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Gastropod Species Distribution and its Relation with some Physico-chemical Parameters of the Malatya's Streams (East Anatolia, Turkey)

Serap Koşal Şahin

Istanbul University Faculty of Fisheries. Ordu Street. No: 200 Laleli-İstanbul-Turkey; E-mail: serap@istanbul.edu.tr

Abstract: In order to determine the gastropod fauna of Malatya's streams, samplings were made from 15 stations between August 2005 and September 2006. According to our results, gastropod fauna in Malatya's streams samplings involved 5 taxa of Prosobranchia (*Theodoxus anatolicus* (Récluz, 1841), *Bithynia pseudemmerica* Leach 1818*, Bithynia tentaculata* (Linnaeus, 1758), *Hydrobiidae* Simpson 1865, *Viviparus viviparus* Cobb, 1920) and species of Pulmonata (*Galba truncatula* (Linnaeus, 1767), *Radix ovata* (Draparnaud 1801), *Physella acuta* (Draparnaud 1805), *Planorbis planorbis* Höglund, 1947, *Planorbis carinatus* O.F. Muller, 1774, *Planorbarius corneus* (Linnaeus 1758), *Acroloxus lacustris* (Linnaeus 1758)). According to the Shannon-Wiener index, the species diversity in Malatya's streams samplings region had a diversity of 0.774; station O_2 were found to have highest diversity while station Su to have the poorest. According to the Bray-Curtis similarity index station 1 and 8 were found to be most similar to each other for the gastropod species. Also, some physico-chemical parameters of the water (dissolved oxygen, water temperature, NO_{2^-} -N and NO_{3^-} -N) were analysed. The abundance of some of the 12 species was correlated positively with temperature ($p<0.01$).

Key words: Gastropod, seasonal distribution, pollution, Turkey

Introduction

It is known that the distributions of some macroinvertebrates inhabiting springs are related to concentration of particular chemicals and to physical variables such as temperature and pH (Glazier 1991). Molluscs, in which also gastropods are placed, are distributed in many habitats with their highly adaptation abilities. Because of the high adaptation capabilities of gastropods show a wide distribution of areas. Therefore, ecologically they constitute an important part of life in terrestrial and aquatic ecosystems (Kalyoncu *et al.* 2008). As some are edible, many being agricultural pests or hosts to parasitic organisms, they have parasitological importance (Şeşen & Yildirim 1993). Only a little part of this rich fauna has been clarified by malacological studies, which increased in number in the recent years (Şahin & Yildirim 2007). Most of these studies have been conducted in relation to the distribution and taxonomy of the gastropods. However, only little information is available on the ecology of aquatic gastropods and other benthic macrofauna in Turkey (Şereflişan *et al.* 2009, Yildiz *et al.* 2010, Kalyoncu & Yildirim 2009). There were not any documented studies on the gastropods of Malatya. Species show different tolerances and prefences to various ecological variables. If ecological prefences and tolerance levels of individual species are known, the past, current and future habitat conditions can be estimated.

Material and Methods

Study area

Malatya is located at the upper Fırat River basin in Eastern Anatolia. The branches of the southeast Taurus mountains that took shape during the 3rd Upper Eoucene period cover the south of East-West direction (Önal & Kaya 2007). There were 15 stations in the study area. Malatya's aquatic system includes a lot of streams (Fig. 1).

Hisardere(H)	38° 14′ 836″ N, 37° 58′ 474″ E
Dedeyazı(D)	38° 13′ 336″ N, 37° 51′ 661″ E
Ören(Ö)	38° 12′ 643″ N, 37° 52′ 944″ E
Gelin pınarı(G)	38° 14′ 902″ N, 37° 55′ 712″ E
Büyük çimiş(B)	38° 19′ 097″ N, 37° 56′ 134″ E
Sultan suyu(Su)	38° 17′ 302″ N, 38° 01′ 540″ E
Salih çeşmesi(Sa)	38° 15′ 939″ N, 38° 00′ 759″ E
Melet(M)	38° 11′ 117″ N, 37° 59′ 280″ E
Takaz-1(T1)	38° 00′ 475″ N, 37° 59′ 363″ E
Takaz-2(T2)	38° 00′ 520″ N, 37° 59′ 454″ E
İnek pınarı(İ)	38° 21′ 638″ N, 37° 13′ 505″ E
Elemendik-1(E1)	38° 19′ 393″ N, 38° 09′ 365″ E
Elemendik-2(E2)	38° 19′ 873″ N, 38° 03′ 253″ E
Orduzu Pınarbaşı-1(O1)	38° 21′ 171″ N, 38° 23′ 070″ E
Orduzu Pınarbaşı-2(O2)	38° 25′ 502″ N, 38° 21′ 062″ E

Sampling

Sampling was quantitative using Ekman grab (225 cm^2). Gastropods were separated from sediment using a system of sieves of different mesh sizes (20 mm, 2 mm, 1 mm and 0.5 mm). Gastropods were preserved in 75% ethanol. Samples were collected from 15 stations between August 2005 and September 2006. Gastropod samples collected during each season to include 15 stations with the help of the inflatable boat (Fig. 1).

Welch's (1998) method was followed to collect, sift and preserve the samples. The density of gastropods (number/m^2) in each sample was calculated according to Clark *et al.* 1989.

$$D = (N/n \times 44).$$

where D is density, N is the number of specimens collected and n is the number of grap samples. In the laboratory they were identified and counted using a trinocular microscope. Gastropods were identified at species level using taxonomic keys (Schutt 1965, Zhadiin 1965, Maca 1977). Chemical analysis of water samples for the four seasons of each station were obtained from the surface. Water samples for chemical analysis were collectedfrom surface each station. Three major water variables – temperature (C°), dissolved oxygen (DO/mg/L) and pH, were measured with YSI 556 model multiparameter instrument.

The levels of NO_2- -N (µg/L) and NO_3- -N (µg/L) were measured in the laboratory according to the standard methods (Claude *et al.* 1992). Geographical data (coordinates) were recorded with geographical positioning system (Garmin e-trex – GPS) unit. The coordinates are marked on the Google map. All materials were deposited in the Istanbul University, Faculty of Fısheries.

Log base 10 was applied to the data and than Shannon-Wiener species diversity index and Bray-Curtis similarity index were determined. The similarities for species composition were determined using Bray-Curtis index (Krebs 1999). Pearson Correlation index was used to determine if there were any correlation between the physicochemical features and the number of individuals using the computer program.

Results and Discussion

A total of 12 taxa were found between August 2005 and September 2006. Minimum of 5 taxa of Prosobranchia (*Theodoxus anatolicus* (*Ta*) (Récluz, 1841), *Bithynia pseudemmerica* (*Bp*) Schütt, 1964, *Bithynia tentaculata* (*Bt*) (Linnaeus 1758), Hydrobiidae (Hyd), *Viviparus viviparus* (*Vv*) (Linnæus, 1758), 7 species of Pulmonata (*Galba truncatula* (*Gt*) (O.F. Müller, 1774), *Radix ovata* (Ro) (Draparnaud, 1805), *Physella acuta* (*Pa*) Draparnaud 1805, *Planorbis*

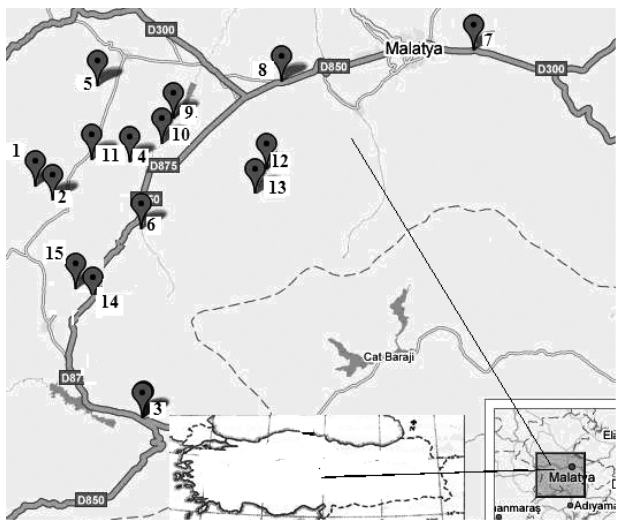

Fig. 1. Sampling stations in Malatya www.google.map.com 12. 11. 2008).

planorbis (*Pp*) (Linnæus, 1758), *Planorbis carinatus* (*Pc*) O.F Müller, 1774, *Planorbarius corneus* (*P.co*) (Linnæus, 1758) and *Acroloxus lacustris* (*Ac*) (Linnæus, 1758) .

According to the Shannon-Wiener index, the species diversity in Malatya's aquatic system was found to be 0.774 at average. The highest level of diversity was found at station 14 (1.539) and its lowest was found at station 5 (0.056) (Table 1).

DO levels were between 5.9 and 13.4 mg/L (Table II). The pulmonate species belonging to the genus *Physella* and *Viviparus* were considered as biological indicators of organic pollution and eutrophication (Ertan *et al.* 1996). Both common in organically-rich polluted waters, can tolerate low levels of oxygen values below (5.9 mg/L). In addition *Physa acuta* is frequently occurring in warm water discharges from power stations in some rivers, but very rarely and not numerously in clay pit ponds (Serafinski *et al.* 2001). This study supports that information 2383 *Physa acuta*/m^2 were collected from station 11 in the summer (Fig. 2).

Bithynia tentaculata is an eurytopic species. The species exists on a diet of detritus (95% detritus and 5% algae). *B. tentaculata* was collected only from at station 12 through the study period (Table 2). pH varies between 6.8 and 8.2 (Table 2). The lowest pH value that was measured in the field was 6.8 (measured at station 2 in summer).

According to water quality parameters stations 1, 2, 5, 7, 8, 10, 12 were determined to be quality classes I-II (Ertan *et al.*1996).

Correlation between the abundance gastropod species and physico-chemical parameters of the study area are presented in Table 3. Except of *Acroloxus lacustris* and *Theodoxus anatolicus* were found to have significantly positive correlation with the water temperature. While *Acroloxus lacustris* and *Theodoxus anatolicus* prefer cold water Showed positive correlation with temperature of the other species identified (Table 3). *Galba truncatula* first occurred in May and/or June and second was noted in September (Mkroud *et al.* 2002). In the present study support these findings (Fig 2).

It is well known that *Planorbis planorbis* is more common species can tolerate substantial changes in different environmental variables (Kalyoncu *et al*. 2009). This study supports the information this species were determined all seasons. 1825 *P. planorbis*/m^2were collected in spring, 2047 *P. planorbis*/m^2 were collected in summer, 995 *P. planorbis*/m^2 were collected in autumn and 1811 *P. planorbis*/m^2 were collected in winter (Fig. 2).

Theodoxus anatolicus was an indicator species of clean water. This type of clean water source waters are usually parts of the eye, or fast-flowing, even a short hand gastropod distributed extensions. Anatolia, which completely covers a wide spread and largest inland lake was later due to links hydrogeograhic of aquatic systems (Ertan *et al.* 1996; Mkroud *et al*. 2002). In the present study it was collected in cold water (5.3 ºC) and high oxygen levels (13.4 mg/L) (Fig. 2).

According to the Bray-Curtis similarity index, station 8 and 1 were found to be the most similar to each other (at 75%) among all. In both stations only *Hydrobiidae* sp. was determined. Most generally, such as Hydrobiidae abundant and prefer highly oxygenated water (Ertan *et al.* 1996).

Autumn and winter were found to be the most similar (66%) while summer and winter were found to be the most dissimilar among all seasons with respect to the gastropod diversity (Fig. 3).

In conclusion, until the present study almost

Table 1. Seasonal and station-based distribution of gastropod taxa in Malatya from August 2005 to September 2006.

	Stations														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Spring	262	42	56	0	0	1410	222	278	883	883	1727	883	1403	2371	1168
Summer	1260	28	278	22	556	2610	778	1268	1860	1310	2873	2911	1843	2814	1416
Autumn	222	0	48	0	0	889	56	278	0	110	0	1543	436	748	459
Winter	12	0	75	0	112	56	12	0	222	75	181	959	28	42	111
Average	439	18	114	6	167	1241	267	456	741	595	1195	1574	928	1494	789
Shannon-Wiener İnd	0,905	0,511	0,311	0,112	0,056	1.021	0.413	0.906	0.913	0.901	1.012	1.095	1.011	1.539	0.909

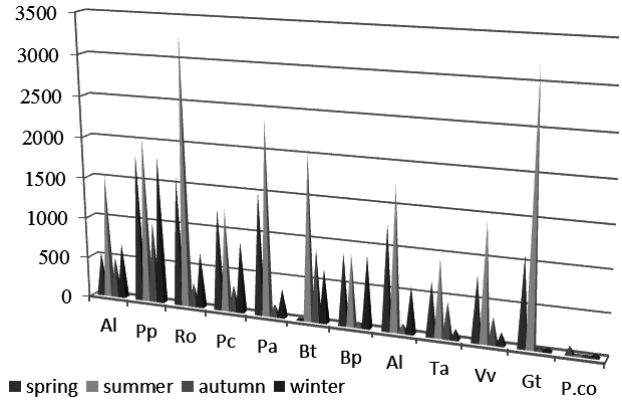

Fig. 2. Seasonal density of gastropod taxa in Malatya's stream, Turkey.

Table 2. The highest and lowest sea.sonal values of the measured physico-chemical parameters.

Stations	Variable						
	DO (mg/L) min max	Temp. (ºC) min max	pH min max	EC (µs/cm) min max	NO_3^--N µg/L min max	NO_2^-N µg/L min max	Initials of species
1	8…8.3	5.6…24.7	7…7.8	330-415	0…0	0…0	Hyd.
2	7.2...7.5	11.2…27	6.8…7.7	370-403	0.1…0.3	0…0	Ro
3	8.1...8.3	7.3…26	7.2…7.6	375-400	2…1.4	0…0.01	Pp, Pco, Vv, Pa
4	8.2…10.5	6.3…25.3	7…8.2	310-330	0.1…0.2	0…0,01	Pp, Pa
5	5.9…8.3	5.6…26.4	7.3…7.4	330-390	0.1…0.2	0…0	Gt, Pa
6	8.1…8.7	7.3…25.7	7.2…7.9	483-520	0.3..1.2	0.01.0,03	Pc, Ro, Pa
7	6.2…7.9	4.6…18.2	7…8.2	510-550	0…0.04	0…0	Al
8	8.6…10.2	6.4…19	7.2…8.2	330-403	0…0.1	0…0	Hyd
9	8.6…9.2	5.2…19.2	7.6…8.1	260-320	0…1.2	0…0.01	Pp,Pc
10	9.2…10.3	5.3…18	7…7.6	250-335	0…0.5	0…0	Al
11	7.6..…9	6.8…23	7.2…8.1	350-423	0…0.01	0…0.01	Pa
12	8.3…10.5	6…21	7…7.4	320-370	0.2…0.6	0.01...0.02	Bt,Bp
13	8.6…12.9	6.7…19.4	7.2…7.7	330-400	0…0.03	0…0.01	Pa,Pp
14	5.3…13.4	5.8…13.2	7.2…7.8	340-385	0,2…0.3	0…0	Ta
15	7.8.…9.2	6.5…19.5	7…7.5	330-360	0.5…1.2	0.01…0.03	Pp,Pco,Pc,Vv, Pa

Table 3. Pearson's correlation coefficients between abundance of Gastropod species and examined physico-chemical parameters of Malatya's streams.

Species	DO	PH	TEMP	EC	NO_2^--N	NO_3^--N
Hydrobiidae	-0.0948	0.8276	0.9589*	0.9277*	0.5736	-0.9688
Acroloxus lacustris	0.2620	0.8276	0.8678	0.9687*	0.8662	-0.6850
Galba truncatula	0.1940	0.5980	0.9857*	0.9832*	0.6450	-0.9342
Theodoxus anatolicus	0.1234	0.7199	0.3122	0.9196	0.8098	-0.4533
Radix ovata	0.2524	0.5865	0.9967**	0.9986*	0.7375	-0.9722
Bithynia pseudemmerica	0.2620	0.6151	0.9857*	0.9687*	0.8662	-0.4850
Bithynia tentaculata	-0.0249	0.8140	0.9555*	0.9292*	0.7059	-0.9073
Planorbis planorbis	0.3129	0.5638	0.9565*	0.9222*	0.9240	0.9612
Physella acuta	0.3270	0.5530	0.9836*	0.9915*	0.8444	-0.5972
Planorbis carinatus	0.4201	0.4742	0.9435*	0.9604*	0.9179	-0.9947
Planorbarius corneus	-0.5217	0.9136	0.9136*	0.6487	0.1137	-0.5230
Viviparus viviparus	-0.2090	0.9063	0.9888*	0.8292	0.6137	-0.8031

** $p<0.01$, * $p<0.05$.

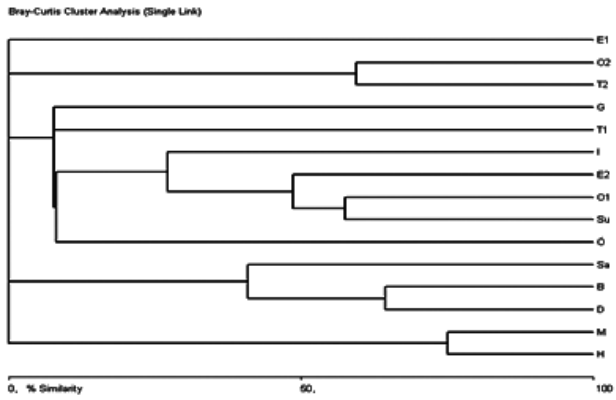

Fig. 3. The similarity dendrograms of stations in Malatya in respect of Gastropod species (single-linkage, Bray-Curtis, log base 10).

nothing was known about the life cycle and ecological requirements of these gastropod species in some countries. We found that most of these species show a wide tolerance for different water and weather conditions (with exceptions noted in the text above), and that their prevalence shows a positive relationship with temperature, dissolved oxygen levels, and pH. Further detailed studies on each of these individual parameters are needed.

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