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A case study on catch characteristics of European hake gillnet fishery in the southern Sea of Marmara, Turkey

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Abstract: The focus of the present study was to provide information on European hake gillnet fishery in the southern Sea of Marmara (Turkey) based on samples collected during in high fishery season between April and May 2013 with experimental gillnets of different mesh sizes. European hake gillnets of three mesh sizes 28, 30, and 32 mm (nominal bar length) were set at between the 50 and 70 m depth water to test the effects of mesh size on the species composition, size of fish, catch rates, catch composition, bycatch and discard ratios and CPUE estimates. Cluster analysis was used to examine the stability of the results. Multi-dimensional scaling (MDS) was also applied to assess catch species aggregation patterns in the catch. The results showed that, 1062 specimens (182.79 kg) belonging to 8 species were caught and *Merluccius merluccius* and *Solea solea* were two dominant species of the catches with all studied mesh sizes with the percentage of 76.57, 19.54% in biomass and 48.96, 39.36% in number of specimens, respectively. The size frequency distribution of *M. merluccius* and *S. solea* are determined with the length range of 23.5 to 41.0 cm TL (mean 31.9 ± 0.14 cm) and 18.5 to 35.5 cm TL (mean 22.2 ± 0.09), respectively. The highest CPUE estimates by number and biomass of European hake was determined in 30 mm mesh size as 0.093 $n.m^{-1}$ and 25.153 $g.m^{-1}$, respectively. The similarity levels found by cluster analyses indicated that 32 mm mesh size is different from 28 and 30 mm mesh size with 85.67 and 85.55% respectively, for number of specimens and biomass based on standardized data. Since the present study reported here is the first concerning European hake gillnet fisheries and these findings will help to improve the management and conservation of this fishery.

Résumé : *Etude des captures de la pêcherie de merlu au filet maillant dans la partie méridionale de la Mer de Marmara, Turquie*. L'objet de cette étude était de fournir des informations sur la pêcherie de merlu au filet maillant de la partie méridionale de la Mer de Marmara (Turquie) à partir d'échantillons récoltés au cours de la saison de pêche, entre avril et mai 2013, à l'aide de filets maillants expérimentaux de différentes mailles. Les filets maillants pour le merlu de trois mailles, 28, 30 et 32 mm (longueur nominale) ont été déployés entre 50 et 70 m de profondeur afin de tester l'effet de la taille de maille sur la composition spécifique, la taille des poissons, les taux de capture et la distribution des espèces, les taux de capture accessoire et de rejet ainsi que l'estimation du CPUE. L'analyse de groupement et le MDS ont été utilisés pour analyser les résultats. Ceux-ci mettent en évidence que 1062 individus (182,79 kg) appartenant à 8 espèces ont été capturés et que *Merluccius merluccius* et *Solea solea* étaient les 2 espèces dominantes, quelle que soit la maille utilisée (76,57 et 19,54% de la biomasse, 48,96 et 39,36% de l'abondance, respectivement). La fréquence de taille des 2 espèces

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était respectivement de 23,5 à 41,0 cm TL (moyenne = 31,9 ± 0,14 cm) pour le merlu et de 18,5 à 35,5 cm TL (moyenne = 22,2 ± 0,09 cm) pour la sole. Les plus fortes estimations du CPUE en abondance et en biomasse étaient pour le merlu de 0,093 n.m^{-1} et 25,153 g.m^{-1} pour une maille de 30 mm. L niveaux de similarité de l'analyse de groupement a mis en évidence des résultats différents des deux autres mailles pour la maille de 32 mm. Ces premières données relatives à la pêcherie de merlu au filet maillant vont permettre d'améliorer la gestion et la conservation de la pêcherie.

Keywords: European hake ● gillnet ● catch composition ● CPUE ● Sea of Marmara

Introduction

Hakes constitute a group of species with a large range commercial importance and the genus *Merluccius* is currently represented by 12 species that are widely distributed (Cohen et al., 1990; Silva-Segundo et al., 2011). Among them, the European hake *Merluccius merluccius* Linnaeus, 1758, usually found in depths between 50 and 370 m (Lloris et al., 2005), is one of the most economically important exploited demersal species in Europe (Santos et al., 2002; Abella et al., 2005). It is a target species for many European fisheries, as well as an important component of multispecific fisheries carried out by all coastal countries. In the Mediterranean Sea, hake is mainly caught with trawls, and to a lesser extent, with longlines and gillnets (Lloris et al., 2005). There are deep-water gillnet fisheries targeting the European hake in a number of countries, such as Portugal, Spain, France, England, Italy and Greece (Aldebert et al., 1993; Martos & Peralta, 1995; Papaconstantinou & Stergiou, 1995). The European hake known as heavily exploited in Atlantic; the so-called Northern (ICES Division IIIa, Subareas II, IV, VI and VII and Divisions VIIIa, b & d), and Southern stock (ICES Division VIIIc & IXa) is a main target species in most of Mediterranean fisheries and is evaluated as overfished species (GFCM, 2008; ICES, 2008; Korta et al., 2009).

Gillnets are extensively used in the Sea of Marmara, especially, the European hake is the main target species of deep sea gillnet fishery along the southern Sea of Marmara. According to Turkish Statistical Institute (TSI, 2013), the Sea of Marmara comes in the second place with 204.7 t in total catch when compared to the Aegean Sea (453.9 t), Mediterranean Sea (16.8 t) and Black Sea (0.6 t). Trawl fishing is the main gear in terms of catch for this species along the Turkish Mediterranean, Aegean and Black Sea coasts. However in the Sea of Marmara trawl fisheries has been forbidden by the law since 1981. Therefore this commercial species are mainly caught as target species for gillnets, as bycatch species for beam trawls and beach seines.

Gillnets are widely used in small-scale fisheries (SSF) because they require little investment in labour and equipment, and are effective in catching widely scattered fish populations (Reis & Pawson, 1992). Deep sea European hake gillnet fishery is a major fishing activity for the Gemlik bay, the southern Sea of Marmara. Since beam trawl and beach seine fishery is not suitable for the fishing ground, gillnets are the most commonly used for harvesting European hake in this area due to operation, low discard ratio and high commercial bycatch value. Additionally, there is currently no legislation concerning on European hake fishery except for MLS (25 cm) in Turkish waters. Since the nature of the commercial fishing operations that are necessary for reasonable management of this important fishery we aimed to study the effect of mesh sizes for European hake gillnet fishery. According to our literature survey the present study is the first report and constitutes an additional attempt to improve the available information on catch characteristics of deep sea European hake gillnet fishery in the southern Sea of Marmara.

Fisheries management can have many objectives, including conservation, political, social, and economic objectives. However, the most common advice is based on maximizing yield from a fishery (Maunder et al., 2006). The size of the population, species growth rates and catch size in one region may be quite different depending on the fishing area. Fished species are often regulated by prohibiting the landing of individuals below a MLS. This size limit is typically set big enough that some individuals are allowed to reproduce before capture. According to Hilborn & Hilborn (2012), the growth rates can differ greatly from place to place, and the appropriate size limit in one part of the coast, or even one side of a rocky reef, may be different in another place. Regulations and management need to be very locally adapted. From this point of view the studies of different region has great importance on sustainable fisheries management.

To the best of our knowledge there is no previous report concerned on catch characteristics of European hake gillnet fishery in the southern Sea of Marmara including fisheries

management of this species. The current study reports the effects of different mesh size on species composition, size of fish caught, catch rates, catch composition, bycatch and discard ratios and CPUE for the deep sea European hake gillnet fishery.

Materials and Methods

Study area

The study area is the coastal waters of South-eastern Sea of Marmara, Gemlik Bay which is an approximately 35 km long and 15 km wide basin located in the south-eastern corner of the southern shelf of the Sea of Marmara (Fig. 1). The maximum depth in the bay is about 110 m (Kuşçu et al., 2009). There are 10 fishing ports with registered 1008 fishing vessels which engaged in fisheries (UDHB, 2011). However no records are kept on the number of fishing boats using for the European hake gillnets. The fishing surveys were conducted between April and May 2013 which is the highest fishery season due to the high abundance of hake. This season is the traditional period of operation for the European hake gillnet fishery and 30 mm mesh size is also currently used for commercial European hake fishery so the fishing operations were performed as the way of fishermen.

Data collection

Catch composition, size of fish, catch rates, by-catch and discard ratios and CPUE were estimated for 12 fishing trials using bottom set gillnets conducted between the 50 and 70 m depth. The fishing operations were performed as the way of fishermen. The experimental nets were 200 m long and 60 meshes high (each one) with mesh size 28, 30, and 32 mm (nominal bar length) and were emplaced to the seafloor at the same soaking time (22 hours). After each set, all specimens from the experimental catches were determined and measured for weight (W; g) and total length (TL; cm) for all organisms entangled. In some cases specimens were frozen and brought to the laboratory for identification.

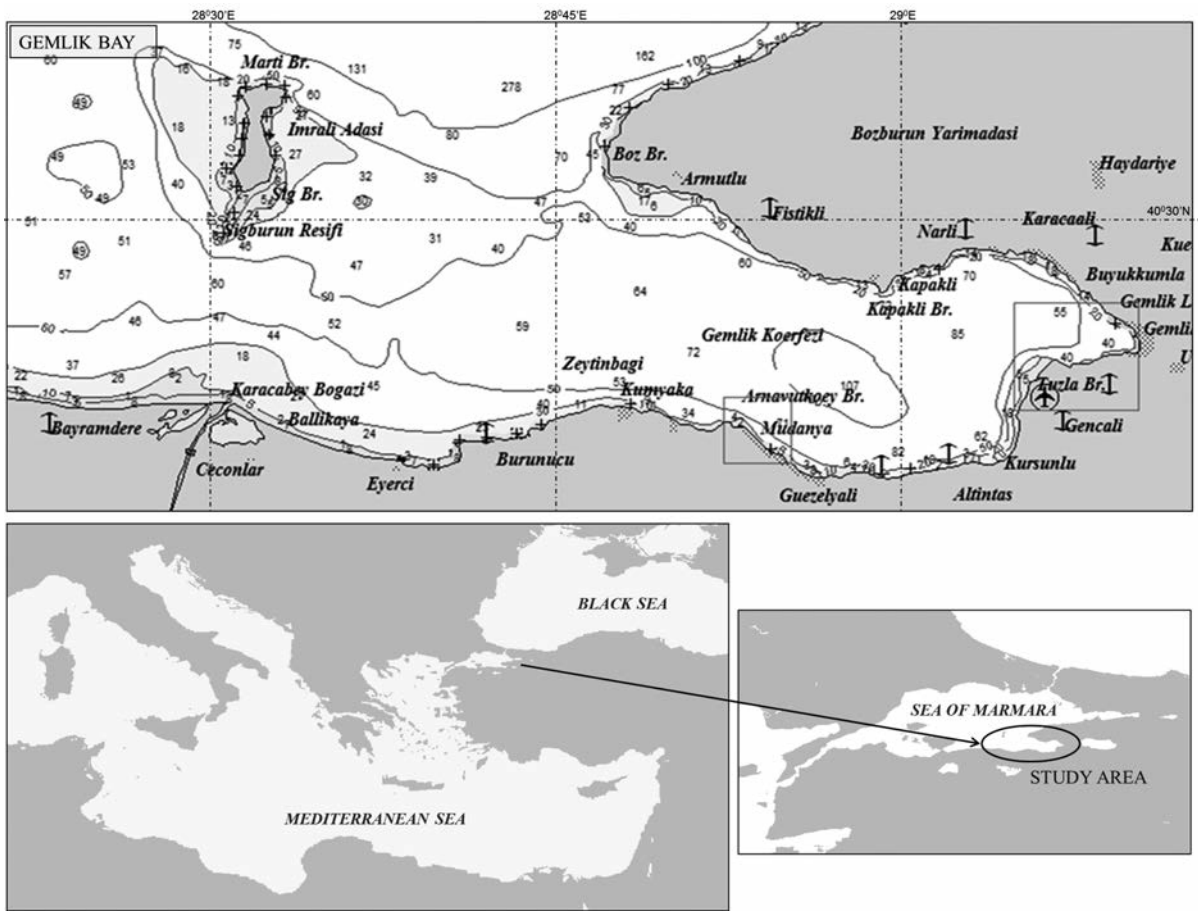

Figure 1. Study area: The Sea of Marmara, Gemlik Bay.

Data analysis

The Catch per unit effort (CPUE) was calculated according to Hyvärinen & Salojärvi (1991) as follows:

$$CPUE = \Sigma (Y / L) / N \quad (1)$$

where Y is the fish biomass (g) or number of specimens in one lift, L is the length (m) of nets lifted and N is the number of lifts. All catch composition were analysed in terms of multivariate analysis using the package PRIMER v6 (Clarke & Gorley, 2006). The Bray-Curtis similarity index was used on standardized data (Bray & Curtis, 1957). In order to explain mesh size differences for catch composition in number and biomass, the Multi-Dimensional Scaling (MDS) ordination method was employed and consulted two dimensional MDS. The relative abundance of different mesh size in all samples formed the matrix which was used for cluster analyses as well as MDS analyses. Clustering was made using the Group-Average linking routine. The MDS analyses in a two-dimensional (2D) plot indicates the similarity of samples. Both cluster and MDS were applied on the numbers and biomass of each species three mesh size. Cumulative dominance curves were plotted for all mesh sizes to show the abundance trends. For statistical analysis the t-test was also used to compare of the mesh size frequency distribution for TL of the species.

Results

Catch composition

A total of 1062 individuals having 182.787 kg in weight were collected during the study, belonging three taxonomic groups (Chondrichthyes, Osteichthyes and Arthropoda). Seven fish species which belong to six families and an invertebrate species were identified. Among them two species were recorded as discard. In total, the Osteichthyes was the most dominant with 98.64% of biomass and 99.34% of specimen number. Both *Merluccius merluccius* and *Solea solea* (Linnaeus, 1758) which are commercially valuable species were observed as the highest catch in all species (Table 1).

The number of specimens, biomass and percentage of their occurrence are shown in Table 2 according to mesh size. The greatest amount of fish caught by number was *M. merluccius* in 28 and 30 mm, *S. solea* in 32 mm mesh size. The highest catch amount by biomass in all mesh size was *M. merluccius* while *S. solea* is the higher in terms of number (Fig. 2).

M. merluccius, *Trachurus mediterraneus* (Steindachner, 1868), *Chelidonichthys lucerna* (Linnaeus, 1758) and *S. solea* in general, were caught in all mesh size with proportions of 76.57, 0.80, 1.61 and 19.54% in biomass, and 48.96, 8.19, 2.54 and 39.36% in number of specimens, respectively. Figure 3 shows the occurrence of *M. merluccius* being target species and other species in terms of percentages. It was observed that *S. solea* is the main bycatch species in comparison with other species.

Cumulative dominance curves were plotted based on all mesh sizes used and shown in figure 4. With respect to mesh size of 28, 30 and 32 mm indicated the similar dominance trend in this study however it can be seen that 30 mm has the highest dominance behaviour.

The similarity levels at which the different groups were indicated by cluster analysis showed that 32 mm mesh size

Table 1. Percentage of species distribution according to level of taxonomic classification in total amount of catch.

	Species	c/nc	n	%	W (g)	%
Chondrichthyes	RAJIDAE					
	Raja clavata	nc	1	0.09	2415.00	1.32
Osteichthyes	MERLUCCIIDAE					
	Merluccius merluccius	c	520	48.96	139968.83	76.57
	CARANGIDAE					
	Trachurus mediterraneus	c	87	8.19	1457.44	0.80
	TRIGLIDAE					
	Chelidonichthys lucerna	c	27	2.54	2946.10	1.61
	SOLEIDAE					
	Buglossidium luteum	nc	1	0.09	40.00	0.02
	Solea solea	c	418	39.36	35711.83	19.54
	LOPHIIDAE					
	Lophius piscatorius	c	2	0.19	175.18	0.10
Arthropoda	PENAEIDAE					
	Parapenaeus longirostris	c	6	0.56	72.75	0.04
Total			**1062**	**100.00**	**182787**	**100.00**

Commercial species (c); non-commercial specimens (nc); number of specimens (n).

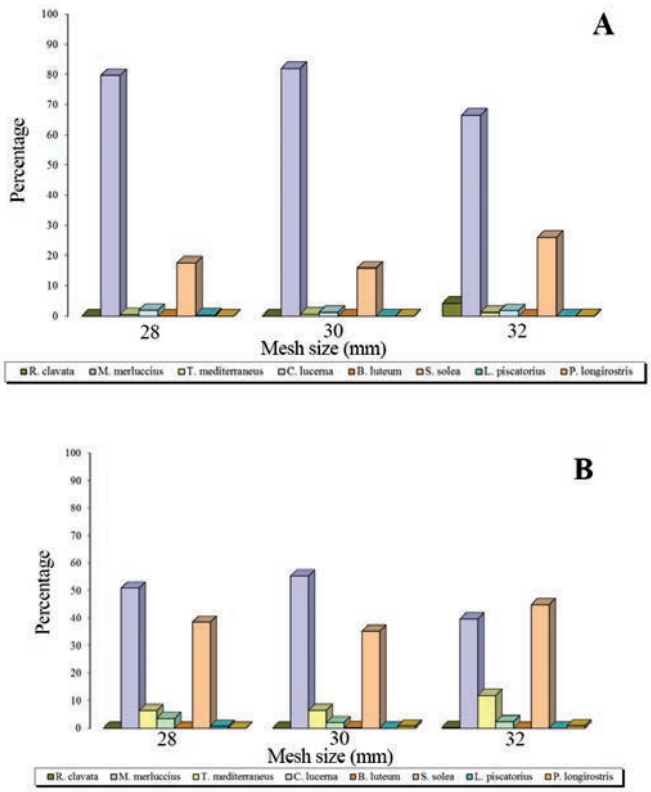

Figure 2. Distribution of fish species according to mesh size in biomass A and in number B.

is different from 28 and 30 mm mesh size with 85.67 and 85.55% respectively, for number of specimens and biomass based on standardized data (Fig. 5).

Multivariate analysis (cluster and MDS) were also used in order to analyse differences in catch composition between the three mesh sizes (Fig. 6).

A total of two species out of the eight caught were non-commercial (Table 1). Table 3 indicates the commercial catch ratio, discard catch ratio and commercial/total catch ratio in number and weight.

Catch size composition

The size ranges of caught fish species are shown in Table 4. The length frequency of *Raja clavata* Linnaeus, 1758 (n = 1), *Buglossidium luteum* (Risso, 1810) (n = 1), *Lophius piscatorius* Linnaeus, 1758 (n = 2) can not be calculated because of the small number of catch. *C. lucerna* (n = 27) and *T. mediterraneus* (n = 87) was evaluated despite of their small numbers.

Among these species *M. merluccius* and *S. solea* which are commercial species were dominant and their size range parameters according to mesh size are also given in Table 5. The size frequency distribution of *M. merluccius* and *S. solea* are depicted in Figure 7 for each mesh size studied as well as total catch, with a length range of 23.5 to 41.0 cm TL (mean 31.9 ± 0.14 cm) and 18.5 to 35.5 cm TL (mean 22.2 ± 0.09),

Table 2. Percentage of species occurrence according to mesh size in number and biomass.

	28 mm				30 mm				32 mm			
Species	**n**	**Occ. %**	**W (g)**	**Occ. %**	**n**	**Occ. %**	**W (g)**	**Occ. %**	**n**	**Occ. %**	**W (g)**	**Occ. %**
R. clavata	-	-	-	-	-	-	-	-	1	0.29	2415.00	4.27
M. merluccius	160	50.96	41978.28	79.69	223	55.33	60367.91	82.06	137	39.71	37622.64	66.54
T. mediterraneus	20	6.37	266.29	0.51	26	6.45	491.03	0.67	41	11.88	700.12	1.24
C. lucerna	11	3.50	1008.98	1.92	8	1.99	931.55	1.27	8	2.32	1005.57	1.78
B. luteum	-	-	-	-	1	0.25	40.00	0.05	-	-	-	-
S. solea	121	38.54	9249.48	17.56	142	35.24	11707.21	15.91	155	44.93	14755.14	26.10
L. piscatorius	2	0.64	175.18	0.33	-	-	-	-	-	-	-	-
P. longirostris	-	-	-	-	3	0.74	31.27	0.04	3	0.87	41.48	0.07
Total	**314**	**100.00**	**52678**	**100.00**	**403**	**100.00**	**73569**	**100.00**	**345**	**100.00**	**56540**	**100.00**

Table 3. Commercial, discard and commercial/total catch ratio in number and biomass for mesh size.

Mesh size	**Commercial**				**Discard**				**Commercial/Total**	
	n	**%**	**W**	**%**	**n**	**%**	**W**	**%**	**n**	**W**
28 mm	314	100.00	52678.21	100.00	0	0.00	0.00	0.00	1.000	1.000
30 mm	402	99.75	73528.97	99.95	1	0.25	40.00	0.06	0.998	0.999
32 mm	344	99.71	54124.95	95.73	1	0.29	2415.00	4.27	0.997	0.957
Total	**1060**		**180332**		**2**		**2455**		**0.998**	**0.987**

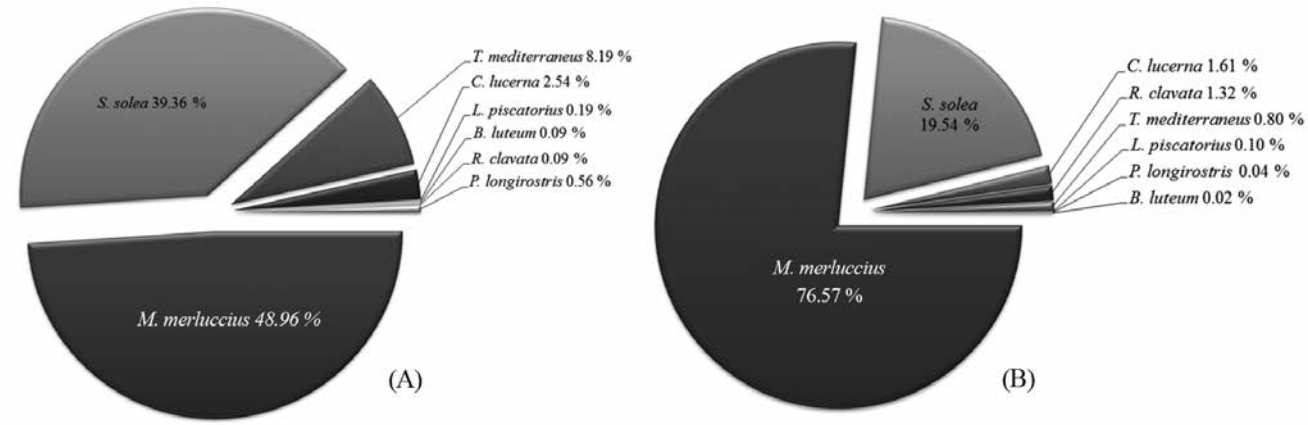

Figure 3. Percentage distribution of the species composition in number of specimens (A) and biomass (B).

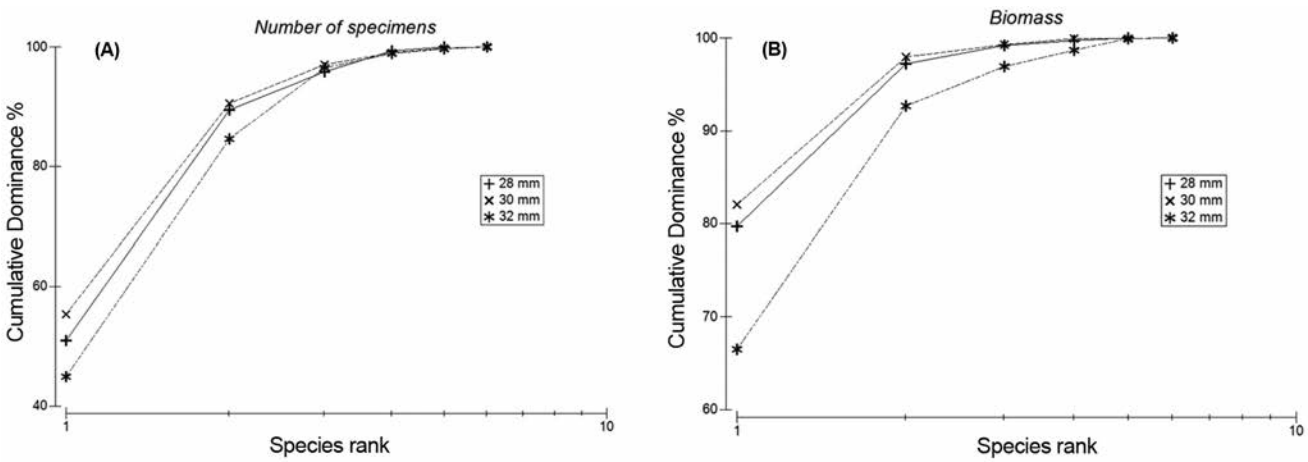

Figure 4. K-dominance curves based on number of specimens (A) and biomass (B).

respectively. The t-test showed statistically that there is no significant differences is between the mesh size frequency distribution for both species ($p < 0.05$).

CPUE estimates

The catch data of each mesh size obtained from 12 fishing operations was standardized with CPUE by number and

Table 4. Size ranges of fish species.

Species	n	TL (cm)			
		min	max	Mean ± se	sd
R. clavata	1	70.0	70.0	-	-
M. merluccius	520	23.5	41.0	31.9 ± 0.14	3.26
T. mediterraneus	87	8.0	16.5	12.2 ± 0.25	2.36
C. lucerna	27	13.7	31.0	20.7 ± 0.82	4.24
B. luteum	1	16.0	16.0	-	-
S. solea	418	18.5	35.5	22.2 ± 0.09	-
L. piscatorius	2	21.2	21.5	-	-

Table 5. Size range parameters of *M. merluccius* and *S. solea* according to mesh size.

Species	Mesh size	n	TL (cm)			
			min	max	Mean ± se	sd
M. merluccius	28	160	24.0	41.0	31.7 ± 0.25	3.11
	30	223	23.5	41.0	32.1 ± 0.21	3.17
	32	137	23.5	41.0	31.8 ± 0.30	3.57
S. solea	28	121	19.0	33.5	21.5 ± 0.16	1.71
	30	142	18.5	26.5	22.0 ± 0.13	1.54
	32	155	18.5	35.5	22.8 ± 0.16	2.05

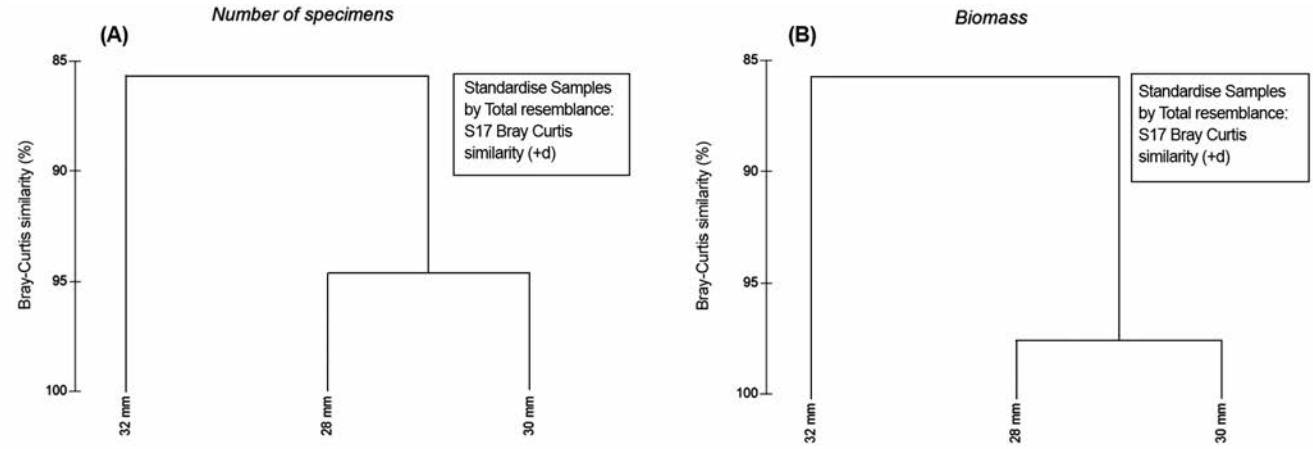

Figure 5. Cluster dendrogram based on group average linking of Bray-Curtis similarity matrix of catch data for all species in number (**A**) and biomass (**B**) at the three mesh sizes.

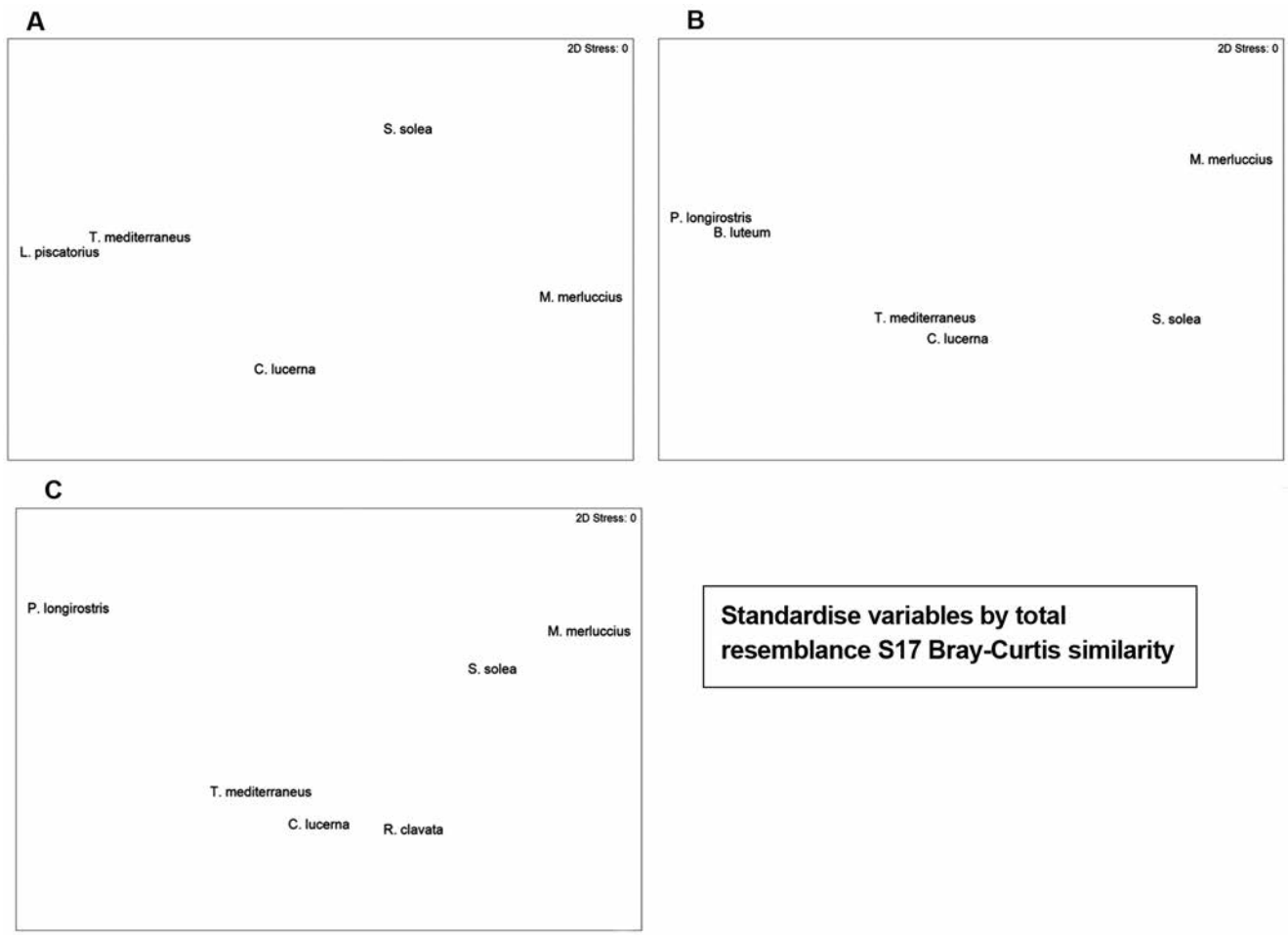

Figure 6. MDS analysis of the collected species in biomass for three mesh sizes. **A.** 28 mm. **B.** 30 mm. **C.** 32 mm.

Table 6. Calculated CPUE estimates for each mesh size by number.

Species	28 mm		30 mm		32 mm	
	Landings (n)	CPUE (n m^{-1})	Landings (n)	CPUE (n m^{-1})	Landings (n)	CPUE (n m^{-1})
R. clavata	0	0.000	0	0.000	1	0.000
M. merluccius	160	0.067	223	0.093	137	0.057
T. mediterraneus	20	0.008	26	0.011	41	0.017
C. lucerna	11	0.005	8	0.003	8	0.003
B. luteum	0	0.000	1	0.000	0	0.000
S. solea	121	0.050	142	0.059	155	0.065
L. piscatorius	2	0.001	0	0.000	0	0.000
P. longirostris	0	0.000	3	0.001	3	0.001
Total	**314**	**0.131**	**403**	**0.168**	**345**	**0.144**

Table 7. Calculated CPUE estimates for each mesh size by biomass.

Species	28 mm		30 mm		32 mm	
	Landings(g)	CPUE (g m^{-1})	Landings (g)	CPUE (g m^{-1})	Landings (g)	CPUE (g m^{-1})
R. clavata	0.000	0.000	0.000	0.000	2415.000	1.006
M. merluccius	41978.280	17.491	60367.910	25.153	37622.640	15.676
T. mediterraneus	266.290	0.111	491.030	0.205	700.120	0.292
C. lucerna	1008.980	0.420	931.550	0.388	1005.570	0.419
B. luteum	0.000	0.000	40.000	0.017	0.000	0.000
S. solea	9249.480	3.854	11707.210	4.878	14755.140	6.148
L. piscatorius	175.175	0.073	0.000	0.000	0.000	0.000
P. longirostris	0.000	0.000	31.270	0.013	41.480	0.017
Total	**52678**	**21.949**	**73569**	**30.654**	**56540**	**23.558**

biomass. Calculated CPUE estimates are presented in Tables 6 and 7 according to mesh size in number of specimens and biomass based on species. Table 8 is also given to summarize total CPUE based on mesh size.

According to Tables 6 and 7, M. *merluccius* was the highest CPUE followed by *S. solea.* When CPUE calculated on the basis of all catch species were considered, 30 mm mesh size was found to be higher than 28 and 32 mm in terms of number and weight (Table 8).

Discussion

The results obtained in the present study aimed to assess the effect of 28, 30 and 32 mm mesh size on species composition, size of fish caught, catch rates, catch composition, bycatch and discard ratios and CPUE estimates for deep sea European hake gillnet fisheries. During the study, 5 families of finfish, 1 family of rays and 1 family of invertebrates were recorded. In the trials, the higher amount of fish caught by weight and number was *M. merluccius* which is the target species for all mesh sizes used and *S. solea* is the main accessory species. Our analyses indicated that the catches from all mesh size used in this study showed a similar species composition. The Bray-Curtis similarity index also worked well with aggregated data and the MDS ordination. The higher abundance of catch species was determined for 30 mm in biomass and number of specimens compared to the 28 and 32 mm mesh size. This can be explained by the differences of species in composition of the catches in terms of number and weights (Erzini et al., 2010). It might be said that the catches from all mesh size used in the study show a similar species composition, if *L. piscatorius*, *B. luteum*, *R. clavata* and *P. longirostris* are negligible.

The total length (TL) frequency for European hake recorded from the experimental mesh size was very similar and recorded with the length range of 23.5 to 41.0 cm TL (mean 31.9 cm). The majority of European hake caught in these mesh size were 29-35 cm TL. The number of fish caught below 25 cm which is minimum landing size (MLS) limit in Turkish waters according to *Turkish Commercial Fishery Regulations 3/1* (2012) were determined to be as

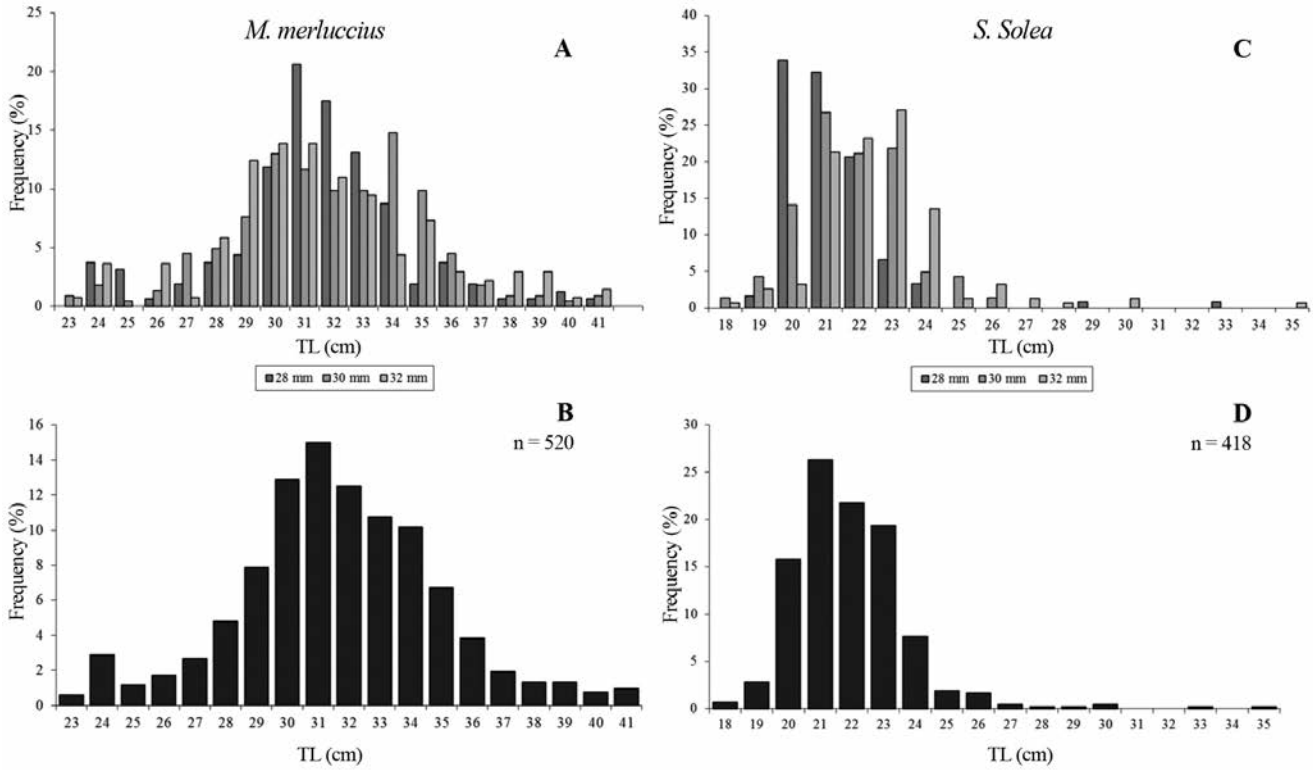

Figure 7. *M. merluccius* (**A & B**) and *S. solea* (**C & D**) size frequency distribution for mesh size and total catch.

18 cm with the percentage of 3.5% in caught all hakes. According to mesh size, the distribution of below MLS of *M. merluccius*, were found 3.8% (28 mm, n = 6), 2.7% (30 mm, n = 6) and 4.4% (32 mm, n = 6) respectively. *S. solea* which has 20 cm MLS was also determined as 3.6% (n = 15). The percentages of undersized of *S. solea* were 1.7% (28 mm, n = 2), 5.6% (30 mm, n = 8) and 3.2% (32 mm, n = 5) depending on mesh size, respectively. *Turkish Commercial Fishery Regulations 3/1* provides an exception to the caught fish of below MLS up to 5% of the total catch in weight. Data obtained from this study showed that the limit was not exceeded for these two species. MLS for *T. mediterraneus* and *C. lucerna* in Turkish waters are 13 cm and 18 cm, respectively. Totally, the number of *T. mediterraneus* (n = 87) and *C. lucerna* (n = 27) caught were also below MLS, representing as 51 (58.6%) and 5 (18.5%) respectively. There is no MLS for *L. piscatorius* and *B. luteum* in Turkish waters. According to Duarte et al. (2002), the length at first maturity of *L. piscatorius* is 70-75 cm for females and 50 cm for males. Although there were two *L. piscatorius* captured, both of their lengths were smaller than those of these sizes. The length at first maturity of *B. luteum* range is 7-8 cm according to FishBase and it was determined as 16 cm in the study.

Table 8. Calculated total CPUE estimates for each mesh size in number and biomass.

Mesh size	Landings (n)	Landings (g)	CPUE (n m^{-1})	CPUE (g m^{-1})
28 mm	314	52678.205	0.131	21.949
30 mm	403	73568.970	0.168	30.654
32 mm	345	56539.950	0.144	23.558
Total	**1062**	**182787**		

There is no previous report on deep sea European hake gillnet fishery catch composition in the southern Sea of Marmara. However there are several studies dealing with European hake using trawl, beam trawl, and gillnet fisheries especially in the northern Sea of Marmara (Deval et al., 2004 & 2007; Bayhan et al., 2006; Yazıcı et al., 2006; Ateş et al., 2009 & 2010; Bök et al., 2010, 2011a & b; Göktürk & Deniz, 2012; Demirel & Dalkara, 2012). Among them, there is one study concerning on European hake gillnet fishery which was carried out in the northern Sea of Marmara by Deval et al. (2004). They reported the selectivity parameters, using the same mesh size (28, 30 and 32 mm) and 200 m long of the net as in the present study. Deval et al. (2004) found that the length ranged from 20 to 42 cm TL for 426 specimens obtained from 9 fishing trials set at between 30 and 50 m depth. They also determined the length between 22 and 40 cm TL for 28 mm (n = 186); 20 and 42 cm TL for 30 mm (n = 180); 24 and

38 cm TL for 32 mm (n = 60), respectively. In the present study the length range were determined between 23.5 and 41.0 cm TL. Depending on the mesh size the length ranged from 24.0 to 41.0 cm TL for 28 mm (n = 160); 23.5 to 41.0 cm TL for 30 mm (n = 223); 23.5 and 41.0 cm TL for 32 mm (n = 137). The maximum length did not change and it was recorded as 41.0 cm TL for all studied mesh size in our case when compared the maximum length between two studies according to mesh size. This can be explained by the fact that this species is easily gilled or entangled by their teeth (Santos et al., 2002; Revill et al., 2007), depending on the depth (Orsi-Relini et al., 2002; Bartolino et al., 2008) and different fishing region as well.

Differences in the Commercial/Total (C/T) catch ratios for studied mesh size can be considered negligible. Thus C/T ratio was found approximately 1.0 by number and by weight for studied mesh size (Table 3). Accordingly discard ratio can be considered negligible in the current study, since their amount was determined as the percentage of 0.00, 0.06, and 4.27 for 28, 30 and 32 mm, respectively. There is only one high value (4.27%) observed for 32 mm mesh size in weight due to the presence of *R. clavata* (2.415 kg) as a discard species. The fact remains that rays are sold commercially if they catch over the amount of 3-3.5 kg by the fishermen. Other commercial species (*T. mediterraneus*, *C. lucerna* and *L. piscatorius*) caught small number and below the MLS are used as food by the crew. The data provided here shows that a diverse assemblage of species are retained and discarded in this gillnet fishery in southern Sea of Marmara. The European hake retained in this gillnet fishery is the species that is targeted by other commercial fishing sectors (e.g. beam trawl, beach-seine and long-lines) in the Sea of Marmara. There are various studies reported on gillnet and other fishing gears for European hake in different areas (Hickford et al., 1997; Borges et al., 2001; Hutchings & Lamberth, 2002; Santos et al., 2002; Stergiou et al., 2004; Gonçalves et al., 2007; Erzini et al., 2010). Correspondingly related studies cited above have been published for the Sea of Marmara. Analysing these studies, it can be seen that the ratio of discard is very low in the present study. The lowest percentage of European hake discard obtained from this study show that these nets are appropriate for European hake fishing. Accordingly discard ratio of these nets are very low and can be ignored.

The highest CPUE estimates by number and biomass of European hake was determined in 30 mm mesh size as 0.093 n m^{-1} and 25.153 g m^{-1}, respectively. Taking into consideration of all mesh size used in this study it can be said that 30 mm mesh size was observed to have more catch efficiency of by number and biomass. This is also supported by the high catch amount of European hake for 30 mm mesh size. Accordingly the species with the higher CPUE was determined to be *M. merluccius* and *S. solea*. Analysis of CPUE is used as an index of abundance, meaning that a proportional change with time in the CPUE is expected to represent the same proportional change in stock size (FAO, 1999; Maunder et al., 2006). As stated by Maunder et al. (2006) the aim of analysing data about a fish stock, including relative abundance trends from CPUE data, is to provide management advice. The present study is the first concerning CPUE estimates for European Hake gillnet fisheries in Gemlik Bay. Based on these CPUE data presented can be used for further studies on the assessment of fish stocks in this region. There is also no reported study or recorded data such as fishing effort, stock size etc. in order to evaluate CPUE estimates finding in this study. So we cannot ascertain the impacts of this fishery on stocks and fisheries management from the data collected here alone. The detailed fishery data should be kept and scientific studies, including monitoring studies, in this area to provide supplementary data in fisheries management applications for European hake. Hence sustainable management can be provided by detection, monitoring, understanding, control of European hake stock. The results obtained from the present study provides also information encouraging further studies on this subject and that should be considered in future management measures for the fishery targeting European hake in the Sea of Marmara.

This study demonstrated that the 30 mm mesh gillnets currently used to target European hake by the fishermen is highly appropriate and catch few European hake less than 25 cm TL compared with the fishery in the Sea of Marmara. The percentage TL frequencies of hake in the commercial (30 mm) and experimental (28 and 32 mm) mesh size were closely comparable and it can therefore be concluded that the results obtained from this paper are representative of those gears used in the southern sea of Marmara deep sea European hake gillnet fishery.

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