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# Aquatic Insects as Bio Indicators for Pollution in Some Egyptian Streams.

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**ABSTRACT**

**Quantitative knowledge on the use of aquatic insects as bioindicators has not been elucidated in Egypt. Given these concerns, the goal of the present study is to use aquatic insect communities as biotic indices for evaluating water quality in some Egyptian fresh water streams. The study was carried out for a period of one year during summer and autumn 2010 and winter and spring 2011. Sampling was done using kicking and dipping method to collect the aquatic insects. Insects were identified up to the family level. Several metrics were used to analyze the aquatic insect data. Physic-chemical parameters of water samples were analyzed using standard methods. A total of 438 aquatic insect individuals (representing 19 families from 7 orders), 535 (20 insect families from 7 orders) and 241 (13 families from 6 orders) were recorded from El-Kassed, Rasheed and Kafr el Zayat streams. According to total taxa richness for Ephemeroptera, Plecoptera and Trichoptera (SEPT) -biotic index, the situation of water quality in the three water bodies was moderate impact; however it was "Good" according to Stroud water research center (SWRC). The SEPT is the most suitable biotic index for calculating water bio-class in Egyptian streams. Margalef's water quality index values were less than 3, indicating that the water quality of the three streams was impacted. Various anthropogenic activities were showing their impacts on the water quality of Egyptian streams. This study, as elsewhere, shows that aquatic insect communities could be good indicators of water quality and should be used as bioindicators of water quality of fresh water streams in Egypt.**

**Key words:** Aquatic insects, Bioindicator, Pollution, Streams.

## INTRODUCTION

Most Egyptian governorates contain a number of fresh water resources such as River Nile, ponds together with a network of streams. All over the world, fresh water resources have been subjected to an increasing pollution load from contaminated runoff water originated from manmade activities like domestic and industrial (Benetti and Garrido 2010), agricultural with intensive use of fertilizers and pesticides (Garcia-Criado et al. 1999) and urbanization. These disturbances produce alteration in the chemical composition of water and in the structure of the communities of organisms living in these environments. Many tools, techniques and methodology exist to evaluate changes in an aquatic environment. In the past, water quality was assessed using only physichochemical parameters, but these reflect punctual pollution. The use of biological methods, known as biological water quality assessment and biological water quality monitoring have been largely developed for recent years (Bhuvaneshwari et al. 2013; De Pauw and Hawkes, 1993). This method is more precise to detect changes in water quality, since aquatic organisms are adapted to specific environmental conditions. If these conditions change, some organisms disappear (intolerant) and be replaced by others (tolerant). Therefore, variation in the composition of aquatic organism assemblages in fresh water ecosystem can indicate possible pollution (Alba-Tercedor 1996). Physicochemical parameters and aquatic insect indicators may work together effectively in assessing the quality of water Aquatic insects are the most diverse group of fresh water benthic macroinvertebrates. Thus, as a highly diverse group, insects inhabiting the benthic environment are valuable indicators of environmental conditions in streams and rivers in biomonitoring studies. They spend all or part of their life cycle within the water. Insects are sensitive to many abiotic and biotic factors in the environment; though degrees of sensitivity differ among various groups. Different aquatic insect taxa have different habitat preference and pollution tolerance. Absence of a sensitive taxa and presence of tolerant ones indicate water quality. Consequently, several researchers have advocated the use of aquatic insect community structure as bio indicators of the condition of an aquatic system (Rosenberg and Resh 1993; Susmita et al. 2013). Moreover, aquatic insects that can be used as indicators for water pollution where the analysis of aquatic insect collection is less expensive than the evaluation of physical and chemical parameters used in assessing quality (Bode et al., 1995; EEA, 2007). This analysis is based on the diversity, abundance and presence or the absence of different taxa and in the tolerance values of the taxa that are directly related to the physical and chemical conditions of the aquatic ecosystem. Biological monitoring of aquatic insects can reflect the degree of impacts of pollutants as well as prolonged effects of habitat disturbance and development of biological criteria is important allowing water quality mangers and policy makers to make informed decision concerning rivers and streams (Kovacs, 1992).

Once aquatic insects are surveyed from an aquatic habitat and analyzed the data can be interpreted using several indices for comparison between sites. A variety of metrics such as taxonomic richness, taxonomic composition, and dominance by tolerant and sensitive taxa and EPT index (Ephemeroptera -Plecoptera Trichoptera) have been used to evaluate water quality (Lenat, 1988; McGonigle, 2000; SWRC Bouchard, 2004 and 2007; Atobatele et al., 2005; Arimoro et al., 2007).

Since streams and River Nile are among the most endangered ecosystems in Egypt, there are urgent demands for comprehensive study to determine the impacts of natural and anthropogenic disturbances on aquatic ecosystems. Therefore, the intention of this study was to evaluate aquatic insect communities as boindicators of habitat quality in fresh water ecosystem. In addition, the influence of different physical and chemical variables on the distribution of aquatic insects was explored in aquatic ecosystems.

## MATERIALS AND METHODS

The Egyptian fresh water ecosystems surveyed for aquatic insects were representative of different types of land use patterns, different anthropogenic activities, source of pollution and hydrological characters.

### Site description

### El kassed stream

El kassed Stream is one of the main fresh water streams in Tanta City. This site is an example of industrial and agricultural impact. It is a major source of domestic water supply to the people of Tanta City and is important for irrigation. It is situated within the vicinity of agricultural area. The average stream length is 20.57 km, mean width of 21 m and a mean depth of 1.20 m. The stream is subjected to various anthropogenic interferences. The stream carries the treated effluents of the Soap and Oil Factory. The stream banks are covered by huge amount of refuge and domestic animal dung. Few free floating water hyacinths covers the surface of the water and papyrus grows on the muddy banks along the stream with roots just under the water. Dead animals were left rotting in the stream.

### Rasheed stream

Rasheed stream takes its course within Kafr el Zayat .It is an important tributary of the River Nile. This site is a model of agricultural impact. The average stream length is 5 km and with a mean width of 28 m. The stream supplies water for irrigation of land and domestic purposes to many villages. The landscape adjacent to the stream is dominated by agriculture and the stream receives substantial agricultural input consisting of agricultural pollutants such as insecticides and fertilizers. The stream surface is occupied by an abundance of the free floating water hyacinths and papyrus grows on the muddy banks along the stream with roots just under the water. Heaps of garbage and a number of animal and bird carcasses were found in the stream. The stream is significant as it supports variable population of fish. The fish are being the major source of income for the local fishermen. Dead animals were left rotting in the stream.

### Fish Aqua Culture

Kafr el Sheikh is located in the Nile Delta. It is an agricultural governorate and is famous by fish rearing. The fish aqua culture in Kafr el Sheikh, was chosen because it is unique of being potential polluter of water bodies with effluents. The area of the water body of the fish aqua culture investigated in this study is approximately 3 acre with maximum depth of 1 m. The fish aqua culture harbors a rich fish biodiversity. Common species cultured include several species of *Tilapia*. The fish aqua culture is composed of stagnant water with a range of shore line areas that inhabited by rooted grass. The fish are a mean of livelihood for the local fishermen who depend mainly on fishery resources of the fish aqua culture. The fish aqua culture receives untreated Abo-Itman agricultural discharge throughout the year except during October through May. The fish aqua culture is supplied with irrigation water from Bahr Khamar stream in Kafr el Sheikh. Although a variety of commercially fish aqua culture feeds are available, fish aqua culture has turned to diets that consists of poultry manure.

**Physicochemical Measurements**

The water samples were also collected from El Kassed and Rasheed streams and the fish aqua culture in plastic containers. The samples were immediately analyzed for physicochemical parameters using standard methods at the Egyptian Health Ministry Laboratories in Tanta. The water quality characteristic measured in this study involved, pH, conductively, turbidity, nitrates, ammonia, phosphates, heavy metals, biological oxygen demand (BOD) and dissolved oxygen (DO).

**Statistical Analysis of Stream Water:** Physicochemical parameters of the stream water samples were compared using Kruskal–Wallis one-way analysis of variance.

## SAMPLING OF AQUATIC INSECTS

Aquatic insect were collected from five sampling sites around the perimeter of El Kassed and Rasheed streams, and the fish aqua culture by kick method (Lenat 1988).

Sampling sites were determined by accessibility. All collections were made at monthly intervals during summer and autumn 2010 and winter and spring 2011. In the laboratory, the collected insects were washed in a 500-µm mesh sieve and coarse debris such as leaves, twigs, rocks and other objects were removed from the sample. Then, the specimens were immediately sorted under a dissecting microscope, counted and identified up to the family level using taxonomic keys (Durand and Levaque, 1981; Greber and Gabrial, 2002) and keys from elsewhere (Merritt and Cummins, 1996). All the sorted insects were preserved in 70% ethanol in properly labeled bottles.

## DATA ANALYSIS

The indices used to monitor the impact of disturbance and pollution in the streams included, total taxa richness for Ephemeroptera, Plecoptera and Trichoptera (SEPT) (Paparisto et al. 2008)., EPT biotic index for abundance and richness (Schmiedt et al. 1998) and Stroud Water Research Centre-biotic index (SWRC-biotic index) suggested by Schmiedt et al. (1998), Mc Gonigle (2000) and SWRC (2007). These metrics were based on the idea that unstressed streams have richer insect taxa that were dominated by intolerant species. Conversely, polluted streamshave fewer numbers of insect taxa and were dominated by tolerant species (Mandaville 2002).

Water quality for each stream was determined by using the diversity (d) indices of Margalef. Margalef's water quality indices above 3.0 indicate clean conditions; values less than 1.0 indicate severe pollution and intermediate indicate moderate pollution (Lenat et al., 1980). Schannon– Wiener Diversity index (H) (Gerritsen et al. 1998) was employed to determine the diversity in the stream.

## RESULTS

The number and abundance of aquatic insect taxa collected vary from season to season. In total, 438 aquatic insect individuals representing 19 families from 7 orders were collected from El-Kassed stream in Tanta from which 35.4% were abundant during summer season (29%) during spring, (18.5%) during winter and (17.1%) during autumn. (Table 1). In Rasheed stream in Kafr el zayat , 535 individuals representing 20 insect families from 7 orders were identified (Table 2) from which 38.8% were abundant during spring season (24.9%) during summer, (20.2%) in autumn and (16.1%) during winter., meanwhile a less number of taxa (241 individuals representing 13 families from 6 orders ) was collected from a fish aquaculture in Kafr el sheikh from which 38.2% were abundant during spring season then (25.3%) during autumn and winter and (11.2%) during Summer (Table 3).

**Table 1:** Number and relative abundance of aquatic insect orders and families identified from El-Kassed stream in Tanta city during summer and autumn 2010 and winter and spring 2011.

| Order | Family | Summer | percent | Autumn | percent | Winter | percent | spring | percent |
|---|---|---|---|---|---|---|---|---|---|
| **١- Ephemeroptera** | Baetidae | 28 | 18.1% | 1 | 1.3% | 1 | 1.2% | 15 | 11.8% |
| | Caenidae | 2 | 1.3% | 1 | 1.3% | 0 | 0.0% | 3 | 2.4% |
| **٢-Plecoptera** | Capnidae | 0 | 0% | 2 | 2.6% | 0 | 0.0% | 0 | 0.0% |
| **٣-Trichoptera** | Hydropsychidae | 20 | 12.9% | 7 | 9.3% | 0 | 0.0% | 1 | 0.8% |
| **4-OdonataZygoptera** | Coenagrionidae | 17 | 10.9% | 17 | 22.7% | 9 | 11.1% | 30 | 23.6% |
| **5-Odonata Anisoptera** | Aeshnidae | 0 | 0.00% | 0 | 0.0% | 1 | 1.2% | 1 | 0.8% |
| | Libellulidae | 1 | 0.7% | 1 | 1.3% | 1 | 1.2% | 3 | 2.4% |
| **6 -Coleoptera** | Dytiscidae | 3 | 1.9% | 2 | 2.7% | 0 | 0.0% | 2 | 1.6% |
| | Noteridae | 10 | 6.5% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| | Hydrophilidae | 5 | 3.2% | 1 | 1.3% | 0 | 0.0% | 4 | 3.2% |
| | Hydranaeidae | 2 | 1.3% | 1 | 1.3% | 0 | 0.0% | 1 | 0.8% |
| **7 -Diptera** | Chironmidae | 50 | 32.3% | 18 | 24.0% | 17 | 20.9% | 25 | 19.7% |
| | Culicidae | 0 | 0.00% | 0 | 0.0% | 0 | 0.0% | 8 | 6.3% |
| | Tabanidae | 3 | 1.9% | 0 | 0.0% | 0 | 0.00% | 0 | 0.0% |
| | Stratiomyiidae | 1 | 0.7% | 0 | 0.0% | 0 | 0.00% | 0 | 0.0% |
| | Ephydridae | 0 | 0.00% | 10 | 13.3% | 0 | 0.00% | 12 | 9.5% |
| **8 -Hemiptera** | Notonectidae | 3 | 1.9% | 0 | 0.0% | 0 | 0.00% | 4 | 3.2% |
| | Croxidae | 5 | 3.2% | 10 | 13.3% | 52 | 64.2% | 15 | 11.8% |
| | Blestomatidae | 3 | 1.9% | 1 | 1.3% | 0 | 0.00% | 3 | 2.4% |
| | Mesovillidae | 2 | 1.3% | 3 | 4.0% | 0 | 0.0% | 0 | 0.0% |
| **Total** | | **155** | **35.4%** | **75** | **17.1%** | **81** | **18.5%** | **127** | **29%** |

**Table 2:** Number and percentage of aquatic insect orders and families identified from Rasheed stream in Kafr el zayat during summer and autumn 2010 and winter and spring 2011

| Order | Family | Summer | percent | Autumn | percent | Winter | percent | Spring | percent |
|---|---|---|---|---|---|---|---|---|---|
| **1-Ephemeroptera** | Baetidae | 4 | 3.0% | 0 | 0.0% | 0 | 0.0% | 46 | 22.1% |
| | Caenidae | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 1 | 0.5% |
| **2-Plecoptera** | | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| **3- Trichoptera** | Hydropsychidae | 15 | 11.3% | 3 | 2.8% | 0 | 0.0% | 0 | 0.0% |
| **4-Odonata:Zygoptera** | Coenagrionidae | 22 | 16.5% | 18 | 16.7% | 1 | 1.2% | 25 | 12.0% |
| **Anisoptera** | Libellulidae | 1 | 0.8% | 19 | 17.6% | 1 | 1.2% | 3 | 1.4% |
| **5- Coleoptera** | Hydrophilidae | 15 | 11.3% | 2 | 1.9% | 12 | 13.9 | 9 | 4.3% |
| | Noteridae | 3 | 2.3% | 1 | 0.9% | 1 | 1.2% | 4 | 1.9% |
| | Dytiscidae | 9 | 6.8% | 16 | 14.8% | 6 | 6.9% | 3 | 1.4% |
| | Hydraenidae | 2 | 1.5% | 2 | 1.9% | 0 | 0.0% | | 0.0% |
| | Staphylinidae | 0 | 0.0% | 2 | 1.9% | 0 | 0.0% | 0 | 0.0% |
| **6- Diptera** | Chironomidae | 33 | 24.8% | 29 | 26.9% | 51 | 59.3% | 58 | 27.9% |
| | Culicidae | 4 | 3.0% | 0 | 0.0% | 0 | 0.0% | 1 | 0.5% |
| | Tabanidae | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 1 | 0.5% |
| | Stratiomyiidae | 1 | 0.8% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| | Ephydridae | 0 | 0.0% | 1 | 0.9% | 2 | 2.3% | 0 | 0.0% |
| **7-Hemiptera** | Notonectidae | 0 | 0.0% | 1 | 0.9% | 0 | 0.0% | 1 | 0.5% |
| | Croxidae | 0 | 0.0% | 1 | 0.9% | 3 | 3.5% | 18 | 8.7% |

**Table 2** (cont.)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Blestomatidae | 21 | 15.8% | 11 | 10.2% | 9 | 10.5% | 37 | 17.8% |
| | Mesovillidae | 3 | 2.3% | 0 | 0.00% | 0 | 0.0% | 0 | 0.0% |
| **8-Orthoptera** | Tridactylidae | 0 | 0.0% | 2 | 1.9 % | 0 | 0.0% | 0 | 0.0% |
| **Total** | | **133** | **24.9%** | **108** | **20.2%** | **86** | **16.1%** | **208** | **38.8%** |

**Table 3:** Number and percentage of aquatic insect orders and families identified from a fish aqua culture in Kafr el sheikh during summer and autumn 2010 and winter and spring 2011

| Order | Family | Summer | percent | Autumn | percent | Winter | percent | Spring | percent |
|---|---|---|---|---|---|---|---|---|---|
| **1-Ephemeroptera** | Baetidae | 2 | 7.4% | 0 | 0.0% | 0 | 0.0% | **0** | 0.0% |
| **2-Plecoptera** | | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| **3-Trichoptera** | Hydropsychidae | 0 | 0.0% | 1 | 1.6% | 1 | 1.6% | 0 | 0.0% |
| **4-Odonata Zygoptera** | Coenagrionidae | 0 | 0.0% | 0 | 0.0% | 2 | 3.3% | 3 | 3.3% |
| **5-Coleoptera** | Dytiscidae | 1 | 3.7% | 1 | 1.6% | 1 | 1.6% | 0 | 0.0% |
| | Hydrophilidae | 0 | 0.0% | 1 | 1.6% | 0 | 0.0% | 0 | 0.0% |
| **6-Diptera** | Chironomidae | 15 | 55.6% | 17 | 27.9% | 20 | 32.8% | 5 | 5.4% |
| | Culicidae | 2 | 7.4% | 1 | 1.6% | 1 | 1.6% | 3 | 3.3% |
| | Tabanidae | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 1 | 1.1% |
| | Stratiomyiidae | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 2 | 2.2% |
| | Ephydridae | 0 | 0.0% | 0 | 0.0% | 26 | 42.6% | 0 | 0.0% |
| **7-Hemiptera** | Notonectidae | 1 | 3.7% | 5 | 8.2% | 3 | 4.9% | 8 | 8.7% |
| | Croxidae | 3 | 11.1% | 25 | 40.9% | 4 | 6.6% | 40 | 43.5% |
| | Blestomatidae | 3 | 11.1% | 10 | 16.4% | 3 | 4.9% | 30 | 32.6% |
| **Total** | | **27** | **11.2%** | **61** | **25.3%** | **61** | **25.3%** | **92** | **38.2%** |

Data generated from the study of the number of aquatic insect orders and families identified were used to classify water quality for the three streams tested.

The SEPT index revealed that the water quality in El Kassed, Rasheed and the fish aqua culture in Kafr El Sheikh was poor in all seasons of the year. The values of SEPT for El Kassed in summer, autumn, winter and spring were 3, 4, 1 and 3 respectively, for Rasheed 2, 1, 0 and 2 and for the fish aqua culture 1, 1, 1 and 0.

Diversity in EL-Kassed and Rasheed streams was fair in summer, autumn and spring, however it was poor in winter. On the other hand, in the fish aquaculture, the diversity was poor in all seasons. Total taxa richness (ST) values for for EL-Kassed in summer, autumn, winter and spring were 16,14,6 and 15, for Rasheed 14,14,9 and 13 and for the fish aquaculture 7, 8, 9 and 8 respectively.

According to the EPT index values, the water quality in El Kased stream was classified in the moderate impact bio-class in winter, spring and summer, while in autumn the water bio-class was classified in the non-impact. In Rasheed stream, the water bio-class was moderate impact in spring, summer and autumn. In winter, the families Ephemeroptera, Plecoptera and Trichoptera were not recorded in Rasheed stream; therefore, the EPT was not estimated- In the fish aquaculture, the water bio-class was moderate impact in summer, autumn and winter. The EPT was not estimated in spring, because none of the Ephemeroptera, Plecoptera and Trichoptera was recorded.

The SWRC biotic index values classified the water quality in El Kassed stream in winter, spring and summer in the good bio-class, while in winter the water quality was determined as excellent bio-class. In Rasheed stream, the water quality in spring and summer and autumn was classified in the good bio-class. In winter, the families Ephemeroptera, Plecoptera and Trichoptera were not recorded; therefore, the SWRC-biotic index was not measured. In the fish aquaculture, SWRC biotic index values classified the water quality in summer, autumn and winter in the good bio-class. In spring, none of the Ephemeroptera, Plecoptera and Trichoptera was recorded; therefore the SWRC-biotic index was not recorded.

Comparing the water quality in the tree water bodies monitored, based on the EPT biotic index values, it was obvious that the water quality in El-Kassed and Rasheed streams and the fish aquaculture was in the moderate impact to non-impact bio-class. Meanwhile, the SWRC biotic index classified the water quality in the three water bodies in the good to excellent bio-class.

According to Margalef's index, the water quality of the tree water bodies was impacted during all seasons because the index values were less than 3 .The Margalef's index values (d) in El-Kassed stream, in summer, the highest impact was reported in winter (1.13), while lowest impact was in summer (2.59), autumn (2.27) and spring (2.64). In Rasheed stream, the maximum impact (1.49) was in winter and spring (1.77) while the minimum impact was in autumn (2.77) and summer (2.23). In the fish aquaculture, the highest impact was reported in spring (1.35), summer (1.51) and autumn (1.48) while least impact (2.08) was in summer.

Season-wise change in the impact of the three water bodies studied. In summer, the maximum impact was in the fish aquaculture (2.08) and the minimum was in El-Kassed stream (2.59). A similar trend was observed in spring. In autumn, the maximum impact was in the fish aquaculture (1.51) and the minimum was in Rasheed stream (2.77). In winter, the maximum impact was in El-Kassed stream (1.13) and the minimum was in Rasheed stream (1.49).

The Schannon-Wiener diversity index in El-Kassed stream indicate that the diversity was higher in summer (2.0), and spring (2.1) than autumn (1.75) and winter (1.02). In Rasheed stream, the diversity was higher in autumn (2.02) and summer (1.9) and lower in winter (1.2) and spring. (1.6). In the fish aquaculture, the higher diversity was recorded in summer (1.82) and spring (1.47) and lower in autumn (1.22) and winter (1.35). These average Schannon-Wiener diversity values showed that the diversities were highest in El-Kassed (1.72) and Rashed (1.6) streams and lower in the fish aquaculture (1.47). The diversity vary from season to season. In summer, the maximum diversity index was in El-Kassed stream and the minimum was in the fish aquaculture. A similar trend was observed in spring. In autumn, the maximum diversities were in Rasheed stream and the minimum was in the fish farm in. In winter, the maximum diversity was in the fish farm and the minimum was in El-Kassed stream.

Data analysis of Physicochemical parameters of the stream water samples indicated that there were significant difference in turbidity, pH, conductivity, dissolved salts, Ca, Mg , Pb and B.O.D between sampling sites and sampling seasons (winter and spring) at p= 0.003, 0.002, 0.001, 0.001, 0.003, 0.008, 0.039, 0.002 respectively.

## DISCUSSION

The low variability of aquatic insect fauna in the Egyptian streams suggested that biotic indices at the family level may overestimate water quality more than those based on species taxonomic level because family taxonomic level usually use intermediate species tolerance values. Lenat and Resh (2001) also suggested that the family taxonomic level may be adequate in terms of cost-efficiency, especially when few taxonomic experts are available. The significant variation of the total number of aquatic insect assemblages collected from the three water bodies could be modulated by their different levels of sensitivity to pollution, together with many other physical and chemical factors in the water body ecosystem. Human activities might change the normal development of these streams, especially at the fish aqua culture. Human activities, such as recreational and agricultural activities were associated with a reduction in species diversity of aquatic insect communities (Wahizatul et al. 2011). In addition, physical and chemical disturbance, seasonal water flow, temperature, ion concentrations, food base of the stream, interaction with the stream biota and substrate were also major factors in determining the composition and abundance of aquatic insects (Ward and Stanford 1979).

The abundance of Ephemeroptera, Plecoptera, Trichoptera and Chironomidae indicates the balance of community, since Ephemeroptera, Plecoptera and Trichoptera are particularly sensitive to water quality and Chironomidae less sensitive to environmental stress. An aquatic community considered to be good if biotic conditions will display an even distribution among these four insect families, while aquatic community with disproportionately high number of Chironomidae may indicate environmental stress (Lenat and Penrose, 1996)). Nymphs and larvae of Ephemeroptera, Plecoptera and Trichoptera were considered integral item of the undisturbed streams (Hynes 1960).

In summer, the absence of Plecoptera and dominance of Chironomidae suggested that the three water bodies were disturbed and polluted. Sensitive species gradually were eliminated during unfavorable condition, resulting in a community structure which was noticeable different from undisturbed sites (North Carolina Division of Environmental Management 1991). Chironomidae were indicative of poor water quality from various anthropogenic activities (Yakub 2004) and dominated in heavily organic polluted water bodies (Ali et al. 2003). Its abundance was related to the amount of detritus, which in turn was negatively correlated with flow velocity (Doisy and Rabeni 2001). The overall family abundance and richness revealed that insects of the order Coleoptera and Hemiptera were the most dominant in El Kassed stream, order Coleoptera and Diptera in Rasheed stream while order Diptera and Hemiptera were the most dominant in the fish aqua culture. Less dominance of Hemiptera in Rasheed stream suggested that Rasheed stream was less polluted than El-Kassed stream and the fish aqua culture in summer. Coleoptera was not dominant by the Dytiscidae during summer indicating pollution of the three Egyptian streams. Majumder et al. (2013) reported the absence of hemipteran insects in a lake and suggested that the lake was less polluted and prevalence of Dytiscidae was indicative of the ecological health of studied lakes. Dytiscidae insects generally prefer leaves of submerged aquatic vegetation in clean freshwater lakes and are predacious in nature. In autumn, order Diptera was the most abundant in El-Kassed stream. In Rasheed stream, the highest percentage of individuals was found in order Odonatawhile in the fish aqua culture order Hemiptera was the most abundant.This result suggests highest pollution in the fish aqua culture , less pollution in El-Kassed stream and the least pollution in Rasheed stream. Dominance of Odonata nymphs in Rasheed stream may be due to dominance of macrophytes where Odonata nymphs were usually associated with macrophytes (Carchini et al. 2004). Therefore, Odonata larvae could be considered as the most useful indicator of ecosystem functioning and environmental impacts in Rasheed stream in autumn. Insects of the order Coleoptera and Hemiptera were the most dominant in El Kassed and Rasheed streams while the insects of order Hemiptera were only the most dominant in the fish aqua culture indicating heavy pollution in the fish aqua culture than in El-Kassed and Rasheed streams because order Coleoptera was relatively dominant by Dytiscidae in El- Kassed and Rasheed streams in autumn. The large number of Dytiscidae in El- Kassed and Rasheed streams could be explained by their numerous physiological, morphological and behavioral adaptations to aquatic habitat. The prevalence of Dytiscidae was indicative of the ecological health of lakes (Majumder et al. 2013). The aquatic Orthoptera, Tridactylidea, was reported for the first time in Egypt in Rasheed stream in autumn.

In autumn, Plecoptera and Ephemeroptera were completely absent in Rasheed stream and the fish aqua culture but was present in El- Kassed stream. Trichoptera was present in all three water bodies but not dominant. In contrast, insects of the order Hemiptera, Diptera, and Coleoptera showed high taxa richness and abundance in all three water bodies. Popoola and Otalekor (2011) and Devi et al. (2013) reported that Coleoptera and Hemiptera were associated with polluted water in Loktak Lake in India. Lenat (1984) reported that Coleoptera and Hemiptera replaced the sensitive Ephemeroptera, Trichoptera and Plecoptera taxa in streams receiving agricultural runoff. Agriculture is an important land use category within Tanta and Kafr El-zyat cities. Consequently, Rasheed and El-Kassed streams receive substantial agriculture runoff. It seems that Coleoptera and Hemiptera were tolerant to agriculture runoff and replaced the sensitive taxa in the three Egyptian streams during autumn. In winter, order Hemiptera was the most abundant in El -Kassed stream. On the other hand, Diptera was the most dominant order with the highest number of individuals in Rasheed stream and the fish aqua culture. Overall family abundance and richness revealed that insects of the order Odonata were the most dominant in El- Kassed this may be due to dominance of macrophytes. Order Coleoptera was the most dominant in Rasheed stream while order Diptera and Hemiptera were the most dominant in the fish aqua culture. Less dominance of Hemiptera in El- Kassed and Rasheed streams suggested that these streams were less polluted than the fish aqua culture in winter. In Rasheed stream, order Coleoptera was dominant by the family Hydrophilidea in winter, indicating sever pollution in the stream. Traditionally, Hydrophilidae beetles inhabit shallower and polluted regions of water bodies with abundant macrophytes and feed on detritus, algae and decaying vegetative matter (Khan and Ghosh, 2001).

In winter, Ephemeroptera, Plecoptera and Trichoptera were completely absent in Rasheed stream, indicating high pollution of the stream. Ephemeroptera was reported only in El- Kassed stream while Trichoptera was collected only from the fish aqua culture but not dominant .In contrast, insects of the order Hemiptera, Diptera, Odonata and Coleoptera showed high taxa richness and abundance in all three water bodies suggesting pollution in the three streams during winter. Sporka et al. (2006) recommended avoiding sampling in winter to avoid extreme hydrological regimes and temperature and for logistical reasons. In spring, order Diptera was the most abundant in El- Kassed and Rasheed streams, meanwhile, order Hemiptera was the most abundant in the fish aqua culture. Overall family abundance and richness revealed that insects of Odonata, Coleoptera, Diptera and Hemiptera were the most dominant in El Kassed,

Coleoptera in Rasheed stream while Diptera was the most dominant in the fish aqua culture. Dominance of these orders in spring and less dominance or complete absence of the taxa of Ephemeroptera, Plecoptera and Trichoptera suggest pollution in the studied streams.

The tree Egyptian streams were not dominant by the major pollution sensitive aquatic insect taxa of Ephemeroptera, Plecoptera and Trichoptera In contrast, insects of the order Hemiptera, Diptera, Odonata and Coleoptera showed high abundance, suggesting pollution of the Egyptian streams. In general, the order of tolerance from high to low was Diptera (true flies, especially the midges, Chironomidae) and Hydropsychid (Trichoptera). These were followed by the remaining Trichoptera then most Ephemeroptera, Plecoptera and family Heptagnildae (Ephemeroptera, Flat – headed may flies). The orders of tolerance from high to low were Diptera especially Chironomidae, Ephemeroptera especially Baetis sp. And Canis sp., Hydropsychidae (Trichoptera) followed by Plecoptera which was detected only at one site (El-Kassed stream) and in one season (autumn).

All the aquatic insects except the Plecoptera reported in the three Egyptian streams belong to the tolerant class in water bodies, which indicate organic pollution of the three streams studied. Similarly, Keci, et al. (2013) reported tolerant species in polluted Ishmi River, Albania. The occurrence of Plecoptera, though low in number was the only sensitive class present during autumn in El-Kassed stream. Since most Plecoptera were considered as clean water species (Gaufin 1973), it was possible that Plecoptera occupied a suitable clean niche in El-Kassed stream. Emere and Nasiru (2009) reported low numbers of Plecoptera and suggested that they occupied niches in perennial Northern Nigerian streams where the oxygen concentration was higher than values recorded for the stream.

According to total taxa richness for Ephemeroptera, Plecoptera and Trichoptera (SEPT), the result showed that the water quality of the three Egyptian water bodies was poor. However, according to EPT-biotic index, the situation of water quality in the three water bodies was moderate impact and it was "Good" according to Stroud Water Research Center (SWRC) biotic index. An explanation for this may be the fact that for the calculation of EPT biotic index only the families constituting EPT group that in general were more sensible to the changes of the water quality and present lower tolerance values were taken in consideration. Meanwhile, SWRC- biotic index calculations take into account all the families found during the study that in general were more tolerant to the water quality changes.

The present findings were in agreement with those of Paparisto et al. (2010) who calculated EPT Biotic index for 4 stations at Shkumbni River in Albania and observed change of classification of water quality. Meanwhile, results obtained from the calculation of SWRC- biotic index for all stations showed that the situation of the water quality for all the stations was stable during the study period.

From the performance of EPT-biotic index and SWRC- biotic index, it was concluded that both indices were not appropriate to be used for estimating water bio class in Egyptian water bodies. Meanwhile, the SEPT was the most suitable biotic index for estimating water bio class in Egyptian streams.

The EPT-biotic index was almost similar during the different seasons. EPT metric values did not markedly differ between seasons because in any single month a reasonable representative selection of the three EPT orders was always present. Sporka et al. (2006) also recommended avoiding sampling in winter to avoid extreme hydrological regimes and temperature and for logistical reasons.

Generally, the high abundance and distribution of sensitive aquatic insect orders reflect the relative cleanliness of the water. According to Margalef's water quality index, values greater than 3 indicate clean conditions (Lenat et al. 1980). In the three water bodies studied, Margalef's water quality index values were less than 3, indicating that the water quality was impacted. The sites classified as impacted 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 others. This may result in the organic pollution of the streams which, in turn affected the integrality and quality of water resources. This may be the case of the Patagonian North West streams observed by Miserendino et al. (2011).

The present data offers a framework for assessing water quality at three Egyptian governorates. Hopefully this study will inspire future work to refine the application of biotic indices using aquatic insects to monitor pollution in other water bodies in Egypt. This will require species level keys in the future to enable more sensitive biomonitoring studies. A long-term biomonitoring of aquatic insects in water bodies is needed to allow authority agencies to take steps to maintain the health of streams and River Nile in Egypt.

In general, pH, BOD and electrical conductivity values were positively correlated with aquatic insect diversity (Arimoro and Ikomi (2008); Muller et al. 2009). The high pH in the fish aquaculture negatively affected aquatic insect taxa which was mainly due to human activities primarily in the form of nutrient runoff most commonly fertilizers, which leads to increased algal growth and higher pH. Low levels of dissolved oxygen values in the Egyptian streams revealed anoxic or septic condition. Low dissolved oxygen has been reported to be deleterious to most aquatic fauna (Emere2000). The change in BOD values affects the aquatic life diversity. Higher diversity of species in El-Kassed and Rasheed streams correspond with lower BOD while lower diversity in the fish aquaculture was correlated to the higher BOD. Heavy metals were not present in detectable quantities in the three streams. This might be due to sedimentation in the streams or bioaccumulation in aquatic insects.

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