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SIZES OF EIGHT OVIPAROUS ELASMOBRANCH SPECIES HATCHED IN TWO MEDITERRANEAN AREAS: A SURVEY AND RECENT DATA

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ABSTRACT

In the present paper, the authors report on the size of eight oviparous elasmobranch species hatched in two Mediterranean areas: off the Tunisian coast (central Mediterranean) and Languedocian coast (southern France, northern Mediterranean). Most of the observations were made in experimental conditions, from egg cases placed in tanks. For each species, no intraspecific variation was observed between specimens from both areas. In contrast, new hatched smallspotted catsharks from the Mediterranean appeared to be smaller than those from the Atlantic.

Key words: Elasmobranchs, size at hatching, oviparous species, Tunisian coast, Languedocian coast, Mediterranean

GRANDEZZA DI OTTO SPECIE OVIPARE DI ELASMOBRANCHI, SCHIUSE IN DUE AREE MEDITERRANEE: REVISIONE E DATI RECENTI

SINTESI

Gli autori riportano la grandezza di otto specie ovipare di elasmobranchi, schiuse in due aree mediterranee: in prossimità della costa tunisina (Mediterraneo centrale) e della costa di Languedoc (Francia meridionale, Mediterraneo settentrionale). La maggioranza delle osservazioni è stata fatta su uova tenute in vasca, in condizioni sperimentali. Non è stata registrata alcuna variazione intraspecifica fra gli individui della prima e della seconda area di studio, per nessuna specie. Per il gattuccio viene segnalato che i giovani esemplari provenienti dal Mediterraneo appaiono più piccoli di quelli atlantici.

Parole chiave: Elasmobranchi, grandezza alla schiusa, specie ovipare, costa tunisina, costa di Languedoc, Mediterraneo

INTRODUCTION

In oviparous elasmobranch species, size at hatching (rather than size at birth) could be recorded only from embryos at the end of development found in egg cases or in recent hatched specimens. Unfortunately, such findings in the wild have been rarely reported in literature. Information on the size at hatching in oviparous elasmobranch species has been mostly provided from experimental observations, carried out on embryonic development in egg cases placed in tanks, or laid by females in captivity. In this paper; we give observations on the size at hatching in 8 oviparous elasmobranch species collected off two Mediterranean areas: the Tunisian (central Mediterranean) and Languedocian coasts (southern France, northern Mediterranean).

MATERIAL AND METHODS

Observations were conducted between 1970 and 2005 on 8 oviparous elasmobranch species from the above mentioned Mediterranean areas (Fig. 1). Of the 8 oviparous elasmobranch species presented in this paper, 5 species occur in both areas: 3 scyliorhinids, the blackmouth catshark *Galeus melastomus* Rafinesque, 1810, the smallspotted catshark *Scyliorhinus canicula* (Linnaeus, 1758), the nursehound *S. stellaris* (Linnaeus, 1758) and 3 rajids, the starry ray *Raja asterias* Delaroche, 1809, the thornback ray *R. clavata* Linnaeus, 1758 and the speckled ray *R. polystigma* Regan, 1923; 2 other rajids occur only off the Tunisian coast: the brown ray *R. miraletus* Linnaeus, 1758, and the rough ray *R. radula* Delaroche, 1809.

Observations and measurements were made on developing embryos removed from egg cases found in the wild, specimens hatched from egg cases deposited in tanks or laid by captive females, smallest free-swimming specimens exhibiting or not remains of internal yolk. Measurements included total length (TL) for scyliorhinids following Compagno (1984) and disc width (DW) for rajids following Clark (1922, 1926) recorded to the nearest millimetre and mass recorded to the nearest decigram.

Wild specimens were collected from trawling performed from off both Tunisian and Languedocian coasts. Egg cases were deposited in tanks located at three sites. The first site was the Institut National des Sciences et Technologies de la Mer of Salammbô (INSTM), the city 15 km north of Tunis (Tunisia); the second site was the aquarium of La Grande Motte, the city located 25 km southeast from Montpellier (France), whereas the third site was the Laboratoire d'Ichtyologie of the Université Montpellier 2 in Montpellier.

Tanks of the first and second sites contained 60 litres and were supplied with water directly drawn from the sea; the flow was 150 litres per hour. The tank of the third site contained 120 litres; it was regularly supplied by marine water collected from the sea and immediately carried to the laboratory.

For each species, we cite vernacular name in English (En), French (Fr) and Arabic Tunisian language (Tn); we also give sizes at first sexual maturity, maximal size and size of the smallest free-swimming specimens when available, size (length x width) and weight of egg cases, previous and recent observations carried out on hatched specimens, or in some cases in embryos at the end of embryonic development.

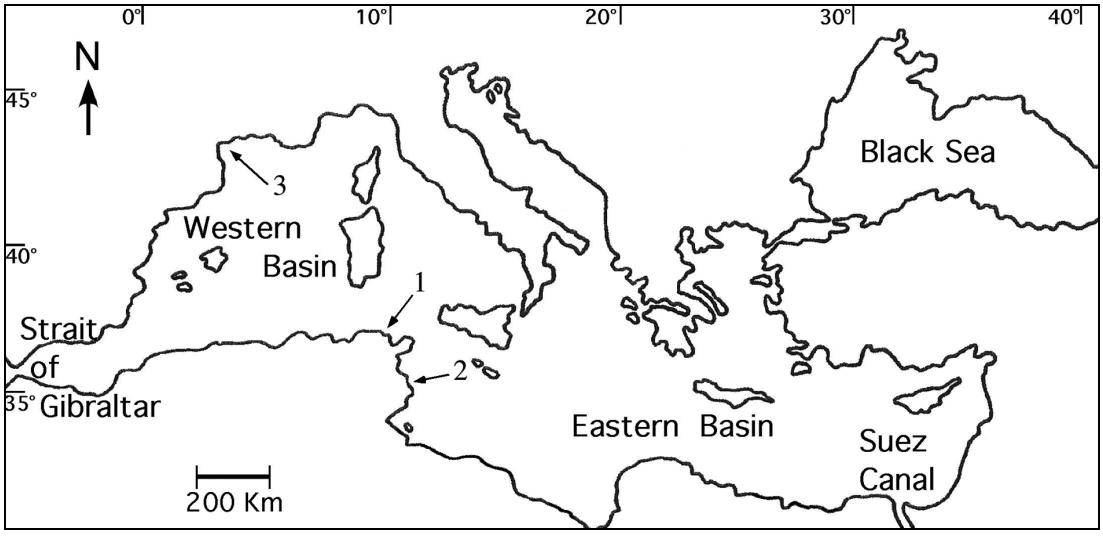

Fig. 1: Map of the Mediterranean Sea showing the areas were female oviparous elasmobranchs were collected. Arrows 1 and 2: Tunisian coast; arrow 3: Languedocian coast.
Sl. 1: Zemljevid Sredozemskega morja z območjema, v katerih so bile ujete samice jajcerodnih morskih psov in skatov. Puščici 1 in 2: tunizijska obala; puščica 3: languedoška obala.

RESULTS

Family Scyliorhinidae

***Galeus melastomus* Rafinesque, 1810**
blackmouth catshark (En), chien espagnol (Fr), gattous bhar (Tn)

Off the Tunisian coast, the blackmouth catshark is abundantly caught off southern areas, at depth between 200 and 600m, its southernmost extension being the Gulf of Hammamet (Capapé & Zaouali, 1977; Bradaï *et al.*, 2000). Males were sexually mature at the size above 400 mm TL, females between 390 and 420 mm TL, whereas the largest male and the largest female were 560 and 550 mm TL, respectively (Capapé & Zaouali, 1977). Off the Languedocian coast, the species is captured at lower depth than the Tunisian specimens, *i.e.* between 120 and 200 m. Males and females sexually matured between 510–550 mm and females between 520–610 mm total length (TL), respectively, while the largest male and the largest female were 620 mm and 650 mm TL, respectively *(unpubl. data)*.

Egg cases from the Tunisian coast were 42–48 mm in length, 18–25 mm in width and weighed 3.7–4.4 g (Capapé & Zaouali, 1977), while egg cases from the Languedocian coast were 36–50 mm in length, 14–21 mm in width and weighing 3.5–5.0 g. Egg cases removed from females of both areas were placed in tanks, but they rapidly degenerated after a week maximum. Egg cases caught off the second area contained developing embryos, which quickly died. They were sorted from the cases, were probably term embryos, both measuring 75 mm TL and weighing 2.9 and 3.2 g. The smallest free-swimming specimens found off the Languedocian coast were 2 males, 125 and 145 mm TL, both weighing 8 g, and two females, 135 and 140 mm TL, weighing 6 g and 8 g, respectively. The smallest blackmouth catshark recorded to date was 9 mm TL, off the south coast of Portugal (Costa *et al.*, 2005).

***Scyliorhinus canicula* (Linnaeus, 1758)**
smallspotted catshark (En), petite roussette (Fr), gattous bhar (Tn)

The smallspotted catshark is probably the elasmobranch species most commonly landed in both areas (Capapé, 1977a; Capapé *et al.*, 2000). Off the Tunisian coast, males were sexually mature at 400 mm TL, females between 400 and 450 mm TL, while the largest male and the largest female were 580 and 560 mm TL, respectively (Capapé, 1977a). Off the Languedocian coast, males and females sexually matured between 430–440 mm and 410–450 mm total length (TL), respectively, while the largest male and the largest female were 550 mm and 510 mm TL, respectively *(unpubl. data)*.

Egg cases from the Tunisian coast were 38–48 mm in length, 14–19 mm in width and weighing 2.3–4.2 g (Capapé, 1977a), while egg cases from the Languedocian coast were 41–58 mm in length, 16–20 mm in width and weighing 4.1–5.9 g. Capapé (1977a) provided information concerning size at hatching from egg cases placed in tanks of the INSTM, and noted that the incubation period decreased with temperature, 271–285 days with a temperature range between 14–19.5 °C, and 177–180 days with temperature range between 19–24 °C. However, no difference was observed between the 5 hatched specimens, a single male and 4 females ranged 84–88 mm TL and weighed 2.1–2.2 g. Of the 8 egg cases removed from females and placed in tanks in the Laboratoire d'Ichtyologie of Université Montpellier 2 with temperature range between 19–21 °C, a single egg hatched after the incubation period of 145 days; the female recorded was 78 mm TL and weighing 1.9 g. Of 3 egg cases with developing embryos placed in the same tank, one aborted, while from the other two a male and a female were hatched two weeks later, measuring 80 mm and 78 mm in length, and weighing 2.0 and 1.8 g, respectively. Ellis & Schackley (1997) noted that eggs took 5–6 months to hatch at water temperature range of 8.5–18.1 °C. Neonates ranged 90–112 mm and weighed 2.6–3.9 g.

***Scyliorhinus stellaris* (Linnaeus, 1758)**
nursehound (En), grande roussette (Fr), gattous bhar el kbir (Tn)

The nursehound is captured off the Tunisian coast less often than the smallspotted catshark (Capapé, 1977b). Moreover, it is considered rare in southern Tunisian areas such as the Gulf of Gabès (Bradaï *et al.*, 2002). Off the Tunisian coast, males and females were sexually mature at 770 mm TL and 790 mm TL, respectively, while the largest male and the largest female were 1080 and 1115 mm TL, respectively (Capapé, 1977b). Off the Languedocian coast, Capapé *et al.* (2000) recorded some specimens and suggested that the species was not so abundant in the area as in the past (Moreau, 1881; Euzet, 1959). Of the 6 specimens observed, an adult female 980 mm TL bore two egg cases, one per oviduct (Capapé *et al.*, 2000).

Egg cases from the Tunisian coast were 92–96 mm in length, 37–39 mm in width and weighing 28.2–29.5 g (Capapé, 1977b), while egg cases from the Languedocian coast were 94 mm in length, 37 mm in width and weighing 29 g (Capapé *et al.*, 2000). Of the 10 egg cases placed in tanks from INSTM of Salammbô, only two were hatched after an incubation period of 198 and 201 days. One male and one female measured 108 mm TL and 107 mm TL, respectively, both weighing 4.5 g. Size at hatching for specimens from the Languedocian coast were from 105 to 110 mm TL according to Capapé *et al.*

(2006a), who noted that the incubation period ranged between ten and twelve months, in agreement with Moreau (1881) and Ehrenbaum (1927) for *S. stellaris* from the Atlantic and North Sea. Moreover, neonates from the Adriatic Sea were larger, as the size at hatching was between 130 and 163 mm according to Skaramuca & Prtenjaca (1985). These differences may be due to fact that embryos developed in egg capsules deposited in tanks at Salammbô and La Grande Motte, and in natural environment in the Adriatic Sea.

Family Rajidae

***Raja asterias* Delaroche, 1809**
starry ray (En), raie étoilée (Fr), kerchella (Tn)

The starry ray is commonly captured off the northern coast of Tunisia from the Algerian border to the Gulf of Tunis and it is unknown southward (Capapé, 1977c). Males and females were sexually mature when over 360 mm and 430 mm DW, respectively, while the largest male and the largest female were 470 and 520 mm DW, respectively (Capapé, 1977c). Off the Languedocian coast, preliminary observations reported by Capapé *et al.* (2006b) showed that males and females were adult when over 330 mm and 360 mm DW, respectively.

Egg cases from the Tunisian coast were 103–110 mm in length with horns, 45–48 mm in length without horns, 34–37 mm in width and weighing 9.4 g (Capapé, 1977c), while egg cases from the Languedocian coast were: length with horns between 9.6 and 105 mm, length without horns between 43 and 47 mm, width between 32 and 34 mm, and weighing between 9.2 and 9.7 g (Capapé *et al.*, 2006b). Of 10 egg cases placed in tanks at the INSTM, only two were hatched after 154 and 147 days, a female 67 mm DW, 6.5 g, and a male 68 mm DW, 6.6 g, respectively. Egg cases of Languedocian *R. asterias* were not placed in tanks, however, a juvenile male, 72 mm DW, 7.9 g, with remains of internal yolk was recorded, suggesting a recently hatched specimen and the smallest starry ray recorded to date in the area.

***Raja clavata* Linnaeus, 1758**
thornback ray (En), raie boűclée (Fr), kerchella (Tn)

The thornback ray is commonly captured throughout the coast of Tunisia from the Algerian to the Libyan borders (Capapé, 1976; Bradaï *et al.*, 2004). Males and females were sexually mature when over 480 mm and 540 mm DW, respectively, while the largest male and the largest female were 640 and 680 mm DW, respectively (Capapé, 1976). Off the Languedocian coast, preliminary observations reported by Capapé *et al.* (2006b) showed that males and females were adult when over 330 mm and 360 mm disc width, respectively. *R. clavata* was reported off the Languedocian coast by people from Doumet (1860) to Quignard (1965), where it was previously very common. In contrast, recent investigations conducted by Capapé *et al.* (2007a) in the area showed that captures remain rather occasional. The smallest male and female adults were 420 mm and 540 mm DW, respectively, whereas the largest male and largest female were 510 mm and 690 mm DW. Production of egg cases was observed throughout the year, except in April and August.

Egg cases from the Tunisian coast were 121–135 mm in length with horns, 70–78 mm in length without horns, 50–54 mm in width and weighing 13–18 g (Capapé, 1976), while egg cases from the Languedocian coast were between 122–127 mm long with horns, 61–66 mm long without horns, 50 and 56 mm wide, and weighing between 19.5 and 22.5 g.

Of 10 egg cases placed in tanks from the INSTM, only two were hatched after 148 and 142 days, two females 75–76 mm DW and 7.9–8.0 g (Capapé, 1976). No egg case from the Languedocian coast was placed in tanks; the smallest free-swimming specimens recorded to date in the area, a male and a female, were both 110 mm DW and weighed 31 g. Clark (1922) noted that the incubation period in laboratory tanks was between 4 and 5.5 months; 23 embryos were hatched, with DW ranging from 65 to 85 mm (these data were in agreement with those recorded by Capapé (1976)). Further, Ellis & Schackley (1995) carried out studies in aquarium on *R. clavata* from the Bristol Channel. They noted that the incubation period lasted less than 7 weeks, and that total mean length, disc width and mass of newly hatched specimens were 118, 75 mm and 8.9 g, respectively.

***Raja miraletus* Linnaeus, 1758**
brown ray (En), raie miroir (Fr), kerchella (Tn)

The brown ray is commonly captured throughout the coast of Tunisia from the Algerian to the Libyan borders (Capapé & Quignard, 1974; Bradaï *et al.*, 2004). Males and females from the Gulf of Tunis were sexually mature when over 220 mm and 240 mm DW, respectively, while the largest male and the largest female were 320 mm and 330 mm DW, respectively (Capapé & Quignard, 1974). *R. miraletus* was reported off the Languedocian coast by researchers from Doumet (1860) to Quignard (1965). Euzet (1959) and Quignard (1965) recorded some specimens only and considered the occurrence of the species very rare in the area. Capapé *et al.* (2006b) noted that no specimen was recorded in the area since Quignard (1965). In contrast, Capapé *et al.* (2007b) noted that *R. miraletus* is commonly landed at fishing sites along the Senegalese coast. Adult males and females are mostly captured in spring and summer. The smallest sexually mature male and female were 270 mm

and 310 mm DW, respectively. The largest male and the largest female adults were 380 mm and 415 mm DW, respectively. They were the largest *R. miraletus* reported to date for both males and females.

Egg cases of Tunisian brown rays were 84–88 mm in length with horns, 42–47 mm in length without horns, 27–32 mm in width, and weighing 4.9–6.0 g. Egg cases of Senegalese brown rays were 88–97 mm in length with horns, 48–52 mm without horns, their widths were 28–32 mm, and they weighed 8.7–9.9 g. Several eggs were placed in tanks from the INSTM of Salammbô, and 14 were hatched. Temperature varied between 14 and 24.5 °C. The incubation period lasted for 123–135 days. Seven females and 7 males were hatched, measuring between 60 and 64 mm DW and weighing 3.9–4.2 g (Capapé & Quignard, 1974).

***Raja polystigma* Regan, 1923**
speckled ray (En), raie tachetée (Fr), kerchella (Tn)

The speckled ray is abundantly caught off the northern coast of Tunisia from the Algerian border to the Gulf of Tunis, southward the species is occasionally captured (Capapé & Quignard, 1978). Males and females were sexually mature when over 340 mm and 400 mm DW, respectively, while the largest male and the largest female were 450 and 470 mm DW, respectively (Capapé & Quignard, 1978). Off the Languedocian coast, *R. polystigma* was only reported by Quignard (1965), however, no specimen was available for confirmation. The specimen described by Capapé *et al.* (2006c) confirmed the occurrence of the species in the area.

Egg cases of Tunisian *R. polystigma* were 103–110 mm in length with horns, 45–48 mm in length without horns, 34–37 mm in width, and weighing 9.4g (Capapé & Quignard, 1978). Twelve egg cases were placed in tanks of the INSTM of Salammbô, and they were all hatched. Moreover, the smallest Tunisian specimen observed was 110 mm in disc width and weighing 22 g.

***Raja radula* Delaroche, 1809**
rough ray (En), raie râpe (Fr), kerchella (Tn)

The rough ray is commonly caught off the Tunisian coast from the Algerian to the Libyan borders and entered brackish waters (Capapé, 1974; Capapé *et al.*, 2004; Mejri *et al.*, 2004). Males and females were sexually mature when over 320 mm and 340 mm DW, respectively, while the largest male and the largest female were 400 and 420 mm DW, respectively (Capapé, 1974). *Raja radula* has never been recorded off the Languedocian coast.

Egg cases of Tunisian *R. radula* were 100–120 mm in length with horns, 51–57 mm in length without horns, 34–37 mm in width, and weighing 9.6–10.5 g (Capapé, 1974). Several eggs were placed in tanks from the INSTM of Salammbô, and 11 were hatched. Temperature varied between 14 and 24 °C. The incubation period lasted for 134–148 days. Six females and 5 males were hatched, measuring between 61 and 66 mm DW and weighing 6.0–6.3 g (Capapé, 1974). The smallest free-swimming Tunisian rough rays were found in a brackish area, the Tunis Southern Lagoon, by Mejri *et al.* (2004). These were two females 120 mm and 135 mm DW, respectively, weighing 14 g and 15 g, respectively.

DISCUSSION

Observations conducted over a period of three decades in two Mediterranean areas show that information on the size at hatching of elasmobranch oviparous species was very rare and concerned only experimental observations. Observations from other Mediterranean areas and outside the Mediterranean were also very rare; inter- and intraspecific comparison remain difficult to assess.

Size at hatching is related to size of egg cases in elasmobranch oviparous species. A good instance was given by observation in the smallspotted catshark. Egg cases from the Atlantic specimens of *Scyliorhinus canicula* found in British waters were larger than those from the Mediterranean (off both Tunisian and Languedocian coasts); consequently, newly hatched specimens were larger in the first area than in the second, matured at a larger size and reached larger maximal size (Capapé *et al.*, 1991; Ellis & Schackley, 1997) and are in agreement with Leloup & Olivereau's findings (1951). Similar patterns were observed in *Galeus melastomus* and *Scyliorhinus stellaris*. In contrast, egg cases, size at hatching, size at sexual maturity and maximal size were practically the same for rough rays from British waters (Clark, 1922, 1926; Steven, 1936; Holden *et al.* 1971, Holden, 1975) and for specimens from both Tunisian and Languedocian coasts (Capapé, 1976; Capapé *et al.*, 2007a). However, *Raja clavata* from the Adriatic Sea were smaller (Jardas, 1973), due probably to the fact that temperature and salinity are higher in the latter area (Dulčić & Grbec, 2000). These intraspecific changes suggest that larger specimens probably give larger egg cases, which consequently provide larger specimens (see Mellinger *et al.*, 1984).

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VELIKOST OSMIH JAJCERODNIH VRST MORSKIH PSOV IN SKATOV, IZVALJENIH V DVEH SREDOZEMSKIH OBMOČJIH: PREGLED IN NOVEJŠI PODATKI

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POVZETEK

Avtorji članka poročajo o velikosti osmih jajcerodnih morskih psov in skatov, izvaljenih v dveh sredozemskih območjih: v bližini tunizijske (srednje Sredozemlje) in laguedoške obale (južna Francija, severno Sredozemlje). Večino opažanj so zabeležili v eksperimentalnih okoliščinah, in sicer na jajcih v rezervoarjih. Pri preučevanih vrstah ni bila opažena nobena intraspecifična variacija med primerki iz obeh območij. Po drugi strani pa so bile novorojene navadne morske mačke iz Sredozemlja videti manjše kot atlantske.

Ključne besede: Elasmobranchii, velikost ob izvalitvi, jajcerodne vrste, tunizijska obala, languedoška obala, Sredozemlje

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