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Effect of some chemical parameters on the abundance degrees of some aquatic insects and invertebrates in El-Zomor and El-Mariotya canals, Giza (Egypt)

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Abstract

The effect of some chemical changes in water quality were studied during two years (October, 2001 - August, 2003) and recorded at six sampling sites situated at El-Zomor and El-Mariotya canals (branches from the River Nile). The aim of the present work is to study the effect of some chemical parameters on the abundance degrees of some aquatic insects and invertebrates in these two canals. Determination and estimation of the chemical parameters and abundance degrees are carried out in the field and laboratory of Department of Entomology, Faculty of Science, Cairo University. Data of chemical factors and abundance degrees of collected aquatic invertebrates were analyzed by using one-way analysis of variance (ANOVA). The data obtained showed that, there is a strong correlation coefficients ($P < 0.05$ & $r = 0.634$) and ($P < 0.10$ & $r = 0.506$) between electrical conductivity values and insects (Diptera and Odonata) that distributed in these two canals. The semi-logarithmic graphs showed that the water quality of samples is changed to some extent where the chloride ions is higher than bicarbonate and; sulphate, magnesium are higher than calcium and sodium during some reported months especially at El-Zomor canal.

Key words: Chemical parameters - Abundance degrees- Aquatic insect and invertebrates.

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1. Introduction

The biological approach for assessing streams and rivers is the use of benthic macroinvertebrates, especially aquatic insects, as indicators of pollution [1]. The presence or absence of certain families of aquatic insects can indicate whether a particular water body is healthy or polluted. Worldwide, due to over human explosions, most of the fresh water bodies are being subjected to increasing pollution loads. Consequently, changes the physic-chemical properties (temperature, dissolved oxygen, carbonates, alkalinity, phosphates, nitrates and metal concentrations) can adversely affect the diversity, distribution and composition of aquatic insects [2-4]. Human activities including runoff from agricultural land, sewage outfalls or commercial effluent evaluated in light of the potential impact on ecosystem processes and components. It was only recently that biological surveillance of rivers had established, in many countries, as an integral part of monitoring water quality. Whether used alone or in conjunction with other groups, benthic invertebrates had established as a most useful group in monitoring water quality in rivers. According to water salinity and other factors in the aquatic habitats of Egypt, the abundance of aquatic insect groups can coincide with many other vertebrates and invertebrates as well as aquatic and semi-aquatic plant species. However, this attention the knowledge is still poor about the taxonomy, biology and ecology of most of the Egyptian aquatic insects specially those of Giza Governorate. Therefore, the region bounded and passed by many water surfaces needs a lot of investigation.

Chemical factors play an important role in the determination of the nature of the aquatic habitats. Thus, the effect of chemical parameters on the abundance of aquatic insect groups can coincide with many other vertebrates and invertebrates.

2. Material and Methods

The study area lies between 30º 00′ and 31º 15′ latitudes, and 31º 00′ and 31º 15′ longitudes and it is situated in the Western region of Cairo, Giza Governorate (Egypt). Samples of Nile water collected from Rosetta branch (a branch of the River Nile, figure 1a) considered as a control. The water sample sites at El-Zomor and El-Mariotya canals represented in figure 1-b. The water samples analyzed in the laboratories of Faculty of Science, University of Cairo.

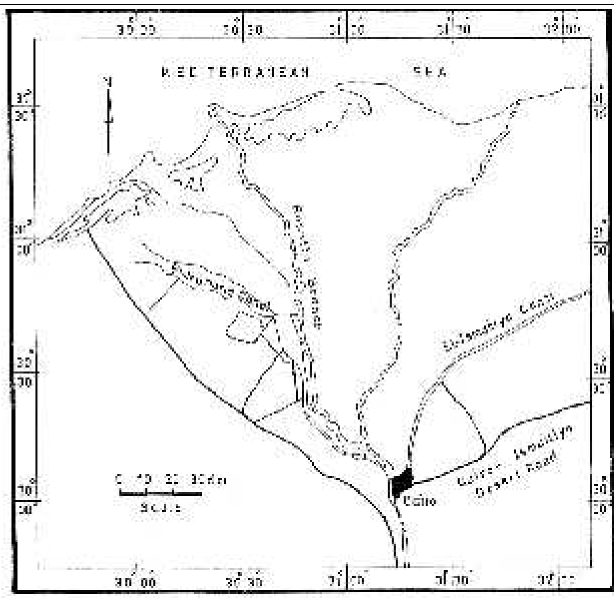

Figure (1a): Location of the studied water sample site (control)

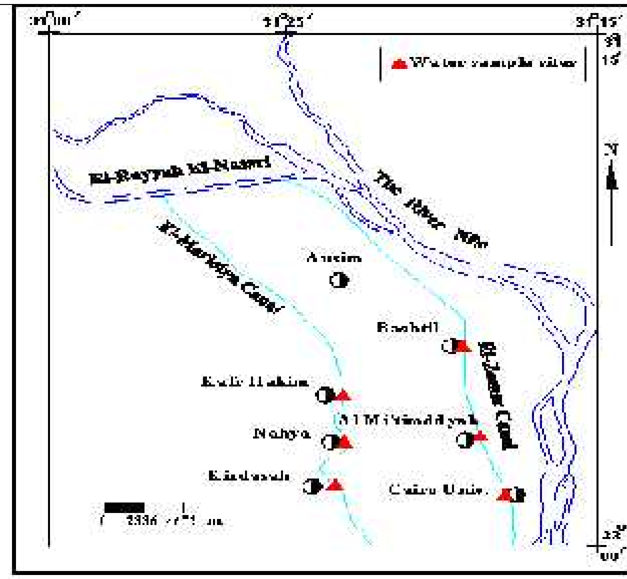

Figure (1b): Location of the studied water sampling sites at El-Zomor and El-Mariotya canals, Giza Governorate

According to W.H.O. (1997) , Sampling should be properly planned and ideally carried out with sufficient frequency to enable any temporal (seasonal) variations in the quality of the water to be detected. Samples should be collected, stored and dispatched in suitable sterilized bottles [5].

Chloride values (Cl^-) were determined in the laboratory by titration against standard silver nitrate solution using potassium chromate according to the methods suggested by W.H.O. (1975) [6]. Salinity values were determined in the laboratory according to Chebotarev (1955) [7]. The electrical conductivity (E.C.) expressed in micromhos (micro ohm^{-1}) per centimeter at 25 ºC and considered as a function of the total salinity of the invertebrate breeding water. Its value was determined in the field by using a portable electrical conductivity meter RS-232. Sulphate values (SO_4) determined gravimetrically by turbidity method using Spectrophotometer (20 D) apparatus according to the method of Chairman *et al.* (1964) [8].

Calcium (Ca^{2+}) values were determined by using Murexide indicator, while magnesium values (Mg^{2+}) were estimated by subtracting the calcium values after determined both (Ca^{2+} & Mg^{2+}) values by using Eriochrome black T indicator. Meanwhile, Sodium (Na^+) values and potassium (K^+) values were determined by using Flame photometer apparatus (Rainwater and Tatcher, 1960) [9]. Classification of water quality according to the chemical parameters investigated by using the semi-logarithmic graphs for water analysis proposed by Scholler (1962) [10].

The abundance degrees (A) for the aquatic invertebrates collected from El-Zomor and El-Mariotya canals during the whole sampling period were calculated according to Facylate, 1971 [11]. The data of chemical factors and abundance degrees of collected aquatic invertebrates calculated by using one-way analysis of variance (ANOVA) according to computer program, copyright (C) 1997-2011, Intel Corporation. The data drawn using Microsoft Excel 2010 [12].

3. Results

Chloride Content

Chloride values exhibit some variations throughout the period of investigation at all sampling sites (figure 2a-b). Statistical analysis shows that there is a significant ($P < 0.01$) difference between sampling site IZ and all sampling sites at El-Zomor and El-Mariotya canals.

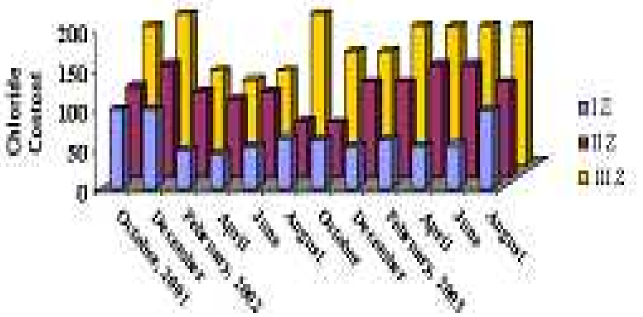

Figure (2a): Chloride content of the invertebrate breeding sampling sites at El-Zomor canal, Giza Governorate (October, 2001-August, 2003)

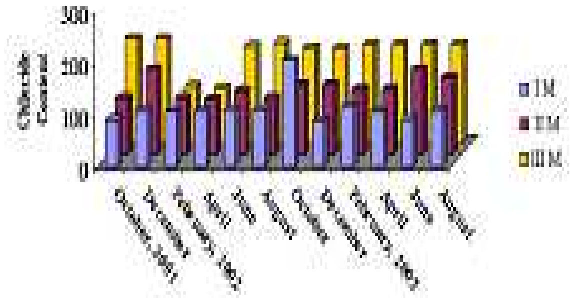

Figure (2b): Chloride content of the invertebrate breeding sampling sites at El-Mariotya canal, Giza Governorate (October, 2001-August, 2003).

Salinity Values

Salinity values in both sampling sites IIIZ and IIIM are higher than sites IZ, IIZ & sites IM, IIM (figure 3a-b). There are very high significant (P < 0.001) differences between IZ and IIIZ, IM, IIM, and IIIM as well as between IIZ and IIIZ, IIIM; and between IIIZ and IM. There are high significant (P < 0.01) differences between IZ and IIZ, and significant (P < 0.05) differences between IIZ and IIM. However, there are no significant (P > 0.05) differences between IIZ and IM as well as between IIIZ and IIM.

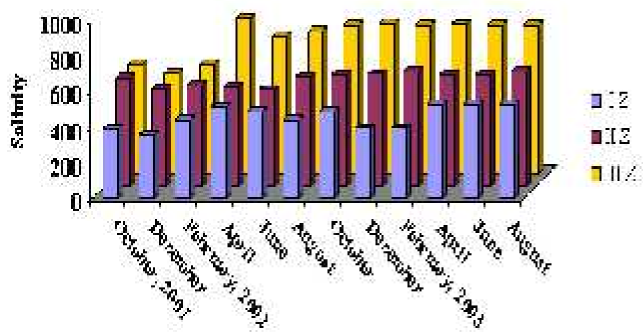

Figure (3a): Salinity values (T.D.S.) of the invertebrate breeding sampling sites at El-Zomor canal, Giza Governorate (October, 2001-August, 2003)

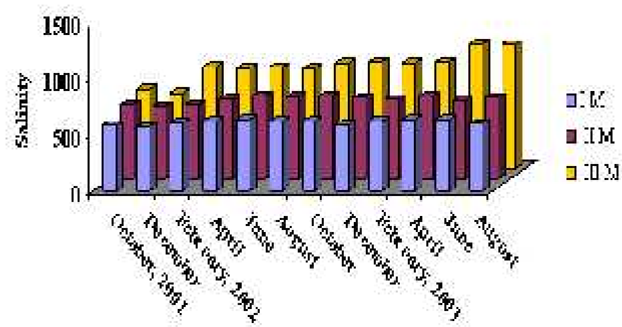

Figure (3b): Salinity values (T.D.S.) of the invertebrate breeding sampling sites at El-Mariotya canal, Giza Governorate (October, 2001-August, 2003)

Elecrical Conductivity

The annual mean value of electrical conductivity are being 863.28 micromhos / cm at El-Zomor canal and 1038.07 micromhos / cm at El-Mariotya canal (figure 4a-b). Statistical analysis showed significant (P < 0.05) differences between El-Zomor and El-Mariotya canal sampling sites.

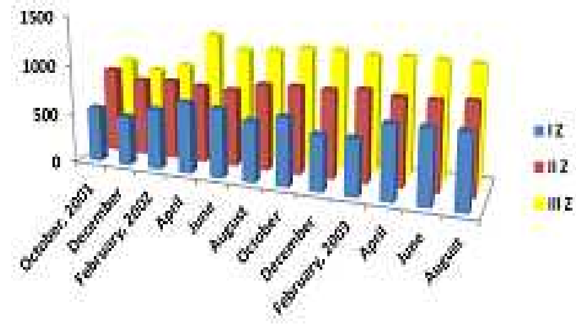

Figure (4a): Electrical conductivity (E.C.) of the invertebrate breeding sampling sites at El-Zomor canal, Giza Governorate

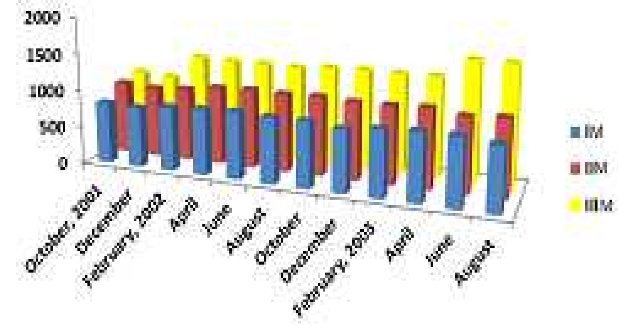

Figure (4b): Electrical conductivity (E.C.) of the invertebrate breeding sampling sites at El-Mariotya canal, Giza Governorate

The results of the studied areas compared to the main branch of the River Nile (control=Rosetta branch) show that the water quality of samples is changed to some extent. The semi-logarithmic graphs (figure 5a-i) show that the chloride ions is higher than bicarbonate and sulphate, Magnesium is higher than calcium and sodium during some months especially at El-Zomor canal.

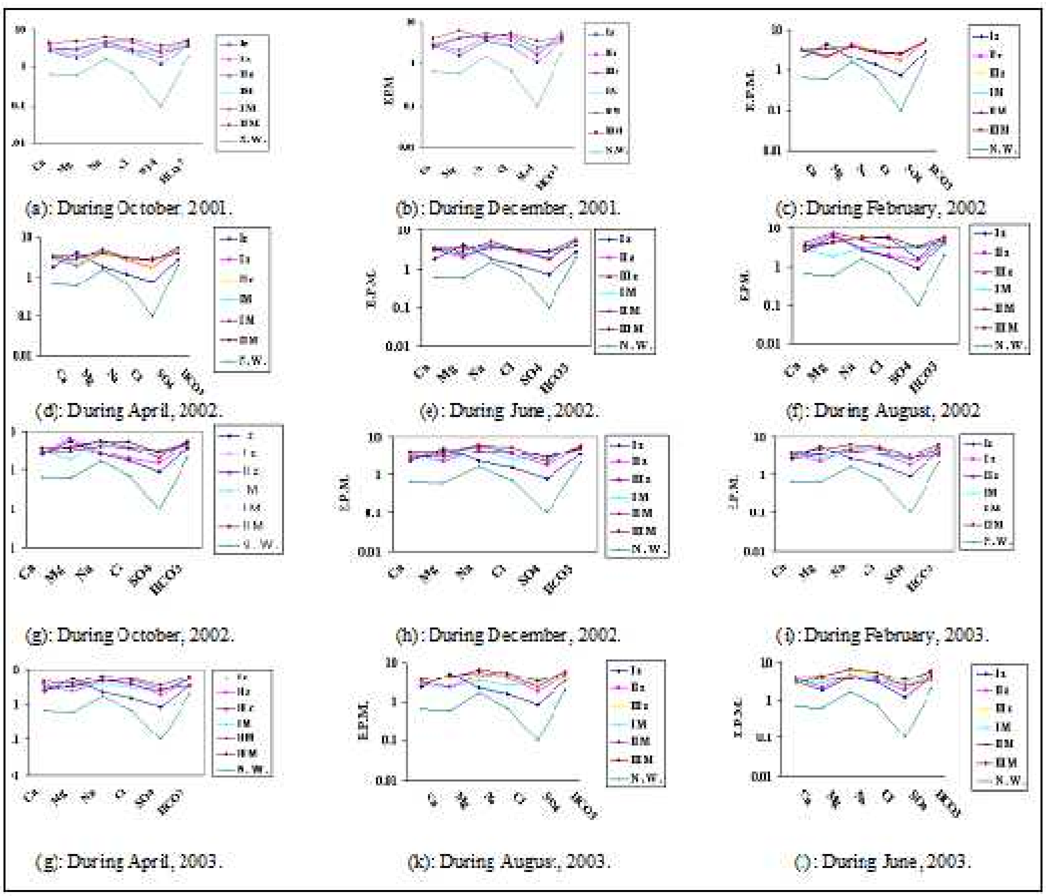

Figure (5a-i): Changes of ion values of the invertebrate breeding water sampling sites at El-Zomor and El-Mariotya canals, Giza Governorate (October, 2001 - August, 2003)

Abundance of Collected Aquatic Invertebrates

Figure (6a-f) represent the data of the bimonthly abundance of aquatic invertebrates collected from sites IZ, IIZ and IIIZ (El-Zomor canal); sites IM, IIM and IIIM (El-Mariotya canal). The 47217 and 36657 aquatic invertebrate specimens collected from El-Zomor and El-Mariotya canals respectively belong to five different orders (Diptera, Ephemeroptera, Odonata, Cladocera and Cyclopoida). The correlation coefficient (t) of the salinity, chlorinity, electrical conductivity values and the five collected orders show that:

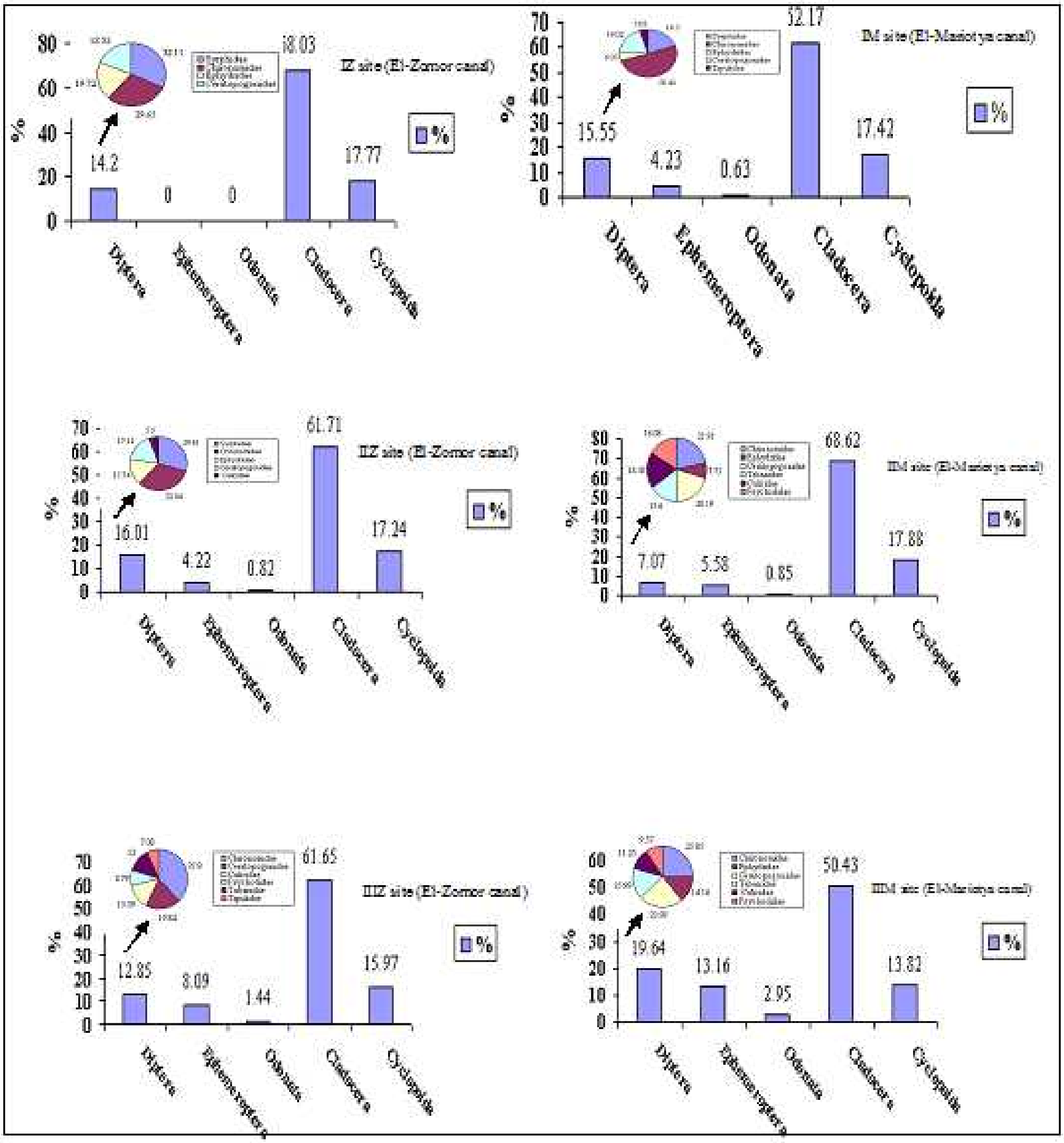

Figure (6a-f): Abundance degrees of the collected invertebrates at El-Zomor and El- Mariotya canals, Giza Governorate (October, 2001- August, 2003)

Order Diptera

There are significant ($P < 0.05$) differences between dipterous insects collected from the six sampling sites at El-Zomor and El-Mariotya canals. There is a weak correlation coefficient between collected dipterous insects and salinity values ($P < 0.10$ & $r = 0.198$) and between collected dipterous insects and chlorinity values ($P < 0.10$ & $r = 0.066$) at El-Zomor and El-Mariotya canals. Meanwhile there is a strong correlation coefficient ($P < 0.05$ & $r =$

0.634) between collected dipterous insects and electrical conductivity values at El-Zomor and El-Mariotya canals.

Order Ephemeroptera

There are significant (P < 0.05) differences between Ephemeroptera nymphs collected from the six sampling sites at El-Zomor and El-Mariotya canals. There is a moderate correlation coefficient (P < 0.10 & r = 0.325) between collected Ephemeroptera nymphs and salinity values, a weak correlation coefficient (P < 0.10 & r = 0.089) between collected Ephemeroptera nymphs and chlorinity values and a weak correlation coefficient (P < 0.10 & r = 0.328) between collected Ephemeroptera nymphs and electrical conductivity values at El-Zomor and El-Mariotya canals.

Order Odonata

There is a moderate correlation coefficient (P < 0.10 & r = 0.378) between collected Odonata naiads and salinity values and a moderate correlation coefficient (P < 0.10 & r = 0.327) between collected Odonata naiads and chlorinity values at El-Zomor and El-Mariotya canals. Meanwhile there is a strong correlation coefficient (P < 0.10 & r = 0.506) between collected Odonata naiads and electrical conductivity values at El-Zomor and El-Mariotya canals.

Order Cladocera (*Daphnia* spp.)

There are significant (P < 0.05) differences between the mean numbers of *Daphnia* spp. collected from the six studied sampling sites at El-Zomor and El-Mariotya canals. The correlation coefficient are moderate at El-Zomor and El-Mariotya canals between the collected *Daphnia* spp. (Cladocera) and salinity, chlorinity and electrical conductivity values (P < 0.10 & r = 0.352), (P < 0.10 & r = 0.358) and (P < 0.10 & r = 0.318), respectively.

Order Cyclopoida (*Cyclops* spp.)

There are significant (P < 0.05) differences between the mean numbers of *Cyclops* spp. collected from the six sampling sites at El-Zomor and El-Mariotya canals. The correlation coefficient are moderate at El-Zomor and El-Mariotya canals between collected *Cyclops* spp. (Cyclopoida) and salinity, chlorinity and electrical conductivity values (P < 0.10 & r = 0.383), (P < 0.10 & r = 0.319) and (P < 0.10 & r = 0.350), respectively.

Statistical analysis between the data of aquatic invertebrates collected from El-Zomor canal show significant differences (P < 0.05) between the mean numbers of Diptera, Ephemeroptera, Odonata, Cladocera (*Daphnia* spp.) and Cyclopoida (*Cyclops* spp.) collected from all sites at El-Zomor canal. In addition, there are significant differences (P < 0.05) between the mean numbers of Diptera, Ephemeroptera, Odonata, Cladocera (*Daphnia* spp.) and Cyclopoida (*Cyclops* spp.) collected from all sites at El-Mariotya canal.

4. Discussion and Conclusion

Chemical Analysis

The periodical changes in the chemical composition of the invertebrate breeding water at El-Zomor and El-Mariotya canals might be governed by various factors: The first factor was the climatologically changes between collecting months (summer, spring, winter and autumn). These changes although not drastic influence the chemical reactions between the invertebrate breeding water at El-Zomor and El-Mariotya canals, and the sediments that affected by the rate of evaporation. The second one was the amount of discharges (human activities, sewage pipes at sites IZ, IIZ and IIM and agricultural runoff from the adjacent lands, which might be greater during the different periods of the year). As the portion of irrigation water actually absorbed by plants or evaporated is essentially free from dissolved salts, the re-circulation of water through several cycles of irrigation tend to increase the concentration of dissolved salts at El-Mariotya canal sampling sites especially at IIIM site. Similarly, it reported that there is a significant effect on the benthic community in water streams, as agricultural field runoff includes nutrients [13], [14].

The electrical conductivity (E.C.) considered as an indirect measure of salinity [11] and as an index of pollution [16]. The results obtained indicated that the annual mean value of electrical conductivity (E.C.) at El-Zomor canal (836.28 micromhos / cm.) is lower than that at El-Mariotya canal (1038.07 micromhos / cm.). The sequence of E.C. values at both canals is ascending (IZ < IIZ < IIIZ & IM < IIM < IIIM). This means that breeding water at IZ and IM sampling sites are less saline and polluted than at other sampling sites.

The chloride values exhibits some variations in the six sampling sites at El-Zomor and El-Mariotya canals. Statistically there is a significant (P < 0.01) difference between IZ site and all sites at El-Zomor and El-Mariotya canals. The salinity values at El-Mariotya canal increased significantly than that recorded at El-Zomor canal. There is very high significant (P < 0.001) differences between IZ and IIIZ, IM, IIM, and IIIM as well as between IIZ and IIIZ, IIIM; and between IIIZ and IM. There is a high significant difference (P < 0.01) between IZ and IIZ. There is a significant (P < 0.05) difference between IIZ and IIM. Meanwhile there is no significant (P > 0.05) difference between IIZ and IM as well as between IIIZ and IIM. So that it appears that physical gradients and saline effects influence the benthic community structures, although governed by geomorphological processes, do not confirm to the typical river gradient. This localized saline impact influences the benthic community structure [17].

Abundance Degrees of Aquatic Invertebrate Orders

The use of aquatic insects in biomonitoring and toxicity testing, for establishing the impairment of aquatic ecosystem quality has become popular [18- 21].

Survey of the aquatic invertebrates present in the six studied sampling sites along El-Zomor and El-Mariotya canals reveals the existence of 47217 and 36657 specimens, respectively which belonging to 5 different orders namely: Diptera, Ephemeroptera, Odonata, Cladocera and Cyclopoida.

The distributions of the collected invertebrates reflect the chemical characters of each sampling site largely. The most abundant order is Cladocera (*Daphnia* spp.) at all sampling sites, at El-Zomor (68.03, 61.71 & 61.65 %) and at El-Mariotya (62.17, 68.62 & 50.43 %) canals. Concerning abundance of the insects at El-Zomor sampling sites, the least abundant order is Diptera (14.20 %) at site IZ and Odonata (0.82 & 1.44 %) at IIZ and IIIZ. This pattern agree with that reported by Joydeb *et al.*, 2013 [18]., Takhelmayum & Gupta, 2011 [22]; and Verma & Saksena, 2010 [27]. It suggested that El-Zomor canal sites are less polluted and rich in aquatic vegetation. Meanwhile at El-Mariotya sampling sites, the least abundant percent at IM, IIM and IIIM is Odonata (0.63, 0.85 & 2.95 %), respectively. It suggested that the least abundance of insects belonging to Diptera and Odonata is greatly influence the vertical distribution of Cladocera (*Daphnia* spp.) [24].

Bimonthly abundance of *Cyclops* spp. (Cyclopoida) showed that the highest number is 995 individuals during April, 2003 (IZ sampling site). In all sampling sites of the two canals, density of *Cyclops* spp. displayed a dial periodicity in April (2002 & 2003). Density and species richness of aquatic insects in the drift displayed a dial periodicity whereas density and species diversity exhibited a seasonal periodicity. As density negatively correlated with discharge [25].

Also, IZ site had the least number of collected families (6 families belonging to 3 orders), where it is less saline and polluted than at other sampling sites; while the other sampling sites (IIZ, IIIZ, IM, IIM & IIIM) have 9, 12, 11, 10 and 11 families belonging to five orders [26]. Regarding to the less chloride values, salinity and the lower values of E.C. at site IZ; Bimonthly abundance of Diptera showed that the highest number recorded is 443 individuals during June, 2003 (IZ site). Syrphidae are the most abundant (4.56 %) at only IZ sampling site. Collected Chironomidae are the most abundant (5.13, 4.87, 7.84, 1.55 & 4.92 %) at IIZ, IIIZ, IM, IIM and IIIM, respectively. A similar pattern of dipterous insects reported from other lentic ecosystems [27], because many of the dipterans prefer lentic habitats are breeding ground early life stages [28]. It suggested that Syrphidae prefer less saline and polluted water compared to Chironomidae.

Bimonthly abundance of Ephemeroptera showed that the highest number recorded is 403 nymphs during June, 2003 (IIIM site). Baetidae are abundant (4.46, 2.29, 5.58 & 13.16 %) at IIIZ, IM, IIM and IIIM sites, respectively. In addition, Caenidae are abundant (4.22 %) at IIZ sampling site, however at IZ sampling site Ephemeroptera nymphs was not present because the breeding water was quiet. This might be because Caenidae species generally preferred stream areas, where there was high water current [29]. The baetid mayfly is widely distributed in most freshwater ecosystems in Africa thus it could be used in biomonitoring and setting of water quality criteria for freshwater ecosystems [30].

Bimonthly abundance of Odonata showed that the highest number recorded is 35 naiads during December, 2002 (IIIM site). Coenagrionidae are abundant (0.82, 0.86, 0.36 & 1.60 %), at IIZ, IIIZ, IM and IIIM, respectively. While Aeshnidae reaches 0.85 % (IIM) and there is no record of Odonata at IZ sampling site. Odonata naiads collected from IIIM (El-Mariotya canal) affected by high electrical conductivity, chloride values as well as the re-circulation of water through several cycles of irrigation (agricultural lands). In contrast, the absence of Odonata at IZ site (residential area). Clark, 2007 [31] reported that nutrient input from anthropogenic activities for example, runoff from agricultural land, sewage outfalls or commercial effluent. This nutrient over enrichment or eutrophication can have numerous undesirable impacts on aquatic ecosystems. Joydeb, 2013 [18] reported that urban lakes are less polluted and rich in aquatic vegetation. Both IZ and IM sites (El-Zomor and El-Mariotya canals) less polluted than the other sites.

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