OnLine Journal of Biological Sciences 2(2): 124-129, 2002

Terrestrial Fungi from Water and Submerged Mud Polluted by the Industrial Effluents (Aswan, Egypt)

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Abstract: Sixty-four species in addition to one variety representing 31 genera of terrestrial fungi were recovered from surface water and submerged mud collected monthly (12 months) from five successive water sites exposed to the industrial effluents of Kima factory for fertilizers at Aswan. The monitored physico-chemical characteristics varied depending upon the site and time of sampling. There are variations in diversity and abundance of isolated fungi depending upon the employed nutritive media (glucose or cellulose), tested sample (water or mud), site and the time of sampling. The poorest samples in fungi were generally those collected during higher temperature months and from sites exposed directly to the industrial effluents. *Aspergillus* and *Trichoderma* were the most prevalent genera.

Key words: Terrestrial fungi, industrial effluents, water, mud

Introduction

Despite an increasing number of publications dealing with the terrestrial fungi from different types of soils, as yet, relatively limited information is available about the terrestrial fungi inhabiting water (Park, 1974; Nasar and Munshi, 1980; Mangiarotti and Carreta, 1984). In Egypt, some investigations were carried out dealing with the occurrence, distribution and seasonality of terrestrial fungi in various unpolluted water areas (El-Hissy, 1974; El-Hissy *et al.*, 1982; Khallil, 1990) as well as from submerged mud (El-Hissy *et al.*, 1982; El-Nagdy, 1981 and Khallil, 1984). However, few studies were conducted to isolate terrestrial fungi from water and submerged mud polluted by some industrial effluents (Khallil and Abdel-Sater, 1992). Thus, the present work aimed to study the monthly fluctuations of terrestrial fungi inhabiting water and submerged mud which are exposed to the industrial effluents of Kima factory for fertilizers (Aswan, Egypt).

Materials and Methods

During the period from January to December (1996), Surface water (S) and Submerged mud (M) samples were monthly collected from five successive sites (site 1- site 5) along the canal (site 1-site 4) and River Nile (site 5) that located one Km north the point of mixing effluents of polluted canal of Kima factory with the River Nile. These sites (Fig. 1) and samples were named as follows:

S1: Surface water samples at the beginning of discharging the effluents of Kima factory for fertilizers in the canal water.
S2: Surface water samples at one Km north S1.
S3: Surface water samples at 3 Km north S1.
S4: Surface water samples at the beginning of mixing the effluents of polluted canal of Kima factory with River Nile water.
S5: Surface water samples from River Nile after one Km north the point of mixing the effluents of polluted canal of Kima factory with the River Nile water. Submerged mud samples were also taken at the same locations of surface water samples and named as: M1, M2, M3, M4 and M5.

Using glucose and cellulose-Czapek's agar media, terrestrial fungi were isolated from surface water and submerged mud as described by Khallil (1990) and El-Hissy *et al.* (1990a), respectively. Some physico-chemical characteristics of surface water and submerged mud samples were determined. These characteristics are temperature, pH, dissolved oxygen, total soluble salts, organic matter, calcium, magnesium, sulphate, nitrate, phosphate and phosphorus contents. Using the methods described elsewhere (El-Hissy *et al.*, 1990b).

Results and Discussion

Regarding the diversity and monthly fluctuations of terrestrial fungi, sixty-four species in addition to one variety belonging to 32 genera were isolated from surface water and submerged mud samples on glucose and cellulose-Czapek's agar media (Tables 1-4). Thirty-nine species representing 20 genera and 41 species belonging to 23 genera were isolated from surface water samples on glucose and cellulose-Czapek's agar, respectively (Tables 1 and 2). Furthermore, forty-one species in addition to one variety representing 19 genera and 42 species belonging to 23 genera were isolated from submerged mud samples using glucose-and cellulose-Czapek's agar media, respectively (Tables 3 and 4). These terrestrial fungi originate either from air or washed with rain water (Sparrow, 1968). More specifically, Park (1972a,b) reported that these fungi mainly originate from animal or plant, the whole or part, living or dead and soil or litter having been in contact with water. Most of these fungi were previously isolated from various water areas, soil, air, seeds and grains in Egypt by several authors. The total counts of terrestrial fungi inhabiting surface water and submerged mud exhibited some regular distribution and almost increased from site 1 (which directly exposed to the industrial effluents) to site 5 (where the effluents are considerably diluted). The lowest count was recorded in samples (either surface water or submerged mud) collected from site 1 whereas the highest total count was in those collected from site 5. Khallil and Abdel-Sater (1992) reported a similar inhibitory effect on fungal abundance in Nile water exposed to the industrial effluents of superphosphate factory at Assiut. It was found that the richest samples in fungal populations were those collected during the low or moderate temperature months. Similar observations were reported by several authors. On the contrary, El-Hissy (1979a) observed that summer months were the richest in terrestrial fungi whereas the winter months were the poorest.

It was interesting to notice that fungi isolated from the water and mud samples on glucose-Czapek's agar, were nearly the same as those isolated on cellulose-Czapek's agar medium except that; *Aspergillus candidus, Acremonium strictum, Cephalosporium* species, *Cochliobolus lunatus, Curvularia clavata, C. ovoidea, Cylindrocarpon* species, *Emericella nivea, Fusarium semitectum, Geotrichum candidum, Gibberella fujikuroi, Mycosphaerella tassiana, Myrothecium species, Penicillium brevicompactum, P. frequantans, P. lanosum* and *P. nigricans* which were isolated only on cellulose agar. On the other hand, some fungal species

Table 1: Collective total counts (colonies / ml water in all samples), numbers of cases of isolation (out of 12 months) and occurrence remark of terrestrial fungal genera and species isolated from surface water samples of canal polluted with industrial effluents of Kima factory for fertilizers and the River Nile during the period from January to December 1996, on glucose-Czapek's agar at 28°C

Sites	Site1			Site2			Site3			Site4			Site5		
	T C	N C I	O R	T C	N C I	O R	T C	N C I	O R	T C	N C I	O R	T C	N C I	O R
Total counts	10.14			38.80			47.64			55.88			64.06		
Acremonium	0.0	0.0		0.0	0.0		1.33	1.0	L	1.25	1.0	L	11.45	2.0	L
A. butyri	0.0	0.0		0.0	0.0		0.0	0.0		1.25	1.0	L	11.45	2.0	L
Acremonium species	0.0	0.0		0.0	0.0		1.33	1.0	L	0.0	0.0		0.0	0.0	
Alternaria alternata	0.0	0.0		0.0	0.0		0.0	0.0		0.33	1.0	L	0.33	1.0	L
Aspergillus	9.07	11.0	H	16.15	9.0	H	12.58	12	H	27.9	11.0	H	22.24	9.0	H
A. clavatus	0.0	0.0		0.0	0.0		0.25	1.0	L	0.0	0.0		0.0	0.0	
A. flavus	0.83	3.0	M	1.41	3.0	M	3.50	5.0	M	6.66	7.0	H	0.75	3.0	M
A. fumigatus	4.16	2.0	L	1.91	2.0	L	2.91	2.0	L	1.58	5.0	M	11.25	3.0	M
A. niger	3.0	6.0	H	9.08	5.0	M	2.75	6.0	H	17.20	11.0	H	5.16	7.0	H
A. ochraceus	0.0	0.0		0.91	2.0	L	0.50	1.0	L	1.0	2.0	L	0.0	0.0	
A. oryzae	0.25	1.0	L	0.25	1.0	L	0.50	1.0	L	0.0	0.0		0.0	0.0	
A. terreus	0.33	1.0	L	2.08	5.0	M	1.25	1.0	L	1.49	3.0	M	4.50	2.0	L
A. ustus	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0		0.33	1.0	L
A. versicolor	0.5	2.0	L	0.5	1.0	L	0.50	1.0	L	0.0	0.0		0.25	1.0	L
A. wentii	0.0	0.0		0.0	0.0		0.50	1.0	L	0.0	0.0		0.0	0.0	
Botryotrichum atrogriseum	0.0	0.0		0.75	1.0	L	0.33	1.0	L	0.0	0.0		0.25	1.0	L
Chaetomium species	0.0	0.0		0.25	1.0	L	0.0	0.0		0.0	0.0		0.0	0.0	
Cladosporium species	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0		0.33	1.0	L
Emericella nidulans	0.0	0.0		0.66	1.0	L	0.33	1.0	L	3.33	3.0	M	0.83	2.0	L
Fennelia flavipes	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0		0.25	1.0	L
Fusarium	0.0	0.0		0.0	0.0		3.0	2.0	L	5.50	7.0	H	0.50	1.0	L
F.nivale	0.0	0.0		0.5	1.0	L	5.50	4.0	M	2.75	4.0	M	2.25	2.0	L
F.oxysporum	0.0	0.0		0.0	0.0		1.0	1.0	L	2.0	3.0	M	0.75	1.0	L
F.poae	0.0	0.0		0.0	0.0		0.0	0.0		0.25	1.0	L	0.0	0.0	
F. sporotrichoides	0.0	0.0		0.5	1.0	L	0.0	0.0		0.0	0.0		0.0	0.0	
F. tabacinum	0.0	0.0		0.0	0.0		1.50	1.0	L	0.50	2.0	L	1.0	1.0	L
Monocillium indicum	0.0	0.0		1.33	1.0	L	0.0	0.0		0.0	0.0		0.0	0.0	
Mortierella species	0.0	0.0		0.0	0.0		0.0	0.0		0.25	1.0	L	0.50	1.0	L
Mucor	0.25	1.0	L	6.0	7.0	H	4.91	7.0	H	6.25	9.0	H	0.75	2.0	L
M. circinelloides	0.25	1.0	L	4.5	6.0	H	3.41	5.0	M	3.75	5.0	M	0.50	2.0	L
Mucor species	0.0	0.0		1.5	1.0	L	1.50	2.0	L	1.0	5.0	M	0.25	1.0	L
Myrothecium	0.0	0.0		1.25	1.0	L	0.50	1.0	L	1.0	1.0	L	1.33	1.0	L
M. roridum	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0		1.33	1.0	L
M. verrucaria	0.0	0.0		1.25	1.0	L	0.50	1.0	L	1.0	1.0	L	0.0	0.0	
Penicillium	0.25	1.0	L	3.0	5.0	M	14.75	4.0	M	1.41	3.0	M	3.32	4.0	M
P. chrysogenum	0.0	0.0		0.25	1.0	L	1.25	2.0	L	0.66	1.0	L	1.50	1.0	L
P. citrinum	0.0	0.0		0.25	1.0	L	11.0	2.0	L	0.50	1.0	L	0.50	1.0	L
P. funiculosum	0.25	1.0	L	0.50	1.0	L	0.0	0.0		0.0	0.0		0.0	0.0	
P. janthinellum	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0		0.66	1.0	L
P. lilacinum	0.0	0.0		0.25	1.0	L	0.0	0.0		0.25	1.0	L	0.0	0.0	
P.oxalicum	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0		0.66	1.0	L
P.rugulosum	0.0	0.0		1.25	1.0	L	2.50	1.0	L	0.0	0.0		0.0	0.0	
P. verruculosum	0.0	0.0		0.50	1.0	L	0.0	0.0		0.0	0.0		0.0	0.0	
Rhizopus stolonifer	0.0	0.0		0.75	1.0	L	0.0	0.0		0.0	0.0		0.0	0.0	
Scopulariopsis	0.25	1.0	L	0.25	1.0	L	0.33	1.0	L	0.50	1.0	L	12.50	2.0	L
S. brevicaulis	0.0	0.0		0.25	1.0	L	0.33	1.0	L	0.0	0.0		0.50	1.0	L
S. brumptii	0.25	1.0		0.0	0.0		0.0	0.0		0.50	1.0	L	12.0	1.0	L
Syncephlastrum racemosum	0.0	0.0		0.25	1.0	L	0.0	0.0		0.0	0.0		0.25	1.0	L
Torula	0.0	0.0		0.33	1.0	L	0.0	0.0		1.66	1.0	L	0.50	1.0	L
T.graminis	0.0	0.0		0.33	1.0	L	0.0	0.0		0.66	1.0	L	0.0	0.0	
T. herbarum	0.0	0.0		0.0	0.0		0.0	0.0		1.0	1.0	L	0.50	1.0	L
Trichoderma species	0.33	1.0	L	7.33	6.0	H	7.08	8.0	H	6.0	9.0	H	6.98	5.0	M
Trichurus spiralis	0.0	0.0		0.0	0.0		0.0	0.0		1.25	1.0	L	0.0	0.0	
Number of genera	5			14			10			13			16		
Number of species	9			23			20			21			24		

T C = Total counts, N C I = Number of cases of isolation, O R = Occurrence remark, L = Low occurrence (1-2 months), M= Moderate occurrence (3-5 months) and H = High occurrence (6-12 months).

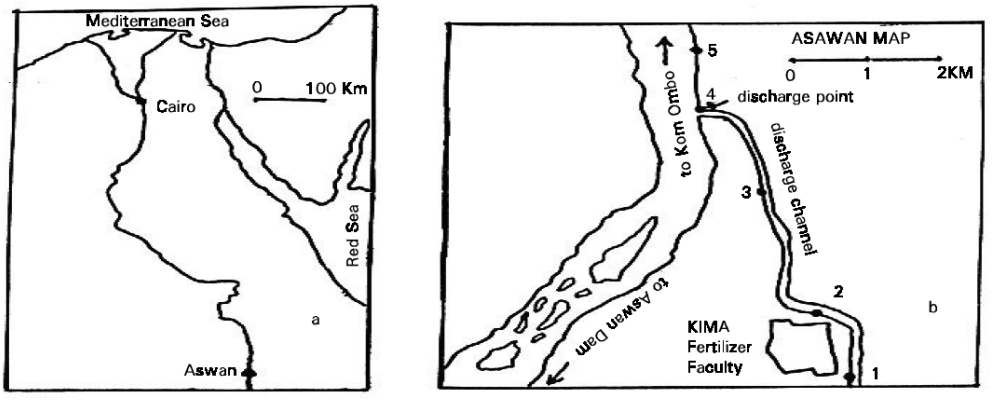

Fig. 1: Maps show the study area and site location (a: general map of Egypt, B: map show the drainage canal of Kima factory for fertilizers and River Nile at Aswan district

Table 2: Collective total counts (colonies / ml water in all samples), numbers of cases of isolation (out of 12 months) and occurrence remarrk of terrestrial fungal genera and species isolated from surface water samples of canal polluted with industrial effluents of Kima factory for fertilizers and the River Nile during the period from January to December 1996, on cellulose-Czapek's agar at 28°C

Sites	Site1			Site2			Site3			Site4			Site5		
Fungal genera and species	T C	N C I	O R	T C	N C I	O R	T C	N C I	O R	T C	N C I	O R	T C	N C I	O R
Total counts	7.90			22.14			27.14			52.15			42.12		
Acremonium	0.0	0.0		0.0	0.0		2.0	3.0	M	3.0	3.0	M	2.25	3.0	M
A. butyri	0.0	0.0		0.0	0.0		0.25	1.0	L	1.50	2.0	L	2.25	3.0	M
A. strictum	0.0	0.0		0.0	0.0		0.50	1.0	L	1.50	1.0	L	0.0	0.0	
Acremonium species	0.0	0.0		0.0	0.0		1.25	1.0	L	0.0	0.0		0.0	0.0	
Alternaria alternata	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0		0.25	1.0	L
Aspergillus	6.57	10.0	H	6.99	8.0	H	8.49	11.0	H	23.6	11.0	H	12.31	9.0	H
A. flavus	2.50	2.0	L	1.75	5.0	M	0.25	1.0	L	0.50	2.0	L	0.25	1.0	L
A. fumigatus	1.66	5.0	M	1.41	3.0	M	0.83	3.0	M	4.41	3.0	M	2.66	6.0	H
A. niger	2.16	6.0	H	1.33	4.0	M	3.91	9.0	H	13.25	8.0	H	3.65	5.0	M
A. oryzae	0.0	0.0		0.50	1.0	L	0.0	0.0		2.50	1.0	L	0.0	0.0	
A. terreus	0.0	0.0		2.0	4.0	M	3.50	5.0	M	2.25	6.0	H	5.0	3.0	M
A. ustus	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0		0.50	2.0	L
A. versicolor	0.0	0.0		0.0	0.0		0.0	0.0		0.25	1.0	L	0.0	0.0	
A. wentii	0.25	1.0	L	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Botryotrichum atrogriseum	0.0	0.0		0.25	1.0	L	0.0	0.0		0.0	0.0		0.0	0.0	
Chetomium species	0.0	0.0		0.25	1.0	L	0.0	0.0		0.25	1.0	L	0.0	0.0	
Cochliobolus lunatus	0.0	0.0		0.0	0.0		0.0	0.0		0.25	1.0	L	0.0	0.0	
Curvularia	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0		1.25	2.0	L
C. clavata	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0		0.75	1.0	L
C. ovoidea	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0		0.50	2.0	L
Cylendrocarpon species	0.0	0.0		0.0	0.0		0.0	0.0		0.75	1.0	L	0.0	0.0	
Doratomyces species	0.0	0.0		0.50	1.0	L	0.58	2.0	L	0.0	0.0		0.25	1.0	L
Emericella nivea	0.0	0.0		0.0	0.0		0.0	0.0		0.25	1.0	L	0.0	0.0	
Fennelia flavipes	0.0	0.0		0.0	0.0		1.0	1.0	L	0.0	0.0		0.0	0.0	
Fusarium	0.0	0.0		0.25	1.0	L	1.0	1.0	L	2.50	2.0	L	0.0	0.0	
F.nivale	0.0	0.0		0.25	1.0	L	0.0	0.0		0.0	0.0		0.0	0.0	
F.poae	0.0	0.0		0.0	0.0		1.0	1.0	L	0.0	0.0		0.0	0.0	
F. tabacinum	0.0	0.0		0.0	0.0		0.0	0.0		2.50	2.0	L	0.0	0.0	
Geotrichum candidum	0.0	0.0		0.25	1.0	L	2.0	1.0	L	0.0	0.0		0.0	0.0	
Gibberella fujikuroi	0.0	0.0		0.0	0.0		0.33	1.0	L	0.0	0.0		0.0	0.0	
Mortierella species	0.0	0.0		0.0	0.0		2.25	2.0	L	1.25	1.0	L	0.33	1.0	L
Mucor	0.0	0.0		3.0	5.0	M	1.25	3.0	M	3.75	2.0	L	8.33	4.0	M
M. circinelloides	0.0	0.0		1.75	3.0	M	0.75	2.0	L	2.25	1.0	L	0.25	1.0	L
M. hiemalis	0.0	0.0		1.0	1.0	L	0.0	0.0		1.50	1.0	L	0.58	2.0	L
Mucor species	0.0	0.0		0.25	1.0	L	0.50	1.0	L	0.0	0.0		7.50	2.0	L
Myrothecium roridum	0.0	0.0		0.33	1.0	L	0.33	1.0	L	0.0	0.0		0.0	0.0	
Penicillium	1.33	4.0	M	4.33	6.0	H	1.58	5.0	M	6.58	3.0	M	7.91	6.0	H
P. bervi-compactum	0.0	0.0		0.0	0.0		0.25	1.0	L	0.0	0.0		0.0	0.0	
P. capsulatum	0.0	0.0		0.25	1.0	L	0.25	1.0	L	0.0	0.0		0.0	0.0	
P. chrysogenum	0.80	3.0	M	2.58	3.0	M	0.33	1.0	L	0.50	1.0	L	5.91	4.0	M
P. citrinum	0.0	0.0		0.25	1.0	L	0.25	1.0	L	0.0	0.0		0.25	1.0	L
P. corylophillum	0.0	0.0		0.75	2.0	L	0.25	1.0	L	0.0	0.0		0.0	0.0	
P. cyaneum	0.0	0.0		0.0	0.0		0.0	0.0		0.33	1.0	L	1.0	1.0	L
P. duclauxi	0.0	0.0		0.25	1.0	L	0.25	1.0	L	0.0	0.0		0.25	1.0	L
P. frequentans	0.0	0.0		0.25	1.0	L	0.0	0.0		0.0	0.0		0.0	0.0	
P. funiculosum	0.50	2.0	L	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
P. janthinellum	0.0	0.0		0.0	0.0		0.0	0.0		5.75	1.0	L	0.50	1.0	L
P. nigricans	0.5	0.2	L	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Rhizopus stolonifer	0.0	0.0		0.25	1.0	L	0.0	0.0		0.0	0.0		0.25	1.0	L
Scopulariopsis	0.0	0.0		0.25	1.0	L	0.0	0.0		0.25	1.0	L	2.75	1.0	L
S. brevicaulis	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0		2.75	1.0	L
S. brumptii	0.0	0.0		0.25	1.0	L	0.0	0.0		0.25	1.0	L	0.0	0.0	
Syncephlastrum racemosum	0.0	0.0		0.25	1.0	L	0.75	1.0	L	0.0	0.0		0.0	0.0	
Torula herbarum	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0		1.25	2.0	L
Trichoderma species	0.0	0.0		5.24	8.0	H	5.58	7.0	H	10.16	7.0	H	5.0	6.0	H
Number of genera	2			13			13			12			12		
Number of species	6			20			19			17			19		

T C = Total counts, N C I = Number of cases of isolation, O R = Occurrence remark, L = Low occurrence (1-2 months), M = Moderate occurrence (3-5 months) and H = High occurrence (6-12 months).

(*Aspergillus carneus*, *A. clavatus*, *A. sydowi*, *A. tamarii*, *Emericella nidulans* var. *Lata*, *Fusarium oxysporum*, *Humicola grisea*, *Monocillium indicum*, *Myrothecium verrucaria*, *Penicillium lilacinum*, *P. oxalicum*, *P. ruglosum*, *Torula graminis* and *Trichurus spiralis*) were isolated on glucose and missed on cellulose agar in (Tables 1-4).

Irrespective to the used isolation medium, two genera namely; *Aspergillus* and *Trichoderma* were of high monthly occurrence either in surface water or submerged mud samples (Tables 1-4). In this respect, Nasar and Munshi (1980) and Khallil (1990) reported that *Aspergillus*, *Penicillium* and *Fusarium* were the most prevalent genera in various water areas.

Aspergillus contributed the broadest spectrum of species and was represented by fourteen species althrough the year, of which *Aspergillus niger*, *A. flavus*, *A. fumigatus* and *A. terreus* were the commonest species whatever the employed media.

The highest population of *Aspergillus* (27.9 and 23.6 colonies/ ml water in on glucose and cellulose media, receptively) was recorded in site 4. Moreover, the highest monthly counts (11.5 colonies/ ml water) of *Aspergillus* was recorded during

Table 3: Collective total counts (colonies / gm dry mud in all samples), numbers of cases of isolation (out of 12 months) and occurrence remark of terrestrial fungal genera and species isolated from submerged mud samples of canal polluted with industrial effluents of Kima factory for fertilizers and the River Nile during the period from January to December 1996, on glucose-Czapek's agar at 28°C

Sites	Site1			Site2			Site3			Site4			Site5		
Fungal genera and species	T C	N C I	O R	T C	N C I	O R	T C	N C I	O R	T C	N C I	O R	T C	N C I	O R
Total coun	1386.02			6815.63			6521.15			5724.44			1938.25		
Acremonium	33.87	1.0	L	0.0	0.0		21.90	1.0	L	0.0	0.0		34.45	1.0	L
A. butyri	0.0	0.0		0.0	0.0		21.90	1.0	L	0.0	0.0		0.0	0.0	
Acremonium species	33.87	1.0	L	0.0	0.0		0.0	0.0		0.0	0.0		34.45	1.0	L
Aspergillus	687.25	11.0	H	3265.74	10.0	H	5508.95	12.0	H	3342.44	11.0	H	6544.89	11.0	H
A. carneus	0.0	0.0		0.0	0.0		542.50	1.0	L	295.70	2.0	L	20.40	1.0	L
A. flavus	140.30	4.0	M	1173.05	7.0	H	653.87	5.0	M	134.10	4.0	M	364.44	4.0	M
A. fumigatus	153.00	4.0	M	266.13	4.0	M	2875.13	3.0	M	307.45	5.0	M	126.51	3.0	M
A. niger	208.60	5.0	M	1034.46	10.0	H	974.59	9.0	H	2275.04	10.0	H	1428.93	11.0	H
A. ochraceus	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0		21.30	1.0	L
A. oryzae	0.0	0.0		394.70	2.0	L	70.20	2.0	L	131.10	2.0	L	96.46	2.0	L
A. sydowi	0.0	0.0		12.20	1.0	L	0.0	0.0		0.0	0.0		251.6	1.0	L
A. tamarii	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0		15.3	2.0	L
A. terreus	15.00	2.0	L	143.50	3.0	M	367.96	6.0	H	178.25	4.0	M	4213.05	6.0	H
A. versicolor	143.20	2.0	L	136.40	1.0	L	0.0	0.0		0.0	0.0		0.0	0.0	
A. wentii	0.0	0.0		105.30	1.0	L	14.70	1.0	L	0.0	0.0		6.80	1.0	L
Botryotrichum atrogriseum	0.0	0.0		71.02	1.0	L	20.10	1.0	L	707.50	2.0	L	75.3	1.0	L
Doratomyces species	0.0	0.0		12.20	1.0	L	0.0	0.0		0.0	0.0		0.0	0.0	
Emericella nidulans var. lata	0.0	0.0		113.68	1.0	L	180.79	2.0	L	0.0	0.0		128.59	2.0	L
Fennelia flavipes	8.20	1.0	L	0.0	0.0		0.0	0.0		143.9	1.0	L	62.75	2.0	L
Fusarium	0.0	0.0		0.0	0.0		81.4	3.0	M	606.7	4.0	M	82.20	1.0	L
F.nivale	0.0	0.0		0.0	0.0		0.0	3.0		346.2	1.0	L	82.20	1.0	L
F.oxysporum	0.0	0.0		0.0	0.0		60.60	1.0	L	64.5	3.0	M	0.0	0.0	
F.poae	0.0	0.0		0.0	0.0		15.50	1.0	L	0.0	0.0		0.0	0.0	
F. sporotrichoides	0.0	0.0		0.0	0.0		5.30	1.0	L	0.0	0.0		0.0	0.0	
Humicola grisea	0.0	0.0		0.0	0.0		0.0	0.0		147.6	1.0	L	0.0	0.0	
Hypomyces chrysospermae	0.0	0.0		20.60	1.0	L	0.0	0.0		0.0	0.0		0.0	0.0	
Monocillium indicum	0.0	0.0		36.42	1.0	L	0.0	0.0		4.32	1.0	L	0.0	0.0	
Mortierella species	104.95	3.0	M	10.20	1.0	L	0.0	0.0		0.0	0.0		26.00	1.0	L

Table 3: Continued

Sites	Site1			Site2			Site3			Site4			Site5		
Fungal genera and species	T C	N C I	O R	T C	N C I	O R	T C	N C I	O R	T C	N C I	O R	T C	N C I	OR
Mucor	123.70	3.0	M	79.069	6.0	H	160.67	6.0	H	107.67	5.0	M	370.87	5.0	M
M. circinelloides	4.75	1.0	L	756.69	4.0	M	92.00	2.0	L	51.74	4.0	M	284.78	4.0	M
M. hiemalis	13.65	1.0	L	0.0	0.0		15.43	1.0	L	0.0	0.0		0.0	0.0	
Mucor species	105.30	1.0	L	16.60	2.0	L	53.24	4.0	M	55.93	2.0	L	122.09	1.0	L
Myrothecium verrucaria	36.50	1.0	L	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Necteria haematococca	0.0	0.0		0.0	0.0		0.0	0.0		60.60	1.0	L	122.09	1.0	L
Penicillium	175.03	2.0	L	1844.70	3.0	M	37.69	3.0	M	80.16	4.0	M	258.02	5.0	M
P. capsulatum	0.0	0.0		1569.40	1.0	L	0.0	0.0		0.0	0.0		0.0	0.0	
P. chrysogenum	136.40	1.0	L	255.30	1.0	L	20.73	2.0	L	51.84	3.0	M	11.48	1.0	L
P. citrinum	0.0	0.0		0.0	0.0		0.0	0.0		23.70	1.0	L	0.0	0.0	
P. corylophillum	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0		157.50	1.0	L
P. cyaneum	0.0	0.0		50.0	1.0	L	0.0	0.0		4.62	1.0	L	12.97	1.0	L
P. duclauxi	0.0	0.0		0.0	0.0		5.30	1.0	L	0.0	0.0		0.0	0.0	
P. funiculosum	11.60	1.0	L	16.66	1.0	L	80.26	2.0	L	90.50	1.0	L	212.41	2.0	L
P. janthinellum	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0		31.80	1.0	L
P. lilacinum	27.03	1.0	L	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
P. oxalicum	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0		22.97	1.0	L
P. rugulosum	0.0	0.0		0.0	0.0		11.66	1.0	L	0.0	0.0		0.0	0.0	
Rhizopus stolonifer	4.10	1.0	L	0.0	0.0		0.0	0.0		0.0	0.0		21.30	1.0	L
Scopulariopsis	37.92	4.0	M	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
S. brevicaulis	11.60	1.0	L	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
S. brumptii	26.32	3.0	M	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Syncephlastrum recemosum	0.0	0.0		28.86	2.0	L	138.12	3.0	M	42.90	1.0	L	24.50	2.0	L
Trichoderma species	174.50	4.0	M	604.86	8.0	H	291.25	9.0	H	390.15	9.0	H	1196.24	8.0	H
Number of genera	10			12			10			12			13		
Number of species	16			17			20			19			25		

T C = Total counts, N C I = Number of cases of isolation, O R = Occurrence remark, L= Low occurrence (1-2 months), M= Moderate occurrence (3-5 months) and H= High occurrence (6-12 months).

October 1996 at site 4 on glucose agar medium. On the other hand, the highest total counts of *Aspergillus* in submerged mud (6544.89 and 4152.53 colonies/gm dry weight mud on glucose and cellulose media, respectively) was recorded respectively at M5 and M3. The highest monthly counts of *Aspergillus* (3828.7 and 2012.7 colonies/gm dry weight mud) was recorded in M5 and M3 during June and July 1996 respectively. *Aspergillus* was also reported as the most prevalent genus in water samples collected from River Nile (El-Hissy, 1974; El-Hissy *et al.*, 1982; Badran, 1986; Khallil, 1990), Ibrahimia canal (Abdel-Hafez and Bagy, 1985), fresh water ponds (Nasar and Munshi, 1980), Aswan High Dam Lake (El-Hissy *et al.*, 1990b; Moharram *et al.*, 1990) and on aquatic plants (Nassar, 1991). *Aspergillus niger, A. flavus, A. fumigatus* and *A. terreus* were the most prevalent species either in surface water or submerged mud samples. These species were fairly common in Nile water (El-Hissy *et al.*, 1982, Badran, 1986; Khallil and Abdel-Sater, 1992), submerged mud (El-Hissy *et al.*, 1990b) and waste waters and stabilization pond (Hiremath *et al.*, 1985).

Table 4: Collective total counts (colonies / gm dry mud in all samples), numbers of cases of isolation (out of 12 months) and occurrence remark of terrestrial fungal genera and species isolated from submerged mud samples of canal polluted with industrial effluents of Kima factory for fertilizers and the River Nile during the period from January to December 1996, on cellulose-Czapek's agar at 28°C

Sites	Site1			Site2			Site3			Site4			Site5		
Fungal genera and species	T C	N C I	O R	T C	N C I	O R	T C	N C I	O R	T C	N C I	O R	T C	N C I	O R
Total counts	1383.22			2571.57			5766.13			3775.12			6102.05		
Acremonium butyri	0.0	0.0		0.0	0.0		3.87	1.0	L	0.0	0.0		0.0	0.0	
Alternaria alternata	0.0	0.0		0.0	0.0		3.80	1.0	L	0.0	0.0		0.0	0.0	
Aspergillus	586.05	9.0	H	1437.29	9.0	H	4152.53	11.0	H	2801.20	8.0	H	2175.20	9.0	H
A. candidus	0.0	0.0		0.0	0.0		110.30	1.0	L	0.0	0.0		0.0	0.0	
A. flavus	8.20	1.0	L	400.20	5.0	M	26.72	3.0	M	95.90	3.0	M	30.80	3.0	M
A. fumigatus	293.70	3.0	M	194.19	3.0	M	2061.46	8.0	H	5.80	1.0	L	122.51	4.0	M
A. niger	125.95	7.0	H	616.41	7.0	H	662.56	10.0	H	2214.90	8.0	H	570.0	10.0	H
A. ochraceus	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0		9.30	1.0	L
A. oryzae	94.60	1.0	L	74.44	3.0	M	279.70	2.0	L	37.07	1.0	L	57.25	1.0	L
A. terreus	63.60	3.0	M	152.05	6.0	H	1011.79	5.0	M	489.73	4.0	M	1385.34	8.0	H
Botryotrichum atrogriseum	0.0	0.0		0.0	0.0		3.87	1.0	L	39.60	1.0	L	0.0	0.0	
Cephalosporium species	0.0	0.0		0.0	0.0		30.98	1.0	L	0.0	0.0		0.0	0.0	
Cladosporium species	0.0	0.0		71.02	1.0	L	0.0	0.0		0.0	0.0		0.0	0.0	
Cochliobolus lunatus	0.0	0.0		0.0	0.0		0.0	0.0		75.80	1.0	L	0.0	0.0	
Curvularia ovoidae	0.0	0.0		0.0	0.0		4.1	1.0	L	0.0	0.0		0.0	0.0	
Doratomyces species	0.0	0.0		0.0	0.0		87.74	2.0	L	0.0	0.0		0.0	0.0	
Emericella nidulans	10.50	1.0	L	0.0	0.0		3.87	1.0	L	0.0	0.0		7.90	1.0	L
Fennelia flavipes	13.16	1.0	L	113.60	1.0	L	0.0	0.0		0.0	0.0		0.0	0.0	
Fusarium	0.0	0.0		16.64	1.0	L	66.20	1.0	L	0.0	0.0		21.87	2.0	L
F.nivale	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0		11.23	1.0	L
F.poae	0.0	0.0		16.64	2.0	L	0.0	0.0		0.0	0.0		10.64	2.0	L
F.semitectum	0.0	0.0		0.0	0.0		16.6	1.0	L	0.0	0.0		0.0	0.0	
F. sporotrichoides	0.0	0.0		0.0	0.0		49.60	1.0	L	0.0	0.0		0.0	0.0	
Hypomyces chrysospermae	0.0	0.0		0.0	0.0		44.00	1.0	L	0.0	0.0		0.0	0.0	
Mortierella species	0.0	0.0		0.0	0.0		0.0	0.0		242.40	1.0	L	0.0	0.0	
Mucor	6.30	1.0	L	149.81	2.0	L	979.70	7.0	H	65.18	4.0	M	46.88	2.0	L
M. circinelloides	0.0	0.0		149.81	2.0		935.50	3.0	M	58.28	3.0	M	46.88	2.0	L
M. hiemalis	0.0	0.0		0.0	0.0		19.20	1.0	L	0.0	0.0		0.0	0.0	
Mucor species	6.30	1.0	L	0.0	0.0		25.00	3.0	M	6.90	1.0	L	0.0	0.0	
Mycosphaerella tassiana	0.0	0.0		0.0	0.0		3.87	1.0	L	0.0	0.0		0.0	0.0	
Myrothecium	26.30	1.0	L	0.0	0.0		0.0	0.0		0.0	0.0		243.70	1.0	L
M. roridum	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0		243.7	1.0	L
Myrothecium species	26.30	1.0	L	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Necteria haematococca	0.0	0.0		0.0	0.0		0.0	0.0		40.70	1.0	L	0.0	0.0	
Penicillium	108.60	3.0	M	172.38	4.0	M	27.00	2.0	L	43.25	1.0	L	422.75	5.0	M
P. chrysogenum	21.10	1.0	L	0.0	0.0		0.0	0.0		43.25	1.0	L	56.65	2.0	L
P. citrinum	21.70	1.0	L	39.50	1.0	L	0.0	0.0		0.0	0.0		0.0	0.0	
P.corylophillum	0.0	0.0		33.78	1.0	L	0.0	0.0		0.0	0.0		0.0	0.0	
P. duclauxi	65.80	1.0	L	0.0	0.0		0.0	0.0		0.0	0.0		27.9	2.0	L
P. frequentans	0.0	0.0		88.90	1.0	L	4.99	1.0	L	0.0	0.0		0.0	0.0	
P. janthinellum	0.0	0.0		10.2	1.0	L	0.0	0.0		0.0	0.0		0.0	0.0	
P. lanosum	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0		18.5	1.0	L
P. verruculosum	0.0	0.0		0.0	0.0		22.00	1.0	L	0.0	0.0		319.70	2.0	L
Scopulariopsis brumptii	13.16	1.0	L	0.0	0.0		0.0	0.0		79.10	1.0	L	0.0	0.0	
Syncephlastrum racemosum	0.0	0.0		94.70	1.0	L	5.30	1.0	L	0.0	0.0		93.90	2.0	L
Torula herbarum	0.0	0.0		0.0	0.0		0.0	0.0		8.70	1.0	L	0.0	0.0	
Trichoderma species	619.15	3.0	M	516.13	9.0	H	349.30	7.0	H	379.19	11.0	H	3089.85	8.0	H
Number of genera	8			8			15			10			8		
Number of species	11			13			20			12			16		

T C = Total counts, N C I = Number of cases of isolation, O R = Occurrence remark, L = Low occurrence (1-2 months), M = Moderate occurrence (3-5 months) and H = High occurrence (6-12 months).

Trichoderma came behind *Aspergillus* and was highly represented in either surface water or submerged mud samples. The highest counts of *Trichoderma* species (7.33-10.16 colonies/ml water) was recorded in site 2 and 4 on both employed agar media, respectively. The highest population (3.5-4.9 colonies/ml water) was produced in surface water collected from site 5 and 4 during June and September 1996 on the both isolation media. With regard to submerged mud samples, it was recorded that the highest total counts (1196.24 and 3089.85 colonies/gm dry weight mud) was recorded from M5 on glucose and cellulose media, respectively. The highest monthly total counts (945.9 and 2549.6 colonies/gm dry mud) was recorded in site 5 during June 1996 on glucose and cellulose agar, respectively (Tables 1-4). On the contrary, this genus was isolated in rare frequency of occurrence from the Nile water near Assiut (El-Hissy, 1974; Khallil and Abdel-Sater, 1992).

Mucor occupied the third position and was of high incidence in water samples collected from sites 2,3 and 4 whereas exhibited a low incidence in site 1 and 5. It was represented by two identified (*M. circinelloides* and *M. hiemalis*) in addition to unidentified species. The richest months in *Mucor* were generally January, November and December 1996. Several investigation (El-Nagdy, 1981; Badran, 1986; El-Hissy *et al.*, 1990b; Moharram *et al.*, 1990; Khallil and Abdel-Sater, 1992) revealed low or moderate occurrence of *Mucor* in various water areas.

Penicilium was of high or moderate occurrence in water samples on cellulose- (3-6 months out of 12) and glucose- (1-5 months) Czapek's agar medium. This genus was represented in low or moderate occurrence in submerged mud samples using glucose (1-4 months) and cellulose (1-5 months out of 12). *Penicillium* appeared in high seasonal occurrence in various Egyptian water areas (El-Hissy, 1974; 1979ab; El-Hissy *et al.*, 1990b; El-Nagdy, 1981; Abdel-Hafez and Bagy, 1985; Badran, 1986; Moharram *et al.*, 1990; Khallil and Abdel-Sater, 1992). It was represented by 12 and 13 species on glucose and cellulose agar media, respectively from water and mud samples (Tables 1-4). *Penicillium*

chrysogenum was the commonest species irrespective to the tested substrate and nutritive media.

Fusarium was represented by six species in low, moderate or high occurrence depending upon the tested samples (water or mud), site employed, nutritive medium and sampling time (Tables 1-4). This genus was repeatedly isolated from water habitats (e.g. El-Nagdy, 1981; El-Hissy *et al.*, 1990b; Moharram *et al.*, 1990; Khallil and Absel-Sater, 1992).

Acremonium butryi, Emericella nidulans, Morteirella species, *Scopulariopsis brumptii* and *Syncephalastrum racemosum* were of moderate to low occurrence and recorded from water and mud samples on both glucose and cellulose-Czapek's agar media at 28°C. *Morteirella* species was recorded from water samples only on glucose but from mud samples on glucose and cellulose-Czapek's agar. *Alternatia alternata, Myrothecium roridum* and *Torula hernbarum* were isolated from mud samples only on cellulose agar whereas from water samples on glucose and cellulose agar. Khallil and Abdel-Sater (1992) recorded *Emericella nidulans* and *Nectria haematococca* in high incidence and *Syncephalastrum racemosum* in rare occurrence from water, soil and air polluted by the industrial effluents of Manquabad superphosphate factory at Assiut.

Acremonium strictum, Acremonium species, *Alternaria alternata, Botryotrichum atrogriseum, Chaetomium* species, *Cladosporium* species, *Cephalosporium* species, *Cochliobdus lunata, Curvularia clavata, C. ovoidea*), *Cylendrocarpon* species, *Doratomyces* species, *Emericella nidulans* var. *lata, E. nivea, Fennellia flavipes, Geotrichum candidum, Gibberella fujikuroi, Humicola grisea, Hypomyces chrsospermae, Rhizopus stolonifer, Monocillium indicum, Mycosphaerella tassiana, Myrothecium roridum, M. verrucaria, Myrothecium* species, *Nectria haematococca, Scopulariopsis brevicaulis, Trichurus spiralis, Torula graminis* and *T. herbarum*) were recovered during this study with low frequency of occurrence. It is concluded that the poorest samples in terrestrial fungi were those collected from the site 1 which is exposed directly to the industrial effluents and this elucidate that these effluents exhibited an adverse effect on fungal population. Similar findings were obtained by Khallil and Abdel-Sater (1992).

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