Spatial distribution and abundance of fishes residing in seagrass meadows on Alexandria coast.

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Abstract

Fishes inhabiting seagrass beds on three sites (Montazah, Miami and Agamy) along Alexandria coast were investigated from 2001 to 2003. Fish collection and visual censuses were conducted. Sampling using cast nets and trammel nets were done. Seasonal variations as well as diurnal variations in species composition were observed.

Results revealed that there was a wide heterogeneity in species composition and abundances at the three localities, showing the occurrence of 55 fish species belonging to 24 families. Family Sparidae had the largest number of species, representing by 12 species, whereas the Carangidae, Labridae, and Serranidae shared each by four species. The highest species richness was observed at Miami area, while the lowest at Agami. Only ten species were found at all sites, 15 species shared in two localities while 30 species were occurred at one site, disappearing from the others.

Only one seagrass species occur at Agamy area (*Posidonia oceanica*), whereas the other two sites Miami and Montazah are distinguished by the occurrence of two different species (*Posidonia oceanica* and *Cymodocea nodosa).*

More abundant fish were found at Miami, dominating in most of the year by *Siganus rivulatus* and *Diplodus sargus sargus*. Montazah area was dominated by *S. rivulatus* , *D. sargus sargus* and *Lithognathus mormyrus* , whereas the fish fauna in Agamy, was dominated by *Diplodus sargus sargus* around the year. Seasonal variations of number, distribution and density of species are more related with the migratory activity than with variation of abiotic parameters. Activity pattern within fish assemblages vary prominently where diurnal and nocturnal differences have been reported. The present data show strong activity of most species during daytime, decreasing their rate sharply at the end of afternoon. Most immigration and emigration from seagrass meadows occur at dawn and dusk, respectively. The present study reveal that the diurnal changes are more important than the seasonal variations in fish abundance. The environmental constraints could affect distribution patterns in fish richness, as well as fauna and flora.

Introduction

The marine Coastal zone have attracted the attention of various authors due to its importance to littoral fish assemblages and recognized worldwide as habitats used by a variety of fish for reproduction, feeding, and shelter (Odum & Heald, 1975; Wallace *et al*. 1984; Whitfield *et al*., 1989 and Williamson & Mather, 1994). Although the literature pertaining to the trophic niches of fish is very poor, studies on feeding relationships among species in seagrass beds (Pollard, 1984 and Motta *et al*., 1995), on the other hand, hold a key in ecosystem research. However, despite the extension of such systems and their potential importance in several areas of the Mediterranean Sea (Marbà *et al.,* 1996) informations on the fish fauna associated with these vegetated ecosystems is still scanty (Bussotti & Guidetti, 1996, 1999; Guidetti & Bussotti (2000). Reliable studies on fish populations and their biology are considered as essential in many types of ecological studies especially those concerned with the management of exploited species. Studies of seasonal changes in abundance and composition of the fish assemblage, in different regions of the world have attracted the attention of various authors (Mahon & Smith, 1989; Sogard *et al*., 1989; Ungaro *et al*., 1998; Gertner *et al*., 1999; Jeffrey, 2000; Lahlah, 2000 Guidetti *et al*., 2001; Caballero & Schmitter – Soto, 2001; Rong Kuo *et al*., 2001 and others).

The present investigation aims to give further information on fish fauna inhabiting seaweeds and seagrass beds, together with the temporal and spatial distribution for coastal marine fish fauna in Alexandria seagrass meadows. Diurnal changes in fish fauna inhabiting seagrass meadows along Alexandria coast, is another aspect, which needs clarification.

MATERIALS AND METHODS

The present study started from March 2001-March 2003.Using Cast nets and Trammel nets sampling for abundance of fish species and species richness were done. It was decided to collect fish samples from three locations namely Montazah, Miami and El-Agami relative to the presence and existence of seagrass meadows of both *P. oceanica* and *C. nodosa*, With the aim of studying the ichthyofauna abundant in seagrass beds. Fish trips were organized once per season for each area. Diurnal variations of species abundance in coastal seagrass meadows were done, for this purpose, Miami station was chosen example to study species richness in day and afternoon. Two fishing operations were carried out as well as diving, one in the morning (10:00h) and the other in the afternoon (16:00h).

Fish obtained by the above two sampling methods were identified and counted number of fish caught per hour, were then found. Fish abundance was expressed as follows:

A- Abundant species: these were obtained in large numbers, more than 100 individuals per hour of fishing in the area considered. These are considered to be permanent residents.

B- Species present with 20-100 individuals are classified as common. These are considered to be temporary residents.

C- Species with less than 20 individuals were considered as rare species.

To study the vertical distribution of fish, Visual censuses were done once per month. They are made, along random transects of about 10x2m. Five replicates of visual censuses were done each time, considering fishes in the seagrass habitat. The diver thus records the fish species observed at different depths for each species.

Systematic identifications of fish species were done according to Lythgoe & John (1979), Fisher *et al.*, (1987) and Nelson (1994).

Some ecological indices taken in the field for species diversity. The species diversity was calculated using both the equations of Maragalef (1968) and Heip (1974), the former equation gives species richness (number of species) for a relatively small community.

RESULTS

Fish inhabiting seagrass beds received little attention on our Egyptian coasts. Spatial and temporal distributions of these fishes need further clarification. In the following part, spatial and temporal distribution of fishes in seagrass beds will be given.

Temporal and spatial distribution of coastal fish populations inhabiting seagrass beds showed variations according to local environmental condition. Seasonal variations as well as diurnal variations in species composition were observed. Diurnal variations (morning and afternoon) were found to be more significant than the seasonal (Table 1).

Table (1): Seasonal variation of fish species richness for each station in the study area during the investigation period (2002-2003).

No. of species / station								
Station	**Montazah**		**Miami**				**Ei-Agami**	
Total No.	**29**		**34**				**26**	
Time	**10: 00**		**10: 00h**		**16: 00h**		**10: 00**	
			20		31			
Season	No.	%	No.	%	No.	%	No.	%
Spring	5	17.24	5	25	16	51.61	13	50
Summer	17	58.62	11	55	11	35.48	7	30.43
Autumn	7	24.13	5	25	18	58.06	7	30.43
Winter	15	51.72	16	80	7	22.58	8	30.77

The present results revealed the presence of 55 species fish (Table 2), which belong to 24 families. Species richness was found to be higher in Miami seagrass beds more than the other two areas. Sparidae had the largest number of species. Sparidae were represented by 12 species, Carangidae (4 species), Labridae (4 species) and Serranidae (4 species). These four families included 43.64 % of the total number of species recorded during the present study. Families Soleidae, Sciaenidae and Scombridae were represented by 3 species, while families Siganidae, Scorpaenidae, Mullidae, Clupeidae and Mugilidae were represented by 2 species. The rest of the families observed at the study areas were represented by only one species for each. In addition, the largest number of species of family Sparidae was found at Miami 9 species, followed by Montazah and El-Agami, 8 and 5 species, respectively. The number of species that were recorded as rare during the present study exceeded that of abundant and common species, respectively at all stations throughout the year. Miami and Montazah contained the largest number of species classified rare, while El-Agami had the least. The number of species classified as common were similar at all stations, while the abundant species were present mostly at Montazah.

Table (2): Number of species of each family at the different stations according to the present results.

Family	**Total no. of species**	**Station**			
		Montazah	**Miami**		**El-Agami**
			10:00h	16:00h	
Sparidae	12	8 (66.67)	9 (75)	8 (66.67)	5 (41.67)
Carangidae	4	1 (25)	1 (25)	2 (50)	3 (75)
Labridae	4	3 (75)	2 (50)	3 (75)	3 (75)
Serranidae	4	1 (25)	1 (25)	3 (75)	1 (25)
Soliedae	3	2 (66.67)	-	1 (33.33)	-
Sciaenidae	3	2 (66.67)	-	-	1 (33.33)
Scombridae	3	1 (33.33)	1 (33.33)	2 (66.67)	1 (33.33)
Siganidae	2	1 (50)	1 (50)	2 (100)	2 (100)
Scorpaenidae	2	-	1 (50)	2 (100)	-
Mullidae	2	2 (100)	2 (100)	1 (50)	1 (50)
Clupeidae	2	1 (50)	-	-	2 (100)
Mugilidae	2	-	-	1 (50)	2 (100)
Monacantidae	1	1 (100)	1 (100)	1 (100)	1 (100)
Muraenidae	1	-	-	1 (100)	-
Sphyraenidae	1	1 (100)	-	1 (100)	1 (100)
Gobiidae	1	1 (100)	-	-	-
Syngnathidae	1	1 (100)	-	-	-
Holocentridae	1	-	-	1 (100)	-
Stromatidae	1	1 (100)	-	-	-
Atherinidae	1	1 (100)	-	-	1 (100)
Haemulidae	1	-	1 (100)	-	-
Dasyatidae	1	-	-	1 (100)	1 (100)
Scaridae	1	-	-	-	1 (100)
Pomatomidae	1	1 (100)	-	1 (100)	-
Total number	**55**	**29**	**20**	**31**	**26**

Despite differences in fish assemblage structure between stations some fish were abundant in all stations, with some seasonal variations: *Lithognathus mormyrus*, *Oblada melanura* (Sparidae), followed by *Seriola dumerili* (Carangidae), *Coris julis*, *Labrus viridis* (Labridae), *Mullus barbatus* (Mullidae), *Stephanolepis diaspros* (Monacanthidae) and *Sphyraena sphyraena* (Sphyraenidae). On the other hand, *D. sargus sargus* was the only fish species that was recorded at all stations and all season, followed by *S. rivulatus*, which may indicate that they are permanent inhabitants.

The spatial (vertical) distribution of the most abundant fish species during the different seasons of the year was don e by SCUBA diving (Table 3). Generally, there are no important different spatial distributions of the most abundant species in the same season and space.

Table (3): Spatial distribution of the abundant fish species at the different study stations according to the present results.

Season	Station	Species	Depth range (m)	Max. Depth (m)	Length range (cm)
Spring	Montazah	*Diplodus sargus sargus*	4-8	13	12-24
		Siganus rivulatus	5-11	13	12-18
	Miami at16:00h	*Siganus rivulatus*	4-11	11	12-18
	El-Agami	*Siganus rivulatus*	8-10	14	12-18
Summer	Montazah	*Lithognathus mormyrus*	3-6	13	12-16
		Diplodus sargus sargus	4-11	13	9-24
		Coris julis	3-6	13	12-15
		Gobius niger	3-9	13	9-13
	Miami at10:00 h	*Diplodus sargus sargus*	3-11	11	9-24
		Siganus rivulatus	1-6	11	10-21
	Miami at16:00h	*Diplodus sargus sargus*	3-11	11	9-24
		Siganus rivulatus	1-6	11	10-21
	El-Agami	*Sardinella maderensis*	8-12	14	12-15
		Sparisoma (Euscarus) cretense	4-10	14	15-20
Autumn	Miami at16:00h	*Siganus rivulatus*	2-6	10	12-20
	El-Agami	*Lithognathus mormyrus*	4-8	14	8-12
Winter	Montazah	*Siganus rivulatus*	5-8	10	13-23
	Miami at10:00h	*Siganus rivulatus*	3-6	10	13-23
	El-Agami	*Sardinella maderensis*	8-12	16	10-16
		Sphyraena sphyraena	6-13	16	17-35

Discussion and conclusion

Seagrasses in the three areas of study were found to be composed of *P. oceanica* and *C. nodosa*. *P. oceanica*, was found flourished in Montazah together with *C. nodosa*, while El-Agami, contained mainly *P. oceanica*. Miami composed both species and heavy mass of algae.

Several authors have recorded the abundance of fish assemblages in seagrass meadows. Bouchon-Navaro *et al*., (1992), studied the fish community of the seagrass beds in the Bay of Fort-de-France, identifying 65 species of fish belonging to 28 fish families. Harmelin-Vivien (1982, 1983 & 1984), studied the distributions of fish fauna in seagrass beds. Sogard *et al*., (1989), studied the spatial distribution and abundance of icthyofauna in Florida Bay seagrass meadows. On the other hand, Stoner (1983), studied the effect of sea-grass biomass on the organization of bottom fauna assemblage in seagrass meadows. While, Guidetti *et al*., (2001), in the Mediterranean made a visual survey in seagrass meadows. On the other hand, Rossier & Kulbicki (2000), studied fish assemblage in algal beds and compared them with those in coral reefs. Pompo & Rebelo (2002), studied spatial and temporal organization of a coastal lagoon fish community in Ria De Aveir, Portugal, and were recorded 43 fish species from 21 families were caught. Also Koutrakis *et al*., (2000), studied the seasonal changes in distribution and abundance of the fish fauna in the two estuarine systems of Strymonikos gulf (Macedonia, Greece), 55 fish species representing 20 families were recorded. Guidetti *et al.*, (1996) and Bussotti & Guidetti, (1999), made comprehensive studies on fish fauna associated with different seagrass system in the Mediterranean.

Although the estuarine fish communities have been extensively studied in other sites of the world (Marais & Baird, 1980; Whitfeild, 1983; Tremain & Adams, 1995 and others), literature concerning the distribution and abundance of fish fauna in European and Mediterranean estuarine systems is rather limited (Koutrakis *et al*., 2000).

The interaction between fish and its habitat (physical, as well as biological characteristics) may be key factors in predicting changes in overall abundance, breeding population size and other aspects of population structure, that cannot neglect, however physical characteristics of water and climatological features (Tuney & perkins, 1972; Bianch, 1992 a & b; Rooker & Dennis, 1991;Barber *et al*., 1997; Harris & Cyprus, 1999; Lin & Shoa, 1999; Koutrakis *et al*., 2000; Caldeira *et al.*, 2001; Die Tos *et al*., 2002 and others). On the other hand, recent studies provided evidence that mineralogical features of rocky substrate (e.g. amount of quartz) may influence the structure of sub-littoral benthic communities in the

Mediterranean (Bavestrillo *et al*., 2000 & Cerrano *et al*., 1999 and Guidetti & Cattaneo-Vietti, 2002). According to Guidetti & Cattaneo-Vietti, (2002), Rock type could be thus indirectly influencing distribution patterns for the associated benthic fauna and nectobenthic. Different benthic assemblages (i.e. macro-algae & zoo-benthos) related to mineralogical rocky types may provide different architectural structures as well as different food resources (Guidetti & Cattaneo-Vietti, 2002). In addition to these abiotic factors, there are several biotic factors that affect on the composition of fish assemblages in seagrasses including seagrass algal communities which influences on fish recruitment (Jones, 1984; Zieman *et al*., 1989; Carr, 1991and Levin, 1993) and adult abundance (Choat & Ayling, 1987;Anderson, 1994; Levin & Hay, 1996 and Rossier & Kulbicki, 2000).

In the present study, the variations in abundance of coastal fishes in Alexandria waters at different stations can be explained by the variations of the abiotic, as well as biotic conditions in the area..

Species richness in aquatic environments has been investigated by various authors (Bell & Harmelin-Vivien, 1983; Harmelin-Vivien, 1982; Guidetti *et al.*, 1996; Guidetti, 2000; Guidetti & Bussotti, 2000: Guidetti & Bussotti, 2001 and others). Most previous research on fish communities associated with Mediterranean seagrass concerns *P. oceanica* meadows, while other studies on fish from seagrass beds formed by other marine phanerogams are lacking (Guidetti & Bussotti, 2000).

In the present investigation, fish fauna were studied in three areas along Alexandria coasts, which comprise seagrasses. In fact, two types of seagrasses occur, namely, *P. oceanica* and *C. nodosa*. At Montazah and Miami, seagrass meadow comprises mostly *C. nodosa* together with some *P. oceanica*. El-Agami seagrass beds consist of *P. oceanica* only. However, in El-Agami station, the seagrass meadows were found at deeper areas ranged from 7 to 25m.

Considering the species richness, it can be noticed that Montazah comprises 17fish families to which belong 29 species, while Miami seagrasses comprise 17 families to which belong 34 species. On the other hand, El-Agami seagrass beds include 15 fish families to which belong 26 fish species. This shows that at Miami, where *P. oceanica* and *C. nodosa* are present the species richness is the highest, followed by Montazah. El-Agami, has the least value of species richness. In this area, the seagrass beds where *P. oceanica* only occurred and go down to deeper areas and these does not allow most coastal fish species to live, within it.

Water mass movements in that area also would be another factor (Ginsbury, 1956; Tuney & Perkins, 1972; Mahon & Smith, 1989; Fargo & Tyler, 1991; Darovec, 1995;

Caldeir, 2001 and other). The present data shows that El-Agami station has low abundance of plankton and bottom fauna as well as seaweeds.

However, the two-way ANOVA revealed that the species richness (D), exhibited significant temporal fluctuations at Montazah and Miami (P= 0.027688, ANOVA). The seasonal variation was accompanied with fluctuations in species richness in the two areas; Tukey's multiple tests revealed that a *Posterioi* differences in the mean species richness (D) was significantly different between spring and winter in the two areas.

. The comparison between the fish community associated with *C. nodosa* and *P. oceanica* at Montazah and Miami and those found in *P. oceanica* at El-Agami revealed the presence of a less value of species richness at El-Agami. This finding is corresponding to that given by Bussotti & Guidetti (1999), who reported that *C. nodosa* meadows, contains much more fish species than those of *P. oceanica* meadows. Although the relative abundance of several fish species may differ in the two ecosystems, however the present observations could be considered as basic features of fish communities of Mediterranean seagrass ecosystems. These observations are also in accordance with Guidetti & Bussotti (2000), in their study on fish fauna of a mixed meadow composed of the seagrasses *C. nodosa* and *Zostera noltii* in the Western Mediterranean (Italy waters). However, the present results might indicate that water depth might have a role in affecting species richness.

During the present study at Montazah, Miami and El-Agami, fish were more abundant at Miami station where the catch was dominated by *S. rivulatus* and *D. sargus sargus* in most seasons. Montazah station, was dominated by *S. rivulatus*, *D. sargus sargus* and *L. mormyrus* in most seasons. While at El-Agami, fish fauna was dominant by *D. sargus sargus* in all seasons. Various authors have mentioned seasonal variations in fish abundance in seagrass beds. Laegdsguard & Johnson, (1995), cited that fish abundance in subtropical areas increases in summer and decreased in winter The present study revealed the presence of seasonal variations of fish abundance. According to Bennett (1989) & Monteiro (1989), the seasonal variation of number, distribution and density of species in a lagoon is more related with the migratory activity than with variation of abiotic parameters. This is generally true for offshore, especially to migratory species, but at inshore area, environmental constraints are more important, this conclusion was given by several authors in different regions of the world (Massé *et al*., 1996; Harris & Cyprus, 1999; Koutrakis *et al.*, 2000; Hamukuaya *et al*., 2001 and others). The present data coincide with those works, as the data shows variations in the number of species and their abundance in Miami station, that might be a result of differences in local conditions between these areas. Local environmental differences among the three locations might have an effect on fish aggregates and abundance in different seagrass beds.

According to the present results, *Epinephelus canines* and *E. guaza*, were only observed in Miami. *Solea aegyptiaca* and *S. vulgaris,* were not found at El-Agami but they were only occurred at Montazah, while *Microchirus variegates* and *Scorpaena porcus*, were found only at Miami. From the Sparidae fish family, *D. cervinus cervinus* was only observed at Miami, while *P. pagrus* was only noticed at Montazah. Carangidae family, *Campogramma vadigo* was only found at El-Agami. *Pomatomus saltatix* was not present at El-Agami. *Scomberomorus commerson* was occurred only at Miami. No mugilid fishes were observed at Montazah. The two species of Clupeidae (*Sardina pilchardus* and *Sardinella maderensis*), were not recorded at Miami. Muraenidae and Holocentridae, were only observed at Miami. From Scaridae, *Sparisoma (Euscarus) cretense* was only found at El-Agami. All of the aforementioned fishes are considered as temporary visitors of seagrass beds. These fish species have proved to be present in the commercial catch; though not in large quantities (Allam, *et al*., 1998). The presence of one of these fish species in a locality and not the others might be affected by differences prevailing ecological and chemical conditions in each locality.

Bussotti *et al.*, (2002), came to a similar conclusion and suggested that environmental constraints could affect distribution patterns in fish species richness and in the abundance of several fish species as already observed for sessile benthos and plankton assemblages. Shallow marine areas could exert the role of refuge and/or nursery for some littoral fish species during the adult and/or juvenile stages of their life histories, or to aspects of life history i.e. reproduction, recruitment (Williams & Sale, 1981 and Williams, 1983). In the present study, the vegetation at Miami station was more or less abundant during most of the study period, this may explain the relative increase in the number and abundance of fish species in this area by reducing predator-related mortality for some fish species (Berglund & Bengtsson, 1981; Coen *et al*., 1981; Heck & Thoman, 1981 and Minello & Zimmerman, 1983). The positive correlations between the structural complexity of seagrass beds and abundance and diversity of fish are commonly explained by the variation in the predation rate on fish (Stoner, 1983; Orth *et al.*, 1984 and Bell & Pollard, 1989), higher food availability (Burchmore *et al*., 1984 and Guidetti & Bussotti, 2000) and habitat selection by adults and juveniles (Williams *et al*., 1990 and Connolly, 1994).

Variations of species abundance in coastal seagrasses show diurnal variations. We can see that number of species in the morning, was far less than in the afternoon in spring and autumn, while in summer the number of species was the same at morning and afternoon. In winter, the number of species in the morning was much higher than in the afternoon. This might be due to bad sea conditions prevailing in the offshore area in the morning during winter, which cause the fish to immigrate towards the coasts and in seagrass beds. In the afternoon normally the weather is far better than in the morning and hence leave the coasts to the offshore area.

According to Rooker & Dennis, (1991), diurnal movements may be responsible for significant difference in day time abundance which might be related to feeding strategy. Gibson *et al.*, (1996), came to a similar conclusion for the dial changes of fish on a Scottish Sandy beach. Also according to Starck & Davis (1966); Hobson (1973 & 1974); Ogden & Ehrlich (1977) and Ogden & Zieman (1977), a variety of species do show daily diurnal variation in abundance. Activity pattern within fish assemblages vary prominently and diurnal and nocturnal differences have been reported in several studies (Hobson, 1973; Collette & Talbot, 1972 and Ebiling & Bary, 1976). Santos *et al.*, (2002), studied diurnal variations in fish assemblage in southern Portugal, and stated that fish abundance varied throughout the day, with minima during night and maximum around midday. Light intensity is the factor responsible for most changes observed in the qualitative and quantitative composition of the fish community (Hobson, 1972; Harmelin-Vivien, 1982; McFarland, 1986 and Harmelin, 1987). The present results show that during daytime, most species were active but by the end of the afternoon, a strong reduction in swimming activity of most species was observed. The end of the morning corresponds to the period of highest fish activity. According to Santos *et al.*, (2002) in southern Portugal, most immigration and emigrations from seagrass meadows occur at dawn and dusk, respectively.

Lin & Shao, (1999), mentioned that the dial changes in the assemblage structures are relatively small as compared to the seasonal changes, and the effect of a seasonal cycle is more important than dial cycle in determining the temporal pattern changes in fish assemblage in subtropical waters. According to the present observations, the diurnal variations were found to be more important than the seasonal variations in fish abundance.

Spatial heterogeneity of the abiotic environment is responsible for the concentration of fish in the most favorable areas, the extent of which vary from microhabitat to the regional scale. The use of space by a fish is defined by its pattern of movement, which may be related to the presence of other fish, especially conspecific, as well as, to the physical environment (Massé *et al.*, 1996).

The present data show some variation in distributions of different fish species; which are not important. The widest range in vertical fish distribution was observed with *D. sargus sargus* at Miami and Montazah, also *S. spyraena* at El-Agami. According to Sogard *et al*., (1989), species richness was clearly influenced by water depth. The distribution of fish, particularly juveniles, has been correlated with a variety of habitat variables (e.g. depth and thermal range, bottom type and micro-habitat structure) through a range of spatial scales (Auster *et al*., 1995, 1997 & 2003; Steves & Cowen, 2000 and Sullvan *et al*., 2000). Also, the distribution of fish expands after settlement, potentially as a result of both growth and changes in oceanographic conditions (Sullivan *et al*., 2000). In Bahrain (Arabian-gulf), Smith & Saleh (1987), reported that species richness increased with depth the high abundance of many of species at certain depth, and absence or rarity at other depth, suggests that bathymetric differences in abundance are real, and not mere artifacts. Caldeira *et al*., (2001), came to a similar conclusion for the inshore stations, suggesting that served as an "ecological safe" place. Moreover, it is well documented that several fish species in the Mediterranean sea (Garcia-Rubies & Macpherson, 1995) and other areas (Bennett, 1989; Ruiz *et al.*, 1993) use very shallow habitats for settlement, where the risk of predation is considered to be reduced (Ruiz *et al.*, 1993).

In the present study, variations of body size of fish with depth range were noticed, varying between 8 and 35 cm in total length. Several laboratory and field studies show that fish prefer the company of individuals matching in body size (Ranta *et al*., 1992 and Pitcher, 1993). This is generally true for single-species schools, but references to multi-species aggregations are less frequent (Fréon, 1996 and Massé *et al.*, 1996), these observations nearly have the same trend in the results of the present study. Generally, there are no important different spatial distributions of the most abundant species in the same season and space. The present results are also in agreement with that given by Hamukuaya *et al*., (2001).

The annual average richness values (D), were found to vary between 2.27 and 1.40 for the whole area of investigation. As shown the higher values at Miami (1.66 and 2.27) and Montaza (1.96), with the least richness at El-Agami (1.40) and the least number of species. The above discussion, indicated that the environmental constraints could affect distribution patterns in fish species richness, as well as, flora and fauna. In the later, richness at Miami was high as compared to Montazah and El-Agami areas. Seasonal variations of species richness (D, H and J) in the study areas is more or less the same with slight fluctuations; also the values of diversity indices (D, H and J) of fish were higher in the afternoon ($P<0.05$, Student *t*-test), than in the morning preliminary.

In conclusion the present study provides first observations on fish assemblage associated with seagrass meadows in shallow marine areas in the Mediterranean. A potentially important ecological role of these meadows habitats for many littoral fishes during different phases of their life history, is evident.

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