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ORIGINAL ARTICLE

Sexual maturity and fecundity of *Scyliorhinus canicula* (Linnaeus, 1758) in the Aegean Sea

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Abstract

A total of 325 small-spotted catsharks, *Scyliorhinus canicula*, ranging from 263 to 488 mm in total length (TL) and from 62 to 395 g in round weight (RW), were sampled from trawl catches in the Aegean Sea during the two-year period 2005–2007. The overall ratio of males to females was 1.06:1, and of the specimens almost 60% were mature. The size of mature males and females ranged between 371–488 mm and 364–467 mm in total length, respectively, while total length at 50% maturity was estimated at 396 mm for males and 399 mm for females. Ovary weight varied from 0.1 to 25.4 g and maximum oocyte diameter was 18 mm. Gonadosomatic indices ranged from 0.13 to 9.77 in female fish and from 0.25 to 6.36 in male fish, showing significant seasonal changes only in females (p-value <0.05). Ovarian fecundity reached a maximum of 18 ripe oocytes in the ovary of a 460 mm TL female. Only one pair of egg cases was found in each one of the 30 adult females examined.

Key words: Scyliorhinus canicula, *sexual maturity, Mediterranean Sea*

Introduction

The small-spotted catshark, *Scyliorhinus canicula* (Linnaeus, 1758) belongs to the family Scyliorhinidae (Carcharhiniformes) and is considered to be the most abundant species of catshark in European inshore waters (Ellis & Shackley 1997). It is found in the northeastern Atlantic from Norway and British Isles south to Senegal, including the Mediterranean Sea, primarily over sandy, gravely or muddy bottoms at depths of a few metres down to 400 m (Compagno 1984). It is an oviparous species and lays its eggs in a protective egg case, which are deposited in pairs and anchored to macroalgae and other solid structures (Wheeler 1978).

Several aspects of the reproductive biology of the small-spotted catshark related to its breeding season and embryonic development, maturity and annual reproductive cycle have been studied in the Atlantic Ocean (Harris 1952; Sumpter & Dodd 1979; Ellis & Shackley 1997; Rodríguez-Cabello et al. 1998; Henderson & Casey 2001; Loppion et al. 2008). In the Mediterranean Sea, only few studies are focused on the reproductive biology of the small-spotted catshark, mainly in areas where it has a relatively high economic value, although this species is widely distributed and one of the most abundant sharks in the catches of the trawl fishery. Capapé et al. (1991, 2008a) studied the maturity and fecundity of the small-spotted catshark in Southern France (North-Western Mediterranean), while a previous study (Capapé 1977) deals with some traits of its reproductive biology in Tunisia (South-Central Mediterranean). In Greece and other countries of the eastern Mediterranean Sea, the small-spotted catshark has never had a high commercial value, but like other bottom-dwelling shark species it is strongly affected by trawl fisheries, being caught as by-catch and largely discarded. Although there is no information about the total catch of the species, it was evident from the data of the Mediterranean International bottom Trawl Survey program (MEDITS) that there is a high level of fishing mortality. Abundance indices and length frequency distributions suggested the existence of 'sub-sectors' which are exposed either

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to different level of fishing effort (e.g. the small-spotted catshark in the Tyrrhenian Sea seems to be more heavily exploited than in the Aegean Sea) or to other factors (e.g. environmental factors). These data obviously represent a first step for the implementation of assessments aimed at the management of the stocks (Serena et al. 2001). However, the lack of adequate scientific information on the population characteristics is often one of the reasons for failing to introduce suitable management measures for Chondrichthyan species (Cavanagh & Gibson 2007).

In the present paper we focus on the study of some life history traits of the small-spotted catshark in the Aegean Sea, such as sexual maturity and fecundity, with the aim of providing information on the basic biological characteristics of the stock that is lacking and which could be useful for conservation and management purposes in the Eastern Mediterranean Sea.

Materials and methods

Sampling

A total of 325 small-spotted catsharks (*Scyliorhinus canicula*) were obtained from incidental catches of bottom trawlers from December 2005 to April 2007 (Table I). Sampling was carried out in areas of the central and southwest Aegean Sea where the depth ranged between 250 and 450 m (Figure 1). Since trawl fishery in Greece is closed from 1 June to 30 September, no samples were taken during the summer months. All specimens were initially preserved in ice (on board) and later frozen at -20°C until dissection could be done.

Measurements and sex ratio

The identification was confirmed and measurements were taken based on Compagno (1984). Total length (TL) of each specimen was measured to the nearest millimetre (mm), from the tip of the snout to the tip of the upper lobe of the caudal fin (Compagno 1984). Round weight (RW) was measured as the total weight of the specimens to the nearest gram (g), dressed weight (DW) was measured to the nearest gram (g). Sex was determined by direct examination of the claspers in males. The sex ratio (males:females) was calculated for the total number of specimens and for each season. Sex ratio was compared with the 1:1 proportion using the chi-squared test. The Kolmogorov–Smirnov two-sample test was used to test for significant differences in the length and weight frequencies by sex. For males, inner length (CLi), outer length (CLo) and base width (CLb) of the left clasper were recorded. CLi was measured from the point of insertion at the cloaca to the distal tip of the clasper and CLo was measured from the point of outside insertion at the pelvic fin to the tip of the clasper (Compagno 1984). Liver and gonads were removed from the body cavity and their length and weight were measured to the nearest millimetre and centigram, respectively. In males, the testes are paired organs, while in females only the right ovary develops. Maximum length and width of the left nidamental gland as well as maximum width of the left oviduct were measured in females.

Maturity stages

Sexual maturity was determined by macroscopic observation of the reproductive organs. In males, maturity was assessed by the length, flexibility or rigidity of the claspers, the size and condition of the testes and vas deferens and by the presence of sperm in the genital tract. A four-stage maturity scale (from I to IV) was used.

Table I. Number of specimens, total length (TL) and round weight (RW) range, mean and standard deviation for male and female *Scyliorhinus canicula* in each season.

			TL (mm)			RW (g)		
Season	Sex	N	Range	Mean	SD	Range	Mean	SD
Spring	♀	62	303–467	396.0	36.8	94–395	233.6	71.3
	♂	67	293–471	409.8	35.9	77–316	232.0	57.2
	♀+♂	129	293–471	403.2	71.3	77–395	232.8	64.1
Autumn	♀	36	305–460	398.0	37.3	96–376	230.3	71.7
	♂	31	321–466	398.2	35.5	110–360	210.3	60.8
	♀+♂	67	305–466	398.1	36.2	96–376	221.0	67.1
Winter	♀	60	263–457	382.7	39.7	62–366	207.3	65.7
	♂	69	282–488	396.8	46.7	75–372	215.9	72.9
	♀+♂	129	263–488	390.3	44.0	62–372	211.9	69.5
Total	♀	158	263–467	391.4	38.4	62–395	222.8	69.9
	♂	167	282–488	402.3	40.9	75–372	221.3	65.0
	♀+♂	325	263–488	397.0	40.0	62–395	222.1	67.4

N, number; SD, standard deviation.

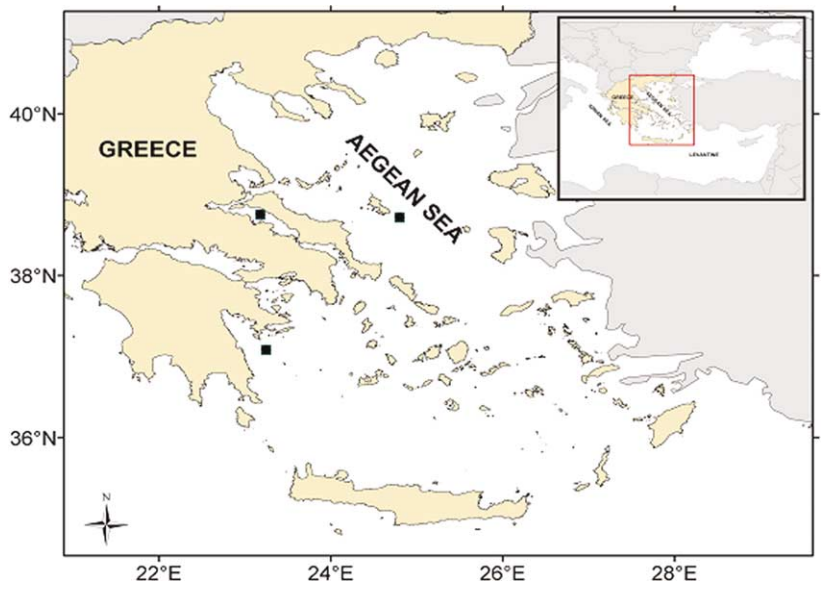

Figure 1. Sampling sites of *Scyliorhinus canicula* from the Aegean Sea.

- Immature (Stage I) – claspers soft and small; testes thread-like and undeveloped; vasa deferentia undeveloped.
- Maturing (Stage II) – claspers soft and small; vasa deferentia beginning to coil.
- Mature (Stage III) – claspers rigid with the same length as the pelvic fins (modification from Ivory et al. 2004) or larger than them; testes enlarged; vasa deferentia extremely coiled at proximal end of ducts.
- Adult, running (Stage IV) – claspers rigid and longer that the pelvic fins; enlarged testes; vasa deferentia extremely coiled with sperm present throughout their length; sperm flows with pressure on the cloaca.

In females, maturity was assessed by the size, condition and coloration of the nidamental glands, the size of the ovary and oocytes and by the presence of egg cases in the oviducts (Ivory et al. 2004). According to a four-stage maturity scale (from I to IV), females were classified as follows.

- Immature (Stage I) – ovary thin with oocytes extremely small; nidamental glands undeveloped; thread-like oviducts.
- Maturing (Stage II) – ovary with small oocytes; nidamental glands opaque and small; thin oviducts.
- Mature (Stage III) – ovary large with oocytes at different sizes of development; nidamental glands opaque, white and large; thick oviducts.
- Adult, laying and resting (Stage IV) – ovary large with oocytes ranging from small to large; nidamental glands opaque, white and large, sometimes containing developing egg cases; oviducts large and thick and often containing fully formed egg cases (Ivory et al. 2004).

Size at first maturity

Length at 50% maturity was determined through the fitting of maturity ogives. The percentages of mature individuals per length class were estimated for males and females separately. The specimens in Stages I and II were considered as 'immature' while the specimens in other stages were considered as 'mature'. A logistic curve was fitted to the data and the total length at which 50% of individuals are sexually mature was calculated (King, 1995) using the equation: $P_i = 1/[1 + e^{(a + bL)}]$, where P_i is the proportion of mature individuals in length class i while a and b are fitted parameters which can change during the life cycle. The mean length at sexual maturity was calculated as $L_{50} = a/b$ (Spare & Venema 1992).

Gonadosomatic and hepatosomatic indexes

Gonadosomatic indexes (GSI) were calculated using the following equations: $GSI = (GW/DW) \times 100$, where GW is gonad weight in g and DW is dressed weight of the specimens in g. Variations in GSI related to sexual maturity stage and season were considered in both sexes. Hepatosomatic indexes (HSI) were calculated using the following equations: $HSI = (LW/DW) \times 100$, where LW is liver weight in g and DW is dressed weight of the specimens in g. Variations in HSI related to sexual maturity stage were considered in both sexes. Analysis of variance (ANOVA) was used to test for significant differences in mean GSI values and in mean HSI values considering sexual maturity and season as factors.

Fecundity

Ovarian fecundity was determined by the number of ripe oocytes in the ovary of mature females. Three oocyte stages (ripe, maturing and immature) were identified macroscopically according to size and colour. Both ripe oocytes having a yellow colour and maturing oocytes having a white colour were counted with the naked eye and their diameters were measured with a Vernier caliper. Immature oocytes, being translucent in colour and small in size, were measured using a stereoscope equipped with a SONY Exwave HAD digital camera and a system of Image Analysis and video capturing software (Image Analysis Pro Plus, 3.1).

The number and size of egg cases occupying the oviducts were recorded. Length and width of egg cases were measured with a caliper to the nearest millimeter and their mass was weighed to the nearest centigram.

Results

Sex ratio, length and weight frequency distributions

The total sample consisted of 167 male and 158 female fish. The overall sex ratio was almost equal for males and females (M:F) 1.06:1, while for each sampling season, spring, autumn and winter it was 1.08, 0.86 and 1.15, respectively. The sex ratio favoured females significantly in autumn and males in winter (χ^2-test, p-value <0.05).

In males, total length (TL) ranged from 282 to 488 mm (402.3 $\pm$ 40.9) and round weight (RW) ranged from 75 to 372 g (221.3 $\pm$ 65.0). In females, total length (TL) ranged from 263 to 467 mm (391.4 $\pm$ 38.4) and round weight (RW) ranged from 62 to 395 g (222.8 $\pm$ 69.9) (Table I). Average TL was slightly higher for males than for females, while the contrary was observed for the average RW (Table I). The length and weight frequency distributions for both sexes are shown in Figure 2. The results obtained from the Kolmogorov–Smirnov two-sample test indicated that males and females did not have significantly different length and weight frequency distributions (KS test, p-value >0.05).

Sexual maturity

Mature and adult specimens were predominant in the samples examined. Out of 167 male *Scyliorhinus canicula*, 21 were classified as immature (Stage I), 31 as maturing (Stage II) and 115 as mature (Stage III), while out of 158 females, 55 were noted as immature (Stage I), 18 as maturing (Stage II), 55 as mature (Stage III) and 30 as adult (Stage IV). The distribution of each maturity stage of males and females according to their size are presented in Figure 3.

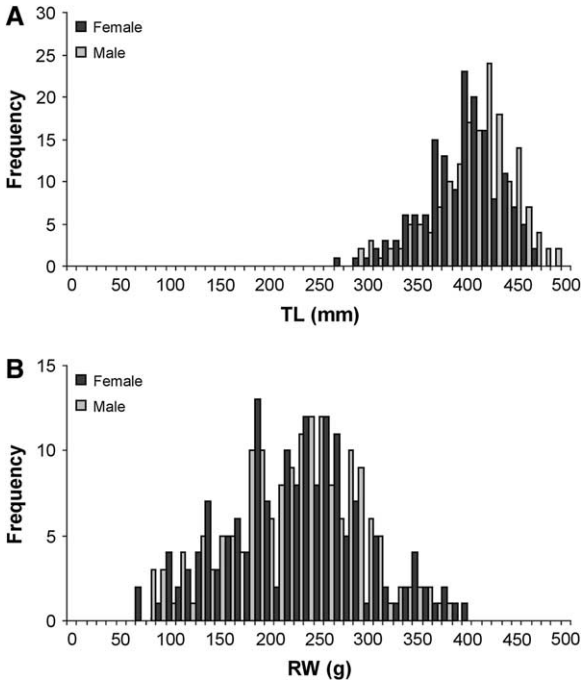

Figure 2. (A) Total length and (B) round weight frequency distribution of *Scyliorhinus canicula* from the Aegean Sea.

The reproductive organs' measurements for male and female small-spotted catsharks are given in Tables II and III, respectively. The weight of the left testicle ranged from 0.09 to 7.4 and of the right one

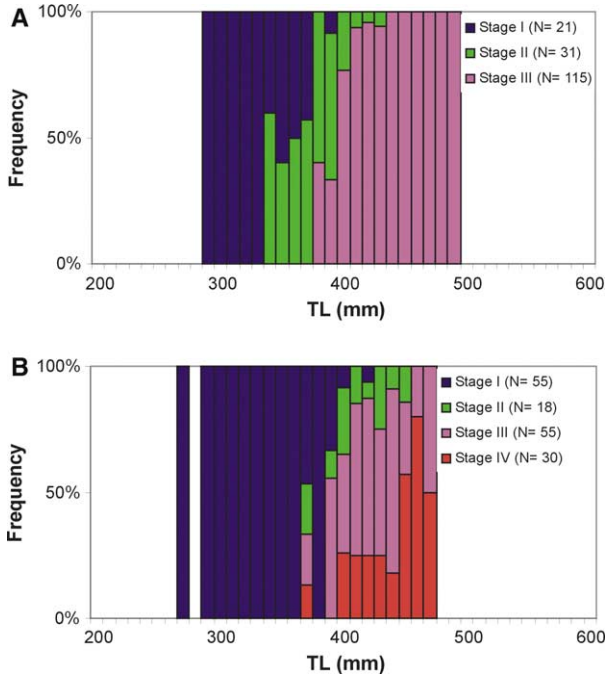

Figure 3. Length–frequency distribution in different stages of maturity in (A) male and (B) female *Scyliorhinus canicula* from the Aegean Sea.

Table II. External and internal reproductive organ measurements of *Scyliorhinus canicula* males in each maturity stage.

	I			II			III		
Characteristic	Range (*N*)	Mean	SD	Range (*N*)	Mean	SD	Range (*N*)	Mean	SD
Outer clasper length (mm) – Left	4–20 (21)	9.6	4.9	10–24 (31)	20.6	3.3	17–30 (115)	23.0	2.3
Inner clasper length (mm) – Left	10–30 (21)	17.9	6.0	19–36 (31)	30.8	4.3	28–41 (115)	33.0	2.6
Clasper base width (mm) – Left	1–4 (21)	2.4	0.9	2–7 (31)	4.1	1.3	3–8 (115)	5.1	1.0
Length of testicle (mm) – Left	25–51 (21)	39.8	7.2	35–98 (31)	55.6	13.7	54–125 (115)	77.9	13.1
Weight of testicle (g) – Left	0.1–0.7 (21)	0.3	0.2	0.6–2.6 (31)	1.5	0.5	2.3–7.4 (115)	4.4	1.3
Length of testicle (mm) – Right	27–52 (21)	41.9	7.9	40–108 (31)	64.5	17.1	57–132 (115)	88.8	13.8
Weight of testicle (g) – Right	0.1–0.6 (21)	0.3	0.1	0.8–2.8 (31)	1.7	0.6	2.3–7.5 (115)	4.7	1.4

N, number; SD, standard deviation.

from 0.12 to 7.46 g. Ovary weight varied from 0.12 to 25.41 g. Testis and ovary weight increased with total length with onset of maturity. The clasper outer length (CLo) as well as the weight and width of the nidamental gland (NG_L) increased with total length in more profound way than any other reproductive organ and demonstrated the differentiation from one stage of maturity to the other (Figure 4).

Size at maturity

The smallest sexually mature male was 371 mm in TL and 166 g in RW, while the smallest sexually mature female was 364 mm in TL and weighed 171 g. In mature males, total length (TL) ranged from 371 to 488 mm (422.6 ± 24.2) and round weight (RW) ranged from 166 to 372 g (253.5 ± 45.2). In mature and adult females total length (TL) ranged from 364 to 467 mm (414.2 ± 23.5) and round weight (RW) ranged from 171 to 395 g (265.5 ± 50.9). According to the estimates of mean length at sexual maturity, males and females attain sexual maturity at almost similar size. Mean total length at 50% maturity was estimated at 396 mm for males and at 399 mm for females.

Gonadosomatic and hepatosomatic indexes

Gonadosomatic indices reached higher values in female than in male specimens ranging from 0.25 to 6.36 (3.58 ± 1.58) in males and from 0.13 to 9.77 (2.83 ± 2.39) in females. In both males and females, GSI was found to increase significantly at the 95% confidence level from one stage of maturity to another (ANOVA: p-value < 0.05) (Figure 5). Although the higher values of GSI were observed in spring for males, no significant variation was found between the mean GSI from one season to another (ANOVA: p-value > 0.05). For females, GSI showed a statistically significant variation from one season to another (ANOVA: p-value < 0.05) and mean values ranged from a minimum of 2.12 during winter to a maximum of 3.57 during autumn (Figure 6).

Table III. Internal reproductive organ measurements of *Scyliorhinus canicula* females in each maturity stage.

	I			II		
Characteristic	Range (*N*)	Mean	SD	Range (*N*)	Mean	SD
Weight of ovary (g)	0.1–2.2 (55)	1.0	0.6	1.6–3.5 (18)	2.2	0.6
Ovary length (mm)	25–98 (55)	61.5	20.0	46–123 (18)	86.1	20.0
Left oviduct width (mm)	0.5–5.0 (30)	2.2	1.4	3.0–6.5 (13)	5.3	1.1
Left nidamental gland weight (g)	0.03–0.6 (29)	0.3	0.2	0.4–1.8 (15)	0.9	0.4
Left nidamental gland length (mm)	9–23 (30)	15.3	3.5	15–25 (16)	19.5	3.2
Left nidamental gland width (mm)	5–12 (30)	8.8	1.8	8–14 (16)	11.5	1.7
	III			IV		
	Range (*N*)	Mean	SD	Range (*N*)	Mean	SD
Weight of ovary (g)	2.1–24.3 (55)	7.9	4.6	1.7–25.4 (30)	11.6	6.7
Ovary length (mm)	52–140 (55)	93.2	22.0	54–151 (30)	99.4	24.5
Left oviduct width (mm)	4–10 (33)	6.3	1.4	14–19 (27)	16.8	1.4
Left nidamental gland weight (g)	0.9–3.6 (49)	1.9	0.6	1.4–4.4 (27)	2.6	0.8
Left nidamental gland length (mm)	18–28 (50)	22.6	2.8	18–32 (27)	24.8	3.6
Left nidamental gland width (mm)	10–22 (50)	14.3	2.7	13–25 (27)	18.3	3.3

N, number; SD, standard deviation.

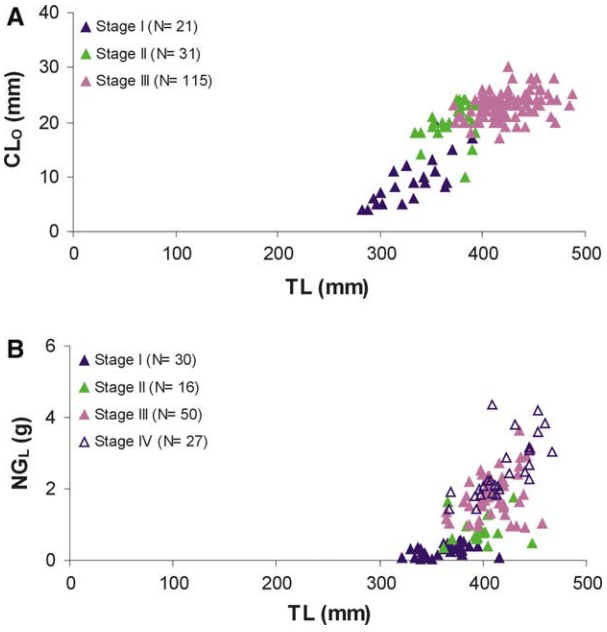

Figure 4. Correlation between (A) clasper outer length (CLo), (B) left nidamental gland weight (NG_L) to total length in *Scyliorhinus canicula* from the Aegean Sea.

Hepatosomatic indices reached higher values in female than in male specimens. Values ranged from 2.13 to 12.09 (6.54 $\pm$ 1.75) in males and from 2.61 to 41.72 (15.27 $\pm$ 7.56) in females. Statistically significant differences were found between mean HSI from one stage of maturity to another only for females (ANOVA: p-value <0.05), whereas in males mean HSI did not show any significant variation (ANOVA: p-value >0.05) (Figure 7).

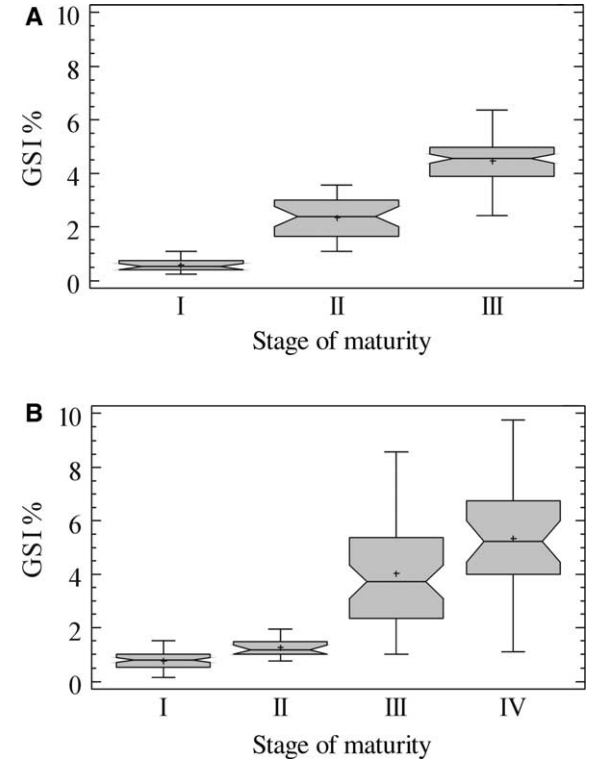

Figure 5. Gonadosomatic index (%) for (A) male and (B) female *Scyliorhinus canicula* in each stage of maturity from the Aegean Sea; asterisk (+): mean, horizontal line: median, grey area: 50% of the values, notch: 95% confidence level for median, vertical line: minimum, maximum.

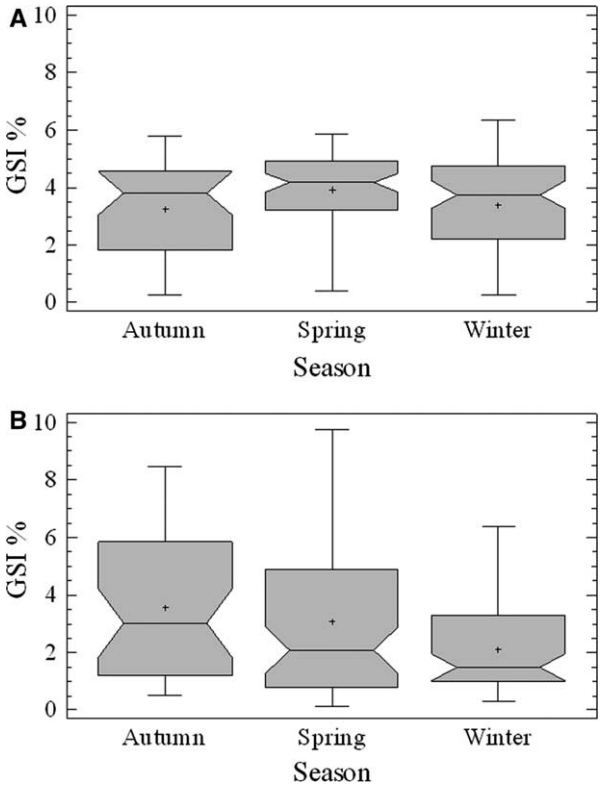

Figure 6. Gonadosomatic index (%) for (A) male and (B) female *Scyliorhinus canicula* in each sampling season from the Aegean Sea; asterisk (+): mean, horizontal line: median, grey area: 50% of the values, notch: 95% confidence level for median, vertical line: minimum, maximum.

Fecundity

In mature females, numerous maturing oocytes (Stage II) occupied the ovaries along with ripe oocytes (Stage III). The number of ripe oocytes in individual ovaries ranged from 2 to 18. Ovarian fecundity was estimated at 7.23 $\pm$ 3.62, reaching 18 ripe oocytes in the ovary of a 460 mm TL female.

In a total of 70 females, 6.390 oocytes were measured, out of which 5.551 oocytes were immature ranging from 0.13 to 2.75 mm in diameter (1.04 $\pm$ 0.56), 528 were maturing ranging from 2.76 to 8.5 mm in diameter (5.14 $\pm$ 1.72), while 311 ripe oocytes ranged from 9 to 18 mm in diameter (12.0 $\pm$ 2.02).

In 27 out of the 30 adult females, a pair of fully formed egg cases was carried in their oviducts while in 3, a pair of egg cases in a process of formation was found inside their nidamental glands. The

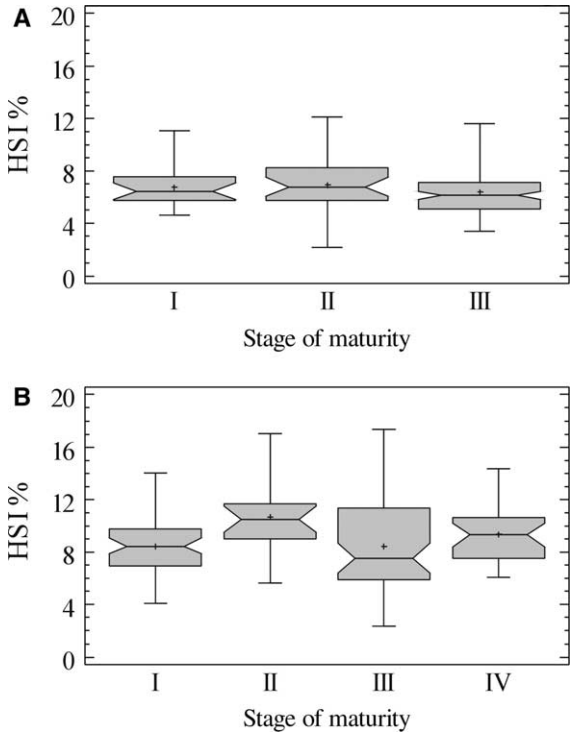

Figure 7. Hepatosomatic index (%) for (A) male and (B) female *Scyliorhinus canicula* in each stage of maturity from the Aegean Sea; asterisk (+): mean, horizontal line: median, gray area: 50% of the values, notch: 95% confidence level for median, vertical line: minimum, maximum.

dimensions of egg cases occupying the oviducts ranged from 31 to 73 mm (56.70 ± 10.32) in length and from 14 to 19 mm (16.92 ± 1.30) in width. The weight of egg cases ranged from 0.76 to 3.54 g (2.01 ± 0.49). Out of the 30 pairs of egg cases, 15 were carried in adult females caught during spring, 8 were carried in adult females caught during autumn and 7 were carried in adult females caught during winter.

Discussion

Previous studies on the small-spotted catshark in the Aegean Sea are concerned with weight–length relationships (Filiz & Bilge 2004), sexual dimorphism (Erdogan et al. 2004; Filiz & Taşkavak 2006) and its depth distribution pattern in the North Aegean Sea (D'Onghia et al. 1995). The present study reports for the first time basic information on the reproductive biology of the species in the area, providing data on the mean length at 50% maturity, fecundity and egg case deposition. Our results showed that small-spotted catshark reaches smaller sizes and reproduces at even smaller lengths in the Mediterranean Sea in comparison with East the Atlantic Ocean, confirming the findings of Leloup & Olivereau (1951). Similar observations were also found by Capapé (1977) and Capapé et al. (1991, 2008a). Variations in maximum size and size at maturity have been noted in all areas studied and could be attributed, as in other shark species, to genetic or environmental factors and physiological constraints (Lombardi-Carlson et al. 2003).

The maximum length of small-spotted catshark in Atlantic waters has been documented as 1000 mm (Compagno 1984), but specimens exceeding 800 mm are rarely observed (Ivory et al. 2004). In the Mediterranean Sea the highest values were in Northern Tunisia, where males and females reached 580 mm and 560 mm in TL, respectively (Capapé 1977). In the present study, maximum total length was relatively lower (488 mm in males and 467 mm in females) than that recorded in other regions of the Mediterranean Sea (Capapé 1977; D'Onghia et al. 1995; Carbonell et al. 2003; Filiz & Bilge 2004; Abella & Serena 2005; Filiz & Taşkavak 2006; Capapé et al. 2008a).

The size distribution of the two sexes was almost similar and mean sizes did not show statistically significant differences. This finding seems reasonable as D'Onghia et al. (1995) noted that no segregation of sexes and sizes occurs in the population in the North Aegean Sea.

Size at maturity

Several studies, conducted in different areas of the Atlantic and Mediterranean, seem to agree that the length of first sexual maturity is the same for males and females (Leloup & Olivereau 1951; Zupanovic 1961; Capape et al. 1991). However, recent studies in the Eastern Atlantic (Ivory et al. 2004) showed that females attain maturity at a greater total length and at later age (570 mm, 7.9 years) than males (535 mm and 6.6 years). Moreover, Ellis & Shackley (1997) showed that females mature at a greater length than males, being 550 mm the length at 50% maturity for females and 520 mm for males. Our results showed that both males and females reach 50% maturity at almost equal total length (396 mm for males and at 399 mm for females). These values are similar to those found for small-spotted catshark in other areas of the Mediterranean Sea (Leloup & Olivereau 1951; Zupanovic 1961), but lower than those found in the Atlantic (Ivory et al. 2004). Differences in the size at maturity between the Atlantic and Mediterranean populations were confirmed for the first time by Leloup & Olivereau (1951), according to whom small-spotted catshark matured between 520 and 600 mm at Roscoff and between 370 and 475 mm at Banyuls.

Maturity and reproductive organs

We concluded that the parameters that distinguish mature from immature specimens are the weight and width of the nidamental gland in females and clasper outer length in males. Similar observations were made for clasper length and nidamental gland width in previous studies in the Atlantic Ocean (Ellis & Shackley 1997; Ivory et al. 2004), but the lengths above which the onset of maturation was observed were higher in the Atlantic Ocean than in the Aegean Sea.

GSI and HIS indices

In the present study only in the case of females was a statistically significant difference found between the mean GSI from one season to another. However, in the western Mediterranean Sea, GSI did not show significant monthly variations throughout the year both in males and females (Capapé et al. 2008b). Vitellogenic activity seems to be constant all year round, and all adult females have numerous maturing and ripe oocytes inside their ovary ready to be fertilized in the uterus. In the present study the maximum oocyte diameter was exactly the same as that found along the Languedocian coast, reaching 18 mm (Capapé et al. 2008a), while it was slightly smaller than the maximum oocyte diameter (19 mm) in the eastern Atlantic (Ellis & Shackley 1997).

Our results showed also that the liver is larger in females than in males as indicated by differences in HSI. According to Kollman et al. (1929), HSI ranged from 6.3 to 11 in females and 4–6 in males, while according to Leloup & Olivereau (1951) HSI ranged from 4 to 7 in females and from 3.5 to 5.5 in males. This may be related to the increased energy expenditure that females face during vitellogenesis, oocyte maturation, and gestation. The liver is a key organ in female reproduction because it is involved in yolk formation through production of vitellogenin, the yolk precursor (Koob & Callard 1999). This explains why statistically significant differences were found in HSI only in the case of females in different stages of maturity. The variation of this index is considered to be a normal situation for them as they attain maturity. In another study in the western Mediterranean Sea, HSI did not show significant monthly variations throughout the year in either males or females (Capapé et al. 2008b).

Egg cases deposition

Given that only one pair of egg cases was found in each one of the 30 adult females examined, it was assumed that egg cases are deposited in the environment as a pair and do not remain for long inside the oviducts. The maximum proportion of egg-carrying females was found in spring; however, we could not suggest a specific egg-laying season in the Aegean Sea. The fact that females carrying egg cases appeared in all three seasons examined could suggest egg deposition all year round. However, a more specific monthly sampling programme targeting a larger sample of mature and adult specimens throughout the year, including summer, could give more precise and complete information about the egg deposition period in the Aegean Sea.

In the Eastern Atlantic Ocean, eggs were observed in all months except August and September, and egg laying peaked during summer, with egg cases being found in 50% of mature females (Ellis & Shackley 1997), while according to Ford (1921), egg laying occurred especially in spring with a gap between August and October. Rodríguez-Cabello et al. (1998) and Lo Bianco (1888) suggested that egg laying must have an extended period. Fauré-Fremiet (1942) found egg-laying females from June to January. Leloup & Olivereau (1951) and Capapé et al. (1991) suggested that egg laying takes place without interruption throughout the year, while in a recent study by Capapé et al. (2008a,b) several egg-bearing specimens were found in each month, except September.

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