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Spatio – temporal variability in composition of inshore juvenile fish populations along the west coast of Istra, northern Adriatic

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A total of 5601 fishes belonging to 13 families and 38 species were caught in May (1361), July (3192), September (574) and November (474), 2000; on 3 locations (Tar Cove, Mirna Estuary and Marić Cove) along the west coast of Istra, Croatia, using a 50 m long beach seine. Five species, Atherina hepsetus *(47.47%),* Atherina boyeri *(27.73%),* Diplodus annularis *(9.96%),* Pomatoschistus marmoratus *(1.62%) and* Liza aurata *(1.54) comprised 88.32% of the total catch. The community structure was specified by species richness (D), diversity (H), evenness (J), and JACCARD similarity coefficient (K). The annual value of D was 4.29, ranging from 0.84 (Mirna Estuary in May) to 3.19 (Tar Cove in September). H values ranged from 0.17 (Tar Cove in May) to 2.45 (Marić Cove in May), with annual value of 1.66. The overall value of J was 0.46, ranging from 0.01 (Tar Cove in May) to 0.25 (Marić Cove in November). The coefficient K was highest between Tar and Marić Coves in May (0.68) and had a lowest value between Mirna Estuary and Marić Cove in September and November, and also between Tar Cove and Mirna Estuary in May (0.52). Preliminary results of the present study provide a basis for future studies of aspects that may influence the distribution and abundance of juvenile fishes during different seasons along the west coast of Istra.*

Key words: Fish assemblages, composition, richness, diversity, evenness, similarity, northern Adriatic

INTRODUCTION

In the last decade, increasing attention has been paid to juvenile fish populations in different shallow habitats (lagoons, estuaries, reefs and coastal regions in many parts of the world), mainly because, due to their high productivity, many species utilise these areas as nursery and feeding grounds (ALI and HUSSAIN, 1990). Most of the studies found in the literature deal with seasonal variations in the numbers of individuals, species diversity, and the influence of abiotic factors on abundance and species performance (ALI and HUSSAIN, *op.cit.*; HAY, 1991; SALE, 1991; TZENG and WANG, 1992; WHITFIELD, 1994; LAEGDSGAARD and JOHNSON, 1995; GUIDETTI and BUSSOTTI, 2000a). However, except the study on the temporal fluctuations of inshore juvenile fish populations in the Kornati Archipelago (DULČIĆ *et al.*, 1997) and previous preliminary and incomplete investigations in the same region (KRALJEVIĆ and JUG-DUJAKOVIĆ, 1987; KRALJEVIĆ and PALLAORO, 1991), most of the published material on fishes from the eastern

Adriatic is focused on taxonomy, general fishery aspects, and, to a lesser extent, to the biology of various species (KRALJEVIĆ *et al.*, 1994; KRALJEVIĆ *et al.,* 1996; KRALJEVIĆ and DULČIĆ, 1997). There have only been a few papers on juvenile fish populations in the eastern Adriatic (FROGLIA, 1977; KATAVIĆ, 1980; JARDAS, 1985; JARDAS *et al.*, 1986; JUG-DUJAKOVIĆ, 1988; GUIDETTI and BUSSOTTI, 2000b).

No study on juvenile fish populations has been done yet in the north-eastern Adriatic, though it includes important fishery grounds. The present study provides the first data on the temporal fluctuations in juvenile fish composition, species diversity and association in relation to temperature and salinity, from the western coast of Istra peninsula.

MATERIALS AND METHODS

Study area

The investigation was conducted along the western coast of the Istrian peninsula (Croatia), northern Adriatic, at two locations, the Mirna

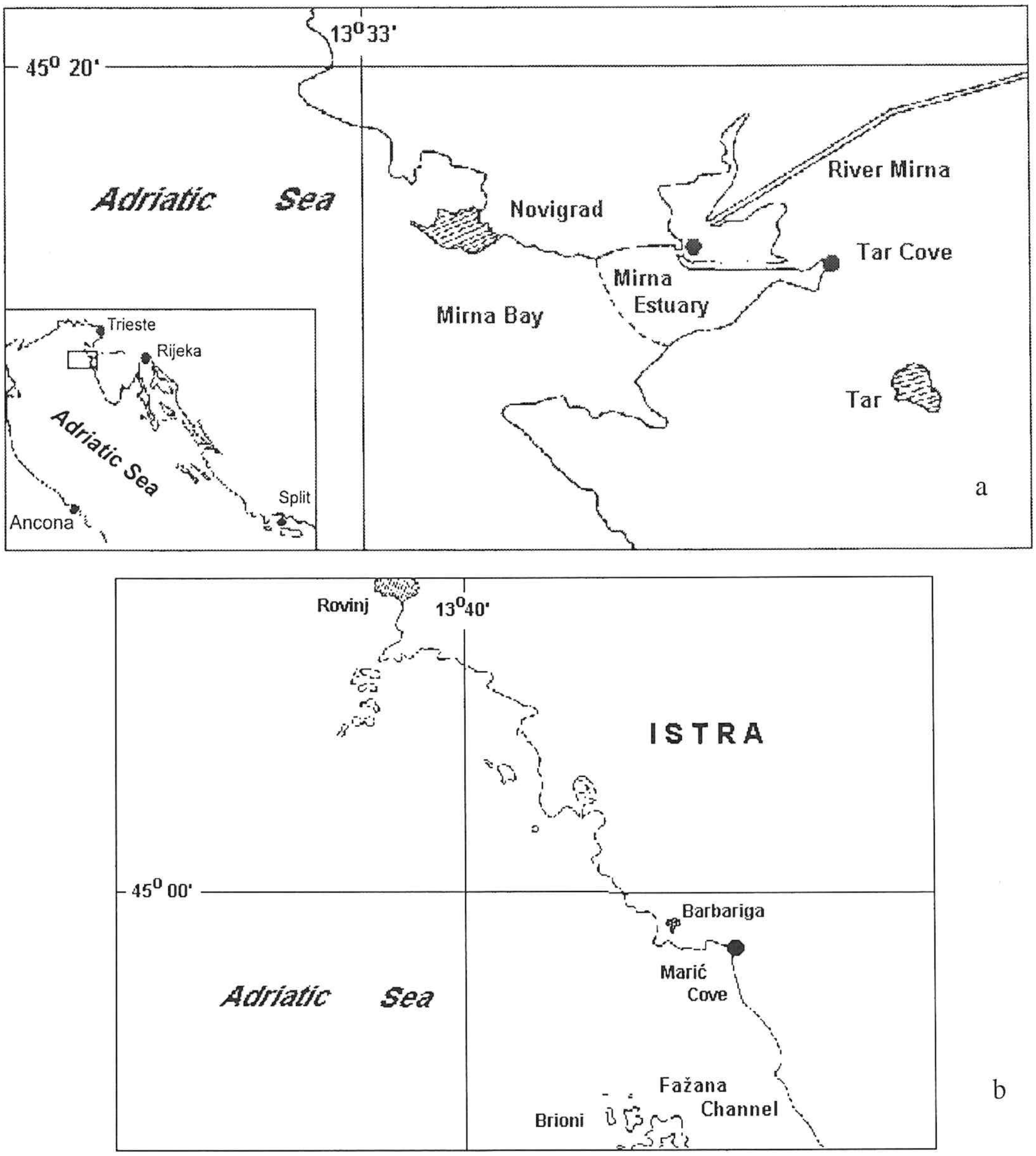

Fig. 1. Sampling areas: Mirna Estuary (a) and Tar Cove (b)

Bay (Fig.1a) and Marić Cove (Fig.1b). Mirna Bay is a specific and productively rich habitat for a large number of commercial fish species. Traditionally, this estuary has been fished once or twice a year for more than 900 years (PLANČIĆ, 1952). Here, we selected two sampling stations and named them: Mirna Estuary, (45°19'N; 13°34'E), at the estuary entrance, and Tar Cove, (45°18'N; 13°38'E), as the easternmost and shallowest part of Mirna Bay. Depth at the estuary entrance reaches 23 m, reduces in its inner parts to 8m in the Tar Cove, and in some places does not exceed 3m (KRALJEVIĆ *et al.*, 1994). The delta-like end of the Mirna River mouth, flooded plains, shoal belt and gradual increase of depth from the eastern bay part (Tar Cove) westward and offshore show that settling of particles carried by the river is going on. This points to the fact that Tar Cove is the residue of submerged Mirna River valley (BASIOLI, 1956). Both stations at the Mirna Bay were sandy, sandy-clay and sandy-mud. Marić Cove (44°59'N; 13°48'E) is situated almost opposite the Brijuni Islands (one of eight national parks of the Republic of Croatia) and communicates directly with the open sea. The bottom of this cove was characteristically hard, sandy and sandy-clay laterally overgrown by meadows of *Cymodocea nodosa*.

Sampling techniques

Fish samples were collected using a 50m long beach seine. Net depth at the beginning of wings was 30cm and 250cm at the central part together with the sac. Outer wings were of 8mm mesh size and central sac of 4mm (DULČIĆ *et al.*, 1999). The net was always hauled from the entrance of the cove (max. depth 2m) to its inner end (JARDAS, 1986). Juveniles were sampled in May, July, September and November 2000, without replicates per site and time. Collected organisms were sorted and preserved in 4% formaldehyde (pH from 8.5 to 9.0). The fish species were identified according to ŠOLJAN (1975) and JARDAS (1996). Juvenile fishes were defined as specimens with already formed scales, and were accepted as juveniles until the moment of first sexual maturity (KATAVIĆ, 1984). Physical-chemical parameters were measured by classical methods at every station before net hauling. Temperature was measured with a mercury thermometer and salinity with a laboratory inductive salinometer.

Data analysis

Temporal changes in community structure, abiotic factors and relationships between these variables were analysed using multiple linear regression. Community structure was specified by species richness (D), diversity (H), evenness (J) and JACCARD similarity coefficient of similarity (K) using formulae proposed by MARGALEF (1968), SHANNON and WEAVER (1949), PIELOU (1966) and BOESCH (1977), respectively.

$$D = S-1/Ln\ N$$ (MARGALEF, 1968)

Where S=number of species and N=number of individuals

$$H = -\Sigma P_i\ Ln\ P_i$$ (SHANNON and WEAVER, 1949)

Where Pi represents the proportion of each species in the sample as a whole

$$J = H / Ln\ S$$ (PIELOU, 1966)

$$K = a / a + b + c$$ (BOESCH, 1977)

Where a = sum of species occurring in both (A) and (B), b = sum of species occurring in (A) but not in (B), c = sum of species occurring in (B) but not in (A).

The degree of relationship existing between these variables and abiotic factors (temperature and salinity) was determined by R^2, e.g. the coefficient of multiple determinations.

For comparing abiotic factors between three sampling locations, an ANOVA model was used.

RESULTS

Temporal fluctuations of abiotic factors

Analysis of variance revealed significant correlation between temperature (ANOVA: $p<0.01$; $F=0.44$; $F_{.01,2,9}=8.02$), and significant difference between salinity ($F=20.88$) among three sampling stations. Mean monthly variation of sea temperature and salinity averaged over those stations is presented in Fig.2. Monthly temperature ranged from 11.4°C (at Mirna Estuary in November) to 29.4°C (at Marić Cove in July). Monthly salinity values ranged from 12 psu (at Mirna Estuary in November) to 39 psu (at Tar Cove in May). The difference in salinity between stations was large (12.2-39 psu). Salinity values were more stable in Marić Cove (32.1-38.7 psu) than at Mirna Estuary (12.2-22.6 psu) and at Tar Cove (26-39.2 psu). While seawater temperature shows typically Adriatic seasonal cycles, there are no such cycles in salinity, because stations in Mirna Bay are strongly influenced by Mirna River.

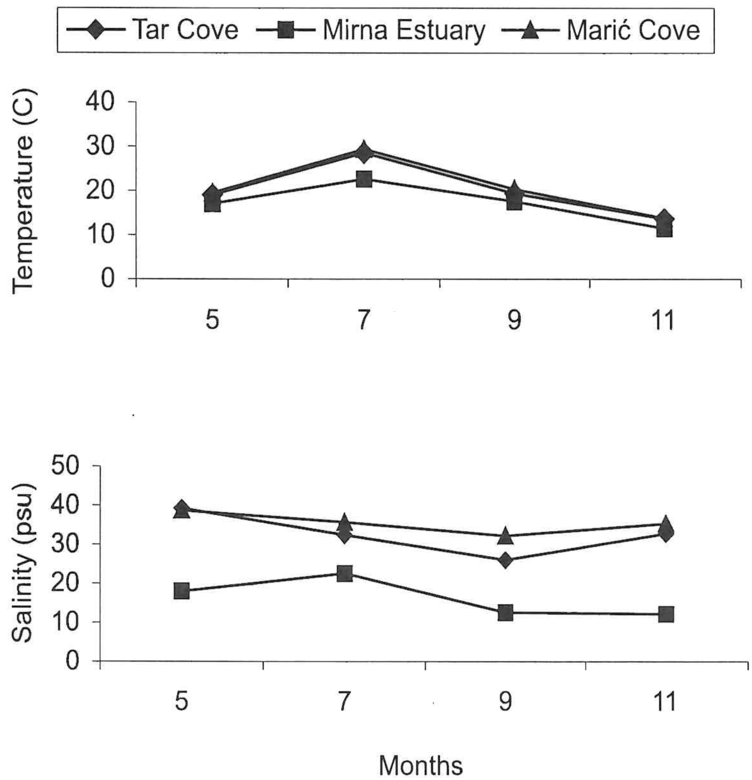

Fig. 2. Monthly variations in the mean sea water temperature (°C) and salinity (psu) in the investigation area

Temporal and spatial fluctuations in juvenile fish compositions and abundance

A total of 5601 individuals representing 13 families and 38 species were collected in May (1361), July (3192), September (574) and November 1998 (474). The total highest number of individuals was caught in Tar Cove (3228), and the lowest in Marić Cove (938). The peak catch of species was found in September (30; 78.95%), and the peak of individuals in July

(3192). The number of captured individuals increased in spring and summer, and decreased in late autumn. *Atherina hepsetus* (47.47%), *Atherina boyeri* (27.73%), *Diplodus annularis* (9.96%), *Pomatoschistus marmoratus* (1.62%) and *Liza aurata* (1.54%) comprised 88.32% of the total sample (Table 1). *A. hepsetus* was the dominant species in the collection during the entire investigation, with highest abundance in July (1324; 41.48%). Only, in the absence of *A. hepsetus*, at Mirna Estuary, *A. boyeri* (1294; 90.17%) became highest in abundance. Monthly variations in the number of species, number of individuals, richness, diversity and evenness in the investigation area between May and November are presented in Figure 3. The annual value of *D* was 4.29, ranging from 0.84 (Mirna Estuary in May) to 3.19 (Tar Cove in September). *H* values fluctuated from 0.17 (Tar Cove in May) to 2.45 (Marić Cove in May), with mean annual value of 1.66. The overall value of *J* was 0.46, ranging from 0.01 (Tar Cove in May) to 0.25 (Marić Cove in November). The coefficient *K* was highest between coves Tar and Marić in May (0.68) and had lowest values between Mirna Estuary and Marić Cove in September and November, and also between Tar Cove and Mirna Estuary in May (0.52). According to the same coefficient, coves Tar and Marić were most similar.

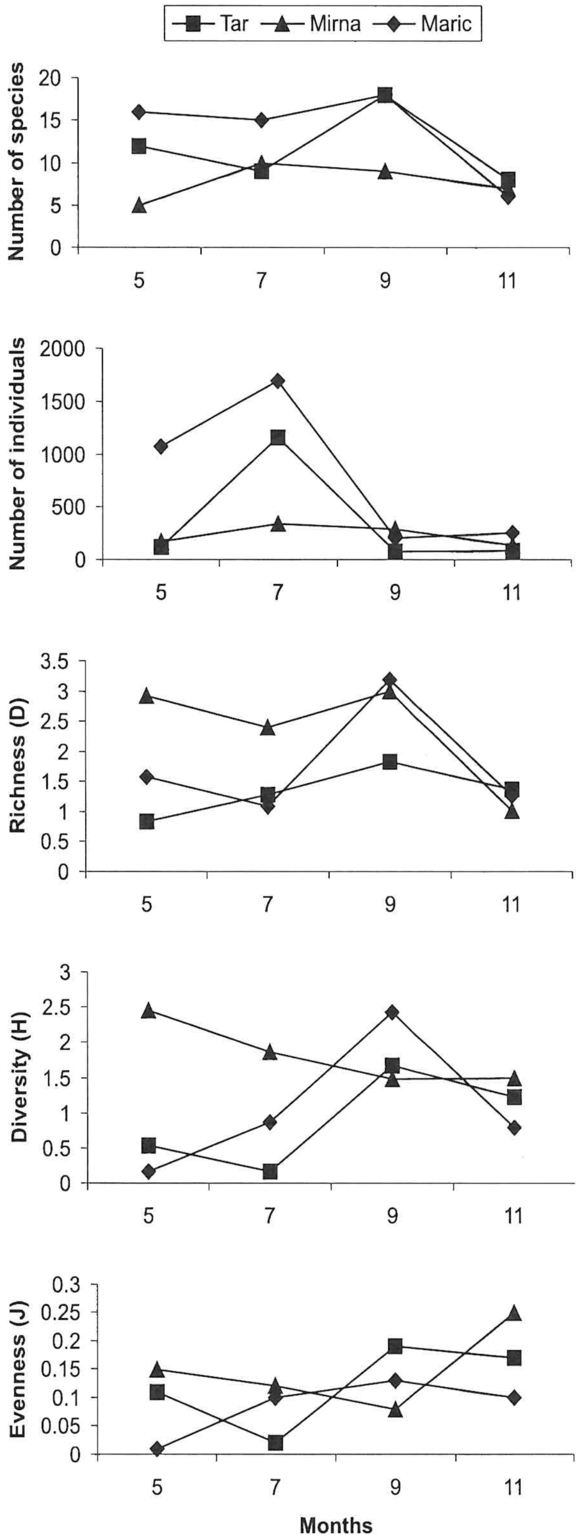

Fig. 3. Monthly variations in the number of species, number of individuals, richness, diversity and eveness in the investigation area between May and Number

Fish abundance and diversity indices in relation to abiotic factors

The relationship between abiotic factors such as temperature and salinity and the biotic factors (number of species, number of individuals, diversity) was analysed by using multiple linear regression models. The significance level for the variables included in the model was set at $p<0.05$. Results indicated that variations in abiotic factors could predict more than 74% of monthly variations in biotic factors. In Mirna Estuary and Tar Cove, variations in salinity could predict more than 66% of monthly variations in number of species. Variation in number of individuals showed no significant correlations with variations of abiotic factors. At Marić

Table 1. Monthly changes in species composition of fish collected in the investigation are

Ser.	Family, species	TAR COVE				MIRNA ESTUARY				MARIĆ COVE				TOTAL	
		May	July	Sep.	Nov.	May	July	Sep.	Nov.	May	July	Sep.	Nov.		
no.		N	N	N	N	N	N	N	N	N	N	N	N	N	%
	Anguillidae														
1	*Anguilla anguilla*					2	1	3						6	0.11
	Cyprinodontidae														
2	*Aphanius fasciatus*								1					1	0.02
	Syngnathidae														
3	*Nerophis ophidion*												6	6	0.11
4	*Syngnathus acus*			1										1	0.02
5	*S. typhle*	1	20	6	20					6		4	4	61	1.09
	Moronidae														
6	*Dicentrarchus labrax*							1						1	0.02
	Carangidae														
7	*Lichia amia*							5						5	0.09
	Mullidae														
8	*Mullus barbatus*			9							5	18		32	0.57
9	*M. surmuletus*		41		1		3					2		47	0.84
	Sparidae														
10	*Diplodus annularis*	1	437	19	6	3		20			60	12		558	9.69
11	*D. puntazzo*	1								20	4	3	26	54	0.96
12	*D. sargus*										4			4	0.07
13	*D. vulgaris*	4	1	8						21	10	3		47	0.84
14	*Lithognathus mormyrus*							1						1	0.02
15	*Sarpa salpa*	3		5						17	28	5		58	1.04
16	*Sparus aurata*	2		2						9	4			17	0.30
	Labridae														
17	*Symphodus cinereus*	1	6	5	6					1	5	2	16	42	0.75
18	*S. melanocercus*									2		2		4	0.07
19	*S. occelatus*	2		7						8	2	7		26	0.46
20	*S. tinca*											3		3	0.05
	Gobiidae														
21	*Gobius bucchichi*									1				1	0.02

Table 1. cont'd

Ser.	Family, species	TAR COVE				MIRNA ESTUARY				MARIĆ COVE				TOTAL	
		May	July	Sep.	Nov.	May	July	Sep.	Nov.	May	July	Sep.	Nov.		
no.		N	N	N	N	N	N	N	N	N	N	N	N	N	%
22	*G.cobitis*									1				1	0.02
23	*G. geniporus*							3						3	0.05
24	*G. niger*		4	4		2	3			1	4	3		21	0.37
25	*Pomatoschistus marmoratus*				2	8	12		4	22	12	4	27	91	1.62
26	*Zosterissessor ophiocephalus*	5	28	6	14		1		2					56	1.00
	Callionymidae														
27	*Callionymus pusillus*											2		2	0.04
	Blenniidae														
28	*Lipophrys pavo*		3	4			2							9	0.16
29	*Parablennius gattorugine*										1			1	0.02
30	*P. sanguinolentus*	1												1	0.02
31	*P. tentacularis*				1				1					2	0.04
	Mugilidae														
32	*Chelon labrosus*										11			11	0.20
33	*Liza aurata*	6		5			2	17		20	21	15		86	1.54
34	*L. ramada*			12						15		12		39	0.70
35	*L. saliens*			3			1		34	13				51	0.91
36	*Mugil cephalus*			30			3	2	4					39	0.70
	Atherinidae														
37	*Atherina boyeri*			53	206	103	1129	27	35					1553	27.73
38	*A. hepsetus*	1047	1152	27						12	172	191	58	2659	47.47
	Total number of individuals	1074	1692	206	256	118	1157	79	81	169	343	289	137	5601	100
	Total number of species	12	9	18	8	5	10	9	7	16	15	18	6	38	

Cove, variations in temperature could predict more than 85% of monthly variations in number of species and individuals. These results indicated that even if temperature controlled monthly fluctuations of biotic factors, a casual relationship would not always exist.

DISCUSSION

Shallow bottoms near the coasts play an important role in the life stages of many demersal fishes because many of them have complex life cycles that begin with a pelagic larval stage in open waters, followed by demersal stages in coastal habitats (GARCIA-RUBIES and MACPHERSON, 1995). Many biotic and abiotic factors play an important role in determining the success during the early life stages of demersal fishes (BIAGI, 1998).

According to the results of this study, 38 species either permanently or temporarily occupy the investigation area, and represent 9.3% of the relatively rich Adriatic ichthyofauna (410 fish species and subspecies) (DULČIĆ and GRBEC, 2000). Long-term investigation will probably indicate a greater number of species living in this area.

Juveniles of five numerically dominant species, (*A. hepsetus*, *A. boyeri*, *D. annularis*, *P. marmoratus* and *L. aurata*) belonged to the productive and low trophic level species with high ecological efficiency (DULČIĆ *et al.*, 1997). Collected fishes were mainly represented by juvenile stages. They settled to those shallow bottoms near the coast after their pelagic larval stage in the open waters of the northern Adriatic. The study sites, due to their high productivity, probably play a role of nursery ground, providing suitable food and shelter from predation. The nursery function of estuaries and inshore waters has been well documented all over the world (BLABER and BLABER, 1980; LENANTON, 1982; ROBERTSON and DUKE, 1987; BLABER and MILTON, 1990; TZENG and WANG, 1992; BIAGI, 1998). In temperate seas such as the Adriatic, most species have internalised their biological cycles according to seasonal patterns. They spawn or settle in a quite short and well-defined period of the year (DULČIĆ *et al.*, 1997) choosing adequate habitats. So, presence of many species and abundance individuals were positively or negatively correlated with seawater temperature. This is a reason why multilinear correlation coefficients between biotic factors and water temperature are not significant (DULČIĆ *et al.*, 1997). However, the same coefficients between biotic factors and salinity were significant because the ability to adjust to salinity fluctuations is the single most important adaptation required by fishes entering shallow coastal areas, especially estuaries (WHITFIELD, 1993). ALI and HUSSAIN (1990) found significant positive or negative correlation between abiotic and biotic factors. According to our investigations, two families, Atherinidae (75.20%) and Sparidae (13.19%) dominated representing 88.39% of the whole sample, while Mugillidae (4.03%), Gobiidae (3.11%) and Labridae (1.34%) were less abundant and all other families (8) were rare and occasional (<1.00%). KRALJEVIĆ and PALLAORO (1991) and DULČIĆ *et al.* (1997) obtained similar results.

A high species number was observed in September (30), characterised by median temperature (mean value 19.1°C) and settlement timing of these species. GRUBIŠIĆ (1982) and JARDAS (1996) indicated that spring and summer were the spawning periods for most common species in the eastern Adriatic, and the five most abundant species from this study are among them. Ecological separation of the dominant species by settlement and recruitment timing resulted in the fact that species didn't compete one with the other for the same niche (TZENG and WANG, 1992). DULČIĆ *et al.* (1997) observed segregation inside families, since some species settle at different times of the year.

Juvenile fish assemblage at the investigation area exhibited a great range for the values of species richness (*D*), diversity (*H*) and evenness (*J*). The highest value of richness is calculated for Tar Cove in September (*D*=3.19), and the lowest for Mirna Estuary in May (*D*=0.84). This difference resulted in the fact that only a few species (5) were caught in Mirna Estuary in May due to relatively low sea temperature (*T*=17.04°C) and salinity (*S*=18.0psu). At the same time (May); in Marić Cove was characterized by the highest value of diversity (*H*=2.45), due to catch of 16 fish species, but in September; the same cove had the maximal value of evenness (*J*=0.25) because of a catch of only 6 species. From a general point of view, our results showed great temporal fluctuations in fish composition and abundance. But as previously stated, further extensive investigations are necessary because we collected fish samples only four times per year (from May to November, every two months) without replicates per site and time. Analyses using multiple linear regression models suggests that about 76% of the variability associated with monthly fluctuations in biotic factors could be predicted by abiotic factors. These values could be comparable with values obtained in studies performed in similar areas, bays and estuaries (Table 2). According to the JACCARD similarity coefficient (*K*), the most similar coves were Tar and Marić (0.68), with values similar to the findings of ALI and HUSSAIN (1990). The results of the sampling station Mirna Estuary were similar to Colorado Lagoon in California (ALLEN and HORN, 1975). This location had the lowest monthly values of temperature and

Table 2. Diversity index values from the literature

AREA	*D*	*H'*	*J'*	SOURCE
Colorado Lagoon, California	0.5-1.73	0.03-1.11	0.01-0.57	ALLEN and HORN] (1975)
Upper Newport Bay, California		0.42-1.76		ALLEN (1982)
Iriven Bay, west coast of Scotland	1.5-3.08	1.17-1.97	0.57-0.77	NASH and GIBSON (1982)
Lynnof Lorn, west coast of Scotland	1.4-3.34	1.23-1.95	0.50-0.72	NASH and GIBSON (1982)
Cabrillo beach area, Los Angeles		0.50-2.50		ALLEN *et al.* (1983)
Malaga Bay, Spain		1.17-3.00	0.27-0.65	REINA-HERVAS and SERRANO (1987)
Kohr-al-Zubair, north-western Arabian Gulf	1.17-3.47	1.19-2.36	0.57-0.80	ALI and HUSSAIN (1990)
Kornati Archipelago, middle Adriatic	2.35-5.71	1.12-2.79	0.32-0.77	DULČIĆ *et al.* (1997)
Krka Estuary, middle Adriatic				
Sovlja Cove	1.23-3.19	0.44-2.18	0.20-0.81	DULČIĆ *et al.* (2000)
Žaborić Cove	1.20-4.38	0.42-2.74	0.20-0.84	DULČIĆ *et al.* (2000)
Žrnovnica Estuary, middle Adriatic	2.37-3.95	1.58-2.09	0.54-0.68	VUČKOVIĆ (2000)
Cetina Estuary, middle Adriatic				
right coast of Cetina River	3.28-4.23	1.90-2.31	0.61-0.74	VUČKOVIĆ (2000)
left coast of Cetina River	2.16-3.63	1.42-1.62	0.51-0.58	VUČKOVIĆ (2000)
Neretva Estuary, southern Adriatic				
Little Neretva	1.26-2.73	0.10-0.75	0.06-0.26	FURČIĆ (2001)
Klek Cove	1.66-3.05	0.33-0.52	0.12-0.18	FURČIĆ (2001)
	1.54-1.75	0-26-0.55	0.10-0.22	FURČIĆ (2001)
Donji Molunat Bay, southern Adriatic	2.65-2.95	1.33-1.71	0.44-0.62	DULČIĆ *et al.* (1998)
Northern Adriatic				
Tar Cove	1.08-3.19	0.17-2.42	0.01-0.13	Present study
Mirna Estuary	0.84-1.83	0.16-1.67	0.02-0.19	Present study
Marić Cove	1.02-3.00	1.48-2.45	0.08-0.25	Present study

salinity among the investigated stations. As a result of those findings, we observed the lowest diversity index values from the literature (Table 2). Furthermore, it is the poorest sampling station by number of species, among our investigated river estuary stations on the eastern Adriatic coast. We found that variation in salinity at that station could probably predict more than 66% of monthly variations in number of species. DULČIĆ *et al.* (1997) collected the lowest number of juvenile individuals in Kornati Archipelago from June to September when they measured extremely high and low temperatures in the shallow coves. Temperature was the main factor affecting the fish population in the Colorado Lagoon (ALLEN and HORN, 1975). ALLEN (1982) observed that temperature and salinity accounted for 83% of the variation in fish abundance in Newport Bay. Temperature also played an important role in north-western Arabian Gulf (ALI and HUSSAIN, 1990) and for the community of fish larvae and juvenile in the Tanshui River Estuary (TZENG and WANG, 1992).

There are a variety of mechanisms affecting community structure including competition for space, food, predation or constraints on recruitment (ROSS, 1986). The main factors affecting juvenile settlement in the shallow waters are substrate type (CARR, 1991; LEVIN, 1991, MACPHERSON, 1994) and depth (GARCIA-RUBIES, 1995; GARCIA-RUBIES and MACPHERSON, 1995, GUIDETTI and BUSSOTTI, 2000b). The above factors affect the abundance, mortality and growth of settlers (MACPHERSON, 1994). The relative importance of each factor differs according to species (DULČIĆ *et al,* 1997). Also, human activities can severely impact the coastal zones and their associated coastal habitats. This is especially true for the northern Adriatic, and peninsula Istra because the economy of the region depends on tourism, fisheries and other maritime activities. For these reasons, anthropogenic pressure must be well defined and then controlled by strong legislative restrictions and reasonable measures.

In conclusion, our preliminary results and the literature data suggest that the structure of fish assemblages is affected by a large number of interplaying biological interactions (starvation, predation) and physical-chemical factors (fluctuations of temperature and salinity, habitat complexity, hydrodynamic forces, etc.). A lack of knowledge of settlement and recruitment processes is one of the main sources of uncertainty in the models directed toward the assessment and management of exploitable resources (BIAGI, 1998). Therefore, it is necessary to conduct long-term investigations to determine spatio-temporal variability in composition and number of factors (and connection between them) that can impact structure of juvenile fish population in northern Adriatic Sea.

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Prostorno - vremenska raznolikost u sastavu ribljih zajednica uzduž zapadne obale Istre, sjeverni Jadran

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SAŽETAK

Ukupno je 5601 riba svrstanih u 13 porodica i 38 vrsta ulovljeno u svibnju (1361), srpnju (3192), rujnu (574) i studenom (474), 1998. godine, na 3 lokaliteta sa zapadne obale Istre (Tarska vala, ušće Mirne, uvala Marić), koristeći 50 m dugu malu obalnu potegaču. Pet vrsta: *Atherina hepsetus* (47,47%), *Atherina boyeri* (27,73%), *Diplodus annularis* (9,96%), *Pomatoschistus marmoratus* (1,62%) i *Liza aurata* (1,54) su sačinjavale 88,32% od ukupnog ulova. Struktura populacije je određena indeksom obilja (*D*), indeksom raznolikosti (*H*), indeksom jednoličnosti (*J*) i JACCARD-ovim koeficijentom sličnosti (*k*). Godišnja je vrijednost indeksa *D* bila 4,287, kolebajući od 0,838 (ušće Mirne u svibnju) do 3,191 (Tarska vala u rujnu). Indeks *H* je kolebao od 0,170 (Tarska vala u svibnju) do 2,453 (uvala Marić u svibnju), sa godišnjom vrijednošću od 1,661. Godišnja je vrijednost indeksa *J* bila 0,46, kolebajući od 0,01 (Tarska vala u svibnju) do 0,25 (uvala Marić u studenom). Koeficijent *k* je bio najveći između Tarske vale i uvale Marić u svibnju (0,66), a najmanji između ušća Mirne i uvale Marić u rujnu i studenom, kao i između Tarske vale i ušća Mirne u svibnju (0,52). Prema istom koeficijentu, najsličnije su Tarska vala i uvala Marić (0,68). Rezultati ove studije nude osnovu za buduća istraživanja čimbenika koji mogu utjecati na raspodjelu i obilje nedoraslih riba za vrijeme različitih godišnjih doba na zapadnoj obali Istre.