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Investigation of Some Physicochemical Characteristics of Farobroman River Water by Using Benthic Macroinvertebrates as Biological Indicator

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Abstract: Nowadays, in the water quality determination studies, presence investigation of the benthic macroinvertebrates is known as completion of the pollution denotation ways. In this study, weather and water temperature, dissolved oxygen (DO) and the physiographic and hydrologic factors were measured. The Farobroman River is one important river of the Northwest of Neyshabour city. Macroinvertebrate samples were taken using Surber's sampler (30 x 30 cm and 200µ mesh size) in 30 day intervals with 3 replicates in 7 sampling sites for a period of 6 months (Jun-Nov. 2011). The collected organisms were preserved in 4% formalin solution and transferred to the laboratory for identification and counting. Totally, 28 families belong to 8 orders and 4 classes from 3 phyla were identified. Phylum Arthropoda, family Chironomidae were dominated all over the river. Due to the results, the maximum abundance with number of $2981.5/m^2$ at the station 5 in September and the minimum abundance with $685.2/m^2$ at the station 1 in July were record. Population structure was measured including total abundance, EPT and EPT/CHIR indices. Species diversity, species richness were also determined using Shannon-Weiner, Margalef and Pielou indices. The minimum and maximum values of Shannon-Weiner index were observed in stations 5 (1.22) and 3 (2.70) respectively. Evaluation of indicators revealed less water quality at stations 2 and 7 which located at the lowermost of fish farms. This reduction might be implicated to the effluents of water damps from fish farms running into the river as diversity and total abundance (%) of sociable macroinvertebrates decreased and that of resistant macrofauna increased due to water pollution. Hence, from the obtained results, it could be concluded that the use of benthic macroinvertebrates as bioindicator for the assessment of water quality of the river is desirable.

Key words: Farobroman River % Macro-Invertebrates % Biological Indicator % Neyshabour % Shannon-Weiner Index

INTRODUCTION

One of the best practical methods to understand ecological status of a water body and determine impacts of human intervention in reducing water quality is using benthic macroinvertebrates as assessment tools for monitoring their biological integrity and health. Within recent decades aquatic ecosystems have been altered at different scales and registered as negative consequences of anthropogenic activities (e.g., mining, dam construction, artificial eutrophication, river canalization and recreation). Detection of resulting impacts on streams depends on the use of biomonitors combined with physical (e.g., temperature, suspended solids) and chemical (e.g., nutrient levels, concentrations of potential toxins) data [1].

Biological indicator use in monitoring programs provides a more exact measure of anthropogenic effects on aquatic ecosystems [2, 3] and have the advantage of monitoring water quality over a long period of time, thus providing a more adequate picture of level of pollutant effects on the ecosystem than is the case for chemical methods, which provide only momentary evidence of water quality [4].

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Within the organisms commonly used as biological indicators, benthic macroinvertebrates stand out as ideal due to: relatively low mobility and long life cycles, reflecting temporal patterns and local conditions; high diversity, abundance and consequently in providing a wide range of responses to different environmental pollution agents; large size and easy identification at high taxonomic (such as family) resolution by non-specialists; well standardized and low-cost methodologies; and temporal and spatial stability, reflecting changes in ecosystem processes [5].

Microbiological monitoring of organisms important in determining water contamination levels is usually done by fecal pollution indicators, represented by bacteria counts of coliform groups [6, 7]. This parameter is used by government agencies to classify water bodies as to use and sanitary levels (balneability and potability). Aquatic bacteria and fungi feed on dissolved organic matter, multiplying rapidly under favorable conditions. Some authors suggest that the number and composition of yeast species present in rivers and lakes can be used as organic enrichment indicators in water bodies [8, 9].

Species within the genera Cryptococcus, Debaryomyces and Rhodotora are characteristically found in non-polluted waters, while Candida and Saccharomyces species can be frequently found in eutrophic waters [10, 11].

MATERIALS AND METHODS

Sampling Stations: The seven working stations were established with more or less similar distances (approximately 3 km) of the river. Investigation site was the Farobroman River, flowing at the Northwest side of the Neyshabour city. The river is about 25 Km long and run through various agricultural lands and nearby the main city. From the above seven station samples were collected in the month June to November 2011 at regular monthly intervals. Table 1 and Fig. 1 show the location of each sampling station and the location of working area, respectively.

Invertebrate Sampling: Invertebrate was collected monthly with three replicates across the river at all the seven stations with a view to monitor changes caused by

Table 1: Locations and geographic points of sampling stations in the Farobroman River

Station number	Elevation(m)	Position
1	1754	E 58°55‘ 10.2” N 36° 20‘ 40.7 ”
2	1717	E 58°54‘ 35.4” N 36° 20‘ 24.4 ”
3	1952	E 58°52‘ 57.8” N 36° 20‘ 33.8 ”
4	1531	E 58°52‘ 15.3” N 36° 20‘ 17 ”
5	1504	E 58°51‘ 47.8” N 36° 19‘ 51.9 ”
6	1463	E 58°51‘ 31.6” N 36° 19‘ 35.3 ”
7	1351	E 58°50‘ 44.5” N 36° 18‘ 39.6 ”

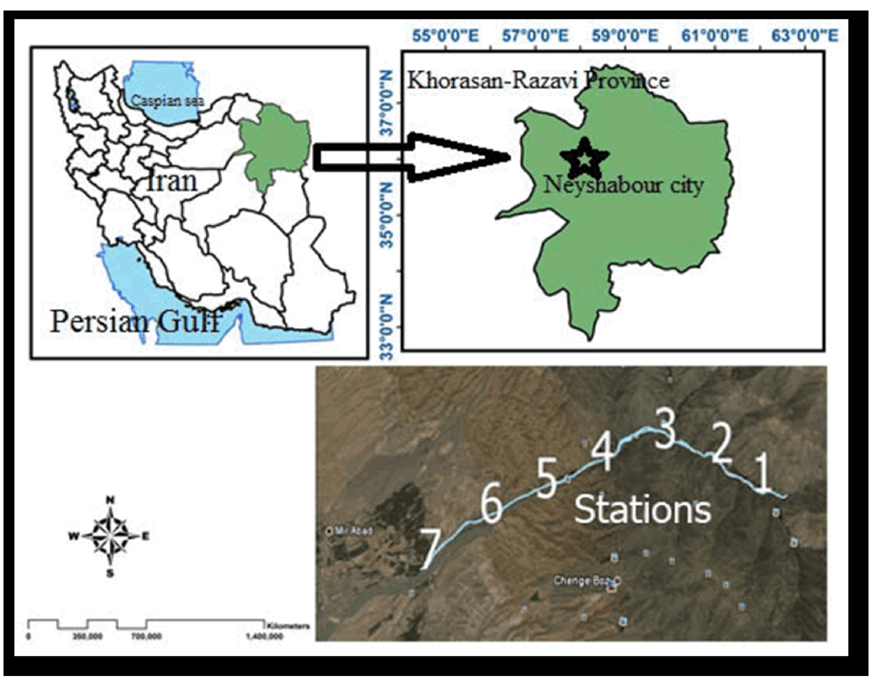

Fig. 1: Location of working area (Neyshabour, Iran, 2012)-The images are From Arc GIS and Google Earth 2012

the seasonal limnological cycle during the study period (June 2011 until November 2011). Invertebrate sampling was accomplished by Surber or foot square-foot sampler.

For each station sampling started at 8 AM continue up to 4 PM to complete the collection and measuring the physicochemical characteristics of water. After collection of sample it transferred to the Hydrobiology Laboratory of Fisheries discipline, Gorgan University of Agricultural science and Natural resources. Triplicate benthos samples were collected from seven stations during the period of June-November, 2011 by using a Surber's sampler. The benthos samples were preserved in a 250 ml plastic container with 4% formalin and habitat water solution further laboratory study. Collected samples were transferred to an empty tray, classified by groups and counted. The abundance of benthic macro invertebrates in a square meter area was calculated following Jhingran *et al.* [11] as follows:

$$N = \frac{m}{ah}$$

where, N= Number of macro-invertebrates in 1 square meter; n= number of macro-invertebrates per sample; a = area used and h=number of hauls taken.

The data gathered from monthly samples were pooled to furnish the value of S-W Index. The Shannon-Wiener Index of species diversity (H) is defined as Wilhm and Dorris [12]:

$$\text{H} = -\sum\left(\frac{ni}{N}\right) log2 \left(\frac{ni}{N}\right)$$

where, S = number of species in a sample; N= total number of individuals in the sample; ni= number of individuals in each species; i.e. N= E ni.

For identification of collected benthos work of Wilhm and Dorris [12], Wilhm [13], Pearson [14] and Osborne *et al.* [15] were used.

RESULTS AND DISCUSSION

Healthy, effective functioning rivers provide a wealth of reliable benefits to people, from the provision of good quality drinking water, to resources such as fish and reeds, to recreational pleasure. Poorly functioning river systems gradually lose their valued attributes, require continual expensive remedial actions, or are costly to the nation in other ways, such as through collapsing banks, sediment-filled dams and water quality problems. It is therefore important for government, but more so for humans to be able to evaluate their influences on the riverine system. Bioassessments and monitoring was thus developed for the rapid evaluation of these systems, using organisms of both fauna and flora as an indication of the ecological state of the system. The most valuable information for prediction, monitoring and assessment is based on understanding why changes will occur or have occurred, because this allows informed judgments and decisions to be made about present or future impacts.

In an ideal situation the quality of running water should be assessed by the use of physical, chemical and biological parameters in order to provide a complete spectrum of information for appropriate water management. However, such a study needs much more time and expenses than the study of the biological parameters alone.

Table 2: The species wise distribution of different macro benthos in the Farobroman River

Phylum	Class	Order	Family
Arthropoda	Crustacea	Amphipoda	Gammaridae
	Insecta		Siphlonuridae
	Coleoptera	Elmidae	Blepharoceridae
		Diptera	Ceratopogonidae
			Chironomidae
			Dixidae
			Simulidae
			Tabanidae
			Tipulidae
		Ephemeroptera	Beatidae
			Heptageniidae
			Caenidae
			Ephemerllidae
			Ephemera
		Hemiptera	Gerridae
		Hydrocarina	Hygrobatidae
		Plecoptera	Chloroperlidae
			Perlidae
			Nemouridae
		Trichoptera	Glossosomatidae
			Sericostomatidae
			Hydropsychidae
			Rhyacophilidae
			Polycentropodidae
Annelida	Oligochaeta		Lumbricidae
			Lumbriculidae
Platyhelminthes	Turbelaria		Planariidae

Table 3: Abundance of benthos (indv/m^2) in different stations in the Farobroman River

Stations	Jun	Jul	Aug	Sep	Oct	Nov	Total
1	959.26	685.19	955.56	1122.22	748.15	1103.70	5585.19
2	2940.74	2411.11	2281.48	2870.37	2877.78	2914.81	16318.52
3	1625.93	2244.44	1218.52	2433.33	2414.81	2637.04	12607.41
4	1177.78	1570.37	925.93	2185.19	2059.26	2225.93	10188.89
5	1970.37	2770.37	1637.04	2981.48	2355.56	2412.96	14183.33
6	1466.67	1874.07	1937.04	2533.33	1837.04	2818.52	12533.33
7	1129.63	1685.19	1951.85	2244.44	1933.33	2288.89	11311.11
Total	11270.37	13240.74	10907.41	16370.37	14225.93	16401.85	82727.78

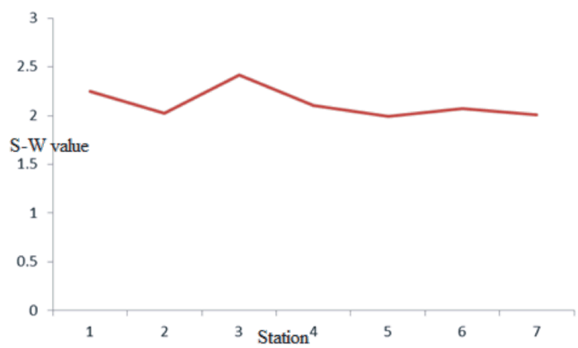

Fig. 2: Shannon-Wiener Indices at different stations of Farobroman River.

In the present study 28 families were identified (Table 2). These belong to Oligochaeta, Turbelaria, Insecta and Crustacea. The organisms were Oligochaeta: Lumbricidae and Lumbriculidae. Turbelaria: Planariidae.

Insecta: Elmidae, Siphlonuridae, Blepharoceridae, Ceratopogonidae, Chironomidae, Dixidae, Simulidae, Tabanidae, Tipulidae, Beatidae, Heptageniidae, Caenidae, Ephemerllidae, Ephemera, Gerridae, Hygrobatidae, Chloroperlidae, Perlidae, Nemouridae, Glossosomatidae, Sericostomatidae, Hydropsychidae, Rhyacophilidae and Polycentropodidae. Crustacea: Gammaridae.

Benthos Abundance: Macrobenthos abundance varied between 685.19 (July-Station 1) and 2981.48 indv. mG^2 (September-Station 5) in the present study. The maximum abundance 2981.48 indv. mG^2 was recorded from station-V and the minimum 685.19 indv. MG^2 in station 1 (Table 3). In India Mishra [16] recorded the average density of macro benthic organisms in the polluted portion of Ganga River was 119-4053 indv. mG^2 which supported the result of present investigation.

Shannon-Wiener Index: The Shannon-Wiener (S-W) indices of diversity (H) of the benthic macroinvertebrates, was not under the number 1 and it shows that there is not high pollution at this river.

It is apparent from Figure 2 that the any stations did not show very trenchant differences in the mean values of diversity index amongst each other. Although the mean species diversity value of station 5 is much lower compared to those of other six stations which indicating high pollution in station 5. Lower value of S-W index indicates the higher level of pollution [12].

Shannon-Wiener Index is a sensitive indicator of pollution and its values do not fluctuate widely. Shannon-Wiener index of diversity in the present study has shown a variation range 1.22±0.23 to 2.70±0.08.

Johnson and Brinkhurst [17] observed the values ranging from 1.00 to 3.66 in their study, Mackey *et al.* [18] reported that in their study the Shannon-Wiener index ranged from 1.3 to 2.5 from 50 polluted streams.

Osborne *et al.* [15] observed values ranging from a minimum of 0.14 to a maximum of 2.69 whereas Godfrey [19] found the value ranging from 1.938 to 5.34. The investigation is supported by the above findings.

Ransom and Derris [20] made a similar observation in their work on Keystone reservoir in the USA. The somewhat lower values of the index of diversity during the investigation can be attributed to the residual effect of the pollutants' settled at the bottom which come from different domestic sources, municipal wastes disposal, agricultural wastes and industrial wastes discharge to the river. According to Wilhm and Dorris [12] species diversity (S-W) index (H) value ranged from >3 indicates clean water, 1.00 to 3.00 indicates moderately and <1.00 indicates heavily polluted condition of water. Exposed to progressively increasing amount of domestic discharge and urban runoff, the benthos of station 2 and 7 was found to be less and less able to support a diverse and stable macrobenthic community.

Table 4: H’ Shannon-Index at different stations of Farobroman River

	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7
Jun	AB2.41+0.02a	C1.89+0.02b	C2.40+0.06a	BC1.99+0.08b	C1.22+0.23d	C1.580+0.13c	C1.89+0.09b
Jul	BC2.30+0.15b	A2.14+0.08b	B2.53+0.06a	AB2.26+0.03b	B1.68+0.09d	B1.89+0.04c	C1.79+0.09cd
Aug	D1.98+0.20c	C1.88+0.12c	A2.70+0.08a	A2.50+0.09ab	A2.48+0.04ab	A2.55+0.14ab	A2.38+0.08b
Sep	CD2.13+0.11ab	AB2.06+0.01ab	D2.06+0.04ab	BC1.87+0.08c	AB2.14+0.07a	B2.01+0.06b	B2.03+0.02ab
Oct	A2.58+0.06a	BC1.94+0.03d	C2.41+0.06b	BC2.25+0.06c	AB2.07+0.14d	A2.43+0.04b	B2.06+0.07d
Nov	D2.06+0.04bc	A2.18+0.11b	C2.38+0.05a	C1.74+0.11e	AB2.17+0.05b	B1.93+0.11cd	C1.88+0.05de

According to the results, it is conclude that the maximum impact of pollution in Farobroman River is felt at station 2 and 7 since in between the station 2; enough geographical distance is not available for stream's self-purification and pollution abatement. Thus, stations 2 and 7 are the most affected area of this river (Table 4).

Humans may have the ability to manipulate the environment to suit their needs, but this requires a responsible approach. Our present generation must therefore stand up and be accountable for our actions, focusing our knowledge and intuition toward a better future that includes the availability of clean, freshwater for all the nations of the world.

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