Egyptian Journal of Aquatic Biology & Fisheries
Zoology Department, Faculty of Science,
Ain Shams University, Cairo, Egypt.
ISSN 1110 – 6131
Vol. 24(6): 197 - 205 (2020)
www.ejabf.journals.ekb.eg

The influence of certain ecological parameters on a potable water treatment plant in El-Dakahleyia Province.

Mansour Galal*, Gamalat Osman, Khalid Giba and Mona Maamoun
Zoo. Dept., Fac. of Science, Menoufia Univ., Sheben El-Koum, Egypt.

*Corresponding author : Mansour_galal_eg@yahoo.com

ARTICLE INFO

Article History:
Received: July 21, 2020
Accepted: Sept. 2, 2020
Online: Sept. 6, 2020

Keywords:
Physico-chemical parameters
Protozoa
Water treatment
Zooplankton

ABSTRACT

This study was carried out on El-Sharqe Water Treatment Plant in El-Mansoura city to follow up various types of zooplankton, certain physicochemical parameters and their possible role in the efficiency of the water treatment process. The relative percentage of Protozoa to the total zooplankton ranged from 93.3 to 86.5% and from 94.6 to 84.9% in the Nile and El-Mansouria influents; respectively while those of rotifers, worms and insect larvae were fewer and more or less similar to each other. The highest and lowest numerical densities of all these groups were recorded mostly on September 2018 and on $Jannuary_{2018}$ respectively.

Regarding the physicochemical parameters of influent and effluent water samples, it appears that electrical conductivity, total dissolved solids, dissolved oxygen, and nitrates are higher in the effluent samples as compared with those of the influent ones, turbidity, alkalinity, consumed oxygen, ammonia and nitrites follow an antagonistic behaviour. It was obvious that consumed oxygen, iron, ammonia and nitrite concentrations achieved zero levels in the effluent samples which might give a good indication for the efficient performance of this water treatment plant. It is necessary to mention that nitrates followed a particular behaviour where its concentrations achieved higher levels in the effluent as compared with the influent due to the higher aerial oxidation rate in the latter samples.

Statistically, zooplankton particularly Protozoa proved higher positive correlations with temperature, P^H, electrical conductivity, turbidity, nitrites and nitrates where their correlation coefficients (r) ranged mostly between 0.8 and 0.92. On the other hand, the application of the multiple regression proved highly significant relationships between certain zooplankton organisms versus some of the physicochemical parameters ($0.002 < P < 0.001$).

INTRODUCTION

River Nile is one of the longest rivers in the world; 6650 km in length. It starts at Uganda and Passing through Tanzania, Rwanda, Burundi, Congo, Kenya, Eritrea, Ethiopia, Sudan and Egypt **(Karyabwite, 2000).** It extends for about 940 km in Egypt after the High Dam and it divides into two branches at El-Kanater Barrage; Damietta and Rosetta. El-Mansoura city lies on the banks of Damietta branch; its width and depth are

about 200 and 12 meters respectively **(Abdo, 2004).** Raw water quality differs at different parts of this branch according to the various human activities **(Zeng and Rasmussen, 2005).** Accordingly, water treatment processes has to be done to remove the different types of pollutants (organic, inorganic, microbial…etc) in order to have safe potable water **(Logsdon, 1999).** Water quality evaluation includes Physical, chemical and/or biological treatment processes **(Nadeen and Saeed, 2014).** Zooplankton groups with particularly protozoa are influenced by many physical and chemical parameters in the field **(Galal, 1989). Ali *et al*. (2014)** proved that, Nile water quality is characterized by high nutrients concentration because of the high values of water coming from the pumping station. In addition, variations in pH and alkalinity were found to be controlled by the level of CO_2 liberated through the nitrification process undertaken within the system followed nutrients and phytoplankton peaks.

According to the results obtained by **Fishar *et al.* (2019)**, there was a negative correlation between temperature, pH and zooplankton. Rotifers have high positive correlation with nutrient and EC, while Protozoan organisms were positively correlated with DO.

Mola and Ahmed (2015) studied Zooplankton and some Physico-chemical parameters in water samples collected from five Stations on the Nile between Helwan and El- Qanater El-Khayria on May, 2013 to February, 2014. They illustrated that the principal component analysis (PCA) proved a negative correlation between nutrients, major salts and the dominant zooplankton due to the increasing of the illegal wastewater discharge. Therefore, they recommended a treatment of wastewater from Iron and Steel Factory beside Starch and glucose Company before discharging to improve the water quality.

MATERIALS AND METHODS

This study was carried out at El-Sharqe Water Treatment Plant in El-Mansoura city, Dakahleyia province. Water samples were collected thrice monthly from effluent and the two water inlets (Nile and El-Mansouria influents) at 20-30 cm below water surface of this treatment plant using:

1- Sterilized one-liter polypropylene bottles for zooplankton organisms. Three bottles of water were collected at each station and taken as quickly as possible to the laboratory. These samples were mixed well by inverting ten times gently and replicates of 100ml from each station were taken to be sedimented via the cold sedimentation technique at 7^0C **(Galal, 1989).** The cold sedimentation unit (Fig. 1) consists of a shallow cylindrical chamber of two cubic centimeter capacity and a long tubular chamber of 2.5 cm diameter and 100 ml capacity. The precipitated volume was examined microscopically for identification and counting of the different zooplankton organisms by using Swift (M4000-D) light microscope made in Japan. The protozoan identification was performed according to **Patterson and Hedley (1996).** The results are expressed as number of organisms X10 / L.

2- Double-washed glass bottles; with chromic acid and distilled water; of 500 ml were used for collecting and measuring the physicochemical parameters of sampling water according to **APHA (2017).**

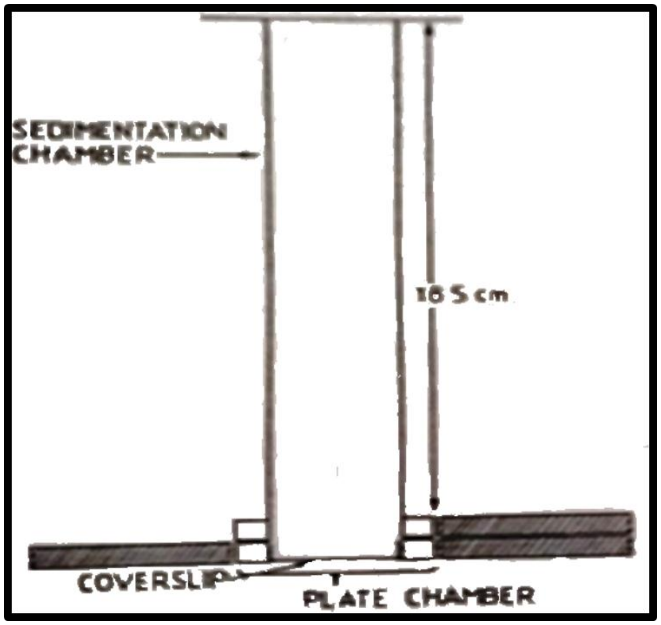


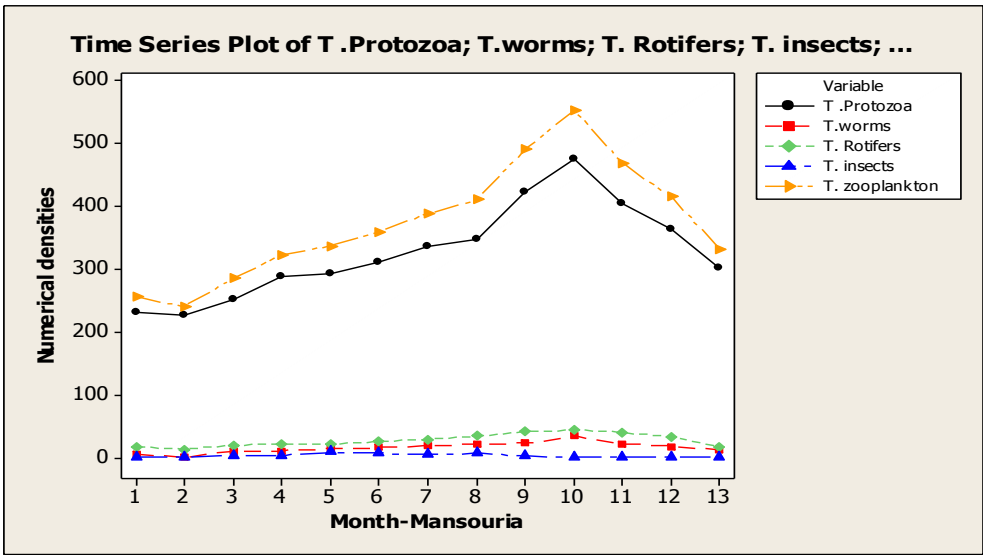
Fig. 1: Cold Sedimentation unit

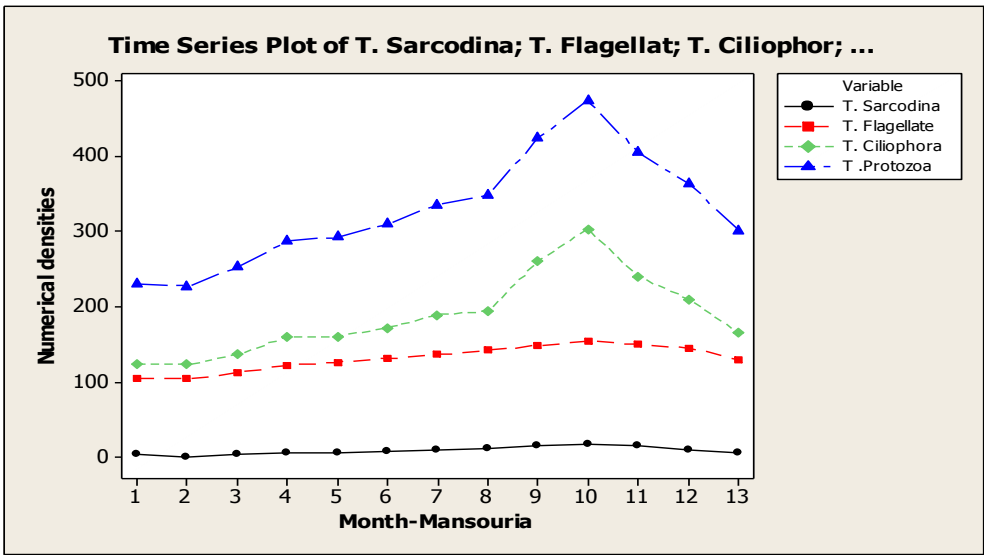
RESULTS AND DISCUSSION

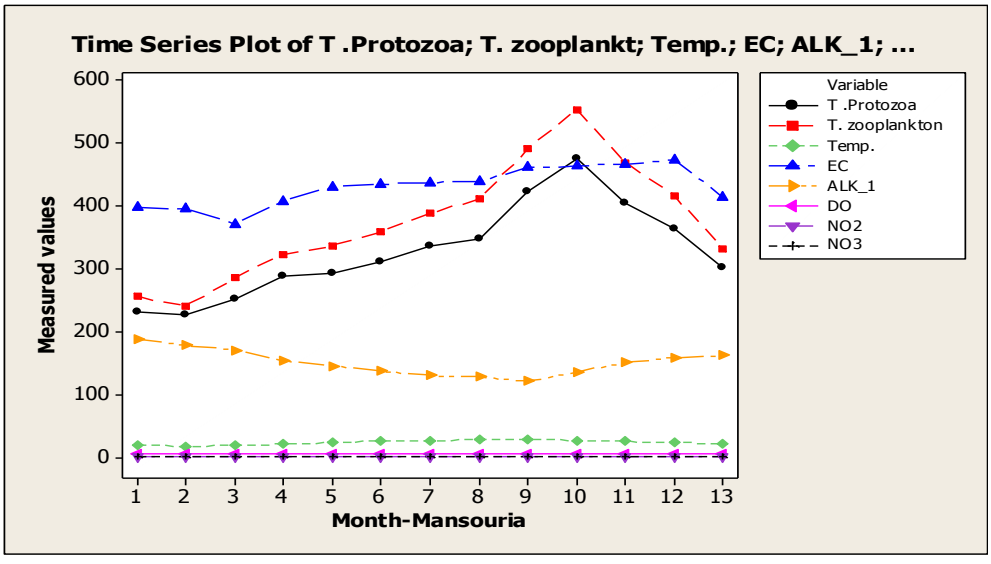
Water samples of the two influents supplying El-Sharqe Water Treatment Plant exhibited the presence of many types of zooplankton particularly, protozoans, rotifers, worms and insect larvae. The most abundant group belongs to the protozoan organisms followed by rotifers, worms and then insect larvae. Figure (2a) showed the maximal and minimal numerical values of the total zooplankton and most of its differential types per liter in El-Mansouria influent. It was proved that the lower densities were detected during $Jannuary_{2018}$, which gradually increase to achieve the uppermost ones on $September_{2018}$ then declined again until minimum numerical densities during $December_{2018}$. Simultaneously, Figure (3a) illustrated that different types of zooplankton belonging to The Nile influent behave similarly to those of the Nile one where their highest values were recorded mostly on $September_{2018}$ and their lowest numerical densities were detected on $Jannuary_{2018}$. It is necessary to keep in mind that total protozoan organisms followed the same behaviour as total zooplankton, where their relative percentage ranged from 93.3 to 86.5% and from 94.6 to 84.9% in the Nile and El-Mansouria influents respectively. On the other hand, the numbers of rotifers, worms and insect larvae were fewer in numbers and more or less similar to each other.

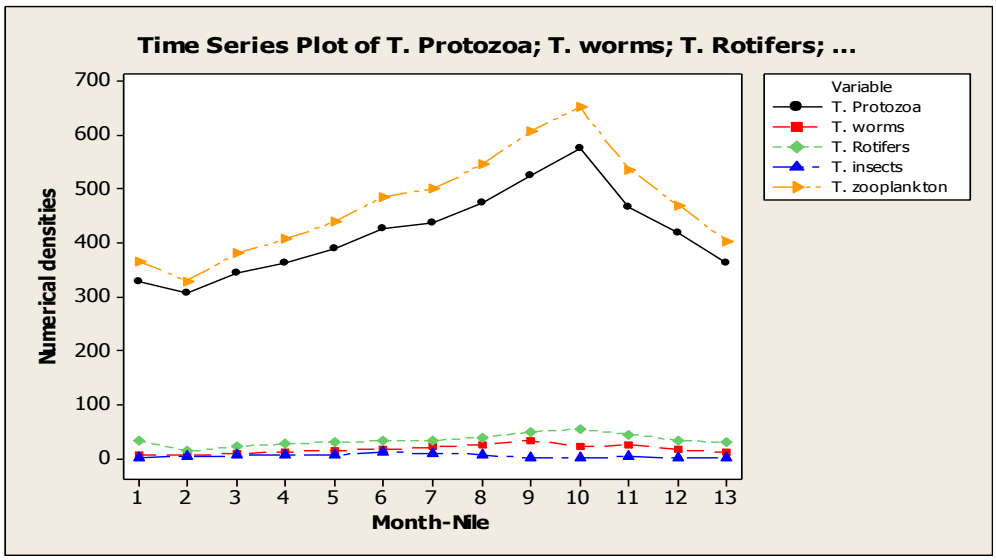
Kingdom Protista was illustrated by three main protozoan phyla; *Sarcodina*, Mastigophoera and Ciliophora where the latter dominates the other two phyla during the whole studying period at both influents of the previously mentioned water plant. It is worthy to mention that these three protozoan phyla represented more or less the lowest numerical densities on a period extending between $December_{2017}$ and $January_{2018}$ and then

go upwards till reaching maximal numbers during September$_{2018}$ and then go downwards till minimal value during December$_{2018}$ as shown in Figures 2b and 3b.









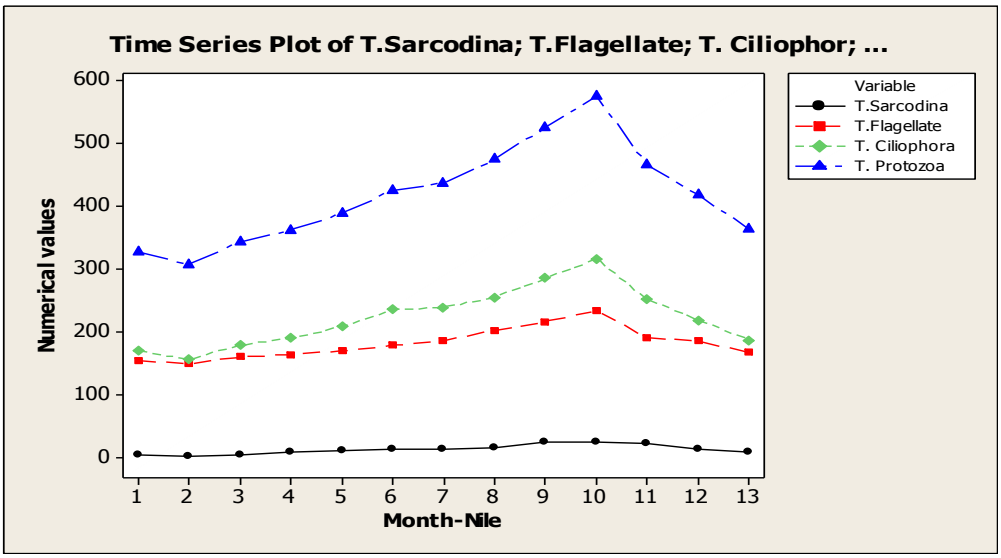
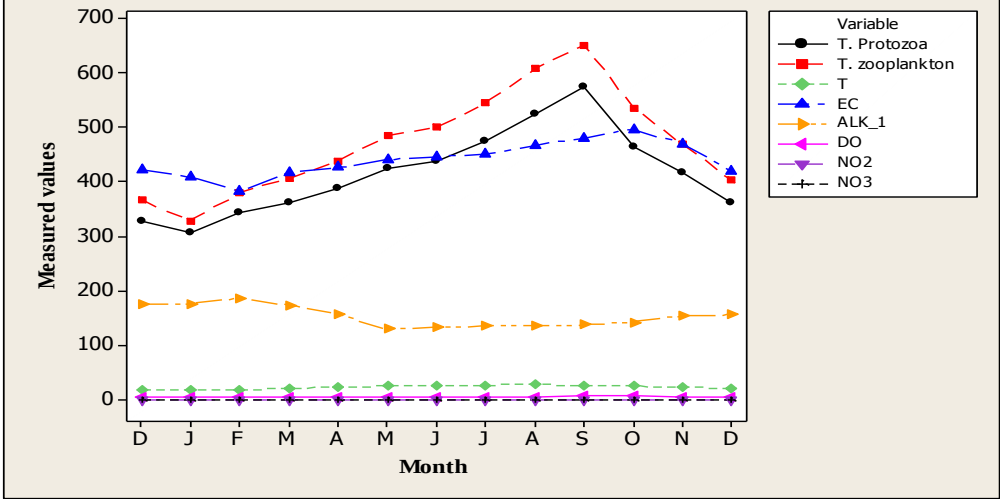


Fig. (3c) Time Series Plot of T. Protozoa; T. zooplankt and certain physico-chemical parameters at The Nile



The physico-chemical characteristics were used to investigate the effect of these parameters on zooplankton distribution and simultaneously to evaluate the performance efficiency of the present water treatment plant taking in our consideration that the influent water of El-Sharqe WTP is a mixture between both the Nile and El-Mansouria influents.

Comparing the estimated physico-chemical parameters of both influent water samples, it was clear that their values are more or less similar to each other with very few exceptions as shown in Figures 2c and 3c, while those of the effluent ones are mostly quite different (Figure 4). Having a glance to the data belonging to both influent and effluent samples of the present water treatment plant, it appears that water temperatures are more or less similar in all the samples, while electrical conductivity, total dissolved solids, dissolved oxygen, and nitrates are higher in the effluent samples as compared with those of the influent ones.

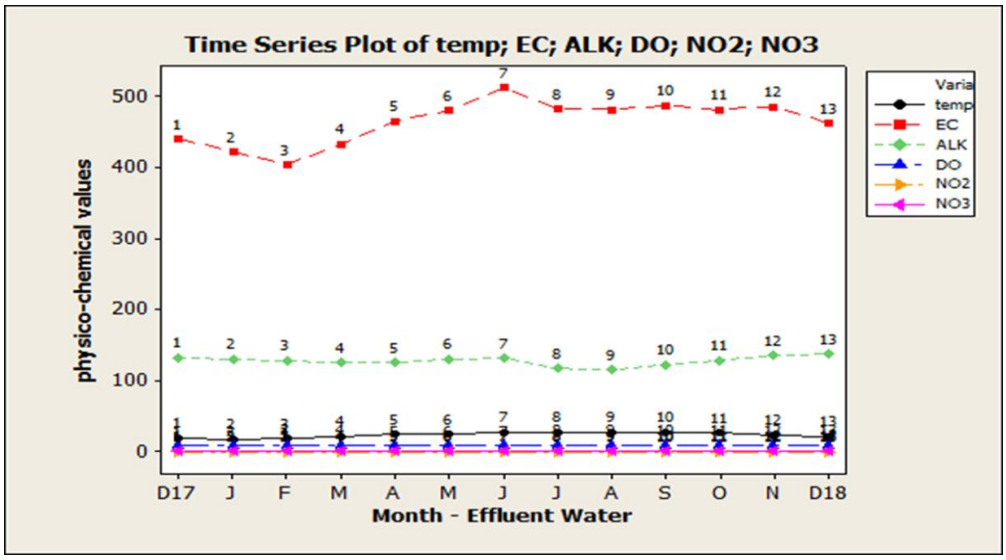


Fig. 4: Physico-chemical parameters of the effluent water at El-Sharqe WTP.

On the other hand, data of turbidity, alkalinity, consumed oxygen, ammonia and nitrites followed a different behaviour. This is parallel to the data obtained by **Galal *et al*. (2014)** and opposite to those of **Khalifa *et al*. (2016).** It was obvious that consumed oxygen, iron, ammonia and nitrite concentrations achieved null value in the effluent samples which might give a good indication for the efficiency performance of this water treatment plant. Regarding nitrate concentrations, its values followed a particular behaviour as compared with most of the other physico-chemical parameters where the nitrate levels achieved higher concentrations in the effluent samples than those of the influent ones due to the higher oxidation rate in the latter samples.

Zooplankton has highly positive correlation with some physico-chemical parameters as temperature, pH, electric conductivity, turbidity, dissolved oxygen, nitrite and nitrate, which is parallel with data obtained by **Galal *et al*. (2014 and 2020).** According to **Khalifa *et al*. (2016),** there was no correlation between zooplankton and temperature or pH. It was recorded that free-living protozoan organisms are represented by three main groups; ciliates, sarcodines and flagellates and the former exhibited the most abundant type from the quantitative point of view **(Finlay *and* Estban,1998).**

Emam (2006) mentioned that Protozoa is one of most important group among zooplankton which can tolerate high ratio of pollutants. Simultaneously, **Madoni and Zangrossi (2005)** confirmed that ciliates play an important role in the decomposition process by feeding on bacterial populations and consequently lowering pollutants. Applying the correlation analysis between all the biotic components proved that Pearson's correlation coefficient is highest among total zooplankton against total protozoa and its phyla ($r > 0.96$) as compared with those belonging to rotifers, worms and insect larvae (where r ranged from 0.8 to 0.26) which emphasize the predominance of the various protozoan phyla over the different zooplankton groups. On the other hand, correlation between zooplankton and the physicochemical parameters indicated that r-values are highest with temperature (0.92), p^H (0.80), electrical conductivity (0.83), turbidity (0.73), nitrites (0.82) and nitrates (0.84) as compared with others. Pearson's correlations among total protozoa and both physical and chemical factors showed nearly similar pattern to those of zooplankton, where their highest levels achieved with temperature (0.89), p^H(0.79), electrical conductivity (0.82), turbidity (0.72), dissolved oxygen (0.67), nitrites (0.80) and nitrates (0.83) as compared with the others.

Few simple significant regression relationships were obtained. The application of the multiple regression one indicates the presence of many significant relationships between biotic and abiotic data as could be seen in Table (1) in both Nile and El-Mansouria influents, which proved the presence of a chemostat situation in water passing to El-Sharqe WTP that may affect significantly the treatment process.

It was obvious that all biotic components are highly significant with water temperature, electrical conductivity and alkalinity (Alk.) except those of insect larvae.

Simultaneously, the previously biotic parameters showed high significant ($0.002 > P < 0.001$) relationships with dissolved oxygen (DO), nitrites (NO_2) and nitrates (NO_3).

Table 1: Summary of the significant relationships between certain biotic and abiotic parameters at the influent water of El-Sharqe WTP at El- Mansoura province using the multiple regression analysis.

Parameters	**Df**	**F**	**P**
Nile influent			
total Zooplankton Vs Temp, EC, Alk	3,9	24.9	<0.001
total Protozoa Vs Temp, EC, Alk	3,9	18.8	<0.001
Rotifers Vs Temp, EC, Alk	3,9	16.9	<0.001
worms Vs Temp, EC, Alk	3,9	31.4	<0.001
Ciliates Vs Temp, EC, Alk	3,9	19.6	<0.001
Flagellates Vs Temp, EC, Alk	3,9	12.5	0.001
Sarcodines Vs Temp, EC, Alk	3,9	33.6	<0.001
Mansouria influent			
total Zooplankton Vs Temp, EC, Alk	3,9	14.23	0.001
total Protozoa Vs Temp, EC, Alk	3,9	12.7	0.001
Rotifers Vs Temp, EC, Alk	3,9	14.18	0.001
worms Vs Temp, EC, Alk	3,9	10.73	0.002
Ciliates Vs Temp, EC, Alk	3,9	8.97	0.005
Flagellates Vs Temp, EC, Alk	3,9	26.64	<0.001
Sarcodines Vs Temp, EC, Alk	3,9	13.84	0.001

Finally, it could be concluded that the current investigation, using the direct treatment process is in a concomitant agreement with those of **Galal *et al*. (2013, 2014, 2017).** While those of both potable and waste-water treatment processes according to

Galal (1989) and **Galal *et al*. (2018 and 2020)** proved better performance efficiency which might be referred mainly to the application of the biological treatment processes.

REFERENCES

Abdo, M. H. (2004). Environmental studies on the River Nile at Damietta branch region, Egypt. J. Egypt. Acad. Soc. Environ. Develop., (D- Environmental Studies), 5

Ali, E.M.; Shabaan, S.A.; Soliman, A.I. and El-Shenawy, A.S. (2014). Characterization of Chemical Water Quality in the Nile River, Egypt. International Journal of Pure & Applied Bioscience. 2 (3): 35-53.

APHA (2017). American Public Health Association. Standard methods for the examination of water and wastewater. 23th ed. American Water Works Association and the Water. Environment Federation.

Emam, W. (2006). Preliminary study on the impact of water pollution in El-Rahawy drain dumping in Rosetta Nile branch on zooplankton and benthic invertebrates. M. Sc. Thesis, Zoo. Dep. Fac. of Sci. Ain Shams Uni.

Finlay, B. J and **Esteban, G. F.** (1998). Freshwater protozoa: biodiversity and ecological function. Biodiversity and Conservation (7): 1163- 1186.

Fishar, M. R.; Mahmoud, N. H.; El- Feqy, F. A., and Gaber, K. M. G. (2019). Community composition of zooplankton in El-Rayah El-Behery, Egypt. Egyptian Journal of Aquatic Biology & Fisheries. 23(1): 135 – 150. www.ejabf. journals. ekb. eg

Galal, M. (1989). Ecological studies on the ciliate and bacterial populations of slow sand filters. Ph. D. Thesis, Univ. of London.

Galal, M.; Khallaf, E. A.; Alnnenae, A. and Yahia, A. (2013). A comparison of certain ecological aspects at surface and ground water treatment works in El-Menofeyia province, Egypt. J. Egypt. Acad. Soc. Environ. Develop., 14 (1): 145-154.

Galal, M.; Khallaf, E. A.; Alnnenae, A. and Mousa, A. (2017). Comparison between different Water- Treatment Works in El-Menofeyia Province, Egypt. J. Egypt. Acad. Soc. Environ. Develop., 18 (1): 171-181.

Galal, M.; Khallaf, E; El-Sbbagh, S. and Nabet, N. (2014). Population analyses of microfauna at a Wter Treatment Plant at Shebeen AlKoom, Minufeya, Egypt. Egypt. J. Aquat. Biol. & Fish., 18(1): 127-138.

Galal, M.; Khallaf, S.; A, Mohammad M. N. Authman and Awaad El-Sebaae (2020). Ecological studies on some planktonic organisms at Mahallet Ziad Waste – water treatment plant in El Gharbia Province, Egypt. J. Egypt. Acad. Soc. Environ. Develop., 21 (1):1-10.

Galal, M.; Khallaf, E. A.; Mohamed, A.H. and Nabet, N. (2018). Comparative study on two different Waste-water treatment plants in El-Menofeyia Province, Egypt. J. Egypt. Acad. Soc.Environ. Develop., 19 (1): 19-31.

Karyabwite, D.R. (2000). Water sharing in the Nile River valley. Project GNV011: Using GIS/Remote sensing for the sustainable use of natural resources. *UNEP/ DEWA/ GRID*, Geneva.

Khalifa, N. S. and Bendary, R. E. (2016). Composition and Biodiversity of zooplankton and Macrobenthic populations in El-Rayah El-Menoufy, Egypt. Inter. International J. Appl. Envir. Sci., 11(2):683-700. http://www.ripublication.com

Logsdon, G.; Hess, A. and Horsley, M. (1999). Guide to selection of water treatment processes, in Water Quality and Treatment. 5th ed., Letterman, R.D., Ed., McGraw-Hill, New York.

Madoni, P. and Zangrossi, S. (2005). Ciliated protozoa and saprobical evaluation of water quality in the Taro River (northern Italy). Ital. J. Zool., 72: 21-25.

Mola, H. R.A. and Ahmed, N. A. M. (2015). Zooplankton Community Structure and Diversity Relative to Environmental Variables in the River Nile from Helwan to El-Qanater El-Khayria, Egypt. International Journal of Environment., 4(2):140-150.

Nadeen, S. M.S. and Saeed, R. (2014). Determination of Water Quality Parameters of Water Supply in Different Areas of Karachi City. Eueopean Academic Research., 1(12): 6030-6050.

Patterson, D. J. and Hedley, S. (1996). Free-living freshwater protozoa. A color guide. Wolfe Publishing Ltd., England.

Zeng, X. and Rasmussen, T. C. (2005). Multivariate Statistical Characterization of Water Quality in Lake Lanier, Georgia, USA. Journal of Environmental Quality, 34, 1980-1991. https://doi.org/10.2134/jeq2004.0337.

ARABIC SUMMARY

تأثير عوامل بيئية معينة على احدى محطات معالجة مياه الشرب بمحافظة الدقهلية.

منصور جلال – جمالات عثمان – خالد جبة – منى مأمون
قسم علم الحيوان – كلية العلوم – جامعة المنوفية – شبين الكوم – مصر

أجريت هذه الدراسة بمحطة الشرق لمعالجة مياه الشرب بمدينة المنصورة بمحافظة الدقهلية وذلك فى الفترة من ديسمبر ٢٠١٧ وحتى ديسمبر ٢٠١٨، وذلك لدراسة الهائمات الحيوانية وبعض العوامل الفيزيقية والكيميائية للمآخذ المختلفة لهذه المحطة ودورها فى التأثير على كفاءة معالجة مياه الشرب لهذه المحطة. ولقد أظهرت النتائج أن الأوليات هى الأكثر شيوعآ من غيرها سواء العجليات أو الديدان أو يرقات الحشرات وهى تتكون من ثلاث طوائف هى اللحميات والسوطيات والهدبيات مرتبة تصاعديآ من حيث الكثافة العددية الاانها تظهر تباينآ عدديآ بداخل كل مجموعة فى الشهور والفصول المختلفة. ولقد وجدت انواع مختلفة من تلك الكائنات تصل لذروتها العددية فى سبتمبر وتتناقص بدرجة كبيرة فى شهر يناير، كما أنها تتاثر معنويآ و بدرجات متفاوتة عمليآ وإحصائيآ ببعض العوامل الفيزيقية والكيميائية بما قد يؤثر ايجابآ على كفاءة عملية المعالجة.