

## Species of *Mucor* from India-II

By Usha Baijal and B. S. Mehrotra

Department of Botany, University of Allahabad, Allahabad, India

With plates XXXVIII—XL.

Ten species of *Mucor* are being described here. Out of these two are new species, three are new varieties and five are new reports from India.

### *Mucor zychae* sp. nov.

(Figs. 1—4, Plate XXXVIII, Fig. 6, Plate XL).

Caespituli in "oat meal agar", PDA et SMA albae, tenues, alti; sporangiophoris simplicibus,  $7\ \mu$  crassis, interdum sub sporangio ipso vesiculariter incrassatis; sporangia globosa, brunneola, 45—90 (105)  $\mu$  diam., tunica incrustata et diffluente praedita; columella saepe centralis, plerumque conica,  $17.5\text{--}31.5(35) \times 14\text{--}25.5\ \mu$ , hyalina, collario brevi praedita; sporangiosporae late ellipsoideae, interdum reniformes vel globosae,  $12\text{--}24(31.5) \times (5.2)6\text{--}15.7\ \mu$ , plerumque  $15\text{--}18 \times 10.5\text{--}12\ \mu$ ; mycelii gemmae adsunt.

Colonies on oat meal agar<sup>1</sup>, PDA<sup>2</sup> and SMA<sup>3</sup> white, delicate and high; sporangiophores unbranched,  $7\ \mu$  in diameter, sometimes with a vesicular swelling just below the sporangium; sporangia globose, brownish, 45—90 (105)  $\mu$  in diameter; wall incrusted and diffluent; columellae mostly conical,  $17.5\text{--}31.5(35) \times 14\text{--}25.5\ \mu$  (at base), hyaline, with a short collar; sporangiospores broadly ellipsoidal, sometimes reniform and globose,  $12\text{--}24(31.5) \times (5.2)6\text{--}15.7\ \mu$  mostly  $15\text{--}18 \times 10.5\text{--}12\ \mu$ ; on germination one or two, mostly one germ tube coming out; mycelial gemmae present.

Type: Mx—28, isolated from the manured soil of Allahabad. Culture deposited in BSM Culture Collection, Botany Department, University of Allahabad, and also at NURD, Peoria, Illinois under No. A—13, 491.

This species can be placed in the section *Hiemalis* because of the

<sup>1</sup>) Oat meal agar — Oat meal 20 gm; agar — 20 gm; yeast extract — 0.5 gm; distilled water — 1000 ml.

<sup>2</sup>) SMA — Dextrose — 40 gm; Asparagine — 2 gm;  $\text{KH}_2\text{PO}_4$  — 0.5 gm;  $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$  — 0.25 gm; Thiamine chloride — 0.5 gm; agar — 20 gm; distilled water — 1,000 ml. pH—6.

<sup>3</sup>) PDA — Potato (Peeled and sliced) — 200 gm; Dextrose — 20 gm; agar — 20 gm; distilled water — 1000 ml.

presence of smaller (less than 100  $\mu$ ) sporangia, unbranched sporangiophores and diffluent sporangial wall. In this section it resembles with *Mucor subtilissimus* Oudemans due to the presence of conical columellae, but differs from it mainly in shape and size of sporangiospores, which are elliptical,  $7 \times 2.5 \mu$  in *M. subtilissimus* while in the present isolate sporangiospores are ellipsoidal,  $12-24 \times 6-15.7 \mu$ . It is, therefore, being described here as a new species. The species is being named after Dr. H. Z y c h a.

***Mucor mousanensis* sp. nov.**

(Figs. 5—9 Plate XXXVIII, Figs. 1—2 Plate XL).

Caespituli in SMA et PDA primum albidii, postea griseoli, lanuginosi, alti, paterae tectum attingentes; sporophoris primum simplicibus et hyalinis, postea pallide brunneolis et ramulis 1—2 brevibus auctis; sporangia globosa vel compressa, nigrescentia, 30—135  $\mu$ , plerumque 75—90  $\mu$  diam., tunica spinulosa, caerulescenti vel brunneola, fragili praedita; columella plerumque oblonga, interdum ovoidea vel dorsoventraliter compressa, caerulescens vel brunneola, plerumque brunneola,  $24.5-75 \times 18-63 \mu$ ; sporangiosporae plerumque oblongae vel cylindraceae,  $6-9 \times 3.7-6 \mu$ , plerumque  $6.7 \times 4.5 \mu$ ; chlamyosporae non visae.

Colonies on SMA and PDA at first white, grayish on aging, cottony, high enough to touch the lid; sporangiophores at first simple and hyaline later on light brown and with one or two short side branches; sporangia globose or dorsiventrally compressed, blackish, 30—135  $\mu$  mostly 75—90  $\mu$  in diameter; wall spiny, bluish or brownish, fragile (seen in pieces); columellae mostly oblong sometimes oval or broader than long, bluish or brownish, mostly brownish,  $24.5-75 \times 18-63 \mu$ ; sporangiospores mostly oblong to cylindrical,  $6-9 \times 3.7-6 \mu$  mostly  $6.7 \times 4.5 \mu$ ; chlamyosporae not seen.

Type: Mx—14, isolated from mouse dung. Culture deposited in BSM Culture Collection, Botany Department, University of Allahabad and at NURD, Peoria, Illinois, U.S.A. under No. 12, 622.

This species can be placed in the *Fragilis* section due to the presence of smaller (less than 100  $\mu$ ) sporangia with fragile wall. In this section it shows slight resemblance with two species, viz., *Mucor lausannensis* Lendner and *M. griseo-roseus* Linnemann. With the former it resembles only in having scarcely branched sporangiophores, a character usually not found in the species of this section, but it differs from this species in the rest of the characters; with the latter species it shows resemblance in the cylindrical shape of the sporangiospores but differs substantially in colony colour, size of sporangiospores and size and shape of columella. It is, therefore, being described here as a new species.

*Mucor luteus* Linnemann var. **indica** var. nov.

(Figs 10—12 Plate XXXVIII).

Caespituli in SMA et PDA usque ad 1 cm alti, pallide lutei; sporangiophoris usque ad 24.75  $\mu$  diam., primum simplicibus, postea breviter ramulosis; sporangia globosa, aurea, 40—165 (190)  $\mu$ , plerumque 90—100  $\mu$  diam., tunica incrustedata, diffluenti praedita; columella globosa, ovoidea, pyriformis vel dorsiventraliter compressa, plerumque intus plasmate aurantiaco repleta, 38.5—73  $\times$  35—70  $\mu$ , vel 21—73  $\mu$  diam.; sporangiosporae hyalinae, plerumque oblongo-ellipsoideae, 6—15  $\times$  4.5—7.5  $\mu$ .

Colonies on SMA and PDA 1 cm. high, light yellow in colour; sporangiophores upto 24.75  $\mu$  in diameter, at first unbranched but on aging little branched; sporangia globose, golden yellow in colour, 40—165 (190)  $\mu$  mostly 90—100  $\mu$  in diameter; sporangial wall incrusted, diffluent; columellae globose, oval, pyriform or sometimes dorsiventrally compressed, mostly filled with orange yellow coloured contents, oval ones, 38.5—73  $\times$  35—70  $\mu$ , and globose ones, 21—73  $\mu$  in diameter; sporangiospores hyaline, mostly oblong elliptical, 6—15  $\times$  4.5—7.5  $\mu$ .

Type: Mx—15, isolated from the rotten fruit of *Ficus glomerata*. Culture deposited in BSM Culture Collection, Botany Department, University of Allahabad, also at NURD, Peoria, Illinois, U.S.A.

This isolate can be placed in the section Hiemalis, because of the presence of mostly unbranched sporangiophores, smaller sporangia and diffluent sporangial wall. In this section it comes close to *M. luteus* Linnemann by its shape and size of sporangiospores, but differs from it in having larger sporangia and columellae. This difference has been found to be stable even after a period of 2 years. It is, therefore, being described here as a new variety.

*Mucor griseo-ochraceus* Naumov var. **minuta** var. nov.

(Figs. 13—17 Plate XXXVIII, Fig. 3 Plate XL).

Caespituli in SMA, "oat meal agar" et PDA obscure grisei, sub 20—25° C bene crescentes; sporangiophoris in zonulis duabus ordinatis, ramulosis, septatis vel non septatis, usque 24  $\mu$  diam., interdum sub-sporangio ipso vesiculariter inflatis; sporangia globosa, obscure grisea, 30—225  $\mu$  (307.5)  $\mu$ , plerumque 150—180  $\mu$  diam., tarde diffluentia, punctata; columella globosa, ovoidea vel pyriformis, hyalina, 24.5—119  $\times$  17.5—87  $\mu$ ; sporangiosporae globosae, subglobosae vel ovoideae, hyalinae, 3—7.5 (9)  $\times$  3—6 (7.5)  $\mu$ , plerumque 4.5  $\mu$  diam.; gemmae non visae.

Colonies on SMA, oat meal agar and PDA dirty gray, growing well at 20—25° C; sporangiophores in two zones, branched, septate or non-septate, upto 24  $\mu$  in diameter, sometimes swollen just below sporangia; sporangia globose, dirty gray, 30—225 (307.5)  $\mu$ , mostly 150—

180  $\mu$  in diameter; sporangial wall slowly diffluent, punctate; columellae globose, oval or pyriform, hyaline, sometimes provided with projections, 24.5—119  $\times$  17.5—87  $\mu$ ; sporangiospores globose, subglobose or short oval, mostly the latter, hyaline, 3—7.5 (9)  $\times$  3—6 (7.5)  $\mu$ , mostly 4.5  $\mu$  in diameter; gemmae not seen.

Type: Mx — 26, isolated from the soil of Shillong, pH 7. Culture deposited in BSM Culture Collection, Botany Department, University of Allahabad and also at NURD, Peoria, Illinois, U.S.A.

This isolate can be placed in the section *Caninus* due to the presence of sporangiophores in two zones and large sporangia (larger than 100  $\mu$ ). In this section it comes close to *M. griseo-ochraceus* Naumov, by the presence of dirty gray coloured colony and globose to oval sporangiospores, but sporangiospores in this isolate are smaller (3—6  $\mu$  mostly 4.5  $\mu$  spherical sporangiospores and oval ones, 4.5—7.5  $\times$  3.7—6  $\mu$ ) than in the isolate described by Naumov (6—13  $\mu$  for spherical one and (6.5) 9—11 (15)  $\times$  5.5—7 (10)  $\mu$  for oval ones). This isolate is, therefore, being described as a new variety.

*Mucor recurvus* Butler, Mycologia 44: 561, 1952.

(Figs. 18—25, Plate XXXVIII, Fig. 9, Plate XL).

Colonies on oat meal agar, PDA and SMA at first white later yellow orange in colour; sporangiophores 10.5—21  $\mu$  in diameter, at first curved later erect; hyaline or with orange coloured contents, mostly unbranched or with one or two side branches; sporangia globose, orange brown in colour, (45) 60—180 (210)  $\mu$  in diameter; sporangial wall incrustated, diffluent leaving a collar, incrustated with needle shaped crystals; columellae oval, pyriform or globose with a flattened base 24.5—87.5  $\times$  21—73.5  $\mu$  hyaline or with orange coloured contents; sporangiospores ellipsoidal, sometimes reniform, with orange coloured contents in the centre, 22.5—33.5 (42)  $\times$  9.7—12.5  $\mu$ ; on germination the sporangiospores swell up and give out mostly two, sometimes one or three germ tubes.

Description based on an isolate from soil of Shillong, pH 7. Culture deposited in BSM Culture Collection, Botany Department, University of Allahabad under No. Mx — 29, and also at NURD, Peoria, Illinois, U.S.A.

This isolate differs from the description of type species in having somewhat larger sporangiospores, and the absence of alcoholic odour.

It has been reported here for the first time from India.

*Mucor recurvus* Butler var. *indica* var. nov.

(Figs. 26—38, Plate XXXVIII, Figs. 4—5, Plate XL).

Caespituli in SMA et „oat meal agar“ pallide aurantiaci, alti;

sporangio-phoris hyalinis vel intus plasmate aurantiaco farctis, usque 17.5  $\mu$  diam., primum curvulis, postea erectis, simplicibus vel ramulis 1—2 praeditis; sporangia globosa, aurantiaca, 40—150  $\mu$  diam., diffluentia et collarium relinquentia, crystallis acicularibus incrustata; columella globosa, conica vel ovoidea, plasmate aurantiaco farcta, 21—70 (77)  $\times$  21—52.5 (66.5)  $\mu$ ; sporangio-sporae pallide luteae, in cumulo aurantiacae, plerumque plasmate aurantiace farctae, ellipsoideae, reniformes vel globosae, 12—16.5 (18)  $\times$  (8.2) 9—12  $\mu$ , plerumque 15—16.5  $\times$  9  $\mu$ ; sporangiola bi-vel oligospora, sphaerica, 16—24.4  $\mu$  diam., non dehiscentia, caduca, tunica incrustata et persistenti praedita.

Colonies on SMA and oat meal agar pale yellow orange in colour, sporangiophores hyaline or with yellow orange coloured contents, upto 17.5  $\mu$  in diameter, at first curved later erect, unbranched or with one or two curved side branches; sporangia globose, orange in colour, 40—150  $\mu$  in diameter; wall incrustated, diffluent leaving a collar, incrustated with needle shaped crystals; columellae globose, conical or oval with a flattened base, filled with orange coloured contents, 21—70 (77)  $\times$  21—52.5 (66.5)  $\mu$ ; sporangiospores pale yellow in colour, orange yellow in mass, mostly with orange coloured contents, ellipsoidal sometimes reniform or globose, 12—16.5 (18)  $\times$  (8.2) 9—12  $\mu$  mostly 15—16.5  $\times$  9  $\mu$ ; on germination spores swell up and give out one or two, mostly one germ tube; on aging the colony forming short, simple or mostly branched, permanently circinate, sporangiophores bearing sporangiola at the tip and branches; sporangiola also produced on circinate branches from sporangiophores which terminate into sporangia; sporangiola two to few sporic, spherical, 16—24.4  $\mu$  in diameter, non-dehiscent, caducous; wall incrustated and persistent.

Type: Mx — 47, isolated from the heavily manured soil of Allahabad. Culture deposited in BSM Culture Collection, Botany Department, University of Allahabad and also at NURD, Peoria, Illinois, U.S.A.

This species can be placed in the Petropolitanus section because of the presence of large (larger than 100  $\mu$ ) sporangia and the absence of short branched sporanspores near substratum. In this section this isolate can be placed near *M. recurvus* Butler because of the presence of yellowish orange colony, orange sporangia, young sporangiophores being curved, and sporangiospores with orange coloured contents. However this isolate does not reach the same dimensions of sporangiospores as in *M. recurvus*. Here the sporangiospores are ellipsoidal, 10.5—16.5  $\times$  9—12  $\mu$  in size as against 20—26  $\times$  10—12  $\mu$  in *M. recurvus*. The presence of sporangiola, on aging of the culture, and the absence of alcoholic odour are additional criteria which distinguish this isolate from *M. recurvus*. This isolate is, therefore, being considered as a new variety, *M. recurvus* var. *indica*, the name being based on the place of origin.

*Mucor petrinsularis* Naumov, Petersb. Pilze 14: 1915.

(Figs. 1—6, Plate XXXIX, Fig. 8, Plate XL).

Colonies on SMA and PDA at first white later on grayish or brownish, not very high; sporangiophores upto  $38.5 \mu$  in diameter, branched, sympodially, each successive branch  $45.2 \mu - 2 \text{ mm.}$  in length, arising with a septum at the place of attachment of branch; sporangia provided with a septum at the place of attachment of branch; sporangia brown,  $45-150 \mu$  in diameter, at maturity the sporangium opens irregularly and spores remain adherent to the columella, wall diffluent, columellae pyriform, oval, subglobose or globose, brownish, mostly smooth sometimes with projections at tip,  $(18.5) 31.5-87.5 \times 15.75-49 (64.6) \mu$ ; sporangiospores globose, or broad oval, mostly the former, smooth or with rounded projections,  $6-12 \mu$  in diameter, and oval ones,  $9-21 \times 7.5-15 \mu$ ; chlamyospores not known.

Description based on an isolate, from the soil of Shillong, pH 6.8. Culture deposited in BSM Culture Collection, Botany Department, University of Allahabad, under No. Mx — 27, and also at NURD, Peoria, Illinois, U.S.A.

It has been reported here for the first time from India.

*Mucor lamprosporus* Lendner, Mucor. d. l. Suisse 3 (1): 92, 1908.

(Figs. 7—17, Plate XXXIX, Fig. 7, Plate XL).

Colonies on oat meal agar, PDA and SMA white, high and cottony; sporangiophores at first curved, later erect, unbranched or with a short curved branch; sporangia spherical,  $30-60 (105) \mu$ ; sporangial wall spiny and diffluent; columellae globose broader at base, sometimes somewhat oval,  $10.5-24.5 (27) \mu$  in diameter; sporangiospores globose, sometimes oval, but mostly the former, hyaline  $6-10.5 \mu$  in diameter, oval ones,  $7.5-12 \times 6-9 \mu$  in size; at maturity the colony forming short, simple or mostly branched, permanently circinate sporangiophores bearing sporangiola at the tip and branches; sporangiola also produced on circinate branches from sporangiophores which terminate into sporangia; sporangiola one to few sporic, caducous, non-dehiscent up to  $35 \mu$  in diameter; wall spiny, persistent.

Description based on an isolate, from soil of Shantiniketan, pH 7.6. Culture deposited in BSM Culture Collection, Botany Department, University of Allahabad, under No. Mx — 61, and also at NURD, Peoria, Illinois, U.S.A.

It has been reported here for the first time from India.

*Mucor varians* Povah, Bull. Torrey Bot. Cl. 44: 297, 1917.

(Figs. 18—20, Plate XXXIX).

Colonies on SMA and PDA at first white later on yellowish; sporangiophores unbranched or little branched, erect or somewhat coiled,

up to 14  $\mu$  in diameter; sporangia brownish, 30—60 (70)  $\mu$  in diameter; sporangial wall diffluent, leaving a collar at the base; columellae globose, oval or pyriform, mostly oval, hyaline, 11.2—49  $\times$  9.7—42  $\mu$ ; sporangiospores very irregular in shape, mostly broad oval to ellipsoidal, sometimes with one or two blunt projections, 4.5—10.5  $\times$  3—6  $\mu$ .

Description based on an isolate from soil of Allahabad, pH 7. Culture deposited in BSM Culture Collection, Botany Department, University of Allahabad, under No. Mx — 57.

It has been reported here for the first time from India.

\* *Mucor heterosporus* Fischer, Rabenhorst, Krypto. flora 1: 199, 1892.

(Figs. 21—28, Plate XXXIX, Fig. 10, Plate XL).

Colonies on SMA, PDA and oat meal agar high, light gray in colour, growing well at 20—25° C; sporangiophores at first curved later erect, upto 24.5  $\mu$  in diameter, unbranched or with one curved or straight short or long branch; sporangia globose, brownish 45—120  $\mu$  mostly 90—105  $\mu$  in diameter; wall spiny and diffluent; columellae globose, oval or dorsiventrally compressed, hyaline, or filled with brownish coloured contents, 21.5—59.5  $\times$  21.5—52.5  $\mu$ ; sporangiospores irregular, polyhedral, provided with rounded projections 9—22.5 (31.5)  $\times$  7.5—10.5  $\mu$  mostly 10.5—12  $\mu$  long; on germination spores swell up, become round and give out one to three germ tubes.

Description based on an isolate from soil of Shillong, pH 6.4. Culture deposited in BSM Culture Collection, Botany Department, University of Allahabad under No. Mx — 25 and also at NURD, Peoria, Illinois under No. A—13339 and also at CBS, Baarn.

A comparison was made with an isolate of *M. heterosporus* obtained from CBS, deposited by Linnemann, but that isolate did not show the indented margined sporangiospores.

#### A c k n o w l e d g m e n t s

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Fischer, A. 1892. Phycomycetes: Mucorinae in Rabenhorst's Kryptogamen-Flora V. Deut. Oest. u. d. Schweiz, 1 (4): 161—310.

\*) Reported for the first time since it was first reported by Fischer in 1892.

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#### Plate XXXVIII

Figs. 1—4 *Mucor zychnae* sp. nov. 1—2. Columellae. 3. Sporangiospores. 4. Mycelial gemmae.

Figs. 5—9 *Mucor mousanensis* sp. nov. 5. A sporangium. 6. A columella with attached sporangial wall. 7—8. Columellae. 9. Sporangiospores.

Figs. 10—12 *M. luteus* var. *indica* var. nov. 10—11. Columellae. 12. Sporangiospores.

Figs. 13—17 *M. griseo-ochraceus* var. *minuta* var. nov. 13. Upper portion of a sporangiophore showing the manner of branching. 14—16. Columellae. 17. Sporangiospores.

Figs. 18—25 *M. recurvus* Butler 18—21. Successive stages of development of sporangium. 22—23. Columellae. 24. Sporangiospores. 25. Germinating sporangiospores.

Figs. 26—38 *M. recurvus* Butler var. *indica* var. nov. 26—29. Successive stages of development of sporangium. 30—32. Columellae. Note the presence of needle-shaped crystals on collar. 33. Sporangiospores. 34. Germinating sporangiospores. 35. Upper portion of a sporangiophore with sporangium at its tip. 36—37. Upper portions of branched sporangiophores with sporangia at their tips. 38. Sporangia.

#### Plate XXXIX

Figs. 1—6 *Mucor petrinularis* Naumov 1—2. Upper portions of sporangiophores showing the pattern of branching. 3—4. Columellae. 5. Sporangiospores. 6. Germinating sporangiospores.

Figs. 7—17 *Mucor lamprosporus* Lendner. 7—10. Successive stages of development of sporangium. 11. A portion of a sporangiophore with sporangia at tips. 12. A portion of a sporangiophore from which all the sporangia have fallen. 13. A portion of a sporangiophore with sporangia on its branches and a columella at its tip. 14. Sporangia. 15—16. Columellae. 17. Sporangiospores.

Figs. 18—20 *Mucor varians* Povah. 18—19. Columellae. 20. Sporangiospores.

Figs. 21—28 *Mucor heterosporus* Fischer 21—24. Successive stages of development of a sporangium. 25. An enlarged sporangium. 26. Columella. 27. Sporangiospores. 28. Germinating sporangiospores.

#### Plate XL

Figs. 1—2 *Mucor mousanensis* sp. nov. 1. Upper portion of a sporangiophore with columella at its tip showing the fragile nature of the sporangial wall. X 600. 2. Sporangiospores X 700.

Fig. 3. *Mucor griseo-ochraceus* Naumov. var. *minuta* var. nov. 3. Sporangiospores X 600.

Figs. 4—5 *Mucor recurvus* Butler var. *indica* var. nov. 4. A columella X 600 Note the presence of needle shaped crystals on columella. 5. Sporangiospores X 950.



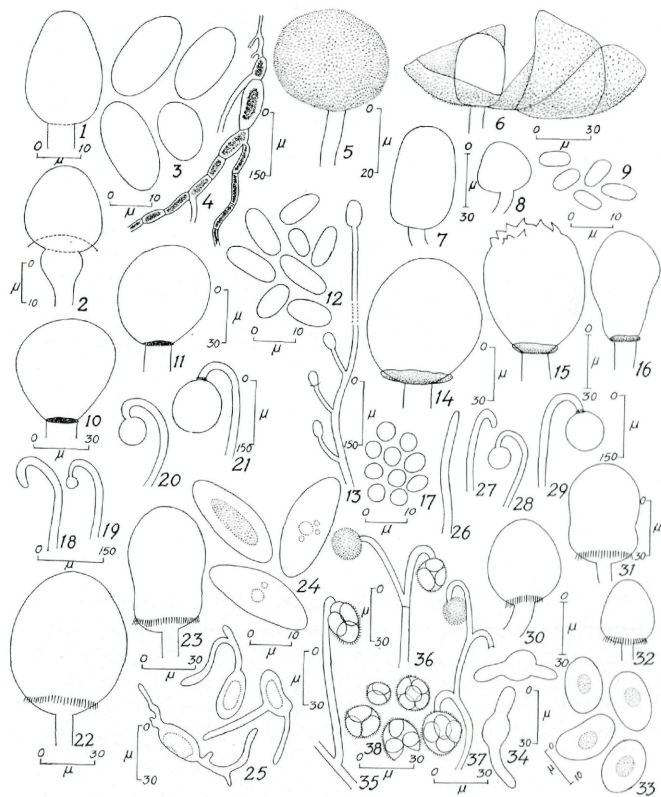
Fig. 6 *Mucor zychnae* sp. nov. 6. Sporangiospores X 830.

Fig. 7 *Mucor lamprosporus* Lendner. 7. Upper portion of a sporangio-  
phore with sporangiolum at the tip of one its circinate branches X 600.

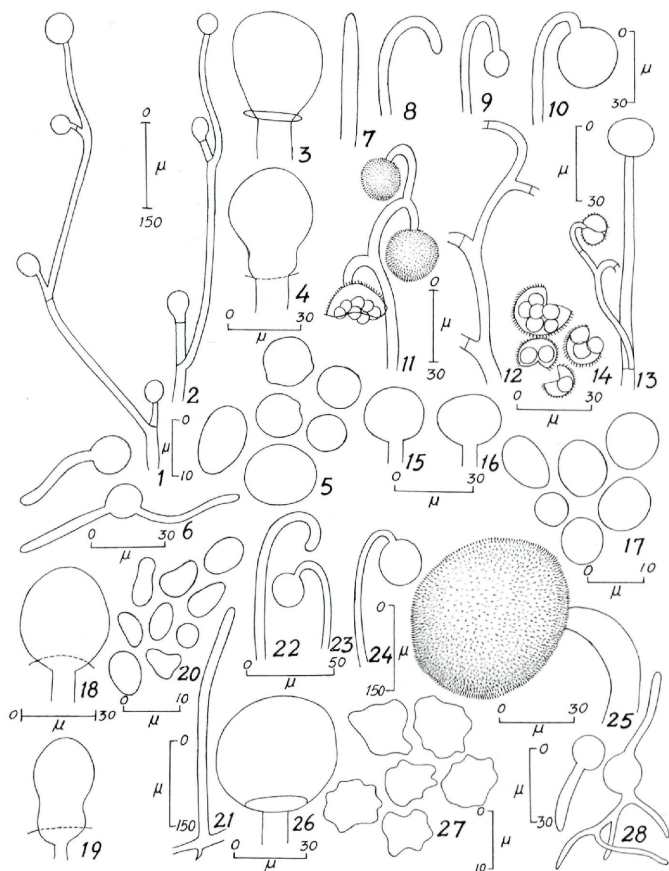
Fig. 8 *Mucor petrinsularis* Naumov. 8. Sporangium opening in place  
X 160.

Fig. 9 *Mucor recurvus* Butler. 9. Sporangiospores X 400.

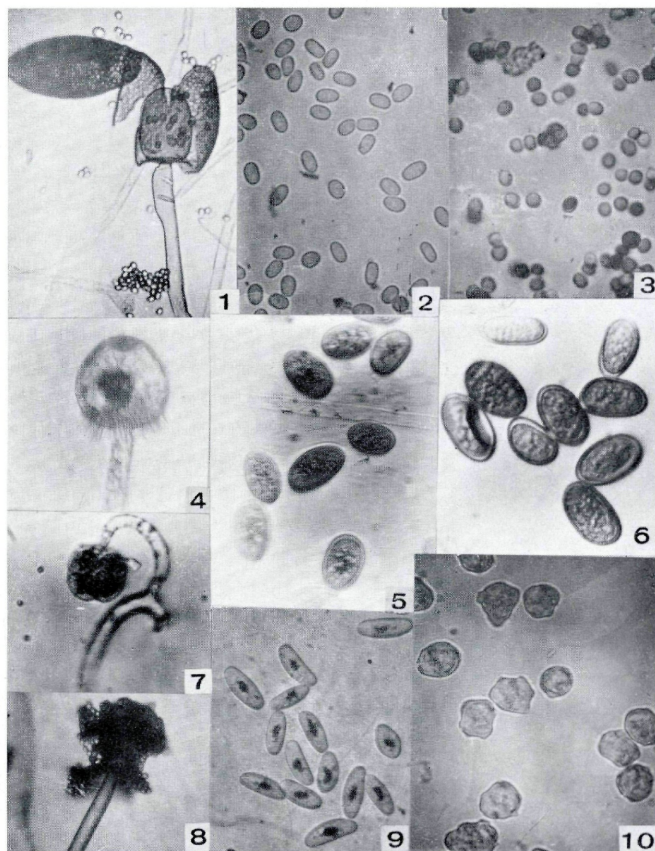
Fig. 10. *Mucor heterosporus* Fischer. 10. Sporangiospores. X 800.











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