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Diversity and Density of Macrobenthic Invertebrates Associated with Macrophytes in the El-Rayah El-Nasery and El-Rayah El-Behery, Nile River, Egypt

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ABSTRACT

A hydrobiological investigation of macrobenthic fauna was seasonally conducted to address El-Rayah El-Nasery and El-Rayah El-Behery from spring 2014 to winter 2015. A total of 52 species were recorded belonging to three phyla. and represented by 33,438 and 12,066 individuals/m^2 in both rayahs, respectively. Arthropoda was the most predominant (30 species), followed by Mollusca (15 species) and Annelida (7 species). Station- N8 recorded the highest density and diversity, while the lowest abundance and species number of macrobenthic fauna was found in station- B6. The latter station was proved to be contaminated with organic waste originated from ElRahawy drain.The diversity and density of macrobenthic fauna were higher in El-Rayah El-Nassery compared to El-Rayah El-Behery due to organic pollution in the latter flowing from the Rosetta Branch after confluence with El Mahmoudia canal.

INTRODUCTION

The River Nile; the world's longest river has a dynamic impact on culture, public health, economy, social life and politics in Egypt **(Abdel-Hamid *et al.*, 1992; Abdel-Satar, 2005; Moustafa *et al.*, 2010)**. At the Delta Barrage, North of Cairo, the Nile River splits into two main distributaries; the Damietta and the Rosetta branches, and four rayahs (irrigated channels): El-Nassery, El-Behery, El-Monofiy, and El- Tawfiky **(Saad & Goma, 1994; Abdel Aziz, 2005; Ghannam *et al.*, 2015; Talab *et al.*, 2016; Abd El-Karim *et al*., 2016)**. These rayahs are important for irrigation, navigation, fishing and other domestic uses in many governorates in Egypt **(Hossam & Ahmed, 2005)**. However, the rayahs are filled with overlooked ecosystems that may play significant roles in the dynamics of these environments.

Macrobenthic invertebrates are one of the most important taxa for identifying the health of aquatic ecosystems as they reflect changes in the environment in an integrative

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and continuous manner, thus, they have been widely used for ecological water quality monitoring **(Guareschi *et al*., 2017)**.

In an aquatic ecosystem, the abundance and variation of aquatic vegetation are the main factors that determine the qualitative and quantitative richness of macrobenthic invertebrate fauna **(Sharma & Sharma, 2015)**. Aquatic macrophytes act as an important habitat for invertebrates, and they are directly utilized as a food source **(Gregg &Rose 1982, 1985)**.In addition, they are used for shelter from predators (Harrod, 1964), spawning and attachment sites **(Keast, 1984)**. Moreover,they indirectly act upon the periphyton growing on the surface of macrophytes **(Higler, 1975)**.

This study is part of the first comprehensive investigation on the macrobenthic invertebrates associated with macrophytes in two rayahs: El-Rayah El-Nassery and El-Rayah El-Behery of the River Nile. The irrigation canals of the Nile River have gained a considerable concern as a water source for drinking and irrigation. Thus, the current study was organized to examine the composition, spatial distribution, diversity and seasonal changes related to some environmental variables of macrobenthic invertebrate communities associated with the macrophytes of the two irrigated channels; namely, El-Rayah El-Nassery and El-Rayah El-Behery.

MATERIALS AND METHODS

Study area and stations

El-Rayah El-Behery

The Behery channel arises from the Rosetta Branch and is directed to northwest of the city of Alexandria. Its length is about 220 km. Nine stations were selected along El-Rayah El-Behery to represent all types of habitats in this ecosystem (Fig. 1),starting from El- Qanater El-khayreya City (station B1, 130°10'47.36"N- 31°6'18.69"E) to El-Siuof, Alexandria (station B9, 31°13'6.67" N- 29°59'39.74" E).

El-Rayah El-Nassery

The Nassery channel begins at the Rosetta Branch, parallel to the Behery channel, and is then directed to the northwest towards the city of Nopareia. It is connected to the Noubria canal, which branches from the Qanater Bolin , and is then directed northwest until it reaches the Mediterranean Sea through Mariout Lake. Eight stations were selected along El-Rayah El-Nassery to represent all types of habitats in this ecosystem (Fig. 1), starting from El- Qanater El-khayreya City (station N1, 30°10'36.78" N- 31° 6'29.77" E) to Nubariya (station N8, 30°59'54.76 N- 29°51'49.97" E).

Fig. 1. A map of the River Nile Delta showing the sampling sites in the two studied channels

Sampling and analysis

Physiochemical parameters

Water samples were collected from the studied sites to measure the DO and BOD according to **APHA (2005)**. Analysis was perfomed in the Chemistry Lab at National Institute of Oceanography and Fisheries- (NIOF), El- Qanater El-khayreya. While,some other environmental parameters were measured on spot (in the field). Water temperature, pH and electrical conductivity (EC) were measured using a multi-probe portable meter (Crison, Spain MM40+).

Collection and analysis of macroinvertebrates samples

The sampling program refers to a national project funded by the NIOF for studying the environmental conditions and fisheries of the Nile River Rayahs (El-Nassery, El-Monofiy, El-Tawfiky and El-Behery). Samples of freshwater macrobenthic invertebrate were seasonally collected; from spring 2014 to winter 2015. The macrophytes within a 0.125 m^2 quadrat were cut, thoroughly shaken and washed into a 500 µm mesh sweep net to dislodge the associated macroinvertebrates. Collections were made from the two most abundant species of macrophyte (*Ceratophyllum demersum* and *Eichornia crassipes*) at each site. The macroinvertebrates (>500 µm) were separated from the substrate using 500 µm mesh sieves, followed by hand-picking, and were stored in plastic jars with 7% formalin solution before identification. Invertebrates were identified with respect to species level where possible.

Statistical analysis

Abundance data were used to calculate the number of species (S), number of individuals (N), Shannon diversity index (H'), Margalef's species richness (d) and Pielou's evenness (J') using the PRIMER® statistical package. The community dominance index (CDI) was calculated based on the exploitation index delineated by McNaughton (1968). The canonical correspondence analysis (CCA) ordination program was applied using the CANOCO Fortran program **(Ter Braack, 1986, 1994)**.

RESULTS

Taxonomic composition

Quantitative and qualitative distributions of macrobenthic invertebrates were evaluated in association with the macrophytes of two rayahs, El-Rayah El-Nassery and El-Rayah El-Behery, of the Nile River. The sampled populations from the 2 rayahs included 52 species belonging to three phylawith 33,438 and 12,066 individuals/m^2, respectively. Arthropoda, in both study sites, had the richest taxonomic representation with 30 species (30,944 and 11,421 individuals/m^2, respectively), which constituted 92% and 94% of the total individuals, respectively. Mollusca had the second highest density with 15 species and were estimated to be 7% of the total individuals in El-Rayah El-Nassery (2304 individuals/m^2). Conversely, in El-Rayah El-Behery, they represented 4% of the total individuals (538 individuals/m^2). Annelida , represented by seven species, contributed less to total abundance and species richness, constituting less than 3% of the total individuals in the two rayahs ((Figs. 2 & 3).

The macrobenthic invertebrate distribution in the rayahs varied significantly by station. The highest density and diversity were observed at station N8 (27 species and 11,765 individuals/m^2). Contrarily, station B6 had the lowest abundance and species number of macrobenthic fauna (6 species and 130 individuals/m^2) (Tables 1 &2).

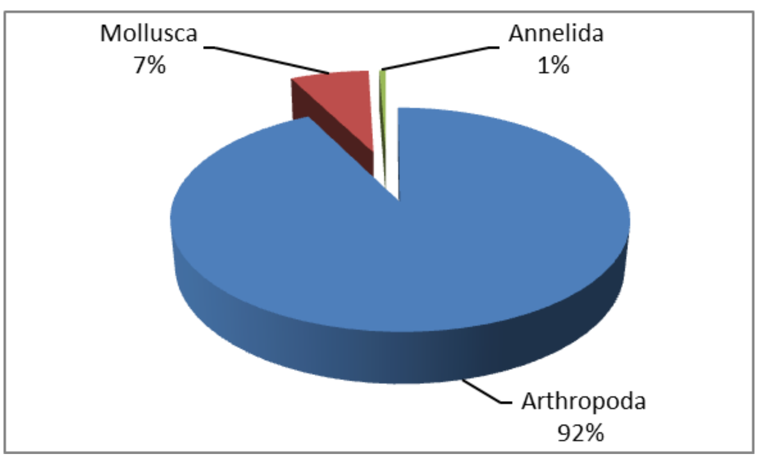

Fig. 2. Relative abundance of macrobenthic groups in El-Rayah El-Nassery

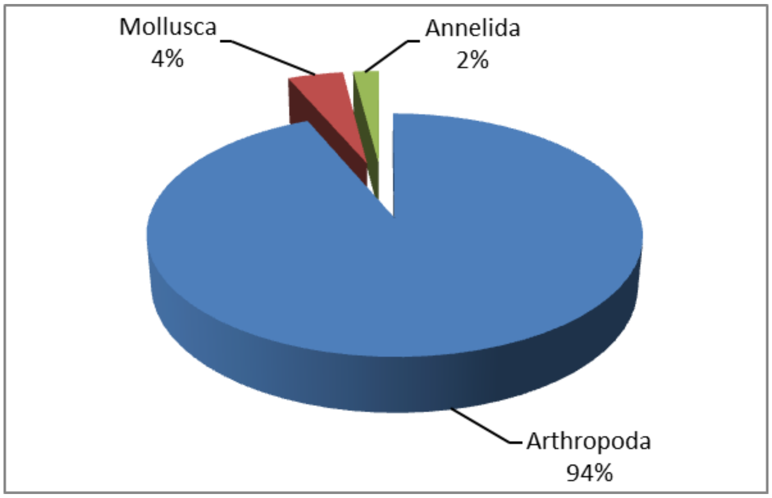

Fig. 3. Relative abundance of macrobenthic groups in El-Rayah El-Behery

Table 1. Community of macrobenthic invertebrates (ind./m^2) at the different stations along El-Rayah El-Nassery

	Station								
Species	**N1**	**N2**	**N3**	**N4**	**N5**	**N6**	**N7**	**N8**	Average
Arthropoda									
Chironomidae larva	1100	4170	1258	2110	2576	1400	3410	10568	26592
Chironomidae pupa	56	246	284	238	122	67	475	92	1580
***Micronecta* sp.**	32	91	54	7	3	5	4	72	268
***Ischnura* sp.**	28	241	139	30	82	66	110	136	832
Hydroptilidae larva	39	45	24	12	26	5	4	7	162
***Caenis* sp.**	8	263	149	20	30	22	4	5	501
***Cloenon* sp.**	0	0	0	0	0	0	0	0	0
***Baetis* sp.**	18	192	123	9	10	59	4	60	475
Lepidoptera larva	4	0	8	0	2	3	8	3	28
Hydroptilidae larva	0	0	0	0	8	0	4	0	12
***Coanagrion* sp.**	4	21	119	0	0	10	8	0	162
Caridina nilotica	2	34	24	0	11	14	8	4	97
***Gammarus* sp.**	0	0	0	0	0	0	4	6	10
Mesovelia vittigera	0	4	4	0	0	0	0	0	8
***Philopotamus* sp.**	0	12	23	3	0	12	4	0	54
***Hyphoporus* sp.**	0	0	12	0	0	0	0	0	12
***Sympetrum* sp.**	0	4	0	0	4	0	0	4	12
***Enallagma* sp.**	0	0	0	0	3	8	0	0	11
Procambarus clarkii	0	4	0	0	0	0	0	0	4
Rhagovelia nigricans	0	8	0	0	0	0	0	0	8
Ecnomus (Trichoptera)	0	4	0	0	0	0	0	8	12

Tabanidae larva	0	24	0	0	0	0	0	0	24
Laccobius(Hydrophilidae)	0	0	0	0	0	0	4	0	4
***Collembola* sp.**	0	0	4	0	0	0	0	0	4
Crocothemis erythraea	0	0	0	0	0	0	0	0	0
Sphaerodema urinator	0	0	0	0	0	0	0	0	0
Rhyacophila dorsalis	0	0	0	0	0	0	0	0	0
***Stenolophus* sp.**	0	0	0	0	0	0	0	0	0
***Trithemis* sp.**	16	9	16	0	4	6	4	4	59
Hydropsyche instabilis	0	5	0	0	8	0	0	0	13
Total Arthropoda	1307	5377	2241	2429	2889	1677	4055	10969	30944
Mollusca									
Theodoxus niloticus	3	20	69	8	114	130	173	153	670
Gabbiella senaariensis	4	0	4	0	16	82	48	325	479
Viviparus contectus	0	0	4	0	0	0	0	0	4
Lanistes carinatus	5	0	4	0	0	3	4	0	16
Cleopatra bulimoides	7	11	4	5	2	16	24	12	81
Physa acuta	2	1	2	6	3	39	38	77	168
Bulinus forskalii	0	0	0	0	0	0	0	0	0
Bulinus truncates	16	0	80	9	13	214	185	162	679
Melanoides tuberculata	49	4	3	0	8	7	4	7	82
Biomphalaria alexandrina	0	0	0	0	0	3	53	2	58
Helisoma duryi	0	0	0	0	0	7	26	6	39
Lymnaea natalensis	0	0	0	0	0	0	0	0	0
Pila ovate	0	0	0	0	0	2	0	7	9
Succinea Cleopatra	0	0	0	0	0	4	0	0	4
Corbicula fluminalis	0	7	4	0	4	0	0	0	15
Total Mollusca	86	43	174	28	160	507	555	751	2304
Annelida									
Limnodrilus udekemianus	0	40	30	0	4	4	11	6	95
Helobdella conifer	8	8	8	4	8	4	4	7	51
Allolobophora caliginosa	0	0	0	0	0	0	0	0	0
Limnatis nilotica	4	4	0	0	0	0	0	16	24
Branchiura sowerbyi	0	0	0	4	0	0	0	8	12
***Batracobdelloides* sp.**	0	0	0	0	0	0	0	0	0
Barbronia assiuti	0	0	0	0	0	0	0	8	8
Total Annelida	12	52	38	8	12	8	15	45	190
Total ind./m^2	1405	5472	2453	2465	3061	2192	4625	11765	33438
Total species/m^2	20	26	26	14	23	26	26	27	

Table 2. Community of macrobenthic invertebrates (ind./m^2) at the different stations along El-Rayah El-Behery

	Station									
Species	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**B8**	**B9**	Average
Arthropoda										
Chironomidae larva	4800	396	1028	1664	1535	105	88	155	69	9840
Chironomidae pupa	36	53	70	93	150	0	5	0	0	407
***Micronecta* sp.**	66	3	1	14	27	0	3	0	0	114
***Ischnura* sp.**	2	68	17	38	42	0	15	24	53	259
Hydroptilidae larva	11	11	28	45	59	0	0	0	0	154
***Caenis* sp.**	10	15	38	163	25	0	3	0	0	254
***Cloenon* sp**	0	0	0	0	0	0	0	0	0	0
***Baetis* sp.**	0	0	2	66	44	0	2	33	39	186
Lepidoptera larva	0	0	0	2	16	0	0	0	0	18
Hydroptilidae larva	0	0	0	0	0	0	0	0	0	0
***Coanagrion* sp.**	0	0	0	0	0	0	0	0	5	5
Caridina nilotica	0	12	0	44	3	0	4	0	0	63
***Gammarus* sp.**	0	0	0	0	0	0	0	0	0	0
Mesovelia vittigera	0	0	0	0	0	0	0	0	12	12
***Philopotamus* sp.**	0	4	4	0	0	4	1	0	0	13
***Hyphoporus* sp.**	0	0	0	0	0	0	0	0	0	0
***Sympetrum* sp.**	0	0	0	0	0	0	0	0	0	0
***Enallagma* sp.**	0	0	0	5	3	0	0	4	5	17
Procambarus clarkii	0	0	0	0	0	0	0	0	0	0
Rhagovelia nigricans	0	0	0	0	0	0	0	0	0	0
Ecnomus (Trichoptera)	0	0	0	0	0	0	0	0	0	0
Tabanidae larva	0	0	0	0	0	0	5	0	0	5
Laccobius(Hydrophilidae)	0	4	0	0	0	0	0	4	0	8
***Collembola* sp.**	0	0	4	0	0	0	0	0	5	9
Crocothemis erythraea	0	6	0	0	0	0	0	0	0	6
Sphaerodema urinator	0	0	0	0	0	0	0	3	4	7
Rhyacophila dorsalis	0	0	4	0	10	0	0	0	0	14
***Stenolophus* sp.**	0	0	0	0	0	0	4	0	0	4
***Trithemis* sp.**	4	2	2	3	4	0	2	0	3	20
Hydropsyche instabilis	0	0	0	2	4	0	0	0	0	6
Total Arthropoda	4929	574	1198	2139	1922	109	132	223	195	11421
Mollusca										
Theodoxus niloticus	2	0	16	122	41	0	0	0	0	181
Gabbiella senaariensis	0	0	0	3	0	0	2	28	5	38
Viviparus contectus	0	0	0	0	0	0	12	0	0	12
Lanistes carinatus	4	0	0	0	0	0	2	3	0	9

Cleopatra bulimoides	0	0	3	0	0	0	4	8	4	19
Physa acuta	0	58	0	36	2	0	12	21	16	145
Bulinus forskalii	0	0	0	0	0	0	0	12	0	12
Bulinus truncatus	4	4	8	35	0	0	4	0	2	57
Melanoides tuberculata	0	0	0	0	0	0	12	0	0	12
Biomphalaria alexandrina	0	4	0	0	0	0	0	0	2	6
Helisoma duryi	0	0	0	12	0	0	0	0	0	12
Lymnaea natalensis	0	2	0	0	0	0	5	5	2	14
Pila ovate	0	0	0	0	0	0	0	0	0	0
Succinea cleopatra	0	0	0	0	4	0	0	7	0	11
Corbicula fluminalis	0	2	0	0	0	0	0	4	4	10
Total Mollusca	10	70	27	208	47	0	53	88	35	538
Annelida										
Limnodrilus udekemianus	0	0	0	0	53	2	7	8	19	89
Helobdella conifer	0	4	0	9	4	3	21	12	0	6
Allolobophora caliginosa	0	0	0	0	12	0	0	0	0	1
Limnatis nilotica	4	7	0	0	0	8	0	4	8	3
Branchiura sowerbyi	0	0	0	0	0	8	0	12	0	2
***Batracobdelloides* sp.**	0	0	0	12	0	0	16	0	0	3
Barbronia assiuti	4	0	0	0	0	0	0	0	12	2
Total Annelida	8	10.5	0	21	69	21	44	36	39	107
Total ind./m2	4947	655	1225	2368	2038	130	229	347	269	12066
Total species/m2	12	18	14	19	19	6	22	18	19	

Seasonal variation in macrobenthic invertebrate density was observed between winter and summer. The cold season was the favorable period for macrobenthic invertebrate growth (Figure 4). The total macrobenthic density reached a maximum value in El-Rayah El-Nassery and El-Rayah El-Behery during winter (11,127 and 3,762 organisms/ m^2, respectively) and a minimum value during summer (717 and 255 organisms/m^2, respectively).

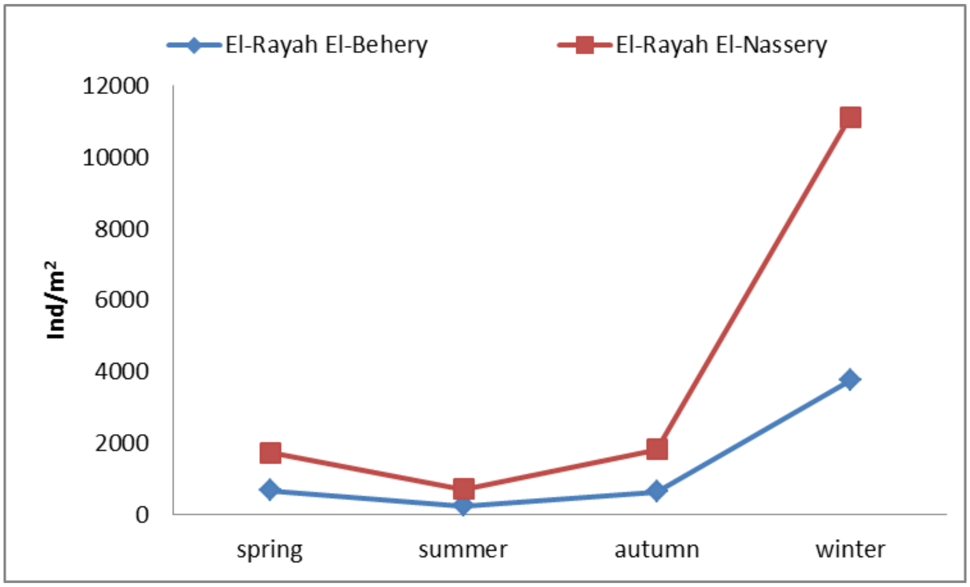

Fig. 4. Seasonal variation in macrobenthic invertebrate density observed in El-Rayah El-Nassery and El-Rayah El-Behery. Ind/m^2 = individuals/m^2

The community structure of macrobenthos in El-Rayah El-Behery indicated that station B7 recorded the highest richness value (SR = 3.9) and the highest diversity (H' = 2.4) as well. At station N8 in El-Rayah El-Nassery, the number of species was high, noting thatone species (*Chironomidae larva*) constituted 90% of the total number of individuals. Therefore, minimum species diversity (H' = 0.6) and minimum evenness (E = 0.2) were observed at that station, primarily due to the uneven distribution of individuals among species. The highest evenness (E = 0.8) and consequently the lowest CDI (47.6%) were observed at station B7 due to the lack of dominant species. Station B6 had the lowest value of richness (SR = 1), having low number of species (6) and individuals (130). The maximum dominance percentage (CDI = 98.4%) was observed at station B1 due to the dominance of one species; namely, *Chironomidae larva*, which constituted 97% of the total number of individuals at this station (Tables 3 & 4)

Table 3. Population density (total individuals/m^2), total species/m^2, species richness (SR), equitability (E), diversity index (H') and dominance percentage (CDI %) of macrobenthic invertebrates in El-Rayah El-Nassery

	Station							
	N1	**N2**	**N3**	**N4**	**N5**	**N6**	**N7**	**N8**
Total individuals/m^2	1405	5472	2453	2465	3061	2192	4625	11765
Total species/m^2	20	26	26	14	23	26	26	27
SR	2.6	2.9	3.2	1.7	2.7	3.2	3.0	2.8
E	0.4	0.3	0.6	0.2	0.3	0.5	0.3	0.2
H'	1.1	1.1	1.9	0.6	0.8	1.5	1.1	0.6
CDI %	82.3	81.0	62.9	95.3	88.1	73.6	84.0	92.6

Table 4. Population density (total individuals/m^2), total species/m^2, species richness (SR), equitability (E), diversity index (H') and dominance percentage (CDI %) of macrobenthic invertebrates in El-Rayah El-Behery

	Station								
	B1	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**B8**	**B9**
Total individuals/m^2	4947	655	1225	2368	2038	130	229	347	269
Total species/m^2	12	18	14	19	19	6	22	18	19
SR	1.3	2.6	1.8	2.3	2.4	1.0	3.9	2.9	3.2
E	0.1	0.5	0.3	0.4	0.4	0.4	0.8	0.7	0.8
H'	0.2	1.5	0.8	1.3	1.1	0.8	2.4	2.1	2.3
CDI %	98.4	70.8	89.6	77.1	82.7	86.9	47.6	54.2	45.4

Tables (5 & 6) reveals that, the highest water temperature (26 °C) in both rayahs was recorded at station N5, while the lowest (23.3 °C) was determined at station N8. The highest value of EC (654.3 µmhos) was recorded at station B9, whereas station B1 showed the lowest (379.5 µmhos). The mean values of 487.3 and 417.4 µmhos were measured in El-Rayah El-Behery and El-Rayah El-Nassery, respectively. The pH of the rayahs was found to fluctuate between 7.9 (station B9) and 8.47 (station B4), with a mean of 8.25 in El-Rayah El-Behery and 8.34 in El-Rayah El-Nassery. The dissolved oxygen (DO) ranged from 3.18 mg/L (station B9) to 9.05 mg/L (station N8), with a mean of 6.43 mg/L in El-Rayah El-Behery and 7.63 mg/L in El-Rayah El-Nassery. The BOD values ranged from 3.9 mg/L (station N4) to 8.5 mg/L (station B9) with a mean of 5.84 mg/L in El-Rayah El-Behery and 4.88 mg/L in El-Rayah El-Nassery.

Table 5. Physicochemical parameters at the different stations in El-Rayah El-Nassery

	Station								Mean
	N1	**N2**	**N3**	**N4**	**N5**	**N6**	**N7**	**N8**	
Temperature 0°C	24.38	24.68	24.70	24.03	26.05	25.65	25.03	23.53	24.75
EC µgS/cm	382.25	384.00	386.50	393.00	397.00	403.00	437.00	556.50	417.41
pH	8.30	8.33	8.38	8.40	8.21	8.33	8.32	8.42	8.34
DO mg/l	7.63	7.44	6.92	7.11	7.56	7.52	7.78	9.05	7.63
BOD mg/l	5.05	3.95	4.54	3.96	5.13	5.30	5.04	6.06	4.88
COD mg/l	10.29	7.98	9.26	8.48	8.40	9.39	8.87	10.72	9.17

Table 6. Physicochemical parameters at the different stations in El-Rayah El-Behery

	Station									Mean
	B1	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**B8**	**B9**	
Temperature °C	24.85	24.68	24.95	23.73	24.58	24.33	25.75	25.05	23.83	24.64
EC µgS/cm	379.50	381.75	383.50	394.50	397.00	609.00	581.50	604.75	654.33	487.31
pH	8.39	8.32	8.29	8.47	8.27	8.26	8.23	8.13	7.93	8.25
DO mg/l	7.64	7.58	7.37	8.09	7.32	6.21	5.40	5.12	3.18	6.43
BOD mg/l	4.85	4.43	5.07	4.84	4.71	6.35	6.02	7.71	8.56	5.84
COD mg/l	7.24	7.63	7.84	8.92	7.95	17.48	18.67	17.36	21.72	12.76

CCA analysis revealed a strong relationship between water quality and the distribution of the dominant macrobenthic species. For example, in El-Rayah El-Nassery, the individuals of *Physa acuta* and *Theodoxus niloticus* were associated with NH_3, and the individuals of *Bulinus truncatus* were associated with EC and NO_2. Individuals of *Helobdella conifer* demonstrated a closer relationship with NO_3. DO was the variable most associated with the distribution of Mollusca species (Fig. 5). In El-Rayah El-Behery, *Caenis* sp. and Hydroptilidae larva were closely associated with pH and DO, whereas *Ischnura* sp. and *Limnodrilus udekemianus* were associated with EC, NH_3, and NO_3. Individuals of *Micronecta* sp had a strong relationship with DO, whereas *Gabbiella senaariensis* exhibited a clear relationship with BOD and COD (Fig. 6).

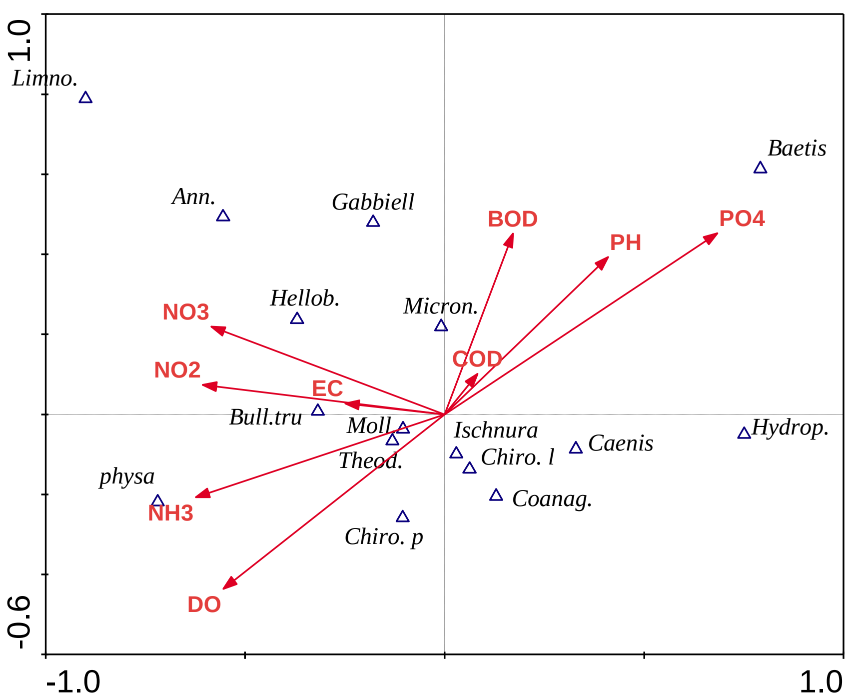

Fig. 5. Biplot of canonical correspondence analysis (CCA) showing relationships between the dominant macrobenthic species and chemical and physical variables in El-Rayah El-Nassery

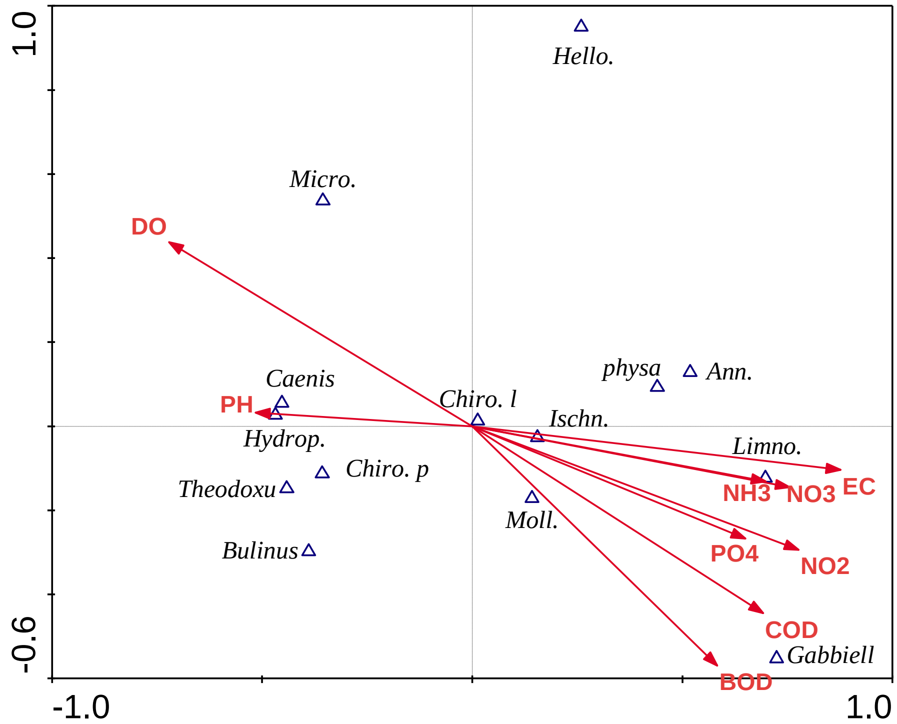

Fig. 6. Biplot of canonical correspondence analysis (CCA) showing relationships between the dominant macrobenthic species and chemical and physical variables in El-Rayah El-Behery

The similarity index (Figs. 7 & 8) demonstrated a strong relationship between stations B4 and B5 (S = 74%). Similar relations were obtained between stations N6 and N7 (S = 76.4%) as well as N4 and N5 (S = 74.8%). Stations B4 and B6 had the lowest similarity compared to other stations.

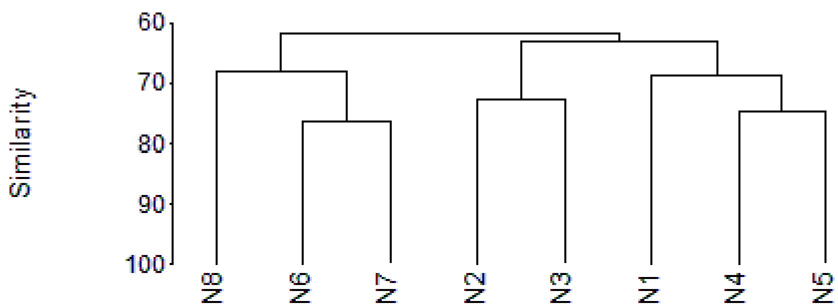

Fig. 7. Similarity between the different stations in El-Rayah El-Nassery

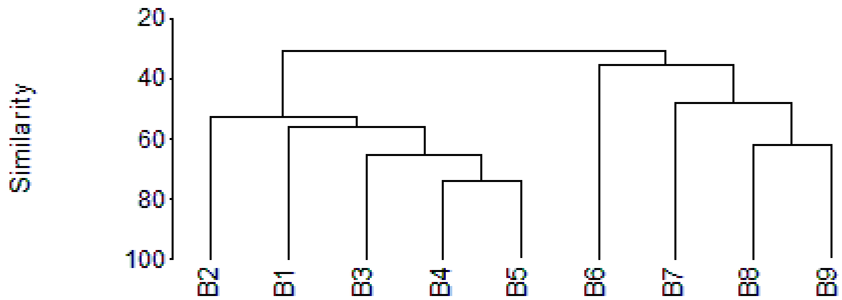

Fig. 8. Similarity between the different stations in El-Rayah El-Behery

DISCUSSION

The macrobenthic community of El-Rayah El-Behery and El-Rayah El-Nassery consisted of 52 species with 33,438 individuals/m^2. Compared to the macrobenthic fauna collected using the grab method at the same study sites, **Ibrahim (2019)** found that the macrobenthic community was represented by 41 species with 50,181 individuals/m^2. Moreover, Hyanes (1970) detected a direct relationship between the quantity and richness of aquatic macrophytes and these variables in its associated fauna.On the other hand, **Fishar and William (2006)** stated that "the grab" is the least effective sampling method for obtaining a realistic list of taxa present at a site. It was noted that, the seasonal growth of aquatic macrophytes is an important factor that influences the abundance of invertebrate diversity **(Hargeby, 1990)**.

Species diversity indicates the number of species existing in the area and also the evenness with which the individuals are distributed within the same species. In the presence of pollution, tolerant species become relatively more numerous and can dominate the community, whereas less tolerant species become rare or may disappear **(Rygg, 1985)**. This corresponds well with the present study, in which a few species, such as *Chironomidae larva*, *Chironomidae pupa*, *Ischnura* sp., *Theodoxus niloticus* and *Limnodrilus udekemianus* dominated the fauna and together constituted about 89% of the total individuals in both rayahs. While, the other present speciesexisted with few individuals.

Remarkably, a clear difference is found between the southern part (from B1 to B5) and the northern part (from B6 to B9) of El-Rayah El-Behery with respect to the diversity and density of macrobenthic fauna. The diversity and density of macrobenthic fauna in the south are notably greater than those in the north, where El-Rayah El-Behery confluences with the El-Mahmoudia canal after Damanhur City at station B6 (El-Mahmoudia canal is a branch of the Rosetta Branch at El-Mahmoudia City). Thus, station B6;, the beginning of the El-Mahmoudia Canal, recorded the lowest diversity (6 species) and the lowest density (130 individuals) as well. Station B6 receives Rosetta Branch water contaminated with organic pollution from El Rahawy drain. In addition, many water treatments and electrical power plants have been established on the two canal banks ofboth the rayahs; El-Behery and El-Nassery. However, it was found that the latter was less polluted compared to El-Rayah El-Behery. Correspondingly, the diversity and density of the macrobenthic fauna in El-Rayah El-Nassery were higher than those in El-Rayah El-Behery. **Margalef (1968)** and **Odum (1969)** reported that higher diversity tends to be observed in areas of environmental stability. Thus, it seems possible that diversity could be used as a substitute for assessing the degree of environmental pollution.

Noticealy,water quality has clear effects on the density and diversity of macrobenthic fauna. In the present study, specifically in El-Rayah El-Nassery, the individuals of *Physa acuta* and *Theodoxus niloticus* were associated with NH_3. This finding is in agreement with that of **Ertan *et al.* (1996)**. The Pulmonata species, belonging to the genus *Physa*, are considered biological indicators of organic pollution and eutrophication. In El-Rayah El-Behery, *Caenis* sp. and *Micronecta* sp. are closely associated with DO. This agrees with the findings of **Goulart and Callisto (2003)**, who found that Ephemeroptera species are well represented in high-quality environments because they require high concentrations of dissolved oxygen in water. **Goulart and Callisto (2003)** also demonstrated that Hemiptera sp. are typical species of unpolluted environments. The abundance and distribution of Chironomidae species are less influenced by chemical and physical variables, and thus, they dominate low-quality environments. In freshwater ecosystems, Chironomidae are indicators of poor water quality. This family is often abundant in degraded locations, and for its survival, Chironomidae does not require many resources **(Goulart & Callisto, 2003; Serra *et al.*, 2017)**.

CONCLUSION

The diversity and density of macrobenthic fauna were higher in El-Rayah El-Nassery than in El-Rayah El-Behery due to organic pollution in the latter flowing from the Rosetta Branch after confluence with the El-Mahmoudia canal. Chironomidae, which can act as an indicator of environmental stress, was a major macrobenthic family found in this study. This indicates that the present study area suffers from several sources of pollution. In the future, systematics and ecology of macrobenthos should be initiated on the rayahs to determine the critical factors influencing the ecology of macrobenthic fauna.

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