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PREFACE

Qatar occupies a peninsula which projects into the Arabian Gulf. It occupies approximately 10,600 km^2. The north-south axis is almost 180 km. in length and the east-west width, at its widest point in the central area, is 85 km. The peninsula of Qatar lies between 50° 45′ and 51° 40′ E longitude and 24° 40′ and 26° 10′ latitude.

According to Batanouny (1981) the landforms in Qatar include the following phyto-ecogeomorphological systems:

1) **Rocky and Conglomerates Hamadas:** This type of landform occupies the major area of Qatar, the ground surface is covered with stone fragments which are the produce of **in situ** weathering. The vegetation is usually poor.

2) **Rocky Ridges:** These are confined to south-west of the country. In this form the plant cover is also very poor.

3) **Depressions:** There are about 850 surface depressions which lie below the surrounding land surface at a depth ranging from a few meters to as 20 meters. There are two types of depressions: deep depressions, which are locally called 'Rodat', and shallow depressions, locally called 'Manga' (sing.), which lie just a few centimeters below the surrounding surface.

   The rodat range from a few hundred meters to 2 - 3 meters in diameter. During the rainy season, these depressions receive run-off water in addition to water-borne — and/or wind-borne materials. These depressions harbour denser vegetation compared to the surrounding elevated land and the dominant plant species vary among different depressions. The agricultural lands in Qatar are confined to this type of depressions, depending on underground water supplies. The number of farms varies from year to year, perhaps due to deterioration of water quantity and quality. In 1970 there were 250 farms occupying 0.17% of the total area of Qatar.

4) **Wadis and Runnels:** The wadis are relatively deep and log runnels which occur mainly in the south-west. The accumulated water and sediments are usually concentrated in the lower parts of the wadis. A marked feature in these wadis is the presence of fine sediments which crack after drying or have rolled solid crusts when thin.

5) **Sabkhas:** Sabkha is an Arabic term denoting inland or coastal saline flats with fine silt and calcareous sands. They are widespread along the coastal margins of Qatar. The soil is of high salt content and the water table is near soil surface. In some parts, the sabkhas may be inundated

by sea water during high tide. In the present text, the sabkhas are referred to as salt marshes.

6) **Sand Formations:** A considerable area of Qatar is covered by aeolian sands which overlie all other deposits. These aeolian sands occur in the form of thin sheets, small hummock, dunes, barkhan dunes or large dune fields.

Rainfall in Qatar

Rainfall in Qatar is scanty, as in other parts of the arid zone. It is confined to 8 months extending from October to May. The average annual rainfall in Doha is 78.1 mm. (17 years) (Batanouny, 1981).

INTRODUCTION

Soil fungi play a significant role in determining soil fertility. Many of them are plant pathogens. Several dermatophytes are soil inhabitants; hence, any study on soil fungi is much appreciated, especially if there is no precedent information.

The literature on soil fungi is voluminous and includes studies from many parts of the world.

In Arab countries, considerable attention has been paid to the fungus flora of soil during the last few decades. This coincided with the appearance of many useful systematic monographs on fungi which facilitate the task of today's soil mycologists to a great extent.

In Egypt, a pioneer study was carried out by Sabet (1935), who indentified 73 species belonging to 35 genera from 12 soil samples which were collected from different localities in Egypt. Ragab (1956) compiled a list of 16 fungal species which were isolated from soil and infected plants. Besada and Yusef (1968) surveyed fungi in various soil types and isolated 33 genera and 45 species. Moubasher and Moustafa (1970) studied soil fungi in agricultural and desert soils, with particular emphasis on *Aspergillus, Penicillium and Penicillium* - related genera. They isolated a total of 40 genera and 103 species and observed that several species were common in both types of soil. Moubasher and El-Dohlob (1970) and Moubasher and Abdel-Hafez (1978 b) reported that Eygptian soil fungi displayed seasonal periodicities with their total population flourishing in moderate temperature months and declining drastically during summer months. Salama *et al.* (1971) isolated 31 genera from sand dunes of the coastal areas of the Mediterranean and the most frequent were *Rhizopus, Aspergillus, Hormodendrum, Penicillium, Alternaria, Fusarium, Cephalosporium and Helminthosporium*. Moubasher *et al.* (1971) determined fungi in citrus plantations in Upper Egypt. They found that the fungus flora of five varieties of citrus was not specific but basically similar to that in other Egyptian cultivated soils. The basic components were *Aspergillus, Fusarium and Penicillium*. Moubasher and Mazen (1972) isolated 11 genera and 23 species of dematiaceous hyphomycetes and the dominant species were *Humicola grisea, Stachybotrys atra* and *Cladosporiun herbarum*. They stated that dematiaceous hyphomycetes were more commonly isolated from desert sandy soils than from cultivated clay soils, but the reverse was observed in case of Mucorales fungi (Moubasher, *et al.*, 1975). Abdel-Fattah (1973) made an extensive survey of desert soil fungi in Egypt and isolated 161 species; the most frequent were *A. fumigatus, A. niger, A. nidulans, P. notatum* and *P. chrysogenum*.

The fungal flora of Wadi-Hof was studied by Ali *et al.* (1975), who observed that *Penicillium* and *Aspergillus* were dominant in different habitats, followed by *Stemphylium, Alternaria, Cladosporium* and *Fusarium*. Moubasher and Abdel-Hafez (1978 a) identified 155 species in addition to 3 varieties of *A. nidulans*, which belong to 50 genera from 100 soil samples collected from different localities in Egypt and the most frequent species were *A. niger*, *A. fumigatus*, *A. terreus*, *Mucor racemosus*, *P. notatum*, *P. chrysogenum* and *A. flavus*. El-Magraby (1980) isolated 205 species, which belong to 51 genera, from Wadi-Bir-El-Ain near Sohag, Egypt; *Aspergillus* and *Penicillium* were the most prevalent and contributed the broadest spectra of species (40 species each). The genus *Fusarium* was intensively surveyed in Egyptian soils by Abdel-Hafez (1981), who found that *F. solani* was the most common species, followed by *F. oxysporum*.

In Iraq, Al-Doory *et al.* (1959) isolated 150 species, which belong to 41 genera from soil in central Iraq; the most frequent species were *A. niger*, *Fusarium moniliforme*, *Pythium ultimum*, *A. fumigatus*, *A. terreus*, *Fusarium poae* and *Hormiscium stilbosporum*. Around Basrah, Ismail and Abdullah (1977) recovered 37 species from 4 soil samples.

In Kuwait, Moustafa (1975) isolated 46 genera and 101 species from 40 soil samples, collected from salt marshes, and his results show that there is no fungal flora characteristic of saline soils. Moustafa and Al-Mussallam (1975) recovered 82 species and 44 genera from 40 composite soil samples, representing salt marshes, salt depressions and coastal sands. The soil mycoflora of the desert of Kuwait was investigated by Halwagy *et al.* (1982), who identified a total of 52 genera and 130 species; *Fusarium*, *Aspergillus*, *Penicillium*, *Stachybotrys*, *Myrothecium*, *Ulocladium*, *Phoma* and *Alternaria* were the most frequent genera.

In Saudi Arabia, Ali (1977) and Abdel-Hafez (1981, 1982 a, b) investigated soil fungi of desert and identified 24 genera and 47 species, and 34 genera and 80 species, respectively.

In Sudan, Nour (1956) made a preliminary survey of fungi from various soil types. He isolated 18 genera and 35 species; the most common species were *Rhizopus stolonifer*, *A. niger*, *A. nidulans*, *Curvularia lunata*, *Cladosporium sphaerospermum*, *A. terreus*, *Alternaria tenuis* and *Cladosporium cladosporioides*.

In Libya, Naim (1967) isolated 17 genera and about 44 species of fungi from soil in citrus fields. The most common genera were *Aspergillus*, *Penicillium*, *Alternaria* and *Hormodendrum*.

In Qatar no previous study has been carried out on soil fungi. The present study was designed to study intensively soil fungi and their distribution in various localities and habitats. For this purpose, 42 soil samples were collected and assayed for their fungal content and for some of their physical and chemical properties.

Comparison was also made between the soil fungal floras in Qatar and in the neighbouring Arab countries.

MATERIALS AND METHODS

Collection of Soil Samples

Forty-two soil samples were collected from different locations of the peninsula during March-April 1980, January 1981, 1982 (samples Nos. 1 - 25) and April 1982 (samples Nos. 26 - 42). Samples were taken from a depth of about 10 cm after removal of surface layer. At the same location, the sample was collected from at least three different sites, thoroughly mixed together and placed in a double layered polyethylene bag, which was tightened and stored in the laboratory at low temperature. Dilution plate method was carried out for the first 25 samples to determine mesophilic fungal content on three isolation media. Samples Nos. 26 - 42 were assayed for thermophilic fungal content by using Warcup's method. Locations of the former samples are illustrated in Fig. (1) and those of the latters are spotted in Fig. (2).

Locations and Description of Soil Samples

1) Al-Mibriz Private Farm, beside Al-Khor City Road, a depression land, cultivated mainly by *Medicago sativa.*

2) A depression on Dukhan Road, dominated by *Francoeuria crispa.*

3) From the same depression, but away from any plants.

4) Rodat Al-Faras Government Farm, under *Allium cepa.*

5) The same Farm as sample No. 4, under *Vitis vinifera.*

6) Salt marsh at Al-Khor, a fine sandy soil, saturated by sea water. This sample was from a lagoon area connected with the Gulf. The water table was about 2 cm deep near the soil surface and was exposed in some places. The dominant plant was *Salsola soda* which was inundated with sea water during high tides and also *Arthrocnemum glaucum* was present.

7) Slightly elevated zone, directly after the previous site, more saline, covered by *Salsola soda.*

8) The same zone as sample No. 7, but devoid of plants.

9) The same salt march, however, far from sea water but inundated by the water tide. The dominant plant was *Halocnemon strobiolaceum,* in masses form, surrounded by accumulations of small amounts of soil about 24 - 30 cm high, which was rich in organic matter and had a darker colour.

10) Private farm on Al-Shamal Road, under *Hibiscus esculentus.*

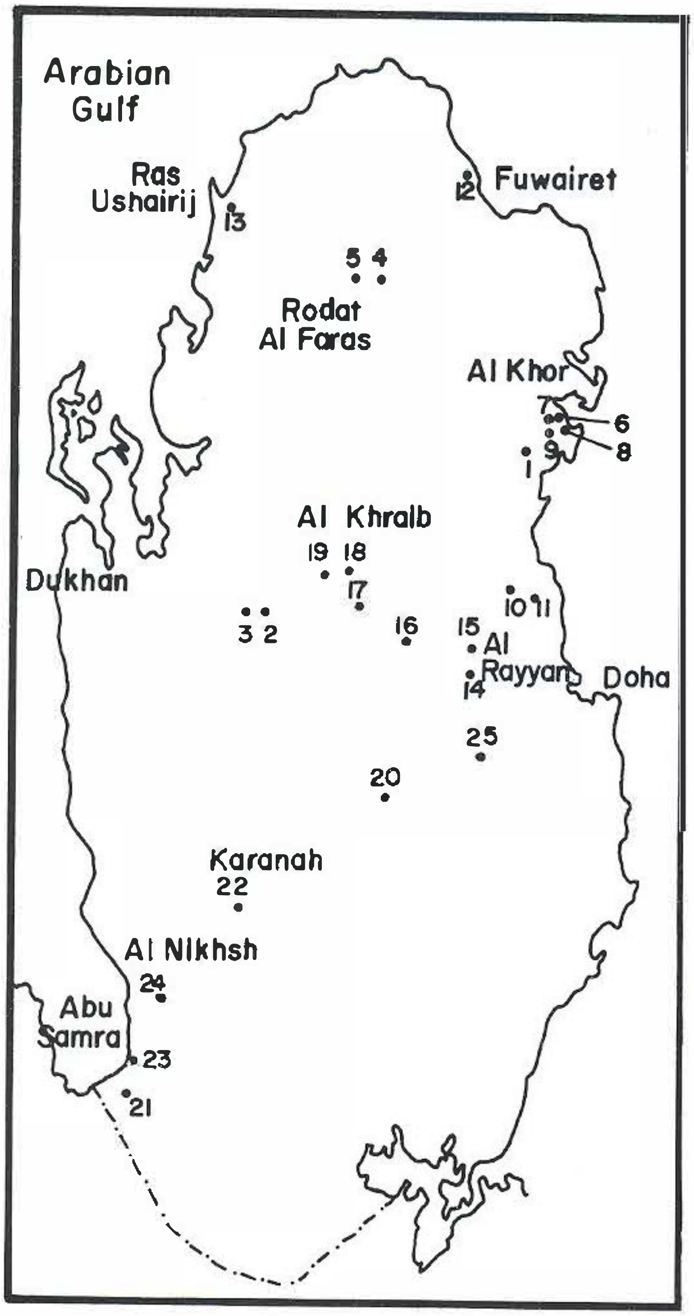

Fig. 1 : Localities of the samples Nos. 1 to 25

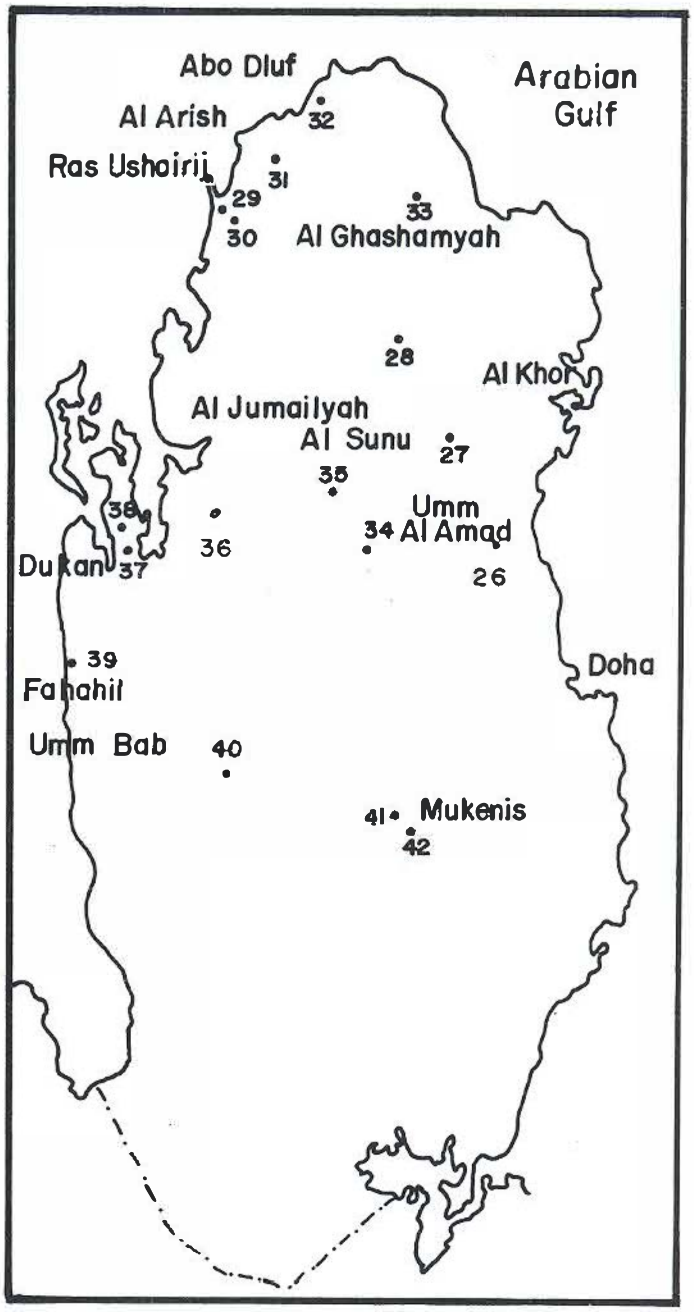

Fig. 2 : Localities of the samples Nos. 26 to 42

11) From the same Farm as sample No. 10, but under *Zea mays*.

12) Fuwairet Shore, sandy elevated soil accumulated around *Lolium sp*.

13) About 15 km from Ras Ushairij, a pure community of *Halocnemon strobiolaceum*; the area was polluted by oil from an undetermined time and tar crusts appeared frequently on the surface.

14) Private Farm on Rayyan Road, approximately 15 km from Doha City, under *Hordeum vulgare*.

15) From the same Farm as sample No. 14, but under *Medicago sativa*.

16) Experimental Government Farm on Rayyan Road, under *Cucurbita pepo*.

17) Private Farm beside Al-Shahaniyah Police Centre, under citrus trees.

18) Al-Khraib Farm, under tomato plants.

19) The same Farm as sample No. 18, but under *Brassica oleracea*.

20) Private farm near Umm El-Shubrum, under tomato plants.

21) Experimental Government Farm in Ubo-Samrah, under wheat plants.

22) A depression at Al-Karaanah, under *Ziziphus nummularia*.

23) Near Abu Samrah, beside the Gulf Shore, a pure community of *Halocnemon strobiolaceum*.

24) Al-Niksh, depression dominated by *Lycium shawii* and other plants surrounded by accumulated sand.

25) Al-Sielia Government Farm, under radish plants.

26) Umm Alamad on Al-Shamal Road, a depression dominated by *Rumex vesicarium, Lycium shawii, Acacia tortilis,* and *Stipa sp*.

27) Al-Jasmea Farm on Al-Shamal Road, under *Olea europaea*.

28) Depression behind Rodat Al-Faras, dominated by annuals, *Bromis sp., Filago spathiolata, Scrophularia desertii, Anagallis arvensis, Plantago minor, Trigonella sp.,* and *Helianthemum ellipticum* (Fig. 3).

29) On Ras-Ushairig Road, a pure community of *Halocnemon strobiolaceum* in an oil-polluted area which was tested for mesophilic fungi under sample No. 13.

Fig. 3: A depression behind Rodat Al-Faras, dominated by annuals.

Fig. 4: 4 Salt marsh in Abo-Dluf, a community of *Halopelis perfoliata*

30) From the same area as sample No. 29, but collected at a distance from the dominant plant.

31) From a desert location, near the Radio Transmission Station of Al-Arish, under a community of *Zygophyllum quatarense*.

32) Salt marsh in Abu Dluf, a community of *Halopopelis perfoliata* (Fig. 4).

33) A Private Farm near Al-Ghashamiyah, under *Phoenix dactylifera* (Fig. 5).

34) Near Al-Khraib, a depression dominated by annuals.

35) Al- Sunu Farm, under *Medicago sativa*.

36) Between Al-Jumailiyah and Dukhan, a depression dominated by annuals, *Glossenema edula, Acacia sp*. and others.

37) Near Bir Zekrit, a desert location dominated by *Zygophyllum quatarense*.

38) An area near that of sample No. 37, but devoid of any plants.

39) Sandy elevated area between Dukhan and Fahahil, dominated by Gramineae plants.

40) An area on the Umm Bab - Mukeinis Road, very poor in desert plants.

41) Mukeinis Farm, under *Cucurbita pepo.*

42) From thc same Farm as sample No. 41, soil rich in leaf debris.

Mechanical Soil Analysis

Soil classes were determined by using the hydrometer method and the textural triangle in Fig. (6).

Chemical Soil Analysis

Organic matter, calcium carbonate, anions (carbonate, bicarbonate, chloride, sulphate), cations (Ca, Mg, Na, K) and pH of the test soil samples were determined.

Determination of Soil Fungi

The dilution plate method was employed for the determination of mesophilic fungi and Warcup's method for thermophilic fungi. Six plates were employed for each soil sample, and for each isolation medium.

Fig. 5: A Private farm near Al-Ghashamiyah
cultivated by *Phoenix dactylifera*

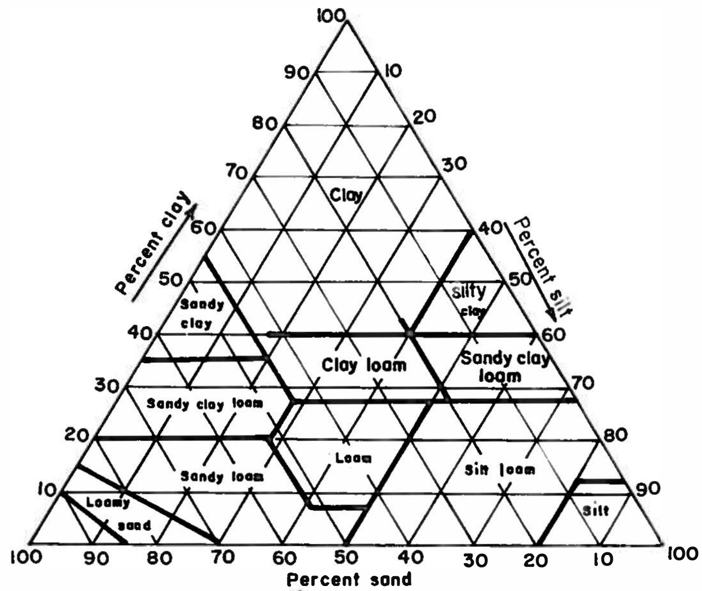

Fig. 6: Soil Triangle, a guide for textural classification

Isolation Media

1) **Glucose-Czapek's agar medium:** ($NaNo_3$: 2 gm; K_2Hpo_4: 1 gm; $MgSo_4$. $2H_2O$: 0.5 gm; Kcl: 0.5 gm; Glucose: 10 gm; Agar-agar: 15 gm; per 1 litre); Rose begnal (1/15000) as a bacteriostatic agent was added.

2) **50% - Czapek's agar:** The 10 gm glucose were replaced by 500 gm sucrose and the volume was brought to one litre.

3) **Cellulose-Czapek's agar:** The glucose was replaced by 30 gm cellulose.

Identification of Fungal Genera and Species

The following references were used for the identification of fungal genera and species:

1) Ames (1969), for *Chaetomium* species.

2) Barron (1968), for the genera of *Hyphomycetes*.

3) Barron *et al*. (1961), for *Microascus* species.

4) Booth (1971 and 1977), for *Fusarium* species.

5) Brown and Smith (1957), for *Paecilomyces* species.

6) Cooney and Emerson (1964), for thermophilic fungi.

7) De Vries (1952), for *Cladosporium* species.

8) Domsch *et al.* (1980), for soil fungal species in general.

9) Ellis (1971 and 1976), for *Dematiaceous hyphomycetes.*

10) Gams (1971), for *Acremonium* and *Verticillium* species.

11) Gilman (1957), for soil fungi in general.

12) Morton and Smith (1963), for *Scopulariopsis*, *Doratomyces* and *Microascus* species.

13) Onions and Barron (1967), monophialidic species of *Paecilomyces.*

14) Pitt (1979) for *Penicillium* species and its teleomorphs.

15) Ramirez (1982), for *Penicillium* species.

16) Raper and Fennell (1965), for *Aspergillus* species.

17) Raper and Thom (1949), for species of *Penicillium* and penicillium - related genera.

18) Simmons (1967), for *Alternaria, Stemphylium* and *Ulocladium* species.

19) Sutton (1980), for Coelomycetes.

20) Zycha *et al*. (1969), for Mucorales fungi.

For checking the identification of many fungi, the mycologists in C.M.I., England, and in C.B.S. Baarn, the Netherlands were consulted.

EXPERIMENTAL RESULTS

I — Soil Chemical Analysis

1) Organic matter content

The highest content of organic matter (4.057%) was determined in sample No. 42, which was collected from a private farm in Mukeinis; it was rich in leaf debris (Table 1). Samples No. 9 (2.959%), collected from Al-Khor salt marshes, and No. 25 (2.305%), collected from the government farm at Al-Sielia, were also rich in organic matter. Samples Nos. 7, 15, 16, 20, 27, 41 were of low content of organic matter (1.283%, 1.297%, 1.013%, 1.011%, 1.301%, 1.118% respectively), whereas the rest of the samples were poor in organic matter content, ranging from 0.072% to 0.927%.

In samples Nos. 3, 24, 36, 40 the organic matter content was nil; these samples were all desert soils.

2) Salinity

The E.C. values fluctuated between 0.94 to 245 millimho. The highest values were determined in samples No. 9 (245), No. 28 (311), No. 7 (178) and No. 13 (133), which were all collected from salt marshes, apart from No. 28, which was a desert soil.

3) Calcium carbonate content

The tested soil samples were generally high in their content of $CaCo_3$, indicating that these soil samples are of limestone origin. The values amounted to 95.05%, 89.232%, 88.47%, 79.48%, 77.346%, 72.715%, 71.606% in soil samples Nos. 32, 12, 8, 30, 7, 9 and 28 respectively. The least value (24.36%) was in soil sample No. 24, collected from a depression whose flora was dominated by *Lycium shawii*.

4) pH

The pH values did not show appreciable differences and lied in the alkaline side, ranging from 7.2 in sample No. 42, collected from Mukeinis farm, to 8.53 in sample No. 28, gathered from a depression dominated by annuals; this sample had also a high value of E.C.

II — Soil Mechanical Analysis

Results in Table (2) and Figure (6) reveal that the texture of soils examined could be classified into:

1) **Sandy clay loam:** Includes samples Nos. 1, 10, 11, 17, 18, 20, 33 and 35, which represent different cultivated soils, Nos. 26 and 28 which were gathered from depressions and samples Nos. 6, 8 and 13, which were all from salt marshes.

Table (1): Chemical analysis of the 42 soil samples revealing pH, electrical conductivity (E.C.) estimated in millimoh, organic matter content calculated as percentage of air dry soil and content of various anions and cations estimated as Meq./L.

Sample No.	PH	E.C.	O.M.	$CaCO_3$	CO_3	HCO_3	Cl	SO_4	Ca	Mg	Na	K
1	7.99	5.1	0.798	54.77	0.18	0.37	8.95	52.30	26.72	15.18	17	2.9
2, 3	7.61	2.5	—	36.72	0.37	1.75	3.41	17.27	18.24	2.26	2	0.3
4, 5	7.68	7.50	0.306	34.11	0.37	1.98	24.57	48.58	28.42	11.98	33	2.1
6	8.17	0.94	0.519	46.18	1.38	1.52	3.41	1.91	5.51	1.41	1	0.2
7	8.33	178	1.283	77.346	—	5.1	1562.2	130.3	110.3	2263	1330	31
8	8.39	70	0.779	88.47	—	3.23	706.55	87.41	71.05	82.14	630	14
9	8.3	245	2.959	72.715	—	14.0	2343.5	46.37	159	339.87	1800	45
10	8.09	16	0.388	53.37	0.18	2.63	99.41	79.87	35.63	24.26	117	5.2
11	7.67	8.2	0.388	59.01	0.46	2.58	14.2	73.32	45.17	17.69	23	4.7
12	7.89	10.5	0.098	89.233	—	4.52	80.24	16.63	16.97	18.02	62	4.4
13	8.26	133	0.761	87.22	—	4.61	1104.21	1611.25	69.99	178.07	1000	22
14	8.3	14.5	0.893	43.34	0.46	2.58	98.7	55.56	37.11	30.09	88	2.1
15	8.06	9.1	1.297	42.32	1.57	3.97	46.44	47.04	31.6	17.62	48	1.8
16	7.63	3.8	1.013	41.26	1.11	5.86	7.39	27.27	25.66	5.57	9	1.4
17	7.86	4	0.103	34.76	0.18	1.34	8.24	39.31	25.45	12.22	10	1.4
18	7.76	4.6	0.201	42.25	0.41	3.18	11.36	37.38	22.06	16.62	12	1.7
19	7.95	1.9	0.120	51.20	0.37	3.18	6.82	9.55	6.89	5.53	7	0.5
20	8.19	19.6	1.011	42.88	0.46	3.37	128.53	76.09	36.9	45.35	121	5.2
21	7.76	3.85	0.399	59.84	0.46	2.63	8.38	36.09	29.48	7.78	10	0.3
22	7.45	3.8	0.127	33.38	1.75	5.07	10.94	24.88	28.84	6.38	6	1.4
23	7.25	4.95	0.678	63.90	0.46	4.38	17.47	37.87	26.72	17.66	14	1.8
24	7.83	72.5	—	24.63	—	5.53	733.53	89.78	44.54	97.30	670	20
25	7.54	7.35	2.303	50.09	1.66	6.96	25.56	51.79	29.69	22.23	32	2
26	8.02	1.0	0.319	47.75	0.37	1.84	1.63	5.60	6.57	1.57	1	0.3
27	7.93	2.5	1.301	37.41	1.01	3.32	10.08	9.76	9.33	5.94	8	0.9
28	8.53	311	0.927	71.606	—	3.69	2683.1	239.15	80.58	445.36	2.350	50
29	8.17	72	0.584	69.48	—	3.7	720.80	86.80	65.7	119.60	610	17
30	8.37	98	0.656	79.48	—	5.1	1008.3	139.8	72.1	107.10	950	24
31	7.95	5.7	0.524	70.62	0.37	1.80	27.41	33.88	31.92	11.24	19	1.3
32	8.27	12.6	0.346	95.05	0.37	1.29	81.52	49.39	9.59	22.78	97	3.2
33	8.13	31.5	0.961	58.76	0.55	2.44	264.87	68.22	45.71	79.67	199	11.7
34	7.81	2.2	0.370	45.07	1.20	2.81	2.41	20.03	20.82	3.03	2	0.6
35	8.29	1.6	0.308	42.70	1.57	3.46	4.69	5.97	5.99	4.67	4	1.1
36	7.64	2.98	—	38.44	1.48	2.40	5.68	26.79	22.86	8.09	4	1.4
37	7.83	8.7	0.122	59.03	1.48	4.34	9.52	70.51	22.86	31.09	28	3.9
38	7.73	34.0	0.198	63.55	0.46	1.87	269.84	71.28	47.46	45.49	240	10
39	7.64	2.6	0.072	45.30	0.65	1.25	2.27	29.87	28.16	3.18	2	0.7
40	7.76	2.65	—	29.37	0.92	1.84	2.41	29.29	26.33	5.23	2	0.9
41	7.81	7.1	1.118	57.88	2.49	3.87	14.49	43.14	27.75	17.44	17	1.8
42	7.2	79.8	4.057	46.56	4.98	10.88	749.16	43.89	67.35	249.56	460	32.0

Table (2): Soil texture of the 42 soil samples tested as revealed from the percentage content of clay, silt and sand.

Sample No.	Clay	Silt	Sand	Soil Texture
1	32.88	24	43.12	Sandy clay loam
2, 3	4.44	5	90.56	Sandy
4, 5	46.88	18	35.12	Clay
6	22.88	16	61.12	Sandy clay loam
7	36.88	24	39.12	Clay loam
8	22.88	10	67.12	Sandy clay loam
9	42.88	28	29.12	Clay
10	28.88	22	49.12	Sandy clay loam
11	24.88	16	57.12	Sandy clay loam
12	3.44	2	94.12	Sandy
13	22.88	12	65.12	Sandy clay loam
14	6.88	24	69.12	Sandy loam
15	14.88	10	75.12	Sandy loam
16	16.88	10	73.12	Sandy loam
17	32.88	10	57.12	Sandy clay loam
18	30.88	16	53.12	Sandy clay loam
19	16.88	14	69.12	Sandy loam
20	26.88	24	49.12	Sandy clay loam
21	5.44	1	93.56	Sandy
22	4.44	2	93.56	Sandy
23	6.52	4.8	88.68	Sandy
24	5.52	3.8	90.68	Sandy
25	15.04	13.6	71.36	Sandy
26	25.04	19.6	55.36	Sandy
27	35.04	20.32	44.66	Loam
28	21.04	8.32	70.64	Sandy clay loam
29	13.04	8.32	78.64	Sandy loam
30	17.04	10.32	72.64	Sandy loam
31	7.76	18.32	73.92	Sandy loam
32	5.88	3.16	90.96	Sandy
33	25.76	22.32	51.92	Sandy clay loam
34	11.76	6.32	81.92	Loamy sand
35	24.48	21.04	54.48	Sandy clay loam
36	5.24	3.52	91.24	Sandy
37	6.24	3.52	90.24	Sandy
38	6.88	5.88	87.24	Sandy
39	3.88	4.6	91.52	Sandy

Table, 2 (contd.)

40	9.76	9.2	81.04	Loamy sandy
41	27.92	9.76	62.32	Sandy loam
42	27.76	27.92	44.32	Clay loam

2) **Sandy loam:** Includes samples Nos. 14, 15, 16, 19 and 41 from different cultivated soils, samples Nos. 29 and 30 from salt marshes and sample No. 31 from a desert site.

3) **Loamy sand:** Includes samples Nos. 34 and 40 which were collected from desert sites.

4) **Loam:** Includes sample No. 27, from a cultivated land under *Olea europaea*.

5) **Sandy:** Includes samples Nos. 3, 12, 22, 24, 36, 37, 38 and 39, which were gathered from different desert sites, Nos. 23 and 32 collected from salt marshes, and No. 21 from cultivated soil in the Government Experimental Farm in Abu Samrah.

6) **Clay loam:** Represented by sample No. 7 which was collected from Al-Khor salt marsh.

7) **Clay:** Includes samples Nos. 4 and 5 collected from the Government Farm in Rodat Al-Faras and sample No. 9 from an area beside Al-Khor shore.

III — List of all Fungi Recovered in the Present Investigation

Aspergillus amstelodami (Mong.) Thom and Raper

A. awamori Nakazawa

A. carneus (Van Tieghem) Blochwitz

A. clavato-nanica Batista, Maia and Alecrim

A. egyptiacus Moubasher and Moustafa

A. fisheri var. *spinosus* Raper and Fennell

A. flavus (Link) Fresenius

A. fumigatus Fresenius

A. glaucus group

A. japonicus Saito

A. nidulans group

A. nidulans (Eidam) Winter

A. nidulans var. *acristatus* Fennell and Raper

A. nidulans var. *dentatus* Sandhu and Sandhu

A. nidulans var. *echinulatus* Fennell and Raper

A. niger Van Tieghem

A. niveus Blochwitz

A. ochraceus group

A. ochraceus Wilhelm

A. quadrilineatus Thom and Raper

A. rugulosus Thom and Raper

A. subsessilis Raper and Fennell

A. sydowii (Bainier and Sartory) Thom and Church

A. tamarii Kita

A. terreus Thom

A. terreus var. *africanus* Fennell and Raper

A. ustus (Bainier) Thom and Church

A. versicolor (Vuillemin) Tiraboschi

A. violaceus Fennell and Raper

A. viride-nutans Ducker and Thrower

A. wentii Wehmer

Penicillium brevicompactum Dierckx

P. canescens Sopp

P. chrysogenum Thom

P. citrinum Thom

P. corylophilum Dierckx

P. cyclopium Westling

P. funiculosum Thom

P. jenseni Zaleski

P. lanosum Westling

P. lavendulum Raper and Fennell

P. luteum series

P. notatum Westling

P. oxalicum Currie and Thom

P. purpurogenum Stoll

P. stoloniferum Thom

P. vinaceum Gilman

Absidia corymbifera (Cohn) Saccardo and Trotter

Acremonium humicola (Onions and Barron) Gams

A. roseo-griseum (Saksena) Gams

A. roseolum (Oud.) Gams

A. roseum (Oud.) Gams

A. strictum Gams

Alternaria alternata (Fries.) Keissler

A. chlamydospora Mouchacca

A. phragmospora Van Emden

A. mouchaccae Simmons

A. tenuissima (Kunze ex Pers.) Wiltshire

Arthrobotrys oligospora Fresenius

Ascotricha chartarum Berkeley

Beauveria alba (Limber) Saccardo

Botryodiplodia theobromae Patouillard

Botryotrichum atrogriseum Van Beyma

B. piluliferum Saccardo and Marchal

Camarosporium capparidis Ahmad

Chaetomium globosum Kunz

C. olivaceum Cooke and Ellis

Cladosporium cladosporioides (Fresenius) de Vries

C. elatum (harz), Nannfeldt

C. herbarum (Persoon) Link

C. oxysporum Berkeley and Curtis

C. sphaerospermum Penzig

C. tenuissimum Cooke

Coniothyrium fuckelii Saccardo

C. orulosum

Cunninghamella echinulata Thaxter

C. elegans Lendner

Curvularia lunata (Wakker) Boedijn

Cylindrocarpon candidum (Link) Wollenweber

C. congoense Meyer

Drechslera australiensis (Bugnicourt) Subramanian and Jain

D. halodes (Drechsler) Subramanian and Jain

D. hawaiiensis Ellis

D. dematioidea (Bubak and Wroblewski) Subramanian and Jain

Fusarium acuminatum Ellis and Everhart

F. equiseti (Corda) Saccardo

F. fusarioides (Fragoso and Ciferri) Booth

F. heterosporum Nees

F. lateritium Nees

F. moniliforme var. *subglutinans* Wollenweber and Reinking

F. oxysporum Schlechtendahl

F. semitectum Berkeley and Ravenel

F. solani (Martius) Saccardo

F. sulphureum Schlechtendahl

Gliocladium roseum, Bainier

Gymnoascus zuffianus

Histoplasma sp.

Humicola fusco-atra Traaen

Humicola grisea Traaen

H. insolens Conney and Emerson

Macrophomina phaseolina (Tassi) Goidanich

Malbranchea pulchella var. *sulfurea* (Miehe) Cooney and Emerson

Metarrhizium anisopliae (Metschnikoff) Sorokin

Microascus desmosporus (Lechmere) Curzi

M. manginii (Loubiere) Curzi

M. niger (Sopp.) Curzi

M. trigonosporus Emmons and Dodge

Monodictys castaneae (Wallroth) Hughes

Mortierella sp.

Mucor fuscus Bainier

Mucor hiemalis Wehmer

Mucor racemosus series

M. racemosus Fresenius

Myriococcum albomyces Cooney and Emerson

Myrothecium roridum Tode

M. verrucaria (Albertini and Schweinitz) Ditmar

Paecilomyces griseoviridis Onions and Barron

P. variotii Bainier

Papularia sp.

Phoma eupyrena Saccardo

P. exigua Desmazieres

P. herbarum Westendorp

P. leveillei Boerema and Bollen

P. multipora Pawar, Mathur and Thirumalachar

P. pomorum Thom

P. sorghina (Saccardo) Boerema, Dorenbosch and Van Kesteren

Phoma multirostrata (Mathur, Menon and Thirumalachar) Dorenbosch and Boerema

Pyrenochaeta sp.

Rhizoctonia solani Kühn

Rhizopus arrhizus Fischer

R. nigricans Ehrenberg

R. oryzae Went and Prinsen Geerligs

Scolecobasidium variabile Barron and Busch

Scopulariopsis brevicaulis (Saccardo) Bainier

S. brumptii Salvanet-Duval

S. candida (Gueguen) Vuillemin

S. carbonaria Morton and Smith

S. sphaerospora Zach

Sepedonium chrysospermum (Bull.) Fries

Sporotrichum roseolum Oudemans and Bijerinck

Stachybotrys atra var. *microspora* Mathur and Sankhla

Stemphylium bortyosum Wallroth

S. consortiale (Thumen) Groves and Stolko

S. lycopersici (Engjoji) Yamamoto

S. vesicarium (Wallr.) Simmons

Thermoascus aurantiacus Miehe

Thermomyces languinosus Tsiklinsky

Torula herbarum (Persoon) Link

Trichocladium canadens Huges

Trichoderma sp.

Trimmatostroma sp.

Tritirachium album Limber

Ulocladium atrum Preuss

U. botrytis Preuss

U. chartarum (Preuss) Simmons

U. tuberculatum Simmons

Verticillium lamellicola (Smith) Gams

IV — Determination of Fungal Content of the Soil Samples

According to the dilution plate method, the soil samples were serially diluted until an appropriate dilution was reached, which supported a reasonable number of colonies per plate. The dilution 1 : 2000 was employed in ten samples, 1 : 1000 in four samples, 1 : 500 in seven samples, 1 : 200 in two samples and the least dilution of 1 : 100 was also used in two samples (Table 3).

1) Total count of fungi

(i) On glucose-Czapek's agar

The richest soil sample in the total count was found to be No. 16, which contributed 66.3 colonies/mgm of dry soil (Tables 4 and 5). This soil was abnormally rich in *A. nidulans* group, especially *A. quadrilineatus*. It also contributed the third broadest spectrum of species (20 spp.) and was collected from the Government Experimental Farm on Rayyan Road from a plot cultivated with *Cucurbita pepo*. The second richest sample was No. 11, which was collected from a private farm on Al-Shamal road from a plot cultivated with *Zea mays*. It yielded 56.34 colonies/mgm of dry soil and fifteen species. The poorest soil sample was No. 23; it gave 0.19 colonies/mgm of soil and contributed four species. This samples was collected from a desert site. Soil samples Nos. 7 and 19 were also poor in their fungal content; the latter was collected from a cultivated soil and both samples yielded narrow spectra of species (2 an 3 spp., respectively). The range of species did not always follow the total count of fungi (table 5). For instance, the broadest range of twenty-nine species was recovered from sample No. 24, yielding 10.19 colonies/mgm of dry soil, which was not the richest in total count. The same conclusion was also right with sample No. 16, as mentioned before. But generally, the soil samples, which were rich in fungal content, were also high in their species content.

Table (3) : The diluation values which were employed in the 25 soil samples.

Sample No.	Dilution
1	1 : 1000
2	1 : 500
3	1 : 500
4	1 : 2000
5	1 : 2000
6	1 : 500
7	1 : 500
8	1 : 500
9	1 : 500
10	1 : 1000
11	1 : 1000
12	1 : 100
13	1 : 100
14	1 : 2000
15	1 : 2000
16	1 : 2000
17	1 : 2000
18	1 : 2000
19	1 : 2000
20	1 : 2000
21	1 : 2000
22	1 : 500
23	1 : 200
24	1 : 200
25	1 : 1000

Table (4) : Total and percentage counts and percentage frequency of occurrence of fungal genera and species recovered in the 25 soil samples, on glucose-Czapek's agar, incubated at 28°C (counts per mgm dry soil in every sample).

Species	Total count	%T	%F	O.R.
Aspergillus	100.66	26.75	76	H
A. terreus	10.8	2.87	48	M
A. flavus	21.24	5.64	36	M
A. versicolor	6.97	1.85	32	M
A. niger	2.4	0.64	20	L
A. egyptiacus	7.28	1.93	16	L
A. fumigatus	5.88	1.26	12	R
A. carneus	1.23	0.33	12	R
A. nidulans	10.66	2.83	8	R
A. flavus series	1	0.27	8	R
A. sydowi	0.36	0.19	8	R
A. quadrilineatus	19	5.05	4	R
A. nidulans var. *echinulatus*	6	1.59	4	R
A. nidulans group	4.33	1.15	4	R
A. fischeri var. *spinosus*	0.33	0.09	4	R
A. terreus var. *africanus*	0.33	0.09	4	R
A. niveus	0.33	0.09	4	R
A. violaceus	0.33	0.09	4	R
A. japonicus	0.33	0.09	4	R
A. rugulosus	0.33	0.09	4	R
A. awamori	0.23	0.06	4	R
A. ustus	0.17	0.05	4	R
A. viride-nutans	0.1	0.03	4	R
A. amstelodami	0.17	0.05	4	R
Aspergillus spp.	0.86	0.23	16	L
Cladosporium	15.27	4.06	64	H
C. cladosporioides	5.99	1.59	44	M
C. sphaerospermum	8.45	2.25	36	M
Cladosporium spp.	0.83	0.22	12	R
Fusarium	86.64	23.02	60	H
F. solani	64.33	17.09	56	H
F. oxysporum	8.99	2.39	36	M
F. equiseti	4.69	1.25	32	M
F. semitectum	0.99	0.26	16	L
F. fusarioides	0.66	0.18	8	R
F. acuminatum	0.58	0.15	8	R

Table, 4 (contd.)

F. lateritium	0.33	0.09	4	R
F. sulphureum	1	0.27	4	R
F. moniliforme var. *subglutinans*	0. 5	0.13	4	R
Fusarium spp.	4.57	1.21	36	M
Stadhybotrys atra var. *microspora*	19.02	5.05	56	H
Acremonium	45.78	12.16	44	M
A. strictum	43.28	11.5	32	M
Acremonium spp.	2.5	0.66	20	L
Penicillium	9.51	2.53	36	M
P. corylophilum	1.16	0.31	16	L
P. chrysogenum	1.76	0.47	12	R
P. brevi-compactum	4.16	1.11	8	R
P. oxalicum	0.83	0.22	4	R
P. luteum series	0.33	0.09	4	R
P. jensenii	0.08	0.02	4	R
P. purpurogenum	0.33	0.09	4	R
Penicillium spp.	0.86	0.23	8	R
Botryotrichum	7.16	1.90	36	M
B. piluliferum	5.25	1.40	24	L
B. atrogriseum	0.08	0.02	4	R
Botryotrichum spp.	1.83	0.49	12	R
Alternatia	10.57	2.78	24	L
A. alternata	9.09	2.42	20	L
I. chlamydospora	0.58	0.15	4	R
A. phragmospora	0.33	0.09	4	R
A. mouchaccae	0.08	0.02	4	R
Alternaria spp.	0.49	0.13	12	R
Scopulariopsis	4.38	1.16	28	M
S. brumptli	1.72	0.46	20	L
S. brevicaulis	2.33	0.62	12	R
S. sphaerospora	0.33	0.09	4	R
Myrothecium	5.33	1.42	24	L
M. verrucaria	4	1.06	16	L
M. roridum	1.33	0.35	12	R
Humicola	3.99	1.06	24	L
H. fuscoatra	3.39	0.09	12	R
H. grisea	0.43	0.11	8	R
Humicola spp.	0.17	0.05	4	R
Phoma	2.61	0.69	20	L
P. sorghina	0.15	0.04	8	R
P. herbarum	0.33	0.09	4	R
P. multirosrata	0.1	0.03	4	R

Table, 4 (contd.)

Phoma spp.	2.03	0.54	16	L
Torula herbarum	0.33	0.09	4	R
Mucor	38.34	10.19	20	L
M. racemosus	12.34	3.27	16	L
M. hiemalis	16.67	4.43	4	R
M. racemosus series	9.33	2.48	4	R
Microascus	0.45	0.12	16	L
M. manginii	0.19	0.05	12	R
M. trigonosporus	0.19	0.05	8	R
Microascus spp.	0.07	0.02	4	R
Ulocladium	1.11	0.03	12	R
U. tuberculatum	0.36	0.1	8	R
U. atrum	0.42	0.11	4	R
Ulocladium spp.	0.33	0.09	4	R
Rhizopus	2.99	0.79	12	R
R. oryzae	2.66	0.71	8	R
R. nigricans	0.33	0.09	4	R
Macrophomina phaseolina	0.24	0.06	8	R
Paecilomyces variotii	1	0.27	8	R
Scolecobasidium variabile	1.66	0.44	8	R
Trichocladium canadense	0.66	0.18	8	R
Camarosporium capparidis	0.06	0.02	8	R
Stemphylium	1.34	0.36	8	R
S. botryosum	0.67	0.18	4	R
S. consortiale	0.67	0.18	4	R
Coniothyrium	0.25	0.07	8	R
C. fuckelii	0.17	0.05	4	R
C. sp.	0.08	0.02	4	R
Cylindrocarpon	0.83	0.22	8	R
C. Congoense	0.33	0.09	4	R
Clyindrocarpon spp.	0.5	0.13	4	R
Cunninghamella	0.36	0.1	8	R
C. echinulata	0.33	0.09	4	R
C. elegans	0.03	0.008	4	R
Drechslera	0.36	0.1	8	R
D. hawaiiensis	0.03	0.008	4	R
D. halodes	0.33	0.09	4	R
Chaetomium globosum	0.3	0.08	4	R
Gliocladium roseum	1.33	0.35	4	R
Verticillium lamellicola	0.33	0.09	4	R
Tritirachium album	0.75	0.02	4	R
Sepedonium chrysospermum	0.33	0.09	4	R

Table, 4 (contd.)

Botryotrichum-like	0.1	0.03	4	R
Papularia	0.03	0.008	4	R
Mortierella	0.5	0.13	4	R
Unidentified	4.53	1.20	60	H
Sterile mycelium	7.1	1.89	44	M

% T = Percentage total count calculated to the gross total of all fungi.

% F = Percentage frequency of occurrence calculated to the 25 soil samples.

O.R. = Occurrence remarks:

H: high frequency; more than 49% of the samples.

M: moderate frequency; between 25 - 50% of the samples.

L: low frequency; between 13 - 24% of the samples.

R: rare frequency; less than 13% of the samples.

Table (5): Total count and number of fungal species in each sample, recovered on glucose-Czapek's agar, incubated at 28°C (count per mgm dry soil).

Sample No.	Total count	No. of Species
1	16.17	15 + 2 species variety
2	22.99	16 + 1 species variety
3	3.99	4
4	7.97	13 + 3 species variety
5	44.97	17 + 1 species variety
6	0.57	2 + 1 species variety
7	1.34	2
8	3.16	2
9	2.66	1
10	2.17	5
11	56.34	14 + 1 species variety
12	2.22	8 + 1 species variety
13	—	—
14	15.16	5
15	14.99	9 + 1 species variety
16	66.3	19 + 1 species variety
17	3.32	6 + 1 species variety
18	30.65	19 + 1 species variety
19	2.65	3
20	21.9	12 + 1 species variety
21	25.41	10 + 1 species variety
22	1.71	7
23	0.19	4
24	10.19	28 + 1 species variety
25	18.50	13 + 1 species variety
	375.52	**Gross total count**

(ii) On 50% sucrose-Czapek's agar

The highest fungal content was also estimated in soil sample No.16, which reached 69.65% colonies/mgm of dry soil and also gave a broad spectrum of species (twenty-one species) (Tables 6 and 7). In sample No. 20, the total count was as high as 45.63 colonies/mgm of soil and donated the widest spectrum of 28 species. In soil sample No. 5, the total count was 39.64 colonies/mgm of dry soil and the spectrum was twenty species. These three samples were from cultivated localities. The lowest total count was also in sample No. 23 with a spectrum of two species. The narrowest spectrum was also of two species and was found in samples Nos. 7 and 8 with total counts of 1.08 and 2.91 colonies/mgm of dry soil, respectively. Sample No. 13 was completely free from fungi, not only on this medium but also on the other two media. This sample was gathered from a site near the sea shore that was polluted with crude oil, precipitated inshore by water currents from undetermined time. Crusts of tar, covering vast areas of the sampling site, were easily noticed. This observation is very interesting as it suggests that soil pollution with crude oil drastically affects the fungal inhabitants of soil.

(iii) On cellulose-Czapek's agar

The highest total count was estimated in soil sample No. 20 with 99.31 colonies/mgm of dry soil but the range of species was not the highest (nineteen species only) (Tables 8 and 9). The highest species spectrum was recorded in sample No. 24 contributing thirty-one species. The second sample in total count was No. 21 with 28.32 colonies/mgm of dry soil and with only a moderate number of eleven species. Sample No. 16 had a moderate value of total count (28.64 colonies/mgm of dry soil), but yielded a comparatively high number of eleven species. The poorest sample was No. 8 from which 0.083 colonies/mgm of dry soil were recorded and only one species.

(iv) Comparison between the three isolation media

The highest total count of all fungi in this investigation (384.44 colonies/mgm dry soil in twenty-five samples) was determined on 50% sucrose agar, represented by thirty-five genera with ninety-three species and three species varieties (Table 7).

The lowest gross total count (283.299 colonies/mgm in twenty-five soil samples) was recorded on cellulose-Czapek's agar with thirty-seven identified genera and eighty species and five species varieties (Table 9).

On glucose-Czapek's agar, the gross total count was 376.36 colonies with thirty-four genera and 79 species and 5 species varieties (Table 5).

Thus, on cellulose agar, although it supported the lowest gross total count, the spectra of genera and species were wider than those on glucose agar and the broadest spectrum of species was encountered on 50% sucrose agar. This could be due to the

Table (6) : Total and percentage counts and percentage frequency of occurrence of fungal genera and species recovered in the 25 soil samples, on 50% sucrose-Czapek's agar, incubated at 28°C (counts per mgm dry soil in every sample).

Species	Total count	%T	%F	O.R.
Aspergillus	148.51	38.63	80	H
A. flavus	23.7	6.17	48	M
A. versicolor	20.58	5.35	48	M
A. amstelodami	19.49	9.07	36	M
A. terreus	15.24	3.96	36	M
A. egyptiacus	7.04	1.83	32	M
A. nidulans group	11.69	3.04	20	L
A. sydowi	0.64	0.17	20	L
A. quadrilineatus	14.17	3.69	12	R
A. niger	4.5	1.17	12	R
A. ochraceus	3.74	0.97	12	R
A. ustus	1.5	0.39	12	R
A. carneus	1.17	0.30	12	R
A. fumigatus	1.88	0.49	12	R
A. nidulans	16.66	4.33	8	R
A. tamarii	1.0	0.26	8	R
A. nidulans var. *echinulatus*	2.67	0.7	4	R
A. nidulans var. *dentatus*	0.33	0.09	4	R
A. flavus series	0.33	0.09	4	R
A. clavato-nanica	0.33	0.09	4	R
A. subsessilis	0.33	0.09	4	R
A. awamori	0.07	0.02	4	R
A. viride-nutans	0.07	0.02	4	R
A. wentii	0.03	0.008	4	R
A. glaucus group	0.02	0.005	4	R
Aspergillus spp.	1.33	0.35	8	R
Cladosporium	38.62	10.05	68	H
C. sphaerospermum	28.75	7.48	56	H
C. cladosporioides	8.29	2.16	44	M
C. herbarum	0.08	0.02	4	R
C. oxysporum	0.33	0.09	4	R
C. tenuissimum	0.67	0.17	4	R
Cladosporium spp.	0.5	0.13	8	R
Penicillium	14.53	3.78	56	H
P. chrysogenum	3.67	0.96	12	R
P. funiculosum	0.99	0.26	12	R

Table, 6 (contd.)

P. brevi-compactum	3.66	0.95	12	R
P. corylophilum	1.83	0.48	8	R
P. jensenii	0.12	0.03	8	R
P. luteum series	0.07	0.02	4	R
P. cyclopium	0.33	0.09	4	R
P. notatum	0.17	0.04	4	R
P. vinaceum	0.33	0.09	4	R
P. lanosum	0.67	0.17	4	R
P. canescens	0.33	0.09	4	R
P. citrinum	0.33	0.09	4	R
P. lavendulum	0.03	0.008	4	R
Penicillium forming cleistothecia	0.33	0.09	4	R
Penicillium spp.	1.67	0.43	12	R
Fusarium	54.63	14.42	56	H
F. solani	39.52	10.3	36	M
F. oxysporum	2.67	0.7	20	L
F. equiseti	2.68	0.7	16	L
F. semitectum	2.99	0.77	12	R
F. fusarioides	1.08	0.28	8	R
F. acuminatum	0.66	0.17	8	R
F. lateritium	0.67	0.17	4	R
F. sulphureum	0.33	0.09	4	R
F. heterosporum	0.17	0.04	4	R
Fusarium spp.	3.86	1.0	24	L
Acremonium	15.39	3.74	44	M
A. strictum	11.74	3.05	32	M
A. roseum	1.33	0.09	4	R
A. humicola	0.33	0.09	4	R
Acremonium spp.	1.99	0.52	16	L
Scopulariopsis	9.29	2.42	40	M
S. brumptii	7.09	1.84	36	M
S. brevicaulis	3.67	0.95	4	R
S. sphaerospora	1.33	0.35	4	R
S. carbonaria	0.17	0.04	4	R
S. candida	0.03	0.008	4	R
Botryotrichum	5.3	1.38	24	L
B. piluliferum	5.23	1.36	24	L
B. atrogriseum	0.07	0.02	4	R
Alternaia	2.33	2.73	24	L
A. chlamydospora	1.67	0.43	16	L
A. tenuissima	0.17	0.04	4	R
Alternatia spp.	0.49	0.13	12	R

Table, 6 (contd.)

Mucor	36.49	9.49	20	L
M. racemosus	1.16	0.3	12	R
M. racemosus series	4.	1.04	4	R
M. hiemalis	31.33	8.15	4	R
Stachybotrys atra var. *microspora*	3.57	0.93	20	L
Phoma	2.83	0.74	16	L
P. pomorum	0.08	0.02	4	R
P. exigua	0.33	0.09	4	R
Phoma spp.	2.42	0.63	16	L
Chaetomium	2.17	0.56	16	L
C. globosum	2	0.52	12	R
Chaetomium spp.	0.17	0.04	4	R
Paecilomyces	2.33	0.61	16	L
P. variotii	2	0.52	12	R
P. griseoviridis	0.33	0.09	4	R
Humicola	1.66	0.43	12	R
H. fuscoatra	1.33	0.35	8	R
Humicola spp.	0.33	0.09	4	R
Microascus	3.5	0.91	12	R
M. trigonosporus	1.33	0.35	8	R
M. manginii	0.12	0.03	4	R
M. niger	1.67	0.43	4	R
Microascus spp.	0.38	0.1	4	R
Clyindrocarpon	1.32	0.34	12	R
C. congoense	0.33	0.09	4	R
C. candidum	0.33	0.09	4	R
Clyindrocarpon spp.	0.66	0.17	4	R
Botryodiplodia theobromae	5.66	1.47	8	R
Myrothecium	3	0.78	8	R
M. verrucaria	2.67	0.7	4	R
M. roridum	0.33	0.09	4	R
Ulocladium	0.58	0.15	8	R
U. botrytis	0.5	0.13	8	R
U. atrum	0.08	0.02	4	R
Stemphylium	1.17	0.3	8	R
S. botryosum	1	0.16	4	R
S. lycopersici	0.17	0.04	4	R
Drechslera australiensis	0.33	0.08	4	R
Macrophomina phaseolina	0.33	0.09	4	R
Monodictys castaneae	0.33	0.09	4	R
Ascotricha chartarum	1.33	0.35	4	R
Curvularia lunata	0.33	0.09	4	R

Table, 6 (contd.)

Gliocladium roseum	5.33	1.39	4	R
Tritirachium album	0.83	0.22	4	R
Sepedonium chrysospermum	0.33	0.09	4	R
Gymnoascus zuffianus	0.33	0.09	4	R
Arthrobotrys oligospora	0.03	0.008	4	R
Trimmatostroma	0.03	0.008	4	R
Torula	0.02	0.005	4	R
Trichoderma	0.17	0.04	4	R
Metarrhizium anisopliae	0.08	0.02	4	R
Absidia	0.33	0.09	4	R
Unidentified	7.84	2.04	36	M
Sterile mycelium	5.62	1.46	52	H

% T = Percentage total count calculated to the gross total of all fungi.

% F = Percentage frequency of occurrence calculated to the 25 soil samples.

O.R. = Occurrence remarks:

H : high frequency; more than 49% of the samples.

M : moderate frequency; between 25 - 50% of the samples.

L : low frequency; between 13 - 24% of the samples.

R : rare frequency; less than 13% of the samples.

Table (7): Total count and number of fungal species in each sample, recovered on 50% sucrose-Czapek's agar incubated at 28°C (count per mgm dry soil).

Sample No.	Total count	No. of Species
1	12.58	17
2	31.34	16
3	3.16	9
4	11.64	9 + 1 species variety
5	39.64	20
6	4.25	4
7	1.08	2
8	2.91	2
9	0.99	3
10	2.51	4
11	15.53	14
12	1.64	8 + 1 species variety
13	—	—
14	13.65	6
15	26.98	13
16	69.65	21 + 1 species variety
17	13.64	15
18	40.97	14 + 1 species variety
19	5.65	6
20	45.63	27 + 1 species variety
21	26.65	7 + 1 species variety
22	1.99	6
23	0.23	2
24	3.92	19
25	8.18	14 + 1 species variety
	384.44	**Gross total count**

Table (8): Total and percentage counts and percentage of occurrence of fungal species recovered in the 25 soil samples, on cellulose-Czapek's agar, incubated at 28°C (counts per mgm dry soil in every sample).

Species	Total count	%T	%F	O.R.
Aspergillus	55.84	19.67	76	H
A. terreus	5.03	1.77	28	M
A. niger	1.87	0.66	28	M
A. versicolor	2.49	0.87	24	L
A. fumigatus	6.11	2.15	20	L
A. flavus	17.82	6.29	16	L
A. egyptiacus	1.07	0.37	12	R
A. quadrilineatus	8.02	2.83	8	R
A. nidulans	3.33	1.17	8	R
A. ochraceus	4.08	1.44	4	R
A. nidulans var. *echinulatus*	2.76	0.94	4	R
A. nidulans var. *acristatus*	1	0.35	4	R
A. nidulans var. *dentatus*	0.33	0.11	4	R
A. flavus series	0.67	0.23	4	R
A. niveus	0.33	0.11	4	R
A. violaceus	0.33	0.11	4	R
A. ochraceus group	0.33	0.11	4	R
A. awamori	0.13	0.04	4	R
A. viridi-nutans	0.03	0.01	4	R
A. sydowi	0.03	0.01	4	R
Aspergillus spp.	0.08	0.02	4	R
Fusarium	36.5	13.13	52	H
F. solani	28.52	10.06	52	H
F. equiseti	1.2	0.42	12	R
F. oxysporum	2.99	1.05	12	R
F. semitectum	1	0.35	8	R
F. fusarioides	0.08	0.02	8	R
F. lateritium	0.36	0.12	8	R
F. moniliforme var. *subglutinans*	0.07	0.02	4	R
Fusarium spp.	2.26	0.79	28	M
Cladosporium	6.66	2.35	48	M
C. sphaerospermum	1.42	0.5	24	L
C. cladosporioides	3.42	1.2	24	L
C. herbarum	0.33	0.11	4	R
C. oxysporum	0.33	0.11	4	R
C. elatum	0.5	0.17	4	R

Table, 8 (contd.)

Cladosporium spp.	0.66	0.23	8	R
Stachybotrys atra var. *microspora*	84.29	29.75	40	M
Botryotrichum	11.05	3.9	32	M
B. piluliferum	10.37	3.6	24	L
B. atrogriseum	0.68	0.24	12	R
Mucor	25.03	8.83	32	M
M. racemosus	9	3.17	12	R
M. hiemalis	12.17	4.29	8	R
M. racemosus series	3.2	1.12	4	R
M. fuscus	0.33	0.11	4	R
Mucor spp.	0.33	0.11	4	R
Acremonium	14.87	5.24	28	M
A. strictum	8.33	2.94	16	L
A. roseum	2.67	0.94	4	R
A. roseolum	1	0.35	4	R
A. roseo-griseum	0.33	0.11	4	R
A. humicola	0.67	0.23	4	R
Acremonium spp.	1.87	0.66	12	R
Humicola	2.67	0.94	28	M
H. grisea	0.68	0.24	12	R
H. fuscoatra	1.75	0.61	8	R
Humicola spp.	0.24	0.08	8	R
Penicillium	3.39	1.19	24	L
P. chrysogenum	0.19	0.06	12	R
P. stoloniferum	0.42	0.14	8	R
P. jensenii	1	0.35	4	R
P. brevi-compactum	1.42	0.5	4	R
P. lavendulum	0.03	0.01	4	R
Penicillium spp.	0.33	0.11	4	R
Alternaria	8.33	2.94	24	L
A. alternata	7.99	2.82	20	L
A. chlamydorspora	0.34	0.12	8	R
Scopulariopsis	2.21	0.78	24	L
S. brumptii	1.71	0.6	20	L
S. brevicauils	0.5	0.17	8	R
Phoma	1.87	0.66	20	L
P. eupyrena	0.41	0.14	8	R
P. leveillei	0.13	0.04	4	R
P. multirostrata	0.03	0.01	4	R
Phoma spp.	1.3	0.45	16	L
Myrothecium	2	0.7	20	L
M. roridum	1.67	0.58	16	L

Table, 8 (contd.)

Myrothecium spp.	0.33	0.11	4	R
Chaetomium	1.86	0.65	20	L
C. globosum	1.2	0.42	12	L
C. olivaceum	0.33	0.11	4	R
Chaetomium spp.	0.33	0.11	4	R
Drechslera	2	0.7	16	L
D. hawaiiensis	0.5	0.17	8	R
D. halodes	1	0.35	4	R
D. australiensis	0.33	0.11	4	R
D. dematioidea	0.17	0.06	4	R
Clyindrocarpon spp.	0.83	0.29	12	R
Microascus	0.47	0.16	12	R
M. manginii	0.4	0.14	8	R
M. desmosporus	0.07	0.02	4	R
Paecilomyces	0.53	0.18	12	R
P. variotii	0.5	0.17	8	R
Paecilomyces sp. white monophialidic	0.03	0.01	4	R
Torula	1.33	0.15	12	R
T. herbarum	0.33	0.11	4	R
Torula spp.	1	0.35	8	R
Ulocladium	1.91	0.67	12	R
U. botrytis	1.33	0.46	4	R
U. atrum	0.25	0.08	4	R
U. chartarum	0.33	0.11	4	R
Rhizopus	0.66	0.23	8	R
R. oryzae	0.33	0.11	4	R
R. arrhizus	0.33	0.11	4	R
Macrophomina phaseolina	0.11	0.03	8	R
Sporotrichum	0.83	0.29	12	R
S. roseolum	0.33	0.11	4	R
Sporotrichum spp.	0.5	0.17	8	R
Trichoderma spp.	0.17	0.06	4	R
Stemphylium vesicarium	0.33	0.11	4	R
Coniothyrium spp.	0.03	0.01	4	R
Curvularia lunata	0.33	0.11	4	R
Gliocladium roseum	0.33	0.11	4	R
Tritirachium album	2	0.7	4	R
Scolecobasidium variabile	1	0.35	4	R
Histoplasma	0.08	0.02	4	R
Pyrenochaeta	0.92	0.32	4	R
Camarosporium capparidis	0.1	0.03	4	R

Table, 8 (contd.)

Beauveria alba	0.03	0.01	4	R
Botryodiplodia theobromae	0.33	0.11	4	R
Coniothyrium	0.03	0.01	4	R
Papularia	0.03	0.01	4	R
Trimmatostroma	0.07	0.02	4	R
Unidentified	5.7	2.01	52	H
Sterile mycelium	6.86	2.42	40	M

% T = Percentage total count calculated to the gross total count of all fungi.

% F = Percentage frequency of occurrence calculated to the 25 soil samples.

O.R. = Occurrence remarks:

H: high frequency; more than 49% of the samples.

M: moderate frequency; between 25 - 50% of the samples.

L: low frequency; between 13 - 24% of the samples.

R: rare frequency; less than 13% of the samples.

Table (9): Total count and number of fungal species in each sample, recovered on cellulose-Czapek's agar, incubated at 28°C (count per mgm dry soil).

Sample No.	**Total count**	**No. of Species**
1	2.67	2
2	9.65	9 + 1 species variety
3	2.01	5
4	2.15	6 + 1 species variety
5	18.67	13 + 1 species variety
6	8.33	1
7	2.75	2
8	0.08	1
9	2.16	3
10	4.68	10
11	11.33	9
12	1.55	7 + 1 species variety
13	—	—
14	11.03	8
15	6.32	4 + 1 species variety
16	22.64	11 + 2 species variety
17	9.89	18 + 1 species variety
18	13.66	5
19	2.99	2 + 1 species variety
20	99.31	18 + 1 species variety
21	28.32	11
22	3.66	11 + 1 species variety
23	0.29	4 + 1 species variety
24	5.46	28 + 2 species variety
25	15.51	10 + 1 species variety
	285.11	**Gross total count**

selective effects of the three carbon sources, as well as the concentration of sucrose, on soil fungi and their competitive ability to establish themselves on the isolation media.

2) Aspergillus

Aspergillus showed the highest frequency of occurrence among all genera of fungi on the three media; it was recovered from 76%, 80% and 76% of the samples with total percentage counts of 26.75%, 38.63% and 19.67% on glucose, 50% sucrose and cellulose media respectively. The number of *Aspergillus* species identified was eighteen species and three varieties on glucose, nineteen species and two varieties on 50% sucrose and fourteen species and three varieties on cellulose medium.

On glucose medium, *A. terreus* (48% of soil samples), *A. flavus* (36%) and *A. versicolor* (32%) were the most frequent, although they were rated as moderate frequency. Two species were of low occurrence: *A. niger* (20%) and *A. egyptiacus* (16%). The rest were of rare occurrence, fluctuating between 4 - 12%.

On 50% sucrose medium, *A. flavus* and *A. versicolor* (48%), *A. amstelodami* and *A. terreus* (36%) and *A. egyptiacus* (32%) were the most frequent, but were rated as moderate frequency. *A. nidulans* group (20%) and *A. sydowi* (20%) were of low occurrence and the rest of species were of rare occurrence fluctuating between 4 - 12%.

On cellulose medium, *A. terreus* and *A. niger were of moderate frequency (28%), while A. versicolor* (24%), *A. fumigatus* (20%) and *A. flavus* (16%) were of low frequency. The rest of the species were of rare frequency.

Previous results show that despite *Aspergillus'* consistently high occurrence on the three media, its most frequent species were rated as moderate frequency. It is also noteworthy that on 50% sucrose medium, *A. asmtelodami* was the third most frequent *Aspergillus* species, but was absent on cellulose medium and of rare frequency on glucose medium. Also, the sequence of the rate of frequency was considerably altered on the three media, especially with regard to the common species.

3) Cladosporium

This genus ranked second on the frequency basis on glucose and 50% sucrose media, but on cellulose, it was relegated to the third place behind *Aspergillus* and *Fusarium*. Its frequencies were 64%, 68% and 48% on glucose, 50% sucrose and cellulose media, respectively. The total percentage counts of this genus were 4.06%, 10.05% and 2.35% on the three media, respectively.

Despite its high frequency and total count on glucose medium, this medium supported a narrow spectrum of species, namely: *C. cladosporioides* (44% frequency) and *C. sphaerospermum* (36%). On 50% sucrose, beside the highest frequency and greatest total count, it supported the widest spectrum of species encountered (five species), namely: *C. sphaerospermum* (56% frequency), *C. cladosporioides* (44%), *C. herbarum* (4%), *C. oxysporum* (4%) and *C. tenuissimum* (4%).

Although cellulose agar yielded the lowest frequency (48%) and a total count of 6.66/mgm of soil in the 25 soil samples, the spectrum of species was also broad and five species were recovered: *C. sphaerospermum* (24% frequency), *C. cladosporioides* (24%), *C. herbarum* (4%) *C. oxysporum* (4%) and *C. elatum* (4%).

On the three media, the highest total counts of this genus were regularly recorded in sample No. 2 which was gathered from a depression on Dukhan road under *Francoeuria crispa*.

4) Fusarium

This genus, after *Aspergillus*, gained second place on cellulose medium. It was encountered in 52% of the soil samples, contributing 13.13% of total fungi. It was relegated to the third place on both glucose (60%) and 50% sucrose media (56%) with total percentage counts of 23.02% and 14.42% on the two media, respectively.

On glucose-Czapek's medium: Nine species were identified (Table 8). The highest frequency (56%) was possessed by *F. solani,* followed by *F. oxysporum* (36%) and *F. equiseti* (32%). While *F. semitectum* had low frequency (16%), other species were of rare frequency, namely: *F. fusorioides* (8%), *F. acuminatum* (8%), *F. lateritium* (4%), *F. sulphureum* (4%) and *F. moniliforme* var. *subglutinans* (4%).

On 50% sucrose medium: Nine species were identified (Table 8). Also, *F. solani* achieved the highest frequency (36%) and percentage total count (10.2%), while *F. oxysporum* (20%) and *F. equiseti* (16%) fell within the range of low frequency. The rest of the list were arranged in the rare class as follows: *F. fusarioides* (8%), *F. acuminatum* (8%), *F. lateritium* (4%), *Fusarium* species near to *lateritium (4%), F. sulphureum* (4%) and *F. heterosporum (4%).*

On cellulose-Czapek's medium : F. solani was also the first with a 52% frequency and a percentage total count of 10.06% (Table 11). The other six species, identified on this medium, were rated as low frequency as follows: *F. equiseti* and *F. oxysporum* (12%), *F. semitectum, F. fusarioides* and *F.* near to *lateritium* (8%) and *F. moniliforme* var. *subglutinans* (4%).

On conclusion, *F. solani* was consistently the dominant species of *Fusarium* on the three experimental media. Its highest total counts were regularly contributed by soil sample No. 5, which was collected from Rodat Al-Faras Government Farm under *Vitis vinifera,* sample No. 14 from a farm on Rayyan road, cultivated with

Hordeum vulgare, and sample No. 15 from the same farm, under *Medicago sativa*.

Samples Nos. 6, 7, 8, 9 and 13 which were gathered from salt marshes in Al-Khor and Ras Ushairij were completely free from *Fusarium*.

5) Penicillium

On 50% sucrose medium : This geneus was the third major genus identified on this medium, with a frequency of 56%, which was equal to that of *Fusarium*, and a percentage total count of 3.78%.

P. chrysogenum, *P. funiculosum*, *P. brevicompactum* were recorded in 12% of the samples, while *P. corylophilium* and *P. jenseni* were in 8% of the samples and the remaining nine species were each represented in one sample only, as shown in Table (6).

On glucose medium : It came in the sixth place, as it was encountered in 36% of soil samples, contributing 2.53% of total fungi and seven species. *P. corylophilium* posessed the highest frequency (16%) with a percentage total count of 0.31%. *P. chrysogenum* was the runner-up and was recovered from 12% of the samples, with a percentage total count of 0.47%. Other species were of rare frequency, ranging between 4 - 8%.

On cellulose medium : It came in the ninth place with a low frequency of 24%, accounting for 1.19% of total fungi, and was represented by five species, with *P. chrysogenum* as the leading species, encountered in 12% of the samples. *P. stoloniferum* was represented in 8% of the samples, whereas the other species were encountered in only 4% of the samples. There was no specific distribution of *Penicillium* species which were isolated from various habitats, such as cultivated soil, desert depressions and salt marshes.

6) Stachybotrys

On glucose-Czapek's medium : It was a widely distributed genus and was isolated from 56% of the samples, accounting for 5.05% of total fungi. *S. atra* was the only species identified and was represented by *S. atra* var. *microspora*.

On 50% sucrose medium : The genus was of low frequency (20%) with a total count of 0.93% of total fungi and was also represented by *S. atra* var. *micrsopora*.

On cellulose-Czapek's medium : It came also fourth, after *Aspergillus*, *Fusarium* and *Cladosporium*, as on glucose medium, with a moderate frequency (40%), sharing in the total count of fungi with 29.75%.

7) Other genera

(i) On glucose medium

Acremonium was of moderate frequency (44%) and possessed 12.16% of total fungi. It was represented by *A. strictum* (32% of samples) and an unidentified species (20%).

Botryotrichum ranged also in the moderate frequency (36%), contributing 1.9% of total fungi. Two species were identified: *B. piluliferum* (24%) and *B. atrogriseum* (4%).

Eight genera were in the low frequency range: *Alternaria* (24%, four species) *Scopulariopsis* (24%, three species), *Myrothecium* (24%, two species), *Humicolo* (24%, two species), *Phoma* (20%, three species), *Mucor* (20%, two species), Rhizopus (16%, two species) and *Microascus* (16%, two species).

The nineteen following genera were identified in rare frequency on this medium: *Ulocladium* (12%, two species), *Machrophomina* (8%, one species), *Paecilomyces* (8%, one species), *Scolecobasidium* (8%, one species), *Trichocladium* (8%, one species), *Camarosporium* (8%, one species), *Stemphylium* (8%, two species), *Coniothyrium* (8%, one species), *Cylindrocarpon* (8%, one species), *Cunninghamella* (8%, two species), *Drechslera* (8%, two species), *Chaetomium* (4%, one species), *Gliocladium* (4%, two species), *Verticillium* (4%, two species), *Tritirachium* (4%, two species), *Sepedonium* (4%, two species), *Papularia* (4%), *Torula* (4%, one species), and *Mortierella (4%)*.

(ii) On 50% sucrose medium

Acremonium was also of moderate frequency (44%) and had a total count of 3.74% of total fungi. It contributed 3 species, *A. strictum* (32% frequency), *A. roseum* (4%) and *A. humicola* (4%).

Scopulariopsis gained a better position on this medium than on glucose medium. It was encountered on 40% of the samples, contributing 2.42% of total fungi. It was represented by five species: *S. brumptii* (36%), *S. brevicaulis* (4%), *S. sphaerospora* (4%), *S. carbonaria* (4%) and *S. candida* (4%).

The following six genera were of low frequency: *Boryotrichum* (24%, two species), *Alternaria* (24%, three species), *Mucor* (20%, three species), *Phoma* (16%, two species). *Chaetomium* (16%, one species) and *Paecilomyces* (16%, two species). Other genera were of rare frequency, ranging from 4 - 12%, as shown in Table (6).

(iii) On cellulose-Czapek's medium

Botryotrichum was also of moderate frequency (32%), contributing 3.9% of total fungi and two species, *B. piluliferum* (24% frequency) and *B. atrogriseum* (12%). *Mucor* exhibited moderate frequency (32%) and accounted for 8.83% of total fungi. It was represented by three species: *M. racemosus* (frequency, 12%), *M. hiemalis* (8%) and *M. fuscus* (4%).

Acremonium was recovered from 28% of the soil samples, yielding 5.24% of total fungi. Five species were identified, namely, *A. strictum* (16%), *A. roseum* (4%), *A. roseolus* (4%), *A. roseo-griseum* (4%), and *A. humicola* (4%). *Humicola* was also of moderate frequency (28%) and gained a total count of 0.94%. It was represented by *H. grisea* (12%) and *H. fuscotra* (8%).

Six genera were in the low range of frequency: *Alternaria* (24%, two species), *Scopulariopsis* (24%, two species), *Phoma* (20%, three species), *Myrothecium* (20%, one species), *Chaetomium* (20%, three species), and *Drechslera* (16%, four species).

Twenty-two genera came in the rank of rare frequency (4% - 12%), as presented in Table (8).

V — Determination of Thermophilic Fungi

Seventeen soil samples were collected from various localities in the north and the middle of the peninsula and assayed for their content of thermophilic fungi using Warcup's method. All fungi recovered at 45°C are considered as thermophilic (Table 10).

The richest sample was No. 28 (187. 488 colonies per plate) which was collected from a depression behind Rodat Al-Faras. This soil sample was classified as sand clay loam type, with a low organic matter content (0.927%), a high value of salinity (E.C. 311 millimho) and a moderate content of $CaCo_3$ (71.606%). Eight species were isolated from this sample. The poorest sample was No. 39 (0.16 colonies) which was collected from a desert site; it was sandy soil with 0.072% organic matter, E.C. 2.6 millimho and a moderate $CaCo_3$ (45.30%). One species was isolated from this sample.

Samples Nos. 29, 30, 32, 37 and 40 were completely free from thermophilic fungi. Samples Nos. 29 and 30, which were gathered from the area polluted with crude oil at Ras-Ushirij, were completely free from any fungi, as was the case at 28°C (sample No. 13). These two samples had low contents of organic matter (0.584% and 0.656%) and high contents of $CaCo_3$ (69.48% and 79.48%) and salinity (E.C. values 72 and 98, millimho, respectively). Sample No. 37, which was gathered under *Zygopllum quatarense* from Bir Zekrit, was sandy soil with 0.122% o.m. and E.C. 8.7 millimho. Sample No. 40 was loamy sandy with (0) content of organic matter. Sample No. 32 was sandy with 0.346% organic matter and the highest value of $CaCo_3$ content (95.05%). It was gathered from a salt marsh in Abu-Dluf, under *Halopolis perfoliata.*

Sixteen species belonging to twelve genera were isolated during this part. The most dominant species was *A. fumigatus* which was encountered in 41.17% of the samples, and the richest sample of this species was No. 28 from a desert depression. *A. terreus* came second (35.22%) and the richest sample was No. 34 from a desert depression.

Four species lied in the low range of frequency, namely: *A. nidulans* group (23.53%), *Scopulariopsis* sp. (23.53%), *Sporotrichum* sp. (17.65%) and *Malbrancheae pulchella* var. *sulfurea* (17.76%).

Other species were of rare frequency, namely: *Absidia corymbifera* (11.76%), *A. egyptiacus* (11.76%), *Myriococcum albomyces* (11.76%), *Chaetomium* sp. (11.76%), *Mucor* sp. (11.76%), *Paecilomyces variotii* (11.76%), *A. niveus* (5.88%), *Thermomyces lanuginosus* (5.88%), *Humicola insolens* (5.88%), *Paecilomyces* sp. (5.88%), *Thermoascus aurantiacus* (5.88%).

Table (10): Total and percentage counts, and percentage frequency of occurrence of fungal species recovered on glucose-Czapek's agar incubated at 45°C (count per plate in each sample).

Species	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	Total Count Per Plate	Total Percentage	Frequency
Aspergillus fumigatus	0.5		81.5			3.33			6.666	1.16	0.83		4					97.986	55.8	41.17
A. terreus			3			1.833		6.83	8	6.83				0.16				26.653	15.18	35.29
A. nidulans group			1.16			0.33			0.16							16.16		17.81	10.14	23.53
A. egyptiacus									1.16							0.16		1.32	0.75	11.76
A. niveus									0.333									0.333	0.189	5.88
Aspergillus spp.	3.66		0.333						3.666							0.16		7.819	4.5	23.53
Scopulariopsis spp.						1.16			0.83		0.16						0.16	2.31	1.32	23.52
Sporotrichum spp.			0.166					0.5	2.83									3.5	1.99	17.65
Absidia corymbifera			0.83						0.83									1.66	0.95	11.76
Thermomyces lanuginosus										1.49								1.49	0.85	5.88
Paecilomyces variotii										0.66							0.16	0.82	0.47	11.75
Paecilomyces spp.								0.32										0.32	0.18	5.88
Thermoascus aurantiacus										0.16								0.16	0.09	5.88
Myriococcum albomyces	0.66									0.16								0.82	0.47	11.75
Humicola insolens	0.16																	0.16	0.09	5.88
Malbranchea pulchella var. *sulfurea*		0.16								0.16						0.5		1.82	0.47	17.65
Chaetomium spp.		0.16							0.33									0.49	0.28	11.76
Mucor spp.			0.333							0.16								0.49	0.28	11.76
Sterile myceilum	1	0.16	0.166			0.166		0.16	9									10.65	6.07	35.29
Total count in each sample	**5.98**	**0.48**	**87.488**			**6.819**		**7.81**	**33.805**	**10.78**	**0.99**		**4**	**0.16**		**16.98**	**0.32**	**175.61**		

DISCUSSION

This is a pioneer study of soil fungi in Qatar. The study of soil fungi is of considerable importance. They play a great role in soil fertility. Many of them are root pathogenes inducing severe diseases in plants. Several dermatophytes are also soil inhabitants.

In the present investigation, the dilution plate and Warcup's methods, three isolation media and two temperatures of incubation, were employed for the isolation of soil fungi.

Fifty-three genera, 142 species and eight species varieties were collected from forty-two soil samples representing different localities of Qatar. From them, four genera and six species were only recovered at 45°C and are, thus, considered as real thermophilic in the sense of the definition proposed by Cooney and Emerson (1964).

The soil dilution used fluctuated between 1 : 100 for desert soil and 1 : 2000 for cultivated soils. In Saudi Arabian desert soils, Ali (1977) used a dilution of 1 : 400, and Abdel-Hafez (1981) used 1 : 50 to 1 : 300 to estimate cellulose decomposing fungi, and 1 : 100 to 1 : 400 to estimate mesophilic fungi (1982 a). In Kuwait, Halwagy *et al.* (1982) used various dilutions from 1 : 100 to 1 : 1000. In Sudan, Nour (1956) used larger dilutions, ranging from 1 : 20,000 to 1 : 40,000. In Egyptian agricultural soils, the range 1 : 1000 and 1 : 10,000 was employed by Moubasher and his co-workers, whereas in salt marsh soils the range 1 : 10 - 1 : 25 was used (Abdel-Fattah *et al.*, 1977 a).

All these genera and species were recorded before in Egypt (Moubasher and El-Dohlob, 1970; Moubasher and Moustafa, 1970; Moubasher and Mazen, 1971 and 1972; Salama *et al.*, 1971; Abdel Fattah, 1973; Mazen, 1973; Ali *et al.*, 1975; Moubasher *et al.*, 1975; Abdel Fattah *et al.*, 1977 a, b; Abdel Hafez *et al.*, 1977 and 1981; Moubasher and Abdel Hafez, 1978 a, b; El-Abyad *et al.*, 1979; El-Hissy *et al.*, 1980 and El-Maghraby, 1980), in Saudi Arabia (Ali, 1977 and Abdel Hafez, 1981, 1982 a, b), in Kuwait (Moustafa, 1975; Moustafa and Al-Musallam, 1975 and Halwagy *et al.*, 1982), in Iraq (Al-Doory *et al.*, 1959, Ismail and Abdullah, 1977), in Syria (Sizova *et al.*, 1967), and in Jordan (Abdel Hafez, 1976).

Three isolation media were employed for the isolation of mesophilic soil fungi (recovered at 28°C). 50% sucrose-Czapek's agar supported the highest gross total count of fungi (384.44 colonies/mgm dry soil in 25 soil samples), followed by glucose-Czapek's agar (376.36 colonies/mgm), whereas cellulose-Czapek's agar supported the lowest gross total count. The fact that the medium which contained high sugar concentration was the best, looks peculiar; but it may show that soil fungi in Qatar are osmophilic in nature, a character which would enable them to exist under and tolerate xerophytic conditions in Qatar. Abdel Hafez (1982 b) concluded that the Saudi Arabian soil fungi were of osmophilic nature. Also on 50% sucrose agar, the broadest spectrum of species was encountered, which further supports the previous suggestion that Qatari soil fungi are osmophilic in nature. Most likely, the effect of high sugar concentration of fungi is not a selective one, but the medium is not a luxurious one for the growth of almost all fungi and thus enables both fast-growing (slightly checked by the high sugar concentration) and slow-growing fungi to have much room to grow upon and, hence, give better opportunity for more colonies and species to appear in the plates.

The number of colonies per mgm of soil ranged between 66.3 and 0.19 colonies in the case of glucose agar, 69.65 and 0.23 colonies in 50% sucrose agar and 99.31 and 0.08 colonies in cellulose agar. The richest soil samples were regularly collected from agricultural sites where edaphic conditions are more suitable for fungal growth and sporulation than those of the desert and salt marsh soils.

An interesting observation is that of sample No. 13, which was collected from a site near the seashore that was polluted with crude oil, precipitated inshore by water currents from undetermined time. Crusts of tar were covering vast areas of the sampling site and this soil sample was completely free from fungi on all media of isolation, which suggests that soil pollution with crude oil drastically affects fungal inhabitants of soil.

The results of the present investigation reveal that, in general, there was no specific distribution of fungi in the different habitats. *Aspergillus,* which was the most common genus on the three isolation media, was recovered from 76 - 80% of the samples representing the various habitats of Qatar. *A. terreus,* was recovered from 14 samples and distributed as follows: 9 samples out of 14 from cultivated lands and 5 samples out of 5 from desert sites. *A. flavus* was recovered from thirteen samples: 9 samples from cultivated soils, 1 sample out of six from salt marshes and 3 samples from desert soils. *Cladosporium cladosporioides* was isolated from thirteen samples which represent cultivated and desert soils. *Fusarium solani* was encountered in sixteen samples, representing cultivated, salt marsh and desert soils. These preceding results lend further support to the previous statement, that there is no specific distribution of fungi in the various soils and habitats, advocated by Moubasher and his co-workers in Egyptian and Jordanian soils, Ali (1977) and Abdel Hafez (1981, 1982 a and b) in Saudi Arabian soils, Halwagy *et al.* (1982) in Kuwaiti soils and Ranzoni (1968) in the Sonoran Desert, U.S.A. These results shed more light on the capability of these micro-organisms to colonise different habitats and on the adaptability to encounter the various fluctuations of atmospheric and edaphic conditions.

Effect of Medium of Isolation on the Frequency of Fungi

The response of fungi to the type of isolation medium can be classified into the following categories, taking glucose-Czapek's as a control:

1) Fungi promoted by 50% sucrose agar, such as *A. amstelodami* (from 4 - 36%), *A. flavus* (36 - 48%), *A. versicolor* (32 - 48%), *A. egyptiacus* (16 - 32%),

Cladosporium sphaerospermum (36 - 56%) and *Scopulariopsis brumptii* (20 - 36%). *A. amstelodami* belongs to the *A. glaucus* group whose members are known to be osmophilic (Raper and Fennell, 1965). Abol-Nasr (1981), in his investigation on soil fungi of the Red seashore, observed that *A. flavus* and *A. versicolor* had a higher frequency of occurrence on 40% sucrose agar compared with that on 1% glucose agar.

2) Fungi inhibited by 50% sucrose agar, such as *P. corylophilum* (from 16 - 8%), *A. niger* (20 - 12%), *A. terreus* (48 - 36%) and *Fusarium solani* (56 - 36%). Abol Nasr (1981) also observed that *A. terreus* frequency was lower on 40% sucrose than that on 1% glucose agar.

3) Fungi promoted by cellulose agar, such as *A. niger* (20 - 28%) and *Chaetomium globosum (4 - 12)*.

4) Fungi inhibited by cellulose agar, such as *A. terreus* (48 - 28%), *A. flavus* (36 - 16%), *A. versicolor* (32 - 24%), *F. oxysporum* (36 - 12%), *F. equiseti* (32 - 12%), *P. corylophilum* (16 - 10%) and *C. cladosporioides* (44 - 24%).

The precedent observations strongly recommend the use of more than one isolation medium in any survey of fungi, in order to recover more fungi and to give more precise information on the occurrence of various fungi in the various localities and habitats.

Effect of Soil Salinity and Organic Matter Content of the Soils Tested on Fungal Population

Moubasher and El-Dohlob (1970) stated that the soil fungal population is governed by a complex of factors which act simultaneously and that it is deceptive to attribute the variations in the soil fungal population to one factor alone.

The present data show that the highest total count of fungi on glucose-Czapek's agar was estimated in sample No. 16 (66.3 colonies per mgm of dry soil), which was collected from an agricultural land and which contained a low value of salinity (3.8 millimho) associated with a low value of organic matter (1.013%). The poorest sample was No. 9, collected from a salt marsh, which contained high salinity (245) associated with a relatively high content of organic matter (2.959%), indicating that the high salinity alleviated the richness in organic matter and greatly reduced the fungal population. Sample No. 23 was also poor in fungal count and in organic matter and contained a low value of total soluble salts. It is reasonable to assume that the increase in organic matter content of the soil, which represents in general a nutrtitive base for the microorganisms to colonise, exploit, grow and increase their numbers, is beneficial to the soil fungal flora unless other factors are limiting. High salinity is toxic for almost all fungi and, hence, it inhibits fungal population. In this respect, Abdel Fattah *et al.*, (1977 a), working on Egyptian salt marsh soils, and Abol Nasr (1981) on soil fungi of the Red seashore, indicate that the poorest soil samples in total count of fungi were significantly higher in their content of total soluble salts than the richest soil samples, whereas no significant difference was calculated between their content in organic content.

As mentioned earlier, 49 genera and 136 species were collected from the isolation plates at 28°C. *Aspergillus* was consistently the most common genus in Qatari soils on the three isolation media; it was recovered from 76%, 80% and 76% of the soil samples, constituting 24.6%, 38.6% and 19.4% of the gross total counts of all fungi on glucose, 50% sucrose and cellulose agar media, respectively. It contributed the broadest spectrum of species (23 species and five varieties) among all fungal genera. *A. terreus* was the most frequent *Aspergillus* species on glucose and on cellulose agar and the fourth most frequent on 50% sucrose agar. *A. flavus* was the most frequent, together with *A. versicolor,* on 50% sucrose medium, but it came second behind *A. terreus* on glucose medium, and third on cellulose medium. *A. niger* occupied the second place behind *A. terreus* on cellulose medium, the fourth on glucose medium, and was of rare occurrence on 50% sucrose medium. These three common *Aspergillus* species were also among the most common soil fungi in Egypt (Moubasher and Moustafa 1970, Moubasher and El-Dohlob 1970, Moubasher and Abdel Hafez 1978 a and b, Abdel Fattah *et al.,* 1977 a, and El-Abyad *et al.,* 1979), in Jordan (Abdel Hafez, 1976), in Saudi Arabia (Ali, 1977 and Abdel Hafez 1981, 1982 a, b), in Kuwait (Halwagy *et al., 1982* and Moustafa and Sharkas, 1982), in Iraq (Al-Doory *et al.,* 1959, Ismail and Abdullah, 1977), in Sudan (Nour, 1956), in Syria (Sizova *et al.,* 1967) and in Libya (Naim, 1967).

A. egyptiacus recently described by Moubasher and Moustafa (1972) from an Egyptian soil, was the fifth most common *Aspergillus* species on 50% sucrose agar and was encountered in 32% of the soils samples tested; but it was of rare occurrence on glucose and cellulose agar media. This species was also recorded in soils of Jordan (Abdel Hafez, 1976), Kuwait (Moustafa and Al-Musallam, 1975) and of Saudi Arabia (Abdel Hafez, 1982 a).

A. fumigatus was the fourth most frequent *Aspergillus* species on cellulose agar medium, but was of rare occurrence on glucose and 50% sucrose media. This species showed profoundly different behaviour in Egyptian soils. In soil samples collected in the 1960's (Moubasher and El-Dhlob, 1970, Moubasher and Moustafa, 1970), it was of rare occurrence, whereas in samples collected in the seventies (Moubasher and Abdel Hafez, 1978 a, b), it was the second commonest fungal species after *A. niger*. It was concluded, in this respect, that it is likely that some fungi show not only seasonal periodicities, but also long term periodicities.

Aspergillus amstelodami (= Eurotium amstelodami) gained a forward position (third place) on 50% sucrose medium, but was absent on cellulose medium and of rare frequency on glucose medium. This species is a real osmophilic fungus (Raper and Fennell, 1965) and was rated as highly osmophilic (Abdel Fattah, 1973 and Abol Nasr, 1981). On 50% sucrose medium this species was recovered from 9 soil samples out of 25 samples, seven of them were from cultivated land and two from desert sites.

Penicillium contributed 16 species. It was the third most frequent genus (together with *Fusarium)* on 50% sucrose medium and was encountered in 56% of the soil samples, contributing 3.8% of total fungi.

P. chrysogenum (P. notatum is now considered as synonym of *P. chrysogenum)* was the leading species on 50% sucrose (together with *P. funiculosum* and *P. brevicompactum)*, ahead of *P. corylophilum* and on cellulose agar medium, whereas it came second on glucose medium behind *P. corylophilum. P. notatum (= P. chrysogenum)* was the fourth most common fungal species in Egyptian desert soils (Abdel-Fattah, 1973), third most common in Egyptian salt marsh soils (Abdel-Fattah *et al.*, 1977 a), sixth and fifth in Egyptian soils (Moubasher and Moustafa, 1970) and Moubasher and Abdel Hafez, 1978 a), fourth in Wadi Bir-El-Ain soils in Egypt (El-Magraby, 1980) and third in soils of Red seashore soils (Abol Nasr, 1981). *P. corylophilum* was also a common soil fungus in Egypt (Moubasher and collaborators), Jordan (Abdel Hafez, 1976), Sudan (Nour 1956). *Penicillium* species did not show any specific distribution among different soil types and habitats.

Fusarium was also one of the most common genera in Qatari soils. It gained the second place, behind *Aspergillus,* on cellulose agar, where it was recovered from 52% of the soil samples, accounting for 12.4% of the total number of colonies of all fungi. It was relegated to the third place on both glucose (60% of the samples) and 50% sucrose (56%) media. Nine species of *Fusarium* were collected. *F. solani* was consistently the most dominant species of *Fusarium* on the three experimental media. It was isolated from 56%, 36% and 52% of the soil samples tested on glucose, 50% sucrose and cellulose agar media, respectively. Its highest counts were regularly contributed by soil samples from cultivated lands. *F. solani* was regularly followed by *F. oxysporum* and *F. equiseti.*

It is noteworthy that *Fusarium* was recovered on glucose agar from 15 samples, 12 samples out of 14 from agricultural lands, 3 samples out of 5 from desert lands, and 1 sample out of 6 from salt marshes. This distribution points to *Fusarium* prevailing in agricultural soils rather than in desert and salt marsh soils, which may indicate some ecological selectivity. Abol Nasr (1981) observed that *Fusarium* was of low occurrence on Red seashore soils which are almost sandy, whereas it is one of the most prevalent genus in Egyptian agricultural soils, as reported by Moubasher and his collaborators. However, Halwagy *et al.* (1982) recorded that *Fusarium* was the most frequent genus in the desert of Kuwait. *F. solani,* followed by *F. oxyspornm,* was also the most common *Fusarium* species in Egyptian soils (Abdel Hafez, 1981). The remaining *Fusarium* species were also recorded in Egyptian soils. In Kuwait, *F. equiseti* and *F. acuminatum* were the most common fungal species in the desert soils. In Iraq, *F. equiseti* was the only *Fusarium* species isolated from central Iraq (Al-Doory *et. al., 1959)*, whereas around Basrah, *F. solani, F. acuminatum, F. equiseti* and *F. oxysporum* were recorded. In Sudan, *F. solani* was the only species isolated by Nour (1956). In Jordanian soils (Abdel Hafez, 1976), most of *Fusarium* species recorded in Qatari soils were also encountered.

Cladosporium ranked second, behind *Aspergillus*, on glucose and 50% sucrose media, but on cellulose it was relegated to the third place behind *Aspergillus* and *Fusarium* (frequencies, 64, 68 and 48%, respectively), constituting 4.06, 10.04 and 2.35% of the gross total counts of all fungi on the three media, respectively. Five species of the genus were identified, of which *C. cladosporioides* and *C. sphaerospermum* were the most common on the three isolation media, followed far behind by *C. herbarum, C. oxysporum* and *C. tenuissimum*. 50% sucrose yielded the highest total count and the broadest spectrum of species (all species), whereas on glucose medium only *C. cladosporioides* and *C. sphaerospermum* were encountered. On the three media, the highest total counts of *Cladosporium* were regularly estimated in sample No. 2 collected from a depression on Dukhan road, under *Francoeuria crispa*.

Cladosporium has a special ecological interst, because it is the most common fungus in the air in Egypt, as is the case in many temperate and tropical localities (Moubasher and Moustafa, 1974). In Egyptian soils, it occupied the sixth place in the order of occurrence (Moubasher and Moustafa, 1970) and was represented by three species, of which *C. herbarum* was the commonest (Moubasher and Mazen, 1972). In Wadi Hof, Egypt (Ali *et al.*, 1975), *C. herbarum* was the only species isolated, in Sudan, *C. cladosporioides* and *C. sphaerospermum* (Nour, 1956), in Saudi Arabia, *C. herbarum, C. sphaerospermum* and *C. cladosporioides* (Abdel Hafez, 1982 a, b), in Kuwait, *C. cladosporioides* and *C. herbarum* (Moustafa and Sharkas, 1982, and Halwagy *et al.*, 1982), in Iraq *Hormodendrum cladosporioides (= C. cladosporioides)* (Al-Doory *et al.*, 1959).

Stachybotrys was of high frequency of occurrence in Qatari soils. On glucose medium, it was recovered from 56% of the samples, accounting for 4.7% of the gross total count of all fungi. It was represented by one species variety, *S. atra* var. *microspora*. According to Jong and Davis (1976), this species variety is promoted to a species level, *S. microsporum*. This organism was more frequently isolated on glucose medium, but gained an exceedingly high count on cellulose medium (29.75% of total fungi). *S. atra* is a strong cellulose decomposer (Moustafa and Sharkas, 1982) and this property probably enables it to overrun weak decomposers in colonizing cellulosic substrates and gain better counts in the isolation plates. *S.atra (= S. chartarum)* is one of the common fungi in Egyptian soils (Moubasher and collaborators) and it was also recorded in Kuwait, Iraq, Jordan and Saudi Arabia.

Acremonium was represented in Qatari soils by *A. strictum, A. roseum, A. roseolum, A. humicola* and *A. roseo-griseum*. *A. strictum* was the most common species and was represented in 32, 33 and 16% of the soil samples on glucose, 50% sucrose and cellulose media, respectively; the other species were far less frequent. *A. strictum (= Cephalosporium acremonium)* and *A. roseo-griseum (C. roseo-griseum)* were recorded in Egyptian, Iraqi and Saudi Arabian soils. *Acremonium roseolum (= Paecilomyces roseolus)* was also recorded in Egyptian soils.

Botryotrichum was of moderate occurrence and was represented by *B.*

piluliferum and *B. atrogriseum* (rare occurrence). The maintainment of the dark coloured *B. atrogriseum* in the genus *Botryotrichun* is debatable (Barron, 1968). *B. piluliferum* was also recorded in Egypt, Saudi Arabia, Kuwait and Iraq.

From *Alternaria*, *A. alternata*, *A. chalmydospora*, *A. phragmospora*, *A. tenuissima* and *A. mouchaccae* were identified. *A. alternata* was the most common species, as was the case in Egypt, Sudan *(A. tenuis = A. alternata)*, Iraq, Kuwait and Saudi Arabia.

Scopulariopsis was represented by five species, of which *S. brumptii* was the most frequent. *S. brevicaulis*, *S. candida*, *S. carbonaria* and *S. sphaerospora* were less frequent. *S. brevicaulis* and *S. brumptii* were recorded in Egypt, whereas only *S. brevicaulis* was isolated in Kuwait and Saudi Arabia; in Iraq and Sudan, the whole genus remained unrecorded. Its teleomorph, *Microascus*, was represented by 4 species, namely: *M. trigonosporus*, *M. desmosporus*, *M. manginii* and *M. niger*, which were all of rare occurrence. *M. trigonosporus* was recorded in Saudi Arabia.

The remaining genera and species were almost of rare occurrence (refer to list of fungi collected in the present investigation). Almost all of them were isolated from soils of the neighbouring Arabic countries.

Thermophilic fungi

These fungi were surveyed in 17 samples; five samples were completely free of these fungi.

Twelve genera and 16 species were isolated at 45°C ; 4 genera and 6 species were not recovered at 28°C and are, thus, considered true thermophilic fungi, in the sense of the definition of Cooney and Emerson (1964), according to which 'a thermophilic fungus' is that with a maximum temperature for growth at or above 50°C and a minimum temperature at or above 20°C. All the thermophilic species were isolated from Egyptian soils (Mazen, 1973; Abdel Fattah, 1973; Abdel Fattah *et al.*, 1977, b; Moharram, 1980 and El-Magraby, 1980), peanut seeds (Moubasher et al., 1979, Moubasher *et al.*, 1980 and El-Hissy *et al.*, 1981), from soil and wheat and broad bean straws in Egypt, (Moubasher *et al.*, 1982), from Kuwaiti soils (Moustafa *et al.*, 1976) and from Jordanian soils (Abdel Hafez, 1976). There are no records available on thermophilic fungi from soils of other Arabic countries. *Aspergillus* was the most prevalent genus and was recovered from 10 samples out of 17 constituting 45.56% of total fungi. *A. fumigatus* was the most dominant fungal species and was even more frequently isolated at 45°C than at 28°C (41.17% and 12% constituting 30.09% and 1.52% of total fungi, respectively). *A. fumigatus* was also the most common thermophilic species in Egyptian soils and peanut seeds and wheat and broad been straws. This species has long been known as the thermophilic fungus, but Crisan (1959) and Cooney and Emerson (1964) considered it as thermotolerant as it has a maximum near to 50°C and a minimum well below 20°C.

A. terreus came second, behind *A. fumigatus*, and emerged from 35.29% of the samples contributing 8.49% of total fungi.

Penicillium was completely eliminated at 45°C. However, Abdel Fattah (1973) isolated *P. asperum* and *P. pulvillorum* from Egyptian desert soils and Abdel Hafez (1976) recovered *P. dupontii* from Jordanian soils.

Malbranchea pulchella var. *sulphurea* (frequency, 17.65%), *Absidia corymbifera* (11.76%), *Myriococcum albomyces* (11.76%), *Thermomyces lanuginosus* (5.88%), *Thermosascus aurantiacus* (5.88%), *Humicola insolens* (5.88%), were not encountered at 28°C and are real thermophilic according to Cooney and Emerson, 1964.

On conclusion, the preceding results and discussion reveal that the fungus flora of the soils of Qatar is basically similar to that of the neighbouring Arabic countries. It is of osmophilic nature, enabling it to exist under and tolerate the dry conditions of this country. It also includes many thermophilic species.

SUMMARY

1) 53 genera and 142 species and 8 species varieties were collected from 42 soil samples representing different localities of Qatar.

2) The richest soil samples in fungi were regularly collected from agricultural lands.

3) There was no specific distribution of fungal species in the various soil types and habitats.

4) 50% sucrose-Czapek's agar supported the highest gross total count of all fungi and the broadest spectrum of species, comparable with glucose - and cellulose-Czapek's agar, which reveals that the soil fungal flora is generally of osmophilic nature.

5) The organic matter content of the soil and the total soluble salts seem to intervene together in affecting the soil fungal population.

6) *Aspergillus* was consistently the most common genus in Qatari soils. It contributed 23 species and 5 varieties of which *A. terreus*, *A. flavus*, *A. versicolor* and *A. niger* were the most frequent species. *A. egyptiacus* was of moderate occurrence in the soil samples on 50% sucrose agar. *A. amstelodami* ranked third with regard to the frequency of occurrence on 50% sucrose agar but was completely absent on cellulose agar and of rare occurrence on glucose agar.

7) *Penicillium* contributed 16 species of which, *P. chrysogenum*, *P. corylophilum*,

P. funciulosum and *P. brevicompactum* were the most frequent species. The genus was the second most frequent (together with *Fusarium*) on 50% sucrose agar.

8) *Fusarium* was one of the most common genera. 8 species and one species variety of the genus were collected, of which *F. solani* was consistently the most dominant and was regularly followed by *F. oxysporum* and *F. equiseti*.

9) *Cladosporium* ranked second or third, depending on the isolation medium. Five species of the genus were encountered, of which *C. cladosporioides* and *C. sphaerospermum* were the most common.

10) *Stachybotrys* was of high occurrence in Qatari soils; it was represented by one species variety: *S. atra* var. *microspora*.

11) *Acremonium* was of moderate occurrence in Qatari soils and was represented by five species of which *A. strictum* was the most common.

12) *Botryotrichum* was of moderate occurrence and was represented by *B. piluliferum* and *B. astrogriseum* (rare occurrence).

13) *Alternaria* (five species) and *Scopulariopsis* (five species) were generally of moderate occurrence. *A. alternata* and *S. brumptii* were the most common species, respectively.

14) *Microascus*, the teleomorph of *Scopulariopsis*, was represented by four species which were all of rare occurrence.

15) The rest of genera and species were almost of rare occurrence.

16) At 45°C, 12 genera and 16 species were isolated. *A. fumigatus* was the most dominant fungal species. *Malbrancheae pulchella* var. *sulphurea*, *Absidia corymbifera*, *Myriococcum albomyces*, *Thermomyces lanuginosus*, *Humicola insolens* and *Thermoascus aurantiacus* were only encountered at 45°C.

17) The results and discussion of the present investigation reveal that the soil fungal flora of Qatari soils is basically similar to that of the neighbouring Arabic countries.

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APPENDIX

PLATES AND PHOTOGRAPHS

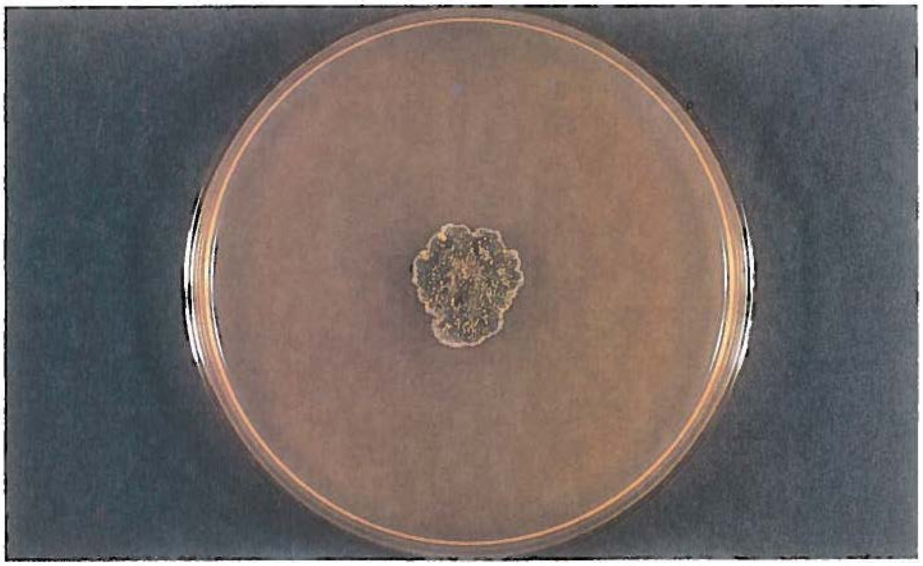
N.B.:

1) Microscopic specimens were stained with cotton blue or fuchsin; some were not stained.

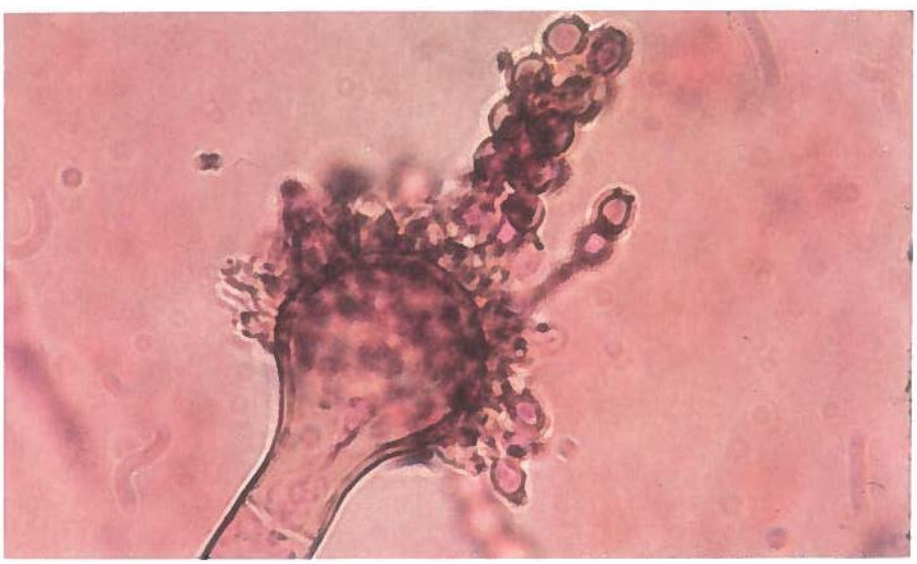
2) Magnification of photomicrographs is X 1085, unless otherwise stated.

3) All colonies were grown on Czapek's yeast extract agar and incubated at 28°C, unless otherwise stated.

Aspergillus amstelodami



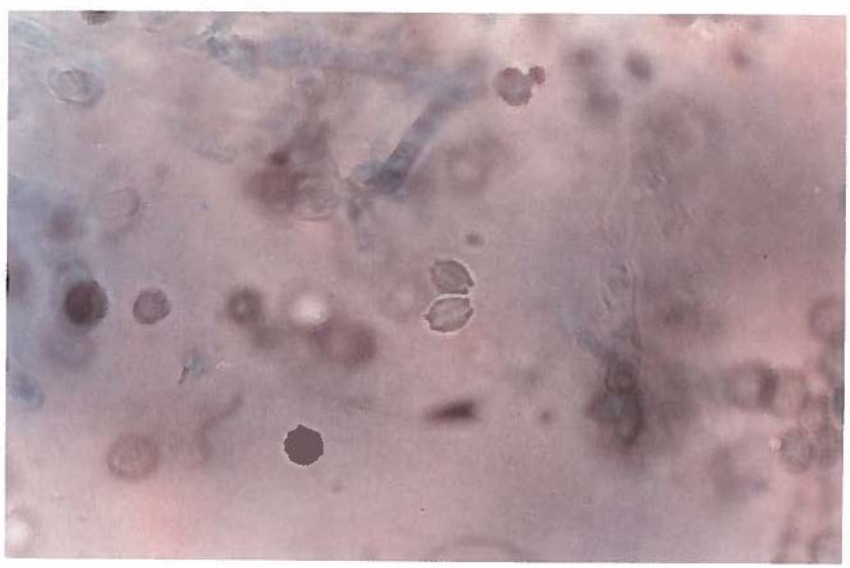
12-day old colony on malt agar at 28°C



Conidiophore bearing uniseriate phialides

Aspergillus amstelodami *(contd.)*

Cleistothecium and asci



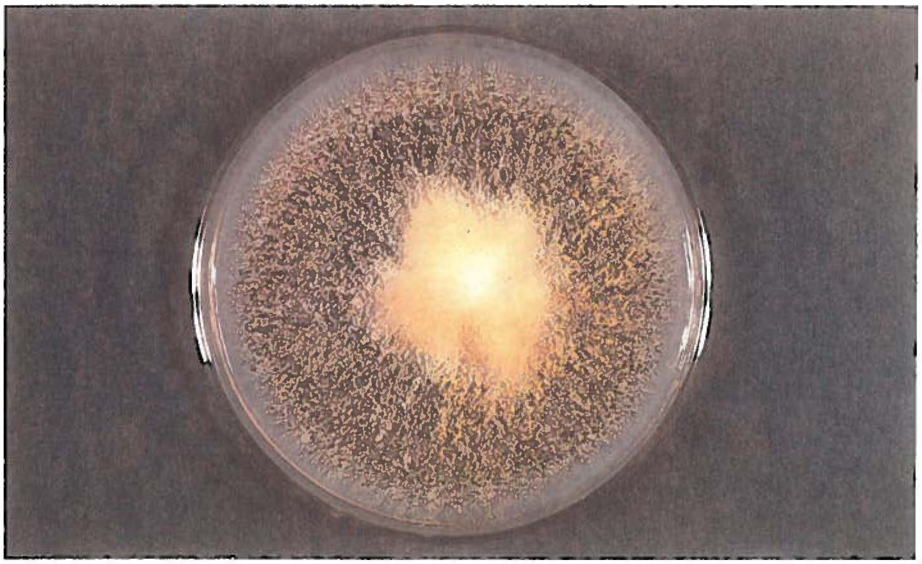
Ascospores with two equatorial crests and conidia

Aspergillus fumigatus

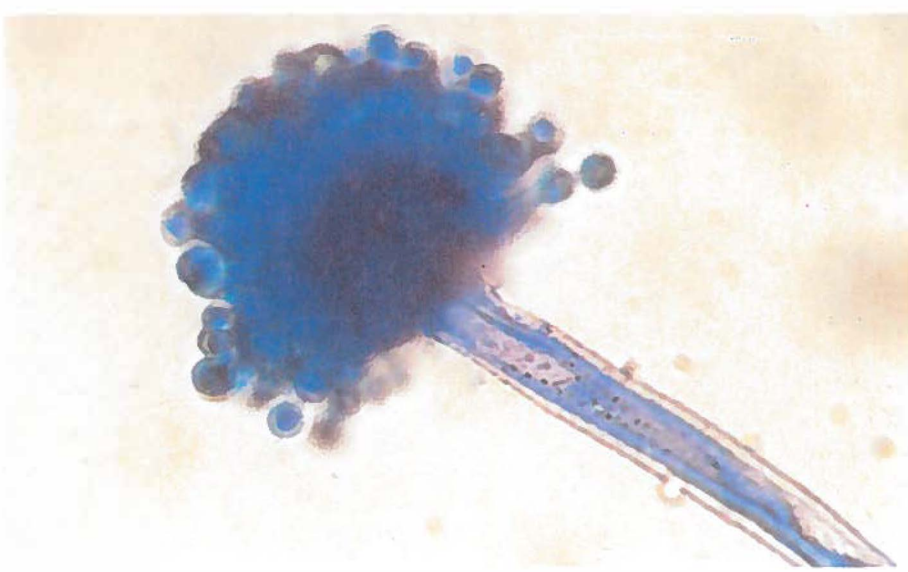
3-week old colony (hyaline isolate)

Conidiophore bearing uniseriate phialides

Aspergillus flavus

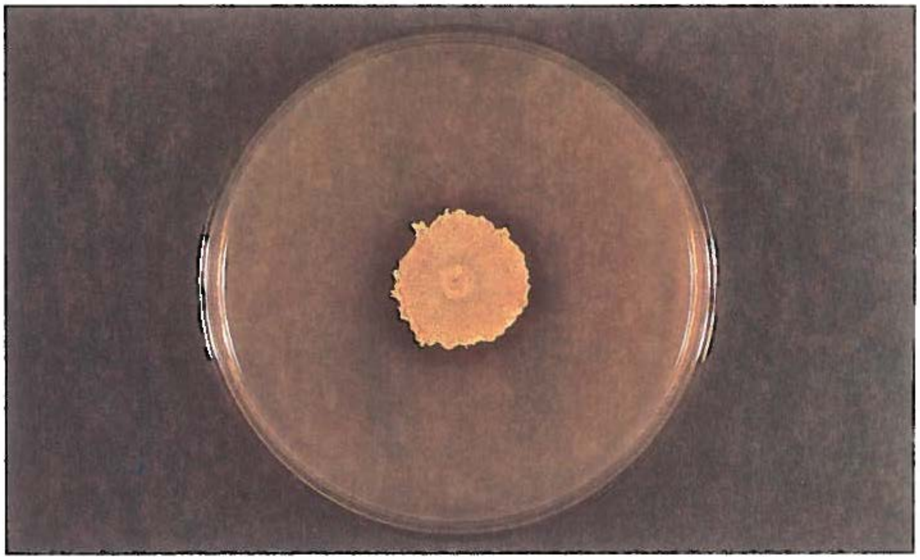


12-day old colony of A. flavus isolate forming sclerotia



Conidiophore

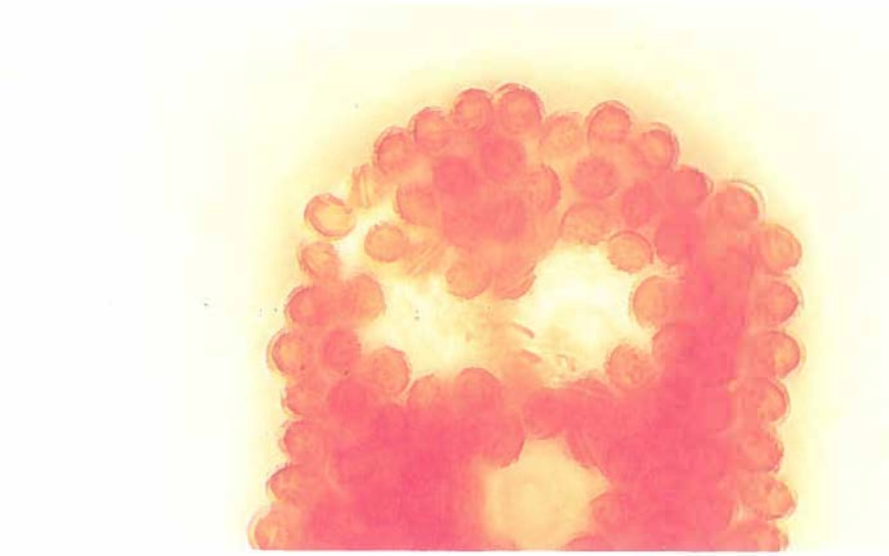
Aspergillus nidulans



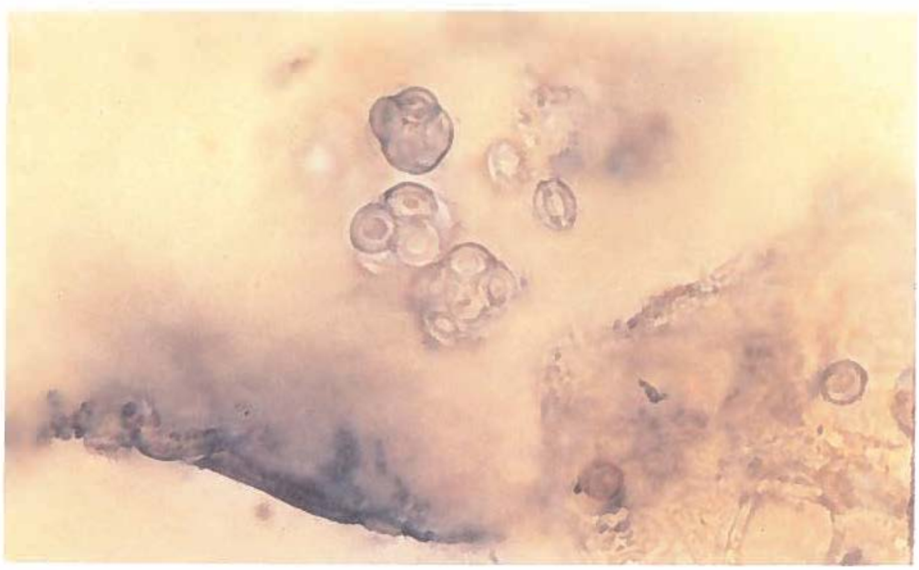
12-day old colony

Conidiophore bearing biseriate phialides

Aspergillus nidulans *(contd.)*

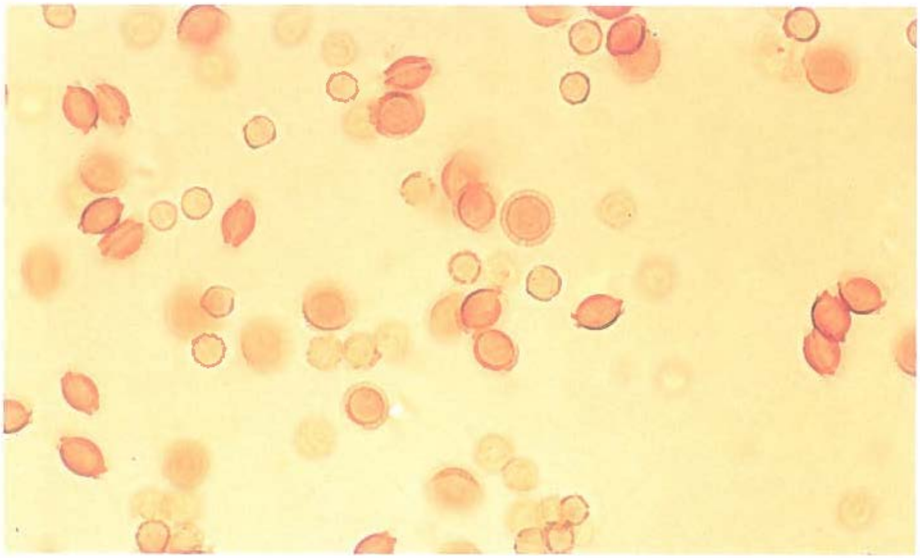


Cleistothecium (natural colour)

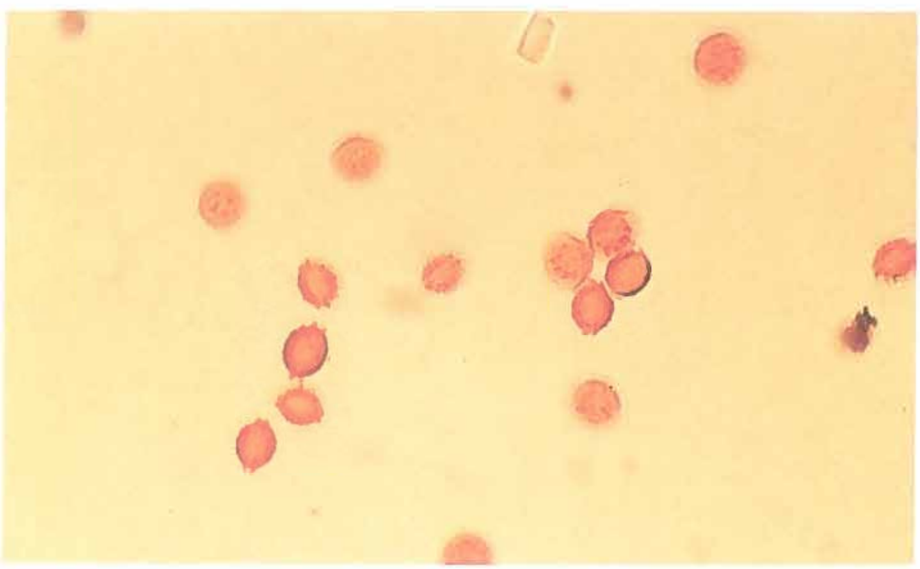


Asci

Aspergillus nidulans *(contd.)*



Ascospores (natural colour)



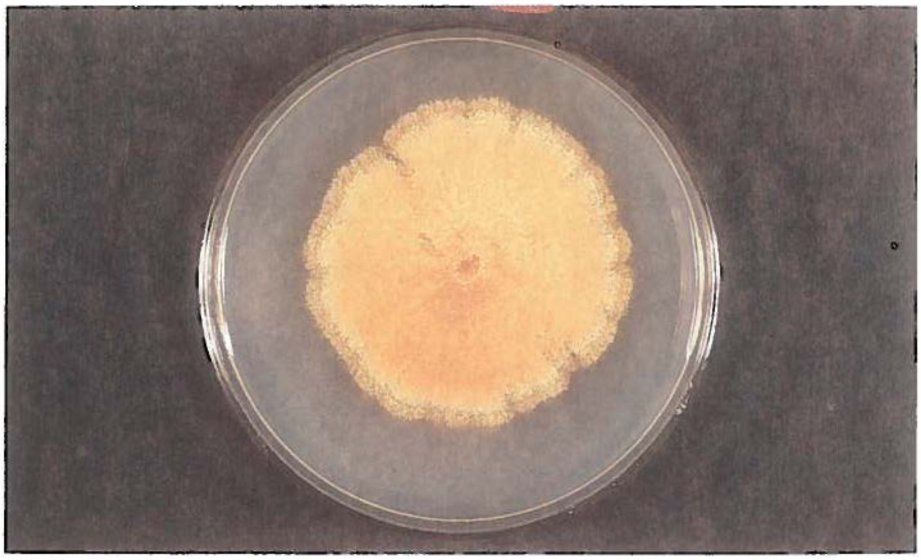
Ascospores of **A. nidulans** var. **echinulatus** (natural colour)

Aspergillus ochraceus

12-day old colony

Conidiophore bearing uniseriate phialides

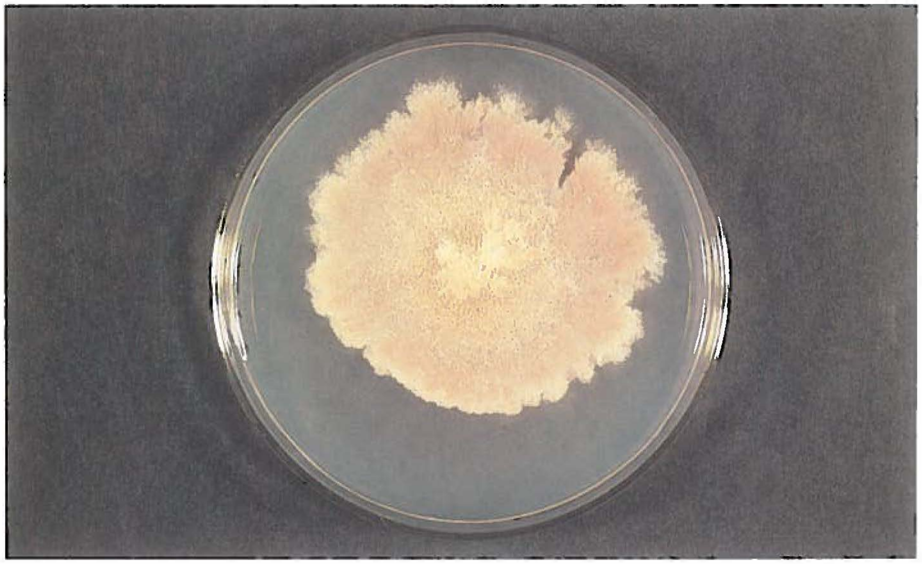
Aspergillus terreus



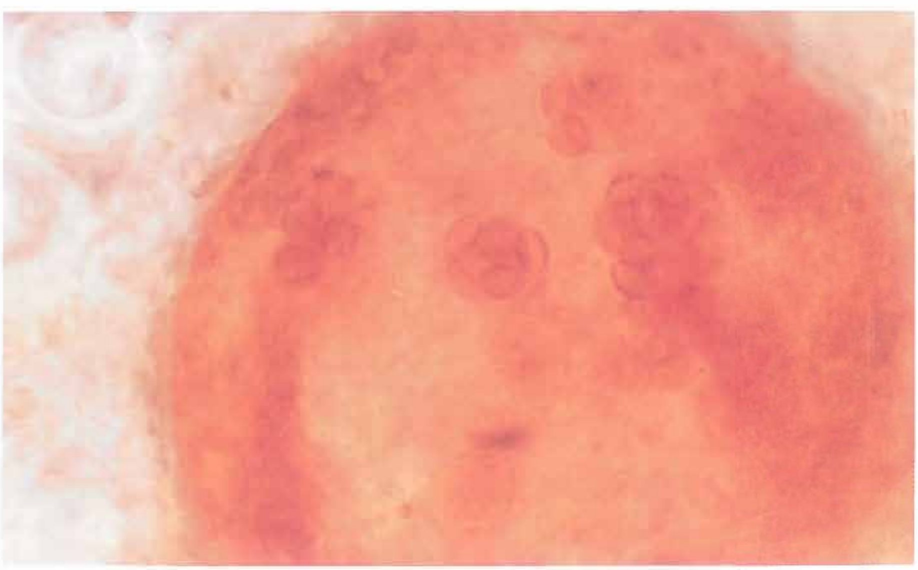
12 - day old colony

Conidiophore bearing biseriate phialides

Aspergillus quadrilineatus

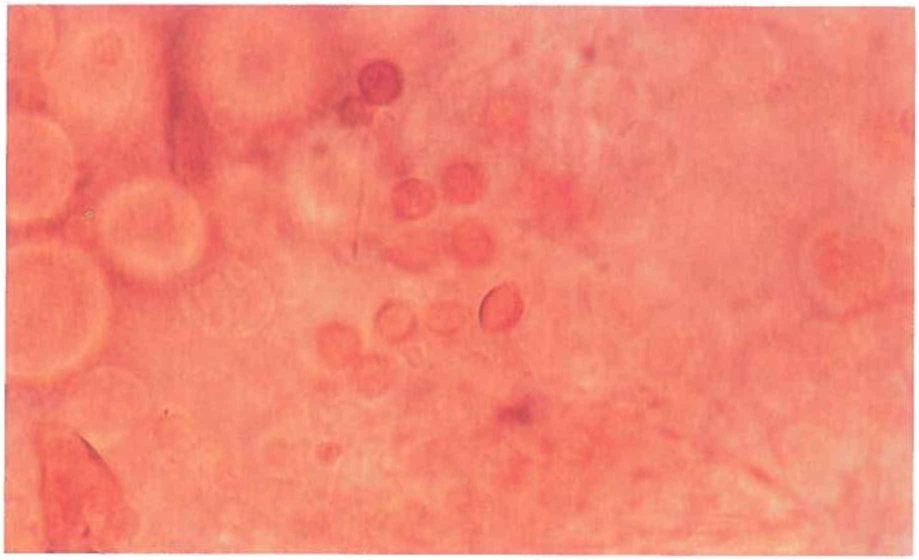


12 - day old colony



Cleistothecium and asci (natural colour)

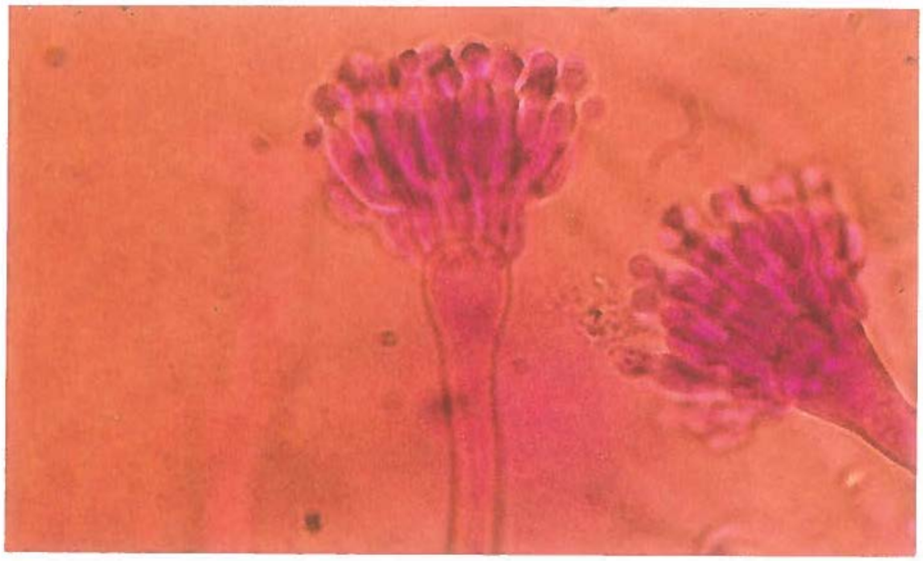
Aspergillus quadrilineatus *(contd.)*



Ascospores with four equatorial crests (natural colour)

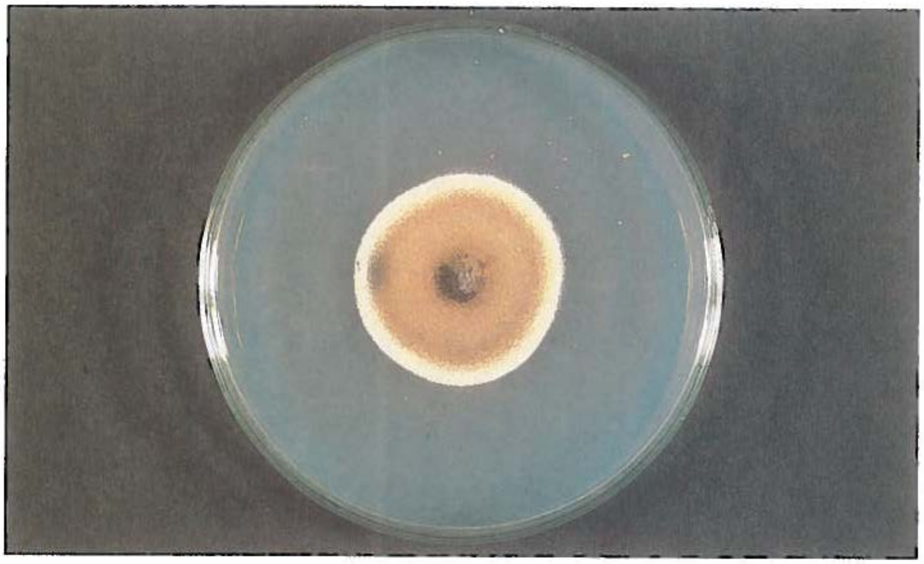
Conidiophores bearing biseriate phialides X 434

Aspergillus quadrilineatus *(contd.)*

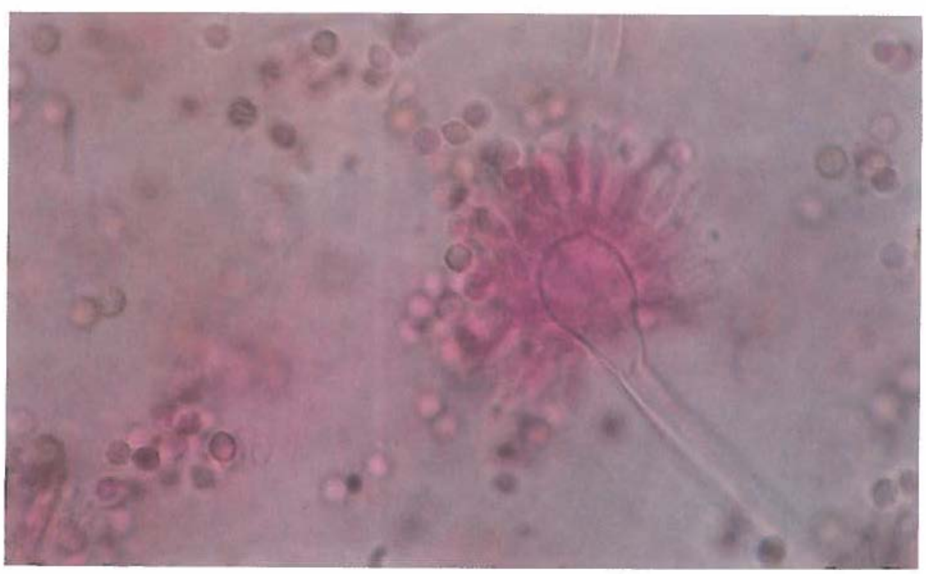


Conidiophore bearing biseriate phialides

Aspergillus versicolor



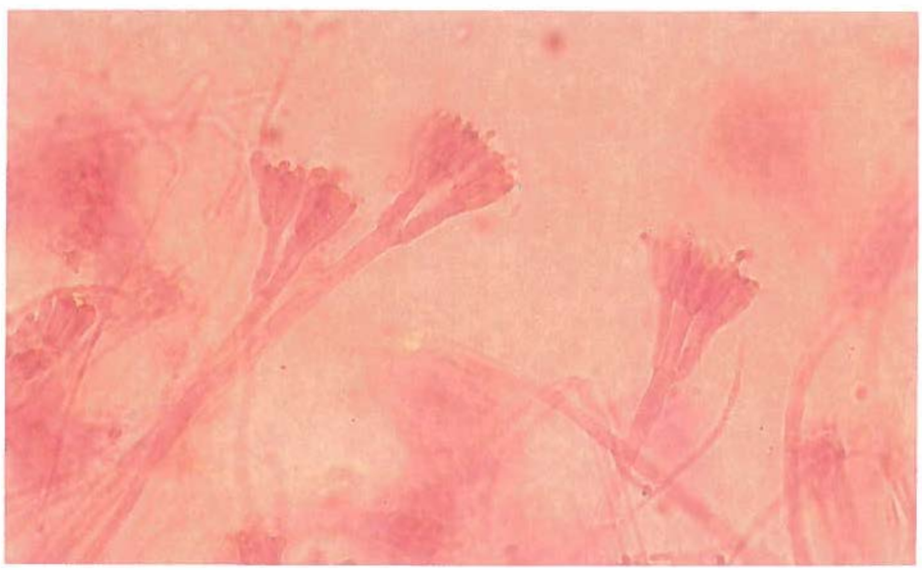
12-day old colony



Conidiophore bearing biseriate phialides

Penicillium corylophium

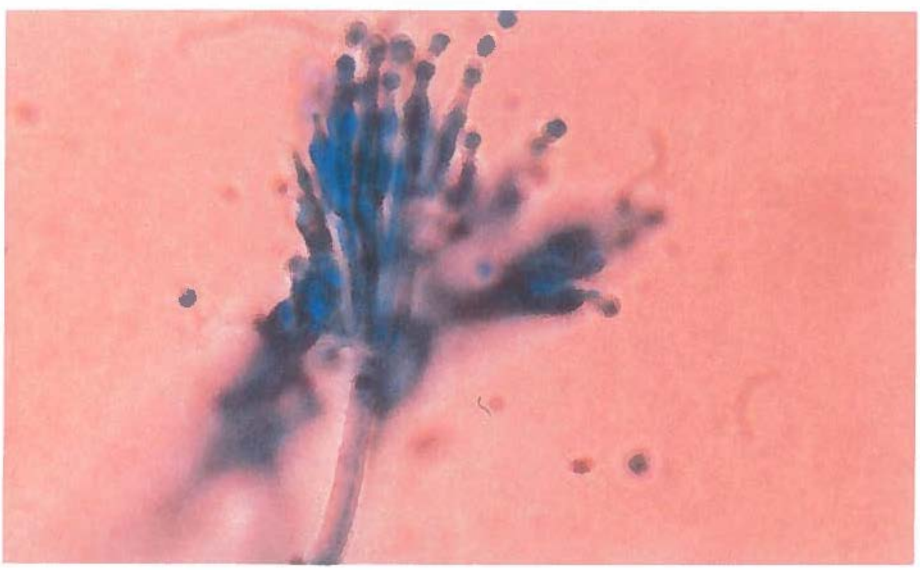
13 - day old colony; note that masses of conidia detached easily



Conidiophores; penicillus bearing 2-3 metulae X 434

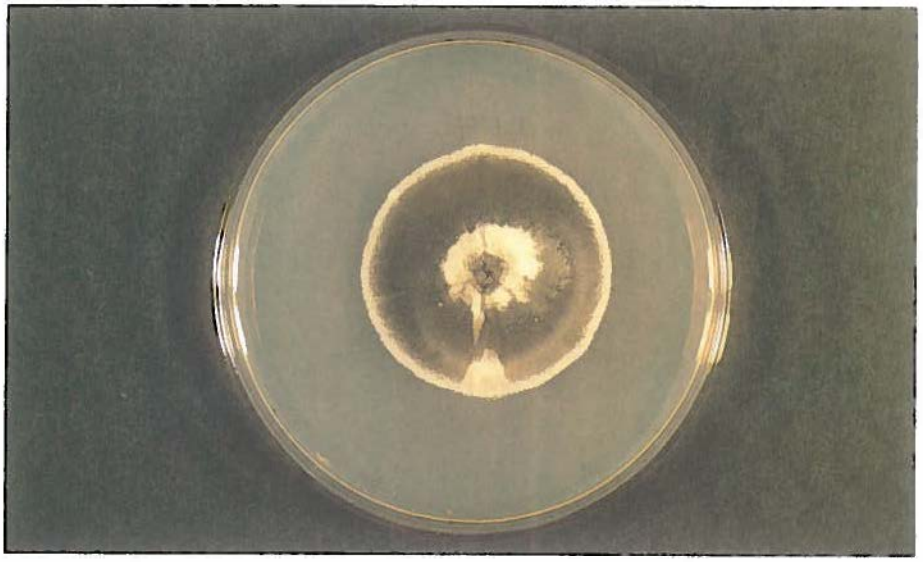
Penicillium chrysogenum

Conidiophore and asymmetrical penicillus



Conidiophore and asymmetrical penicillus

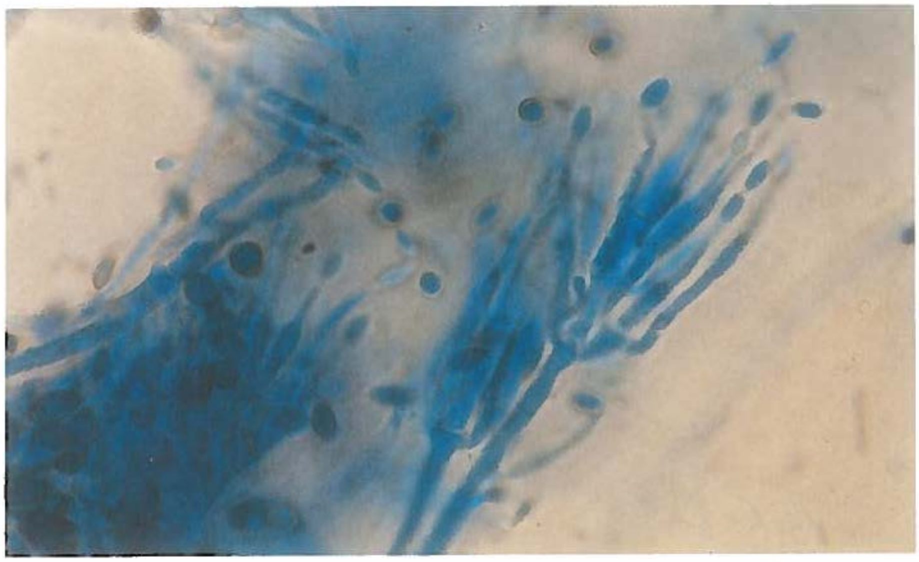
Penicillium jensenii



13 - day old colony

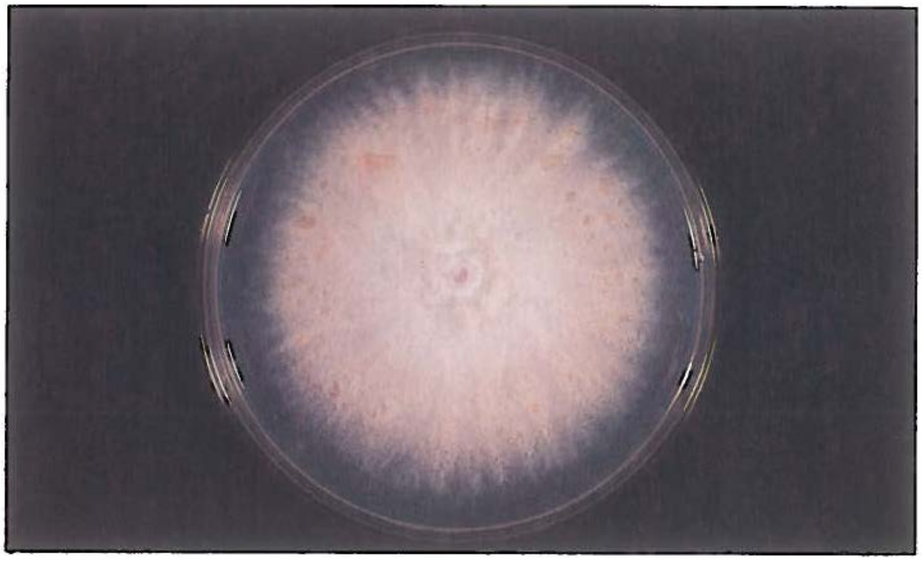
Penicillus showing the divaricate character

Paecilomyces variotii



Penicillus with long and slender phialides

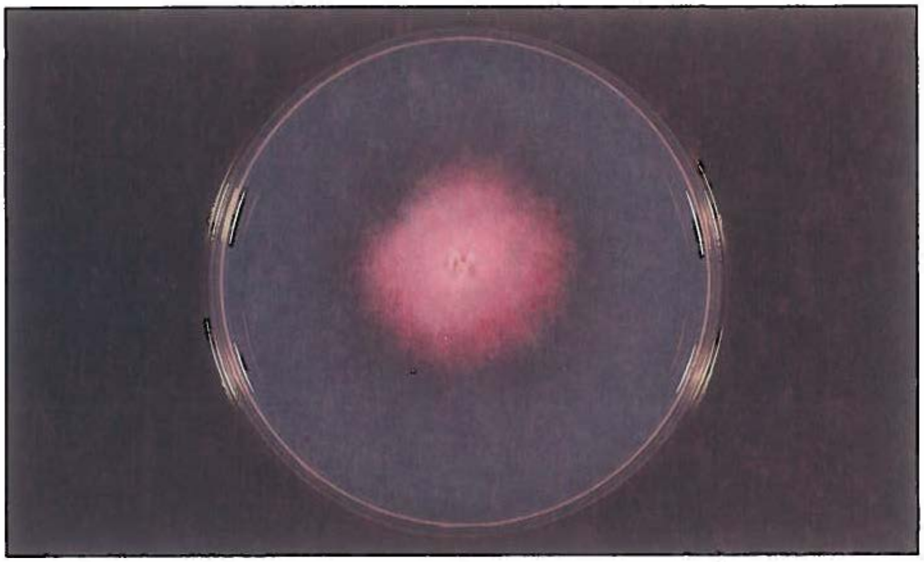
Fusarium acuminatum



5-day old colony on potato sucrose agar at 25°C

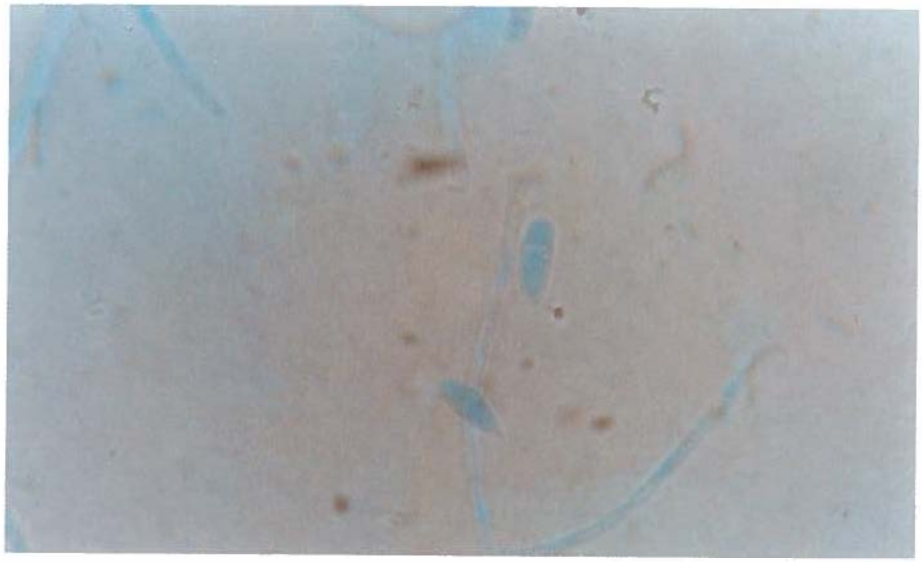
Conidia with acuminate apical cell

Fusarium fusarioides

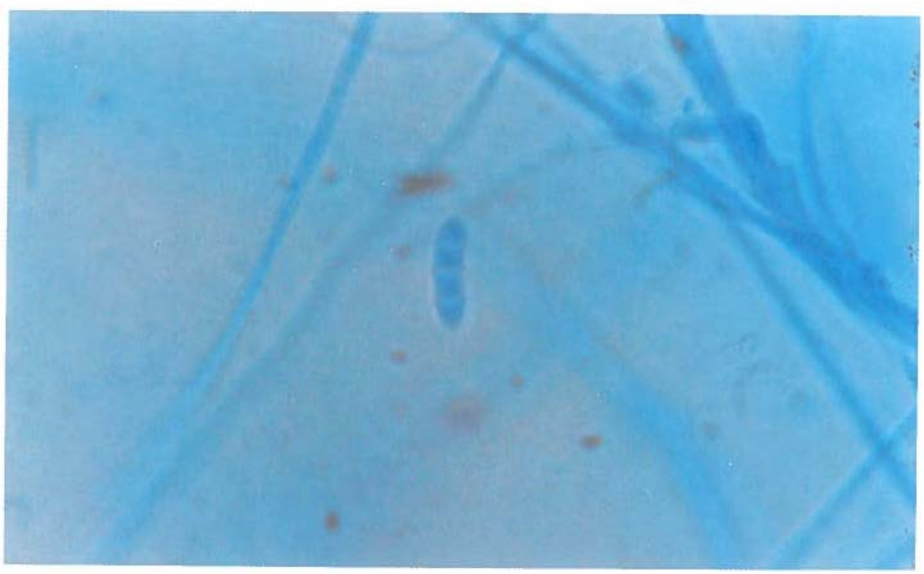


5-day old colony on potato sucrose agar at 25°C

Fusarium fusarioides *(contd.)*

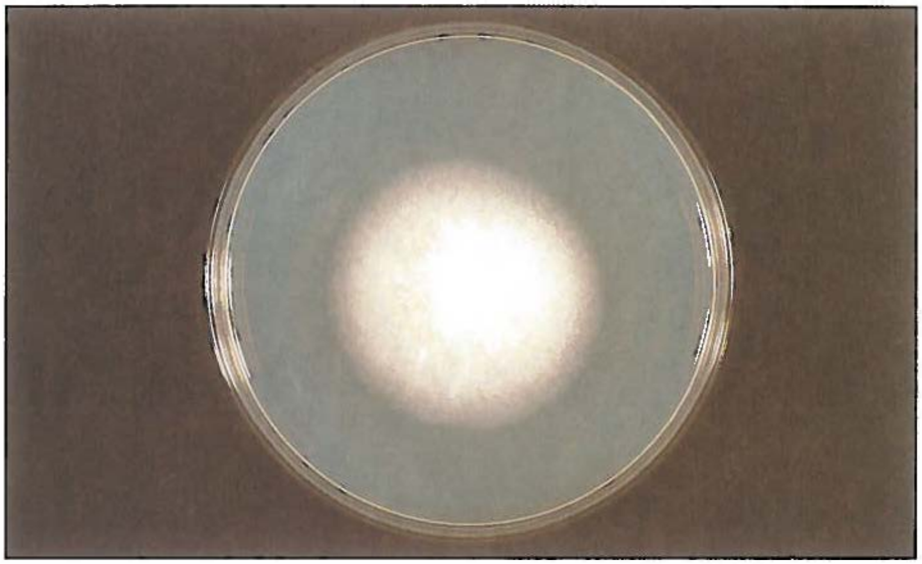


Clavate 1 - septate microconidia



Macroconidium

Fusarium solani

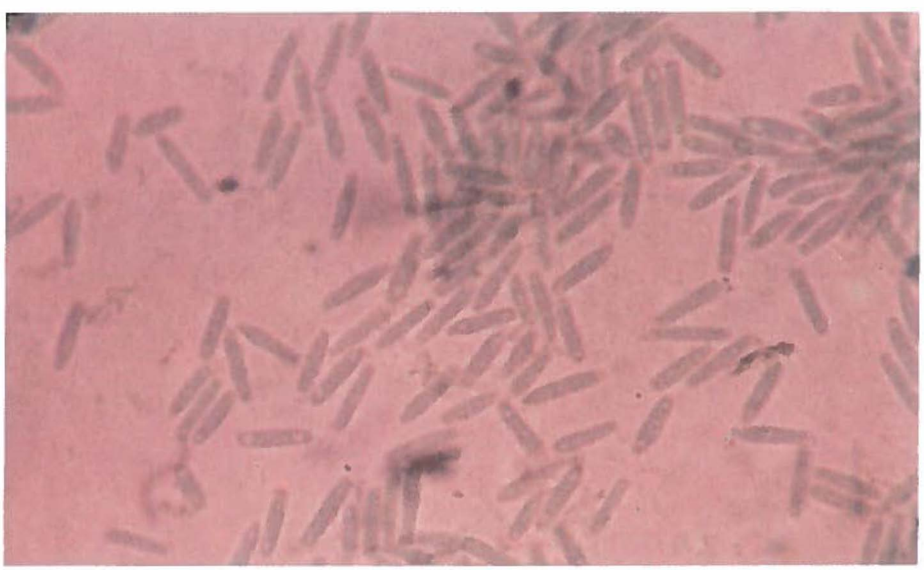


6 - day old colony on potato sucrose agar at 25°C

Micro and macroconidia

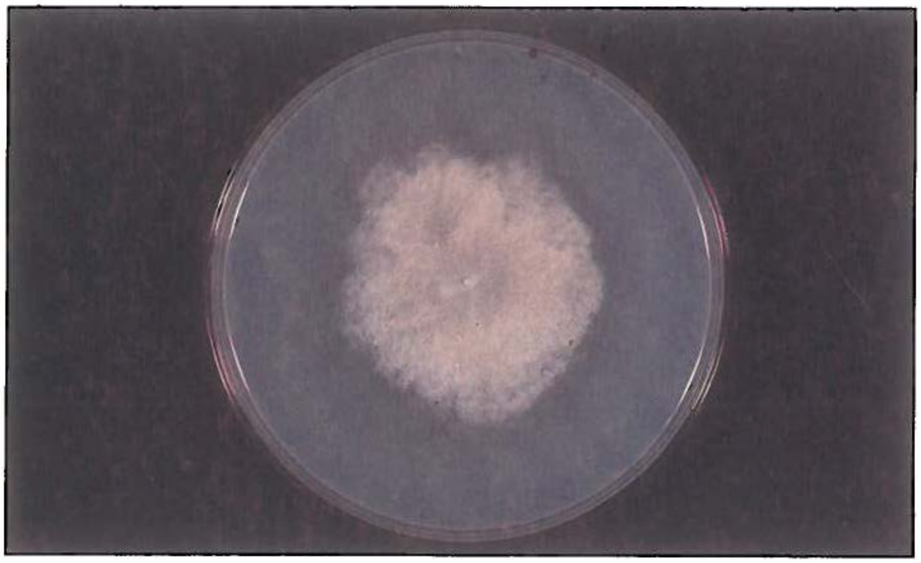
Myrothecium roridum

7-day old colony forming sporodochia

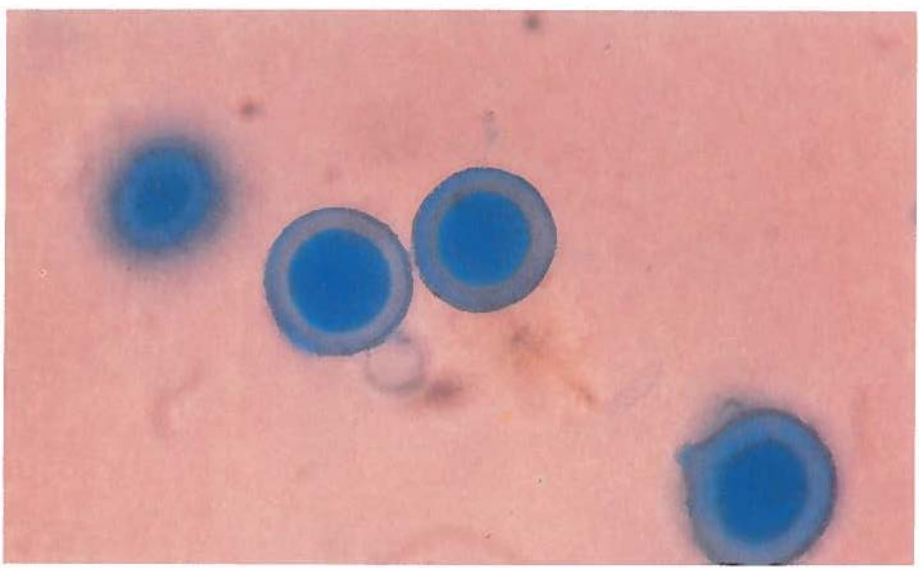


Conidia

Botryotrichum piluliferum

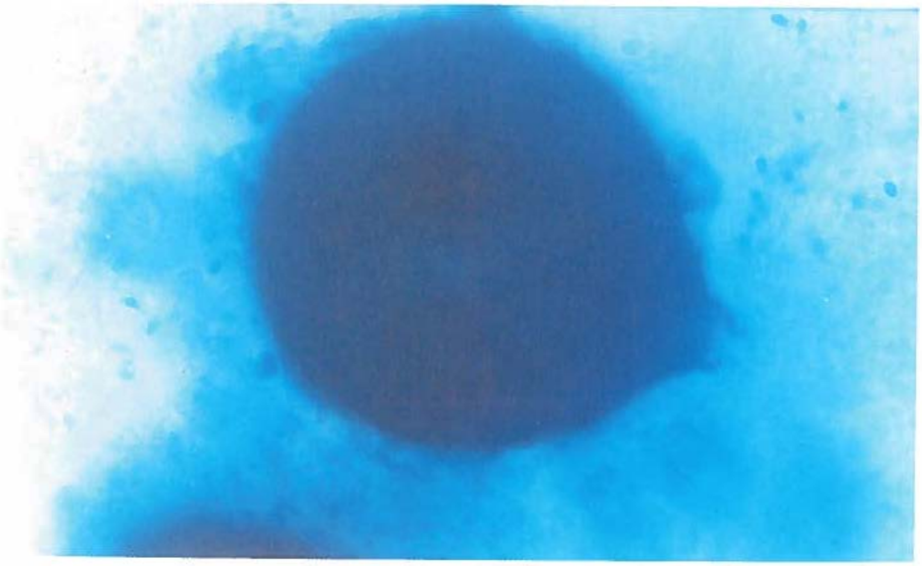


7-day old colony



Thick-walled conidia

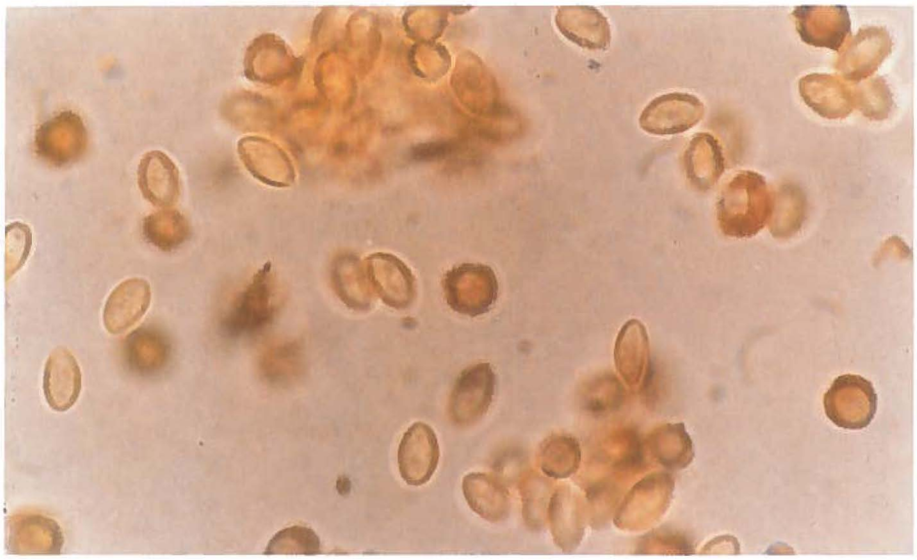
Microascus desmosporus



Perithecium

Ascospores

Microascus niger



Ascospores

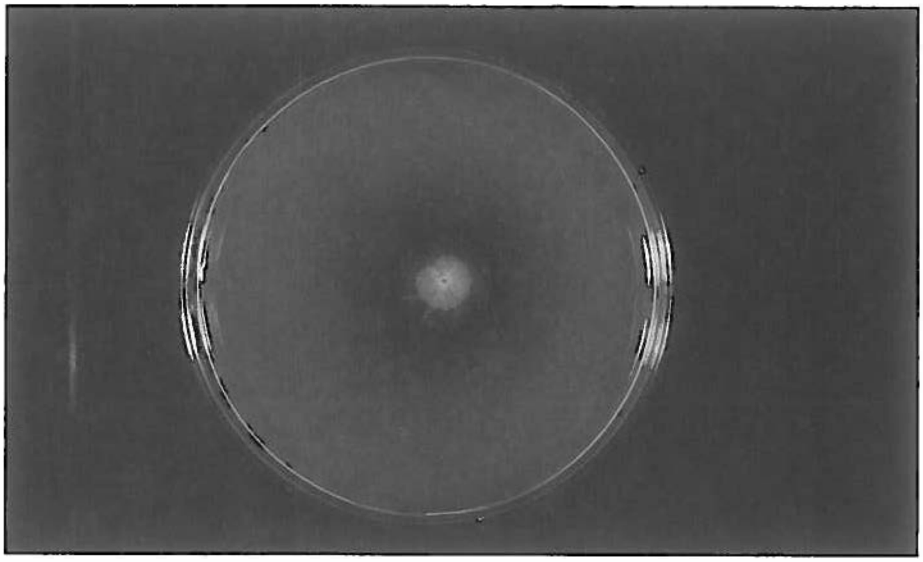
Microascus mangini

Perithecial ostiole and ascospores

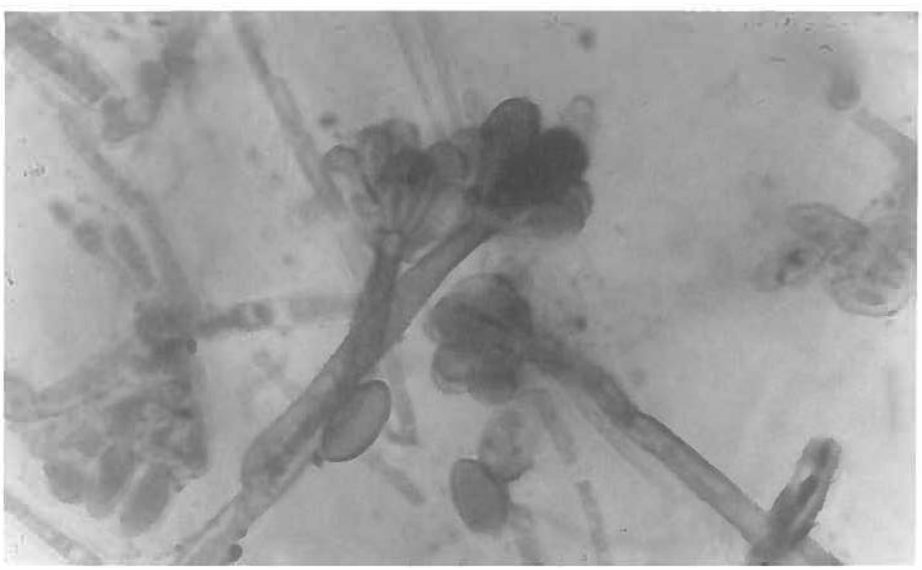
Alternaria alternata

Conidiophores and conidia

Stachybotrys atra

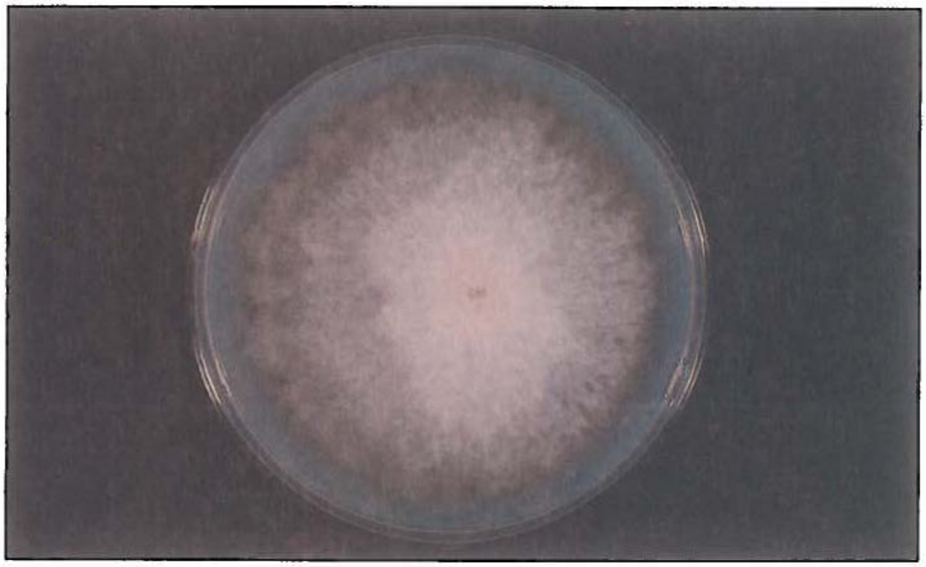


11-day old colony

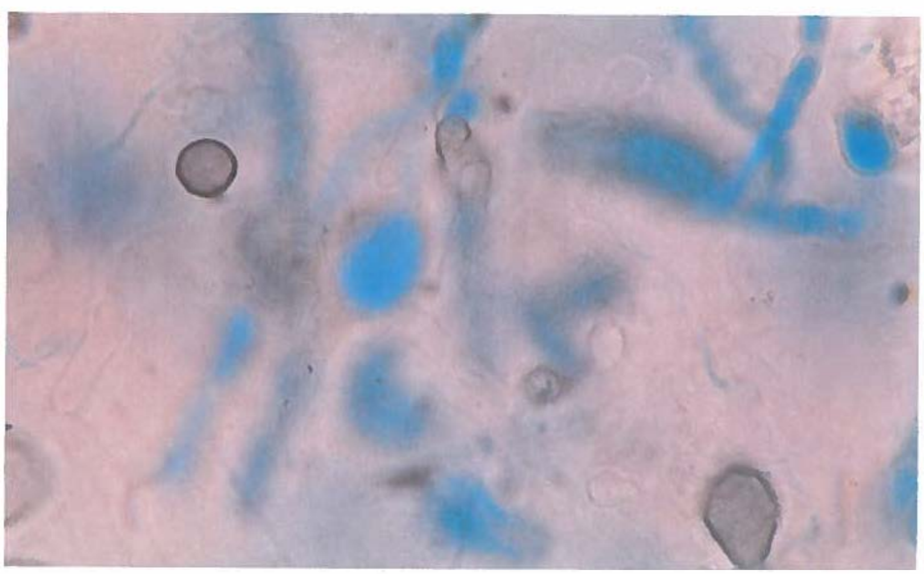


Conidiophores and conidia

Humicola grisea



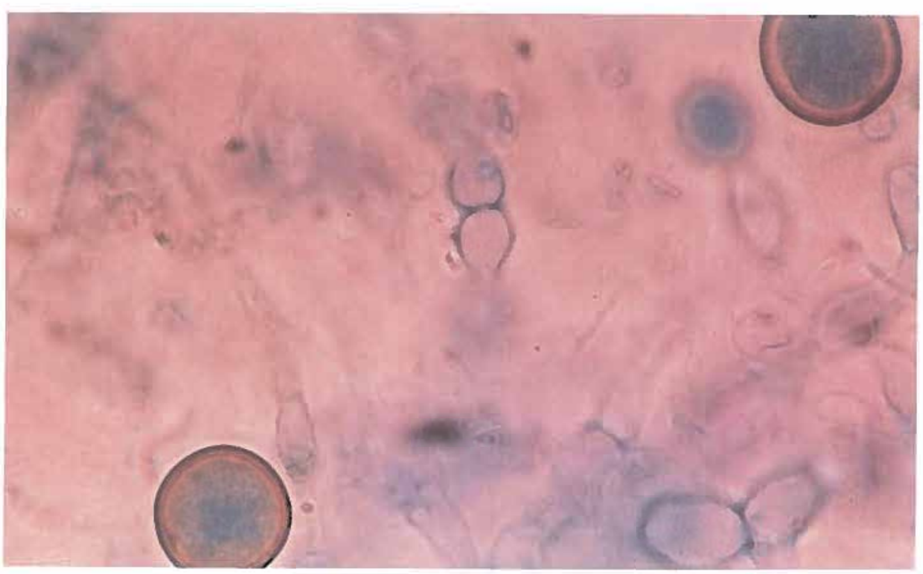
20 - day old colony



Conidia

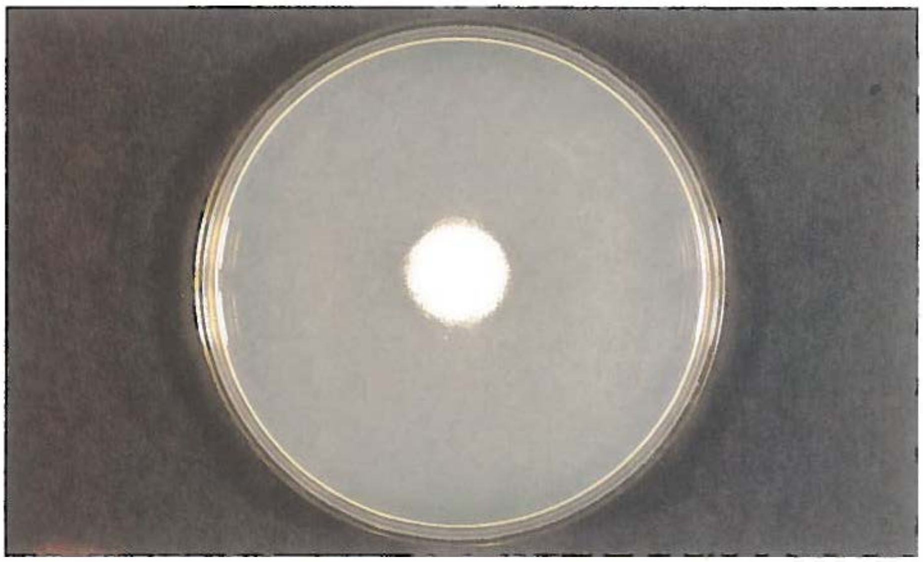
Humicola fuscoatra

20-day old colony

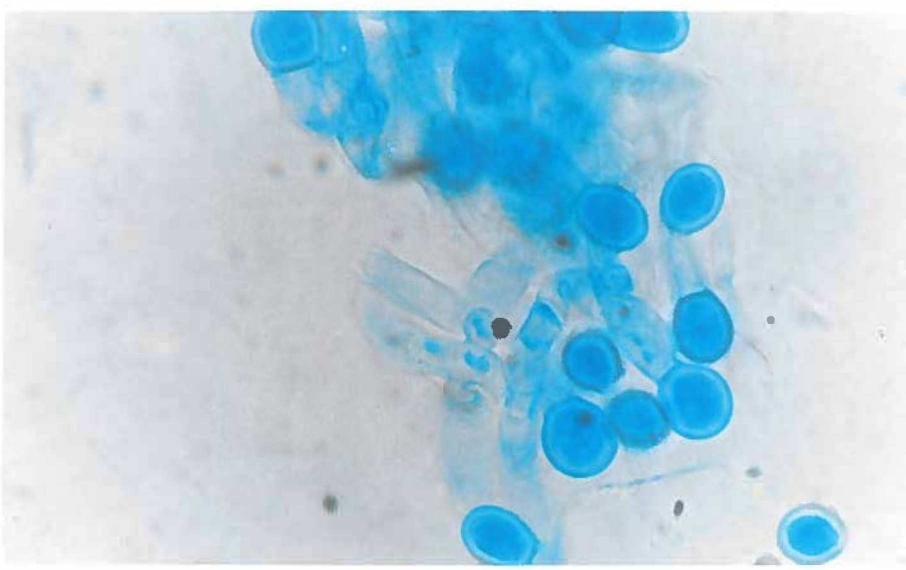


Conidia

Scopulariopsis candida

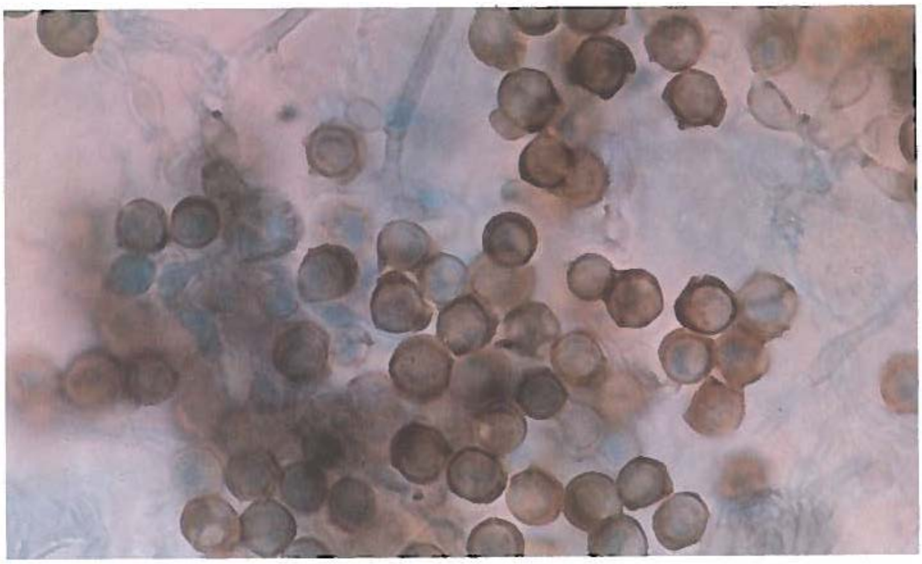


6-day old colony

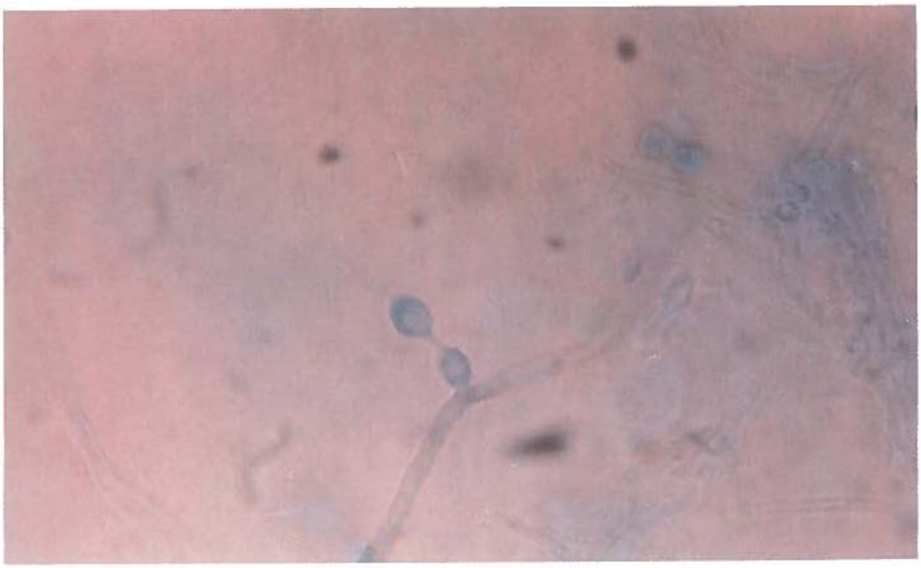


Annellophores and annellospores

Scopulariopsis sphaerospora



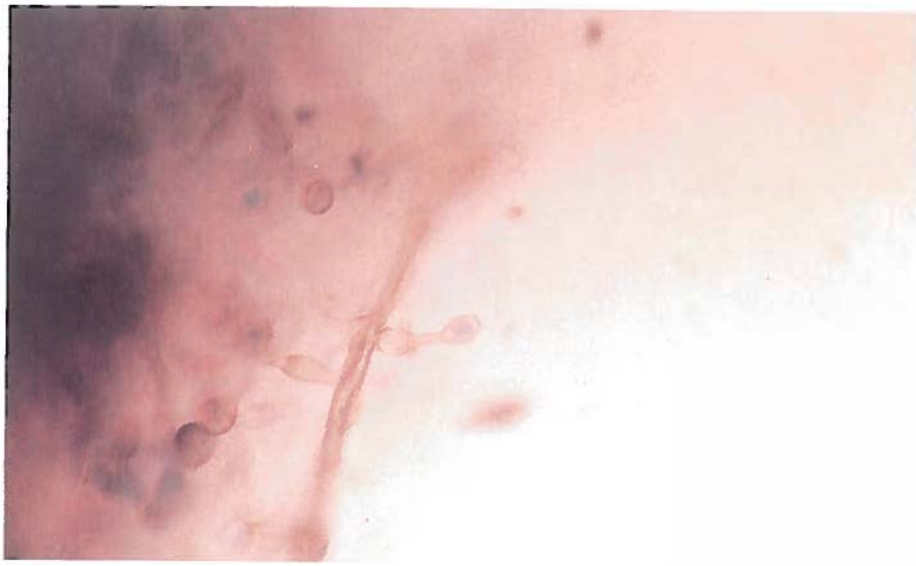
Annellospores



Annellophore bearing an annellospore

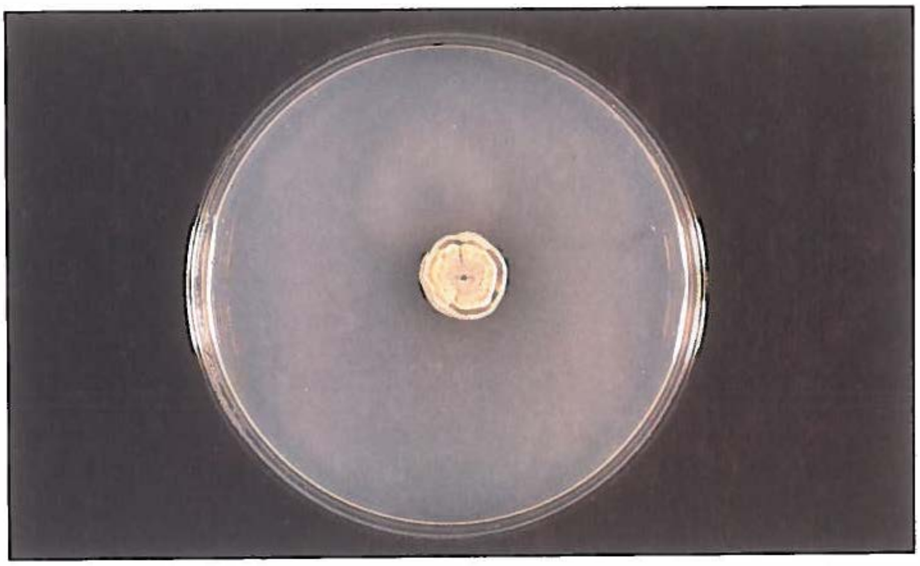
Scopulariopsis brumptii

11 - day old colony

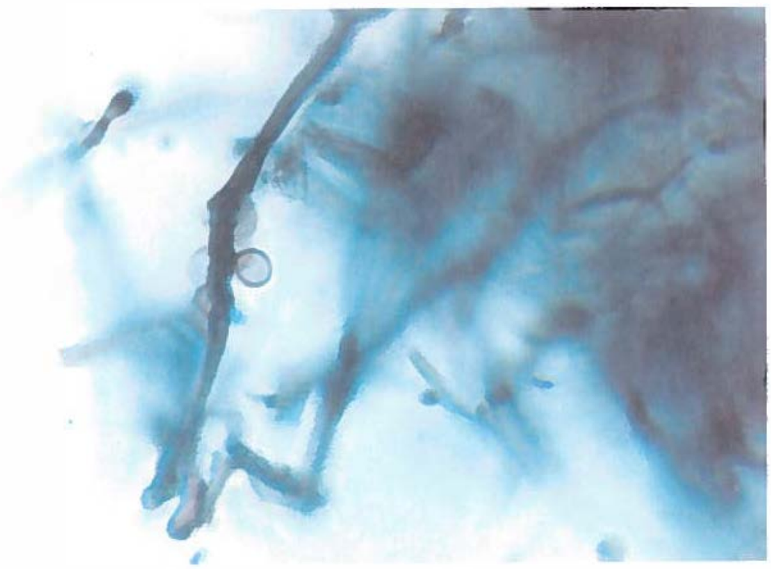


Annellophore bearing an annellospore

Ascotricha chartarum (anamorph)



2-week old colony

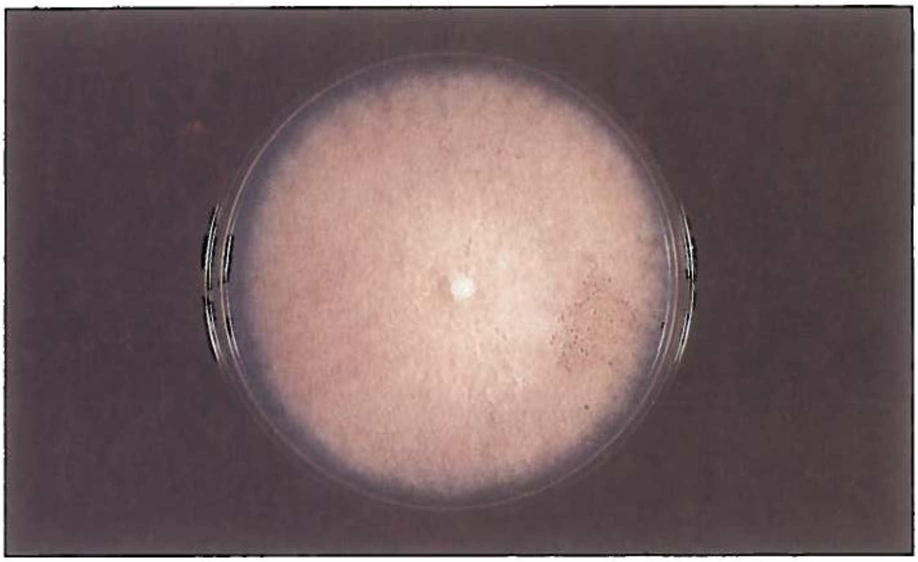


Conidiophore and conidia

Stemphylium vesicarium

Conidium constricted at the three median septa

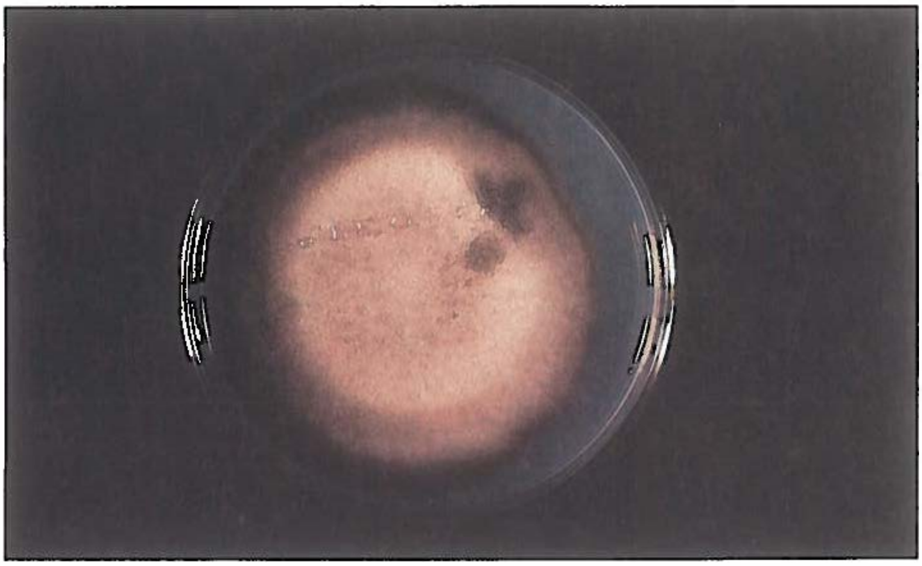
Stemphylium botryosum



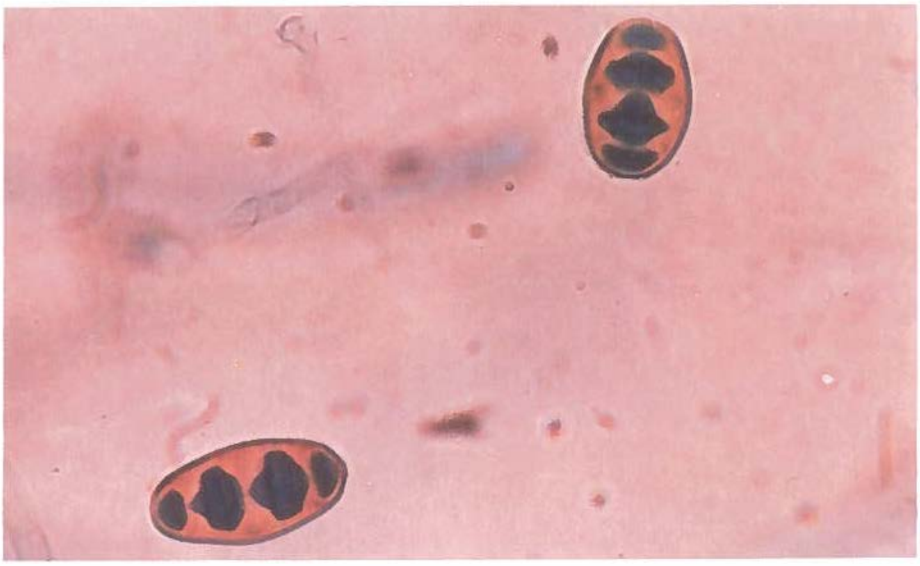
11-day old colony

Conidiophores and conidia

Drechslera australiensis

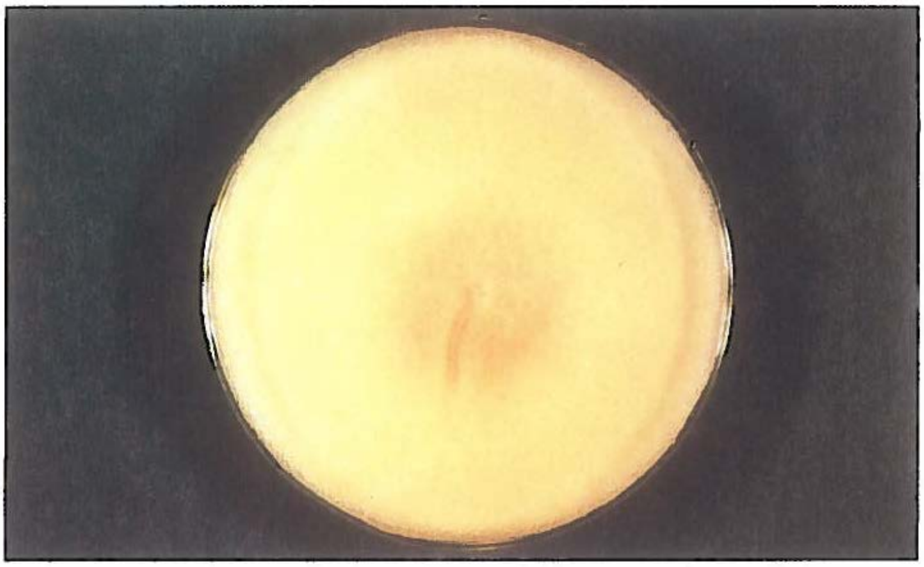


11-day old colony



Conidia with 3 pseudosepta

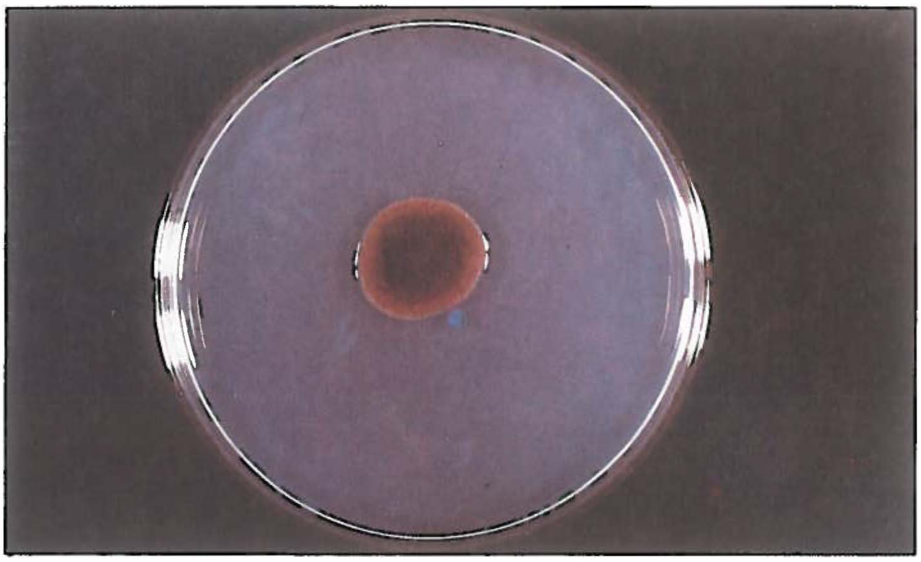
Drechslera halodes



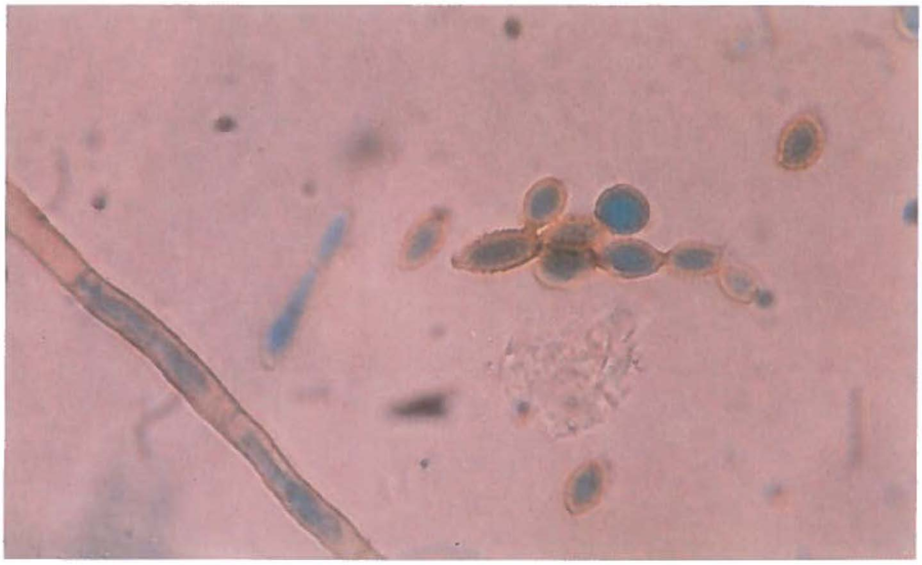
6-day old colony

Conidium

Cladosporium claladosporioides



11 - day old colony



Conidia

١٢ ـ جنس بوتريوتريكم ، أيضا ذو تكرار متوسط ويمثله نوعان :
بوتريوتريكم بليولفيرم ، وبوتريوتركم أتروجريزيم ، وهذا الأخير ذو تكرار نادر.

١٣ ـ كان جنسا الترناريا (٥) أنواع وسكوبيولاريوس (٥) أنواع عموما ذواتا تكرار متوسط ، كان الترناريا الترناتا وسكوبيولاريوس برومبتايي أكثرها شيوعا.

١٤ ـ كان جنس الميكرواسكس ، الطور التام لجنس سكوبيلاربوبس ممثلا بأربعة أنواع ، كانت كلها ذات تكرار نادر.

١٥ ـ كانت باقي الأجناس والأنواع في معظمها ذات تكرار نادر.

١٦ ـ عند درجة ٤٥°م تم عزل ١٢ جنساً و١٦ نوعاً ، وكان اسبرجلس فيومجاتس أكثر الأجناس شيوعا ، وتم رصد ٦ أنواع لم تعزل عند درجة حرارة ٢٨°م وهي : مالابرانكيا بولكيلا فاريتي سلفوريا ، ابسيديا كوريمبيفرا ، ميروكوكام البومايس ، ثيروموما يس لانجيونوسس ، هيوميكولا انسلوينس ، ثرموا سكس اورنتيا كس.

١٧ ـ أوضحت الدراسة الحالية أن الفلورا الفطرية للتربة في قطر مشابهة أساساً لتلك التي توجد في البلاد العربية المجاورة.

الملخص العربي

الفطزيات هي احديالمكونات الحية الهامة للتربة . وهي تلعب دوراً بارزاً في احداث خصوبة التربة بما تحلله من مواد عضوية مختلفة فيها . وكثير من فطريات التربة تسبب أمراضاً خطيرة للنباتات الاقتصادية . كما تأوي التربة كثيراً من الفطريات التي تسبب أمراضاً للانسان والحيوان مثل الأمراض الجلدية والاسبرجيللوزيس وغيرها . ولهذا فان دراسة فطريات التربة تمثل أهمية خاصة .

وتتلخص نتائج هذا البحث فيما يلي :

١ ـ جمع خلال هذا البحث الذي أجري على فطريات التربة في دولة قطر (٥٣) جنسا و (١٤٢) نوعا ، و (٨) أصناف ، وذلك من (٤٢) عينة تربة ممثلة لمناطق مختلفة في شبه جزيرة قطر.

٢ ـ كانت العينات المأخوذة من أراضي زراعية ، تشكل بانتظام أغنى العينات .

٣ ـ لم يكن هناك توزيع خاص لأنواع الفطريات في البيئات وأنواع التربة المختلفة .

٤ ـ سجل أعلى مجموع كلي للفطريات وأكبر عدد من الأنواع على بيئة تشبكس المحتوية على ٥٠٪ سكروز ، وذلك بالمقارنة مع بيئة تشبكس العادية المحتوية على جلوكوز ، وبيئة تشبكس سيللوز ، مما يكشف عن أن لفطريات التربة طبيعة أزموزية .

٥ ـ أظهرت النتائج أن محتوى التربة من المادة العضوية والملوحة تبدو متداخلة مع بعضها في تأثيرها على المحتوى الفطري للتربة .

٦ ـ جنس الأسبرجلس ، كان أكثر الأجناس شيوعاً في تربة قطر ، فقد تم تعريف ٢٣ نوعاً منه ، و ٥ أصناف ، وكانت أسبرجلس تريس ، وأسبرجلس فلافس ، وأسبرجلس فيرزيكلور ، وأسبرجلس نيجر ، أكثر الأنواع شيوعا بينما كان أسبرجلس ايجبتياكس ذا توزيع متوسط في عينات التربة على وسط غذائي تشبكس المحتوي على ٥٠٪ سكروز .

وجاء اسبرجلس امستلودامي في المرتبة الثالثة في التكرار على الوسط الغذائي تشبكس ٥٠٪ سكروز ، ولكنه لم يظهر على الوسط الغذائي تشبكس المحتوي على ٣٠٪ سيللوز ، وكان تكراره نادراً على الوسط الغذائي تشبكس المحتوي على ١٠٪ جلوكوز .

٧ ـ تم تعريف ١٦ نوعا في البنسليوم حيث كان أكثرها تكراراً ، بنسليوم كرايزوجينم ، بنسليوم كورويلو فيلم ، بنسليوم فنكيولوزم ، وبنسليوم بريفي كومباكتم ، وجاء جنس البنسليوم مع جنس الفيوزيريم ، في المرتبة الثانية في التكرار على الوسط الغذائي تشبكس المحتوي على ٥٠٪ سكروز .

٨ ـ من الأجناس المعروفة أيضا ، جنس الفيوزيريم ، وقد تم رصد (٨) أنواع وصنف واحد منه حيث كان فيوزيريم سولاني ، هو النوع السائد بانتظام ، ويتبعه فيوزيريم أوكسيورام ، وفيوزيريم أكويزيتاي .

٩ ـ جاء جنس كلادوسبوريم في المرتبة الثانية أو الثالثة حسب وسط العزل ، وتم تعريف (٥) أنواع منه كان أكثرها شيوعاً كلادوسبوريم كلادوسبوريويدز وكلادوسبوريم سفيروسبرم .

١٠ ـ كان جنس ستاكي بوتريس ذا تكرار عالي في التربة القطرية ، ويمثله صنف واحد فقط هو ستاكي بوتريس أتراصنف ميكروسبورا .

١١ ـ جنس اكريمونيام ، ذو تكرار متوسط في التربة القطرية وتمثله (٥) أنواع حيث كان اكريمونيام ستريكتم أكثرها شيوعاً .

مركز البحوث العلمية والتطبيقية

S.A.R.C.

فطريات التربة في دولة قطر

الأستاذ الدكتور

عبد العال حسن مباشر

أستاذ الفطريات - قسم النبات - كلية العلوم - جامعة قطر
ونائب رئيس جامعة أسيوط للدراسات العليا والبحوث سابقاً

السيدة / عائشة عبد الله تركي السبيعي

مدرس مساعد بقسم النبات - كلية العلوم - جامعة قطر

١٩٨٧م

مركز البحوث العلمية والتطبيقية
جامعة قطر
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