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Ecological studies on some aquatic insects in the Damietta branch, River Nile of Egypt as bioindicators of pollution

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ABSTRACT

Aquatic insects are bioindicators of water quality be situated used in assessing the environmental integrity of streams. Their composition and density in Damietta Branch which one of two branches of the Nile River in Egypt was assessed and the influence of different pollutants in the water on their distribution during different seasons. Insects were sampled using standard entomological methods, while the physico-chemical parameters of the water were analyzed using APHA methods to estimate water quality parameters. Results of physico-chemical parameters revealed that almost all measurements are fall within the permissible limits. A total of 2,847 aquatic insects was sampled throughout the studied period among all sites, 19 families belonging to seven insect orders were identified. The richness of the aquatic insects was affected by the nature of the substrate, macrophytes, and anthropogenic activity in the water stream. The results show that low varieties of species were observed in sites (4, 5 and 6) than in sites (1, 2 and 3).

INTRODUCTION

Fresh water is one of the most essential assets builds up about 70% of the body weight of human beings and practically all living life forms and keeping up the equalization of nature. The River Nile had overwhelming impacts on the economy, culture, public health, social life and political aspects in Egypt as being utilized for different purposes like agriculture, industries, hydropower, fisheries and recreational uses (**Abdel-Hamid *et al.* 1993**). Due to the apparent necessity of freshwater in Egypt, the study of aquatic insects and its utilization for surveying wellbeing and water quality status in Egypt (e.g. network streams and River Nile) escalated but still very limited **(Badawy *et al*. 2013; El Husseiny *et al*. 2015 ; Haggag *et al*. 2018**).

A bio indicator is an organism or a communal of organisms that contains information for the quality of their environment (**Markert *et al*. 1999**). The most diverse of fresh water benthic macroinvertebrates is the aquatic insects which are a group of arthropods and spend all or part of their life cycle within water (**Popoola and Otalekor,**

2011). Therefore, aquatic insects are very good bioindicators of water quality since they have various environmental instabilities tolerance levels (**Arimoro and Ikomi, 2007**).

Attentively, the significance of aquatic insects in indicating the ecological integrity of running fresh water has been ignored in the past, mainly when compared to the traditionally popular environmental indicators, such as fish and birds (**Bauernfeind and Moog, 2000; Palmer *et al.* 2000**). Latterly, aquatic insects were been used as they are adapted to specific environmental conditions. If these conditions altered, some organisms disappeared (i.e. intolerant) and have been replaced by others (i.e. tolerant). Therefore, variation in the composition of aquatic insects' assemblages in the fresh water ecosystem can indicate possible pollution (**Scheibler, 1996; Bream *et al*. 2017**). Moreover, Aquatic insects were informed as efficient biomonitors to water contaminants by several authors such as **Harrahy and Clements (1997); Groenendijk *et al.* (1998).** Additionally**, Allan (1975)** stated that, diversity indices are planned to evaluate the features of population such as richness, evenness and total number of existing individuals. Meanwhile, **Hellawell (1992)** reported that diversity indices can also be used to measure environmental stress and consequently indicated the degree of pollution and so water quality, whether it was clean conditions, moderate pollution or severe pollution. Thus, any changes in one of these three features will affect the whole population and consequently the diversity indices (**Mandaville, 2002**).While, **Tokeshi and Townsen (1987)** predicted that aquatic habitats with high frequency of disturbance or low availability of refuges will have low species diversity**.**

Physical and chemical techniques used to measure the physico-chemical characteristics of the fresh water which are the most important principles in the nature's identification, quality and status of water for any aquatic ecosystem (**Mohamed and Gad, 2005**). The variations in Physico-chemical characteristics lead to qualitative and quantitative alterations in the planktonic organisms (**Gao and Song, 2005**).

Physico-chemical parameters and aquatic insect indicators may work together in assessing the quality of water. Variations in the physical - chemical properties of water (e.g., Temperature, Dissolved oxygen and metal concentrations) influence the distribution patterns of aquatic insects in the water, since some of them are highly sensitive to pollution while others are tolerant or tolerant to pollution and environmental disturbances **(Bauernfeind and Moog, 2000).**

Published works on the use of aquatic insects for assessing health and water quality status of streams revealed that studied in Africa is not extensive **(Arimoro and Ikomi, 2007)**. Hence, we piloted the present study to depict the water quality of the selected Egyptian streams based on physical–chemical parameters and afford baseline assessment of the seasonal composition, abundance and dominance of aquatic insect communities in certain Egyptian streams.

MATERIALS AND METHODS

Description of the studied area:

The existing work was carried out in and around Mansoura city in Damietta branch (120 Km north of Cairo) for a period of one year from sprin 2018 to winter 2019) (Figs. 1 and 2). Damietta branch in Mansoura is the important source for both drinking and fishing as well as the principle stream for irrigation to many crops. Six stations were visited twice a month during the day (7.00 a.m. - 11.00 p.m.). The first, second and third stations are located 1, 3, 5 km group (A) before Mansoura City on the River Nile, respectively. However, the fourth, fifth and sixth stations group (B) were located 2 and 5 km north on the River Nile. On the other hand, there are some different plants on all stations (the vegetated area inside and around the stations) and it considered the urban zones.

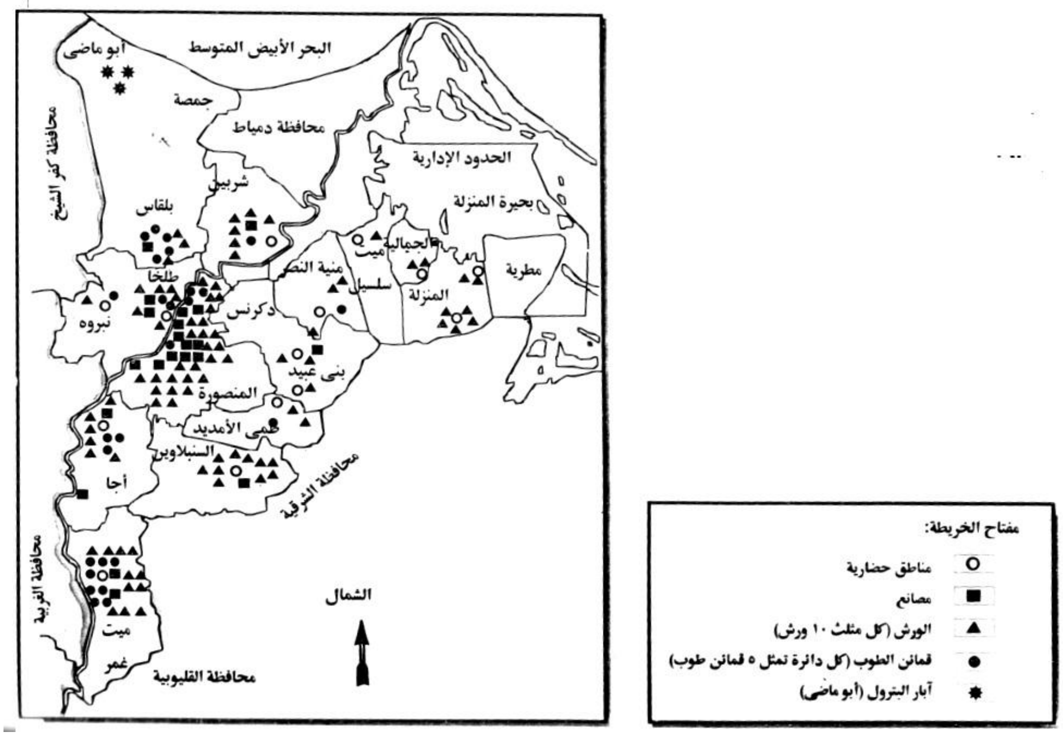


Fig. 1. A map of Mansoura city showing the distribution of factories.

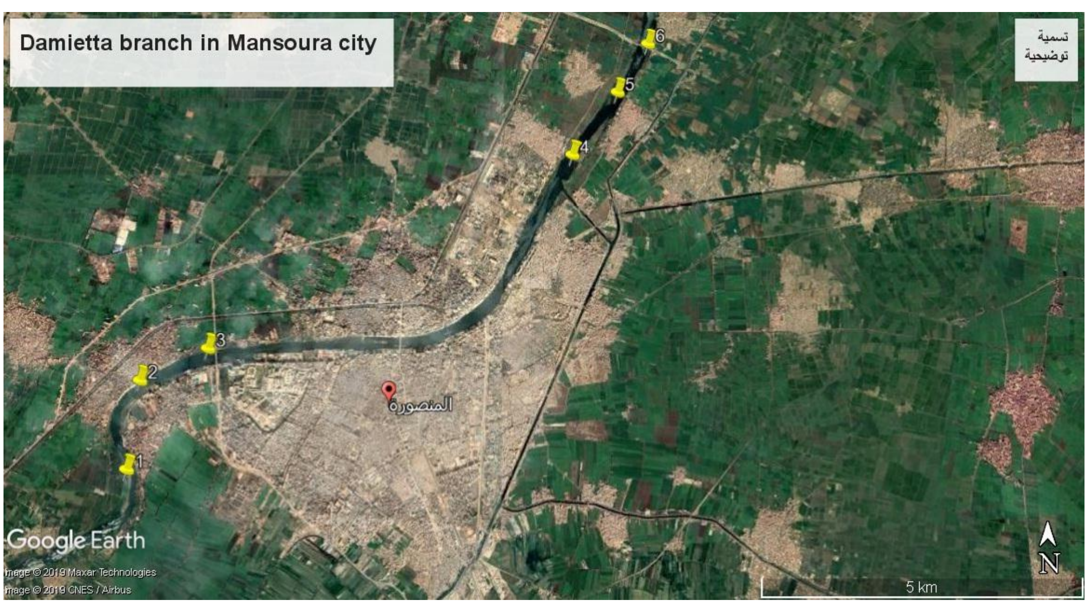


Fig. 2. A map of the study area in Mansoura city.

WATER SAMPLING AND ANALYSIS:

A- Water sampling and physicochemical measurements:

We collected water samples from a depth not less than 30 cm using a Van Dorn water sampler with a capacity of 1.2 litters. After collection, we kept water samples in cleaned stoppered plastic bottles for further examination. We collected the water sample during the period from spring 2018 to winter 2019, from the one branches in 200 ml labeled plastic containers (bottle), washed with nitric acid to remove any contaminates to preserve the samples until analysis. The samples were immediately analyzed for the physicochemical parameters of water as temperatures (Temp) using a mercury thermometer of the range (0–100°C) and pH by Hanna HI98150. However, other parameters of the samples were analyzed using standard methods at Water Central Station in Aga. The turbidity (Tur) , Electrical conductivity (E. C) (μS/cm), Dissolved Oxygen (D.O) and Biological Oxygen Demand (B.O.D) (mg/L). The measured parameters were then compared with the standard according to WHO (2004).

B- Aquatic insect's collection and identification:

Sampling techniques of aquatic insects was due to **Dowing and Rigler, 1984; Boonsoong *et al.* 2008** protocols as follows:

1- Aquatic insects were hand-picked throughout and collected using aquatic dip net of 45μmmesh and sweeping net with 45 μm mesh dragged along the bank over the vegetation, and then the net is properly checked for insects clinging on mesh.
2- Kick/sweep method is also used, with standard three- minutes in their collection (**Armitage, 1978**), where vegetation disturbed, water splashed and the substrate, rocks, floating plants and logs were disturbed by kicking with feet several times to flush insects out of their cervices, and turning over rocks and logs then dragged the aquatic net and check its mesh properly for the insects.
3- Large stones found in the sampling area were hand-lifted and gently rubbed to collect clinging insects then carried into the net.
4- Immediately collected insects were sorted by naked eyes into orders and placed in plastic labeled vials with 70% ethyl alcohol, then taken to department of entomology and taxonomy laboratory for identification to family level using taxonomic keys (**Badawy *et al*. 2013**). Counted and then preserved in mixture of absolute ethyl alcohol and 5% glycerin in properly labeled bottles or vials for small specimens.

A) Biodiversity measurement:

a) Margalef's index was used as a simple measure of family richness, when greater than 3 indicate clean conditions, less than 1 indicate severe pollution and intermediate value indicate moderate pollution (**Margalef, 1958; Lenat, 1984**)

b) **Measurement of evenness**: For calculating the evenness of families, the Pielou’s Evenness Index (e) was used (**Pielou, 1966**).

c) Simpson’s Diversity Index (D):

Diversity within the benthic macro invertebrate community was described using the Simpson’s diversity index (“D”), since this is nearly the most tractable and statistically useful calculation and is calculated using the following equation (**Lande, 1996**).

d) Shannon – Wiener diversity index (1949):

The Shannon- Wiener diversity index (H′) values less than 1 in all seasons indicating a polluted nature of stream water (**Türkmen and Kazanci, 2010**).

5- Statistical analysis

So as to give a measurable centrality to the outcomes found through the different parameters examined, information preparing is finished utilizing ANOVA, which we used to examination fluctuation at a certainty interim of 95%.

RESULTS

1. Physico-chemical characteristics of water

The physical and chemical properties of water measured at the four seasons in Mansoura city are presented in table 1 during the study period. The temperature of water recorded its greatest value during summer (30^0C), while the smallest was during winter (17.3^0C). In addition, the results clarified narrow variations in pH value between the four seasons, ranged between 7.3 - 7.9 (in alkaline side) respectively. The dissolved oxygen (D.O) ranged between 3.2 - 4.5 mg/L during summer and winter seasons, respectively and therefore, the highest value of (B.O.D) (3.1 mg/L) was recorded in summer and the lowest one (1.8 mg/L) occurred in winter. However, the results indicated that electrical conductivity and turbidity showed their higher values during winter and its lower one during summer.

Additionally, as clarified by results of LSD Test (table 1), there was slight significant difference between all four seasons for dissolved oxygen while it shows no significant difference between spring and summer. Meanwhile, the temperature and turbidity differed significantly only during summer and winter. However, there was significant difference for Electrical conductivity only during winter Moreover, B.O.D showed no significant differences between seasons. On the other hand, there is significant difference for pH among the four seasons except of spring.

Insect community composition and diversity:

As shown in table 2, a total of 2,847 aquatic insects were sampled throughout the studied period among different sites, 19 families belonging to seven insect orders which identified. Coleoptera and Hemiptera recorded the highest number of families (four) and others ranged between (two - three) families.

From sites (1, 2 and 3), hemipterous and coleopterous individual abundance are the higher (Fig.3A), 47.0% & 20.2%, respectively. While in sites (4, 5 and 6), hemipterous, odonatous and coleopterous individual abundance are the higher 40.9%, 28.8 % & 26.0% (Fig.3B), respectively. Meanwhile, individuals of Trichoptera recorded the least order, less than one percentage in different sites.

Table1. Seasonal variation of physicochemical parameters for water samples collected from Damietta branch in Mansoura city throughout the studied period.

Seasons / Parameters	Group A				Group B			
	Spring	summer	Autumn	Winter	Spring	summer	Autumn	Winter
Temp. (°C)	24.6 ± 0.6 [a]	29.5 ± 1.0 [b]	24.0 ± 0.6 [c]	17.3 ± 0.7 [d]	25.2 ± 0.6 [a]	30.0 ± 1.0 [b]	23.9 ± 0.6 [c]	19.7 ± 0.7 [d]
Turb. NTU	15.9 ± 0.9 [a]	9.0 ± 1.0 [b]	12.7 ± 1.5 [c]	16.7 ± 2.5 [a]	15.9 ± 0.9 [a]	11.0 ± 1.0 [b]	12.7 ± 1.4 [c]	17.7 ± 2.4 [a]
pH	7.3 ± 0.2 [a]	7.5 ± 0.1 [a, b]	7.7 ± 0.3 [a, c]	7.9 ± 0.1 [b, c]	7.5 ± 0.2 [a]	7.6 ± 0.1 [a, b]	7.7 ± 0.3 [a, c]	7.9 ± 0.1 [b, c]
EC.µS/cm	390.3 ±12.5 [a]	370.7 ± 8.3 [a]	401.1 ±57.0 [a]	510.0 ± 10.7 [b]	383.3 ± 12.6 [a]	371.1 ± 9.3 [a]	400.3 ±57.0 [a]	510.7 ± 11.7 [b]
D.O mg/L	3.4 ± 0.3 [a]	3.2 ± 0.2 [a]	4.0 ± 0.2 [b]	4.5 ± 0.4 [b]	3.6 ± 0.4 [a]	3.2 ± 0.2 [a]	4.0 ± 0.2 [b]	4.4 ± 0.4 [b]
B.O.D mg/L	1.9 ± 0.1 [a]	3.1 ± 0.6 [a]	2.8 ± 1.0 [a]	1.9 ± 0.3 [a]	2.0 ± 0.1 [a]	3.0 ± 0.6 [a]	2.8 ± 1.0 [a]	1.8 ± 0.3 [n]

Group A: site (1, 2, 3); Group B: (4, 5, 6); Temp. : Temperature; Turb. : Turbidity; pH, Hydrogen ion concentration E.C., electric conductivity; D.O: Dissolved Oxygen; B.O.D: Biological Oxygen Demand; Mean ± SD followed by letter (a): Not significantly different (P>0.05), (b): Significantly different (P<0.05), (c): Highly significantly different (P<0.01), (d): Very highly significantly different (P<0.001).

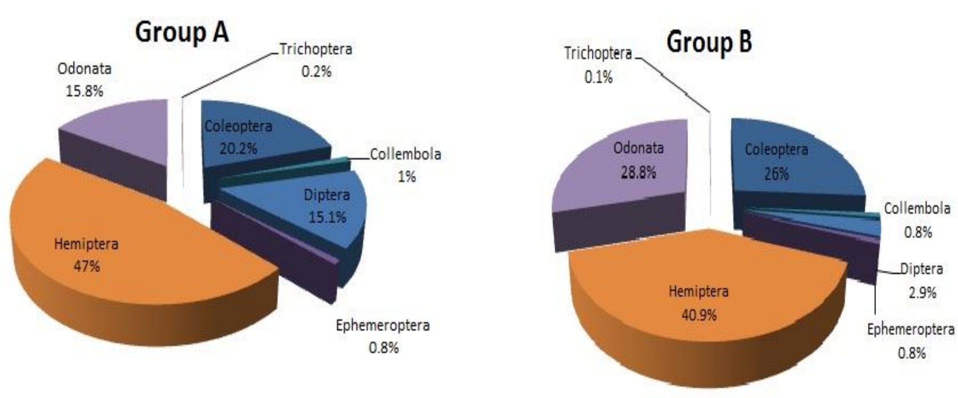
As shown in Table 2, freshwater community from sites (4, 5, and 6) characterized with increasing the abundance of Blestomatidae (31.6%), Libellulidae (18.3%), Dytiscidae (15.4%) and Gyrinidae (10.5%) and Corixidae (9.0%). Meanwhile, in sites (1, 2 and 3) hemipterous families: Corixidae and Blestomatidae (25.1% & 13.5%), coleopterous families: Dytiscidae (10.4%) & Gyrinidae (9.4%), and Libellulidae (7.5%) ranked the most abundant families.

Moreover, from sites (1, 2 and 3), the most abundant family in summer and spring was Corixidae (fig 4A) represented by 220 and 201 individuals, respectively. While chironomids dominates in winter (150 individuals), Blestomatidae (70 individuals) and Dytiscidae (61 individuals) ranked the most abundant families in autumn. However, in sites (4, 5 and 6) the most abundant family in summer, autumn and winter was Blestomatidae by 94, 98 and 104 individuals, respectively (fig 4B). In addition, family Libellulidae was high in winter (90 individuals). In spring, both Coenagrionidae and Blestomatidae ranked the most abundant families 52 and 53 individuals, respectively. Furthermore, in sites (1, 2 and 3) summer recorded the highest season, where the seasonal abundance reached 37.5%, while the least season was during autumn (15.7%). On the other hand, in sites (4, 5 and 6) the highest peak of abundance was attained during summer (30.8%), while the least level of abundance was during spring (20.8%).

Table 2. Seasonal variation of aquatic insect families during the study period from Damietta branch in Mansoura city.

Order	Family	Group (A)					Group (B)				
		Spring	Summer	Autumn	Winter	Total%	Spring	Summer	Autumn	Winter	Total%
Coleoptera	Dytiscidae	30	50	61	40	10.4	32	50	55	33	15.4
	Gyrinidae	50	71	40	3	9.4	28	41	36	11	10.5
	Hydrophilidae	0	4	1	1	0.3	0	0	0	0	0.0
	Hydroscaphidae	1	1	0	0	0.1	0	1	0	0	0.1
Collembola	Entomobryidae	2	1	4	9	0.9	0	0	5	3	0.7
	Poduridae	0	0	1	1	0.1	0	0	1	0	0.1
Diptera	Chironomidae	0	6	40	150	11.2	1	2	1	1	0.5
	Culicidae	10	40	11	6	3.8	3	11	8	4	2.4
	Psychodidae	1	1	0	0	0.1	0	0	0	0	0.0
Ephemeroptera	Baetidae	0	7	3	1	0.6	0	0	5	0	0.5
	Caenidae	1	1	2	0	0.2	0	1	2	0	0.3
Hemiptera	Blestomatidae	40	61	70	64	13.5	53	94	98	104	31.6
	Corixidae	201	220	5	11	25.1	11	77	2	9	9.0
	Notonectidae	22	93	0	0	6.6	0	0	0	0	0.0
	Veliidae	3	21	0	2	1.8	0	0	2	1	0.3
Odonata	Aeshnidae	9	5	2	2	1.0	10	9	4	2	2.3
	Coenagrionidae	60	48	15	5	7.3	52	20	18	0	8.2
	Libellulidae	36	27	17	50	7.5	40	34	38	90	18.3
Trichoptera	Hydroptilidae	0	1	2	0	0.2	0	0	1	0	0.1
Taxa abundance		**466**	**658**	**274**	**345**	**1743**	**230**	**340**	**276**	**258**	**1104**

Group A, Group B: see footnote table 1.



A **B**

Fig. 3. A: sites (1, 2 and 3), **B: sites (4, 5 and 6)** families' richness of aquatic insect orders during the study period from Damietta branch in Mansoura city, Egypt.

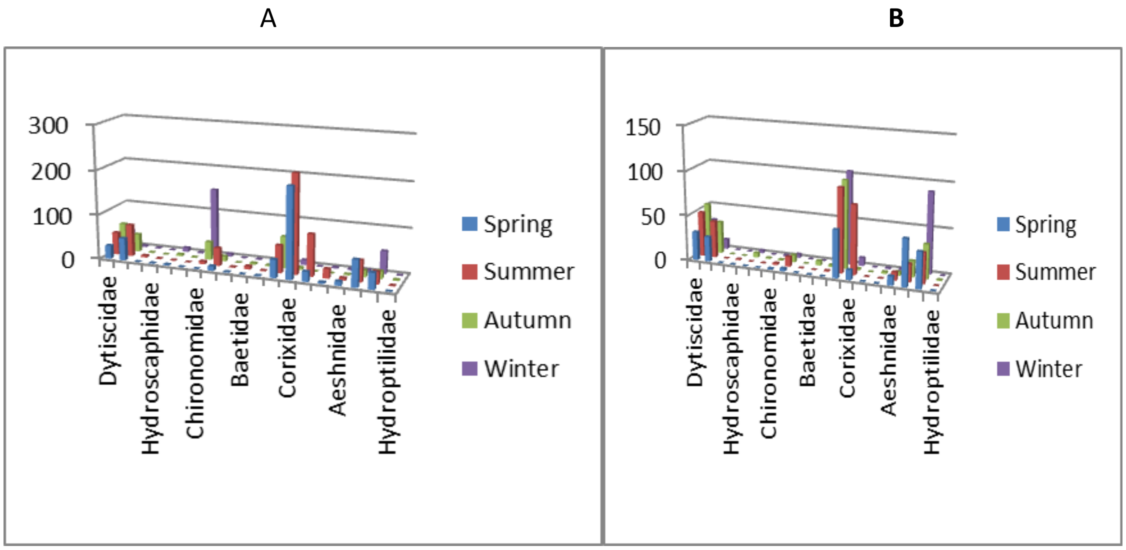


Fig. 4. A: sites (1, 2 and 3), B: sites (4, 5 and 6) seasonal variation of aquatic insect families during the study period from Damietta branch in Mansoura city, Egypt.

Overall pattern of diversity:

As shown in table 3, a total of 2,847 aquatic insects was sampled throughout the studied period among different sites, 19 families belonging to seven insect orders were identified. In sites (1, 2 and 3), 1743 different individuals were sampled, which were identified into 19 families, Taxa- richness (table 3). While in sites (4, 5 and 6, taxa community was 1104 individuals and 16 different families (table 4).

Margalef index, which indicates the richness index of families, recorded the maximum value (2.41) in sites (1, 2 and 3) whereas, in sites (4, 5 and 6) recorded (2.14). In addition, the higher value of diversity indices (Shannon diversity index (2.26), Simpson index (0.689) and taxa evenness (0.505) were recorded in sites (1, 2 and 3) community.

In sites (1, 2 and 3), summer represented the highest season in taxa richness and individuals' abundance, 18 families, 658 individuals, Margalef index, 2.62, Shannon diversity index, 2.11 and Simpson index, 0.830. On the contrary, autumn was the minimal one individuals' abundance (274 individuals) but winter was the minimal one in taxa richness, taxa evenness and Shannon diversity, 14 families, 0.3883 and 1.69, respectively.

Table 3. Overall diversity matrices that represented seasonal diversity indices of aquatic insect taxa throughout the study period from Damietta branch in sites (1,2 &3).

Diversity indices	Spatial variation in sites (1,2 &3)				Overall diversity indices in Dakahlia
	Spring	Summer	Autumn	Winter	
Individuals (mean± SE)	466	658	274	345	1743
Taxa_S	14	18	15	14	19
Shannon_H	1.85	2.11	2.04	1.69	2.263
Simpson_1-D	0.7652	0.8302	0.8332	0.7397	0.6894
Margalef (Richness index for families)	2.12	2.62	2.49	2.23	2.412
Evenness_e^H/S	0.4541	0.4583	0.5119	0.3883	0.5059

Table 4. Overall diversity matrices that represented seasonal diversity indices of aquatic insect taxa throughout the study period from Damietta branch in sites (4,5 &6).

Diversity indices	Spatial variation in sites (4,5 &6)				Overall diversity indices in Fayoum
	Spring	Summer	Autumn	Winter	
Individuals (mean± SE)	230	340	276	258	1104
Taxa_S	9	11	15	10	16
Shannon_H	1.871	1.897	1.883	1.445	1.93
Simpson_1-D	0.827	0.8208	0.7921	0.696	0.816
Margalef (Richness index for families)	1.471	1.716	2.491	1.621	2.141
Evenness_e^H/S	0.7219	0.6062	0.4384	0.4243	0.4306

DISCUSSION

1- Environmental factors

1.1. Physico-chemical Water Properties:

As accordance with **Parinet *et al*. (2005)**, analytical parameter in the current study was chosen for describing the water quality which is an important approach process. Generally, almost all parameters were within the permissible limits (**WHO, 2004**). Temperature directly affected aquatic organisms and plant life as well as physico-chemical characteristic of water (**Turker *et al*. 2003**).

In the current study, the maximum value of water temperature was recorded during summer, while the minimum one was during winter at different sites. **Mohamed and Gad (2005)** related the similar results to meteorological conditions and air temperature as dependent factors in describing water temperature. Increasing the value of turbidity during winter and decreasing during summer can be explained in relation to the mining activities of the stream areas, and so decreased amount of water during winter than summer. Seasonal variation of pH value was detected in the present study of different sites lies in slightly alkaline side and according to **FAO (1986) and WHO (2004)**, this range of pH value is normal and acceptable in reference to their permissible range for irrigation water (6.5-8.4). The pH values of the Nile water were always shifted to the alkaline side; however acidic discharged wastes were occasionally recorded. Also, the change in pH is mainly due to photosynthetic activities of phytoplankton and aquatic plants and respiration of animals and plants as well as variations in temperature (**Kwiatkowski and Roff, 1976**).

The current results clarified that the estimated value of conductivity was high at all sites, more 300 µS/cm, but within the permissible limits. Moreover, the electrical conductivity increased during winter and decreased during summer in all sites. This increasing coincided with that decreasing the level of water during winter lead to an elevated concentration of dissolved solid or waste water released from domestic origin into streams (**Arimoro and Muller, 2009**). In this study results revealed that D. O ranged within the normal range according **WHO (2004)**, except in hotter seasons. In summer, the D. O was somewhat low in study area. There is evidence that, oxygen concentrations in the aquatic habitats showed a seasonal fluctuation being higher during winter than during summer (**Abdel-Hamid *et al*. 1993; Breitburg, 2002**). This evidence agreed with our results that mainly attributed to the elevation of water temperature in summer, and spring leading to the decrease of the solubility of oxygen gas (**Ueda *et al*. 2000**).

In the present study, the maximum value of Biological oxygen demand (B.O. D) was during summer but the minimum one was during winter on contradictory to the seasonal variation of D.O. As accordance with the conclusion of **Idroos and Manage (2012)** who detected the negative correlation between the levels of B.O. D and D.O. Also, in this study of different sites were in agreement with the reported range by **El-**

Sheekh (2016) along the River Nile from Aswan to Cairo. Moreover, **Alinnor (2005)** attributed the increasing of B.O. D concentrations to the strong effect of agricultural runoff, industrial wastes, decomposition of organic matter and discharging untreated domestic sewage that is analogous to the case in Damietta branch.

2.1. Insect community composition and classification:

The absence or scarcity of Ephemeroptera, Trichoptera and Plecoptera, (EPT) which considered as a good indicator of unpolluted streams, in this studied streams indicated a water little poor quality according to **Paparisto *et al*. 2009**, who regarded the EPT entomo-fauna as the most diagnostic of water quality. Also, **Caspers (1961)** observed that nymphs and larvae of Ephemeroptera, Plecoptera and Trichoptera were considered integral item of the undisturbed streams. According to **Popoola and Otalekor (2011)**, such variations in diversity of aquatic insects may be attributed to the degree of anthropogenic interference in the ecological balance of fresh water bodies. In pooled data it was as follows:

In spring, order Hemiptera and Odonata were the most abundant in all sites. The dominance of hemipteran insects in indicated polluted water as **Majumder *et al*. (2013)** reported the absence of hemipteran insects in a lake with less pollution. Moreover, **El Husseiny *et al*. (2015)** founded that the highest percentage of order Hemiptera and Odonata individuals in the fish aqua culture correlated to the highest pollution. However, the dominance of order Odonata may be due to dominance of macrophytes as their nymphs are usually associated with macrophyte where females lay their eggs (**Arimoro, *et al.* 2007**). Especially family Coenagrionidae that showed their maximum abundance in spring from different sites due to their fragile body that prefer slow flowing water bodies with detritus and stones as shelters.

In summer, order Hemiptera and Coleoptera were the most abundant in selected sites. The domination of these order indicated polluted water, coordinated with the results of **Popoola and Otalekor (2011); Takhelmayum *et al*. (2013)**, who reported that Coleoptera and Hemiptera were associated with polluted water in Loktak Lake in India. While, **Barman and Gupta (2015)** reported that the abundance or dominance of order Hemiptera especially Veliidae in the stream, could be due to their modified body structure, where they are known as ponds skaters, who stay on the surface of water, can walk on the surface of water and can utilize atmospheric variables without totally depending on water. While the presence of family Notonectidae in summer, especially in sites (1,2 &3) and its absence in other seasons may be due to runoff sewage where it predominant, in fresh water according to **Ahmed and El-Shenawy (2001)**. However, the abundance of Notonectidae (Anisops sp.) in sewage water could be due to the fact that they produce haemoglobin in large modified fat-body cells within their abdomen and this haemoglobin act as supplementary oxygen (**BASU *et al.* 2016**).

Moreover, some families collected from Damietta branch in Mansoura city as Aeshnidae, Libellulidae, Gyrinidae and Belostomatidae showed high abundance in spring and summer that may explained by the low dissolved oxygen that is may be related to some pollution (**Mykrä *et al*. 2007**). In addition, family Corixidae also showed high abundance in spring and summer that was contributed to the sheltered areas, and the increase of anthropogenic sources as their main food that agreed with the findings of **Nieser and Melo, 1999**, who reported that Corixidae inhabit sites with vegetation and in shallow places with low current.

In autumn, order Coleoptera (Dytiscidae) and Hemiptera (Belostomatidae) were the most abundant in all sites. **Lenat (1984)** reported that Coleoptera and Hemiptera replaced the sensitive Ephemeroptera, Trichoptera and Plecoptera taxa in streams receive agricultural runoff, so, it seems that Dytiscidae and Belostomatidae were tolerant to agriculture runoff and replaced the sensitive taxa in selected areas.

In winter, order Diptera and Hemiptera were the most abundant in sites (1, 2 &3). On the other hand, Hemiptera and Odonata were the most dominant order in sites (4, 5 &6). Order Diptera dominance for the first time was related to the abundance of Chironomidae which is an indicative of poor water quality from various anthropogenic activities and dominated in heavily organic polluted water bodies **(Ali *et al*. 2008; Yakub, 2008**).

Hence, *Chironomus* larvae have also been used as pollution indicators by the number of workers (**Curry, 1954**). Furthermore, the abundance of Chironomidae in this study may be due to the low level of fresh water in winter and therefore, increasing the concentration of pollutants. Correspondingly, **Doisy and Rabeni, 2001** reported that chironomid abundance is related to the amount of detritus, which in turn is negatively correlated with the flow velocity. Similarly, **Yule and Yong (2004)** stated that standing and slow-flowing streams and muddy or sandy areas, with high fine-sediment particles, are known to support higher diversity and abundance of Chironomidae.

3.1. Overall pattern of diversity in streams:

Diversity indices are planned to evaluate the features of the population such as richness, evenness and total number of existing individuals **(Allan, 1975)**. Thus, any changes in any of these three features will affect the whole population and consequently the diversity indices **(Mandaville, 2002)**. Moreover, according to **Hellawell (1992)** diversity indices can also be used to measure environmental stress and consequently indicated the degree of pollution and so water quality, whether it was clean conditions, moderate pollution or severe pollution.

a- Number of individuals and Taxa_S:

In our study, 1743different individuals were sampled, which were identified into 19 families in sites (1, 2&3). While in sites (4, 5&6), taxa community was 1104 individuals and 16 different families. Low varieties of species was observed in sites (4, 5&6) than in sites (1, 2&3), this may be due to organic impacted area which leads to low nutrient substance for feeding. This finding was consistent with **Ndaruga *et al.* (2004)** results, who observed that heavily organic impacted areas have low varieties of species.

b- Shannon- Wiener diversity index (H′) and Simpson index:

When the Shannon- Wiener diversity index (H′) values found to be less than 1 in all the seasons that indicating polluted nature of stream water **(Türkmen and Kazanci, 2010).** The higher values of Shannon diversity index (2.26) and Simpson index (0.68) calculated in sites (1, 2&3). Whereas, the minimum values of these diversity indices recorded during winter were Shannon (1.69and 1.44) and Simpson diversity index (0.73and 0.69) for two group areas (A & B), respectively. Low values of these indices, especially in sites (4, 5&6), may be due to little nutrients where input of nutrients to water body enriches primary productivity and so reflected by an increase in aquatic insects (**Arimoro and Ikomi, 2009)**. Also, low Shannon diversity index value indicates disturbed nature of water body **(Türkmen and Kazanci, 2010).**

c- Margalef's (Richness index for families):

Margalef's water quality index values greater than 3 indicate clean conditions, values less than 1 indicate severe pollution and intermediate value indicate moderate pollution (**Lenat, 1984**). In our present study, Margalef's water quality index values were generally less than 3, indicating that the water quality was moderate impacted.

Poor water quality in the two group areas may be due to which the impacted sites were characterized by the presence of banks with little or no vegetation in the margins, presence of household waste, huge amount of refuge, domestic animal dung, and dead animals left rotting in the stream, among other pollution sources. The present study results may investigate organic pollution of the streams which, in turn affected the integrality and quality of water resources. Similarly, as the case of the Patagonian North West streams observed by **Miserendino *et al*. (2011)**.

All of indices indicated that Varity of pollution this may be due to anthropogenic impacted area which lead to low nutrient substance for feeding. Therefore, there is a necessity to some attention with the fresh water which as the main supply of drinking water and other needed activity.

CONCLUSION

Due to the apparent necessity of freshwater in Egypt we can be used aquatic insects a bioindicator for assessing health and water quality. Generally, almost all physical and chemical parameters were within the permissible limits. Summer recorded the highest season in all sites, while autumn and winter resembled the least season. Low values of diversity indices in all sites, may be due to little nutrients where input of nutrients to water body enriches primary productivity that reflected by an increase in aquatic insects.

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Arabic summary

دراسات بيئية على بعض الحشرات المائية بفرع دمياط بنهر النيل كمؤشرات حيوية للتلوث.

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الحشرات المائية هي مؤشّرات حيوية لجودة المياه تستخدم لتقييم السلامة البيئية للتيارات. حث تم تقييم أحد فرعي نهر النيل في مصر (فرع دمياط) وتأثير الملوثات المختلفة في الماء على توزيعها خلال المواسم المختلفة. تم أخذ عينات من الحشرات باستخدام الطرق الحشرية القياسية ، في حين تم تحليل القياسات الفيزيائية والكيميائية للمياه باستخدام طرق APHA لتقدير جودة المياه. كشفت نتائج المعايير الفيزيائية والكيميائية أن جميع القياسات تقريبًا تقع ضمن الحدود المسموح بها. تم أخذ عينات من ٢٨٤٧ حشرة مائية طوال فترة الدراسة بين جميع المواقع ، وتم تحديد ١٩ عائلة تنتمي إلى سبع حشرات. تأثر ثراء الحشرات المائية نتيجة للنشاط البشري المنشأ في مجرى الماء. أظهرت النتائج أن أصنافًا قليلة من الأنواع لوحظت في المواقع (٤ و ٥ و ٦) عنها في المواقع (١ و ٢ و ٣) ، وقد يكون ذلك بسبب المنطقة المتأثرة بالنشاط البشري والتي تؤدي إلى انخفاض المواد الغذائية الازمة لتغذية الحشرات. لذلك ، هناك ضرورة لبعض الاهتمام بالمياه العذبة التي تعتبر المصدر الرئيسي لمياه الشرب وغيرها من الأنشطة اللازمة.