

The genus *Cunninghamella* — a reassessment

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The genus *Cunninghamella* MATRUCHOT (1903) is one of the most common members of the order Mucorales, frequently found in soil, grains and other organic substrates. Since THAXTER (1903) described the first species a number of them have been added. A key to the species was presented by ZYCHA (1935) who recognised six species, viz. *C. albida* (SACCARDO) MATRUCHOT, *C. microspora* (RIV.) MATRUCHOT, *C. elegans* LENDNER, *C. ramosa* PISPEK, *C. blakesleeana* LENDNER, and *C. echinulata* (THAXTER) THAXTER. Later ALCORN & YEAGER (1938) published a monograph describing eight species, viz. *C. africana* MATRUCHOT, *C. albida*, *C. elegans*, *C. verticillata* PAINE, *C. microspora*, *C. bertholletiae* STADEL, *C. blakesleeana* and *C. echinulata*. NAUMOV (1939) recognised 12 species in this genus, and CUTTER (1946) retained in his monograph only five species, viz. *C. echinulata*, *C. bainieri* NAUMOV, *C. blakesleeana*, *C. bertholletiae* and *C. elegans*. Later MILKO & BELJAKOVA (1967) while reviewing this genus, retained only four species, viz. *C. echinulata*, *C. homothallica* KOMINAMI & TUBAKI, *C. elegans* and *C. blakesleeana*. Recently, SAMSON (1969) recognised seven species within this genus, viz. *C. echinulata*, *C. blakesleeana*, *C. vesiculosa* MISRA, *C. homothallica*, *C. phaeospora* BOEDIJN, *C. polymorpha* PISPEK, and *C. elegans*.

To fulfil a mycologist's interest in this genus a survey of the available species and strains of this genus was undertaken over nearly four years and during this period the cultures received from culture collections and the ones isolated in India were periodically examined to ascertain the stability and reliability of characters with diagnostic value. All isolates were simultaneously studied on two media, viz., SMA (Dextrose — 40 gms; Asparagine — 2 gms; 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 gms; distilled water — 1000 cc.; pH-6) and Oat meal agar (Oat meal — 20 gms; Yeast extract — 0.5 gm; agar — 20 gms; distilled water — 1000 cc.).

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As result of the constant examination of the species and strains of the genus *Cunninghamella* we arrived at certain conclusions with respect to the reliability of characters.

a) Branching of the conidiophores: It has been found that the branching pattern should be determined in cultures not older than 6 days (preferably 4 days). CUTTER (1946) also recommended 6 days as the proper time for studying the cultures. In older cultures from the basal parts of the main conidiophore may arise haphazard and irregular branches without any definite pattern which are different from what is found in the distal part of the main conidiophore. In mature but not old colonies the following three categories in the branching pattern of conidiophores can be distinguished in the species of *Cunninghamella*: 1. Irregular/cymose, 2. Verticillate and 3. Pseudoverticillate (branches arise singly but so close to each other that branching appears to be verticillate when examined with low magnification).

The above categories are, however, not absolute, and due emphasis should be given to the pattern found in the majority of the conidiophores in a colony.

b) Nature of conidia: In ornamentation, conidia vary from smooth to spiny. Too much emphasis, however, could not be placed on the size of the spines or extent of echinulation, as ornamentation of the spores tends to vary under varying cultural conditions. During the course of our physiological studies, made in liquid media, it has been found that the presence of certain substances the size of the spines is much reduced in species that are generally known to produce strongly echinulate conidia on solid media.

In describing the shape of the spores different terminologies have been employed by the monographers of this genus. We followed SNELL & DICK (1957) in this respect. Spores, which have been described as oval by others, are here called obovate because of the point of attachment of conidia to the vesicle. In size and colour the conidia of each of the species fall within a definite range except in one, *C. bainieri*, where the two following categories are known: one colourless and small, approximately reaching the size range of most other species of this genus, and the other brown and much larger in size (called giant conidia).

SAMSON (1969) emphasized on the mating reaction between the isolates as an evidence of affinity or disaffinity. In our opinion, however, the mating reaction may indicate some affinity between the isolates but failure to mate may not necessarily mean disaffinity as this disability may be due to running down of the cultures or unfavourable environmental and nutritional conditions.

Cunninghamella MATRUCHOT 1903, Ann. Myc. 1: 47

Cunninghamella MATRUCHOT 1903, Ann. myc. 1: 47.

Actinocephalum SAITO 1904, Bot. Mag. Tokyo 19: 36.

Saitomyces RICKER 1906, J. Mycol. 12: 61.

Muratella BAIN. & SART. 1913, Bull. Soc. mycol. Fr. 29: 129.

Colonies floccose or granular, white or coloured; mycelium at first non-septate later septate, rhizoids on aerial mycelium present or absent; conidiophores branched, irregularly, cymosely, pseudoverticillately or verticillately with each branch terminating in a hyaline or light coloured vesicle of varying shape and size; conidia formed singly on short sterigmata produced over the entire or upper region of the vesicle, one-celled, varying in shape but mostly globose, subglobose to obovate, smooth to strongly echinulate, hyaline to dark brown in colour; heterothallic or homothallic; zygospores *Mucor*-like; saprophytic. This genus has been reported on a wide variety of substrates and is of world-wide distribution.

Type species: *C. echinulata* (THAXTER) THAXTER (1903).

Key to the species of the genus *Cunninghamella*

1. Homothallic 1. *C. homothallica* KOMINAMI & TUBAKI
- 1*. Heterothallic 2
2. Fertile part of vesicle much smaller and constricted from the lower much larger sterile part 2. *C. vesiculosa* MISRA..
- 2*. Vesicle not as above 3
3. Colonies on maturity white to pale 4
- 3*. Colonies on maturity gray 9
4. Conidiophores branching mostly irregular cymose, sometimes verticillate 5
- 4*. Conidiophores branching pseudoverticillate to verticillate.... 6
5. Secondary vesicles generally subglobose to broadly clavate, upto 32 μ m in length..... 3. *C. echinulata* (THAXT.) THAXT.
- 5*. Secondary vesicles generally broadly clavate to clavate, longer, upto 60 μ m 3a. *C. echinulata* var. *indica* var. nov
6. Heads with normal (hyaline) and with giant conidia.....
- 4. *C. bainieri* NAUMOV
- 6*. Heads with normal conidia only 7
7. Secondary and primary vesicles similar in shape, conidia finely to strongly echinulate 8
- 7*. Secondary vesicles generally of different shape than the primary ones, conidia finely to strongly echinulate.....
- 5. *C. indica* sp. nov.
8. Conidia smooth to finely echinulate, verticils generally widely spaced 6. *C. blakesleeana* LENDNER
- 8*. Conidia strongly echinulate, verticils generally compact.....
- 6a. *C. blakesleeana* var. *verticillata* comb. nov.
9. Conidia globose only 10

- 9*. Conidia not as above 11
 10. Conidia small (upto 10—(15) μm)... 9. *C. phaeospora* BOEDIJN
 10*. Conidia large (upto 24 μm).....
 10. *C. brunnea* RAI, AGARWAL & TIWARI
 11. Conidia globose to obovate, spinulose.... 7. *C. elegans* LENDNER
 11*. Conidia generally obovate, lacrymoid to subglobose, mostly
 punctate..... 8. *C. polymorpha* PISPEK

1. *C. homothallica* KOMINAMI & TUBAKI 1952, Nagaoa, 1: 24
 Plate 1, fig. 1—5

Colonies on oat meal agar and SMA floccose, white above and brown at surface due to presence of numerous zygospores; conidiophores irregularly or cymosely branched upto 20 μm in diameter, generally with septum above the origin of branch; terminal vesicles globose to pyriform, 17.5—45 μm in diameter, lateral vesicles upto 28 μm in diameter; conidia mostly globose 9—16.5 μm in diameter, sometimes obovate to ellipsoidal (upto 20×13.5 μm), echinulate, spines upto 3 μm in length; zygospores globose, brown, 35—60 μm in diameter, borne in between swollen suspensors upto 24 μm in diameter, exospore warty, homothallic.

Description based on culture No. 168.53 received from CBS, Baarn, Holland.

2. *C. vesiculosa* MISRA 1966, Can. J. Bot. 44: 441. — Plate 1, fig. 6—8

Colonies on Oat meal agar and SMA floccose, white; conidiophores 7—10.5 μm in diameter, cymosely or irregularly branched, often with septum above the origin of the branch; vesicles fertile only in the upper portion, rest of the portion remaining sterile, slightly constricted just below the fertile portion, $28-52.5 \times 21-28$ μm at the broadest portion; conidia subglobose to ovoid, hyaline, 13.5—18 μm in diameter, echinulate, spines upto 8 μm in length, usually longer towards the free end and smaller towards the attached end.

Description based on the original type culture received from the author.

3. *C. echinulata* (THAXTER) THAXTER 1903, Rhodora 5: 98. —
 Plate 1, fig. 9—14

Oedocephalum echinulatum THAXTER 1891, Bot. Gaz. 16: 17.
Cunninghamella africana MATRUCHOT 1903, Ann. Myc. 1: 47.

Colonies on oat meal agar and SMA floccose, at first white later pale ochraceous buff in colour, rhizoids present, aerial mycelium septate at maturity; conidiophores upto 2 mm in length, mostly smaller, upto 10 μm in diameter, mostly branched, branches arising singly monochasial cymosely, irregularly, oppositely or rarely verti-



Plate 1: *Cunninghamella homothallica* KOMINAMI & TUBAKI: 1—2. Upper portions of conidiophores showing the pattern of branching. — 3. Conidia. — 4. Immature zygospore. — 5. Fully developed zygospore. — *C. vesiculosa* MISRA: 6—7. Two conidiophores showing branching pattern. — 8. Conidia. — *C. echinulata* (THAXTER) THAXTER: 9—11. Upper portions of conidiophores. — 12. Conidia. — 13—14. Short conidiophores arising from aerial hyphae bearing single conidia at their tips. — *C. echinulata* var. *indica* var. nov.: 15—16. Upper portions of branched conidiophores. — 17. Conidia. — 18. Vesicle (enlarged) showing the long sterigmata

cillately, often with septum above the origin of branch; primary vesicles oval to broadly clavate or pyriform, sometimes globose, 21—35 μm sometimes upto 41 μm in width, secondary vesicles of same shape as primary but smaller in size, 13.5—32 \times 9—24 μm ; conidia, borne on sterigmata upto 1.5 μm in length, produced on the entire or only upper part of the vesicle, hyaline to pale brown in colour, mostly globose, 5.5—22.5 μm (mostly 13.2—15.5 μm in diameter), rarely obovate or ellipsoidal (12.7—21 \times 10.5—18.1 (—20) μm), verrucose to strongly echinulate, spines upto 4.5 μm in length; numerous short lateral branches, simple or branched with a blunt end or a very short vesicle upto 8 μm in diameter, bearing on to few conidia, arise from conidiophores or aerial mycelium.

Description based on culture CBS (156.28); received from CBS as a neotype deposited by SAMSON.

C. echinulata (THAXTER) THAXTER is the type species of the genus. In the absence of a type culture the isolate received from CBS (originating from A. F. BLAKESLEE) is accepted here also as neo-type of the species. Out of all the cultures examined this comes fairly close to the description given by THAXTER, the author of this species. Emphasis has to be laid on the general occurrence of irregular branching a character which occurs only in two more species of this genus, viz. *C. homothallica* KOMINAMI & TUBAKI and *C. vesiculosa* MISRA, which can be easily distinguished on the basis of other characters.

3a. *C. echinulata* var. *indica* var. nov. — Plate 1, fig. 15—18

Coloniae in agar farina avenae et SMA floccosae, albae; rhizoides bene formatae; conidiophori 6—10.5 μm diam, ramosi, ramis emergentibus in cyma irregulari, interdum modo verticillato; vesiculae primariae ovoides vel late clavatae, 13.5—60 (—70 \times 11—42 (—49) μm , vesiculae secundariae plerumque late clavatae vel clavatae, tot vel partim fertiles, 31—60 \times 17—35 μm ; conidia globosa vel subglobosa, 10.5—22.5 μm plerumque 15—18 μm diam., pallida vel albidobrunnea, valde echinulata, spinae 1.7—4.4 μm longae, affixae sterigmatibus quae raro longitudinem 11 μm attingunt. Typus: BSM (C-4), India.

Colonies on Oat meal agar and SMA floccose, white; rhizoids well developed; conidiophores 6—10.5 μm in diameter, branched, branches arising irregularly, in pairs or in verticils; primary vesicles oval to broadly clavate, sometimes globose, 13.5—60 (—70) \times 11—42 (—49) μm in size; secondary vesicles mostly broadly clavate to clavate, 31—60 \times 17—35 μm , wholly or partly fertile; conidia globose to subglobose, 10.5—22.5 μm mostly 15—18 μm in diameter, pale to light brown, strongly echinulate, spines 1.7—4.4 μm , borne on short or long sterigmata which rarely reach upto 11 μm in length.

Type: C-4, BSM Culture Collection, isolated from garden soil (pH 6.8) in Calcutta, India; isotype in CBS, Baarn, Holland.

This isolate differs from *C. echinulata* (THAXTER) THAXTER mainly

in the shape and size of the secondary vesicles (which are broadly clavate to clavate and larger in size) and less in the pattern of conidiophore branching. In addition up to 11 μm long sterigmata have never been reported in any species of *Cunninghamella*.

4. *C. bainieri* NAUMOV 1939, Clés Mucorinées, 107. — Plate 2, fig. 1—3

Actinocephalum japonicum SAITO 1904, Bot. Mag. Tokyo 19: 1.

Muratella elegans BAIN. & SART. 1913, Bull. Soc. mycol. Fr. 29: 129—136

Cunninghamella dalmatica PISPEK 1929, Acta bot. Inst. bot. Zagreb 4: 100.

C. echinata PISPEK 1929, Acta bot. Inst. Zagreb 4: 102.

Colonies on Oat meal agar and SMA pale smoke gray to pale ochraceous buff, at first floccose later on somewhat granular; conidiophores 10.5—12.5 μm in diameter, verticillately to pseudoverticillately branched; terminal vesicles globose to subglobose, 31.5—42 μm in diameter, secondary vesicles of the same shape but smaller in size, 14—35 μm in diameter; conidia borne on different vesicles; normal conidia mostly globose to oval, hyaline, globose (6—10.5 μm in diameter) or oval (9.7—15 \times 9—12 μm), echinulate, spines 2—3 μm in length; giant conidia globose, brown, thick walled upto 28 μm in diam., borne either singly or in groups of few on generally verrucose, secondary vesicles, echinulate, sometimes smooth, spines 1.5—2 μm in length.

Description based on culture C-5 (BSM), isolated from garden soil (pH 7) in Allahabad, India, and on cultures received from CBS as *C. dalmatica* (No. 148.29) and *C. echinata* (No. 149.29).

The presence of giant conidia in this species is a distinct character not seen in any species of this genus. The retention of this species is, therefore, fully justified. CUTTER (1946) also maintained this species, but MILKO & BELJAKOVA (1967) and SAMSON (1969) considered this to be a synonym of *C. echinulata*. Besides the presence of giant conidia this species differs from *C. echinulata* in having verticillately branched conidiophores.

5. *Cunninghamella indica* sp. nov. — Plate 2, fig. 8—10

Coloniae in agarò farina avenae et SMA accrescentes rapidissime, floccosae, albae; rhizoides presentes (macroscopice visibiles in medio liquido); conidiophori usque 16 μm diametro, verticillatice ramosi, habentes multos vortices ramorum, quorum numerus attingere potest 12 in uno vortice, tumidi usque 24 μm diametro in loco ramificationis; vesiculae primariae globosae, 31.5—66.5 μm diametro, vesiculae secundariae plerumque clavatae vel late clavatae, interdum subglobosae, 14—30 μm diam.; conidia elata in sterigmatibus usque 3.3 μm longis, hyalina, globosa vel subglobosa, 4.5—11 μm , interdum obovata, 9—15.4 \times 7.5—13.2 μm , verrucosa vel echinulata, spinae 0.5—2.2 μm , interdum 3.3 μm longae. Typus: BSM (C-2). India.

Colonies on Oat meal agar and SMA growing very rapidly, floccose, white; rhizoids present macroscopically visible (in liquid



Plate 2: *Cunninghamhamella bainieri* NAUMOV: 1. Upper portion of verticillately branched conidiophore. — 2. A short lateral branch with a very short vesicle and a giant conidium. — 3. Giant and normal conidia. — *C. blakesleeana* LENDNER: 4–6. Upper portions of conidiophores showing the pattern of branching. — 7. Conidia. — *C. indica* sp. nov.: 8. Conidia. — 9. Upper portion of branched conidiophore showing clavate secondary vesicles. — 10. A secondary vesicle enlarged with young conidia. — *C. blakesleeana* var. *verticillata* (PAINE) comb. nov.: 11–12. Upper portions of branched conidiophores. — 13. Conidia

media); conidiophores upto 16 μm in diam., verticillately branched, bearing many whorls of branches with upto 12 branches in a whorl, swollen upto 24 μm in diameter at the place of branching; primary vesicles globose, 31.5—66.5 μm in diameter, secondary vesicles mostly clavate to broadly clavate, sometimes subglobose, 14—30 μm in breadth; conidia borne on sterigmata upto 3.3 μm in length, hyaline, globose to subglobose, 4.5—11 μm , sometimes obovate, 9—15.4 \times 7.5—13.2 μm , verrucose to echinulate, spines 0.5—2 μm , sometimes 3.3 μm in length.

Type: C-4, BSM Culture Collection, isolated from soil (pH 6.1), Nainital, India. Subculture in CBS, Baarn, Holland.

This isolate differs from all the known species of *Cunninghamella* in having secondary vesicles of quite different shape than the primary ones, and therefore, it has been described here as a new species.

6. *C. blakesleeana* LENDNER 1927, Bull. Soc. bot. Genève 19: 234. — Plate 2, fig. 4—7

Cunninghamella 'A' BLAKESLEE, CARTLEDGE & WELCH 1921, Bot. Gaz. 72: 185.

Colonies on Oat meal agar and SMA at first white later on pale in color, floccose, rhizoids present; conidiophores branched, branches arising solitarily or in verticils, widely spaced; primary vesicles globose to oval, upto 50 μm in diameter; secondary vesicles globose, sometimes broadly clavate, 10.5—30 μm in width; conidia borne on sterigmata upto 3.3 μm in length, hyaline, mostly globose to subglobose, sometimes obovate, 7.5—10.5 μm in diameter, sometimes abnormal in size and shape (13.5—32 \times 9—13.5 μm), smooth to finely echinulate, spines widely spaced, 0.6—1.1 μm rarely 2 μm in length.

Description based on culture C-7 (BSM), isolated from soil in Allahabad, India. Two further Indian samples (Gorakhpur [pH 7.5] and Rewa [pH 8]) and material received from CBS (133.27), C. W. HESSELTINE (NRRL 1370) and A. A. MILKO (+ and — strains) were also studied.

In general it has been accepted that finely echinulate to almost smooth conidia, borne on solitary or verticillate branches of the conidiophores, are a reliable character for this species. Sometimes conidia of abnormal size and shape (but of the same colour as the normal ones) are also seen in some strains of this species. Earlier, this character has also been mentioned by CUTTER (1946) who stated that it is not unusual to encounter outsize conidia upto 35 μm long.

6a. *C. blakesleeana* var. *verticillata* (PAINE) var. nov., stat. nov. — Plate 2, fig. 11—13

C. verticillata PAINE 1927, Mycologia 19: 253.

Colonies on Oat meal agar and SMA at first white later pale ochraceous buff in colour, granular in appearance; rhizoids present; conidiophores 10.5—14.0 μ m in diameter, pseudo-verticillately to verticillately branched, usually having a number of compact whorls of branches, swollen at the point of attachment of branches; terminal vesicles globose to subglobose 28—52 μ m in diameter, lateral vesicles of similar shape but smaller in size, 14—28 μ m in diameter, smooth to verrucose; conidia hyaline, mostly globose to subglobose, 7.5—12 μ m in diameter, sometimes obovate (10.5—18 \times 1—13.5 μ m), mostly strongly echinulate, spines 2.0—3.5 μ m (mostly 2.2 μ m) in length.

Description based on culture C-8 (BSM), isolated from garden soil (pH 6.8) in Allahabad. Cultures isolated from soils collected in various other parts of India were also studied.

This is the most common species in India. It is characterised by the verticillate branching pattern of conidiophores and the strongly echinulate conidia. No giant conidia are observed in this species. PAINE (1927) described this species as *C. verticillata*. Later CUTTER (1946) and SAMSON (1969) considered it to be a synonym of *C. blakesleeana*. ZYCHA (1935) and MILKO & BELJAKOVA (1967) to that of *C. echinulata*. From *C. blakesleeana* this species differs only in having compactly arranged branches of conidiophores and strongly echinulate conidia but from *C. echinulata* it differs in the branching pattern of conidiophore which is verticillate in the present isolate but irregular in *C. echinulata*. This isolate has, therefore, been described here as a variety of *C. blakesleeana*.

7. *C. elegans* LENDNER 1907, Bull. Herb. Boissier 7: 250 — Plate 3, fig. 1—3

C. bertholletiae STADEL 1911, Diss. Kiel, pp. 1—35.

Colonies on Oat meal agar and SMA at first white later on gray in colour; rhizoids present; conidiophores upto 12.5 μ m in diameter, branched verticillately; terminal vesicles subglobose to oval, 21.0—38.5 μ m in diameter, lateral vesicles of same shape but smaller, upto 20 μ m in diameter; conidia globose, subglobose to obovate, mostly globose, 6—10 μ m in diameter, obovate ones 6.6—12.1 \times 4.4—8.8 μ m, pale brown at maturity, punctate to spinulose, spines upto 0.5 μ m in length.

Description based on culture C-10 (BSM), isolated from farm soil in Allahabad (pH 7). Further Indian cultures (isolated from forest soil in Rewa (pH 7.4), wheat and paddy grains) and material

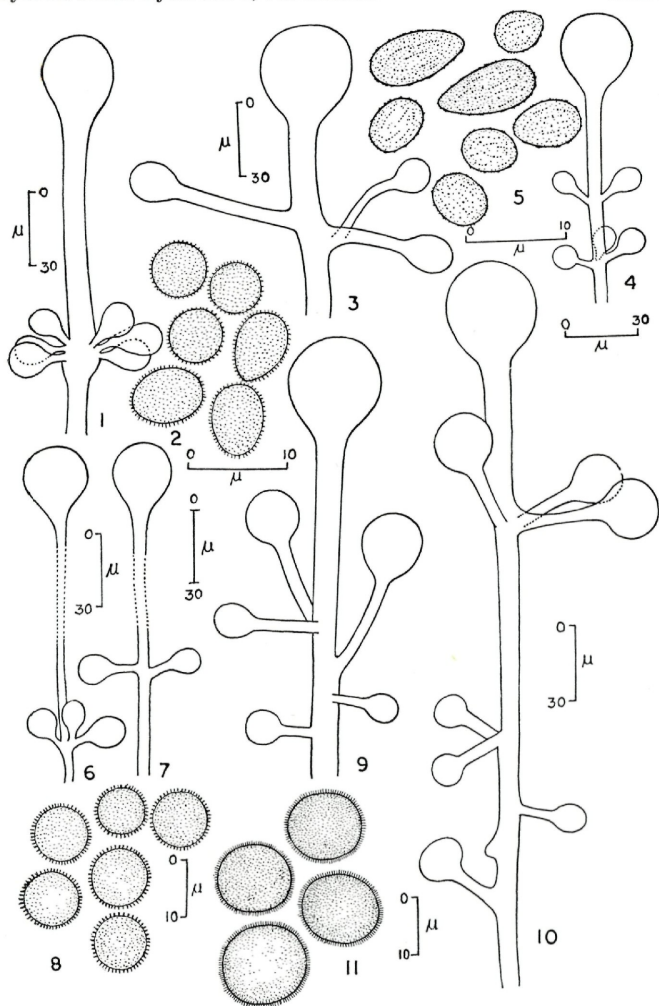


Plate 3: *Cunninghamella elegans* LENDNER: 1. Verticillately branched conidiophore. — 2. Conidia. — *C. polymorpha* PISPEK: 3–4. Upper portions of branched conidiophores. — 5. Conidia. — *C. phaeospora*. BOEDIJN: 6–7. Upper portions of conidiophores. — 8. Conidia. — *C. brunnea* RAI, AGARWAL & TIWARI: 9–10. Upper portions of conidiophores. — 11. Conidia

received from CBS (160.28) and A. A. MILKO (+ and — strains) were also studied.

8. *C. polymorpha* PISPEK 1929, Acta bot. Inst. bot. Zagreb 4: 103. — Plate 3, fig. 3—5

Colonies on Oat meal agar and SMA floccose at first white later on light gray in color; rhizoids present; conidiophores mostly verticillately branched, branches short or long, secondary branches arising in verticillate manner from primary ones also commonly observed; vesicles globose, subglobose to oval, sometimes pear shaped upto 40 μm in diameter, secondary vesicles of similar shape but smaller in size; conidia borne on sterigmata upto 3.3 μm in length, usually lacrymoid, obovate, ellipsoidal to subglobose, rarely globose, 5.5—16.4 \times 4.4—8.8 (9.9) μm , hyaline to pale brown, punctate, sometimes smooth.

Description based on culture C-11 (BSM), isolated from soil in Allahabad, India (university farm [pH 8.2] and garden [pH 7]).

PISPEK (1929) created this species on the basis of variously branched conidiophores and globose, ovoid to ellipsoidal conidia, which were described to be smooth and with granular contents. From the figures it appears that globose conidia were rare in his isolate. All the earlier workers, except SAMSON (1969), doubted the validity of this species. We are also of the opinion that this should be treated as a separate, valid species.

It is reported here for the first time from India.

9. *C. phaeospora* BOEDIJN 1958, Sydowia 12: 348

Colonies on Oat meal agar and SMA at first white, later on light gray in colour, few rhizoidal structures seen; conidiophores 3.5—7 μm in diameter, branched, branches arising singly, oppositely or in verticils; vesicles globose, subglobose to oval, 17.5—28.0 μm (27—55 μm : BOEDIJN, 1958) in diameter, lateral vesicles of similar shape but smaller in size, 7—19.5 μm in diameter; conidia globose to sub-globose, 6.6—11.0 μm (9—15 μm : BOEDIJN, 1958) in diameter, at first hyaline later dark brown, conspicuously echinulate, spines thick and compact, upto 1.5 μm in length.

Description based on culture C-12 (BSM), isolated from soil in Nainital (pH 6.1), India. The isolate CBS (692.68) was also examined.

This species is generally recognised and is here being reported for the first times from India. It is characterised by the exclusive presence of globose, shortly echinulate and brown conidia.

10. *C. brunnea* RAI, AGARWAL & TIWARI 1968, J. Gen. Appl. Microbiol. 14: 443. — Plate 3, fig. 9—11.

Colonies on Oat meal agar and SMA at first white later on dark gray in colour, numerous rhizoids present; conidiophores

arise singly or in groups, 10 μm in diameter, septate at maturity, mostly branched, branches arising singly, oppositely, pseudoverticillately or sometime verticillately; primary vesicles globose, 24.5—54 (59.4) μm in diameter, light brown in colour, secondary vesicles of similar shape but smaller in size, upto 28 μm sometimes 35 μm in diameter; conidia globose, hyaline when young, pale brown to dark brown at maturity, 7.7—24.0 μm in diameter, mostly echinulate (sometimes smooth), spines thin, very compact, upto 1 μm in length.

Description based on culture C-13 (BSM), isolated from forest soil (pH 8.2) in Rewa, India.

SAMSON (1969) has made this species a synonym of *C. phaeospora* (without giving a reason), but we are of the opinion that this species should be maintained as a separate entity due to the presence of larger conidia with thin spines and the origin of certain conidiophores in groups.

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