

Studies of *Mucor* from India-III.

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With Plates VIII—XI.

In this series nine species of the genus *Mucor* are being reported from India. Two have been found to be new species, four are new reports from India and the remaining three were earlier reported from parts of India other than Allahabad.

Mucor praini Chodat et Nechitch 1904 (Inst. Bot. Geneve VI. ser. 5, S. 38; Abb. bei Wehmer 1907, Lendner 1908). — Figs. 1—4.

Syn.: *M. mandshuricus* Saito et Naganishi 1914 (Rep. Centr. S. Mandsh. Railw Co. 1).

Colonies growing rapidly, 1 cm. in height at 25° C on synthetic mucor agar *) (SMA) and Oat-meal agar **) for 4 days; sporangio-phores 3.5 cm. in height, sympodially branched, smooth, hyaline; sporangia globose, smooth, slightly transparent, from yellow to deep brown, larger sporangia 70—90 μ (—100 μ) in diameter on SMA, 30—80 μ (—85 μ) in diameter on oat-meal agar, smaller sporangia yellow, 10—30 μ on SMA and oat-meal agar, sporangial wall slowly deliquescing, leaving a small collar at the base; columellae often globose, sometimes slightly elongate and ovoid, hyaline, 40—54 μ in diameter, averaging 53 μ in diameter; sporangiospores subglobose to elliptical, elliptical ones 4.5—8.5 \times 3.2—4.5 μ in size, subglobose 3—8 (—10) μ , in diameter, smooth walled; chlamydospores hyaline with a thick wall, smooth, variable in form, ellipsoid, ovoid, spherical or irregular, upto 24 μ in diameter.

Description based on the isolate collected from the soil of Allahabad. Culture deposited in BSM Culture Collection, Botany Department, University of Allahabad under No. Mx. — 50 and also at NRRL, Peoria, Illinois under No. A-13,803. It was previously reported from India by Butler (1918); Butler et al. (1923—24); Hutchinson and Ram Ayyer (1915).

*) SMA = Dextrose - 40 gm; Asparagine - 2 gm; KH_2PO_4 - 0.5 gm; $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ - 0.25 gm; Thiamine chloride - 0.5 mg; agar - 20 gm; distilled water - 1,000 ml. pH - 6.

**) Oat-meal agar - Oat-meal 20 gm; agar - 20 gm; yeast extract - 0.5 gm; distilled water - 1000 ml.

Mucor alternans van Tieghem 1887, Gayon et Dubourg, Ann. de l'Inst. Pasteur, I, p. 534. — Figs. 19—22.

Colonies on synthetic Mucor agar (SMA) at 25° C growing restrictively, at first white, later brownish, odor musty; sporangiophores erect, 6—15 μ thick, usually marked with alternate branching, mostly non-septate, smooth walled, hyaline, gradually becoming yellowish; sporangia at first yellow turning brownish black, globose, incrusting, 30—100 μ in diameter, wall slowly diffuent; columellae smooth walled, faintly brown in colour, with a short collar, subglobose to oval, 20—40.5 \times 18—30 μ ; sporangiospores oval to ellipsoidal, 3.3—7.5 \times 3.0—6.0 μ , smooth; chlamyospores intercalary, hyaline, with granular contents, usually solitary, globose in shape, 16.2—25.0 μ in diameter. Zygospores not seen.

Description based on culture isolated from Allahabad soil. Culture deposited in the BSM culture collection, Botany Department, University of Allahabad under No. MX-51 and also at NRRL, Peoria, Illinois, under No. A-13,804.

Zycha (1935) and Lendner (1908) considered *Mucor alternans* van Tieghem as synonymous to *Mucor ambiguus* Vuillemin. However, Fischer (1892) and Naumov (1939) thought it fit to keep these species as distinct entities. The three isolates on which the present description is based, resemble with the essential character of *Mucor alternans* van Tieghem, on which the species was probably based, viz., alternate branching pattern of the sporangiophores, floccose colony and finely stippled wall of sporangiospores. It is being reported here for the first time from India.

Mucor subtilissimus Oudemans 1898 (Nederl. Kruidkund. Arch. 3. S. 435; Abb. bei Nadson u. Philippow 1925 a).

Syn.: *M. guilliermondi* Nadoson et Philippow 1925 (Ren. Gén. Bot 37, S. 450). — Figs. 34—36.

Colonies growing on synthetic mucor agar for 4—6 days at 25° C over 2 cm in height, white floccose, faint yellow on aging, odor none; sporangiophores erect, hyaline, simple, with two or three septa, 6—8 μ thick, smooth walled; sporangia globose, 10—40 μ in diameter on oat-meal agar, 20—60 μ in diameter on SMA, sporangial wall smooth, deliquescent rapidly, columellae globose, hyaline, with a collar, 15—25 μ in diameter; sporangiospores elliptical with rounded ends, hyaline, uniform in size, provided with a dark granule at each end, 2.5—10.5 \times 2.0—5.0 μ on oat-meal agar, 2.5—8.0 \times 1.5—4.0 μ on SMA. Zygospores and chlamyospores not seen.

Description based on culture isolated from the soil of Vindhayachal (Mirzapur). Culture deposited in the BSM culture collection, Botany Department, University of Allahabad under No. MX-52 and

also at NRRL, Peoria, Illinois, under no. A-13,805. This fungus has been earlier listed by Mishra (1966) among the soil fungi of Gorakhpur.

Mucor microsporus Namyslowski 1910 (Bull. Intern.-Ac. Cracovie Cl. Math. Nat. B; S. 517, Abb. bei Ling-young 1930).

Syn.: *M. cylindrosporus* Ling-young 1930 (Rev. gén. Bot. 42, S. 731). — Figs. 30—33.

Colonies growing on oat-meal agar and synthetic mucor agar, at first white with age becoming yellowish, mycelium cottony; odor faint; sporangiophores simple, up to 2 cm. high, 4—8 μ thick, smooth walled, hyaline, strongly attenuated below the columella; sporangia at first yellow, later on brownish, globose, 20—90 μ in diameter, mostly 60 μ in diameter, sporangial wall diffluent; columellae smooth walled, spherical, sometimes broader than high, always with flat base and a short collar, 25—45 μ in diameter on oat-meal agar and 20—40 μ in diameter on SMA; sporangiospores regularly ellipsoidal, hyaline, smooth, 2—4.0 (—5 μ) \times 1.0—3.5 μ on SMA, 2—5.5 \times 1.0—4.0 μ on oat-meal agar. Zygosporae and chlamydosporae not seen.

Description based on culture isolated from the soil of Gyanpur. Culture deposited in the BSM Culture Collection, Botany Department, University of Allahabad under No. Mx. 49. It is being reported here for the first time from India.

***Mucor ramificus* sp. nov.** — Figs. 10—14.

Caespites in SMA et in "oat meal agar" celeriter crescentes, floccosi, primum albi, postea grisei, odore indistincto; sporangiophora sympodialiter ramosa, ramulis brevioribus in apice evolutis, levibus, rectis, interdum collabentibus, 300—1000 μ longa, 12.5—16.2 μ crassa; sporangia globosa, in "oat meal agar" 20—60 μ diam., in SMA 20—90 μ diam., luteola, pariete diffloxo ad columellae basin collare breve relinquente; columella globosa vel subglobosa 20—42.5 \times 10—27.5 μ ; sporangiosporae ellipsoideae vel ovoideae, 5.5—10 \times 2.5—6 μ , leves, pallide luteolae; chlamydosporae solitariae vel catenatae, 15—20 μ diam.; zygosporae non visae.

Colonies on SMA and oat-meal agar for 5—8 days at 25° C rapidly growing, floccose, at first white, later on grayish in colour, odor faint; sporangiophores sympodially branched with smaller branches confined to the apical region, smooth erect, after sometime collapsing, 300—1000 μ in length, 12.5—16.2 μ thick; sporangia globose, 20—60 μ in diameter on oat-meal agar, 20—90 μ on SMA, bright yellow, sporangial wall diffluent, leaving a short collar at the base of columella; columellae globose, subglobose, and often somewhat broader than high, 20—42.5 \times 10.0—37.5 μ ; sporangiospores, oval or ellipsoidal, 5.5—10.0 \times 2.5—6.0 μ ,

smooth, light yellow in mass, chlamydospores solitary or in chain, 15—20 μ in diameter. Zygosporangia not seen.

Description based on culture isolated from the soil of Ghazipur. Type: Culture deposited in the BSM Culture Collection, Botany Department, University of Allahabad under M. 52 and also at NRRL, Peoria, Illinois, under no. A-14034.

This isolate is placed in the section *Hiemalis* of the key to the genus *Mucor* because of the smaller sporangia (below 100 μ) and deliquescent sporangial wall. In this section it comes close to *Mucor luteus* because of elliptical sporangiospores having length twice their width. However, this isolate differs from *M. luteus* in the presence of richly branched sporangiophores with the branches usually confined to the apical region.

Mucor corticolus Hagem 1910 (Ann. mycol. 8, S. 277; Abb. 8). — Fig. 5—9).

Colonies on oat-meal agar and synthetic *Mucor* agar at 25° C rapidly growing, gray or deep grayish in colour, odor none; sporangiophores erect, smooth, hyaline, upto 2 cm. in height, sympodially branched, branches usually 1—2 mm long, 10—12 μ thick, often more or less curved; sporangia globose, 20—60 μ in diameter on SMA, 15—80 μ in diameter on oat-meal agar, with diffluent wall; columellae slightly oval, 18—32 \times 15—27 μ , with or without colourless content and usually with a collar; sporangiospores oval or elliptical 3.5—9.0 \times 3.0—6.0 μ . Zygosporangia not seen.

Description based on cultures isolated from the soil of Allahabad. Culture deposited in the BSM culture collection under No. Mx-83, Botany Department, University of Allahabad. It is being reported here for the first time from India.

Mucor griseo-lilacinus Povah 1917 (Bull. Torrey Bot. Cl. 44, S. 301; Abb. 6—10). — Fig. 27—29.

Syn.: *M. jauchae* Lendner 1918 (Bull. Soc. Bot. Genève 10, S. 374).

Colonies on SMA and oat-meal agar growing rapidly, gray, sometimes deep grayish in colour, 4—8 mm. high on SMA, 10—12 mm. on oat-meal agar at 25° C; odor none; sporangiophores simple, smooth, hyaline, 8—16 μ thick; sporangia at first yellow and then dark gray, 35—100 μ in diameter, sporangial wall diffluent, leaving a small collar at the base of the columella; columellae globose, bluish gray, 20—40 μ in diameter on SMA, 20—65 μ in diameter on oat-meal agar; sporangiospores regularly oval, 3.0—4.0 \times 4.0—8.0 μ on SMA, 4—10 \times 3.5—5.5 μ on oat-meal agar; chlamydospores produced in substrate mycelium, inter-calary, sometimes solitary hyaline, 10—20 μ in diameter. Zygosporangia not seen.

Description based on cultures isolated from the soil of Allahabad. Culture deposited in BSM Culture Collection, Botany Department, University of Allahabad, India under No. Mx-82. It is being reported here for the first time from India.

Mucor caninus Persoon, 1796 (Observat. I. p. 96, Taf. VI, 374).

M. mucedo (Linné, 1762, spec. plant. II, S. 1655 p. pt.) (Fresenius 1850) (Beitr. Z. Mykol., S. 7; Abb. auch bei Brefeld 1872, Bainier 1882 und in zahllosen anderen Abhandlungen). Abb. 1—3, 23, 27—29.

M. brevipes Riess 1853 (Bot. Ztg., S. 136).

M. rigidus Leger 1895 (These Paris, S. 71).

M. proliferus Schostakowitsch 1896 (1898 a) (Ber. d. Deutsch. Bot. Ges. 14, S. 260).

M. ingricus Naumov 1915 (Petersb. Pilze). — Figs. 23—26.

Colonies on SMA and oat-meal agar, gray, deep gray, often silvery gray at 25° C, colonies reverse near faint yellow, sometimes dull yellow, sporangiophores of two size ranges, larger ones up to 12 cm in height, 10—45 μ in diameter, erect, shorter sporangiophores branched sympodially; sporangia 80—250 μ in diameter, at first yellow, then deep gray or brownish black, sporangial wall diffluent, incrustated with needle shaped crystals of calcium oxalate, leaving a collar; columellae cylindrical, campanulate or spherical, 70—150 \times 30—90 μ , filled with red orange content; sporangiospores elliptical or subcylindrical, typically short cylindrical with rounded ends, twice as long as broad, variable in size, 4—18 \times 3—8.0 μ . Chlamydospores and zygospores not seen.

Description based on isolate from cow dung at Allahabad. Culture deposited in BSM Culture Collection Botany Department, University of Allahabad under No. Mx-81 and also at NRRRL, Peoria, Illinois, No. A-14126. It was reported for the first time by Dalvi (1930) from fermented tan liquor at Bombay; G in a i (1936) from dung of Zebra and Camel at Bombay; B a r u a h (1953) from soil of Assam; S a k s e n a and S a r b h o y (1962) from soil of Allahabad and M e h r o t r a (1965) from Deer dung at Allahabad.

Mucor peacockensis sp. nov. — Figs. 15—18.

Caespites in SMA et in „oat meal agar“ celeriter crescentes, primum hyalini, postea obscure lutei vel olivaceo-grisei, plerumque 2—3 cm alti, subtus lutei, odore indistincto; sporangiophora recta, nunc majora, 2—4 cm alta in SMA, 2—6 cm alta in „oat meal agar“, non ramosa, saepe guttulis numerosis adhaerentibus praedita, sporangia primum lutea, postea grisea, globosa, in sporangiophoris majoribus 110—200 μ diam., in sporangiophoris brevioribus 70 μ diam., pariete diffluo collare ad basin columellae relinquentia; columella oblonga vel piriformis,

40—61 \times 35—40 μ , plasmate luteo-brunneoole repleta; sporangiosporae cylindratae vel semilunatae, interdum oblongo-ellipsoideae, leves, plasmate luteo repletae, 10.5—30 \times 6—10.5 μ , plerumque 15 \times 7.5 μ ; zygosporae et chlamydosporae non visae.

Colonies on SMA and oat-meal agar growing rapidly at 25° C, at first colourless later dark yellow to olive gray in colour, typically 2—3 cm in height reverse yellow, odor faint; sporangiophores of two size ranges, larger ones 2—4 cm high on SMA and 2—6 cm in height on oat-meal agar, unbranched, often with numerous adhering droplets, shorter ones 8—10 mm high; sporangia at first yellow, later grayish, globose, 110—200 μ in diameter on larger sporangiophores and 70 μ in diameter on shorter ones, sporangial wall diffluent, leaving a collarette at the base of the columella; columellae oblong or pyriform, 40—61 \times 35—40 μ on SMA and oat-meal agar, with yellowish brown contents; sporangiospores, cylindrical to planoconvex, sometimes oblong elliptical smooth, contents yellow, 10.5—30.0 \times 6.0—10.5 μ , usually 15.0 \times 7.5 μ . Zygosporae and chlamydosporae not seen.

Description based on culture isolated from Peacock dung at Allahabad. Type: Culture deposited in the BSM Culture Collection, Botany Department, University of Allahabad, under No. M. 53 and also at NRRL, Peoria, Illinois under No. A-14033.

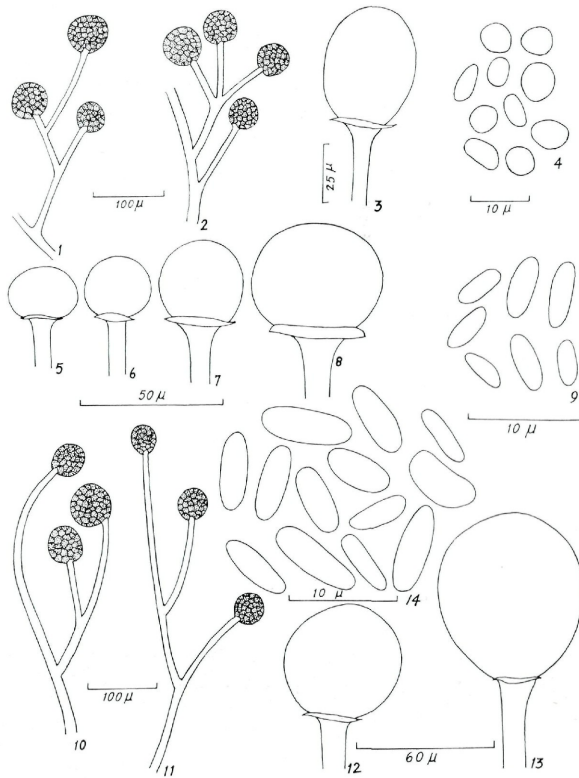
The presence of sporangiophores of two size ranges, place this isolate in the section canius of the genus *Mucor*. However, this isolate differs from all the species of this section in the presence of much larger sporangiospores.

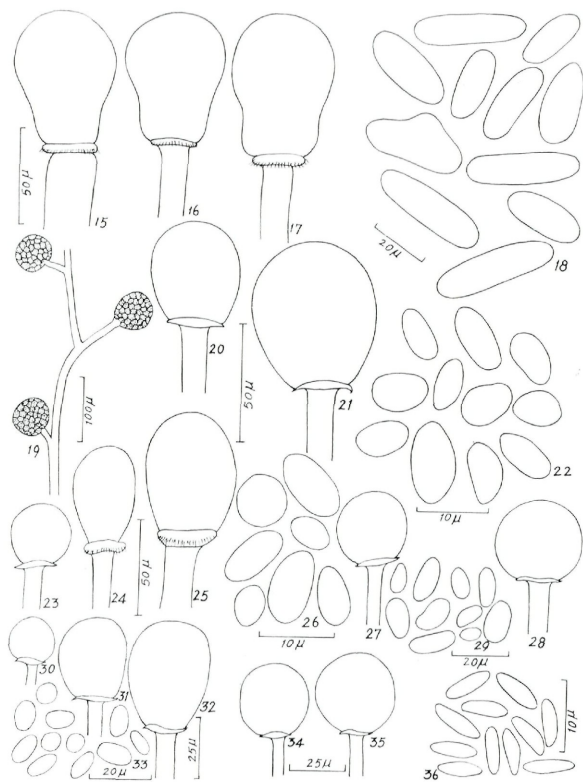
A c k n o w l e d g m e n t s

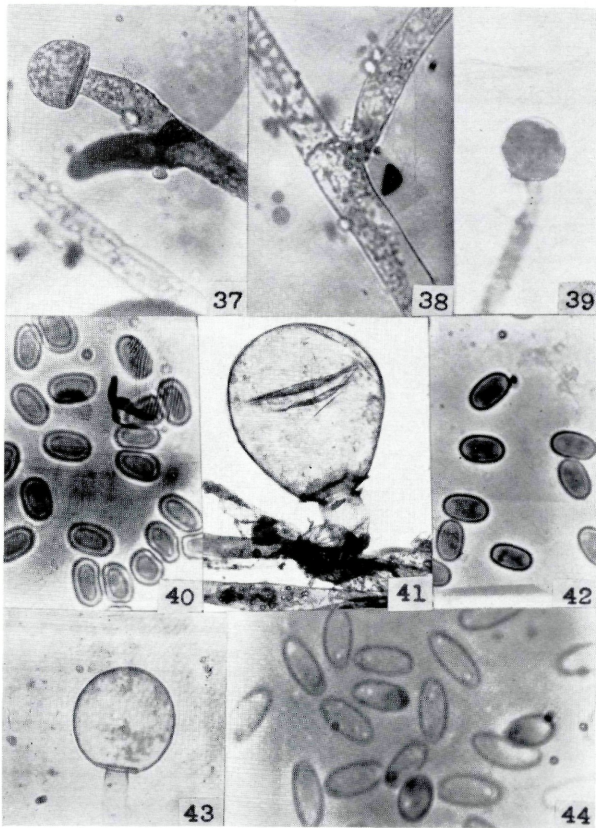
The authors are grateful to Dr. C. W. Hesseltine for his valued opinion on some of the isolates and to Dr. F. Petrak for the Latin diagnoses. The junior author is also indebted to the University Grants Commission for providing Post-graduate Research Scholarship. This study was partly financed out of PL. 480 grant made to the senior author.

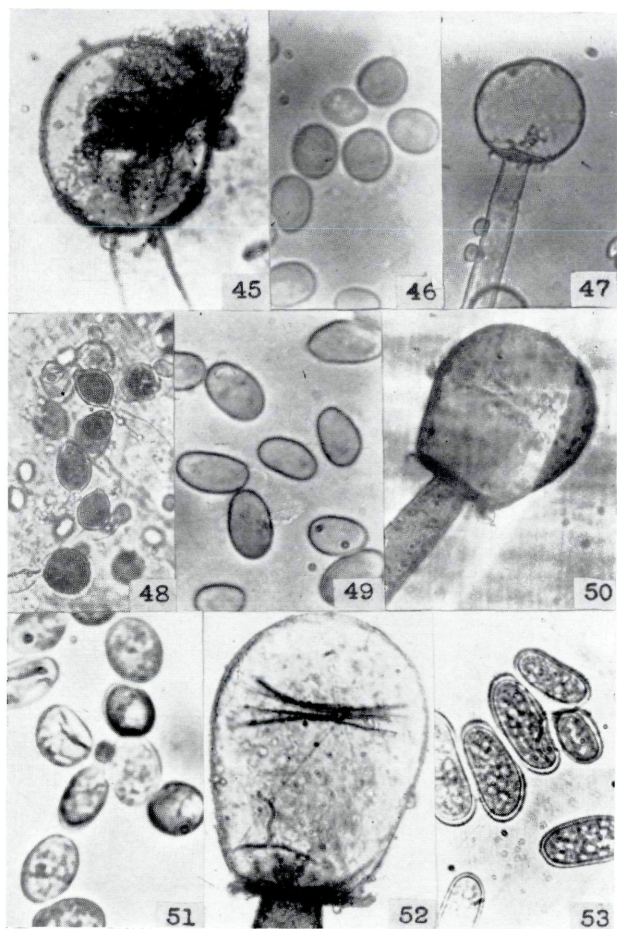
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Explanation of plates I—IV.

Plate VIII.

Fig. 1—4. *Mucor praini* Chodat et Nechitch 1—2. Sprangiophores showing manner of branching 3. columella 4. sporangiospores. — Fig. 5—9. *Mucor corticolus* Hagem 5—8. columellae 9. sporangiospores. — Fig. 10—14. *Mucor ramificus* sp. nov. 10—11 upper portion of sprangiophores showing branching pattern 12—13. columellae 14. sporangiospores.

Plate IX.

Fig. 15—18. *Mucor peacockensis* sp. nov. 15—17. columellae 18. sporangiospores. — Fig. 19—22. *Mucor alternans* van Tieghem 19 a portion of the sprangiophore showing alternate branching 20—21. columellae 22. sporangiospores. — Fig. 23—26. *Mucor caninus* Persoon 23—25. columellae 26. sporangiospores. — Fig. 27—29. *Mucor griseo-lilacinus* Povah 27—28. columellae 29. sporangiospores. — Fig. 30—33. *Mucor microsporus* Namyslowski 30—32. columellae 33. sporangiospores. — Fig. 34—36. *Mucor subtilissimus* Oudemans 34—35. columellae 36. sporangiospores.

Plate X.

Fig. 37 & 40. *Mucor ramificus* sp. nov. 37—38. sprangiophores showing branching $\times 550$ 40. sporangiospores, $\times 1000$. — Fig. 39 & 42. *Mucor microsporus* Namyslowski 39. columella $\times 400$ 42. sporangiospores. — Fig. 41. *Mucor caninus* Persoon, columella $\times 550$. — Fig. 43—44. *Mucor subtilissimus* Oudemans 43, columella $\times 720$; 44. sprangiophores, $\times 1570$.

Plate XI.

Fig. 45—46. *Mucor alternans* van Tieghem 45. columella with sporangial wall $\times 750$ 46. sporangiospores $\times 1500$. — Fig. 47—49. *Mucor griseo-lilacinus* 47 Povah 47. columella $\times 450$. 48. chlamyospores $\times 450$; 49. sporangiospores $\times 1300$. — Fig. 50—51. *Mucor corticolus* Hagem 50. columella $\times 936$ 51. sporangiospores, $\times 1300$. — Fig. 52—53. *Mucor peacockensis* sp. nov. 52. columella $\times 830$ 53. sporangiospores, $\times 1300$.

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Autor(en)/Author(s): Mehrotra B. S., Nand Krishna

Artikel/Article: [Studies of Mucor from India - III. 67-73](#)