

Taxonomic studies on the fungi of Kuwait

I. Zygomycetes

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ABSTRACT

In this paper, notes on the frequency of occurrence, keys and descriptions of 10 species belonging to four families in the class Zygomycetes are provided, with illustrations and photographs.

INTRODUCTION

Because no attention has been given to the study of fungi in Kuwait, nothing was known about the quantitative and qualitative composition of the fungal flora of the country until 1972 when a number of investigations were carried out by the author (Moustafa 1973, 1975a, 1975b, 1975c, 1976; Moustafa and Al-Musallam 1975; Moustafa and Kamel 1976; Moustafa *et al.* 1976). From several studies on the ecology of fungi in Kuwaiti soil and atmosphere, during the period from 1972 to 1976 inclusive, it was possible to isolate some of the 205 species belonging to different fungal categories. The taxonomy of these groups will be dealt with in a number of papers; this one on the Zygomycetes represents the first of the series.

KEYS AND DESCRIPTIONS

MUCORALES

Key to the 4 families of Mucorales observed in Kuwait

- | | |
|---|--------------------|
| 1. Sporangia all columellate and alike | Mucoraceae |
| 1. Columellate sporangia lacking or if present, accompanied by sporangioles, merosporangia or conidia | 2 |
| 2. Spores pigmented, with polar tufts of cilia or striate | Choanephoraceae |
| 2. Spores usually hyaline, without cilia, not striate | 3 |
| 3. Spores develop in rows in elongated merosporangia | Piptocephalidaceae |
| 3. Spores develop singly as blastoconidia on swellings | Cunninghamellaceae |

Key to genera of family Mucoraceae

- | | |
|--|----------------|
| 1. All sporangia pyriform, with a definite apophysis; rhizoids present | <i>Absidia</i> |
| 1. All sporangia spherical, rhizoids present or absent | 2 |

- | | |
|---|--------------------|
| 2. Sporangia with a definite apophysis, rhizoids present | <i>Rhizopus</i> |
| 2. Sporangia without a definite apophysis | 3 |
| 3. Stolons and rhizoids present | <i>Actinomucor</i> |
| 3. Stolons and rhizoids absent | 4 |
| 4. Branches or stalks bearing the sporangia circinate or recurved | <i>Circinella</i> |
| 4. Branches or stalks bearing the sporangia not circinate | <i>Mucor</i> |

Absidia corymbifera (Cohn) Sacc. & Trotter in Sylloge Fung. **21**: 825 (1912).

= *Absidia ramosa* (Lindt) Lendner in Mat. Flore Cryptogam. Suisse **3**: 133 (1908).

Figs. 1 & 2, Plate I.

Common, isolated several times from the soil and air. Thermotolerant (Moustafa *et al.* 1976), able to grow at temperatures up to 45°C. Colonies at first white becoming greyish to smoky later on; sporangiophores variable in length, 40–220 up to 350 μm , arising singly or in clusters of 2–3, roughened, brownish at the apophysis; rhizoids present; sporangia apophysate, smooth walled, the terminal ones subglobose to pyriform, 25–35 up to 70 μm in diameter, while the laterals globose to oval, relatively smaller, 15–25 μm in diameter; columellae smooth, globose, oval to elongated, with or without collars, 10–(14–18)–25 μm in diameter; spores elliptical, smooth, variable in size 6.5–7.6 \times 3.5–4.5 μm in diameter; heterothallic.

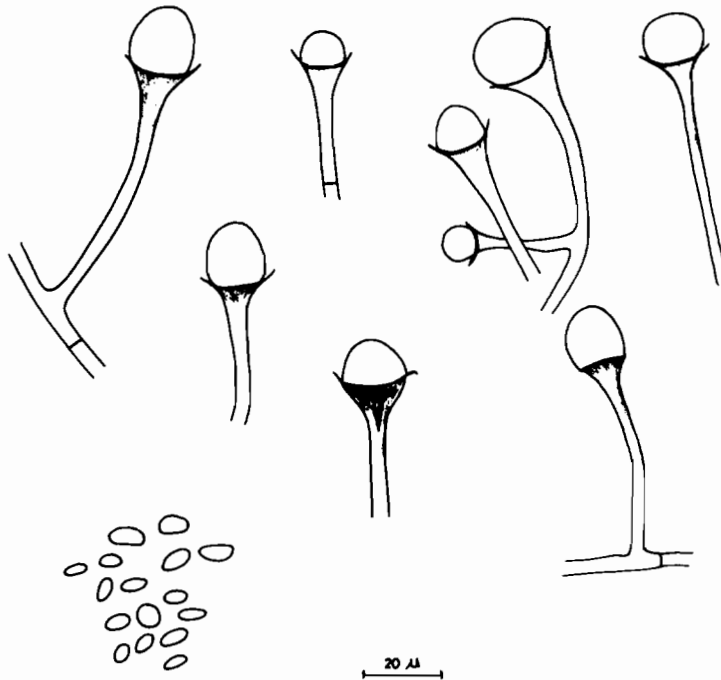


Fig. 1. *Absidia corymbifera*, columellae, collars, apophyses and sporangiospores.

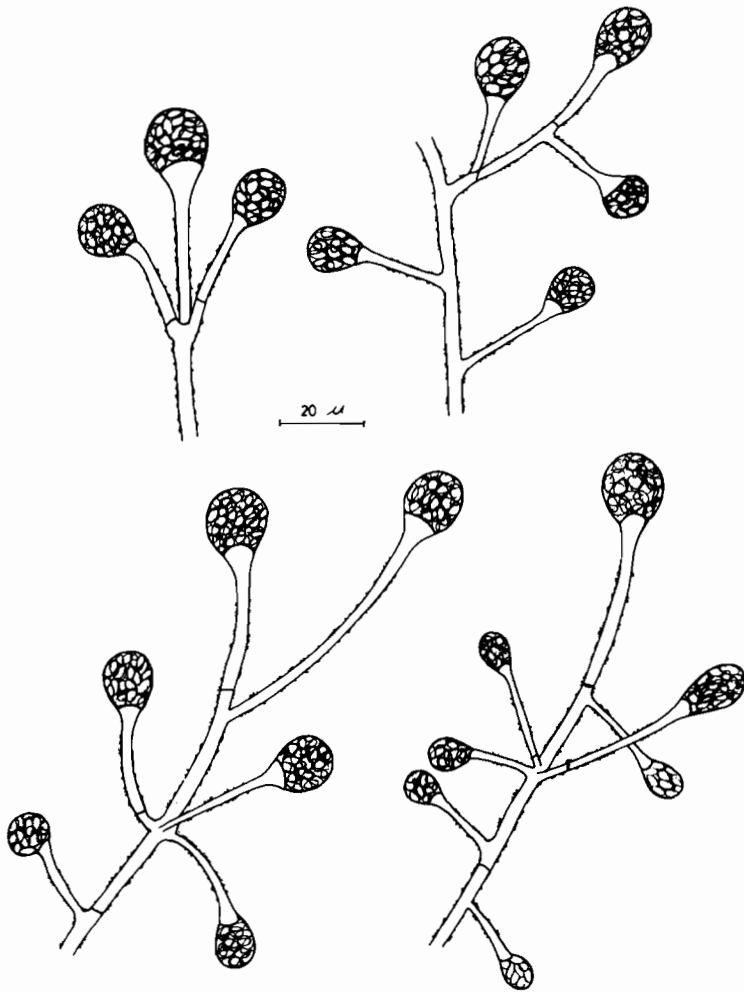


Fig. 2. *Absidia corymbifera*, different types of sporangiophore branching.

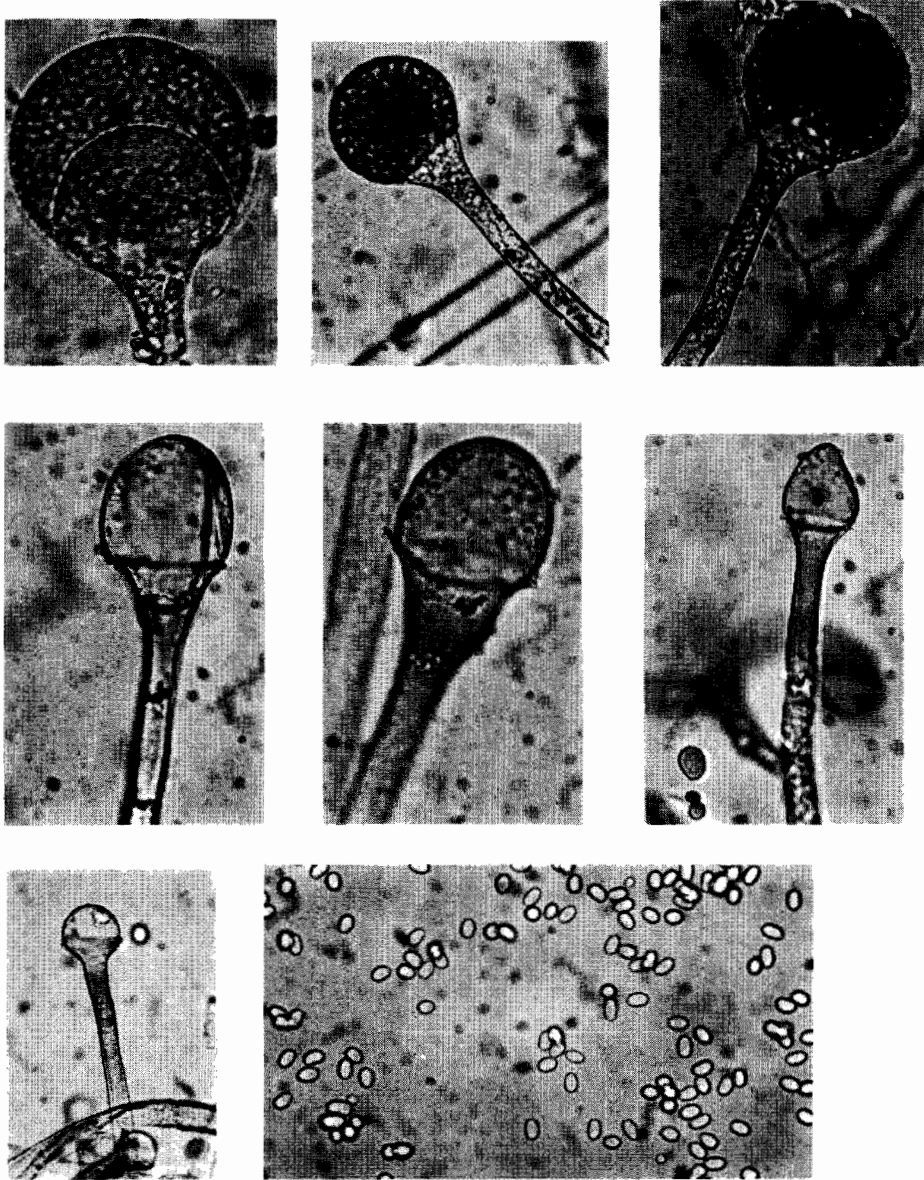


Plate I. *Absidia corymbifera*, apophysate sporangia, different types of columellae, collars and oval to ellipsoidal sporangiospores.

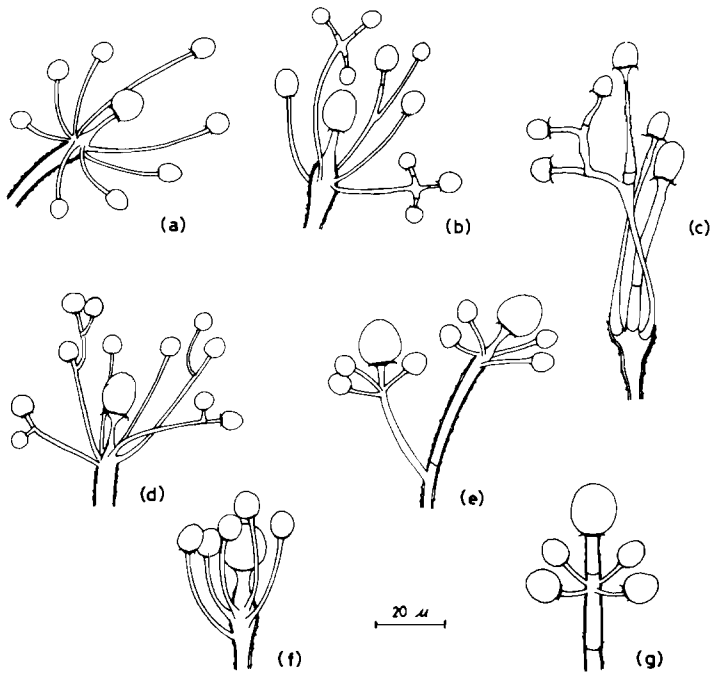


Fig. 3. *Actinomucor elegans*, different types of compact branching of sporangiophores.

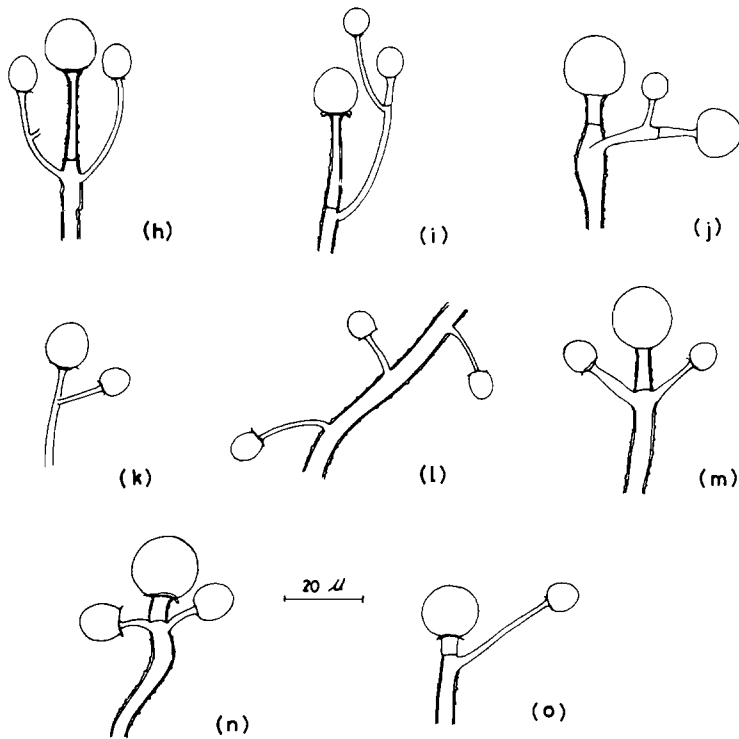


Fig. 4. *Actinomucor elegans*, different types of simple branching of sporangiophores.

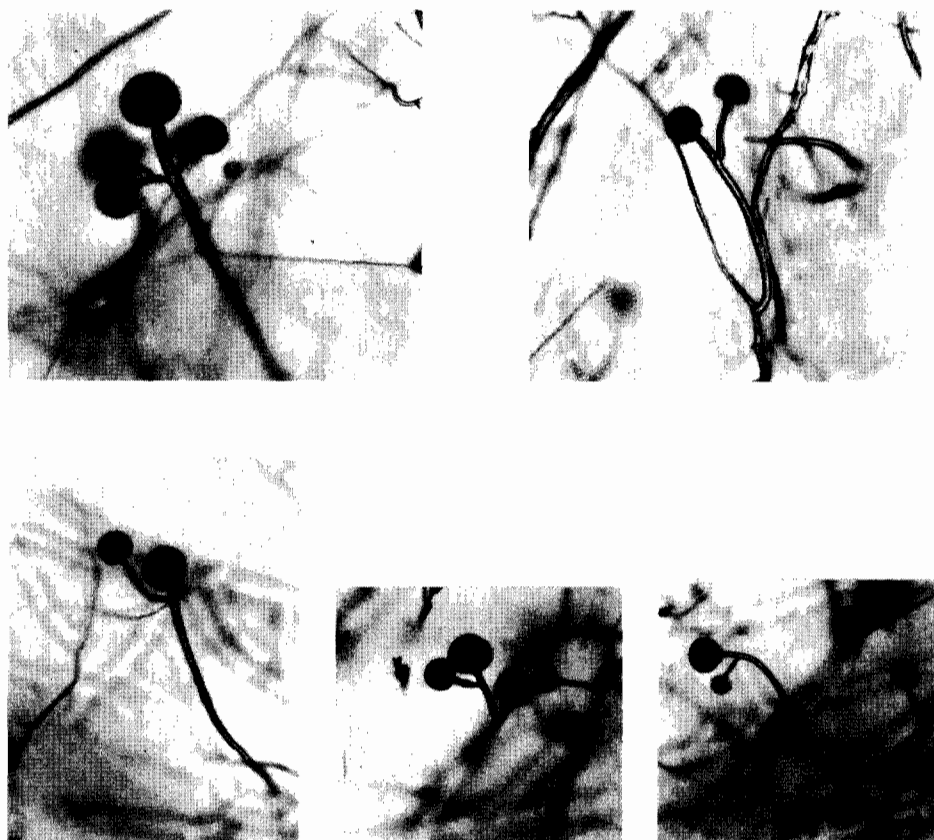


Plate II. *Actinomucor elegans*, whole mount showing apices of sporangiophores bearing sporangia.

Actinomucor elegans (Eidam) Benjamin & Hesseltine in *Mycologia* 49: 241 (1957).
Figs. 3 & 4, Plates II & III

Very common in the soil, isolated many times. Thermotolerant (Moustafa *et al.* 1976), able to grow at temperatures up to 40°C. Colonies cottony, at first white becoming drab-grey later on, rhizoids present but not always arising opposite the sporangiophores; sporangiophores branched verticillately or racemosely; in both cases they terminate with large, spherical, black sporangia, 90–140 μm in diameter, secondary sporangia on lateral branches are relatively small, 25–50 μm in diameter; columellae of large sporangia oval to pyriform, or elongated, 80 \times 50 μm , while those of secondary sporangia are globose to flattened, 15–35 μm in diameter; sporangiospores smooth or faintly roughened, globose, 6–8 μm in diameter; no zygospores.

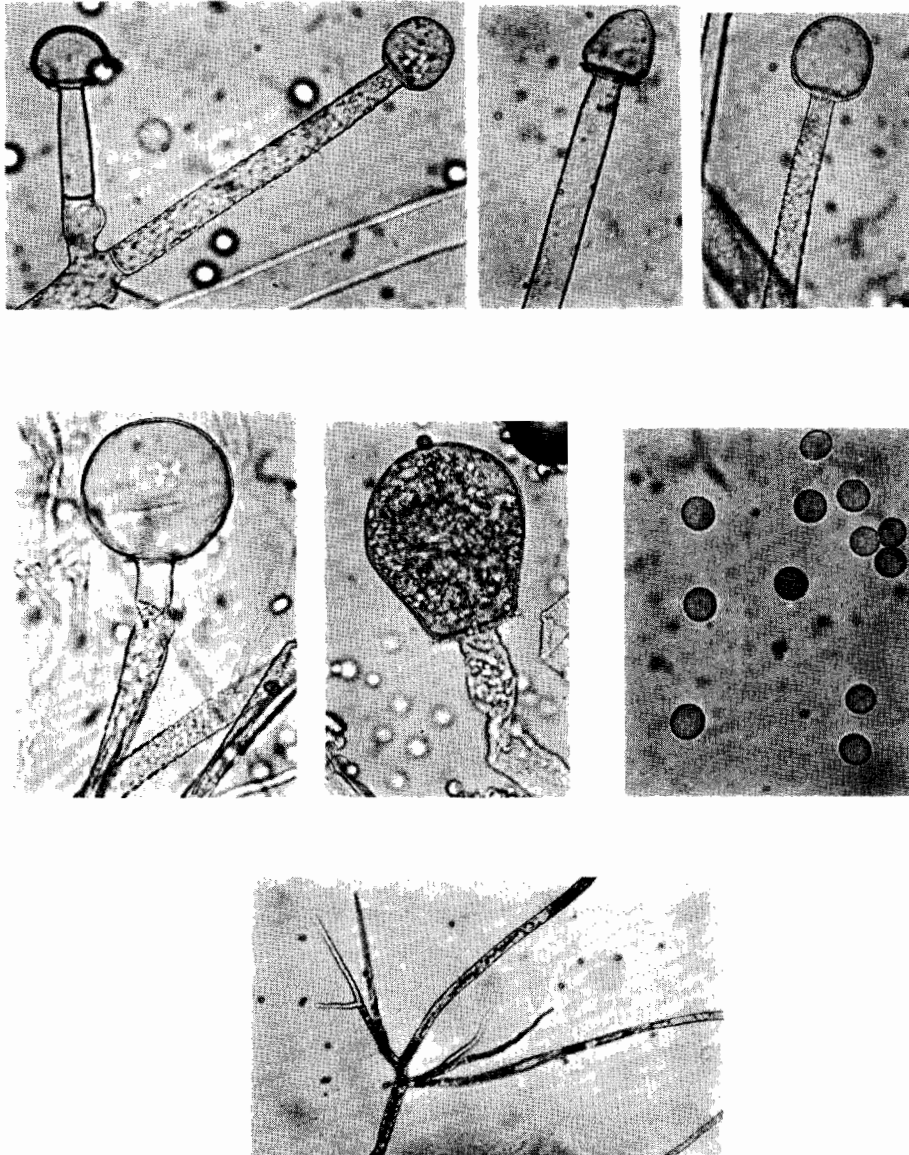


Plate III. *Actinomucor elegans*, rough sporangiophores, different types of columellae, collars, globose to subglobose sporangiospores and rhizoids.

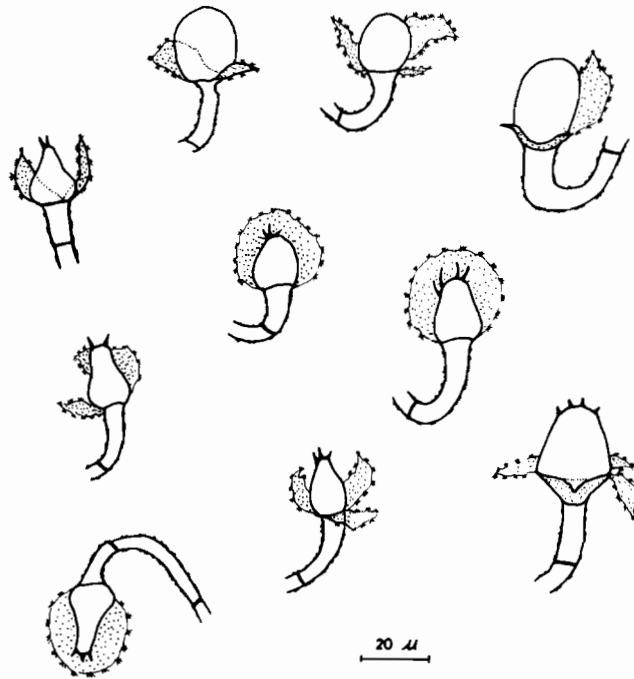


Fig. 5. *Circinella umbellata*, dehiscent sporangia showing different types of columellae and spines.

Circinella umbellata van Teighem & Le Monnier in Ann. Sci. Nat. Ser. V 17: 298 (1873).

Fig. 5, Plates IV & V.

Very rare, isolated few times from soil and air. Colonies at first white, becoming grey to pale pinkish buff; sporangiophores branched sympodially, rough, particularly near the sporangia; sporangia spherical, 60–80 μm in diameter, borne on short, circinate, rough, stalks forming umbels of 6–9 up to 12 branches; columellae irregular in shape and size but most of them with large collar and some projections (1–4); spores globose to subglobose, 6–8 μm in diameter; heterothallic.



Plate IV. *Circinella umbellata*, whole mount showing sporangial initials, clusters of sporangia and sympodial branching.

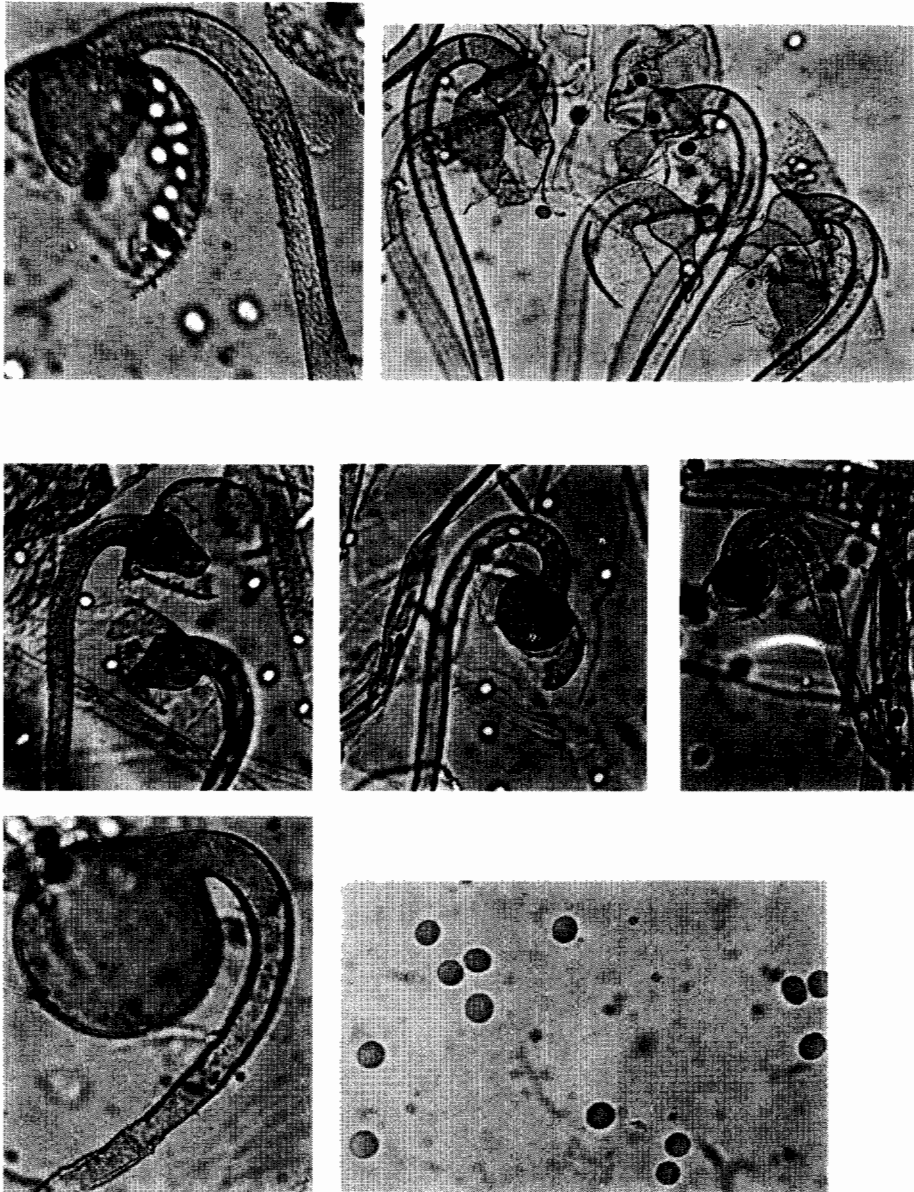


Plate V. *Circinella umbellata*, rough sporangiophores, dehiscent sporangia with different types of columellae showing constrictions and prominent spines at their apices, collars, globose to sub-globose sporangiospores.

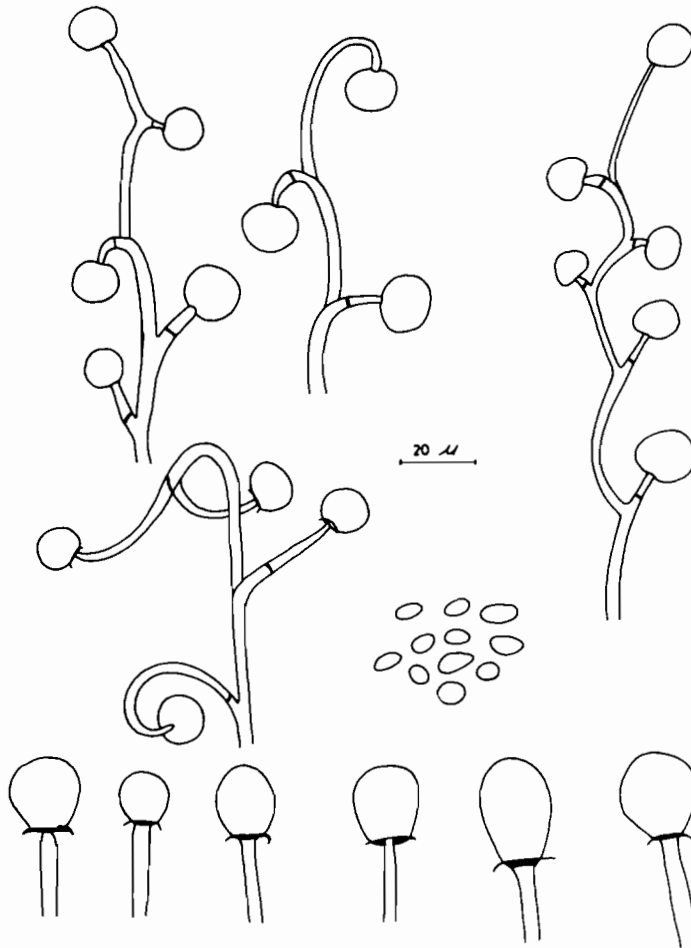


Fig. 6. *Mucor circinelloides*, different types of sporangiophore branching, columellae and sporangiospores.

Mucor circinelloides van Teighem in Ann. Sci. Nat. Ser. VI 1: 94 (1875).

Fig. 6, Plate VI.

Very common in the soil, isolated many times, thermotolerant (Moustafa *et al.* 1976), able to grow at temperatures up to 40°C. Colonies at first white becoming greyish to smoky later on, mycelium sub-hyaline, smooth, coenocytic; sporangiophores rough, branching monopodially and sympodially, with regular septa at side branches; sporangia spherical, up to 90 μm in diameter, columellae variable in shape and size, ranging from subglobose to elongated, 24–40 \times 16–28 μm , with small collars; sporangiospores also irregular in size and shape, globose, subglobose to oval, 6–9 \times 3–6 μm ; heterothallic.

Key to the species of *Rhizopus* in Kuwait.

Sporangiospores 7–8 μm .
Sporangiospores 8–12 μm .

R. arrhizus
R. stolonifer

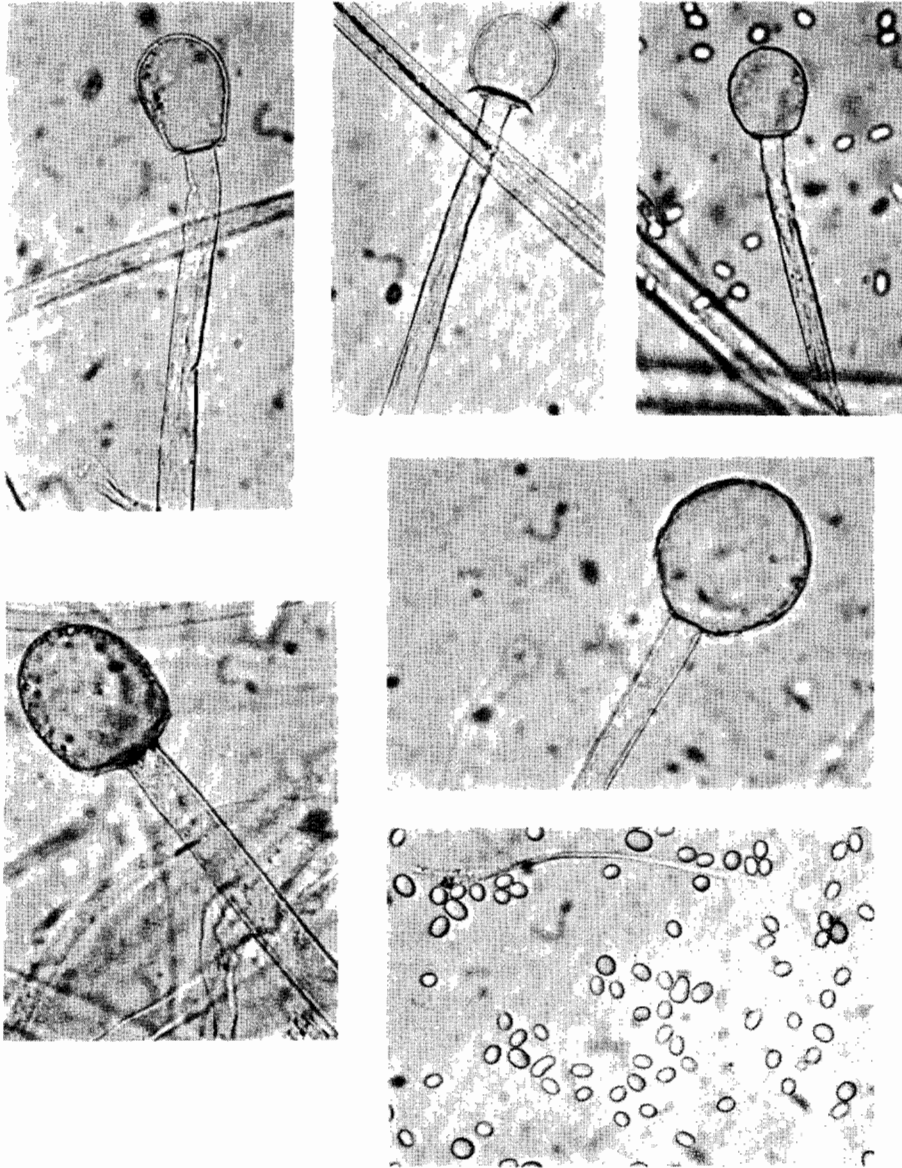


Plate VI. *Mucor circinelloides*, sporangiophores with different types of columellae, collars, subglobose sporangiospores.

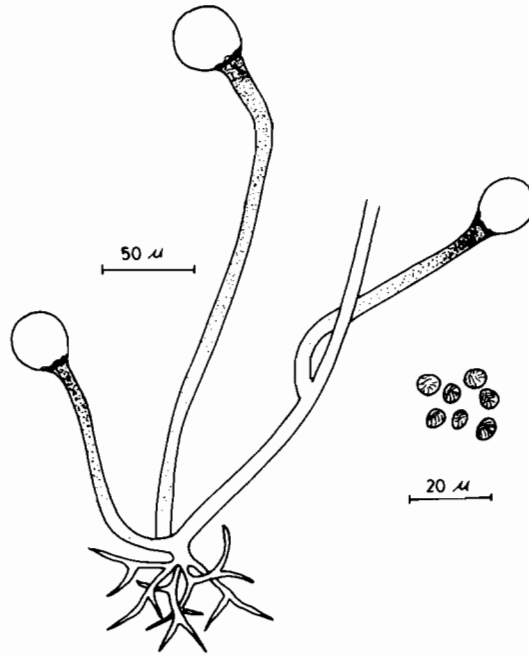


Fig. 7. *Rhizopus arrhizus*, dark pigmented sporangiophores and subglobose, striated sporangiospores.

R. arrhizus Fischer in Rabenhorst Cryptog. Fl. 1: 233 (1892).
Fig. 7, Plate VII.

Very common in the air, less common in the soil. Sporangiophores relatively shorter than those of *R. stolonifer*, 180–350 up to 650 μm long and 20–30 μm wide, arising either singly or in small clusters of 2–3 opposite the richly branched rhizoids; sporangia spherical, 100–200 μm in diameter, columellae dome-shaped, 70–120 μm up to 180 μm in diameter; spores variable in shape and size, globose, subglobose, oval, angular, 5–(7–8)–10 up to 12 μm in diameter, with prominent striations; heterothallic.

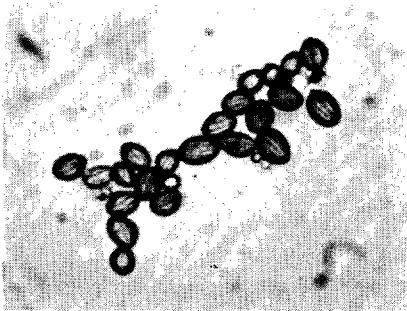
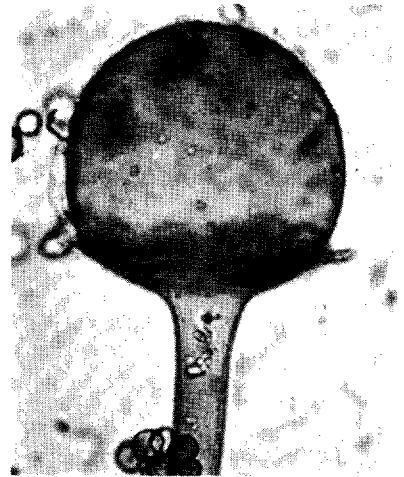
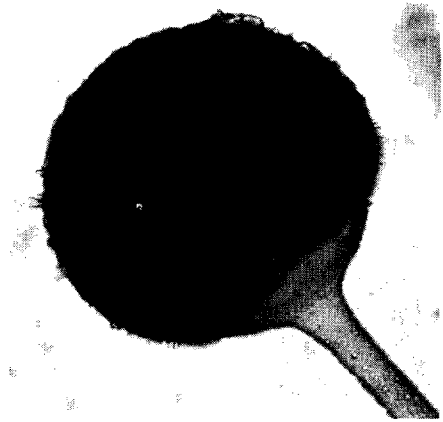
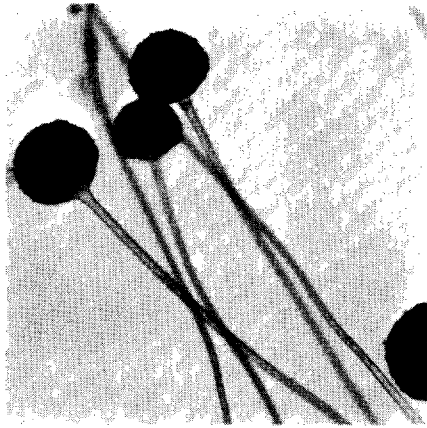


Plate VII. *Rhizopus arrhizus*, sporangiophores with apophysate sporangia, dome-shaped columellae, collars and striated sporangiospores.

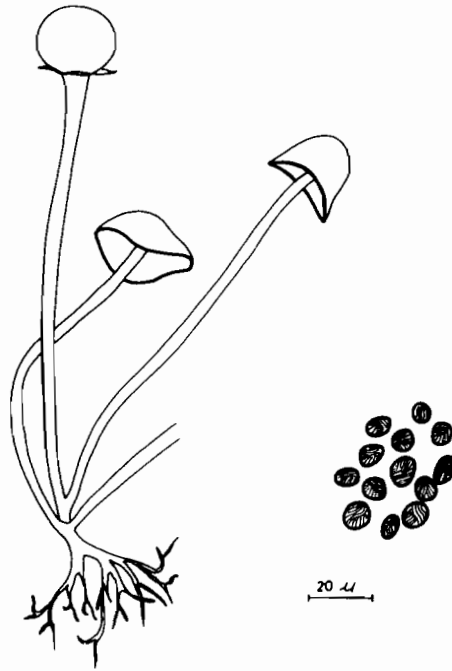


Fig. 8. *Rhizopus stolonifer*, sporangiophores with invaginated columellae, striated sporangiospores.

Rhizopus stolonifer (Ehrenb. ex Fr.) Vuill.

Fig. 8.

Very common in the air, less common in the soil. Sporangiophores 280–650 up to 950 μm long and 30–40 μm wide, arising in clusters of 2–5 opposite the richly branched rhizoids; sporangia spherical, 120–300 μm in diameter; columellae dome-shaped, 80–140 up to 220 μm in diameter; spores variable in shape and size, globose, subglobose, oval, angular, 6–(9–12)–14 up to 18 μm in diameter, with prominent striations; heterothallic.

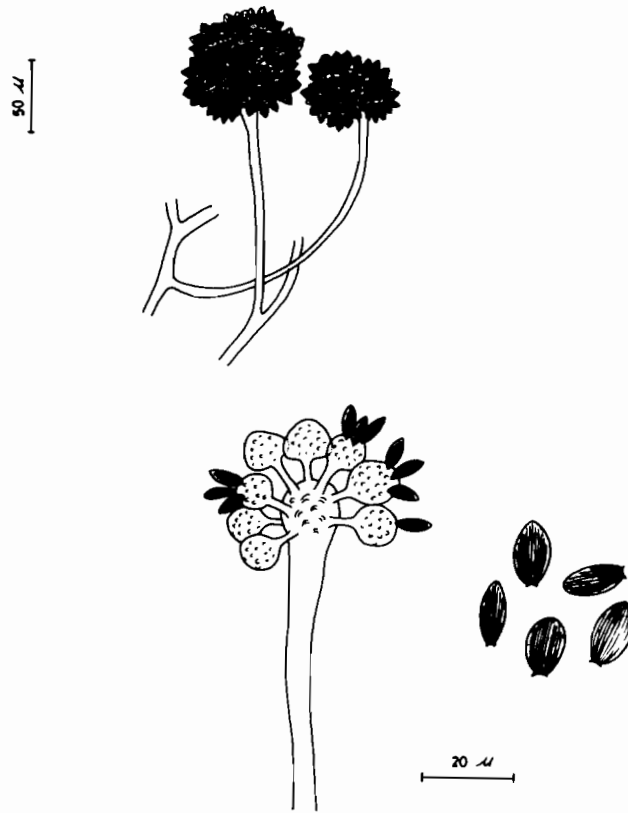


Fig. 9. *Choanephora cucurbitarum*, apex of conidiophore with vesicles and striated conidia.

FAMILY CHOANEPHORACEAE

Choanephora cucurbitarum (Berk. & Rav.) Thaxt. in *Rhodora* 5: 97 (1903).

Fig. 9, Plate VIII.

Very rare, isolated once from the air (Moustafa & Kamel 1976). Colonies at first white becoming grey later on; conidiophores smooth, 280–460 μm long and 18–25 μm wide, with terminal, large, hyaline, flattened, primary vesicles (60–80 μm) from which secondary vesicles (35–50 μm) arise on secondary branches, 20–40 μm in length; conidia elliptical, 11 \times 18 μm , with prominent striations and protuberant scars; sporangiophores not branched, 150–300 μm long and 8–12 wide; sporangia globose, 45–70 μm in diameter; collumellae globose, 12–20 μm in diameter, sporangiospores ellipsoidal, brown, with polar tufts of cilia, 13 \times 22 μm ; heterothallic.

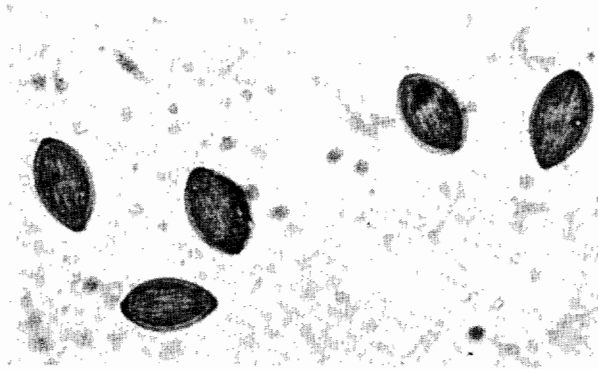
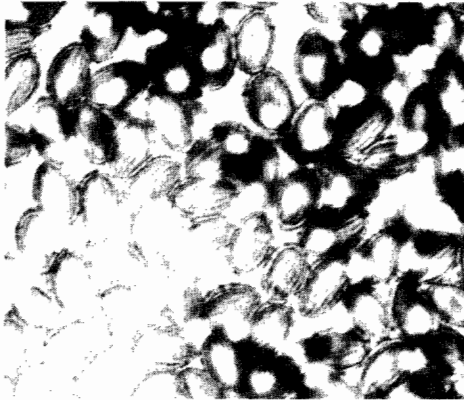


Plate VIII. *Choanephora cucurbitarum*, striated, broadly fusiform conidia with prominent scars.

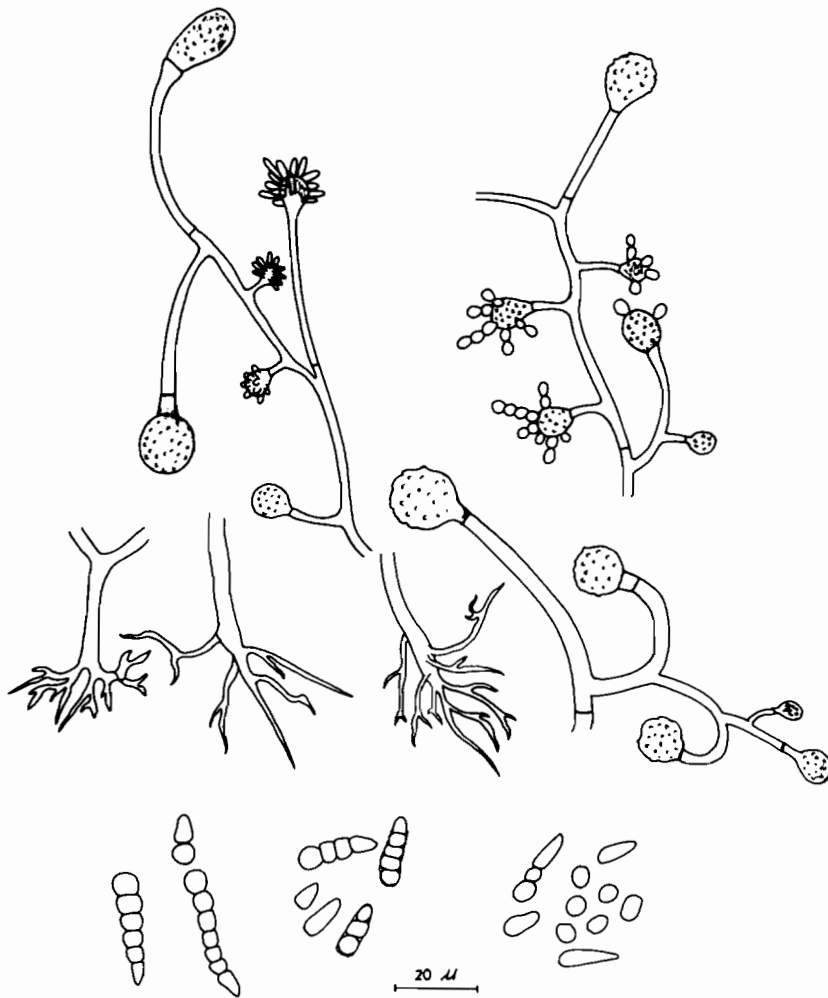


Fig. 10. *Syncephalastrum racemosum*, sporangiophores bearing vesicles and merosporangia in different stages of development, mature merosporangia and merospores.

FAMILY PIPTOCEPHALIDACEAE

Syncephalastrum racemosum Cohn ex Schröter in Cryptog. Fl. Schles. 3 (1): 217 (1886).
Fig. 10, Plate IX.

Very common in the air and soil. Colonies cottony, white at first becoming smoky later on; mycelium coenocytic, verrucose, with regular septa below the vesicles and at side branches; sporangiophores up to 450 μm long and 24 μm thick, emerging from the substrate directly or from stolons, branching racemosely or irregularly; rhizoids present; vesicles verrucose, brown, variable in shape and size, globose, oval, pyriform to elongated, with the terminal ones larger (40–60 μm in diameter) than the lateral ones (15–35 μm); merosporangia cylindrical, variable in size, 14–(18–26)–40 μm , with

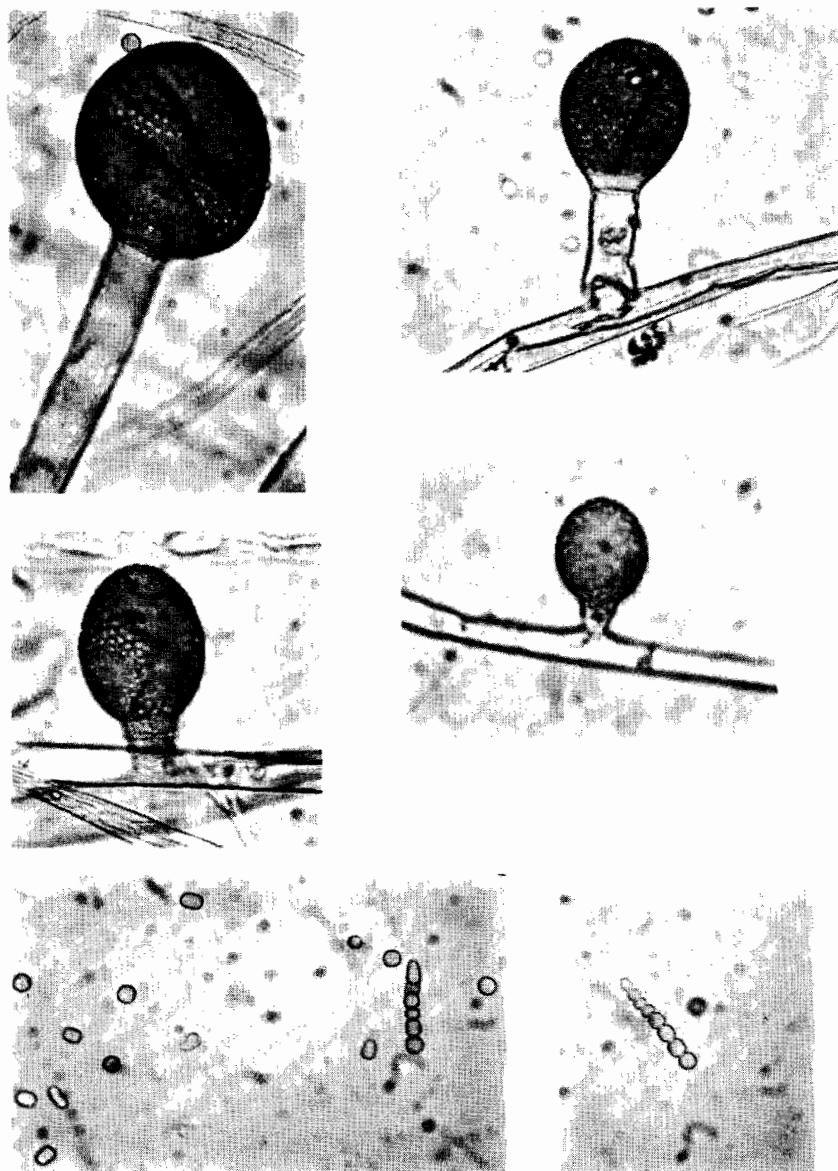


Plate IX. *Syncephalastrum racemosum*, mature, dark-coloured vesicles showing scars of merosporangial attachment, merosporangia and merospores.

4-7 up to 16 or 18 spores mostly in uniseriate arrangement; spores variable, globose, elliptical to cylindrical, 3.5-11.5 × 3.5-5.7 μm; heterothallic.

FAMILY CUNNINGHAMELLACEAE

Key to the species of *Cunninghamella* in Kuwait.

Pseudoconidia hyaline
Pseudoconidia brownish

C. elegans
C. phaeospora

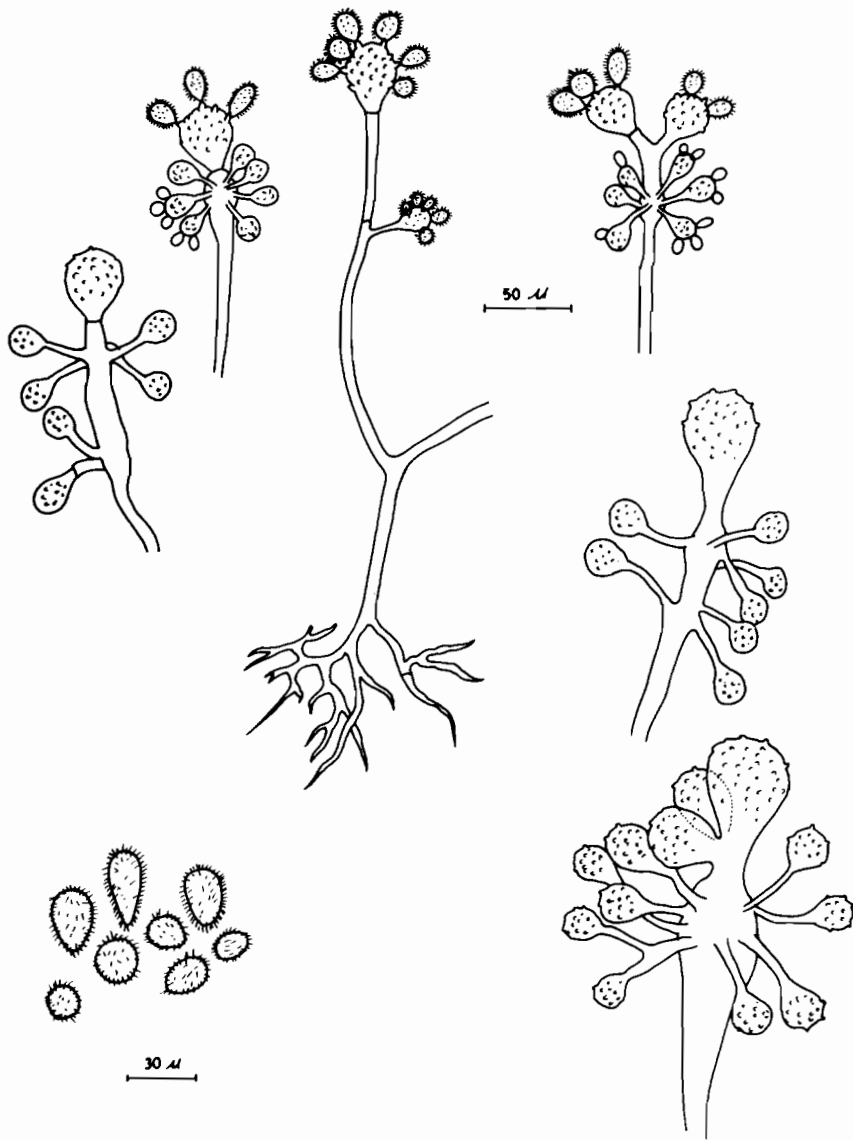


Fig. 11. *Cunninghamella elegans*, conidiophores with vesicles bearing developing and mature, spiny conidia.

Cunninghamella elegans Lendner in Bull. Soc. Bot. Genève 19: 234 (1927).
Fig. 11, Plate X.

Not common, isolated few times from soil and air. Colonies cottony, white at first becoming cream-grey later on; conidiophores branches verticillately or irregularly; vesicles globose to subglobose with terminal ones more verrucose and larger (24–55

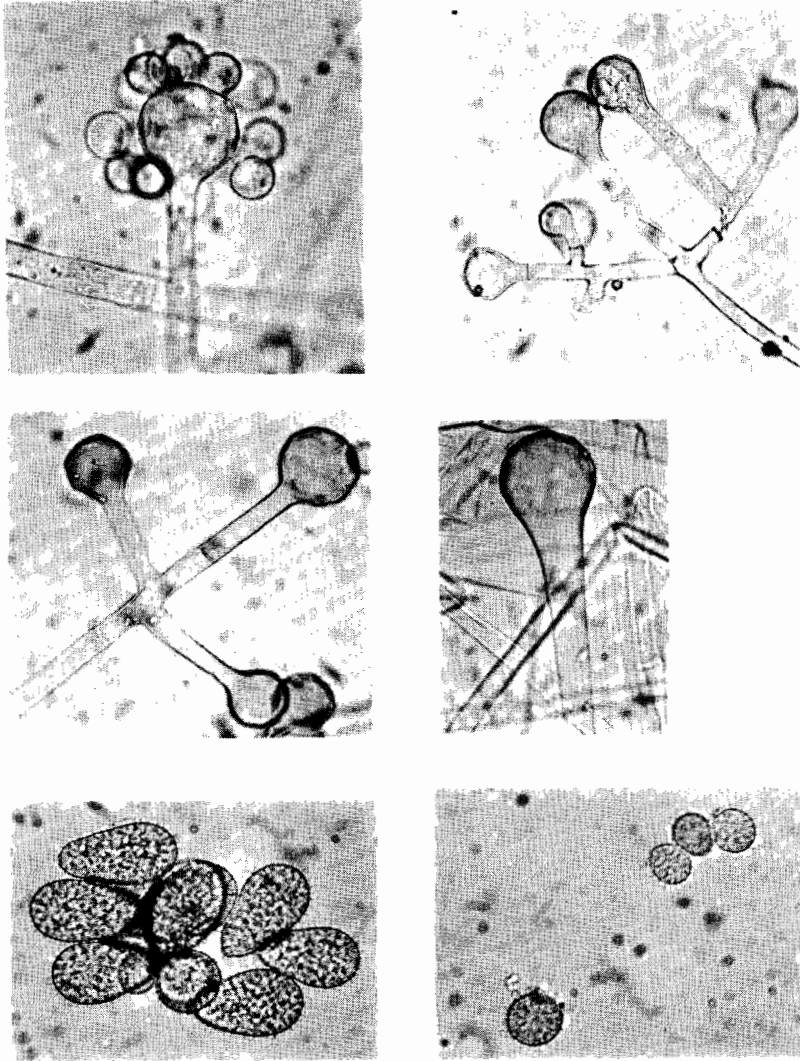


Plate X. *Cunninghamella elegans*, vesicle with developing conidia, mature-spiny conidia (= sporangioles).

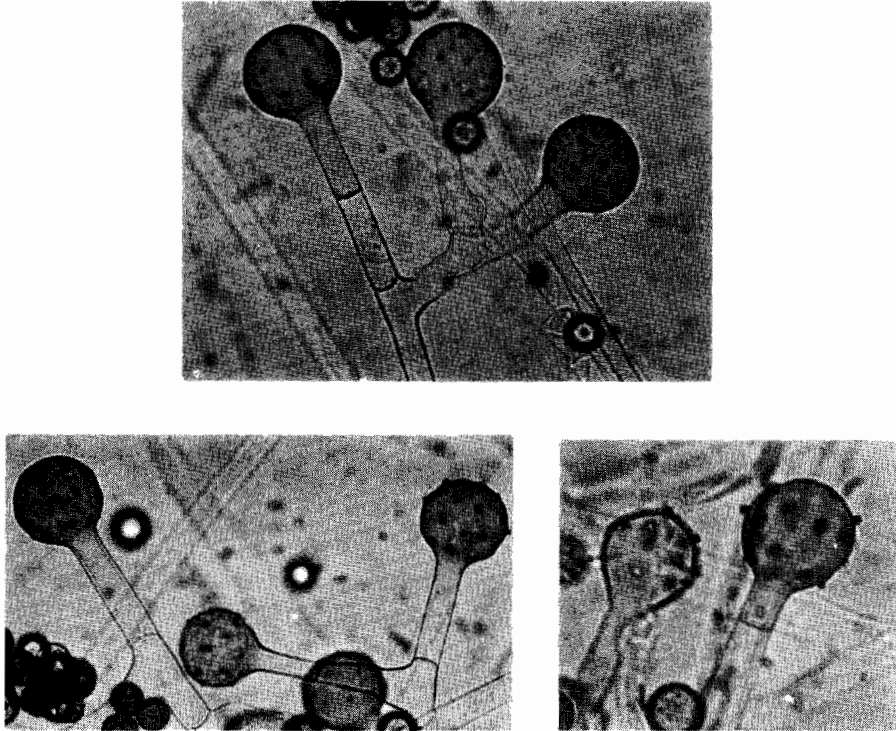


Plate XI. *Cunninghamella phaeospora*, dark-coloured vesicles with scars of conidial attachment.

μm in diameter) than the lateral vesicles (10–20 μm); conidia 1-celled, globose to subglobose, ellipsoidal, 8–18 μm in diameter, hyaline, with relatively long echinulations; heterothallic.

C. phaeospora Beodijn in Sydowia **12**: 348 (1958).

Fig. 11, Plate XI.

Not common, isolated few times from soil and air, thermotolerant (Moustafa *et al.* 1976), growing at temperatures up to 40°C. Colonies cottony, at first white becoming greyish to smoky; conidiophores branching irregularly or in cymose type, solitary branches are also common, vesicles globose to subglobose, brownish, verrucose, regularly with septa underneath, terminal vesicles larger (25–45 μm in diameter) than lateral ones (14–24 μm); conidia globose to subglobose, short echinulate, brownish, 10–18 μm in diameter; heterothallic.

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دراسات تصنيفية على فطريات الكويت
١ - الزيجموايسيتات

عبد الواحد فهميم مصطفى
قسم النبات بجامعة الكويت

في هذا البحث تم حصر ووصف عشرة أنواع مختلفة من الفطريات التابعة لفصيلة الزيجموايسيتات في الكويت ، وهذه الفطريات تم عزلها من مصادر مختلفة كالتربة والهواء . وحيث أن هذه الفطريات تابعة لعائلات وأجناس مختلفة فقد تم عمل المفاتيح اللازمة للتعرف عليها .