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Spatiotemporal variation of shallow water fish assemblages along the coastline of Çanakkale, Turkey

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ABSTRACT

Objective: To determine the shallow water fish species richness of Çanakkale and to analyse the spatiotemporal variations of these fish assemblages.
Methods: Samplings were carried out monthly with a beach seine between January and December 2007. Samples were collected from 6 stations (No. 1, 2, 3, 4, 5, 6). Stations 1 and 4 located in the Çanakkale Strait, 2 and 5 in North Aegean Sea, 3 and 6 in Sea of Marmara.
Results: A total of 112 fish species were sampled and the two most common species were *Atherina boyeri* and *Pomatoschistus marmoratus*. A total of 93 species were sampled in the Çanakkale Strait, 85 in the Aegean Sea, and 77 in the Sea of Marmara. Shannon diversity index was the highest in the Aegean Sea. Dominant species were caused significant differences of both regional and seasonal fish assemblage fluctuations. Species richness and abundances decreased significantly in winter. Although more species were caught at night and a greater abundance of fishes was obtained during the day, no significant differences were found between day and night in terms of species richness and abundance.
Conclusions: The results supported the biogeographical differences between the Aegean Sea, the Çanakkale Strait and the Sea of Marmara in terms of the shallow water fish community. The inventory in the current study can serve as baseline data prior to management strategies to ensure sustainable conservation of the area.

1. Introduction

The coastline of Çanakkale consists of 3 different regions: the North Aegean Sea, the Çanakkale Strait, and the Sea of Marmara. The Aegean Sea is connected directly to the Sea of Marmara through the Çanakkale Strait and thus connected indirectly to the Black Sea via the Istanbul Strait[1]. The straits are a channel for low salinity and relatively cold waters originating Black Sea to flow into the Aegean Sea and also, are conduit for high salinity water and relatively warm waters moving from the Aegean Sea to the Sea of Marmara. These synchronized variations caused opposite contributions to the density by temperature and salinity. In addition, on the annual basis, the Black Sea influx is about 4 times greater than the nutrient outflow to the Aegean basin via the Çanakkale Strait[1,2]. These Straits, a biological corridor between the Aegean Sea and the Black Sea, are a migration route of many fish species[3].Because of this, Çanakkale coastline, having nutrient rich waters, is suitable as the spawning grounds for many fish species. And also, the coastline is suitable for observing the biogeographically differences between the seas.

Species richness has been considered as one of the most significant indicators of ecological value[4]. The species richness within an area may change seasonally or diurnally due to the abiotic and biotic factors. Composition and abundance of fish communities exhibit changes that are affected mainly by environmental (such as salinity and temperature) and biological factors (such as migration, mortality, and recruitment)[5,6].

Shallow waters are proper as shelter and foraging sites for juvenile fish[6]. Many fish species are using the shallow waters in the early part of their lives. Additionally, these species settle in shallow waters and undertake ontogenetic migrations towards deeper waters as they grow[7]. These areas are highly diverse ecosystems, and thus ideally suited for advancing our understanding of diversity patterns[8]. Information of the fish species richness of the shallow waters in the North Aegean Sea and the Sea of Marmara, where fisheries source are heavily exploited, is particularly scarce. Few studies were conducted focused on fish species richness in the shallow waters of the South Aegean Sea[9,10] and north entrance of the Istanbul Strait[11]. Although, demersal fish richness and distributions have been studied from the deeper waters in the North Aegean Sea[12-

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16] and the Sea of Marmara[16,17], no study has been conducted on shallow waters' fish species richness in the North Aegean Sea and the Sea of Marmara. In addition, there is no information on biogeographical differences in the shallow waters between the North Aegean Sea, the Çanakkale Strait and the Sea of Marmara. The aim of this study was twofold: first, to determine the shallow water fish species richness of Çanakkale, and second, to analyse the spatiotemporal variations of these fish assemblages.

2. Materials and methods

2.1. Study area and field sampling

This study was carried out in the shallow waters (0–2 m) of Çanakkale which has 671 km coastline that includes the North Aegean Sea, the Çanakkale Strait and the Sea of Marmara (Figure 1). The Çanakkale Strait which is a part of the Turkish Straits system, is 62 km long with a mean depth of 55 m.

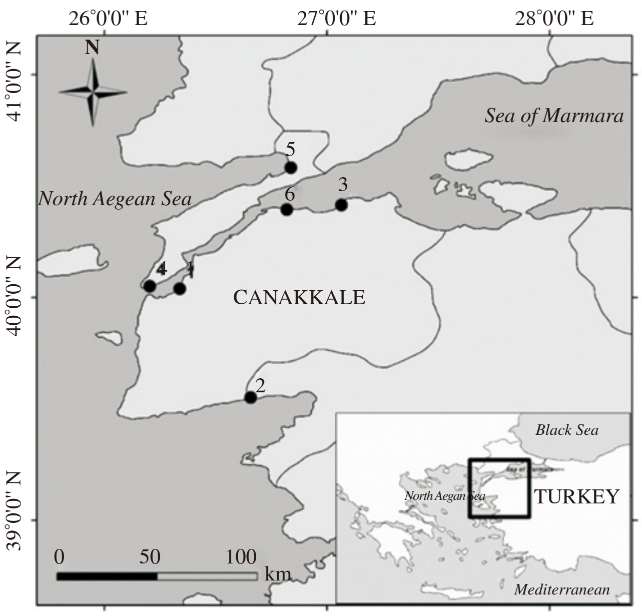

Figure 1. Sampling stations including the Çanakkale Strait, the North Aegean Sea, and the Sea of Marmara, Turkey.

Samples were collected monthly from 6 stations (No. 1, 2, 3, 4, 5, 6) with a beach seine with a total wing length of 32 m, a height of 2 m and 2 m long bag with 13 mm stretch mesh size at wing, and 5 mm stretch mesh at bag between January and December 2007 (Figure 1). Stations 1 and 4 located in the Çanakkale Strait, 2 and 5 in the North Aegean Sea, 3 and 6 in the Sea of Marmara. Beach seine operations were carried out according to Able *et al.*[18] and Wilber *et al.*[19]. The hauls were made parallel to the shore with two times both day and night, randomly and at least 100 m apart from each other. The surface water temperature and salinity were measured with a Hach Lange HQ40d probe at each station during the samplings.

Fish were killed with an overdose of quinaldine and stored in 4% formaldehyde with sea water. Fish identifications have been made according to Whitehead *et al.*[20] and Mater *et al.*[21].

2.2. Data analysis

Species diversity was given by the number of taxa (S) and the Shannon index (H)[22]. The Dominance (D) index and the Simpson (1-D) index were also calculated. In the "season" scaling factor, winter represents December, January and February, spring represents March, April and May, summer represents June, July and August, and autumn represents September, October and November 2007. The effects of the temperature and salinity on stations (1, 2, 3, 4, 5 and 6) and seasons (winter, spring, summer and autumn) were analysed by repeated measures ANOVA with a least significant difference test. The relationship between environmental factors, the seas and species were determined using Pearson correlation coefficient. The analytical determinations were performed in triplicate and differences were considered to be significant for $P < 0.05$ and $P < 0.01$. All analytical determinations of the temperature and salinity were performed in triplicate and differences were considered to be significant when $P <$ 0.05[23]. The software used was PASW® Statistics 18 for Windows (IBM SPSS Inc., Chicago, IL).

Analysis of similarities (ANOSIM) and similarity percentage (SIMPER) statistical analyses were used in order to determine similarities of the stations, day-night, and seasonal species richness. Catch per unit effort (CPUE) was calculated by dividing total catch of a species by the number of the beach seine hauls during the sampling period. Correspondence analysis was executed with seasonal CPUE values of the species. These statistical analyses were performed with PAST version 2.17c package program[24]. Statistical significance level (α) was set at 0.05.

3. Results

A total of 66381 fish belonging to 112 species were collected during the samplings. The six most common species were *Atherina boyeri* (Risso, 1810) (*A. boyeri*), *Pomatoschistus marmoratus* (Risso, 1810) (*P. marmoratus*), *Liza aurata* (Risso, 1810) (*L. aurata*), *Mullus surmuletus* (Linnaeus, 1758) (*M. surmuletus*), *Diplodus vulgaris* (Geoffroy Saint-Hilaire, 1817) (*D. vulgaris*) and *Diplodus annularis* (Linnaeus, 1758) (*D. annularis*) which comprised 79.83% of the total catch. The remaining species constituted only 20.17% of the total catch. In addition, 10 species were represented by only one individual each (Table 1). A total of 101 species were caught during the night against 98 species during the day. The maximum amount of fish were captured in the day period (CPUE = 170.12). Contrary to this, the Shannon index and the Simpson index reached their highest value in the night. Furthermore, the Dominance index was the highest (0.31) for the day (Table 2). The ANOSIM analyses did not show any significant differences between day and night ($R = 0.3333$; $P > 0.05$).

Table 1

Number of individuals (*N*), proportion (*N*%) and CPUE of fish species collected by beach seine in Çanakkale coastline from January to December 2007.

Species No.*	Species	*N*	*N*%	CPUE
1	*Aidablennius sphinx*	2	0.00	0.01
2	*Apletodon bacescui*	2	0.00	0.01
3	*Arnoglossus kessleri*	58	0.09	0.23
4	*Arnoglossus laterna*	6	0.01	0.02
5	*A. boyeri*	33032	49.76	132.13
6	*Atherina hepsetus*	1053	1.59	4.21
7	*Belone belone*	323	0.49	1.29
8	*Boops boops*	2	0.00	0.01
9	*Buglossidium luteum*	2	0.00	0.01
10	*Callionymus lyra*	15	0.02	0.06
11	*Callionymus pusillus*	12	0.02	0.05
12	*Callionymus risso*	43	0.06	0.17
13	*Chelidonichthys lucerna*	27	0.04	0.11
14	*Chelon labrosus*	865	1.30	3.46
15	*Clinitrachus argentatus*	153	0.23	0.61
16	*Conger conger*	11	0.02	0.04
17	*Coris julis*	3	0.00	0.01
18	*Coryphoblennius galerita*	1	0.00	0.00
19	*Dentex dentex*	11	0.02	0.04

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Table 1 *(continued)*

Species No.*	Species	N	N%	CPUE
20	*Dicentrarchus labrax*	185	0.28	0.74
21	*D. annularis*	1 849	2.79	7.40
22	*Diplodus puntazzo*	52	0.08	0.21
23	*Diplodus sargussargus*	220	0.33	0.88
24	*D. vulgaris*	1 789	2.70	7.16
25	*Echiichthys vipera*	19	0.03	0.08
26	*Engraulis encrasicolus*	2	0.00	0.01
27	*Eutrigla gurnardus*	1	0.00	0.00
28	*Gaidropsarus mediterraneus*	55	0.08	0.22
29	*Gasterosteusaculeatus aculeatus*	1	0.00	0.00
30	*Gobius bucchichi*	40	0.06	0.16
31	*Gobius cobitis*	39	0.06	0.16
32	*Gobius couchi*	2	0.00	0.01
33	*Gobius geniporus*	145	0.22	0.58
34	*Gobius niger*	70	0.11	0.28
35	*Gobius paganellus*	213	0.32	0.85
36	*Gobius* sp.	11	0.02	0.04
37	*Hippocampus hippocampus*	3	0.00	0.01
38	*Labrus merula*	1	0.00	0.00
39	*Labrus viridis*	82	0.12	0.33
40	*Lepadogaster lepadogaster*	8	0.01	0.03
41	*Lepidorhombus whiffiagonis*	2	0.00	0.01
42	*Lipophrys canevae*	1	0.00	0.00
43	*Lipophrys trigloides*	2	0.00	0.01
44	*Lithognathus mormyrus*	368	0.55	1.47
45	*L. aurata*	2 786	4.20	11.14
46	*Liza ramada*	454	0.68	1.82
47	*L. saliens*	1 070	1.61	4.28
48	*Liza* sp.	26	0.04	0.10
49	*Merlangius merlangus*	12	0.02	0.05
50	*Microchirus ocellatus*	4	0.01	0.02
51	*Microchirus variegatus*	2	0.00	0.01
52	*Microlipophrys dalmatinus*	28	0.04	0.11
53	*Millerigobius macrocephalus*	1	0.00	0.00
54	*Mugil cephalus*	3	0.00	0.01
55	*M. surmuletus*	1 912	2.88	7.65
56	*Myliobatis aquila*	21	0.03	0.08
57	*Nerophis ophidion*	125	0.19	0.50
58	*Oblada melanura*	6	0.01	0.02
59	*Oedalechiluslabeo*	8	0.01	0.03
60	*Ophidion barbatum*	38	0.06	0.15
61	*Ophidion rochei*	29	0.04	0.12
62	*Pagellus acarne*	427	0.64	1.71
63	*Pagellus bogaraveo*	140	0.21	0.56
64	*Parablennius gattorugine*	21	0.03	0.08
65	*Parablennius incognitus*	31	0.05	0.12
66	*Parablennius sanguinolentus*	117	0.18	0.47
67	*Parablennius tentacularis*	98	0.15	0.39
68	*Pegusa lascaris*	97	0.15	0.39
69	*Platichthys flesus*	8	0.01	0.03
70	*Pomatoschistus bathi*	618	0.93	2.47
71	*P. marmoratus*	11 619	17.50	46.48
72	*Pomatoschistus minutus*	131	0.20	0.52
73	*Pomatoschistus pictus*	27	0.04	0.11
74	*Raja miraletus*	3	0.00	0.01
75	*Raja radula*	6	0.01	0.02

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Table 1 *(continued)*

Species No.*	Species	N	N%	CPUE
76	*Salaria basilisca*	5	0.01	0.02
77	*Salaria pavo*	15	0.02	0.06
78	*Sardina pilchardus*	3	0.00	0.01
79	*Sarpa salpa*	631	0.95	2.52
80	*Sciaena umbra*	5	0.01	0.02
81	*Scophthalmus maximus*	7	0.01	0.03
82	*Scophthalmus rhombus*	19	0.03	0.08
83	*Scorpaena porcus*	272	0.41	1.09
84	*Serranus cabrilla*	7	0.01	0.03
85	*Serranus hepatus*	6	0.01	0.02
86	*Serranus scriba*	16	0.02	0.06
87	*Solea solea*	95	0.14	0.38
88	*Sparus aurata*	55	0.08	0.22
89	*Sphyraena viridensis*	17	0.03	0.07
90	*Spicara smaris*	189	0.28	0.76
91	*Spondyliosoma cantharus*	55	0.08	0.22
92	*Sprattus sprattus*	45	0.07	0.18
93	*Squatina oculata*	1	0.00	0.00
94	*Symphodus cinereus*	912	1.37	3.65
95	*Symphodus ocellatus*	944	1.42	3.78
96	*S. roissali*	1 238	1.86	4.95
97	*Symphodus rostratus*	4	0.01	0.02
98	*Symphodus tinca*	157	0.24	0.63
99	*Synapturichthys kleinii*	13	0.02	0.05
100	*Syngnathus abaster*	400	0.60	1.60
101	*Syngnathus acus*	275	0.41	1.10
102	*Syngnathus typhle*	226	0.34	0.90
103	*Torpedo marmorata*	1	0.00	0.00
104	*Trachurus mediterraneus*	1	0.00	0.00
105	*Trachurus trachurus*	15	0.02	0.06
106	*Tripterygion delaisi*	11	0.02	0.04
107	*Tripterygion melanurum*	1	0.00	0.00
108	*Tripterygion tripteronotum*	13	0.02	0.05
109	*Umbrina cirrosa*	18	0.03	0.07
110	*Uranoscopus scaber*	11	0.02	0.04
111	*Zebrus zebrus*	6	0.01	0.02
112	*Zosterisessor ophiocephalus*	43	0.06	0.17

*: Species number have been used for correspondence analyses. *L. saliens*: *Liza saliens*; *S. roissali*: *Symphodus roissali.*

Table 2

Biodiversity indexes and CPUE of fishes by station, season, and day-night caught in coastline of the Çanakkale.

Parameter		Taxa	Individual	CPUE	D	H	1-D
Station	1 (CSt)	77	9 335	37.34	0.22	2.47	0.78
	2 (AS)	61	3 720	14.88	0.22	2.19	0.78
	3 (SM)	69	7 891	31.56	0.42	1.75	0.58
	4 (CSt)	73	30 154	120.62	0.39	1.40	0.61
	5 (AS)	67	12 133	48.53	0.14	2.62	0.86
	6 (SM)	36	3 148	12.59	0.78	0.69	0.22
Season	Winter	71	8 240	32.96	0.25	2.08	0.70
	Spring	81	11 835	47.34	0.30	2.07	0.75
	Summer	86	34 035	136.14	0.33	1.80	0.78
	Autumn	70	12 271	49.08	0.22	2.27	0.67
Day-night	Day	98	42 531	170.12	0.31	1.99	0.69
	Night	101	23 850	95.40	0.24	2.27	0.76

D: Dominance index; H: Shannon index; 1-D: Simpson index; CSt: The Çanakkale Strait; AS: The Aegean Sea; SM: The Sea of Marmara.

Monthly average sea surface water temperature ranged between 11.5 °C (January) and 29.4 °C (June) in the shallow waters of Çanakkale between January and December 2007. The minimum and the maximum surface water temperature were recorded as 8.8 °C and 32.4 °C. In all stations, temperature showed decreased trend in the winter while increased trend in the summer (Figure 2). In terms of temperature, no significant differences were found among stations throughout the year ($P > 0.05$). However, repeated

Table 3

Pearson correlation coefficient between environmental factors, and species in the Çanakkale Strait, the Aegean Sea and the Sea of Marmara.

Locations		CSt			AS			SM		
		Temperature	Salinity	Species	Temperature	Salinity	Species	Temperature	Salinity	Species
CSt	Temperature	1.000	-0.262	0.762**	0.975**	0.544	0.585*	0.898**	-0.529	0.596*
	Salinity	-0.262	1.000	-0.036	-0.417	0.364	-0.115	-0.191	0.546	-0.198
	Species	0.762**	-0.036	1.000	0.672*	0.469	0.602*	0.559	-0.234	0.581*
AS	Temperature	0.975**	-0.417	0.672*	1.000	0.440	0.641*	0.908**	-0.647*	0.605*
	Salinity	0.544	0.364	0.469	0.440	1.000	0.094	0.534	0.010	0.028
	Species	0.585*	-0.115	0.602*	0.641*	0.094	1.000	0.665*	-0.494	0.822**
SM	Temperature	0.898**	-0.191	0.559	0.908**	0.534	0.665*	1.000	-0.749**	0.696*
	Salinity	-0.529	0.546	-0.234	-0.647*	0.010	-0.494	-0.749**	1.000	-0.751**
	Species	0.596*	-0.198	0.581*	0.605*	0.028	0.822**	0.696*	-0.751**	1.000

CSt: The Çanakkale Strait; AS: The Aegean Sea; SM: The Sea of Marmara. *: Correlation is significant at the 0.05 level (2-tailed); **: Correlation is significant at the 0.01 level (2-tailed).

measures ANOVA analysis showed that sea surface temperatures were significantly different between seasons ($P < 0.05$).

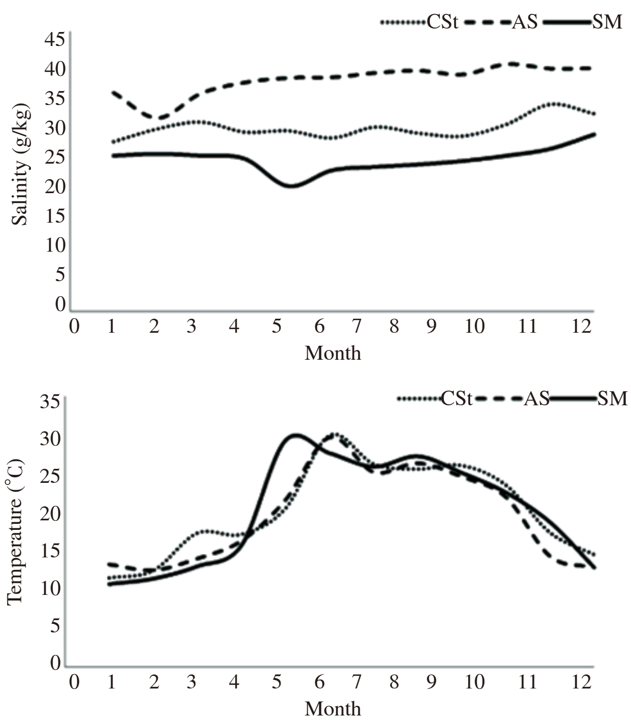

Figure 2. Mean monthly salinity and temperature values taken from the Aegean Sea, the Çanakkale Strait and the Sea of Marmara.

CSt: The Çanakkale Strait; AS: The Aegean Sea; SM: The Sea of Marmara.

In addition, as shown in Table 3, positive correlation was found between species number and temperature in all region. Species richness and abundance were significant different among seasons ($R = 0.5957$; $P < 0.05$). Differences of the fish assemblages were mainly caused by change in occurrence of the dominant species (Table 4). The correspondence analyses showed that seasons had an important effect on the existence of fish species in the shallow waters. Axis I and Axis II explained 49.2% and 27.7% of the total variance respectively in the correspondence analyses. The most abundance species was *P. marmoratus* (Species No. 71) in summer, *L. aurata* (Species No. 45) in winter, *D. vulgaris* (Species No. 24) in spring (Figure 3).

The Shannon index has the lowest value (1.80) in summer whereas species richness and abundance were reached the highest values in the same season. Additionally, the Dominance index was higher in summer than other seasons, due to the contribution of the most abundance species *A. boyeri* and *P. marmoratus* (Table 4). The most important change of the Shannon index was observed from summer to autumn. The Shannon index peaked (2.27) in autumn whereas species richness and abundance were decreased in the same season. On the other hand, the minimum number of individuals was found in winter (Table 2).

Mean salinity values were recorded between 27.5 (February) and 36.0 (December) during the sampling period. The minimum and the maximum salinity values were measured as 18.8 and 39.8 g/kg, respectively (Figure 2). There was a significant difference between salinity levels for the North Aegean Sea, the Çanakkale Strait, and the Sea of Marmara ($P < 0.05$) according to least significant difference test. The highest number of fish species were caught from Station 1 (77 species) while the maximum amount of fish were obtained from Station 4 ($n = 30154$, CPUE = 120.62). Both stations were located in the Çanakkale Strait and a total of 93 species were sampled in these stations. In the North Aegean Sea, a total of 85 species were obtained (Stations 2 and 5), while catches in the Sea of Marmara comprised 77 species (Stations 3 and 6). The Shannon and the Simpson indices reached their highest value (2.62 and 0.86, respectively) in Station 5, located in the North Aegean Sea. The highest value of the Dominance index and the lowest value of the Shannon index and the Simpson index were determined from Station 6, located in the Sea of Marmara (Table 2). Statistically significant differences in species richness among stations were found ($R = 0.5957$; $P < 0.05$). The SIMPER showed that dominant species, *A. boyeri* and *P. marmoratus* had the greatest effect in emergence of the species richness variation in the stations (Table 4).

Table 4

Simper analysis results for fish species contributed to differences among seasons and among stations.

Seasonal			Stations		
Species	Average dissimilarity	Contribution (%)	Species	Average dissimilarity	Contribution %
A. boyeri	18.18	35.25	*A. boyeri*	25.31	38.69
P. marmoratus	10.28	19.94	*P. marmoratus*	10.30	15.75
L. aurata	2.50	4.85	*D. vulgaris*	4.48	6.85
M. surmuletus	2.21	4.28	*L. aurata*	3.34	5.10
D. annularis	1.96	3.79	*M. surmuletus*	2.07	3.16
L. saliens	1.82	3.53	*D. annularis*	2.04	3.12
D. vulgaris	1.56	3.02	*L. saliens*	1.72	2.63
S. roissali	1.46	2.84	*S. roissali*	1.51	2.30

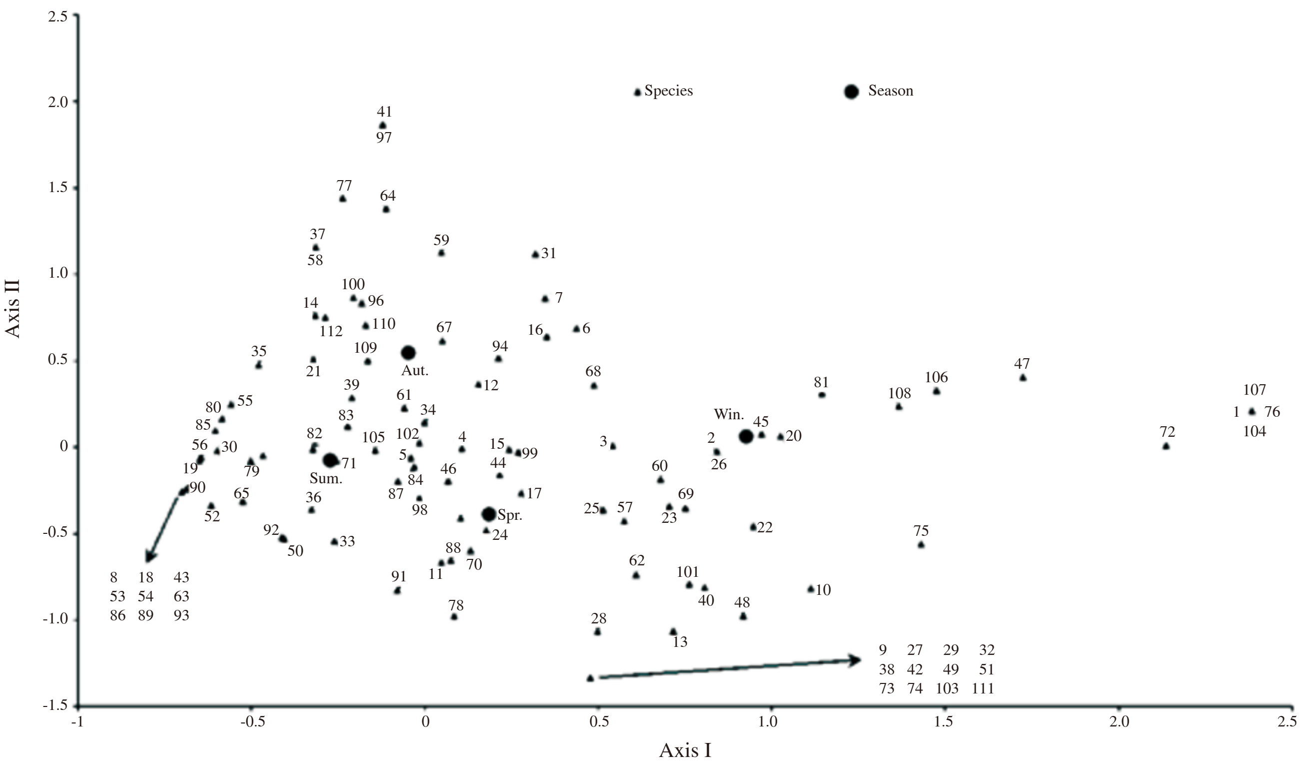

Figure 3. Ordination diagram resulting from Canonical corresponces analyses with four seasons and 112 species. The numbers represent the species of fish. Aut: Autumn; Sum: Summer; Spr: Spring; Win: Winter.

4. Discussion

A total of 512 native fish species have been reported in the Turkish seas[25]. In this study, a total of 112 species were obtained from the coastline of Çanakkale which comprised 21.8% of the total marine fish fauna of Turkey. The less saline and nutrient-rich the Black Sea inflow[1] likely explain the higher overall species richness in this study than found by the other researchers in the shallow waters: 54 species (3 m)[9] and 61 species in the South Aegean Sea (3–6 m)[10]. Also, 25 species have been reported from the shallow waters of Istanbul Straits[11].

The dynamic nature of the fish community of the shallow waters results from an interaction between seasonal and diurnal changes in species richness and relative abundances. Some species tend to move regularly from shallow to deeper waters or from deeper to shallow waters during the night for feeding. The migration is associated with trophic structure of fish species. On the other hand, some species were found only during the day or during the night with none occurring in both periods[26]. The finding of the current study showed that 11 species were captured only during the day and 14 species only during the night. Furthermore, diel variations in fish catches have been reported due to either fishing gear selectivity and fish behaviour or a combination of both[27,28]. Nash and Santos reported that the species which are sensitive to light, do not see net during night and therefore capture efficiencies are higher at night[28]. In the current study, even though species richness was higher during the night than during the day, a greater abundance of the species were captured throughout the day caused by the dominant species. However, no significant differences were found between day and night in terms of species richness and abundance.

Fish species richness is affected mainly by environmental factors, such as salinity and temperature[29]. For a given location, season is recognized as the main driver of fish species richness differences due to the variation in water temperatures[27,30]. Sea surface temperatures were significantly different among seasons and the shallow water fish assemblage undergoes a strong seasonal variation in abundance and species richness in the study area. This difference could be caused by temperature fluctuations during the year. The results of this study indicate that fish species richness and abundance were increased in summer season. This finding is in agreement with the studies of Harmelin-Vivien *et al.*[31] and Rodrigues and Vieira[32] which showed that juvenile abundance of the most fish species increases in summer season. On the other hand, most of the marine species were strongly associated with higher salinity[33]. In the current study, salinity was found significantly different among the North Aegean Sea, the Çanakkale Strait and the Sea of Marmara. Mean salinity values showed an increasing trends from the Sea of Marmara to the North Aegean Sea. Species richness of these areas was significantly different from each other. Less abundant but more diverse fish communities were observed in the North Aegean Sea than that of in the Sea of Marmara. A decrease in species richness also has been reported between the North Aegean Sea and the Sea of Marmara, from west to east[2,16]. Also, the Shannon and the Simpson indices reached their highest values in the North Aegean Sea. In contrast to this, both indices reached their lowest levels and the Dominance index reached its highest value (primarily caused by the dominant species, *A. boyeri*) in the Sea of Marmara. Keskin *et al.*[16] found that the mean species richness and abundances in the Sea of Marmara were lower than the North Aegean Sea due to the barrier effect of Turkish Straits system. However, we found that the highest species richness and abundance were obtained from the Çanakkale Strait. The Aegean Sea is connected to the Sea of Marmara by the Çanakkale Strait. The strait is an important migration route of many fish species[34]. These fish species can also be used in the strait for reproduction or the sea currents carried the fish eggs and larvae from the Aegean Sea and Sea of Marmara to the strait.

The survey area is very important for the demersal and small-scale fisheries in the Aegean Sea and the Sea of Marmara[30,35].

The present results describe the fish species richness and abundance in the coastline of Çanakkale. The results supported the biogeographical differences between the Aegean Sea, the Çanakkale Strait and the Sea of Marmara in terms of the littoral fish community. The inventory in the current study can serve as baseline data prior to management strategies to ensure sustainable conservation of the area.

Conflict of interest statement

We declare that we have no conflict of interest.

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