Pakistan J. Zool., vol. 46(4), pp. 1061-1068, 2014.

Estimation of Age, Growth and Reproduction of Boarfish, *Capros aper*, in the South Aegean Sea

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Abstract.- The present study investigated the age, growth, reproduction of boarfish (*Capros aper* L., 1758) collected from the South Aegean Sea between December 2009 and November 2010. The length-weight relationship was $W= 0.019*L^{2.93}$ (n=790; r^2= 0.95). Age data based on otoliths were comprised from 0^+ to 4^+. The parameters of the fitted von Bertalanffy growth equation were L_∞ = 11.05 cm, k = 0.447 year^{-1}, t_0 = -0.480. Macroscopic gonad examination and analysis of the monthly values of the GSI, indicated that reproduction occurs between April and August. Individuals become sexually mature at around 6.69 cm total length (TL) (a size that can be reached on 1.84 years) for both sexes. Sex ratio (female:male) was found as 1.00:0.74.

Keywords: Growth and reproduction, boarfish, *Capros aper*.

INTRODUCTION

Members of the teleost family Caproidae (known as boarfish) are widely distributed throughout Atlantic, Indian, and Pacific Oceans (Nelson, 2007). Caproids are generally small to medium sized coastal marine fishes that are abundant and by-catch species in demersal, pelagic and crustacean-trawl fisheries (Sartor *et al*., 2001; Borges *et al.*, 2005; Fonseca *et al.*, 2005; Farrell *et al.*, 2012). The family is characterized by having rhomboidical-shaped, laterally compressed and small protractil mouth (Nelson, 2007). There are 18 species within the Caproidae, and one belongs to the genus *Capros*.

Until recently, biological studies on this species have been limited in literature, because *Capros aper* (Linnaeus, 1758) has no commercial value, especially in Mediterranean, being a small size fish. The boarfish is distributed along the Eastern Atlantic (western Norway, Skagerrak, Shetlands and western Scotland to Senegal) and the Mediterranean (Quéro, 1986) between 40-700 m (Mytilineou *et al.*, 2005). This species spreads a wide range habitats including over rock or coral, but also over sandy ground and feed mainly on crustaceans, worms, mollusks (Quéro, 1986).

In last 30 years, abundance of *C. aper* has been increased exponentially in most parts of Northeast Atlantic (Southwest Ireland, Celtic Sea, Biscay Bay), that represents the main existence region of species, owing to climate change and/or variability of its distribution (Blanchard and Vandermeirsch, 2005). Thus, the boarfish have recently become newly target species in commercial fishery conducted in Northern Atlantic. The annual catch rates increased from 600 t to 21584 t in Celtic Sea (White *et al.*, 2011) and from 18382 t to 100000 t in Celtic Sea and Southwest of Ireland (Hüssy *et al.*, 2012b).

Despite the increasing globally exploitation and importance of this species in commercial fisheries, no detailed information on its biology in Mediterranean is known. The aim of present study was therefore to determine biological parameters of *C. aper*.

MATERIALS AND METHODS

Study sites

Specimens of *C. aper* were collected randomly between 30-225 meters depths via F/V AKYARLAR (crustacean trawl vessel) during sixty-eight hauling carried on from December 2009 to November 2010 in South Aegean Sea (37.5° to 37.0° N). In the sampling, traditional bottom trawl nets (44 mm strecthed mesh size), locally called Ottoman nets, were used. Towing duration was limited to 30 minutes and the average trawling speed was approximately 2.5 knots. Specimens were

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0030-9923/2014/0004-1061 $ 8.00/0

identified on board and then stored on ice and carried in the laboratory.

For each fish, total length (TL, cm) to the nearest 0.1 cm and wet weight (W, g) to the nearest 0.01 g were measured in the laboratory. The sagittal otoliths from 600 fish were removed for age estimation.

Age and growth

Estimated age was accomplished by sectioned otoliths. Each pair of sagittal otoliths was embedded in polyester catalyst and cut through Buehler-Isomet precision saw. The section was mounted on glass microscope slide with Buehler Crystalbond Mounting Wax and observed on stereo microscope using reflected light against a dark background. Annuli were identified as translucent and opaque zones where formed around the sulcus. Sum of each translucent and opaque zone was accepted representing annual growth. Otoliths were read twice by two different readers (blind reading). When no agreement between the two readings was found, the otolith was excluded.

To examine fish growth, von Bertalanffy growth equation was calculated using the iterated least square method (Beverton and Holt, 1957):

$$L_t = L_\infty \, (1\text{-}e^{-k(t\text{-}t0)}),$$

where, L_∞ is the asymptotic total length, L_t the total length at age t, k the growth curvature parameter and t_0 is the theoretical age that fish would have been at zero length (Sparre and Venema, 1992). Von Bertalanffy growth curves were fitted to each sex separately and to combined data. The differences between sexes were compared by *F*-test.

Growth performance index (φ') that allows to compare the growth rates of populations living in different areas was calculated by the following formula (Pauly and Munro, 1984),

$$\varphi' = \log_{10} k + 2 \log_{10} L_\infty$$

The logarithmic relationship between weight and length (LWR) was accomplished by the following formula (Sparre and Venema, 1992): $ln\ W = ln\ a + b\ ln\ TL$.

Parameter *a* and *b* were calculated by least-squares regression, as was the coefficient of determination (r^2). Standard error was calculated for the slope (*b*): significant difference of *b* values from 3, which represents isometric growth, was tested by the *t-test* (Pauly and Munro, 1984) with values of $P < 0.05$ considered significant. Upon the statistical approach, differences on LWR between sexes were tested by analysis of covariance (ANCOVA).

Reproductive biology

Sex of specimens was assessed by the existence of ovaries or testes. Stage of reproduction was assigned by macroscopic observation based on Holden and Raitt (1974). Fish were classed as being either mature (stage 3 or greater were accepted as capable of spawning during current spawning period) or immature (stage 2 or less). The gonads were then weighed to the nearest 0.01 g and a gonadosomatic index (GSI) (gonad weight expressed as a percentage of bodyweight without gonad) was calculated (Wootton, 1991). The parameters, length (L_{50}) and age (A_{50}) at first maturity, for combined sexes, were obtained by fitting logistic ogives to the proportion of sexually mature individuals by non-linear least squares analysis (King, 1995). Difference of maturity curves between sexes were determined by chi-square test.

RESULTS

A total of 790 specimens of *C. aper* were collected during the surveys. The collected fish ranged in total length from 3.50 to 10.50 cm (mean ± S.D = 7.19±0.27 cm) and in weight from 2.53–25.82 g (mean ± S.D = 7.42±3.44 g).

The otolith core region of boarfish was slightly opaque, followed by a narrower translucent zones. Counts of opaque zones were made for 600 boarfish otoliths. Counts ranged from 1 to 4. There was 94% agreement between all readings then 36 otoliths were not considered. Thus, 199 (35.3%) males, 325 (57.6%) females and 40 (0.7%) undetermined individuals (n = 564) were used for direct reading on otoliths. In terms of appropriate age readings, maximum age was found as 4 years for both sexes. Percentage of age groups belonging to population were 0^+ (6%), 1^+ (6%), 2^+ (61%), 3^+ (22%) and 4^+ (5%) (Fig. 1). As a result, 0^+ and 1^+

years old individuals were poorly observed while 2+ years old ones were dominant.

The estimated von Bertalanffy growth parameters fitted from data were as follows: L_∞ = 11.05 cm, k = 0.45 year^{-1} and t_0 = -0.480 year for the total sample. The differences between sexes were not statistically significant in *F*-test (P>0.05). However, females reached a greater asymptotic length value than males (Table I). The growth performance index (φ´) was estimated as 1.74 for the total sample.

Table I.- Estimated von Bertalanffy growth parameters of *C. aper.*

Sex	n	L_∞	k	t_0	Φ'
♂	318	11.12	0.415	-0.520	1.71
♀	432	11.35	0.432	-0.346	1.75
Total	790	11.05	0.447	-0.480	1.74

Comparison of LWRs between sexes did not represent statistical significance (ANCOVA: F = 2.175, P = 0.344) and the values of b suggest a negative allometry growth (*t-test*, P < 0.05) (b = 2.94 for female and b = 2.93 for male and for the total sample). The high value of r^2 indicated a strong relationship between length and weight (Table II).

As a result of 790 fish that were dissected there were significantly more females (432) than males (318) (χ^2 = 17.328, P < 0.05) and overall sex ratio was found as 1:0.74 (f:m). The number of males was higher than females only in February while the females were more abundants during the rest of the sampling period (Table III).

By the analysis of GSI, *C. aper* displayed spring/summer spawning period between April and August (Fig. 2). Females and males had peak of GSIs during June and May respectively (Fig. 2) however males displayed a similar seasonal pattern in mean GSI values. Additionally, the average maximum GSI values of females was 4.95 compared to 1.1 for males. There were no significant differences between maturity curves for female and male *C. aper* (χ^2 = 0.945, P > 0.05). The data were therefore combined and showed that *C. aper* matured at 6.69 cm TL and 1.84 years (Figs. 3 and 4).

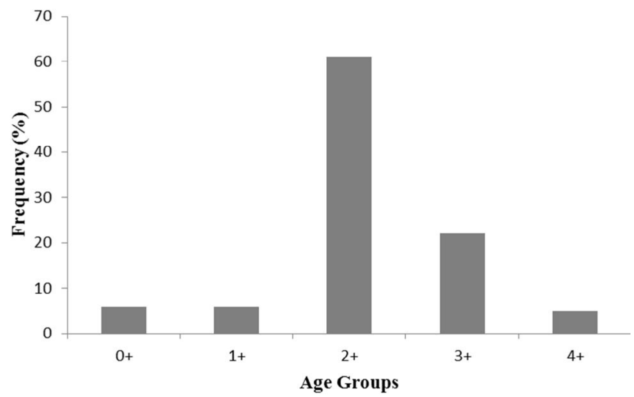

Fig. 1. Frequency of age groups for all individuals of *C. aper*.

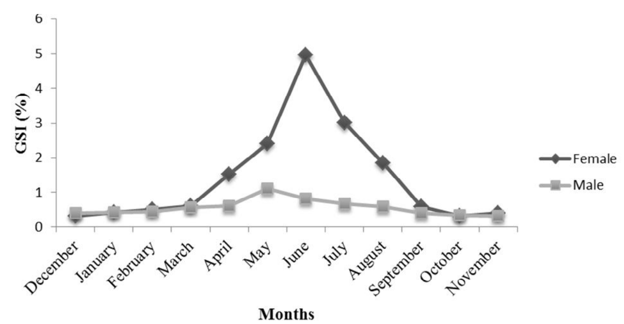

Fig. 2. Variation in gonadosomatic index (GSI) for *C. aper*.

Table II.- Length-weight relationships of *C. aper.*

Sex	n	*L*min – *L*max (cm)	*W*min – *W*max (g)	$W = aL^b$			Growth type
				a	b ± S.D	r^2	
♂	318	5.00 – 9.20	2.45 – 15.19	0.0198	2.934 ± 0.05	0.93	A(-)
♀	432	5.20 – 10.50	2.53 – 25.82	0.0193	2.937± 0.05	0.95	A(-)
Total	790	3.50 – 10.50	1.20 – 25.82	0.0194	2.934 ± 0.04	0.95	A(-)

Table III.- Sex ratio of *C. aper* by months.

Month	Female	Male	Ratio (F:M)
January	18	17	1 : 0.94
February	22	23	1 : 1.04
March	19	13	1 : 0.68
April	33	18	1 : 0.55
May	81	64	1 : 0.79
June	52	31	1 : 0.60
July	71	50	1 : 0.70
August	39	31	1 : 0.79
September	28	19	1 : 0.68
October	23	20	1 : 0.87
November	26	23	1 : 0.88
December	20	9	1 : 0.45
Total	432	318	1 : 0.74

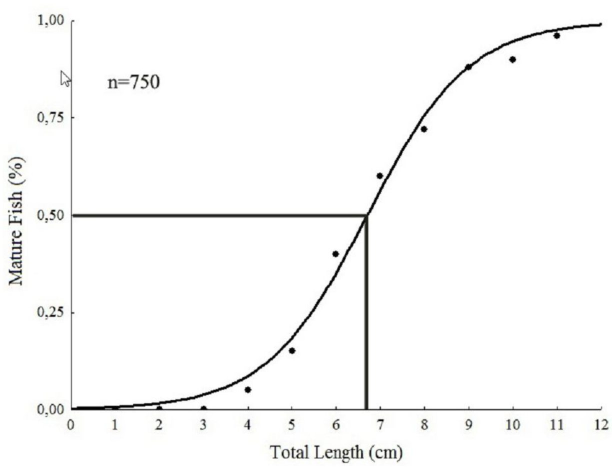

Fig. 3. Length at maturity of *C. aper.*

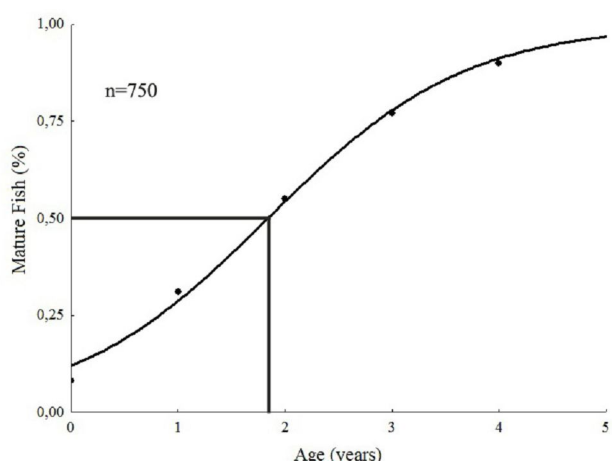

Fig. 4. Age at maturity of *C. aper.*

DISCUSSION

The reproduction cycle of boarfish was observed between April and August. Spawning period based on monthly changes in gonadosomatic index for females, suggested in present study, is similar to preliminary studies. Tortonese (1970) reported a spawning period for *C. aper* as March and August in Mediterranean. Kaya and Özaydın (1996) stated that the collected specimens in July were mature and suggested that spawning period of *C. aper* occurs in spring and summer. In the Northern Atlantic, Farrell *et al.* (2012) claimed that *C. aper* spawn between April-September. Consequently, this suggested that *C. aper* prefer warm waters to spawning. It may be related to oceanographic conditions that are suitable for improving successful recuitment. As it is known, when water temperature begin to warm, larvae may have high food availability (Wootton, 1991). However, without a understanding of the early life history of *C. aper* and oceanographic conditions in species distribution area, possible link between spawning time and oceanographic these processes remain unknown.

According to *t*-test, there was a significant difference in the mean GSI indices between males and females ($P < 0.05$). The GSI patterns of *C. aper* are similar to most of marine fishes. As a known, GSI values of males are commonly lower than those of females. The difference in male and female gonadosomatic indices suggests that energy invested in gamete production by male is probably less than that invested by females. Difference on mean GSI values belonging to males and females of *C. aper* arised from this phenomenon.

Males and females of *C. aper* reached first maturity at 6.69 cm TL and 1.84 years, from their growth rate. Results from reproduction data associated with age and length showed that females are considerably early maturing. In Atlantic Ocean, White *et al.* (2011) found that the length and age at maturity were 8.05 cm (TL) and 4.60 years, respectively. Hüssy *et al.* (2012a), estimated these values as 9.72 cm (TL) and 3.4 years, respectively. In the Mediterranean, these values were found as 8.50 cm (TL) and 2 years by Kaya and Özaydın (1996). Results of reaching maturing time in present study and previous studies conducted in Mediterranean, show similarity. Besides, northern populations of fish is known to reach sexual maturity later because of oceanographic conditions such as primarily water temperature. Sex ratio of *C. aper* was explicitly biased towards females. Males predominated only in February with females predominating through the year. In group spawners, large amounts of sperm enable advantages for successfully fertilizing eggs and broadcast spawning which groups of fish congregate together with the potential for sperm from one male to fertilize the eggs of many females and the eggs from one female to be fertilized by many males and thus males must have gonads of equivalent sizes to females (Karleskint *et al.,* 2010). There is observed distinctly difference in GSI values between male and female *C. aper*, however, the monthly oscillations in GSI values show similarities for both sexes. Therefore, it may be clue that boarfish are group spawners. Additionally, the both sexes were observed in all months, it is indication that females and males co-occur in continental shelf throughout the year.

Growth of boarfish show similarity with pelagic fishes in the Mediterranean based on results of age and growth characteristics. The boarfish, spreading in the Mediterranean Sea, grow rapidly, attain maturation at early stage of life (~2 years), after which growth slowed considerably, ranging of age-classes in population is narrow (from 0^+ to 4^+ years old), and show high colonisation or schooling rate (*r*-strategy). Males and females *C. aper* grow at similar rates. However, females may attain slightly larger sizes than males after sexual maturation. Greater and faster growth trends in females than in males is recognised phenomenon in many marine fishes (Landa and Piñeiro, 2000). The advantages of females reach larger sizes than males may be related to increase reproductive success (*e.g.*, raising fecundity) since there is no observed sexual dimorphism or social interactions in members of this genus.

The exponential length of *C. aper* was estimated as 11.05 cm in Aegean Sea for present study. It may be accepted as realistic because the largest captured specimen was 10.5 cm. This value is different from results of studies from Atlantic waters where asymptotic lengths were reported as 12.89 cm by White *et al.* (2011) and 15.47 cm (mean) by Hüssy *et al.* (2012a). Many demersal fish stocks are much smaller in Mediterranean than Atlantic. This is the best known phenomenon called as dwarfism (Stergiou *et al.,* 1997).

Results of ANCOVA showed that no significant difference was found between males and females in the length-weight relationships. The length-weight relationship, based on 790 individuals, represented negative allometric growth in accordance with the results reported by other authors (Kaya and Özaydın, 1996; Lamprakis *et al.,* 2003; Filiz and Bilge, 2004; Leblebici *et al.,* 2006; White *et al.,* 2011; Hüssy *et al.,* 2012a). The length-weight relationship in fishes can be affected by a number of factors, including season, habitat, gonad maturity, sex, diet and stomach fullness, health and preservation techniques, and differences in the length ranges considering the caught specimen (Tesch, 1971; Wootton, 1991). Furthermore, comparison of length-weight relationships values belong to present and previous studies are also presented in Table IV.

Different longevity has been suggested for boarfish spreading on different seas and oceans. Age-reading results of present study indicated that age classes of *C. aper* varied between 0^+ to 4^+ years (Table V). The age composition of *C. aper* in commercial fishing area showed that typically, between 2 and 3 years old fishes are exploited as a discard.

Regarding age and growth of boarfish, there are considerable differences with data of previous studies. As mentioned by Campana (1984), age-reading from sectioned otoliths are observed higher ages than otoliths read whole. Despite that sectioned otoliths were used to increase precision of age-reading, maximum age was found only 4 years. In the Mediterranean, Kaya and Özaydın (1996) reported maximum age as 4 years. White *et al.* (2011) claimed life span of *C. aper* as 26 years and Hüssy *et al.* (2012b) found as 8 years in Northern Atlantic Ocean. Nevertheless, sampling stations of these two studies (White *et al.*, 2011, Hüssy *et al.,* 2012b) are closer, surprisingly the authors have found extremely different results. It may be reason that White *et al.* (2011) collected samples from

Table IV.- Length-weight relationships values of *C. aper* in different areas (min and max are minimum and maximum total lengths and weights in centimeter and gram, respectively; *a* and *b* are the parameters of the relationship and r^2 is the correlation coefficient).

Author	n	Regions	Sampling depth (m)	TL (min-max)	W (min-max)	*a*	*b*	r^2	Growth type
Kaya and Özaydın (1996)	350	Yeşilova Bay	241	8.50 (mean)	12.45 (mean)	0.00002	2.92	0.94	- (A)
Lamprakis *et al.* (2003)	609	Thracian Sea	356	2.90 - 12.20	-	0.02790	2.76	0.94	- (A)
Filiz and Bilge (2004)	455	Sığacık Bay	382	2.90 - 10.10	0.68 - 16.74	0.02320	2.83	0.98	- (A)
Leblebici *et al.* (2006)	951	Aegean Sea	426	3.10 - 9.50	-	0.02180	2.88	0.98	- (A)
White *et al.* (2011)	868	Northern Atlantic	600	1.50 - 14.00	0.63 – 91.0	0.00005	2.91	0.99	- (A)
Present study	790	Aegean Sea	225	3.50 - 10.50	1.20 – 25.82	0.01940	2.93	0.95	- (A)

closed area for fishing or role of differences in preparatory and viewing methods of otoliths. Presence of old fish was not surprising, where is no over-exploitation, fishing pressure or predation in the stock. However, Hüssy *et al.* (2012a) explained that *C. aper* has high abundance in trawl composition as a discard species and subject to predation mortality (diet of sharks, rays and bony fishes) but then suggested that *C. aper* has high longevity. As is known, drastic occurence of any species in trawl composition means exposed to overfishing. Overfishing negatively affects the existence of age classes, especially older age groups, in the population (King, 1995). Consequently, this hypothesis seems to be thought-provoking. Even so, there may be an alternative hypotheses to support longevity of boarfish. For instance, Lopes *et al.* (2006) mentioned about different morphotypes of *C. aper* which have presumably different growth rate and age features. Those authors may have collected morphotype of *C. aper* has slowest growth rate. There are on the other hand species morphologically similar to *C. aper* in the North Atlantic (*e.g.* Genus: *Antigonia*). These species (Genus: *Antigoni*a and *Capros*) may be share potentially the same distribution area. Therefore, species identification should be more careful and sensitive. Nonetheless, it should be noted that variation of maximum age, length and longevity between studies may be influenced by, especially, mesh size, sampling depth and sea-bottom characteristics.

In conclusion, understanding the life history or population dynamics of non-commercial fishes is important because the existence and/or nonexistence of non-commercial fish populations may affect abundance of target species. Non-commercial fish resources are important not only in terms of biodiversity but also in terms of quantities harvested and even more in terms of future commercial harvests. Accordingly, comprehensive studies on non-commercial fish populations are keystones to understand their biological aspects on marine food web and essential for sustainable fisheries management (Alverson *et al.*, 1994). On the other hand, economical benthopelagic fish families reported preying on *C. aper* such as Merluccidae, Phycidae and Sparidae were abundant both in the

Table V.- Results of the mean lengths and percentage per age group for males, females and undetermined *C. aper* specimens.

Age (Years)	♂		♀		Undetermined		Total	%
	n	Mean TL (cm)	n	Mean TL (cm)	n	Mean TL (cm)		
0+	5	5.22 ± 0.19	6	5.29 ± 0.16	23	4.46 ± 0.47	34	6.03
1+	18	5.40 ± 0.44	6	5.50 ± 0.34	10	5.59 ± 0.11	34	6.03
2+	121	6.97 ± 0.43	215	6.90 ± 0.40	7	6.52 ± 0.62	343	60.81
3+	47	8.50 ± 0.46	77	8.60 ± 0.51	-	-	124	21.98
4+	8	9.10 ± 0.20	21	9.20 ± 0.51	-	-	29	5.15
Total	199		325		40		564	100.00

Mediterranean and Aegean Sea (Gomes *et al.*, 1998; Morato *et al.*, 1999; Cabral and Murta, 2002).

The present study will increase the knowledge on age, growth, reproduction biology of boarfish in the Aegean Sea. It may also put across role and importance of *C. aper* in the food chain of marine ecosystem. Thus, the biology of commercial fish species that are main predators of *C. aper* may be understood better. Thereby, enforce regulation related to commercial fisheries may make more sensitive and appropriate.

ACKNOWLEDGEMENTS

This research was supported by Muğla University Scientific Research Fund (BAP 09/31). We would like to thank the "Republic of Turkey, Ministry of Agriculture and Rural Affairs, General Directorate of Protection and Control" and "Turkish Coast Guard Command (TCGC)" and "TCG Aegean Sea Area Command" for giving trawl permission in prohibited areas during the survey. Also, the authors would like to thank the two anonymous reviewers for their suggestions and comment.

REFERENCES

ALVERSON, D.L., FREEBERG, M.H., MURAWSKİ, S.A. AND POPE, J.G., 1994. *A global assessment of fisheries by-catch and discards.* FAO Fisheries Techical Papers, Rome, No. 339.

BEVERTON, R.J.H. AND HOLT, S.J., 1957. *On the dynamics of exploited fish populations.* Fishery Investigations Series II Volume XIX, Ministry of Agriculture, Fisheries and Food. London, pp. 1-533.

BLANCHARD, F. AND VANDERMEIRSCH, F., 2005. Warming and exponential abundance increase of the subtropical fish *Capros aper* in the Bay of Biscay (1973–2002). *C.R. Biol.,* **328:** 505–509.

BORGES, L., ROGAN, E. AND OFFICER, R., 2005. Discarding by the demersal fishery in the waters around Ireland. *Fish. Res.,* **76:** 1-13.

CABRAL, H.N. AND MURTA, A.G., 2002. The diet of blue whiting, hake, horse mackerel and mackerel off Portugal. *J. appl. Ichthyol.,* **18:** 14-23.

CAMPANA, S.E., 1984. Comparison of age determination methods for the starry flounder. *Trans. Am. Fish Soc.,* **113:** 365-369.

FARRELL, E.D., HÜSSY, K., COAD, J.O., CLAUSEN, L.W. AND CLARKE, M.W., 2012. Oocyte development and maturity classification of boarfish (*Capros aper*) in the Northeast Atlantic. *ICES Mar. Sci.,* **69:** 498-507.

FİLİZ, H. AND BİLGE, G., 2004. Length-weight relationships of twenty-four fish from the North Aegean Sea, Turkey. *J. appl. Ichthyol.,* **20:** 431-432.

FONSECA, P., CAMPOS, A., LARSEN, B.R., BORGES C.T. AND ERZINI, K., 2005. Using a modified Nordmøre grid for by-catch reduction in the Portuguese crustacean-trawl fishery. *Fish. Res.,* **75:** 223-239.

GOMES, T.M., SOLA, E., GRÓS, M.P., MENEZES, G. AND PINHO, M.R, 1998. Trophic relationships and feeding habits of demersal fishes from the Azores: importance to multispecies assessment. *ICES J. Mar. Sci.,* **35:** 7-21.

HOLDEN, M.J. AND RAITT, D.F.S., 1974. *Method of resource investigation and their application.* FAO Fisheries Technical Papers, 115, (Rev. 1), 1-214.

HÜSSY, K., COAD, J.O., FARRELL, E.D., CLAUSEN, L.W. AND CLARKE, M.W., 2012a. Sexual dimorphism in size, age, maturation and growth characteristics of boarfish (*Capros aper*) in the Northeast Atlantic. *ICES Mar. Sci.,* **69:** 1729-1735.

HÜSSY, K., COAD, J.O., FARRELL, E.D., CLAUSEN, L.W. AND CLARKE, M.W., 2012b. Age verification of boarfish (*Capros aper*) in the Northeast Atlantic. *ICES Mar. Sci.,* **69:** 34-40.

KARLESKINT, G., TURNER, R. AND SMALL, W.J., 2010. *Introduction to marine biology*, Brooks/Cole Books.

KAYA, M. AND ÖZAYDIN, O., 1996. *Capros aper (L., 1758)'in biyolojisi üzerinde bir ön çalışma (Pisces: Caproidae).* [A preliminary study on biology of *C. aper*]. *Turk. J. Zool.,* **22:** 303-306.

KING, M., 1995. *Fisheries biology, assessment and management*, Fishing News Books.

LAMPRAKIS, M.K., KALLIANIOTIS, A.A., MOUTOPOULOS, D.K. AND STERGIOU, K.I., 2003. Weight–length relationships of fishes discarded by trawlers in the north Aegean Sea. *Acta Ichthyol. Piscat.,* **33:** 145-151.

LANDA, J. AND PİÑEIRO, C., 2000. Megrim (*Lepidorhombus whiffiagonis*) growth in the north-eastern Atlantic based on back-calculation of otolith rings. *ICES Mar. Sci.,* **57:** 1077-1090.

LEBLEBİCİ, S., YAPICI, S., ÖZAYDIN, O. AND TOSUNOĞLU, Z., 2006. *Ege Denizi'nde Peri Balığı (Capros aper L., 1758)'nın Morfometrik Özelliklerinin Araştırılması* [An investigation of morphometric features of the boarfish (*Capros aper L., 1758*) in the Aegean Sea]. Türkiye Kıyıları 2006 Konferansı: 7-11 Kasım 2006, Muğla, 497-504.

LOPES, M., MURTA, G.A. AND CABRAL, N.H., 2006. Discrimination of snipefish *Macroramphosus* species and boarfish *Capros aper* morphotypes through multivariate analysis of body shape. *Helgoland Mar. Res.,* **60:** 18-24.

MORATO, T., SOLÀ, E., GRÓS, M.P. AND MENEZES, G., 1999. Diets of forkbeard (*Phycis phycis*) and conger eel (*Conger conger*) off the Azores during spring of 1996 and 1997. *Arquipélago Life Sci.,* **17:** 51-64.

MYTILINEOU, C., POLITOU, C.Y., PAPACONSTANTINOU, C., KAVADAS, S., D'ONGHIA, G. AND SION, L., 2005. Deep-water fish fauna in the eastern Ionian Sea. *Belgian J. Zool.,* **135:** 229–233.

NELSON, J.S., 2007. *Fishes of the World.* Wiley Publishing, Oxford, UK.

PAULY, D. AND MUNRO, J.L., 1984. Once more on the comparison of growth in fish and invertabrates. *ICLARM Fishbyte,* **2:** 1-21.

QUÉRO, J.C., 1986. Caproidae. Fishes of the north-eastern Atlantic and the Mediterranean. UNESCO, Paris. vol. 2, pp. 777-779.

SARTOR, P., SARTINI, M., REALE, B. AND SBRANA, M., 2001. Analysis of the discard practices in the *Merluccius merluccius* L., (1758) bottom trawl fishery of the northern Tyrrhenian Sea. *Biol. Mar. Medit.,* **8:** 771-774.

SPARRE, P. AND VENEMA, S.C., 1992. *Introduction to tropical fish stock assessment.* Part 1. Manual FAO Fisheries Techical Papers. No: 306/1, Rev. 1, pp. 376.

STERGIOU, K.I., CHRISTOU, E.D., GEORGOPOULOS, D., ZENETOS, A. AND SOUVERMEZOGLOU, C., 1997. The Hellenic Seas: physics, chemistry, biology and fisheries. *Oceanogr. Mar. Biol., Annu. Rev.,* **35:** 415-538.

TESCH, F.W., 1971. In*: Methods for assesment of fish production in freshwater*. Blackwell Scientific Publications, Oxford and Edinburgh.

TORTONESE, E., 1970. *Osteichthyes (Pesci Ossei) Parte Prima, Fauna d'Italia,* [Osteichthyes (Bony Fish) Part One, Fauna of Italia] 10. Office Grafische Calderini, Bologna.

WHITE, E., MINTO, C., NOLAN, C.P., KING, E., MULLINS, E. AND CLARKE, M., 2011. First estimates of age, growth, and maturity of boarfish (*Capros aper*): a species newly exploited in the Northeast Atlantic. *ICES Mar. Sci.,* **68:** 61-66.

WOOTTON, R.J., 1991: *Ecology of teleost fishes.* Chapman and Hall, London, UK.

(Received 1 April 2014, revised 2 May 2014)