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BIOLOGICAL EVALUATION OF THE WATER QUALITY IN NORTHWEST IRAN BY USING AQUATIC INSECT

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ABSTRACT

Some of the aquatic insects can be used as bioindicators for water pollution and as well as in a medicine and food for others animals, can play an important role in the ecosystem. The aim of this study was to investigate the biological index and aquatic insect fauna in Meshkin shahr Khiyav Chayi River in Ardabil Province. This cross-sectional study was conducted in the summer of 2020, which coincides with the season of aquatic insects.. Samples of aquatic insects were collected at 10 points of river. The biological index was determined by the formula of Hilsenhoff (1988). In general, 259 aquatic insect samples were collected belonging to Coleoptera, Ephemeroptera, Hemiptera, Diptera, Trichoptera and Plecoptera and families of Leptophlebiidae, Elmidae, Corixidae, Culicidae, Leptoceridae, Simulidae, Baulidae, Perlidae, Perlida and Hydropsychidae. In this study, the water quality index was estimated at 7.6 which in terms of quality is fairly poor in summer.

Key words: Biological index, aquatic insects, water quality, Culicidae, Khyavachai river, summer, abundance, water pollution, fauna, Meshkin Shahr, Iran

The most important vital communities of rivers are aquatic organisms. These creatures are used as the second and third food levels of other aquatic species and can be considered as an indicator of water quality (Lind, 1979). About 30 orders of insects are related to aquatic habitats, 10 of which are aquatic insects and the rest are semi-aquatic or part of their life depends on water (Merritt and Cummins 1996). A group of insects are used as indicators of water pollution and live in a wide range of aquatic habitats such as seas, lakes, rivers, and water pools, and can show a role both medically and nutritionally for other creatures (Voshell, 2002). Aquatic insects have different sensitivity to biotic and abiotic water factors. The most important of these factors are the changes in dissolved oxygen (DO) and Biochemical Oxygen Demand (BOD) which, if contaminated in water, the balance between DO and BOD is disturbed, resulting in reduced oxygen and increased water pollution (Zimmerman, 1993). This increase in pollution will disturb the balance of life of aquatic insects and as a result sensitive insects will be killed and few insects resistant to water pollution will survive. Therefore, the detailed study of aquatic insect fauna and the identification of species in aquatic habitats can help to precisely determine the biological index (BI) (Ostovan, 2009). Among the important aquatic insects, a number of species of Ephemeroptera, Plecoptera and Trichoptera are known as indicators of water pollution, and these families are named biological indicators (Compin and Céréghino 2003). Biological indexes are used to determine water quality based on aquatic creatures, including insects, and the number of families and important species in water are decision-making, and divided between zero and 10 (Table 1). Whatever the indicator increases towards 10, water is highly contaminated (Hilsenhoff, 1988; Hilsenhoff, 2017). The purpose of this study was to evaluate the status of the BI index and water quality of the Khyavachai River in Meshkin shahr County, Ardabil Province, which is the most important river used for supplying drinking water to 80,000 residents of Meshkin shahr County.

MATERIALS AND METHODS

Meshkin shahr County is located in the central part of Ardebil Province in northwestern Iran and has a population of over 161156. The city has a mild mountainous climate. Sabalan Mountain is located 2 km from the city, which is the main source of the Khyavachai River, and the length of the river is more than 2 km, which eventually flows into the Ghar Sou River, and there is more seasonal activity of aquatic insects in the summer (Moradiasl, Rassi et al., 2018).

Table 1. Abundance of aquatic insects-Khyavachai River, Northwest of Iran

Order	Family	n_i	a_i	$n_i a_i$
Coleoptera	Elmidae	30	4	120
	Leptophlebiidae	1	2	2
Ephemeroptera	Cenidae	1	7	7
	Baetidae	10	4	40
Hemiptera	Corixidae	24	5	120
	Chironomidae	21	8	168
Diptera	Culicidae	132	8	1056
	Simulidae	30	6	180
Plecoptera	Perlidae	1	1	1
Trichoptera	Leptoceridae	1	2	2
	Hydropsychidae	8	5	40
Total	-	259	-	1736

The sampling of aquatic insects was conducted from 10 sites, in 20 km from the beginning of the river, with three sampling times on both left, right and middle parts of the river at a distance of two km by netting, dipping and direct survey of the river rocks methods. Sampling was carried out from early July until the end of September in the study area, 1998. Then, the samples were stored in ethanol and identified using morphological keys (Borror and White, 1970; Bouchard, Ferrington et al., 2004; Subramanian and Sivaramakrishnan, 2007). Biological index (BI) was computing using Table 1 and the following formula: $BI = \sum n_i a_i / N$ Where (n_i) is the number of samples per family of insects, (a_i) the tolerance to infection of a species in the family, is ranged between zero to 10, which is based on the response of organisms to water 90 polluting organic material in various laboratory and field conditions. (N) is total number of samples (Hilsenhoff 1988). The index rates in relation to water quality are as follows:

Biotic index-water quality-degree of pollution: 0.00-3.50; Excellent; No pollution; 3.51-4.50; Very good; Possible slight pollution; 4.51-5.50; Good; Some pollution; 5.51-6.50; Fair; Fairly significant pollution; 7.51-8.50; Poor, Very significant pollution; and 8.51-10.00; Very poor; Severe pollution.

RESULTS AND DISCUSSION

A total of 259 specimens of aquatic insects were collected and identified to belong to Coleoptera, Ephemeroptera, Hemiptera, Diptera, Trichoptera and Plecoptera and 11 families of Leptophlebiidae, Elmidae, Corixidae, Culicidae, Leptoceridae, Simulidae, Baulidae, Perlidae, Perlida and Hydropsychidae. Culicidae were the most abundant family observed throughout the river, while the lowest were those of the families Leptophlebiidae, Cenidae, Perlidae and Leptoceridae (Table 1). The biological index was up to 6.7 for Khyavachai River in Meshgin shahr County according to the Hilsenhoff (1988). As a result, water quality is relatively weak, and there is a significant contamination of organic materials.

The use of aquatic insects to determine water contamination has been much faster and less costly than traditional methods of sampling and transporting to the laboratory and performing physical and chemical tests (Borror and White, 1970). Various studies have been conducted in Iran based on biological indices and water quality has been measured in different regions. Davoodian et al. (2013) Studied biological index in two separate sites of Karr River in Marvdasht City of Fars Province. The index was calculated up to 5.54 and 7.6, showing that river water is classified from relative to highly contaminated. This index was up to 3.79 in Sepidan City where water quality was very good (Hosseini, Ostovan et al., 2012). In the present study, the water quality of the Khyavachai River was relatively weak when the biological-index biological index was computed up to 6.7. Given that there are fifteen swimming pools, hotels, and restaurants along the Chiyai Chai River at Mashkin Shahr, it is a tourist area and many travelers commute to there every year during the summer, and all the wastewater and sewage from pools and restaurants flow into the river, which is likely to be one of the major causes of contamination of the river, cause of water quality causing poor water quality. In the present study, 11 families of aquatic insects belonging to 4 orders were collected which is desirable in terms of biodiversity. In accordance with the study, 12 and 18 families belonging to 6 orders were identified in the three rivers of Meshginshahr and the Tigris River in Aryan town, Fars Province, respectively (Sadeghi, Shole Saadi et al., 2016; Shayeghi, Moradi et al., 2016).

In the present study, the abundance of the family Culicidae was higher than other aquatic insects and is the predominant species. This is in agreement with earlier studies (Mousa Kazemi, Zaim et al., 2000; Abai, Azari-Hamidian et al., 2007). The least abundance belonged to the family Perlidae, which is slightly more sensitive to pollution (Batty, Atkin et al., 2005). While in other studies in northern Iran, the family was not collected (Abbaspour, Hedayatifard et al., 2013). Based

on the results of this study, it can be said that the water quality of this river is unfavorable in summer, which may be due to the activity of mineral warm waters and the places around this river in summer. That is consistent with the findings of other studies (Tabatabaei, AMIRI et al., 2010, Karami, Mirdar Harijani et al., 2017). Khyavachai River is very rich in aquatic insect's fauna and in summer it has relatively poor water quality, which could be due to the entering of waste and sewage outlets, spa and travelers in the summer season. Therefore, it is suggested to study in other seasons. Khiyav Chayi river was of fairly poor quality in summer due to the activities of seasonal spa, water parks and summer travelers. Because this river, the only source of drinking water is the city, water healthcare should be fully respected. Water source disinfection should be also performed regularly.

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AUTHOR CONTRIBUTION STATEMENT

Both authors equally contributed.

CONFLICT OF INTEREST

No conflict of interest.

REFERENCES

Abai M S, Azari-Hamidian H, Ladonni M, Hakimi K, Mashhadi-Esmail K, Sheikhzadeh A, Kousha M,Vatandoost H. 2007. Fauna and checklist of mosquitoes (Diptera: Culicidae) of East Azerbaijan Province, northwestern Iran. Journal of Arthropod-Borne Diseases 1(2): 27-33.

Abbaspour R Hedayatifard M, AlizadehH R A, Hassanzadeh H, Karimi J M. 2013. Bioassessment of Macrobenthic Fauna of the Cheshmeh Kileh River, Northern Iran. American-Eurasian Journal of Agricultural and Environmental Sciences 13(6): 747-753.

Batty L C, Atkin L, Manning D A C. 2005. Assessment of the ecological potential of mine-water treatment wetlands using a baseline survey of macroinvertebrate communities. Environmental Pollution 138(3): 412-419.

Borror D J, White R E. 1970. A field guide to insects: America north of Mexico, Houghton Mifflin Harcourt. p. 337.

Bouchard R W, Ferrington L C, Karius M L. 2004. Guide to aquatic invertebrates of the Upper Midwest.Compin A, Céréghino R. 2003. Sensitivity of aquatic insect species richness to disturbance in the Adour–Garonne stream system (France). Ecological Indicators 3(2): 135-142.

Davoodian S, Ostovan H, Maleki F, Gheibi M. 2013. Estimation of Biotic Index and Water quality of kor river in kooh Sabz and Pole Khan Region by using of Aquatic Insects Fauna. The 11th Conference and Exhibition Environment, Energy and Clean industry, Tehran University, 2-3 June.

Hilsenhoff W L. 1988. Rapid field assessment of organic pollution with a family-level biotic index. Journal of the North American Benthological Society 7(1): 65-68.

Hilsenhoff W L. 2017. An improved biotic index of organic stream pollution. The Great Lakes Entomologist 20(1): 7.

Hosseini S A, Ostovan H, Hosseini S E. 2012. Estimation of field biotic index and water quality of Khong river in Sepidan region by using aquatic insects fauna. Plant Protection Journal 4(1): 29-35.

Karami M, Mirdar Harijani J, Gharaei A, Pouria M. 2017. Assessment of water quality of Gamasiab River using BMWP and ASPT Indices. Journal of Aquatic Ecology 7(1): 29-38.

Lind O T. 1979. Handbook of common methods in limnology, The CV Mosley Company.

Merritt R W, Cummins K W. 1996. An introduction to the aquatic insects of North America, Kendall Hunt. pp. 133-145

Moradiasl E, Rassi Y, Hanafi-Bojd A A, Vatandoost H, Saghafipour A, Adham D, Aabasgolizadeh N, Omidi Oskouei A, Sadeghi H. 2018. The relationship between climatic factors and the prevalence of visceral leishmaniasis in North West of Iran. International Journal of Pediatrics 6(2): 7169-7178.

Mousa Kazemi S H, Zaim M, Zahraee A. 2000. Fauna and ecology of Culicidae of the Zarrin-Shahr and Mobarakeh area in Isfahan Province. Armaghan Danesh 5(17-18): 46-54.

Ostovan H. 2009. Estimation of field biotic index and water quality of Kor river in autumn season using aquatic insects fauna. Plant Protection Journal 1(1): pe1-pe11.

Sadeghi M, Shole Saadi E, Estevan H. 2016. Determination of biological indicator and water quality of Aniger River (Fars) using aquatic insect fauna. Quarterly Entomology Research 7(4): 327-335.

Shayeghi M, Moradi-Asl E , Saeidi Z, Mozafari E, Poudat A, Salimi M, Vatandoost H. 2016. Aquatic insects fauna of Meshkin Shahr, Ardabil Province, northwestern Iran 2014. Journal of Marine Science: Research and Development 6(4): 2-4.

Subramanian K, Sivaramakrishnan K. 2007. Aquatic insects of India-A field guide. Ashoka Trust for Ecology and Environment (ATREE), Bangalore, India. pp. 62.

Tabatabaei T, Amiri F, Pazira A A. 2010. Monitoring structure and biodiversity of benthic macrofauna community as pollution index on Mossa and Ghanam creek. Fisheries Journal 3(4): 1-13.

Voshell J R. 2002. A guide to common freshwater invertebrates of North America.p. 442.

Zimmerman M C. 1993. The use of the biotic index as an indication of water quality. Tested Studies for Laboratory Teaching 5: 85-98.

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