occurred in several of my collections. On hempseed in water oogonia (diameter generally about 70—80 μ) were easily produced, while the number of antheridia was somewhat varying. — *S. mixta* has been employed by Obel (1910 a, p. 173; 1910 b, p. 422) in his experiments on the sexual reproduction in the *Saprolegniaceae*.

Petersen (1909, p. 378, 1910, p. 519) says with reference to *S. monoica*: "The latter (that is *S. monoica*) may vary towards *Saprolegnia mixta*, and this again towards *Saprolegnia monoica*. Owing to my ignorance of the real character of these species, I have referred all the monoica-shaped forms to *Saprolegnia monoica*, even if certain characters of *Saprolegnia mixta* were present."

Localities: 47 ($^{18}/_4$ 31, isolated from twigs). — 49 ($^3/_3$ 31, isolated from twigs). — 53 ($^{19}/_5$ 31, isolated from twigs). — 58? ($^{14}/_5$ 32, on twigs). — 63 ($^{25}/_4$ 31, on an apple).

Distribution: N. America, Switzerland, Germany, Denmark, Latvia, Lapland (*S. mixta* var. *Asplundii* Gäumann).

Saprolegnia ferax (Gruith.) Thuret. Ann. sci. nat. bot. sér. 3, 14, p. 214, pl. 22, 1850. — *Saprolegnia Thureti* de Bary. Abh. Senckenb. naturf. Ges. 12, p. 326, pl. 5, figs. 1—10, 1881. — Petersen in Bot. Tidsskr. 29, p. 380, fig. I, b, 1909; in Ann. myc. 8, p. 521, fig. I, b, 1910.

Reported by Petersen from 15 localities in Sealand. I have found it in the following localities: 1 ($^{22}/_{3}$ 31). — 2? ($^{5}/_{11}$ 31). — 9 ($^{3}/_{5}$ 31). — 32 ($^{1}/_{9}$ 31). — 35 ($^{25}/_{4}$ 31 and $^{17}/_{5}$ 31). — 40 ($^{9}/_{6}$ 31). — 41 ($^{1}/_{9}$ 31). — 47 ($^{21}/_{3}$ 31 and $^{18}/_{4}$ 31). — 49 ($^{3}/_{3}$ 31). — 50 ($^{25}/_{4}$ 31). — 51 ($^{27}/_{9}$ 30, $^{15}/_{2}$ 31, $^{14}/_{3}$ 31, and $^{14}/_{4}$ 31). — 52 ($^{15}/_{2}$ 31, $^{14}/_{3}$ 31, and $^{9}/_{5}$ 31). — 53 ($^{8}/_{11}$ 31). — 54 ($^{21}/_{3}$ 31, $^{18}/_{4}$ 31, and $^{21}/_{10}$ 31). — 59 ($^{11}/_{6}$ 31). — 63 ($^{25}/_{4}$ 31, $^{18}/_{10}$ 31, and $^{5}/_{4}$ 31). — 65 ($^{21}/_{3}$ 31 and $^{21}/_{10}$ 31). — 68 ($^{7}/_{3}$ 31). — 71 ($^{16}/_{4}$ 32). — 77 ($^{16}/_{4}$ 32). — 82 ($^{20}/_{9}$ 30). — 83 ($^{20}/_{9}$ 30). — 86 ($^{10}/_{5}$ 32). — 87 ($^{11}/_{5}$ 32). — 89 ($^{11}/_{7}$ 32). — 90 ($^{13}/_{5}$ 32). — 93 ($^{14}/_{5}$ 32). — 97 ($^{12}/_{6}$ 31). — 99 ($^{30}/_{8}$ 31). — 100 ($^{31}/_{8}$ 31). — 101 ($^{6}/_{8}$ 32). — 106 ($^{25}/_{4}$ 31). — 107? ($^{10}/_{8}$ 30). — 111? ($^{10}/_{2}$ 31).

Distribution: N. America, France, Switzerland, Bulgaria, Germany, Denmark, Latvia, Finland, Lapland, Japan.

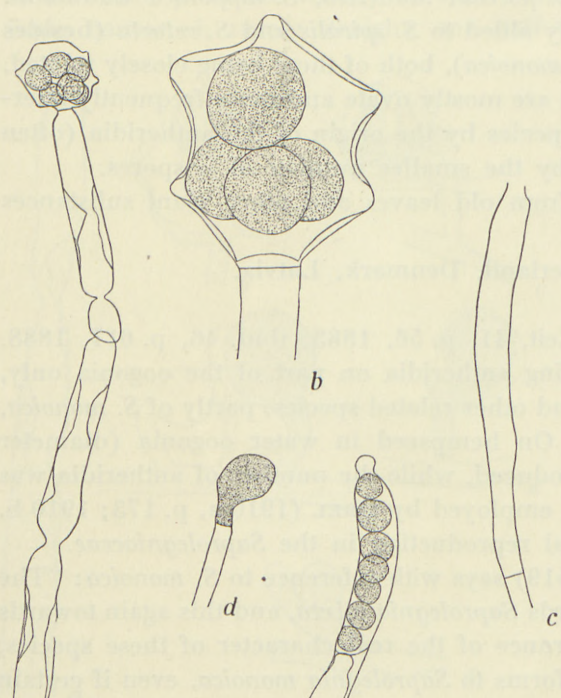

Fig. 5. *Saprolegnia latviaca. a*, Proliferating sporangia with an oogonium, × 155; *b*, Oogonium, × 430; *c*, Empty sporangium, × 155; *d*, Gemma, × 155; *e*, Cylindrical oogonium in an old sporangium, × 155.

Saprolegnia latviaca Apinis. Acta Horti Bot. Univ. Latv. 4, p. 211, pl. 1, figs. 1—12, 1929. — Fig. 5.

Hyphae slender and flaccid. Sporangia cylindrical, proliferating. Gemmae globular or oval, only sparingly developed or entirely absent. Oogonia spherical or subspherical, 62.5—72.5 μ in diameter, terminal on main hyphae, beset with blunt outgrowths which are 7.5—10 μ long, the end of these being furnished with a pit or sometimes perforated; at times oogonia are formed within the empty sporangia, they are then cylindrical. Oospores centric, generally 25 μ in diameter, 3—10. Antheridia absent.

It was cultivated on hempseed in water; it attained only a slight growth, but relatively numerous oogonia were produced.

In my plant oogonia as large and as small as those described by Apinis (30—110 μ) did not occur; similarly, I have not observed oogonia on side branches, or intercalary ones; further, Apinis reports the number of oospores to be 1—30 in each oogonium.

These differences, however, are rather unimportant; possibly Apinis had a more abundant material at his disposal. Certain of these characters may for the rest vary; in one of my cultures only a few oospores occurred in an oogonium (about 5), while in another culture the number was generally greater (about 10). Owing to the absence of antheridia it is probably nearly allied to *S. ferax*.

Saprolegnia latviaca seems to be a rare fungus. Hitherto it has only been reported from Latvia (2 localities, isolated from moist soil, rich in humus). I have only seen it in 3 samples from a bog. Perhaps it has great difficulty in holding its own in the competition with other fungi; it was accompanied by *Aplanes Treleaseanus* and *Saprol. litoralis*.

Localities: 7 ($^{11}/_{6}$ 32, isolated from *Sphagnum*).

Distribution: Latvia, Denmark.

Saprolegnia hypogyna Pringsheim. Pringsh. Jahrb. wiss. Bot. 9, p. 196, pl. 18, figs. 9 and 10, 1873. — Maurizio in Flora 79, p. 125, pl. 4, figs. 5—27, 1894. — Petersen in Bot. Tidsskr. 29, p. 381, 1909; in Ann. myc. 8, p. 521, 1910.

This species, which is distinguished by the absence of branched antheridia, usually, instead of these, possessing one or more hypogynous (antheridial?) cells, sending one or several upgrowths (antheridial tubes?) into the oogonia, occurs in several forms, as pointed out especially by Maurizio.

From this country Petersen mentions a single form of *S. hypogyna*, as far as I can see, it is Maurizio's Var. IV (or V); also Obel (1910 a, p. 197; 1910 b, p. 422) has observed this species.

I have found 4 of Maurizio's forms, viz. *Var. I*: hypogynous cells absent, upgrowth into the oogonium present; wall strongly pitted. — *Var. III*: one hypogynous cell, sometimes an upgrowth into the oogonium; wall with numerous pits. — *Var. IV*: one hypogynous cell, often an upgrowth into the oogonium; wall with few pits; 10—20 or more oospores. — *Var. V*: more than one hypogynous cell, usually two; upgrowth into the oogonium; wall unpitted or with few pits; about 8 oospores.

Localities: 31 ($^{31}/_{8}$ 31, isolated from roots of *Myrica*). — 41 ($^{1}/_{9}$ 31, isolated from dead bees in the water). — 62 ($^{7}/_{11}$ 31, isolated from water with green algae). — 64 ($^{18}/_{10}$ 31, two cultures isolated from sand and from twigs). — 65 ($^{21}/_{10}$ 31, isolated from twigs). — 87 ($^{11}/_{5}$ 32, isolated from twigs). — 98 ($^{29}/_{8}$ 31, isolated from sand).

Distribution: N. America, Switzerland, Germany, Denmark, Latvia, Lapland.

Saprolegnia torulosa de Bary. Beitr. z. Morph. u. Phys. d. Pilze 4, p. 31, pl. 6, figs. 3—17, 1881; in Bot. Zeit. 46, p. 618, 1888. — Fig. 6, a—b.

Hyphae and sporangia as usual. Oogonia more or less elongated, often nearly cylindrical, 90—237× 40—58.5 μ, mostly about 135× 55 μ, arranged in chains, less commonly single (terminal on main hyphae); oogonial wall smooth, unpitted. Oospores centric, 22.5—27.5 μ in diameter, 4—27, generally about 10. Antheridia absent (according to de Bary and Fischer (1892) antheridia sometimes present). Occasionally an ingrowth from the partition wall of the oogonium will occur; in that case it is somewhat reminiscent of *S. hypogyna*.

My observations agree in all essentials with the descriptions given by de Bary and Fischer (1892), but the oospores are said to be smaller (Fischer: 14—22 μ, de Bary: 15—25 μ), and, as previously mentioned, antheridia were occasionally found by these authors; furthermore the oogonial wall is stated by them to be sometimes slightly pitted.

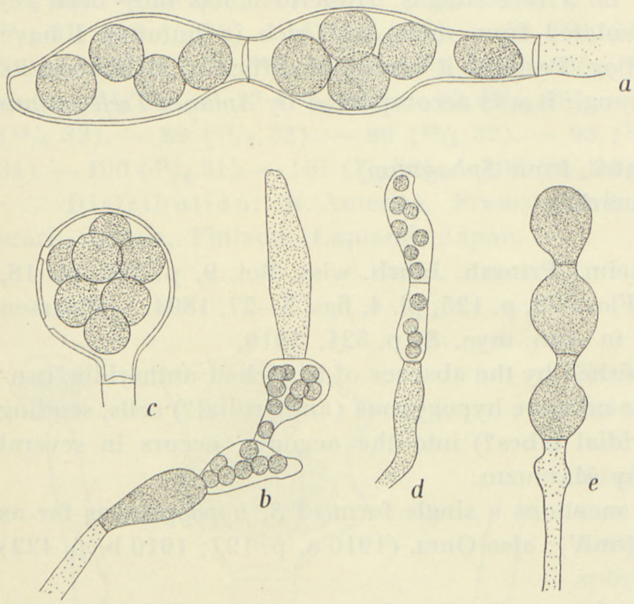

Fig. 6. *Saprolegnia torulosa. a*, Two oogonia in a chain, × 344; *b*, Chain of oogonia, × 124. *Saprolegnia variabilis. c*, Single oogonium, × 254; *d*, Two oogonia in a chain, × 124; *e*, Chain of young oogonia, × 124.

It is closely related to *S. rhaetica* Maurizio and to *S. variabilis* v. Minden, these species being possibly identical and perhaps also identical with *S. torulosa*; but in any case, the present plant is most in accordance with the descriptions of the latter species.

It seems to differ from *S. rhaetica* by the longer and larger oogonia (*S. rhaetica*: 48—61.5 μ in diameter). The difference between *S. torulosa* and *S. variabilis* is mentioned at p. 19. Outside the genus *Saprolegnia, S. torulosa* is reminiscent of *Isoachlya toruloides* and *I. monilifera*, but differs from these amongst other things in the type of the sporangia. Altogether, the relation of *S. torulosa* and related species of *Saprolegnia* to *Isoachlya* is rather obscure.

Localities: 30 (31/8 31, isolated from dead bees in the water). — 31 (31/8 31, two cultures isolated from sand and from roots of *Myrica*).

Distribution: N. America, Germany, Denmark, Finland, Lapland.

Saprolegnia variabilis v. Minden. Krypt. Fl. Mark Brandenb. 5, p. 524, 1915. — Fig. 6, c—e.

Hyphae and sporangia typical. Oogonia spherical, 49—89 μ in diameter or elongated, 92—112 × 40—70 μ, terminal or intercalary or arranged in chains; oogonial wall smooth, without or with few to rather numerous pits. Oospores centric, spherical or somewhat elliptic, 20—27.5 μ in diameter, few to numerous. Antheridia absent.

This plant is with some doubt referred to *S. variabilis* which, perhaps, is the same as *S. rhaetica*. It is also very nearly related to *S. torulosa*; it differs from this species in the appearance of the oogonia, which are often spherical and single and, when elongated, not as long as in *S. torulosa*; in some slides single and spherical oogonia occurred most frequently, in others oogonia in chains were most common; possibly it is to be regarded as a form of *S. torulosa*.

Localities: 16 ($^{9}/_{6}$ 31, isolated from twigs of *Pinus*).

Distribution: Germany, Denmark.

Saprolegnia asterophora de Bary. Pringsh. Jahrb. wiss. Bot. 2, p. 189, pl. 20, figs. 25—27, 1860. — Petersen in Bot. Tidsskr. 29, p. 380, fig. III, h, 1909; in Ann. myc. 8, p. 521, fig. III, h, 1910.

This species, reported from two places by Petersen, I have found in the following localities: 48 ($^{18}/_{4}$ 31). — 54? ($^{21}/_{3}$ 31).

Distribution: N. America, Germany, Denmark, Latvia, Finland.

Leptolegnia de Bary. Bot. Zeit. 46, p. 609, 1888.

Sporangia cylindrical, not thicker than the hyphae, proliferating. Zoospores in a single row, escaping through an apical pore, swimming away at once.

Leptolegnia caudata de Bary. Bot. Zeit. 46, p. 631, pl. 9, fig. 5, 1888. — Petersen in Bot. Tidsskr. 29, p. 381, fig. II, 1909; in Ann. myc. 8, p. 521, fig. II, 1910.

This fungus, not found by me, was observed in two places in northern Sealand by Petersen, who described its attack on the crustacean *Leptodora Kindtii*.

Distribution: N. America, Germany, Denmark, Latvia, China, Japan.

Aplanes de Bary. Bot. Zeit. 46, p. 650, 1888.

Sporangia cylindrical, thicker than the hyphae, secondary ones often formed by internal proliferation as in *Saprolegnia*. Zoospores in several rows, frequently sprouting within the sporangium. Hyphae stout and stiff as in *Achlya*. In the two species referred to *Aplanes* sporangia are rarely produced. The antheridia mostly arise very near the oogonia.

The position of this genus is rather uncertain.

Key to the Species.

I. Oogonia more or less elongated . . . . *A. androgynus* p. 19.
II. Oogonia mostly spherical . . . . *A. Treleaseanus* p. 20.

Aplanes androgynus (Archer) Humphrey. Transact. Am. Phil. Soc. 17, p. 134, 1893. — Petersen in Bot. Tidsskr. 29, p. 387, 1909; in Ann. myc. 8, p. 526, 1910. — *Saprolegnia androgyna* Archer. Quart. Journ. Micr. Sci. 7, p. 123, pl. 6, 1867. — *Achlya Braunii* Reinsch. Pringsh. Jahrb. wiss. Bot. 11, p. 284, pl. 14, figs. 1—6, 1878. — *Aplanes Braunii* de Bary. Bot. Zeit. 46, p. 650, pl. 9, fig. 2, 1888.

This fungus is recorded by Petersen from three localities, but in my experience it is far commoner than would appear from his report. It occurs especially in bogs, and almost constantly in company with *Pythiomorpha undulata,* and also frequently with *Aplanes Treleaseanus, Saprolegnia delica,* and *S. litoralis.*

Oogonia are formed in great number, whereas the production of sporangia is very scanty. The sporangia observed were either proliferating, provided with a terminal pore, or the zoospores were sprouting within them.

Localities: 1 ($^{20}/_{5}$ 31, on a decaying frog and on twigs of *Betula*). — 4 ($^{8}/_{11}$ 31, isolated from *Sphagnum*). — 12 ($^{8}/_{6}$ 31, isolated from soil). — 14 ($^{8}/_{6}$ 31, isolated from soil). — 15 ($^{8}/_{6}$ 31, isolated from soil and plant remains). — 16 ($^{9}/_{6}$ 31, isolated from sand). — 18 ($^{9}/_{6}$ 31, isolated from mud and plant remains). — 21 ($^{10}/_{6}$ 31, isolated from *Sphagnum* and soil). — 23 ($^{11}/_{6}$ 31, isolated from soil and plant remains). — 24 ($^{11}/_{6}$ 31, isolated from *Sphagnum* and plant remains). — 25 ($^{11}/_{6}$ 31, isolated from soil and *Sphagnum*). — 26 ($^{12}/_{6}$ 31, isolated from *Sphagnum* and plant remains).

Distribution: N. America, England, Germany, Denmark, Latvia.

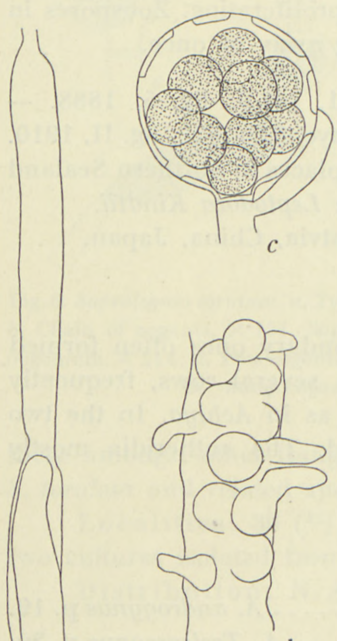

Fig. 7. *Aplanes Treleaseanus. a,* Proliferating sporangia; *b,* Outline drawing of part of sporangium containing sprouting spores, × 430; *c,* Oogonium with antheridium, × 318.

Aplanes Treleaseanus (Humphrey) Coker. The Saprolegniaceae p. 79, pl. 20, 1923. — *Saprolegnia sp.* 2 Reinsch. Pringsh. Jahrb. wiss. Bot. 11, p. 295, pl. 14, figs. 7—13, 1878. — *Saprolegnia Treleaseana* Humphrey. Transact. Am. Phil. Soc. 17, p. 111, pl. 17, figs. 56—59, 1892. — *Achlya Treleaseana* (Humphrey) Kauffman. Ann. Rept. Mich. Acad. Sci. 8, p. 27, 1905. — *Saprolegnia paradoxa* H. E. Petersen. Bot. Tidsskr. 29, p. 379, fig. I, d and e, 1909; Ann. myc. 8, p. 520, fig. I, d and e, 1910. — *Saprolegnia monoica* var. *turfosa* v. Minden. Krypt. Fl. Mark Brandenb. 5, p. 516, 1915. — *Saprolegnia turfosa* (v. Minden) Gäumann. Bot. Notiser 1918, p. 154. — Fig. 7.

Hyphae stout and vigorous. Sporangia very few, cylindrical, often proliferating from within as in *Saprolegnia*; sometimes the zoospores sprout within the sporangia. Gemmae elongated, often in rows. Oogonia mostly spherical, 57—120 μ in diameter, racemosely arranged on short lateral branches, more rarely terminal on main hyphae; oogonial wall smooth, with numerous conspicuous pits. Oospores 20—27.5 μ in diameter, one to several. Antheridial branches androgynous, arising from the oogonial stalks, usually very near the oogonia.

On hempseed in water this species produced numerous oogonia and gemmae, but very few sporangia, in some cultures none. The emergence of the zoospores was not observed. On agar it formed a very vigorous growth and developed many oogonia; on $^{29}/_{1}$ 32 a piece of agar with the fungus was transferred to water with hempseed, on $^{12}/_{2}$ 32 numerous sexual organs and a few sporangia were observed.

It has been recorded by several authors, being mostly referred to *Saprolegnia* owing to the frequent proliferation of the sporangia. *Sapr. paradoxa* H. E. Petersen, which is no doubt identical with *Apl. Treleaseanus*, is reported from two places in Sealand. — I have found it mostly in bogs.

Localities: 4 ($^{8}/_{11}$ 31, isolated from soil). — 6 ($^{10}/_{5}$ 31, isolated from water and soil). — 7 ($^{11}/_{6}$ 32, 2 cultures isolated from *Sphagnum*). — 16 ($^{9}/_{6}$ 31, isolated from soil). — 19 ($^{9}/_{6}$ 31, isolated from plant remains and soil). — 20 ($^{10}/_{6}$ 31, isolated from *Sphagnum*). — 23 ($^{11}/_{6}$ 31, isolated from *Sphagnum*). — 24 ($^{11}/_{6}$ 31, isolated from *Sphagnum*). — 25 ($^{11}/_{6}$ 31, isolated from *Sphagnum* and soil). — 26 ($^{12}/_{6}$ 31, 2 cultures isolated from *Sphagnum* and from twigs of *Betula*).

Distribution: N. America, Germany, Denmark, Lapland.

Isoachlya Kauffman. Am. Jour. Bot. 8, p. 231, pls. 13 and 14, 1921.

Sporangia variable in shape, often pyriform or cylindrical, thicker than the hyphae; the secondary ones formed either by internal proliferation as in *Saprolegnia*, or by lateral branching as in *Achlya*; zoospores in several rows, generally set free through a terminal pore, swimming away at once.

Key to the Species.

I. Sexual organs not produced . . . . *I. parasitica* p. 21.
II. Oogonia terminal or in chains. Antheridia mostly absent . . *I. monilifera* p. 22.

Isoachlya parasitica (Coker) Nagai. Jour. Fac. Agric. Hokkaido Imp. Univ. 32, p. 12, pl. 2, figs. 27—34, 1931. — *Saprolegnia parasitica* Coker. The Saprolegniaceae p. 57, pl. 18, 1923. — Fig. 8.

Hyphae delicate and slender. Sporangia of various shapes, often cylindrical and frequently more or less irregular, 315—364 × 42—84 μ; the secondary ones formed by internal proliferation or by lateral branching. The zoospores usually escape through an apical mouth of the sporangium, more rarely through openings in the side-wall; swimming away immediately; sometimes the spores germinate within the sporangium. Gemmae numerous, variable in shape. Sexual organs not observed.

This fungus was found on a dead *Leusiscus* upon which many sporangia were present; it was cultivated on hempseed in water for a long time; it produced numerous sporangia and gemmae, but no oogonia.

A similarly sterile fungus was described by Coker as *Saprol. parasitica.* Nagai regards it as belonging to *Isoachlya*, owing to the manner in which the secondary sporangia are formed, "later (sporangia) typically renewed by lateral branching or rarely pro-

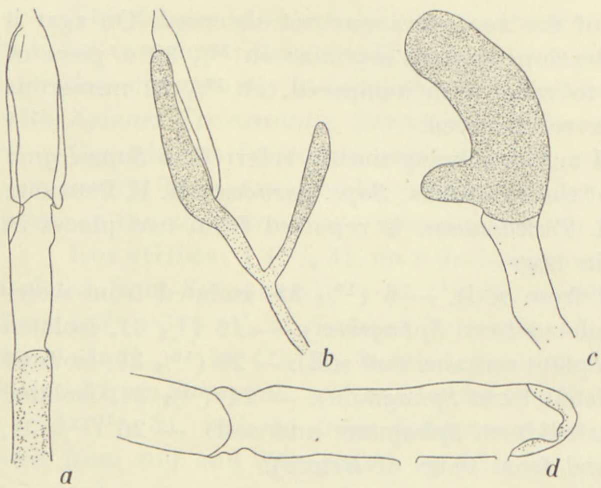

Fig. 8. *Isoachlya parasitica*. *a*, Proliferating sporangia, × 155; *b*, Sporangia; lateral branching, × c. 75; *c*, Gemma, × 155; *d*, Sporangium which has emptied by openings in the side wall, × 155.

liferated inwardly through the empty ones." — As previously mentioned, it is possible that, on the whole, the genus *Isoachlya* is not well-founded. The same remarks that are made on *Achlya sp.* (p. 28) apply to this fungus.

Kanouse (1932) states that *Saprolegnia parasitica* is able to produce sexual organs on certain media, amongst others on hempseed in water (on this medium my plant only developed sporangia and gemmae).

Such sterile fungi have been mentioned several times in the literature, being usually referred to *Saprolegnia*; they are often said to cause diseases in fish.

Localities: 71 ($^{16}/_{4}$ 32, on a dead *Leusiscus*).

Distribution: N. America, England, Germany, Denmark, Latvia, Japan.

Isoachlya monilifera (de Bary) Kauffman. Am. Jour. Bot. 8, p. 231, 1921. — *Saprolegnia monilifera* de Bary. Bot. Zeit. 46, p. 629, pl. 9, fig. 6, 1888.

This species has been used by Obel (1910 a, p. 192; 1910 b, p. 422) in his physiological experiments. Not found by me.

Distribution: N. America, Germany, Denmark, Latvia, Japan.

Achlya Nees v. Esenbeck. Nova Acta Acad. Leop. 11, p. 514, 1823.

Sporangia usually cylindrical, thicker than the hyphae; the secondary ones formed by lateral branching. The zoospores in several rows, encysting in a hollow sphere at the mouth of the sporangium on escaping. Mycelium generally consisting of vigorous, stout hyphae. — The characters chiefly employed to distinguish the species are 1) presence or absence of pits and outgrowths of the oogonial wall, 2) structure, size, and number of the oospores, 3) origin of the antheridia when present.

Key to the Species.

I. Oospores centric. Antheridia androgynous. Oogonial wall unpitted, yellowish; oogonia racemosely arranged.
   1. Oogonial wall smooth .... *A. racemosa* p. 23.
   2. Oogonial wall with short, blunt outgrowths; oospores 1—4 ....
      A. racemosa var. *stelligera* p. 23.

3. Oogonial wall with long, pointed outgrowths; generally 1 oospore . . . *A. radiosa* p. 24.

II. Oospores eccentric (or subcentric; in *A. oligacantha* possibly centric). Antheridia androgynous or diclinous (absent in *A. caroliniana*); oogonial wall unpitted or with pits, colourless.

1. Oogonial wall smooth.
   a. Antheridia androgynous; oogonial wall with numerous pits . . . . *A. americana* p. 24.
   b. Antheridia androgynous; oogonial wall unpitted . . . . *A. polyandra* p. 24.
   c. Antheridia androgynous or diclinous; oogonial wall pitted . . . . *A. imperfecta* p. 25.
   d. Antheridia diclinous; oogonial wall unpitted or with a few pits . . . *A. Klebsiana* p. 25.
   e. Antheridia absent. Oogonia small (33.8—52 μ); wall unpitted; generally only 1 oospore . . . . *A. caroliniana* p. 26.
2. Oogonial wall set with outgrowths.
   a. Outgrowths numerous, almost equally long; oogonial stalks bent *A. recurva* p. 27.
   b. Outgrowths of varying number and size; oogonial stalks straight . . *A. oligacantha* p. 27.

III. Oogonia absent . . . . *A. sp.* p. 28.

Achlya racemosa Hildebrand. Pringsh. Jahrb. wiss. Bot. 6, p. 249, pl. 15, 1867. — Petersen in Bot. Tidsskr. 29, p. 382, fig. III, i, 1909; in Ann. myc. 8, p. 522, fig. III, i, 1910.

Recorded by Petersen from 23 places in Sealand and from 2 lakes in Jutland. It is also mentioned by Obel (1910 a, p. 196). I have observed it in the following localities: 1 ($^{22}/_{3}$ 31, $^{20}/_{5}$ 31, $^{5}/_{11}$ 31). — 3 ($^{15}/_{3}$ 31, $^{10}/_{5}$ 31). — 4 ($^{19}/_{4}$ 31). — 9 ($^{3}/_{5}$ 31). — 11 ($^{8}/_{6}$ 31). — 26 ($^{12}/_{6}$ 31). — 27 ($^{12}/_{6}$ 31). — 28 ($^{13}/_{6}$ 31). — 35 ($^{25}/_{4}$ 31). — 36 ($^{25}/_{4}$ 31, $^{17}/_{5}$ 31, $^{18}/_{10}$ 31, $^{5}/_{4}$ 32). — 42 ($^{29}/_{8}$ 31). — 45 ($^{10}/_{5}$ 32). — 47 ($^{18}/_{4}$ 31, $^{21}/_{10}$ 31). — 48 ($^{21}/_{3}$ 31, $^{18}/_{4}$ 31). — 50 ($^{25}/_{4}$ 31). — 51 ($^{1}/_{5}$ 32). — 53 ($^{10}/_{2}$ 31, $^{10}/_{5}$ 31, $^{8}/_{11}$ 31). — 54 ($^{18}/_{4}$ 31). — 55 ($^{25}/_{4}$ 31). — 56 ($^{16}/_{4}$ 32). — 60 ($^{29}/_{12}$ 30). — 61 ($^{29}/_{12}$ 30). — 62 ($^{14}/_{4}$ 31, $^{15}/_{4}$ 31). — 63 ($^{25}/_{4}$ 31). — 64 ($^{5}/_{4}$ 32). — 65 ($^{21}/_{3}$ 31). — 66 ($^{18}/_{4}$ 31). — 67 ($^{19}/_{4}$ 31). — 68 ($^{19}/_{4}$ 31, $^{10}/_{5}$ 31). — 69 ($^{7}/_{3}$ 31). — 70 ($^{19}/_{4}$ 31). — 71 ($^{16}/_{4}$ 32). — 76 ($^{16}/_{4}$ 32). — 77 ($^{31}/_{8}$ 30). — 80 ($^{16}/_{4}$ 32). — 81 ($^{8}/_{4}$ 32). — 84 ($^{10}/_{5}$ 32). — 86 ($^{10}/_{5}$ 32). — 88 ($^{11}/_{5}$ 32). — 91 ($^{14}/_{5}$ 32). — 92 ($^{14}/_{5}$ 32). — 93 ($^{14}/_{5}$ 32). — 94 ($^{12}/_{5}$ 32). — 105 ($^{14}/_{4}$ 30). — 106 ($^{25}/_{4}$ 31). — 110 ($^{26}/_{1}$ 30).

Distribution: N. America, France, Germany, Denmark, Latvia, Finland, Lapland, Japan.

Achlya racemosa var. **stelligera** Cornu. Ann. sci. nat. bot. sér. 5, 15, p. 22, 1872. — Petersen in Bot. Tidsskr. 29, p. 383, fig. III, d, 1909; in Ann. myc. 8, p. 522, fig. III, d, 1910. — *Achlya colorata* Pringsheim. Sitzungsber. Akad. Wiss. Berlin, p. 855, pl. 14, figs. 12, 15—31, 1882.

In my experience this fungus is connected by transitional forms with *A. racemosa*, so that it is probably to be considered as a variety of that species. It is recorded by Petersen from 6 places; also mentioned by Obel (1910 a, p. 197, fig.). It was found by me in the following localities: 1 ($^{22}/_{3}$ 31, $^{20}/_{5}$ 31, $^{5}/_{11}$ 31). — 2 ($^{17}/_{4}$ 31). — 3 ($^{13}/_{4}$ 30, $^{5}/_{10}$ 30, $^{16}/_{11}$ 30, $^{15}/_{3}$ 31, $^{19}/_{4}$ 31, $^{10}/_{5}$ 31). — 4 ($^{19}/_{4}$ 31). — 5 ($^{9}/_{4}$ 32). — 8 ($^{8}/_{11}$ 31). — 11 ($^{8}/_{6}$ 31). — 13 ($^{8}/_{6}$ 31). — 36 ($^{17}/_{5}$ 31). — 38 ($^{13}/_{5}$ 32). — 44 ($^{11}/_{4}$ 32). — 47 ($^{18}/_{4}$ 31). — 48 ($^{21}/_{3}$ 31, $^{18}/_{4}$ 31). — 53 ($^{10}/_{2}$ 31, $^{9}/_{4}$ 31). — 54 ($^{18}/_{4}$ 31). — 55 ($^{25}/_{4}$ 31). — 56 ($^{16}/_{4}$ 32). — 57 ($^{12}/_{4}$ 30). — 61 ($^{29}/_{12}$ 30). — 62 ($^{14}/_{4}$ 31, $^{15}/_{4}$ 31). — 63 ($^{25}/_{4}$ 31, $^{5}/_{4}$ 32). — 64 ($^{5}/_{4}$ 32). — 65 ($^{21}/_{3}$ 31). — 67 ($^{19}/_{4}$ 31). — 68 ($^{19}/_{4}$ 31, $^{10}/_{5}$ 31). — 69 ($^{7}/_{3}$ 31, $^{19}/_{4}$ 31). — 70 ($^{7}/_{3}$ 31). — 71 ($^{16}/_{4}$ 32). — 77 ($^{31}/_{8}$ 30). — 84 ($^{10}/_{5}$ 32). — 86 ($^{10}/_{5}$ 32). — 87 ($^{11}/_{5}$ 32). — 88 ($^{11}/_{5}$ 32). — 90 ($^{13}/_{5}$ 32). — 91 ($^{14}/_{5}$ 32). — 92 ($^{14}/_{5}$ 32). — 94 ($^{12}/_{5}$ 32). — 105 ($^{14}/_{4}$ 30).

Distribution: N. America, England, France, Germany, Denmark, Latvia.

Achlya radiosa Maurizio. Zeitschr. f. Fischerei u. deren Hilfswiss. Mitt. Deutsch. Fischerei-Ver. 7, p. 57, figs. 18 and 19, 1899. — *Achlya decorata* H. E. Petersen. Bot. Tidsskr. 29, p. 383, fig. III, a and e, 1909; in Ann. myc. 8, p. 522, fig. III, a and e, 1910. — *Achlya asterophora* v. Minden. Krypt. Fl. Mark Brandenb. 5, p. 549, fig. 2, c, 1915.

Found once by Petersen. Employed by Obel (1910 a, p. 183; 1910 b, p. 422) in his experiments on the sexual reproduction in the *Saprolegniaceae*. I have observed it in the following localities: 28 ($^{13}/_{6}$ 31). — 48 ($^{21}/_{3}$ 31, $^{8}/_{4}$ 31). — 49? ($^{3}/_{3}$ 31). — 55 ($^{11}/_{10}$ 30, $^{1}/_{11}$ 30, $^{25}/_{4}$ 31). — 60 ($^{21}/_{4}$ 30, $^{29}/_{12}$ 30). — 61 ($^{29}/_{12}$ 30). — 63 ($^{5}/_{4}$ 32). 73 ($^{26}/_{9}$ 30). — 80 ($^{30}/_{8}$ 30). — 96 ($^{11}/_{6}$ 31). — 102 ($^{19}/_{4}$ 30). — 105? ($^{14}/_{4}$ 30).

Distribution: Switzerland, Germany, Denmark.

Achlya americana Humphrey. Transact. Am. Phil. Soc. 17, p. 116, figs. on pls. 14, 15, 16, and 18, 1893. — *Achlya polyandra* f. *americana* H. E. Petersen. Bot. Tidsskr. 29, p. 385, fig. III, g, 1909; in Ann. myc. 8, p. 524, fig. III, g, 1910.

Reported from 5 places by Petersen. I have found it in the following localities: 8 ($^{8}/_{11}$ 31). — 56 ($^{16}/_{4}$ 32). — 92 ($^{14}/_{5}$ 32). — 93 ($^{14}/_{5}$ 32).

Distribution: N. America, Germany, Denmark, Latvia, Japan.

Achlya polyandra Hildebrand. Pringsh. Jahrb. wiss. Bot. 6, p. 258, pl. 16, figs. 7—11, 1867. — *Achlya gracilipes* de Bary. Bot. Zeit. 46, p. 635, pl. 10, figs. 2 and 6, 1888. — Petersen in Bot. Tidsskr. 29, p. 385, 1909; in Ann. myc. 8, p. 524, 1910.

Found in 3 localities by Petersen; also mentioned by Obel (1910 a, p. 195; 1910 b, p. 422). Not observed by me.

Distribution: N. America, Germany, Denmark, Latvia.

Achlya imperfecta Coker. The Saprolegniaceae p. 118, pls. 38 and 39, 1923. — *Achlya de Baryana* var. *intermedia* v. Minden. Krypt. Fl. Mark Brandenb. 5, p. 545, 1915. — Fig. 9.

Hyphae stout and thick. Sporangia and zoospores as in general in *Achlya*. Gemmae cylindrical, in rows formed by segmentation of the hyphae. Oogonia mostly spherical, 67.5—84 μ in diameter, arranged racemosely on branches about as long as the diameter of the oogonia; oogonial wall smooth, generally with numerous pits, sometimes with few pits only. Oospores eccentric, containing one large or several small oil drops, 22.5—27.5 μ in diameter, 7—12, often filling the oogonium. Antheridial branches mostly androgynous, arising from the main hyphae or from the oogonial stalks, sometimes diclinous.

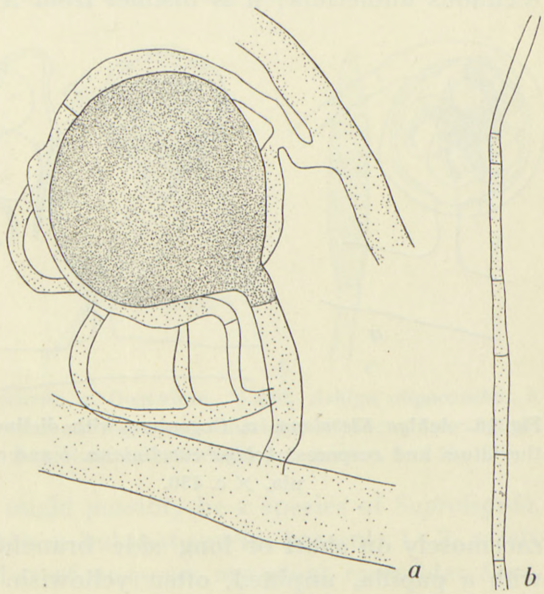

Fig. 9. *Achlya imperfecta*. *a*, Young oogonium with androgynous and diclinous antheridia, × 344; *b*, Gemmae, × c. 60.

In culture from the beginning of November 1931 to February 1932. It attained a vigorous growth on hempseed in water and on agar; it did not form sexual organs until $^{4}/_{2}$ 32. (See also p. 28).

My plant differs from Coker's and v. Minden's in generally having more numerous pits in the oogonial wall. Coker reports the oospores to be 17—23 μ in diameter; the oospores measured by me were 22.5—27.5 μ; this agrees with Apinis' observation (1929): 20—27 μ. Coker says: "The great majority of the eggs go to pieces before maturity." I have not observed this, and neither v. Minden nor Apinis mention this fact. It is near *A. americana*, but the latter only has androgynous antheridia.

Localities: 53 ($^{8}/_{11}$ 31, isolated from soil).

Distribution: N. America, Germany, Denmark, Latvia.

Achlya Klebsiana Pieters. Bot. Gaz. 60, p. 486, pl. 21, figs. 1—4, 1915. — Coker in The Saprolegniaceae p. 120, pl. 40, 1923. — Fig. 10, a.

Sporangia cylindrical, for instance 455 × 77 μ. Oogonia spherical, 56—70 μ in diameter, rarely slightly oval, racemosely arranged on side branches which are one half to 2—3 times as long as the diameter of the oogonia; wall smooth, unpitted or with one or two pits. Oospores eccentric with one large oil drop (or with several small oil drops) 17.5—25 μ, mostly 22.5 μ in diameter, usually about 6 in an oogonium. Antheridial branches diclinous, winding more or less about the oogonia.

My observations seem to agree with the descriptions given by Pieters and Coker; however, the characteristic projections of the antheridia were not as distinct in my specimens as figured by Coker.

It differs from *A. americana* in the usually unpitted oogonial walls and the diclinous antheridia; it is distinct from *A. imperfecta* in having only diclinous antheridia.

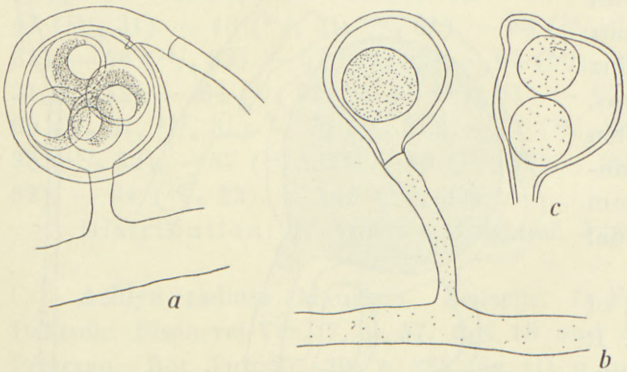

Fig. 10. *Achlya Klebsiana. a*, Oogonium with diclinous antheridium and oospores. *Achlya caroliniana. b* and *c*, Oogonia, × c. 430.

Localities: 58 ($^{14}/_{5}$ 32, on twigs).

Distribution: N. America, Denmark.

Achlya caroliniana Coker. Bot. Gaz. 50, p. 381, 1910; in The Saprolegniaceae p. 122, pl. 41, 1923. — Coker and Braxton in Jour. Elisha Mitchell Sci. Soc. 42, p. 144, pl. 12, fig. 7, 1926. — Fig. 10, b—c.

Oogonia usually spherical, 33.8—52 μ in diameter, arranged racemosely on short or long side branches; oogonial wall smooth, or sometimes with a papilla, unpitted, often yellowish. Sometimes an ingrowth from below is present in the oogonia. Oospores eccentric (?) 20—25 μ in diameter, 1—2, rarely 3—4 in an oogonium. No antheridia.

It was accompanied by *A. racemosa* which I did not succeed in exterminating from the cultures; so the sporangia of *A. caroliniana* were not observed with certainty.

Besides on hempseed in water it was cultivated on agar from November 7, 1931, to March 8, 1932. In some cultures it attained a rather vigorous growth and produced numerous oogonia, in others it grew sparingly, but oogonia were easily formed.

Owing to the characteristic small oogonia, the unpitted wall, the few oospores, and the absence of antheridia, there can be no doubt that it is identical with *A. caroliniana.*

Both in 1910 and 1923 Coker says that antheridia were not observed. Coker and Braxton, however, found an "Achlya caroliniana, form with antheridia". In this plant antheridia — according to the figure apparently of diclinous origin — were present on 25—40 % of the oogonia.

Localities: 31? ($^{31}/_{8}$ 31, isolated from sand). — 36 ($^{18}/_{10}$ 31, isolated from soil and plant remains).

Distribution: N. America, Denmark.

Achlya recurva Cornu. Ann. sci. nat. bot. sér. 5, 15, p. 22, 1872. — v. Minden in Krypt. Fl. Mark Brandenb. 5, p. 543, 1915. — Fig. 11, a.

Oogonia spherical, 49.5—72.6 μ in diameter (without outgrowths), terminal on main hyphae or on side branches which are bent; oogonial wall set with numerous blunt outgrowths, 6.6—13.2 μ mostly about 9 μ in length, unpitted. Oospores 23—30 μ in diameter, 3—9 in an oogonium.

Of this fungus only a very small material was found, and I was not able to observe sporangia. Similarly, no antheridia were seen on the few oogonia present in the culture. But owing to the peculiar oogonia it must doubtless be referred to *A. recurva* as described briefly by CORNU and in somewhat more detail by v. MINDEN. In addition to these reports, there is only a brief mention of it by HARTOG (1888) without any description.

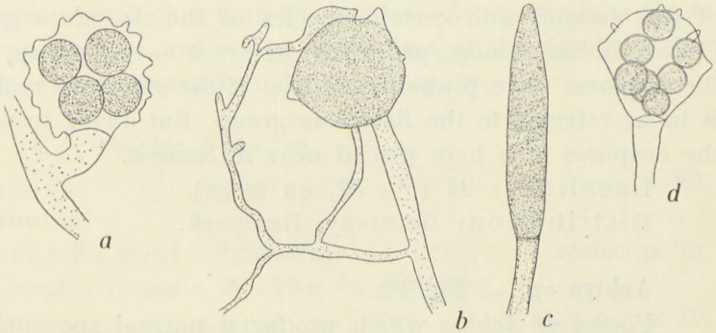

Fig. 11. *Achlya recurva. a,* Oogonium, × 430. *Achlya oligacantha. b,* Young oogonium with androgynous antheridia, × 155; *c,* Sporangium, × 70; *d,* Oogonium (antheridium not drawn), × 155.

Since no sporangia were observed it might possibly be a species of *Saprolegnia.* It is somewhat reminiscent of *Sapr. asterophora,* but that species has only 1—2, rarely 3 oospores in an oogonium. In the number of oospores my plant resembles *Sapr. papillosa* (Humphrey) Apinis, but this species differs from it in the more oblong, sometimes intercalary oogonia; furthermore, the oogonial stalks seem to be always straight.

Achlya recurva is certainly most nearly allied to *A. oligacantha,* but it is easily distinguished from that species by the bent oogonial stalks and the more numerous and more regular outgrowths of the oogonia.

Localities: 47 ($^{18}/_{4}$ 31, on twigs).

Distribution: France, Germany, England, Denmark.

Achlya oligacantha de Bary. Bot. Zeit. 46, p. 647, pl. 10, fig. 1, 1888. — Petersen in Bot. Tidsskr. 29, p. 385, 1909; in Ann. myc. 8, p. 524, 1910. — Fig. 11, b—d.

Since DE BARY described it, this species has only been reported by PETERSEN, who found it in a lake in north-eastern Sealand. I have observed it once and shall here mention my observations.

Hyphae and sporangia as usual in *Achlya.* Oogonia spherical, 70—133 μ in diameter (without outgrowths), sometimes pyriform, about 90 × 75 μ (without outgrowths), terminal on main hyphae, more rarely on lateral branches; oogonial wall unpitted, furnished with blunt outgrowths varying in number (sometimes absent) and size, generally 7.5—10 μ long, 7.5 thick. Oospores centric (?), mostly about 27 μ in diameter, 3 to about 20, usually 7—10, often filling the oogonium. Antheridial branches androgynous, arising from the oogonial stalks, more rarely diclinous, much branched.

In the original description the length of the outgrowths of the oogonia is stated to be up to 30 μ. According to de Bary mostly 4—8, rarely more than 12 oospores occur; in the oogonia observed by me up to 20 were rather common. The structure of the oospores is said to be centric. But since it is possible that this word does not correspond to the modern interpretation of the term, and because of the supposed connection of this fungus with certain species of the *Apiculata* group (subcentric oospores), Coker, in his monograph (1923), refers it to that group. As far as I was able to see, the oospores were probably centric. If the structure really is centric, *A. oligacantha* is to be referred to the *Racemosa* group. But owing to my incomplete knowledge of the oospores it is here placed near *A. recurva*.

Localities: 91 ($^{14}/_{5}$ 32, on twigs).

Distribution: Germany, Denmark.

Achlya sp. — Fig. 12.

Forms of *Achlya* which produced normal sporangia and gemmae, but which did not form sexual organs, were of common occurrence.

As an example may be mentioned that an *Achlya* which was isolated from twigs from locality No. 54 on October 21, 1931 and which was cultivated on hempseed in water till April 7, 1932, and on agar from November 1, 1931 to February 28, 1932 only produced non-sexual organs. Another *Achlya*, isolated from mud from the same pond, was kept in culture for about three months on hempseed and agar also without developing sexual organs.

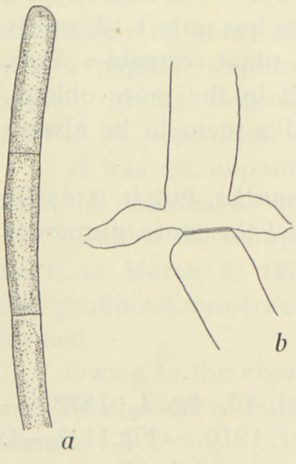

Fig. 12. *Achlya* sp. *a*, Gemmae, × 75; *b*, Part of empty gemmae, × 155.

Weston (1917) and Coker (1923) cultivated sterile forms of *Achlya* for about two years and seven months respectively.

In other genera similar sterile forms have been described as species (*Isoachlya parasitica* p. 21, *Dictyuchus sterile* p. 32). It should be noted, however, that Couch (1926) succeeded in obtaining sexual reproduction in sterile forms of *Dictyuchus* by growing different strains together.

Sometimes sterility is probably due to external conditions. It is a fact that species of *Achlya* frequently have difficulty in producing sexual organs when the temperature is too high (see also p. 57). Thus in the warm summer of 1932 two *Achlya* were grown on hempseed without forming oogonia; both of them had been isolated from twigs upon which sexual organs of *A. racemosa* var. *stelligera* and *A. racemosa* respectively were present.

On the other hand, *A. imperfecta* (p. 25) was kept in culture on hempseed and agar from the beginning of November 1931 to February 1932 before forming sexual organs; in this case a too high temperature does not seem to have had any influence. — NAGAI (1931) described a species, *A. flexuosa,* quoting the sterile *Achlya sp.* mentioned by other authors as synonyms; possibly this species behaved like *A. imperfecta* in my cultures (the sexual organs of *A. flexuosa* were observed after 6 months).

Aphanomyces de Bary. Pringsh. Jahrb. wiss. Bot. 2, p. 178, 1860.

Sporangia long, cylindrical, not thicker than the hyphae. Zoospores in a single row, liberated through a terminal pore, remaining some time at the mouth of the sporangium before swimming away. Generally only one oospore.

Key to the Species.

I. Oogonial wall smooth .... *A. laevis* p. 29.
II. Oogonial wall with outgrowths.
  1. Oogonial wall uneven or with short outgrowths .... *A. scaber* p. 29.
  2. Outgrowths 4—6 μ in length; oogonia 20—25 μ in diameter .... *A. stellatus* p. 29.
  3. Outgrowths up to 8 μ long; oogonia 30—40 μ in diameter . . *A. coniger* p. 30.

Aphanomyces laevis de Bary. Pringsh. Jahrb. wiss. Bot. 2, p. 179, pl. 20, figs. 17 and 18, 1860. — Petersen in Bot. Tidsskr. 29, p. 386, fig. III, c, 1909; in Ann. myc. 8, p. 525, fig. III, c, 1910.

Common on dead insects in the water. It is reported by PETERSEN from 11 places; also mentioned by OBEL (1910 a, p. 192). Found by me in the following localities: 76 ($^{6}/_{9}$ 30). — 79 ($^{10}/_{8}$ 30). — 80 ($^{30}/_{8}$ 30). — 82 ($^{20}/_{9}$ 30). — 85 ($^{13}/_{7}$ 32). — 100 ($^{31}/_{8}$ 31). — 116 ($^{20}/_{9}$ 30). — 119 ($^{20}/_{7}$ 30).

Distribution: N. America, Bulgaria, Germany, Denmark.

Aphanomyces scaber de Bary. Pringsh. Jahrb. wiss. Bot. 2, p. 178, pl. 20, figs. 14—16, 1860. — Petersen in Bot. Tidsskr. 29, p. 387, 1909; in Ann. myc. 8, p. 525, 1909.

This species, observed once by PETERSEN, I have not found.

Distribution: N. America, Germany, Denmark.

Aphanomyces stellatus de Bary. Pringsh. Jahrb. wiss. Bot. 2, p. 178, pl. 19, figs. 1—13, 1860.

Hyphae delicate. Sporangia not thicker than the hyphae; zoospores encysting in a hollow sphere at the mouth of the sporangium on escaping. Oogonia spherical, 20—25 μ in diameter, terminal; oogonial wall with outgrowths, 4—6 μ in length, not pitted. One oospore, 14—17 μ in diameter. Antheridial branches androgynous or diclinous.

My plant obviously agrees with *Aph. stellatus*; this species has been reported by Petersen (1903) as found in Denmark. In his papers from 1909 and 1910, however, it is mentioned as *Aph. coniger*.

Localities: 79 ($^{10}/_{8}$ 30, on teguments of nymphs of *Phryganeae*). — 80 ($^{30}/_{8}$ 30, on dead larvae of gnats).

Distribution: N. America, England, France, Germany, Denmark, Latvia, Japan.

Aphanomyces coniger H. E. Petersen. Bot. Tidsskr. 29, p. 387, fig. III, b and f, 1909; in Ann. myc. 8, p. 525, fig. III, b and f, 1910.

Petersen found this species in a lake in North Sealand; not noticed by me. It seems to be rather difficult to distinguish from *Aph. stellatus*.

Distribution: Denmark.

Dictyuchus Leitgeb. Bot. Zeit. 26, p. 502, 1868; in Pringsh. Jahrb. wiss. Bot. 7, p. 357, 1870.

Sporangia cylindrical; the secondary ones formed by lateral branching, or intercalary. Zoospores escaping through separate openings in the walls of the sporangium; in the empty sporangia a distinct network is present (dictyosporangia). One oospore, always (?) eccentric.

6 (7?) species have been described as belonging to this genus. I have found three, *D. monosporus*, *D. Magnusii*, and *D. sterile*. Further I have once seen a plant which seems to be the same as *D. carpophorus*; in my opinion, however, the latter is probably not different from *D. monosporus*, considering the variation of the distinguishing characters. So *D. carpophorus* is mentioned as a synonym to *D. monosporus* in the following.

Many points of resemblance are present too, in *D. monosporus* and *D. Magnusii*. They differ from each other in the size of the oogonia, in the more or less distinct winding of the antheridia about the oogonia, and possibly in the arrangement of the sporangia; these characters may vary, it is true. Another — more important — distinguishing character is also given, viz. the structure of the oospores; but in reality this character does not seem to be fully elucidated. In the figures of *D. monosporus* given by Leitgeb the oospores are apparently centric, but in the foot-note on p. 371 it says: "Oefters fand ich Oogonien mit scheinbar vollkommen entwickelter Oospore, in der ein grosser Oeltropfen sich befand." This observation would seem to suggest an eccentric structure. — Fischer (1892) says about this species: "Oosporen . . . . concentrisch." By v. Minden (1915) they are said to be centric; by Nagai (1931) they are reported as eccentric. In the plant referred by the writer to *D. monosporus*, the oospores are typically eccentric, containing 1—2 large or several small oil drops.

According to Lindstedt's figures, *D. Magnusii* seems to have centric oospores (this fact is not mentioned in the text). By Humphrey they are stated to be centric, and Pieters (according to Coker 1923) says: "eggs single, centric, with two to many oil drops." Possibly this last remark might suggest an eccentric structure. By Fischer and v. Minden they are said to be centric. I have — although with some doubt — seen eccentric oospores in my *D. Magnusii.*

Key to the Species.

I. Oogonia present.

1. Antheridia winding about the oogonia; the latter mostly about 30 μ in diameter .... *D. monosporus* p. 31.
2. Antheridia not encircling the oogonia; the latter mostly 35—40 μ in diameter .... *D. Magnusii* p. 31.

II. Oogonia not produced .... *D. sterile* p. 32.

Dictyuchus monosporus Leitgeb. Pringsh. Jahrb. wiss. Bot. 7, p. 357, pl. 22, figs. 1—12 and pl. 23, figs. 1—8, 1870. — *Dictyuchus carpophorus* Zopf. Beitr. Phys. u. Morph. nied. Organismen 3, p. 48, pl. 3, figs. 1—17, 1893. — Fig. 13, a—b.

Hyphae sometimes with irregular swellings. Sporangia cylindrical, the primary ones terminal, those formed later produced laterally or intercalary; they are often separated from each other, then functioning as a sort of gemmae. Zoospores 12.5—15.5 μ, in 1 or 2 rows in the sporangium, escaping through separate openings in the wall. Oogonia usually globular, 27.5—37.5 μ, mostly about 30 μ in diameter, or sometimes about 39×31 μ, terminal on generally long side branches; oogonial wall smooth, unpitted. One oospore, eccentric with one or two, rarely several small, oil drops, 22.5—27 μ, mostly 25 μ in diameter. Antheridial branches diclinous, encircling the oogonia.

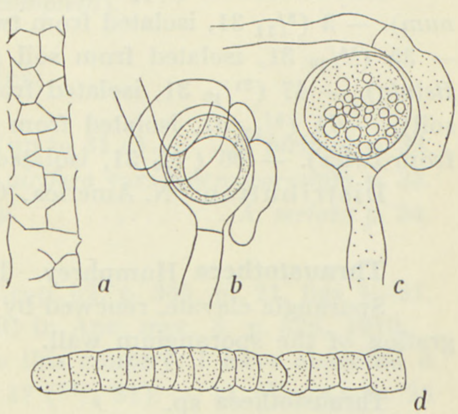

Fig. 13. *Dictyuchus monosporus. a,* Outline drawing of part of empty sporangium; *b,* Oogonium with antheridia. *Dictyuchus Magnusii, c,* Oogonium with antheridium; *d,* Upper part of young sporangium. — $\times$ 430.

This fungus was cultivated on hempseed in water for about $4^1/_2$ months. Here it produced numerous sporangia, but no sexual organs; the latter were only developed on twigs.

Localities: 53 ($^8/_{11}$ 31, on twigs of *Quercus*). — 65 ($^{21}/_{10}$ 31, on twigs of *Alnus*).

Distribution: England, France, Germany, Denmark, Latvia, Japan.

Dictyuchus Magnusii Lindstedt. Synopsis d. Saprolegniaceen p. 7, pl. 1, figs. 1—15, 1872. — Fig. 13, c—d.

Sporangia cylindrical; zoospores in 1 or 2 rows, escaping through separate openings in the walls of the sporangium. Oogonia generally spherical, 35—40 μ in diameter, or sometimes about 39 × 30 μ; oogonial wall smooth without pits. One oospore, eccentric (?), 25—30 μ, mostly 25 μ in diameter. Antheridial branches diclinous, not surrounding the oogonia.

Localities: 47 ($^{18}/_{4}$ 31, on twigs of *Alnus*). — 103 ($^{6}/_{4}$ 31, on twigs).

Distribution: N. America, Germany, Denmark.

Dictyuchus sterile Coker. The Saprolegniaceae p. 151, pl. 52, 1923.

Sporangia cylindrical, renewed by lateral branching; they are often separated from each other (resting spores). Zoospores leaving the sporangium as usual in this genus or sometimes sprouting in the sporangium. Sexual organs not produced.

Such sterile forms of *Dictyuchus* were cultivated on hempseed in water for some length of time, for instance for 4 months; sporangia were easily produced, but never oogonia. The same remarks apply to this species as to *Achlya sp.* (p. 28) (and to *Isoachlya parasitica*). — Couch (1926) has proved that a sterile strain together with another sterile strain was able to produce oogonia. Thus *D. sterile* probably cannot be maintained as a distinct sterile species.

Localities: 1 ($^{5}/_{11}$ 31, on twigs of *Betula*). — 2 ($^{5}/_{11}$ 31, isolated from *Sphagnum*). — 3 ($^{8}/_{11}$ 31, isolated from twigs). — 17 ($^{9}/_{6}$ 31, isolated from twigs of *Pinus*). — 35 ($^{18}/_{10}$ 31, isolated from soil and plant remains). — 45 ($^{10}/_{5}$ 32, on twigs of *Betula*). — 47 ($^{21}/_{10}$ 31, isolated from twigs of *Alnus*). — 48 ($^{21}/_{10}$ 31, isolated from soil). — 71 ($^{5}/_{11}$ 31, isolated from soil and plant remains). — 91 ($^{14}/_{5}$ 32, isolated from twigs). — 96 ($^{11}/_{6}$ 31, isolated from a decaying potato).

Distribution: N. America, Germany, Denmark, Latvia, Japan.

Thraustotheca Humphrey. Transact. Am. Phil. Soc. 17, p. 131, 1893.

Sporangia clavate, renewed by lateral branching; Zoospores liberated by disintegration of the sporangium wall.

Thraustotheca sp.

Sometimes sporangia of the *Thraustotheca*-type were seen in cultures on ant-eggs in water, but no sexual organs. — ?*Thraustotheca clavata*, reported by Sawada (according to Nagai 1931), was also only seen in the asexual stage.

Localities: 27 ($^{12}/_{6}$ 31, isolated from twigs). — 41 ($^{1}/_{9}$ 31, isolated from bees in the water). — 80 ($^{30}/_{8}$ 30, isolated from twigs of *Alnus*). — 92 ($^{14}/_{5}$ 32, isolated from twigs of *Alnus*).

2. Leptomitaceae.

Mycelium either composed of filamentous hyphae segmented by constrictions, or consisting of a basal portion with slender more or less segmented branches bearing the reproductive organs. Zoospores with two cilia. Oogonia with one oospore (in *Apodachlya* and *Leptomitus* typical sexual organs unknown).

Key to the Genera.

I. Mycelium composed of filamentous hyphae with constrictions. Typical oogonia not known with certainty.
  1. Sporangia generally oval or pyriform .... *Apodachlya* p. 33.
  2. Sporangia cylindrical .... *Leptomitus* p. 35.

II. Mycelium divided into a basal portion and slender branches with constrictions. Sexual organs present.
  1. Basal portion cylindrical, not much thicker than the branches. Sporangia subcylindrical, mostly in whorls .... *Sapromyces* p. 35.
  2. Basal portion large, generally much thicker than the branches. Sporangia oval to elliptic .... *Rhipidium* p. 36.

Apodachlya Pringsheim. Ber. Deutsch. Bot. Ges. 1, p. 289, 1893.

Hyphae filamentous, constricted into segments. Sporangia subspherical, pyriform, oval or almost cylindrical, single or more rarely in rows. Resting spores (oogonia?) with one oospore (?) (several oospores (?) in *A. completa*).

Key to the Species.

I. Sporangia single.
  1. Sporangia 12—24 μ (up to 35 μ) × 12—20 μ (up to 31 μ) . . . . . *A. pirifera* p. 33.
  2. Sporangia 36—63 × 18—36 μ .... *A. pirifera* var. *macrosporangia* p. 33.

II. Sporangia single or in rows, 35—97 × 15—25 μ .... *A. seriata* p. 34.

Apodachlya pirifera Zopf. Nova Acta Acad. Leop. 52, p. 365, pl. 21, figs. 1—21, 1888. — Petersen in Bot. Tidsskr. 29, p. 388, 1909; in Ann. myc. 8, p. 526, 1910.

Petersen found this species in 23 places in this country. I have observed it in the following localities: 1 ($^{22}/_{3}$ 31, $^{20}/_{5}$ 31). — 3? ($^{19}/_{4}$ 31). — 11 ($^{8}/_{6}$ 31). — 28 ($^{13}/_{6}$ 31). — 29 ($^{13}/_{6}$ 31). — 35 ($^{30}/_{3}$ 30, $^{18}/_{10}$ 31). — 36 ($^{17}/_{5}$ 31, $^{5}/_{4}$ 32). — 38 ($^{11}/_{7}$ 32). — 40 ($^{9}/_{6}$ 31). — 43 ($^{3}/_{5}$ 31). — 47 ($^{18}/_{4}$ 31, $^{21}/_{10}$ 31). — 48 ($^{21}/_{3}$ 31, $^{18}/_{4}$ 31). — 49 ($^{8}/_{6}$ 30, $^{3}/_{3}$ 31). — 50 ($^{25}/_{4}$ 31). — 51? ($^{14}/_{4}$ 31). — 52 ($^{15}/_{2}$ 31). — 53 ($^{14}/_{9}$ 30, $^{10}/_{5}$ 31). — 57 ($^{20}/_{8}$ 30). — 60 ($^{24}/_{4}$ 30, $^{29}/_{12}$ 30). — 61 ($^{29}/_{12}$ 30). — 63 ($^{8}/_{3}$ 31). — 64 ($^{5}/_{4}$ 32). — 65 ($^{21}/_{3}$ 31, $^{21}/_{10}$ 31). — 66? ($^{18}/_{4}$ 31). — 67 ($^{19}/_{4}$ 31). — 68 ($^{7}/_{3}$ 31, $^{19}/_{4}$ 31). — 70 ($^{7}/_{3}$ 31, $^{19}/_{4}$ 31). — 73 ($^{26}/_{9}$ 30). — 76 ($^{31}/_{8}$ 30, $^{6}/_{9}$ 30). — 80 ($^{30}/_{8}$ 30). — 81 ($^{8}/_{4}$ 32). — 82 ($^{20}/_{9}$ 30). — 88 ($^{11}/_{5}$ 32). — 93 ($^{14}/_{5}$ 32). — 95 ($^{11}/_{6}$ 31). — 102 ($^{19}/_{4}$ 30). — 103 ($^{6}/_{4}$ 31, $^{9}/_{5}$ 31). — 105 ($^{14}/_{4}$ 30). — 106 ($^{25}/_{4}$ 31). — 107 ($^{10}/_{8}$ 30). — 109 ($^{12}/_{4}$ 30). — 117 ($^{9}/_{5}$ 31).

Distribution: N. America, England, Germany, Denmark.

Apodachlya pirifera var. **macrosporangia** Tiesenhausen. Arch. Hydrobiol. u. Planktonkd. 7, p. 295, fig. 19, 1912.

Hyphae branched, constricted into segments of various sizes. Sporangia mostly pyriform, 35—63 × 18—36 μ, averaging about 40 × 24 μ, terminal. Zoospores c. 10 μ, about 10 in a sporangium, escaping through a short terminal or somewhat lateral exit tube, remaining some time at the mouth of the sporangium before swimming away. Oogonia (?) spherical, 27—31, 5 μ in diameter, 1 oospore (?).

This variety differs from *A. pirifera* in the larger size of the reproductive organs.

Localities: 36 ($^{30}/_{3}$ 30, on twigs of *Quercus*). — 37 ($^{3}/_{5}$ 31, on twigs). — 48 ($^{18}/_{4}$ 31, on twigs). — 63 ($^{8}/_{3}$ 31, on twigs of *Alnus*). — 90 ($^{13}/_{5}$ 32, on twigs).

Distribution: Switzerland, Denmark.

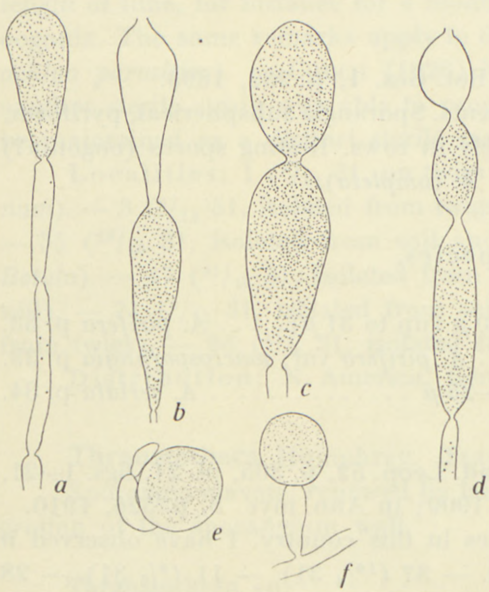

Fig. 14. *Apodachlya seriata* n. sp. *a*, A single sporangium, × 344; *b*, *c* and *d*, Sporangia in rows, b—c, × 464; d, × 344; *e* and *f*, Resting spores, e with antheridium (?), × 344.

Apodachlya seriata A. Lund n. sp. — Fig. 14.

Sporangia saepissime pyriformia vel subcylindrica, 35—97 × 15—25 μ, singula vel in seriebus ad 4. Zoosporae per collum breve evacuatae et in cumulo cavo globoso ante sporangia positae, demum liberantur. Sporae perdurantes 27—32.5 μ diam.

Hyphae branched, constricted into segments, which are 42.5—100 × 5—10 μ, mostly 70—80 × 5—8 μ. Sporangia pyriform, oval, or subcylindrical 35—97 × 15—25 μ, generally 50—60 × 20 μ, terminal on main hyphae, more rarely on lateral branches, or in rows up to four. Zoospores 10—12 μ in diameter, about 26 in a sporangium; escaping through a short apical exit tube, encysting in a hollow sphere at the mouth of the sporangium. Resting spores (oogonia?) spherical, 27—32.5 μ in diameter, generally borne on short side branches, composed of one to few short segments. 1 oospore (?). Antheridia possibly present.

This species is characterized by the long sporangia which are often in rows.

Sometimes certain organs on the oogonia (?) were observed which might possibly be antheridia; fertilizing tubes were not seen, however.

Localities: 56 ($^{16}/_{4}$ 32, on twigs of *Alnus*). — 113 (Apr. 32, on twigs; coll. Dr. H. E. Petersen).

Leptomitus Agard. Syll. Alg. 1824, p. 47.

Hyphae filamentous, constricted into long segments. Sporangia cylindrical, formed directly from segments of the hyphae. Sexual organs not observed.

Leptomitus lacteus (Roth.) Agard. Syll. Alg. 1824, p. 47.

Not observed either by PETERSEN or by me, but it has been found in Denmark by OBEL (1910 a, p. 192; 1910 b, p. 422).

Distribution: N. America, England, France, Germany, Denmark, Latvia.

Sapromyces Fritsch. Österr. Bot. Zeitschr. 43, p. 420, 1893.

Mycelium differentiated into a cylindrical basal portion with branches which are segmented by constrictions; the basal portion not much thicker than the branches. Sporangia subcylindrical, mostly arranged in whorls. Oogonia with one oospore.

Sapromyces Reinschii (Schroeter) Fritsch. Österr. Bot. Zeitschr. 43, p. 420, 1893. — Petersen in Bot. Tidsskr. 29, p. 390, fig. IV, b, c, and d, fig. V, 1909; in Ann. myc. 8, p. 527, fig. IV, b, c, and d, fig. V, 1910. — *Hyphomycetarum* Reinsch. Contrib. ad Algol. et Fungol. I, pl. 14, 1875. — *Naegelia* sp. I—II. Reinsch. Pringsh. Jahrb. wiss. Bot. 11, p. 298, pl. 15, figs. 1—11, 1878. — *Naegeliella Reinschii* Schroeter. Engler u. Prantl Nat. Pfl. Fam. I, p. 103, fig. 85, 1897. — *Rhipidium elongatum* Cornu. Ann. sci. nat. bot. sér. 5, 15, p. 15, 1872. — Fig. 15.

This species has been reported by PETERSEN from a few places in this country.

I have mostly found it on apples, but also on twigs and other vegetable substrata. It occurs in very loose, whitish tufts or mats, which are easily distinguished from those of *Rhipidium* and *Blastocladia*. It was found particularly in company with *Rhipidium* and *Gonapodya*.

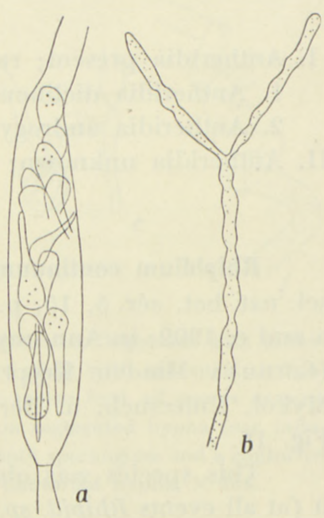

Fig. 15. *Sapromyces Reinschii*. *a*, Sporangium containing sprouting spores, × 344; *b*, Peculiar segmented hyphae, × 124.

Sporangia of this fungus are easily produced, whereas its sexual organs only were observed twice. The zoospores are liberated through a terminal opening; sometimes they germinate within the sporangia (also figured by COKER 1923, pl. 60).

The hyphae are generally straight, but once hyphae were observed which were often curved and segmented by slight constrictions different from the usual ones; these hyphae in part resembled the *interruptum*-forms of *Rhipidium*.

An attempt was made to determine the time elapsing until *Sapromyces* appeared on apples in a small lake (locality No. 45). After about one week *Pythiomorpha* *gonapodyides* and hyphae of a *Saprolegnia* were found; after about three weeks a few hyphae and sporangia of *Sapromyces Reinschii* together with *Gonapodya siliquae-formis* had appeared.

Localities: 3 ($^{13}/_{4}$ 30, on twigs; $^{16}/_{11}$ 30, on an apple). — 4 ($^{13}/_{4}$ 30, on twigs of *Betula*; $^{16}/_{11}$ 30, $^{19}/_{4}$ 31, $^{10}/_{5}$ 31, $^{12}/_{7}$ 31, on apples). — 5 ($^{9}/_{4}$ 32, on an old rhizome of *Menyanthes*). — 17 ($^{9}/_{6}$ 31, on a cone of *Pinus*). — 27 ($^{12}/_{6}$ 31, on twigs of *Alnus*). — 35 ($^{25}/_{4}$ 31, on an apple). — 45 (July 32, on an apple).

Distribution: N. America, France, Switzerland, Austria, Germany, Denmark, Latvia.

Rhipidium Cornu. Bull. soc. bot. France 18, p. 58, 1871; in Ann. sci. nat. bot. sér. 5, 15, p. 15, 1872.

Basal portion large, more or less branched or lobed, with rhizoids at its base. The slender branches generally only constricted at their point of origin and just below the reproductive organs. Sporangia terminal, oval or elliptic. Oogonia with one oospore.

Key to the Species.

I. Antheridia present; reproductive organs not arranged in umbels.
  1. Antheridia diclinous . . . . *R. continuum* p. 36.
  2. Antheridia androgynous . . . . *R. americanum* p. 37.
II. Antheridia unknown; sporangia and oogonia arranged in umbels . . . .
  R. parthenosporum p. 38.

Rhipidium continuum Cornu. Bull. soc. bot. France 18, p. 58, 1871; in Ann. sci. nat. bot. sér. 5, 15, p. 15, 1872. — Petersen in Bot. Tidsskr. 29, p. 389, fig. IV, a and e, 1909; in Ann. myc. 8, p. 526, fig. IV, a and e, 1910. — *Rhipidium europaeum* (Cornu) v. Minden. Krypt. Fl. Mark Brandenb. 5, p. 597, figs. 9 a—e, 1915; in Falck's Mykol. Untersuch. u. Ber. 2, p. 169 and 187, text figs. 3 and 5—14, pl. 2, 1916. — Fig. 16.

This species was observed by Petersen in 4 localities. — In my experience it (at all events *Rhipid. sp.*) may be found in almost all aquatic habitats. Its development on twigs and similar substrata is often restricted by the presence of other fungi, bacteria, protozoa and other organisms, and thus the examination is made difficult. The best substratum for it is apples, upon the surface of which it occurs in dense, whitish mats or tufts and attains a vigorous growth.

Rh. continuum (and also *Rh. americanum*) apparently prefer to live in small ponds and pools, which are often rich in organic matter, but they also occur in large lakes. Both of them are able to thrive in ponds densely covered with aquatic plants, particularly *Lemna*; their need of oxygen is certainly not very great.

Rh. continuum is very variable in shape. Large and vigorous individuals with long branches were found as well as small, slender specimens; sometimes plants were observed with sporangia on short, swollen branches, in part similar to those of *Rh. parthenosporum*. Moreover *Rh. continuum* var. *interruptum* (originally described by CORNU as *Rh. interruptum*) was found 4 times; this variety is distinguished by the numerous constrictions of the branches. The forming of such constrictions is probably due to external conditions. Once peculiar contorted hyphae without reproductive organs were also observed.

Localities: 3 ($^{13}/_{4}$ 30?, $^{16}/_{11}$ 30, on apples). — 49 ($^{26}/_{9}$ 30, on twigs of *Fraxinus*; $^{8}/_{6}$ 30 and $^{1}/_{11}$ 30, on apples). — 51 ($^{27}/_{9}$ 30?, on twigs of *Fraxinus*; $^{7}/_{11}$ 30, $^{15}/_{2}$ 31, $^{14}/_{3}$ 31, $^{29}/_{11}$ 31, on apples). — 81 ($^{8}/_{4}$ 32, on twigs of *Aesculus*). — With doubt: 2 ($^{17}/_{4}$ 31, on an apple). — 4 ($^{16}/_{11}$ 30, on an apple). — 35 ($^{1}/_{11}$ 30, $^{25}/_{4}$ 31, on apples). — 47 ($^{16}/_{12}$ 30, on an apple). — 50 ($^{1}/_{11}$ 30, $^{25}/_{4}$ 31, on apples). — 54 ($^{18}/_{4}$ 31, on an apple). — 60 ($^{21}/_{4}$ 30, on an apple). — 62 ($^{19}/_{2}$ 31, on an apple). — 63 ($^{25}/_{4}$ 31, on an apple). — 74 ($^{5}/_{4}$ 32, on twigs of *Populus*). — 78 ($^{23}/_{11}$ 30, on an apple). — 82 ($^{20}/_{9}$ 30, on twigs of *Fraxinus*).

In addition indeterminable species of *Rhipidium* (*Rh. continuum* or *Rh. americanum*) were found in the following localities: 36 ($^{5}/_{4}$ 32, on an apple). — 64 ($^{5}/_{4}$ 32, on an apple). — 65 ($^{16}/_{12}$ 30, on an apple). — 66 ($^{18}/_{4}$ 31, on twigs). — 88 ($^{11}/_{5}$ 32, on twigs). — 102 ($^{30}/_{5}$ 31, on an apple). — 118 ($^{2}/_{6}$ 31, on an apple).

Distribution: N. America, France, Bulgaria, Germany, Denmark.

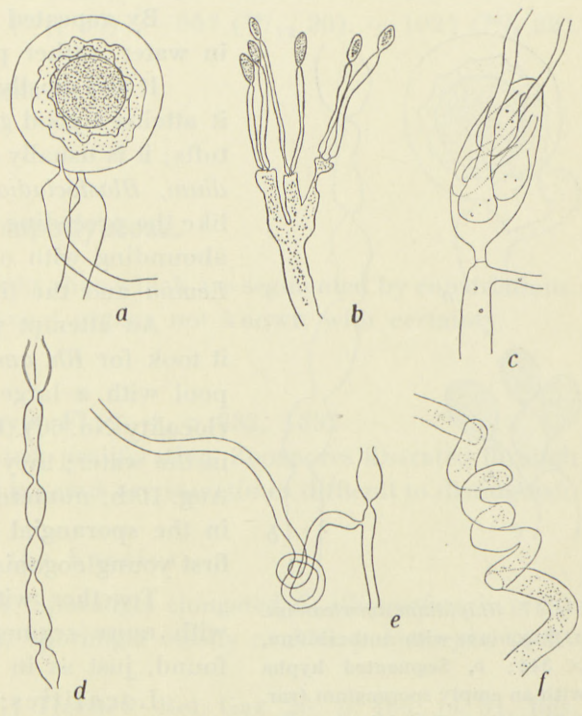

Fig. 16. *Rhipidium continuum*. *a*, Oogonium with antheridium, × 344; *b*, Part of plant with sporangia; *c*, Sporangium with sprouting spores (not all spores drawn), × 344; *d*, Sporangium on segmented hypha (var. *interruptum*), × 124; *e*, An empty sporangium and a contorted hypha, × 124; *f*, Contorted hypha, × 344.

Rhipidium americanum Thaxter. Bot. Gaz. 21, p. 320, pls. 21 and 22, figs. 1—15, 1896. — v. Minden in Krypt. Fl. Mark Brandenb. 5, p. 599, 1915; in Falck's Mykol. Untersuch. u. Ber. 2, p. 182 and 188, pl. 3, figs. 21, 1916. — Fig. 17, a—b.

Basal portion very variable in shape and size, for instance 56—189 μ thick, slender or broad and monstrously swollen, more or less branched or lobed. Length of the branches bearing the reproductive organs also very variable; they are provided with constrictions at their point of origin and below the sporangia and oogonia. Sporangia ovoid-oval, 42—56 × 28—35 μ, mostly terminal. Oogonia spherical, 42—49 μ in diameter, terminal. One oospore, about 35 μ in diameter, furnished with ridges and thickenings, when mature. Antheridia androgynous, arising from the oogonial stalks just below the oogonia; fertilizing tubes often distinct.

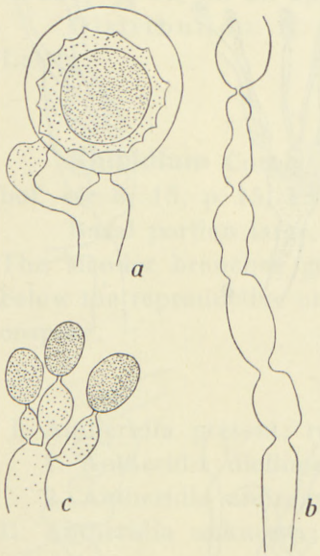

Fig. 17. *Rhipidium americanum. a*, Oogonium with antheridium, × 344; *b*, Segmented hypha with an empty sporangium (var. *interruptum*). *Rhipidium parthenosporum. c*, Sporangia, × 124.

By repeated transfers to apples and fruits of rose in water, rather pure cultures were obtained.

It was mostly found on apples on the surface of which it attains a good growth, forming dense, whitish mats or tufts; it is usually accompanied by other species of *Rhipidium, Blastocladia, Sapromyces,* or *Macrochytrium.* Just like the preceding species, it often occurs in small ponds abounding with organic matter and often covered with *Lemna* and the like.

An attempt was made to find out how much time it took for *Rh. americanum*(?)[1] to appear on apples in a pool with a large content of decaying plant substances (locality No. 60). On Aug. 1st, 32 the apples were placed in the water; they were examined at short intervals. On Aug. 10th, numerous small tufts consisting of *Rhipidium* in the sporangial stage were present; on Aug. 24th the first young oogonia were observed.

Together with the typical *Rh. americanum* plants with more segmented branches than usual were once found, just as in *Rh. continuum* var. *interruptum.*

Localities: 1 ($^{20}/_{5}$ 31). — 4 ($^{16}/_{11}$ 30, $^{10}/_{5}$ 31, $^{12}/_{7}$ 31?). — 35 ($^{30}/_{11}$ 30?, $^{25}/_{4}$ 31). — 36 ($^{25}/_{4}$ 31). — 47 ($^{21}/_{3}$ 31). — 52 ($^{9}/_{5}$ 31). — 62 ($^{14}/_{4}$ 31). — 102 ($^{26}/_{8}$ 32). On apples. — With doubt: 2 ($^{17}/_{4}$ 31, on an apple). — 49 ($^{1}/_{11}$ 30, on an apple). — 50 ($^{1}/_{11}$ 30, on an apple). — 51 ($^{7}/_{11}$ 30, $^{14}/_{4}$ 31, on apples). — 60 (Aug. 32, on an apple). — 107 ($^{10}/_{8}$ 30, on twigs of *Alnus*).

Distribution: N. America, Germany, Denmark, Latvia.

Rhipidium parthenosporum Kanouse. Am. Jour. Bot. 14, p. 344, pl. 48, figs. 34—37, 1927. — Fig. 17, c.

Basal portion slender, for instance 700 × 30 μ, slightly branched; the branches bearing the reproductive organs short, enlarged, arranged in umbels with constrictions at the base and below the sporangia and oogonia. Sporangia oval, 32—58

[1] Antheridia were not observed with certainty, so the fungus was possibly *Rh. continuum.*

$\times$ 25—35 μ, produced terminally on the short branches. Oogonia spherical, arranged in the same manner as the sporangia. Antheridia unknown.

The sporangia observed by me were smaller than those described by KANOUSE (50—60 $\times$ 34—50 μ); mature oogonia were not seen, but spherical organs were present which were probably young oogonia.

It occurred in dense mats or loose tufts.

Localities: 47 (${}^{21}/_{3}$ 31). — 49 (${}^{1}/_{11}$ 30). — 65? (${}^{16}/_{12}$ 30). — 102? (${}^{26}/_{8}$ 32). On apples.

Distribution: N. America, Denmark.

3. Gonapodyaceae.

Mycelium composed of filamentous hyphae which are segmented by constrictions. Zoospores usually with one cilium. Sexual organs not known with certainty.

Gonapodya Fischer. Rabenh. Krypt. Fl. 1, 4, p. 382, 1892.

Sporangia terminal, oval to elongated, proliferating. Zoospores liberated through a terminal pore. — The two species in this genus are sometimes difficult to distinguish.

Key to the Species.

I. Hyphae with numerous constrictions. Sporangia elongated *G. siliquaeformis* p. 39.
II. Hyphae often with few constrictions. Sporangia mostly oval *G. polymorpha* p. 39.

Gonapodya siliquaeformis (Reinsch) Thaxter. Bot. Gaz. 20, p. 480, pl. 31, figs. 6—10, 1895. — Petersen in Bot. Tidsskr. 29, p. 397, fig. XI, 1909; in Ann. myc. 8, p. 533, fig. XI, 1910.

Found by PETERSEN in 6 places in northern Sealand; I have observed it in the following localities: 1 (${}^{20}/_{5}$ 31). — 45 (July 32). — 47? (${}^{21}/_{10}$ 31). — 51 (${}^{27}/_{9}$ 30). — 59 (${}^{11}/_{6}$ 31). — 62 (${}^{19}/_{12}$ 30). — 76 (${}^{31}/_{8}$ 30). — 80 (${}^{30}/_{8}$ 30). — 82 (${}^{20}/_{9}$ 30). — 85 (${}^{27}/_{7}$ 32).

Distribution: N. America, England, France, Bulgaria, Germany, Denmark, Latvia.

Gonapodya polymorpha Thaxter. Bot. Gaz. 20, p. 481, pl. 31, figs. 11—16, 1895 — Petersen in Bot. Tidsskr. 29, p. 398, figs. XII, XIII, and XIV, 1909; in Ann. myc. 8, p. 534, figs. XII, XIII, and XIV, 1910.

PETERSEN has reported this species from 9 localities; it was found by me in the following localities: 5 (${}^{9}/_{4}$ 32). — 16 (${}^{9}/_{6}$ 31). — 35 (${}^{11}/_{10}$ 30). — 36? (${}^{5}/_{4}$ 32).

— 49 ($^{11}/_{10}$ 30, $^{26}/_{9}$ 30?). — 51 ($^{27}/_{9}$ 30). — 53 ($^{14}/_{9}$ 30, $^{19}/_{4}$ 31, $^{10}/_{5}$ 31). — 57 ($^{20}/_{8}$ 30). — 60 ($^{21}/_{4}$ 30, Oct. 30). — 76? ($^{21}/_{8}$ 30). — 81 ($^{8}/_{4}$ 32).

Distribution: N. America, England, Germany, Denmark, Latvia, Finland.

4. Blastocladiaceae.

Mycelium consisting of a basal cell with rhizoids. Constrictions do not occur. Zoospores generally with one cilium. Resting spores (oogonia?) present.

Recently Kniep (1929) has pointed out the presence of zoosporangia, resting spores, ♂ and ♀ gametangia with uniciliate gametes in *Allomyces*; accordingly the *Blastocladiaceae* — at all events *Allomyces* — would seem to be closely related to the *Monoblepharidaceae*. *Allomyces* is said to have a regular alternation of generation (Kniep 1930).

Blastocladia Reinsch. Pringsh. Jahrb. wiss. Bot. 9, p. 298, 1878.

Basal portion branched or unbranched. Zoospores usually with one cilium. Peculiar resting spores (oogonia?). Antheridia absent (said to be present in *B. globosa* Kanouse, 1927).

Hitherto 8 species of *Blastocladia* have been described; in addition to these a new species is described in this paper. They may be divided into two groups: 1) The *Pringsheimii*-group, in which the basal cell is large, more or less swollen, unbranched or with few branches; it contains *B. Pringsheimii* Reinsch, *B. prolifera* v. Minden, *B. globosa* Kanouse, and *B. truncata* Sparrow. 2) The *Ramosa*-group, in which the basal cell is slender and frequently much branched, includes *B. ramosa* Thaxter, *B. rostrata* v. Minden, *B. gracilis* Kanouse, *B. tenuis* Kanouse (which is unbranched or only a little branched), and probably also *B. angusta* A. Lund n. sp.

Key to the Species.

I. Basal portion more or less — often much — swollen, unbranched or slightly branched . . . . *B. Pringsheimii* p. 40.

II. Basal portion slender, not swollen, generally much branched.
1. Sporangia 49—95 × 25—40 μ . . . . *B. rostrata* p. 42.
2. Sporangia 72—150 × 23—30 μ; the whole plant longer and more slender *B. gracilis* p. 43.
3. Sporangia long and thin, 60—185 × 6—14 μ. Plant very slender . . . . *B. angusta* p. 44.

Blastocladia Pringsheimii Reinsch. Pringsh. Jahrb. wiss. Bot. 11, p. 298, pl. 16, figs. 1—10, 1878. — Petersen in Bot. Tidsskr. 29, p. 395, fig. X, 1909; in Ann. myc. 8, p. 532, fig. X, 1910. — v. Minden in Krypt. Fl. Mark Brandenb. 5, p. 603, 1915; in Falck's Mykol. Untersuch. u. Ber. 2, p. 189 and 211, text figs. 15—17, pl. 4, figs. 25—33, 1916. — Fig. 18.

This species has been reported by PETERSEN from 4 places in northern Sealand. I have ascertained its presence in several localities, particularly in pools and ponds with stagnant water which often abound with organic matter. In such habitats it thrives well even if the surface of the water is covered by a dense layer of aquatic plants, such as *Lemna*; apparently it does not require much oxygen. On the other hand it also occurs in large lakes. I have found it all the year round, and often under the ice.

On twigs and the like this species generally does not thrive very well owing to the presence of other organisms; among the Phycomycetes accompanying it, *Rhipidium* is "stronger" than *Blastocladia*, often conquering and entirely ousting it.

On apples *B. Pringsheimii* attains a vigorous growth. It occurs in dense, whitish tufts.

It was tried to determine the time it takes for it to appear on apples:

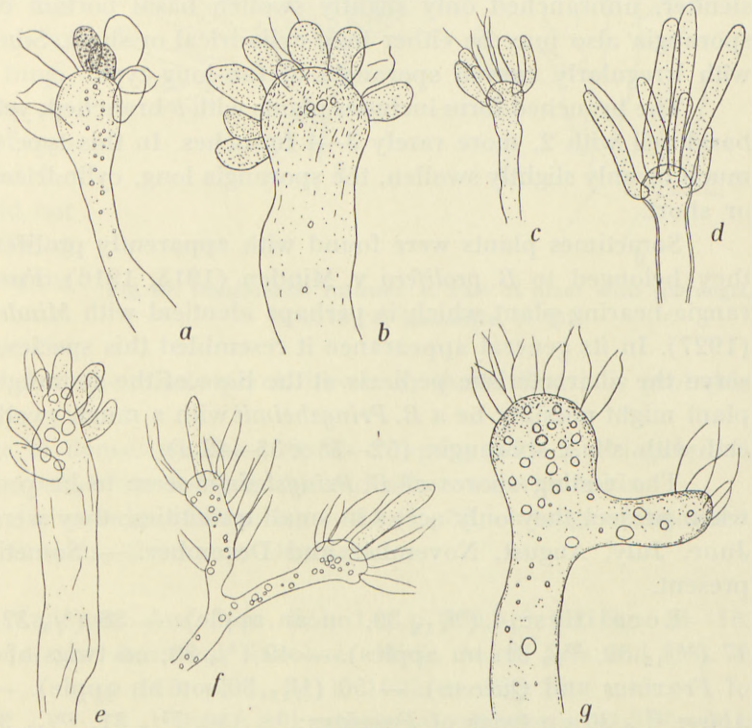

Fig. 18. *Blastocladia Pringsheimii. a*, Unbranched basal cell, resting spores, and short sporangia; *b*, Large unbranched basal cell, short sporangia *(Mindeniella spinospora ?)*; *c*, Slender, unbranched basal cell; sterile filaments present; *d*, Unbranched basal cell, long sporangia; *e*, Unbranched basal cell, short sporangia; *f*, Branched basal cell, long sporangia; *g*, Large, branched basal cell. — × 124.

1. Pool with stagnant water, large content of decaying plant substances (locality No. 60): On Aug. 1st, 32 some apples were placed in the water; on Aug. 10th tufts of *Rhipidium* were found; on Aug. 15th a few sporangia-bearing plants of *B. Pringsheimii* were observed.
2. Large lake (locality No. 85). In this case about 3 weeks passed (July 4th to July 27th, 32) before *B. Pringsheimii* appeared (plants with sporangia and a few resting spores); it was accompanied by *Gonapodya siliquaeformis*, *Pythiomorpha gonapodyides*, and *Pythiogeton utriforme*.

B. Pringsheimii varies very much in shape and size. Two forms may be distinguished, one with unbranched and another with slightly branched basal cell. In the form with unbranched basal portion the plants are vigorous with a much swollen basal cell, which bears either long, cylindrical sporangia, about 100—210 × 13—35 μ, or short sporangia which may be nearly cylindrical, for instance 57 × 10 μ, or only about twice as long as broad, 33—66 × 16—40 μ. In addition forms with a more slender, unbranched only slightly swollen basal portion occur; in these plants the sporangia also may be either long cylindrical or short. Sometimes plants were found with irregularly curved sporangia of the long type.

The branched form includes plants with a branched, yet always slightly branched, basal cell with 2, more rarely 3—4 branches. In this type too the basal cell may be much or only slightly swollen, the sporangia long, cylindrical (for instance 212 × 28 μ), or short.

Sometimes plants were found with apparently proliferating sporangia; possibly they belonged to *B. prolifera* v. Minden (1915, 1916). Further I once found a sporangia-bearing plant which is perhaps identical with *Mindeniella spinospora* Kanouse (1927). In its general appearance it resembled this species, but I was unable to observe the characteristic pedicels at the base of the sporangia. On the other hand this plant might possibly be a *B. Pringsheimii* with a much swollen and unbranched basal cell with short sporangia (52—78 × 33—42 μ).

The resting spores of *B. Pringsheimii* seem to be produced rather rarely, and when present they only occur in small quantities; they were found in January, May, June, July, August, November and December. — Sometimes sterile filaments are present.

Localities: 4 ($^{16}/_{11}$ 30, on an apple). — 36 ($^{5}/_{4}$ 32, on twigs of *Quercus*). — 47 ($^{16}/_{12}$ 30, $^{21}/_{3}$ 31, on apples). — 49 ($^{8}/_{6}$ 30, on twigs of *Populus*; $^{26}/_{9}$ 30, on twigs of *Fraxinus* and *Quercus*). — 50 ($^{1}/_{11}$ 30, on an apple). — 51 ($^{20}/_{5}$ 30, on twigs of *Abies*; $^{27}/_{9}$ 30 on twigs of *Fraxinus*; $^{7}/_{11}$ 30, $^{15}/_{2}$ 31, $^{29}/_{11}$ 31, on apples). — 53 ($^{10}/_{5}$ 31, on an apple). — 54 ($^{18}/_{4}$ 31, on an apple). — 60 ($^{12}/_{1}$ 30, $^{21}/_{4}$ 30, on apples; Oct. 30, $^{29}/_{12}$ 30 on twigs; $^{24}/_{8}$ 32, on an apple). — 62 ($^{30}/_{3}$ 30, $^{14}/_{4}$ 31, on apples). — 63 ($^{25}/_{4}$ 31, on an apple). — 65 ($^{16}/_{12}$ 30, $^{18}/_{4}$ 31, on apples). — 66 ($^{18}/_{4}$ 31, on an apple). 74 ($^{5}/_{4}$ 32, on twigs of *Populus*). — 78 ($^{23}/_{11}$ 30, on an apple). — 80 ($^{16}/_{4}$ 32, on a rhizome of *Nymphaea*). — 81 ($^{8}/_{4}$ 32, on twigs of *Aesculus*). — 85 ($^{27}/_{7}$ 32, on an apple). — 88 ($^{11}/_{5}$ 32, on a rhizome of *Nuphar*). — 102 ($^{30}/_{5}$ 31, $^{26}/_{8}$ 32, on apples). — 103 (Aug. 32, on an apple). — 107 ($^{10}/_{8}$ 30, on twigs of *Alnus*).

Distribution: N. America, England (?), Bulgaria, Germany, Denmark.

Blastocladia rostrata v. Minden. Krypt. Fl. Mark Brandenb. 5, p. 604, 1915; in Falck's Mykol. Untersuch. u. Ber. 2, p. 195 and 211, text figs. 18 and 19, pl. 4, figs. 34 and 35, 1916. — Kanouse in Am. Jour. Bot. 14, p. 299, 1927. — Fig. 19.

Basal cell almost cylindrical, about 40—63 μ thick, copiously branched in a dichotomous manner. Rhizoids rather stout. Sporangia generally subcylindrical, 45—95 × 25—40 μ, produced terminally or laterally on the branches. Zoospores 7.5—10 μ, escaping through a terminal opening. Sterile filaments absent.

The examination of this plant was rendered difficult by the presence of other fungi. Cultures were obtained by repeated transfers to fruits of rose in water. It was cultivated for about 2 months, but it did not produce resting spores. Owing to the absence of these organs it can only with some doubt be referred to *B. rostrata*; the shape of the sporangia and of the whole plant, however, shows that it is probably identical with this species.

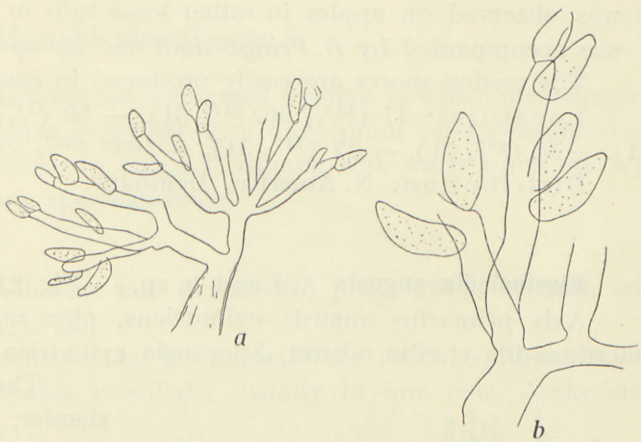

Fig. 19. *Blastocladia rostrata. a,* Part of plant with sporangia, × c. 75; *b,* Sporangia, × 155.

It occurred on twigs in dense, whitish tufts in company with *B. Pringsheimii, Rhipidium continuum, Macrochytrium botrydioides* and other water moulds.

Localities: 74 ($^5/_4$ 32, on twigs of *Populus*). — 81 ($^8/_4$ 32, on twigs of *Aesculus*).

Distribution: N. America, Germany, Denmark.

Blastocladia gracilis Kanouse. Am. Jour. Bot. 14, p. 300, pl. 33, figs. 14—16, 1927. — *Blastocladia ramosa* var. *luxurians* Kanouse. Mich. Acad. Arts and Lett. 5, p. 113, pl. 1, fig. 1, 1925. — Fig. 20.

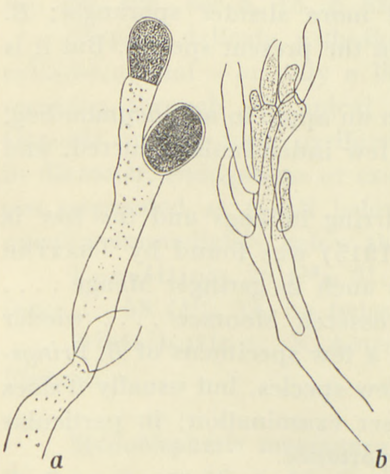

Fig. 20. *Blastocladia gracilis. a,* Branch with resting spores, × 344; *b,* Part of plant with sporangia.

Basal cell cylindrical, slender, about 50—80 μ thick, more or less — often copiously — branched. Not very many rhizoids. Sporangia cylindrical, 72—150 × 23—30 μ, terminal or lateral. Zoospores escaping through a terminal opening. No sterile filaments. Resting spores subspherical-oval, 40—66 × 20—39 μ.

This fungus agrees in all essentials with Kanouse's description of *B. gracilis*; sometimes the plants observed by me were more branched than those figured in the original descriptions. *B. gracilis* was possibly observed by Petersen (1909, p. 396, fig. X, d; 1910, p. 532, fig. X, d) who figures a form of *B. Pringsheimii* "with slender . . . branched basal cell."

I have found this species in several places, but it is not nearly as common as *B. Pringsheimii.*

It was observed on apples in rather loose tufts or mats of a violet tinge; generally it was accompanied by *B. Pringsheimii* and by species of *Rhipidium*.

The resting spores are easily produced in contrast to those of *B. Pringsheimii*.

Localities: 47 ($^{16}/_{12}$ 30, $^{21}/_{3}$ 31). — 50 ($^{1}/_{11}$ 30). — 51 ($^{29}/_{11}$ 31). — 52 ($^{14}/_{3}$ 31). — 54 ($^{18}/_{4}$ 31). — 62 ($^{14}/_{3}$ 31). — 102? ($^{26}/_{8}$ 32). — 103? (Aug. 32). On apples.

Distribution: N. America, Denmark.

Blastocladia angusta A. Lund n. sp. — Fig. 21.

Axis primarius anguste cylindricus, plus minus ramosus, c. 150 × 14—28 μ. Interdum fila sterilia adsunt. Sporangia cylindrica, longa, 60—185 × 6—14 μ.

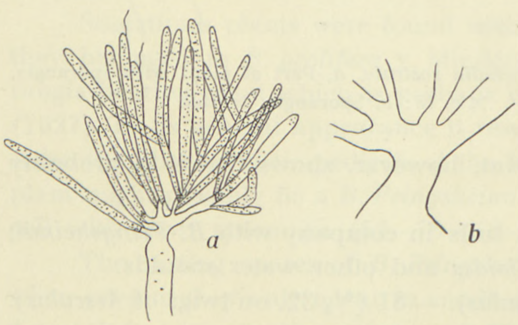

Fig. 21. *Blastocladia angusta* n. sp. *a*, Plant with sporangia, × 129; *b*, Upper part of the basal cell showing branching, × 580.

The whole plant very delicate and slender, attached to the substratum by means of thin branched rhizoids. Basal portion slender, cylindrical, for instance 150 μ long, 14—28 μ thick, more or less branched. Sporangia long, cylindrical, 60—185×6—14 μ. Zoospores set free through a terminal opening. Sterile filaments sometimes present. Resting spores not observed.

This species is distinguished by its slender, more or less branched basal portion and its long, thin sporangia. I presume that it belongs to the *Ramosa*-group. It differs from *B. ramosa* in the longer and more slender sporangia; *B. gracilis* and *B. rostrata* are altogether much larger than the present species. But it is also in some degree resembling *B. Pringsheimii*.

It was found once in small dense, whitish tufts on an apple in a *Sphagnum* bog, in company with *Sapromyces* and *Rhipidium*. Only a few individuals occurred, and only in the sporangial stage.

The only species of *Blastocladia* otherwise occurring in bogs and the like is probably *B. ramosa* which according to v. Minden (1915) was found by Thaxter in "einem mit Sphagnum bewachsenen Sumpf, wenn auch in geringer Menge . . . . Ich selbst (v. Minden) habe sie einmal in einem grösseren Moorsee . . . . wieder gefunden, aber auch nicht in so grosser Menge." Yet, a few specimens of *B. Pringsheimii* were also found once in the same bog as the new species, but usually it does not occur in such localities. *B. angusta* requires closer examination; in particular the observation of its resting spores would be of importance.

Localities: 4 ($^{16}/_{11}$ 30, on an apple).

5. Monoblepharidaceae.[1]

Mycelium consisting of filamentous not segmented hyphae, in which the structure of the plasma is reticular. Zoospores generally with one cilium (*Monoblepharis*) or two cilia (*Diblepharis*). Oogonia with one oospore, usually with warts when mature. Fertilization by means of uniciliate spermatozoids.

Monoblepharis Cornu. Bull. soc. bot. France 18, p. 59, 1871; in Ann. sci. nat. bot. sér. 5, 15, p. 15 and 82, 1872.

The cytoplasma of the hyphae has a characteristic reticular appearance. Sporangia long, cylindrical; zoospores uniciliate, usually in one row. Antheridia hypogynous or epigynous.

Key to the Species.

I. Antheridia hypogynous. Oospores endogenous or exogenous *M. sphaerica* p. 45.
II. Antheridia separated from the oogonia, or hypogynous. Oospores exogenous *M. macrandra* p. 45.
III. Antheridia mostly epigynous. Oospores exogenous.
  1. Antheridia on the upper part of the oogonia; oogonial wall rounded at the point of insertion .... *M. polymorpha* p. 46.
  2. Antheridia on the lower part of the oogonia; oogonial wall with an interruption at the point of insertion .... *M. brachyandra* p. 46.

Monoblepharis sphaerica Cornu. Bull. soc. bot. France 18, p. 59, 1871; in Ann. sci. nat. bot. sér. 5, 15, p. 82, pl. 2, figs. 1—6, 1872. — Fig. 22, a—c.

Hyphae delicate with the typical structure of the cytoplasma. Sporangia long cylindrical, not — or only a little — thicker than the hyphae. Zoospores about 10 μ, escaping through an apical opening, sometimes germinating in the sporangium. Oogonia mostly long pyriform or elongated. One oospore, spherical, about 17.5 μ in diameter, endogenous or exogenous, when mature with warts. Antheridia hypogynous, separated as a cell below the oogonium; spermatozoids liberated through an opening immediately below the oogonium.

Localities: 28 ($^{13}/_{6}$ 31, on twigs of *Picea*). — 51 (Aug. 33, on twigs of *Fraxinus*). — 58 ($^{14}/_{5}$ 32, on twigs). — 59 ($^{11}/_{6}$ 31, on twigs).

Distribution: N. America, England, France, Germany, Denmark, Latvia, Finland.

Monoblepharis macrandra (Lagerh.) Woronin. Mém. de l'Acad. impér. sci. de St. Petersbourg 16, p. 13, figs. on pls. 2 and 3, 1904. — *Monoblepharis polymorpha* var. *macrandra* Lagerheim. Bihang K. Svenska Vet.-Akad. Handl. 25, Afd. 3, No. 8,

[1] Recently a taxonomic treatment of the *Monoblepharidales* has been given by Sparrow (1933).

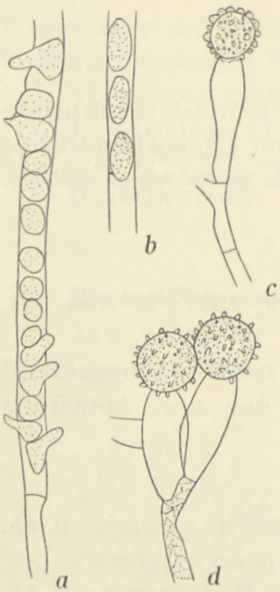

Fig. 22. *Monoblepharis sphaerica*, *a*, Sporangium containing sprouting spores; *b*, Part of sporangium with zoospores; *c*, Empty oogonium with mature oospore and antheridium. *Monoblepharis polymorpha*. *d*, Two oogonia, oospores, and an antheridium. — × 430.

p. 35, figs. on pls. 1 and 2, 1900. — Petersen in Bot. Tidsskr. 29, p. 399, fig. XV, c, 1909; in Ann. myc. 8, p. 535, fig. XV, c, 1910.

Petersen has found this species in 6 localities in northern Sealand; I have not observed it.

Distribution: N. America, England, Germany, Hungary, Switzerland, Denmark, Sweden, Finland.

Monoblepharis polymorpha Cornu. Bull. soc. bot. France 18, p. 59, 1871; in Ann. sci. nat. bot. sér. 5, 15, p. 83, pl. 2, figs. 7—32, 1872. — Fig. 22, d.

Hyphae and sporangia as usual in *Monoblepharis*. Oogonia pyriform or elliptic; one oospore, spherical, about 22.5 μ, provided with warts at maturity, exogenous. Antheridia epigynous, arising from the upper part of the oogonia.

This species was found in April, May, June, August, and September; often it is impossible to determine species of *Monoblepharis* because the forming of their sexual organs is sometimes made difficult; apparently the oogonia are chiefly produced in the spring.

Localities: 51 (Aug. 33, on twigs of *Fraxinus*). — 58 ($^{14}/_{5}$ 32, on twigs). — 59 ($^{11}/_{6}$ 31, on twigs). — 63 ($^{5}/_{4}$ 32, on twigs of *Alnus*). — 95 ($^{11}/_{6}$ 31, on twigs of *Alnus*). — 115 ($^{20}/_{9}$ 30, on twigs of *Alnus*).

Indeterminable species were found on twigs of *Alnus, Populus, Quercus, Betula, Fraxinus, Fagus*(?), *Picea*, and *Abies* in the following localities: 35 ($^{11}/_{10}$ 30). — 36 ($^{4}/_{5}$ 30). — 47 ($^{18}/_{4}$ 31). — 49 ($^{8}/_{6}$ 30, $^{3}/_{3}$ 31). — 52 ($^{27}/_{9}$ 30, $^{15}/_{2}$ 31). — 53 ($^{10}/_{2}$ 31, $^{19}/_{4}$ 31). — 55 ($^{25}/_{4}$ 31). — 57 ($^{12}/_{4}$ 30). — 68 ($^{19}/_{4}$ 31). — 76 ($^{31}/_{8}$ 30, $^{6}/_{9}$ 30). — 80 ($^{30}/_{8}$ 30). — 88 ($^{11}/_{5}$ 32). — 102 (Apr. 30). — 103 ($^{6}/_{4}$ 31, $^{13}/_{5}$ 31). — 108 ($^{12}/_{4}$ 30). — 109 ($^{12}/_{4}$ 30). — 114 ($^{13}/_{5}$ 30). — 117 ($^{9}/_{5}$ 31).

Distribution: N. America, England, France, Switzerland, Austria, Germany, Denmark, Latvia, Finland.

Monoblepharis brachyandra Lagerheim. Bihang K. Svenska Vet.-Akad. Handl. 25, Afd. 3, No. 8, p. 37, figs. on pl. 1 and 2, 1900. — Petersen in Bot. Tidsskr. 29, p. 400, fig. XV, a and b, 1909; in Ann. myc. 8, p. 536, fig. XV, a and b, 1910.

Mentioned by Petersen from 2 places in Sealand. I have observed it with some doubt in locality 103 ($^{6}/_{4}$ 31).

Distribution: N. America, Germany, Denmark, Sweden, Latvia.

6. Pythiaceae.

Mycelium consisting of filamentous hyphae without constrictions, which in some cases are undulated and sometimes provided with a few septa. Zoospores with two cilia. Oogonia with one oospore.

Key to the Genera.

I. Zoospores formed within the sporangium. Sporangia symmetrical . . . . *Pythiomorpha* p. 47.

II. Zoospores differentiated outside the sporangium.

1. The contents of the sporangium discharged into a vesicle, in which the zoospores are differentiated. Sporangia symmetrical . . . . *Pythium* p. 50.
2. The contents of the sporangium discharged into a long vesicle; at the rupture of the vesicle the plasma passes into the water, later on the zoospores are differentiated. Sporangia often asymmetrical . . . *Pythiogeton* p. 53.

Pythiomorpha H. E. Petersen. Bot. Tidsskr. 29, p. 391, 1909; in Ann. myc. 8, p. 528, 1910.

Sporangia symmetrical. Zoospores differentiated in the sporangium. Sexual organs rarely produced.

This genus, originally placed in a distinct family, *Pythiomorphaceae*, by PETERSEN, is now generally referred to the *Pythiaceae* due to its undoubted relation to other genera in this family, especially to *Phytophthora*. *Pythiomorpha gonapodyides* Petersen has even been placed in *Phytophthora* by BUISMAN (1927). This fungus as well as the other species of *Pythiomorpha* (*P. undulata* Apinis, *P. Oryzae* Ito and Nagai, *P. Miyabena* Ito and Nagai) possess many points of resemblance to *Phytophthora*. They differ, however, from the latter as described by DE BARY (according to FISCHER 1892) in the absence of typical conidia and in the frequent proliferation of the sporangia[1].

Key to the Species.[2]

II. Hyphae not undulated. Sporangia about $45 \times 22\ \mu$ . . . . *P. gonapodyides* p. 47.
I. Hyphae often undulated. Sporangia $45—117 \times 35—43\ \mu$ . . . . . . *P. undulata* p. 48.

Pythiomorpha gonapodyides H. E. Petersen. Bot. Tidsskr. 29, p. 391, figs. VI and VII, 1909; in Ann. myc. 8, p. 528, figs. VI and VII, 1910.

Reported by PETERSEN from 3 places in Sealand. In my experience it is common in Sealand as well as in Jutland. It was observed on twigs of *Alnus*, *Betula*,

[1] Moreover, according to KANOUSE (1927) the zoospores of *Pythiomorpha* are diplanetic in contradistinction from the monoplanetic ones of *Phytophthora*.

[2] In addition 3 undetermined species are mentioned (p. 49).

and *Quercus*, and on apples; it often occurs in pools and small ponds, frequently in company with *Rhipidium* and *Blastocladia*. Sexual organs have not been found with certainty in nature, but they have been observed in cultures by Kanouse (1925b).

Localities: 36? ($^5/_4$ 32). — 45 (July 32). — 47 ($^{21}/_3$ 31). — 50 ($^3/_3$ 31). — 51 ($^7/_{11}$ 30). — 52 ($^{14}/_3$ 31). — 53 ($^{10}/_5$ 31). — 59 ($^{11}/_6$ 31). — 60 (Jan. 30, Oct. 30). — 62 ($^{30}/_{10}$ 30, $^{14}/_4$ 31). — 63 ($^{25}/_4$ 31). — 75 ($^{10}/_2$ 31). — 85 ($^3/_7$ 32, $^{27}/_7$ 32). — 95 ($^{11}/_6$ 31). — 101 ($^{29}/_8$ 32). — 102 ($^{19}/_4$ 30). — 103 ($^6/_4$ 31?, $^{29}/_8$ 32). — 113? (Apr. 32, coll. Dr. H. E. Petersen). — 117 ($^9/_5$ 31).

Distribution: N. America, England, Germany, Denmark.

Pythiomorpha undulata Apinis. Acta Horti Bot. Univ. Latv. 4, p. 234, text fig. 4, 1929. — Fig. 23.

Hyphae about 6—7.5 μ thick, often undulated, slightly branched, when old often yellowish and sometimes with a few septa; on staining with chloriodide of zinc they become a reddish-violet colour. Sporangia usually oval, 45—117 × 35—43 μ, frequently about 70 × 40 μ, terminating the main hyphae or on side branches, often borne on

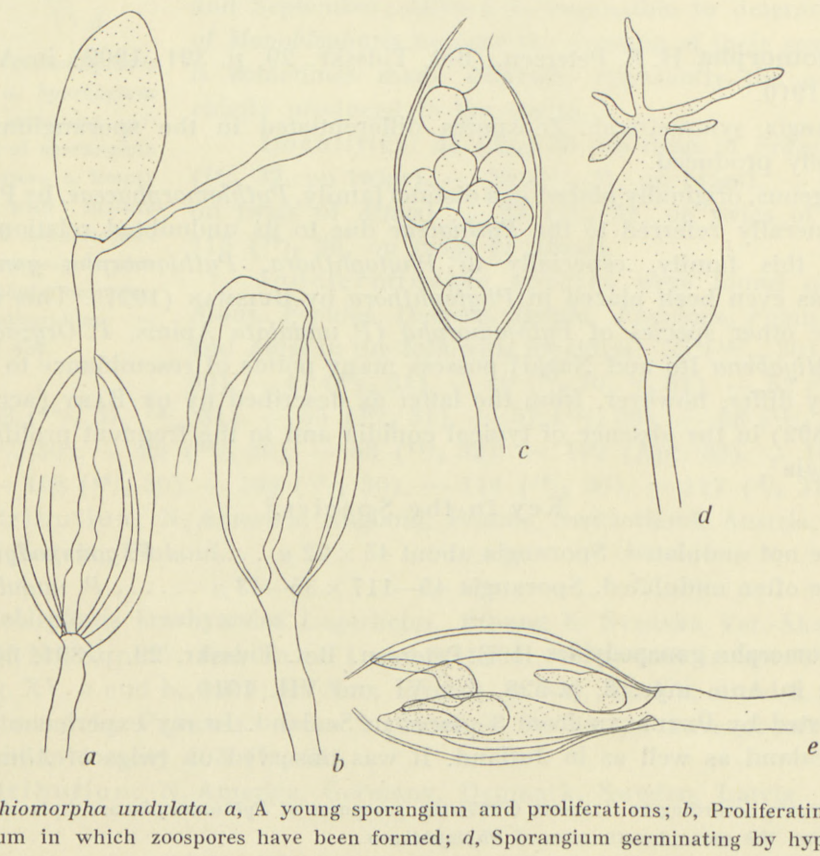

Fig. 23. *Pythiomorpha undulata*. *a*, A young sporangium and proliferations; *b*, Proliferating sporangia; *c*, Sporangium in which zoospores have been formed; *d*, Sporangium germinating by hyphae; *e*, Sporangium containing sprouting spores. — × 430.

hyphae arising just below other sporangia; proliferations frequent. Zoospores, about 15, formed in the sporangium, c. 14 μ, escaping through a terminal opening; sometimes sprouting in the sporangium. In some cases the sporangia germinate by means of hyphae. Sexual organs not observed.

In Apinis's opinion *Pythium undulatum* H. E. Petersen is the same as the fungus under consideration. In spite of the great morphological resemblance of these species, they are probably different; according to Petersen (1909, 1910) the zoospores of *Pythium undulatum* are differentiated in a vesicle, which never occurs in *Pythiomorpha undulata*. I myself have once seen a sporangium at the mouth of which the zoospores were lying in a vesicle; this fungus was probably *Pythium undulatum*. But most of the sporangia observed were of the *Pythiomorpha*-type. On the other hand, *Pythiomorpha undulata* is regarded as a synonym of *Pythium undulatum* by Sparrow (1932).

Pythiomorpha undulata is common in bogs, occurring in company with *Aplanes*, *Saprolegnia delica*, *S. litoralis* and other water moulds.

In regard to the localities below it is to be noted that the liberation of the zoospores was not observed in all cases; sometimes it may possibly have been *Pythium undulatum*.

Localities: 1 ($^5/_{11}$ 31, isolated from *Sphagnum*). — 2? ($^{17}/_4$ 31, on an apple; $^{20}/_5$ 31, isolated from soil). — 3? ($^{15}/_3$ 31, on twigs). — 4 ($^8/_{11}$ 31, isolated from *Sphagnum*). — 12 ($^8/_6$ 31, isolated from soil). — 13 ($^8/_6$ 31, isolated from soil). — 15 ($^8/_6$ 31, isolated from soil and plant remains). — 16 ($^9/_6$ 31, isolated from sand). — 19 ($^9/_6$ 31, isolated from soil). — 21 ($^{10}/_6$ 31, isolated from *Sphagnum* and soil). — 22 ($^{10}/_6$ 31, isolated from *Sphagnum*). — 24 ($^{11}/_6$ 31, isolated from *Sphagnum* and plant remains). — 30 ($^{31}/_8$ 31, isolated from roots of *Salix repens*). — 33 ($^1/_9$ 31, isolated from *Sphagnum* and soil). — 39 ($^{13}/_5$ 32, isolated from *Sphagnum*). — 40 ($^9/_6$ 31, isolated from twigs of *Picea*).

Distribution: Latvia, Denmark.

In this place three fungi resembling species of *Pythiomorpha*, especially *P. undulata*, may be mentioned. As the escape of the zoospores was not observed, it is not proved, however, that they really belong to this genus, but at all events the zoospores were seen lying fully differentiated in the sporangia.

Pythiomorpha sp. I. Fig. 24, a—b. Hyphae about 2.5—5 μ thick, slightly branched, scarcely undulated, staining reddish-violet with chloriodide of zinc. Sporangia oval-ovoid, 50—75 × 35—52 μ, proliferating; often a sporangium arises below another sporangium. Sometimes the sporangia germinate by means of hyphae.

This fungus differs from *P. gonapodyides* in the branched hyphae and in the larger sporangia, and from *P. undulata* in the generally smaller sporangia (and in its occurrence in alkaline water). It is reminiscent of *P. Oryzae* Ito and Nagai, to which species it may possibly be referred.

Localities: 51 ($^{29}/_{11}$ 31, on an apple). — 71 ($^{16}/_4$ 32, on twigs of *Salix*).

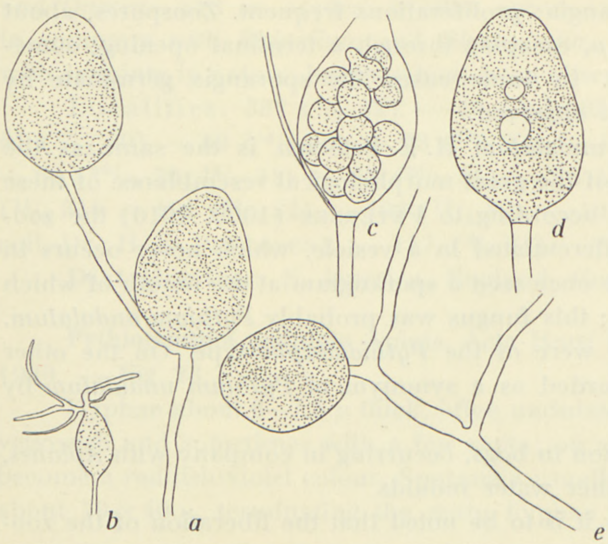

Fig. 24. *Pythiomorpha* sp. I. *a*, Sporangia. × 430; *b*, Sporangium germinating by hyphae, × 155. *Pythiomorpha* sp. II. c, Sporangium containing spores, × 430. *Pythiomorpha* sp. III. *d* and *e*, Sporangia, × 430.

Pythiomorpha sp. II. Fig. 24, c. Hyphae about 5 μ thick, branched, not undulated, sometimes divided by septa. Sporangia oval-ovoid, 67—103 × 42—56 μ, proliferating, in some cases germinating by hyphae. The zoospores sometimes sprout in the sporangium.

The general appearance of this fungus is different from that of *P. undulata* (and it was found in alkaline water).

Localities: 48 ($^{21}/_{10}$ 31, isolated from soil).

Pythiomorpha sp. III. Fig. 24, d—e. Hyphae about 4—5 μ thick, branched, not undulated. Sporangia oval-ovoid, 40—67 × 30—42 μ, proliferating.

It resembles *P. Miyabena* Ito and Nagai; perhaps it is identical with this species.

Localities: 1 ($^{5}/_{11}$ 31, isolated from *Sphagnum*). — 27 ($^{12}/_{6}$ 31, on twigs of *Alnus*).

Pythium Pringsheim. Pringsh. Jahrb. wiss. Bot. 1, p. 303, 1858.

Sporangia symmetrical, discharging the plasma into a vesicle, in which the zoospores are differentiated. Oogonia with one oospore.

Key to the Species.

I. Sporangia not separated from the hyphae by septa.
   1. Hyphae 1.5—4 μ thick; oogonia c. 25 μ. Parasitic in algae or saprophytic .... *P. gracile* p. 51.
   2. Hyphae c. 3—5 μ thick; oogonia c. 30 μ. Parasitic on certain plankton-crustaceans .... *P. Daphnidarum* p. 51.

II. Sporangia usually ovoid-oval or elliptic.
   1. Hyphae not undulated; sporangia about 30 × 25 μ. Saprophytic, mostly in water .... *P. proliferum* p. 51.
   2. Hyphae often undulated; sporangia about 130 × 50 μ. Saprophytic on plant substances in water .... *P. undulatum* p. 51.

III. Sporangia spherical or subspherical.
1. Tube of discharge long, lateral. Sporangia proliferating. Saprophytic in water and in soil .... *P. rostratum* p. 51.
2. Tube of discharge rather short, lateral. No proliferations. Mostly parasitic on seedlings and saprophytic in soil .... *P. de Baryanum* p. 52.
3. Tube of discharge short, terminal. Saprophytic on plant substances in water .... *P.* (?) *sp.* p. 53.

Pythium gracile Schenk. Verh. d. phys.-med. Ges. Würzburg 9, p. 12, 1859. — Petersen in Bot. Tidsskr. 29, p. 392, 1909; in Ann. myc. 8, p. 530, 1910.

Mentioned by PETERSEN; found by me in locality 78 ($^{12}/_{10}$ 30, in *Vaucheria*).

Distribution: England, France, Bulgaria, Belgium, Germany, Denmark, India.

Pythium Daphnidarum H. E. Petersen. Bot. Tidsskr. 29, p. 392, fig. VIII, b and g, 1909; in Ann. myc. 8, p. 530, fig. VIII, b and g, 1910.

This fungus was found parasitic on two species of *Daphnia* and on *Bosmina Coregoni* in three lakes by PETERSEN. I have not observed it.

Distribution: Denmark.

Pythium proliferum de Bary. Pringsh. Jahrb. wiss. Bot. 2, p. 182, 1860. — Petersen in Bot. Tidsskr. 29, p. 394, fig. VIII, e, 1909; in Ann. myc. 8, p. 531, fig. VIII, e, 1910.

Reported by PETERSEN from 3 places. I have found it in the following localities: 1 ($^{5}/_{11}$ 31). — 2 ($^{5}/_{11}$ 31). — 35 ($^{18}/_{10}$ 31). — 42 ($^{29}/_{8}$ 31). — 45 ($^{10}/_{5}$ 32). — 47 ($^{21}/_{10}$ 31). — 48 ($^{21}/_{10}$ 31). — 51 ($^{29}/_{11}$ 31). — 84 ($^{10}/_{5}$ 32). — 88 ($^{11}/_{5}$ 32). — 100 ($^{31}/_{8}$ 31). — 103 ($^{6}/_{4}$ 31).

Distribution: England, France, Bulgaria, Germany, Czechoslovakia, Denmark, India.

Pythium undulatum H. E. Petersen. Bot. Tidsskr. 29, p. 394, fig. VIII, a and d, fig. IX, 1909; in Ann. myc. 8, p. 531, fig. VIII, a and d, fig. IX, 1910.

Reported from 12 localities by PETERSEN. Morphologically this species resembles *Pythiomorpha undulata* (p. 48). I have with doubt observed it in locality 3 ($^{10}/_{5}$ 31).

Distribution: N. America, France, Czechoslovakia, Denmark.

Pythium rostratum Butler. Mem. Dept. Agric. India. Bot. sér. 1, p. 84, pl. 5, figs. 11—22, 1907. — Fig. 25.

Hyphae about 2—3 μ thick, branched. Sporangia spherical, 22.5—35 μ in diameter, terminal, in older stages often with vacuoles; at maturity a papilla is formed which gives off a long, more or less lateral, rarely terminal, tube of discharge, 15—67 $\times$ 2.5—5 μ, mostly about 15—25 μ in length. The sporangium discharges its contents into a vesicle in which about 10—15 zoospores are differentiated, which are c. 12—15 μ. The walls of the sporangium collapse; sometimes proliferations are found. Sexual organs were not observed.

This fungus seems to be identical with *P. rostratum* which was isolated by Butler from garden soil in France. This species is near to — possibly identical with — *P. imperfectum* Cornu; in the description of the latter (Cornu 1872) it merely says: "Le P. imperfectum présente des sporanges sphériques, munies d'un long tube de sortie du plasma et situés a l'extrémité de filaments grêles comme ceux du P. proliferum." It also resembles *P. laterale* Pringsh., but for this species too the description is insufficient.

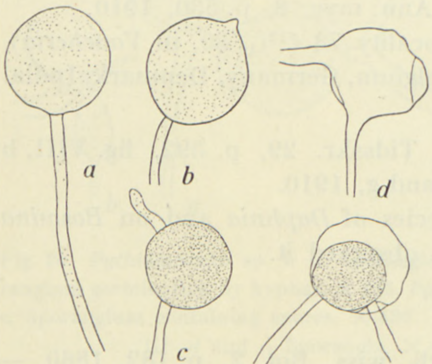

Fig. 25. *Pythium rostratum*. *a*, Young sporangium; *b*, Older sporangium, a papilla has been formed; *c*, Sporangium with tube of discharge; *d*, Empty sporangium; *e*, Proliferating sporangia. — × 430.

P. rostratum is very common in this country, but it is often difficult to examine because it almost always occurs among other Phycomycetes. It was mostly found in small ponds and pools, often containing many organic substances.

Localities: 1 ($^5/_{11}$ 31, on twigs of *Betula*). — 3 ($^8/_{11}$ 31, isolated from twigs of *Betula*). — 4 ($^8/_{11}$ 31, isolated from soil). — 5 ($^9/_4$ 32, on a rhizome of *Menyanthes*). — 8 ($^8/_{11}$ 31, isolated from twigs). — 17 ($^9/_6$ 31, on twigs of *Pinus*). — 35 ($^{24}/_4$ 31, on an apple). — 36 ($^5/_4$ 32, on twigs of *Picea*). — 42 ($^{29}/_8$ 31, on twigs of *Alnus*). — 47 ($^{18}/_4$ 31, on twigs; $^{21}/_{10}$ 31, isolated from twigs). — 49 (March 31, isolated from twigs). — 51 ($^{27}/_9$ 30, isolated from twigs of *Fraxinus*; $^{15}/_2$ 31, $^{29}/_{11}$ 31, $^1/_5$ 32, on apples). — 52 ($^{15}/_2$ 31, on twigs of *Abies*; $^{14}/_3$ 31, on twigs). — 53 ($^{10}/_2$ 31, on twigs of *Quercus*). — 54 ($^{21}/_{10}$ 31, isolated from mud). — 60 (Oct. 30, isolated from twigs of *Alnus*). — 62 ($^{14}/_4$ 31, on an apple). — 64 ($^5/_4$ 32, on twigs of *Alnus*). — 71 ($^{16}/_4$ 32, on twigs of *Salix*). — 74 ($^5/_4$ 32, on twigs of *Populus*). — 75 ($^5/_{10}$ 30, $^1/_4$ 31, on twigs). — 77 ($^{16}/_4$ 32, on twigs). — 80 ($^{30}/_8$ 30, on twigs of *Fraxinus*). — 81 ($^8/_4$ 32, on twigs of *Aesculus*). — 88 ($^{11}/_5$ 32, on a rhizome of *Nuphar*). — 93 ($^{14}/_5$ 32, isolated from twigs). — 95 ($^{11}/_6$ 31, on twigs). — 97 ($^{12}/_6$ 31, isolated from soil). — 102 ($^{26}/_8$ 32, on an apple).

Distribution: France, Denmark.

Pythium de Baryanum Hesse. Ueber Pythium de Baryanum etc., Halle 1874. — Petersen in Bot. Tidsskr. 29, p. 395, 1909; in Ann. myc. 8, p. 532, 1910.

This species was found once by Petersen on the dead larva of an insect in a ditch. Not observed by me.

Distribution: Widely distributed. (Mostly saprophytic in soil or parasitic on seedlings).

Pythium (?) sp. — Fig. 26.

Hyphae about 7 μ thick, branched. Sporangia subspherical, about 40 μ in diameter, terminal or lateral; tube of discharge short, terminal. Sexual organs were not seen.

This fungus occurred in small quantity on hempseed in water together with *Saprolegnia ferax*. Since only a few individuals were seen, it was not possible to study it very thoroughly; thus the forming of the zoospores was not observed, but judging by its general appearance it is probably a *Pythium*.

Localities: 59 ($^{11}/_{6}$ 31, isolated from twigs).

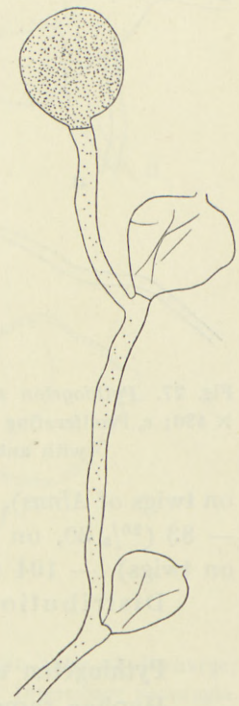

Fig. 26. *Pythium* (?) sp. A young sporangium and two empty ones, × 430.

Pythiogeton v. Minden. Falck's Mykol. Untersuch. u. Ber. 2, p. 228, 1916.

Sporangia often asymmetrical, discharging the plasma into a long vesicle; at the rupture of the vesicle the plasma passes into the water, where the zoospores are differentiated. Oogonia with one oospore.

Key to the Species.

I. Shape of the sporangia very variable, exit tube long *P. utriforme* p. 53.

II. Shape of the sporangia rather constantly subspherical or slightly oval.
   1. Sporangia with long exit tube . . . . . . *P. uniforme* p. 54.
   2. Sporangia with short exit tube . . . . *P.* (?) *sp.* p. 55.

Pythiogeton utriforme v. Minden. Falck's Mykol. Untersuch. u. Ber. 2, p. 228 and 242, pl. 6, figs. 56—65, 1916. — Fig. 27.

Hyphae about 2—4 μ thick, more or less branched, not staining with chloriodide of zinc. Sporangia variable in shape and size, often pyriform, 45—97 × 31—67 μ, terminal, with their long axis at right angles to the hyphae. In young stages the plasma of the sporangium is refractive, later on more granulated, and often contains a vacuole. Tube of discharge varying greatly in length, about 49—63 μ, the appearance of its plasma similar to that of the young sporangia. When the sporangia are emptied the walls collapse; proliferations frequent. Oogonia mostly spherical, 28—57 μ in diameter, sometimes about 34 × 36 μ, terminal, filled with refractive plasma when young, wall smooth. One oospore, spherical, 16—39 μ in diameter, with a thick wall. One antheridium on each oogonium, diclinous (?).

This fungus was cultivated on twigs and on apples; it is unable to grow on hempseed. It was mostly found on twigs, particularly at the broken ends in mats or tufts, in company with other *Pythiaceae* and with species of *Saprolegnia, Achlya, Gonapodya* and *Monoblepharis*; on apples it was usually accompanied by *Rhipidium* and *Blastocladia* and often much contaminated by bacteria and other organisms. It often occurs in small ponds and pools which frequently abound with decaying organic matter; probably it does not require much oxygen.

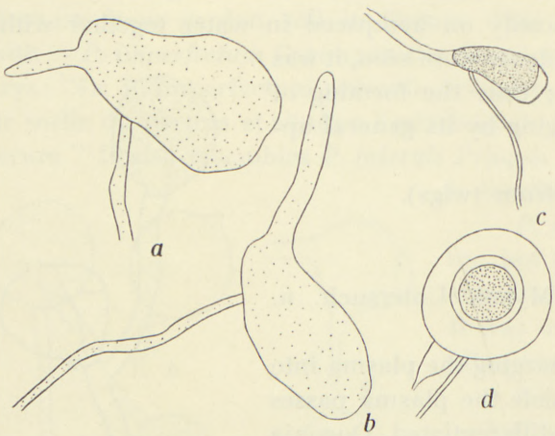

Fig. 27. *Pythiogeton utriforme.* *a* and *b*, Sporangia, × 430; *c*, Proliferating sporangia, × 155; *d*, Oogonium with antheridium, × 430.

The time required for *P. utriforme* to appear on apples was determined in a large lake (locality No. 85); 3 weeks passed before the first sporangia were observed ($^4/_7$—$^{27}/_7$ 32).

Localities: 1 ($^{20}/_5$ 31, $^5/_{11}$ 31, on twigs of *Betula*). — 35 ($^{25}/_4$ 31, on an apple). 45 ($^{10}/_5$ 32, on twigs of *Betula*). — 50 ($^{25}/_4$ 31, on an apple). — 53 ($^{19}/_4$ 31, on twigs of *Quercus*). — 55 ($^1/_{11}$ 30, on twigs of *Fagus*). — 60 (Oct. 30, on twigs of *Alnus*). — 62? ($^{19}/_4$ 31, on an apple). — 65 ($^{21}/_3$ 31, $^{21}/_{10}$ 31, on twigs of *Alnus*). — 73 ($^{26}/_9$ 30, on twigs of *Alnus*). — 82 ($^{20}/_9$ 30, on twigs of *Alnus*). — 83 ($^{20}/_9$ 30, on twigs of *Fraxinus*). — 85 (July 32, on an apple). — 95 ($^{11}/_6$ 31, on twigs). — 104 ($^6/_4$ 31, on a decaying potato).

Distribution: Germany, Denmark.

Pythiogeton uniforme A. Lund, n. sp. — Fig. 28, a—c.

Hyphae ramosae. Sporangia 40—56 × 30—40 μ, terminalia vel lateralia, saepissime in hyphis modo generis *Pythiogetonis* proprio affixa. Zoosporae ex contentu sporangii, per collum longum liberato, extra sporangium formatae sunt; proliferationes frequenter occurrunt.

Hyphae about 3—5 μ thick, much branched, sometimes divided by septa. Sporangia subspherical or slightly oval, 40—56 × 30—40 μ, terminating the main hyphae or on side branches, mostly with their long axis at nearly right angles to the hyphae, filled with a granulated plasma. Tube of discharge about 39—70 × 5.6 μ, filled with refractive plasma when young. At maturity the plasma of the sporangium passes through the tube of discharge as a long flowing stream; after some time about 20 biciliate zoospores are differentiated. When the sporangium has emptied, the walls collapse; proliferations frequent. Sexual organs not observed.

On hempseed in water numerous sporangia were developed; on agar only hyphae were produced. It thrives well on hempseed lying at the bottom of the culture-dish in contradistinction from most of the aquatic fungi; probably its need of oxygen is not very great, just as in *P. utriforme*.

Localities: 72 ($^{18}/_{10}$ 31, isolated from sand).

Pythiogeton (?) sp. — Fig. 28, d—f.

Once a fungus was found in which the plasma of the sporangium passed into the water as a long stream just as in *Pythiogeton*. The formation of the zoospores

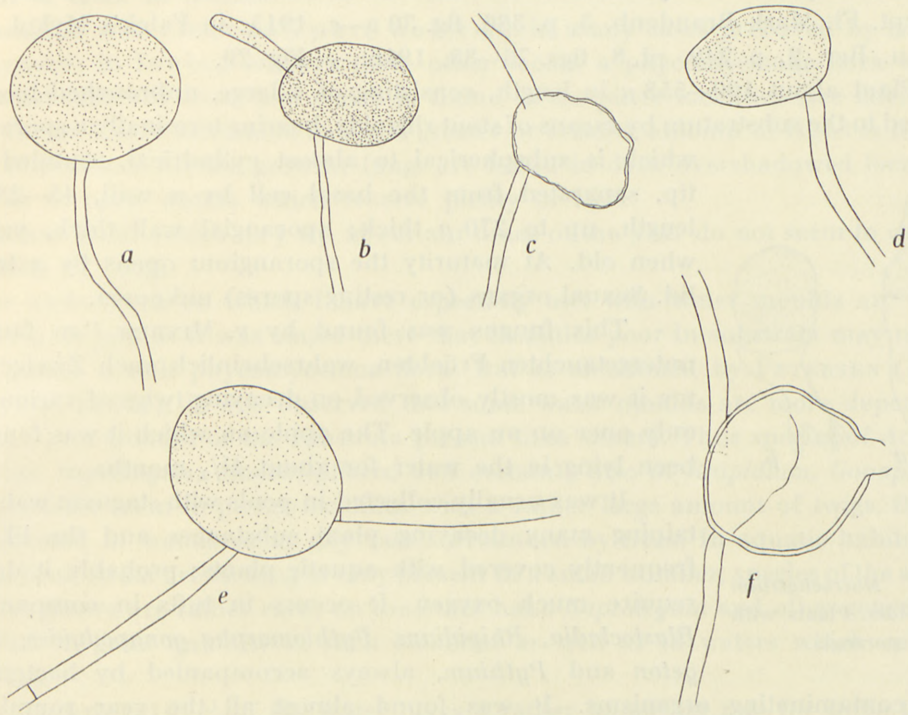

Fig. 28. *Pythiogeton uniforme* n. sp. *a*, Young sporangium; *b*, Sporangium with tube of discharge; *c*, Empty sporangium. *Pythiogeton*(?) sp. *d*, Young terminal sporangium; *e* and *f*, Intercalary sporangia. — × 430.

was not observed, however, so that it cannot be referred to this genus with certainty. The sporangia measured 50—75 × 33—50 μ, were terminal or intercalary, at maturity provided with a short tube of discharge.

Localities: 4 ($^{8}/_{11}$ 31, isolated from *Sphagnum*).

7. Macrochytriaceae.

As a supplement to the above treatment of the Oomycetes, one genus, *Macrochytrium* v. Minden, which includes one species, and which belongs to the *Chytridineae*, may be mentioned here. This fungus resembles the higher Phycomycetes, particularly *Blastocladia*, in the stout rhizoids and the large basal cell. But according to v. Minden, the manner of liberation of the uniciliate zoospores points to its position in the *Chytridineae*. By v. Minden (1915) it was placed in the family *Hyphochytriaceae* together with *Zygochytrium* Sorokin and *Tetrachytrium* Sorokin. In the writer's opinion *Macrochytrium* is to be separated from the latter — rather doubtful — genera, and to be considered as a representative of a distinct family.

Macrochytrium botrydioides v. Minden. Centralbl. Bakt. II, 8, p. 824, 1902; in Krypt. Fl. Mark Brandenb. 5, p. 386, fig. 30 a—c, 1915; in Falck's Mykol. Untersuch. u. Ber. 2, p. 249, pl. 8, figs. 76—85, 1916. — Fig. 29.

Plant about 100—558 μ in length, consisting of a large, unbranched basal cell, attached to the substratum by means of stout rhizoids, bearing terminally a sporangium, which is subspherical to almost cylindrical, rounded at the tip, separated from the basal cell by a wall, 45—284 μ in length, up to 270 μ thick; sporangial wall thick, yellowish when old. At maturity the sporangium opens by a terminal lid. Sexual organs (or resting spores) unknown.

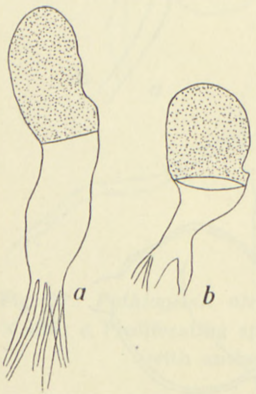

Fig. 29. *Macrochytrium botrydioides*. Plants with sporangia.

This fungus was found by v. Minden "an faulenden untergetauchten Früchten, wahrscheinlich auch Zweigen." By me it was mostly observed on decaying twigs of various trees, only once on an apple. The apple on which it was found had been lying in the water for about $4^1/_2$ months.

It was usually collected in pools with stagnant water, containing many decaying plant substances and the like, and frequently covered with aquatic plants; probably it does not require much oxygen. It occurs in tufts in company with *Blastocladia*, *Rhipidium*, *Pythiomorpha gonapodyides*, *Pythiogeton* and *Pythium*, always accompanied by bacteria and other contaminating organisms. It was found almost all the year round, from February to May and August to October.

Localities: 49 ($^{26}/_9$ 30, on twigs of *Quercus*). — 51 ($^{20}/_5$ 30, on twigs of *Abies*; $^{27}/_9$ 30, on twigs of *Fraxinus*; $^{15}/_2$ 31, on an apple). — 60 (Oct. 30, on twigs of *Alnus*). 65 ($^{21}/_3$ 31, on twigs of *Alnus*). — 81 ($^8/_4$ 32, on twigs of *Aesculus*). — 107 ($^{10}/_8$ 30, on twigs of *Alnus*).

Distribution: Germany, Denmark.

III. Notes on the Occurrence in General.

Most of the inquirers who have occupied themselves with the freshwater Phycomycetes have aimed chiefly at a systematical treatment. The factors which condition the growth and occurrence of these fungi are not very well known. Petersen's studies on them in this country (1909, p. 358; 1910, p. 504) deserve particular attention.

According to my experience water moulds may no doubt be found in any body of freshwater; still ponds, pools, and quiet bays of larger waters, where the water is rather calm, present better conditions for them than large lakes where the water is often in motion.

Localities with clear and pure water are in many cases preferred by certain Phycomycetes; in fouled waters there often occurs a phycomycetous flora which is somewhat different from that which is found in the purer localities (see later on).

As far as I have been able to see, a greater or smaller amount of light is hardly of great importance for the growth; fungi are found in dark overshadowed localities as well as in open waters which receive plenty of light.

Shallow pools which dry up at certain times of the year do not seem to exhibit any paucity of fungi.

The substrata on which I have especially met with water moulds are mentioned on p. 4, just as it was stated there that localities poor in substrata may nevertheless contain a rich phycomycetous flora. But as mentioned by Petersen (1909, p. 373; 1910, p. 516), it was observed that some water moulds are more dependent on the sort and amount of the substrata present than others. Thus species of *Achlya, Apodachlya, Sapromyces, Monoblepharis,* and certainly also of *Rhipidium, Gonapodya,* and *Blastocladia* seem to prefer localities with a rather large amount of twigs, that is waters situated in woods or at any rate surrounded by trees. In aquatic habitats in which such substrata are lacking or only present in a small number, species of the above mentioned genera are rather rare; on the other hand *Saprolegnia* and other genera are represented in great quantity in such localities as well as in waters which contain many twigs.

The temperature[1] of the water plays a rather important role for some freshwater Phycomycetes, whereas others would seem to be fairly independent of it. Species of *Achlya* thrive best in rather cold water, too high a temperature rendering it difficult for them to fructify. Moreover, algae and other organisms will easily gain the upper hand in high temperatures, so that on the whole the freshwater fungi often have some difficulty in holding their own in competition with them. These conditions were especially studied by me in the warm July of 1932. On a hot day I then found the temperature of the water in a large lake to be 24° C., and in this month the temperature in my cultures was varying from 18°.0—22°.5 C. During this period fungi were sought for in vain on twigs in Mørke Sø at Svejbæk (No. 45); the twigs were thickly covered with algae and other growths, but only a very few Phycomycetes were found on them, and only vegetative mycelium. This was all the more remarkable since in May there occurred vigorous growths of fungi on twigs in this very lake. In the same warm month several forms of *Achlya* were kept in cultures; they readily formed sporangia but no sexual organs (see also *Achlya* sp., p. 28).

Petersen gives some observations on the influence of the temperature on

[1] Observations on the seasonal distribution of the *Saprolegniaceae* in North Carolina have been given by Coker (1923, p. 13).

Achlya racemosa, and arrives at the result that this species only forms oogonia in the spring at rather low temperatures, and that these oogonia may remain long on the hyphae, so that the oogonia found later in the year were in reality developed in the spring. My experience with regard to *A. racemosa* is that it is true that a rich formation of sexual organs takes place in the spring, and that the oogonia found in the summer are often yellow and evidently old, but nevertheless such organs were often produced — at any rate in cultures — in the warmer months.

Species of *Saprolegnia* are apparently not as dependent on temperature conditions as those of *Achlya*; the species with which I have met have fructified all the year round.

By laboratory experiments Maurizio (1899) arrived at the result that the *Saprolegniaceae* are tolerant of very low temperatures; even after freezing, cultures of them were produced on suitable substrata. They are likewise tolerant of high temperatures, but their propagation is much delayed. — Couch (1932) found that *Leptolegnia caudata* grows rapidly at temperatures between 25° and 30° C., and that the rate of growth diminished at temperatures below 18° C. It did not develop oogonia at high temperatures (27°—35° C.), just as the formation of these organs was likewise prevented by low temperatures. They were most readily developed at c. 18°—22° C.

With regard to *Apodachlya pirifera* Petersen states that it occurs most frequently in the spring, whereas it was not observed in July, August, and September. I have found sporangia of this species from February to October (including both months) and in December; and resting spores in April(?), May, and July; the resting spores are rarely met with.

Species of *Rhipidium* and *Blastocladia* seem to be rather independent of the temperature conditions. Well-developed, sporangia-bearing individuals may be met with at all times of the year. In *Rhipidium* sexual organs are readily formed, such were found of *Rhipid. americanum* in March, April, May, July(?), August, and November, and of *Rhipid. continuum* from February to April, in June, September, and November. *Blastocladia Pringsheimii* only comparatively rarely forms resting spores — and often only in small number — but in any case they occur all the year round (January, May, June, July, August, November, December). *Blastocladia gracilis* readily develops resting spores, and their formation, too, is independent of the season of the year. — Both species of *Gonapodya* were likewise found at different seasons of the year.

The genus *Monoblepharis* is met with all the year round, but the formation of the sexual organs seems principally to take place in the spring. — Sparrow (1933), however, states that species of *Monoblepharis* in cultures with water at 8°—11° C. only developed sporangia, while sexual propagation took place at higher temperatures (21° C.).

The occurrence of the *Pythiaceae* observed is probably not very dependent on the temperature; I have found several of them at the different seasons. As a rule, however, they rarely formed oogonia.

The amount of oxygen in the water is of no little importance, since most submersed Phycomycetes probably require much oxygen, whereas, on the other hand, some species require much less oxygen in order to thrive.

In nature most of these fungi grow on substrata rather easily accessible to the air. In larger waters substrata like twigs etc. are washed towards the shores by the motion of the waves, and as a rule the fungi occur here on the substrata floating on — or near — the surface of the water, more rarely on such which have gone to the bottom, but even in that case the air has fairly easy access to them, since most lakes are shallow near the shores, and since the water is frequently in motion. The same applies in some degree to small ponds and pools. However, many of these are rather poor in oxygen; partly the water in them is often stagnant and frequently rich in decaying organic substances, mud, and the like, and partly their surface is commonly covered with a dense carpet of aquatic plants. In such waters there rarely occur luxuriant growths of the Phycomycetes which require much oxygen — in any case only on substrata which lie near the surface; on the other hand, certain others, whose need of oxygen is evidently not very great, thrive well here.

As far as I can see, the following require much oxygen in order to thrive: The *Saprolegniaceae*; of the *Leptomitaceae*: *Apodachlya* and *Sapromyces*; probably all *Monoblepharidaceae*; of the *Pythiaceae*: probably *Pythium* and *Pythiomorpha* in part. The water moulds which require the greatest supply of oxygen are presumably the *Saprolegniaceae*. That the oxygen supply required by *Saprolegnia* and *Achlya* is high appears among other things from the fact that in cultures they only thrive well on hempseed floating on the surface of the water, whereas, as soon as the seeds fall to the bottom of the culture dishes (only about 4 cm. below the surface of the water), they thrive very badly and do not form reproductive organs. Maurizio (1899) amongst other things also dealt with the importance of oxygen for the *Saprolegniaceae*, and likewise arrived at the conclusion that they thrive best when there is a plentiful air supply.

The freshwater Phycomycetes which are able to thrive with a small supply of oxygen are, of the *Leptomitaceae*: *Rhipidium* (*continuum* and *americanum*), the *Gonapodyaceae*, among the *Blastocladiaceae*: *Blastocladia* (*Pringsheimii* and *gracilis*), and of the *Pythiaceae*: *Pythiomorpha (gonapodyides)*, *Pythiogeton* (*utriforme* and *uniforme*), and also the chytridiaceous fungus *Macrochytrium*. These fungi are often met with in small ponds and pools with stagnant water containing much decaying matter (often smelling strongly of H_2S), and the surface of which is frequently covered with aquatic plants. But in addition they also may grow in large lakes. I have kept these fungi under culture for a long time in dishes with water. After some time the water frequently was much fouled by bacteria and the like, and the surface was covered with a dense coating consisting of *Saccharomycetes*, *Penicillium*, bacteria, protozoa, and others. Apparently, however, this did not inconvenience these fungi, which attained a luxuriant growth.

v. Minden (1916) reports that he has arrived at similar results with regard to some of the above-mentioned species.

IV. Occurrence relative to the pH.

Simultaneously with my systematic studies I endeavoured to gather some particulars as to the occurrence in the various types of waters of the species of Phycomycetes which were found, the hydrogen ion concentration of the water being used as an expression hereof.

Hitherto the water moulds have not — as far as I know — been subjected to any investigations of this kind. Some few inquirers have endeavoured to determine experimentally the importance of the hydrogen ion concentration for a small number of these fungi. Thus Lilienstern (1924, 1927) found that *Saprolegnia monoica* developed sporangia most readily on acid substrata, whereas its oogonia were most easily produced at an alkaline reaction; in one of her experiments there occurred sporangia at pH 2.6 and 5.5, and oogonia at pH 7.3 and 8.0. According to these experiments, then, this species will thrive both on acid and alkaline substrata, whereas the formation of its reproductive organs seems to be in some degree conditioned by a certain pH. It may be mentioned that, according to my investigations, *Saprol. monoica* occurs in all types of aquatic habitats.

Dörries and Haase (1930) found that *Leptomitus lacteus* thrives best at pH 2.9—5.4, and that its minimum growth lay at pH 2.5, its maximum at pH 7.5. Couch (1932) arrived at the result that *Leptolegnia caudata* only developed oogonia at an acid and a neutral reaction, but that it can thrive vegetatively at very different reactions (pH 3.0—9.0).

As regards the succeeding statements it should be noted that there may possibly be some inaccuracies, partly because only a rather limited number of samples could be examined, and partly because errors may creep in owing to the way in which these fungi spread. Their dispersal takes place by means of spores and parts of the mycelium which may probably be carried with the rain-water or through ditches and the like from one lake to another, perhaps even over great distances.

1. Method of Determination of the pH.

In determining the hydrogen ion concentration of the water the colorimetric method was employed (see e. g. Iversen 1929, p. 279, and Olsen 1921, p. 14).

The following indicators were used: bromphenolblue pH 3.2—4.8, bromcresolgreen pH 4.0—5.6, bromcresolpurple pH 5.2—6.8, bromthymolblue pH 6.0—7.6, phenolred pH 6.8—8.4, thymolblue pH 8.0—9.6. As standards were used solutions of hydrochloric acid, citrate, primary potassium phosphate, secondary sodium phosphate, borate, soda lye. To avoid changes in the colour of the liquids they were renewed several times, as a rule every month or every second month, and kept in the dark as far as possible.

The determination of the pH values was made by adding a certain number of drops of the indicator solution to a certain amount of the water to be examined, and then comparing the colour produced with that of the standard solutions. The determination was nearly always made on the spot, though sometimes not until after the return (the pH value does not seem to be essentially altered even if the water is left to stand for 24 hours in an ordinary glass). It was often necessary to use a comparator, especially when the water was coloured by humous substances (see Olsen 1921, p. 16).

Since the water moulds are generally found by the shores of the waters, the pH determinations were always made there.

As a rule — in the case of waters only visited once or a few times — the pH maximum and minimum were determined in addition to the hydrogen ion concentration of the water at the time (as indicated by Iversen 1929). In this way a fairly exact picture is obtained of the fluctuations to which the hydrogen ion concentration is subject. In order to determine the pH maximum the amount of water required is boiled in a Jena glass. Thus the carbon dioxide of the water is expelled, corresponding approximately to the maximum CO_2 reduction in nature caused by the CO_2 assimilation of the green plants. Conversely, in order to arrive at the minimum pH value, CO_2 must be added to the water (by blowing air from the lungs into the water during stirring) until the pH remains constant.

2. Types of Aquatic Habitats and their Phycomycetous Flora.

The aquatic habitats examined by me may be divided into the following groups according to their pH conditions (see also Iversen 1929, p. 283):

highly acid,	abbreviated where	convenient to	h.a.
slightly acid,	—	—	s.a.
neutrally acid,	—	—	n.a.
neutrally alkaline,	—	—	n.alk.
constantly alkaline,	—	—	c.alk.

At times, however, it may be difficult to draw sharp lines of demarcation between these groups, especially between certain of the neutrally alkaline and constantly alkaline waters, so that my distinction between these is not perhaps always quite satisfactory.

18 waters were examined several times a year ("periodically investigated"), 4 being highly acid (Nos. 1—4[1]), 2 slightly acid (Nos. 35—36), 8 neutrally alkaline (Nos. 47—54), and 4 constantly alkaline (Nos. 62—65), so that the writer is rather well acquainted with their phycomycetous flora, and has obtained a good insight into the fluctuations to which the hydrogen ion concentration of the water is subject.

In the tables in the sequel each of the periodically investigated waters is placed in a separate column in which the frequency of each of the species found is expressed

[1] The numbers refer to the list of localities given at the end of the paper.

by the number of times it was observed in the lake or pond in question. The other, less thoroughly examined, waters are given in one column in which the frequency of the species is indicated by the number of waters in which they were observed. Finally the total number of waters in which each species was found is also stated. These figures of course have not general validity, but they probably give a relative impression of the frequency of the species.

Highly Acid Waters (Nos. 1—34).

This type is mostly represented by bogs. As a rule the water is coloured brown by the humous substances contained in it; I have only met with one such lake with uncoloured water, viz. Madum Sø, No. 16 (see also Iversen 1929, p. 309). As a rule the pH varies very little, mostly from c. 3.5 to c. 4.5. In Sealand there are only relatively few highly acid waters, 4 of which were examined periodically. In addition, samples were taken from 30 other waters of this type, principally in the vicinity of Skørping (north-eastern Jutland).

A number of the fungi observed here (table 1) also occurred in waters with other pH conditions, but several of them were only found in bogs and similar localities (some of these, however, also in slightly acid and neutrally acid water), viz.

Saprolegnia diclina (also in n.a. water)
— *delica*
— *monoica* var. *montana*
— *litoralis* (also in s.a. water)
— *latviaca*
— *torulosa*
— *variabilis*
Aplanes androgynus
— *Treleaseanus*
Achlya caroliniana (?) (also in s.a. water)
Sapromyces Reinschii (also sometimes in s.a. and n.a. water)
Blastocladia angusta
Pythiomorpha undulata (also sometimes in s.a. water)
— sp. III
Pythium undulatum (?)
Pythiogeton (?) sp.

Several of these seem to be rare; the following are of fairly frequent occurrence in highly acid waters (here species which may be found in waters with other pH conditions are also included):

Saprolegnia diclina
— *delica*
— *litoralis*

Table 1. Phycomycetes found in h.a. Waters and their Frequency.

(See explanation p. 61.)

Species	Periodically investigated				Other h. a. waters	Total number of waters
	Bøllemose (No. 1)	Ditch near Bøllemose (No. 2)	St. Gribsø (No. 3)	Bøndernes Mose (No. 4)		
Saprolegnia diclina	2	..	..	..	3	4
— *delica*	..	..	..	1	3	4
— *monoica*	1	..	1		1	3
— — var. *montana*	..	..	..	..	1	1
— *litoralis*	..	1	..	..	7	8
— *ferax*	1	1?	..	..	2	3 (4?)
— *latviaca*	..	..	..	..	1	1
— *hypogyna*	..	..	..	..	1	1
— *torulosa*	..	..	..	..	2	2
— *variabilis*	..	..	..	..	1	1
Aplanes androgynus	2	..	..	1	10	12
— *Treleaseanus*	..	..	..	1	9	10
Achlya racemosa	3	..	2	1	5	8
— — var. *stelligera*	3	1	6	1	4	8
— *radiosa*	..	..	..	..	1	1
— *americana*	..	..	..	..	1	1
— *caroliniana*	..	..	..	..	1?	1?
Dictyuchus sterile	1	1	1	..	1	4
Thraustotheca sp.	..	..	..	..	1	1
Apodachlya pirifera	2	..	1?	..	3	4 (5?)
Sapromyces Reinschii	..	..	2	5	3	5
Rhipidium continuum	..	1?	1 (2?)	1?	..	1 (3?)
— *americanum*	1	1?	..	2 (3?)	..	2 (3?)
Gonapodya siliquaeformis	1	..	..	..	..	1
— *polymorpha*	..	..	..	..	2	2
Blastocladia Pringsheimii	..	..	..	1	..	1
— *angusta*	..	..	..	1	..	1
Monoblepharis sphaerica	..	..	..	..	1	1
Pythiomorpha undulata	1	2?	1?	1	10	12 (14?)
— sp. III	1	..	..	..	1	2
Pythium proliferum	1	1	..	..	..	2
— *undulatum*	..	..	1?	..	..	1?
— *rostratum*	1	..	1	1	3	6
Pythiogeton utriforme	2	..	..	..	..	1
— (?) sp.	..	..	..	1	..	1

Aplanes androgynus
— *Treleaseanus*
Achlya racemosa
— — var. *stelligera*
Dictyuchus sterile
Apodachlya pirifera
Sapromyces Reinschii
Rhipidium (*continuum* or *americanum*)
Pythiomorpha undulata
Pythium rostratum.

Slightly Acid Waters (Nos. 35—42).

The water is either brownish or uncoloured. The pH values mostly range from c. 5.3 to c. 6.8; they never exceed 7. Only two waters of this type have been investigated periodically. In addition 6 other slightly acid waters were visited.

There is hardly any phycomycetous flora which is peculiar to the slightly acid waters; in the composition of species (table 2) they probably come nearest to the highly acid waters.

Neutrally Acid Waters (Nos. 43—46).

This type of waters is reminiscent of the slightly acid ones, but the pH maximum always lies above the neutral point. The pH values mostly range from c. 5.2 to c. 7.5; the water is coloured or uncoloured. No periodical examination was made of any neutrally acid lake; altogether samples were only taken from 4 such waters (most thoroughly studied is No. 45).

The following Phycomycetes were found in neutrally acid waters:

Saprolegnia diclina
Achlya racemosa
— — var. *stelligera*
Dictyuchus sterile
Apodachlya pirifera
Sapromyces Reinschii
Gonapodya siliquaeformis
Pythiomorpha gonapodyides
Pythium proliferum
Pythiogeton utriforme.

It cannot be decided — on the basis of these few observations — that there are any species peculiar to this type of waters; both the neutrally acid and the slightly acid waters seem to resemble the highly acid.

An attempt was made to ascertain how long it took before fungi appeared on apples in a neutrally acid lake; this is mentioned on p. 35.

Table 2. Phycomycetes found in s.a. Waters and their Frequency.

(See explanation p. 61.)

Species	Periodically investigated		Other s. a. waters	Total number of waters
	Det blanke Vand (No. 35)	Dommermose (No. 36)		
Saprolegnia crustosa	..	..	1	1
— *monoica*	..	..	1	1
— *litoralis*	..	..	2	2
— *ferax*	2	..	2	3
— *hypogyna*	..	..	1	1
Achlya racemosa	1	4	1	3
— — var. *stelligera*	..	1	1	2
— *caroliniana*	..	1	..	1
Dictyuchus sterile	1	..	..	1
Thraustotheca sp.	..	..	1	1
Apodachlya pirifera	2	2	2	4
— — var. *macrosporangia*	..	1	1	2
Sapromyces Reinschii	1	..	..	1
Rhipidium continuum	2?	..	..	1?
— *americanum*	1 (2?)	1	..	2
— sp.	..	1	..	1
Gonapodya polymorpha	1	1?	..	1 (2?)
Blastocladia Pringsheimii	..	1	..	1
Monoblepharis sp.	1	1	..	2
Pythiomorpha gonapodyides	..	1?	..	1?
— *undulata*	..	..	2	2
Pythium proliferum	1	..	1	2
— *rostratum*	1	1	1	3
Pythiogeton utriforme	1	..	..	1

Neutrally Alkaline Waters (Nos. 47—61).

Most of the observed waters of this type are ponds or pools with stagnant, often highly polluted, mostly uncoloured water, abounding with decaying substances. The pH is mostly ranging from c. 6.5 to c. 7.7. 8 were examined periodically; in addition 7 other neutrally alkaline waters were visited.

Some of the species occurring here (table 3) are also found in aquatic habitats with other pH conditions; several of them, however, were only found in neutrally alkaline waters (also often in constantly alkaline waters which seem to have almost the same flora); these are:

Pythiopsis Humphreyana (also in c.alk. water?)
Saprolegnia pseudocrustosa
— *glomerata*

Saprolegnia mixta (also in c.alk. water)
— *asterophora*
Achlya imperfecta
— *Klebsiana*
— *recurva*
Dictyuchus monosporus (also in c.alk. water)
— *Magnusii* (also in c.alk. water)
Apodachlya seriata
Rhipidium parthenosporum (also in c.alk. water)
Blastocladia gracilis (also in c.alk. water)
Monoblepharis polymorpha (also in c.alk. water)
Pythiomorpha sp. I (also in c.alk. water)
— sp. II
Pythium (?) sp.
Macrochytrium botrydioides (also in c.alk. water).

Many of these were only found once. The following species are of fairly frequent occurrence in neutrally alkaline waters (such as occur in waters with other pH conditions are also included):

Saprolegnia monoica
— *ferax*
Achlya racemosa
— — var. *stelligera*
— *radiosa*
Apodachlya pirifera
Rhipidium (*continuum* or *americanum*)
Gonapodya polymorpha
Blastocladia Pringsheimii
— *gracilis*
Monoblepharis sp.
Pythiomorpha gonapodyides
Pythium rostratum
Pythiogeton utriforme.

With regard to the time that elapses before fungi appear on apples in a neutrally alkaline pond, see p. 41.

Constantly Alkaline Waters (Nos. 62—104).

This type is often represented by lakes in contrast to the above-mentioned which are for the most part bogs, ponds and pools. The pH is mostly ranging from c. 7.0 to c. 8.4. The water is as a rule uncoloured, rarely brownish. 4 such waters were examined periodically; in addition samples were taken from 39 other constantly alkaline waters. (Table 4).

Table 3. Phycomycetes found in n. alk. Waters and their Frequency.

(See explanation p. 61.)

Species	Periodically investigated								Other n. alk. waters	Total number of waters
	Pond 1 Ermelund (No. 47)	Pond 2 Ermelund (No. 48)	Pool 1 Jonstrup Vang (No. 49)	Pool 2 Jonstrup Vang (No. 50)	Pool 1 Kongelund (No. 51)	Pool 2 Kongelund (No. 52)	Sortedam (No. 53)	Kildesø (No. 54)		
Pythiopsis Humphreyana	..	..	1	..	1	..	..	..	..	2
Saprolegnia pseudocrustosa	..	1	..	..	..	..	..	..	..	1
— *monoica*	..	..	1	1	..	1	..	..	2	5
— *glomerata*	..	..	1	..	..	..	..	..	..	1
— *mixta*	1	..	1	..	..	..	1	..	1?	3 (4?)
— *ferax*	2	..	1	1	4	3	1	3	1	8
— *asterophora*	..	1	..	..	..	..	..	1?	..	1 (2?)
Achlya racemosa	2	2	..	1	1	..	3	1	4	10
— — var. *stelligera*	1	2	..	..	..	..	2	1	4	8
— *radiosa*	..	2	1?	..	..	..	..	..	3	4 (5?)
— *americana*	..	..	..	..	..	..	..	..	1	1
— *imperfecta*	..	..	..	..	..	..	1	..	..	1
— *Klebsiana*	..	..	..	..	..	..	..	..	1	1
— *recurva*	1	..	..	..	..	..	..	..	..	1
Dictyuchus monosporus	..	..	..	..	..	..	1	..	..	1
— *Magnusii*	1	..	..	..	..	..	..	..	..	1
— *sterile*	1	1	..	..	..	..	..	..	..	2
Apodachlya pirifera	2	2	2	1	1?	1	2	..	3	9 (10?)
— — var. *macrosporangia*	..	1	..	..	..	..	..	..	..	1
— *seriata*	..	..	..	..	..	..	..	..	1	1
Rhipidium continuum	1?	..	3	2?	4 (5?)	..	..	1?	1?	2 (6?)
— *americanum*	1	..	1?	1?	2?	1	..	..	1?	2 (6?)
— *parthenosporum*	1	..	1	..	..	..	..	..	..	2
Gonapodya siliquaeformis	1?	..	..	..	1	..	..	..	1	2 (3?)
— *polymorpha*	..	..	1 (2?)	..	1	..	3	..	2	5
Blastocladia Pringsheimii	2	..	2	1	5	..	1	1	1	7
— *gracilis*	2	..	..	1	1	1	..	1	..	5
Monoblepharis sphaerica	..	..	..	..	1	..	..	..	2	3
— *polymorpha*	..	..	..	..	1	..	..	..	2	3
— sp.	1	..	2	..	..	2	2	..	2	6
Pythiomorpha gonapodyides	1	..	..	1	1	1	1	..	2	7
— sp. I	..	..	..	..	1	..	..	..	..	1
— sp. II	..	1	..	..	..	..	..	..	..	1
Pythium proliferum	1	1	..	..	1	..	..	..	..	3
— *rostratum*	2	..	1	..	4	2	1	1	1	7
— (?) sp.	..	..	..	..	..	..	..	..	1	1
Pythiogeton utriforme	..	..	..	1	..	..	1	..	2	4
Macrochytrium botrydioides	..	..	1	..	3	..	..	..	1	3

The following species were only found in constantly alkaline waters (several of these, however, also occurred in neutrally alkaline waters, in which the composition of species seems to be about the same):

Pythiopsis Humphreyana (?) (also in n.alk. water)
Saprolegnia mixta (also in n.alk. water)
Isoachlya parasitica
Achlya oligacantha
Aphanomyces laevis
— *stellatus*
Dictyuchus monosporus (also in n.alk. water)
— *Magnusii* (also in n.alk. water)
Rhipidium parthenosporum (?) (also in n.alk. water)
Blastocladia rostrata
— *gracilis* (also in n.alk. water)
Monoblepharis polymorpha (also in n.alk. water)
— *brachyandra* (?)
Pythiomorpha sp. I (also in n.alk. water)
Pythium gracile
Pythiogeton uniforme
Macrochytrium botrydioides (also in n.alk. water).

Several of these species were only found once. The following are of fairly frequent occurrence in constantly alkaline waters (including species which may be found in waters with other pH conditions):

Saprolegnia ferax
— *hypogyna*
Achlya racemosa
— — var. *stelligera*
— *radiosa*
Aphanomyces laevis
Dictyuchus sp.
Apodachlya pirifera
Rhipidium sp.
Gonapodya siliquaeformis
Blastocladia Pringsheimii
Monoblepharis sp.
Pythiomorpha gonapodyides
Pythium proliferum
— *rostratum*
Pythiogeton utriforme.

On p. 41 mention is made of an attempt to ascertain how long a period of time elapses before fungi appear on apples in a constantly alkaline lake.

Table 4. Phycomycetes found in c.alk. Waters and their Frequency.
(See explanation p. 61.)

Species	Periodically investigated				Other c. alk. waters	Total number of waters
	Pool, Agricult. College Garden (No. 62)	Chara Pond Jonstrup Vang (No. 63)	Søndersø (No. 64)	Fortunsø (No. 65)		
Pythiopsis Humphreyana	..	1?	..	..	..	1?
Saprolegnia crustosa	..	..	..	..	2	2
— *monoica*	..	..	..	..	2	2
— *mixta*	..	1	..	..	..	1
— *ferax*	..	3	..	2	14	16
— *hypogyna*	1	..	2	1	2	5
Isoachlya parasitica	..	..	..	..	1	1
Achlya racemosa	2	1	1	1	17	21
— — var. *stelligera*	2	2	1	1	14	18
— *radiosa*	..	1	..	..	4	5
— *americana*	..	..	..	..	2	2
— *oligacantha*	..	..	..	..	1	1
Aphanomyces laevis	..	..	..	..	6	6
— *stellatus*	..	..	..	..	2	2
Dictyuchus monosporus	..	..	..	1	..	1
— *Magnusii*	..	..	..	..	1	1
— *sterile*	..	..	..	..	3	3
Thraustotheca sp.	..	..	..	..	2	2
Apodachlya pirifera	..	1	1	2	13 (14?)	16 (17?)
— — var. *macrosporangia*	..	1	..	..	1	2
Rhipidium continuum	1?	1?	..	..	1 (4?)	1 (6?)
— *americanum*	1	..	..	..	1	2
— *parthenosporum*	..	..	..	1?	1?	2?
— sp.	..	..	1	1	3	5
Gonapodya siliquaeformis	1	..	..	..	4	5
— *polymorpha*	..	..	..	..	1 (2?)	1 (2?)
Blastocladia Pringsheimii	2	1	..	2	9	12
— *rostrata*	..	..	..	..	2	2
— *gracilis*	1	..	..	..	2?	1 (3?)
Monoblepharis polymorpha	..	1	..	..	1	2
— *brachyandra*	..	..	..	..	1?	1?
— sp.	..	..	..	..	6	6
Pythiomorpha gonapodyides	2	1	..	..	6	8
— sp. I	..	..	..	..	1	1
Pythium gracile	..	..	..	..	1	1
— *proliferum*	..	..	..	..	4	4
— *rostratum*	1	..	1	..	11	13
Pythiogeton utriforme	1?	..	..	2	6	7 (8?)
— *uniforme*	..	..	..	..	1	1
Macrochytrium botrydioides	..	..	..	1	1	2

3. Survey of the Occurrence of the Individual Species.

For the abbreviations h.a., s.a., n.a., n.alk., and c.alk. see p. 61; the figures appended denote the number of waters in which the species were found.

Achlya americana 1 h.a., 1 n.alk., 2 c.alk.
— *caroliniana* 1 h.a.?, 1 s.a.
— *imperfecta* 1 n.alk. Pond abounding with decaying substances.
— *Klebsiana* 1 n.alk.
— *oligacantha* 1 c.alk.
— *racemosa* 8 h.a., 3 s.a., 1 n.a., 10 n.alk., 21 c.alk.
— *racemosa* var. *stelligera* 8 h.a., 2 s.a., 1 n.a., 8 n.alk., 18 c.alk. Usually occurs in company with the main species.
— *radiosa* 1 h.a., 4 (5?) n.alk., 5 c.alk. Seems to prefer small ponds with calm water.
— *recurva* 1 n.alk. Pond with stagnant polluted water.
Aphanomyces laevis 6 c.alk. Doubtless occurs in all waters containing suitable substrata (teguments of nymphs of *Phryganeae* etc.).
— *stellatus* 2 c.alk. The remark on the foregoing species also applies to the present species, but it is more rare.
Aplanes androgynus 12 h.a. Occurs especially in bogs.
— *Treleaseanus* 10 h.a. Like the foregoing species occurs frequently in bogs.
Apodachlya pirifera 4 (5?) h.a., 4 s.a., 1 n.a., 9 (10?) n.alk., 16 (17?) c.alk.
— *pirifera* var. *macrosporangia* 2 s.a., 1 n.alk., 2 c.alk.
— *seriata* 1 n.alk.
Blastocladia angusta 1 h.a.
— *gracilis* 5 n.alk., 1 (3?) c.alk. Occurs especially in ponds with stagnant, often foul water.
— *Pringsheimii* 1 h.a., 1 s.a., 7 n.alk., 12 c.alk. Often found in small pools and ponds frequently abounding with decaying plants.
— *rostrata* 2 c.alk.
Dictyuchus Magnusii 1 n.alk., 1 c.alk.
— *monosporus* 1 n.alk., 1 c.alk.
— *sterile* 4 h.a., 1 s.a., 1 n.a., 2 n.alk., 3 c.alk. This apparently sterile fungus can, however, hardly be regarded as a distinct species.
Gonapodya polymorpha 2 h.a., 1 (2?) s.a., 5 n.alk., 1 (2?) c.alk. Connected with the succeeding species by transitional forms, so that they are sometimes difficult to distinguish. As far as I can see, both species occur in acid as well as in alkaline water.
— *siliquaeformis* 1 h.a., 1 n.a., 2 (3?) n.alk., 5 c.alk.
Isoachlya parasitica 1 c.alk.
Macrochytrium botrydioides 3 n.alk., 2 c.alk. Occurs especially in pools and ponds with stagnant water.

Monoblepharis brachyandra 1 c.alk.?.
— *polymorpha* 3 n.alk., 2 c.alk.
— *sphaerica* 1 h.a., 3 n.alk.
— sp. 2 s.a., 6 n.alk., 6 c.alk.
Pythiogeton (?) *sp.* 1 h.a.
— *uniforme* 1 c.alk.
— *utriforme* 1 h.a., 1 s.a., 1 n.a., 4 n.alk., 7 (8?) c.alk.
Pythiomorpha gonapodyides 1 s.a.?, 1 n.a., 7 n.alk., 8 c.alk. Frequent in smaller waters.
— sp. I. 1 n.alk., 1 c.alk.
— sp. II. 1 n.alk.
— sp. III 2 h.a.
— *undulata* 12 (14?) h.a., 2 s.a. Frequent in bogs.
Pythiopsis Humphreyana 2 n.alk., 1 c.alk.?.
Pythium gracile 1 c.alk.
— *proliferum* 2 h.a., 2 s.a., 1 n.a., 3 n.alk., 4 c.alk.
— *rostratum* 6 h.a., 3 s.a., 7 n.alk., 13 c.alk.
— (?) *sp.* 1 n.alk.
— *undulatum* 1 h.a.?.
Rhipidium americanum 2 (3?) h.a., 2 s.a., 2 (6?) n.alk., 2 c.alk. Both this and the following species probably occurs in all types of waters, but they seem to prefer small ponds and pools, often containing many decaying plants.
— *continuum* 1 (3?) h.a., 1 s.a.?, 2 (6?) n.alk., 1 (6?) c.alk.
— *parthenosporum* 2 n.alk., 2 c.alk.?.
— sp. 1 s.a., 5 c.alk.
Saprolegnia asterophora 1 (2?) n.alk. Ponds with stagnant water.
— *crustosa* 1 s.a., 2 c.alk.
— *delica* 4 h.a. Found exclusively in bogs.
— *diclina* 4 h.a., 2 n.a.
— *ferax* 3 (4?) h.a., 3 s.a., 8 n.alk., 16 c.alk.
— *glomerata* 1 n.alk.
— *hypogyna* 1 h.a., 1 s.a., 5 c.alk.
— *latviaca* 1 h.a. Found in 3 places in a bog. Recorded from similar localities in Latvia (Apinis).
— *litoralis* 8 h.a., 2 s.a. Occurs especially in bogs.
— *mixta* 3 (4?) n.alk., 1 c.alk.
— *monoica* 3 h.a., 1 s.a., 5 n.alk., 2 c.alk.
— *monoica* var. *montana* 1 h.a. Bog. Similar localities have been recorded from Germany (v. Minden).
— *pseudocrustosa* 1 n.alk.
— *torulosa* 2 h.a.
— *variabilis* 1 h.a.

Sapromyces Reinschii 5 h.a., 1 s.a., 1 n.a. Occurs especially in bogs.
Thraustotheca sp. 1 h.a., 1 s.a., 2 c.alk.

As will appear from the above, a great deal of the freshwater Phycomycetes found by the writer may occur in so to speak all pH types of waters, thus e. g. *Achlya racemosa, A. racemosa* var. *stelligera, Apodachlya pirifera, Saprolegnia monoica, Saprol. ferax, Pythium proliferum, Pyth. rostratum.*

On the other hand, several species seem to be limited to — or at any rate to prefer — certain definite types of aquatic habitats, so that a number of water moulds are in the main distributed in two groups, one of which is peculiar to acid (especially highly acid) waters, whereas the other group belongs to neutrally alkaline and constantly alkaline waters[1]. As species typical of acid — especially highly acid — waters may be mentioned: *Aplanes androgynus, Apl. Treleaseanus, Pythiomorpha undulata, Sapromyces Reinschii, Saprolegnia delica, Saprol. litoralis, Saprol. diclina,* whereas the following seem to prefer alkaline waters: *Blastocladia gracilis, B. Pringsheimii,* species of *Monoblepharis, Pythiomorpha gonapodyides, Achlya radiosa, Macrochytrium botrydioides.*

As previously mentioned, the slightly acid and the neutrally acid waters do not seem to harbour any phycomycetous flora peculiar to them. In the composition of species they mostly seem to resemble the highly acid waters. With regard to the slightly acid, the occurrence of *Saprol. litoralis, Sapromyces Reinschii,* and *Pythiomorpha undulata* would seem to point in that direction; as to the neutrally acid, the occurrence of *Saprol. diclina* and *Sapromyces Reinschii* would seem to favour this assumption.

Whether the freshwater Phycomycetes are indeed dependent on the hydrogen ion concentration of the water, or whether other, parallel, factors come into play, can of course only be settled experimentally. Observations were made, however, which would seem to indicate that the pH is not the decisive factor. In my cultures with water, tap-water which is alkaline (pH 7.2—7.7) was employed, and in this fungi from all types of waters thrive well, as a rule producing abundant sporangia and sexual organs. On determining the pH in the cultures after about 1 month, it turned out that the water remained alkaline in the cultures derived from neutrally alkaline and constantly alkaline lakes, and that as a rule it had become still more alkaline (pH 7.0—8.4), except in the cultures with apples. The acid content of these fruits caused the water to become highly acid (pH c. 4.0); the fungi occurring on apples, some of which in nature usually are only met with in neutrally alkaline and constantly alkaline waters, showed a vigorous growth here. In cultures with soil, *Sphagnum* etc. from highly acid waters, the water showed a more or less acid reaction (pH 4.7—6.0), whereas the water in the cultures containing twigs from such lakes and bogs remained alkaline (pH 7.0—8.4); in the latter cultures also the fungi did well in spite of the fact that in nature several of them seem to occur in acid waters only.

[1] As mentioned above the phycomycetous flora seems to be almost the same in n.alk. and in c.alk. waters.

V. Localities investigated.

In this part of the paper all the localities are included, in which freshwater Phycomycetes were found, the acid being mentioned at the beginning, the alkaline at the end. In most cases brief notes on the higher vegetation and the reaction of the water are given; moreover lists of the Phycomycetes observed are added. — The following abbreviations are used: *c. S.* = central Sealand; *n.e. S.* = north-eastern Sealand; *c. J.* = central Jutland; *n.e. J.* = north-eastern Jutland; *n.w. J.* = north-western Jutland; *n. J.* = northern Jutland.

Highly Acid Waters (Nos. 1—34).

1. **Bøllemose,** Jægersborg Hegn, n.e. S. Lake with *Calla palustris, Typha, Iris pseudacorus, Potentilla palustris, Glyceria fluitans, Eriophorum polystachyum, E. vaginatum, Sphagnum.* Surrounded by boggy soil with *Calluna, Molinia, Vaccinium uliginosum, V. myrtillus, Betula, Salix,* and other plants. — pH: 4.2 (March), 4.4 (April), 4.4 (May), 4.4 (July), 4.1 (November).

Phycomycetes: *Saprolegnia diclina, S. monoica, S. ferax, Aplanes androgynus, Achlya racemosa, A. racemosa* var. *stelligera, Dictyuchus sterile, Apodachlya pirifera, Rhipidium americanum, Gonapodya siliquaeformis, Pythiomorpha undulata, Pythiom.* sp. III, *Pythium proliferum, Pyth. rostratum, Pythiogeton utriforme.*

2. **Ditch near Bøllemose,** Jægersborg Hegn, n.e. S. Small ditch with stagnant water. *Calla palustris, Juncus effusus, Sphagnum.* The surrounding soil is boggy. — pH: 4.0 (March), 3.6 (April), 3.7 (May), 3.6 (July).

Phycomycetes: *Saprolegnia litoralis, S. ferax* (?), *Achlya racemosa* var. *stelligera, Dictyuchus sterile, Rhipidium continuum* (?), *Rhip. americanum* (?), *Pythiomorpha undulata* (?), *Pythium proliferum.*

3. **St. Gribsø,** Grib Skov, n.e. S. Rather small lake with *Nuphar luteum, Iris, Phragmites, Glyceria, Equisetum fluviatile, Sphagnum* (*cuspidatum* var. *submersum*). Here and there surrounded by boggy soil with *Calluna, Vaccinium myrtillus, Melampyrum vulgatum,* and other herbaceous plants; foliiferous trees (*Fagus, Betula, Alnus*) and *Picea.* — pH: 4.3 (February), 4.3 (April), 4.4 (May), 4.4 (July), 3.9 (November).

Phycomycetes: *Saprolegnia monoica, Achlya racemosa, A. racemosa* var. *stelligera, Dictyuchus sterile, Apodachlya pirifera* (?), *Sapromyces Reinschii, Rhipidium continuum, Pythiomorpha undulata* (?), *Pythium undulatum* (?), *Pyth. rostratum.*

4. **Bøndernes Tørvemose,** Grib Skov, n.e. S. Peat bog with small pools. The vegetation in the pools consists chiefly of an abundance of *Sphagnum* (mostly *cuspidatum* var. *plumosum*) besides green algae. In the bog there occur *Calluna, Vaccinium uliginosum, V. myrtillus, Eriophorum vaginatum, Deschampsia flexuosa, Sphag-*

num, Betula, Picea, Salix repens. — pH (in one of the pools): 3.5 (February), 3.6 (April), 3.6 (May), 3.6 (July), 3.3 (November).

Phycomycetes: *Saprolegnia delica, Aplanes androgynus, Apl. Treleaseanus, Achlya racemosa, A. racemosa* var. *stelligera, Sapromyces Reinschii, Rhipidium continuum*(?), *Rhip. americanum, Blastocladia Pringsheimii, Bl. angusta, Pythiomorpha undulata, Pythium rostratum, Pythiogeton*(?) sp.

5. **Lille Gribsø,** Grib Skov, n.e. S. Lake surrounded by quaking *Sphagnum* bog and *Calluna, Gramineae, Cyperaceae, Betula, Picea.* — pH: 4.5 (February 31).

Fig. 30. **St. Gribsø.** *Equisetum fluviatile, Iris, Nuphar;* surrounded by *Picea* and foliiferous trees.

Phycomycetes: *Saprolegnia delica, Achlya racemosa* var. *stelligera, Sapromyces Reinschii, Gonapodya polymorpha, Pythium rostratum.*

6. **Ditch near Lille Gribsø,** Grib Skov, n.e. S. — Phycomycetes: *Aplanes Treleaseanus.*

7. **Maglemose,** Grib Skov, n.e. S. Bog with *Eriophorum, Calluna, Empetrum, Vaccinium, Sphagnum* and other plants.

Phycomycetes: *Saprolegnia litoralis, S. latviaca, Aplanes Treleaseanus.*

8. **Ditch at Buresø,** Grib Skov, n.e. S. Small ditch in a bog with *Eriophorum, Rhynchospora alba, Calluna, Sphagnum* and other plants — pH: 3.6 ($^{8}/_{11}$ 31).

Phycomycetes: *Achlya racemosa* var. *stelligera, A. americana, Pythium rostratum.*

9. **Ditch in a birch bog,** Tokkekøb Hegn, n.e. S. — pH: 4.4, minimum 4.4, maximum 4.5 ($^3/_5$ 31).

Phycomycetes: *Saprolegnia ferax, Achlya racemosa.*

10. **Ryttermose,** Silkeborg Sønderskov, c. J. Bog with *Sphagnum, Calluna, Eriophorum, Oxycoccus quadripetalus, Erica, Drosera, Pinus, Picea,* and a few *Betula.*

Phycomycetes: *Saprolegnia litoralis.*

11. **Bregnesø,** Hellumtved near Skørping, n.e. J. Small lake situated in a bog. *Eriophorum polystachyum, E. vaginatum, Juncus effusus,* species of *Carex, Sphagnum.*

Fig. 31. **Bøndernes Tørvemose.** One of the pools is seen. *Eriophorum vaginatum, Calluna, Betula, Picea.*

Surrounded by *Picea,* a few *Pinus* and *Juniperus, Trientalis, Calluna, Sphagnum.* — pH: 4.8, minimum 4.7, maximum 5.2 ($^8/_6$ 31).

Phycomycetes: *Achlya racemosa, A. racemosa* var. *stelligera, Apodachlya pirifera.*

12. **Peat bog near Bregnesø,** Hellumtved, n.e. J. Situated in a *Calluna* heath east of Bregnesø.

Phycomycetes: *Aplanes androgynus, Pythiomorpha undulata.*

13. **St. Øxsø,** Rold Skov, n.e. J. Lake with species of *Carex, Eriophorum polystachyum, Heleocharis palustris, Nuphar luteum,* and *Phragmites.* Surrounded by *Picea, Betula,* a few *Salix,* and *Calluna* heaths with *Picea, Sphagnum* and other mosses, *Andromeda,* and *Eriophorum.* — pH: 4.2 ($^8/_6$ 31). (See also Iversen 1929, p. 309).

Phycomycetes: *Saprolegnia diclina, Achlya racemosa* var. *stelligera, Pythiomorpha undulata.*

14. **Sphagnum bog near St. Øxsø,** Rold Skov, n.e. J. — Phycomycetes: *Saprolegnia monoica* var. *montana, Aplanes androgynus.*

15. **Mossø.** Tvillingskov, south of Skørping, n.e. J. Small lake with *Eriophorum*, species of *Carex, Potentilla palustris, Sphagnum* and other mosses. The lake is surrounded by *Picea, Pinus,* a few *Betula, Calluna* heath with *Picea, Vaccinium, Eriophorum, Cornus suecica, Trientalis europaea, Drosera, Oxycoccus.* — pH: 4.0 ($^{8}/_{6}$ 31). (See also Iversen 1929, p. 309).
Phycomycetes: *Saprolegnia litoralis, Aplanes androgynus, Pythiomorpha undulata.*

16. **Madum Sø,** south-east of Skørping, n.e. J. Large lake with *Phragmites, Litorella, Lobelia, Juncus supinus, Cyperaceae,* a small quantity of *Sphagnum,* and other plants. Surrounded partly by wood of conifers and partly by wood of *Fagus.* — pH: c. 4.4 ($^{9}/_{6}$ 31). (See also Iversen 1929, p. 309).
Phycomycetes: *Saprolegnia diclina, S. litoralis, S. variabilis, Aplanes androgynus, Apl. Treleaseanus, Gonapodya polymorpha, Pythiomorpha undulata.*

17. **Swamp north-east of Madum Sø,** n.e. J. Shallow swamp in wood of conifers. *Sphagnum,* a small quantity of *Phragmites* and *Calluna, Eriophorum.* — pH: 4.0 ($^{9}/_{6}$ 31).
Phycomycetes: *Dictyuchus sterile, Sapromyces Reinschii, Pythium rostratum.*

18. **Sphagnum pool No. 1 north-west of Madum Sø,** n.e. J. Pool in *Calluna* heath; *Sphagnum* in quantity, *Eriophorum vaginatum,* species of *Carex.* — pH: c. 3.9 ($^{9}/_{6}$ 31).
Phycomycetes: *Saprolegnia litoralis, Aplanes androgynus.*

19. **Sphagnum pool No. 2 north-west of Madum Sø,** n.e. J. Somewhat larger than No. 18. *Sphagnum, Eriophorum.* Surrounded by *Calluna* heath. — pH: 4.4 ($^{9}/_{6}$ 31).
Phycomycetes: *Aplanes Treleaseanus, Pythiomorpha undulata.*

20. **Lille Øxsø,** Rold Skov, n.e. J. Small lake situated in *Calluna* heath surrounded by wood of conifers. — pH: 3.6 ($^{10}/_{6}$ 31). (See also Iversen 1929, p. 308).
Phycomycetes: *Aplanes Treleaseanus.*

21. **Moist heath near Lille Øxsø.** n.e. J. — Phycomycetes: *Saprolegnia delica, Aplanes androgynus, Pythiomorpha undulata.*

22. **Farsø Mose,** Rold Skov, n.e. J. Rather large bog with *Sphagnum, Nuphar luteum, Eriophorum,* and other plants. — pH: 3.8, maximum 3.8 ($^{10}/_{6}$ 31).
Phycomycetes: *Saprolegnia delica, Pythiomorpha undulata.*

23. **Pool, Hellum Skov,** south-east of Skørping, n.e. J. Pool in *Calluna* heath. *Sphagnum, Eriophorum.* — pH: 3.8 ($^{11}/_{6}$ 31).

Phycomycetes: *Aplanes androgynus, Apl. Treleaseanus.*

24. **Langmose,** Hellum Skov, south-east of Skørping, n.e. J. Lake situated in a bog. *Sphagnum, Eriophorum.* Surrounded by moist heath. — pH: 4.0 ($^{11}/_{6}$ 31).

Phycomycetes: *Saprolegnia litoralis, Aplanes androgynus, Apl. Treleaseanus, Pythiomorpha undulata.*

25. **Horsmose,** south-east of Hellum Skov, n.e. J. Peat bog surrounded by cultivated fields. Much *Sphagnum.* — pH: 4.0 ($^{11}/_{6}$ 31).

Phycomycetes: *Aplanes androgynus, Apl. Treleaseanus.*

26. **Gaardsø Mose,** Nørlund Skov, south-west of Skørping, n.e. J. Rather large bog in wood of conifers. The open water is surrounded by a swamp with *Sphagnum, Eriophorum, Drosera, Calluna,* a few *Betula.* — pH: 3.2 ($^{12}/_{6}$ 31).

Phycomycetes: *Aplanes androgynus, Apl. Treleaseanus, Achlya racemosa.*

27. **Pool by the road, Aalborg-Rold,** n.e. J. Situated in wood of *Picea. Sphagnum, Eriophorum, Juncus effusus,* and other plants. — pH: 4.0, minimum 4.0, maximum 4.2 ($^{12}/_{6}$ 31).

Phycomycetes: *Achlya racemosa, Thraustotheca* sp., *Sapromyces Reinschii, Pythiomorpha* sp. III.

28. **Small pond west of Skørping,** n.e. J. Situated in wood of *Picea* with a ground flora of *Anemone, Oxalis acetosella,* and *Convallaria majalis.* — pH: 4.7, minimum 4.7, maximum 4.7 ($^{13}/_{6}$ 31).

Phycomycetes: *Achlya racemosa, A. radiosa, Apodachlya pirifera, Monoblepharis sphaerica.*

29. **Pool west of Skørping,** n.e. J. Resembles No. 28. Situated in wood of *Picea.* — pH: 4.8 ($^{13}/_{6}$ 31).

Phycomycetes: *Apodachlya pirifera.*

30. **Hykær,** north-west of Nors, n.w. J. Rather small shallow lake with sandy bottom. *Phragmites, Heleocharis palustris, Scirpus lacuster, Polygonum amphibium.* Surrounded by meadows passing into downs. — pH: 5.2, minimum 4.8, maximum 5.2 ($^{31}/_{8}$ 31).

Phycomycetes: *Saprolegnia monoica, S. torulosa, Pythiomorpha undulata.*

31. **Præstekær,** north-west of Nors, n.w. J. Small, shallow lake with sandy bottom. *Lobelia, Heleocharis, Phragmites.* The lake is surrounded by meadows with *Narthecium ossifragum, Gentiana, Drosera, Gramineae, Cyperaceae; Sphagnum* here and there. — pH: c. 5.2, minimum 4.8, maximum 5.4 ($^{31}/_{8}$ 31).

Phycomycetes: *Saprolegnia diclina, S. hypogyna, S. torulosa, Achlya caroliniana* (?).

32. **Lake in the heath south-east of Vorupør,** n.w. J. Small shallow lake with sandy bottom. *Heleocharis* and other *Cyperaceae, Sphagnum.* Surrounded by heaths and downs. — pH: 5.2, minimum 4.8, maximum 5.2 ($^1/_9$ 31).

Phycomycetes: *Saprolegnia ferax.*

33. **Sphagnum pool south-east of Vorupør,** n.w. J. Small pool about 1.5×1.0 m, filled with *Sphagnum.* Situated in heath with *Calluna, Myrica* and other plants.

Phycomycetes: *Pythiomorpha undulata.*

Fig. 32. **Det blanke Vand.**

34. **Sphagnum pool north-west of Nors,** n.w. J. Small pool with *Sphagnum,* in *Calluna* heath. — pH: 4.3, minimum 4.3, maximum 4.7 ($^2/_9$ 31).

Phycomycetes: *Saprolegnia litoralis.*

Slightly Acid Waters (Nos. 35—42).

35. **Det blanke Vand,** Jonstrup Vang, n.e. S. Small lake (or pond) in wood of *Picea. Hydrocharis morsus ranae, Lemna,* a few *Iris, Phragmites, Equisetum fluviatile;* according to Iversen (1929, p. 314) *Fontinalis* is common; near the shore *Juncus effusus* and species of *Carex.* Surrounded by *Alnus* and *Picea.* — pH: c. 6.3 (February), 6.5 (March), 6.8 (April), 6.8 (May), 6.5 (July), 6.5 (September), 6.4 (October).

Phycomycetes: *Saprolegnia ferax, Achlya racemosa, Dictyuchus sterile, Apodachlya pirifera, Sapromyces Reinschii, Rhipidium continuum* (?), *Rhip. americanum,* *Gonapodya polymorpha, Monoblepharis* sp., *Pythium proliferum, Pyth. rostratum, Pythiogeton utriforme.*

36. **Dommermose,** Jonstrup Vang, n.e. S. Small lake (or pond). The surface often covered with *Lemna minor* and *Hydrocharis morsus ranae*; *Riccia fluitans* is common; a few *Menyanthes trifoliata* and *Equisetum fluviatile.* The lake is surrounded by *Picea* with the usual ground flora, a few *Quercus.* — pH: 6.0 (February), 6.2 (March), 6.3 (April), 6.8 (May), 5.3 (September), 5.3 (October).

Phycomycetes: *Achlya racemosa, A. racemosa* var. *stelligera, A. caroliniana, Apodachlya pirifera, Apod. pirifera* var. *macrosporangia, Rhipidium americanum, Rhip.* sp., *Gonapodya polymorpha* (?), *Blastocladia Pringsheimii, Monoblepharis* sp., *Pythiomorpha gonapodyides* (?), *Pythium rostratum.*

37. **Pool in Sortemose** near Lillerød, n.e. S. Small shallow pool with *Sphagnum* and other mosses. Surrounded by *Salix* and *Betula* on boggy soil. — pH: 5.2, minimum c. 5.0, maximum c. 6.8 ($^{3}/_{5}$ 31).

Phycomycetes: *Saprolegnia litoralis, Apodachlya pirifera* var. *macrosporangia.*

38. **Uglesø,** Silkeborg Østerskov, c. J. Lake in wood of *Picea. Nuphar luteum,* at the shore *Cyperaceae,* a small quantity of *Sphagnum.* The lake is surrounded by *Betula, Alnus, Fagus,* and here and there *Picea* on boggy ground with *Vaccinium* and *Calluna.* — pH: c. 6.9, minimum 5.3, maximum c. 6.9 ($^{13}/_{5}$ 32).

Phycomycetes: *Saprolegnia crustosa* var. II, *Achlya racemosa* var. *stelligera, Apodachlya pirifera.*

39. **Mørksø in Hoksmose,** Silkeborg Østerskov, c. J. Small lake in a *Sphagnum* bog. *Nuphar,* at the shore *Sphagnum.* Surrounded by *Eriophorum vaginatum, Calluna, Sphagnum, Betula, Pinus.* — pH: c. 4.5, maximum c. 6.4 ($^{13}/_{5}$ 32).

Phycomycetes: *Saprolegnia litoralis, Pythiomorpha undulata.*

40. **Pond in Jægersborg Skov,** south of Skørping, n.e. J. Small pond in wood of *Picea.* Surface covered with *Lemna* and green algae, further: *Equisetum fluviatile, Alisma plantago aquatica.* — pH: 5.2, minimum 4.8, maximum 6.2 ($^{9}/_{6}$ 31).

Phycomycetes: *Saprolegnia monoica, S. ferax, Apodachlya pirifera, Pythiomorpha undulata.*

41. **Vorup Sø,** n.w. J. Rather large lake with *Heleocharis palustris, Phragmites, Lobelia* and other plants. Surrounded by heaths and downs. — pH: 6.8, minimum 5.6, maximum c. 6.9 ($^{1}/_{9}$ 31).

Phycomycetes: *Saprolegnia ferax, S. hypogyna, Thraustotheca* sp.

42. **Barnsø** in Tved Plantage, n.w. J. Pond in wood of conifers, near the alkaline Nors Sø (No. 98). *Heleocharis palustris, Polygonum amphibium, Equisetum fluviatile, Myriophyllum, Nuphar, Scirpus lacuster, Phragmites*; here and there by the

shore *Sphagnum*. Surrounded by *Calluna* and conifers. — pH: 6.5, minimum 5.2, maximum c. 6.8 ($^{29}/_{8}$ 31). (See also Iversen 1929, p. 315).

Phycomycetes: *Achlya racemosa, Pythium proliferum, Pyth. rostratum.*

Neutrally Acid Waters (Nos. 43—46).

43. **Pond, Donse Overdrev,** n.e. S. Pond surrounded by *Fagus* and *Betula*. — pH: 6.0, minimum 5.2, maximum 7.3 ($^{3}/_{5}$ 31).

Phycomycetes: *Apodachlya pirifera.*

Fig. 33. **Mørke Sø.** In the background wood of *Fagus.*

44. **Agersø,** Rudeskov, n.e. S. Small lake in wood consisting mainly of *Picea*. Surrounded by *Alnus, Betula,* a few *Fagus* and *Salix*. — pH: c. 6.5, minimum 5.2, maximum 8.0 ($^{11}/_{4}$ 32).

Phycomycetes: *Achlya racemosa* var. *stelligera.*

45. **Mørke Sø,** Svejbæk, c. J. Small lake surrounded by — mostly young — *Betula* on boggy soil with *Vaccinium myrtillus, V. vitis idaea, Luzula pilosa, Gramineae,* here and there *Juniperus communis* and *Calluna, Frangula alnus* and a few *Picea*; by the shore here and there *Sphagnum palustre* and *Dryopteris thelypteris.* — pH: c. 6.9, minimum 5.2, maximum 7.9 ($^{10}/_{5}$ 32).

Phycomycetes: *Saprolegnia diclina, Achlya racemosa, Dictyuchus sterile, Sapromyces Reinschii, Gonapodya siliquaeformis, Pythiomorpha gonapodyides, Pythium proliferum, Pythiogeton utriforme.*

46. **Bog north-west of Nors Sø,** n.w. J. The bog is surrounded by a swamp with *Sphagnum, Eriophorum polystachyum* and other *Cyperaceae, Salix repens,* and *Calluna.* Situated among heaths and downs with *Calluna, Psamma, Pinus* and other plants. — pH: 6.4, minimum 5.2, maximum 7.2 ($^{29}/_{8}$ 31).

Phycomycetes: *Saprolegnia diclina.*

Neutrally Alkaline Waters (Nos. 47—61).

47. **Pond No. 1, Ermelund,** n.e. S. Surface often covered by *Lemna*; *Equisetum fluviatile*; the bottom consisting of mud with many decaying plant substances.

Fig. 34. **Pond No. 1, Ermelund.** *Lemna, Equisetum fluviatile;* in the background *Alnus* and *Fagus.*

Situated in wood of *Fagus*; on the shores foliiferous trees, particularly *Alnus.* — pH: 6.9 (February), c. 6.4 (March), 6.8 (April), 7.2 (May), 6.9 (July), 6.9 (September), 6.7 (October).

Phycomycetes: *Saprolegnia mixta, S. ferax, Achlya racemosa, A. racemosa* var. *stelligera, A. recurva, Dictyuchus Magnusii, Dict. sterile, Apodachlya pirifera, Rhipidium continuum* (?), *Rhip. americanum, Rhip. parthenosporum, Gonapodya siliquaeformis* (?), *Blastocladia Pringsheimii, Bl. gracilis, Monoblepharis* sp., *Pythiomorpha gonapodyides, Pythium proliferum, Pyth. rostratum.*

48. **Pond No. 2, Ermelund,** n.e. S. Small pond, in part resembling No. 47, but "cleaner". *Potamogeton natans, Lemna minor* and other plants. — pH: 6.9 (February), 6.0 (March), 6.8 (April), 6.8 (May), 6.9 (July), 7.2 (September), 6.9 (October).

Phycomycetes: *Saprolegnia pseudocrustosa, S. asterophora, Achlya racemosa, A. racemosa* var. *stelligera, A. radiosa, Dictyuchus sterile, Apodachlya pirifera, Apod. pirifera* var. *macrosporangia, Pythiomorpha* sp. II, *Pythium proliferum.*

49. **Pool No. 1, Jonstrup Vang,** n.e. S. Small shallow pool in a muddy swamp in wood of *Fagus*; at the bottom mud and many decaying leaves and twigs. Sometimes the pool dries up. Surrounded by *Iris pseudacorus, Phragmites communis, Carex Hudsonii, Quercus, Fraxinus, Fagus.* — pH: 6.9 (February), 6.5 (March), 6.7 (April), 7.7 (May), 7.2 (July), 7.2 (September).

Phycomycetes: *Pythiopsis Humphreyana, Saprolegnia monoica, S. glomerata,*

Fig. 35. **Pool No. 1, Jonstrup Vang.**

S. mixta, S. ferax, Achlya radiosa (?), *Apodachlya pirifera, Rhipidium continuum, Rhip. americanum* (?), *Rhip. parthenosporum, Gonapodya polymorpha, Blastocladia Pringsheimii, Monoblepharis* sp., *Pythium rostratum, Macrochytrium botrydioides.*

50. **Pool No. 2, Jonstrup Vang,** n.e. S. Shallow pool in wood of *Fagus*; occasionally it dries up. Resembles No. 49. *Lemna, Iris, Carex Hudsonii*; surrounded by *Quercus, Fagus, Fraxinus.* — pH: 6.8 (February), 6.9 (March), 7.2 (April), 7.6 (May), 7.0 (July), 7.0 (September).

Phycomycetes: *Saprolegnia monoica, S. ferax, Achlya racemosa, Apodachlya pirifera, Rhipidium continuum* (?), *Rhip. americanum* (?), *Blastocladia Pringsheimii, Bl. gracilis, Pythiomorpha gonapodyides, Pythiogeton utriforme.*

51. **Pool No. 1, Kongelund,** n.e. S. Surface often covered by *Lemna*; the bottom consists of mud with much decaying organic matter. Surrounded by *Alnus,*

Fraxinus, and *Picea*. — pH: 6.9 (February), 6.9 (March), 7.4 (April), 8.2 (May), 6.9 (July), 7.2 (September), 7.0 (November).

Phycomycetes: *Pythiopsis Humphreyana, Saprolegnia ferax, Achlya racemosa, Apodachlya pirifera* (?), *Rhipidium continuum, Rhip. americanum* (?), *Gonapodya siliquaeformis, Gon. polymorpha, Blastocladia Pringsheimii, Bl. gracilis, Monoblepharis sphaerica, Mon. polymorpha, Pythiomorpha gonapodyides, Pythiom.* sp. I, *Pythium proliferum, Pyth. rostratum, Macrochytrium botrydioides.*

52. **Pool No. 2, Kongelund,** n.e. S. Surface often covered by *Lemna*. Surrounded by foliiferous trees (*Fagus, Fraxinus, Tilia, Betula*) and *Picea*. — pH: 7.0 (February), 6.9 (March), 7.2 (April), 8.0 (May), 6.9 (July), 7.2 (September), 7.1 (November).

Phycomycetes: *Saprolegnia monoica, S. ferax, Apodachlya pirifera, Rhipidium americanum, Blastocladia gracilis, Monoblepharis* sp., *Pythiomorpha gonapodyides, Pythium rostratum.*

53. **Sortedam,** Hillerød, n.e. S. Pond with *Lemna* and, along the shore, *Baldingera, Glyceria* and other plants; the bottom muddy. Surrounded by *Fagus* and *Quercus*. — pH: 6.4 (February), 6.5 (March), 7.5 (April), 8.0 (May), 7.1 (July), 7.2 (November).

Phycomycetes: *Saprolegnia mixta, S. ferax, Achlya racemosa, A. racemosa* var. *stelligera, A. imperfecta, Dictyuchus monosporus, Apodachlya pirifera, Gonapodya polymorpha, Blastocladia Pringsheimii, Monoblepharis* sp., *Pythiomorpha gonapodyides, Pythium rostratum, Pythiogeton utriforme.*

54. **Kildesø,** Jægersborg Dyrehave, n.e. S. Pond with muddy bottom, containing many decaying plant substances. *Phragmites, Sparganium, Cyperaceae, Potamogeton natans, Equisetum, Iris.* The pond is surrounded by foliiferous trees, mostly *Fagus* and *Alnus*. — pH: 7.4 (February), 6.3 (March), 7.6 (April), 8.0 (May), 7.5 (July), 7.5 (September).

Phycomycetes: *Saprolegnia ferax, S. asterophora* (?), *Achlya racemosa, A. racemosa* var. *stelligera, Rhipidium continuum* (?), *Blastocladia Pringsheimii, Bl. gracilis, Pythium rostratum.*

55. **Pool No. 3, Jonstrup Vang,** n.e. S. Shallow pool in wood of *Fagus*; the bottom covered with many decaying leaves. *Lemna trisulca, Phragmites, Salix.* — pH: c. 6.8 (February), c. 7.2 (April), minimum c. 6.7, maximum c. 8.4.

Phycomycetes: *Achlya racemosa, A. racemosa* var. *stelligera, A. radiosa, Monoblepharis* sp., *Pythiogeton utriforme.*

56. **Pool, Jægerhuset** near Furesø, n.e. S. *Iris, Phragmites, Salix*; muddy bottom with many old leaves. The pool is surrounded by foliiferous trees (chiefly *Alnus*), and *Cyperaceae*. — pH: c. 7.0 ($^{16}/_{4}$ 32).

Phycomycetes: *Achlya racemosa, A. racemosa* var. *stelligera, A. americana, Apodachlya seriata.*

57. **Løgsø,** Rudeskov, n.e. S. Lake in wood consisting partly of *Fagus*, partly of *Picea*. Surrounded by *Betula* and a few *Picea*. — pH: c. 6.7, minimum c. 6.0, maximum c. 7.8 (11/4 32).

Phycomycetes: *Saprolegnia monoica, Achlya racemosa* var. *stelligera, Apodachlya pirifera, Gonapodya polymorpha, Monoblepharis* sp.

58. **Ditch near Ørnsø,** by Silkeborg, c. J. Small ditch with foul water in wood of foliiferous trees.

Phycomycetes: *Saprolegnia mixta* (?), *Achlya Klebsiana, Monoblepharis sphaerica, Mon. polymorpha.*

Fig. 36. **Pool No. 1, Aastrup.** The water covered by *Lemna minor.*

59. **Pond near Torup Hedegaard,** south-east of Skørping, n.e. J. Small pond with muddy bottom. Surface covered by *Lemna*; the pond is surrounded by *Betula* and *Alnus*. — pH: 6.6, minimum 6.4, maximum 8.4 (11/6 31).

Phycomycetes: *Saprolegnia ferax, Gonapodya siliquaeformis, Monoblepharis sphaerica, Mon. polymorpha, Pythiomorpha gonapodyides, Pythium* (?) *sp.*

60. **Pool No. 1, Aastrup,** near Hjørring, n. J. Pool with muddy bottom and much decaying organic matter; reminiscent of No. 51. Surface often covered by *Lemna*. Surrounded by *Alnus, Fraxinus, Acer*. — pH: 7.0, minimum c. 6.9, maximum c. 7.3 (6/8 32).

Phycomycetes: *Saprolegnia monoica, Achlya racemosa, A. radiosa, Apodachlya pirifera, Rhipidium continuum* (?), *Rhip. americanum* (?), *Gonapodya polymorpha,* *Blastocladia Pringsheimii, Pythiomorpha gonapodyides, Pythium rostratum, Pythiogeton utriforme, Macrochytrium botrydioides.*

61. **Pool No. 2, Aastrup,** near Hjørring, n.J. Resembles No. 60, but is "cleaner".
Phycomycetes: *Achlya racemosa, A. racemosa* var. *stelligera, A. radiosa, Apodachlya pirifera.*

Constantly Alkaline Waters (Nos. 62—104).

62. **Pool in the Agricultural College Garden,** Copenhagen, n.e. S. — pH: c. 7.7 (February), 7.3 (March), 7.8 (April), 7.8 (May), c. 8.0 (July), c. 8.0 (September), 7.8 (November).
Phycomycetes: *Saprolegnia hypogyna, Achlya racemosa, A. racemosa* var. *stelligera, Rhipidium continuum* (?), *Rhip. americanum, Gonapodya siliquaeformis, Blastocladia Pringsheimii, Bl. gracilis, Pythiomorpha gonapodyides, Pythium rostratum, Pythiogeton utriforme* (?).

63. **Chara-pond, Jonstrup Vang,** n.e. S. Shallow pond in wood of foliiferous trees. *Phragmites, Cyperaceae, Characeae.* Surrounded chiefly by *Alnus.* — pH: 7.1 (February), 8.0 (April), 8.2 (May), 7.9 (July), 7.6 (September), 7.2 (October).
Phycomycetes: *Pythiopsis Humphreyana* (?), *Saprolegnia mixta, S. ferax, Achlya racemosa, A. racemosa* var. *stelligera, A. radiosa, Apodachlya pirifera, Apod. pirifera* var. *macrosporangia, Rhipidium continuum* (?), *Blastocladia Pringsheimii, Monoblepharis polymorpha, Pythiomorpha gonapodyides.*

64. **Sondersø** near Værløse, n.e. S. Rather large lake with zones of *Phragmites* and *Scirpus lacuster.* Here and there surrounded by foliiferous trees, mostly *Alnus.* — pH: 7.2 (February), 7.6 (March), 8.4 (April), 8.5 (May), 7.7 (July), 8.0 (October).
Phycomycetes: *Saprolegnia hypogyna, Achlya racemosa, A. racemosa* var. *stelligera, Apodachlya pirifera, Rhipidium* sp., *Pythium rostratum.*

65. **Fortunsø,** Ermelund, n.e. S. Pond with *Scirpus lacuster, Glyceria aquatica, Potamogeton natans, Polygonum amphibium, Lemna minor.* It is surrounded by *Alnus,* a few *Fraxinus* and *Acer.* — pH: 7.4 (February), 7.1 (March), 8.4 (April), 7.7 (May), 7.6 (July), 7.5 (September), 7.2 (October).
Phycomycetes: *Saprolegnia ferax, S. hypogyna, Achlya racemosa, A. racemosa* var. *stelligera, Dictyuchus monosporus, Apodachlya pirifera, Rhipidium parthenosporum* (?), *Rhip.* sp., *Blastocladia Pringsheimii, Pythiogeton utriforme, Macrochytrium botrydioides.*

66. **Pond in the Botanical Garden,** Copenhagen, n.e. S. — pH: 7.1 (February), 7.3 (March), 8.0 (April), 7.6 (May), 8.0 (July), c. 8.0 (September), 7.8 (November).
Phycomycetes: *Achlya racemosa, Apodachlya pirifera* (?), *Rhipidium* sp., *Blastocladia Pringsheimii.*

67. **Badstue-Dam,** Hillerød, n.e. S. Pond surrounded by foliiferous trees. — pH: 8.2 (April), c. 7.7 (November).

Phycomycetes: *Achlya racemosa, A. racemosa* var. *stelligera, Apodachlya pirifera.*

68. **Badstue-Ø-Dam,** Hillerød, n.e. S. Pond communicating with No. 67. — pH: 7.5 (April), 8.2 (May), 8.3 (July), 7.7 (November).

Phycomycetes: *Saprolegnia ferax, Achlya racemosa, A. racemosa* var. *stelligera, Apodachlya pirifera, Monoblepharis* sp.

Fig. 37. **Fortunsø.**

69. **Hesteskodam,** Hillerød, n.e. S. Pond surrounded by foliiferous trees. — pH: 7.6 ($^{19}/_{4}$ 31).

Phycomycetes: *Achlya racemosa, A. racemosa* var. *stelligera.*

70. **Frederiksborg Slotssø,** n.e. S. Rather large lake. — pH: 7.2 (March), 9.0 (July).

Phycomycetes: *Achlya racemosa, A. racemosa* var. *stelligera, Apodachlya pirifera.*

71. **Mølleaa,** n.e. S. Rivulet in which collections were made partly at Frederiksdal and partly in Jægersborg Hegn. — pH: 7.0, minimum 6.9, maximum 8.9 ($^{5}/_{11}$ 31).

Phycomycetes: *Saprolegnia ferax, Isoachlya parasitica, Achlya racemosa, A. racemosa* var. *stelligera, Dictyuchus sterile, Pythiomorpha* sp. I, *Pythium rostratum.*

72. **Ditch in Jonstrup Vang,** n.e. S. Small ditch with running water in wood of *Fagus*. — pH: 7.7 ($^{18}/_{10}$ 31).
Phycomycetes: *Pythiogeton uniforme.*

73. **Pond in a garden near Jonstrup Vang,** n.e. S. — pH: 7.6, minimum 6.9, maximum 8.0 ($^{5}/_{4}$ 31).
Phycomycetes: *Achlya radiosa, Apodachlya pirifera, Pythiogeton utriforme.*

74. **Hulsø,** Hareskov, n.e. S. Lake surrounded by *Betula*, a few *Pinus, Populus,* and *Salix*. — pH: c. 7.6, minimum 6.9 ($^{5}/_{4}$ 32). (See also IVERSEN 1929, p. 316).
Phycomycetes: *Rhipidium continuum* (?), *Blastocladia Pringsheimii, Bl. rostrata, Pythium rostratum.*

75. **Esrom Sø,** n.e. S. Large lake. — pH: 7.5 (February), 8.7 (April).
Phycomycetes: *Pythiomorpha gonapodyides, Pythium rostratum.*

76. **Fureso,** n.e. S. Large lake with zones of *Phragmites* and *Scirpus lacuster.* — pH: 7.5, minimum 6.8, maximum 8.7 ($^{16}/_{4}$ 32). (As to this lake, see WESENBERG-LUND 1917).
Phycomycetes: *Achlya racemosa, Aphanomyces laevis, Apodachlya pirifera, Gonapodya siliquaeformis, Gon. polymorpha* (?), *Monoblepharis* sp.

77. **Ditch by Prinsessesti,** Lyngby, n.e. S. Ditch with stagnant water, containing many old leaves and twigs. *Lemna minor* and green algae in abundance. Around the ditch *Alnus*. — pH: 7.2, minimum 6.9, maximum 8.2 ($^{16}/_{4}$ 32).
Phycomycetes: *Saprolegnia ferax, Achlya racemosa, A. racemosa* var. *stelligera, Pythium rostratum.*

78. **Ditch in Ryget Skov,** near Værløse, n.e. S. Ditch with stagnant water in a swampy wood of *Betula*. — pH: 7.2, minimum 6.7, maximum 8.5 ($^{17}/_{4}$ 32).
Phycomycetes: *Rhipidium continuum* (?), *Blastocladia Pringsheimii, Pythium gracile.*

79. **Farum Sø,** n.e. S. Rather large lake with zones of *Phragmites* and *Scirpus lacuster*; surrounded by foliiferous trees. — pH: 7.9, minimum 6.7, maximum 8.5 ($^{17}/_{4}$ 32). (As to this lake, see WESENBERG-LUND 1917).
Phycomycetes: *Aphanomyces laevis, Aph. stellatus.*

80. **Bagsværd Sø,** n.e. S. Lake with zones of *Phragmites* and *Cyperaceae*. Situated in wood consisting partly of foliiferous trees, partly of conifers. — pH: 7.5, minimum 6.5, maximum 8.6 ($^{16}/_{4}$ 32). (As to this lake, see WESENBERG-LUND 1917).
Phycomycetes: *Achlya racemosa, A. radiosa, Aphanomyces laevis, Aph. stellatus, Thraustotheca* sp., *Apodachlya pirifera, Gonapodya siliquaeformis, Blastocladia Pringsheimii, Monoblepharis* sp., *Pythium rostratum.*

81. **Canal at Faste Batteri,** Amager, n.e. S. Water quiet, often covered by *Lemna minor,* near the shore *Scirpus maritimus.* Surrounded by a few foliiferous trees, mostly *Populus* and *Alnus.* — pH: 7.5, minimum 6.9, maximum 8.5 ($^{29}/_{6}$ 32).

Phycomycetes: *Achlya racemosa, Apodachlya pirifera, Rhipidium continuum, Gonapodya polymorpha, Blastocladia Pringsheimii, Bl. rostrata, Pythium rostratum, Macrochytrium botrydioides.*

82. **Sorø Sø,** c. S. Rather large lake surrounded by foliiferous trees.

Phycomycetes: *Saprolegnia ferax, Aphanomyces laevis, Apodachlya pirifera, Rhipidium continuum* (?), *Gonapodya siliquaeformis, Pythiogeton utriforme.*

Fig. 38. **Julsø.** Part of lake showing *Nuphar, Polygonum amphibium, Scirpus lacuster,* and *Phragmites.*

83. **Ditch in Sorø Skov,** c. S. Small ditch in wood of foliiferous trees.

Phycomycetes: *Saprolegnia ferax, Pythiogeton utriforme.*

84. **Borres Sø,** near Svejbæk, c. J. Large lake with *Phragmites, Potamogeton natans, P. lucens, P. perfoliatus, Nuphar luteum, Nymphaea alba, Polygonum amphibium.* Surrounded by *Alnus* and other foliiferous trees. — This lake and Nos. 85, 90, and 92 intercommunicate. — pH: 8.2 ($^{10}/_{5}$ 32).

Phycomycetes: *Achlya racemosa, A. racemosa* var. *stelligera, Pythium proliferum.*

85. **Julsø,** near Svejbæk, c. J. Large lake with *Polygonum amphibium, Potamogeton lucens, P. crispus, P. filiformis, P. perfoliatus, Nuphar luteum, Nymphaea alba, Phragmites* and *Scirpus lacuster* in zones. Surrounded by foliiferous trees. — pH: c. 8.0 ($^{11}/_{5}$ 32).

Phycomycetes: *Saprolegnia crustosa* var. III, *Aphanomyces laevis, Gonapodya* *siliquaeformis, Blastocladia Pringsheimii, Pythiomorpha gonapodyides, Pythiogeton utriforme.*

86. **Slaaensø** near Svejbæk, c. J. Fairly small lake with *Nuphar, Nymphaea, Phragmites, Scirpus lacuster, Helodea canadensis, Characeae.* Surrounded by *Vaccinium, Pteridium aquilinum, Calluna,* and wood mainly consisting of conifers; communicates with No. 84 by a canal. — pH: 7.5, maximum 8.2 ($^{10}/_{5}$ 32).

Phycomycetes: *Saprolegnia ferax, Achlya racemosa, A. racemosa* var. *stelligera.*

87. **Thor Sø** near Virklund, c. J. Rather large lake; zones of *Phragmites.* Surrounded by foliiferous trees; the ground here and there boggy, with *Vaccinium,* a few *Juniperus,* mosses in abundance. — pH: 7.5, minimum 6.5, maximum 8.6 ($^{11}/_{5}$ 32).

Phycomycetes: *Saprolegnia ferax, S. hypogyna, Achlya racemosa* var. *stelligera.*

88. **Ellesø** near Virklund, c. J. Lake communicating with No. 84 by a brook. Zones of *Phragmites, Nuphar luteum,* surrounded by foliiferous trees and by fields and meadows. The ground around the lake here and there somewhat boggy with *Vaccinium* and *Calluna.* — pH: 7.5 ($^{11}/_{5}$ 32).

Phycomycetes: *Achlya racemosa, A. racemosa* var. *stelligera, Apodachlya pirifera, Rhipidium* sp., *Blastocladia Pringsheimii, Monoblepharis* sp., *Pythium proliferum, Pyth. rostratum.*

89. **Avnsø,** Silkeborg Østerskov, c. J. Lake communicating with No. 90 by a canal. *Phragmites* in zones, *Nuphar luteum, Potamogeton perfoliatus.* The lake is surrounded by foliiferous trees. — pH: c. 7.6, minimum 6.9, maximum c. 8.4 ($^{11}/_{7}$ 32).

Phycomycetes: *Saprolegnia ferax.*

90. **Brassø** near Silkeborg, c. J. Large lake communicating with No. 89; surrounded by foliiferous trees. — pH: 7.8 ($^{13}/_{5}$ 32).

Phycomycetes: *Saprolegnia ferax, Achlya racemosa* var. *stelligera, Apodachlya pirifera* var. *macrosporangia.*

91. **Almindsø** near Silkeborg, c. J. Lake communicating with No. 92. — pH: 7.3 ($^{14}/_{5}$ 32).

Phycomycetes: *Achlya racemosa, A. racemosa* var. *stelligera, A. oligacantha, Dictyuchus sterile.*

92. **Vejlsø** near Silkeborg, c. J. Communicating with Nos. 90 and 91.

Phycomycetes: *Achlya racemosa, A. racemosa* var. *stelligera, A. americana, Thraustotheca* sp.

93. **Lyngsø** near Silkeborg, c. J. Lake with zones of *Phragmites* and *Cyperaceae.* Surrounded by *Fagus, Betula* and *Picea.* — pH: 8.2 ($^{14}/_{5}$ 32).

Phycomycetes: *Saprolegnia ferax, Achlya racemosa, A. americana, Apodachlya pirifera, Pythium rostratum.*

94. **Knudsø** near Ry, c. J. Large lake with zones of *Phragmites* and *Scirpus lacuster*. — pH: 8.2 ($^{12}/_{5}$ 32).

Phycomycetes: *Achlya racemosa, A. racemosa* var. *stelligera.*

95. **Duck-pond at Torup Hedegaard,** south-east of Skørping, n.e. J. Small pond with *Lemna, Potentilla palustris* and other plants. — pH: 7.3, maximum 8.4 ($^{11}/_{6}$ 31).

Phycomycetes: *Saprolegnia monoica, Apodachlya pirifera, Monoblepharis polymorpha, Pythiomorpha gonapodyides, Pythium rostratum, Pythiogeton utriforme.*

96. **Terndrup Mølledam,** n.e. J. Pond with muddy bottom. Surrounded by meadows with *Caltha palustris, Cardamine pratensis,* species of *Ranunculus* and other plants. — pH: 7.7 ($^{11}/_{6}$ 31).

Phycomycetes: *Achlya radiosa, Dictyuchus sterile.*

97. **Teglsø,** Rold Skov, n.e. J. Lake with *Potamogeton natans, Polygonum amphibium, Batrachium aquatile, Menyanthes trifoliata, Typha, Characeae.* — pH: 7.2, maximum 8.2 ($^{12}/_{6}$ 31).

Phycomycetes: *Saprolegnia ferax, Pythium rostratum.*

98. **Nors Sø,** Thy, n.w. J. Large lake with *Potamogeton perfoliatus, Polygonum amphibium, Characeae* in abundance, *Phragmites, Heleocharis palustris.* Here and there chalky cliffs on the shore. — pH: c. 7.5, minimum 6.6, maximum c. 8.6 ($^{29}/_{8}$ 31). (See also Iversen 1929, p. 322).

Phycomycetes: *Saprolegnia hypogyna.*

99. **Vester Vandet Sø,** Thy, n.w. J. Large lake with *Polygonum amphibium, Potamogeton perfoliatus, Characeae, Heleocharis palustris.* — pH: c. 8.0, minimum c. 6.8, maximum c. 8.8 ($^{30}/_{8}$ 31).

Phycomycetes: *Saprolegnia ferax.*

100. **Blegsø,** Thy, n.w. J. Shallow lake with sandy bottom. *Potamogeton perfoliatus, P. natans, Polygonum amphibium, Myriophyllum, Characeae* in abundance. — pH: 7.6, maximum 8.7 ($^{31}/_{8}$ 31). (See also Iversen 1929, p. 316).

Phycomycetes: *Saprolegnia ferax, Aphanomyces laevis, Pythium proliferum.*

101. **Pool, Ilbro,** near Hjørring, n. J. *Polygonum amphibium, Myriophyllum, Lemna trisulca.* Surrounded by meadows with *Gramineae, Cyperaceae, Cirsium palustre, Angelica silvestris, Filipendula ulmaria* and other plants. — pH: c. 7.6 (August 32).

Phycomycetes: *Saprolegnia crustosa* var. II, *S. ferax, Pythiomorpha gonapodyides.*

102. **Pool, Bøgsted,** east of Hjørring, n. J. Surface covered by *Lemna minor.* Surrounded by meadows with *Cirsium palustre, C. oleraceum, Phragmites, Scirpus silvaticus, Sium latifolium, Impatiens noli tangere, Gramineae,* a few *Fraxinus, Alnus* and *Betula.* — pH: 7.0 (August 32).

Phycomycetes: *Saprolegnia monoica, Achlya radiosa, Apodachlya pirifera, Rhipidium americanum, Rhip. parthenosporum* (?), *Rhip.* sp., *Blastocladia Pringsheimii, Bl. gracilis* (?), *Monoblepharis* sp., *Pythiomorpha gonapodyides, Pythium rostratum.*

103. **Pond at Fuglsig,** south of Hjørring, n. J. *Lemna minor, L. polyrhiza, Ceratophyllum demersum*; surrounded by foliiferous trees. — pH: c. 7.7, minimum 6.9, maximum c. 9.0 ($^6/_8$ 32).

Phycomycetes: *Dictyuchus Magnusii, Apodachlya pirifera, Blastocladia Pringsheimii, Bl. gracilis* (?), *Monoblepharis brachyandra* (?), *Mon.* sp., *Pythiomorpha gonapodyides, Pythium proliferum.*

Fig. 39. **Pool, Bøgsted.** The water covered by *Lemna minor.* Surrounded by *Phragmites, Cirsium oleraceum, C. palustre* and other plants.

104. **Duck-pond at Fuglsig,** south of Hjørring, n. J. Communicates with No. 103.

Phycomycetes: *Pythiogeton utriforme.*

In the localities below the pH was not determined:

105. **Fuglesangsø,** Jægersborg Dyrehave, n.e. S. Pond, probably alkaline.

Phycomycetes: *Achlya racemosa, A. racemosa* var. *stelligera, A. radiosa* (?), *Apodachlya pirifera.*

106. **Ditch by Chara-pond,** Jonstrup Vang, n.e. S. Probably alkaline.

Phycomycetes: *Saprolegnia ferax, Achlya racemosa, Apodachlya pirifera.*

107. **Ditch near Farum,** n.e. S. — Phycomycetes: *Saprolegnia monoica, S. ferax*(?), *Apodachlya pirifera, Rhipidium americanum*(?), *Blastocladia Pringsheimii, Macrochytrium botrydioides.*

108. **Ditch, Rudeskov,** n.e. S. — Phycomycetes: *Monoblepharis* sp.

109. **Pond, Rudeskov,** n.e. S. — Phycomycetes: *Apodachlya pirifera, Monoblepharis* sp.

110. **Pool, Rudeskov,** n.e. S. — Phycomycetes: *Achlya racemosa.*

111. **Ditch, Grib Skov,** n.e. S. — Phycomycetes: *Pythiopsis Humphreyana*(?), *Saprolegnia ferax*(?).

112. **Ditch, Grib Skov,** n.e. S. — Phycomycetes: *Saprolegnia monoica* (coll. Dr. H. E. Petersen).

113. **Pond near Lillerød,** n.e. S. — Phycomycetes: *Apodachlya seriata, Pythiomorpha gonapodyides*(?) (coll. Dr. H. E. Petersen).

114. **Pool, Auderød Skov,** near Frederiksværk, n.e. S. — Phycomycetes: *Monoblepharis* sp.

115. **Pool near Sorø,** c. S. — Phycomycetes: *Saprolegnia monoica, Monoblepharis polymorpha.*

116. **Tuel Sø near Sorø,** c. S. — Phycomycetes: *Aphanomyces laevis.*

117. **Marl-pit at Hvidegaarde** near Hjørring, n. J. — Phycomycetes: *Apodachlya pirifera, Monoblepharis* sp., *Pythiomorpha gonapodyides.*

118. **Pool, Tolne Skov,** n. J. — Phycomycetes: *Rhipidium* sp.

119. **Lake at Raabjerg Mile,** n. J. — Phycomycetes: *Aphanomyces laevis.*

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