ACTA MYCOLOGICA
Vol. XXVIII (1): 31-38
1993

Occurrence and distribution of Chytridiales related to some physical and chemical factors

SAMY K. M. HASSAN

Botany Department, Faculty of Science, Minia University,
Egypt

H a s s a n S. K. M.: *Occurrence and distribution of Chytridiales related to some physical and chemical factors.* Acta Mycol. XXVIII (1): 31-38, 1993.

Physical and chemical properties of water and soil were positively corelated with the occurrence and distribution of chytrides. Thirty-six zoosporic members of chytrids belonging to fourteen genera were recorded in the present study. *Nowakowskiella, Karlingia, Cladochytrium, Endochytrium* and *Rhizophlyctis* were the most common genera observed along River Nileshore and other canals in nine Governorates in Egypt during the winter of 1989/1990.

INTRODUCTION

Most ecological studies on chytrids in soils primarily concern their distribution (W i l o u g h b y, 1961, 1965; B a r r, 1969; B o o t h, 1971 a, b, c; B o o t h, B a r r e t t, 1971; K a r l i n g, 1970, 1979, 1987, 1988). Although many publications deal with chytridiaceous fungi in Egypt (E l - N a g h y, H a s s a n, E l - K o m y, 1985 a, b, 1987; H a s s a n, 1990 a, b, c, d; H a s s a n, S h o u l k a m y, 1991; H a s s a n, F a d l - A l l a h, 1991), relativety very little is known about the relationship between seasonal occurence and distribution of zoosporic fungi and physical and chemical properties of water streams nad soils in the Delta region and Upper Egypt (E l - H i s s y, K h a l l i l, 1989; H a s s a n, F a d l - A l l a h, 1991).

Numerous soil chytrids have been reported allover the world, but little informations is known about their occurrence in Egypt. Therefore, the present investigation concerned the occurrence and distribution of *Chytridiales* in Egypt.

MATERIAL AND METHODS

During the winter of 1989/1990, thirty-four soil samples were collected from the humus layer of Nile shore and other canals as performed by W i l l o u g h b y (1965). Soils of nine Governorates in Egypt have been studied (Fig. 1). Subsequent analyses of soil including hydrogen concentration, calcium, magnesium, sodium, potassium, phosphate, nitrate, chloride and organic matter content were carried out in the laboratory (M a c k e r e t h, H e r o n, T a l l i n g, 1978).

Chytrids were isolated from soil using scales of onion skin, cellophane and bleached bromegrasse leaves (*Bromus catharicus*). Five grams of soil samples were placed in each of five sterile 9 cm Petri dishes and covered with 20 ml of soil extract solution as performed by H a n s o n (1945). Ten parts of baiting substra were put on the surface of each disk and then incubated at 20-23°C for two or three weeks.

The developing chytridaceous fungi were identified (S p a r r o w, 1960; B a t k o, 1975; B a t k o, H a s s a n, 1982; K a r l i n g, 1977. Isolated strains of chytrids were subcultured od the same substrate using the induction of medium (M e n d o z a, P r e n d a s, 1988).

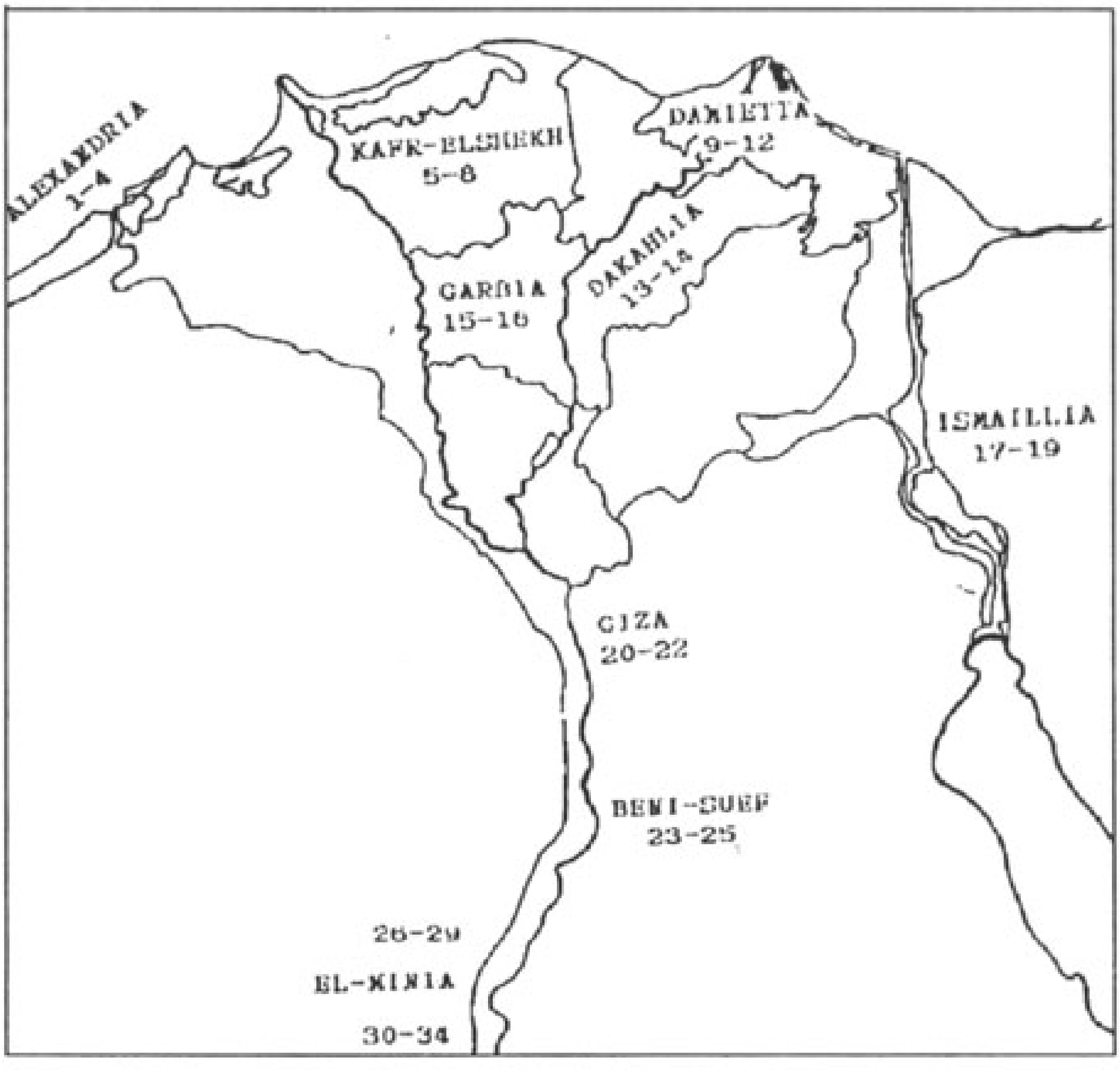

Fig. 1. Location map of soil samples collected from different governorates along Nile shore and other canals

RESULTS AND DISCUSSION

Thirty six species of *Chytridiales* in addition to other five unidentified chytrids belonging to fourteen genera have been recorded in the present investigation (Table1).

The present results (Table 2), show that all tested soil samples had low organic matter content (0.26-1.8 %) except for two samples-no. 28 and 33 that have relatively high values of organic matter, 2.9 % and 3.08 %, respectively. There were no appreciable differences in the pH of the soil samples. Most of them were alkaline with pH 7.1-8.15. Six samples, however, were slightly acidic pH 6.45-6.85 and one was neutral. Calcium content ranged from 14 mg/l to 90 mg/l. Only two samples no. 9 and 20 contained high concentration of calcium 290 and 320 mg/l. respetively. Most of the soil samples had low concentration of sodium.

Soil sample no. 29 collected from El-Minia Governorate had the highest number of chytrids (fifteen species) representing 37 % of the total number of isolates including 8.6 % as the highest value of relative density of individuls recorded in the present study (Table 1). The following contents of Na, Ca, Mg, K, phosphate and organic matter were noted : Ca^{2+}– 54 mg/l, Mg^{2+}– 1 mg/l, K^{+}– 2.4 g/l, 40 mg/l phosphate, 1.8 % organic matter. The pH amounted to 7,15. On the other hand, the lowest number of zoosporic chytrids (2 species) representing 5 % of the total number of isolates were recorded in soil sample no. 25; it has relatively high concentration of both sodium and nitrate, 10 mg/l and 360 mg/l, respectively. It contains, however, a low content of organic matter (0.9 %).

Much of the ecological studies on occurrence of chytidiaceous fungi proved that both physical and chemical factors play an important role in the occurrence and distribution of *Chytridiales*: T r i b e (1975), W i l l o u g h b y (1964), S p a r r o w (1969), B o o t h (1971c), H a s s a n, F a d l-A l l a h (1991). The authors postulated that high concentration sodium inhibits the growth of chytrids. Reletively high values of organic matter fawours the growth of chytrid population, however moderate concentration of Ca^{2+}, Mg^{2+}, K^{+} and nitrate favours the occurrence and affects the distribution of zoosporic members of *Chytridiales*. Moreover, slightly high value of pH (near neutrality promoted the growth of chytridiaceous fungi. These results were in agreement with the data recorded in the present study. *Nowakowskiella*, *Karlingia*, *Cladochytrium*, *Endochytrium* and *Rhizophlyctis* were the most common genera recorded in soil samples (Table 1).

Nowakowskiella was recorded 32 times and comprised 94 % of the tested soil sampes (32 out of 34) and 40 % of the total number of fungi. It was represented by ten species. *N. ramosa* and *N. hemosphaerospora* were the most common and numerous in species. They occured in 76.5 % of the soil samples (26 out of 34) and 73.5 % (25 out of 34), respectively: they comprised; 41 % and 38.2 % of the total number of *Nowakowskiella* species: 16.5 % and 15.4 % of the total number of fungi.

Table 1

Total number (TN) of *Chytridiales* (mg/dry soil), number of cases of isolation (NCI) (out of 34 samples) and occurrence remarks (OR) in soil samples collected from Nile shore and other canals during the winter of 1989/90

Isolated fungi	Soil samples																																NC I	RO	TN
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34			
A – *Nowakowskiella*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7880
N. delica Whiffen	o	o	.	o	.	.	.	.	.	.	.	.	.	.	.	.	.	o	.	.	.	.	.	o	.	.	.	.	.	.	.	.	.	.	5	R	155
N. elegans (Nowak.) Schröter	.	o	.	.	o	.	.	.	.	o	.	.	.	.	.	o	o	.	.	.	.	.	.	.	.	o	o	.	o	.	o	.	.	o	10	L	420
N. elongate Karling	.	.	.	.	.	.	.	o	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	o	.	.	.	2	R	110
N. granulata Karling	o	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	o	.	.	.	.	.	.	.	.	.	2	R	90
N. hemisphaerospora Shanor	~	o	.	.	o	+	o	+	.	+	.	~	+	.	+	+	+	~	o	+	.	.	.	.	+	+	~	o	~	~	+	~	~	+	25	H	3010
N. macrospora Karling	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	~	.	.	.	.	+	4	R	470
N. multispora Karling	.	.	o	.	.	.	.	.	.	+	.	o	.	.	o	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	R	260
N. profusa Karling	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	o	.	.	.	.	.	.	.	.	.	.	.	.	.	o	.	.	.	2	R	50
N. ramosa Butler	~	~	~	+	+	+	o	+	.	+	+	.	+	+	.	~	o	+	o	.	o	.	+	.	.	+	~	+	~	+	~	o	.	~	26	H	3235
N. scluptura Karling	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	o	.	o	.	.	.	2	R	80
Cladochydrium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1430
C. aurantiacum Richards	.	.	.	.	o	o	.	o	o	o	o	.	.	.	.	.	o	.	.	.	.	.	.	o	.	.	o	.	.	.	.	.	.	o	11	L	450
C. hyalinum Berdan	o	o	.	o	.	.	o	o	o	.	.	.	o	.	+	.	.	o	.	.	.	.	.	.	.	.	o	o	~	.	.	.	o	o	14	L	785
C. replicatum Karling	o	.	.	.	.	.	.	.	.	.	o	.	o	.	.	o	.	.	.	.	.	.	o	.	.	.	.	.	.	.	.	.	.	.	5	R	195
Septochytrium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1495
S. macrosporum Karling	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	1	R	80
S. variabile Berdan	+	.	+	.	o	+	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	~	~	.	.	.	.	.	13	L	1415
B – *Karlingia*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1850
K. granulata Karling	o	.	o	.	.	.	.	.	.	o	.	.	.	.	o	.	.	.	.	o	.	o	.	.	.	.	.	.	.	.	.	.	.	.	6	R	300
K. hyalina Karling	.	.	.	.	.	.	.	.	.	o	.	.	.	.	o	o	o	.	.	.	.	.	o	.	.	.	.	.	o	.	.	.	.	.	6	R	265
K. lobata Karling	.	.	.	.	.	o	.	.	.	.	.	.	o	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	R	110
K. rosea (de Bary et Woronin) Johanson	o	o	o	o	.	.	o	o	.	.	o	.	.	o	o	o	.	o	.	+	o	o	.	o	.	o	.	o	o	o	.	o	o	o	22	M	1175
Rhizophlyctis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	830
R. boneseyi Sparrow	.	.	.	.	.	.	.	o	.	o	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	R	55
R. fusca Karling	o	o	.	o	.	.	o	.	o	o	.	.	.	.	.	o	.	.	.	.	.	.	.	.	.	.	.	o	o	o	.	.	.	.	10	L	440
R. hirsutus Karling	.	.	.	.	.	.	.	.	.	o	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	o	.	o	.	.	.	.	3	R	70
R. petersenii Sparrow	o	.	.	.	o	.	.	o	.	.	.	.	o	.	.	.	.	o	.	o	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	R	265
Chytridium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	800
C. proliferum Karling	.	.	.	.	.	.	.	o	.	.	o	.	.	.	.	.	.	.	.	o	.	.	.	.	o	.	.	.	o	.	.	.	.	.	5	R	190

Chytridium sp.	o	.	o	.	o	.	.	.	.	.	o	.	o	+	.	.	.	.	.	.	+	.	o	.	.	.	.	.	+	.	.	.	o	.	10	L	610
Chytriomyces	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	290
C. aureus Karling	.	o	.	.	.	.	o	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	R	65
Chytriomyces sp.	.	.	.	.	.	+	.	.	.	o	.	.	.	.	.	.	.	.	.	.	o	.	.	.	.	.	.	.	.	.	.	.	.	.	3	R	225
Polyphagus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	65
P. parasiticus Scherffel	.	.	.	.	.	.	.	.	o	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	R	875
C – *Endochytrium*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2430
E. digitatum Karling	.	.	.	.	.	.	.	.	o	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	R	40
E. psedodistomum Karling	+	+	+	+	.	+	+	.	+	.	+	.	.	+	+	.	+	~	o	.	+	.	.	.	.	+	+	.	+	~	.	.	.	~	19	M	2275
Endochytrium sp.	.	.	.	.	.	.	.	.	o	.	.	.	.	.	.	.	.	o	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	R	115
Entophlyctis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	175
E. crenata Karling	.	.	.	.	.	.	.	o	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	R	65
E. vaucherii Fischer	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	o	.	.	.	1	R	70
Entophlyctis sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	o	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	R	40
Diplophlyctis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	600
D. nephrochytrioid Karling	.	o	o	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	o	.	.	.	.	.	.	6	R	415
D. verrucosa Kobayashi et Ookubo	o	o	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	o	.	.	.	.	.	.	3	R	185
Nephrochytrium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	265
N. appendiculatum Karling	o	o	.	o	.	.	.	.	.	.	.	.	.	.	o	.	.	.	.	.	.	.	.	.	.	.	.	o	o	.	.	.	.	.	6	R	235
N. amazonese Karling	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	o	o	.	.	.	.	.	2	R	30
D – *Hypochytrium*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	615
H. catenoides Karling	+	+	.	.	.	.	+	.	.	.	.	~	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	R	615
E – *Rozella*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	855
R. diplophlyctoid Karling	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	o	.	.	~	.	.	.	.	+	5	R	465
Rozella sp.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	4	R	410
No. of isolated species	13	13	11	8	8	7	9	14	7	10	9	3	10	6	8	8	11	10	3	4	6	2	4	3	2	9	10	9	15	6	7	3	4	10	262		
Total number of individuals	1085	830	840	570	530	600	525	850	430	695	650	290	830	420	535	535	805	825	200	260	390	115	225	90	125	690	695	530	1680	640	550	290	330	950	19600		
Relative density of individuals	5.53	4.23	4.28	2.91	2.70	6.06	2.65	4.33	2.19	3.54	3.31	1.48	4.23	2.14	2.73	2.73	4.11	4.21	1.02	1.32	1.99	0.58	1.15	0.46	0.63	3.52	3.54	2.70	8.57	3.26	2.80	1.48	1.68	4.85	100 %		

H – High occurrence (from 25-34 cases of isolation), M – Moderate occurrence (from 17-24 cases of isolation), L – Low occurrence (from 9-16 cases of isolation), R – Rare occurrence (less than 9 cases of isolation); o – Up to 75 mature sporangia, + – From 76-150 mature sporangia, ~ – More than 150 mature sporangia; A – *Cladochytriaceae*, B – *Rhizidiaceae*, C – *Entophlyctaceae*, D – *Harpochytriaceae*, E – *Olpidiaceae*.

Table 2

Average values of some physical and chemical properties of soil samples collected from different localities along the Nile shore and other canals during the winter of 1989/1990

No. location sampling		Physical and chemical properties								
		pH value	Ca^{++} (mg/l)	Mg^{++} (mg/l)	Na^{+} (mg/l)	K^{+} (mg/l)	PO_4^{3-} (mg/l)	NO_3^{-} (mg/l)	Cl^{-} (g/l)	Organ. matter (%)
1	Aleksandria (1-4)	7.55	25	3	5	2	30	75	2.45	0.48
2		7.45	25	30	3	1	260	20	1.70	0.56
3		7.60	57	42	3	2	40	160	2.42	0.56
4		7.20	90	72	8	4	300	170	2.76	0.60
5	Kafr-Elshekh (5-8)	6.45	36	20.4	8	3.5	40	20	0.03	1.32
6		7.10	58	30	2	2	100	120	0.92	1.28
7		7.50	44	6.6	3	4	50	100	1.02	1.08
8		7.30	35	5.4	6	1	100	40	1.00	1.28
9	Demitta (9-12)	6.65	290	306	46	6	200	150	3.19	0.87
10		7.20	32	24	4	1	90	60	0.90	0.90
11		6.90	45	96	20	2	40	150	0.14	0.89
12		6.85	46	168	46	5	120	70	0.03	0.55
13	Dakahlia (13-14)	7.25	35	21	2	1	75	25	1.77	0.72
14		7.15	35	54	19	3.5	60	2	1.91	0.28
15	Garbia (15-16)	7.30	29	18	2	2	160	100	1.23	0.58
16		7.25	14	18.6	2	1	60	125	2.06	0.54
17	Ismaillia (17-19)	7.95	49	30	7	1	2	20	1.12	0.68
18		8.15	19	30	7	1	90	40	1.15	0.40
19		7.15	71	24	13	2	175	150	2.05	1.20
20	Giza (20-22)	7.35	320	90	9	6	2	175	2.93	0.60
21		7.15	21	17.4	2	1	280	35	1.02	0.72
22		7.45	23	48	3	1	20	20	1.20	0.56
23	Beni-Suef (23-25)	7.15	18	26	15	2	20	130	0.19	0.95
24		7.00	41	48	19	2	10	125	0.13	0.80
25		7.32	38	51	10	1	45	360	0.25	0.90
26	El-Minia (26-29)	7.16	27	48	3	1	75	25	0.99	1.38
27		7.90	30	11	5	2	100	10	1.70	0.39
28		7.10	40	24	2	0	35	20	2.48	2.90
29		7.15	30	54	2	1	40	40	2.41	1.80
30	El-Minia (30-34)	7.00	46	12	2	1	75	50	1.01	1.30
31		6.85	25	13.2	2	1	35	60	1.29	0.26
32		7.15	27	45	2	1	10	20	1.02	0.92
33		7.10	26	32.4	3	6	90	10	1.10	3.08
34		6.85	32	32.4	1	0	30	17.5	2.91	1.79

Six species of *Nowakowskiella* were found in soil sample No. 31 collected from the south part of El-Minia Governorate. Sparrow (1960), El-Naghy et al. (1985 a), Hassan and Shoulkamy (1991) and Hassan and Fadl-Allah (1991) noted that both *N. ramosa* and *N. hemisphaerospora* were common in soil and water samples and were widly distributed allover the world.

Karlingia was the second most common qenus found in the examined soil samples and was reported 27 times out of 34,comprising 79.4 % of the total number of isolated species and 9.4 % of the total number of fungi. It was represented by four species *K. rosea* was the most common species and occured moderately. It was detected in 64.7 % of the tested soil samples (22 out of 34) and in 63.5 % of the total number of *Karlingia* species. S p a r r o w (1960), K a r l i n g (1973) noted that *K. rosea* is a common widely distributed species.

Cladochytrium was recorded 23 times out of 34 and constituted 67.6 % of the tested soil samples representing 7.3 % of the total number of fungi. Three species belonging to this genus were recorded. *C. hyalium* occured in low numbers and was observed in 41.2 % of the soil samples, compising 54.9 % of the total number of *Cladochytrium* species.

Endochytrium, was recorded in 55.9 % of the soil samples. It included two species among which *E. pseudodistomum* occured moderately.

Rhizophlyctis was found in 44.1 % of the tested soil samples. This genus was represented by four species among which *R. fusca* qccured in low numbers and was recorded in 29.4 % of the soil samples.

The occurrence and distribution of chytridiaceous fungi in the tested soil samples varied. This may by due to the differences in their physical and chemical properties. D a y a l and T a n d o n (1963) and M i s r a (!982) noted that calcium has a positive and an important effect on the number of aquatic fungi. Moreover S p a r r o w (1969) and B o o t h (1971 c) recorded that organic matter and Mg^{2+} content as vell as pH a positive effect on zoosporic fungi. High concentration of Na^{+} however, inhibits the normal growth of chytrids and most of zoosporic fungi. Thus, the results of this paper were in agreement with those recorded in the previous investigation.

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