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RESEARCH ARTICLE

Seasonal Change of Community Structure and Abundance of Macrobenthos in Roudan River

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Abstract

The macrobenthos community on the Roudan River and its relationship to its physical and chemical environment are described. The sampling design consisted of 3 stations and with 3 replicate in four seasons. The Roudan is a long central river that drains a vast central part of Iran and is constrained by the transport of sediments from the mountain and land. Sixteen species were collected in the three stations. It was highly dispersed within the flooding water and dominated in density by highly diversified insects. During these periods in three stations, along the river, the turbid, but enriched by exports from adjacent mudflats and detritus was colonized by a large and abundant macrobenthos community that was dominated by by Chironomus and Paraleptophtebia belonging to order Diptera and Ephemeroptera respectively. The limnaea belonging the order Lymnaeidae and classes of Gastropoda was dominant in station 2 due to the presences of higher grass in riverside and less turbidity of the river in this part of the river. Besides of the macrobenthos of the clasess Insecta and Gastropoda which was dominant in all the sampling station and in different season, the macrobenthos of the groups of Maxillopoda, Secernentea, Arachnida, Malacostraca are also observed and recorded.

INTRODUCTION

Benthos is the organism that inhabits in the bottom of ekil ydob retawa riveraes ro . Macro benthos play as an important role in aquatic community consist of involved in mineralization, promoted and mixing of sediments and the flux of oxygen into sediments, cycling of organic matter and in an effort to assess the quality of inland water (Lind, 1979). The rivers in the central part of Iran which have constant running water, considered to be one of the richest freshwater biological resources. This is considered a frail environment, inhabiting all the types of flora and fauna.

The Roudan river is an important river lie along the 110 km stretch between the mountain to the land therefore consist a variety of zooplankton, phytoplankton and macrobenthose of different environment and climate. Situated at different part of the river between the mountain to the land, are subjected to frequent and significant environmental changes. In particular, the chemical composition of river waters is determined by the highly variable dilution of land runoff flows to the river. The river is relatively free from pollution impacts, except in station two, for human recreation, which is especially intense on holidays and during summer vacations gathering. However the macrobenthos and zooplankton breed continuously (Hart 1981), species composition does not vary seasonally, and there often is little seasonal variation in zooplankton biomass and production (Richerson et al. 1977). Therefore, we may assume that seasonal changes in the dynamics of macrobenthos of Roudan river are minimal and that these populations approach a stable age distribution. The interpretation of macrobenthos dynamics in rivers is complicated by several factors. Patterns of regular seasonal change often are confounded by irregular variations in population size (Kalk 1979).

Roudan river is a long river, its shallow part is suitable for eutrophication.The process of eutrophication in shallow and warm water can greatly change the community structure of aquatic organisms. To date, very few scientific studies have been published on the subject of biological study in river of Roudan. Roudan river has a serious will have problem due to several factors, including, insufficient infrastructure, the rapid population increase, and the discharging of domestic and industrial wastewater into the river. In the present study, the zooplankton and macrobenthose community on the Roudan River and its relationship to its physical and chemical environment are described. In addition to its descriptive aspects, this paper seeks to address whether due to significant geomorphologic and ecological differences, it is possible to demonstrate the existence of a special macrobenthos individual or community structure.

Materials and methods

Study area: Roudan river, long river of central part of Iran of more than 110 km, forms a complex hydro-system. It drains from the Mountain of south part of Iran and pass several difference land with dramatically different topographical, geological, hydrological aspects. Upstream, the river passes through the Mountain which colonize poor, hard, lateritic soils. Downstream, it moves slowly through a vast swamp, that is formed upon clay soils originating from the deposition of river side silt. Roudan river during the rainy season is acidic but rich enough in phytoplankton, dissolved oxygen and nutritive elements. Along the river, the vegetation present on the river banks and is adapted to varying periods of dry and rainy season.

Sampling program: In all, 36 samples of Macrobenthos were collected during the daytime over four season at three station in three replication. To take potential variations into account that could be introduced by temperature and rainy condition, the environmental and macrobenthos data were obtained during periods of 4 seasons at dry and rainy period. The following analyses were performed on the collected water:

A sampling unit was taken in each stratum with a 0.04 m^2 quadrate sampler, buried to a depth of 25 cm, and the macrobenthos were sorted using a 0.5mm-mesh sieve.

The benthic animal remaining on the sieve was sorted out and fixed in 10% formaldehyde solution in fresh water on board and were subsequently identified and count separately for each taxa in the laboratory. The number of individuals of 5 taxonomic groups (Insecta, Maxillopoda, Gastropoda, Arachnida, Secernentea were recorded. The individuals of each species group were counted and placed into different classes and orders.

Results

The average values for a set of physicochemical parameters in the Roudan river as representatives of macrobenthos inhabited environments at different season are shown in Table 1. During the winter seasons, the waters of the river contain a mixture of approximately higher amounts of brackish water, the salinity were higher 1.4 PSU, and thus corresponded to the waters originating from the drainage of the small salty river in these region. The seasonal variability in the relative differences of brakish water compare to freshwater results in significant changes in the concentrations of nutritional elements, suspended particulate mineral matter and dissolved organic compounds. Therefore the community of benthos have changed in winter season.

Table 1. Physico-chemical parameters scored at different station and seasons

Season	Station	Air temperature (°C)	Water temperature (°C)	Salinity (PSU)	Total Hardness Mg(CaCo3)/l	Alkalinity ppm	DO mg/l	PH
Spring	S1	24±0.0	27.3+0.57	0.8+0.0	196.7+1.1	54+1.7	9+0.6	9.3+0.25
	S2	41.9±0.1	30.3±1.2	1.1±0.1	197.3±1.2	56.7±3.1	8.6±0.3	9±0.1
	S3	37.4±0.2	32.7±0.4	0.98±0.1	204±8	60±2	8.4±0.6	8.9±0.03
Summer	S1	24.4±0.0	28.4±0.2	0.8±0.1	188±3.5	68.7±8	10.1±1	8.1±0.0
	S2	24±0.2	29±0.3	1±0.2	173.3±4.2	61.3±4.9	8.7±0.1	8.3±0.1
	S3	34.1±0.1	35.8±0.3	0.84±0.1	203.3±8.3	69±3	9.4±0.7	8.2±0.07
Autumn	S1	12.5±0.0	15.3±0.06	0.8±0.07	230.7±1.2	61±1	9.9±0.3	8.2±0.01
	S2	21.8±0.2	21.4±0.4	1±0.1	231.3±3.1	56.9±0.2	9.9±0.6	8±0.1
	S3	22.1±0.1	21.5±0.8	0.95±0.05	241.3±8.1	60.3±2.1	10.3±0.7	7.9±0.11
Winter	S1	14±0.5	15.6±0.8	1.4±0.16	206.7±20.4	50±1	10.6±0.9	8.2±0.07
	S2	19.9±0.6	20.9±0.5	1.4±0.1	203±8.1	49.3±4	10.3±0.3	8.3±0.1
	S3	21.7±0.8	21.5±0.6	1.6±0.2	218.7±7.6	57.7±3.5	9.5±0.5	8.2±0.1

S= Station

Seasonal change also have effect in water temperature in this way that the mean water temperature in dawn stream shows at least 6 degree higher than upstream. The trend of water temperature was to increase from the first station to the third station and it was significant ($P<0.05$). The highest temperature was in summer and autumn in third station (34.2± 1.7). Water temperature in autumn and winter in first station was 15.4±0.5 while 21.4±0.5 in second and third station. The higher temperature in station 3 had significant adverse effect in community and abundance of macrobenthoses. The oxygen content was higher than 7.8 in all three station and all seasons and the maximum was 11.2 mg/l, that shows the productivity pattern of phytoplankton in a period of proper time. The PH, during the summer, autumn and winter was in the range of 7.9-8.26, while in spring it was 9±0.2. In summer and autumn the average alkalinity was 64.4±6 while in spring and winter lower 54.6±4.6. Total hardness was highest in autumn 234.4±6.8 and lowest in summer 188.2±13.9. The hardness and alkalinity value was highest in station 3 comparing to other station

Macrobenthos community patterns in the year of 2010, the total macrobenthos densities varied from 1128 in station 2 to 2427 ind l^{-1} in station 3, with a mean of 1665 ind l^{-1}. The densities observed in season were not the same order of magnitude, ranging from 106 to 858 ind l^{-1}, with a mean of 400 ind l^{-1}. During the season survey, the density was higher in summer and lower in winter, the densities were nearly 2.5-fold lower in winter compare with summer, specifically the difference were between station 1 and 2 (Table 2).

Table 2- Density of species [ind l^{-1}], and total number of individuals in station 1 in season

Macrobenthose	Spring	Summer	autumn	Winter	Total	class
Lymnaeidae-Lymnaea	23	40	83	2	148	Gastropoda
Hemiptera-corixa	5	6	-	9	20	Insecta
Diptera-ceretopogonidae	35	45	46	54	180	Insecta
Odonata-Anisoptera	7	2	-	21	30	Insecta
Arachnidae	69	38	2	41	150	Arachnida
Ephemeroptera- Paraleptophtebia2	118	153	42	236	549	Insecta
Trichoptera -Hydropsychae	39	51	100		190	Insecta
Diptera-Chironomus 1	146	431	257	167	1001	Insecta
Diptera- Spaniotoma	-0	60	4	2	66	Insecta
Cyclopoida-Cyclops	0	13	-	27	40	Maxillopoda
Diptera-Simulium*	0	1			1	Insecta
Diptera-Tabanidae*	0	14	1	2	17	Insecta
Tylenchida-Nematoda	0	4	25	3	32	Secernentea
Odonata –Zygoptera*	0	0		1	1	Insecta
Coleoptera**	0	0		2	2	Insecta
Total	442	858	560	567	2427	

*It is not presented in station 2. **It is presented only in station 1.

Table 3- Density of species [ind l^{-1}], and total number of individuals in station 2 in season

Macrobenthose	Spring	Summer	autumn	Winter	Total	Class
Lymnaeidae-Ly mnaea2	177	182	30	0	379	Gastropoda
Hemiptera-corixa	5	2	0	0	7	Insecta
Diptera-ceretopogonidae	7	6	2	7	22	Insecta
Odonata-Anisoptera	2	0	3	9	14	Insecta
Arachnidae	4	2	1	2	9	Arachnida
Ephemeroptera –Paraleptophtebia3	40	41	23	26	130	Insecta
Trichoptera-Hydropsychae)	18	18	3	0	39	Insecta
Cyclopoida-Cyclops	0	6	0	9	15	Maxillopoda
Diptera-Chironomus1	162	142	42	37	383	Insecta
Diptera- Spaniotoma	0	50	16	15	81	Insecta
Tylenchida-Nematoda	0	15	22	1	38	Secernentea
Total	415	464	142	106	1127	

Table 4- Density of species [ind l^{-1}], and total number of individuals in station 3 in season

Macrobenthose	Spring	Summer	autumn	Winter	Total	class
Lymnaeidae-Lymnaea	7	16	0	0	23	Gastropoda
Hemiptera-corixa	22	1	1	7	31	Insecta
Diptera-ceretopogonidae	37	35	5	0	77	Insecta
Odonata-Anisoptera	3	1	0	6	10	Insecta
Arachnidae	7	1	1	4	13	Arachnida
Ephemeroptera –Paraleptophtebia2	27	44	56	41	168	Insecta
Trichoptera-Hydropsychae	41	48	15	9	113	Insecta
Diptera-Chironomus 1	119	452	62	162	795	Insecta
Odonata-Zygoptera	1	1	0	1	3	Insecta
Diptera- Spaniotoma3	0	57	41	63	161	Insecta
Diptera-Tabanidae	0	1	0	1	2	Insecta
Amphipoda-Gammarus**	0	2	0	1	3	Malacostraca
Cyclopoida-Cyclops	0	0	8	28	36	Maxillopoda
Tylenchida-Nematoda	0	0	0	6	6	Secernentea
Diptera-Simulium	0	0	0	1	1	Insecta
Total	264	659	189	130	1442	

**It is presented only in station 1

During the four sampling seasons, about 70 percent (26 out of 35) of the identified macrobenthos taxa was encounter in all seasons. Among the remaining taxa, 9 and 7 were present only in summer and winter respectively. Based on the information of table 1 most of macrobenthos detected was belong to class of insect. In particular, the insect identified during the four season was mostly dominated by Chironomus, belonging to order of dipteral (50% of the insect assemblage), ranging from 383 in station 2 to 1001 ind l^{-1} in station 1. Ephemeroptera Paraleptophtebia was the second most abundant insect (20%, 847 ou of 4094 ind.).

Except insect that was the most aboundant benthos in the Roudan river there was some other classes of benthos such as: Gastropoda, Arachnida , Malacostraca, Maxillopoda and Secernentea. The presence of these croup comparing to insects were 17% , 65% and 6% in station 1, 2 and 3 respectively. The result showed significant differences in aboundance of insects with other macrobenthos in 3 station ($P<0.05$) and also showed the differences in sediment structure in station 2 compare to two other stations. Among macrobenthos (except insect) the biomass of Lymnaeidae-Lymnaea was considerable. Lymnaeidae-Lymnaea in spring and summer in station 2 was numerous and it was 30 percent of total benthos of the station 3 in all around the year. Malacostraca had the fewest frequency and only few number were observed in station 3. Calanoid Cyclops were mainly presented in two season; summer and winter. In autumn and spring not any Cyclops were detected. Based on their individual contributions to the diversity indices for taxonomic abundance and biomass, 26 out of 35 taxa were retained in the river, forming nearly 70% of the total taxa in each season. Among the macrobenthos, Coleoptera was observed only in station 1 and Amphipoda-Gammarus only in station 3 while Simulium, Tabanidae and Zygoptera all from order of Diptera were absent in station 2 but the high number of Lymnaea belonging to the order of Lymnaeidae and class of Gastropoda were counted in this station. In addition to macrobenthos taking sample of zooplankton such as Rotatoria, showed very few number of them (range 4-10; mean 6) and only in winter season.

Discussion

Twenty percent of macrobenthos species in Roudan river exhibited clear seasonal change in population size. Some of these, such as those of Diptera- Spaniotoma and Diptera-Tabanidae are absence in spring and some of them such as Lymnaeidae-Lymnaea is absence in up-stream or down-stream in winter. The presence of Lymnaea in mid-stream is the reflected of situation of this part of the river. There are several article illustrate the correlation between the morphology of river side or costal status with aquatic organism. . The morphodynamic state of the beaches reflects the harshness of these environments and could indicate the kind of fauna that colonize different beaches (Brown & McLachlan 1990; Jaramillo & McLachlan 1993).

As the results showed in tables 2-4, there were magnitude differences in macrobenthos of station 2 with those of others. As previously described station 2 is a place for spending holidays of peoples, therefore some pollution may introduce to the river at this site. There are many reports on pollution impact to benthic fauna and benthic succession after local extinction of native fauna such as Pearson (1975), Tsutaumi and Kikuchi (1983). Therefore, the benthic fauna continue to be the subject of much research in the fields of hydrobiology and ecology because of the important of benthic organisms in the nutrition of fishes and as biological indicators of pollution.

As explained in the results zooplankton sampling in order to have more information about total characteristic of river showed the presence of few number (>10) of Brachionus in every sampling stage. The obtain rear rotifer in the river is due to high temperature at sampling site that is not proper temperature for reproduction of rotatoria , therefore only in winter some very few individual were caught in the river. Zooplankton species are important indicators for lakes since most of them are used to determine the quality, the trophic level, and the level of pollution river of lakes. For example, the Keratella and Brachionus species of Rotifera are indicators of productive lakes, while the Filinia and Polyarthra species of Rotifera are indicators of polluted water (Emir, 1994).

In the present study, a positive correlation was found at the first and third stations between the species and temperature ($r = 0.50$ and $r = 0.20$). The appearance and abundance macrobenthos also depend on the structure of river bottom and substance of study area. In presence of submerged grasses the macrobenthos of Gastropoda classes increases significantly comparing with other station ($P<0.05$). Dexter (1983) and Borzone et al. (1996) showed that the density of the macrofauna was negatively correlated to mean grain size. In addition, Defeo et al. (1992) found a negative correlation between beach slope and macrofaunal density, concluding that both slope and grain size are factors determining beach macrofaunal structure.

Monthly and annual fluctuations in population density are common among sandy beach macrofauna, where peaks in abundance are often a consequence of variations in recruitment rates (Souza & Gianuca 1995). In oceanic beaches, where strong variation of abiotic variables are observed, physical factors are usually more important than biological ones in controlling the community structure of intertidal benthos. The morphodynamic state of the beaches reflects the harshness of these environments and could indicate the kind of fauna that colonize different beaches (Brown & McLachlan 1990; Jaramillo & McLachlan 1993). Jaramillo et al. (2001) however, stated that the morphodynamics was not always a useful predictor of sandy beach community structure. Therefore, the absence and/or the low abundance of some species can also be related to their life cycle.

Beside the structure of bottom of the river, slop and temperature, the time of sampling (befor rainy, sun rise, windy condition), the depth of the river and place of sampling also is very important. In the present study we take sample at different depth as replication of sampling. There were quit big differences between the sampling at different depth. Bakus in 1990 also reported that the effect of depth is a factor in controlling population density of macrobenthic fauna. The direction and effect of wind is very important. In the present study we toke sample at calm condition in order to have not bias sampling method, however its effect in inducing macrobenthos activity during the year is important. Hylleberg et al. (1985) reported that the amplitude and direction of the monsoon wind and the shifting of monsoon has a considerable impact in term of sediment disturbance, this would have an effect directly on the density and diversity of macrobenthic fauna. In spite of higher organic loads in station 3 and also higher temperature that my result in higher surface productivity, meanwhile macrobenthos in all season was higher in station 1 comparing with the others. The relation between macrobenthos and surface productivity was pay attention by Soltwedel (2000), who stated that the flux of organic matter from surface productivity to the sea floor has been proven to exert considerable control on benthic standing stocks (Soltwedel, 2000). The objective of that paper was to provide current information focusing on the abundance of macrofauna; Polychaetes, bivalves, gastropods and the crustaceans. The results clearly showed that areas with increased organic matter, human disturbances such as recreational boating and waves hitting were the factors controlling the distribution pattern among the macrobenthos. The richer communities were generally found in areas with increased productivity and enhanced input of organic matter to the shore, (Sunilkumar and Antony, 1994).

At the end, the status of river according to its Physicochemical and structure of sediment determine the construction of benthos and all together determine the life of higher organism like fish (Yousefian et al., 2010). In the other hand the quality of the river make special characteristics for migration and propagation of fishes (Yousefian, 2011; Yousefian and Mosavi, 2008). The presence of high biomass of Chironomus and the proper quality of water shows that Roudan river can be used for aquaculture, but other parameters also should be consider.

Conclusion

The density and diversity of benthos were changed due to causes of pollution and physicochemical parameters. In station 3 one of the main factors is the presence of people and causes to increase pollution and in the others mainly the change of temperature, salinity are factors in abundance of macrobenthos.

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