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Distribution of Oligochaeta species as bioindicators of organic pollution in Ankara Stream and their use in biomonitoring

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Abstract: Specimens of the Oligochaeta species to be used as bioindicators of organic pollution were collected from Ankara Stream between April 1991 and November 1992. These species have been interpreted together with physico-chemical and the most important ecological parameters of the sampling point and evaluated to be used in biomonitoring.

Key Words: Aquatic Oligochaeta, bioindicator, Ankara Stream, pollution, biomonitoring.

Organik kirlilik biyoidikatörü olan Oligochaeta türlerinin Ankara Çayı'nda dağılımı ve biyolojik izlemede kullanılması

Özet: Ankara Çayı'nda Nisan 1991 ve Kasım 1992 tarihleri arasında organik kirlilik biyoidikatörü olan Oligochaeta türleri toplanmıştır. Bu türler örnekleme noktalarının fiziko-kimyasal ve en önemli ekolojik parametreleri ile birlikte yorumlanarak biyolojik izlemede kullanılmak üzere değerlendirilmiştir.

Anahtar Sözcükler: Sucul Oligochaeta, biyoidikatör, Ankara Çayı, kirlilik, biyolojik izleme.

Introduction

Using most of the aquatic Oligochaeta species and especially the species belonging to the families of Naididae and Tubificidae as bioindicator organisms is quite common (1, 2, 3). If only the results obtained from the physico-chemical analyses are used to evaluate the water quality as it is generally done in Turkey, there will be deficiencies in the interpretations. Therefore, biological data must also be collected together with physico-chemical data. The community composition of the species and the trophic structure of the waterbody can be used as indicators for determination of the prolonged effects of pollutants.

Oligochaeta species are suitable invertebrate groups for biomonitoring due to their long life cycles.

The studies on Oligochaeta fauna in Turkey are rather limited. In recent years, 26 species were determined in Turkey (4, 5, 6, 7, 8, 9, 10, 11, 12). However, no study has so far been carried out in Turkey toward the interpretation of the water quality by using these species as biological parameters together with physico-chemical data.

This study involves the data on the distribution of the Oligochaeta species which are collected during previous research (13) with the aim to observe the water quality with biological and physico-chemical data and the use of Oligochaeta species as bioindicators. Furthermore, the bottom structure of the stations, current rate and the plant composition in water were given. With this study, for the first time in Turkey, water quality parameters and the important ecological features of the aquatic habitat are interpreted using Oligochaeta species as bioindicators of organic pollution.

Materials and Methods

Monthly sampling of physico-chemical parameters and benthic macroinvertebrates were performed from the 20 stations selected in the Ankara Stream and its tributaries beginning from April 1991 to November 1992. The stations are marked on the map (Fig.1). The stations that had Oligochaeta species are as follows:

Station 1 : The Kocaçay Stream which is very close to the source of the Ankara Stream

Station 5 : The outlet of the Çubuk I Dam

Station 6 : The Incesu Stream (the outlet of Eymir Lake)

Station 11 : The Hatip Stream

Station 15 : The Mera Stream (the inlet of the Kurtboğazi Dam)

Station 18 : The Zir Stream

The physico-chemical parameters such as dissolved oxygen (DO), pH, water temperature (T), conductivity (EC), Ca, Mg, CO₃, HCO₃, SO₄, Cl, chemical oxygen demand (COD), Na, K, N-NO₃, N-NO₂, N-NH₄, P-PO₄, Cd, Pb, Cu, Ni, Zn, Fe, Mn and B were measured according to

the standard methods of DSI (The State Water and Hydraulic Works) (14). Classification of physico-chemical parameters was performed according to the criteria of inland water quality that is commonly used in Turkey (15).

The sources of pollutants effecting the Ankara Stream are given in the Table 1.

The benthic macroinvertebrate community was sampled by the kicking method for 15 minutes. The Oligochaeta samples were kept in 4 % formaldehyde in the field and transferred to 80 % ethly alcohol in the laboratory.

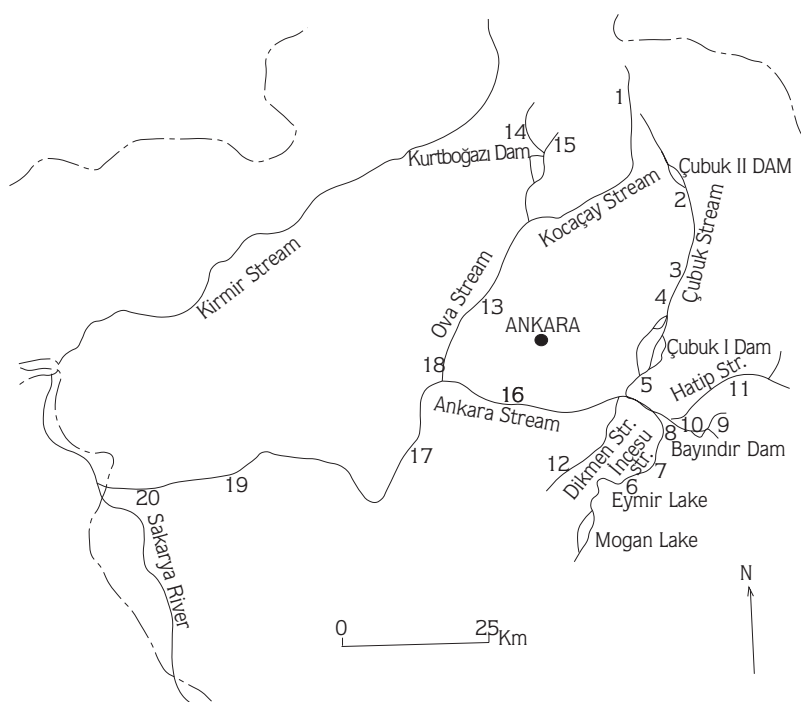


Figure 1. Study area and sampling stations

Stream	Sources of Pollutant
The Kocaçay Stream	Agricultural and domestic sewage,
The Çubuk Stream	Agricultural and domestic sewage, food and soft drinks factories, Coca-Cola Factory, slaughter houses
The outlet of Çubuk I Dam	Agricultural and domestic sewage
The Incesu Stream (The outlet of Eymir Lake)	Agricultural and domestic sewage
The Hatip Stream	Agricultural and domestic sewage, dairy farms, slaughter houses, meat combines
The Mera Stream (The inlet of the Kurtboğazi Dam)	Agricultural and domestic sewage, chicken farms
The Zir Stream	Agricultural and domestic sewage, slaughter houses, meat combines, packing factory

Table 1. The sources of pollutant effecting the Ankara Stream

Stations	pH	DO	N-NO ₃	N-NO ₂	N-NH ₄	P-PO ₄	COD	Organic substance
		(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	mgO ₂ /l	mgO ₂ /l
1	7.9-8.2 (I)	7.4-11.2 (II-I)	0-9.34 (I-II)	0-0.34 (I-IV)	0-2.6 (I-IV)	0-0.96 (I-IV)	10-80 (I-IV)	1.2-10
5	7-8.6 (I-III)	9-12 (I)	0.17-15.08 (I-III)	0-0.31 (I-IV)	0.29-1.66 (II-III)	0.12-1.99 (II-IV)	20-140 (I-IV)	2.5-17.95
6	7.7-8.5 (I)	8-13 (I)	0-0.68 (I)	0-0.022 (I-III)	0-4.06 (I-IV)	0.17-1.36 (III-IV)	0-100 (I-IV)	0-12.8
11	7.7-8.2 (I)	6-8.6 (II-I)	0.4-3.4 (I)	0.03-0.19 (III-IV)	0.08-3.33 (I-IV)	0.4-1.44 (III-IV)	0-30 (I-II)	0-3.66
15	7.2-8.3 (I)	4-12 (III-I)	1.06-3.61 (I)	0.014-8.57 (III-IV)	0-3 (I-IV)	1.12-1.93 (IV)	0-40 (I-II)	0-5.1
18	7.2-7.9 (I)	3.3-11.4 (III-I)	0.39-5.1 (I-II)	0.02-0.31 (III-IV)	0-3.4 (I-IV)	0.19-1.45 (III-IV)	0-90 (I-IV)	0-11.84

Table 2. The highest and the lowest annual values of the measured physico-chemical parameters and the classes of the water quality in the stations in 1991.

In determining the Oligochaeta species we basically followed Brinkhurst 1971 (16).

Results

The sampling of the physico-chemical parameters and benthic macroinvertebrates was performed in the Ankara Stream and its tributaries in 1991 and 1992. In this

study, Oligochaeta species as bioindicators of organic pollution were determined to the species level and evaluated with the physico-chemical parameters to use in biomonitoring. The values belonging to physico-chemical parameters have been given in Girgin and Kazancı 1994 (13). In this paper, the highest and the lowest annual values of the inorganic chemical parameters indicating the organic pollution and their classes of water quality have

Stations	pH	DO	N-NO ₃	N-NO ₂	N-NH ₄	P-PO ₄	COD	Organic substance
		(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	mgO ₂ /l	mgO ₂ /l
1	7.2-8.9 (I-III)	7.2-12.2 (II-I)	0-2.55 (I)	0-0.017 (I-III)	0-0.399 (I-II)	0.104-0.499 (II-III)	0-145 (I-IV)	2-10.75
5	7.7-9.2 (I-IV)	4.4-10 (I)	0-1.702 (I)	0-0.273 (I-IV)	0-1.75 (I-III)	0.042-2.29 (II-IV)	10-130 (I-IV)	4.09-10.68
6	7.8-8.6 (I-III)	2.6-11 (IV-I)	0-0.86 (I)	0-0.023 (I-III)	0 (I)	0.229-0.87 (III-IV)	14-138 (I-IV)	3.6-11.5
11	7.4-8 (I)	10(april) (I)	1.28-2.66 (I)	0.0086-0.089 (II-IV)	0-3.99 (I-IV)	0.23-1.21 (III-IV)	0-49 (I-II)	2.03-9.93
15	7.4-8.3 (I)	3.2-11.5 (III-I)	1.49-8.29 (I-II)	0.0034-0.066 (II-IV)	0 (I)	0.68-1.872 (IV)	1-114 (I-IV)	2.4-9.17
18	7.5-8.3 (I)	2.2-10 (IV-I)	0-2.127 (I)	0-0.096 (I-IV)	0-10.66 (I-IV)	0-11.02 (I-IV)	0-251 (I-IV)	2.16-22.88

Table 3. The highest and the lowest annual values of the measured physico-chemical parameters and the classes of the water quality in the stations in 1992.

Oligochaeta species	Stations					
	1	5	6	11	15	18
Naididae						
Naididae gen. sp.	4					
Nais sp.	1					
Tubificidae						
Tubificidae gen. sp.	1	11	1	2		7
<i>Tubifex tubifex</i> (Müller, 1774)				1		5
<i>Psammoryctides moravicus</i> (Hrabe, 1934)			1			3
<i>Limnodrilus hoffmeisteri</i> Claparede, 1862					11	1
<i>Limnodrilus udekemianus</i> (Claparede, 1862)						19
<i>Pelosclex ferox</i> Leidy, 1851					4	
Haplotaxidae						
<i>Haplotaxis gordioides</i> (Hartmann, 1821)		2				
Lumbricidae						
<i>Eisniella tetraedra</i> (Savigny)				1		

Table 4. The numerical distribution of Oligochaeta species in the stations.

been given in tables in order to give an idea about the general structure of the stream system (Tables 2 and 3).

The numerical distribution of the determined Oligochaeta species has been given in Table 4.

In the distribution of the Oligochaeta species, the physical features of the microhabitat in which they live are as significant as the water quality of the aquatic ecosystem in which they exist. Therefore, water quality zones determined in terms of biological and physico-chemical features, the bottom structure of the stations during sampling, vegetation and their current conditions and the Oligochaeta species that they have were given in Table 5.

Discussion

Oligochaeta samples collected from the Ankara Stream belong to the families of Naididae, Tubificidae, Haplotaxidae and Lumbricidae. In the Zir Stream, 5 species such as Tubificidae gen sp. (this sample could not be determined to the species level because the individuals were not adult), *Limnodrilus udekemianus*, *Limnodrilus hoffmeisteri*, *P. moravicus*, *T. tubifex* were determined. In 1991, in the samplings carried out in this station *Limnodrilus udekemianus* was found in April, July, August and October, *Limnodrilus hoffmeisteri* in October; *P. moravicus* in July and August; *T. tubifex* in April, Tubificidae gen. sp. in April, July and August. In this station, 0.08 mg/l N-NO₂ (class IV), 1.1 mg/l P-PO₄ (class IV), 6 mg/l Cd (class III), 30 mg/l Pb (class III), 3.3 mg/l dissolved oxygen (class III), 6.6 mgO₂/l organic substance were determined in April; 0.03 mg/l N-NO₂ (class III), 0.7 mg/l P-PO₄ (class IV), 11 mg/l Cd (Class IV), 70 mg/l Pb (class IV), 7.2 mg/l dissolved oxygen (class II) in July; 0.02 mg/l N-NO₂ (class III), 2.06 mg/l N-NH₄ (class IV), 1.41 mg/l P-PO₄ (class IV), 8 mg/l Cd (class III), 5.2 mg/l dissolved oxygen (class III) in August; 0.063 mg/l N-NO₂

(class IV), 0.7 mg/l P-PO₄ (class IV), 90 mgO₂/l COD (class IV), 11.84 mgO₂/l organic substance, 4.8 mg/l dissolved oxygen (class III) in October. In the periods when these species were collected, these physico-chemical values obtained showed that there was a heavy metal pollution in this station Pb and Cd were also high indicating the heavy metal pollution. Dissolved oxygen values were also low. These species were found in the regions in which the organic pollution was high the dissolved oxygen was low too.

The inlet of Kurtboğazi Dam, the station where *Limnodrilus hoffmeisteri* exists, the Mera Stream has heavy organic pollution of 0.21 mg/l N-NO₂ (class IV) and 1.59 mg/l P-PO₄ (class IV) and heavy metal pollution of 30 mg/l Pb (class III) were obtained in April 1991. The measurement of 22 mg/l Ni also corresponds to class II water quality. However, the dissolved oxygen in this station in April 1991 when samples were collected was 10.2 mg/l (class I). *P. ferox* was found in station 15 during the same period. The habitat of this species is lakes. At the same time, the fact that the oxygen level is low is an important negative factor for this species and this species is sensitive to the low oxygen (17). Although the oxygen demand by the measured pollutants was high in the station 15, the dissolved oxygen was high enough to maintain this species. It is seen that this species can survive in the regions where there is heavy organic pollution and high-oxygen levels.

E. tetraedra and *T. tubifex* were found in the Hatip Stream in March 1992, the values of the physico-chemical parameters were 0.07 mg/l N-NO₂ (class IV), 1.07 mg/l N-NH₄ (class III), 0.23 mg/l P-PO₄ (class III), and 3.6 mgO₂/l organic substance. On March 1992, the concentration of Cd and Pb were found to be high indicating the heavy metal pollution 7 mg/l Cd (class III) and 250 mg/l Pb (class IV).

Stations	Water quality zones	structure of substratum	Aquatic vegetation	Flow rate	Oligochaeta species
1. The Kocaçay Stream	Beta mesosaprobic	stony, partial sandy	-	rapid	Naididae gen. sp. <i>Nais</i> sp. Tubificidae gen. sp.
5. The outlet of Çubuk I Dam	Alpha mesosaprobic	stony	<i>Cladophora</i>	slow	Tubificidae gen. sp. <i>Haplotaxis gordioides</i>
6. The Incesu Stream, the outlet of Eymir Lake	Alpha mesosaprobic	gravelly, some stony, marshy along the shore	<i>Cladophora</i> <i>Typha</i> , <i>Juncus</i> <i>Ranunculus</i> sp.	medium	Tubificidae gen. sp. <i>Psammoryctides moravicus</i>
11. The Hatip Stream	Alpha mesosaprobic	stony, marshy along the shore	<i>Typha</i> , <i>Juncus</i>	rapid	Tubificidae gen. sp. <i>Tubifex tubifex</i> <i>Eiseniella tetraedra</i>
15. The Mera Stream, the inlet of The Kurtboğazi Dam	Alpha mesosaprobic	stony	<i>Lemna</i> sp. <i>Mentha</i> sp. <i>Cladophora</i>	medium	<i>Limnodrilus hoffmeisteri</i> <i>Peloscoclex ferox</i>
18. The Zir Stream	Alpha mesosaprobic	stony, partial marshy	<i>Typha</i> , <i>Juncus</i> , <i>Cladophora</i>	medium	Tubificidae gen. sp. <i>Tubifex tubifex</i> <i>Psammoryctides moravicus</i> <i>Limnodrilus hoffmeisteri</i> <i>Limnodrilus udekemianus</i>

Table 5. The ecological features of the stations in where Oligochaeta species were found.

In the inlet of Çubuk I Dam where *H. gordioides* exists, heavy organic pollution due to 0.07 mg/l N-NO₂ (class IV) and 1.12 mg/l P-PO₄ (class IV), 4.43 mgO₂/l organic substance and heavy metal pollutant of 70 mg/l Pb (class IV) were obtained in April 1991. At the same station, the value of 4 mg/l Cd was class II water quality.

As it is seen, in the Tables 2 and 3, according to the COD values in the station 11 in the both years classes I and II water qualities (0-49 mgO₂/l) and in the station 15 in 1991, the classes I and II water quality (0-40 mgO₂/l) were determined. In the other stations in both years water quality values were ranging from I to IV (0-251 mgO₂/l).

The amount of organic substance is one of the features showing pollution in waters, when the total

amount of organic substance in waters exceeds 3.5 mg/l, pollution can be regarded as a bacteriological pollution. As it is seen in the Tables 2 and 3, this value was exceeded in these stations. These values showed that was an organic pollution in these streams.

The members of the family Naididae were found in β mesosaprobic zone of the Kocaçay Stream (station 1).

In the distribution of Oligochaeta species the data related to the water quality are as important as the physical features of the microhabitats in which they live. The most important of these physical features are the existence of the type of bottom material, current rate and the vegetation with the different features. These features mentioned above are given in Table 5.

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