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MACROINVERTEBRATE COMMUNITY STRUCTURE OF THE KIRMIR CREEK-SAKARYA RIVER

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ABSTRACT

The purpose of this study is to determine the qualitative properties and seasonal distributions of the macroinvertebrates in the Kirmir Creek. For this purpose, three different stations were selected to take sediment and water samples monthly throughout one year.

The benthic fauna of the Kirmir Creek was found to consist of 14 animal groups. It was determined that percentage of the groups was 75% Tubificidae, 15% Chironomidae, 5% Physidae, and 5% Sphaeridae at station 1; 78% Tubificidae, 8% Chironomidae, 5% Physidae, and 9% other animals at station 2; 78% Tubificidae, 9% Chironomidae, 7% Unionidae, and 11% other animals at station 3. These bioindicators showed that the Kirmir Creek has been exposed to organic pollution.

Key words: Macroinvertebrate, Organic Pollution, Kirmir Creek.

Kirmir Çayı-Sakarya Nehri'nin Makroinvertebrata Topluluk Yapısı

ÖZET

Bu çalışmanın amacı Kirmir Çayındaki bentik organizmaların niteliklerini ve mevsimsel dağılımlarını belirlemektir. Bu amaçla, bir yıl süreyle aylık sediment ve su örnekleri almak için üç istasyon seçildi.

Kirmir Çayının bentik faunası olarak 14 çeşit hayvan grubu bulundu. Bu hayvan gruplarının yüzdeleri şöyledir: % 75 Tubificidae, % 15 Chironomidae, % 5 Physidae ve % 5 Sphaeridae (İstasyon 1); % 78 Tubificidae, % 8 Chironomidae, % 5 Physidae ve % 9 diğer (İstasyon 2); % 78 Tubificidae, % 9 Chironomidae, % 7 Unionidae ve % 11 diğer (İstasyon 3). Biyoindikatör olarak kabul edilen bu hayvan grupları Kirmir Çayının organik kirliliğe maruz kaldığını göstermiştir.

Anahtar sözcükler: Makroinvertebrata, Organik Kirlilik, Kirmir Çayı.

INTRODUCTION

Today rapid increase of pollution and industrial development affect ecological equilibrium. It causes pollution effects to water resources. Streams, rivers and creeks are more affected and they carry these pollution components to lakes, dams, seas and oceans.

In streams, it is necessary to determine water quality not only by chemical analysis but also by biological observation. Because organism communities show stress caused by multi factors and cumulative effects. Chemical analysis shows only one situation, but biological organism positions evaluate damage of habitat, fluctuation effects of flow on organisms and other effects of pollution (Rosenberg and Resh, 1993).

Usage of bioindicators began about 100 years ago to assess water quality. Different groups of organisms are used for determination of water quality such as bacteria, fungus, micro algae, protozoa, rotifera, cladocerans, copepods, and macroinvertebrates. In Europe, the most common method is presence or absence of and macroinvertebrates. It is easy and effective because macroinvertebrates integrate all of the changes of water quality during their lifespan. Rosenberg and Resh (1993) cited that biotic indices of benthos show effects of organic or inorganic pollution in water. Macroinvertebrate communities give a response to hydraulic, organic and toxic stress with decrease of sensitive species and increase of tolerant species.

In pollution studies on stream systems, benthic macroinvertebrates are prefferred to work. These organisms are placed in food chain between alg-microorganism and fish. Also, collection of them is easy because they can not change their place and are visible by eyes. Their life spans are long enough to see seasonal changes and to investigate them in family level.

There are some studies reported about the benthic macroinvertebrate communities of streams (Georgudaki et al., 2003, Demir et al., 2001).

Marneffe et al. (1997) observed the Warche River. They used macroinvertebrates and rotifers as bioindicators in the river affected by sewage, and paper mill effluents. At the polluted area, water quality and biotic indices were declined.

The Kirmir Creek is a water source for irrigation and fishing in this area, but exposed to environmental pollution. The purpose of this study was to determine the qualitative and properties and find whether there are changes in seasonal and local distributions of the benthic fauna or not. Biological indicators of environmental situation were first mentioned by Kolkwitz and Marsson, 1908; 1909 (Rosenberg and Resh, 1993). The authors classified rivers according to pollution degree (especially sewages) in the 5 zones, which are catharobic, oligosaprobic, beta-

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mesosaprobic, alfa-mesosaprobic, polysaprobic. Rivers can tolerate some organic load, but after some point they begin to become polluted. Their self-refreshing capacity can be enough. Under the effect of a point-pollution, firstly Tubificidae, then *Chironomus* and then *Asellus* can increase when going away from that area and clean water species rise (Uslu and Turkmen, 1987).

MATERIALS AND METHODS

Benthic Sampling

This study was conducted in the Kirmir Creek in the Sakarya River Basin. Three stations, placed between Yeşilöz and Kızılcahamam province (60 km long) were chosen on the Kirmir Creek (130 km long) to take benthic samples and water measurement (figure 1). The Kirmir Creek locates in the North-West part of the middle Anatolian Region. It is on the 40-41 N and 32-33 E of the Sakarya River basin in the boundaries of Ankara. The depth was generally shallow (30-50 cm), but it reached 2-3 m in some points. The bottom structure was sometimes sandy, stony and muddy. Even there were some operating quarries on the Creek.

Samples were taken twice from each site by Ekman sampler (15x15 cm) during to 12 months. Every sample was put in the separate plastic bags marked for site, sample number and date. Samples

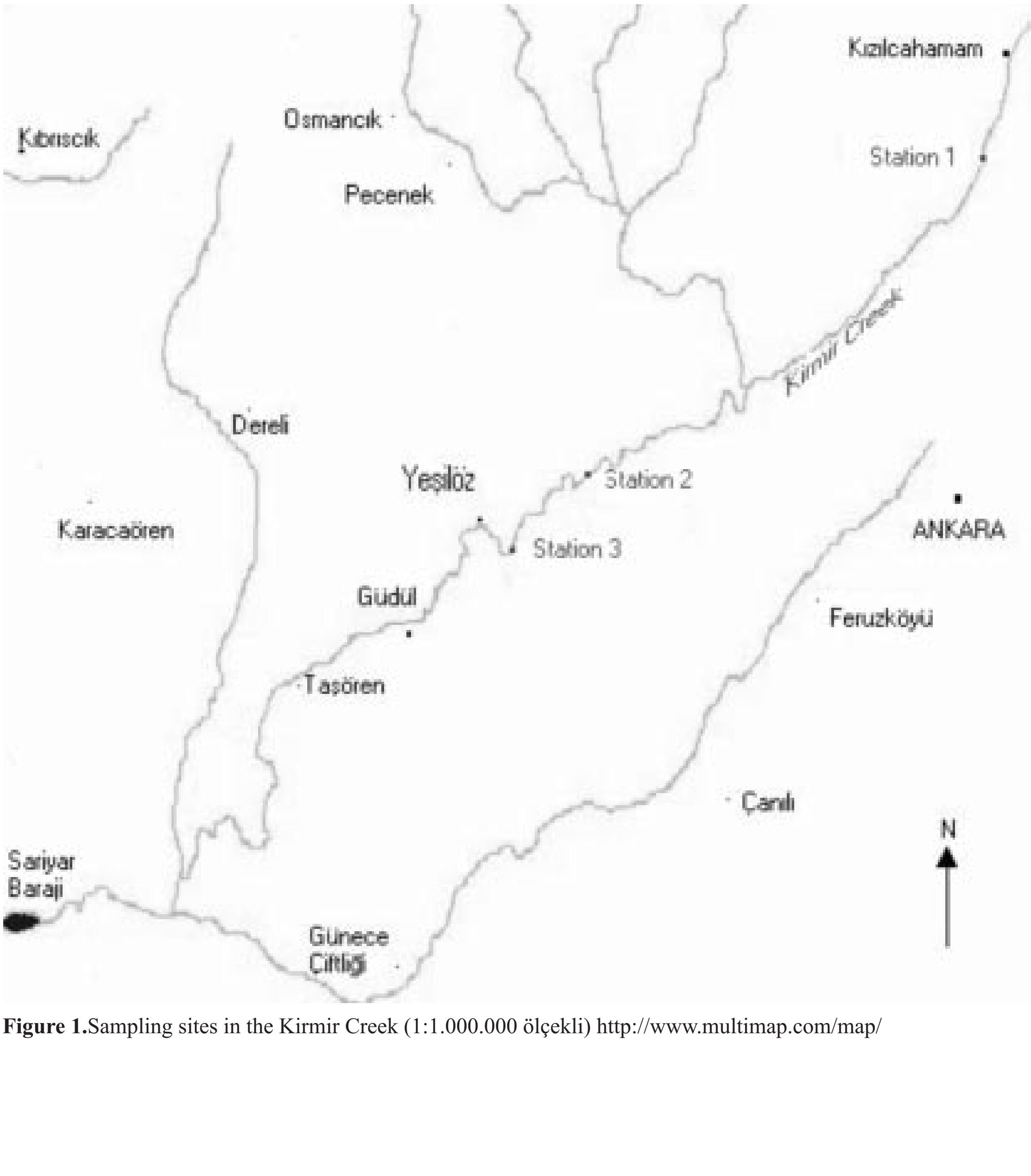


Figure 1. Sampling sites in the Kirmir Creek (1:1.000.000 ölçekli) http://www.multimap.com/map/

were distinguished with sieves (mesh-size 210-3360 m).

Sieved-macroinvertebrate organisms were conserved with 5% formal. After that organisms were distinguished taxonomically under invert and dark field microscopes. After organisms were classified according to their family and their abundances were calculated for individuals/m^2. For identification various sources were used (Macan, 1959; Edmondson, 1959; Smith and Quigley, 1986).

Means and standard deviations of abundance were calculated for each site and each month. To see abundance differences between sampling sites and months SSPS program was run for one way of analysis of variance (ANOVA) and Duncan tests.

Water Analysis

Temperature, Dissolved oxygen (DO), pH parameters were measured by standard methods. Temperature and pH were measured in the field. DO was analyzed by Winkler method in the laboratory.

RESULTS

Water parameters were shown at the Figure 2, 3 and 4 for each site. In the station 1, temperature was about 5 C in winter and 25 C in summer. DO was 7-8 mg/L from February to September then went to about 20 mg/L. pH did not change during the whole year.

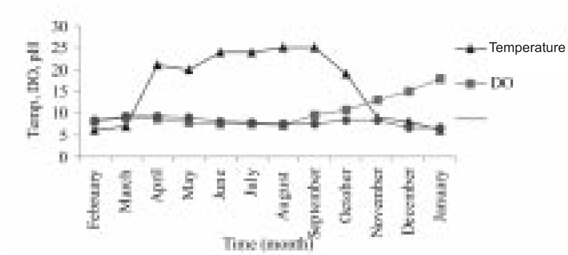


Figure 2. Temperature, DO and pH in the station 1

In the second station temperature was the same as station 1, but little bit high in August. DO was about 10 mg/L until August and went high in the rest of the year. pH did not show any differences.

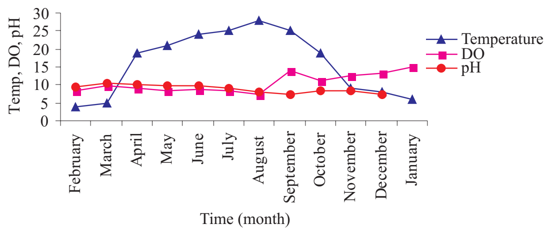


Figure 3. Temperature, DO and pH in the station 2

In the third station temperatures was like other two stations. DO fluctuated during the year (6-14 mg/L). pH was alkaline in winter, close to acidic level in summer.

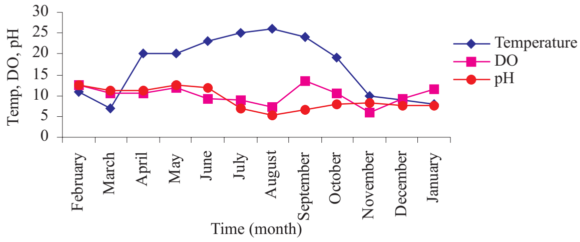


Figure 4. Temperature, DO and pH in the station 3

In this study animals were grouped in twelve families in eight orders (Table 1). There were 2 families (Chironomidae, Tabanidae) in Diptera, 1 family (Heptagenidae) in Ephemeroptera, 1 family (Dytiscidae) in Coleoptera, 1 family (Hydropsychidae) in Tricoptera, 1 family (Libellulidae) in Odonata, 1 family (Tubificidae) in Oligochaeta, 3 families (Lymnaeidae, Physidae, Planorbidae) in Gastropoda, 2 families (Unionidae, Sphaeridae) in Bivalvia.

Table 1. Benthic fauna found in the Kirmir Creek

Class	Order	Family
Insecta	Diptera	Chironomidae
		Tabanidae
	Coleoptera	Dytiscidae
	Ephemeroptera	Heptagenidae
	Tricoptera	Hydropsychidae
	Odonata	Libellulidae
Annallide	Oligochaeta	Tubificidae
Mollusca	Gastropoda	Lymnaeidae
		Physidae
		Planorbidae
	Bivalvia	Unionidae
	(Pelecypoda)	Sphaeridae

The total number of organisms were given in the Table 2. It demostrated that abundance increased depending on stations and time of year and reached the highest in station 1.

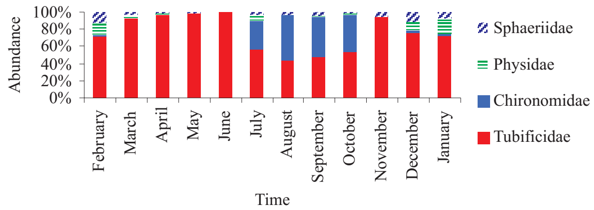
Table 2. Total abundance (individuals/m^2) of bentic fauna (mean ± SE)

Months \ Sites	1	2	3
1	26045±1607	4177±1922	5955±378
2	4755±2395	4933±2585	3627±485
3	17755±1497	4933±0	2688±1654
4	40378±21733	1644±1166	5222±456
5	53199±12450	1999±157	791±9
6	12266±2017	2489±1008	1333±314
7	23689±3404	6600±646	1488±488
8	31333±1702	5955±157	1600±0
9	14089±5106	10222±4034	3555±693
10	19844±5783	2377±708	6533±598
11	22800±5957	5466±2049	6822±1182
12	30577±2804	3400±47	8067±2158

During to a year, total organism abundance changed depend on sampling sites and months. Differences were found significant ($p<0.05$).

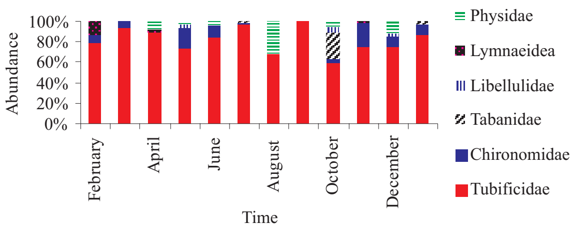
In the station 1 benthic fauna composition was 4 species (Figure 5). Most of the abundance was tubificidae around 40-70% all the months except for July. They became maximum (71%) in Feburary and November. During to 8 months tubifex was in company with its cocons. Cocons were appeared in March and they did not seen in the hottest month August, September and October. The second dominant organism was chironomidae. From July to October chironomid was seen about 30-50%. Physidae was seen as third kid of family and high especially in December, January and Feburary (10-15%).

Figure 5. Macroinvertebrate compositions in the station 1



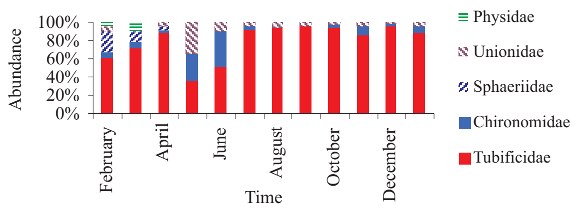
In the station 2, diversity was the highest, that is 13 animals. Tubificidae was the dominant family (43-99%) and it increased regularly during the months. Chironomidae was present (5-20%) except for August and September. Physidae was not seen for 6 months and was 32% in August. The rest of the nine kids of family (Tabanidae, Hydropsychidae, Dytiscidae, Hydropsychidae, Libellulidae, Lymnaeidae, Planorbidae, Sphaeridae, Unionidae, Hirudinae) was less in winter.

Figure 6. Macroinvertebrate compositions in the station 2



Eight species were seen in the station 3. Most of the composition was *Tubifex*. It is interesting not to see any eggs (cocons) of it during the year. In May and June, Tubificidae, Chironomidae and Unionidae shared the total composition. In February and March diversity increased.

Figure 7. Macroinvertebrate compositions in the station 3



In the location 3, three invertebrates were seen dominant. Tubificidae was 35-95% during to the whole year. Especially their percentages were 80-90% from July to December. Chironomidae increased from 2 to 30-40% in May and June. Unionidae went to 34% in May. Less diversity was found in this station. Because it was the most polutted. The other 5 families (Tabanidae, Libellulidae, Lymnaeidae, Physidae, Planorbidae) were seen in winter months (Feburary and March).

Results from water analysis and assesment of benthic fauna indicator species indicated that the Kirmir Region 1 had polysaprobic, the region 2 and 3 had alfa-mesosaprobic characteristics.

DISCUSSION

Biological productivity can be measured as quality, quantity and seasonal distribution of benthic fauna in water. They are also considered as bioindicators of pollution. Especially, benthic fauna is more prefferred than fito and zooplanktons, bacteria, fungi, etc. The studies on benthic fauna were often done for lakes in Turkey (Kırgız, 1988; Sözen, 1993; Ahiska, 1992; Karaşahin, 1998) and studies on stream and river communities are not common and recent (Geldiay and Bilgin, 1969; Şahin et al., 1988; Tanınmış, 1988; Şahin, 1991; Çetinkaya, 1994), although they are carried out in other countries (Bis et al., 2000; Jamil et al., 1999).

In this work, abundance and diversity of macroinvertebrates in the Kirmir Creek were determined. Samples were classified as family. Benthic fauna were Chironomidae, Tabanidae, Heptagenidae, Dytiscidae, Hydropsychidae, Libellulidae, Tubificidae, Lymnaeidae, Physidae, Planorbidae, Unionidae, and Sphaeridae.

In station 1, percentage of the total organisms was the individuals of Tubificidae family by at less 40%. It reached 71% in winter. Tubifex worms were seen with its eggs in most of the time. The other dominant organism was chironomidae by 30-50%. Physidae from Mollusca class consisted of rest of the group. The most diversity of family was found in station 2. Tubificidae had again high percentage. It was almost 100% in July and September. The other organisms were often seen Chironomidae and Physidae. Chironomidae went to peak in November (21%) and Physidae in August (32%). Station 3 had eight families. Tubificidae, Chironomidae and Unionidae consisted of 94% of total biomass. Tubificidae was most of all animals (78%) during the year. Unionidae also became the highest number in May (34%). Kırgız (1988) studied abundances and seasonal distributions of benthic fauna on the Seyhan Dam Lake. He collected 28 species in 6 animal groups. It was 77% Chironomidae larvae, 18% Oligochaeta and 4% others.

Collected dominant macroinvertebrates

(Tubificidae, Chironomidae, Physidae, Unionidae) were more than 90% for each site. 12 families were collected overall. The site 2 had the highest diversity and the highest abundance belonged to the site 1.

The present study, macroinvertebrate community structure demonstrated that the Kirmir Creek was seen afffected by some pollutant factors such as domestic effluents, road run-off and some industrial and commercial wastes. Particularly, domestic wastes and sewage from urban areas (Yeşilöz, Çeltik, Kızılcahamam and others), water that was running along road and whole organic matters that (see by eyes) were not processed in slaughterhouses.

The numbers of Tubificidae, Chironomidae and Mollusca that are tolerant organisms to organic pollution increase and mollusc accumulate metals in their tissues. Jamil et al (1999) found that copper and silver were higher in Unio spp. than other mussel species. Viarengo and Canesi (1991) used mussels to evaluate pollution effects in sea water. Because they are sessile, filter-feeding organisms and able to accumulate many arrays of pollutants (pesticides, hydrocarbons and metals) in their tissues.

Çetinkaya et al. (1994) investigated limnological parameters of the Karasu River flowing to the Van Lake. Water parameters, macrophytes, planktons, benthos and fish were analyzed. According to benthic fauna analysis, bioindicator species demostrated that eight stations had the animals that live among three different regions (oligosaprobic, beta mesosaprobic and alfa mesosaprobic). They observed Bivalve, Gastropoda, Mollusca, Diptera, Isopoda, Trichoptera, Ephemeroptera, Odonata. Tubificidae, Chironomidae, Physidae and Sphaeridae propogate in impacted water body. Those invertebrates invaded this creek. Annual average abundance of all species was 288761 for site 1, 58093 for site 2 and 47650 for site 3.

There were some operating quarries on the creek. This activity can damage creek ecosystem and macrobenthic habitats. It affects water productivity and benthic structure.

Recently, cage fish farms and tourism have argued about who is polluting our seas. This kind of works can be useful to assess the situation of water body in many bays. Thus, our seas, river and streams can be controlled and protected from environmental damages. As reports some companies or enterprises can be obliged to take cautions and install treatment plants. This kind of research can be also enlarged for monitoring physical, chemical and medical parameters, together.

On the other hand, the tabanidae family of Diptera is an important insect group with respect to human health and economical situation because of their sucking blood. Knowing seasonal and dairy activities of this species will give avantages to take some precautions against them. *Tabanus bromius* is an agent of Trypanosomiasis, Tularaemia and Anthrax diseases and carries *Trypanosoma theileri* Lavaera to human (Kılıç, 1993).

CONCLUSION

Nowadays, environmental pollution is a common problem all over the world. Water bodies such as streams, rivers, lakes, seas, and oceans are affected with many kind of organic pollutants or others. In most streams and rivers, macroinvertebrate community gives an excellent result about the water quality of stream. Because these organisms cannot immediately move out of their habitat and they are common, easy to collect to classify in taxa. Some species are sensitive to pollution and some are tolerant. If there is any pollution problem, macroinvertebrate community structure will show it.

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