

Watermolds of Sat Tal (Naini Tal), India

G. S. MER & R. D. KHULBE

Department of Botany, D. S. B. Constituent College, Kumaun University,
Naini Tal — 263 002, INDIA

Abstract. — Nineteen species of watermolds (belonging to different genera of Saprolegniaceae) are described from several habitats in the Kumaun Himalayan region, India. Two species of *Saprolegnia* (*S. glomerata*, *S. subterranea*) are reported for the first time in India.

Introduction

Important contributions in the field of taxonomy of watermolds in other countries have been made by several investigators including SPARROW (1943, 1960), JOHNSON (1956), SCOTT (1961), MILANEZ 1965, 1968, 1969), SEYMOUR (1970) and DICK (1971).

In India, CHAUDHURI & KOCHHAR (1935), HAMID (1942), SAKSENA & BHARGAVA (1944), DAYAL (1958), SRIVASTAVA (1967), DAYAL & THAKURJI (1965, 1968), THAKURJI (1967, 1970) and MANOHARACHARY (1980) studied some watermolds in sub-tropical and tropical regions.

The knowledge of temperate watermolds in India is very poor. A few workers (KHULBE & SATI, 1979; KHULBE, 1980; MER & al., 1981) reported watermolds from this region.

In the present study, more detailed taxonomic work on watermolds has been done in Sat Tal (about 1370 m a. s. l., Kumaun Himalaya) whose climate ranges from temperate to subtropical. The dominant vegetation around the study area is, however, mostly xerophytic (*Opuntia monacantha*, *Pinus longifolia*, *Justicia simplex*, *Marsdenia roylei*, *Rumex hastatus*).

Preserved specimens and slides of different isolates are deposited in the Botany Department, Kumaun University, Naini Tal.

Key to the genera of Saprolegniaceae

1. Primary zoospores in single row, encysted at the mouth of the zoosporangium *Aphanomyces*
- 1*. Primary zoospores in two or more rows 2
2. Primary zoospores encysting at the mouth of the zoosporangium .. *Achlya*
- 2*. Primary zoospores not encysting within or at the mouth of the zoosporangium *Saprolegnia*
- 2**. Primary zoospores encysting within the zoosporangium 3
3. Wall of zoosporangium persisting and perforated after the emergence of zoospores *Dictyuchus*

- 3*. Wall of zoosporangium evanescent, zoospores released in blocks of zoospores 4
4. Zoospores released by thrusting of zoosporangial wall at any point. Oogonial pluriovulate *Thraustotheca*
- 4*. Zoospores released by disintegration of zoosporangial wall. Oogonia uniovulate *Brevilegnia*

Key to Himalayan species of *Achlya* NEES

1. Sex organs absent 2
- 1*. Sex organs present 3
2. Gemmae rod-shaped *Achlya* sp. 1 (5)
- 2*. Gemmae flask-shaped *Achlya* sp. 2 (6)
3. Antheridia declinuous 4
- 3*. Antheridia mostly monoclinal rarely androgynous 5
4. Oospores mostly 4—7 in number *A. klebsiana* (2)
- 4*. Oospores 1—26 in number *A. prolifera* (4)
5. Oogonial stalk curved, oospores 1—4 in number, oogonial wall unpitted *A. orion* (3)
- 5*. Oogonial stalk not curved, oogonial wall pitted. Oospores 4—14 in number *A. americana* (1)

1. *Achlya americana* HUMPHREY in Trans Amer. Phil. Soc. 17: 116 (1892). — Pl. 1, fig. 1

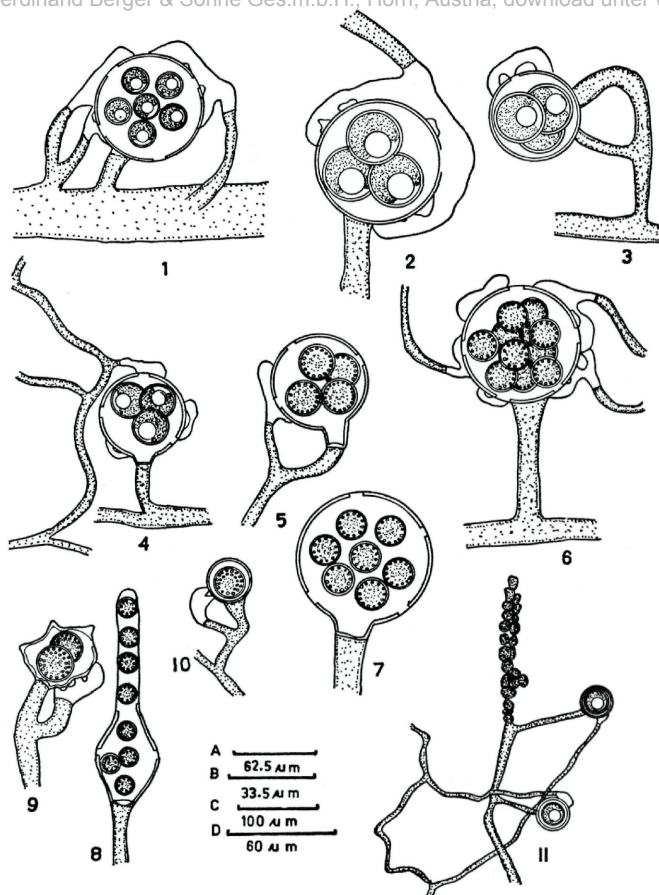
Hyphae stout branched 7.5—139 μ m in diameter, tapering, primary zoosporangia abundant, long, straight, cylindrical and fusiform, 135—675 $\times$ 15—65 μ m, predominantly 370 $\times$ 55 μ m; secondary zoosporangia formed sympodially; zoospores discharge achlyoid; encysted primary zoospores 7.5—12 μ m in diameter; gemmae few, formed by hyphal segmentation 1—4 in a chain, functioning as zoosporangia; oogonia abundant, lateral and terminal, spherical, rarely pyriform, borne racemosely, (46) 65—87, 5 (122) μ m; oogonial wall smooth and pitted; oogonial stalk half to three times longer as the diameter of the oogonia, mostly half to twice; antheridia one to six per oogonium, monoclinal, usually arising near the oogonial stalk, occasionally declinuous; oospores spherical, (2) 4—14 (38) in number, (22) 23—26.5 (29) μ m, eccentric.

Isolated from Ram-Tal water, May 8, 1979. This species was observed in India by CHAUDHURI & KOCHHAR (1935), SAKSANA & RAJGOPALAN (1958), DAYAL & TANDON (1962), SRIVASTAVA (1967), THAKURJI (1970), CHOWDHRY & AGARWAL (1980) and KHULBE (1980).

This isolate is very close to the description given by CHAUDHURI & KOCHHAR (1935) and KHULBE (1980), except for the complete absence of the androgynous antheridial branches but shows almost full agreement with the description given by JOHNSON (1956).

2. *Achlya klebsiana* PIETERS in Bot. Gaz. (Chicago) 60: 486, pl. 21, figs. 1—4 (1915). — Pl. 1, fig. 2

Hyphae moderately stout, branched, 20—80 μ m in diameter at the base, tapering; zoosporangia numerous, long, slender of fusiform,



Pl. 1: 1. *Achlya americana*: mature oogonium with eccentric oospores and monoclinal antheridia. — 2. *Achlya klebsiana*: mature oogonium with eccentric oospores and declinuous antheridium. — 3. *Achlya orion*: oogonium with eccentric oospores and androgynous antheridium. — 4. *Achlya proliferata*: oogonium with eccentric oospores and declinuous antheridium. — 5. *Saprolegnia glomerata*: mature pyriform oogonium with eccentric oospores and androgynous antheridium. — 6. *Saprolegnia declina*: mature oogonium with centric oospores and declinuous antheridia. — 7, 8. *Saprolegnia ferax*: mature oogonia with centric oospores and without antheridia. — 9, 10. *Saprolegnia subterranea*: mature papillated oogonium with subcentric oospores and androgynous antheridium. — 10. Smooth walled oogonium with subcentric oospores and androgynous antheridium. — 11. *Brevilegnia declina*: mature oogonia with eccentric, apertotic oospores with declinuous antheridia.

Scale A: Fig. 1, 4, 5, 6, 7, 9, 10, 11. — Scale B: Fig. 2. — Scale C: Fig. 8. — Scale D: Fig. 3.

195—665 $\times$ 24—40 μm , predominantly 300 $\times$ 35 μm , renewed sympodially; zoospores liberation achlyoid, encysted primary zoospores 9—11 μm in diameter; gemmae abundant, clavate, cylindrical or rod-shaped, (90) 130 (195) $\times$ (15) 35 (45) μm , functioning as zoosporangia; oogonia abundant, lateral or terminal, spherical, (46) 48—53 (80) μm ; oogonial wall smooth, unpitted; oogonial stalk 26—510 μm long, unbranched; antheridia 1—3 per oogonium, declinuous; oospores spherical, eccentric, (1) 6—7 (9) in number, (20) 23 (27) μm .

Isolated from Nal Damayanti Tal soil and diseased seedlings of *Oryza sativa*, August 20, 1979.

This species was recorded in India by CHAUDHURI & KOCHHAR (1935), BHATTACHARYA & BARUAH (1953), MANOHARACHARY (1974, 1979), CHOWDHRY & AGARWAL (1980) and KHULBE (1980).

It differs from current descriptions in having eccentric (CHAUDHURI & KOCHHAR, 1935) and smaller oospores and longer oogonial stalks (JOHNSON, 1956).

3. *Achlya orion* COKER & COUCH in Saprolegniaceae, p. 112, pls. 34 (in part), 35 (1923). — Pl. 1, fig. 3

Hyphae more slender than in other species of *Achlya*, 7.5—82.5 μm in diameter; primary zoosporangia abundant, cylindrical or fusiform, 90—650 $\times$ 11—49 μm ; secondary zoosporangia formed sympodially; zoospores liberation achlyoid; encysted primary zoospores 9—12 μm in diameter; gemmae abundant, cylindrical or rod shaped, 150—250 $\times$ 20—45 μm , formed by hyphal segmentation; oogonia abundant, produced from the base to the tip of the hyphae, spherical, (30) 45—53 (63) μm ; oogonial wall smooth, unpitted, however pits present at the point of antheridial attachment; oogonial stalk mostly curved down; antheridia on all the oogonia, monoclinal and androgynous, but mostly monoclinal arising near the oogonial stalk; oospores 1—8 in number, (1) 2—4 (8) in number, 20—28 μm in diameter, eccentric.

Isolated from Ram Tal soil, April 19, 1979.

It was recorded in India by DAYAL & TANDON (1962), SRIVASTAVA (1967), THAKURJI (1967), DAYAL & THAKURJI (1968), SRIVASTAVA (1978), and MANOHARACHARY (1979).

This isolate differs from typical strains by the occurrence of frequent antheridial branches.

4. *Achlya prolifera* (NEES) de BARRY in Leop. — Carol. 11: 514, pl. 18 (1823). — Pl. 1, fig. 4

Hyphae stout, branched, 7.5—52.5 μm in diameter at base, predominantly 15—45 μm ; zoosporangia abundant, long, straight, cylindrical (225) 375 (540) $\times$ (30) 45—60 (65) μm , secondary zoosporangia formed sympodially; zoospores liberation achlyoid; encysted primary zoospores 7.5—12 μm in diameter; gemmae abundant, mostly clavate, rarely rod shaped, 1—5 in a chain, functioning as zoosporangia; oogonia abundant, lateral, pyriform, borne racemosely, (22.5) 42—75 (120) μm ; oogonial wall smooth with numerous pits; antheridial branches

strictly declinuous, much twistet, branched, winding like a parasite about the oogonia, 1—3 per oogonium, seldom these branches also bear oogonia; oospores spherical, eccentric, (1) 3—12 (16) in number, 20—28 μ m in diameter.

Isolated from Ram Tal soil, April 19, 1979.

Recorded from India by CHAUDHURY & LOTUS (1936), DAYAL & THAKURJI (1965), SRIVASTAVA (1967), SRIVASTAVA & SRIVASTAVA (1976), PRABHUJI (1979) and CHOWDHRY & AGARWAL (1980).

This isolate agrees with the description given by JOHNSON (1956).

5. *Achlya*, sp. 1 (sterile)

Hyphae stout, much branched, tapering, 15—105 μ m thick, predominantly 19—30 μ m at base; primary zoosporangia cylindrical or filiform or cylindrical, (150) 330—375 (540) $\times$ (15) 25—28 (30) μ m; secondary zoosporangia formed sympodially; zoospores discharge achlyoid; encysted primary zoospores 7—11 μ m in diameter; gemmae rod-shaped, 2—10 in a chain, formed by septation of vegetative hyphae into segments, (150) 180—320 (525) $\times$ 15—75 μ m; germination takes place by slender germ tube and sporangia formed at the tip of hyphae, sex organs not developed.

Isolated from Ram Tal water, January 1, 1979.

6. *Achlya*, sp. 2

Hyphae stout, much branched, tapering, 7.5—67.5 μ m in diameter, predominantly 11—23 μ m; primary zoosporangia abundant, fusiform or cylindrical, (150) 330—375 (540) $\times$ (15) 25—28 (30) μ m; secondary zoosporangia formed sympodially; zoospores arranged in two or more than two rows, discharge achlyoid; encysted primary zoospores (7.5) 8.5—9 (12) μ m; gemmae abundant, pyriform, clavate or naviculate, predominantly pyriform, (53) 75—90 (225) $\times$ 45—150 μ m; 3—6 in chain, act as oogonia; some hyphae act as antheridia, declinuous, 1—4 per oogonium; oospheres not maturing and all the oogonial content disorganised at maturity.

Isolated from Ram Tal soil, March 5, 1979.

Key to Himalayan species of *Aphanomyces* de BARY

1. Sex organs absent *Aphanomyces* sp. (sterile) (8)
- 1*. Sex organs present, antheridia declinuous, antheridial stalk not forming helicoid coils *A. laevis* (7)

7. *Aphanomyces laevis* de BARY in Jahrb. Wiss. Bot., 2: 179, pl. 20, figs. 17, 18 (1860). — Pl. 2, fig. 3

Hyphae 2—10 μ m in diameter, delicate, hyaline, straight and sparingly to much branched; primary zoosporangia filamentous, of variable length, 455—805 μ m long and 6—10 μ m in diameter; primary zoospores rod shaped up to 60 in number per zoosporangium, 8—18 $\times$ 5—6.5 μ m, encysting upon emergence at the orifice; encysted primary zoospores 7—8 μ m in diameter; gemmae absent; oogonia terminal on lateral branches of variable length, spherical, (23) 25—26.5 (34) μ m, smooth walled, sometimes roughend due to disintegration of antheridia; antheridia declinuous,

3—6.5 μm thick; oospores hyaline, spherical, single, 20—23 μm in diameter, eccentric with a large central oil globule.

Isolated from Ram Tal water, May 8, 1979.

Recorded in India by SYDOW & BUTLER (1907), SRIVASTAVA (1967), SRIVASTAVA & SRIVASTAVA (1975), KHULBE & BHARGAVA (1977), PRABHUJI (1979), CHOWDHRY & AGARWAL (1980), SATI & KHULBE (1980) and MANOHARACHARY (1981).

8. *Aphanomyces* sp. (sterile)

Hyphae 2.5—11.5 μm in diameter, delicate, hyaline, straight, moderately branched; zoosporangia filamentous, of variable length, up to 865 μm long and 7—10 μm in diameter, primary zoospores rod shaped, 9—20.5 μm long and 6.5—9 μm in diameter within the zoosporangium; encysted primary zoospores 7.5—11 μm in diameter, predominantly 8.5 μm ; sex organs not developed.

Isolated from Ram Tal water and soil, January 1, 1979.

Key to Himalayan species of *Brevilegnia* COKER & COUCH

1. Zoospores in a single row *B. linearis* (10)
- 1*. Zoospores in two or more rows 2
2. Antheridia mostly declinous *B. declina* (9)
- 2*. Antheridia mostly androgynous when present *B. subclavata* (11)

9. *Brevilegnia declina* HARVEY in J. Elisha Mit. Sci. Soc. 42: 243 (1927). — Pl. 1, fig. 11

Hyphae stout as in *Achlya*, moderately branched, (7) 10—12 (26) μm ; primary zoosporangia abundant, terminal, cylindrical to clavate, sometimes formed in cluster, 80—190 $\times$ 9—24 μm ; secondary zoosporangia formed sympodially; zoospores arranged in one to five rows, 5—10 μm in diameter, discharged by disintegration of sporangial wall, swimming stage absent; gemmae absent; oogonia abundant, lateral or terminal, spherical 18—26 μm in diameter; oogonial wall smooth and unpitted, pitted only under the point of attachment of antheridial cell; antheridia mostly declinous, occasionally monoclinal and often lacking on some oogonia even in the same culture; oospores spherical, single, eccentric, (12) 15—20 (25) μm , usually aplerotic or nearly so, rarely plerotic.

Isolated from Ram Tal soil, April 19, 1979. The identity of the culture was confirmed by Dr. T. W. JOHNSON, North Carolina, USA.

KHULBE & SATI (1979) reported this species for the first time in India.

10. *Brevilegnia linearis* COKER & BRAXTON in J. Elisha Mit. Sci. Soc. 42: 214—215 (1927). — Pl. 2, figs. 1, 4

Hyphae stout as in *Achlya*, moderately branched, (7.5) 12.5—15 (19) μm ; primary zoosporangia abundant, terminal, rarely intercalary, cylindrical, rarely branched, 250—335 (673) $\times$ (6.5) 12.5 (16) μm ; secondary zoosporangia formed sympodially; zoospores arranged in a single row, 7—13 μm in diameter, discharged by disintegration of zoosporangial wall,

swimming stage absent; gemmae absent; oogonia abundant, lateral, spherical, (19) 25—35 (37.5) μm ; oogonial wall smooth and unpitted, pitted only at the point of antheridial contact; antheridia androgynous, very rarely monoclinal, often absent on some oogonia; oospores single, spherical, eccentric, mostly plerotic, occasionally aplerotic, (15.5) 22—31 (34) μm .

Isolated from Ram Tal soil, October 8, 1979.

In India this species was observed for the first time by KHULBE (1980).

This isolate differs from the description given by COKER & MATTHEWS (1937) and KHULBE (1980) in having larger oogonia with aplerotic oospores in addition to plerotic ones and presence of monoclinal antheridial branches in addition to androgynous antheridial branches. Material is deposited in the Herbarium, American Type Culture Collection, Maryland, USA (No. NTL-B-1).

11. *Brevilegnia subclavata* COUCH in J. Elisha Mit. Sci. Soc., 42: 227 (1927).

Hyphae stout as in *Achlya*, moderately branched and up to 65 μm at the base; zoosporangia abundant, terminal, mostly clavate and rarely cylindrical, 58—167 $\times$ 25—60 μm , renewed sympodially as well as in basipetalous succession, 2—9 in a row when formed in basipetal succession; zoospores arranged in 2—4 rows, 12—19 μm in diameter, discharged by disintegration of sporangial wall, swimming stage absent; gemmae absent; oogonia abundant, lateral, spherical or sub-spherical, (18) 20—25 (28) μm , oogonial wall smooth and unpitted, pitted only under the point of attachment of antheridial cell; antheridia monoclinal, rarely diclinal and often lacking on some oogonia in the same culture; oospores spherical, single, eccentric, 14—19.5 μm in diameter, usually aplerotic or nearly so, rarely plerotic.

Isolated from Ram Tal soil, March 5, 1979.

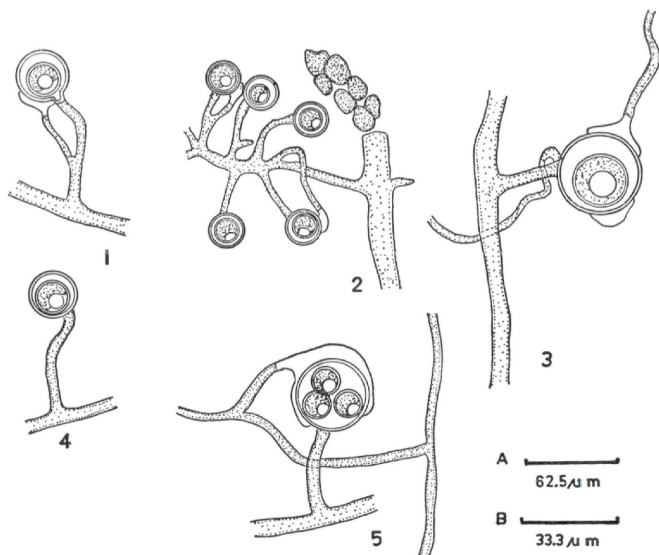
In India the first report of this species is recorded from soil samples (PRABHUJI, 1979).

12. *Dictyuchus sterile* COKER in Saprolegniaceae, p. 151, pl. 52 (1923)

Hyphae stout, much branched, (8) 26—45 (75) μm ; primary zoosporangia formed at the tips of the hyphae, rarely intercalary, cylindrical, blunt, renewed sympodially, branching in sporangia is also of common occurrence, 195—840 $\times$ (9) 30—34 (41) μm , mostly deciduous; primary zoospores arranged in one to three rows, not liberating from the sporangium, but remaining within the zoosporangium and forming a network of walls separating each zoospore as a separate entity in a separate cell, liberate by individual openings, sometimes germinate within the zoosporangium as in *Aplanes*; encysted secondary zoospores 11—15 μm in diameter; gemmae absent; sex-organs not developed.

Isolated from Ram Tal soil, January 1, 1979.

In India this species was recorded earlier by SRIVASTAVA (1967), PRABHUJI (1979) and SRIVASTAVA & MEHRANI (1980).



Pl. 2: 1, 4. *Brevilegnia linearis*: mature oogonia with aplerotic eccentric oospores. — 2. *B. subclavata*: mature oogonia with eccentric plerotic and aplerotic oospores. — 3. *Aphanomyces laevis*: mature oogonium with eccentric oospore and diclinous antheridia. — 5. *Thraustotheca clavata*: mature oogonium with eccentric oospores and diclinous antheridium.

Scale A: Fig. 1, 2, 4, 5. — Scale B: Fig. 3.

Key to Himalayan species of *Saprolegnia* NEES emend. SEYMOUR

1. Zoosporangia renewed mostly by sympodial means 2
- 1*. Zoosporangia renewed by internal proliferation only 3
2. Sex-organs absent *Saprolegnia* sp. (18)
- 2*. Sex-organs present, oogonial papillated, antheridia androgynous *S. subterranea* (17)
3. Sex-organs absent *S. parasitica* (16)
- 3*. Sex-organs present 4
4. Antheridia absent *S. ferax* (14)
- 4*. Antheridia present 5
5. Antheridia diclinous *S. diclina* (13)
- 5*. Antheridia monoclinal *S. glomerata* (15)

13. *Saprolegnia diclina* HUMPHREY in Trans. Amer. Phil. Soc. (N. S.). 17: 109 pl. 17, figs. 50—53. (1893). — Pl. 1, fig. 6

Hyphae slender, abundantly branched, 18.5—47 μ m in diameter, primary zoosporangia abundant, clavate or filiform, straight, 90—300 $\times$ 30—50.5 μ m in diameter; secondary sporangia formed by internal proliferation; zoospore liberation saprolegnioid; encysted primary zoospores 9—11 μ m in diameter; gemmae abundant, variable in shape, function as zoosporangia; oogonia abundant, terminal or lateral, spherical pyriform or oval in shape, (30) 50—65 (95) μ m; oogonial wall smooth and pitted; oogonial stalks short to rather long, mostly one-two times as long as the diameter of oogonia, mostly straight, rarely bent, unbranched; antheridia on all the oogonia, strictly declinuous; oospores spherical, centric, (1) 6—8 (18) in number, 15—25 μ m in diameter.

Isolated from Ram Tal water, January 1, 1979, and from eggs of *Bufo melanostictus*, July 10, 1979. Cultures deposited in the Herbarium, CMI, Kew, England (IMI No. 255008).

The first report of this species for India is by SRIVASTAVA (1967). THAKURJI (1967, 1970) and KHULBE (1977, 1980) also reported it from water samples. Recently, CHOWDHRY & AGARWAL (1980) mentioned it from water and soil samples.

14. *Saprolegnia ferax* (GRUITH.) THURET in Ann. Sci. Nat. Bot., Ser. 11, 14: 214, pl. 22. (1850). — Pl. 1, fig. 7, 8

Hyphae sparingly branched, moderately stout, 7.5—80 μ m, predominantly 15—30 μ m in diameter; gemmae few, variable in shape, function as zoosporangia abundant, clavate or filiform, straight or slightly bent, (90) 250—370 (600) $\times$ (7.5) 15—30 (45) μ m; secondary zoosporangia formed by internal proliferation; zoospore discharge saprolegnioid; encysted primary zoospores 9—14 μ m in diameter; oogonia abundant, terminal, lateral or intercalary, doliform, pyriform or spherical, size variable 71—195 μ m $\times$ 60—83 μ m in doliform, 59—165 $\times$ 28—94 μ m in spherical oogonia; oogonial wall smooth, conspicuously pitted; oogonial stalks short to rather long; antheridia completely absent; oospore number variable, 11—14 (23) in doliform oogonia, 2—14 (30) in spherical oogonia, 12.5—25 μ m in diameter, mostly 20 μ m, centric.

Isolated from Ram Tal water, May 8, 1979.

THAKURJI (1967), DAYAL & THAKURJI (1968) and KHULBE (1977) recorded it from India as *S. lapponica*.

Material of the above mentioned culture is deposited in the Herbarium, American Type Culture collection, Maryland, USA (No. NTL-B-1).

15. *Saprolegnia glomerata* (TIESENHAUSEN) LUND in Kgl. Danske. Selsk. Skrift., Naturv. Math., Afd. IX, 6 (I): 14, fig. 4. — (1934). — Pl. 1, fig. 5

Hyphae moderately stout, 15—65 μ m in diameter, branched; primary zoosporangia, abundant, clavate or filiform, straight or rarely bent, (150) 210—300 (555) $\times$ 30 (60) μ m, renewed internally; zoospore discharge saprolegnioid; encysted primary zoospores 11 (15) μ m in diameter;

gemmae few, clavate or rod-shaped, terminal, single or catenulate, size variable, $120-180 \times 20-45 \mu\text{m}$, function as zoosporangia; oogonia abundant, terminal, spherical or pyriform, rarely cylindrical, $52-122 \mu\text{m}$ in diameter, cylindrical oogonia $105-315 \times 26-30 \mu\text{m}$; oogonial wall smooth and conspicuously pitted; oogonial stalk variable in length; generally one to two times longer as the diameter of the oogonium, stout, straight or sometimes bent also; antheridia present on all oogonia, androgynous, rarely monoclinal; oospores spherical, 6-16 in pyriform, 1-14 in spherical and 2-12 in cylindrical oogonia, $(22.5) 36 (30) \mu\text{m}$, centric.

Isolated from Ram Tal soil, March 5, 1979. — New record for India.

16. *Saprolegnia parasitica* COKER in Saprolegniaceae, p. 57., pl. 18. (1923)

Hyphae stout, branched frequently, $15-80 \mu\text{m}$ in diameter; primary zoosporangia abundant, cylindrical or clavate, straight, $(65) 120-230 (550) \times (17) 20-65 (70) \mu\text{m}$; secondary zoosporangia formed by internal proliferation; zoospore liberation saprolegnioid; encysted primary zoospores $9-11 \mu\text{m}$ in diameter; gemmae abundant, irregular, clavate or spherical, terminal, single or 4-6 in a chain, functioning as zoosporangia, sex organs not developed.

Isolated from Ram Tal soil, January 1, 1979.

This species was observed in India by CHAUDHURY & KOCHHAR (1935), DAYAL (1958), BHARGAVA & al (1971), KHULBE (1977), CHOWDHRY & AGARWAL (1980) and SATI & KHULBE (1980).

This isolate is tentatively identified as *S. parasitica* since COKER (1923) suggested that all non-sporulating (without oogonia and antheridia) forms of *Saprolegnia* belong to *S. parasitica*. But O'BIER (1960) and SEYMOUR (1970) had shown that certain non-sporulating strains might represent a complex of two or more taxa. JOHNSON (1974) had also listed some non-sporulating isolates under *S. parasitica* (on dead or diseased fish).

17. *Saprolegnia subterranea* (DISSMAN) SEYMOUR in Nova Hedwigia 19: 59-62 (1970). — Pl. 1, figs. 9, 10

Hyphae slender, aseptate, branched, $7.5-40 \mu\text{m}$ in diameter, predominantly $12.5-18 \mu\text{m}$; primary zoosporangia abundant, cylindrical, rarely clavate, often slightly curved, $(165) 330-450 (630) \times (7.5) 25-35 (45) \mu\text{m}$; secondary zoosporangia formed mostly sympodially and in basipetal succession, occasionally by internal proliferation; zoospore liberation saprolegnioid; encysted primary zoospores $7.4-9 \mu\text{m}$ in diameter; gemmae abundant, variable in shape and size, act as zoosporangia; oogonia abundant, lateral, spherical or pyriform, sometimes within the empty zoosporangium; oogonial wall of variable form, 40-50% papillated and 50-60% smooth walled, $(26.5) 38-40 (47) \mu\text{m}$; papillae (1) 3-7 (11) in number, 3.3-25 μm long; antheridia mostly androgynous, rarely hypogynous; oospores spherical, single in 96% oogonia and two in 4% oogonia, $(22) 28.5 (35) \mu\text{m}$ in diameter, subcentric, very rarely centric.

Isolated from Ram Tal soil, August 20, 1979. — New for India.

This isolate differs from the description given by SEYMOUR (1970) in having slender hyphae, formation of secondary sporangia in basi-

petal succession, 40—50% frequently papillated oogonia and presence of hypogynous antheridia in addition to androgynous antheridia.

18. *Saprolegnia* sp. (sterile)

Hyphae slender, aseptate, much branched, (4) 15—18 (28) μ m; primary zoosporangia abundant, (150) 185—320 (720) $\times$ (10) 15—30 (42) μ m; zoospores arranged in single or more rows, liberated as in *Saprolegnia*, sometimes a few encysted within the zoosporangium; encysted primary zoospores 7.5—30 μ m in diameter, shape not definite; secondary sporangia formed by means of internal proliferation as well as sympodially; gemmae abundant, curved or branched, sometimes in chain of 3—4, mostly branched, shape and size vary greatly; sex organs not developed.

Isolated from Ram Tal water, January 1, 1979.

19. *Thraustotheca clavata* (de BARY) HUMPHREY in Trans. Amer. Phil. Soc. 17: 131 (1893). — Pl. 2, fig. 5

Hyphae stout, frequently branched, 7.5—22.5 μ m thick at the tip and 7.5—75 μ m in diameter at the base; primary zoosporangia abundant, clavate, (60) 165—240 (390) $\times$ (37.5) 45—60 (90) μ m; renewed sympodially; zoospores spherical, (7.5) 9 (12) μ m, diplanetic; encysted zoospores liberated by the fragile sporangial wall by breaking down, mostly from the middle part and apical region; gemmae absent; oogonia abundant, spherical, (43) 48—60 (71) μ m; oogonial stalk long to short; pits absent; antheridia branches declinuous, 1—4 per oogonium, antheridial cell 7.5—11 μ m thick; oospores spherical, eccentric, (3) 5—10 (11) in number; 16—26 μ m in diameter.

Isolated from Ram Tal, April 19, 1979.

In India CHAUDHURI & LOTUS (1936) and KHULBE (1980) reported this species from water samples but it was found also in soil (SATI & KHULBE, 1980).

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Autor(en)/Author(s): Mer G. S., Khulbe R. D.

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