ANNUAL VARIATION OF THE FISH COMMUNITY COMPOSITION IN THE UREDERRA RIVER (NAVARRA, SPAIN)

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Palabras clave: Diversidad piscicola, variación anual, Rio Urederra, Espafia.

ABSTRACT

The variation of the distribuffon of fish species as a function of the habitat during one year has been studied in the Urederra River (Navarra, northern Spain). Electrofishing samples, taken at eight points in September 1994, May 1995 and September 1995, using the catch-effort method, were compared. The relative abundance, diversity, dominance and species richness were calculated. Both native (*Anguilla anguilla, Salmo trutta fario...*) and introduced *(Gobio gobio, Onchorhynchus mykiss)* species were detected. Man-made modifications at some points of the river probably affected the relative abundance measured for the species.

INTRODUCTION

Longitudinal patterns of fish distribution in rivers have been studied in Europe (GARCÍA DE JALON & LOPEZ ÁLVAREZ 1983, STARMACH *et al*. 1991, GARCÍA DE JALON 1992, PRZYBYLSKI 1993). Differences in fish distribution are related to environmental heterogeneity (GARCÍA DE JALON & LOPEZ ALVAREZ 1983, ZALEWSKI *et al.* 1990, COLLARES-PEREIRA *et al.* 199.5) and to alterations of the water course (COPP & BENNETTS 1996). River dredgings and riparian and instream cover removals lead to decreases in salmonid (KENNEDY *et al*. 1983) and cyprinid populations (COPP & BENNETTS 1996).

Other characteristics such as river width, depth, bottom substratum and dissolved oxygen also influence fish communities (SCHLOSSER 1988, STARMACH *et al.* 1991, COLLARES-PEREIRA *et al.* 1995).

In this study fish assemblages along a small river are analysed as well as the possible influence that some biotic and abiotic factors may have on it.

MATERIAL AND METHODS

The Urederra River (North of Spain) starts from a karstic source situated at an altitude of 750 m and flows into the Ega River (Ebro basin). Its length is 20 km and the mean slope is 0.8 %. Calcareous slabs, rocks and boulders of different size form the bed. The riparian vegetation is made up of shrubs and trees (Willow Salix sp., Ash tree *Fraxinus excelsior* L., Hazel tree *Corylus avellana* L., Poplar Populus alba L. and Black poplar *Populus nigra* L.). Erection of dams and dredging of the river bed have modified the original morphology of the river.

Samples were taken in September 1994, May and September 1995 at eight points (Fig. 1) whose main physical and chemical characteristics are presented in Table 1.

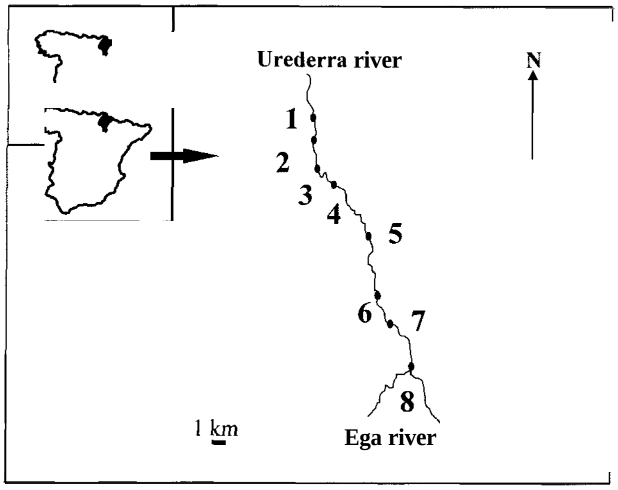

FIGURE 1. Location of the sampling sites in the Urederra River (Navarra, North of Spain). Sampling stations: 1: Baquedano, 2: Zudaire, 3: Arzata, 4: Itako, 5: Artavia, 6: Galdeano, 7: Euliz, 8: Estella.

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TABLE 1. Physical and chemical characteristics in the Urederra River in a) September 1994 b) May 1995 c) September 1995

	Sampling stations																							
Parameters	**1**			**2**			**3**			**4**			**5**			**6**			**7**			**8**		
Altitude (m)	540			520			520			500			480			460			440			430		
Distance from origin (km)	2.4			3.3			4.5			6.5			11.0			14.2			16.1			19.7		
Sampling area (m^2)	1193			1357			886			780			1194			929			1022			761		
	a	**b**	**c**	**a**	**b**	**c**	**a**	**b**	**c**	**a**	**b**	**c**	**a**	**b**	**c**	**a**	**b**	**c**	**a**	**b**	**c**	**a**	**b**	**c**
Width (m)	12	12	12	9	9	8	9	9	8	9	8	8	14	16	14	7	14	14	10	11	10	9	11	9
Depth (cm)	58	61	59	58	31	31	34	34	32	75	85	56	51	40	46	34	20	25	71	83	66	57	50	68
Temperature (° C)	11.6	11.2	11.6	10.3	129	11.3	11.5	99	11.3	10.9	11.3	11.8	13.4	142	146	152	16.4	145	152	154	146	14.8	136	14.4
pH	80	85	76	74	79	74	66	79	70	76	83	73	80	85	80	7.9	78	81	79	68	79	83	81	78
Conductivity (μS)	363	402	356	424	453	376	456	458	439	402	605	628	439	498	426	444	498	445	517	503	507	487	510	498
Oxygen (ppm)	11.0	10.6	10.0	11.3	120	10.0	6.7	93	5.9	54	10.7	7.6	13.0	12.7	11.7	12.5	122	12.9	94	12.5	10.5	10.4	10.1	9.1

Fish were captured by electrofishing using two stopnets limiting each sampling site. Three consecutive removals were made following the catch-effort method (PENCZAK & ZALEWSKI 1981, PENCZAK et al. 1981). Fish species diversity (Shannon's diversity index $H' = -\Sigma p_i \log_2 p_i$), dominance (Simpson's dominance index $D = \Sigma p_i^2$) and species richness (Margalef's diversity index $R = (S - 1)/ \ln N$), where p, is the proportion of the abundance of species "i" at a given site, S is the number of species and N is the total number of fish captures, were calculated (MARGALEF, 1989).

Frequencies were compared using the χ^2 test with Yates correction when necessary (SOKAL & ROHLF, 1979).

RESULTS

The fish fauna of the Urederra River is shown in Figure 2. Alltogether eight fish species were found in the eight stations during the sampling period: Brown trout (*Salmo* trutta fario L.), Rainbow trout (Onchorhynchus *mykiss* (Walb.)), Minnow (Phoxinus phoxinus (L.)), French nase (*Chondrostoma toxostoma* (Vallot)), Barbel (*Barbus* graellsii Steind.), Gudgeon (Gobio gobio (L.)), Stone loach (Barbatula barbatula (L.)) and Eel (Anguilla *anguilla* (L.)). Brown trout was the most numerous species in the first three sampling stations (χ^2=283.2, χ^2=109.4 and χ^2=600.9, respectively, all comparisons 1 df, P<0.001), but its frequency decreased significantly downstream being replaced by minnow

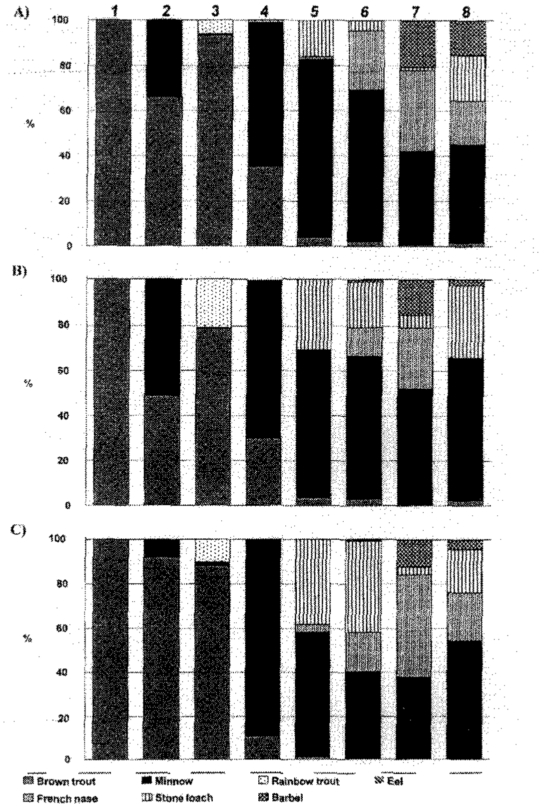

FIGURE 2 Fish fauna composition in % ot the Urederra River A) September 1994, B) May 1995 and C) September 1995.

On the basis of the differences detected in fish distribution in this river, two sections could be distinguished: the upper, salmonid course (sampling stations 1 to 3) and the lower, cyprinid course (rest of stations). This was also observed in the calculated indices (Figure 3). Fish diversity was null in the first station, increased slightly towards station 4 and reached its highest value near the confluence with Ega River.

Species richness followed a similar pattern. At station 3 its value was higher than expected probably due to the existence of a fish-farm which also explained the presence of rainbow trout in the station.

Dominance was maximum at station 1 (exclusive presence of brown trout), decreased slightly down to station 4, at station 5 there was a strong decrease which continued down to station 8.

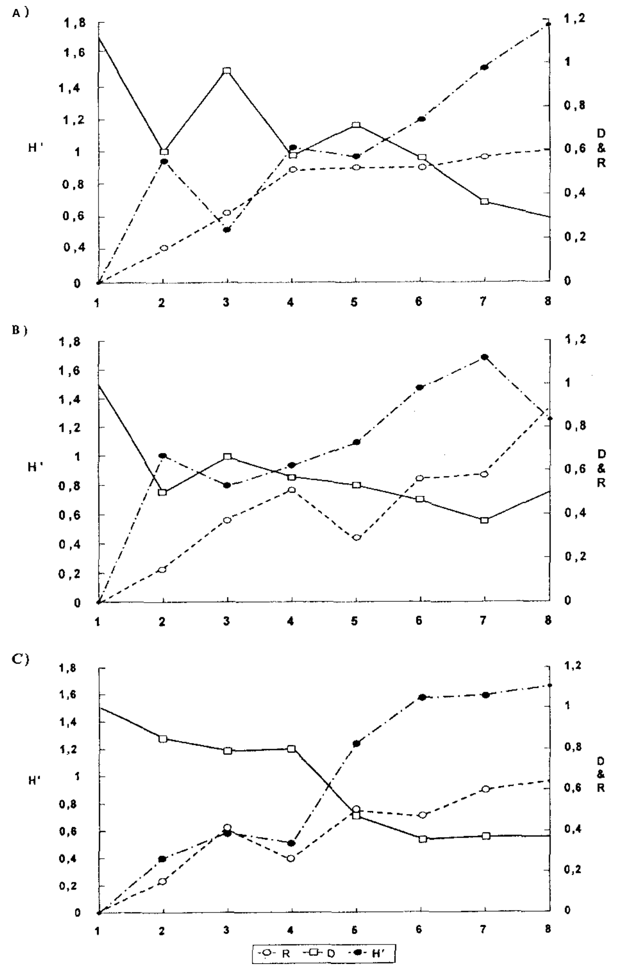

FIGURE 3. Dibersity (H'), dominance (D) and species richness (R) at the eight sampling stations in A) September 1994, B) May 1995 and C) September 1995.

In 1995 some man-madc alterations affected sampling stations 5, h and 7 (Table 2). At station 5 the total number of fish captures were significantly less than in 1994 (χ^2=212 4, ldf, p<0.001), especially those of brown trout and minnow (χ^2=10.4, Idf, p<0.001 and χ^2=275.3, ldf, p<0.001, respectively), although stone loach captures increased (χ^2=5.6, Idf, p<0.05). There were significant differences in the total number of fish captures between September 1994 and September 1995, probably as a consequence of the recolonization of the altered sampling point (χ^2=100.8, ldf, p<0.001). This was mainly due to stone loach (χ^2=402.1, ldf, p<0.001) and french nase (χ^2=43.8, Idf, p<0.001). The brown trout population in this station decreased significantly between the two samplings undertaken in September 1994 and September 1995 (χ^2=22.0, Idf, p<0.001).

At station 6 the river bed was dredged before May 1995. The total number of captures was less than in September 1994 (χ^2=247.8, Idf, p<0.001), as well as the number of minnow captures (χ^2=193.9, Idf, p<0.001), however, there was an increase in stone loach numbers (χ^2=60.6, Idf, p<0.001). In September 1995, the total number of captures was higher than in May 1995 (χ^2=2350.1, Idf, p<0.001), and this was true for stone Ioach, minnow and french nase captures (χ^2=1450.6, Idf, p<0.001, χ^2=569.6, Idf, p<0.001 and χ^2=518.7, Idf, p<0.001, respectively). These changes suggest a recolonization of the affected area by the stone loach.

At station 7 riparian and instream vegetation was removed before and after May 1995 sampling. The total number of captures of all species combined decreased significantly between September 1994 and September 1995 (χ^2=61.3, Idf, p<0.001), as well as of minnow and barbel (χ^2=38.9, ldf, p<0.001 and χ^2=56.9, Idf, p<0.001, respectively).

DISCUSSION

Fluvial ecosystems follow longitudinal patterns of fish assemblages which are predictable to some extent according to the River Continuum Concept (VANNOTE *et al.*, 1980). These patterns are related to increases in spatial heterogeneity and also affect the structure of the fish community increasing its diversity and richness (SCHLOSSER 1987; PRZYBYLSKI *et al.* 1991, PRZYBYLSKI 1993; STARMARCH *et al.*, 1991; GARCÍA DE JALÓN, 1992). In the Urederra river this diversification of fish biocenosis could be clearly appreciated distinguishing two different sections: the upper course (dominated by brown trout) and the lower course, dominated by cyprinids (mainly minnow and french nase) and cobitids (stone loach). The diversity, dominance and species richness

TABLE 2. Alterations observed in the Urederra River during the sampling period. Changes in fish populations arc also shown. S94: September 1994, M95: May 1995, S95: September 1995, n: number of fish.

Sampling station	Human activity	Environmental changes	Population changes
5	Construction of an artificial reef before May 95	-Destruction of gravel pit -Alteration and compression of bed substratum - Increase in submerged area and decrease in mean depth Decrease in stream velocity	- Decrease in total number of fish in M95 followed by an increase in S95 S94: n= 2231; M95: n= 1357; S95: n= 2955 - Increase in stone loach captures S94: n= 356; M95: n= 423; S95: n= 1130 - Decrease in minnows in M95 and recovery of the population in S95 S94: n= 1763; M95: n= 905; S95: n= 1691 - Progressive decrease in brown trout S94: n= 85; M95: n= 47; S95: n= 33
6	Dredging of sampling area before May 95	- Destruction of gravel pit - Alteration and compression of bed substratum - Increase in submerged area and decrease in mean depth - Decrease in stream velocity	- Decrease in total number of captures in M95 followed by a strong increase in S95 S94: n= 2097; M95: n= 1193; S95: n= 5013 -Increase in stone loach captures S94: n= 95; M95: n= 238; S95: n= 2068 - Decrease in minnows in M95 and population growth in S95 S94: n= 1407; M95: n= 758; S95: n= 2016
7	Clearing of river banks before May 95	- Destruction of riparian and emergent vegetation - Decrease in plant cover and disappearance of shelters	-Progressive decrease in total number of fishes S94: n= 1108; M95: n= 973; S95: n= 768 -Decrease in minnows in S95 after the slight increase of M95 S94: n= 461; M95: n= 503; S95: n= 289 -Progressive decrease in the number of barbels S94: n= 228; M95: n= 151; S95: n= 92

indices calculated at every sampling station followed patterns similar to other rivers in Europe (SCHLOSSER 1982, PRZYBYLSKI et al. 1991, STARMACH et al. 1991, PRZYBYLSKI 1993).

Alterations made to vegetation and bed structure in this river probably affected the total number of fish captures and the relative abundance of stone loach, minnow, barbel and brown trout. Something similar has been also reported by KENNEDY et al. (1983), COLLARES-PEREIRA et *al.* (1995) and COPP & BENNETTS (1996) for other water courses in Europe.

Stone loach prefer clear, shallow, running waters being more abundant in stony and gravel areas (SAUVONSAARI 1971, MASTRORILLO et al. 1996). Bed modifications (compression and changes in substratum size) in stations 5 and 6 could favour recolonization by this species.

Diminution in barbel captures in station 7 were probably influenced by macrophyte cover elimination cover modifications which maybe originated the loss of shelters, as observed by COPP & BENNETTS (1996) *for Barbus barbus.*

The changes in the numbers of minnow captures at stations 5, 6 and 7 also seemed to be influenced by bank and bed alterations. This species recolonized stations 5 and 6 but not station 7. This suggests that aquatic vegetation could be especially important for this species.

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