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SEXUAL DIMORPHISM IN THE SMALL – SPOTTED CATSHARK, *SCYLIORHINUS CANICULA* (L., 1758), FROM THE EDREMIT BAY (TURKEY)

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ABSTRACT

Morphometric characteristics and dentition of the small-spotted catshark Scyliorhinus canicula *were analysed. In the year of 1998, 100 individuals were collected by means of trawl hauls from Edremit Bay, northern Aegean Sea. Males have a longer and narrower mouth than females resulting in pronounced sexual dimorphism with respect to the mouth length/mouth width ratio (0.67 and 0.57, respectively). Significant sexual differences in the girth of the head and preoral, prebranchial, head and body lengths were also recorded. Males were found to have longer teeth than females. Reasons for these differences are discussed.*

Key words: *Scyliorhinus canicula*, Scyliorhinidae, sexual dimorphism, morphometric characters, Aegean Sea

DIMORFISMO SESSUALE NEL GATTUCCIO *SCYLIORHINUS CANICULA* (L., 1758) DEL GOLFO DI EDREMIT (TURCHIA)

SINTESI

L'articolo analizza le caratteristiche morfometriche e la dentatura di un centinaio di gattucci Scyliorhinus canicula, *pescati nel 1998 con la rete a strascico nel Golfo di Edremit (mar Egeo settentrionale). Gli esemplari maschi presentavano una mascella più lunga e sottile delle femmine, a dimostrazione dell'evidente dimorfismo sessuale riscontrabile nel rapporto fra lunghezza e larghezza della mascella stessa (0,67 cm per maschi e 0,57 cm per femmine). Importanti diversificazioni sessuali sono state riscontrate anche nelle dimensioni della testa, nella lunghezza del muso e nella posizione delle branchie, nella lunghezza della testa e del corpo. Nell'articolo, gli autori esaminano i possibili motivi di queste differenze.*

Parole chiave: *Scyliorhinus canicula*, Scyliorhinidae, dimorfismo sessuale, caratteristiche morfometriche, mar Egeo

INTRODUCTION

The small-spotted catshark *Scyliorhinus canicula* (L., 1758) is a benthic species distributed along the Atlantic coasts northward to the Shetlands and southern Norway and in the Mediterranean. It occurs on sandy and muddy bottoms, from shallow waters to about 110 m (around British Isles), up to about 400 m (Mediterranean). It feeds on bottom-living invertebrates (molluscs, crustaceans and small fishes). The species maximum-recorded size is to about 100 cm, usually 75 cm (Fischer *et al.*, 1987; Ellis & Shackley, 1995).

Differences in morphology and dentition are two important characteristics for the taxonomy of elasmobranch fishes. However, intraspecific variation, due to growth, sexual dimorphism and geographical and individual differences, has been poorly studied (Ellis & Shackley, 1995). Brough (1937) correlated changes in the lower jaw structure to sexual maturity and observed that these sexual dimorphic characters were more pronounced in the breeding season and were not present in sexually immature specimens. Jardas (1979) reported that males had longer heads than females, while Ellis & Shackley (1995) noted that males of *S. canicula* possessed a longer and narrower mouth than females, showing a pronounced sexual dimorphism. Kerr (1955) examined some aspects of the teeth in genus *Scyliorhinus*. Totaro *et al*. (1984) made a comparison between teeth and scales of newborn and adult specimens of *S. canicula*. Fischer *et al*. (1987) gave a description of teeth similar to those of previous authors, without mentioning dental formula. Ellis & Shackley (1995) found males to have longer teeth than females. Litvinov (2003) found a clearly pronounced sexual dimorphism in the dental form of small-spotted catshark from West African waters.

The aim of the present study was to determine sexual dimorphism based on head morphometrics and dentition of *S. canicula* from Edremit Bay.

MATERIAL AND METHODS

In 1998, fish were collected by trawl hauls, from Edremit Bay, northern Aegean Sea, Turkey. Sex, total length (TOT), mouth length (MoL) and mouth width (MoW) (Compagno, 1984) were recorded to the nearest mm, for 25 female and 75 male specimens. Significant differences of the mouth length (% TOT), mouth width (% TOT) and mouth length/mouth width ratio (MoL/MoW) between the sexes were tested by *t*-test of the differences between means (Sokal & Rohlf, 1994; Edmondson & Druce, 1996). The data were divided into two TOT groups (<50 and >50 cm) with similar tests used to determine any significance between two TOT groups within each sex, and between the same TOT groups of each sex.

A representative subsample of fish (25 males and 25 females) was examined for a further six metric measurements of the head region (preoral length, prebranchial length, head length, head girth and anterior teeth height). These dimensions were measured to the nearest mm and converted to % TOT for statistical analysis.

In order to examine the dentition, the jaws were dissected out of 100 specimens. Tooth height was measured by caliper as the distance from cusp tip to the tip of the longest root. Tooth size (% TOT) was used to determine sexual dimorphism (Ellis & Shackley, 1995).

RESULTS

The mouths of males were significantly longer than of females (3.93 and 3.68%, respectively; $P < 0.05$) and narrower (5.92 and 6.72%, respectively; $P < 0.05$) (Tabs. 1 and 2). These differences resulted in a significant sexual dimorphism with respect to MoL/MoW (0.67 and 0.57 for males and females respectively; $P < 0.05$).

The sexual differences in these metric measurements for each of the size groups (Tab. 3) indicated that sexual dimorphism occurred only in larger TOT groups. The smallest fish sampled (<50 cm) showed no significant differences.

Significant size-based differences were observed for males. MoL/MoW in males increased from 0.62 (<50 cm TOT) to 1.53 (>50 cm TOT) (Tab. 1) with significant differences occurring between fish <50 cm TOT and the larger size group (>50 cm TOT) ($P = 0.001$).

Tab. 1: Differences in** Scyliorhinus canicula **males in mouth morphometrics by TOT (mean ± standard deviation, and range in parentheses).
Tab. 1: Razlike v morfometriji ust pri samcih navadne morske mačke** Scyliorhinus canicula **glede na celotno iztegnjeno dolžino – TOT (srednja vrednost ± standardni odklon ter razpon v oklepaju).

Length (cm)	No.	MoL/MoW	MoL(%)	MoW(%)
<50	65	0.62±0.16 [0.26-0.95]	3.83±0.32 [2.68-4.28]	6.28±1.14 [4.41-9.8]
>50	10	1.53±0.55 [1.05-2.56]	4.68±0.40 [4.39-5.22]	3.31±0.82 [2.04-4.19]
∑	75	0.67±0.38 [0.26-2.56]	3.93±0.43 [2.68-5.22]	5.92±1.47 [2.04-9.8]

Tab. 2: Differences for females of small-spotted catshark in mouth morphometrics by TOT (mean ± standard deviation, and range in parentheses).
Tab. 2: Razlike v morfometriji ust pri samicah navadne morske mačke glede na celotno iztegnjeno dolžino – TOT (srednja vrednost ± standardni odklon ter razpon v oklepaju).

Length (cm)	No.	MoL/MoW	MoL(%)	MoW(%)
<50	15	0.60±0.12 [0.43-0.79]	3.54±0.52 [2.67-4.38]	6.34±1.34 [5.13-10.57]
>50	10	0.52±0.07 [0.51-0.70]	3.99±0.45 [3.53-4.63]	7.65±0.55 [6.98-8.53]
∑	25	0.57±0.11 [0.43-0.79]	3.68±0.53 [2.67-4.63]	6.72±1.29 [5.13-10.57]

This difference in MoL/MoW may be the result of an increase in MoL and a relative decrease in MoW as male fish grew. It was shown that MoL of fish <50 cm significantly differed from larger group >50 cm (P <0.001). Significant differences in MoW were shown between <50 cm and >50 cm TOT groups (P <0.001).

Preoral length, prebranchial length, head length, head girth and anterior teeth height were significantly different between males and females (Tab. 4). Females had shorter, wider heads and longer preoral and shorter prebranchial lengths. In the upper jaw, the anterior teeth were large (up to 3 mm in height). The height of the anterior tooth in the upper male jaws increased from 1.0 mm (TOT = 40 cm) to 3.0 mm (TOT = 78.6 cm), whereas the same measurement for females increased from 0.25 mm (TOT = 28.2 cm) to 2.5 mm (TOT = 70.0 cm).

DISCUSSION

This sexual dimorphism in MoL/MoW was due to an increase in % MoL and decrease in % MoW of males. The changes in mouth morphology may be considered as secondary sexual characteristics. The MoL/MoW values of 0.59 and 0.53 for males and females recorded by Arthur (1950) are similar to those obtained in this study (0.67 and 0.57). The values calculated by Ellis & Sheckley (1995), 0.49 and 0.43 are significantly different from the previously mentioned data.

In the present study, MoL/MoW significantly differed between sexes only for the larger size group and not for specimens <50 cm. It was suggested that changes in mouth morphology were related to sexual maturity (Brough, 1937). It is considered that the changes in mouth morphology of males and the sexual dimorphism in MoL/MoW is related to sexual maturity, since those fish <50 cm were immature. Capapé (1977) noted that the males and females mature at lengths of 40 and 45 cm, respectively, along the Tunisian coast. Capapé *et al.* (1991) stated that males and females mature at lengths of 44 and 41–47 cm, respectively. The same authors also noted that males were larger than females (max. total size were 55 cm for males and 51 cm for females from the Mediterranean coast of France). Ellis & Shackley (1995) suggested that males and females mature at lengths of approximately 52 and 55 cm, respectively. Rodriquez-Cabello *et al.* (1998) reported that females attained first sexual maturity at length of 54.2 cm TOT, while Ivory *et al.* (2002) reported that the length at 50% maturity was 53.5 cm for males (max. TOT = 71.0 cm) and 57.0 cm for females (max. TOT = 70.0 cm).

Tab. 3: Probability values (P) show the statistical differences of MoL/MoW, MoL and MoW between males and females for the two TOT categories and total sample of small-spotted catshark.
Tab. 3: Statistično značilne razlike (P) v MoL/MoW, MoL in MoW med samci in samicami navadne morske mačke pri dveh velikostnih razredih in v skupnem vzorcu.

Length (cm)	MoL/MoW	MoL	MoW
<50	0.485	0.57	0.856
>50	0.001*	0.006*	<0.001*
∑	0.001*	0.027*	0.018*

*Significant difference/statistično značilna razlika (P <0.05)

During a couple of previous studies carried out along Turkish coasts, Geldiay (1969) and Akşiray (1987) established that maximum length was 80 cm and 150 cm, respectively, while Cihangir *et al.* (1997) noted maximum total lengths of 54.6 cm for males and 51.7 cm for females. The findings of our study are relatively in agreement with the previous assessments. As there have been no similar studies on sexual dimorphism of *S. canicula* in Turkish Seas, a comparison of results could not have been made.

Head girth was significantly greater in females and this confirms the results of Brough (1937) and Ellis & Shackley (1995). Preoral length was significantly shorter in males probably as a result of the increased mouth length. Significant differences in prebranchial length, head length and head girth may indicate sexual differences in the base of growth of the whole head region.

Tab. 4: Morphometric values (in cm) for six body dimensions (mean ± standard deviation, and range in parentheses) and probability values of differences (P).
Tab. 4: Morfometrične vrednosti (v cm) za šest telesnih dimenzij (srednja vrednost ± standardni odklon ter razpon v oklepaju) in statistično značilne razlike (P).

Dimension	Males (No. = 25)	Females (No. = 25)	P
Total body length	557.72±128.99 [284-786]	477.5±114.83 [246-700]	0.030*
Preoral length	3.48±0.33 [2.77-4.23]	3.84±0.66 [3.0-6.50]	0.020*
Prebranchial length	12.55±1.16 [10.0-14.23]	11.53±1.70 [8.33-13.65]	0.024*
Head length	17.38±2.14 [13.70-24.04]	16.18±1.64 [13.89-20.34]	0.039*
Head girth	29.18±3.26 [22.00-36.59]	33.82±3.78 [28.88-47.97]	<0.001*
Upper teeth height (anterior)	0.38±0.11 [0.21-0.60]	0.29±0.08 [0.17-0.45]	0.002*

*Significant difference/statistično značilna razlika (P <0.05)

The results of our study confirm that the teeth of *S. canicula* were larger in males and are therefore in agreement with those of Springer (1979), Ellis & Shackley (1995) and Litvinov (2003). Springer (1979) reported that males often have longer teeth than females, *i.e.* that they are even twice as long as in similarly sized females. In male *S. canicula* from West Africa waters, jaws are larger, stronger, and more calcinated (Litvinov, 2003). The reason for the changes in mouth dimensions in males during maturation and the fact that males have longer teeth than females may be explained by different feeding habits and adaptations for reproductive behaviour. Fedducia & Slaughter (1974) attributed sexual dimorphism in the dentition of the family Rajidae to two different feeding habits. However, McEachran (1977) suggested that no sexual differentiation in food exists and that sexually dimorphic dentition may be an adaptation to the reproductive behaviour. In this study, the food of *S. canicula* is composed primarily of crustaceans and small fishes. It has been reported that the small-spotted catshark feeds on decapod crustaceans, molluscs and teleosts (Lyle, 1983; Ellis & Shackley, 1995; Olasa *et al.*, 1998). Lyle (1983) found a significant sexual difference in the diet of small-spotted catshark in Isle of Man waters. Kabasakal (2001) reported that the diet of *S. canicula* is composed of fishes, crustaceans, cephalopods, but that no sexual differences were found in feeding habits.

SPOLNI DIMORFIZEM NAVADNE MORSKE MAČKE *SCYLIORHINUS CANICULA* (L., 1758) IZ EDREMITSKEGA ZALIVA (TURČIJA)

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POVZETEK

V prispevku so analizirane morfometrične značilnosti in zobovje stotih navadnih morskih mačk Scyliorhinus canicula*, ujetih leta 1998 z vlečno mrežo v Edremitskem zalivu (severno Egejsko morje). Ugotovljeno je bilo, da imajo samci daljšo in ožjo čeljust kot samice, kar kaže na izrazit spolni dimorfizem v razmerju dolžine/širine čeljusti (0,67 oz. 0,57 cm). Pomembne spolne razlike so bile zabeležene tudi v obsegu glave, predustnih in predškržnih dolžinah ter dolžinah glave in telesa. Avtorji v članku razpravljajo o možnih vzrokih za te razlike.*

Ključne besede: *Scyliorhinus canicula*, Scyliorhinidae, spolni dimorfizem, morfometrične značilnosti, Egejsko morje

REFERENCES

Akşiray, F. (1987): Türkiye Deniz Balıkları ve tayin anahtarı. II. Baskı, İstanbul, İ.Ü. Rekt. Yay. No: 3490, 811 pp.

Arthur, D. R. (1950): Abnormalities in the sexual apparatus of the common dogfish *(Scyliorhinus canicula).* Proc. Zool. Soc. Lond., 162, 52–56.

Brough, J. (1937): On certain secondary sexual characters in the common dogfish *(Scyliorhinus canicula).* Proc. Zool. Soc. Lond., 107, 217–223.

Capapé, C. (1977): Contribution à la biologie des Scyliorhinidae des côtes tunisiennes. I. *Scyliorhinus canicula* (Linne, 1758): répartition géographique et bathymétrique, sexualité, reproduction, fécondité. Bull. Off. natn. Pêch. Tunisie, 1(1), 83–101.

Capapé, C., J. A. Tomasini & J. L. Bouchereau (1991): Aspects of the reproductive biology of the small spotted dogfish *Scyliorhinus canicula* (Linnaeus, 1758) (Pisces, Scyliorhinidae) from of the Gulf of Lion (southern France). Ichtyophysiol. Acta., 14, 87–109.

Cihangir, B., A. Ünlüoğlu & M. E. Tıraşın (1997): Kuzey Ege Denizi'nde kedibelığı (Chondrichthyes, *Scyliorhinus canicula*, Linnaeus, 1758) 'nın dağılımı ve bazı biyolojik özellikleri. Akdeniz Balıkçılık Kongresi, 9–11 Nisan, İzmir, p. 585–603.

Compagno, L. J. V. (1984): FAO species catalogue. Vol. 4. Sharks of the world. An annotated and illustrated catalogue of shark species known to date. Part 1. Hexanchiformes to Lamniformes. Part 2. Carchariniformes. FAO Fisheries Synopsis, 655 pp.

Edmondson, A. & D. Druce (1996): Advanced Biology Statistics. Oxford University Press, 176 pp.

Ellis, J. R & S. E. Shackley (1995): Ontogenic changes and sexual dimorphism in the head, mouth and teeth of the lesser spotted dogfish. J. Fish Biol., 47, 155–164.

Fedducia, A. & B. H. Slaughter (1974): Sexual dimorphism in skates (Rajidae) and its possible role in differential niche utilization. Evolution, 28, 164–168.

Fischer, W., M. Schneider & M. L. Bauchot (1987): Vertebrés Méditerranée et Mer Noire. FAO ECEE, Rome, Vol. 2, p. 763–1529.

Geldiay, R. (1969): İzmir Körfezi'nin başlıca balıkları ve muhtemel invasionları. E.Ü. Fen Fak. Monog. Seri., 11, 135 pp.

Ivory, P., F. Jeal & C. P. Nolan (2002): Age, determination, growth and reproduction in the lesser-spotted dogfish, *Scyliorhinus canicula*. NAFO SCR DOC, Scientific council meeting, September 2002.

Jardas, I. (1979): Morphological, biological and ecological characteristics of the lesser spotted dogfish, *Scyliorhinus canicula* (Linnaeus, 1758) population in the Adriatic Sea. Acta Adriat., 4(2–3), 1–104.

Kabasakal, H. (2001): Preliminary data on the feeding ecology of some selachians from the north-eastern Aegean Sea. Acta Adriat., 42 (2), 111–118.

Kerr, T. (1955): Development and structure of teeth in the dogfish *Squalus acanthias* L. and *Scyliorhinus canicula* (L.). Proc. Zool. Soc. Lond., 125, 95–114.

Litvinov, F. F. (2003): Sexual dimorphism as an index of the isolation of West African populations of the cat shark, *Scyliorhinus canicula*. J. Ichthyol., 43, 81–85. (translated from Vopr. Ihtiol., 43, 86–90)

Lyle, J. M. (1983): Food and feeding habits of the lesser spotted dogfish, *Scyliorhinus canicula* (L.) in Isle of Man waters. J. Fish Biol., 23, 725–737.

McEachran, J. D. (1977): Reply to "Sexual dimorphism in skates (Rajidae)". Evolution, 31, 218–220.

Olasa, I., F. Velasco & N. Perez (1998): Importance of discarded blue whiting *(Micromesistius poutassou)* in the diet of lesser spotted dogfish *(Scyliorhinus canicula)* in the Cantabrian Sea. ICES J. Mar. Sci., 55(3), 331–341.

Rodriquez-Cabello, C., F. Velasco & I. Olaso (1998): Reproductive biology of the lesser-spotted dogfish *Scyliorhinus canicula* (L. 1758) in the Cantabrian Sea. Sci. Mar., 62(3), 187–191.

Sokal, R. R. & F. J. Rohlf (1994): Biometry: the Principles and Practice of Statistics in Biological Research. 3rd edn. W. H. Freeman and Co., New York, 859 pp.

Springer, S. (1979): A revision of the catsharks, family Scyliorhinidae. NOAA Technical Report NMFS, Circular 422, 152 pp.

Totaro, E. A., G. Papaccio, S. Caporaso & A. Caporaso (1984): Comparison between teeth and scales of newborn and adult specimens of *Scyliorhinus canicula* (Linne), a scanning electron microscopic study. Arch. Biol., 95, 423–428.