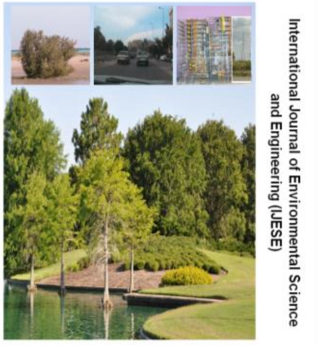
INTERNATIONAL JOURNAL OF ENVIRONMENTAL SCIENCE AND ENGINEERING (IJESE)
Vol. 7: 34- 40 (2016)
http://www.pvamu.edu/research/activeresearch/researchcenters/texged/ international-journal
Prairie View A&M University, Texas, USA



Impact of pollution on macrobenthos diversity of Qalla Drainage System, Lake Maruit, Egypt.

Khalil, M.T. [1]; Saad, A.A.[1]; Fishar, M.R.A.[2]; Abdel-Meguid, M.A. [3]; El-Bably, W.F. [3] and Mohammed, K.A.[3]
1- Ain Shams University, Faculty of Science, Egypt.
2- National Institute of Oceanography and Fisheries, Egypt.
3- National Water Research Center, Environment and Climate Research Institute, Egypt.

ARTICLE INFO
Article History
Received: March 20, 2016
Accepted: April 9, 2016
Available online: Jan. 2017

Keywords:
Qalla Drain
Lake Maruit
Macrobenthos
Diversity
Bivalvia
Pulmonata

ABSTRACT
Impact of pollution on macrobenthos community of Qalla drainage system and Lake Maruit has been studied during summer 2013. 151 quantitative samples of macrobenthos were collected from different 17 locations of the study area. Eight species was identified belong to 2 classes; Gastropoda and Bivalvia. The gastropods *Physa acuta* and *Biomphlaria alexandrina* were detected in polluted areas as they consider pollution tolerant molluscs due to their adaptation for air-breathing (pulmonates). On the other hand, the bivalve *Corbicula consobrina* - the least pollution tolerant mollusc- was appeared in moderate polluted locations. High loads of pollution and contaminants were synchronized with low levels of dissolved oxygen and high levels of biological oxygen demands (BOD) and ammonia which affected the abundance of pollution -sensitive benthos. Shannon and Simpson diversity indices of macrobenthos were statistically calculated for all locations; indicating low values of these indices in most of Qalla Drainage network stations.

1. INTRODUCTION

In long-term water quality monitoring, bio-assessment was widely used on aquatic major groups, such as bacteria, phytoplankton, zooplankton and benthos as they are sensitive to ecological changes (Skulberg, 1995; Whitton and Kelly, 1995; Rosemond, 2000; Rott *et al.*, 2003; Parikh *et al.*, 2006).

Lake Maruit is now considered a major source of pollution to the Mediterranean Sea through El Mex Bay. It receives polluted water from three major sources on a daily basis; industrial effluents, domestic effluents, and drainage water from agriculture. AICZMP report (2009) stated that the Main Basin also receives three major sources of pollution. In the southern eastern side, Qalla drain (agriculture drain) receives the effluent of Alexandria East Wastewater Treatment Plant (EWTP, an overloaded primary treatment plant).

Qalla Network Drainage System consists of seven branched drains and its water is mixture of agricultural runoff and sewage water contaminated with industrial waste from East Alexandria Drainage System (Gleem to Hader and Abu Kir).

* Corresponding author: e-mail, khokhacat@yahoo.com
ISSN 2156-7530

It receives drainage water from the East Treatment Plant (ETP); as a primary treated industrial and wastewaters coming from east and middle of Alexandria.

Also, it receives agriculture drainage water from El-Amlak Drain and untreated wastewater from Dayer Elmatar and Gonat El-Zahr drain (EEAA, 2008).

Analysis of freshwater benthos communities is important in terms of biodiversity measurements and ecosystem health. They played significant roles in the public and veterinary health and thus needed to be scientifically explored more extensively (Supian and Ikhwanuddin, 2002).

2. METHODOLOGY

Qalla Drain and its branches are located in Alexandria Governorate (Fig. 1). 17 sampling locations were selected to cover most of the study area in the main basin of Lake Maruit nearby Qalla Drain and its branches to represent the different habitats. During summer 2013, benthos samples were collected randomly by Ekman bottom grab with an opening area of 234 cm^2 (1/43 m^2). Samples were thoroughly washed from muds in a metallic sieve with mesh size of 0.4 mm sorted directly in the field and preserved in 5% formalin solution. In the Lab, the specimens were identified to species level and number of the individuals per square meter was determined (ind. /m^2).

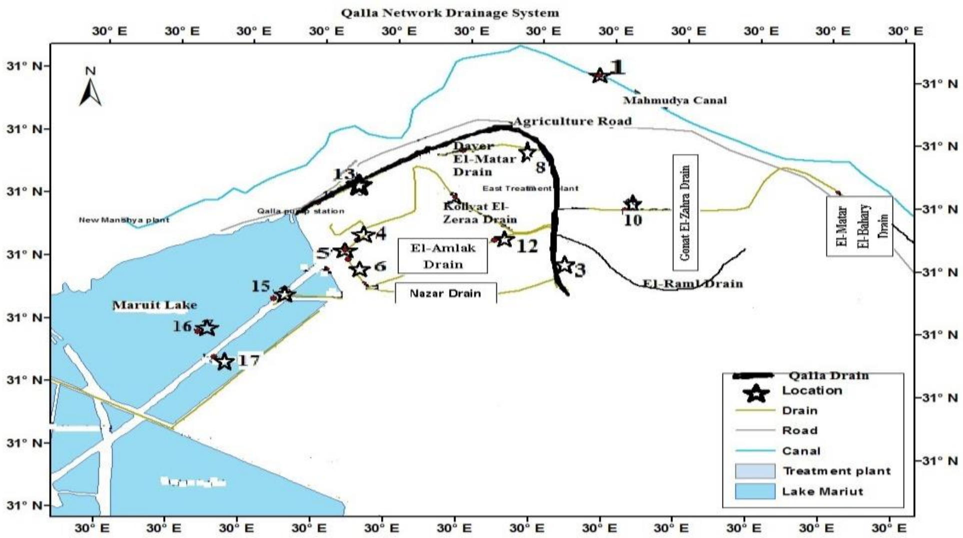


Fig. 1: Qalla Drainage network and its outfall in Lake Maruit, showing sampling locations

Dissolved oxygen, biological oxygen demand (BOD), and ammonia were measured in water samples from the same stations in the study area. Water analysis was done according to the Standard Methods for Examination of Water and Wastewater (APHA, 2005) in the Central Laboratory for Environmental Quality Monitoring in National Water Research Center.

Simpson diversity index (Simpson, 1949) was calculated, as the bigger the value, the lower the diversity. Also, Shannon diversity index (Shannon and Weaver, 1948) was calculated; lower values indicated more diversity while higher values indicated less diversity.

3. RESULTS AND DISCUSSION

Based on a field visit, it was clear that the main Qalla drain and some of its branches are characterized by the presence of huge loaded pollutants due to the disposal of both treated and untreated sewage directly to the water body mainly from Waste Water Treatment Plant.

The most polluted locations were 2, 7, 9, 11, and 14, namely; Terminal Kollyat El-Zeraa Drain, Nazar Drain, Terminal El-Matar El-Bahary Drain, Qalla Drain nearby pump station, and Lake Maruit main basin fish farm, respectively.

There were high loads of the organic matter in that locations, very reactive sludge from the treatment plants in Qalla Drain study area which was generally unsuitable for most benthic organisms (Table 1).

Table 1: Species composition and abundance (indiv. /m^2) of molluscs in Qalla network drainage system.

Taxa & Species / Stations	1	3	4	5	6	8	10	12	13	15	16	17
<u>Class: Gastropoda</u>												
Subclass: Prosobrachia												
Family: Bithyniidae										5		
***Gabbiella senaariensis* (Küster, 1852)**												
Family: Thiardae												
***Melonides tuberculta* (Müller, 1774)**		10	5		9		6	13	5			
***Cleopatra bulimoides* (Olivier, 1804)**			5									8
Subclass: Pulmonata												
Family: Planorbidae												
***Gyraulus ehrenbergi* (Beck, 1837)**											7	
***Biomphalaria alexandrina* (Ehrenberg, 1831)**		7	6	11		7			8			
***Bulinus truncates* (Audouin, 1872)**				7		8						
Family: Physidae												
***Physa acuta* (Olivier, 1804)**						5						
<u>Class: Pelecypoda (Bivalvia)</u>												
Family: Corbiculidae												
***Corbicula consobrina* (Cailliaud, 1827)**	6										5	8

The gastropod *Melanoides tuberculata* was the most important bottom animal inhabiting Lake Maruit Main Basin and Qalla Drain and its branches. This indicated that this prosobranch gastropod favour, relatively clean localities, as it needed unpolluted water for respiration. The same results emphasized by Khalil and Koussa. (2013).

There were three species of pulmonate molluscs recorded in the study locations *Biomphlaria alexandrina*, *Bulinus truncatus*, and *Gyraulus ehrenbergi*. They were important bottom benthos in the Main Basin (as recorded by Khalil and Koussa, 2013) and in the main stream of Qalla Drain and its branches. According to Ibrahim *et al*. (1999), these snails are known to live in many different habitats; stagnant or slowly flowing waters, vegetation and organic-rich as well as brackish or fresh waters.

Results of dissolved oxygen, biological oxygen demand (BOD) in water samples of the study area are shown in Table 2.

Table 2: DO, BOD and ammonia (mg/l) of water samples in the study area.

locations	1	3	4	5	6	8	10	12	13	15	16	17	International limits	Law 48/192 limits
DO	2.5	0.75	0.32	2.1	2.06	1.7	0.08	1.1	0.86	0.53	0.96	1.06	12.6-4	4:5
BOD	8	35	9	8	10	130	17	17	110	10	1	23	6-3	< 10
Ammonia	11.75	34.15	10.64	33.07	5.75	50.4	6.55	23.499	13.69	13.02	61.3	6.33	2.2-0.005	< 0.5

It is appeared that ammonia levels are exceeding the International Guidelines for Freshwater Quality (Chapman, 1992), and Egyptian Law 48/1982 limits for freshwater protection. Ammonia is known to be toxic to aquatic life. Elevated ammonia concentration is a result of its high levels in drains from treatment plant effluents. Khalil and Koussa (2013) observed high relationship between ammonia and snails abundance within the

Main Basin of Lake Maruit.

Also, BOD of water samples exceeded the international guidelines and Law 48/1982 limits for freshwater protection. Relationship between molluscan density and DO, BOD, and ammonia are plotted in Fig. 2, while biodiversity indices are illustrated in Fig. 3. Molluscans biodiversity increased with elevation of DO concentrations, so they displayed similar trends, while BOD and ammonia reflected similar tends in all locations except in location 16 in Lake Maruit. The highest values of BOD were recorded in location 8 nearby the waste water treatment plant.

Low oxygen levels in water were due to the high input of oxygen-demanding substances from treatment plants and organic and domestic drains in the study area. Some minimum levels of DO were required to support most benthic species which considered as oxygen depletion tolerance species. Khalil and Koussa (2013) observed the relationship between DO concentrations and benthos density indicated that a DO value of 4 mg/L or more was conductive to support higher densities of benthos in the main basin of Lake Maruit. When DO was above 4 mg/L, it did not necessarily mean that benthos density will be increased, but rather that there were an opportunity for high benthos density. Biological oxygen demand of surface water samples was exceeded the international guidelines and Law 48/1982 limits for freshwater protection. BOD is associated with wastewater characteristics and affected by the level of its treatment. Therefore, it is a good tool for examining changes based on level of treatment. The same concept was achieved by Khalil and Koussa (2013) as they concluded relations between benthos density and ammonia, DO, and BOD.

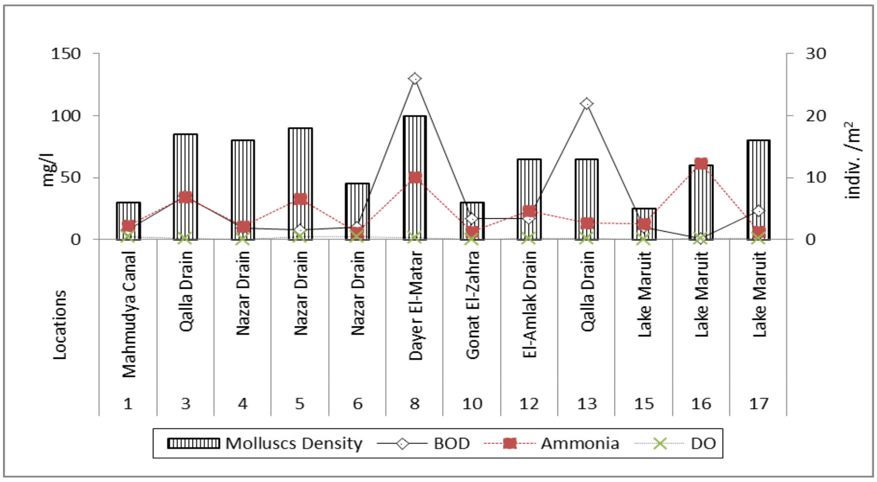


Fig. 2: Molluscs density in relation to DO, BOD and NH_3 concentrations in the study area.

Diversity indices of molluscs were statistically calculated; Shannon and Simpson indices (Table 3 and Fig. 3). For Shannon Index of Diversity, the highest value was 1.82 recorded in location 17 in Lake Maruit and the lowest value was 0.11 in location 12 nearby by Qalla Pump Station in El-Amlak Drain. Simpson Index of Diversity maximum value was 0.71 in location 1 (Mahmoudya Canal; control area) and the minimum value was 0.004 in location 12.

Table 3: Molluscs diversity indices at Qalla Drain network during summer (2013).

Locations	1	3	4	5	6	8	10	12	13	15	16	17
Shannon Index of Diversity	1.51	1.14	0.99	0.32	0.29	1.08	1.01	0.11	0.98	1.1	1.7	1.82
Simpson Index of Diversity	0.7	0.155	0.318	0.23	0.102	0.49	0.291	0.004	0.22	0.2	0.655	0.67

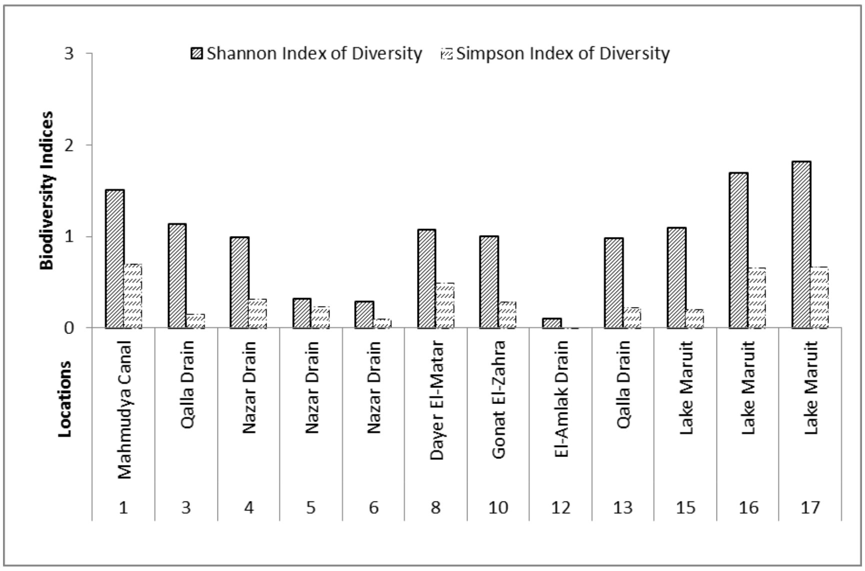


Fig. 3: Molluscs diversity indices in Qalla Drainage network

3.1 Historical records of zoobenthos

Khalil and Koussa (2013) studied the species composition and abundance (indiv. /m^2) of benthic macrofauna in the Main Basin of Lake Maruit during 1998/ 1999. Comparing the species composition of zoobenthos of the present study with historical records of 1960´s and 1998/1999 indicated that new conditions prevailing the bottom of the Main Basin, as a result of increasing wastewater discharge, have greatly affected and changed benthic community. Samaan and Aleem (1972b), during their work in 1960, have shown that benthic community of the Main Basin was dominated by brackish and some marine forms. The polychaete *Nereis diversicolar* was the most important bottom animal, which constituted about 50 percent of the biomass of benthic community. They recorded also the amphipods *Corophium constitutes* and G*ammarus* sp., the barnacle *Balanus improvisus*, the polychaete *Mercierella enigmatica*, and the gastropod *Melanoides tuberculata*. Most of these benthic forms have disappeared completely from the Main Basin, except the last one, while the freshwater gastropods as well as pollution – tolerant forms dominated the benthic community. Only calcareous tubes of polychaetes tubes remained and were found now dispersed all over the Lake bottom with empty shells of *Cardium edule.* This tremendous change in species composition of the benthic community is attributed mainly to two factors; decreasing salinity of the Lake and increasing wastewater discharge from Qalla Drain into the Lake that created a very reactive sludge layer on the bottom of the Main Basin which is unsuitable for most benthic organisms.

In conclusion most of gastropods, bivalves, that recorded in the study area are pollution tolerant species. They can be used as bioindicators for pollution of aquatic ecosystems. Increasing of wastewater discharge from Qalla Drain into Lake Maruit caused deterioration of water quality in the main basin of the Lake t. Moreover, wastewater discharge created a very reactive sludge layer on the bottom of the Main Basin which was unsuitable for most benthic organisms and fish farms and cause deterioration of fish yields production from the lake.

4. REFERENCES

Abd El Gawad, S.S.I. (2009). The Mollusc gastropod *Lanistes carinatus* (Olivier, 1804) as a biomonitor for some trace metals in the Nile River. International Journal of Zoological Research. 11pp.

Abd El-Wakeil, K.F.; Obuid-Allah, A.H.; Mohamed, A.H. and Abd El-Aziz, F.E.A. (2013). Community structure of molluscans in River Nile and its branches in Assiut governorate, Egypt. National Institute of Oceanography and Fisheries. Egyptian Journal of Aquatic Research. 39:193–198.

Alexandria Integrated Coastal Zone Management Project (AICZMP) (2009). Environmental and Social Impact Assessment. Executive Summary, 24 pp.

American Public Health Association {APHA} (2005). Standard methods for the examination of water & wastewater. 21st edition, Eaton, A.D., Clesceri, L.S., Rice, E.W., Greenberg, A.E., Franson, M.A.H. APHA, Washington.

Brinkhurst, R.O. and Jamison, B.G.M. (1971). Aquatic Oligochaete of the World. University of Toronto Press, Ontario, 860pp.

Brown, D.S. (1980). Freshwater Snails of Africa and their Medical Importance. London, Taylor and Francis, 487pp.

Chapman, D. (1992). Water quality assessments, A guide to the use of biota, sediments and water in environmental monitoring. Chapman & Hall, London, (on behalf of UNESCO/ WHO/ UNEP). 585 pp.

EEAA Report (2008). Environmental Work Plan of Alexandria Governorate. Egypt, 145 pp. (in Arabic).

EEAA Report (2010). Summary of the results of the first field trip in August. Wetland Monitoring Program, Lake Maruit, Egypt. 6 pp. (in Arabic).

EEAA Report (2012). Summary of the results of the third field trip in May. Environmental Monitoring Program of the Northern Lakes, Lake Maruit, Egypt. 9 pp. (in Arabic).

El-Khayat, H. M.; Ismail, N. M.; Mahmoud, K. M.; Ragb, F.M.; El-Said, K. M.; Mostafa, B. B.; El-Deeb, F. A. and Tantawy, A.A. (2011). Evaluation of some chemical parameters as potential determinants of freshwater snails with special reference to medically important snails in Egypt. World Academy of Science, Engineering and Technology., 59:1313–1326.

Fernandes, L.J.T. (1991). Impact of Marine Pollution on Selected Intertidal Gastropods of Bombay. Ph.D. Thesis University of Bombay, Bombay 339 pp.

Freshwater Pollution Protection Egyptian Law (48/1982). 200 pp.

Ibrahim, A.M.; Bishai, H.M. and Khalil, T.K. (1999). Freshwater Mollusks of Egypt. Egyptian Environmental Affairs Agency, Publication of National Biodiversity Unit, No.10: 145pp.

Ibrahim, A.M.; Bishai, H.M. and Khalil, T.K. (1999). Freshwater Molluscs of Egypt. Department of Nature Protection, Egyptian Environmental Affairs Agency, Cairo, Egypt., Publication of National Biodiversity Unit, (10): 145pp.

Joeppette, J.H. and Charina, I.N. (2007). Population assessment of commercial gastropods and the nature of gastropod fishery in Panglao Bay, Bohol, Philippines. Kinaadman an Interdisciplinary Research Journal, Holy Name Univeristy, Tagbilaran City, Bohol., 18(2): 107-120.

Khalil, M.T. and Koussa, A.A. (2013). Impact of pollution on the biodiversity of bottom fauna of Lake Maruit, Egypt. The Global Journal of Fisheries and Aquatic Research, 6(6): 282- 294.

Krishnakumari, L. (1990). Ecological and Biochemical Studies with Special Reference to Pollution on Selected Species of Molluscs from Bombay. Ph.D. Thesis, University of Bombay, Bombay, 522 pp.

Lacren, C.D. (1951). The length weight relationship and seasonal cycle in good weight and condition in a Perch (*Perca fluviatilis*). J. Anim. Ecol., 10: 201-219.

Moloukhia, H. and Sleem, S. (2011). Bioaccumulation, Fate and Toxicity of Two Heavy Metals Common in Industrial Wastes in Two Aquatic Molluscs. Journal of American Science., 7(8): 459-464.

Parikh, A.; Shah, V. and Madamwar, D. (2006). Cyanobacterial flora from polluted industrial effluents. Environmental Monitoring and Assessment, 116: 91-102.

Rosemond, A.D. (2000). Use of Algae for Monitoring Rivers III. Journal of Phycology, 36(3): 621–622.

Rott, E.; Pipp, E. and Pfister, P. (2003). Diatom methods developed for river quality assessment in Austria and a cross-check against numerical trophic indication methods used in Europe. Arch., Hydrobiol. Suppl. Algological Studies, 110: 91-115.

Samaan, A.A. and Aleem, A.A. (1972b). Quantitative estimation of bottom fauna in Lake Maruit. Bulletin of the National Institute of Oceanography and Fisheries, Egypt, 2: 375-397.

Shannon, C.E. and Weaver W. (1948). A mathematical theory of communication. The Bell System Technical Journal, 27: 379–423 and 623–656.

Simpson, E.H. (1949). Measurement of diversity. Nature 163: 688.

Skulberg, O.M. (1995). Use of algae for testing water quality. In Wiessner, W.; Schnepf, E. and Starr, R. C., [Eds.] Algae, Environment, and Human Affairs., pp. 25-30.

Sparre, P.; Ursin, E. and Venema, S.C. (1989). Introduction to Tropical Fish Stock Assessment. Part I Manual. Food and Agriculture Organization, Rome, pp. 306-337.

Spooner, D. E. and Vaughn, C. C. (2006). Context-dependent effects of freshwater mussels on stream benthic communities. Freshwater Biology., 51:1016–1021.

Strayer, D. L.; Hunter, D. C.; Smith, L. C. and Borg, C. K. (1994). Distribution, abundance, and roles of freshwater clams (Bivalvia, Unionidae) in the freshwater tidal Hudson River. Freshwater Biology, 31: 239-248.

Supian, Z. and Ikhwanuddin, A.M. (2002). Population dynamics of freshwater molluscs (Gastropod: Melanoides tuberculata) in Crocker Range Park, Sabah. ASEAN Review of Biodiversity and Environmental Conservation (ARBEC). 9 pp.

Vaughn, C.C.; Gido, K.B. and Spooner, D.E. (2004). Ecosystem processes performed by unionid mussels in stream mesocosms: species roles and effects of abundance. Hydrobiologia., 527:35-47.

Walker, B. (1959). The Mollusca. In: Freshwater Biology. W.T; Edmendson, H. B. Ward, and G.C. Wipple, (Eds) 2nd ed., pp. 957-1020. New York, John Wiley and Sons. Inc.

Whitton, B.A. and Kally, M.G. (1995). Use of algae and other plants for monitoring rivers. Australian Journal of Ecology., 20:45-56.

Zimmerman, G.F. and de Szalay, F.A. (2007). Influence of unionid mussels (Mollusca: Unionidae) on sediment stability: an artificial stream study. Fundamental and Applied Limnology, 168: 299–306.

Zingde, M. D. and Govindan, K. (1997). Health status of the coastal waters of Mumbai and regions around. In: Proceeding of the Symposium, on Coastal Cities in India. Indira Gandhi Institute of Development Research, Mumbai, 1pp.