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Macroinvertebrate Communities Associated with the Macrophyte *Potamogeton pectinatus* L. in Lake Manzalah, Egypt

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Abstract: Macroinvertebrates associated with aquatic macrophyte *Potamogeton pectinatus* in Lake Manzalah were studied during four seasons of 2007 from nine stations which covering the lake area. It was found that macroinvertebrate communities consisted of 19 species belonging to four groups. Of these taxa, one oligochaet, eight insects, two crustacean and eight mollusks. The average population density was 176 organisms/m^2 during the period of study. Crustacea occupied the first position of the population density of total macroinvertebrates with 40.86% followed by Insecta (34.73%), Mollusca (23.40%) and Oligochaeta (1.01%). Summer was the most productive season whereas the highest number of individuals was recorded. The diversity index of most studied sites was less than 3, evenness ranged from 0.42 to 0.88. Drops in dissolved oxygen and increase in ammonia taken together can be considered indicative of a poor community of a polluted area.The dominate macroinvertebrates taxa was the amphipod crustacean *Gammarus lacustris* and chironomid larvae. Trichoptera larva was weakly represented because they are indicator for mainly pure running water. The absence of bivalves from macrophytes in the area may be due to the high organic content with the presence of dense vegetation which had a negative impact on the presence of these animals. The results of study support the use of macroinvertebrate communities associated with *Potamogeton pectinatus* is good indicator for monitoring which will be help in management and conservation of Lake Manzalah.

Key words: Macroinvertebrates · Macrophytes · Lake Manzalah · *Potamogeton pectinatus*

INTRODUCTION

The study of biological communities is used as an important tool when assessing environmental conditions and macroinvertebrates are one of the most studied factors [1, 2]. Aquatic macrophytes are an extremely important community in shallow lakes environments and possess rich associated macroinvertebrate fauna. Many species of aquatic macrophytes and their dense stands have an enormous spatial heterogeneity and therefore not only provide shelter for many species of invertebrates, but also play an important role in stabilizing environmental conditions [3]. They provide favorable conditions for many groups by serving as both a substrate and food source for herbivores and periphyton feeders and subsequently for their predators [4, 5]. According to Hynes [6], there is a direct relation between the quantity and richness of aquatic macrophytes and that of its associated fauna. In addition, the aquatic macrophytes' seasonal growth is an important factor that may influence the abundance of invertebrates [7]. According to El-Fiky [8] and Khedr [9], the *Potamogeton pectinatus* community is remarkable for wide range of habitats under which it occurs, from freshwater to brackish and saline water in the northern Egyptian lakes, from shallow and deep and from still to fast running waters. This species offered good swarming places for young fish which sheltered in the tangled leaves when there were plenty of attached organisms on which they feed [9].

Lake Manzalah is a highly dynamic aquatic system. It has undergone extensive physical, chemical and biological changes which have been documented, to some extent, since the early 1900's [10-15]. The lake is considered one of the major sources of fish in Egypt. It contributed nearly 50% of the total country yield during the early 1970's [14] and about 35% during the 1980's [16]. The lake has gradually transformed from a brackish environment [10, 14] to eutrophic freshwater [15], in response to increased freshwater inputs and nutrient loading associated with agricultural land reclamation and urban waste disposal. This transformation process, which

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accelerated during recent years, has influenced several areas of the lake to highly variable degrees.

Lake Manzalah is located in the north-eastern extremity of the Nile Delta (Fig. 1). Its northern border is a narrow sandy fringe which separates the lake from the Mediterranean Sea. It is bordered by the Suez Canal to the east, Damietta Branch of the Nile to the west and cultivated lands to the south.

The lake is the largest of the coastal lakes in Egypt. It covers an area of approximately 100 000 hectares and has a maximum length of 64.5 km, a maximum width of 49 km and a total shoreline length of 293 km. The lake is shallow with an average depth of about 1.0 m. It contains numerous islands which consist of former shorelines, sand dunes and clay hummocks. Fresh and drainage water flows to the lake via seven main sources (Fig. 1). The total annual input from these is approximately 6657 106 m^3. Bahr El Baqar and Hadous drains contribute about 75% of the total inflow. Bahr El Baqar drain carries the partially treated sewage of Cairo. Sewage from Port Said, Damietta, Matariya, Manzalah and Gamaliya is also discharged into the lake. These flows constitute an important source of nutrients to the lake, which in turn promote the high level of fish productivity.

The objectives of this study were to:

- Estimate the abundance of different groups of macroinvertebrates among *Potamogeton pectinatus*.
- Determine the relationship between macroinvertebrates communities and the macrophyte *Potamogeton pectinatus*.
- Use invertebrates communities associated with *Potamogeton pectinatus* as predictors of lake environmental conditions.

MATERIALS AND METHODS

Sampling Stations: Nine stations distributed along the Lake were selected (Fig. 1). Samples were seasonally collected during the year 2007. Two samples were taken from *Potamogeton pectinatus* beds at each site. The macrophytes within a 25 cm quadrate were cut and thoroughly shaken and washed into a 500 μm mesh sweep net to dislodge associated macroinvertebrates.

The collected aquatic macroinvertebrates specimens were transferred to labeled bottles and preserved in 4% formaldehyde and transported to the laboratory for further investigation. In the laboratory, the collected specimens were thoroughly washed by a suitable flow of tap water to remove the mud and the preservative trough a metal sieve (500 μm mesh size). Samples were then poured in a white-bottomed tray of appropriate size and the invertebrates were gently separated from the mud and plant debris by using a fine forceps and good visualization under binocular microscope. All invertebrates' specimens are stored in glass bottles in 75% ethyl alcohol as wet collections. All the specimens were examined and identified as much as possible to species level.

Statistical Analysis: Regression analyses were performed using Microsoft Excel. The Bray Curtis similarity dendrogram, Shanon-Weiner index of species diversity, Species Richness index were calculated using software package PRIMER 5.

RESULTS

Density and Composition: Four major macroinvertebrate groups were recorded to be associated with macrophyte *Potamogeton pectinatus* in Lake Manzalah (Crustacea, Insecta, Mollusca and Oligochaeta). Crustacea were the most abundant group contributing 40.86% of total number of organisms. Insecta and Mollasca followed Crustacea constituted 34.73 and 23.40% of the total population density (P.D.) of macroinvertebrates associated with *Potamogeton pectinatus*, respectively (Fig. 2). The highest P.D. were registered at sites 9, 3 and 1 where 500, 267, 216 organisms/m^2 were recorded, respectively. At site 3, the high P.D. (266.5 organisms/m^2) was due to the large number of Mollusca which constitute 228 individuals/m^2 constituting 85.55% of the total number during the perid of study at this site. Site 2 and site 8 were the poorest sites where 58.8 and 26 individuals/m^2 were recorded respectively (Fig. 3).

Temporal Variations: Macroinvertebrates associated with *Potamogeton pectinatus* in Lake Manzalah were reached its maximum during summer and spring seasons followed by winter and autumn (Fig. 4). The highest average P.D. during summer was resulted from flourishing of Crustacea, while increasing of density during spring resulted from flourishing of Mollusca and Insecta (Fig. 4).

Macroinvertebrates Groups

Mollusca: Mollusca represented by 9 species. *Gyraulus ehrenbergi* is the most abundant mollusk associated with macrophye during this study. *Bulinus truncatus* and *Biomphalaria alexandrina* follow *G. ehrenbergi* in their abundance. *Gyraulus* constituted 70.12% of tatal

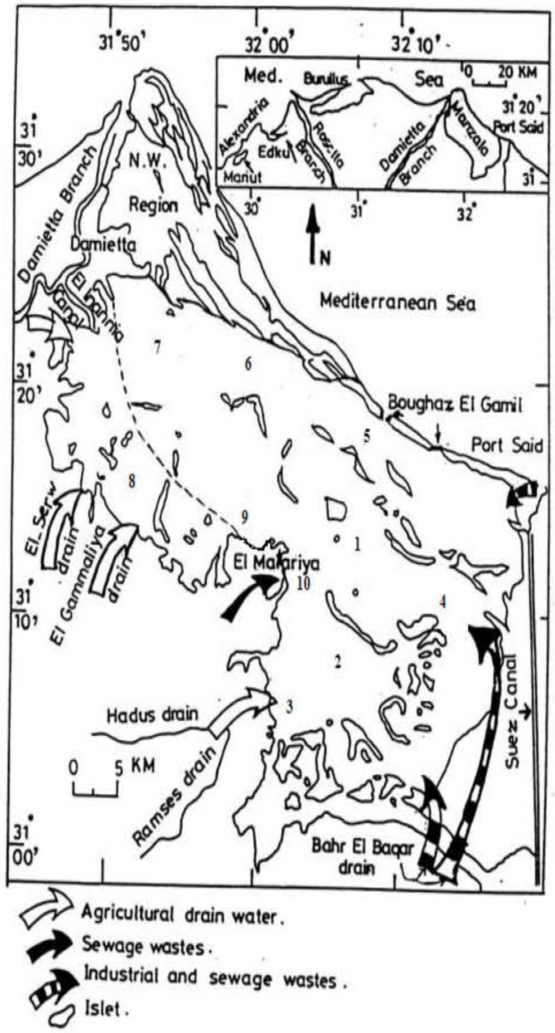

Fig. 1: Map of Lake Manzalah showing sampling locations

Mollusca and it reached its high density at site 3 during spring (800 individuals/m^2). *Bulinus truncatus* and *Biomphalaria alexandrina* constituted about 8.5 and 7.93% of total Mollusca in this study. They reached their highest densities in site 2 and site 3, respectively during spring. *Lymnaea natalensis*, *Melanoides tuberculata* and *Bulinus natalensis*, also found with macrophyte and contributing 4.88, 1.83 and 3.66% of the total Mollusca, respectively. *Succinea cleopatra*, *Pirenella conica* and *Theodoxus niloticus* recorded as a rare form during study (Fig. 5).

Insecta: *Chironomus* larvae showed extensive appearance in all sites. The highest average number recorded in site 9 during spring (500 organisms/m^2). Site 5 is the second populated with *Chironomus* larvae where the average was 71 individual/m^2. Chironomid pupae were recorded with P.D. fewer than the P.D. of Chironomus larvae, the highest P.D. of the pupae was registered at sites 9 and 7. *Hydrovatus* sp. is the second abundant insect species in the area reached its maximum in winter at site 6 (240 organisms/m^2). It disappeared totally from the area during autumn. *Spaniotoma* sp., *Ischnura* sp., *Libellula* sp. and *Caenis* sp.were found on *Potamogeton pectinatus* with averages ranges between 0.5-2.11 organisms/m^2 in the whole area during the whole period of study. Trichoptera species appeared only two times in site 5 during summer and autumn (Fig. 6).

Oligochaeta: Oligochaeta represented only by one species(*Chaetogaster limnaei*) which appeared in sites 1, 3, 4 and 6 (Fig. 7).

Crustacea: Crustacea represented by *Gammarus lacustris* and *Corophium volutator* The first species was observed at sites 9, 6 and 1 with high density and the

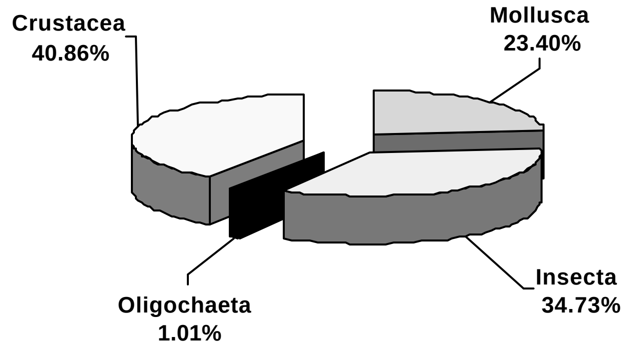

Fig. 2: Percentages of different groups in the area during the study

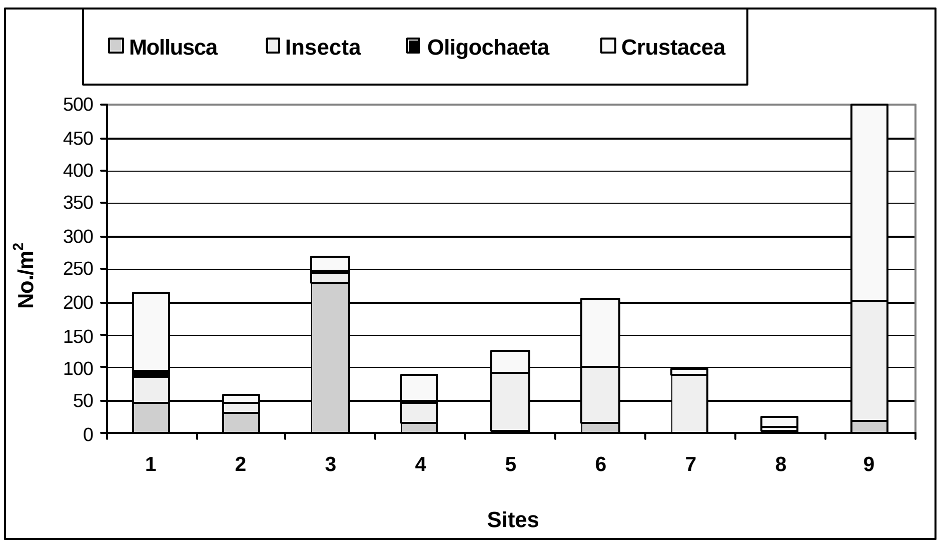

Fig. 3: Average P.D. of different groups in sampling sites during the period of study

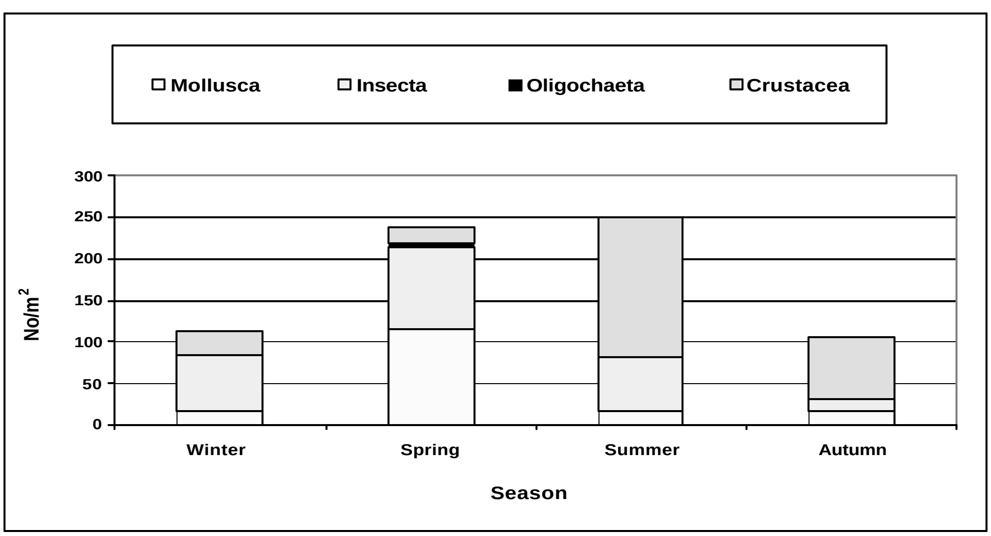

Fig. 4: Average population density (organisms/m^2) of different groups in the whole area during the different seasons

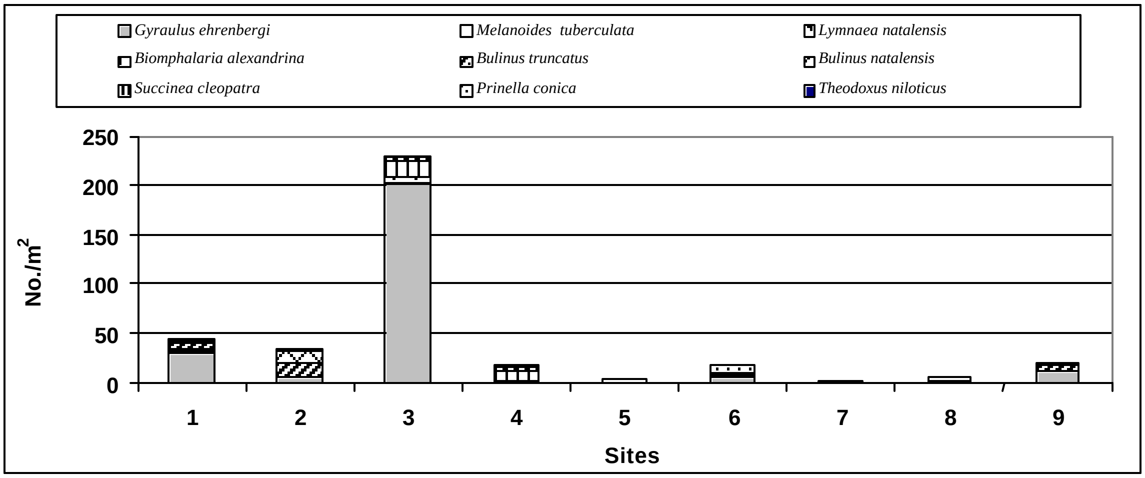

Fig. 5: Average population density (organisms/m^2) of molluscan species in different sites during the whole period of study

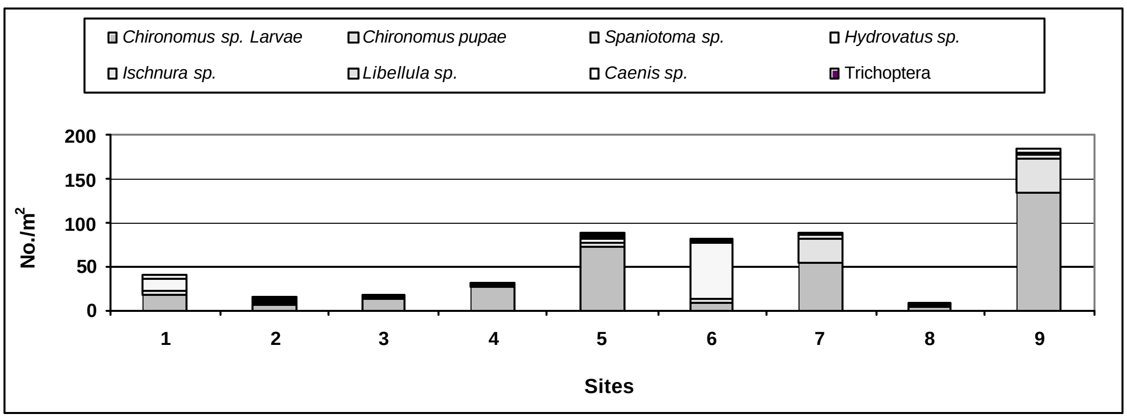

Fig. 6: Average population density (organisms/m^2) of insect species in different stations during the period of study

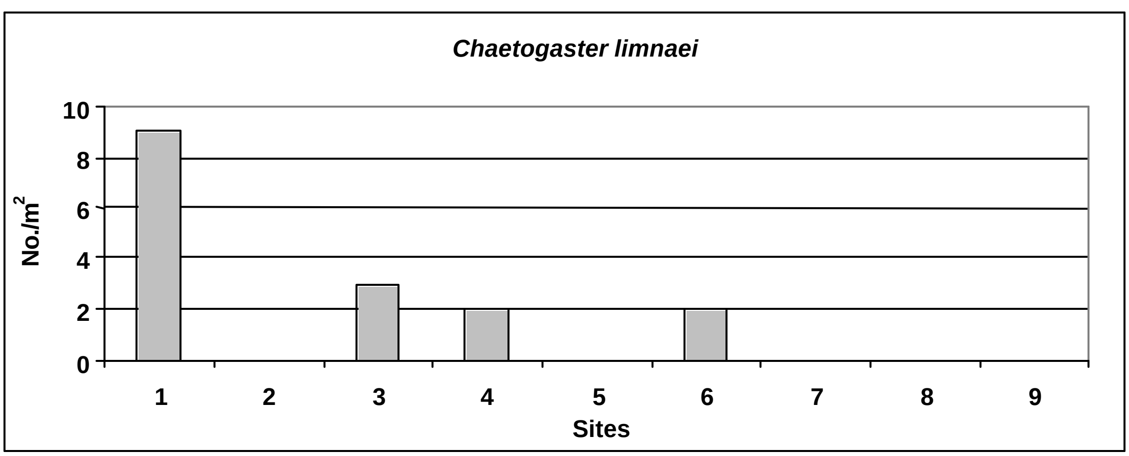

Fig. 7: Average population density (organisms/m^2) of *Chaetogaster limnaei* in different sites during the period of study

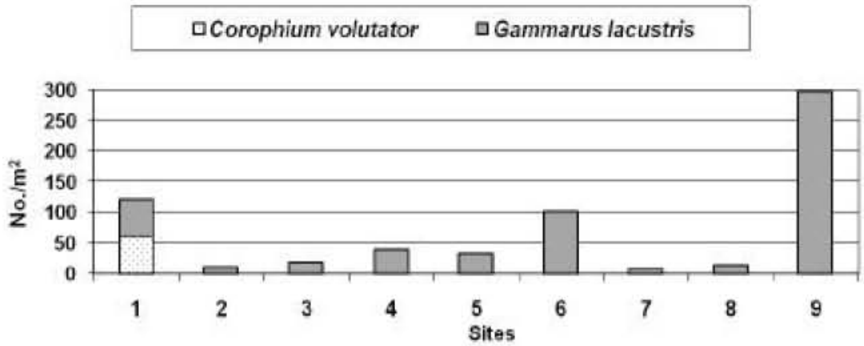

Fig. 8: Average population density (organisms/m^2) of crustacean species in different stations during the whole period of study

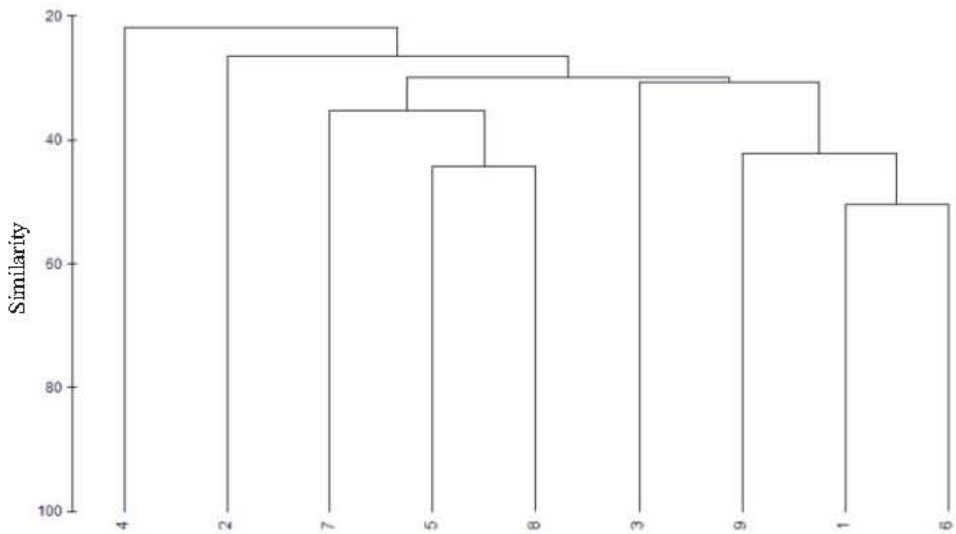

Fig. 9: Cluster analysis similarity between sampling sites of total macroinvertebrates in the studied area

Table 1: Total number of individuals, Number of species, Diversity index, Evenness, Dominance% and Species Richness at each site

Site	1	2	3	4	5	6	7	8	9
Total number of individuals	216.00	58.80	266.60	90.00	126.00	204.00	98.00	26.00	500.00
Number of species	13.00	13.00	10.00	9.00	8.00	13.00	6.00	8.00	12.00
Diversity index	2.80	3.27	1.41	2.15	1.80	2.16	1.69	2.20	1.64
Evenness	0.76	0.88	0.42	0.68	0.60	0.58	0.66	0.73	0.46
Dominance (%)	56.48	40.82	82.55	73.33	83.33	79.90	83.67	65.38	86.60
Species Richness	2.23	2.95	1.61	1.78	1.45	2.26	1.09	2.15	1.77

other sites showed less densities (Fig. 8). Suummer was the most productive season due to flourishing of *Gammarus lacustris* (167organisms/m^2). On the other hand, the lowest average was registered during spring (20 organisms/m^2). The second crustacean, *Corophium volutator* appeared only in autumn at sites 1, 2 and 6 during this study (Fig. 8).

Richness, Evenness and Biodiversity of Macroinvertebrates: A relatively high value of similarity was found between site 1 and 6 and secondly between 8 and 9, whilst site 4 and 7 showed lower value of similarity (Fig. 9). The diversity index of macroinvertebrates ranged between 1.41 and 3.27. Both diversity and richness indices of macroinvertebrates were high in site 2. The evenness index was high in site 2 and low in site 3. It ranged from 0.42 to 0.88 .The dominance percentage reached its maximum (86.6) in site 9, while the lowest one (40.2%) was recorded in site 2 (Table 1).

DISCUSSION

Marcophyte communities play a curcial role for animals and lower plants in aquatic ecosystems by providing habitat complexity, shelter, breeding area, sites of abundant food production for many aquatic animals [17-19] and cover invertebrates from vertebrate predators [20]. Therefore, they influence the diversity, abundance and distribution pattern of aquatic invertebrates and vertebrates [21, 22].

This search work is the first to study the influence of *Potamogeton pectinatus* on the diversity of macroinvertebrates in Lake Manzalah. 19 species of macroinvertebrates were registered associated with macrophyte in Lake Manzalah. Cry and Downing [23] related the differences in numbers of invertebrates in various macrophyte associations to be a result of joint impact of a number of parameters and factors such as plant morphology, surface texture, epiphytic algal growth, community composition, nutrient content of plant tissue and presence of defensive chemical. In this study, it was found that the number of species reached its lowest value at site 4. This may be attributed to the effect of pollution whereas organic wastes and some inorganic material exert, upon decomposition, an oxygen demond which deplet the dissolved O_2 below levels required by aquatic life [24]. The last author investigated some of the water quality parameters at the same time of our sampling and found that ammonia concentration was high in the north southern region. The average ammonia-N concentration in the majority of sites (2, 3, 4, 5 and 7) showed higher levels than the chronic guideline recomended by USEPA [25] for the protection of aquatic life at the recorded average pH values, where the toxicity of ammonia is pH dependent. The drops in dissolved oxygen and increase in ammonia at sites 2,3,4 and 5 can creat environments where only a limited number of species those tolerant to such conditions will survive. This agrees with Buell and Girard [26]. The number of taxa found for site 6 was significantly higher than that found for other sites (Table 1). These results can mostly be explained by the dense macrophytes habit and morphology present in this site. On the other hand, the lowest abundance of macrobenthos was recorded at site 5. This could be mainly attributed to strong water current coming from Boughas El-Gamil which prevents these animals from adhering to their substrata. According to Shäfer [27], high levels of evenness indicate an environment with heterogeneous conditions regulated by a community which is rich in the number of species and the multiplicity of their mutual relationships. The variations found suggest that these conditions were extremely heterogeneous in some sites and simplified in others leading to a less rich community structured in a simpler way.

In the present study, the dominate macroinvertebrtes taxa was the amphipod crustacean *Gammarus lacustris*. This agrees with Kurashove *et al.* [28] who recorded that, Amphipoda were among invertebrates associated with macrophytes in Lake Ladoga. Shannon *et al.* [29] stated that *Gammarus lacustris* was positively correlated with the distribution of the green filamentous alga *Cladpohora glomerata* and its epiphytic diatoms assemblages in the Colorado River. *G. lacustris* was heavily abundant in Lake. The same finding was recorded by Ibrahim *et al.* [30] in Lake Manzalah stations where richness in aquatic vegetation and show maximum abundance in spring and summer.

Chironomid larvae and pupae are important groups of aquatic insects inhabiting area. Chironomid larvae were found in all sites of Lake Manzala with much more concentration in areas rich in *Potamogeton* sp. [30]. Similar results were achived by Samaan and Aleem[31], in Lake Mariut and Samaan *et al.*[32] in Lake Burollus. Ali *et al.*[33] registered chironomid larvae among the macro inverteberates associated with macrophyte in Lake Nasser.

Odonata nymphs (*Ischnura* sp. and *Libellula* sp.) were found to be associated with *Potamogeton pectinatus* in some sites in Lake Manzalah during this study. Odonata are predatory insects [34] and may use macrophytes as a substrate and also as an ambush point to capture their prey. The larvae are an important part of aquatic food webs [35]. The high density of these taxa at site (1) could be explained by the better water quality in this site, since some research has shown that they could be a good environmental condition indicator [36].

Trichoptera larva registered in the area by weak representation during this study. This may be due to discharge of waste from different drains in Manzalah Lake. Trichoptera larvae are indicator for mainly pure running water [37, 38].

Gastropoda ranked the third position among macroinvertebrates associated with macrophyte in the area. The commenst species was *Gyraulus ehrenbergi* followed by *Bulinus truncatus* and *Biomphalaria alexandrina,* this agrees with Kibret and Harrison [39] who stated that Gastropods were not abundant in the weed beds of Lake Awasa (Ethiopia). Few numbers of *Theodoxus niloticus* and *succinea cleopatra* were found to be associated with *Potamogeton* sp. of Lake Manzalah. This agrees with Ibrahim *et al.* [40]. The absence of bivalves from macrophytes in the area may be due to high organic content with the presence of dense vegetation. This agrees with Sanchez-Moyano *et al.* [41] who stated that dense algal (vegetation) cover has a negative effect on the bivalves [42].

Oligochaeta is a typical detritivorous [43]. According to Trivinho-Strixino *et al.* [44], the roots and other submersed parts of macrophytes accumulate detritus and large quantities of organic matter, favoring the establishment of populations of detritivorous and collector feeding organisms. Owing to other factors and interactions, the feeding habits of Oligochaeta may have contributed to presence in Lake Manzalah.

In conclusion, the results of this study support the use of macroinvertebrate communities associated with *Potamogeton pectinatus* as a good indicator for monitoring which will be help in management and conservation of Lake Manzalah.

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