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Deep Sea Fisheries in Mersin Bay, Turkey, Eastern Mediterranean: Diversity and Abundance of Shrimps and Benthic Fish Fauna

Yusuf Kenan Bayhan[1*], Deniz Ergüden[2] & Joan E. Cartes[3]

[1]Fisheries Department, Kahta Vocational School, Adiyaman University, 02400, Kahta, Adiyaman, Turkey;
E-mail: ykbayhan@hotmail.com
[2]Marine Science and Technology Faculty, Iskenderun Technical University, 31220, Iskenderun-Hatay, Turkey;
E-mail: deniz.erguden@iste.edu.tr
[3]ICM-CSIC Institut de Ciencies del Mar, Passeig Maritim de la Barceloneta 3-49, 08003 Barcelona, Spain; E-mail: jcartes@icm.csic.es

Abstract: This study was carried out by trawling at depths between 300-601 m in the Mersin Bay (Eastern Mediterranean) between May and June 2014. Seven shrimp species (*Aristaeomorpha foliacea*, *Aristeus antennatus*, *Parapenaeus longirostris*, *Plesionika edwardsii*, *Plesionika martia*, *Pasiphae sivado* and *Pontocaris lacazei*) were collected as a result of ten trawl operations with a commercial bottom trawl. The most abundant species were *P. longirostris* (52.06%), *A. foliacea* (35.64%) and *P. edwardsii* (9.50%), representing 97.20% of all captured shrimps. The catch per unit effort (CPUE) ranged from 3.094 kg/h to 9.251 kg/h, with an average value of 5.44 ± 2.01 kg/h for shrimps. A total of 37 fish species (28 teleosts and nine elasmobranchs) were captured. The prevailing fish species in catches were *Chlorophthalmus agassizi*, *Merluccius merluccius* and *Etmopterus spinax* in terms of biomass and *Helicolenus dactylopterus*, *Hoplostethus mediterraneus*, *Trachurus trachurus* and *Lepidopus caudatus* in terms of abundance. Seventeen or 45.95% of the captured fish species were with commercial value, while the remaining 20 (54.05%) consisted of discard fishes.

Keywords: Deep-sea fishery, Decapoda, Crustacea, benthic fish fauna, Eastern Mediterranean

Introduction

The Mediterranean Sea has a rich diversity of species, incorporating more than 1,500 mollusc, 1,000 arthropods (only of Crustacea and Pycnogonida) and 650 fish species (Quignard & Tomasini 2000, Ponder & Lindberg 2008, Coll et al. 2010, Öztürk et al. 2014, Bakir et al. 2014, Bilecenoglu et al. 2014). Recent studies by Bilecenoglu et al. (2014) and Erguden et al. (2016) found a current total of 517 fish species in Turkish marine waters: 451 of Osteicthyes, 64 of Chondricthyes, one of Cephalospidomorphi and one of Holocephali. Some 447 species of those fish species are distributed along Turkey Mediterranean coasts. To date, the number of reported fish species is increasing with alien species arriving by several spread routes (Bilecenoglu et al. 2014, Erguden et al. 2016).

Although there have been many studies on the identification of bio-ecological characteristics and deep-sea population structure in the Mediterranean, there are limited numbers of studies on the composition, diversity, fish abundance and especially size distribution of the deep-sea species in the Eastern Mediterranean, Turkey (Anonymous 1993, Başusta 1997, Benli et al. 1999, Can & Aktaş 2005, Can et al. 2006, Gönülal et al. 2010, Yeşilçimen & Kuşat 2011, Dalyan 2012, Yemişken et al. 2014).

Large amounts of species in aquatic ecosystems in the Mediterranean Sea are captured with deep

*Corresponding author: ykbayhan@hotmail.com

trawl nets, mainly above the slope of the continental shelf. As in all the world's oceans, overfishing from the continental shelf in the Mediterranean Sea has led to the need of commercial exploitation of resources living in deeper waters and in more distant regions. However, one of the most important factors limiting deep-sea fishing in the Eastern Mediterranean is the obligation of greater capacity (length and engine power of the boats and requirements for specific equipment); fishing in deep water is hard, laborious and expensive. According to the latest obtained records, there are 185 bottom trawlers in the Turkish Eastern Mediterranean (Anonymous 2014). The number of boats with permission for fishing in international waters (12 miles and above) outside the legal fishing period is 64 (Anonymous 2014) and only 15 of them have been fishing in deep water (200 m and above) in the 2014-2015 fishing season.

In order to improve the management of marine living resources at a sustainable level, their species diversity and abundances must be known. Therefore, the aims of this studies are: determination of fisheries abundance, deep-water species composition of shrimp and benthic fish fauna, their incidence and size distribution of shrimp species living in the deep sea for the first time in international waters of the Mersin Bay, Eastern Mediterranean, Turkey.

Materials and Methods

Our sampling was carried out on 17 May 2014 and 25-27 June 2014 at Mersin Bay (Eastern Mediterranean, Turkey) in international waters ranging between 12.7–35.9 nautical miles from the coast and at water depths between 300 and 601 m. Towing was carried out with the commercial trawler "Çınar Bey" (length 26.15 m and engine power 480 hp), equipped with a two-warp bottom trawl net. This type of net is legally specified for the Mediterranean and has a 44 mm mesh cod-end and PE material was used. The average towing speed was 2.4 knots, the trawl operation lasted a total of 53 h and 10 min and the total trawled area was 2,85 km^2. The coordinates and depths were measured by satellite GPS and echo sounder on the boat, respectively. After every hauling the weight of the shrimps which were overweight were measured using digital scales (± 0.1 g) on board and the lightweight shrimps were measured on 0.001 gram precision digital scales in the laboratory. The catch per unit effort (CPUE) values was calculated according to the following formula:

$CPUE = \sum Wn / \sum tn$

$\sum Wn$ = total weight of samples captured in the nth hauling time for type a

Fig. 1. Map indicating the study area.

Σtn = duration of hauling

For the calculation of the swept-trawled area in the hauling

(a)= D x h x X_2 equality was used,

where

a – trawled area swept by the trawl net;

D – length of the trawled area.

For the precise measurement the geographic coordinates from the GPS of the boat were converted to degrees and transferred to UTM (Universal Transverse Mercator) coordinate system with Netcad program; and the distance between the start and end points for each hauling was calculated.

H – length of the floatlineof the trawl net (23 m).

X_2 – opening ratio of the floatline was taken as 0.5 according to (Pauly 1980).

After each hauling, fishes were selected according to their species and the total weight of fishes in large amounts and lengths of the units separated by sub-sampling method. The number and size of the fishes in small amounts were separately placed in plastic boxes. Fish samples were taken to the Kahta Vocational School laboratory. After the taxonomic analyses, the total length and weight of each specimen were measured with ± 0.01mm and 0.1 g precision, respectively. All the meristic characters were recorded through microscopic inspection; Olympus SZ61 microscope was used for the determination of meristic values. Species determination was accomplished by specialized keys (Whitehead et al. 1989, Nelson 2006, Eschmeyer 2016).

The coordinates, depths, hauling time and duration of the trawl operation are given in Table 1 and the fishery region of the study is shown in Figure 1.

Results

As a result of ten trawl operations, seven shrimp species were captured. These included *Aristaeomorpha foliacea* and *Aristeus antennatus* of the family Aristeidae, *Parapenaeus longirostris* of the family Penaeidae, *Plesionika edwardsii* and

Table 1. Coordinates, depth, time and duration of hauling in the trawl operations.

Date	Hauling number	Coordinates (N/E)		Depth (m)		Trawling time		Total trawling time (minutes)	Average speed (knot/h)
		start	finished	start	finished	start	finished		
17 May 2014	1st	36⁰ 18' 283"/ 34⁰ 26' 134"	36⁰ 12' 606"/ 34⁰ 39' 903"	410 17.3*	411 29.7*	04⁵⁵am	10⁰⁰ am	305	2.4
	2nd	36⁰ 13' 100"/ 34⁰ 38' 570"	36⁰ 18' 831"/ 34⁰ 25' 760"	399 27.0*	415 16.2*	10⁵⁵am	16⁰⁰ pm	305	2.4
	3rd	36⁰ 15' 295"/ 34⁰ 19' 806"	36⁰ 23' 196"/ 34⁰ 26' 713"	522 12.7*	446 14.3*	18¹⁵ pm	22³⁰ pm	255	2.4
25 June 2014	4th	36⁰ 23' 938"/ 34⁰ 28' 532"	36⁰ 12' 187"/ 34⁰ 33' 780"	300 15.2*	542 25.4*	05⁰⁵am	10⁰⁰ am	295	2.4
	5th	36⁰ 12' 253"/ 34⁰ 33' 986"	36⁰ 11' 095"/ 34⁰ 48' 085"	513 25.9*	349 34.6*	10⁵⁰ am	15⁴⁰ pm	290	2.4
	6th	36⁰ 11' 196"/ 34⁰ 46' 990"	36⁰ 14' 754"/ 34⁰ 35' 375"	388 34.0*	386 25.4*	16³⁰pm	20⁴⁰pm	250	2.4
26 June 2014	7th	36⁰ 14' 061"/ 34⁰ 37' 002"	36⁰ 10' 402"/ 34⁰ 49' 538"	377 26.7*	364 35.9*	05⁴⁰ am	10⁰⁵ am	265	2.4
	8th	36⁰ 08' 604"/ 34⁰ 38' 593"	36⁰ 17' 766"/ 34⁰ 22' 533"	582 30.5*	459 14.6*	12¹⁵ pm	20⁰⁰ pm	465	2.4
27 June 2014	9th	36⁰ 16' 417"/ 34⁰ 22' 132"	36⁰ 09' 041"/ 34⁰ 35' 851"	601 15.4*	557 28.0*	05²⁰ am	12⁰⁵ pm	405	2.4
	10th	36⁰ 09' 478"/ 34⁰ 33' 900"	36⁰ 15' 501"/ 34⁰ 21' 292"	555 26.0*	593 16.2*	13⁰⁵ pm	19⁰⁰ pm	355	2.4
Total trawling time								**3190** (53 hr and 10 min)	

(*) Distances from the coast (nautical miles)

P. martia of the family Pandalidae, *Pasiphae sivado* of the family Pasiphaeidae and *Pontocaris lacazei* of the family Crangonidae. Quantities of shrimp species captured for each hauling (g) and average CPUE values and average yield per unit area for each species are given in Table 2. In terms of their abundance for the captured shrimp species, *P. longirostris* (52.06%), *A. foliacea* (35.64%) and *P. edwardsii* (9.50%) were the first three species. The ratio of these three shrimp species to the total amount of shrimps was 97.20%.

The CPUE values for shrimp species showed changes between the species such as; 1176-5343 g/h for *P. longirostris*, 0.014-4945 g/h for *A. foliacea*, 0039-297 g/h for *A. antennatus,* 0031-2557 g/h for *P. edwardsii* and 0.046-284 g/h for *P. martia*. As a result of all hauling, a total of 65.82 g and 1688 g were captured from *P. sivado* and *P. lacazei*, respectively. In each hauling, the catch per unit effort (CPUE) in amount of shrimp regardless of their species ranged from 3.094 kg/h to 9.251 kg/h and the average value was 5.44 ± 2.01.

As a result of all trawl operations, the total trawled area was 2.85 km^2 and the most captured three shrimp species captured in this area were *P. longirostris* (54.14 kg/km^2), *A. foliacea* (37.06 kg/km^2) and *P. edwardsii* (9.88 kg/km^2), respectively.

The amount of shrimp species captured in each hauling in operations carried out between depths of 300-601 m according to the depths is given in Table 3. The values reveal that *P. longirostris* and *P. edwardsii* show distributions at all depths among the captured shrimp species and within these shrimp species captured outside the two species, the majority of *P. martia* (99.9%), *A. antennatus* (81.1%) and the *A. foliacea* (69.9%) were captured deeper an average depth of 520 m according to the amount.

Totally 37 fish species belonging to 33 families in total were obtained from all trawl hauling operations including 28 species belonging to 26 families from the group of bony fish (Osteichthyes) and nine species belonging to seven families from the group of cartilaginous fish (Chondrichtyes) were captured in the total trawling time.

The gravimetric data of the fish species captured in ten trawling operations are given in Table 4. *Chlorophthalmus agassizi* (708000 g), *Merluccius merluccius* (169900 g), and *Etmopterus spinax* (141000 g) were the most captured fishes, respectively in terms of quantity. The most numerically

Table 2. Captured shrimp species, quantities and CPUE (kg/h) values and average yield per unit area (kg/km²)

Date	Hauling number	Average Deepth (m)	Duration (minute)	Shrimp species and their quantity (g) and CPUE (kg/h)												Total quantitiy (g)	Average CPUE (kg/h)
				P. longirostris		*A. foliacea*		*A. antennatus*		*P. edwardsii*		*P. martia*		*P. sivado*		*P. lacazei*			
				quanty (g)	CPUE (kg/h)	quanty (g)	CPUE (kg/h)	quanty (g)	CPUE (kg/h)	quanty (g)	CPUE (kg/h)	quanty (g)	CPUE (kg/h)	quanty (g)	CPUE (kg/h)	quanty (g)	CPUE (kg/h)		
17 May 2014	H1	410	305	17000	3344	-	-	-	-	200	0.039	2.757	*	-	-	0.846	*	**17203.603**	3.384
	H2	407	305	21000	4131	-	-	-	-	13000	2557	-	-	-	-	0.842	*	**34000.842**	6.689
	H3	484	255	5000	1176	7850	1847	167	0.039	133	0.031	-	-	-	-	-	-	**13150**	3.094
25 June 2014	H4	421	295	16000	3254	-	-	-	-	2000	407	-	-	-	-	-	-	**18000**	3.661
	H5	431	290	12800	2648	23900	4945	754	156	7200	1490	-	-	61.120	0.013	-	-	**44715.12**	9.251
	H6	387	250	14000	3360	58	0.014	-	-	470	113	-	-	-	-	-	-	**14528**	3.422
26 June 2014	H7	370	265	23600	5343	-	-	-	-	-	-	-	-	-	-	-	-	**23600**	5.343
	H8	520	465	17200	2219	26500	3419	2300	297	1600	206	2200	284	3.200	*	-	-	**49803.2**	6.426
27 June 2014	H9	579	405	16200	2400	24600	3644	350	0.052	1100	163	900	133	-	-	-	-	**43150**	6.393
	H10	574	355	11500	1944	22700	3837	1300	220	2450	414	270	0.046	1.500	*	-	-	**39720**	6.713
Total			**3190**	**154300 (%52.06)**		**105608 (%35.64)**		**4871 (%1.64)**		**28153 (%9.50)**		**3372.757 (%1.14)**		**65.82 (%0.02)**		**1.688 (*)**		**296372.265 (%100.00)**	
Average CPUE (kg/h)				**2.902**		**1.986**		**0.091**		**0.529**		**0.063**		**0.001**		**1.688**			
Average CPUE (kg/km²)				**54.14**		**37.06**		**1.71**		**9.88**		**1.18**		**0.02 (*)**		**(*)**			

(*) Low value

Table 3. The quantity (g) distribution of shrimp species according to the depth

FAMILIA	Species	17 May 2014			25 June 2014			26 June 2014		27 June 2014		Total (g)
		H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	
		410-411 (410.5) m	399-415 (407) m	446-522 (484) m	300-542 (421) m	349-513 (431) m	386-388 (387) m	364-377 (370.5) m	459-582 (520.5) m	557-601 (579) m	555-593 (574) m	
PENAIDAE	*Parapenaeus longirostris*	17000	21000	5000	16000	12800	14000	23600	17200	16200	11500	154300
ARISTEIDAE	*Aristaeomorpha foliacea*	-	-	7850	-	23900	58	-	26500	24600	22700	105608
	Aristeus antennatus	-	-	167	-	754	-	-	2300	350	1300	4871
PANDALIDAE	*Plesionika edwardsii*	200	13000	133	2000	7200	470	-	1600	1100	2450	28153
	Plesionika martia	2.757	-	-	-	-	-	-	2200	900	270	3372.757
PASIPHAEIDAE	*Pasiphaea sivado*	-	-	-	-	61.120	-	-	3.200	-	1.500	65.82
CRANGONIDAE	*Pontocaris lacazei*	0.846	0.842	-	-	-	-	-		-	-	1.688

captured fishes were *Helicolenus dactylopterus* (364), *Hoplostethus mediterraneus* (364), *Trachurus trachurus* (182) and *Lepidopus caudatus* (125). Seventeen of 37 caught fish species (45.95%) consisted of species with commercial value and 20 species (54.05%) consisted of discard fishes. Among the captured fishes, the bony fish *A. anguilla* is at risk at a Critical Endangered (CR) and *Pagellus bogaraveo* is under Near Threatened (NT), (IUCN 2016). Besides captured and discarded cartilaginous species, although it is obvious that *Hexanchus griseus, Dipturus oxyrinchus, Raja clavata* and *Chimaera monstrosa* are in Near Threatened (NT) and *Oxynotus centrina is* Vulnerable (VU) on the (IUCN 2016) red list for the Mediterranean, these species were mistakenly captured in our study.

The names of the decapod and cephalopod species captured are given in Table 5 according to chronologically and hauling order. Seven species from Decapoda and six species from Cephalopoda class included in the Mollusca phylum were obtained.

Discussion

As a result of this study carried out in Mersin Bay for the purpose of determining the species diversity of the demersal resources and their abundance in the Eastern Mediterranean (Levantine Sea, Turkey), seven shrimp species belonging to five families, 37 fish species belonging to 33 families, seven decapods and six cephalopods belonging to 13 families were captured and the size distribution of the captured fishes was identified.

The first comprehensive study (Anonymous 1993) to determine the demersal fishery sources in Turkish seas was performed at depths between 20-500 m in Marmara, Aegean and East-West Mediterranean (Turkey); 66 fish species belonging to 42 families and 17 invertebrate species were captured in the western Mediterranean during the survey. In the Eastern Mediterranean, 105 fish species belonging to 51 families and 20 invertebrate species were obtained. We consider that the reason for greater numbers considering the family and the species, which were higher than our study, arises from the fact that the studies by (Anonymous 1993) covered a wide depth range starting from 20 meters deep.

In their study, Can & Aktaş (2005) studied at 400-600 m depth in the North-Eastern Mediterranean to determine the population structure and fishing abundance of *A. foliacea*. They identified that CPUE values which shows changes between 0.94 kg/h and 8.0 kg/h for *A. foliacea.* They reported that *P. martia* and *A. antennatus* were present in the overall fishing; the ratio of *A. foliacea* in the total amount of the fishing items and the amount of shrimp were 22.45% and 64.61%, respectively. Also, Can et al. (2006) reported in their study that at 400-600 m depths in North-Eastern Mediterranean that CPUE values of *P. martia* were 4.5 kg/h, 2 units/h and 5 units/h and the ratio of this species to the total amount of fishing items and the amount of shrimp were 5.53% and 6.84%, respectively. In an another selectivity study, Deval et al. (2009) carried out shrimp trawls in the Gulf of Antalya (Eastern Mediterranean) at depths of 441-630 m on deep sea shrimps, and ten successful hauls with a total trawling time of 42 h and 15 min yielded a total weight of about 654.1 kg of marketable species (including *A. foliacea, A. antennatus, P. longirostris, P. martia, P. edwardsii, M. merluccius, H. dactylopterus, P. phycis, Lepidorhombus whiffiagonis, C. agassizi, L. piscatorius and P. bogaraveo*). This four shrimp species considered in this study contributed 61.3% (400.8 kg) of total marketable yield from the codends and they reported that the species with the highest amount in were *A. foliacea* and *A. antennatus*. Although CPUE (kg/h) values in fishing with bottom trawls may vary according to the region, depths and seasons, as a result of the outcomes of operations carried out with bottom trawls in our study and other studies in North-Eastern Mediterranean, it was observed that the most captured species among shrimps were *A. foliacea, P. longirostris, A. antennatus* and *P. martia.*

In other studies in the Mediterranean outside Turkey, Ragonese et al. (2001) carried out a study with bottom trawl nets on the Strait of Sicily. According to the results of this study; it was determined that *A. foliacea* had the most amount of weight in the total catch, the remaining catch consist of 26% bony fishes, 16% cartilaginous fishes, 9% other crustaceans and the remaining 1% consisted of cephalopods. Belcari & Viva (2003) reported that the amount of giant red shrimps landings (*A. foliacea*) shows changes between 1-35 kg/day/boat. Cartes et al. (1994) in the Catalan Sea (Northwestern Mediterranean) studies reported that after gathering with bottom trawls, it is found out that the species with the highest amounts were *P. heterocarpus* at 146-296 m depth, mainly *Pasiphaea sivado*, *Sergestes arcticus* and *Processa nouveli, Solenocera membrancea* and *Nephrops norvegicus* at 245-485 m depths, and *A. antennatus* and *Calocaris mecandrea* below 514 m. Politou et al. (2005) reported that in the Eastern Ionian Sea at depths of 300-1200 m, among the 40 the decapod species they identified, nine were Dendrobranchiata, and 31 were Pleocyemata (17 Caridea, nine Brachyura, three Anomura, one Astacideum and one Palinurum). In

Table 4. Weight/number and total length of the species captured in all trawl operations.

FAMİLİA	Species	W (g)	Number	Length min-max (cm)
HEXANCHIDAE	*Hexanchus griseus*		1	90.0
SCYLIORHINIDAE	*Scyliorhinus canicula*		14	28.0-42.5
	Galeus melastomus		49	32.5-67.0
ETMOPTERIDAE	*Etmopterus spinax*	141000		15.0-30.5
OXYNOTIDAE	*Oxynotus centrina*		4	40.3-46.0
SQUALIDAE	*Squalus blainvillei*		5	27.5-65.0
RAJIDAE	*Dipturus oxyrinchus*		45	24.3-59.0
	Raja clavata		5	28.5-43.5
CHIMAERIDAE	*Chimaera monstrosa*		1	68.0
ANGUILLIDAE	*Anguilla anguilla**		17	45.2-79.5
NETTASTOMATIDAE	*Nettastoma melanurum*		22	28.5-63.0
ARGENTINIDAE	*Argentina sphyraena* *		17	11.2-14.2
STOMIIDAE	*Chauliodus sloani*		11	16.5-23.0
CHLOROPHTHALMIDAE	*Chlorophthalmus agassizi**	708000		11.2-19.3
MYCTOPHIDAE	*Lampanyctus crocodilus*		4	15.0-19.0
MACROURIDAE	*Nezumia sclerorhynchus*		53	17.1-27.3
	Coelorhynchus coelorhynchus		3	14.0-15.0
	Hymenocephalus italicus		6	9.0-15.2
GADIDAE	*Gadiculus argenteus**		3	13.0-15.0
PHYCIDAE	*Phycis blennoides**		35	21.5-45.0
MERLUCCIIDAE	*Merluccius merluccius**	169900		14.3-57.5
LOPHIIDAE	*Lophius budegassa**		39	17.3-56.5
TRACHICHTHYIDAE	*Hoplostethus mediterraneus**		364	7.2-18.4
ZEIDAE	*Zeus faber**		2	16.0-20.0
CENTRISCIDAE	*Macroramphosus scolopax*		13	10.1-13.2
SEBASTIDAE	*Helicolenus dactylopterus**		364	11.0-28.4
SCORPAENIDAE	*Scorpaena notata**		68	21.0-26.5
TRIGLIDAE	*Lepidotrigla dieuzeidei**		6	14.0-16.0
PERISTEDIIDAE	*Peristedion cataphractum*		27	12.0-17.0
EPIGONIDAE	*Epigonus* sp		12	7.0-14.0
CARANGIDAE	*Trachurus trachurus**		182	17.1-21.3
SPARIDAE	*Pagellus bogaraveo**		11	15.0-19.0
MULLIDAE	*Mullus barbatus**		23	18.2-22.0
CALLIONYMIDAE	*Synchiropus phaeton*		23	6.0-16.3
TRICHIURIDAE	*Lepidopus caudatus**		125	20.0-66.5
CAPROIDAE	*Capros aper*		12	8.0-10.0
SCOPHTHALMIDAE	*Lepidorhombus whiffiagonis**		37	21.0-45.5

(*) Commercial species

addition, they reported that *P. longirostris* had the highest amount at 300-500 m depths, *P. heterocarpus* and *P. antigai* followed, and *A. foliacea* and *A. antennatus* had the highest amount at 700-900 m and *Sergia robusta* and *Polycheles typhlops* at 900-1200 m. Spano et al. (2013) found in their study in the Sicily Bospours found out that several shrimp species (*P. longirostris, A. foliacea, A. antennatus, N. norvegicus and P. martia*) were captured in large amounts in the trawl net.

In this study, while there are regional differences according to the abundance of the species between in the 300-601 m depths, *P. longirostris, A. foliacea* and *P. edwardsii* were defined as the species having the

Table 5. Decapod and Cephalopod species captured.

FAMILY	Species	17 May 2014						25 June 2014						26 June 2014				27 June 2014				Total number
		1		2		3		4		5		6		7		8		9		10		
		Numb	Size	Numb	Size	Numb	Size	Numb	Size	Numb	Size	Numb	Size	Numb	Size	Numb	Size	Numb	Size	Numb	Size	
GERYONIDAE	*Geryon longiceps*																	1	bs			1
POTUNIDAE	*Bathynectes maravigna*			2	mbs			1	ms	1	ms					1	ms	1	ms	1	ms	7
DORIPPIDAE	*Medorippe lanata*															1	ss					1
PARTHENOPIDAE	*Parthenope* sp																	1	ms			1
LATREILLADE	*Latreillia* elegans							1	ms													1
POLYCHELIDAE	*Polycheles typhlops*	1	ms	3	mbs					16	smbs											20
DIOGENIDAE	*Dardanus* sp											1	bs									1
ARGONAUTIDAE	*Argonauta argo*													1	bs							1
OCTOPODIDAE	*Pterocto-pus* sp							1	ms			1	ms	1	bs					1	ms	4
OMMASTREPHIDAE	*Illex coindetti*	2	ms	3	bs					2	ms	2	ms	1	bs	18	mbs	4	bs	3	bs	35
LOLIGINIDAE	*Loligo vulgaris*																	7	bs			7
HİSTİOTEUTHIDAE	*Histioteuthis* sp									1	ss											1
SEPIOLIDAE	*Sepietta* sp							6	ms					1	ms	1	bs					8

ss= small size, ms= middle size, bs= big size, mbs= middle, big and small size

highest amounts. Apart from these studies, there are numerous other studies on distribution, species composition and fishing abundance of deep sea shrimp and fish species across the Mediterranean and in Turkey's Mediterranean coast by various researchers (Cartes 1993, Cartes et al. 1994, 2009, Başusta 1997, Benli et al. 1999, Kallianiotis et al. 2000, Rinelli et al. 2000, Mytilineou et al. 2005, Politou et al. 2005, Fanelli 2007, Politou et al. 2008, Gönülal et al. 2010, Yeşilçimen & Kuşat 2011, Ramon 2014). Kallianiotis et al. (2000) reported that the diversity and amount of species changed according to the depth and season; species and amounts of species had higher values in shallow waters and as a result of the study they had obtained a total of 127 species belonging to Osteichthyes, Condrichthyes, Crustaceans and Cephalopods in their study carried out in Greek territorial waters in the North-Eastern Mediterranean at depths of 50-1000 m with bottom trawl.

As a result of their study on the multiplicity of deep sea fish fauna in the Eastern Ionian Sea (Greece), Mytilineou et al. (2005) reported that among the 101 species of fish they defined, *Argentina sphyraena* and *C. agassizi* as the most common species at 300-500 m, *C. agassizi* and *Phycis blennoides* as the most common species at 500-700 m, *Galeus melastomus* and *Nezumia sclerorhynchus* as the most common species at 700-900 m and *Lampanyctus crocodilus* as the most common species at 900-1200 m and the number and abundance of the species reduced depending on the depth. Polīto et al. (2008) stated in their study in the Eastern Ionian Sea (Greece) that *C. agassizii* was the most common at 300-500 m followed by *P. edwardsii* and *Hymenocephalus italicus, A. sphyraena* and *Plesionika antigai*, *A. foliacea, P. martia, C. agassizii* and *H. mediterraneus* are the most common species at 500-700 m, and *A. foliacea* and *A. antennatus* are the most common at 700-900 m depth. Similar results obtained in our study, *C. agassizii* was common at 300-600 m depth, *M. merluccius* and *E. spinax* were also found in large amounts.

Başusta (1997) and Başusta & Erdem (2000) studied the pelagic and demersal fish species from İskenderun Bay in the Northeastern Mediterranean from a systematic point of view and identified 145 species belonging to 67 families and reported that 19 of them were cartilaginous and 126 were from the bony fish group. Benli et al. (1999) reported in their study with bottom trawl at 20-600 m depth in North Cyprus offshore areas that they captured eight cartilaginous fishes, 74 bony fishes, 14 cephalopods and five shrimp species (*A. foliacea, P. longirostris, P. martia, A. glaber, P. cataphractus*) and the number of bony fish species decreased as the depth increased. Yeşilçimen & Kuşat (2011) stated as a result of hauling with bottom trawl nets that at 50-250 m depths in west Mediterranean coast of Turkey (the Gulf of Antalya) 41 species of fish belonging to 34 families were captured and only 12 species belonging to nine families had commercial value. Dalyan (2012) captured 63 species belonging to 33 families in a study carried out at 227-777 m depths in Iskenderun Bay located in the eastern Mediterranean. It was reported that 13 of these species were cartilaginous and 50 of them were bony fish. Considering that 37 cartilaginous and bony fish species belonging to 33 families were captured in this study carrying out in the northeastern Mediterranean (Mersin Bay) coast of Turkey, it's thought that inability to capture certain species and the number of species being lower may be due to the difference of sampling region, the sampling time and the depth variations. In parallel with the results we have obtained, Dalyan (2012) identified in their study in Iskenderun Bay (Northeastern Mediterranean, Turkey) that *C. agassizi* species had the highest values in terms of number of units per area, biomass and dominance calculations and *H. dactylopterus* had the highest value in terms of frequency. Dalyan (2012) stated that *C. agassizi, M. merluccius and L. budegassa, Scyliorhinus canicula, Dipturus oxyrinchus, Coelorhynchus caelorhynchus, L. whiffiagonis, Phycis blennoides* and *Synchiropus phaeton* were observed in all depths of 30 towing samplings. However, in our study, when the distribution according to the depth of the fish species is considered, *C. agassizi, M. merluccius, L. budegassa, H. mediterraneus,* and *H. dactylopterus* were observed in the trawl net in all hauling operations. At the same time, in this study, it was found that the amount of non-commercial and discard fishes was high compared to the total quantity of fish and *H. dactylopterus* and *T. trachurus* were captured in large amounts in terms of quantity following *M. merluccius* which have economic importance for the region. Also, as stated in this study and other studies, the number of species (especially fish) decreases especially as depth increases. According to Politou et al. (2008), this situation imposes relatively high constant temperature, high metabolic and decomposition rates at 13-14 °C at depths below 200 m and causes the emergence of a major food shortage problem. Tselepides & Eleftheriou (1992) and Danovaro et al. (1999, 2000) concluded, as a result of research carried out in previous years, that due to the Mediterranean showing a tendency towards the decrease of macrobenthic abundance and diversity below 400-500 m depths because of its high oligotrophic feature, this plays a decisive role in the availability of nutrients.

As a result, fishing abundance, species composition of benthic fish fauna, their incidence and the size distribution especially of shrimp species living in the deep sea were determined in this study carried on for the first time in international waters in the Mersin Bay, Eastern Mediterranean (Turkey) and the first comprehensive results were demonstrated in order for this study to shed light on future studies in this region.

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References

Anonymous 1993. Survey Report on the Demersal Fish Stocks of the Sea of Marmara, Aegean and the Mediterranean. Ministry of Agriculture and Rural Affairs and Japan International Cooperation Agency (JICA), November, 579 p, (in Turkish).

Anonymous 2012. Circular No: 3/1 of 2012-2016 Fishing Year Regulating Commercial Fishing in Seas and Inland Waters. Ankara, 112 p, (in Turkish).

Anonymous 2014. Records of Republic of Turkey Ministry of Food, Agriculture and Livestock General Directorate of Fisheries and Aquaculture, (in Turkish).

Bakir A. K., Katağan T., Aker H.v., Özcan T., Sezgïn M., Ateş A.s., Koçak C. & Kirkim F. 2014. The marine arthropods of Turkey. Turkish Journal of Zoology. 38: 765-831.

Başusta N. 1997. A study on fishes of Iskenderun Bay. PhD, Çukurova University, Graduate School of Natural and Applied Science, No: 381, Adana, March, 202 p.

Başusta N. & Erdem Ü. 2000. A study on the pelagic and demersal fishes of Iskenderun Bay. Turkish Journal of Zoology, 24, 1-19 (in Turkish).

Belcarï P. & Vïva C. 2003. Fishery and Biology of *Aristaemorpha foliacea* (Risso, 1827) (Crustacea: Decapoda) in the Northern Tyrrhenian Sea (Western Mediterranean). *J*ournal of Northwest Atlantic Fishery Science, 31: 195-204.

Benlï H.a., Bïlecïk N., Cïhangïr B., Katağan T., Cïrïk Ş., Sayin E., Kaya M., Koray T., Çinar M.e., Salman A., Sever M.t., Ünlüoğlu A., Küçüksezgïn F., Buhan E., Yilmaz H. & . 1999. The bio-ecological properties of the surrounding waters of the Turkish Republic of Northern Cyprus. Republic of Turkey Ministry of Food, Agriculture and Livestock General Directorate, Bodrum Fisheries Research Center, No:4, 66 p (in Turkish).

Bïlecenoğlu M., Kaya M., Cïhangïr B. & Çïçek E.2014. An updated checklist of the marine fishes of Turkey. Turkish Journal of Zoology. 38: 901-929.

Can M.f. & Aktaş M. 2005. A preliminary study on population structure and abudance of *Aristaeomorpha foliacea* (Risso,1827) (Decapoda, Natantia) in the deepwater of the northeastern Mediterranean. Crustaceana, 78 (8): 941-946.

Can M.f., Aktaş M. & Demïrcï A. 2006. A preliminary study on population structure and abudance of *Plesionika martia* (A. Milne-Edwards, 1883) (Decapoda:Pandalidae) in the deepwater of the northeastern Mediterranean. E.U. Journal of Fisheries & Aquatic Sciences, 23 (1/3): 365-367.

Cartes J.e.1993. Deep-Sea decapod Fauna of the western Mediterranean-batyhmetric distrubution and biogeographic aspects. Crustaceana, 65: 29-40.

Cartes J.e., Company J.b. & Maynou F. 1994. Deep-water decapod crustacean communities in the Northwestern mediterranean – Influence of Submarine Canyons and Season. Marine & Freshwater Biology, 120 (2): 221-229.

Cartes J.e., Maynou F., Llorïs D., Sola L.g. & Garcïa M. 2009. Influence of trawl type on the composition and diversity of deep benthopelagic fish and decapod assemblages off the Catalan coasts (western Mediterranean). Scientia Marina, 73 (4): 725-737.

Coll M., Piroddi C., Steenbeek J., Kaschner K., Ben Rais Lasram F., Aguzzi J., Ballesteros E., Bianchi C. N., Corbera J., Dailianis T., Danovaro R., Estrada M., Froglia C., Galil B. S., Gasol J. M., Gertwagen R., Gil J., Guilhaumon F., Kesner-Reyes K., Kitsos MS., Koukouras A., Lampadariou N., Laxamana E., López-Fé de la Cuadra C. M., Lotze H. K., Martin D., Mouillot D., Oro D., Raicevich S., Rius-Barile J., Saiz-Salinas J. I., San Vicente C., Somot S., Templado J., Turon X., Vafidis D., Villanueva R., Voultsiadou E.. 2010. The biodiversity of the Mediterranean Sea: estimates, patterns, and threats. PLoS ONE, 5: 1-36.

Dalyan C. 2012. Distribution of upper continental slope fishes of Northeastern Levantine Sea (Eastern Mediterranean). PhD Thesis, Istanbul Universty, Graduate School of Natural and Applied Science, 108 pp. (In Turkish).

Danovaro R., Dïnet A., Duïneveld G. & Tselepides A.1999. Benthic response to particulate fluxes in different trophic environments: a comparison between the Gulf of Lions-Catalan Sea (western Mediterranean) and the Cretan Sea (eastern Mediterranean). Progress in Oceanography, 44: 287-312.

Danovaro R., Tselepïdes A., Oteguï A. & Croce N. D. 2000. Dynamics of meiofaunal assemblages on the continental shelf and deep-sea sediments of the south Aegean Sea (NE Mediterranean): relationships with seasonal changes in food supply. Progress in Oceanography, 46: 367-400.

Deval M.c., Bök T., Ateş C., Ulutürk T. & Tosunoğlu Z. 2009. Comparison of the size selectivity of diamond (PA) and square (PE) mesh codends for deepwater crustacean species in the Antalya Bay, Eastern Mediterranean. Journal of Applied Ichthyology, 25, 372-380.

Ergüden D., Özdemïr O., Gürlek M. & Turan C.2016. The new developments of fauna of alien fish (Indian Pacific and Atlantic origin) in the distribution of Turkey's Mediterranean coast. 19. Sualtı Bilim Toplantısı. 21-23 Ekim 2016. SBT Bildiriler Kitabı, [in Turkısh] (in press).

Eschmeyer W.N. ed. 2016. Catalog of Fishes: Genera, Specıes, References. (http://research.calacademy.org/research/ichthyology/catalog/fishcatmain.asp). Accessed 24.06.2016.

Fanellï E., Colloca F. & Ardïzzone G.2007. Decapod crustacean assemblages off the West coast of central Italy (western Mediterranean). *Scientina Marina*, 71 (1): 19-28.

Gönülal O., Özcan T. & Katagan T. 2010. A contrubition on the distribution of the giant red shrimp *Aristaeomorpha foliacea* (Risso, 1827) alond the Aegen Sea and Mediterranean part of Turkey. *Rapp. Comm. int. Mer.Médit*., vol. 39, p. 534.

Kallïanïotïs A., Sophronïdïs K., Vïdorïs P. & Tselepïde A.

2000. Demersal fish and megafaunal assemblages on the Cretan continental shelf and slope (NE Mediterranean): seasonal variation in species density, biomass and diversty. Progress in Oceanography, 46 (2-4): 429-455. DOI: 10.1016/S0079-6611 (00028-8).

IUCN 2016. The IUCN red List of Threatened Species. Version 2015.4 http://www.iucnredlist.org. (Access date: 25.06.2016).

Mytĭlĭneou C., Polĭtou C.y., Papaconstantĭnou C., Kavadas S., D'onghĭa G. & Sĭon L. 2005. Deep-water fish fauna in the Eastern Ionian Sea. Belgian Journal of Zoology, 135 (2): 229-233.

Nelson J.S. 2006. Fishes of the world, 4th Edition. John Wiley and Sons, Inc. Hoboken, New Jersey, USA, 601p.

Öztürk B., Doğan A., Bĭtlĭs B. B. & Salman A. 2014. Marine molluscs of the Turkish coasts: an updated checklist. Turkish Journal of Zoology, 38: 832-879. DOI:10.3906/zoo-1405-78.

Pauly D. 1980. On the Interrelationships Between Natural Mortality, Growth Parameters and Mean Environmental Temperature in 175 Fish Stocks. Journal Constitution Central Institute for Economic Management. 39 (2): 175-792.

Polĭtou C.y., Maĭorano P., D'onghĭa G. & Mytĭlĭneou C. 2005. Deep-water decapod crustacean fauna of the eastern Ionian Sea. Belgian Journal of Zoology, 135 (2): 235-241.

Polĭtou C.y., Mytĭlĭneou C., D'onghĭa G. & Dokos J. 2008. Demersal faunal assemblages in the deep waters of the eastern Ionian Sea. Journal of Natural History, 42 (5-8): 661-672.

Ponder W.f. & Lĭndberg D. R 2008. Phylogeny and Evolution of the Mollusca. London: University of California Press, p. 469.

Quĭgnard J.p. & Tomasĭnĭ J.2000. Mediterranean fish biodiversity. Biologia Marina Mediterranea, 7: 1-66.

Ramon M., Abello P., Ordĭnes F. & Massutĭ E2014. Deep epibenthic communities in two contrasting areas of the Balearic Islands (western Mediterranean), Journal of Marine Systems, volume: 132, p 54-65, DOI: 10.1016/j.jmarsys. 2014.01.002.

Ragonese S., Zagra M., Dĭ Stefano L. & Bĭanchĭnĭ M. L. 2001. Effect of codend mesh size on the performance of the deep-water bottom trawl used in the red shrimp fishery in the Strait of Sicily (Mediterranean Sea). Hydrobiologia, marine & freshwater biology, 449 (1-3): 279-291.

Rĭnellĭ P., Gĭordano D., Perdĭchĭzzĭ F. & G. 2000. Observation on decapod crustaceans from trawlable bottoms in the southern Tyrrhenian Sea (western Mediterranean). Crustacean ıssues, volume:12, 779-789.

Spano N., Porporato E.m.d. & Ragonese S. 2013. Spatial Distribution of Decapoda in the Strait of Sicily (Central Mediterranean Sea) Based on a Trawl Survey. Crustaceana, Marine & Freshwater Biology, volume: 86 (2): 139-157.

Tselepĭdes A. & Eleftherĭou A. 1992. South Aegean (Eastern Mediterranean) continental slopebenthos: Macroinfaunal-environmental relationships. In: Rowe GT, Pariente V, editors. Deep sea food chains and the global carbon cycle. Dordrecht (Netherlands): Kluwer Academic Publishers, 139-156.

Yemĭşken E., Dalyan C. & Eryilmaz L 2014. Catch and discard fish species of trawl fisheries in the Iskenderun Bay (North-eastern Mediterranean) with emphasis on lessepsian and chondricthyan species. Mediterranean Marine Science, 15 (2): 380-389.

Yeşĭlçĭmen H.Ö. & Kuşat M. 2011. Montly change of economic fish species caught by bottom trawl fishing from Antalya Bay. Journal of Fisheries Sciences.com, 5 (2): 115-121.

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