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Original Article

Catch Composition of the bottom trawl fishery along the coasts of Karataş-Adana (Northeastern Mediterranean Sea)

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Abstract: The catch composition of the bottom trawl fishery along the coasts of Karataş was evaluated in the 2002-2003 fishing season. A total of 110 species were registered, the fishes showed the highest diversity (90 species) followed by 15 crustaceans species and 5 species of cephalopods. The highest catch per unit effort (CPUE) value (66.8 kg h^{-1}) was recorded in September when the fishing season was opened and decreased to the lowest value in March (12.5 kg h^{-1}). The average CPUE was 26.3 ± 18.9 kg h^{-1}. The result showed that catch of fish decrease with increasing depth. The highest fish catch (47.42%) was found in 0-20 m depth range. 35.58 percent of the catch was between 20-50 m, and 17.00% between 50-100 m depth. Lessepsian fish comprise 18.90% of all fish in terms of the number of species and 26.66% of the total fish catch.

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Introduction

The Northeastern Mediterranean is highly suitable fishing area for bottom trawling because of wide continental shelf and sandy and muddy bottom substrate. The bottom trawl hauls in the Mediterranean coast of Turkey are generally performed at depths above 70 m, although the hauls are occasionally performed at depths reaching 150 m depth (Bingel, 1987). With bigger boats being added to the fishing fleet after the 1980s, regional stocks have been under ever-intensifying fishing pressure (Gücü, 1994). Therefore, the fishing effort has exceeded the sustainable production level in the region because of ineffective policies. The effects of this worsening situation were observed through decreases in catch, catch per unit effort (CPUE), average size of landed species, average size of widely caught species in the past, substitution of species with a high commercial value by those with lower value and most importantly, a decrease in the number of species caught (Gücü, 2000). One of most important peculiarities of the NE Mediterranean coast of Turkey is its higher diversity similar to those of tropical waters but with a quite low biomass. Another point to be considered in the Mediterranean, especially for northeastern Mediterranean fisheries, is the Lessepsian fish migration, which began with the opening of the Suez Canal in 1869. From the first record of Lessepsian fish in 1902 (Ben-Tuvia, 1985; Tillier, 1902), new records were reported, and the number of Lessepsian species were increased to 65 (Golaniet al., 2002). Some of the species adapted to the Mediterranean ecosystem (Gücü, 2000), and those that reached trading densities include *Saurida undosquamis*, *Leiognathus klunzingeri*, *Upeneus moluccensis* and *Upeneus pori*. These are often the most abundant species in the main catch (Bingel, 1987; Avşaret al., 2000; Çiçeket al., 2002). For this

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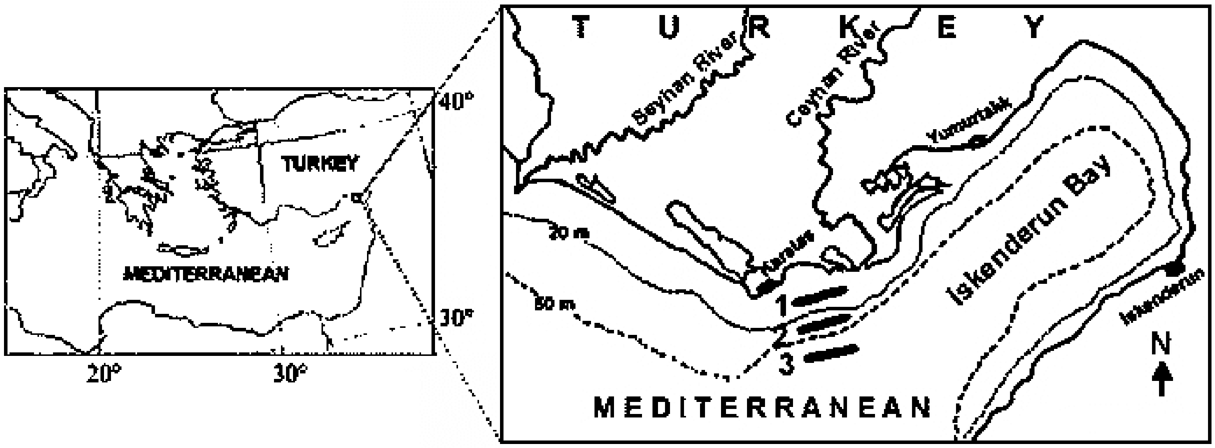

Figure 1. Sampling area and sampling stations along the Karataş Coasts (1: 0-20 m; 2: 20-50 m; 3: 50-100 m depth range).

reason, Lessepsian migration should be monitored year by year (Gücü, 2000). Although some researches were carried out in Turkey during the 1980s (Bingel, 1981, 1987) and 1990s (Anonymous, 1993; Bingelet al., 1993), but no research on this topic has been performed for the last 15 years. Therefore this study, even though it is limited in scope, aimed to report the numerical data on bottom trawl fishing along the coasts of Karataş in the Northeastern Mediterranean.

Materials and Methods

The Karataş Coasts are situated between the Mersin and Iskenderun bays, where bottom trawl fishing is carried out intensively. For this reason, it can be claimed that the coasts of Karataş can be a representative of the mentioned two bays. This study was carried out in one station in three depth levels from 0-20 m, 20-50 m and 50-100 m along the Karataş Coast on a monthly interval during fishing season between September 2002 and April 2003 with a commercial trawling vessel named Coşkun Reis (270 HP, 19.2 m) (Fig. 1). The effective duration of the tows was one hour. Throughout the sampling studies, the Mediterranean-type commercial bottom trawl net consists of 700 round mouth meshes with a 22 mm (knot-to-knot) diamond-shaped cod-end (Bingel, 1987). The towing speed ranged from 2.7 to 3.2 knots.

The large species (*Rhinobatos rhinobatos*, *Raja* spp., *Gymnura altavela*, *Dasyatis pastinaca* etc.) were separated, and weighed to the nearest 0.1 g on the trawling vessel and others were transformed to the laboratory in iceboxes (packed in plastic bags) and then were maintained in deep freeze at -18°C. The samples were weighed and then identified based on Fischer (1987), Whitehead et al. (1984, 1986a, 1986b) and Froese and Pauly (2004). Then numerical trawl fishery data was tabulated. Similarity in proportions of species composition by month and trawl was analyzed using the “Weighted pair–group method with arithmetic averages” based on Davis (1973) by SPSS statistical software. The area (a, km^2) covered in one hour of trawling was calculated according to Avşar (2005): $\alpha = D*h*X_2$, where D is the length of swept area (m), h is the length of the buoy line head rope of trawl (m), and X_2 is the constant opening of buoy line head rope (0.5) (Pauly, 1980). In one hour of trawling, 0.0263 km^2 was covered. The biomass per square kilometers (B) was estimated following the equation $B = \overline{cw}/(\alpha*q)$ (Avşar, 2005), where $\overline{cw}$ is the catch value by hour (g), α is the area covered by the trawl net (km^2), and q is the catchability coefficient of the trawl net (=1) (Bingel, 2002). The first 10 species with the highest biomass in the main catch were evaluated (Bingel, 1987).

Results and Discussion

Throughout the study, 15 crustacean (13.6%), 5 cephalopod (4.6%), and 90 fishes (81.8%, 8 cartilaginous, 82 teleost) species were identified.

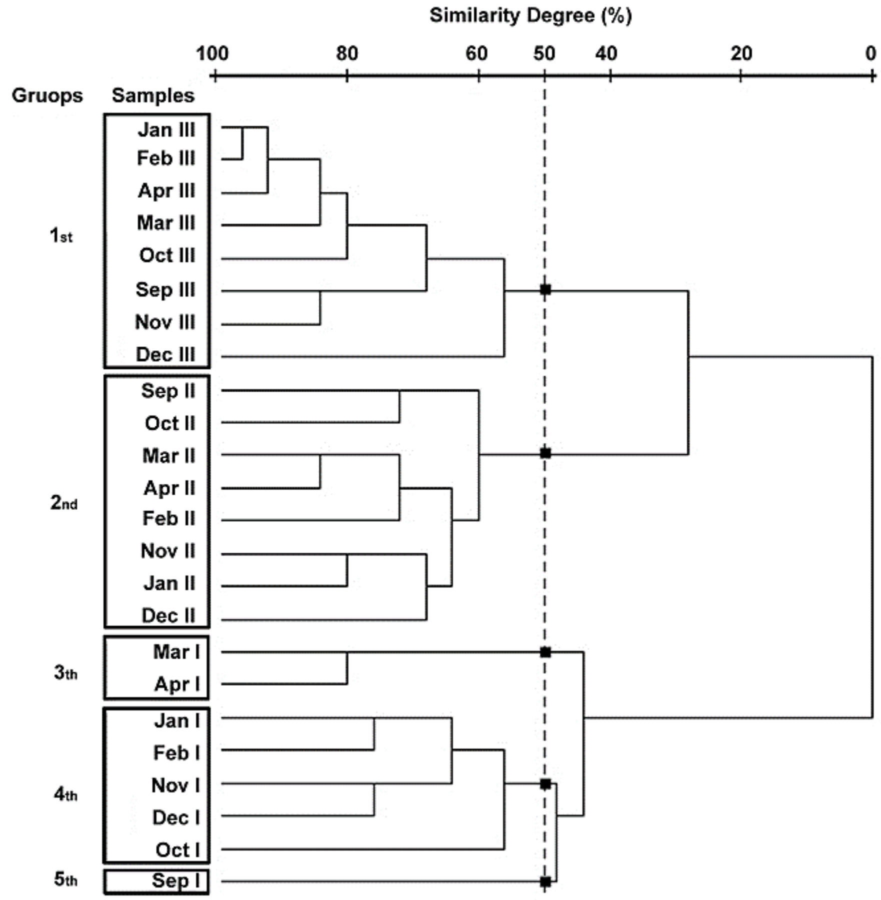

Figure 2. Catch composition similarity dendogram according to depth ranges and months (I: 0-20 m; II: 20-50 m; III: 50-100 m depth range).

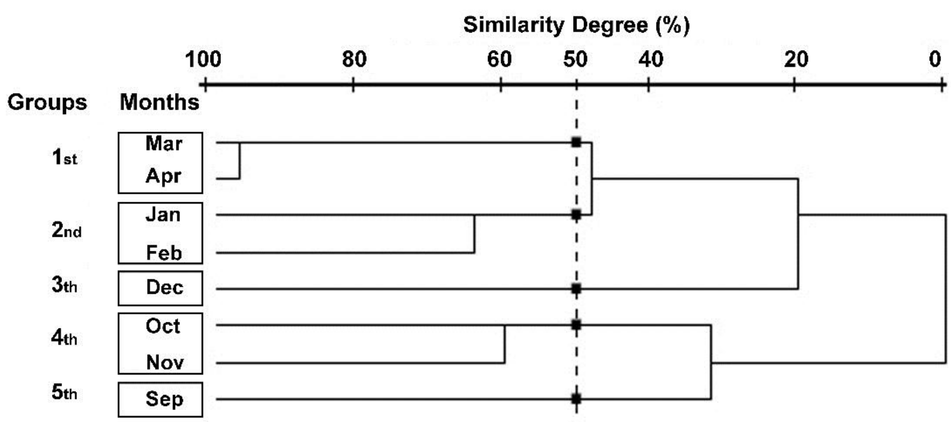

Figure 3. Catch composition similarity dendogram according to monthly catch.

The maximum number of species (43) was caught in October at a 20-50 m depth range, while the lowest caught (19 species) was in November at 50-100 m depth range. 87 species occurred in the depth zone 0-20 m, 92 species in the zone 20-50 m and 41 species in 50-100 m.

Similarity between months and depths: Considering the similarities between months in terms of fish species, it was obvious that 5 different groups could be identified (Fig. 2). The species in the first group consist of fish that live in the 50-100 m depth range; those in the second group live in the 20-50 m depth range, and third, fourth and fifth groups live at 0-20 m depth. Therefore, monthly species and density differences between months were highest at the depths of 0-20 m. On the contrary, the differences

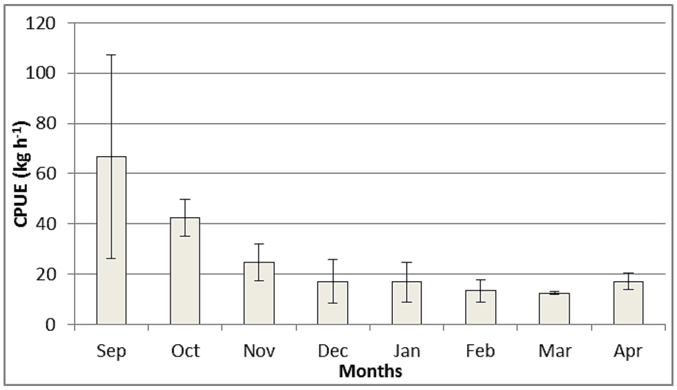

Figure 4. Time series of CPUE and standard deviations.

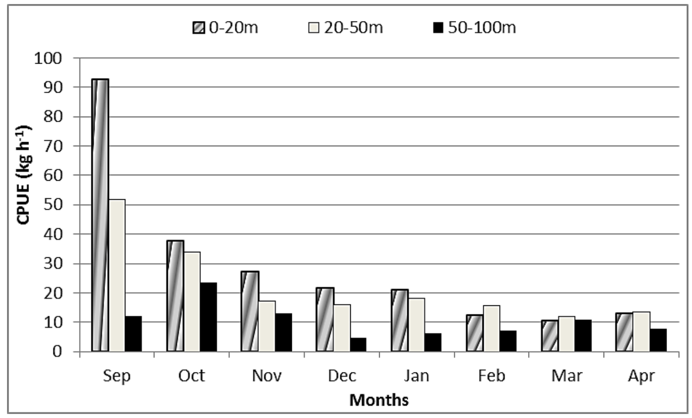

Figure 5. Monthly CPUE fishes in depth ranges.

between months at other depth ranges were low. This may have occurred because the depth range of 0-20 m is near the coast and is used by some species for biological needs such as reproduction, feeding, or overwintering.

For monthly grouping of species composition, five different groups were observed at a similarity level of 50% (Fig. 3). September was a group on its own, followed by October and November in the next group. The third group, December, which is a transition month between autumn and winter, was observed to have similarities with upcoming months instead of the previous months. The months after December comprised two additional groups (January and February, and March and April).

Time-series of catch per unit effort (CPUE): In total, a catch of 631.4 kg was obtained for the entire study period. The highest CPUE value (66.8 kg h^{-1}) was observed in September (Fig. 4). In the following months, CPUE decreased and reached its lowest value (12.5 kg h^{-1}) in March, but it showed a tendency to increase in April. The average CPUE for the entire fishing season was 26.3 ± 18.9 kg h^{-1}, and the average yield per km^2 was 1,000.3 ± 720.7 kg.

The results showed that fish comprised about 79.10% of the total catch while the amount of crustaceans were 13.73%, and that of cephalopods was 7.17%. The monthly CPUE changes were occurred based on depth i.e., the highest CPUE value was recorded in September at the 20-50 m depth range and the lowest at the 50-100 m depth range for the entire fishing season (Fig. 5). The data also shows that 42.33% of the total catch was obtained at a depth of 20-50 m, 39.46% at 0-20 m, and the rest (18.21%) at 50-100 m depth. *Charybdis longicollis* had the highest proportion (31% of total catch at the depth range of 20-50 m).

Monthly changes in CPUE values for fish: 79.10% of the total catch consisted of fish and a total of 499,421.13 g of fish were caught. The highest value in CPUE (52.2 kg h^{-1}) was in September when the fishing season opened, and it decreased in the following months, reaching the lowest value of 12.5 kg h^{-1} in March (Fig. 6). An increase was observed in CPUE in the last month of the fishing season (April). The average CPUE for the entire fishing season was as 20.8 ± 14.4 kg h^{-1}, and the average catch per km-2 was 791.2 ± 606.8 kg.

For seasonal changes in monthly CPUE, a rapid decrease in biomass was observed following the opening of the fishing season. This situation was caused due to the cohort from the previous year i.e. fishing in an area happens because of increases in the previous year's cohort. This was observed in Greece, where the trawl fishing regime is very similar to that of the fishery along the coast of Turkish NE Mediterranean (Stergiou et al., 1997). Somarakis and Machias (2002) reported that prohibiting fishing during summer was an effective way to protect immature fish because these regulations make it possible to prevent the overfishing of mature fish.

Monthly changes in CPUE for fish at various depths: When monthly CPUE changes in fish at different depth ranges are taken into consideration (Fig. 7), except for February, March, and April, the highest

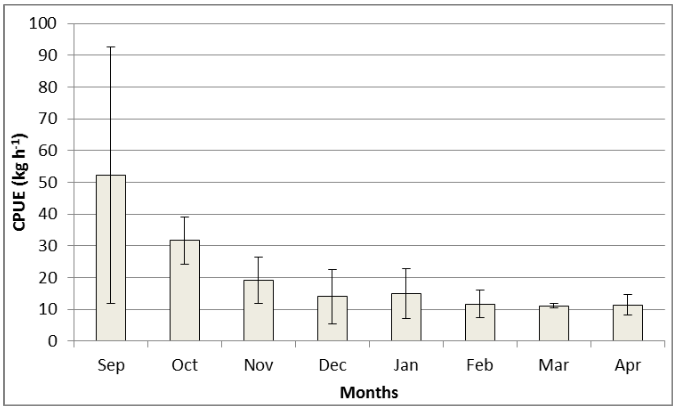

Figure 6. Mean monthly changes in the CPUE value of fish.

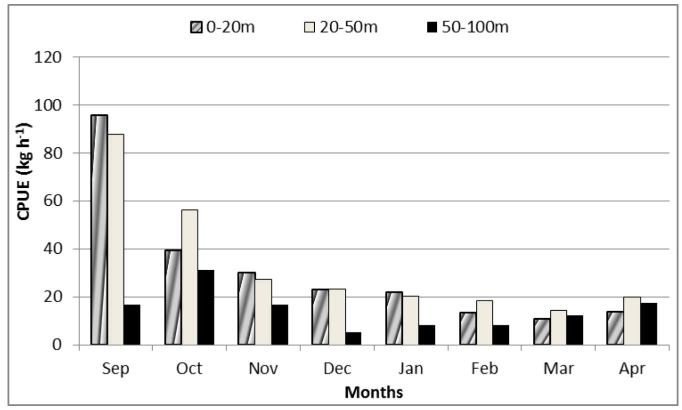

Figure 7. Monthly CPUE fishes in depth ranges.

and lowest CPUE were observed at 0-20 m and 50-100 m depth range, respectively i.e. CPUE decreases from inshore to offshore. Thus, the fish biomass caught at 0-20 m and 20-50 m were 47.42%, and 35.58%, respectively, while it was 17.00% at 50-100 depth range. The average CPUE values according to those depth ranges were 29.6 ± 27.1 kg h^{-1}, 22.2 ± 13.7 kg h^{-1}, and 10.6 ± 6.0 kg h-1, respectively. In addition for three depth ranges, the catch per km^2 was 1,125.5 ± 1,029.4 kg, 844.7 ± 520.9 kg, and 403.5 ± 227.6 kg, respectively.

Based on the results, the highest number of fish species caught for the entire fishing season was at a depth range of 20-50 m (Table 1). In October, 43 fish species were observed at the depth range of 20-50 m. The lowest number of species was 19 at the depth range of 50-100 m. An average of 32 fish species were caught for the whole study period in a trawl operation. A previous study found that the average number of species caught in a trawl for this area was 44 (Bingel, 1987), and the results obtained from this study are parallel to those of Bingel (1987), which suggests that this area has a rich diversity of species.

Monthly changes in percent occurrence of fish in the total catch: The proportion of fish in the total catch was lowest in April (67.45%), and the highest was in January (90.08%) (Fig. 8). Therefore, fish species were more than 2/3 of the total catch.

Lessepsian fish: A total of 17 Lessepsian fish species, belonging to 14 families were spotted in this study (Table 2). Lessepsian fish consists 18.90% of the total number of species. Except for January, the

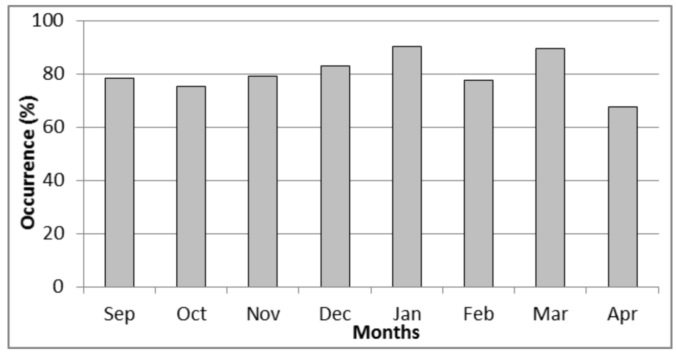

Figure 8. Monthly changes of percentage occurrence of fish in total catch.

highest number of Lessepsian fish species was at a depth of 0-20 m while the lowest number was recorded at the depth of 50-100 m. The highest number of species was in October with 13 species, and then with 0 species in September, December, and March. There was no significant difference in the number of Lessepsian fish species between months (P<0.05).

Monthly changes in CPUE for Lessepsian fish: The highest average CPUE for Lessepsian fish was 11.73 kg h^{-1} in September, and the lowest in November with 3.39 kg h^{-1}. The average CPUE for Lessepsian fish for the whole fishing season was 5.28 ± 3.32 kg h^{-1}.Also, the highest average CPUE was 10.84 ± 9.87 kg h^{-1} at 0-20 m, followed by 4.40 ± 1.95 and 0.84 ± 0.49 kg h^{-1} at 20-50 m and 50-100 m depths, respectively. When the whole study period was considered, 68.18% of the total Lessepsian fish biomass was caught at 0-20 m, 25.60% at 20-50 m, and the rest (6.22%) at 50-100 m depths. This shows that Lessepsian fish disperse along the coast and that

Table 1. Number of this species obtained from each trawl operation.

Months	Depth Ranges			Mean
	0-20 m	20-50 m	50-100 m	
September	29	37	33	33
October	35	43	31	36
November	38	42	19	33
December	37	32	23	31
January	33	33	24	30
February	31	37	25	31
March	29	30	26	28
April	34	34	28	32
Mean	33	36	26	32

Table 2. Monthly changes of each Lessepsian fish species in their total catch.

Species	Months and Percentage Occurrence (%)								Average (%)
	2002				2003				
	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	
Apogon nigripinnis	-	0.39	0.01	0.22	-	0.01	-	-	0.11
Callionymus flamentosus	1.94	3.31	0.16	0.55	0.92	0.22	0.18	0.89	1.46
Cinoglossus sinusarabici	0.66	2.22	1.76	1.23	1.61	0.30	0.62	1.80	1.23
Dussumeria elopsoides	-	-	-	-	-	0.14	1.46	0.85	0.22
Etrumeus teres	-	0.18	1.72	-	-	0.29	-	-	0.19
Fistolaria commersonii	0.38	0.17	0.26	2.07	1.56	0.30	-	-	0.48
Leiognathus klunzingeri	18.82	11.13	3.73	3.36	14.82	11.89	19.22	4.05	12.79
Lagocephalus suezensis	-	1.87	2.63	2.76	-	0.30	-	-	0.83
Pelates quadrilineatus	-	0.14	-	-	-	-	-	-	0.03
Sphyraena chrysotaenia	0.37	-	-	1.43	1.38	-	0.98	0.79	0.48
Stephanolepis diaspros	0.87	0.41	2.86	3.16	0.69	-	0.49	1.19	0.95
Saurida undosquamis	28.38	43.64	71.49	64.03	45.31	47.79	54.61	50.79	45.56
Sargocentron rubrum	-	-	-	0.29	-	-	-	-	0.02
Siganus luridus	-	0.06	-	-	0.19	-	-	0.17	0.04
Siganus rivulatus	0.11	-	0.49	0.17	-0	0.17	0.21	0.42	0.15
Upeneus moluccensis	1.38	4.00	3.27	-	7.82	4.49	2.76	1.48	3.04
Upeneus pori	47.11	32.48	11.62	20.73	25.70	34.10	19.47	37.57	33.11

their biomass decreases commensurate with depth. Both Ben-Tuvia (1985) and Gücü and Gücü (2002) reported that Lessepsian fish use the coast as their preferred habitat. Similarly, Ben-Yami and Glaser (1974) pointed out that Lessepsian species biomass decreases with depth. The 68.18% of the total Lessepsian fish biomass at 0-20 m depth range of the study area is in agreement with the results of the above mentioned works. During 1983-1984, the proportion of Lessepsian fish in the total catch in Iskenderun Bay was 62% (Gücü and Bingel, 1994). In this study, we caught 20.37% showing rapid decline of the proportion of Lessepsian fish since then. Gücü (2000) reported that the CPUE for *Saurida undosquamis* decreased about ten-fold from 1984 to 1996. This difference is assumed to have been caused by overfishing in the area. The lowest (14.01%) proportion of Lessepsian fish in the total fish biomass was in November, and the highest (33.47%) in March with the average proportion of

Table 3. CPUE values, biomass, percentage occurrence of species in main catch (L: Lessepsian).

Number	Species	CPUE (kg h^{-1})	Biomass (kg km^{-2})	Percentage in total catch (%)	Percentage in main catch (%)
1	*Mullus barbatus*	3.11	74.74	11.83	19.48
2	*Charybdis longicollis*	2.56	61.31	9.70	15.98
3	*Saurida undosquamis*	2.49	59.70	9.46	15.56
4	*Pagellus erythrinus*	1.71	41.03	6.50	10.70
5	*Upeneus pori*	1.58	37.88	6.00	9.87
6	*Bothus podas*	1.22	29.27	4.64	7.63
7	*Sepia officinalis*	1.16	27.02	4.28	7.04
8	*Spicara smaris*	8.08	19.40	3.07	5.06
9	*Merluccius merluccius*	7.64	18.35	2.91	4.78
10	*Leiognathus klunzingeri*	6.90	16.77	2.66	4.37
	Total			61.05	100

Table 4. CPUE values, percentage occurrence of species in main catch in between 1983 and 1984 from Iskenderun Bay.

Number	1983			1984		
	Species	CPUE (kg)	%	Species	CPUE (kg)	%
1	*Saurida undosquamis*	10.97	26.79	*Saurida undosquamis*	16.08	41.85
2	*Stephonalepis diaspros*	5.96	14.57	*Citharus linguatula*	3.51	9.14
3	*Leiognathus klunzingeri*	4.48	10.94	*Mullus barbatus*	3.31	8.61
4	*Siganus rivulatus*	2.51	6.14	*Carybdis longicollis*	1.90	4.95
5	*Dasyatis pastinaca*	2.35	5.74	*Merluccius merluccius*	1.55	4.02
6	*Pagellus erythrinus*	2.35	5.74	*Parapenaeus longirostris*	1.45	3.78
7	*Mullus barbatus*	1.48	3.61	*Squatina squatina*	1.24	3.22
8	*Mullus surmuletus*	1.34	3.28	*Arnoglossus laterna*	1.22	3.18
9	*Diplodus annularis*	1.05	2.57	*Myliobatos aquila*	0.925	2.41
10	*Callionymus flamentosus*	0.87	2.11	*Sephia officinalis*	0.800	2.08

26.66% for the whole study period. Lessepsian fish were consisted18.90% of the total species number. Actually, in this research and in the above mentioned studies, species such as *S. undosquamis*, *Upeneus moluccencis*, *Upeneus pori*, and *Leiognathus klunzingeri* have been included in the main catch and become important component of the regional trawl fishery (Bingel, 1987; Gücüet al., 1994). Whereas, in other researches in the studied area (Bingel, 1987; Anonymous, 1993; Gücü et al., 1994), *S. undosquamis*, *U. moluccensis*, and *L. klunzingeri* were the main catch. In recent years, *U. pori* (Çiçek et al., 2002) has also been increasing in the main catch. In this study, we found that above mentioned species were included in the main catch except for *U. moluccensis*. Although it was caught previously and not come across in our work. Ben-Yami and Glaser (1974) reported that there were a significant annual fluctuations in CPUE for this species (during1956 to 1970). Therefore, it can be said that one can face a similar situation in the coasts of Karataş even though no record of *U. pori* was reported in the main catch before 2000, however, it was found in both the study by Çiçek et al. (2001, 2002) and in the present study.

Catch composition: Teleost fish consist 76.98% of the main catch, followed by crustaceans with 15.98% and cephalopods with 7.04% (Table 3) in the main catch. The prevalent species in the main catch were *M. barbatus* (19.48%), *C. longicollis* (15.98%) and *S. undosquamis* (15.56%). Lessepsian fish consist 29.80% of the main catch. If *C. longicollis* is considered to be a Lessepsian crustacean species, this proportion increases to 44.88%.

When the proportion of total catch and CPUE of species that made up the main catch (Gücü and Bingel, 1994) were compared with the results gathered from Iskenderun Bay between 1983 and 1984 in our study area, a great difference was observed between them (Tables 3 and 4). While 6 species included in the main catch in 1983 and 5 species in 1984 were observed, none of these species were included in the main catch in the 2002-2003 fishing season. Moreover, there were remarkable differences in the order of species that were included in the main catch, in terms of CPUE and proportions. For instance, *M. barbatus*, which constituted 19.48% of the catch and weighed 3.1 kg h^{-1} for CPUE in 2002-2003, was seventh in 1983, with 3.61% of the catch with1.5 kg h^{-1} for CPUE. In 1984, it was the third most important component with 8.61% of the catch with 3.3 kg h^{-1} for CPUE. This situation is an indicator of the lack of a remarkable difference in CPUE of this species. *Saurida undosquamis*, which was third in this study with 15.56% of the total catch and 2.5 kg h^{-1} CPUE, was the main component of the catch in 1983 and 1984 with 26.79% and 41.85% of the total catch, respectively. When its CPUE was considered in our study, it was 4 times lower than that of 1983 and 6 times lower than 1984. *Charybdis longicollis*, which was not in the main catch in 1983, became fourth in abundance with 4.95% with 1.9 kg h^{-1} CPUE in 1984. This species was second in abundance at 15.98% of the total catch and 2.6 kg h^{-1} CPUE in 2002-2003 showing a substitution of species with little or no commercial value as result of decreasing commercially important fish due to fishing pressure.

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