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Biodiversity and Distribution of Macrobenthic Invertebrate Community in Lake Nasser, Egypt

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ABSTRACT

Lake Nasser is assumed to be the largest man-made lake in northern Sudan and southern Egypt. It has paramount importance to Egypt as it supplies water to the country. That's why the lake's water quality must be continuously monitored to cope with the difficulties of water scarcity and a reliable water supply. Thus, in March and July 2019, fifteen sites were chosen to reflect the various habitats of the whole lake. Macrobenthic fauna consisted of 9 species represented by three phyla; Annelida, Arthropoda, and Mollusca with a percentage of 74.62%, 15.41%, and 9.97%, respectively and the total density was 863 org./m^2 where the highest densities were found in the southern sectors of the lake. Summer (flood season) exhibited the highest population density. The western station of EL Madiq sector revealed the highest Shannon Weaver index (H′= 1.55) which could be ascribed to the preponderance of 4 species of arthropods and exclusively prevalence of nymphs of *Ischneura*. Contrary, the middle stations of Wadi Abyad and Aswan sectors recorded the least diversity Shannon Weaver values (H′= 0.21 and 0.27, respectively) which may be accounted for the sediment characteristics which led to the absence of all mollusk species and the presence of one annelid species (*Limnodrilus* sp.) and one Insect species (*Chironomus* larvae). The present study revealed that the number of species decreased dramatically to 9 species compared to 15, 43, 39, and 24 in 1987, 1993, 1995, and 2013, respectively. It is recommended to force an effective legal framework to mitigate pollution in Lake Nasser.

INTRODUCTION

Lake Nasser was built by the construction of the Aswan High Dam between January 1964 and June 1968 **(Abd El-Monsef *et al.* 2015; El Gamal & Zaki 2017; Salih *et al.* 2019)**. The Lake's surface area is approximately 5000 km^2 **(Farhat & Aly 2018)**. Its storage capacity is 150–165 km^3, and supplies a water flow of 11,000 m^3/s. The mean depth of Lake Nasser is 90 m, and the maximum width of the Lake is about 60 km **(Abou El Ella & El Samman 2010; El Shemy 2010; Khalifa *et al.* 2015)**.

Latif (1974) and **Iskaros (1988, 1993)** reported that macrobenthic invertebrates are significant food sources of a variety of fish species in Lake Nasser. Macrobenthic invertebrates are better bio-indicators for comprehending the changing aquatic conditions compared to the microbiological and chemical data, which only provide short-term variations **(Ravera, 1998&**

2000). However, information on invertebrates of Lake Nasser is very rare. **Iskaros (1988 & 1993)** studied in detail the spatial distribution and temporal variations of the macrobenthic animals of the lake where he identified 40 species represented by Aquatic Insecta, Mollusca, Annelida, and Platyhelminthes. Thirty-nine macrobenthos species were recorded by **Fishar (1995)**. **El-Shabrawy & Abd El-Regal (1999)** mentioned that the main channel harbored little diversity; only nine species of Arthropoda, Annelida, and Mollusca were recorded. **Iskaros and Gindy (2009)** studied the impact of substrate status on the benthic fauna in Aswan reservoir during spring, summer, autumn 2008, and winter 2009. **Mola and Abdel-Gawad (2014)** studied the spatial and temporal variations of macrobenthic fauna in Lake Nasser khors during 2013 and they found that Khor Tushka West recorded the highest population density while Khor Wadi Abyad was the lowest. Furthermore, they found that spring exhibited the highest population density compared to the other seasons. Also in 2013, **Abdel-Gawad and Mola (2014)** recorded 24 macrobenthic invertebrate species in Lake Nasser main stream. In addition, **Abdel-Gawad (2016)** studied the impact of physico-chemical factors on the distribution and diversity of molluscs in Lake Nasser and she recorded ten species of molluscs, seven of them were Gastropod while three were Bivalve. Moreover, **Wahab *et al.*(2018)** studied the community structure, abundance, and diversity of macrobenthic invertebrates in the four northern khors of Lake Nasser during 2015. They recorded 26 species and mentioned that the western khors were higher in species richness and abundance than that of the eastern khors. **Abdel Gawad and Abdel-Aal (2018)** studied the community structure of both phytoplankton and macrobenthic invertebrates associated with macrophyte *Myriophyllum spicatum* in Dahmeit and Tushka west khors of Lake Nasser during pre-flood, flood and post-flood seasons in 2016.

Obviously, there is not enough data on the mainstream of Lake Nasser's bottom fauna, which is considered one of the main components of the food web and a source of fish diet. Thus, this investigation was dedicated to monitor the macrobenthic invertebrate groups inhabiting the mainstream of Lake Nasser (abundance, distribution, and diversity of the macrobenthos in association with various physical and chemical parameters and seasonal variation). Additionally, it aimed to spotlight the impact of the flood on the bottom fauna.

MATERIALS AND METHODS

The study area:

Fifteen stations have been chosen, accounting for various habitats of the whole lake (Figure 1). These stations could described as five sectors (Aswan High Dam, Wadi Abyad, El-Madiq, Tushka, and Abu Simble). Samples were collected from east, middle, and west of each sector.

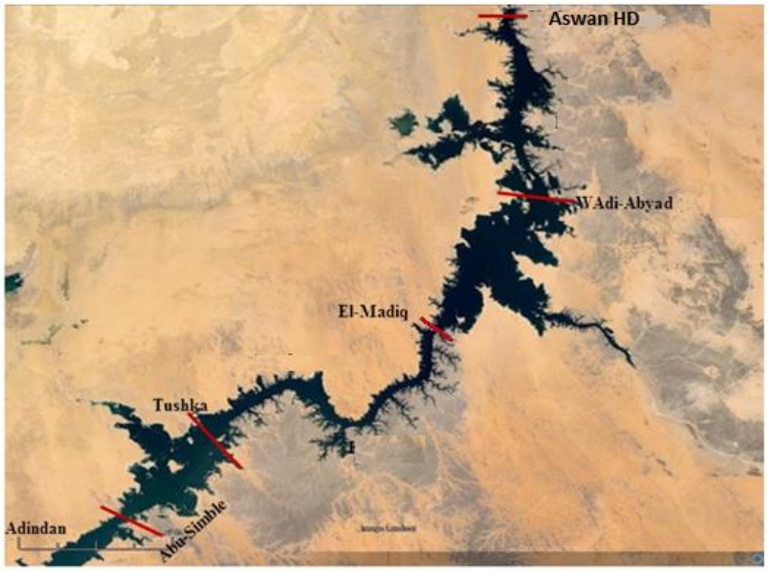

Figure (1): Map of Lake Nasser showing the selected sampling sectors

Sampling Procedures:

Samples of water and macrobenthos have been collected from Lake Nasser in March and July of 2019 (both before and during the flood). The standard procedures for water and wastewater examination were followed while analyzing the samples **(APHA, 2005)**.

The multi-probe portable meter has been used to measure water's temperature, EC, pH, and DO in the field. A typical 25cm diameter Secchi disc was used to measure the water transparency. The observations were made in the field, and results were expressed in cm at the distance at which the Secchi disc disappeared.

A square Ekman grab sampler with a 225cm^2 opening area was used to collect the macrobenthos samples. Each station's surface layer of the bottom deposits was collected. The specimens have been washed immediately to remove any sediments or mud via a 500µm mesh net and then stored in plastic containers with 7% formalin. The samples underwent another sieving process via a 500µm mesh net in the lab. The benthic animals were sorted into genera and species using a zoom stereo microscope. Each group was counted and preserved in a bottle with 7% formalin. The collected species have been identified following **Brown (1980)**, **Ruffo (1982)**, **El-Shimy (1994),** and **Ibrahim *et al.* (1999)**.

Data Treatments and Statistical Analyses:

In order to investigate the relationship between the abiotic and biotic parameters, correlation analysis had been applied to the data via Microsoft Excel. The bottom fauna species diversity index was computed and evaluated to assess the devastating impacts of pollution on the species diversity, and eventually the ecosystem via Primer 5 version 5.2.0. The Bray-Curtiz similarity index was applied to study the similarity between the benthic communities of the studied stations.

RESULTS AND DISCUSSION

Physical and chemical variables:

Water temperature:

Remarkably, the temperature has a direct effect on the aquatic animals and the chemical and physical characteristics as well **(Abdo, 2003)**. Therefore, global warming has a great negative effect on aquatic organisms' diversity. The big variation in temperature of Lake Nasser water all the year-round is considered a controlling feature associated with a scale of tolerance of species **(Mageed & Heikal, 2006)**. During the current study, there was no notable variation between the stations with an annual average of 25℃ (Table 1).

Water transparency:

The light penetration decreases with increasing turbidity. This, in turn, affects many essential processes as photosynthesis. In the current investigation, the northern part of the lake shows the highest transparency, especially in the Aswan sector with a yearly average of 318 cm. The lake's transparency gradually decreased downward to reach its lowest value in the Tushka sector with an annual transparency of 215 cm. No significant effect of water transparency was detected on the distribution of the benthic fauna, as shown in the correlation study (Table 1).

The electrical conductivity (EC):

During the investigation period, the electrical conductivity values represented their highest in the eastern part of the Aswan sector in March (before the flood), with an average of 291 mS/cm. It was noticeable that EC values gradually decreased from the north to the south of the Lake with an average of 259 mS/cm. **Mageed and Heikal (2006)** recorded similar outcomes. There was no significant correlation between EC values and the macrobenthic invertebrates' biodiversity or distribution.

Hydrogen ion concentration (pH):

According to **(WHO, 2003)**, pH is one of the most crucial functional water quality metrics. During the current investigation, there was no significant difference between stations along the lake. Furthermore, pH values were on alkaline side with an average of 8.6.

Dissolved Oxygen (DO):

The peak value of dissolved oxygen in Lake Nasser was in the Tushka sector (annual DO average of 7 mg/l). Furthermore, the western area of the Tushka sector showed its maximum DO concentration in March (9.6 mg/l). Conversely, El-madiq and Abu Simble revealed the lowest DO concentration in summer (5.3 mg/l). However, the Wadi Abyad sector displayed the minimum yearly DO (average of 6.4 mg/l). Generally, Lake Nasser showed a good status in DO, as reported by the Egyptian Decree No. 92/2013.

Table 1. Spatio-temporal variation of physico-chemical parameters of Lake Nasser during March and July 2019

	M1E	M1M	M1W	**Aswan**	M2E	M2M	M2W	**WadiAbyad**	M3E	M3M	M3W	**El-Madiq**	M4E	M4M	M4W	**Tushka**	M5E	M5M	M5W	**Abu Simble**
Temp (˚C)																				
March	18.9	17.8	17.5	**18**	19.6	19.9	20.3	**20**	20.2	20.7	20.1	**20**	20.9	20.1	20.6	**21**	21.1	21.3	21.4	**21**
July	28.2	26.7	26.7	**27**	30	29.7	30.3	**30**	31.1	31.1	31.1	**31**	31.4	31.2	30.9	**31**	30.6	30.6	31.3	**31**
Average	**24**	**22**	**22**	**23**	**25**	**25**	**25**	**25**	**26**	**26**	**26**	**26**	**26**	**26**	**26**	**26**	**26**	**26**	**26**	**26**
Trans (cm)																				
March	400	300	310	**337**	250	400	390	**347**	250	240	280	**257**	190	230	220	**213**	180	180	185	**182**
July	250	300	350	**300**	180	310	220	**237**	270	200	330	**267**	220	250	180	**217**	280	280	305	**288**
Average	**325**	**300**	**330**	**318**	**215**	**355**	**305**	**292**	**260**	**220**	**305**	**262**	**205**	**240**	**200**	**215**	**230**	**230**	**245**	**235**
EC mS/cm																				
March	291	286	282	**286**	285	283	283	**284**	276	278	285	**280**	264	261	261	**262**	254	257	257	**256**
July	246	250	248	**248**	247	246	247	**247**	244	245	250	**246**	237	238	234	**236**	240	243	237	**240**
Average	**269**	**268**	**265**	**267**	**266**	**265**	**265**	**265**	**260**	**262**	**268**	**263**	**251**	**250**	**248**	**249**	**247**	**250**	**247**	**248**
pH																				
March	8.45	8.39	8.37	**8.40**	8.61	8.54	8.49	**8.55**	8.77	8.79	8.77	**8.8**	8.72	8.79	8.7	**8.7**	8.85	8.84	8.71	**8.8**
July	8.49	8.6	8.58	**8.56**	8.5	8.51	8.52	**8.51**	8.71	8.66	8.44	**8.6**	8.55	8.57	8.74	**8.6**	8.43	8.47	8.56	**8.5**
Average	**8.47**	**8.50**	**8.475**	**8.48**	**8.56**	**8.525**	**8.505**	**8.53**	**8.74**	**8.725**	**8.605**	**8.7**	**8.64**	**8.68**	**8.72**	**8.7**	**8.64**	**8.66**	**8.635**	**8.6**
DO (mg/l)																				
March	7.27	8.83	6.25	**7.45**	6.88	6.95	8.08	**7.3**	8.62	8	8.67	**8.4**	7.39	8.9	9.6	**8.6**	9.28	6.98	8.7	**8.3**
July	5.85	5.48	6.34	**5.89**	6.05	5.15	5.38	**5.5**	5.74	4.9	5.13	**5.3**	5.2	5.09	5.8	**5.4**	5.52	5.5	5.02	**5.3**
Average	**6.56**	**7.16**	**6.295**	**6.67**	**6.47**	**6.05**	**6.73**	**6.42**	**7.18**	**6.45**	**6.9**	**6.84**	**6.30**	**7.00**	**7.7**	**7.0**	**7.4**	**6.24**	**6.86**	**6.8**

Macrobenthic invertebrates:

Community structure and density:

Nine macrobenthic invertebrate species were found during the period of study. The benthic invertebrates were related to three different groups; Annelida, Arthropoda, as well as Mollusca, with percentages of 74.62%, 15.41%, and 9.97%, respectively (Figure 2). A similar result was recorded by **Mola and Abdel Gawad (2014)**. In the current investigation, the macrobenthos total density was 863 org./m^2. It was noticeable that the community represented a higher density in the eastern sector of the lake during spring (pre-flood), while the density was higher in the middle sector of Lake Nasser in the summer season (flood season).

The highest population densities were found in the southern part of the lake particularly in Tushka and Abu Simble sector with an average of 1340 and 1065 org./m^2, respectively (Figure 3). This result was in coincidence with **Abdel Gawad and Mola (2014)** which may be ascribed to the bottom characteristics and the food availability as it has been seen as the most crucial features that determine the spatial distribution of the benthic community **(Iskaros and El-Dardir, 2010)**, although, **Nkwoji *et al.* (2010)** pointed out that low macrobenthos community abundance and diversity was significantly impacted by stress caused by pollutants. In this context, the El-madiq sector revealed the poorest density of population, with a yearly average of 445 org./m^2; a finding that matches with that of **Abdel-Gawad and Mola (2014)** who recorded 127 org./m^2 in the El-madiq sector during their survey in 2013.

Regarding the seasonal variation, summer (flood season) exhibited higher population density than spring (pre-flood) which was due to the dominance of *Limnodrillus* spp. and *Chironomus* larvae (Figure 4). This result is in coincidence with **Iskaros and Gindy (2009)** who referred this result to the strong relationship between the benthic fauna standing crop and the amount of organic carbon and calcium carbonate in the sediment. Furthermore, **Latif *et al.* (1979)** mentioned that the macrobenthos standing crop increases with the rise in water level (flood season).

Annelida species composition:

Annelida was the most predominant macrobenthic invertebrates during this investigation period with a yearly average of 644 org./m^2 (Table 2). It represented 74.62% of the total macrobenthic community. It was represented only by one species *Limnodrilus* sp.. According to **Iskaros and El-Dardir (2010),** the oligochaetes dominance in Lake Nasser was due to their adaptability to a variety of habitats and their tolerance to anoxic or low oxygen content conditions. Furthermore, the dominance of *Limnodrilus* spp. was in coincidence with **Iskaros (1993)**, **Fishar (1995)**, **Iskaros and Dardir (2010),** and **Mola and Abdel Gawad, (2014)**.

For the distribution of *Limnodrilus* sp., the middle station of Abu simble sector showed the maximum abundance with an yearly average of 1500 org./m^2. On the other hand, the middle area of El-Madiq sector revealed the minimum density with a yearly average of 75 org./m^2 (Figure 5). By and large, Abu simble and Tushka sectors revealed the highest *Limnodrilus* sp. population density with an annual average of 1065 and 1030 org./m^2, respectively.

With respect to seasonal variation, summer (flood season) had the highest density of population (902 org./m^2) while spring (pre-flood season) exhibited the lowest abundance (386 org./m^2).

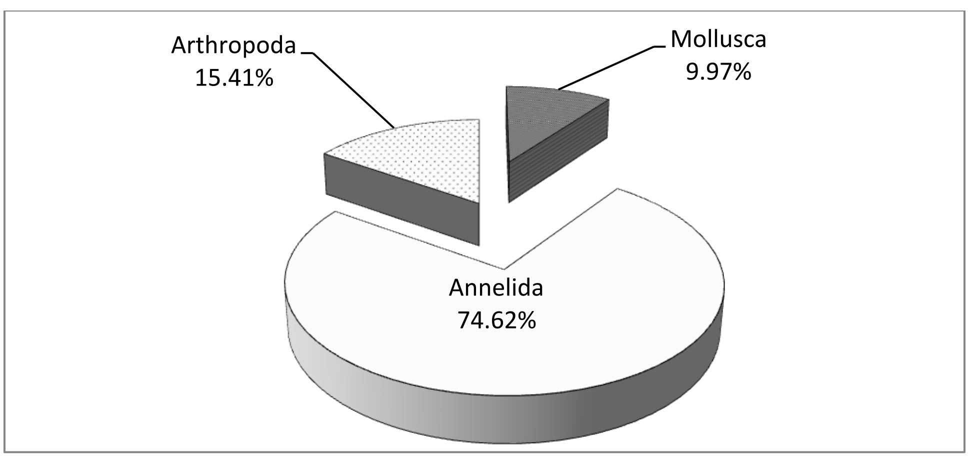

Fig. (2): Community structure of macrobenthic invertebrates in Lake Nasser

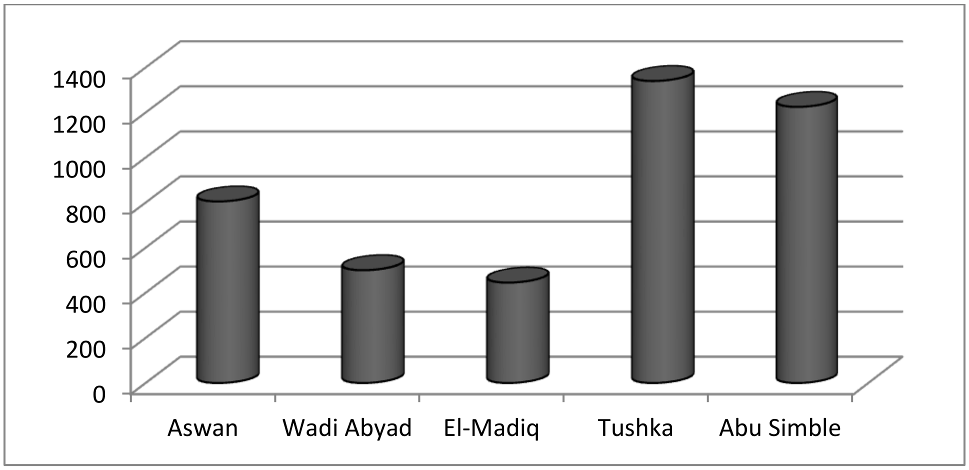

Fig. (3): Spatial variation of macrobenthic invertebrates in Lake Nasser during March 2019 and July 2019.

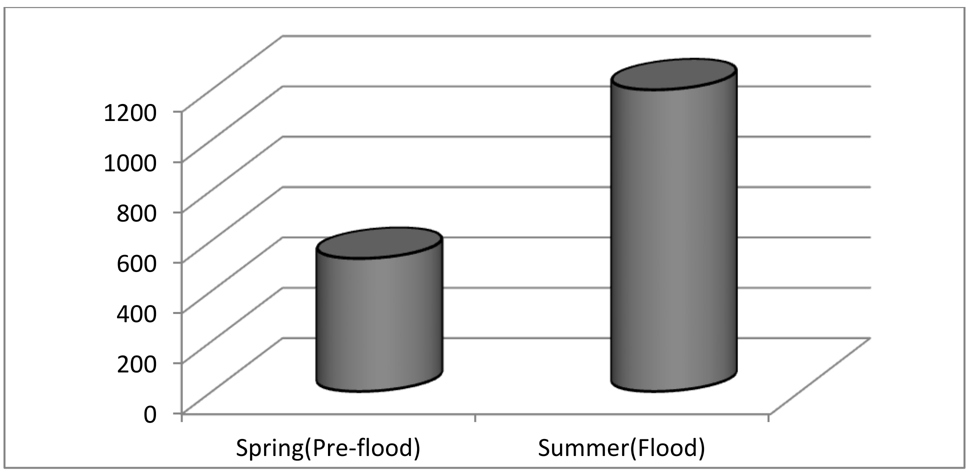

Fig. (4): Seasonal variation of macrobenthic invertebrates in Lake Nasser in March 2019 and July 2019.

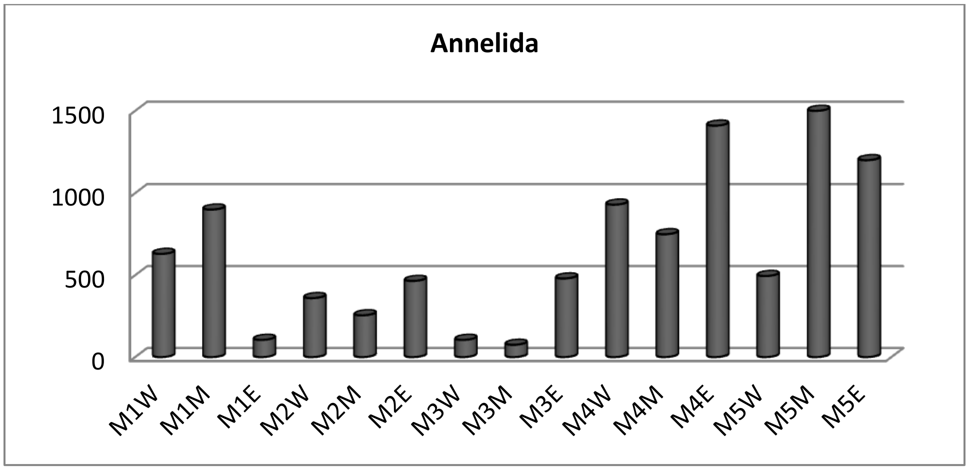

Fig. (5): Spatial variation of Annelida in Lake Nasser during March 2019 and July 2019.

Table 2. Seasonal variation of macrobenthos in Lake Nasser during March and July 2019

	March	July	Average
Mollusca			
Gyraulusehrenbergi	56	18	37
Melanoidestuberculata	10	24	17
Physaacuta	2	0	1
Succinia	2	46	24
Pisidiumpirothi	0	14	7
Subtotal	**70**	**102**	**86**
Arthropoda			
*Chironomus*Larvae	44	154	99
*Cricotopus*sp.	0	34	17
Nymphof*Ischneura*	0	2	1
Pupa of Chironomidae	28	4	16
Subtotal	**72**	**194**	**133**
Annelida			
***Lymnodrillus* spp.**	386	**902**	644
Total	**528**	**1198**	**863**

Arthropoda species composition:

Arthropods were ranked as the second dominant benthic fauna during the period of study with a yearly average of 133 org./m^2 (Table 2). It composed 15.41% of the total macrobenthic invertebrates' community. It was represented by *Cricotopus* sp., nymph of *Ischneura*, larvae, and pupae of *Chironomus* sp. as shown in figure (6).

Regarding spatial distribution, the maximum arthropod population density was represented in the western side of Aswan sector due to the dominance of *Chironomus* larvae with an average of 555 org./m^2, while the middle station of Wadi Abyad revealed the least density with a mean of 15 org./m^2 as shown in Fig. (7).

In terms of seasonal variance, the average arthropod population density during summer (flood season) showed its maximum of 194 org./m^2, whereas the average density during spring (the pre-flood season) was 72 org./m^2 (Table 2).

***Chironomus* larvae:**

Chironomid larvae serve as the main feeding source for *Mormyrus kannume*, *M. caschive*, and *Chrysichthys auratus* in Lake Nasser as mentioned by **Latif (1974)**; **Iskaros (1988),** and **Iskaros (1993)**. During the present investigation, *Chironomus* larvae constituted 74.44% of the arthropod density, while 11.47% of the whole benthic community, with a yearly mean of 99 org./m^2. *Chironomus* larvae ranked as one of the highest population densities during the whole period of investigation. This agrees with the results recorded in the study of **Fishar (2000)**. These larvae prefer to live in the littoral zones of eutrophic and oligotrophic lakes. The dominance of Chironomids in reservoirs is usually an indicator of pollution as they can consume the organic matter and able to survive under oxygen-deprived conditions **(Rosenberg *et al*. 1984)**. In the current study, the largest chironomid density was found in the western section of the Aswan sector with an annual average of 540 org./m^2. It was noticeable that *Chironomus* larvae disappeared from the middle stations of Wadi Abyad and Abu Simble sectors. This could be attributed to the fact that the abundance and dominance of *Chironomus* larvae are related to macrophytes in order to hide from predators and consume the epiphytic microorganisms as a feeding source (**Iskaros *et al.* 2011)**.

For seasonal variation, summer (the flood season) had the largest density (154 org./m^2). Similar results were found in the study of **Iskaros (1988, 1993)**. On the other hand, spring (the pre-flood season) showed the lowest population density (44 org./m^2).

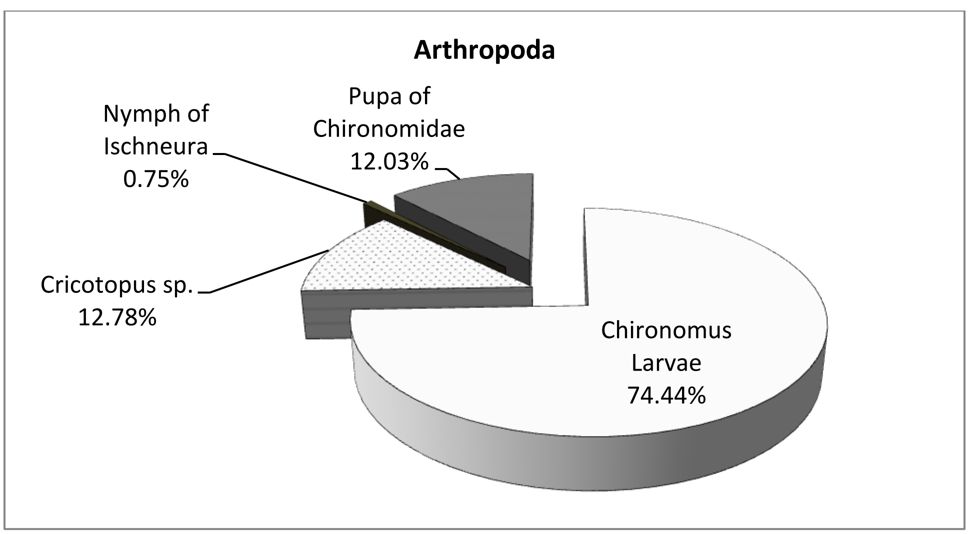

Fig. (6): Community structure of Arthropoda in Lake Nasser

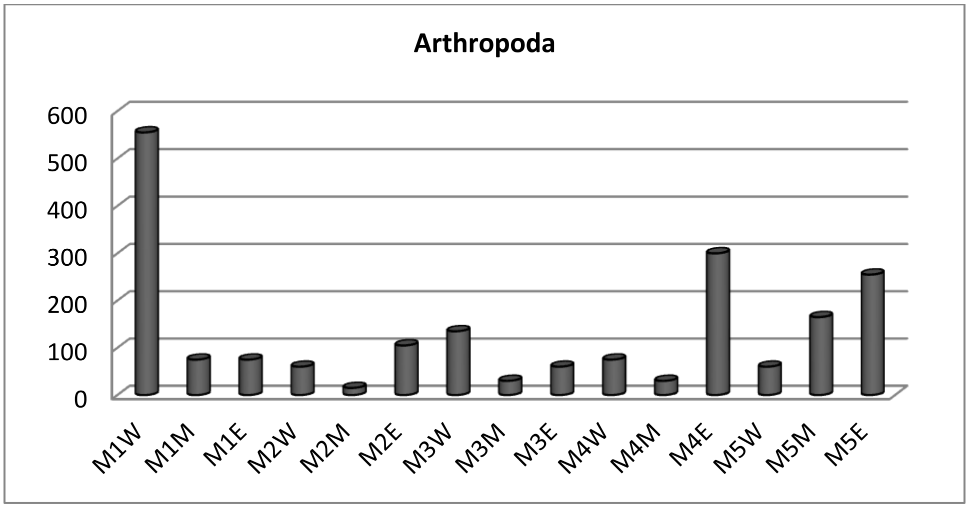

Fig. (7): Spatial variation of Arthropoda in Lake Nasser during March 2019 and July 2019.

Mollusca species composition:

Mollusks made the third rank of the macrobenthic community, which was composed of five species (Fig. 8). *Gyraulus ehrenbergi* was the most dominant mollusk species during March (pre- flood season), while *Succinia* sp. was the most predominant species during July (flood season).

By and large, *Gyraulus ehrenbergi* was the dominant species during this study and represented 43.02% of the total mollusk community.

For spatial distribution, a significant spatial distribution was detected where the western sector of Tushka revealed the maximum density with a yearly average of 465 org./m^2. On the other hand, mollusks disappeared totally from the Abu Simble sector during the period of investigation (Fig. 9).

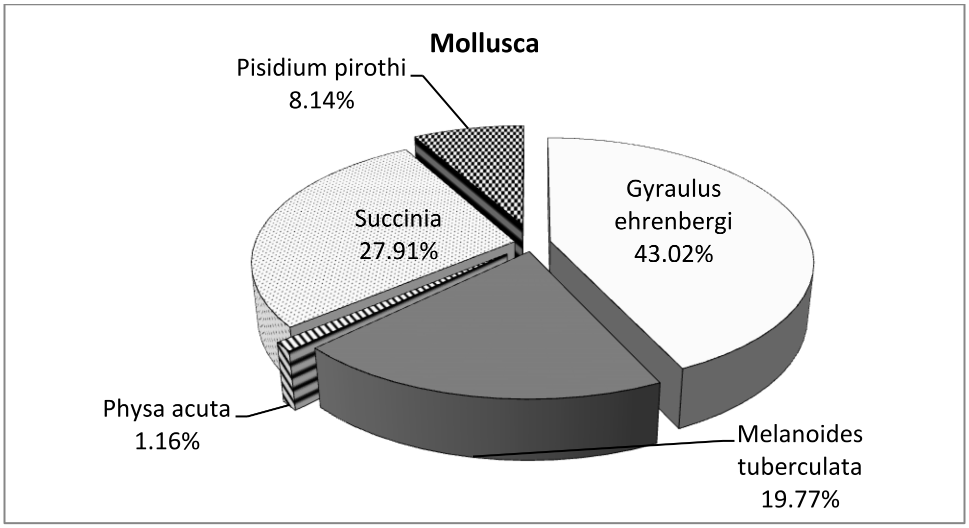

Fig. (8): Community structure of Mollusca in Lake Nasser

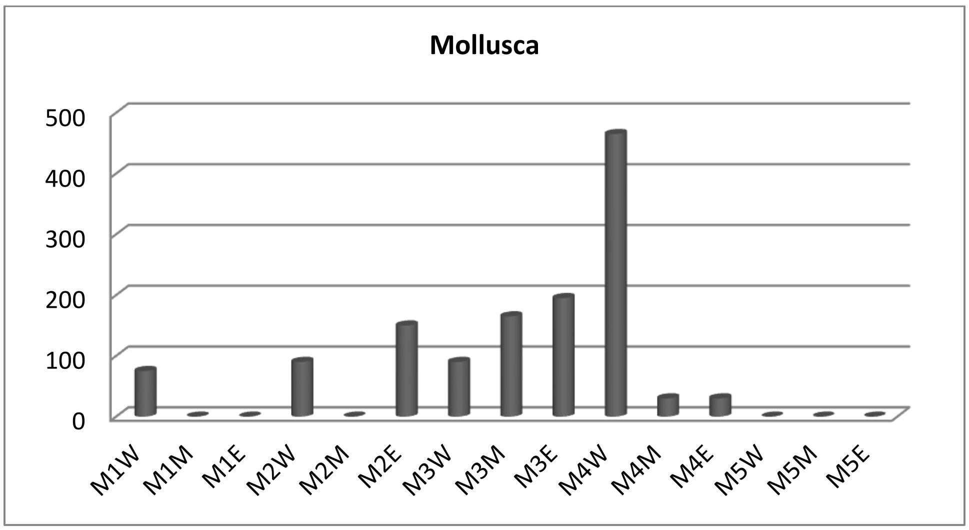

Fig. (9): Spatial variation of Mollusca in Lake Nasser during March 2019 and July 2019.

Macrobenthos diversity:

Because each species in the ecosystem has a particular purpose and maintains freshwater resources, a balanced ecosystem with rich biodiversity increases the ecosystem's productivity. As a result, in contaminated ecosystems, a decline in species diversity is understood. Three stations represented the highest species diversity in Lake Nasser and, therefore, reflect the best environment for the organisms to live in (Table 3). The western station of the EL Madiq sector revealed the highest Shannon Weaver diversity index (H′= 1.55). It could be ascribed to the prevailing of four arthropod species and nymphs of *Ischneura*. This could be a reflection of the excellent water quality in this area. This result is followed by the eastern part of the Wadi Abyad sector and the western part of Tushka which revealed 1.23 and 1.09 of theShannon Weaver index, respectively. On the contrary, the middle stations of the Wadi Abyad and Aswan sectors recorded the least diversity Shannon Weaver index value (H′= 0.21 and 0.27, respectively). It may be attributed to the nature of the sediment, which led to the absence of all mollusk species and the presence of one Annelida species (*Limnodrilus* sp.) and one Insecta species (*Chironomus* larvae). However, the dominance of *Limnodrilus* sp. and *Chironomus* larvae with the absence of all other species has been used to indicate poor water quality, which is confirmed by **Brinkhurst (1974)**, who mentioned that the monogeneric assemblage of tubificid worms, with the dominance of *Limnodrilus hoffmeisteri*, indicates that the water stream is somewhat gross organic pollution and eutrophic.

Because the macrobenthic invertebrate community is thought to be the excellent indicator of the biological and environmental quality of the aquatic ecosystem, to examine the relationships between the population abundace and the stations, the similarity index was applied and the dendrogram is illustrated in Figure (10). Obviously, there were 2 clusters of stations. The first cluster was composed of Abu Simble sector, the middle and eastern stations of Tushka sector, and the middle stations of both Aswan and Wadi Abyad sectors. It could be attributed to the factor of low diversity index in these stations. The second cluster was characterized by higher biodiversity mostly in the northeastern and western stations (Aswan, Wadi Abyad, and El-Madiq).

Table 3. The benthic macroinvertebrates diversity of the different stations in the current study.

Station	S	N	d (Richness)	J' (Evenness)	H'(log) (Shannon)	1-lambda Simpson
St.1 E	3	180	0.39	0.81	0.89	0.54
St.1 M	2	975	0.15	0.39	0.27	0.14
St.1 W	5	1260	0.56	0.60	0.97	0.56
St.2 E	7	720	0.91	0.63	1.23	0.56
St.2 M	2	270	0.18	0.31	0.21	0.11
St.2 W	5	510	0.64	0.61	0.98	0.48
St.3 E	5	735	0.61	0.64	1.02	0.52
St.3 M	4	270	0.54	0.71	0.98	0.55
St.3 W	6	330	0.86	0.87	1.55	0.76
St. 4 E	5	1740	0.54	0.41	0.65	0.32
St.4 M	3	810	0.30	0.29	0.32	0.14
St.4 W	7	1470	0.82	0.56	1.09	0.54
St.5 E	2	1455	0.14	0.67	0.46	0.29
St.5 M	2	1665	0.13	0.47	0.32	0.18
St.5 W	3	555	0.32	0.38	0.42	0.20

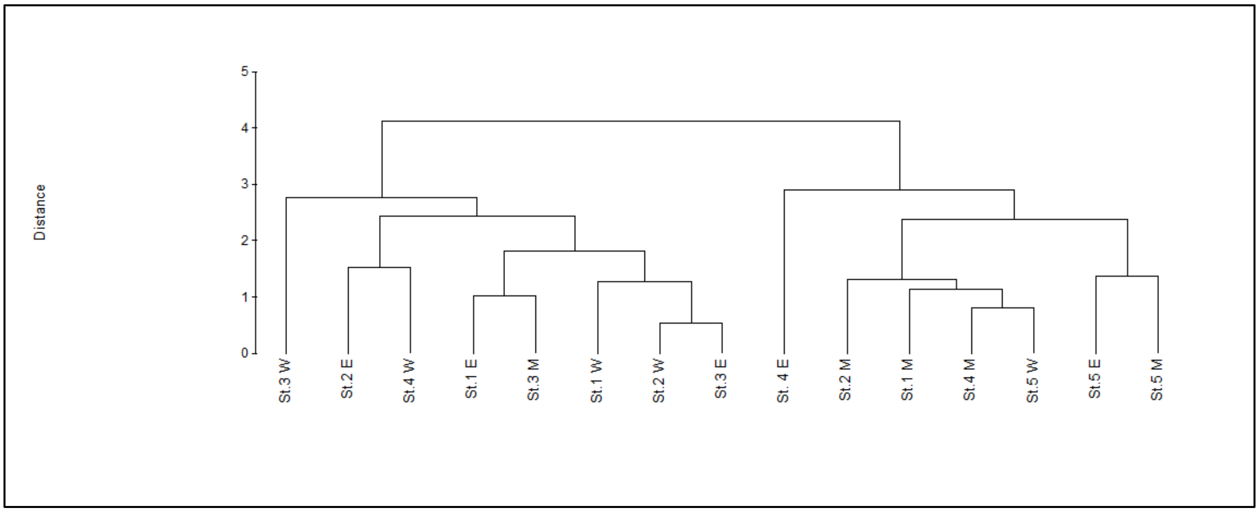

Fig. (10): Dendrogram illustrating the similarity of the 15 studied stations in Lake Nasser.

Long-term changes of macrobenthic invertebrates' community structure:

Obviously, macrobenthic invertebrates are influenced greatly by complex inter-relationships between biotic and abiotic factors. In the present investigation, oligochaetes were the most abundant group, where the decaying detritus and macrophytes provide the bottom with nutrients that assure good nourishment.

Historically, the Lake's substrate was occupied with extremely large numbers of bivalves. During the stagnant period, these bivalves perished and disappeared. Since 1973, oligochaetes and mussels returned to the shallow water of the khors because of the presence of favorable oxygen conditions **(Entz 1976)**.

As shown in Table (4), the number of species decreased dramatically to only 9 species compared to 15, 43, 39, and 24 in 1987, 1993, 1995, and 2013, respectively. This could be related to anthropogenic impacts.

Furthermore, the standing crop of macrobenthic fauna in Lake Nasser was 863 org./m^2 compared to 823 org./m^2 in 1995, and 529 org./m^2 in 2013 (Table 3). Thus, it is clear that Lake Nasser has possessed the same composition of macrobenthic invertebrates since the 1980s till now, although the biodiversity and species richness have been declined to a great extent. **Nassif (2012)** deduced that little species variety and dominance of pollution-tolerant species, such as *Limnodrilus hoffmeisteri* and Chironomus larvae, beside the disappearance of sensitive species demonstrate that the water status of Lake Nasser has suffered greatly.

CONCLUSION

In conclusion, the current study revealed that the macrobenthos biodiversity, as well as species richness in Lake Nasser, showed a drastic decline from one year to another. Therefore, it is recommended to apply an effective legal framework and improve public awareness to maintain Lake Nasser healthy. That is why this paper is an alarming tool for decision-makers and stakeholders to take the right action to mitigate the pollution resources discharging on the most crucial and historical lake in Egypt.

Table 4. The macrobenthic invertebrates list in Lake Nasser recorded by other authors (+ = found, - = not found).

Taxa and species	Elewa (1987)	Iskaros (1988 & 1993)	Fishar (1995)	Abdel-Gawad and Mola (2014)	Current study
Phylum : Cnidaria					
Class : Hydrozoa					
Hydra vulgaris **(Pallas, 1766)**	-	-	+	-	-
Phylum : Bryozoa					
Class : Phyleclolaemata					
Fredericella sultana **(Blumenbach, 1779)**	-	-	+	-	-
Phylum : Arthropoda					
Class : Insecta					
Ablabesmyia **sp.**	-	+	+	-	-
Caenis **sp.**	-	-	+	-	-
Chironomus **sp.**	-	+	+	+	+
Circotopus **sp.**	-	+	+	-	+
Clinotanpus **sp.**	+	+	-	-	-
Coelotanpus **sp.**	-	+	+	-	-
Conchopelopia **sp.**	-	+	-	-	-
Cryptochironomus **sp.**	+	+	+	+	-
Dicrotendipes modestus	-	+	-	-	-
Einfeldina **sp.**	-	+	-	-	-
Enallagma **sp.**	-	-	+	-	-
Gomphus **sp.**	-	+	-	-	-
Ischnura **sp.**	-	-	+	+	+
Libellula **sp.**	-	+	-	-	-
Microchironomus **sp.**	-	+	-	-	-
Micronecta plicata	-	-	+	-	-
Microtendipes **sp.**	+	+	+	-	-
Neurocordula **sp.**	-	-	+	-	-
Nilodorum **sp.**	-	+	+	-	-
Pelopia **sp.**	-	+	-	-	-
Plathemis **sp.**	-	-	+	-	-
Polypedilum **sp.**	-	+	+	+	-
Perithemis **sp.**	-	+	+	+	-
Procladius **sp.**	+	+	+	-	-
Pseudoagrion niloticus	-	+	-	-	-
Tanpus **sp.**	-	+	-	-	-
Dytiscide **sp.**	-	-	+	-	-
Tanytarsus **sp.**	+	+	+	+	-
Hydrovatus **sp.**	-	-	+	+	-
Larvae of Trichoptera	+	+	+	+	-
Pupae of Chironomidae	-	-	-	+	+

Nymphs of Ephemeroptera	-	+	-	-	-
Adult of Corixidae	-	+	-	-	-
Class : Crustacea					
***Cardina nilotica* (P. Roux, 1833)**	-	-	+	-	-
***Chlamydotheca unispinosa* (Baird, 1862)**	-	-	+	+	-
***Potamonautes niloticus* (H. Milne Edwards)**	-	-	-	-	-
***Stenocypris malcolmsoni* (Baired, 1862)**	-	-	+	-	-
Phylum : Annelida					
Class : Oligochaeta					
***Branchiura sowerbyi* (Beddard, 1892)**	+	+	+	+	-
***Limnodrilus hoffmeisteri* (Claparéde, 1862)**	+	+	+	+	+
***Limnodrilus udekemianus* (Claparéde, 1862)**	+	+	+	+	-
***Pristina* sp.**	-	-	+	+	-
Class : Hirudinea					
***Helobdella conifera* (Moore, 1933)**	-	+	+	+	-
Phylum: Mollusca					
Class : Gastropoda					
***Bellamya unicolor* (Olivier, 1804)**	-	+	-	-	-
***Biomphalaria alexandrina* (Ehrenberg, 1831)**	-	+	-	-	-
***Bulinus truncatus* (Audouin, 1827)**	+	+	+	+	-
***Bulinus forskalii* (Ehrenberg, 1831)**	-	+	-	-	-
***Cleopatra bulimoides* (Olivier, 1804)**	-	+	+	+	-
***Gabbiella senaariensis* (Kuster, 1852)**	-	+	-	-	-
***Helisoma duryi* (Wetherbg, 1879)**	-	+	-	-	-
***Lanistes carinatus* (Olivier, 1804)**	-	+	-	-	-
***Lymnaea natalensis* (Krauss, 1848)**	-	+	-	-	-
***Melanoides tuberculata* (Müller, 1774)**	+	+	+	+	+
***Physa acuta* (Darparnaud, 1805)**	+	+	+	+	+
***Pila ovata* (Olivier, 1804)**	-	+	-	-	-
***Segmentorbis angustus* (Jickeli, 1874)**	-	+	-	-	-
***Theodoxus niloticus* (Reeve, 1856)**	-	+	-	-	-
***Valvata nilotica* (Jickeli, 1874)**	+	+	+	+	-
***Gyraulus ehrenbergi* (Beck, 1837)**	-	-	+	+	+
Class : Bivalvia					
***Corbicula consobrina* (Cailliaud, 1827)**	+	-	+	+	-
***Pisidium pirothi* (Jickeli, 1881)**	+	-	+	+	+
***Eupera ferruginea* (Krauss, 1848)**	-	-	+	-	-
Total	**15**	**43**	**39**	**24**	**9**

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