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Species composition, seasonal fluctuations, and residency of inshore fish assemblages in the Pantan estuary of the eastern middle Adriatic

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A total of 9434 fishes, mainly juveniles, belonging to 15 families and 42 species were caught at six stations in the Pantan estuary in the eastern mid Adriatic. Using a 50 m beach seine, 1493 specimens of 25 species were caught in summer, 2594 specimens of 26 species in autumn, 3626 of 24 species in winter, and 1721 of 30 species in spring. Seven species comprised 87.8% of the total: Atherina boyeri *(33.2%),* Pomatoschistus marmoratus *(28.1%),* Liza aurata *(8.3%),* Liza ramada *(7.1%),* Aphanius fasciatus *(5.5%),* Diplodus annularis *(2.9%) and Mugil cephalus (2.6%). An ANOSIM2 test for unreplicated 2-way layouts revealed significant differences in species assemblages among the sites (ρ_{av} = 0.385, P = 0.007). Stations with similar hydrographic conditions had similar species richness and assemblages. Statistically significant differences were not noted between seasons (ρ_{av} = 0.221, P = 0.057) although some seasonal differences, especially between summer and winter, were observed on nMDS plots. The most important ecological category was planktivorous fishes (39.4%), followed by benthic mesocarnivorous fishes (33.9%), and particulate organic matter feeders (21.3%). Twenty-two species were permanent estuary residents, 14 opportunists, and six transients. This study demonstrates that the Pantan estuary is an important fish nursery habitat that, although small, has great spatial fish diversity and therefore deserves special protection.*

Key words: seasonal fluctuations, residency, estuary, fish assemblage

INTRODUCTION

Several studies have emphasized the role of estuaries (CLARIDGE *et al.*, 1986; LENANTON & POTTER, 1987; THIEL *et al.*, 1995), salt marshes (SHENKER & DEAN, 1979), mangroves (ROBERTSON & DUKE, 1987; BLER & MILTON, 1990; LAEGDSGAARD & JOHNSON, 1995), and coastal lagoons (ANTUNES *et al.*, 1988) as nurseries for juveniles of a variety of marine fishes. This role has also been recognized for several marine coastal habitats (BIAGI *et al.*, 1998), such as sheltered sandy beaches (NASH, 1988; NASH *et al.*, 1994) and rocky shores (GIBSON, 1982; SMALE & BUXTON, 1989; GUIDETTI & BUSSOTTI, 2000). For a recent comparison of estuarine and marine sheltered sites see POTTER *et al.* (1997). Most studies focused on seasonal variations in number of individuals, species diversity, and influence of abiotic factors on species distribution (REINA-HARVAS & SERRANO, 1987; TZENG & WANG, 1992; WHITFIELD, 1994; LAEGDSGAARD & JOHNSON,

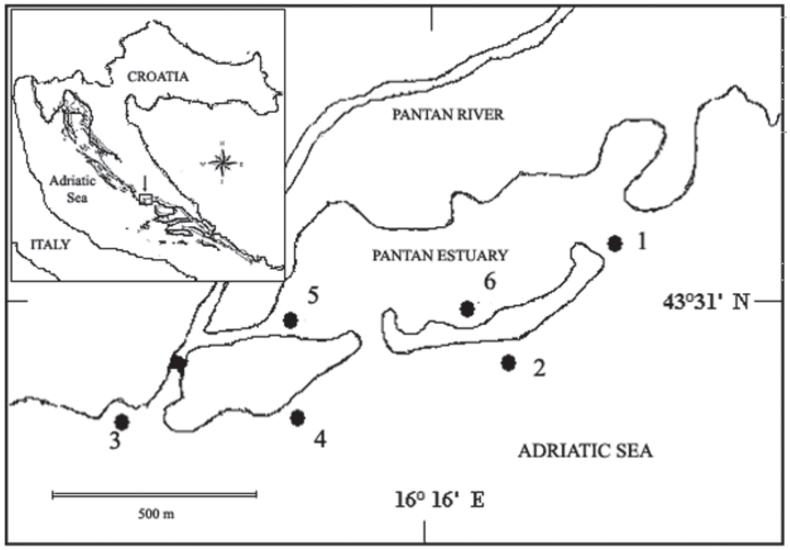

Fig. 1. Study area of Pantan estuary with six sampling stations (●)

1995). Recently, increasing attention has been paid to composition and temporal fluctuations of juvenile fish populations in the eastern Adriatic (DULČIĆ *et al*., 1997; MATIĆ *et al*.; 2000, MATIĆ, 2001). However, there are no published data about inshore fish assemblages in lagoons and estuaries in this region.

Because of the horizontal and vertical oscillations of temperature and salinity, estuary biotopes are inhabited exclusively by highly tolerant eurythermal and euryhaline species. For some of these species, estuaries are essential habitats while for others they represent one phase in the species' inshore-offshore migratory life pattern (TZENG & WANG, 1992). In their pristine state, estuaries are notably poorer in number of species than surrounding marine and freshwater areas but richer in number of individuals (ALLEN, 1982). In terms of productivity, estuaries provide an optimal feeding and nursery habitat for a number of fish species of the upper infralittoral step (TZENG & WANG, 1992).

The present study investigated the seasonal fish assemblage at six sampling stations in the Pantan estuary, using multivariate and univariate techniques. The data presented in this paper are the first for fish assemblages in this area and important for the protection and monitoring of this estuary that is facing increasing anthropogenic pressures.

MATERIAL AND METHODS

The Pantan estuary was developed by synergistic actions of the Adriatic Sea and the Pantan River. The river is characterized by a very short flow (ca. 500 m) and a strong and an inexhaustible underground spring near Trogir in the western part of Kaštela Bay (Fig. 1). Six sampling stations were selected in different parts of the estuary. Stations 2 and 4 were located along with the narrow outer marine zone, stations 1 and 3 in the lateral transitive zone, and stations 5 and 6 in inner estuary zone. Depths at sampling stations were 0.5 m (station 6), 1 m (stations 1, 2, and 5), and 1.5 m (stations 3 and 4). The substrate was predominantly muddy-clayey at stations 1, 5, and 6, rocky-sandy-muddy at station 2, and sandy-muddy at stations 3 and 4. Meadows of *Zostera noltii* were present at all sampling stations, but rare at stations 5 and 6.

The fish fauna was sampled in the summer (August 15, 1999), autumn (October 27, 1999), winter (January 25, 2000), and spring (May 20, 2000). Fish samples were collected using a 50 m beach seine. The height of the net at the beginning of the wings was 30 cm and in the center, together with the sac, 250 cm. The mesh at the wings was 8 mm and in the central sac, 4 mm. The net was always hauled from the deeper part of the sampling station perpendicularly toward the shore. Collected organisms were sorted, preserved in 4% formaldehyde (pH 8.5-9.0), and identified according to JARDAS (1996). Physico-chemical parameters were measured before hauling; temperature was measured with a mercury thermometer and salinity with a laboratory inductive salinometer.

The fish assemblage was analyzed using the PRIMER software package (Plymouth Marine Laboratories, UK; CLARKE & WARWICK, 2001). Species richness (number of species) and abundance (number of specimens) were recorded. Data were transformed for presence/absence and the BRAY-CURTIS similarity matrix was used to generate 2-dimensional ordination plots with the non-metric multidimensional scaling (nMDS) technique (CLARKE, 1993). The ANOSIM2 test for unreplicated 2-way layouts was used to test for differences in species assemblage between seasons and sites (CLARKE & WARWICK, 2001). The probability value was set at 0.05.

Table 1. Temperature (T;°C) and salinity (S; psu) at six sampling stations in the Pantan estuary

	Station 1		Station 2		Station 3		Station 4		Station 5		Station 6	
	T	S	T	S	T	S	T	S	T	S	T	S
Summer	22.0	34.5	23.0	31.0	20.0	31.0	22.0	37.5	18.0	27.0	19.0	31.0
Autumn	18.0	28.0	19.0	33.0	16.0	27.0	19.0	34.5	15.0	22.5	16.0	25.0
Winter	12.4	15.6	15.7	28.9	13.5	18.2	16.0	30.3	11.2	12.7	11.8	13.2
Spring	15.2	30.2	17.9	33.7	21.4	30.5	18.3	32.6	16.4	24.1	17.2	24.8

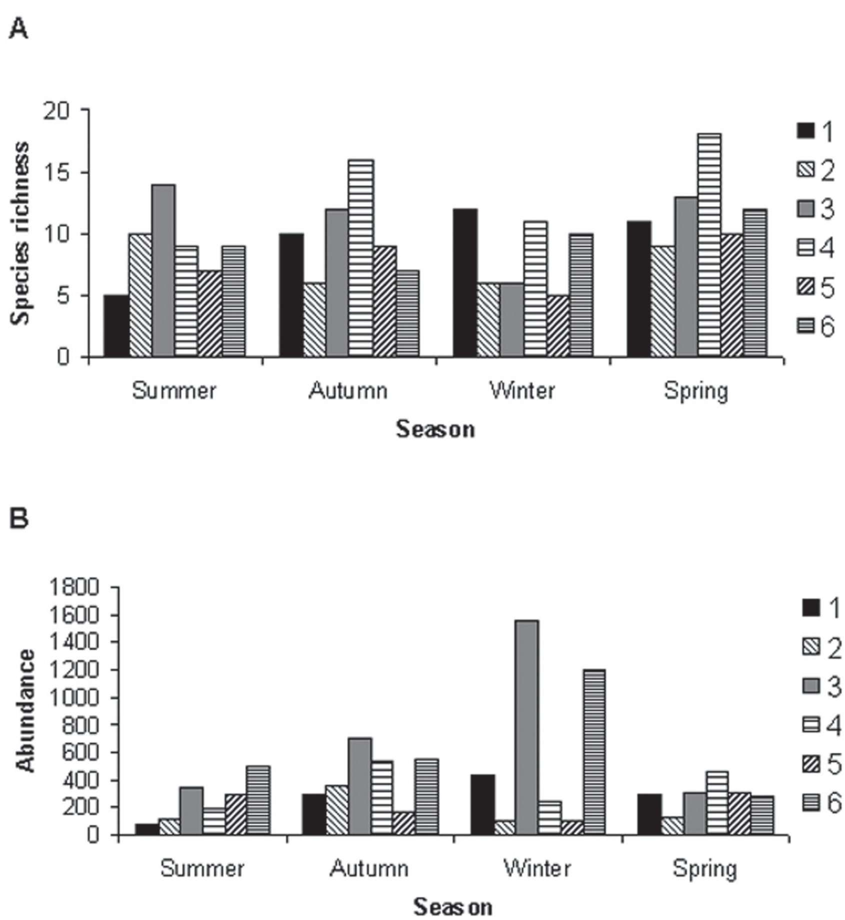

Fig. 2. Species richness (A) and abundance (B) according to season and sampling station

Table 2. Species composition, residency (R), and ecological category (EC) of fish collected in summer (S), autumn (A), winter (W), and spring (Sp)

	Family *species*	R[1]	EC[2]	Station 1				Station 2				Station 3				Station 4				Station 5				Station 6				Total
				S	A	W	Sp	S	A	W	Sp	S	A	W	Sp	S	A	W	Sp	S	A	W	Sp	S	A	W	Sp	
	Clupeidae																											
1	*S. pilchardus*	T	P																67									67
	Engraulidae																											
2	*E. encrasicolus*	T	P									1				1												2
	Anguillidae																											
3	*A. anguilla*	O	-																								1	1
	Cyprinodontidae																											
4	*A. fasciatus*	R	B			1	60																	152	1	298	8	520
	Syngnathidae																											
5	*S. tenuirostris*	R	B			2	5						2							5	1	3	3	1		1	1	24
6	S. typhles	R	B									1																1
	Moronidae																											
7	*D. labrax*	T	-												1													1
	Mullidae																											
8	*M. barbatus*	O	B										2				2											4
9	M. surmuletus	O	B									4	6			15	3											28
	Sparidae																											
10	*D. annularis*	O	S					3				189	2			22	22		12	21	2							273
11	*D. puntazzo*	O	S		4	3				3					14		2	12	1							2		41
12	*D. sargus*	T	S	10								3				1												14
13	*D. vulgaris*	O	S									1			5	3	1	2	4									16
14	*L. mormyrus*	O	S											2														2
15	*S. salpa*	O	H												82			1	2									85
16	*S. aurata*	T	S												1													1
17	*S. cantharus*	O	S					1																				1
	Labridae																											
18	*S. cinereus*	R	L									4	5				9	1	2									21
19	*S. occelatus*	R	L														1	1										2
20	*S. roissali*	R	L									1			1		2	1										5
21	*S. tinca*	R	L	1		1		1				28					9		2									42
	Gobiidae																											
22	*C. quadrivittatus*	R	B			1																						1
23	*G. bucchichi*	R	B																2									2
24	G. cobitis	R	B																1									1
25	*G. niger*	R	B		2	3	41	1				9	12		7				9	18	1		21				32	158
26	*K. caucasica*	R	B												6								36			69	8	119
27	*P. bathi*	R	B		4							3		1			2					3		7				20
28	*P. canestrini*	R	B										27															27
29	*P. marmoratus*	R	B		70	157	9	11	97	1			617	900	55	57	2	5	4	5	63	6	68		461	16	46	2650
30	*Z. ophiocephalus*	R	B					3				1					9					1						14
	Callionymidae																											
31	*C. pusillus*	O	B												1													1
	Blenniidae																											
32	*L. dalmatinus*	R	B						4								1	1	3									9
33	*L. pavo*	R	B		6	17	3	47		1						2	3	1	1				3	5	3		8	100
34	*P. sanguinolentus*	R	B					24	4				1			1			1									31
35	*P. tentacularis*	R	B									1					1	1	3									6
	Mugilidae																											
36	*C. labrosus*	O	PO	1	3		37	2											2	1	3		43	1			4	97
37	L. aurata	O	PO	1	30	193	79		3				14	43	4				23		9		74	24	14	269	8	788
38	*L. ramada*	O	PO		8	34	41		1	34	10			65	1						4		44	292	20	106	13	673
39	*L. saliens*	T	PO		3	2	5						1											5		194		210
40	*M. cephalus*	O	PO			6	5													1			1		2	227		242
	Atherinidae																											
41	*A. boyeri*	O	P	59	165	11	12	16	242	58	77	94	17	551	125	86	463	213	318	234	78	91	8	12	46	11	146	3133
	Soleidae																											
42	*S. kleinii*	O	B																								1	1
	TOTAL			72	295	430	297	109	351	98	87	340	706	1562	303	188	532	239	457	285	163	104	301	499	547	1193	276	9434

[1] O = opportunist; R = resident; T = transient

[2] B = benthic mesocarnivorous fishes; H = herbivorous fishes; L = mesocarnivorous nectobenthic fishes belonging to Labridae; P = planktivorous fishes inhabiting the water column, often aggregated in schools; PO = particulate organic matter feeders; S = meso- and macrocarnivorous sparids

Fish were grouped into ecological categories on the basis of their feeding habits and location in the water column, as per GUIDETTI *et al.* (2002): (1) BEN: benthic mesocarnivorous fishes; (2) HERB: herbivorous fishes; (3) LAB: mesocarnivorous nectobenthic fishes belonging to Labridae; (4) PLA: planktivorous fishes inhabiting the water column, often aggregated in schools; (5) POM: particulate organic matter feeders; and (6) SPA: meso- and macrocarnivorous sparids. *Anguilla anguilla* and *Dicentrarchus labrax* were not included in any of these categories.

The species were also categorized by utilization of the estuary, i.e., whether they were present in the estuary during all or only some life stages. Permanent residents (R) spend their entire life (juvenile to adult) within the estuary and are highly adapted to estuary conditions by possessing specialized physiological adaptations. Opportunists (O), or secondary residents, spend only part of their life in the estuary, usually as juveniles, and generally have few physiological adaptations to estuary conditions. Transients (T), often stenothermal and stenohaline species, enter the estuary only occasionally, usually when conditions in the estuary are very similar to those in the open sea. Transients generally have no specialized adaptations to estuary conditions.

RESULTS

Seasonal variations in sea temperature and salinity are presented in Table 1. Temperature ranged from 11.2°C in winter (station 5) to 23.0°C in summer (station 2). Salinity ranged from 12.7 psu in winter (station 5) to 37.5 psu in summer (station 4).

A total of 9,434 fishes belonging to 15 families and 42 species were caught (Table 2). Most were juveniles, with the main exception being 10% of the *Atherina boyeri* and *Pomatoschistus marmoratus* collected in the winter samples. The highest numbers of species were caught at stations 3 (29) and 4 (26), while at stations 1, 2, 5, and 6, only 16, 14, 13 and 16 species were caught (Fig. 2). The number of species was highest in spring (30), and almost constant throughout the rest of the year: summer (25), autumn (26), and winter (24). The number

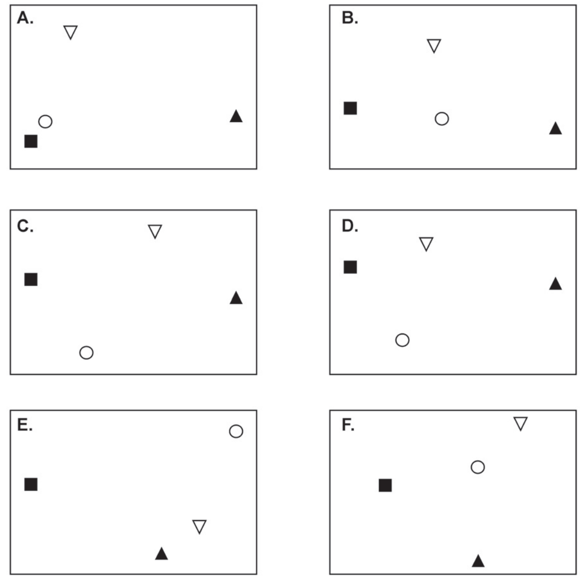

Fig. 3. MDS ordination plot of seasons for six sampling stations (stress < 0.01): (A) Station 1; (B) Station 2; (C) Station 3; (D) Station 4; (E) Station 5; (F) Station 6 (▲)

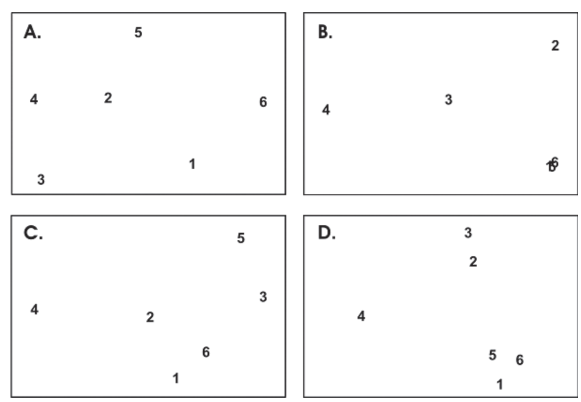

Fig. 4. MDS ordination plot of sampling stations for four sampling seasons (stress ≤ 0.01): (A) summer; (B) autumn; (C) winter; (D) spring

of specimens was highest in winter (3,626), somewhat lower in autumn (2,594), and lowest in spring (1,721) and summer (1,493).

Most species were found at all stations. *A. anguilla* and *Solea kleinii* were recorded only at station 6. The most abundant species were *A. boyeri* (33.2%), *P. marmoratus* (28.1%), *Liza aurata* (8.4%), *L. ramada* (7.1%), *Aphanius fasciatus* (5.5%), *Pomatoschistus bathi* (5.1%), *Diplodus annularis* (2.9%) and *Mugil cephalus* (2.6%), which comprised 87.8% of the total sample.

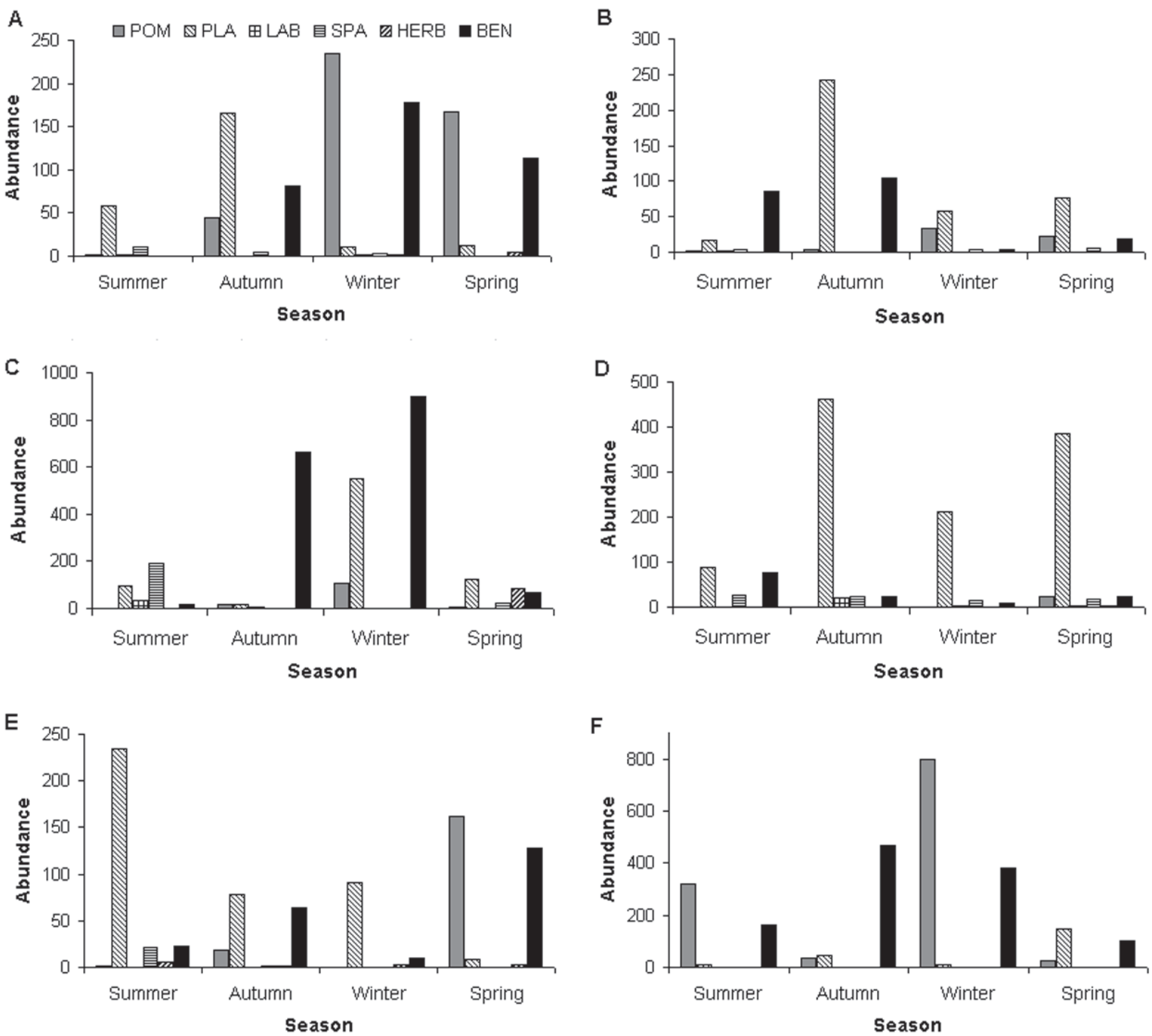

Fig. 5. Abundance of fish belonging to each ecological category: (A) Station 1; (B) Station 2; (C) Station 3; (D) Station 4; (E) Station 5; (F) Station 6

Characteristic Pantan estuary ichthyofauna includes freshwater euryhaline species that prefer low salinity biotopes, such as *A. anguilla*, *A. fasciatus*, *Pomatoschistus canestrini*, and *Knipowitschia caucasica*, and marine euryhaline species that prefer biotopes with low to moderately high salinity, such as *P. bathi*, *P. marmoratus*, *A. boyeri*, *Singnathus tenuirostris*, *Zosterisessor ophiocephalus*, and *Lipophrys pavo*. The ichthyofauna also includes juveniles of euryhaline marine species for which this highly productive habitat provides a nursery ground (i.e., S*parus aurata*, *D. labrax*, *D. annularis*, *Diploidus puntazzo*, *D. sargus*, *D. vulgaris*, *Lithognathus mormyrus*, *Sarpa salpa*, *Mullus surmuletus*, and almost all species of Mugilidae)

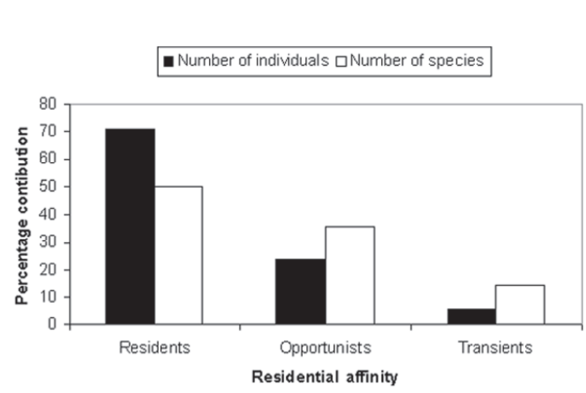

Fig. 6. Contribution of resident, opportunist, and transient fish to the overall number of species and individuals caught at six sampling stations in the Pantan estuary

and euryhaline marine species that permanently live in the estuary and surrounding marine area where the salinity fluctuates ±10 psu (i.e., *Syngnathus typhle*, *Gobius niger*, *G. bucchichi*, *G. cobitus*, *Parablennius sanguinolentus*, *P. tentacularis*, *Symphodus tinca*, and *S. cinereus*). Former reports of *P. canestrini*, *P. bathi*, and *K. caucasica* were very rare, therefore it is interesting to hereby mark their new, reliably established existence.

The nMDS plots of the fish assemblages reveal seasonal differences (Fig. 3). At sites 1-4, there were differences between the summer and winter assemblages, while the autumn and spring assemblages were positioned between those of summer and winter. At sites 5 and 6, located in the inner part of the lagoon, the summer and winter assemblages are more similar to each other than to those of the other sites. Assemblages in stations 1, 5, and 6 are similar, especially in the autumn and spring (Fig.4), as are assemblages at stations 2 and 3, especially in spring. The assemblage at station 4 differs from the assemblages at the other stations.

The ANOSIM2 test for unreplicated 2-way layouts showed significant differences in assemblages between sites (ρ_{av} = 0.385, P = 0.007) but not seasons (ρ_{av} = 0.221, P = 0.057) although the P value was close to 0.05.

The most important ecological category was BEN (39.4 %), followed by PLA (33.9 %) and POM (21.3 %). PLA, primarily due to *S. pilchardus* and *A. boyeri*, was highest at station 4 (Fig. 5). Station 3 was the only station with a higher abundance of LAB and SPA specimens. HERB was well represented at station 3, thanks to one high catch of *S. salpa*. Stations 2 and 3 differed from the others by distribution of BEN and PLA. Stations 1, 5, and 6 were similar, with high numbers of POM and BEN, and differed with respect to distribution of PLA individuals, that were less abundant at station 6.

Residential categories are shown in Fig. 6. Permanent residents comprised 22 species and were represented by 3755 individuals (39.80% of the catch). Opportunists comprised 14 species, represented by 5384 fish (57.07% of the catch). Transients comprised the remaining six species, represented by 295 individuals (3.11% of the catch).

DISCUSSION

Due to the relationship between the sea and inland waters, estuaries and lagoons are characterized by environmental unpredictability (COGNETTI & MALTAGLIATI, 2000). Their shallow bottoms play an important role in the life stages of many demersal fishes. Many species have a complex life cycle that begins with a pelagic larval stage in open waters, followed by a demersal stage in coastal habitats (GARCIA-RUBIES & MACPHERSON, 1995). Earlier studies have demonstrated that temperature and salinity are important regulating factors for spatial and temporal distribution of fish species in estuary systems (McERLEAN *et al*., 1973; ALLEN & HORN, 1975; ALLEN, 1982; ALI & HUSSAIN, 1990; TZENG & WANG, 1992; BIAGI *et al*., 1998; RUCHON *et al*., 1998).

The water temperature and salinity fluctuations in the Pantan estuary are consistent with seasonal cycles in the Adriatic (ZORE ARMANDA *et al*., 1991). However, the influence of the Pantan River on hydrographic conditions was observed at the sampling stations. The spatial and temporal differences in temperature and salinity indicate the diversity of habitats that exist within this estuary. Stations 5 and 6 have a lower temperature and salinity than the other stations. Station 1, located in a transitive area, has similar hydrographic characteristics as stations 5 and 6, indicating the relatively high influence of the Pantan River. Station 3, also located in a transitive area, has hydrographic conditions similar to the outer stations 2 and 4, again indicating the stronger river discharge in the area around station 1 than station 3.

According to this study, 42 species permanently or temporarily occupy the study area. Recorded species represent about 10% of the relatively rich Adriatic ichthyofauna (DULČIĆ & GRBEC, 2000). The fish entering the Pantan estuary from the open waters of the mid Adriatic were mainly in the juvenile stage, though a small number of adults were found.

Planktivorous fishes, mainly *A. boyeri*, were present at all sampling stations, suggesting that this group is extremely euryhaline. GUIDETTI & BUSSOTTI (2000) previously noted the absence of an evident relationship between atherinidae and benthic substrates. Fishes classified as BEN (Gobiidae and Bleniidae) or POM (mostly Mugilidae) made a small contribution to the ichthyofauna at station 4, located in the outer part of the estuary, indicating that they prefer areas of lower salinity. Station 3 was the only one station with a high presence of juvenile specimens of Labridae, Sparidae, and herbivorous fishes, suggesting that these fish prefer transition areas.

The highest species richness was recorded at stations 3 and 4. Together with station 2, these stations were least influenced by the Pantan River. This finding agrees with earlier findings that estuaries and lagoons have a smaller number of species than surrounding regions (ALLEN, 1982). Fish assemblages at stations 1, 5, and 6 were similar. These stations were also similar with respect to hydrographic conditions and number of species.

The high number of species recorded in spring shows that the Pantan estuary is an important spawning and nursery area. The nursery function of estuaries, lagoons, and inshore waters has been well documented throughout the world (BLABER & BLABER, 1980; LENANTON, 1982; ROBERTSON & DUKE, 1987; BLABER & MILTON, 1990; TZENG & WANG, 1992; BIAGI *et al*., 1998). The high number of individuals in winter is primarily attributed to *P. marmoratus* and *A. boyeri*, which are euryhaline and tolerate a wide range of salinity (FOUDA, 1995). After the spring-summer spawning of *A. boyeri* (JARDAS, 1996; TOMASINI *et al*., 1999), the lagoon fills with juveniles. A similar seasonal migration of *A. boyeri* was observed in the water system of the Camarque in southern France (ROSECCHI & CRIVELLI, 1995). A high contribution of *A. boyeri* to fish assemblages was also noted by GUIDETTI & BUSSOTTI (2002). The great number of individuals in autumn and winter can also be attributed to the abundance of species of the Mugilidae family that peaks in October (CLARIDGE & POTTER, 1985). Other species were more abundant in spring and early summer, when juveniles migrate to deeper waters to avoid extremely high or low temperatures in shallow coves (KRALJEVIĆ & PALLAORO, 1991).

According to the multivariate analysis of the fish assemblage structures, there were no seasonal differences, although the obtained probability level was close to 0.05. A possible explanation is the presence of a few dominant species in all seasons, especially A. boyeri, that could have masked variations in densities of remaining fish species, as previously observed by GUIDETTI & BUSSOTTI (2002). Differences between sites were more pronounced than differences between seasons. Further study should consider taking replicate samples to test differences by the ANOSIM with-replicates procedure.

The Pantan estuary is an essential biotope for some jeopardized populations (*A. fasciatus*, *S. tenuirostris*, *K. caucasica*, *P. canestrini*) that require conditions exclusive to lagoons and estuaries. Such locations are devastated mainly by anthropogenic influences. *Aphanius fasciatus* is already an alarmingly thinned and imperiled lagoon species. The other above-mentioned species are similarly, though not as critically, imperiled due to the rarity of estuary and lagoon biotopes along the eastern Adriatic coast. Their populations are thinned, unconnected, and widely separated. The *A. boyeri* population of the Mesolongi and Etolikon lagoons in western Greece is slightly overexploited (LEONARDOS & SINIS, 2000).

The residential status (resident, opportunist, or transient) of the Pantan estuary fishes reflects their ecological characteristics. To permanently reside in the estuary, a fish must have the ability to adapt and cope with the variable conditions (salinity and temperature) of the estuary or lagoon. Many fish have evolved specialized physiological and/or behavioral adaptations (ZANDER *et al*., 1999). Increasing the specialization of these adaptations to cope with localized conditions may be a strategy to exist as a permanent estuary resident. Further, most resident species produce demersal eggs (DEMARTINI, 1978) or exhibit parental care (DEMARTINI & PATTEN, 1979), resulting in limited dispersal of the larvae. Although opportunists can periodically cope with the variable conditions of the estuary (usually as juveniles), they do not normally breed within estuaries and lagoons

(GIBSON, 1982). Some opportunists, such as *Diplodus* sp. and *Mugilidae* spp., use estuaries as nurseries (KATAVIĆ, 1980). They usually produce planktonic larvae that are distributed near shore currents (STEVENS *et al*., 1989). As a result, opportunists generally have larger geographic ranges than permanent residents. Transient species from the open sea normally have extended pelagic larval phases to increase dispersal by currents (VICTOR, 1986). Given that most transient species are distributed in channels and the open sea, they were usually found in the estuary only during late spring and summer when the abiotic conditions of the estuary were similar to those of the open sea. Most of the transients were caught only once and only at one station. Therefore, transients made little contribution to the dynamics of the estuary fish assemblages.

In conclusion, the relatively small Pantan estuary has great spatial diversity and is inhabited by more than 42 fish species, some of which are very rare and previously unstudied. Our results show that, due to its trophic characteristics and production capacity, the Pantan estuary is a rich nursing habitat for juveniles of fish species from the upper infralittoral zone. However, due to anthropogenic pressures such as industry, tourism, fisheries, and other maritime activities, it is necessary to effectively protect and monitor this important fish habitat.

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Sastav vrsta, sezonska kolebanja i rezidentnost priobalnih ribljih zajednica u estuariju Pantan u središnjem dijelu istočnog Jadrana

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SAŽETAK

Na 6 postaja u estuariju Pantana, središnji dio istočnog Jadrana ukupno je tijekom ljeta (N=1497, S=25), jeseni (N=2591, S=26), zime (N=3627, S=24) i proljeća (N=1721, S=30) ulovljeno 9436 uglavnom nedoraslih riba, koje pripadaju u 15 porodica i 42 vrste, koristeći 50 m dugu obalnu potegaču. Sedam vrsta: *Atherina boyeri* (33.3%), *Pomatoschistus marmoratus* (23.2%), *Liza aurata* (8.3%), *Liza ramada* (7.1%), *Aphanius fasciatus* (5.5%), *Pomatoschistus bathi* (5.1%) and *Diplodus annularis* (2.9%) je sačinjavalo 85.4% ukupnog uzorka. Rezultati ANOSIM2 testa bez replika pokazuju značajnu razliku u sastavu vrsta na 6 različitih postaja (ρ_{av}=0.385, P=0.007). Pokazalo se da postaje sa sličnim hidrografskim uvjetima imaju i slično obilje vrsta kao i samu strukturu zajednice. Nije utvrđena statistički značajna razlika između sezona (ρ_{av}=0.221, P=0.057). Ipak, određena sezonska razlika, posebice između ljetnih i zimskih uzoraka, je uočena na nMDS prikazima. Najvažnija su ekološka skupina bile planktivorne ribe (33.7%), a slijedili su bentoski mezokarnivori (33.3%) i detrivori (22.4%). U estuariju stalno obitavaju 22 vrste, njih 14 su oportunisti dok su preostalih 6 tranzitne vrste. Rezultati ove studije pokazuju da je estuarij Pantan važno stanište nedoraslih riba. Iako je dimenzijama malo, stanište ima veliku prostornu raznolikost vrsta i stoga zaslužuje posebnu zaštitu.

Ključne riječi: sezonska kolebanja, rezidentnost, estuarij, zajednice riba, Jadran