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Characterization of Functional Groups of Microalgae in Lake Manzala and their Potentiality for Bioremediation and Biomonitoring of Pollutants

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(Non-Flowering Plants)

BY

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CONTENTS

Subject	Page
List of tables	iii
List of figures	ix
List of Plates	xviii
List of abbreviations	i
INTRODUCTION	1
REVIEW OF LITERATURE	4
Phytoplankton functional groups	4
Phytoplankton as Water quality monitoring	6
Environmental Factors in Manzala Lake	14
A. Abiotic Factors	15
B. Biotic Factors: Plankton Community	27
Heavy metals	31
A. Heavy metals in water	31
B. Heavy metals in fish	32
Micro-algae and pollutants bioremediation	33
A. Micro-algae and nutrients removal	34
B. Micro-algae and bioremediation of heavy metals	36
MATERIALS AND METHODS	41
Field experiment	41
Water analysis	43
Physico-chemical parameters	44
Biological Analyses	49
Phytoplankton	49
Estimation of phytoplankton biomass	50
Chlorophyll "a"	58
Zooplankton	58
Heavy Metals in Water	59
Fish analysis	60
Collection of fish samples	60
Determination of heavy metals in fishes	60
Laboratory experiment	61
Media used for isolation of algae	61
Isolation and Purification of algae	62
Algal strains	62
Deign of experiment	63
Measurements	64
Remediating rate for heavy metals	65

Statistical analyses	65
RESULTS	66
Field experiment	66
Physico-chemical parameters of water	66
Biological analysis	119
phytoplankton	119
Phytoplankton biomass	156
Phytoplankton Functional groups in Manzala Lake	163
Zooplankton	173
Heavy metals	189
Heavy metals in water	189
Heavy metals in fish	216
Laboratory experiment	272
Effect of Pb ²⁺ on <i>Chroococcus minutes</i>	274
Effect of Cd ²⁺ on <i>Chroococcus minutes</i>	278
Effect of Pb ²⁺ on <i>Chlorella vulgaris</i>	282
Effect of Cd ²⁺ on <i>Chlorella vulgaris</i>	286
Pb ⁺² and Cd ⁺² metals removal	290
DISCUSSION	295
SUMMARY	319
REFERENCES	328
ARABIC SUMMARY	1

List of Tables

Table no.	Title	Page no.
1	Location of stations sampled	42
2	Percentage of unionized ammonia in aqueous solutions at different pH values and temperatures.	46
3	Geometrical shapes and formulas for calculating biovolume	51
4	Different concentrations of two heavy metals (Pb^{+2} & Cd^{+2}) using for showing the bioremediation rate of two both algae.	64
5	Monthly fluctuation of water temperature (oC) in different sites during the study period at Manzala Lake	67
6	Seasonal fluctuation of water temperature (oC) in different sites during the study period at Manzala Lake	68
7	Monthly fluctuation of Secchi disc depth (cm) in different sites during the study period at Manzala Lake	71
8	Seasonal fluctuation of Secchi disc depth (cm) in different sites during the study period at Manzala Lake	72
9	Monthly fluctuation of pH in different sites during the study period at Manzala Lake	75
10	Seasonal fluctuation of pH in different sites during the study period at Manzala Lake	76
11	Monthly fluctuation of dissolved oxygen (mg/l) in different sites during the study period at Manzala Lake	79
12	Seasonal fluctuation of dissolved oxygen (mg/l) in different sites during the study period at Manzala Lake	80
13	Monthly fluctuation of salinity (g/l) in different sites during the study period at Manzala Lake	83
14	Seasonal fluctuation of salinity (g/l) in different sites during the study period at Manzala Lake	84
15	Monthly fluctuation of electric conductivity, EC (μ mhos) in different sites during the study period at Manzala Lake	87
16	Seasonal fluctuation of electric conductivity, EC (μ mhos) in different sites during the study period at Manzala Lake	88
17	Monthly fluctuation of total dissolved solids, TDS (mg/l) in different sites during the study period at Manzala Lake	91
18	Seasonal fluctuation of Total dissolved solids, TDS (mg/l) in different sites during the study period at Manzala Lake	92
19	Monthly fluctuation of total alkalinity (mg/l as $CaCO_3$) in different sites during the study period at Manzala Lake	95

20	Seasonal fluctuation of Total alkalinity (mg/l) in different sites during the study period at Manzala Lake	96
21	Monthly fluctuation of ortho-phosphate (mg/l) in different sites during the study period at Manzala Lake	99
22	Seasonal fluctuation of ortho-phosphate (mg/l) in different sites during the study period at Manzala Lake	100
23	Monthly fluctuation of total phosphate (mg/l) in different sites during the study period at Manzala Lake	103
24	Seasonal fluctuation of total phosphate (mg/l) in different sites during the study period at Manzala Lake	104
25	Monthly fluctuation of Nitrate NO ₃ (mg/l) in different sites during the study period at Manzala Lake	107
26	Seasonal fluctuation of Nitrate NO ₃ (mg/l) in different sites during the study period at Manzala Lake	108
27	Monthly fluctuation of nitrite NO ₂ (mg/l) in different sites during the study period at Manzala Lake	111
28	Seasonal fluctuation of nitrite NO ₂ (mg/l) in different sites during the study period at Manzala Lake	112
29	Monthly fluctuation of ammonia NH ₄ (mg/l) in different sites during the study period at Manzala Lake	115
30	Seasonal fluctuation of ammonia (NH ₄) (mg/l) in different sites during the study period at Manzala Lake	116
31	Monthly fluctuation of total nitrogen (mg/l) in different sites during the study period at Manzala Lake	119
32	Seasonal fluctuation of Total nitrogen (mg/l) in different sites during the study period at Manzala Lake	120
33	Monthly fluctuation of Chlorophyll a (µg/l) in different sites during the study period at Manzala Lake	123
34	Seasonal fluctuation of Chlorophyll a (µg/l) in different sites during the study period at Manzala Lake	124
35	Species composition of various phytoplankton groups at Manzala Lake during the study period	131
36	Seasonal and annual mean of Bacillarophyceae (org. ×10 ³ /l) in water samples collected from the four regions of Lake Manzala during the study period.	147
37	Seasonal and annual mean of Chlorophyceae (org. ×10 ³ /l) in water samples collected from the four regions of Lake Manzala during the study period	148
38	Seasonal and annual mean of Cyanophyceae (org. ×10 ³ /l) in water samples collected from the four regions of Lake Manzala during the study period	149
39	Seasonal and annual mean of Euglenophyceae (org. ×10 ³ /l) in	150

	water samples collected from the four regions of Lake Manzala during the study period	
40	Shannon and Weaver diversity, evenness of species, Berger-Parker index and Simpson index of phytoplankton at the studied regions	158
41	Seasonal variation of phytoplankton groups biomass at different four regions of Manzala Lake during the study period.	162
42	Pearson's Correlation coefficients between different phytoplankton (number and biomass) and environmental variable factors	165
43	Dominant phytoplankton species (5% of the total biomass) in Manzala Lake between July 2016 and June 2017 with their taxonomic name and functional group	167
44	Seasonal variation of phytoplankton functional groups biomass of four regions in Manzala Lake during the study period	171
45	Pearson correlation coefficients between biomass of the dominant phytoplankton functional groups and environmental variable factors	176
46	Monthly fluctuations of Rotifers (ind. /l) in water samples of Manzala Lake at different sites during the study	179
47	Seasonal fluctuations of Rotifers (ind. /l) in water samples of Manzala Lake at different sites during the study	180
48	Monthly fluctuations of Copepoda (ind. /l) in water samples of Manzala Lake at different sites during the study	183
49	Seasonal fluctuations of Copepoda (ind. /l) in water samples of Manzala Lake at different sites during the study	184
50	Monthly fluctuations of Cladocera (ind. /l) in water samples of Manzala Lake at different sites during the study	184
51	Seasonal fluctuations of Cladocera (ind. /l) in water samples of Manzala Lake at different sites during the study	185
52	Monthly fluctuations of other Zooplankton (ind. /l) in water samples of Manzala Lake at different sites during the study	186
53	Seasonal fluctuations of Other Zooplankton (ind. /l) in water samples of Manzala Lake at different sites during the study	187
54	Monthly fluctuation of iron (Fe) concentration (mg/l) in water of Manzala Lake at different stations during the study period	190
55	Seasonal concentrations of Fe (mg/l) (mean \pm standard deviation) of water samples collected from Manzala Lake during July 2016-June 2017	191
56	Monthly fluctuation of manganese (Mn) concentration (mg/l) in water of Manzala Lake at different stations during the study period	194

57	Seasonal concentrations of Mn (mg/l) (mean \pm standard deviation) of water samples collected from Manzala Lake during July 2016-June 2017	195
58	Monthly fluctuation of zinc (Zn) concentration (mg/l) in water of Manzala Lake at different stations during the study period	198
59	Seasonal concentrations of Zn (mg/l) (mean \pm standard deviation) of water samples collected from Manzala Lake during July 2016-June 2017	199
60	Monthly fluctuation of copper (Cu) concentration (mg/l) in water of Manzala Lake at different stations during the study period	202
61	Seasonal concentrations of Cu (mg/l) (mean \pm standard deviation) of water samples collected from Manzala Lake during July 2016-June 2017	203
62	Monthly fluctuation of lead (Pb) concentration (mg/l) in water of Manzala Lake at different stations during the study period	206
63	Seasonal Concentrations of Pb (mg/l) (mean \pm standard deviation) of water samples collected from Manzala Lake during July 2016-June 2017	207
64	Monthly fluctuation of cadmium (Cd) concentration (mg/l) in water of Manzala Lake at different stations during the study period	210
65	Seasonal Concentrations of Cd (mg/l) (mean \pm standard deviation) of water samples collected from Manzala Lake during July 2016-June 2017	211
66	Annual mean of heavy metals concentration (mg/l) in water of different sites of Lake Manzala during the study period.	214
67	Seasonal concentrations of Fe ($\mu\text{g/g}$ dry wt.) in different organs and tissues of some fish Species collected from Manzala Lake during July 2016-June 2017	217
68	Annual average of iron concentrations ($\mu\text{g/g}$ dry wt. in different organs of some fishes collected from different regions of Lake Manzala during the study period	223
69	Seasonal concentrations of Mn ($\mu\text{g/g}$ dry wt.) in different organs and tissues of some fish Species collected from Manzala Lake during July 2016-June 2017	226
70	Annual average of Mn concentrations ($\mu\text{g/g}$ dry wt. in different organs of some fishes collected from different regions of Lake Manzala during the study period	232
71	Seasonal concentrations of Zn ($\mu\text{g/g}$ dry wt.) in different organs and tissues of some fish Species collected from Manzala Lake during July 2016-June 2017	236
72	Annual average of Zn concentrations ($\mu\text{g/g}$ dry wt. in different	241

	organs of some fishes collected from different regions of Lake Manzala during the study period	
73	Seasonal concentrations of Cu ($\mu\text{g/g}$ dry wt.) in different organs and tissues of some fish Species collected from Manzala Lake during July 2016-June 2017	245
74	Annual average of Cu concentrations ($\mu\text{g/g}$ dry wt. in different organs of some fishes collected from different regions of Lake Manzala during the study period	250
75	Seasonal concentrations of Pb ($\mu\text{g/g}$ dry wt.) in different organs and tissues of some fish Species collected from Manzala Lake during July 2016-June 2017	254
76	Annual average of Pb concentrations ($\mu\text{g/g}$ dry wt. in different organs of some fishes collected from different regions of Lake Manzala during the study period	260
77	Seasonal concentrations of Cd ($\mu\text{g/g}$ dry wt.) in different organs and tissues of some fish Species collected from Manzala Lake during July 2016-June 2017	262
78	Annual average of Cd concentrations ($\mu\text{g/g}$ dry wt. in different organs of some fishes collected from different regions of Lake Manzala during the study period	269
79	The effect of different concentrations of Pb^{2+} (ppm) on optical density of <i>Chroococcus minutus</i> during incubation period 12 days	275
80	The effect of different concentrations of Pb^{2+} (ppm) on chlorophyll a contents of <i>Chroococcus minutus</i> during incubation period 12 days	277
81	The effect of different concentrations of Cd^{2+} (ppm) on optical density of <i>Chroococcus minutus</i> during incubation period 12 days	279
82	The effect of different concentrations of Cd^{2+} (ppm) on chlorophyll a contents of <i>Chroococcus minutus</i> during incubation period 12 days	281
83	The effect of different concentrations of Pb^{2+} (ppm) on optical density of <i>Chlorella vulgaris</i> during incubation period 12 days	283
84	The effect of different concentrations of Pb^{2+} (ppm) on chlorophyll a contents of <i>Chlorella vulgaris</i> during incubation period 12 days	285
85	The effect of different concentrations of Cd^{2+} (ppm) on optical density of <i>Chlorella vulgaris</i> during incubation period 12 days	287
86	The effect of different concentrations of Cd^{2+} (ppm) on chlorophyll a contents of <i>Chlorella vulgaris</i> during incubation period 12 days	289
87	Uptake accumulation of Pb^{+2} and Cd^{+2} ions at various concentrations (ppm) estimated (mg/l) after 3, 6, 9 and 12 days of exposure by <i>Chroococcus minutus</i> and <i>Chlorella vulgaris</i>	291

88	Percentage of metal removal from the culture media by <i>Chroococcus minutus</i> and <i>Chlorella vulgaris</i> exposed to different concentrations (ppm) of Pb^{2+} and Cd^{2+} after incubation period 12 days	294
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List of Figures

Figure no.	Title	Page no.
1	Manzala Lake map clear main drain canals	41
2	The studied 12 sites of the four regions at Manzala Lake during the study period.	43
3	Monthly variation of Water temperature in different sites at Manzala Lake during the study period.	69
4	Seasonal fluctuation of water temperature (oC) in different sites at Manzala Lake during the study period.	69
5	Annual average of water temperature (oC) in Manzala Lake during the study period.	69
6	Seasonal fluctuation of Transparency (cm) in different sites at Manzala Lake during the study period.	73
7	Seasonal fluctuation of Transparency (cm) in different sites at Manzala Lake during the study period.	73
8	Annual average of Transparency (cm) in Manzala Lake during the study period	73
9	Monthly variation of pH in different sites at Manzala Lake during the study period.	77
10	Seasonal fluctuation of pH in different sites at Manzala Lake during the study period	77
11	Annual average of pH in Manzala Lake during the study period.	77
12	Monthly variation of DO (mg/l) in different sites at Manzala Lake during the study period	81
13	Seasonal fluctuation of DO(mg/l) in different sites at Manzala Lake during the study period	81
14	Annual average of DO (mg/l) in Manzala Lake during the study period	81
15	Monthly variation of salinity (g/l) in different sites at Manzala Lake during the study period	85
16	Seasonal fluctuation of salinity (g/l) in different sites at Manzala Lake during the study period	85
17	Annual average of salinity (g/l) in Manzala Lake during the study period	85
18	Monthly variation of electric conductivity, EC (μ mhos) in different sites at Manzala Lake during the study period	89
19	Seasonal fluctuation of electric conductivity, EC (μ mhos) in different sites at Manzala Lake during the study period	89

20	Annual average of electric conductivity, EC (μmhos) in Manzala Lake during the study period	89
21	Monthly variation of TDS (mg/l) in different sites at Manzala Lake during the study period	93
22	Seasonal fluctuation of TDS (mg/l) in different sites at Manzala Lake during the study period	93
23	Annual average of TDS (mg/l) in Manzala Lake during the study period	93
24	Monthly variation of Total alkalinity (mg/l) in different sites at Manzala Lake during the study period	97
25	Seasonal fluctuation of total alkalinity (mg/l) in different sites at Manzala Lake during the study period	97
26	Annual average of total alkalinity (mg/l) in Manzala Lake during the study period	97
27	Monthly variation of O-P (mg/l) in different sites at Manzala Lake during the study period	101
28	Seasonal fluctuation of O.P (mg/l) in different sites at Manzala Lake during the study period	101
29	Annual average of O-P (mg/l) in Manzala Lake during the study period	101
30	Monthly variation of TP (mg/l) in different sites at Manzala Lake during the study period	105
31	Seasonal fluctuation of TP (mg/l) in different sites at Manzala Lake during the study period	105
32	Annual average of TP (mg/l) in Manzala Lake during the study period	105
33	Monthly variation of NO_3 (mg/l) in different sites at Manzala Lake during the study period	109
34	Seasonal fluctuation of NO_3 (mg/l) in different sites at Manzala Lake during the study period	109
35	Annual average of NO_3 (mg/l) in Manzala Lake during the study period	109
36	Monthly variation of NO_2 (mg/l) in different sites at Manzala Lake during the study period	113
37	Seasonal fluctuation of NO_2 (mg/l) in different sites at Manzala Lake during the study period	113
38	Annual average of NO_2 (mg/l) in Manzala Lake during the study period	113
39	Monthly variation of NH_4 (mg/l) in different sites at Manzala Lake during the study period	117
40	Seasonal fluctuation of NH_4 (mg/l) in different sites at Manzala Lake during the study period	117

41	Annual average of NH ₄ (mg/l) in Manzala Lake during the study period	117
42	Monthly variation of TN (mg/l) in different sites at Manzala Lake during the study period	121
43	Seasonal fluctuation of TN (mg/l) in different sites at Manzala Lake during the study period	121
44	Annual average of TN (mg/l) in Manzala Lake during the study period	121
45	Monthly variation of Chlorophyll a (µg/l) in different sites at Manzala Lake during the study period	125
46	Seasonal fluctuation of Chlorophyll a (µg/l) in different sites at Manzala Lake during the study period	125
47	Annual average of water Chlorophyll a (µg/l) in Manzala Lake during the study period	125
48	Monthly variation of Bacillariophyta, Euglenophyta, Cyanophyta and chlorophyta at region (1).	144
49	Monthly variation of Bacillariophyta, Euglenophyta, Cyanophyta and chlorophyta at region (2).	144
50	Monthly variation of Bacillariophyta, Euglenophyta, Cyanophyta and chlorophyta at region (3).	145
51	Monthly variation of Bacillariophyta, Euglenophyta, Cyanophyta and chlorophyta at region (4).	145
52	Seasonal variation on the algal composition of region (1) in Lake Manzala during the studied period	151
53	Seasonal variation on the algal composition of region (2) in Lake Manzala during the studied period	152
54	Seasonal variation on the algal composition of region (3) in Lake Manzala during the studied period	153
55	Seasonal variation on the algal composition of region (4) in Lake Manzala during the studied period	154
56	Annual average of phytoplankton species (org.×10 ³ /l) in water samples collected from the four regions of Lake Manzala during the study period	155
57	Seasonal variation of Phytoplankton groups biomass; Bacillariophyta, Chlorophyta, Cyanophyta and Euglenophyta, respectively at four regions of Manzala Lake	163
58	Seasonal and spatial variation of total biomass in four regions of Manzala Lake	164
59	Seasonal and spatial variation of PFGs biomass in four regions of Manzala Lake	175
60	Monthly variations of total zooplankton (ind. /l) in water samples collected from the different sites of Lake Manzala during 2016-2017	177

61	Monthly variations of Rotifers (ind. /l) in water samples collected from the different sites of Lake Manzala during 2016-2017	181
62	Seasonal variations of Rotifers (ind. /l) in water samples collected from the different sites of Lake Manzala during 2016-2017	181
63	Monthly variations of Copepoda (ind. /l) in water samples collected from the different sites of Lake Manzala during 2016-2017	185
64	Seasonal variations of Copepoda (ind. /l) in water samples collected from the different sites of Lake Manzala during 2016-2017	185
65	Monthly variations of Cladocera (ind. /l) in water samples collected from the different sites of Lake Manzala during 2016-2017	189
66	Seasonal variations of Cladocera (ind. /l) in water samples collected from the different sites of Lake Manzala during 2016-2017	189
67	Monthly variations of Other Zooplankton (ind. /l) in water samples collected from the different sites of Lake Manzala during 2016-2017	193
68	Seasonal variations of Other Zooplankton (ind. /l) in water samples collected from the different sites of Lake Manzala during 2016-2017	193
69	Seasonal population of all zooplankton groups during the study period	194
70	Monthly variation of iron concentration (mg/l) in water samples collected from different sites of Manzala Lake during the study period	198
71	Seasonal variation of Fe concentration (mg/l) in water samples collected from different sites of Manzala Lake during the study period	199
72	Monthly variation of Mn concentration (mg/l) in water samples collected from different sites of Manzala Lake during the study period	202
73	Seasonal variation of Mn concentration (mg/l) in water samples collected from different sites of Manzala Lake during the study period	203
74	Monthly variation of Zn concentration (mg/l) in water samples collected from different sites of Manzala Lake during the study period	206
75	Seasonal variation of Zn concentration (mg/l) in water samples collected from different sites of Manzala Lake during the study period	207
76	Monthly variation of Cu concentration (mg/l) in water samples collected from different sites of Manzala Lake during the study period	210
77	Seasonal variation of Cu concentration (mg/l) in water samples collected from different sites of Manzala Lake during the study period	211
78	Monthly variation of Pb concentration (mg/l) in water samples collected from different sites of Manzala Lake during the study period	214
79	Seasonal variation of Pb concentration (mg/l) in water samples collected from different sites of Manzala Lake during the study period	215
80	Monthly variation of Cd concentration (mg/l) in water samples collected from different sites of Manzala Lake during the study period	218
81	Seasonal variation of Cd concentration (mg/l) in water samples collected from different sites of Manzala Lake during the study period.	219

82	Annual variation of heavy metals concentration (mg/L) in water of the different sites of Lake Manzala during the study period	221
83	Seasonal variations of Fe ($\mu\text{g/g}$) dry wt in different organs of some fish species collected from region (1) of Manzala lake during the study period	225
84	Seasonal variations of Fe ($\mu\text{g/g}$) dry wt in different organs of some fish species collected from region (2) of Manzala lake during the study period	226
85	Seasonal variations of Fe ($\mu\text{g/g}$) dry wt in different organs of some fish species collected from region (3) of Manzala lake during the study period	227
86	Seasonal variations of Fe ($\mu\text{g/g}$) dry wt in different organs of some fish species collected from region (4) of Manzala lake during the study period	228
87	Annual mean of iron concentration ($\mu\text{g/g}$ dry wt.) in different tissues of some fish species collected from the region (1) of Lake Manzala during the study period	229
88	Annual mean of iron concentration ($\mu\text{g/g}$ dry wt.) in different tissues of some fish species collected from the region (2) of Lake Manzala during the study period	230
89	Annual mean of iron concentration ($\mu\text{g/g}$ dry wt.) in different tissues of some fish species collected from the region (3) of Lake Manzala during the study period	230
90	Annual mean of iron concentration ($\mu\text{g/g}$ dry wt.) in different tissues of some fish species collected from the region (4) of Lake Manzala during the study period	231
91	Seasonal variations of Mn ($\mu\text{g/g}$) dry wt in different organs of some fish species collected from region (1) of Manzala lake during the study period	233
92	Seasonal variations of Mn ($\mu\text{g/g}$) dry wt in different organs of some fish species collected from region (2) of Manzala lake during the study period	234
93	Seasonal variations of Mn ($\mu\text{g/g}$) dry wt in different organs of some fish species collected from region (3) of Manzala lake during the study period	235
94	Seasonal variations of Mn ($\mu\text{g/g}$) dry wt in different organs of some fish species collected from region (4) of Manzala lake during the study period	236
95	Annual mean of Mn concentration ($\mu\text{g/g}$ dry wt.) in different tissues of some fish species collected from the region (1) of Lake Manzala during the study period	238
96	Annual mean of Mn concentration ($\mu\text{g/g}$ dry wt.) in different tissues of some fish species collected from the region (2) of Lake Manzala	239

	during the study period	
97	Annual mean of Mn concentration ($\mu\text{g/g}$ dry wt.) in different tissues of some fish species collected from the region (3) of Lake Manzala during the study period	239
98	Annual mean of Mn concentration ($\mu\text{g/g}$ dry wt.) in different tissues of some fish species collected from the region (4) of Lake Manzala during the study period	240
99	Seasonal variations of Zn ($\mu\text{g/g}$) dry wt in different organs of some fish species collected from region (1) of Manzala lake during the study period	243
100	Seasonal variations of Zn ($\mu\text{g/g}$) dry wt in different organs of some fish species collected from region (2) of Manzala lake during the study period	244
101	Seasonal variations of Zn ($\mu\text{g/g}$) dry wt in different organs of some fish species collected from region (3) of Manzala lake during the study period	245
102	Seasonal variations of Zn ($\mu\text{g/g}$) dry wt in different organs of some fish species collected from region (4) of Manzala lake during the study period	246
103	Annual mean of Zn concentration ($\mu\text{g/g}$ dry wt.) in different tissues of some fish species collected from the region (1) of Lake Manzala during the study period	248
104	Annual mean of Zn concentration ($\mu\text{g/g}$ dry wt.) in different tissues of some fish species collected from the region (2) of Lake Manzala during the study period	248
105	Annual mean of Zn concentration ($\mu\text{g/g}$ dry wt.) in different tissues of some fish species collected from the region (3) of Lake Manzala during the study period	249
106	Annual mean of Zn concentration ($\mu\text{g/g}$ dry wt.) in different tissues of some fish species collected from the region (4) of Lake Manzala during the study period	249
107	Seasonal variations of Cu ($\mu\text{g/g}$) dry wt in different organs of some fish species collected from region (1) of Manzala lake during the study period	252
108	Seasonal variations of Cu ($\mu\text{g/g}$) dry wt in different organs of some fish species collected from region (2) of Manzala lake during the study period	253
109	Seasonal variations of Cu ($\mu\text{g/g}$) dry wt in different organs of some fish species collected from region (3) of Manzala lake during the study period	254
110	Seasonal variations of Cu ($\mu\text{g/g}$) dry wt in different organs of some fish species collected from region (4) of Manzala lake during the study period	255

111	Annual mean of Cu concentration ($\mu\text{g/g}$ dry wt.) in different tissues of some fish species collected from the region (1) of Lake Manzala during the study period	257
112	Annual mean of Cu concentration ($\mu\text{g/g}$ dry wt.) in different tissues of some fish species collected from the region (2) of Lake Manzala during the study period	257
113	Annual mean of Cu concentration ($\mu\text{g/g}$ dry wt.) in different tissues of some fish species collected from the region (3) of Lake Manzala during the study period	258
114	Annual mean of Cu concentration ($\mu\text{g/g}$ dry wt.) in different tissues of some fish species collected from the region (4) of Lake Manzala during the study period	258
115	Seasonal variations of Pb ($\mu\text{g/g}$) dry wt in different organs of some fish species collected from region (1) of Manzala lake during the study period	261
116	Seasonal variations of Pb ($\mu\text{g/g}$) dry wt in different organs of some fish species collected from region (2) of Manzala lake during the study period	262
117	Seasonal variations of Pb ($\mu\text{g/g}$) dry wt in different organs of some fish species collected from region (3) of Manzala lake during the study period	263
118	Seasonal variations of Pb ($\mu\text{g/g}$) dry wt in different organs of some fish species collected from region (4) of Manzala lake during the study period	264
119	Annual mean of Pb concentration ($\mu\text{g/g}$ dry wt.) in different tissues of some fish species collected from the region (1) of Lake Manzala during the study period	266
120	Annual mean of Pb concentration ($\mu\text{g/g}$ dry wt.) in different tissues of some fish species collected from the region (2) of Lake Manzala during the study period	267
121	Annual mean of Pb concentration ($\mu\text{g/g}$ dry wt.) in different tissues of some fish species collected from the region (3) of Lake Manzala during the study period	267
122	Annual mean of Pb concentration ($\mu\text{g/g}$ dry wt.) in different tissues of some fish species collected from the region (4) of Lake Manzala during the study period	268
123	Seasonal variations of Cd ($\mu\text{g/g}$) dry wt in different organs of some fish species collected from region (1) of Manzala lake during the study period	271
124	Seasonal variations of Cd ($\mu\text{g/g}$) dry wt in different organs of some fish species collected from region (2) of Manzala lake during the study period	272

125	Seasonal variations of Cd ($\mu\text{g/g}$) dry wt in different organs of some fish species collected from region (3) of Manzala lake during the study period	273
126	Seasonal variations of Cd ($\mu\text{g/g}$) dry wt in different organs of some fish species collected from region (4) of Manzala lake during the study period	274
127	Annual mean of Cd concentration ($\mu\text{g/g}$ dry wt.) in different tissues of some fish species collected from the region (1) of Lake Manzala during the study period	276
128	Annual mean of Cd concentration ($\mu\text{g/g}$ dry wt.) in different tissues of some fish species collected from the region (2) of Lake Manzala during the study period	276
129	Annual mean of Cd concentration ($\mu\text{g/g}$ dry wt.) in different tissues of some fish species collected from the region (3) of Lake Manzala during the study period	277
130	Annual mean of Cd concentration ($\mu\text{g/g}$ dry wt.) in different tissues of some fish species collected from the region (4) of Lake Manzala during the study period	277
131	Semilogarithmic growth of <i>Chroococcus minutus</i> based on Optical density grown in different concentrations of Pb^{+2} in BG medium.	279
132	Semilogarithmic growth of <i>Chroococcus minutus</i> based on Chlorophyll a (mg/l) grown in different concentrations of Pb^{+2} in BG medium.	281
133	Semilogarithmic growth of <i>Chroococcus minutus</i> based on Optical density grown in different concentrations of Cd^{+2} in BG medium	283
134	Semilogarithmic growth of <i>Chroococcus minutus</i> based on Chlorophyll a (mg/l) grown in different concentrations of Cd^{+2} in BG medium.	285
135	Semilogarithmic growth of <i>Chlorella vulgaris</i> based on Optical density grown in different concentrations of Pb^{+2} in BG medium	285
136	Semilogarithmic growth of <i>Chlorella vulgaris</i> based on Chlorophyll a (mg/l) grown in different concentrations of Pb^{+2} in BG medium	287
137	Semilogarithmic growth of <i>Chlorella vulgaris</i> based on Optical density grown in different concentrations of Cd^{+2} in BG medium	287
138	Semilogarithmic growth of <i>Chlorella vulgaris</i> based on Chlorophyll a (mg/l) grown in different concentrations of Cd^{+2} in BG medium.	289
139	Uptake accumulation of Cd ions at various concentrations (ppm) estimated (mg/l) after 3, 6, 9 and 12 days of exposure by <i>Chroococcus minutus</i>	291
140	Uptake accumulation of Cd ions at various concentrations (ppm) estimated (mg/l) after 3, 6, 9 and 12 days of exposure by <i>Chlorella vulgaris</i>	291

141	Uptake accumulation of Pb ions at various concentrations (ppm) estimated (mg/l) after 3, 6, 9 and 12 days of exposure by <i>Chlorella vulgaris</i>	293
142	Uptake accumulation of Pb ions at various concentrations (ppm) estimated (mg/l) after 3, 6, 9 and 12 days of exposure by <i>Chroococcus minutus</i>	293

List of plates

Plate No.	Title	Page
1	Photographic plates for some phytoplankton species that participate as PFGs	166
2	photograph showing <i>Chroococcus minutus</i>	273
3	photograph showing <i>Chlorella vulgaris</i>	273

Summary

Lake Manzala is one of the largest northern Egyptian lakes, which is located in the northeastern part of the Nile Delta, with a maximum length of about 50 km, a maximum width of about 30 km, and an area of about 700 km² that includes open water and a large number of islands, which reduces the water area to less than 500 km². Lake Manzala is one of the shallow lakes, with an average depth of 1.3 m, where it is fed by the waters of the Nile River and groundwater in addition to sea water. The Mediterranean Sea supplies Lake Manzala with salt water through the new and beautiful Bogaz, in addition to the New Damietta Bogaz, while the lake is connected to the Suez Canal through the Kabouti Canal.

There are three main channels connecting the lake with the Damietta branch, which are the Al-Sufra, Al-Tarma and Ananiyah canal, which were established to reduce the salinity percentage in the western part of the lake, in addition to that there are five main drains that supply the lake with sanitary, agricultural and industrial wastewater which are Bahr Al-Baqar drainage, Haddous, Ramses, Al-Sarw and Farskur . Lake Manzala suffers from its exposure to large quantities of industrial, agricultural and sanitary wastewater, which amount to about 7500 million km², especially the southern part of it, where Bahr Al-Cow and Haddous drain about 75% (estimated at about 3.3 billion cubic meters annually for the Sea of Cow, while Haddous is estimated at about 1.7 billion cubic meters). Which in turn leads to an increase in the concentrations of heavy elements that were detected in both water and fish, in addition to the reclamation process, which led to a reduction of about 60% of the volume of the lake's water between 1900 and 2000, as the rate of reclamation in the lake was estimated at about 5 km² annually in The period from 1922 to 1995.

This study included two experiments:

1- **The first experiment:** a study to characterize the functional groups of microalgae in Lake Manzala and their potential potential as evidence for pollutants in the lake

2- **The second experiment:** a study of the ability of two types of wild algae: *Chroococcus*, as an example of blue-green algae and *Chlorella* as one of the green algae isolated from the Ginkgo area in Manzala lake for the biological treatment of heavy metals, cadmium and lead from aqueous solutions containing different concentrations of heavy elements (Cd^{+2} and Pb^{+2}) for algae.

(1) Field experience:**Samples:**

The lake was divided into 4 regions, where 12 sites were chosen, all of which represent these four regions, the first region includes two sites (1 and 2), the second region two sites (11, 12), the third region sites (7, 8, 9, 10), and the fourth region (3, 4, 5, 6).

The results that were reached can be summarized as follows:**A- Water Quality Measurements:**

1- **Temperature:** The water temperature changed from one season to the other, as it ranged from 17 C° recorded in the winter to 31 C° recorded in the summer season, but there was no noticeable change between the sites during one season as the water temperature was affected by the air temperature .

2- **pH:** The pH values of Manzala lake ranged between 7.45 - 8.9 with slight regional and seasonal variations. The lowest pH values were recorded in the two regions (2 and 3) facing most of the lake drains.

3- **Dissolved oxygen:** The lowest values of the dissolved oxygen readings were recorded in the sites of the two regions (2 and 3) due to the increase in the microbial content of consuming oxygen as a result of the richness in the

organic content resulting from the sanitary and agricultural drainage in these two regions, while the highest values were recorded in the region (1) in winter.

4- Sicck disk: measuring the transparency of water is an important way to measure the fertility of water and the amount of its containment of zooplankton and plankton from the soil. In general, the values of the transparency disk have been found low in the sites of both regions (2, 3) and this is due to the sewage in these areas beside the plankton of mud And silt from the soil, while the scale of the transparency disk increased in the first and fourth regions

5- Salinity, electrical conductivity and dissolved salts: The salinity readings in the lake varied, as the highest value (31.5 g / l) was recorded during the summer season at site No. (1), while the lowest value (1.2 g / l) was recorded during the winter and autumn seasons at site No. 9) consequently, it becomes clear that the salinity values show their highest values in the northern part of the lake, and these values decrease in the direction of the southern part of the lake. The highest values of electrical conductivity (53.5 $\mu\text{m S. / cm}$) were recorded during the summer season at site No. (1), while the lowest reading (2.1 $\mu\text{m S. / cm}$) was recorded during the autumn season at location No. (9). The highest reading (29.5 g / l) of dissolved salts was recorded during the fall season at site No. (1), while the lowest reading (1.1 g / l) was recorded during the winter season at site No. (9).

6- Total alkalinity: The alkalinity reading ranged between 245 mg / l (during the summer season at site No. 1) and between 370 mg / l during the fall and spring seasons at site No. (11).

7- Dissolved phosphorous and total phosphorous: dissolved phosphorous and total phosphorous take an opposite direction to salinity, electrical conductivity, and total dissolved salts, as it decreases in the northern region

of the lake at site 1 and increases in the rest of the sites, as a result of the increase of phosphorus in the wastewater pouring into the lake.

8- Total nitrogen: The results showed a clear increase in the total nitrogen readings, as the highest reading was recorded in the third region during August (1.26 ± 0.1 mg / l), while the lowest reading was recorded during January in the first region (0.36 ± 0.02 mg / l).

9- Nitrates: The results showed a clear difference in the nitrate readings, as the highest reading was recorded in the third region during the month of August (0.74 ± 0.08 mg / l), while the lowest reading was recorded during the month of January in the four regions, where it ranged between (0.39 ± 0.04 and 0.47 ± 0.04). mg / l).

10- Nitrite: Nitrite readings ranged from (0.012 ± 0.001 mg / l) to (0.023 ± 0.002 mg / l) at the sites of the first two regions.

And the fourth, while from (0.015 ± 0.002 mg / l) to (0.04 ± 0.005 mg / l) in the second and third regions.

11- Ammonia: The lowest reading of ammonia was recorded in the first region, i.e both sites (1 and 2). It ranged between 0.13 ± 0.01 and 0.14 ± 0.01 mg / l, while the highest reading was in the third region during the month of August.

B- Biological properties

1- Chlorophyll (a): The values of chlorophyll A took the same direction as phosphorus, so the lowest values were at site (1), while the highest values were at site (9). The highest values of chlorophyll a were recorded during summer and autumn and the lowest were in winter. Chlorophyll a is used as an indicator of the fertility of water and its containment of zooplankton. In general, increasing the nutrients in the water leads to an increase in the proportions of phytoplankton and zooplankton and chlorophyll a. Also, an increase in chlorophyll a is accompanied by an increase in the proportion of

dissolved oxygen in the water as a result of an increase in the rates of photosynthesis.

2- Phytoplankton and their density

The number of phytoplankton is positively affected by diatoms, which represent the largest number, followed by green algae and blue-green algae group, followed by flagellated algae, which represent the smallest number. Moreover, the number of phytoplankton increases monthly. It was evident that the numbers of this group of phytoplankton from diatoms were significantly different ($P < 0.05$) between the basins of the second and third regions and the first and fourth regions. It is worth noting that the temperature season has a great impact on the distribution of diatoms, as the largest number of this group was recorded during September and October. Otherwise, the fewest numbers were recorded during August. The most abundant species during the study period were *Cyclotella meneghiniana* and *Navicula angusta*.

The results showed that there were clear significant monthly differences in the numbers of green algae group in different locations. On the other hand, the numbers of green algae in the sites of the second and third regions are higher than their counterparts in the first and fourth. The highest value of Chlorophyta was recorded during August in the second and third regions (6351.5 and 9553 cells $\times 10^3/l$, respectively). Otherwise, its minimum values were recorded during January in the four regions. Among the most common types of green algae were *Chlorella vulgaris*, *Pediastrum* sp., *Scenedesmus denticulatus*, *Ankistrodesmus falcatus*, and *Oocystis* sp.

The results showed monthly differences in the numbers of blue-green algae in the studied regions. On the other hand, we find that the number of blue-green algae increases in the second and third regions, while their numbers decrease in the first and fourth regions. The largest number of

Cyanophyta was recorded during the month of September for the second and third regions (1379.4, 1266.2 cells $\times 10^3$ / l, respectively) and during the month of August (885.3, 857.4 cells $\times 10^3$ /l, respectively). On the other hand, the minimum values were recorded during the month of January. *Microcystis* sp. And *Anabaena* sp. They were the predominant races among the blue-green algae.

The results showed that Euglenophyta represented the least contributor to a number of phytoplankton. It showed that the number of Euglenophyta increased with time, and the highest numbers were recorded during August for the second and third regions (803 and 935.6×10^3 cells / l, respectively). The lowest numbers recorded during January for the first and fourth regions were the *Euglena* sp. and *Phacus longicauda* are dominant among the rest of the species.

Understanding phytoplankton functional groups and their relationships with the environment is critical to sustainable lake management. Therefore, phytoplankton and water samples were collected and analyzed from July 2016 to June 2017 to discover these relationships, with a total of 14 phytoplankton functional groups identified; A, B, C, D, F, H1, J, K, Lo, M, P, S1, X1, W1. Biomass of seven phytoplankton functional groups (C, F, H1, J, Lo, P and X1) was predominant. The biomass of the phytoplankton functional groups in the lake showed seasonal variation with the highest biomass value being recorded in the fall and the lowest in the winter. The P and C functional groups were predominant in the winter when temperatures were very low. The H1 group was predominant in summer corresponding to higher temperatures. In the fall groups Lo and X2 were predominant corresponding to high levels of total phosphorous (TP). The results showed that changes in dissolved oxygen (DO), water temperature (WT), total phosphorous (TP), electrical conduction (EC), transparency (SD)) And total nitrogen (TN) were key

influencing factors associated with changes in the composition of PFGs in Lake Manzala.

3- Zooplankton and its density

- About 37 species of zooplankton, represented by three groups, are Rotifers and copepods and Cladocera addition to some rare species such as protozoa and insect larvae. The second and third regions sites maintained the highest zooplankton densities at 394 org. / l. The results showed that Rotifers predominate over the rest of the zooplankton species, about 36 and 39% of the total number of zooplankton in the second and third regions, respectively, and *Keratella cochlearis*- *Brachionus angularis*- *Brachionus calyciflorus*- *Polyarthra vulgaris* were predominant. Copepoda represented in second position in terms of importance to the second and third regions. Only two had been recorded: *Thermocyclops neglectus* and *Acanthocyclops americanus*. Cladocera was represented by 30 and 26% of the total number of zooplankton at the sites of the second and third regions, respectively. *Diaphanosome excisum*, *Moina micrura* and *Ceriodaphia quadrangula* were the dominant species.

Heavy metals in water and fish tissue:

- Elevation Concentration of all heavy elements in the water in the sites in the southern region of Lake [7, 8, 9, 10] than the rest of the sites due to their proximity to the mouths of the main drains.

- The rise of lead and cadmium elements in the sites [1, 2] near Al-Bughaz, due to its proximity to the highway and the presence of fishing port stations.

-The higher concentration of elements in the liver than in the rest of the organs, followed by the gills, then the meat.

-The high concentration of all elements in catfish tissues, followed by mullet and tilapia.

- The higher concentration of elements in water and fish tissues during the summer than in the rest of the year.

B- Laboratory experiment:

The most important results were that the decrease in the amount of cadmium Cd^{+2} by *Chlorella* 12 days after the start of the experiment was 53.26%, 78.33%, 85.87% and 87.95% for the concentrations 2.0, 4.0, 6.0 and 8.0 ppm; Respectively. *Chlorella* was also shown to remove Pb^{+2} lead at 48.23%, 67.08%, 72.94 and 84.98% at concentrations of 3, 6, 12 and 18 ppm, respectively, 12 days after the start of the experiment. This means that the absorption capacity of heavy metals by *Chlorella* can be exploited to detoxify solutions and environmental cleaning processes. In the case of *Chroococcus*; It was observed that the Cd^{+2} clearance was 54.43 and 48.05% at the highest concentrations of 0.4 and 1.0 ppm, which the algae were exposed to until the last day of the experiment. While the Pb^{+2} lead removal percentage (51.44 and 38.98%) was recorded at the end of the experiment for concentrations of 10 and 20 ppm and decreased to 30.98 and 29.43% for concentrations; 30 and 40 ppm, respectively.

Recommendations

According to our findings:

- 1- The importance of studying the physical and chemical variables, both spatial and seasonal, in determining the functional groups of phytoplankton, and thus in assessing the environmental status of the lake.
- 2- It is important to understand how human activities change the concentrations of potentially toxic metals, what processes affect this change and which activities have the greatest impacts
- 3- The study recommends the necessity of disposing of the internal guts of fish before cooking.
- 4- The study recommends the necessity and utilization of Bahr Al-Cow drainage water after treating it and using it in planting woody trees and others or establishing wastewater treatment plants before dumping it into the lake.
- 5- The necessity of creating channels to deliver the waters of the Mediterranean Sea to mix the water and reduce pollution.
- 6- We recommend the possibility of using algae species isolated from polluted sites for biological treatment of heavy metals, as the ability of algae to remove elements varies according to the element, time period and element concentration. Therefore, the study sheds light on the need to choose algae to remove certain elements and the study recommends the need to work on the use of algae to remove pollutants On a large scale to overcome the problems of water scarcity in Egypt.