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Biological observations on the nursehound, *Scyliorhinus stellaris* (Linnaeus, 1758) (Chondrichthyes: Scyliorhinidae) in captivity

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Observations conducted over two years on nursehounds, Scyliorhinus stellaris*, in captivity provided data on the number of eggs laid per year, embryonic development, size at hatching, length growth following hatching, and estimated fecundity.*

Key words: Scyliorhinidae, *Scyliorhinus stellaris*, eggs, hatching, length growth, captivity

INTRODUCTION

The small-spotted catshark, *Scyliorhinus canicula* (Linnaeus, 1758), was the focus of several articles concerning free-swimming (FORD, 1921; LELOUP & OLIVEREAU, 1951; MELLINGER, 1962ab, 1964; CAPAPÉ, 1977; CRAIK, 1978; CAPAPÉ *et al*., 1991; ELLIS & SHACKLEY, 1997) and captive specimens (MELLINGER, 1989, 1994; HOUZIAUX & VOSS, 1997; DOMI *et al*., 2000).

In contrast, its close relative, the nursehound, *Scyliorhinus stellaris* (Linnaeus, 1758), is lesser known, probably due to its scarcity; the species is not abundantly caught in the marine areas it inhabits (QUÉRO, 1984). Information was provided about the spawning period for specimens from Plymouth in the British Isles (GARSTAND, 1893-1895; FORD, 1921), the Adriatic Sea (SYRSKI, 1876; GRAEFFE, 1888), and off Naples in southern Italy (LO BIANCO, 1909; MASCHLANKA, 1955). In the Adriatic Sea, JARDAS (1979) noted that *S. stellaris* is found in shallow coastal waters at depths up to 60 m, while GRUBIŠIĆ (1982) reported its occurrence throughout the area at depths of 40-100 m, and rarely over 200 m. Aspects of the reproductive biology of the nursehound were reported by ŽUPANOVIĆ (1961ab) for the middle Adriatic,

BINI (1967) for the Italian Seas, CAPAPÉ (1977) for the Tunisian coast, and CAPAPÉ *et al*. (2000) for the Languedoc coast of southern France.

The hatching period was reported by MOREAU (1881), EHREBAUM (1927), and CAPAPÉ (1974a) while MELLINGER & WRISEZ (1989) described embryonic development and MELLINGER *et al.* (1989) compared lipid contents in eggs and neonates. SKARAMUCA & PRTENJAČA (1985) described the first stages of development in newly hatched specimens in tanks

Observations conducted on captive nurse-hounds during two years allow us to report on eggs, hatching, and first growth stages.

MATERIAL AND METHODS

Observations were carried out in four tanks at the aquarium of La Grande Motte, 20 km east of Montpellier in southern France. The first tank contained mature specimens (Tank 1), two others contained eggs (Tanks 2 and 3), and a fourth, neonates (Tank 4). The tanks were supplied with water drawn directly from the sea at a flow of 150 l/h. The tanks were illuminated with fluorescent tubes (36 watts, each), from 10:00 to 18:00 hrs in October-April and from 10:00 to 23:00 hrs in May-September. The total lengths (TL) of neonates and specimens was measured to the nearest millimeter following COMPAGNO (1984).

Tank 1

Four adult specimens were kept in a 6 m^3 tank, together with a loggerhead sea turtle, *Caretta caretta* (Linnaeus, 1758), and a stone bass, *Polyprion americanus* (Bloch and Schneider, 1801). The specimens were fed pieces of teleosts and penaeid shrimps once a day at 17:30 hrs. Egg laying occurred February-December 1987 when the water temperature was 15-22.5°C and the salinity was 28-33 psu.

Tanks 2 and 3

The eggs were removed to two 60 liters tanks as soon as they were laid. The eggs were suspended or deposited on a grating. Water temperature ranged 15-25.5°C. Salinity was maintained at 32 psu.

Tank 4

Soon after hatching, the neonates were moved to Tank 4, also 60 liters. Water temperature varied 16-21°C. Four to five days after hatching, the neonates were fed small pellets, 3-5 mm in diameter, made of crushed teleost pieces. The pellets were quickly consumed by the neonates from the first days. The pellets were progressively enlarged as the size of the neonates increased. When the neonates reached 300 mm TL, they were fed pieces of teleosts as were the adults.

RESULTS

Copulatory behavior

No copulatory or pre-copulatory behavior (DOMI *et al*., 2000) was observed during daytime. Adults rested on the sandy substrate throughout the illuminated period. At the end of the afternoon, they began to move and pre-copulatory behavior was observed.

Egg laying

Generally, egg laying occurred throughout the year except in December and January. The number of eggs produced were 27, 41, and 31 in 1987, 1988, and 1989, respectively. Unfortunately, there were three females in the tank, so we were unable to assess the number of eggs produced by each female.

Hatching

Only 20 of the 27 eggs placed in Tanks 2 and 3 completed embryonic development until hatching. The length of embryonic development was 9-12 months. No embryonic development was observed in eggs deposited directly on the floor.

Growth of neonates

Only six neonates survived. Dates and sizes (TL, mm) at birth are given in Table 1 and length increases are given in Table 2. When the specimens were considered too large for the tanks, they were released into the sea.

Table 1. Dates and sizes at hatching of six Scyliorhinus stellaris *specimens*

Date	Size at hatching (TL, mm)
17 April 1988	110
19 August 1988	106
27 September 1988	110
06 October 1988	105
08 October 1988	110
28 October 1988	106

DISCUSSION

The absence of mating behavior during the illuminated period and the pre-copulatory behavior at late afternoon suggest that mating occurred at night. This is conjuncture and remains difficult to explain. It does not agree with observations of captive *S. canicula* by HOUZIAUX & VOSS (1997) and DOMI *et al*. (2000), who described copulatory behavior occurring during daytime. Further, shark mating occurs in the best environmental conditions in spring or early summer when adult males and females generally approach the coast (MUÑOZ-CHAPULI, 1984; CAPAPÉ *et al*., 2003, 2004; BRADAÏ *et al*., 2005), however, to our knowledge, these authors did not mention whether copulatory behavior takes place during daytime or at night.

The sample of HOUZIAUX & VOSS (1997) was larger than ours and contained thirty captive *S. canicula*. The sex ratio was the same in both samples: one male to three females. The presence of a single male in our sample prevented male competition. This suggests that copulatory behavior depends on the number of males in the small-spotted catshark.

The number of eggs produced each year by a single female could not be determined. If each female produced the same number of eggs per year, then each produced 9-13. If

Table 2. Total length (mm) following hatching and periodically measured in six specimens

Date (Day, Mo, Yr)	1	2	3	4	5	6
17/05/1988	110					
17/06/1988	190					
17/07/1988	210					
17/08/1988	220					
17/09/1988	240	160				
17/10/1988	250	180	165	115	120	
17/11/1988	255	190	170	130	140	120
19/12/1988	260	220	215	160	210	140
19/01/1989	265	230	220	170	215	200
09/ 02/1989	280	240	230	180	220	210
17/06/1989	320	310	305	300	295	295
12/08/1989	370	350	320	310	300	305
26/09/1990	530	520	460	480	470	500

Table 3. Linear growth of six specimens versus duration of captivity

Specimens	Captivity in days	Initial TL (mm)	Final TL (mm)	Growth (TL, mm)
1	899	110	530	420
2	772	106	520	414
3	729	110	460	350
4	720	105	480	375
5	718	110	470	350
6	706	106	500	394

only one female produced eggs, the number ranged 27-41. Consequently, the number of eggs annually produced by the female(s) in Tank 1 could range 9-41. Based on the number of yolky oocytes ready to be ovulated in mature females caught off the Tunisian coast, CAPAPÉ (1977) determined that 77-109 eggs per year could be produced. However, in both oviparous (CAPAPÉ, 1974b, 1977) and viviparous (CAPAPÉ *et al.*, 2003, 2004; SAÏDI *et al.*, 2005) elasmobranchs, some yolky oocytes are not ovulated and enter atresia. Therefore, CAPAPÉ (1977) probably overestimated the fecundity of *S. stellaris* in the natural environment. Captivity can influence elasmobranch fecundity. For example, free-swimming pelagic stingrays, *Dasyatis violacea* (HEMIDA *et al.*, 2003) were slightly more prolific than specimens maintained in tanks (MOLLET *et al*., 2002).

Hatching ranged 10-12 months, in agreement with MOREAU (1881) and EHRENBAUM (1927) for *S. stellaris* from the Atlantic and North Seas, respectively. Only two of ten eggs from Salammbô (Tunisia) suspended in tanks at the Institut National des Sciences et Technologies de la Mer (INSTM) produced neonates of 107 and 108 mm TL, respectively, after hatching periods of 198 and 201 days, or seven months, slightly less than observations cited above (CAPAPÉ, 1974a). Neonates from the Adriatic were larger at hatching, 13.0-16.3 mm (mean 14.6 mm; SKARAMUCA & PRTENJAČA, 1985). This difference may be due to the fact that the embryos at La Grande Motte and Salammbô developed in egg capsules deposited in the tanks while embryos in the Adriatic developed in the natural environment.

After 60 days, the mean length of the Adriatic specimens was 188.5 mm for females and 184.5 mm for males (SKARAMUCA & PRTENJAČA, 1985). The six specimens in our study reached 170-215 mm (mean 192.5 mm) after 60 days, similar to results of SKARAMUCA & PRTENJAČA (1985). (Table 3). Nevertheless, intraspecific differences related to area cannot be excluded, especially in regard to scyliorhinids (LELOUP & OLIVEREAU, 1951). The six specimens were kept in Tank 4 for 706-899 days during which they increased by 375-420 mm with a daily increment of 0.46-0.56 mm. The specimens remained juveniles. Sexual maturity occurs at 770-790 mm TL in *S. stellaris* from the Tunisian coast (CAPAPÉ, 1977) and the Languedoc coast (CAPAPÉ *et al.*, 2000). Consequently, if the growth rate in *S. stellaris* is constant and does not differ significantly between populations, sexual maturity would be reached at the age of four years (BOUGIS, 1989), however this hypothesis needs further investigation.

Although the hydrobiological parameters in our study probably differed from those in the natural environment, our work shows that the nursehound could be a good biological model for ethobiological study. As in the case of its relative, the small-spotted catshark, it appears that acclimatization of nursehounds in tanks is possible by providing appropriate conditions.

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Biološka zapažanja na mački mrkulji, *Scyliorhinus stellaris* (Linnaeus, 1758) (Chondrichthyes: Scyliorhinidae) u kaptivitetu

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SAŽETAK

Preko dvije godine su vršena opažanja na mački mrkulji *Scyliorhinus stellaris* u kaptivitetu. Dobiveni su podaci o godišnje izleglom broju jaja, embrionalnom razvoju, veličini kod leženja, rastu dužine nakon leženja i procjeni plodnosti.

Ključne riječi: Scyliorhinidae, *Scyliorhinus stellaris,* jaja, leženje, porast dužine, kaptivitet