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Effect of Water Fluctuations on Macroinvertebrates Communities of Gomishan Wetland, Iran

[1]F. Shirood Mirzaie, [2]R. Ghorbani, [2]S.A. Hoseini and [3]O. Abdi

[1]Gorgan University of Agricultural Sciences and Natural Resources, Gorgan, Iran
[2]Department of Fisheries,
Gorgan University of Agricultural Sciences and Natural Resources, Gorgan, Iran
[3]Gorgan Organization of Jihad &Agriculture, Iran

Abstract: The effect of water-rise and water-fall on macroinvertebrates communities of Gomishan Wetland was studied. The wetland divided to four stations and in each station, 4 locations (water-rise area, coast area, central area and near the sea) were sampled in 3 repetitions by Ekman Grab. After separations, 10 families of macroinvertebrates were identified. The maximum and minimum density had belonged to the Pyrgulidae (Gastropoda) and Nereidae (Polycheata), respectively. Five indices were calculated to assess the biological health, diversity, richness, evenness and distribution in Gomishan Wetland. The results showed that the density of macroinvertebrates increase by water-rise in summer. The Margalef's Diversity Index and Shannon-Wiener Index showed the low variation, bad status and high pollution in the Gomishan Wetland which the healthiest part of the area was water-rise area. According to Pielou Evenness Index, macroinvertebrates community is becoming more uniform and homogeneous gradually over the time. The analysis of Sorenson Index showed that the water-rise area was different from the others. The type of distribution of macroinvertebrates was contagious in the most locations. The analysis showed considerable change in macroinvertebrates density and diversity in water-rise and water-fall seasons in Gomishan Wetland.

Key words: Water Fluctuation · Macroinvertebrate · Gomishan Wetland

INTRODUCTION

Wetlands have an important ecological and economic role on the earth and provide a proper wildlife habitat for many species of plants and animals [1]. Invertebrates play a major role in recycling nutrients and are the primary consumers through which plant production becomes accessible to higher trophic levels. Compared to other topics such as hydrology, biogeochemistry, soils and wetland plants, they receive minimal attention in general treatments of wetland ecology [2-4] and wetland restoration [5, 6]. The fauna of wetlands is similarly dominated by invertebrates uniquely adapted to the shallow and often fluctuating water levels in wetlands. Rather than referring to these species as “semiaquatic” or “semiterrestrial” it would be simpler and more accurate to use the term “wetland invertebrates” to distinguish this group of taxa from those that inhabit aquatic and terrestrial habitats. The wetland invertebrate communities are dominated by a distinctive group of taxa, many of which do not occur in terrestrial or aquatic (>2 m depth) ecosystems.

According to the wet phase and dry phase of wetlands, they can be divided to different groups. Wiggins *et al*. [7] distinguish temporary habitats that dry phase occurs only for a short period in summer and refill in autumn (autumna1) from those that are typically filled for only a short time in spring (vernal). Although some wetlands are clearly autumnal or vernal, some wetlands are different. For example, playas in Texas and marshes in California have a relatively short wet phase to their hydroperiod, like vernal pools in the Northeast, but the wet phases are in the summer and winter rather than the spring and they might be called “summer-wet” and

Corresponding Author: F. Shirood Mirzaie, Gorgan University of Agricultural Sciences and Natural Resources, Iran.
Tel: +989382698077, Fax: +981712245886.

“winter-wet" hydroperiods, respectively. In Gomishan Wetland, wet phase occurs in summer (personal observations). Therefore, it is classified as summer-wet hydroperiods.

The effect of these fluctuations in the depth of wetlands on macroinvertebrates communities has been less studied. In this study, we tried to determine the effect of water-rise and water-fall of Gomishan Wetland on macroinvertebrates communities. According to importance of macroinvertebrates in wetlands ecosystems, such basic studies seem necessary for correct planning and management policies.

MATERIALS AND METHODS

Gomishan International Wetland is located in the southeast of Caspian Sea [8] and is a coastal and permanent wetland [9]. The average depth of this wetland is 1m [10] and the total area is 20000 ha. The eastern border of this wetland is subjected to change due to fluctuations of Caspian Sea water level. Because of these fluctuations, the depth of water in Gomishan Wetland is variable [8] and the area increased. The increasing of the area is not permanent and decrease by decreasing of Caspian Sea water level [9].

To investigate the influence of water-level fall and rise on macroinvertebrated communities in Gomishan Wetland, the sampling was carried out in spring (as water-level fall season) and summer (as water-level rise season). Due to the large extent of this wetland, it was divided to four stations: Shrimp Breeding Station (1), Gomishan Coast (2), Drainage (3) and Bandar-e-Torkaman coast (4) (Fig. 1).

In each station, the samples of macroinvertebrates were collected from three locations: coast area, near the sea and water-rise area. In each station, 12 samples of macroinvertebrates (replicates) were collected by Ekman Grab (sampling surface area: 225cm^2) which belonged to the four areas: the water-rise area, coast area, central area and near-the-sea area with three repetitions in each area.

The samples of macroinvertebrates were sieved alive over a 60μm mesh-sized sieve. After sieving, the samples were fixed in 4% formalin and transported to the laboratory for counting and identification. The macroinvertebrates was identified by the Atlas of Caspian Sea Invertebrates [11] and counted for the determining of density.

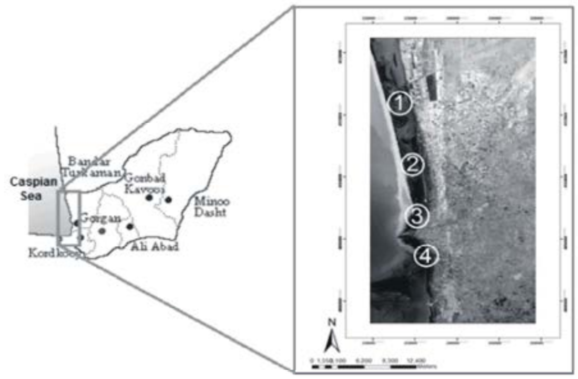

Fig. 1: The study area of Gomishan Wetland and sampling locations.

Table 1: The relationship established by Molvaer *et al.* [14] for the investigation of ecosystem

Result	Shannon-Wiener Index (bits/individual)
High status	4<
Good status	4-3
Moderate status	3-2
Poor status	2-1
Bad status	1-0

Data Analyses: The indices, which have been calculated in this research, contain: Margalef's Diversity Index, Shannon-Wiener Index, Pielou Evenness Index, Sorenson Index and distribution index which have been calculated by the equations below:

Margalef's Diversity Index: $R_i = S - 1/Ln(N)$

Where S is the number of species and N is the density of species. Ross and Cardell [12] have expressed that if the amount of Margalef's index is lower than 4, the study area have pollution but Bellan-Santini [13] notified that there is pollution in the study are, if the amount of Margalef's index is lower than 2.05.

Shannon-Wiener Index: $H' = -\sum_{i=1}^{n} P_i \log 2P_i$

Where n is the total number of species and P_i is the ratio of the species i. Molvaer *et al.*14] have mentioned a standard for the investigation of ecosystem pollution by Shannon-Wiener Index which has been explained in Table 1.

Pielou Evenness Index: $J' = \frac{H'}{H'_{max}} = \frac{H'}{LnS}$

Where H' is the amount of Shannon-Wiener Index and S is the number of taxon in samples.

Sorenson Index: $Q_S = \frac{2C}{A+B}$

Where A and B are the number of species in station A and B, respectively and C is the number of similar species in two stations.

The diversity of macroinvertebrates was investigated by distribution index. This index was obtained by dividing the variance on the average value. If the amount of variance is bigger than the average value, the type of distribution will be contagious (clumped) and if it is smaller, regular distribution will obtained [15, 16].

Excel (2010) and SPSS (16) were used for statistical analyses. The amount of indices were analyzed in different stations and locations with one-way ANOVA/Duncan (p<0.05).

RESULTS

After the investigations, 10 families of macroinvertebrates were identified which consist of Scrobiculariidae, Mytilidae, Pyrgulidae, Chironomidae, \Gammaridae, Cardiidae, Ampharetidae, Tubificidae, Nereididae and Balanidae which belong to the 7 orders, 6 classes and 3 phylum of Mollusca, Arthropoda and Annelida.

The comparisons of Margalef's Index showed that only in the spring, there was a significant difference between water-rise area and the other areas. However, in other locations and in different seasons, there was no significant difference. Low levels of Margalef's Index in various stations and locations show pollution in Gomishan Wetland (Table 2). Also, according to the classification of Ross and Cardell [12] and Bellan-Santini [13], the pollution of Gomishan Wetland was confirmed.

The maximum and minimum amount of Shannon-Wiener Index in both spring and summer, revealed in the central area and water rise area, respectively. The Shannon–Wiener Index value in summer was more than the spring in all locations, except in water-rise area. The water-rise area showed significant difference with coast area and central area only in summer (Table 3). According to the Shannon-Wiener Index and the standard of Molvaer *et al.* [14], the pollution is high in all locations and in both spring and summer seasons and Gomishan Wetland is classified in the class of bad status.

The comparison of the Pielou Evenness Index in different locations of Gomishan Wetland in both spring and summer showed no significant differences between locations and also, between the two seasons (Table 4).

The minimum amount of Sorenson Index can be seen between the water-rise area in the spring and near the sea area in the spring and the central area in summer. It means that there were the most differences between these locations. Also, the value of this index in the coastal area

Table 2: The comparison of Margalef's Index□ in different locations of Gomishan Wetland in spring and summer

Location Season	Water-rise Area	Coast Area	Central Area	Near the Sea
Spring	A 1.73^{a}	A 1.35^{b}	A 1.35^{b}	A 1.33^{b}
Summer	A 1.62^{a}	A 1.49^{a}	A 1.47^{a}	A 1.48^{a}

*Similar superscript letters at the same row and similar letters at the same column show no significant differences between locations and seasons, respectively.

Table 3: The comparison of Shannon-Wiener Index□ in different locations of Gomishan Wetland in spring and summer

Location Season	Water-rise Area	Coast Area	Central Area	Near the Sea
Spring	A 0.37^{a}	A 0.45^{a}	A 0.53^{a}	A 0.52^{a}
Summer	A 0.35^{b}	A 0.63^{a}	A 0.69^{a}	A 0.61^{ab}

*Similar superscript letters at the same row and similar letters at the same column show no significant differences between locations and seasons, respectively.

Table 4: The comparison of Pielou Evenness Index □ in different locations of Gomishan Wetland in spring and summer

Location Season	Water-rise Area	Coast Area	Central Area	Near the Sea
Spring	A 0.46^{a}	A 0.72^{a}	A 0.76^{a}	A 0.83^{a}
Summer	A 0.51^{a}	A 0.8^{a}	A 0.89^{a}	A 0.82^{a}

*Similar superscript letters at the same row and similar letters at the same column show no significant differences between locations and seasons, respectively.

Table 5: The comparison of Sorenson Index □ in different locations of Gomishan Wetland in spring and summer

		Spring				Summer			
Season	Location	Water-rise area	Coast area	Central area	Near the sea	Water-rise area	Coast area	Central area	Near the sea
Spring	Water-rise area	1							
	Coast area	0.61	1						
	Central area	0.61	1	1					
	Near the sea	0.57	0.94	0.94	1				
Summer	Water-rise area	0.88	0.71	0.71	0.66	1			
	Coast area	0.61	1	1	0.94	0.71	1		
	Central area	0.57	0.94	0.94	1	0.66	0.94	1	
	Near the sea	0.66	0.94	0.94	0.88	0.76	0.94	0.88	1

Table 6: The comparison of distribution index and the type of distribution in different locations of Gomishan Wetland in spring and summer

Location	Water-rise area		Coast area		Central area		Near the sea	
Family/season	Spring	Summer	Spring	Summer	Spring	Summer	Spring	Summer
Scrobicularidae	7.9 Con.	5.84 Con.	200.5 Con.	12.8 Con.	15.5 Con.	36.4 Con.	59.5 Con.	87.3 Con.
Mytilidae	12.07 Con.	6.6 Con.	7.7 Con.	3.03 Con.	20.7 Con.	1.1 Con.	38.8 Con.	19 Con.
Pyrgulidae	120.5 Con.	137.1 Con.	518.01 Con.	6109.4 Con.	3058.9 Con.	1303.5 Con.	2845.5 Con.	6114.8Con.
Chironomidae	0 Ran.	0 Ran.	9.8 Con.	29.4 Con.	93.09 Con.	13.9 Con.	160.2 Con.	12.7 Con.
Gammaridae	0 Ran.	0 Ran.	71.7 Con.	10.2 Con.	7.1 Con.	2.6 Con.	63.8 Con.	2.8 Con.
Cardiidae	10.9 Con.	9.55 Con.	11.4 Con.	15.2 Con.	22.4 Con.	8.5 Con.	22.6 Con.	8.4 Con.
Amphartidae	0 Ran.	7 Con	5 Con.	260.9 Con.	1.8 Con.	2416.3 Con.	1 Ran.	0 Ran.
Tubificidae	0 Ran.	0 Ran.	5 Con.	89.6 Con.	3.5 Con.	19.01 Con.	205.1 Con.	731.6Con.
Nereidae	0 Ran.	0 Ran.	0 Ran.	0 Ran.	0 Ran.	2 Con.	2 Con.	0 Ran.
Balanidae	0 Ran.	0.5 Reg.	6.21 Con.	2.8 Con.	11.8 Con.	10.5 Con.	33.2 Ran.	10.1 Ran.

*Con = contagious distribution. *Ran = random distribution. *Reg = regular distribution.

in the summer with the coastal and central areas in spring, the coastal area with the central area in the spring and near the sea area in spring with the central area in summer were equal to 1 that represents the existence of the same families of macroinvertebrates in these locations (Table 5).

The investigation of the distribution index about the macroinvertebrates of Gomishan Wetlands showed that Pyrgulidae and Nereidea had the maximum and minimum distribution, respectively and in the most locations of sampling, contagious distribution was observed. Except the locations that the frequency of macroinvertebrates were zero, random distribution was observed in Amphartidea in near the sea area in spring. The regular distribution was observed only in the Balaeidea family in water-rise area in the summer (Table 6).

DISCUSSION

The comparison of the density of macroinvertebrate in Gomishan Wetland showed that frequency in the coastal area and central area in spring are more than summer but in the near the sea and water-rise area, the density increases in summer compared to the spring. The increasing of the frequency of macroinvertebrates in water-rise area in summer depends on the water-level rise in this season and providing good conditions for the development of these organisms in this location. Due to the water-level rise, the depth increase in Gomishan Wetland and maximum depth appeared in the near the sea area. As a result, the wetland bed in this area compared with other sectors is likely more stable than the others which provides the possibility of the existence of more macroinvertebrates in this location.

The higher amounts of Margalef's Index show the higher level of biological health in the ecosystem. According to table 2, the maximum amount of Margalef's Index is illustrated in water-rise area which indicates biological health is higher in this location. The Average amount of Shannon-Wiener Index in all locations was less than 1, which shows the low variation, Bad status and high pollution in the Gomishan Wetland. The sources of pollutants include the wastewater of farms and agricultural lands, wastewater of shrimp breeding station and urban sewage.

Riazi [15] and Basatnia [17] stated that the amount of Margalef's Index in Gomishan wetland is 0.75 and 0.87, respectively. In the present study, the amount of this index was 1.48, which comparing the numbers represent the increasing trend of this index in the Gomishan Wetland. This increase shows the improving of the biological health of this wetland during the last ten years, however according to Ross and Cardell [12] and Bellan-Santini [13], Gomishan Wetland still suffers from pollution. The average amount of Shannon-Wiener Index declared by Riazi [15] and Basatnia [17] as 0.3 and 0.8, respectively. In the present study, the amount of Shannon-Wiener Index was obtained 0.53. Therefore, over these years, the level of pollution was high and the wetland condition is classified in bad status.

The average amount of Pielou Evenness Index in the present study, which has been performed in 2012, was 0.48. Basatnia [17] declared in a similar research the Pielou Evenness Index as 0.42. Due to the fact that the Pielou Evenness Index is one of the evenness indicators, the increasing of Pielou Index in Gomishan Wetland indicates that the macroinvertebrates community is going to be more uniform and homogeneous gradually over the time.

The analysis of Sorenson Index showed that the water-rise area were different from the other areas. Due to the fact that as the ecosystem is more stable, species are more similar [18], the reason for this difference and the reduction of Sorenson Index could be found in the instability of this location. Furthermore, the difference in the existence of the families in sampling points between the spring and summer is probably due to differences in water depth, changes in agricultural activities adjacent to the wetland, changes in physical and chemicals parameters of water and the life cycle of macroinvertebrates in each season.

The investigation of the distribution Index showed that in most locations of the sampling points, the type of distribution is contagious. The reproductive, biological and nutritional factors are involved in the contagious distribution. Therefore, it can be concluded that the favorable conditions were found only in some areas of the Gomishan Wetland and it has caused the contagious distribution.

The macroinvertebrates communities of Gomishan Wetland are affected by fluctuations and change in water-rise season. Correct planning and management for reservation of Gomishan Wetland, especially in Water-rise area, are needed and more studying are suggested.

REFERENCES

1. Khorasani, N. and J. Mansori, 1986. Wetlands and their values and importance for human. Journal of Mohitshenasi, 12(13): 63-100.
2. Lugo, A.E., M.M. Brinson and S.L. Brown, (eds.) 1990. Forested Wetlands, Ecosystems of the world. Elsevier, Amsterdam, The Netherlands. pp: 527.
3. Mitsch, W.J. and J.G. Gosselink, 1993. Wetlands (2nd ed.), Van Nostrand Reinhold, New York. pp: 722.
4. Fretwell, J.D., J.S. Williams and P.J. Redman, (eds.) 1996. National Summary on Wetland Resources. Water-Supply Paper 2425, U.S. Geological Survey, Washington, DC. pp: 34-45.
5. Kusler, J.A. and M.E. Kentual, (eds.) 1990. Wetland Creation and Restoration: The Status of the Science. Island Press, Washington, DC. pp: 195-232.
6. Wheeler, B.D., S.C. Shaw, W.J. Fojt and R.A. Robertson, 1995. Restoration of Temperate Wetlands, John Wiley & Sons, New York, pp: 273-286.
7. Wiggins, G.B., R.J. Mackay and I.M. Smith, 1980. Evolutionary and ecological strategies of animals in annual temporary pools. Archive für Hydrobiologie Supplement, 58: 97-206.
8. Kiabi, B., R. Ghaemi and A. Abdoli, 1999. Wetlands and river ecosystems in Golestan Province. Department of Environmental Protection in Golestan Province. pp: 182.
9. Behrozi-Rad, B., 2008. The Iran's wetlands. Geographical organization of the armed forces, Iran. pp: 798.
10. Riazi, B., 2001. Information Sheet on Ramsar Wetland (RIS). Ramsar Convention Secretariat. pp: 8.
11. Birshtein, Y.A., L.G. Vinogradov, N.N. Kondanov, T.W. Stakhova and N. Romanova, 1968. An Atlas on Caspian Sea Invertebrates. Translated to Persian by L. Delina and F. Nazari in 1998. Iranian Fisheries Research Organization Publication, Tehran, Iran. pp: 850.
12. Ros, J.D. and M.J. Cardell, 1991. La diversidad específica y otros descriptors de contaminación orgánica en comunidades bentónicas marinas, Actas del Symposium sobre Diversidad Biológica. Centro de Estudios Ramón Areces, Madrid, pp: 219-223.
13. Bellan-Santini, D., 1980. Relationship between populations of amphipods and pollution. Journal of Marine Pollution Bulletin, 11: 224-227.
14. Molvaer, J., J. Knutzen, J. Magnusson, B. Rygg, J. Skei and P. Sorensen, 1997. Classification of Environmental Quality in Fjords and Coastal Waters. SFT guidelines, 97: 30-36.

15. Riazi, B., 2002.The investigation of benthic invertebrates in Gomishan Wetland. Iranian Journal of Natural Resources, 55(2): 211-223.
16. Nezami, S.H.A. and H. Khara, 2005. Investigation on drought effects on diversity, frequency and distribution of benthic fauna in Amirkelayeh Wetland. Iranian Scientific Fisheries Journal, 14(3): 141-156.
17. Basatnia, N., 2011. Effect of aquaculture effluent on macroinvertebrates diversity and abundance of Gomishan Lagoon. Master Science thesis. Gorgan University of Agricultural Science and Natural Resources. pp: 77.
18. Bakhshi, J., N. Biroodian and M. Ghadimi, 2009. Effect of planting Haloxylon Black (*Haloxylon aphyllum*) on the species richness and similarity in Ardestan, Iran. Journal of Pajhoohesh and Sazandegi, 79: 2-10.