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Ecological Analysis of Chironomid Larvae (Diptera, Chironomidae) in Ergene River Basin (Turkish Thrace)

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Abstract

In the present study, chironomid larvae were sampled periodically between the years 1995-96 during the one year at eight different localities of Ergene River Basin. A total of 60 chironomid taxa (325 individuals/m^2) were recorded in the River and its tributaries (Ergene River Basin) during the sampling period. Also, it evaulated the larval chironomid assemblages in Meriç-Ergene River Basin which is amongst the most important wetland area in European part of Turkey. Furthermore, it determined the physicochemical properties of the water to analyse the relationships between species composition of chironomid communities and environmental parameters.

Structure of sediment at each sampling station of Ergene River Basin was revealed to determine the substratum preference of the larvae. It was that found sediment nutrient enrichment strongly influenced chironomid assemblage structure. Furthermore, main results due to species diversity, density of populations, similarities for the sampling stations and the substratum types were discussed.

According to Shannon index, species diversity of the Basin was found as H'=1.41 at average. Also, Spearman index has indicated that significant correlations were found between chironomid larval densities and some environmental variables such as conductivity (r=-0.708), dissolved oxygen (r=+0.810), biological oxygen demand (r=+0.822), and chemical oxygen demand (r=+0.805) for P<0.05.

Keywords: chironomidae, biodiversity, substratum, Ergene River, Turkey.

Ergene Nehir Havzası'ndaki (Trakya) Chironomid Larvalarının (Diptera, Chironomidae) Ekolojik Analizi

Özet

Bu çalışmada, Ergene Nehir Havzası'ndaki 8 farklı lokaliteden, 1995-96 yılları arasında bir yıl boyunca periyodik olarak chironomid larvası örneklemesi yapıldı. Örnekleme periyodu boyunca, Ergene nehri ve kollarında (Ergene Nehir Havzası), toplamda 60 larval chironomid taksonu (325 birey/m^2) kaydedildi. Chironomid kommunitelerinin tür kompozisyonuyla çevresel parametreler arasındaki ilişkiyi saptamak amacıyla, suyun fizikokimyasal özellikleri de belirlendi. Ayrıca, Türkiye'nin Avrupa parçasındaki en önemli sulak alanları arasında bulunan Meriç-Ergene Nehir Havzası'nın larval chironomid içeriği de değerlendirildi.

Ergene Nehir Havzası'ndaki örnekleme istasyonlarının her birinin sediment yapısı, larvaların substrat tercihini belirlemek amacıyla kaydedildi. Sedimentin besin zenginliğinin, chironomid topluluğunun yapısı üzerinde güçlü bir etkisi olduğu saptandı. Ayrıca, örnekleme istasyonlarının ve substrat tiplerinin benzerlikleri, tür çeşitliliği ve populasyon yoğunluğu açısından da değerlendirildi.

Shannon indeksine göre, havzanın larval tür çeşitliliği ortalaması H'=1,41 olarak belirlendi. Ayrıca, Spearman indeksine göre chironomid larvalarının yoğunluğuyla, bazı çevresel değişkenler (iletkenlik (r=-0,708), çözünmüş oksijen (r=+0,810), biyolojik oksijen ihtiyacı (r=+0,822), ve kimyasal oksijen ihtiyacı (r=+0,805) arasındaki ilişkiler istatistiksel açıdan önemli bulundu (P<0,05).

Anahtar Kelimeler: chironomidae, biyoçeşitlilik, substrat, Ergene Nehri, Türkiye.

Introduction

Chironomids are one of the most abundant macroinvertebrate group and they often account for the majority of aquatic insects in freshwater environments (Epler, 2001; Freimuth and Bass, 1994). The larval stage that belongs to the family Chironomidae in various inland water (from lentic to lotic environments) is the longest period of life cycles of these insects. Due to adaptation capability and ecological ability of larvae to extreme environmental conditions of temperature, pH, salinity, depth, flow velocity and productivity, they can be found in many different aquatic environments (Armitage *et al*., 1995). Also, species composition of chironomid assemblages differs qualitatively and quantitatively among microhabitats, and larvae are highly selective in their choice of a site (Maasri *et al*., 2008). Larval chironomids can be also considered as indicators of productivity of stagnant waters, because they are at the lower levels of the food chain and they are a source of food for other animal groups. Consequently, larval chironomids are the most useful group which is used as indicators in biological classification of inland water reservoirs by their abundance in unit area of bottom and species compositions (Kırgız, 1988).

Up to now, larval Chironomidae communities from a lot of streams in Turkish Thrace were studied by Şahin (1987), Kırgız (1988), Özkan and Kırgız (1995), Sever (1997), Kavaz (1997), Kır (1997), Özkan and Çamur-Elipek (2006 and 2007). Until now, there is no study which was performed on ecological analyse of larval chironomid composition in Ergene River Basin (Ergene River and its tributaries).

In this study, both the larval chironomid fauna of Ergene River Basin and the efficiency of the physicochemical variables and substratum structure to distribution of the larvae were discussed. Also, it summarized the larval chironomid assemblages in Meriç-Ergene River Basin by considering the previous studies, which were performed in some upper streams and tributaries of this important wetland area.

Materials and Methods

Ergene brook and Çorlu stream rises from Yıldız (Istranca) mountain ranges in Turkish Thrace region and then they join Meriç River (which is a border river between Greece and Turkey) as Ergene River. The River has 285 km length and maximum 680 cm depth. Quality of water and sediment of Ergene River Basin is deeply affected by numerous factories and agricultural areas settled in Turkish Thrace region (Anonymus, 1989).

To determine the composition of Chironomidae larvae and physicochemical features of the basin, eight localities were chosen for sampling and the stations were sampled periodically intervals during a year: localities before the settlements were chosen as station 1 (on Çorlu stream) and station 3 (on Ergene brook) which have muddy and sandy substratum; the locality after the settlements (Çorlu vicinity) and some factories were chosen as station 2 (on Çorlu stream) which has bad smelling muddy substratum. The locality, where Ergene brook joints Çorlu stream and together make the Ergene River was chosen as station 4, which has muddy and sandy substratum. The localitiy before the intense settlements and factories were chosen as station 5, which has bad smelling miry substratum. The locality after the intense settlements and factories was chosen as station 6 which has sandy and muddy with floral detritus. Although sampling was done at three localities in Oğulpaşa stream, the average data were used as data of station 7 which substratum structure changes at seasonally (sometimes muddy and sandy materials, sometimes with live floral or algal materials, and sometimes with floral detritus). Oğulpaşa stream joins to the Ergene River at station 8, which has muddy substratum with floral detritus (Figure 1).

Larval chironomid samples were collected using Ekman Grab (15cm x 15cm) twice at each station and then washed through 0.5mm sieve and preserved in 70% ethanol. Specimens were stored in a 70% ethanol solution prior to identification. Chernovskii (1961), Fittkau (1962), Beck and Beck (1969), Bryce and Hobart (1972), Sæther (1977), Fittkau and Reiss (1978), Moller-Pillot (1978-1979; 1984), Fittkau and Roback (1983), Şahin (1984; 1987; 1991), Şahin *et al*. (1988), Armitage *et al*. (1995), and Epler (2001) were used to identify the larvae at the lowest possible taxonomic level. Evaluation of species abundance (number of individuals /m^2) and value of specific richness enabled us to determine the Shannon's index for each station (Krebs, 1999). The indices for each station (except stations 2nd, 4th, and 5 th) were averaged for the entire year to compare diversity among the stations.

While some physicochemical parameters including water temperature, conductivity, and pH were measured (using ordinary thermometer, Jenway 3040 mark ion analyser, and WPA CM35 mark conductivity meter, respectively) at the time of the sampling of benthos, water samples taken by Ruttner water sampler were carried to the laboratory to measure the other parameters including dissolved oxygen (DO) (using Winkler method), biological (BOD_5) and chemical oxygen demands (COD), Ca^{+2}, Mg^{+2}, Cl^{-1}, NO_3^{-1}-N, NO_2^{-1}-N and PO_4^{-3} using classical titrimetric and spectrophotometric methods (Egemen and Sunlu, 1999). Quality grades of the water at the sampling sites were determined using National water quality standards (SKKY, 2004).

However, the correlation between data of both larval numbers and physicochemical parameters were determined statistically by using Spearman correlation

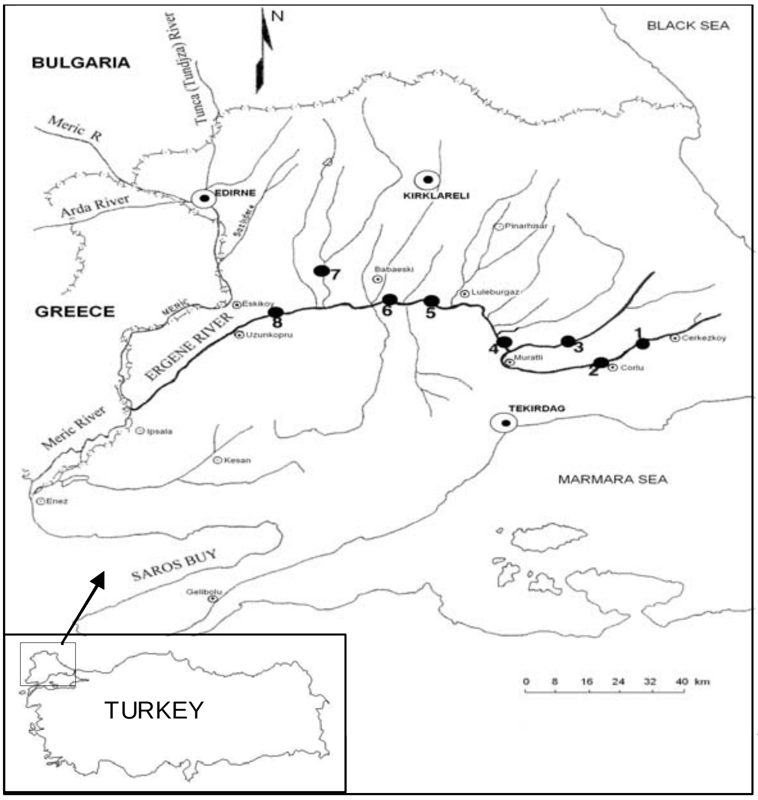


Figure 1. Map of the Ergene River Basin showing the studied area and sampling stations.

index in SPSS 9.0 for Windows. Furthermore, the similarities for larval composition were determined using Bray-Curtis index in terms of both stations and sediment types (Krebs, 1999).

Results and Discussion

A total of 60 chironomid taxa comprised 325 individuals/m² were found in Ergene River Basin during the studied period (Table 1). Although a total of eight different stations were investigated, any larval Chironomidae specimens were found at the Station 2, 4 and 5. It was found out that the most abundant taxa was *Polypedilum nubifer* comprising 25% abundance, followed by *Chironomus tentans* with 8.9%, and *C.plumosus* and *Tanypus punctipennis* with 8.6% abundances in other sampling stations.

It is reported that the larvae belonging to the genus *Chironomus* are often collected in aquatic ecosystems, which are subjected to high organic nutrient enrichment (Freimuth and Bass, 1994). In the current study, the larvae of *Chironomus* were also observed frequently.

While low abundance and diversity of larval chironomids are reported (both species and numbers) in Station 1, 3, and 6, highest values of taxa and number of individuals are recorded in both 7th and 8th station, respectively. Furthermore, the results were supported by Shannon index statistically. It was found that the Basin has different diversity ranging between 0.00 (at 3rd station) and 2.75 (at 7th station).

Abundances of recovered taxa related to current environmental conditions, such as water temperature, conductivity, pH and nutrient show a significant distribution pattern which is well correlated with impacted sites and bad quality of habitats. Station 3 may be attributed to the increase in wasted waters from settlements and factories. This material may decrease the amount of the larval density.

Physicochemical features of the Basin varying at the sampling stations indicates for water temperature an average of 13ºC during sampling period. Same observations show that pH values varying between 7.0 and 7.7, and dissolved oxygen between 2.3 and 8.0 mg L^{-1}, conductivity between 243 and 631 µS cm^{-1}, BOD_5 between 0.8 and 4.0 mg L^{-1}, COD between 55 and 494 mg L^{-1}, calcium between 55 and 94 mg L^{-1}, magnesium between 16 and 33 mg L^{-1}, chloride between 135 and 1538 mg L^{-1}, NO_3 between 3.8 and 14.4 mg L^{-1}, NO_2 between 0.14 and 0.32, PO_4 between 0.10 and 0.58 mg L^{-1}, NH_3 range between 0.08 and 0.95 mg L^{-1} (Table 2).

According to SKKY (2004), these measurements have showed that the water in the Basin was slightly alkaline and occasionally medium hard. Conductivity was very high by values exceeding 243 µS cm^{-1}. The values of conductivity, pH, COD, Chloride, NO_2, PO_4, NH_3 of the Station 7 were lower than those of

Table 1. List of larval Chironomidae of Ergene River Basin with their % abundances and the substratum types (Ave:average)

Species / Station	1	3	6	7	8	Ave	%	Substratum preference
Ablabesmyia monilis (Linnaeus, 1758)				3		1	0.3	Sand
Ablabesmyia sp.				1		1	0.3	Sand
Bryophaenocladius furcatus (Kieffer, 1916)	6			3		2	0.6	Mud, sand, floral detritus, plants
Camptocladius stercorarius De Geer, 1776			11			2	0.6	Sand
Chironomus anthracinus Zetterstedt, 1860				69	41	22	6.7	Mud, sand, algae, floral detritus
Chironomus aprilinus Meigen, 1818				26	3	6	1.8	Mud, sand, algae, floral detritus
Chironomus plumosus (Linnaeus, 1758)				74	67	28	8.6	Every type
Chironomus riparius Meigen, 1804				1	12	2	0.6	Sand, mud
Chironomus tentans Fabricius, 1805				67	79	29	8.9	Mud, sand
Chironomus viridicollis v.d.W., 1877				56	40	19	5.8	Every type
Chironomus sp.				11	3	2	0.6	Every type
Cladotanytarsus mancus (Walker, 1856)				18		3	0.9	Sand, mud, algae, floral detritus
Corynoneura scutellata Winnertz, 1846					7	1	0.3	Sand
Cricotopus albiforceps Kieffer, 1916				14		2	0.6	Sand, mud
Cricotopus annulator Goethgebuer, 1927				1		1	0.3	Floral detritus
Cricotopus bicinctus Meigen,1818				38		7	2.1	Sand, mud, floral detritus, algae
Cricotopus flavocinctus Kieffer, 1924				5		1	0.3	Sand, algae
Cricotopus fuscus Kieffer, 1909				7	3	2	0.6	Sand, mud
Cricotopus ornatus (Meigen, 1818)					5	1	0.3	Sand
Cricotopus sylvestris (Fabricius, 1794)				42	5	10	3.0	Sand, mud, algae, floral detritus
Cryptochironomus defectus Kieffer, 1913				15		3	0.9	Sand, algae, floral detritus
Cryptocladopelma sp.				1	3	1	0.3	Algae, mud
Cryptotendipes holsatus Lenz, 1959				1		1	0.3	Mud
Dicrotendipes nervosus (Staeger, 1839)				6	3	1	0.3	Floral detritus, mud, algae, plants
Dicrotendipes tritomus (Kieffer, 1916)				4	5	1	0.3	Floral detritus, sand, algae
Einfeldia pagana (Meigen, 1838)				1		1	0.3	Plants
Endochironomus tendens (Fabricius, 1775)				1		1	0.3	Mud
Glyptotendipes sp.					5	1	0.3	Floral detritus
Halocladius fucicola (Edwards, 1926)				15		3	0.9	Algae
Hydrobaenus pilipes (Malloch, 1915)				7	3	1	0.3	Floral detritus, mud
Harnischia fuscimana Kieffer, 1921				1		1	0.3	Sand
Limnophyes minimus (Meigen, 1818)				13		2	0.6	Mud, floral detritus
Macropelopia nebulosa (Meigen, 1804)				5		1	0.3	Mud, floral detritus
Macropelopia sp.				1		1	0.3	Sand
Monopelopia tenuicalcar (Kieffer, 1918)				1		1	0.3	Mud, sand
Natarsia punctata (Fabricius, 1805)				1		1	0.3	Mud
Orthocladius thienemanni Kieffer, 1906				2		1	0.3	Mud
Parachironomus arcuatus (Goethgebuer, 1919)					3	1	0.3	Mud
Paratanytarsus lauterborni (Kieffer, 1909)				7	5	3	0.9	Sand, algae, floral detritus
Polypedilum convictum (Walker, 1856)			6	5	7	3	0.9	Mud, sand, algae
Polypedilum(Pent.) exsectum (Kieffer, 1916)				1		1	0.3	Algae
Polypedilum nubeculosum (Meigen, 1804)				4		1	0.3	Sand, mud, floral detritus
Polypedilum nubifer (Skuse, 1889)				384	27	82	25	Mud, sand, floral detritus, plants
Polypedilum sp.				1	3	1	0.3	Mud, plants
Procladius sp.		6		35	3	10	3.0	Every type
Prodiamesa olivacea (Meigen, 1818)				1		1	0.3	Floral detritus
Psectrocladius calcaratus (Edwards, 1929)					3	1	0.3	Sand
Psectrocladius sordidellus (Zetterstedt, 1838)				19		4	1.2	Mud, floral detritus
Psectrotanypus varius (Fabricius, 1787)				37		4	1.2	Sand, mud, plants, floral detritus
Psectrocladius sp.	6					1	0.3	Mud, sand
Rheocricotopus fuscipes (Kieffer, 1909)					5	1	0.3	Mud
Rheotanytarsus sp.				4		1	0.3	Algae
Smittia sp.			6	1		1	0.3	Sand, floral detritus, mud
Stictochironomus sp.-1				17		3	0.9	Algae
Sticochironomus sp.-2				50	3	10	3.0	Mud, sand, algae, floral detritus
Tanytarsus gregarius (Kieffer, 1909)				5	3	1	0.3	Mud, sand, algae, floral detritus
Tanypus kraatzi (Kieffer, 1912)				1		1	0.3	Algae
Tanypus punctipennis Meigen, 1818				114	27	28	8.6	Every type
Virgotanytarsus arduenensis(Goethgebuer, 1919)				5		1	0.3	Sand, algae
Zalutschia megastyla (Shilova, 1971)				2		1	0.3	Mud, sand
Total number	12	6	23	1,204	373	325		
Shannon-Wiener result	0.69	0.0	1.05	2.75	2.57	1.41		
Number of taxa	2	1	3	52	27			

Table 2. Average values of some physicochemical variables of surface water in the Ergene River Basin between years 1995 and 1996

Parameters/Stations	1st	2nd	3rd	4th	5th	6th	7th	8th
Cond. (µS cm^{-1})	494	631	378	551	539	542	243	412
pH	7.5	7.5	7.6	7.4	7.6	7.7	7.0	7.3
DO (mg L^{-1})	3.4	2.3	4.4	2.3	2.5	2.9	8.0	3.9
BOD_5 (mg L^{-1})	1.5	1.0	2.7	0.8	1.2	1.5	4.0	2.5
COD (mg L^{-1})	187	494	269	335	194	263	55	174
Ca (mg L^{-1})	70	94	55	75	71	78	78	82
Mg (mg L^{-1})	33	19	16	21	24	28	27	20
Cl^{-1} (mg L^{-1})	813	1538	242	822	562	568	135	378
NO_3 (mg L^{-1})	7.3	6.5	14.4	12.2	7.3	8.1	9.1	3.8
NO_2 (mg L^{-1})	0.22	0.22	0.22	0.32	0.21	0.32	0.14	0.32
PO_4 (mg L^{-1})	0.47	0.34	0.22	0.53	0.58	0.56	0.10	0.35
NH_3 (mg L^{-1})	0.81	0.88	0.08	0.83	0.62	0.76	0.14	0.95
AT (°C)	14	14	14	14	14	14	16	13
WT (°C)	12	12	13	13	12	12	15	12

Cond: conductivity; DO: dissolved oxygen; BOD_5: biological oxygen demand; COD: chemical oxygen demand; AT: air temperature; WT: water temperature

the other stations. The water of the station 7 joins to Station 8'. Thus, it was seen that the efficiency of polluted water from the other stations decreased at the Station 8. These results show that the River is under a big pollution treatment, but entrance of partially non-polluted water to the River may change the unfavourable conditions.

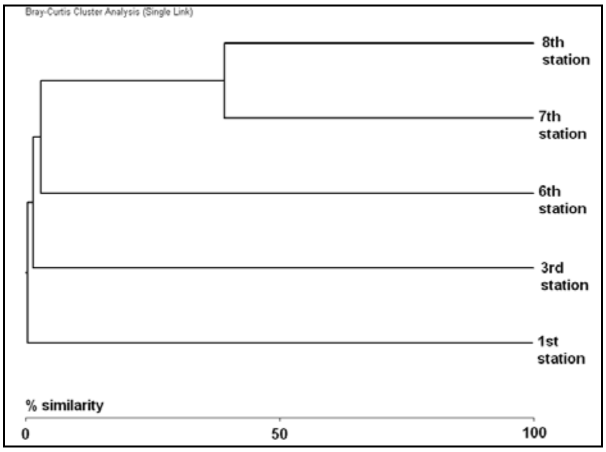
In the previous studies which were performed in Meriç-Ergene River Basin, a total of 498 individuals /m^2 for 65 larval chironomid taxa were reported by Özkan and Çamur-Elipek (2006) in Meriç River; a total of 421 ind/m^2 for 57 larval chironomid taxa were reported by Özkan and Çamur-Elipek (2007) in Sazlıdere stream. In the current study, it was seen that a total of 60 chironomid taxa comprised 325 individuals/m² were found in Ergene River Basin. Also, the total abundance of the identified population in the Basin has been significantly decreased in a total of three stations (Station 1, Station 3, and Station 6) among the other sampling sites.

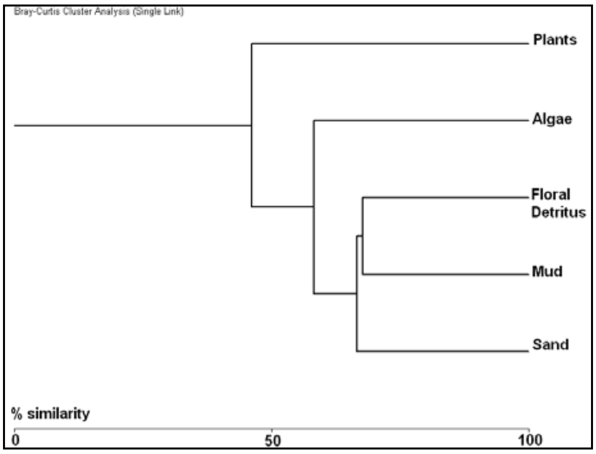
Observations based on Spearman correlation index indicate the stronger relationships between the distribution of larval Chironomid individuals and some environmental variables such as conductivity ($r=-0.708$, $P<0.05$), dissolved oxygen ($r=+0.810$, $P<0.05$), biological oxygen demand ($r=+0.822$, $P<0.05$), and chemical oxygen demand ($r=+0.805$, $P<0.05$). Bray-Curtis similarity index showed in terms of both qualitative and quantitative traits of the species that Station 8 and 7 were the most similar ones (39% similarity). They are followed by the similarities of 8th station with 6th and 3rd stations (3% and 1.5% similarity, respectively). Other results show that Station 8 is significantly different from Station 1; Station 3 is also different from Station 6 (0% similarity). Same observations also report that Station 1 was not similar to Station 3 and 6 (Figure 2). Furthermore, Bray-Curtis indicated that mud and floral detritus rich sediments were similar to each other the most for including the larvae whereas plants and algae rich sediments were different from each other the most (Figure 2).

Although a pollution index, which assume that unpolluted waters are dominated by larvae of the subfamily Orthocladiinae and polluted water by larvae of the subfamily Tanypodinae, has been proposed, this index has not been validate in relation to heavy metal pollution (*see* Mousavi *et al*., 2003). They found dominance of Orthocladiinae and not Tanypodinae in streams polluted with heavy metals. In addition, similar results also reported by Mousavi *et al*. (2003). In the present study larvae of Orthocladiinae populations may be confirm a polluted situation of Ergene river which is significantly considered in agreement with previous studies. *Cricotopus bicinctus*, also abundant in the enriched reach, has been reported in great numbers under high enrichment caused by organic pollution (Maasri *et al*., 2008). *C. bicinctus* is fixed-tube scrapers that feed on available organic matter on the stone surface, and the high correlations suggest chironomid taxa are the most strongly correlated with algal biovolume (Maasri *et al*., 2008). Also, the consistent presence of the resistant *Chironomus* spp. at the sampling stations indicated regular point sources of pollution discharge due to human activities and this caused the water quality deterioration.

Correlations between chironomid taxa and algal biovolumes indicate that chironomid taxa might have preferences for certain algae types (Maasri *et al*., 2008). Some studies have explained the distribution of chironomid larvae on the basis of substratum type (Armitage *et al*., 1995). However, this study identified differences among chironomid assemblages under the certain enviromental conditions. As seen at Table 1, it was found that the chironomid larva in Ergene River Basin have preferred the organic rich sediment structure.

Chironomid communities in Ergene River Basin are deeply affected by high organic and nutrient





	3rd station	6th station	7th station	8th station
1st station	0	0	0.49	0
3rd station	*	0	0.98	1.58
6th station	*	*	1.13	3.03
7th station	*	*	*	39.14

	Sand	Mud	FlDetr	Plants	Algae
Sand	*	66.66	58.46	34.78	54.83
Mud	*	*	67.64	36.73	52.30
Floral detritus	*	*	*	46.15	58.18
Plants	*	*	*	*	33.33
Algae	*	*	*	*	*

Figure 2. Bray-Curtis similarity dendrogram for the sampling stations and the sediment types in Ergene River Basin (FlDetr: floral detritus).

enrichment which cause seasonal fluctuations in both physicochemical and biological conditions. The water can be classified as third class due to urbanization and human activities around the River. Consequently, pollution is being increasingly high and chironomid richness in many impacted streams show a lower biological quality of water.

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