Soil Mycoflora of the Southern Desert of Iraq

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Summary. – Soil microfungi were isolated from two localities in the Southern Desert of Iraq. The two sites were dominated by the halophytes *Halocnemum strobilaceum, Suaeda vermiculata, Nitraria retusa* and *Cyperus conglomeratus*. Sixty three species belonging to 32 genera were identified, of which 30 were found common to both sites. The most common genera were *Aspergillus, Drechslera, Alternaria,* and *Ulocladium*. Ascomycetes were represented by genera such as *Chaetomium, Gymnoascus, Kernia, Melanospora, Lophotrichus* and *Sporormiella*. Mucoraceous genera were represented by *Absidia, Actinomucor, Mucor,* and *Rhizopus*. Six species of thermotolerant and thermophilic fungi were encountered viz. *Mucor pusillus, Chaetomium thermophile, Aspergillus fumigatus, A. candidus Malbranchea pulchella* and *Thermomyces lanuginosus*. The results are discussed in relation to comparable surveys of microfungi that have been carried out in other arid regions.

Introduction

Apart from the work of ABDULLAH (1982), comparatively little attention has been paid to the study of the microfungi inhabiting Iraqi desert soils, and most of the previous investigations have been made on agricultural soils. In this connection, the first report on Iraqi soils fungi was made by TOLBA & al. (1957), who investigated the fungal flora around Baghdad. Al-DOORY & al. (1959), isolated 150 fungal species from soil collected in five provinces of central Iraq including Baghdad. TAMIMI & HADWAN (1980; 1981) have studied the soil and rhizosphere fungi in potato fields in central Iraq. Other studies were made by ISMAIL & ABDULLAH (1977) and El-DOHLOB & Al-HELFE (1982) on soil samples from southern Iraq near Basrah.

Information on desert and arid soil mycoflora in other countries has been provided by many authors e. G. DURRELL & SHIELDS (1960), RANZONI (1968), ELWAN (1962), ELWAN & DIAB (1971), ELWAN & al. (1969), SALAMA & al. (1971), MOUSTAFA & al. (1976), STATES (1978), TAYLOR (1979), STATES (1978), TAYLOR (1979), HALWAGY & al. (1982), and ABDEL-HAFEZ (1981; 1982 a, b, c).

The aim of this work was to list common soil microfungi in four plant communities each dominated by a single plant species from two sites in the Southern Desert of Iraq.

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Materials and Method

Description of study area: Two sites (near Safwan 30° 33′ N, 47° 48′ E and near Samawa 31° 18′ N, 45° 17′ E) were studied. The mean annual rainfall values at Safwan and Samawa are 139.5 mm and 130.2 mm respectively. The mean minimum temperature and mean maximum temperature for the whole Southern Desert area are 6 C° and 42 C° respectively. From May to September, Iraq is one of the areas receiving the highest incidence of solar radiation in the Northern Hemisphere. In the peak of summer it may reach 800 m wh. $day^{-1}cm^{-2}$. In winter it drops to about 240 m wh. $day^{-1}cm^{-2}$ and under heavy cloud as little as 40 m wh. $day^{-1}cm^{-2}$ (THALEN, 1979).

The native vegetation is composed primarily of halophytic plants. Soil samples were collected in November 1982 and January 1983 from areas covered with monospecific stands of *Halocnemum strobilaceum* (PALLAS) M. BIEB., *Nitraria retusa* (FORSSK.) ASCH., *Suaeda vermiculata* FORSSK. and *Cyperus conglomeratus* ROTTB. at both sites. The samples were processed within one week of collection.

Isolation of fungi: Two isolating techniques were employed. Fungal numbers were estimated by the soil dilution and plate count method of JOHNSON & al. (1959). A dilution of 1 : 100 which reflects the relatively low numbers of propagules present was chosen for the estimation of fungal numbers. The soil plate method of Warcup (1950) was also employed. Three types of media were used for the isolation of fungi: GPY (Glucose 10 g, Peptone 2 g, Yeast extract 1 g, Agar 15 g, Aged sea water (Salinity 35%) 1L); Corn Meal Agar (CMA) and Potato Dextrose agar (PDA). To each medium 50 mg/L Chloramphenicol (SDI) was added after autoclaving to rextrict bacterial growth. Twenty four plates were used for each sample (eight plates for each substrate used). The isolation plates were incubated at 25° C for 7 days. After incubation, the number of propagules per gram dry soil was calculated. For the isolation of thermotolerant and thermophilic fungi from each sample, the soil plate method only (WARCUP, 1950) was employed. Four additional plates for each substrate were incubated at 45° C for up to five days. The total soluble salts and chloride contents of the soil samples were determined according to PIPER (1947). The organic matter content was measured by the loss by the ignition method (BEAR, 1964).

Result and Discussion

All the soil samples were alkaline (Table: 1). The pH values ranged between 8.0 to 8.58. The total soluble salt content was high for the majority of the soil samples, and it ranged from 4.75 to 25.0%.

The number of fungal propagules per gram of dry soil was calculated for all the samples (Table: 1). The lowest number of fungal propagules (420 colonies per gram dry soil) was found in saline soil supporting *Suaeda vermiculata* plants at Samawa site. The highest (4120 colonies per gram of dry soil) was obtained from soil samples with *Cyperus conglomeratus* near Safwan.

Generally soil with high soluble salt contents gave a low fungal count. RANZONI (1968) carried out a comprehensive study on the soil microfungi of the Sonoran Desert, U.S.A. He isolated 229 species of fungi belongig to 107 genera from 30 soil samples. Two third of his samples yielded in average less than 12,000 propagules per gram of soil and the fungal counts ranged from 50–34,000 colonies per gram of soil. Data for the total fungal count (133-3166) colonies per gram dry soil) given by ELWAN & al. (1969) for desert soils of Western Arabia and by SALAMA & al. (1971) for the fungal flora of the Western mediterranean coast and Libyan desert soils (1087–3748 colonies per gram of dry soil) agree fairly well with our counts. The results of this investigation indicate that the total count of desert soil is very low as compared with the counts (27,000–282,000) given by Al-DOORY & al. (1959), TOLBA al. (1957), (10916–37158) and ISMAIL & ABDULLAH (1977), (50,000–66,000) for Iraqi agricultural soil.

63 species of fungi belonging to 32 genera were isolated and identified (Table 2). Only thirty species were common to both sites. Fifty-one species were isolated from soil samples collected from Safwan area, while fourty-two species were obtained from Samawa area.

In the present work the majority of species belong to *Aspergillus* (12 species), *Alternaria* (4 species) and *Drechslera* (4 species). *Aspergillus* spp. accounted for 16% of the total species isolated, *Alternaria* and *Drechslera* each for 6% of the total. In Kuwait desert soil, *Aspergillus, Alternaria* and *Drechslera* constituted 16%, 5%, and 3% respectively of the total species isolated (HALWAGY & al., 1982), while in Saudi Arabia desert soil, they constituted 26%, 4% and 3% respectively (ABDEL-HAFEZ, 1982 a).

Among *Aspergillus* species, *A. fumigatus* was the most prevalent fungus, being isolated from 70% of the sampling sites examined. *A. candidus* and *A. niger* were second and third in prevalence, being isolated from 60% and 50% of the sampling sites examined respectively. ABDULLAH (1982) reported *A. candidus* as one of the dominant fungi colonizing herbivore dung in the Southern desert of Iraq. Other species of *Aspergillus* were sporadic.

Penicillium was represented by three species only (Table 2). This may be attributed to the hot and dry soil of the Iraqi Southern desert. EICKER (1974) reported species of *Penicillium* as a fungal group characteristic of low temperature.

Table 1: Plant cover, soil characteristics, number of fungi per gram of dry soil and number of species isolated from each sample.

Soil No.	Plant cover	Soil texture %		pH	Organic matter %	Total soluble salts %	Chloride %	No. Col/ g. dry soil	No species isolated
	Site 1: Safwan								
1.	*Halocneumum strobilaceum*	clay silt sand	7.6 16 76.4	8.10	0.45	8.2	0.16	680	12
2.	*Nitraria retusa*	clay silt sand	5.6 24 70.4	8.40	0.973	9.55	5.92	1680	25
3.	*Suaeda vermiculata*	clay silt sand	3.6 16 80.4	8.60	0.615	15.6	7.06	630	14
4.	*Cyperus conglomeratus*	clay silt sand	5.6 8 86.4	8.00	0.337	4.75	0.33	4120	28
	Site 2: Samawa								
5.	*Halocnemum strobilaceum*	clay silt sand	9.6 30.0 60.4	8.30	0.899	14.95	5.39	480	11
6.	*Nitraria retusa*	clay silt sand	7.2 28 64.8	8.30	0.811	7.25	0.71	1340	25
7.	*Suaeda vermiculata*	clay silt sand	9.6 20.0 70.4	8.60	0.951	25.00	8.76	420	7
8.	*Cyperus conglomeratus*	clay silt sand	19.6 17.0 63.4	8.50	0.777	11.95	3.14	2860	23

Table 2: List of fungi isolated.

Fungal species	Soil sample number from which a fungus was recorded
Absidia sp.	5, 6
Acremonium sp.	3
Actinomucor elegans (EIDAM) BENJ. & HESS.	3
Alternaria alternata (FR). KEISSL.	1, 6, 8
A. chlamydospora MOUCHACCA	1, 3, 5, 7
A. raphani GROVES & STOLKO	4
A. tenuissima (FR.) WILTSHIRE	2
Aspergillus amstelodami (MANG.) THOM & CHURCH	2
A. candidus LINK ex FRIES	2, 4, 6, 7, 8
A. carneus (Van TIEGHEM) BLOCHWITZ	6, 8
A. flavus LINK ex FRIES	2, 6
A. fumigatus FR.	1, 2, 3, 4, 5, 6, 8
A. niger Van TIEGHEM	1, 2, 5, 6
A. nidulans (EIDAM) WINT.	1, 3
A. oryzae (AHLBURG) COHN	4, 8
A. terreus THOM	6, 7
A. versicolor (VUILL.) TIRAB	6
A. wentii WEHMER	2
Aureobasidium pullulans (DeBARY) ARNAUD	6
Botryotrichum sp.	3
Chaetomella sp.	2, 4
Chaetomium globosum KUNZE ex FR.	2, 3
C. spirale ZOPF	1, 5, 6
Cladosporium cladosporoides (FR.) de VRIES	2, 4, 6, 8
C. herbarum (PERS.) LINK ex FR.	2, 3, 4, 6, 8
Curvularia lunata (WALKER) BOEDJIN	3, 4
Dactylaria sp.	2, 4, 8
Drechslera halodes (DRECH.) SUBRAM. & JAIN	1, 5
D. hawaiiensis (BUGN.) SUBRAM. & JAIN	2, 4, 6
D. rostrata (DRECH.) RICH. & FRAS.	3
D. spicifera (BAIN) von ARX	4, 8
Embellisia chlamydospora (HOES & al.) SIMMONS	1, 5, 7
Epicoccum purpurascens EHRENB. ex SCHLECHT.	4
Fusarium oxysporum SCHL. ex FR.	2, 4, 8
F. solani (Mart.) APPEL. & WOLLENW.	2, 4, 6, 8
Gilmaniella sp.	2, 3
Gymnoascus sp.	4, 8
Humicola grisea TRAAEN	1, 5, 6
Kernia nitida (SACC.) NIEUWLAND	4, 5, 8
Lophotrichus bartlettii (MASS. & SALM.) MALLOCH & CAIN	6
Melanospora sp.	2, 4
Mucor sp.	6
Myrothecium roridum TODE ex FR.	3
Nigrospora oryzae (BERK. & BR.) PETCH	8
Penicillium crustosum THOM	5
P. notatum WESTLING	1, 4, 8
Phoma sp.	2, 4, 6, 8
Pithomyces sp.	7
Pleospora sp.	4
Rhizoctonia sp.	2, 4
Rhizopus arrhizus FISCHER	6, 7
Sporormiella minima (AUERSW.) AHMED & CAIN	2, 4, 6
Stachybotrys atra CORDA	2, 3, 6, 7, 8

Fungal species	Soil sample number from which a fungus was recorded
Trichoderma sp.	1, 2, 5
Trimetastroma sp.	2
Ulocladium atrum PREUSS	2, 3, 6, 7, 8
U. botrytis PREUSS	3, 4, 8
U. chartarum (FR.) SIMM.	2
Thermophilic and thermotolerant species	
Aspergillus candidus LINK ex FR.	8
A. fumigatus FRES.	4, 6, 8
Chaetomium thermophile La TOUCHE	8
Malbranchea pulchella var. sulfurea (MIEHE) COONEY & EMERSON	2, 7, 8
Mucor pusillus LINDT.	8
Thermomyces lanuginosus TSIKLINSKY	2, 4

75% of the isolates were darkly pigmented species (Table 2). Similar results have been reported from desert soil in the Nevada Test Valley, U.S.A. (DURELL & SHIELD, 1960), the Sonoran desert (RANZONI, 1968). in Kuwait by HALWAGY & al. (1982) and in Saudi Arabia by ABDEL- HAFEZ (1982 a). The melanic forms have been described as the most successful fungi in desert soil since they can tolerate the harmful effects of ultraviolet light in summer and absorb heat from solar radiation in winter (DURELL & SHIELDS, 1960). Moreover, MOUBASHER & MAZEN (1972) stated that, in general, the percentage population of dematiaceous species was higher in Egyptian sandy soil than in clay soil. It should be mentioned here that all soil samples examined were sandy in texture (Table 1).

The lower fungi were sporadic and poorly represented. Five species were recoverd viz. *Absidia sp., Actinomucor elegans, Rhizopus sp., Mucor* sp., and *M. pusillus*. The latter species was isolated from plates incubated at 45° C. GARRETT (1963) and PHELPS (1973) pointed out that Mucorales are not common in desert soil. However, lower fungi (Mastigomycotina and Zygomycotina) have been show to be very common in Iraqi agricultural soil. TOLBA & al. (1957) reported the following: *Mucor* (11 species), *Rhizopus* (3 species), *Pythium* (5 species), while Al-DOORY & al. (1959) recorded the following: *Mucor* (11 species), *Rhizopus* (4 species), *Pythium* (8 species).

Soil-borne phytopathogenic fungi were represented by species such as *Fusarium oxysporum, F. solani* and *Rhizoctonia sp.* The two former species were reported by ABDULLAH & ISMAIL (1976) and ISMAIL & ABDULLAH (1976) to be very common in tomato fields in Safwan (reclaimed desert) very near to the present study area, causing tomato wilt disease and colonizing the roots of a variety of annual and perennial desert shrubs.

In the present work 9 species of Ascomycetes viz. *Chaetomium globosum, C. spirale, Kernia nitida, Pleospora sp., Gymnoascus sp., Sporormiella minima, Chaetomium thermophile, Melanospora sp.,* and *Lophotrichus bartlettii* were isolated. The last three species are recorded for the first time from Iraq, while others have previously been reported by ABDULLAH (1982) from the same area as coprophilous fungi. The lower number of Ascomycetous fungi recovered was expected since the methods employed were not suitable for isolating them. In neighbouring countries, HALWAGY & al. (1982) isolated the following species from the desert soil of Kuwait: *Thielavia* (3 species), *Chaetomium* (6 species), *Microascus* (1 species), *Achaetomium* (1 species), *Arachniotus* (2 species) and *Talaromyces* (1 species). ABDEL-HAFEZ (1982 a) identified two species viz. *Chaetomium globosum* and *Microascus cinereus* from Saudi Arabia desert soil.

Species such as *Alternaria chlamydospora, Drechslera halodes* and *Embellisia chlamydospora* were of moderate occurrence and recovered from highly saline soil supporting *Suaeda vermiculata* and *Halocnemum strobilaceum* halophytes. These species have been reported by several workers from marine habitats and from saline and arid soils (MOUSTAFA, 1975; KOHLMEYER & KOHLMEYER, 1979; SIMMONS, 1983).

Thermophilic and thermotolerant fungi were represented by six species viz. *Aspergillus fumigatus, A. candidus, Chaetomium thermophile, Malbranchea pulchella* var. *sulfurea, Mucor pusillus* and *Humicola lanuginosa.* All species were recovered from plates incubated at 45° C. The occurrence of thermophilic and thermotolerant species in the Iraqi desert soil was expected, since the surface temperature especially in the tropical and subtropical area rises 10–20° C above air temperature (APINIS, 1972).

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Literature

ABDEL-HAFEZ, S. I. I. (1981). Halophilic fungi of desert soil in Saudia Arabia. – Mycopathologia 75: 75–80.

— (1982 a). Osmophilic fungi of desert soil in Saudia Arabia. – Mycopathologia 80: 9–14.

— (1982 b). Thermophilic and thermotolerant fungi in the desert soils of Saudia Arabia. – Mycopathologia 80: 15–20.

— (1982 c). Cellulose-decomposing fungi of desert soils in Saudia Arabia. – Mycopathologia 78: 73–78.

ABDULLAH, S. K. (1982). Coprophilous mycoflora on different dung types in southern desert of Iraq. – Sydowia 35: 1–5.

— & A. L. S. ISMAIL (1976). Studies on *Fusarium* wilt of tomatoes in Iraq. II. Non-susceptable hosts as carriers of wilt fusaria in Basrah area. – Proc. Indian Nat. Sci. Acad 42 (B): 189–193.

Al-DOORY, Y., M. K. TOLBA, & H. Al-ANI (1959). On the fungal flora of Iraqi soils. II. Central Iraq. – Mycologia 51: 429–439.

APINIS, A. E. (1972). Thermophilous fungi in certain grasslands. – Mycopath. Mycol. Appl. 48: 63–74.

BEAR, F. E. (1964). Chemistry of the soil. – Academic Press. New York. 515 pp.

DURRELL, L. W. & L. M. SHIELDS (1960). Fungi isolated in culture from soils of Nevada Test site. – Mycologia 52: 636–641.

EICKER, A. (1974). The mycoflora of alkaline soil of the open savannah of the Transvaal. – Trans. Brit. mycol. Soc. 63: 281–288.

El-DOHLOB, S. M. & M. A. Al-HELFI (1982). Soil fungi of South Iraq. – Bull. Bas. Nat. Hist. Mus. 5: 23–37.

ELWAN, S. H. (1962). On the fungal flora of Egyptian desert in summer. – Bull. Fac. Sci. Ain Shams. Univ. Cairo 24: 373–379.

— M. Al-KHODAIR & R. MELIANI (1969). Studies in desert microbiology. VIII. Distribution of some soil microorganisms in the Arabian desert. – Proc. Sixth. Arab. Sci. Cong. Damascus (Abstract).

— & A. DIAB (1971). Studies in the desert microbiology. VII. Development of mycoflora in the rhizosphere and soil of three different plants in relation to environment. – U. A. R. Jou. Bot. 14: 37–46.

GARRETT, S. D. (1963). Soil fungi and soil fertility. – Oxford, Pergamon Press, 165 pp.

HALWAGY, R., A. F. MOUSTAFA & S. M. KAMEL (1982). Ecology of the soil mycoflora in the desert of Kuwait. – Jour. Ari. Envir. 5: 109–125.

ISMAIL, A. L. S. & S. K. ABDULLAH (1977). Studies on the soil fungi of Iraq. – Proc. Indian Acad. Sci. 86: 151–154.

— (1976). Occurrence of physiological races in *Fusarium* causing wilt in tomato cultivars in Basrah, Iraq. – Indian Phytopathology 29: 378–380.

JOHNSON, L. E., E. A. CURL, J. H. BOND & H. A. FRIBOURGH (1959). Methods for studing soil microflora. Plant disease relationships. – Burgess Publ. Co., Minneapolis.

KOHLMEYER, J. & E. KOHLMEYER (1979). Marine Mycology. The higher fungi. – Academic Press, New York, 690 pp.

MOUBASHER, A. H., & M. B. MAZEN (1972). Dematiaceous Hyphomycetes in Egyptian soils. – Trans. Br. mycol. Soc. 59: 227–230.

MOUSTAFA, A. F. (1975). Osmophilous fungi in the salt marshes of Kuwait. – Can. J. Microbiol. 21: 1573–1580.

— M. S. SHARKAS & S. M. KAMEL (1976). Thermophilic and thermotolerant fungi in desert and salt-marsh soils of Kuwait. – Norw. J. Bot. 23: 213–220.

PHELPS, J. W. (1973). Microfungi of two Wisconsin sand blows. – Trans. Brit. mycol. Soc. 61: 386–390.

PIPER, C. S. (1947). Soil and Plant analysis. A monograph. – Waite Agricultural Research Institute, Adelaide.

RANZONI, F. V. (1968). Fungi isolated in culture from soils of the Sonoran Desert. – Mycologia 60: 356–371.

SALAMA, A. M., K. ELBATANONI & M. I. ALI (1971). Studies on the fungal flora of Egyptian soils. I. Western Mediterranean coast and Lybian desert. – U. A. R. Jour. Bot. 14: 99–114.

STATES, J. S. (1978). Soil fungi of cool-desert plant communities in northern Arizona and southern Utah. – J. Arizona-Nevada Acad. Sci. 13: 13–17.

SIMMONS, E. G. (1983). An aggregation of *Embellisia* species. – Mycotaxon 17: 216–241.

TAMIMI, K. M., & H. A. HADWAN (1980). Population levels of four species of *Fusarium* and some other rhizospheric fungi found in potato fields of central Iraq.-Proc. 5th Cong. Mediterranean phytop. Union. Greece, 194–198.

— (1981). Population levels of ten species of *Aspergillus* and seven species of *Penicillium* found in potato field soils of central Iraq. – J. Agric. Sci., 14 (in press).

TAYLOR, E. C. (1979). Seasonal distribution and abundance of fungi in two desert grassland communities. – J. Arid Environment 2: 295–312.

TOLBA, M. K., Y. AL-DOORY & M. A. AL-WAHAB (1957). On the fungal flora of Iraqi soils. I. Baghdad area.-Proc. 3rd Arab. Sci. Congr. Beirut: 198–214.

THALEN, J. H. (1979). Ecology and utilization of desert shrub rangelands in Iraq. – W. Junke. B. V. Publisher, The Hague.

WARCUP, J. H. (1950). The soil plate method for isolation of fungi from soil. – Nature. (London) 66: 117–118.