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Diel catch variations in a shallow-water fish assemblage at Duće Glava, eastern Adriatic (Croatian coast)

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An assemblage of shallow-water fish was sampled with a small beach seine over monthly 24-h periods between April 2000 and March 2001 at the sandy beach Duće Glava in the eastern Adriatic. Monthly sets of samples were divided into day and night catches to examine the stability of diel differences in assemblage structure over a 1-y period. A total of 61 species was caught, of which six were exclusively diurnal and 12 were nocturnal. According to abundance and biomass of individuals during day and night, the most abundant species were categorized into several groups. *Ophidion rochei* was exclusively nocturnal, while *Nerophis ophidion* and *Echiichthys vipera* were mostly nocturnal. *Diplodus annularis* and *Mullus surmuletus* were slightly nocturnal. *Diplodus vulgaris*, *Pomatoschistus marmoratus* and *Atherina boyeri* lacked a diel pattern. *Sardina pilchardus*, *Lithognathus mormyrus*, *Atherina hepsetus*, *Sarpa salpa* and *Mullus surmuletus* abundance peaked for a few months, probably related to timing of spawning and recruitment. At the assemblage level, the diel per cent similarity index indicates that there were major differences between the day and night assemblages in April, September, March, and August with respect to number of individuals and September, October, May and March with respect to biomass.

INTRODUCTION

Inshore shallow areas are important fish feeding and nursery grounds (Nash & Santos, 1993; Guidetti & Bussotti, 2000). Extensive work has been completed on the importance of estuaries as nursery grounds for juvenile fish (Claridge et al., 1986) and non-estuarine habitats including surf zones of sandy beaches (Ross et al., 1987). It has been shown that catches using seine nets change over diel periods (Nash, 1986; Wright, 1989; Nash et al., 1994). In part, this reflects net avoidance, as the fish may see the net during daytime and some can avoid it (McCleave & Fried, 1975). It is also due to real changes in abundance and the assemblage structure (Lasiak, 1984; Nash et al., 1994).

Only a limited number of studies to date have examined the day/night catches for a whole year (Allen et al., 1983; Nash & Santos, 1998). Changes in assemblage structure over either diel or tidal cycles which are then superimposed on seasonal changes could have a profound effect on the perception of a fish assemblage. The diel periodicity of an assemblage, or even the lack of periodicity, is caused by changes in catch of the individual species (Nash & Santos, 1998). Some species appear to undergo a change in capture rate dependent on the prevailing photoperiod (Nash, 1986).

This study examines the day and night catches of shallow-water fish over a one year period, for the first time in the Adriatic and provides a description of the major assemblage types in the sandy beach area of Duće Glava in close vicinity to the River Cetina estuary. It also examines the variability of the day and night components over the same period and changes in the catch rates of individual species that contribute to change in assemblage structure.

MATERIALS AND METHODS

Duće Glava is a small south-facing sandy beach on the Croatian Adriatic coast (~20 km south of Split) near the River Cetina estuary (43°26′3″N 16°41′E; Figure 1). The sampling area was characteristically sandy and partially overgrown with meadows of *Cystoseira barbata* and *Ulva rigida*.

Samples were collected monthly for 11 consecutive months from April 2000 to March 2001 (without January 2001). Each month, samples consisting of seven catches were taken at 4-h intervals. The first sample was taken at noon the first day and the final sample was taken at noon the next day. Samples collected between sunrise and sunset were classified as day samples, while samples collected after sunset were classified as night (data provided by State Maritime Hydrometeorological Station in Split). Therefore, night samples were usually those taken at 2000, 2400 and 0400 hours while daily samples were taken at 1200, 1600, 0800 and 1200 (next day). In June, there were only two night and five day samples due to longer daylength.

Sampling was undertaken with a 22 m beach seine with wings of 7.5 m and central collecting area of 7 m (4-mm stretch size mesh at the wings reducing to 2-mm in the centre) at a depth of approximately 1.5 m. Before each catch, water temperature was measured.

Fish were immediately preserved in 4% buffered formalin. Samples were sorted and identfied to species level according to Jardas (1996). The total number of individuals and total weight for each species in each sample was obtained. Collected fish were mainly represented by the juvenile stage (juveniles of the species were taken as specimens with already formed scales and were taken as such until the moment of first sexual maturity).

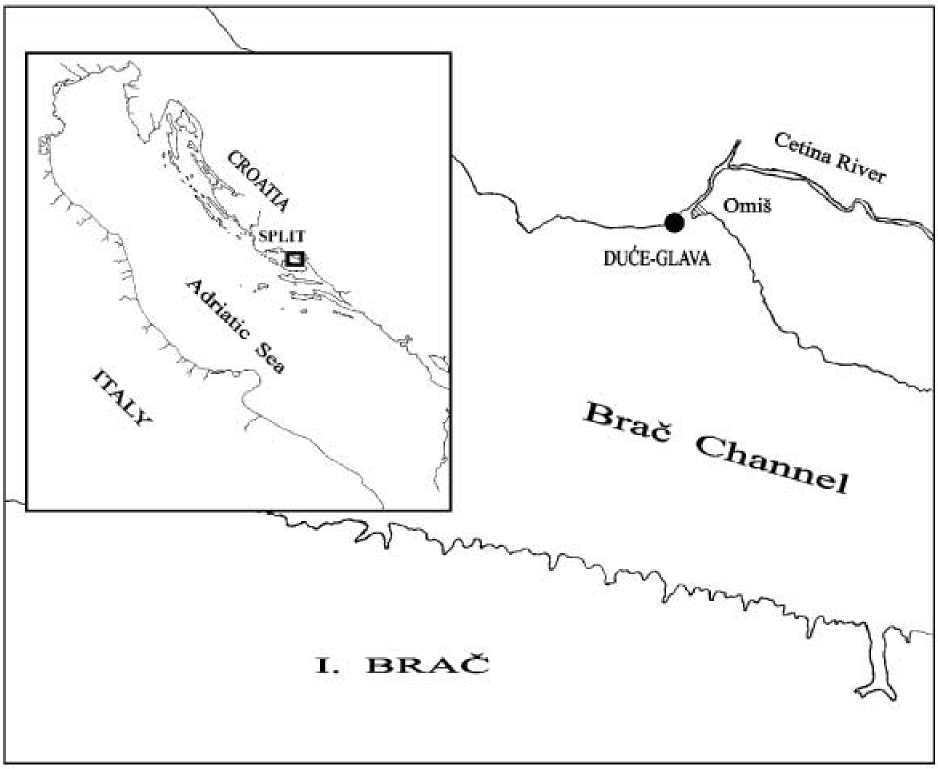

Figure 1. Sampling area.

Diel variation in number of individuals and biomass was determined as a proportion of the catch during day relative to night (day/(day+night)). Values above 0.5 indicate a greater catch during the day, and catches below 0.5 indicate night predominance.

The consistency of diurnal or nocturnal variation in catches was examined using paired *t*-tests on the catch data for each of the rare species (*Ophidion rochei* and *Echiichthys vipera*, according to Jardas, 1996) and species which made significant contributions to either the overall number of individuals or biomass of the assemblage to test differences for either daylight or night catches in each month. Spearman rank correlation tested the relationship between number of individuals and biomass during both day and night. Diel similarity percentage index (PSc) was calculated according to the method of Whittaker & Fairbanks (1958). The formula is: PSc=100–0.5* (i=1 to n) $a_i - b_i$; where a_i=percentage of species i in day sample, b_i=percentage of species i in night sample.

RESULTS

A total of 17,414 individuals and 61 fish species were caught during the whole investigation. Over the entire year, April 2000 to March 2001, there was a higher total number of individuals during the day (9784) than night (7630) (Table 1).

The relative numbers of individuals caught during day and night varied between months with little pattern (Figure 2). Six of the 11 months were characterized by higher relative numbers of individuals at night, and this is particularly pronounced in September (0.34) and March (0.23). The remaining five months had more individuals during the day, with the strongest diurnal pattern in April (0.74) and August (0.69).

The day catch, as a proportion of the total catch in both numbers of individuals and biomass for each month, was used to compare annual changes in diel catch rate (Figure 2). A significantly higher number of individuals were caught during night than day (df=10, t=6.274, $P<0.05$). Mean biomass was significantly higher at night (df=10, t=4.219, $P<0.05$). There was less monthly variability in diel patterns of biomass than for number of individuals. Compared with number of individuals, there was also less fluctuation between day and night in biomass caught. Five months had higher biomass during the day; this was strongest in May (0.61). The remaining six months had a higher biomass at night, particularly February (0.30) and March (0.32) (Figure 2).

In spring and autumn there were relatively similar numbers of species during the day and night, but in summer and winter there were many more species caught at night (Figure 3). During the day, low numbers of species were caught in March (13) and February (15), while high numbers were caught in April (30) and May (27). Number of species present at night was high in August (45) and June (40), and low in December (17) and November (18). In general, greater numbers of species were caught during the night (paired t-test: df=10, t=3.064, $P<0.05$) except in April, May and December when the reverse was true, although there were only slight differences in day and night catches in these months. In November equal numbers of species were caught during the day and night.

Over the entire year, slightly more species were caught at night (54) than day (48). *Pomatoschistus marmoratus* (number: 19.5%; biomass: 4.8%), *Lithognathus mormyrus*

Table 1. *Total catch during the day or night for each species at Duće Glava (by descending total weight).*

Scientific name	Day				Night				Total	
	No.	No. %	Wt.	Wt. %	No.	No. %	Wt.	Wt. %	No.	Wt.
1. *Sardina pilchardus*	2095	21.41	2930.89	20.43	680	8.91	543.69	3.43	2775	3474.58
2. *Salmo trutta trutta*	—	—	—	—	1	0.01	6.90	0.04	1	6.90
3. *Anguilla anguilla*	—	—	—	—	2	0.03	336.13	2.12	2	336.13
4. *Belone belone*	1	0.01	20.60	0.14	8	0.10	108.69	0.68	9	129.29
5. *Syngnathus acus*	22	0.22	17.82	0.12	44	0.58	27.07	0.17	66	44.89
6. *Syngnathus abaster*	7	0.07	6.11	0.04	2	0.03	0.54	0.00	9	6.65
7. *Syngnathus typhle*	54	0.55	135.47	0.94	46	0.60	77.11	0.49	100	212.58
8. *Nerophis maculatus*	8	0.08	4.04	0.03	27	0.35	9.25	0.06	35	13.29
9. *Nerophis ophidion*	210	2.15	94.32	0.66	451	5.91	165.22	1.04	661	259.54
10. *Hippocampus ramulosus*	1	0.01	*	*	—	—	—	—	1	*
11. *Lichia amia*	5	0.05	80.41	0.56	4	0.05	69.18	0.44	9	149.59
12. *Sciaena umbra*	—	—	—	—	1	0.01	5.03	0.03	1	5.03
13. *Mullus surmuletus*	157	1.60	990.05	6.90	271	3.55	1450.69	9.14	428	2440.74
14. *Sparus aurata*	4	0.04	0.34	+	—	—	—	—	4	0.34
15. *Diplodus annularis*	361	3.69	843.05	5.88	606	7.94	2113.00	13.32	967	2956.05
16. *Diplodus puntazzo*	108	1.10	63.50	0.44	40	0.52	19.81	0.12	148	83.31
17. *Diplodus sargus*	3	0.03	30.80	0.21	—	—	—	—	3	30.80
18. *Diplodus vulgaris*	180	1.84	947.50	6.60	138	1.81	599.63	3.78	318	1547.13
19. *Lithognathus mormyrus*	1680	17.17	253.23	1.76	1195	15.66	679.96	4.29	2875	933.19
20. *Pagellus erythrinus*	1	0.01	23.18	0.16	—	—	—	—	1	23.18
21. *Sarpa salpa*	290	2.96	593.29	4.14	37	0.48	42.43	0.27	327	635.72
22. *Labrus merula*	—	—	—	—	1	0.01	4.04	0.03	1	4.04
23. *Labrus viridis*	#	#	30.36	0.21	4	0.05	143.26	0.90	4	173.62
24. *Symphodus cinereus*	25	0.26	193.46	1.35	38	0.50	379.72	2.39	63	573.18
25. *Symphodus roissali*	19	0.19	171.34	1.19	8	0.10	38.76	0.24	27	210.10
26. *Symphodus rostratus*	1	0.01	4.58	0.03	2	0.03	4.61	0.03	3	9.19
27. *Symphodus ocellatus*	113	1.15	391.83	2.73	69	0.90	290.04	1.83	182	681.87
28. *Trachinus draco*	—	—	—	—	3	0.04	30.03	0.19	3	30.03
29. *Echiichthys vipera*	37	0.38	252.25	1.76	75	0.98	563.17	3.55	112	815.42
30. *Gobius cobitis*	7	0.07	23.04	0.16	49	0.64	302.68	1.91	56	325.72
31. *Gobius geniporus*	10	0.10	30.80	0.21	145	1.90	398.11	2.51	155	428.91
32. *Gobius niger*	8	0.08	69.23	0.48	35	0.46	140.79	0.89	43	210.02
33. *Knipowitschia panizzae*	12	0.12	17.82	0.12	29	0.38	46.64	0.29	41	64.46
34. *Pomatoschistus canestrinii*	53	0.54	86.54	0.60	19	0.25	34.18	0.22	72	120.72
35. *Pomatoschistus marmoratus*	1626	16.62	723.01	5.04	1769	23.18	737.26	4.65	3395	1460.27
36. *Zebrus zebrus*	—	—	—	—	12	0.16	6.25	0.04	12	6.25
37. *Zosterisessor ophiocephalus*	—	—	—	—	5	0.07	157.61	0.99	5	157.61
38. *Gobius* sp.	2	0.02	3.68	0.03	#	#	3.35	0.02	2	7.03
39. *Callionymus maculatus*	—	—	—	—	1	0.01	1.27	0.01	1	1.27
40. *Callionymus pusillus*	47	0.48	47.53	0.33	13	0.17	19.23	0.12	60	66.76
41. *Callionymus risso*	90	0.92	66.18	0.46	25	0.33	18.83	0.12	115	85.01
42. *Lipophrys pavo*	1	0.01	5.09	0.04	—	—	—	—	1	5.09
43. *Lipophrys trigloides*	—	—	—	—	1	0.01	1.23	0.01	1	1.23
44. *Parablennius incognitus*	3	0.03	10.63	0.07	5	0.07	17.55	0.11	8	28.18
45. *Parablennius sanguinolentus*	40	0.41	602.01	4.20	24	0.31	309.66	1.95	64	911.67
46. *Parablennius tentacularis*	2	0.02	7.71	0.05	1	0.01	7.35	0.05	3	15.06
47. *Ophidion rochei*	—	—	—	—	63	0.83	1344.02	8.47	63	1344.02
48. *Mugil cephalus*	3	0.03	148.37	1.03	10	0.13	134.90	0.85	13	283.27
49. *Chelon labrosus*	16	0.16	75.73	0.53	72	0.94	290.50	1.83	88	366.23
50. *Liza aurata*	42	0.43	324.80	2.26	96	1.26	822.97	5.19	138	1147.77
51. *Liza ramada*	12	0.12	21.36	0.15	6	0.08	14.97	0.09	18	36.33
52. *Liza saliens*	1	0.01	80.62	0.56	—	—	—	—	1	80.62
53. *Atherina boyeri*	1143	11.68	1595.17	11.12	1061	13.91	1769.84	11.15	2204	3365.01
54. *Atherina hepsetus*	1220	12.47	2132.87	14.87	345	4.52	1145.36	7.22	1565	3278.23
55. *Scorpaena porcus*	1	0.01	20.11	0.14	10	0.13	223.17	1.41	11	243.28
56. *Trigla lucerna*	2	0.02	10.15	0.07	2	0.03	37.34	0.24	4	47.49
57. *Eutriglia gurnardus*	—	—	—	—	1	0.01	*	*	1	*
58. *Lepidotrigla cavillone*	3	0.03	5.44	0.04	2	0.03	5.89	0.04	5	11.33
59. *Arnoglossus laterna*	53	0.54	148.16	1.03	61	0.80	122.61	0.77	114	270.77
60. *Arnoglossus thori*	—	—	—	—	3	0.04	8.48	0.05	3	8.48
61. *Solea kleini*	5	0.05	13.30	0.09	12	0.16	37.95	0.24	17	51.25
Number of species	48				54				61	
Total numbers	9784				7630				17414	
Total weight (g)			14347.77				15867.95			30215.72

*, individuals counted but not weighed; +, value less than 0.01%; #, individuals that were collectively weighed but not individually counted.

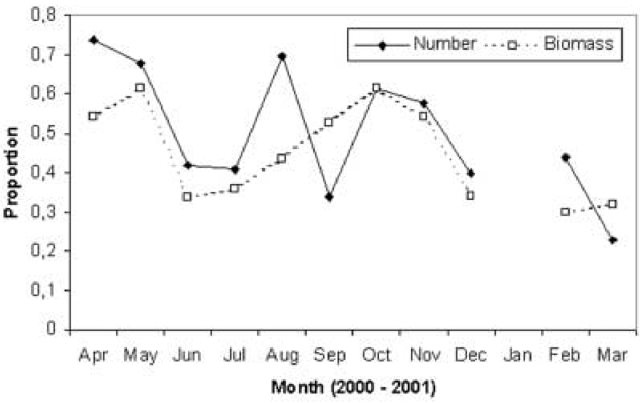

Figure 2. Seasonal variation in number of individuals and biomass (day proportional to night).

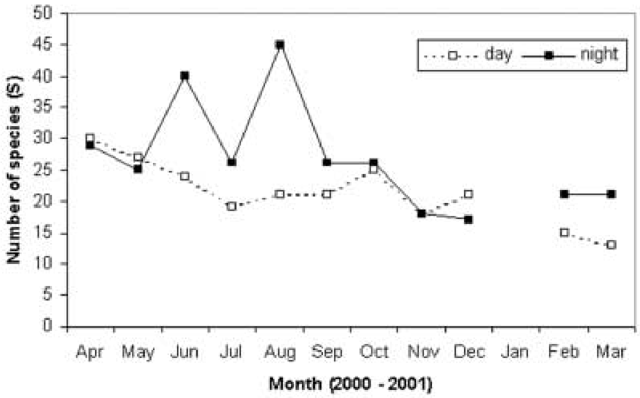

Figure 3. Seasonal variation in number of species caught during day or night.

(16.5%; 3.1%), *Sardina pilchardus* (15.9%; 11.5%), *Atherina boyeri* (12.7%; 11.2%), *Atherina hepsetus* (9.0%; 10.9%), *Diplodus annularis* (5.6%; 9.8%), *Nerophis ophidion* (3.8%; 0.9%), *Mullus surmuletus* (2.5%; 8.1%), *Sarpa salpa* (1.9%; 2.1%) and *Diplodus vulgaris* (1.8%; 5.1%) made significant contributions to either the overall number of individuals (89.2%) or biomass (67.4%) of the assemblage (Table 1). *Lithognathus mormyrus*, *Sardina pilchardus*, *M. surmuletus*, *D. annularis*, *Sarpa salpa*, and *D. vulgaris* were caught in the juvenile stage, while *P. marmoratus*, *A. boyeri*, *A. hepsetus* and *N. ophidon* were caught in the adult stage. Adult fish were caught mostly at night (*O. rochei*, *Anguilla anguilla*, *Scorpaena porcus* and *Belone belone*). With respect to the number of individuals, *Atherina hepsetus*, *Sarpa salpa* and *D. vulgaris* catches all appeared to be mainly diurnal (Table 2). On the other hand, *D. annularis*, *N. ophidion*, *Echiichthys vipera* were mainly nocturnal. *Sardina pilchardus* and *M. surmuletus* did not show any strong diurnal or nocturnal tendency in catches. With respect to the biomass *P. marmoratus*, *L. mormyrus* and *Atherina boyeri* had significantly higher catches during the night. *Liza saliens*, *Diplodus sargus*, *Lipophrys pavo*, *Sparus aurata*, *Pagellus erythrinus* and *Hippocampus ramulosus* were caught only during the day. *Ophidion rochei*, *Anguilla anguilla*, *Zosterisessor ophiocephalus*, *Trachinus draco*, *Arnoglossus thori*, *Salmo trutta trutta*, *Zebrus zebrus*, *Sciaena umbra*, *Labrus merula*, *Callionymus maculatus*, *Lipophrys trigloides* and *Eutrigla gurnardus* were caught exclusively at night. However, this could be considered as 'non-representative' for all species (except *O. rochei* and *Z. zebrus*) due to their low number of individuals.

From April until October, *O. rochei* was collected only at night (both in juvenile and adult stage). Between November and March of the second year, no specimens were caught during night or day, so there was also a seasonal aspect to its diel catch rate. *Nerophis ophidion* and *Echiichthys vipera* abundances were mostly higher during the night, so these species have a preference for shallow water at night. According to our results, *E. vipera* was less strongly nocturnal between July and March of the next year and could be a slightly nocturnal species such as *D. annularis* and *M. surmuletus*. *Diplodus vulgaris*, *P. marmoratus* and *Atherina boyeri* catches lacked any clear diel. *Sardina pilchardus*, *Lithognathus mormyrus*, *A. hepsetus*, *Sarpa salpa* and *M. surmuletus* peaked for a short period and remained scarce or absent for the majority of the year. *Diplodus annularis* also had a peak between May and September especially at night because of its spawning season. For each of these species except *M. surmuletus*, abundance was higher during the day than the night in the month(s) of peak abundance. *Atherina hepsetus* and *S. salpa* had a strong diurnal aspect to their monthly catches during most of the year.

Table 2. *Day or night predominance of catches for selected species at Duće Glava.*

Species	No. of individuals		Biomass	
	t(D/N)	P	t(D/N)	P
P. marmoratus	2.754 (D)	<0.05	3.881 (N)	<0.05
L. mormyrus	1.613 (–)	>0.05	5.504 (N)	<0.05
S. pilchardus	0.966 (–)	>0.05	1.042 (–)	>0.05
A. boyeri	2.909 (D)	<0.05	3.486 (N)	<0.05
A. hepsetus	2.266 (D)	<0.05	2.881 (D)	<0.05
D. annularis	3.832 (N)	<0.05	3.644 (N)	<0.05
N. ophidion	4.483 (N)	<0.05	9.249 (N)	<0.05
M. surmuletus	2.158 (–)	>0.05	1.749 (–)	>0.05
S. salpa	2.905 (D)	<0.05	2.682 (D)	<0.05
D. vulgaris	2.626 (D)	<0.05	3.142 (D)	<0.05
O. rochei	4.104 (N)	<0.05	3.783 (N)	<0.05
E. vipera	2.674 (N)	<0.05	2.870 (N)	<0.05

All tests are paired t-tests (t=t value) with 10 df. D, day; N, night.

Table 3. *Per cent similarity index (%) between day and night of the assemblage structure at Duće Glava for number of individuals and biomass of each species.*

Month	No. of individuals	Biomass
April	14.92	37.42
May	46.75	10.17
June	64.15	67.03
July	52.75	56.54
August	9.28	61.41
September	18.28	34.12
October	32.24	31.09
November	72.82	68.82
December	56.40	44.83
February	50.87	42.22
March	27.99	12.70

There was no relationship between catches in numbers of individuals and biomass during the day (df=9, r_s=0.047, P<0.05) and night (df=9, r_s=−0.118, P>0.05). With respect to the number of individuals, the per cent similarity index indicates that there were major differences between day and night assemblage structure in April (diel similarity: 14.92%), September (18.28%), March (27.99%) and especially August (9.28%) (Table 3). Per cent similarity in diel biomass was low in September (34.12%), October (31.09%), and very low in May (10.17%) and March (12.70%).

DISCUSSION

The Duće Glava fish assemblage is a marine fish assemblage with a relatively high number of species (10) constituting the majority of individuals and biomass which is not typical for many marine fish assemblages with relatively few (3–7) species (Lasiak, 1984; Nash et al., 1994; Nash & Santos, 1998). This difference could probably be explained by the fact that according to the results of this study, 61 species either permanently or temporarily occupy the investigation area.

Changes in species composition and abundance over diel time periods are well known for coral reef assemblages (Hobson, 1991) and to a certain extent have been examined on soft sediments (Horn, 1980; Allen et al., 1983; Nash, 1986; Wright, 1989; Nash et al., 1994; Nash & Santos, 1998). The fish fauna of inshore shallow waters is characterized by a distinct seasonal variation of the community structure, probably influenced by the fluctuations of both environmental variables and habitat complexity (Guidetti & Bussotti, 2000) but also by recruitment of new classes.

Catches of several dominant species were either primarily diurnal (*Atherina hepsetus*, *Sarpa salpa*) or nocturnal (*Nerophis ophidion*, *Diplodus annularis*, *Pomatoschistus marmoratus*, *Lithognathus mormyrus*, *A. boyeri*) and it is the relative abundance of these species in each period which determines the assemblage structure during the day or night. We observed similar numbers of species caught during the day and night in spring and autumn. However, an overall greater number of night caught species was found. This is in accordance with findings of Wright (1989) for an intertidal fish assemblage of Kuwait and Nash & Santos (1998) for a fish assemblage from Porto Pim Bay (Azores). We couldn't specify shared ecological characteristics common to the fish species important in the day as opposed to the nocturnal species.

Two time scales are being considered here. First, diel variations that separate species and conspecifics that could be competing for the same food source, space and/or avoiding the same or similar predators and secondly, seasonal variations in the composition of the diel component, which could be the consequence of changes in behaviour patterns and assemblage structure. There are a number of reasons why smaller fish might be nearer to shore during the daytime. Wright (1989) pointed out that juveniles may use the intertidal zone as a refuge from subtidal predators and they may find their preferred food items there. Also, they may come to shallower waters to feed on plankton or small invertebrates. This could be due to either better visual acuity with high light conditions, or because fish are following the movements of phototactic prey organisms. It is difficult to attribute the distribution patterns of an organism to particular behaviours without more careful observations of behaviour in the field.

The occurrence of larger fish at night was also observed in the study of Nash et al. (1994), and this could be explained as either increased catchability at night or a movement of these individuals into the area at dusk and leaving at dawn or some combination of both. In the case of *Anguilla anguilla* there was a movement of this species into shallow water to feed at night. This was probably also the case with two other species *Belone belone* and *Scorpaena porcus*, even though Nash et al. (1994) found that *B. belone* was predominantly diurnal over the three months at Porto Pim Bay. Bell & Harmelin-Vivien (1982) found that *S. porcus* was also relatively more abundant at night at *Posidonia oceanica* beds near Marseille (France). *Ophidion rochei* was exclusively nocturnal in our study. This could be connected with its ecological characteristics since this nocturnal macrocarnivorous species burrows into the substrate during daylight and emerges at night to feed. This is confirmed also by Bell & Harmelin-Vivien (1982) near Marseille and Letourner et al. (2001) at Gulf of Fos (France). *Echiichtys vipera* were mainly nocturnal in this area which is probably because it also burrows in substrate during daylight, like the cuskeel (Creutzberg & Witte, 1989; Nash & Santos, 1993). Nash et al. (1994) found that this species was predominantly nocturnal at Porto Pim.

Sardina pilchardus and *Mullus surmuletus* did not show any strong nocturnal or diurnal tendency in catches at Duće Glava, while at Porto Pim *S. pilchardus* was predominantly diurnal over three months (August, September and October) and *M. surmuletus* was predominantly nocturnal (Nash et al., 1994). Some species were caught at very close rates between day and night (*P. marmoratus* and *D. annularis*), while *Atherina boyeri* had little pattern in diel catch rate at Duće Glava. *Sarpa salpa* had a strong diurnal aspect during most of the year which is in agreement with findings of Nash et al. (1994) for Porto Pim.

The major disruptions of fish assemblage occur as the assemblage undergoes restructuring through periods of recruitment and as the assemblage switches from the overwintering to spring/summer structure. This is typical for many shallow-water fish assemblages (Lasiak, 1984; Nash, 1986; Ross et al., 1987; Wright, 1989; Nash & Santos, 1998). In our study, *Sardina pilchardus*, *L. mormyrus*, *A. hepsetus*, *Sarpa salpa* and *M. surmuletus* each peaked for a short period of the year that coincides with timing of species-specific spawning or recruitment.

The results showing no correlation between monthly catches in numbers of individuals and biomass during day and night could indicate that probably one year of investigation is not enough or more frequent sampling is required. Possible solutions are either to take a very large number of samples at the risk of restructuring the community, or combine and average samples and ignore the variances. Per cent similarity in diel number of individuals was lowest in August and April, but peaked in June and November. Per cent similarity in diel biomass was highest in the same months as for number of individuals, but lowest in May and March. This indicates that differences in number of species present at day or night are not identically reflected in biomass and number of individuals. In this case, diel habitat partitioning is reflected by low per cent similarity values in the spring and summer spawning season.

This study examines the stability and persistence of the day and night assemblage structure over an intra-annual cycle. There are a number of variations between day and night assemblages, primarily in the number of individuals over seasonal cycles. However, the presence of similarities above 50% does suggest that many species occur in both time periods, in contrast to coral reef assemblages where there is a major change from diurnal to nocturnal assemblages (Helfman, 1986). Nash et al. (1994) and Nash & Santos (1998) pointed out that schooling fish cause difficulties in analysing shallow water fish assemblages because it is extremely difficult to calculate fish densities and interpret trawl or seine net hauls as catches tend to consist of no fish or very large numbers. Parsley et al. (1989) noted that one of the major problems with trawls or seines is a lack of detailed information on the overall efficiency which makes absolute estimates of abundance difficult. The same authors reported that behaviour differs between species and there is often a difference in catchability or vulnerability of species relative to the point in the day–night light cycle. Nash & Santos (1998) noted that it has been argued that individuals do not see nets at such great distances during the night and therefore capture efficiencies are higher then. However, some species are caught at higher levels during the day than at night and there may be changes in behaviour over seasonal timescales. In the case of Duće Glava there is a certain degree of consistency in the diel fish assemblage structure over seasonal cycles. However, the major disruptions occur when the assemblage undergoes restructuring through periods of recruitment of new classes and during the change from an overwintering to a spring/summer structure.

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