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Macro-invertebrates in the Wetlands of the Zarrineh estuary at the south of Urmia Lake (Iran)

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ABSTRACT: This research summarizes the data on benthic macro invertebrates collected from 25 points in the urmia Lake wetlands during November 2008 to February 2009. The purpose of the study was to assess the effects of elevated salinity and nutrient (nitrogen and phosphorus) levels on macro invertebrate abundance and composition. A total of 32 taxa were collected, and the common taxa, including Chironomidae (midges), Corixidae (water boatmen), *Erythemis* (damselflies), *Ephemerella* (mayflies), *Hyalella* (amphipods), and snails. Samples at ponds with salinities greater than 10 ppt showed a shift in community composition to salt-tolerant taxa and a reduction in total diversity. The corixid *Trichocorixa verticalis*, the brine shrimp *Artemia partenogenetica*, and the dipteran *Ephydra* are salt-tolerant species that only occur at high salinity levels. Ponds relatively high in nutrients had fewer total taxa, reduced abundance and diversity of aquatic beetles, lower diversity index values, and a greater dominance by chironomids than ponds low in nutrients. It is suggested to allocate about 10 $\times 10^6$ cubic meters freshwater of the represented rivers to these wetlands to improve their trophic condition and transfer their hypereutrophic waters into the Urmia Lake for more production of the macro invertebrates both in the wetlands and on the lake.

Key words: Benthic invertebrates,Chironomids, Fowls feeding,Trophic states, Artemia

INTRODUCTION

The main primary freshwater sources for Urmia Lake from its south part is the Zarrineh River that guarantee more than 50 percent of annual inflow to the lake, other parallel rivers like Simineh River, and Ghadar River have less importance and represent only 35 percent of the water input to Urmia Lake (Mohaggeg, 2002). Some of the freshwater from these sources flows unimpeded to Urmia Lake, but much of it is impounded within dam or dikes and other artificial structures. The quantity of water flowing into the lake varies yearly with climatic changes. These changes have a profound impact not only on the surface area of the lake but also on the surface area and water quality of its surrounding wetlands specially those that located on its estuary parts. Water quality conditions differed among the wetlands and ranged from mostly freshwater, nutrient-rich (eutrophic) conditions to more saline, nutrient-poor (oligotrophic) conditions. Hydrology has commonly important control on wetland ecosystems, creating the hypoxic conditions necessary for soil development, and the stressed conditions to which specialized vegetation is adapted (Mitsch and Gosselink, 2007). Habitat complexity can shape the trophic interactions between macro invertebrates and other organisms such as fish and consequently affect food webs. Vegetation structure and diversity, fish presence and water fowl presence have been found to control macro invertebrate's populations (Honung and Foote, 2006). Wetlands can support diverse invertebrate communities including aquatic, semi aquatic and terrestrial species. Some invertebrates, such as certain mosquitoes and fairy shrimp, are obliged to live in wetlands while a number of terrestrial insects including some beetles, moths and butterflies feed only on wetland plants. In addition, many invertebrates that evolved in other habitats can opportunistically inhabit wetlands (Sharitz and Batzer, 1999). The "macro" in macro invertebrates generally refers to invertebrates that are large enough to be seen with the unaided eye (Voshell, 2002), or to be retained by a standard sieve mesh opening size, usually about 500 microns (McCafferty and Provonsha, 1981). Aquatic macro invertebrates form an important component of the tropic structure of any wetland ecosystem, that they feed on algae and macrophytes

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(Grubh and Mitsch, 2003) and are important as food for fishes (Findlay *et al.,* 1989) and aquatic birds (Kostecke *et al.,* 2005). Macro invertebrates are recognized therefore as key links between wetland primary production and higher trophic levels (Grubh and Mitsch, 2004). A combination of oxygen-rich open water and detritus producing emergent plant areas has been found to maximize invertebrate biodiversity (Nelson *et al.,* 2000). Biodiversity in these systems is considered to be very high because of their position at the interface between aquatic and terrestrial environments (Junk 2003).

This research summarizes the data on benthic macro invertebrates collected from 25 sites in the wetlands situated on the estuary of Zarrineh River from November 2008 to February 2009. These collections provided data to assess the effects of elevated salinity levels and eutrophic conditions (as indicated by nitrogen and phosphorus levels) on macro invertebrate abundance and composition.

MATERIALS & METHODS

The situations of 25 points sampled from 5 wetlands in 2008-2009 are showed on Fig. 1. Three replicate samples of each site were collected. Samples were placed in plastic jars with labels and preserved in alcohol. Processing of the samples was conducted from November 2008 to February 2009. Samples were washed with tap water on a 500 µm-mesh brass sieve to remove the alcohol and finer debris. The remaining material was placed in a white enamel pan for separating animals from the larger debris. If a sample contained relatively few animals (<100), all animals were collected. If a sample contained a large number of animals, all of the uncommon taxa were collected completely, and abundant taxa (typically Chironomidae) were sub sampled. Identifications were based on keys given in the Taxonomic References, indicated on Table.1.

Most animals were intact and identifiable from the field samples, but a few taxa showed evidence of significant decomposition during the period between collection and processing. Snails were often present only as empty shells, and oligochaetes frequently disintegrated during washing. The biological Integrity of the macro invertebrate populations on each wetland estimated based on shanon biodiversity index. Statistical tests (e.g., descriptive measures, regression and correlation, comparisons of means between samples, principal components analysis) were calculated using SPSS analytical Software. Water chemistry data were obtained from same points as the macro invertebrate samples collected.

Table1. Main references used for Macro invertebrate's identification in this study

invertebrates groups	Reference
Oligochaeta	Pennak 1978 and Peckarsky, 1990
Hirudinea	Sladecek, 1984
Mollusca (Gastropoda)	Zhadin,1952
Amphipoda	Karaman,1977
Decapoda	Hay,1896 and Hobbs1989
Odonata	Watson,1991
Ephemeroptera	Elliott,1988
Hemiptera	Unwin,2001
Trichoptera	Neboiss,1991
Coleoptera	Skidmore,1991
Diptera (Chironomidae)	Warwick,1990 and Ashe,1983

RESULTS & DISSCUSION

A total of 32 taxa were collected (Table 2). The most abundant taxa were Chironomus and other Diptra (Tanypodinae), Gastropoda (snails), Crustacea (Hyalella), Hemiptera (Corixids and Notonecta), Odonata (damselflies), Ephemeroptera (mayflies). The related abundance of these taxa at the sampling sites during one year is indicated in fig. 2.

There was a positive relationship between density of vegetation and abundance of macro invertebrates in the samples. The density of submerged vegetation in the sampling area was recorded as sparse, moderate or dense at the time of the sampling. Analysis with ANOVA indicated a significant difference between abundance of macro invertebrates and density of vegetation (p=0.03).

There was spatial and temporal variation in abundance of different taxa collected. Some macro invertebrate assemblages changed seasonally because taxa have been found to colonize wetlands at different times of the year (De Szalay and Resh, 2000). Different taxonomic groups of macro invertebrates are sensitive to different pollutants and can act as key indicators of disturbance caused by stressor gradients (e.g., nutrient gradients) in wetland ecosystems. These attributes of macro invertebrates make them attractive biological indicators in biological assessment programs. Nowadays, macro invertebrates have been used as key indicators of wetland condition (Gallbrand et al. 2007). Pollution-tolerant macro invertebrate taxa were more abundant at the freshwater nutrient-rich sites than at the more saline, oligotrophic reference sites (Gray, 2005). In particular, tolerant macro invertebrates such

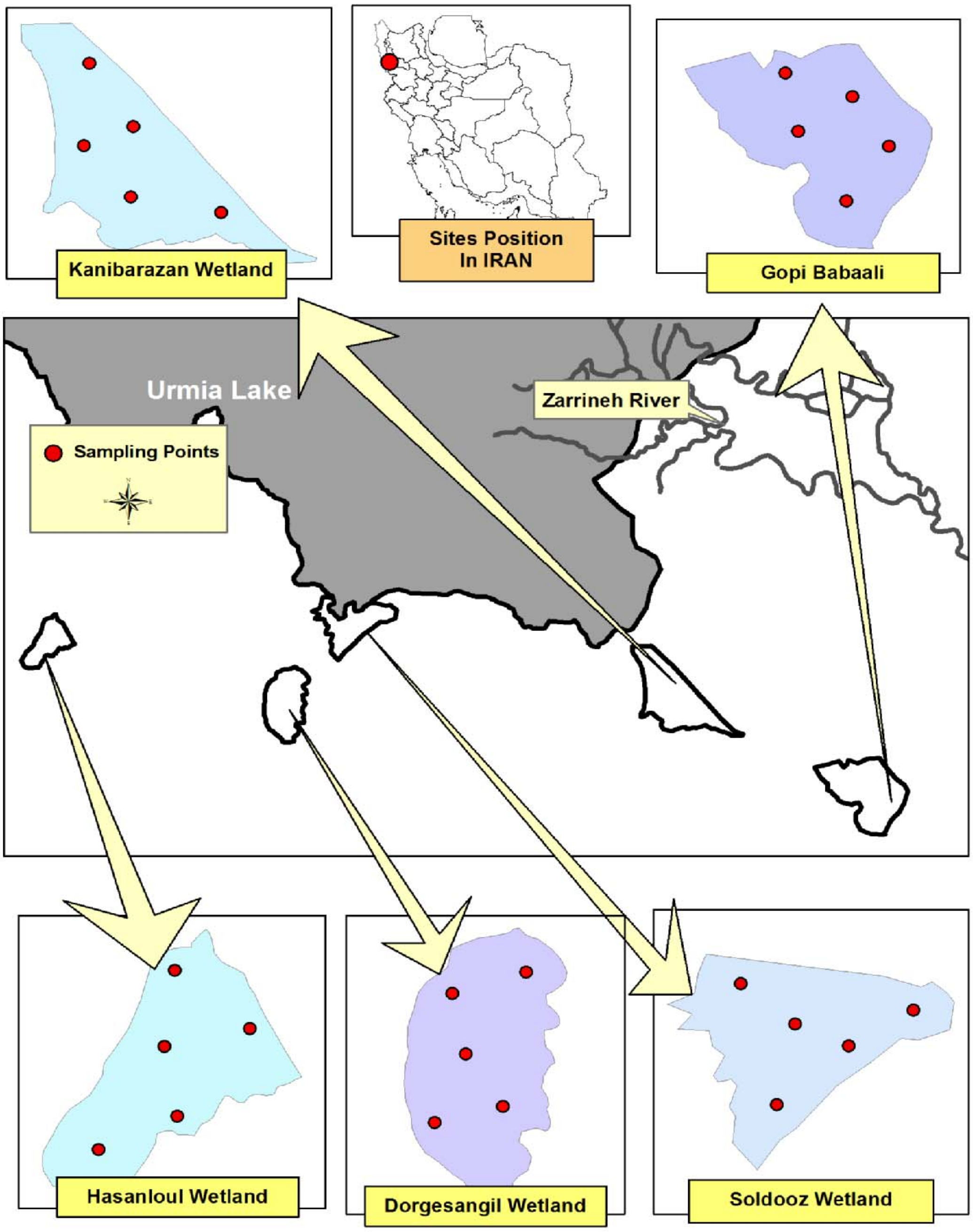

Fig. 1. Map of wetlands and the situation of sampling sites

as flatworms, leeches, gastropods, and chironomids were usually abundant at the nutrient-rich sites, whereas pollution sensitive species such as Ephemeroptera (mayflies) and Odonata (damselflies and dragonflies) were in far greater numbers at oligotrophic sites. In higher salinities only corixid *Trichocorixa verticalis*, the brine shrimp *Artemia partenogenetica*, and the dipteran *Ephydra* were found.

Some of the macro invertebrate taxa observed at the wetland sites served as extremely sensitive indicators of water quality. A consistently sensitive indicator of water quality was the number of Ephemeroptera (mayflies) in the impounded sites. Mayflies were typically far more abundant at the relatively saline, oligotrophic reference sites than at the freshwater, more nutrient-rich sites. Invertebrate species diversity was also generally higher at the relatively saline, oligotrophic sites than at the nutrient-rich sites.

Table 2. List of macro invertebrate taxa collected at sampling sites during the study period

Class(subclass)	Order	Family	Genus	Species
Gastropoda	Basommatophora	Physidae	*Costatella*	*acuta* (Draparnaud,1805)
Bivalvia	Eulamellibranchiata	Sphaeriidae	*Sphaerium*	*corneum* (Linnaeus, 1758)
Gastropoda	Mesogastropoda	Thiaridae	*Melanopsis*	*tuberculata* (Muller, 1774)
Gastropoda	Basommatophora	Lymnaeidae	*Lymnaea*	*auricularia*(Linnaeus, 1758)
Clitellata (Hirudinea)	Rhynchobdellida	Piscicolidae	*Piscicola*	*geometra* (Linnaeus, 1761)
Clitellata (Hirudinea)	Rhynchobdellida	Glossiphoniidae	*Helobdella*	*stagnalis*(Linnaeus, 1758)
Clitellata(Oligocheata)	Haplotaxida	Tubificidae	*Limnodrilus*	*hoffmeisteri (Claparede, 1862)*
Clitellata(Oligocheata)	Haplotaxida	Tubificidae	*Branchiura*	*sowerbyi(Beddard, 1892)*
Malacostraca	Amphipoda	Hyalellidae	*Hyalella*	*Azteca* (Saussure, 1858)
Branchiopoda	Anostraca	Artemiidae	*Artemia*	*parthenogenetica* (Barigozzi,1974)
Insecta	Odonata	Coenagrionidae	*Coenagrion*	*hastulatum* (Charpentier, 1825)
Insecta	Odonata	Libellulidae	*Erythemis*	*collocata* (Hagen, 1861)
Insecta	Ephemeroptera	Baetidae	*Callibaetis*	*nigritus* (Banks, 1918)
Insecta	Ephemeroptera	Caenidae	*Campusurus*	*notatus* (Eaton,1868)
Insecta	Ephemeroptera	Ephemerelliidae	*Ephemerella*	*ignita* (Poda, 1761)
Insecta	Hemiptera	Corixidae	*Corisella*	*Inscripta* (Uhler, 1894)
Insecta	Hemiptera	Corixidae	*Trichocorixa*	*Verticalis* (Fieber, 1851)
Insecta	Hemiptera	Corixidae	*Nepa*	*cinerea*(Linnaeus, 1758)
Insecta	Hemiptera	Notonectidae	*Notonecta*	*indica* (Linnaeus, 1771)
Insecta	Trichoptera	Leptoceridae	*Limnophilus*	*flavicornis* (Fabricius, 1787)
Insecta	Coleoptera	Dytiscidae	*Coptotomus*	*interrogatus* (Fabricius 1801)
Insecta	Coleoptera	Dytiscidae	*Laccophillus*	*hyalinus* (De Geer, 1774)
Insecta	Coleoptera	Dytiscidae	*Hydaticus*	*stagnalis* (Fabricius, 1787)
Insecta	Coleoptera	Hydrophilidae	*Enochrus*	*sayi* (Gunderson, 1977)
Insecta	Diptera	Ceratopogonidae	*Culicoides*	*impunctatus* (Goetghebuer 1920)
Insecta	Diptera	Ephydridae	*Ephydra*	*Cinerea* (Jones 1906)
Insecta	Diptera	Chaoboridae	*Chaoborus*	*crystallinus* (De Geer, 1776)
Insecta	Diptera	Chaoboridae	*Chaoborus*	*punctipennis* (Say, 1823)
Insecta	Diptera	Chironomidae	*Chironomus*	*plumosus* (Linnaeus, 1758)
Insecta	Diptera	Chironomidae	*Coelotanypus*	*tricolor* (Loew, 1861)
Insecta	Diptera	Chironomidae	*Subfam.*	*Tanypodinae* (Kieffer, 1906)
Insecta	Diptera	Chironomidae	*Microchironomus*	*nigrovittatus*(Malloch, 1915)

Plant communities can enhance macro invertebrate communities by providing food and habitat (Batzer and Wissinger, 1996) as well as structure to the ecosystem, altering water flow, enhancing sedimentation rates, creating oxic-anoxic boundaries (Humphrey and Stevenson, 1992). Nairn (1995) noted that more pollution-tolerant taxa were found near the inflow than pollution-intolerant taxa. More gastropods were collected in the inflow in the sampling period. The presence of mayflies is in general an indicator of good water quality and there were more of the Ephemeropterans Baetidae, Caenidae and Ephemerelliidae in the outflow which enters the Urmia Lake. However, the families Baetidae and Caenidae are exceptions to the rule that mayflies being good indicators of water quality, as they can be found in polluted as well as pristine water (Voshell, 2002).

This research also reported some factors that may be affecting macro invertebrate community dynamics at the wetland sites. More important potentially confounding factors include the salinity and freshwater inflow, which could affect macro invertebrate community composition, especially when total salinity exceeds 10 parts per thousand (ppt).

Tolerant species such as Chironomous were more abundant at eutrophic sites with fresh waters but sensitive species like mayflies and Hyallela were more abundant at relatively saline oligotrophic sites. The total number of macro invertebrates and its biomass represented on the eutrophic wetlands were more than that of the oligotrophic wetlands with high salinity (more than 50 ppt) but the biomass of total taxa showed the reverse state especially at the relatively saline wetlands.

Considerable amounts of nutrients from hydrologic sources in Urmia Lake are likely removed because the rivers discharges flow through wetlands, also the discharges of the Zarrineh and other input Rivers always pass through reservoirs before entering the Urmia Lake. During the low water years, the loading more salts from the Urmia Lake is adequate to cause oligotrophic conditions in wetlands, and this reduces the macro invertebrate populations and imposes a limitation for fowl feeding, specially when the salinity of these areas reaches up to higher than 50 ppt.

CONCLUSION

In the freshwater wetlands far from the Urmia Lake, the amount of entered waters and their nutrients (nitrogen and phosphorus) have the major role in their trophic states. But increased salinity from 0 up to 20 or 30 ppt on the saline areas near of the lake created favorable salinity to bloom blue-green algae (Stephens, 1990) then, in these areas the population of macro invertebrates grew rapidly. In higher salinities increased cyanobacteria populations was observed as Wurtsbaugh (2005) reported that the cyanobacteria population were very abundant on Farmington bay , when salinities ranged from 0.5 – 5%.

The abundant population of cyanobacteria could increase nitrogen fixation from the air on the wetlands and could affect their trophic states as Wurtsbaugh (2006) observe it on Farmington bay. Higher salinities above the 50 or 60 ppt could reduce the cyanobacteria population and also reduce primary production on the wetlands areas so that the food limitation on macro invertebrates can reduce their population.

The reducing of freshwater sources and their discharges flow through Urmia Lake during the recent years not only has increased the salinity of the lake but also the salinity on its periphery wetlands and so their trophic status has become more oligotrophic. Although, this condition may increase the wetlands Biological Integrity showing on Shanon's diversity index on the macro invertebrate populations, on the other hand, the salinities more than 50 ppt decreased the biomass of total taxa dramatically.

It is recommended that manage the rivers discharges flow to wetlands to manage their salinity and also to built suitable channels from these wetlands to transfer their hypereutrophic water to the Urmieh Lake to improve the trophic status both in the wetlands and in the lake.

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