Additional notes on species of *Aspergillus*, *Eurotium* and *Emericella* from Egyptian desert soil

R. A. SAMSON AND J. MOUCHACCA

Centraalbureau voor Schimmelcultures, Baarn, The Netherlands, and Laboratoire de Cryptogamie, Paris, France

SAMSON, R. A. and MOUCHACCA, J. 1975. Additional notes on species of *Aspergillus*, *Eurotium* and *Emericella* from Egyptian desert soil. Antonie van Leeuwenhoek **41**: 343–351.

Aspergillus floriformis, *A. pseudodeflectus*, *Eurotium xerophilum* (st. con. *A. xerophilus*) and *Emericella purpurea* (st. con. *A. purpureus*) are described and illustrated as new species. In addition the morphology of strains identified as *Aspergillus melleus*, *A. caespitosus* and *A. versicolor* is discussed.

INTRODUCTION

In a previous paper (Samson and Mouchacca, 1974) some *Emericella* and *Aspergillus* species isolated from Egyptian desert soil were reported. In the meantime several new isolates were obtained from other soil samples. Amongst them a number of new and interesting species were found which are herewith described.

Aspergillus floriformis Samson et Mouchacca, spec. nov. — Fig. 1.

Coloniae in agaro Czapekii fere lente crescunt, paucis conidiophoris e mycelio intricato luteo assurgentibus, margine lobato et fimbriato; conidiophora atypica; conidia globosa, viridula, asperata, 4–5 μm diam. Coloniae in agaro malt dicto 40% sucrosi addito celeriter crescunt, densum stratum conidiophororum formant, virides. Hyphae vegetativae fortiter incrustatae verrucis hyalinis 4–5 μm diam., capitula conidiorum viridia, radiantia, biseriata; conidiophora levia, brunnea, circa 150 μm longa, 5.5–7.0 μm diam.; vesiculae globosae vel subglobosae, 11–15 μm diam.; metulae cylindricae, 9–11 × 4–5 μm; phialides binae ad quaternae verticillatae lageniformes, collo brevi distincto praeditae, 6–8 × 4–6 μm; conidia globosa, asperata, viridula, 3.5–4.7 μm diam. Cellulae hülle dictae globosae vel ellipsoideae, 16–20 μm diam.

Typus CBS 937.73 isolatus ex arena deserti occidentalis in Aegypto. In herb. CBS.

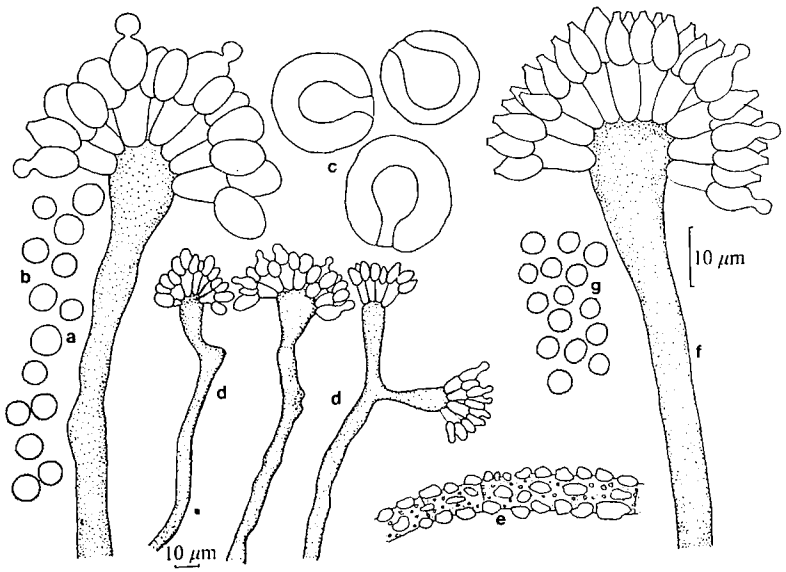

Fig. 1. *Aspergillus floriformis*, a, b. conidiophores and conidia, produced on Czapek agar, c. Hülle cells, d. atypical conidiophores, produced on MEA with 20% sucrose, e. encrusted vegetative hypha, f, g. conidiophores and conidia, produced on MEA with 40% sucrose.

Colonies on Czapek agar growing rather restrictedly, attaining a diameter of 3 cm within 7 days at 25 C consisting of a dense yellow mycelial felt from which only a few conidiophores arise; margin lobed and fimbriate. Colony colour cream with a pale green tinge due to the conidiogenous structures. Reverse yellow-brown. Conidiophores atypical with all elements swollen and with an irregular branching; stalk, smooth, brown. Conidia globose, finely echinulate, greenish, 4–5 μm in diam. Hülle cells absent.

Colonies on malt extract agar (MEA) with similar growth, but colour more green, because of a richer sporulation. Reverse yellow. Hülle cells absent.

Colonies on MEA with 40% sucrose growing rapidly, attaining a diameter of 8 cm within 7 days at 25 C, consisting of a dense felt of numerous conidiophores; colour green near Grape Green (Ridgway, 1912, Pl. 45). Reverse yellow brown. Odour not pronounced. Vegetative hyphae usually heavily encrusted with colourless warts, 4–5 μm in diam. Conidial heads green, radiate, biseriate. Conidiophores smooth, brown, ca. 150 μm long and 5.5–7.0 μm in diam.; vesicles globose to subglobose, 11–15 μm in diam. Metulae cylindrical, 9–11 × 4–5 μm. Phialides in whorls of 2 to 4, flask-shaped with short but distinct neck, 6–8 × 4–6 μm. Conidia globose, finely echinulate, greenish, 3.5–4.7 μm in diam. Hülle cells present, but not abundantly, globose to ellipsoidal, 16–20 μm in diam.

The species has its growth optimum at 35 C and a temperature range of 15 to 45 C. It is osmophilic; on MEA with additional sucrose or glycerine concentrations the strain can grow at an $a_w = 0.88$.

Type culture CBS 937.73, isolated from desert soil collected in the Western Desert, Egypt.

The brown pigmented conidiophores with radiate, biseriate heads produced particularly on MEA with 40% sucrose, indicate that this fungus belongs in the *Aspergillus versicolor* group. It differs from the other known species by atypical growth on Czapek and malt extract agars, showing the lobed, fimbriate colony margin. It is close to *A. silvaticus* Fennell et Raper, from which it differs by the atypical sparse growth on normal Czapek and malt extract agars and the absence of clusters, consisting of Hülle cells.

Aspergillus pseudodeflectus Samson et Mouchacca, spec. nov. — Fig. 2.

Coloniae in agaro Czapekii fere lente crescunt, mycelio albo capitulis conidiorum brunneis intermixto; hyphae vegetativae leves, hyalinae, 2.5–5.0 μm diam.; capitula conidiorum radiantia, biseriata; conidiophora brevia, curvata, asperata, brunnea, 35–75 × 2.5–3.5 μm; vesiculae globosae vel clavatae, 4–6 μm diam.; phialides binae ad ternae verticillatae, lageniformes collo brevi distincto praeditae, 5.5–7.5 × 3.0–3.5 μm; conidia globosa vel ellipsoidea, crassitunicata, brunnea, verruculosa vel cristis brunneis praedita, 3.5–4.0 μm diam. Cellulae hülle dictae absunt.

Coloniae in agaro malt dicto 40% sucrosi addito celeriter crescunt, conidiophoris abundantibus virides; capitula conidiorum radiantia, biseriata; conidiophora recta, levia, flavo-brunnea, ad 150 μm longa, 3.5–4.5 μm diam.; conidia globosa, flavo-brunnea, levia, 2.5–3.2 μm diam.

Typus CBS 756.74, isolatus ex arena deserti occidentalis in Aegypto. In herb. CBS.

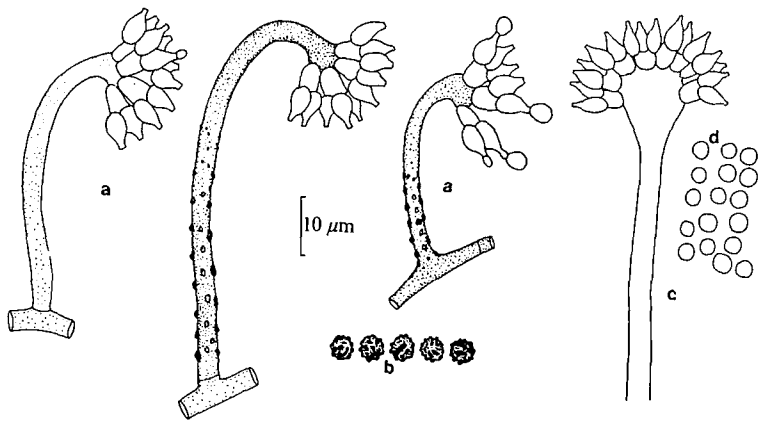

Fig. 2. *Aspergillus pseudodeflectus*, conidiophores and conidia. a, b. on Czapek agar, c, d. on MEA with 40% sucrose.

Colonies on Czapek agar growing rather restrictedly, attaining a diameter of 2.5 cm within 7 days at 25 C, consisting of a white mycelial felt intermixed with brown conidiogenous structures, obscured by loose hyaline, aerial mycelium. Reverse yellow. Exudate and odour not produced. Vegetative hyphae smooth, hyaline, 2.5–5.0 μm in diam. Conidial heads brown, radiate, biseriate. Conidiophores short, curved, rough-walled with warty protuberances, brown, 35–75 × 2.5–3.5 μm. Vesicles globose to clavate, 4–6 μ in diam. Metulae more or less cylindrical, 4.0–5.5 × 2.5–4.0 μm. Phialides in whorls of 2 to 3, flask-shaped, with short but distinct neck, 5.5–7.5 × 3.0–3.5 μm. Conidia globose to ellipsoidal, thick-walled, brown, ornamented with small warts and colour bars, 3.5–4.0 μm in diam. Hülle cells absent. Colonies on MEA showing similar growth as on Czapek, but growth somewhat faster about 3 cm in diam. within 7 days at 25 C. Conidiophores mostly longer up to 125 μm.

Colonies on MEA with 40% sucrose, growing rapidly, attaining a diameter of 8 cm within 7 days at 25 C, consisting of a white mycelial felt from which numerous conidiophores arise, giving the colony a green appearance near Vetiver Green (Ridgway, Pl. 47), Reverse uncoloured. Conidial heads radiate, biseriate, green. Conidiophores straight, smooth, yellow brown, up to 150 μm long and 3.5–4.5 μm in diam. Conidia globose, yellow-green, smooth, 2.5–3.2 μm in diam. Hülle cells absent.

The species has its growth optimum at 30 C with a temperature range of 12 to 40 C. It is osmophilic; on MEA with additional sucrose or glycerine concentrations the strain can grow at an $a_w = 0.86$–0.88.

Type culture CBS 756.74 isolated from soil collected in the Western Desert, Egypt.

A. pseudodeflectus has its curved brown conidiophores and the ornamented conidia in common with *A. deflectus* Fennell et Raper of the *A. ustus* group. In this species growth is slower and it produces elongate Hülle cells. The brown conidiophores and the green radiate conidial heads produced on malt or Czapek agar with higher sucrose concentrations indicate that *A. pseudodeflectus* belong in the *A. versicolor* group. It also resembles *A. recurvatus* Raper et Fennell which was isolated from a desert area in California (USA). The latter species is green on Czapek and malt agar and has Hülle cells, although this was not reported in the first description (Raper and Fennell, 1965). It is further characterized by the production of abundant yellow mycelium, which is absent in *A. pseudodeflectus*.

Aspergillus caespitosus Raper et Thom

Two strains were isolated from Egyptian desert soil (CBS 946.73 and 654.74), which are identical with *Aspergillus caespitosus* in nearly all morphological aspects. CBS 654.74 produces, however, more conspicuous, purple clusters,

consisting of Hülle cells. The type of *A. caespitosus* isolated from soil in Arkansas (USA) and the Egyptian strains grow well on Czapek and malt agars with 20 to 80% sucrose. Optimal growth occurs at 30 C.

Aspergillus versicolor (Vuill.) Tiraboschi

Several isolates were obtained, which fit into the species concept of *A. versicolor*. The growth on Czapek agar is, however, restricted (11 mm within 7 days). They produce white to yellow colonies with many atypical conidiophores. On MEA with 40% sucrose growth is somewhat faster, attaining a diameter of 21 mm within 7 days at 25 C. The colonies are yellow-green with normally developed conidiophores. Conidia are globose, echinulate, 2.0–3.5 μm in diam. Optimal growth occurs at 24 C.

Aspergillus melleus Yukawa

Colonies on Czapek agar growing restrictedly, attaining a diameter of 1.5 cm within 7 days at 25 C, consisting of a dense layer of sclerotia. Conidiogenous structures absent or sparsely produced in the central part of the colony. Sclerotia hard, more or less globose, 100–200 μm in diam., white at first, later becoming yellow to brownish. On MEA colonies similar, but conidial structures more abundant especially in older cultures. Conidiogenous structures mostly atypical, suggesting a divaricate penicillus, consisting of irregularly branched conidiophores, bearing on each branch a whorl of 2 to 3 phialides.

Colonies on MEA with 20 or 40% sucrose growing faster, attaining a diameter of 8 cm within 7 days at 25 C, consisting of a dense layer of yellow to brownish sclerotia obscured by a loose overgrowth of aerial mycelium and conidiophores. Conidial head pale yellow near Colonial Buff (Ridgway, Pl. 30), radiate, biseriate. Conidiophores similar to those of other strains of *A. melleus*. Conidia globose, smooth, hyaline, 2.0–2.5 μm.

The strain has its growth optimum at 35 C with a temperature range of 20 to 45 C. It is osmophilic, growing on Czapek and malt agars with 40% or more sucrose.

Culture studied: CBS 743.74 isolated from soil sample collected in the Western Desert of Egypt.

The Egyptian isolate is considered as a variant of *Aspergillus melleus*. On Czapek and malt agar the strain is predominantly sclerotial and therefore difficult to recognize as *A. melleus*. However, colonies on media with higher sucrose concentrations produced the conidiogenous structures of this species. Because of its sclerotial appearance and its habitat CBS 743.74 resembles *A. arenarius* Raper et Fennell, which, however, has green, columnar, conidial heads of the *A. versicolor* type.

Eurotium xerophilum Samson et Mouchacca, spec. nov. — Figs. 3, 4a.
stat. con. *Aspergillus xerophilus* Samson et Mouchacca, stat. nov.

Coloniae in agaro Czapekii et malt dicto haud crescunt; tantum 20 vel 40% sucrosi addito celeriter crescunt, stratum densum ascomatum luteum formant; initialia e magno glomo hypharum ascogenarum convolutarum constant; ascomata globosa, lutea, 75–125 μm diam., pariete e cellulis applanatis simplicibus composito; asci globosi vel subglobosi, octospori, evanescentes, 11–13 μm diam., ascosporae oblatae, hyalinae, leves, duabus cristis praeditae, 6.0–7.5 × 4.2–5.5 μm. Status conidialis plerumque abest vel sparsus in coloniis vetustis. Coloniae in agaro Czapekii 70% sucrosi addito celeriter crescunt, ascomatibus numerosis hyphis aeriis obtectis e quibus conidiophora oriuntur; capitula conidiorum dilute caeruleo-viridia vel griseo-viridia, uniseriata, radiantia; conidiophora levia, hyalina, 50–120 × 4.5–6 μm; vesiculae globosae, 15–25 μm diam.; phialides lageniformes, collo brevi distincto praeditae, 5.5–9 × 2.5–3.5 μm. Conidia globosa vel ellipsoidea, levia vel asperulata, hyalina, 2.5–4.5 μm diam.

Typus CBS 938.73, isolatus ex arena deserti occidentalis in Aegypto. In herb. CBS.

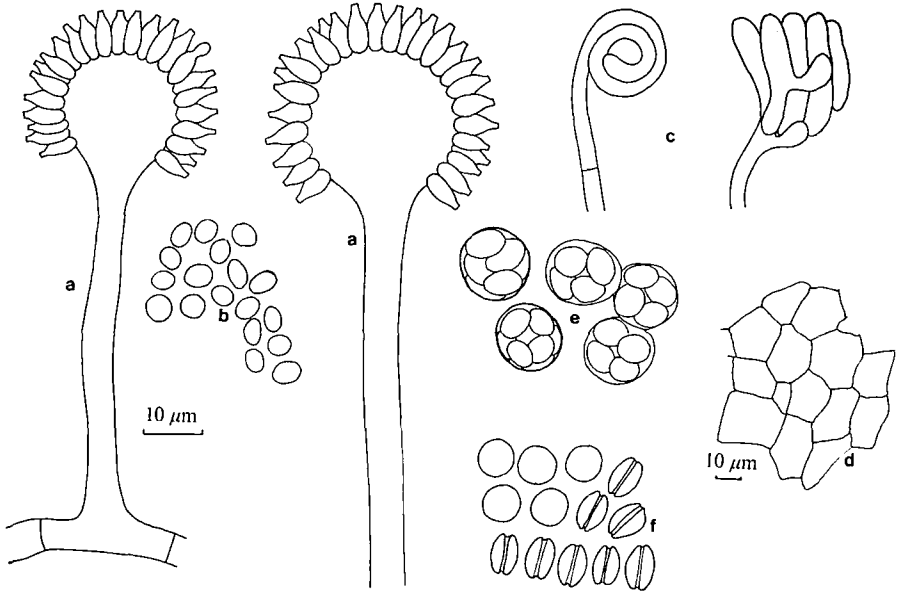

Fig. 3. *Eurotium xerophilum*, a, b. conidiophores and conidia, c. initials, d. part of ascoma wall, e. asci, f. ascospores.

Colonies on Czapek and malt extract agar fail to grow at various temperatures. On MEA with 20 or 40% sucrose growing rapidly attaining a diameter of 4.0 cm within 5 days at 25 C, consisting of a dense layer of numerous ascomata, giving the colony a yellow colour near Antimony Yellow (Ridgway, Pl. 15). Initials consisting of a large coil of ascogenous hyphae. Ascomata globose, yellow, non-ostiolate, 75–125 μm in diam., with a peridial wall consisting of one layer of yellow, flattened cells, 5–12 μm in diam. Asci in chains, globose to sub-

globose, 8-spored, evanescent, 11–13 μm in diam. Ascospores oblate, hyaline, smooth to finely roughened with one furrow, 6.0–7.5 × 4.2–5.5 μm. Conidial state mostly absent or sometimes sparsely produced in very old dry cultures.

Colonies on Czapek with 70% sucrose growing rapidly, attaining a diameter of 6 cm within 10 days at 25 C, consisting of a dense felt of numerous ascomata obscured by an overgrowth of aerial hyaline mycelium from which conidiophores arise. Conidial heads pale blue green or greyish green, uniseriate, radiate. Conidiophores, smooth-walled, hyaline, 50–120 × 4.5–6 μm. Vesicles globose, 15–25 μm in diam. Phialides flask-shaped, with a short but distinct neck 5.5–9 × 2.5–3.5 μm. Conidia globose to ellipsoidal, smooth or very finely roughened, hyaline, 2.5–4.5 μm in diam.

The species has its optimum growth at 24 C with a temperature range of 10 to 36 C. It is strongly osmophilic; on MEA with additional sucrose or glycerine concentrations it can grow at an $a_w = 0.75$–0.79.

Cultures examined: CBS 938.73 = Type culture; CBS 755.74, isolated from soil samples collected in the Western Desert of Egypt.

Eurotium xerophilum resembles *E. minus* (Mangin) Subramanian (1972) on basis of the similarity of the ascospore size and shape. It differs, however, from this species by the strong osmophily and the pale blue-green to grey-green conidial heads with small, smooth to very finely roughened, hyaline conidia. Smooth conidia are also found in *Aspergillus chevalieri* (Mangin) Thom et Church var. *intermedius* Thom et Raper (st. asc. *Eurotium chevalieri* Mangin var. *intermedium* (Thom et Raper) Malloch et Cain). The conidia of this species are ellipsoidal, mostly 3–4 μm in long axis and greenish.

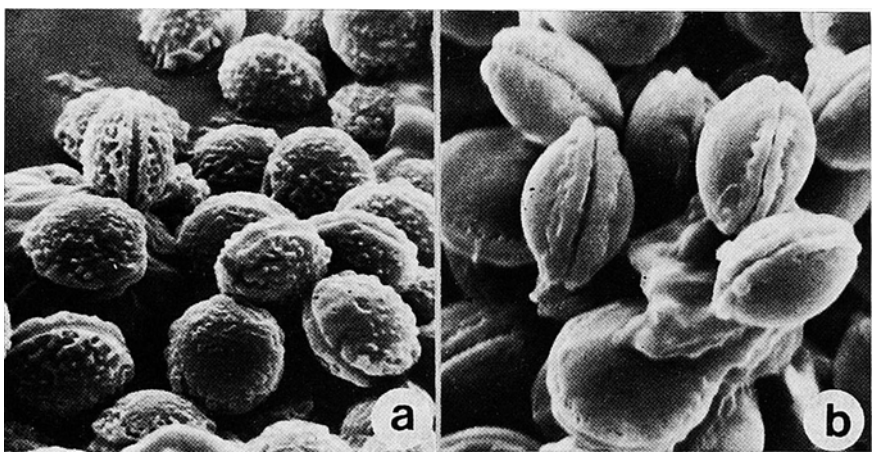

Fig. 4. Scanning electron micrographs of ascospores (ca. 3200 ×). a. *Eurotium xerophilum*, b. *Emericella purpurea*.

The strong osmophily of *E. xerophilum* is similar to that of *E. halophilicum* Christensen, Papavizas et Benjamin, which grows very restrictedly, attaining a diameter of 1–2 cm within one month on Czapek agar with 70% sucrose. *E. halophilicum* differs also from *E. xerophilum* by the light-coloured, sometimes pale yellow ascomata.

Emericella purpurea Samson et Mouchacca, spec. nov. — Figs. 4b, 5.
stat. con. *Aspergillus purpureus* Samson et Mouchacca, stat. nov.

Coloniae in agaro Czapekii lente crescunt, ascomatibus numerosis hyphis hyalinis vel luteis aeriis obtectis; ascomata matura lutea ad purpureum; vergentia hyphae vegetativae hyalinae, nonnumquam flavidae, leves, 1.5–3.0 μm diam. Ascomata e glomis compactis irregularibus hypharum tenuium oriuntur; fere globosa, 100–150 μm diam., pariete e nonnullis stratis cellularum flavarum applanatarum composito, numerosis cellulis hülle dictis plerumque globosis, 13–22 μm diam. obtecta; asci catenulati, globosi vel subglobosi, octospori, 14–17 μm diam.; ascosporae lenticulares, duabus cristis praeditae, purpureae, valvis levibus, 6–7 × 4.5–5.2 μm. Conidiophora plerumque absunt, sed in agaro Czapekii 20% vel pluri sucrosi addito formata post unum mensem; capitula alba, radiantia, biseriata; conidiophora hyalina, 40–50 × 2.5–5 μm; vesiculae ellipsoideae vel clavatae, 6–8 μm diam.; metulae cylindricae, 3.5–6 × 2.5–3.5 μm, phialides bines ad ternas ferunt; phialides lageniformes collo brevi distincto praeditae, 6–8 × 2.5–3.0 μm; conidia ellipsoidea vel cylindrica, hyalina, levia, 3.5–5.5 × 1.5–2.0 μm.

Typus CBS 754.74, isolatus ex arena deserti occidentalis in Aegypto. In herb. CBS.

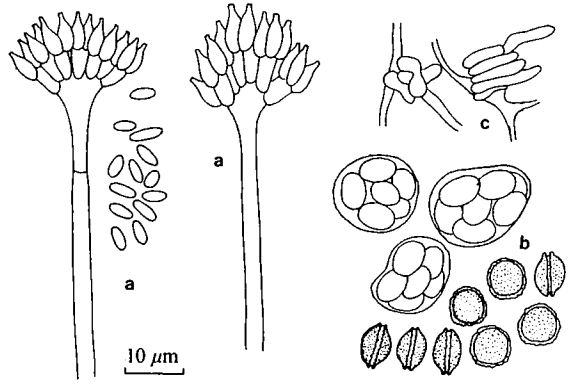

Fig. 5. *Emericella purpurea*, a. conidiophores and conidia, b. asci and ascospores, c. initials.

Colonies growing restrictedly on Czapek agar, attaining a diameter of 2 cm within one month at 25 C (ca. 3 cm at 30 C), consisting of a dense layer of numerous ascomata intermixed with and obscured by hyaline or yellow aerial mycelium. Colour yellowish with a purplish cast from ripe ascomata. Vegetative hyphae, sometimes yellowish, smooth-walled, 1.5–3 μm in diam. Odour pronounced, herb-like. Exudate mostly present as yellow drops. Reverse yellowish or brownish. Ascoma initials developing as irregular compact clues of thin

hyphae. Ascomata more or less globose, 100–150 μm in diam., non-ostiolate; the wall, consisting of one to several layers of yellow, flattened cells, covered by numerous thick-walled Hülle cells, which are mostly globose, 13–22 μm in diam. Asci produced in chains, globose to subglobose, 8-spored, 14–17 μm in diam. Ascospores one-celled, red-purple, lenticular with two low crests, valves smooth-walled, 6–7 × 4.5–5.2 μm. Conidial structures mostly absent on Czapek or MEA, but sometimes produced in old slant cultures on the glass surface; on Czapek agar with 20% or more sucrose conidiophores are produced after one month. Conidial heads white, radiate, biseriate. Conidiophores hyaline, 40–50 × 2.5–5 μm. Vesicles ellipsoidal to clavate, 6–8 μm in diam. Metulae cylindrical, 3.5–6 × 2.5–3.5 μm bearing 2 to 3 phialides each. Phialides flask-shaped with short but distinct neck, 6–8 × 2.5–3 μm. Conidia ellipsoidal to cylindrical, hyaline, smooth, 3.5–5.5 × 1.5–2 μm.

Colonies on MEA grow faster attaining a diameter of 3.5 cm within one month at 25 C.

The species has its growth optimum at 30 C with a temperature range of 15 to 35 C. It grows well on MEA with 20 or 40% sucrose (diam. 6.5 cm within one month at 25 C). On Czapek agar with 20 to 80% sucrose only hyaline aerial mycelium and a limited number of conidiogenous structures are produced.

Type culture CBS 754.74, isolated from soil sample, collected in the Western Desert of Egypt.

This species can be distinguished from the other *Emericella* species by the red-purple ascospores (6–7 × 4.5–5.2 μm) with low crests, the restricted growth on Czapek agar, and the hyaline conidiophores, producing hyaline, smooth-walled cylindrical conidia.

The authors wish to thank Ir. M. B. Northolt (RIV, Bilthoven) who determined the a_w value for some strains. The SEM micrographs were made with the cooperation of the SEM Research Group of the University of Amsterdam.

Received 3 *June* 1975

REFERENCES

RAPER, K. B. and FENNELL, D. I. 1965. The genus *Aspergillus*. — Williams and Wilkins Comp., Baltimore.

RIDGWAY, R. 1912. Color standards and color nomenclature. — Washington, DC.

SAMSON, R. A. and MOUCHACCA, J. 1974. Some interesting species of *Emericella* and *Aspergillus* from Egyptian desert soil. — Antonie van Leeuwenhoek **40**: 121–131.

SUBRAMANIAN, C. V. 1972. The perfect states of *Aspergillus*. — Curr. Sci. **41**: 755–761.